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Performance of Wastewater Treatment Plants (BASP and SWTP) In Kathmandu Valley: Case Study of Bagmati Area Sewerage Treatment Plant (BASP) and Sunga Wastewater Treatment Plant (SWTP).

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Master of Science Thesis
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The findings, interpretations and conclusions expressed in this study do neither necessarily reflect the views of the UNESCO-IHE Institute for Water Education, nor of the individual members of the MSc committee, nor of their respective employers.

Abstract

Kathmandu valley faces numerous environmental problems due to the rapid urban growth and unplanned settlement. The rapid and haphazard urban growth is exerting immense pressure on urban environment and municipal mangers often do not have sufficient expertise and resources to deal with the rapid growth. In this context, urban sanitation has become a major challenge for municipalities and small towns in Nepal

The majority of urban areas do not have access to sewerage networks except for three cities in the Kathmandu Valley. Most of the domestic as well as industrial wastewater generated from these cities is discharged into the local rivers without any treatment. Out of the total urban population only 76 % have access to toilets while the remaining use opens spaces, riverbanks for defecation. More than 60% of urban wastewater is directly deposited in tributaries in the Bagmati River in the Kathmandu Valley. This is one of the most pressing problems of Kathmandu. Existing wastewater treatment systems are becoming antiquated while urban growth has rapidly increased the number of people requiring new services. In most cases, sewer and sewage treatment systems are lacking or not functioning, or operating at far below the capacity and standards required for municipalities. In addition, many towns in the country are unable to operate schemes in a financially viable manner while providing the quality of service necessary to satisfy customers' expectations.

The main objective of this study is to evaluate the performance in terms of operation and maintenance, financial viability, environmental quality and regulations from the concerned authorities of the two separate wastewater treatment plants, Bagmati Area Sewerage Treatment Plant (BASP) and Sunga Wastewater Treatment Plant (SWTP) in the Kathmandu valley.

The performance of the two wastewater treatment plants is studied, focusing on four main indicators. In-order to find the present scenario and problems about the wastewater treatment systems, the study was carried out by literature reviewed, interviews with 24 key informants, 54 numbers of households and 19 of the industries in BASP area, and 5 of households in Sunga community.

Two different systems has been observed, one is the conventional centralize wastewater treatment plant and the other a community based wastewater treatment plant (reed bed). The performance of the cluster or community based wastewater treatment plants seems rather better although the coverage area is minimal. The study recommended some preventive measure of the problems and recommendation for the further study about the problem of wastewater treatment plants in Kathmandu valley.

Keywords:
Sewerage Treatment System, Operation and Maintenance Financial Viable, Quality, Conventional wastewater treatment plant, Community based wastewater treatment plant.

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ADB	Asian Development Bank
BASP	Bagmati Area Sewerage Project
BOD	Biological Oxygen Demand
CBS	Central Bureau of Statistics (Government of Nepal)
COD	Chemical Oxygen Demand
CW	Constructed Wetland
DDC	District Development Comittee
DWSS	Department of Water Supply and Sewerage
ENPHO	Environment and Public Health Organization
HMG	His Majesty's Government (of Nepal)
IA	Implementing Agency
JICA	Japanese International Cooperation Agency
KMC	Kathmandu Metropolitan City
MCWSW	Ministry of Child, Women and Social Welfare
MDG	Millennium Development Goal
MLD	Ministry of Local Development
MOES	Ministry of Education and Sport
MoEST	Ministry of Environment, Science, Technology
MOF	Ministry of Finance
MOH	Ministry of Health
MOPE	Ministry of Population and Environment
MPPW	Ministry of Physical Planning and Works
NBSM	Nepal Bureau of Standard and Metrology
NGO	Non government organisation
NPC	National Planning Commission
NWSC	Nepal Water Supply Cooperation
OD	Oxidisation Ditch
PDA	Pilot and Demonstration Activities
STP	Secondary Treatment Plant
SWTP	Sunga Wastewater Treatment Plant
TSS	Total Suspended Solid
USAID	United States Agency for International Aid
VDC	Village Development Committee
WSPs	Wetland Stabilization Pond
WUSC	Water Users and Sanitation Committee
WWTP	Wastewater Treatment Plant
RBTS	Reed Bed Treatment Systems

1 Introduction

1.1 Background

Rapid urbanization and haphazard settlements in many cities of developing countries is creating increasing pressure on the natural resources and the environment. In Nepal too, the unregulated growth in the urban and the peri-urban areas (4.71% in Kathmandu valley and average 2.25 % annual population growth rate is leading to serve problems like shortage of drinking water, inadequate and inappropriate sanitation facilities causing pollution of water bodies) (CBS,2007). Even when a lot has been achieved in the water supply sector in the country since 1973, sanitation sector has not seen much improvement with mere 25% coverage in the country with 53% in the urban and 21% in the rural areas (Anoymous, 2003, Shrestha, 2003).
In Nepal almost all the sanitation improvement works and its evaluation are done on the basis of the WHO definition. According to this definition, improved sanitation is the access to a public sewer, connection to a septic system, a pour flush latrine, a simple or a ventilated improved pit latrine (Rosemarin, 2004). However, thought is not given to the type, design and impact of the facility on public health and environment. Therefore, even when there is an increase in the sanitation coverage, there is no reduction in the incidence of water related mortality and morbidity.
Sanitation systems in the Kathmandu valley are based on a combination of onsite and offsite system. Most of the houses in the urban areas of the Kathmandu Valley have cistern-flush or pour flush type toilets connected predominately to the sewerage system or open drains (NSASC, 2000). Most of the river has turned into a sewer and is becoming more and more polluted every day. We all know that this is mainly due to untreated sewer that we discharge everyday from our homes and industries. In the absence of an appropriate and sufficient wastewater treatment system, disposal of wastewater is done unsystematically with potential health risk and environment pollution.

1.2 Wastewater treatment status in Kathmandu valley

Rivers in the Kathmandu valley have abundant natural flow during the wet season (from June through September), which can effectively dilute untreated wastewater discharged into the rivers. In contrast, the flow drastically decreases during the dry season. Since the wastewater is constantly discharged throughout the year, the rivers turn into open sewer channels during the dry season. Major wastewater management infrastructure in the Kathmandu valley consists of treatment plants, pump stations, collector mains and interceptors.
Although there are seven (public and community based) wastewater treatment plants in Kathmandu valley, among them three are not operational, two are partially operating and the remaining two are in fully operational condition. (Shrestha, 1999) (Table 1.1)

Table 1.1 Present Situation of Wastewater Treatment Plant in Kathmandu Valley

Wastewater treatment plant and location	Date of operation	Capacity	Type of treatment plant	Current Status
Hanumanghat, Bhaktapur	1975	0.5 MLD *	Stabilization Pond	Not operational
Sallaghari,Bhaktapur	1983	2.0 MLD	Aerated pond	Not operational
Kodku,Lalitpur	1981	1.1 MLD	Stabilization pond	Partially Operational
Dhobighat,Lalitpur	1981	15.4 MLD	Stabilization pond	Not operational
Teku Septage Treatment Plant,Kathamndu	1999	40 m3/day	Reed Bed type	Partially Operational
Bagmati Area Sewerage Treatment Plant, Kathmandu	2002	17.3 MLD	Oxidation Ditch type	Fully Operational
Sunga Wastewater Treatment Plant,Thimi	2005	50 m3/day	Reed Bed type	Fully Operational

*MLD: Million Litters Per day
Source: (Shrestha, 1999) and (Metcalf and CEMAT, 2000), Field Survey, (2007)
Apart from the Teku Septage Treatment Plant (TSTP), Bagmati Area Sewerage Treatment Plant (BASP) and Sunga Waste Water Treatment Plant (SWTP), all the other plants are under the control of the Nepal Water Supply Corporation (NWSC).
The TSTP is under the control of KMC whereas an independent authority (Government of Nepal, High Powered Committee for Implementation & Monitoring) manages the BASP. SWTP is the only community based wastewater treatment plant which is controlled by the Sungatole Community.
Apart from the WWTP under NWSC, BASP and SWTP, there are many private initiatives taken at the institutional level to treat wastewater. One of them is the growing use of Constructed Wetland (CW) Systems, which is being promoted by Environment and Public Health Organization (ENPHO). There are already 11 CWs operating in different parts of Nepal among them 9 CWs lie inside the Kathmandu valley. The treatment capacity are ranges from 0.5 m^3/day in private household and 75 m^3/day in landfill leached in the pokhara district septage treatment (Shrestha, 2004a).

The largest wastewater treatment plant (Dhobighat Waste Stabilization Pond) built for the treatment of wastewater from Kathmandu and Patan did not operate even for a year due to failure of a wastewater lifting pump. All of the treatment systems failed due to the lack of proper operation and maintenance although this type of treatment technology is supposed to be the simplest method of wastewater treatment (ENPHOW, 2003). Within the last decade, 14 studies have been conducted and several plans and programmes have been prepared on wastewater management in Kathmandu (Annex A13). Among them, the Bagmati Area Development conceptual Master Plan, 1997/98 is said to be the "Present Master Plan". The plan proposes 14 conventional wastewater treatment plants (WWTP) of oxidation ditch type wastewater treatment plants is needed at different locations of the Kathmandu valley. Construction of the Bagmati Area Sewerage Construction /Rehabilitation Project (BASP) is a part of the present master plan. However, the master plan and other pervious studies were again reviewed in 1998/99 by Asian Development Bank (ADB) to incorporate the wastewater management plan in Kathmandu valley water supply reform process and recommended a new approach to

improving wastewater management in Kathmandu valley in a phased approach. This includes short-term "low cost/high impact" programs as well as infrastructure rehabilitation and construction (ADB, 2000). It has proposed only 5 conventional WWTP instead of the 14 that proposed in the original master plan.

1.3 General Historic Background of Sewerage Systems and WWTPs

The oldest sewer in the core area of Kathmandu, Latitpur Thimi and Bhaktapur were Built during Malla period (18th century) for conveyance of surface drainage and domestic sewerage. The outfalls were located at open fields and were used for irrigation purposes. The drains were made of rectangular section (ICIMOD, 2005).

The sewerage systems of the core area were further developed during 1898-1950 by Rana dynasty. The sewer mains were made of brick of circular section varying from 600mm dia and 1500mmx1050mm rectangular sections. All the lateral sewers constructed before 1960 were mainly for storm water drainage and flush toilets were not introduced in the valley until 1960. The project undertaken during (1976-83) second (1980-85) and third (1980-88) 30 km sanitary sewer were laid and partially operated and not operated two WWTP were constructed at Balkumari (Kodku) and Sundarighat (Dhobighat).

Most of the wastewaters facilities in Kathmandu are under the control of Nepal Water supply Corporation (NWSC). The NWSC facilities include approximately 5 Kms of interceptor sewer in the Kathmandu and Lalitpur areas (CBS, 2005). The status is in poor condition with portions broken and no ongoing maintenance programs (Metcalf and CEMAT, 2000b).

It is very difficult to say that what the conditions of the sewerage networks are in the Kathmandu valley because,

- In the core area of the municipalities there are undocumented sewers which were constructed many years ago.
- Sewers which were constructed by the municipalities and local ward offices are not constructed in coordination with NWSC Sewerage Division and hence are unaccounted.
- Similarly there are many illegal connections.
- There is a lack of trained personnel in the Sewerage Division to compile records.

1.4 Problem Statement

Over the last several hundred years, humans have begun living in higher and higher densities, leading to high volumes of sewage output in small geographic areas. This high density of sewage has led to the need to treat the wastewater we produce in order to protect human and ecosystem health (Foster and Magdoff, 1998). An assortment of technologies including septic systems in rural areas and sewage treatment plants in urban ones has been developed to deal with this problem.

Due to lack of proper planning, poor management, rapid population growth, urbanization, industrialization, poor sewerage system network, wastewater disposal without primary treatments are the current problems in the sector of wastewater treatment plant in the Kathmandu valley.

Although various stakeholders like High Powered Committee (BASP), NWSC, KMC, Donor agencies, NGOs, community and private parties are working in the sector of wastewater treatment plants, still there is challenging problems in the field of WWTP in Kathmandu valley.

Two different wastewater treatment technology, one is the conventional and another constructed wetlands are executing in the Kathmandu valley but both of these systems are facing problems in the sectors of financial burden for operation and maintenance, lack of skill knowledgeable human resources, lack of regulations and unable to meet the standard quality limits of the wastewater treatment plants. (CBS, 2005)

For Kathmandu Valley, which I chose as a case study for my research, some previous studies have been completed to address the problems of wastewater treatment plant and have recommended constructing and renovating the wastewater treatment in the valley. But their results are still not realistic and needed further work. My study will provide guidance about how to proceed.

1.5 Rational of the study

In light the prevailing condition of the wastewater treatment plant condition in Kathmandu valley it is observed that much effort is needed to improve the performance of the existing wastewater treatment plant. Past experience has shown the operation of three wastewater treatment plants have been stopped which were operated by NWSC. One of the Kodku wastewater treatment plants which are waste stabilization pond operating by NWSC is partially operating. The performance study of the treatment plant was done in 2004 by Pradip Kumar.From his study he concluded that wastewater stabilization ponds are suitable for industrial sector, semi urban and urban area but it should be at least 500 m away from the settlement. But Kodku is surrounded by the urbanized area and the stabilization pond has never been cleaned duringe its operation time so more than half of the depth is filled by accumulated sludge in the primary pond and NWSC is not seriously thinking of operation and maintenance of the existing treatment plant (Pradip, 2004).

Taku wastewater treatment plant (TWTP) is operated by KMC but it is only used for septage treatment. So the interest of my research will focus on the remaining two wastewater treatment plants BASP and SWTP which are fully operating by different sectors and utalize different systems. A fascinating contrast between the two is that BASP is the first biggest conventional type of waste water treatment plant in Kathmandu valley whereas SWTP is the first community operated waste water treatment plant in Nepal (Shrestha, 2003) and (Metcalf and CEMAT, 2000), (ENPHO, 2005).

According to the concern agencies, BASP and ENPHO, no study and research have been conducted in the past to assess the wastewater treatment plant management in Kathmandu valley current situation and outlook of the individual projects. This study has been carried out to explore the existing practices and problems on wastewater treatment plants in Kathmandu valley. The outcome of the study is expected to help to plan for the improvement from the present situation of wastewater treatment plant in Kathmandu Valley.

1.6 Overall Objective

To find the performance in terms of operation and maintenance, financial viability, environmental quality and regulations from the concern authorities of the two separate wastewater treatment plants in the Kathmandu valley.

1.6.1 Specific Objectives

- To find current operation and maintenance practices of BASP and SWTP independently.
- To find the existing role and responsibility of the government sector in the field of wastewater treatment plant particularly in BASP and SWTP.
- To analyze the economic aspects of the different key players in both wastewater treatment plant.
- To find the environmental quality of the both wastewater treatment plants.

1.6.2 Major Research Questions

Between BASP and SWTP, which treatment plant is the most suitable in terms of finances, operation, environmental quality and regulation by the concerned authorities in the highly urbanize Kathmandu valley?

1.6.3 Sub Research Questions

- What is effective management of the operation and maintenance system of two different waste water treatment plants the Kathmandu Valley?
- What is the role of governmental institutions, outsourcing parties, non-governmental organizations and other stakeholders in the development of wastewater treatment plant?
- What are the financial bases of the existing wastewater treatment plants in Kathmandu Valley?
- What is the environmental quality output performance of the two separate wastewater treatment plants?

1.6.4 Scope and Limitation

The scope of the study, which lasted from October 2007 until, April 2008 was to assess the overall state of art practices and problems on wastewater treatment plant in Kathmandu Valley concerning two different wastewater treatment plants. Due the time limitation there is not micro study of all technical design parameters and all laboratory reports of both wastewater treatment plants. The main focuses of my thesis are operation and maintenence, finance, quality and regulation mechanism of the individual wastewater treatment plant. Some of the limitations about the wastewater treatment plants are follows

- The present status of wastewater treatment plants seems to be not satisfactory.
- Very difficult to find relevant data
- No computerized system of data keeping
- Political strike and irregularity of concerned staff makes it very difficult to get appointment for interview.
- Only a small-scale survey was conducted at household level and some industries and community to understand the current practices and problems on different aspects related to wastewater treatment plant.

1.6.5 Organization of Thesis

The report consists of seven chapters, which is briefly summarized as follows:

- Chapter 2: Rules Legislation and Stakeholder Participation, this chapter described the rules and legislation about sanitation and wastewater treatment plants,Water resource strategies and various types of stakeholders participants in the wastewater treatment sectors.

- Chapter 3: Literature Review, the content of the literature review follows of objectives. This starts from the concept of wastewater and its treatment, current situation of wastewater treatment plants, wastewater treatment plant selection, sanitation in urban areas, different between conventional and constructed wetland treatment plants and some previous studies about the wastewater treatment plants in Kathmandu valley.

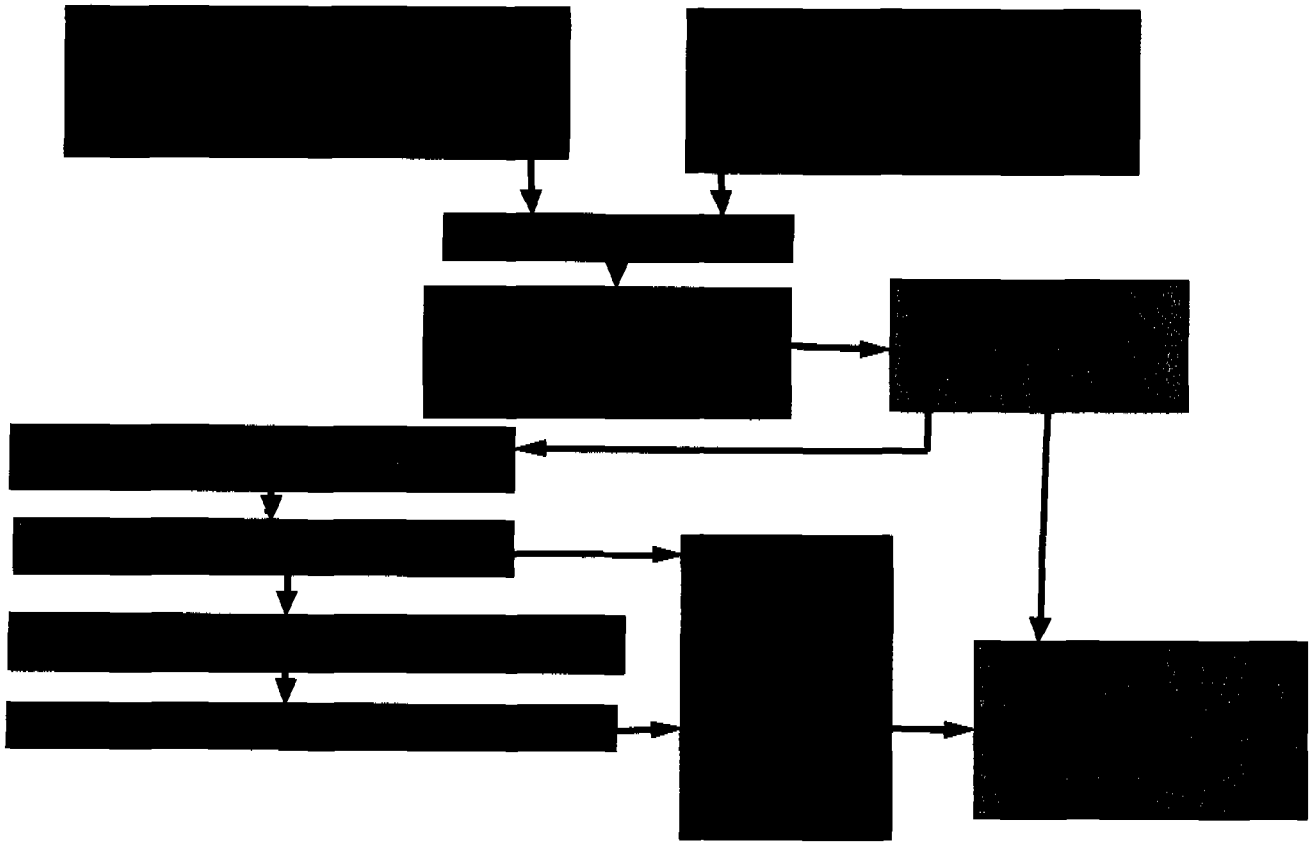
- Chapter 4: Methodology, this chapter provides study related background information like study areas and location map. This chapter also summarizes the procedures undertaken to carryout the study. The household survey, survey in industries and interview with key informants are the main sources of the primary data collections the four indicators operation and maintenance, financial, quality and rules and regulations are the main indicators for analyzing the research questions of the thesis.

- Chapter 5: Case Study: This chapter briefly describes about the two individual wastewater treatment plants BASP and SWTP separately.

- Chapter 6: Results and Discussion, This chapter explains about results focusing on the objective of the research. The four indicators are taking separately in deferent section as follows and find out put from the discussions. In this Chapter, section 6.1.1 to 6.1.5 described about the government rules and regulation related about focusing wastewater treatment plants and result and discussion similarly section 6.2 described about operation and maintenance, section 6.3 about the financial indicators and 6.4 to 6.7 about the quality of the two individual wastewater treatment plants. The section of this chapter 6.8 explains about the management satifaction and section 6.9 provides management problems in BASP since establishment.

- Chapter 7 is the Findings,Conclusions and Recommendations

1.6.6 Conceptual Framework of the Study



Figuer1.1 Conceptual Framework of the Study

2 Rules, Legislation and Stakeholder Participation

2.1 Environmental Protection Act (EPA), 1997

The Ministry of Environment, Science, Technology (MoEST) enforced an "Environmental Protection Act and Environment Protection Rules (EPR)" in 1997. The Ministry, which was established in 1995, is the responsible authority for environmental protection in the country. The EPA and EPR under section 7 address the issue of prevention and control of pollution where it states that "nobody shall create pollution in such a manner as to cause significant adverse impacts on the environment of likely to be hazardous to public life and people's health, of dispose or cause to be disposed sound, heat, radioactive rays and wastes from any mechanical devices, industrial enterprises, or other places contrary to the prescribed standards" (HMG-MOPE, 1997).

The Act does not specify the different categories of waste but it prohibits disposal of any type of waste having adverse impacts on the environment and public health. Therefore haphazard disposal of any type of waste into water bodies or public places would be an offence. So as following the act the industrial waste and even domestic waste can not be disposed of into the environment without proper pre-treatment. Under the EPA and EPR (1997) there is a provision of imposing a maximum penalty of about 1500 US $ to anyone who disobeys the Acts and Rules.

Similarly, MOEST and Nepal Bureau of Standard and Metrology (NBSM), has also formulated two types of standards for wastewater effluent control into inland surface water viz.Generic Standards and Specific Industrial Effluent Standards. The generic standard set a tolerance limit value for all types of industrial effluent discharges and also effluents from wastewater treatment plants (Annex A1,A2) whereas specific industrial effluent standards have been formulated for 9 different types of specific industries. However there have been no any standard limits sets for wastewater discharged from households.

2.2 The Building Code

The Ministry of Physical Planning and Works (MPPW) is the responsible government institution for physical planning and urban development in the country. The development of urban Development and Building Construction (DUDBO) under the MPPW execute different activities related to urban development. Under the Ministry a National Building Code has been developed which provides building regulations for all the municipalities and urban settlements in the country (DUBC, 2005). KMC has formulated its own by laws for urban planning which complements to the National building code. The urban planning ordinance of KMC is also known as the Kathmandu Urban Planning and Building Ordinance. The ordinance which was prepared under Town Development ACT, 1988 and the Local Self Governance ACT, 1999 aims to assist in achieving an orderly and environmentally sustainable development of Kathmandu City.

The Building Regulations (KMC, 2001), which is a part of the ordinance, indicates that each type of construction should be in compliance with the building regulations and in principle, requires a building permit before any type of construction is undertaken. As part of the building requirements sanitary provision is a prerequisite under which the following previsions are indicated.

- It is mandatory that the industrial as well as domestic wastewater should be disposed in septic tanks and soak pits before disposing to the public sewerage.
- The septic tanks and other onsite wastewater disposal structures should be designed in accordance to the standards laid down by the competent sewerage authority.

It is clear that anyone failing to meet the requirements in building regulations will not receive the building permit. This implies that construction of septic tanks is mandatory for all buildings inside the Kathmandu municipality unless it has access to the public sewerage system. Other municipality in Kathmandu valley like Thimi Municipality has not been following the mandate. However, all other municipalities in principle are supposed to follow the National Building Code, which provides a similar directive.

As per the Kathmandu Urban Planning and Building Ordinance of KMC an applicant has to undergo the following steps to obtain a building permit;

- An application is made requesting KMC to issue a Building Permit. The application should be supported by the necessary documents such as proof of ownerships of land, tax clearance, certified copy of cadastral map, detail drawing of the building to be constructed.
- KMC verifies the application and the details submitted .As per the ordinance the building permit is issued based on inspection of works by KMC.It is mentioned that no subsequent stage shall commence before previous stage have been inspected and approved by KMC
- Upon request by the applicant, KMC shall issue a Completion Certificate only after its inspectors have inspected all works after their completion and have found these to be executed in full conformity with conditions of the Building Permit.

2.3 Local Self Governance Act, 1999

As part of the central governments efforts to strengthen decentralised governance in Nepal the Local Self –Governance Act 1999 and associated rules of 2000 was introduced in Nepal. The Act specifies that the local bodies such as Village Development Committees (VDCs), Municipalities, District Development Committees (DDCs) are expected to provide all essential services related to water supply and sanitation to the public. The local bodies are given a mandate to run these services (HMG-MLD,1999).The five municipalities located in the Kathmandu Valley have already taken up the responsibility to manage solid waste and water and wastewater management in respective areas.

2.4 National Sanitation Policies (2002)

The government of Nepal has given high priority to Water and Sanitation Sector over last few decades in order to improve the living condition of people across the country. However, more efforts in terms of resources allocation was put on water supply sector and wastewater management and sanitation were given less emphasis on previous plans and programs. By the end of 9th year of the five year plan, almost about 70% of total population has access to piped water supply and less than one fourth of population has access to basic sanitation facilities. In case of urban areas, almost about 72%, and 53 % population have access to basic water supply and sanitation facilities respectively (Pyakuryal, 2004). Considering the need of appropriate sanitation, HMGN has adopted Sanitation Policy 1998 and revised in 2002. The main provisions in the sanitation policies are:

- Sanitation is an everyday part of human life and is basic right and responsibilities of every citizen to be treated as an essential services
- Partnership between communities, users groups, private parties, NGOs, educational institutions, local authorities will constitute the framework for effective sanitation facilities and services.
- Nepal government will promote the provision of sanitation facilities/services together with increased participation from private sectors, local authorities, social/cultural groups and other related sectors.
- Ensure commitment at all levels
- Ensure effective advocacy/communication/health and hygiene education strategies
- Ensure participatory approach for problem identification /analysis, promotion, implementation, monitoring and evaluation of sanitation program.
- Encourage and facilitate local action plan
- Ensure gender balance and sensitivity
- Integrate sanitation in all community based development programs
- Progressively upgrade sanitation service levels through acceptable and affordable sanitation technologies.

  Wastewater Related Policies Reflected in Sectoral and Other Documents:

  National Water Supply Sector Policy (1999)

- Install sewerage or onsite sanitation systems in urban and peri-urban areas as appropriate
- Make sanitation program as an integral part of water supply programs

  Kathmandu Valley Water Supply and Sanitation (2001)

- Increase the number and upgrade the capacity of existing treatment plant and upgrade the capacity of existing plants, lying and extension of interceptors, collectors main and collector laterals in phased manner.
- On site system and treatment plants employing natural treatment technology in peri –urban areas.

2.5 Nepal Water Resource Strategy

Nepal government 's water resources strategy states that provision of adequate potable water is not enough itself to ensure better health conditions. There should be widespread education regarding hygiene and appropriate sanitation facilities as well. The strategy adopts the following targets as presented in Table 2.1

Table 2.1 Water and Sanitation Targets

Year	Assess to Safe Water Supply (% population)		Provision of Safe Sanitation (% population)
	Basic Services	Good Services	
2007	85	40	60
2012	100	60	80
2017	100	85	100
2027	100	100	100

Source: *WECS, (2002)

*Water and Energy Commission Secretariat

The strategy document further states that the investment is needed for urban sewerage and wastewater treatment are as great as or even greater than those of urban water supply. The current level of services being offered in sanitation is either very poor or non existent, as the existing system can not deal with volume of sewage and wastewater that is being generated. Similar condition is in storm water drainage and wastewater treatment facilities. According to the strategy, before the necessary infrastructures and management systems are in place, a mechanism for a full cost recovery of O & M has to be implemented. One way of achieving this is to include such mechanism as water tariffs, as is presently being done in Kathmandu.

The national policy has a 20 years vision on sanitation and it aims to achieve 100% coverage in hardware sector and in the rural areas, apart from sewerage with treatment facilities and disposal facilities in the town till 2017 (Anonymous,2003).

As per the policy, the sanitation package includes a total of nine components. Among the different components effective and efficient solid and liquid waste collection, treatment and disposal are also mentioned in the policy. To bring about improvement in the sanitation situation, the policy supports the role of community and NGOS in the development efforts. The sanitation policy adopts different strategies where institutional arrangement and strengthening of public private partnership is also one of them.

The estimated amount for urban sewerage and wastewater treatment as indicated in strategy document is at least NRs 50 billion (of which significant share would be targeted for Kathmandu valley). Full coverage cannot be achieved unless a large amount of funding is secured on a continuous basis.

2.6 Nepal Water Plan

Nepal Water Plan prepared by Water and Energy Commission Secretariat (WECS) has made the provision of short-term, medium-term and Long –term plan for sewerage and wastewater treatment.

Short Term Plan The short term plan states that the improvement in wastewater system of Kathmandu Valley will be achieved by adopting low cost appropriate technology options like septic tank, oxidation ponds, reed beds and rehabilitation of existing sewerage treatment works.

The scope of work under this package includes:

- Rehabilitation of four treatment plants
- Rehabilitation /construction of interceptors
- Construction of public toilets
- Construction of demonstration industrial wastewater pre-treatment plant
- Provision of sewer cleaning equipment

Medium and long Term Plan

Under the medium and long term plan, the scope of works includes:

- Construct new treatment plant and upgrade the existing plants with appropriate sludge disposal and handling systems
- Provide new interceptors along the main water courses.
- Rehabilitate, expand and upgrade the collector mains, lateral and sub-laterals
- River training works and Bagmati /Bishnumati aesthetic works
- Private operators to be given responsibilities for managing and operating the new and renovate systems as they are commissioned.

2.7 Potential Stakeholders in Sanitation

2.7.1 Introduction

Although the main stakeholders are consumer himself and the different municipalities and related VDCs, there are a number of institutions and organizations that could be a potential stakeholder for sanitation in the Kathmandu Valley based on their role, responsibilities or future roles. A brief description of these roles has been presented as follows.

2.7.2 Ministry of Local Development (MLD) and Local Bodies

The local bodies refer to the institutions such as the District Development Committees (DDC), Village Development Committees (VDC), Municipalities and Wards. These institutions come under the Ministry of Local Development (MLD). Kathmandu valley comprises of 3 districts and with in these districts there are 5 municipalities' viz. Kathamndu, Bhakatapur, Lalitpur, Thimi and Kirtipur and around 114 VDCs. Each municipality and VDCs is again subdivided into wards. As per the local self governance Act (1999) the individual municipalities are responsible to provide necessary water and sanitation facilities in their respective areas. They are also responsible for environmental protection and pollution control.

2.7.3 The Ministry of Physical Planning and Works (MPPW)

The MPPW was created in 1988 and is responsible to formulate proper policies and action plans for the overall development, expansion and promotion of water and sanitation sector throughout the Kingdom of Nepal, and monitor and supervise implementation decisions. It is also responsible for urban development and planning. The MPPW is the responsible department to look after the urban

planning sector. Similarly under the MPPW, the NWSC and the DWSS are line agencies for management of water supply and sanitation facilities in the urban and rural parts of the country (MPPW, 2005).

2.7.4 Nepal Water Supply Corporation (NWSC)

The Nepal Water Supply Corporation (NWSC) was formed in 1989 under the NWSC Act, 1989 and is under the MPPW. It is responsible for providing water supply and sewerage services to the 5 municipalities in the Kathmandu Valley and additional 23 larger municipalities in Nepal. The Sewerage Department of the NWSC is the responsible department for sewerage management in the Kathmandu Valley. It is responsible for construction of new sewer lines and for operation and maintenance of the existing ones. The NWSC is also responsible for management of wastewater treatment plants located in the Kathmandu valley (NWSC, 2005). NWSC at present collects water supply and sewerage fee from its customers who are connected to its water supply network.

2.7.5 Department of Water Supply and Sewerage (DWSS)

The DWSS established in 1972, under the MPPW is the lead agency for water supply and sanitation (WSS), particularly for the rural parts of the country. It has five regional offices in all developmental regions and district chapters in all 75 districts of the country. The department is responsible for implementation of water and sanitation projects in all areas except the 28 municipalities, which are taken care by the NWSC. The policy of the DWSS is to hand over the completed projects on water supply and sanitation to the local users groups, local bodies such as the municipalities, VDCs or to the NWSC for its operation and maintenance. Similarly, it is responsible for sector planning, coordination, technical standards, management of design and construction activities for water supply and sanitation (WSS) facilities, coordination of health and hygiene education and construction of sanitation facilities (DWSS, 2005). DWSS has different technical sections to carry out central level activities related to WSS such as the environmental sanitation, sewerage management, appropriate technology development section, etc.

2.7.6 Melamchi Water Supply Project (MWSP)

The Melamchi Water Supply Project is a muti-faceted water supply project, which aims to improve the service and deliver water in the Kathmandu Valley. The MWSP is by far the largest water supply project in the country (NGOFUWS, 2005).

As part of the infrastructure development on wastewater management the project plans to rehabilitate existing sewer networks and wastewater treatment plants. Around 4% of the total budget is allocated for wastewater system improvement (NGOFUWS, 2005).

2.7.7 The Ministry of Population and Environment (MOPE)

MOPE was established in the year 1995 as per HMG rules. The Ministry is not directly related to water supply and sanitation. However, in relation to the environment some of the primary functions of the Ministry are as follows (MOPE, 2005):

- Environmental Conservation
- Pollution Control
- Environmental Standards Enforcement and Monitoring

- Environmental Impact Assessment
- Formulate national policy and plans on aspects of environmental conservation
- Identify pollution indicators and indices to set standards

2.7.8 The Non Government Organizations (NGOs) and Environmental Groups

The different NGOs and environmental groups working in the water, sanitation and environmental sector can also be considered as stakeholders of sanitation management in the Kathmandu valley. Currently some NGOs like ENPHO are associated with promotion of stabilization ponds for wastewater treatment system or reed bed type constructed wetlands. Similarly, Lumanti is associated with improvement of water and sanitation facilities in the slum and squatter communities of the valley. Besides, some of the active environmental groups and civil societies such as NGO Forum for Urban Water and Sanitation (NGOFUWS), Pro-Public, Nepal Forum of Environmental Journalist (NEFEJ), Coalition for Clean Environment (CCE) are active groups lobbying for citizens rights and environmental conservation in the Kathmandu valley as well as in the nation.

2.7.9 Donors and funding agencies

The donors and funding agencies is also an important stakeholder in the field of WSS. There are many donor agencies such as Water Aid Nepal, World Bank, ADB, FINIDA, and JICA, etc. supporting programs in the water and sanitation sector in the country.

3 Literature Review

3.1 Wastewater and its treatment

Wastewater is the bi-product of human activity which is unavoidable. It is the liquid, which is mainly the water supply of the community after it has been fouled by variety of uses. Wastewater may be defined as a combination of the liquid or water-carrying pollutants wasted from residences, institutions, commercial and industrial establishments. Domestic or sanitary wastewater refers to liquid discharge from residences business buildings and institutions. The aim of wastewater treatment is to removal of suspended solids (SS), Organic matters (BOD_5), Organic Nitrogen, Ammonia, Phosphorus, Trace elements and Trace organic (MJ Martinez et al., 1999).

In developing countries, like Nepal, the majority of the water pollution problems are created by direct disposal of untreated wastewater into the water bodies. More emphasis is usually given to develop infrastructure, most of the pollution problems remains unaddressed. It is on the same footing that almost all municipalities in Nepal do not have proper wastewater treatment plant and disposal facilities. As a result, the main river of Kathmandu valley, Bagamti, is receiving about 60 MLD of untreated domestic wastewater (Shrestha, 2003).

Most of the rivers in Nepal, and particular the river in Bagmati basin are polluted and degraded in a broad sense with the lose of cultural and religious value as well as reduced environmental quality and changed physical dimensions. The average Biological Oxygen Demand (BOD) and the amount of ammonia and nitrite in the downstream of BASP at Teku are very high. Seventy percent of the river flow below the Teku is untreated sewerage effluent in the dry season and thus is highly polluted (Stanley, 1994).

The estimated eighty percent return flows of domestic consumption in the Kathmandu valley mean BOD of 280 mg/l are discharged into watercourses without any treatment. The watercourses can only take BOD load of 30-80 mg/l .This shows that there is massive organic pollution of the watercourses. It has become virtually impossible for aquatic life to exist in water bodies of Kathmandu valley unless new measures are introduced to treat municipal waste and industrial effluents before they are disposed into the river.

3.1.1 System of wastewater treatment

These systems may be classified into three principal types, as shown in Figure 3.1. Mechanical treatment systems, which use natural processes within a constructed environment, tend to be used when suitable lands are unavailable for the implementation of natural system technologies. Aquatic systems are represented by lagoons; facultative, aerated, and hydrograph controlled release (HCR) lagoons are variations of this technology. Further, the lagoon-based treatment systems can be supplemented by additional pre-or post-treatments using constructed wetlands, aqua cultural production systems, and/or sand filtration. They are used to treat a variety of wastewaters and function under a wide range of weather conditions. Terrestrial systems make use of the nutrients contained in wastewaters; plant growth and soil adsorption convert biologically available nutrients

into less-available forms of biomass, which is then harvested for a variety of uses including methane gas production, alcohol production, or cattle feed supplements.

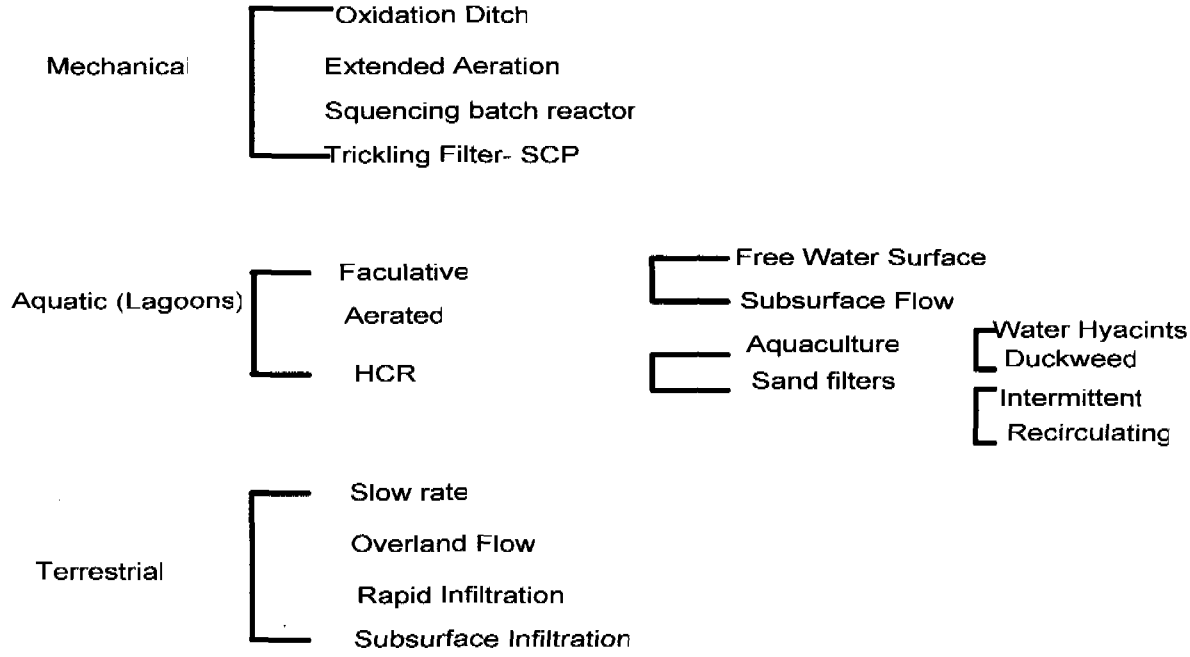


Figure 3.1 Summary of Wastewater Treatment Technologies

Source: Perez, (1993)

Mechanical Treatment Technologies

Mechanical systems utilize a combination of physical, biological, and chemical processes to achieve the treatment objectives. Using essentially natural processes within an artificial environment, mechanical treatment technologies use a series of tanks, along with pumps, blowers, screens, grinders, and other mechanical components, to treat wastewaters. Flow of wastewater in the system is controlled by various types of instrumentation. Sequencing batch reactors (SBR), oxidation ditches, and extended aeration systems are all variations of the activated-sludge process, which is a suspended-growth system. The trickling filter solids contact process (TF-SCP), in contrast, is an attached-growth system. These treatment systems are effective where land is at a premium.

Operation and Maintenance

Operation and maintenance requirements vary depending on the particular technology used. In mechanical activated-sludge plants, maintenance requirements consist of periodically activating the sludge pumps, inspecting the system to ensure that are no blockages or leakages in the system, and checking BOD and suspended solids concentrations in the plant effluent to ensure efficient operation.

Cost

Construction costs and operation and maintenance costs for wastewater treatment systems with a capacity of 0.1 to 1 million gallons per day are summarized in Figures and. most of the cost data come from systems implemented in the United States. Similar systems in Latin America might be less expensive, in some cases, owing to lower labor costs and price differentials in construction materials. Nevertheless, the relative cost comparison among technologies is likely to be applicable to all countries

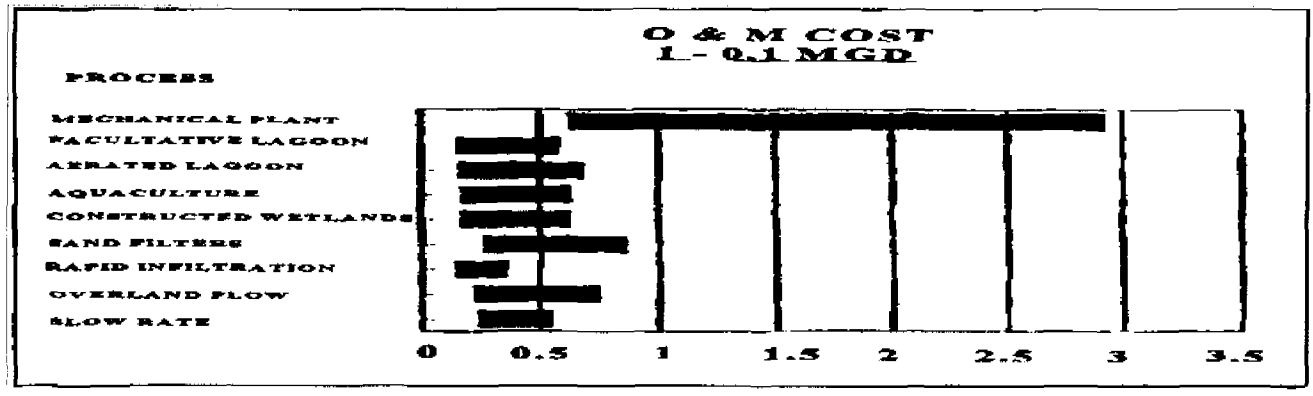


Figure 3 2 O & M Cost for Different Process

Source: Pérez, (1993)

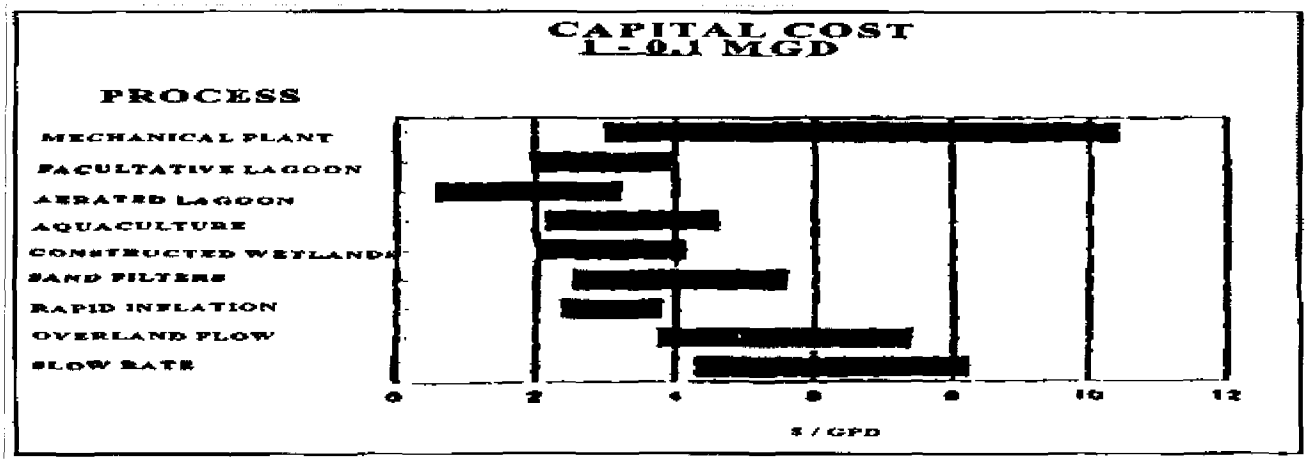


Figure 3.3 Capital Cost for Different Process

Source: Pérez, (1993)

Figure 3.2 compares the operating and maintenance costs (labor, energy, chemicals, and materials such as replacement equipment and parts) of the various systems of 0.1 to 1 mgd treatment capacity.

All costs were obtained from the USEPA Innovative and Alternative Technology Assessment Manual. They have been indexed to the USEPA Operation, Maintenance, and Repair Index of Direct Costs for the first quarter of 1993. All costs are presented in dollars per million gallons of wastewater treated. The cost for mechanical systems is significantly larger than for any of the other systems, particularly at smaller flows. The cost of harvesting plants from aquaculture systems is not included; this could be a significant amount for some systems.

Figure 3.3 compares the capital cost of the wastewater treatment processes. The cost data are also from the Innovative and Alternative Technology Assessment Manual, with the exception of wetland and aquaculture data, which were obtained from more recent sources. All natural systems are assumed to have a facultative lagoon as the primary treatment unit. The cost of chlorination/disinfection is included for all systems except the slow rate and rapid infiltration systems. The cost of land is excluded in all cases, as is the cost of liners for the aquatic treatment systems. The mechanical treatment plant cost was derived as the cost of an oxidation ditch treatment system, and includes the cost of a clarifier, oxidation ditch, pumps, building, laboratory, and sludge drying beds. These costs also include the cost of engineering and construction management, in addition to the costs for piping, electrical systems, instrumentation, and site preparation. All costs are in March 1993 in terms of US dollars.

3.2 Wastewater Management in Urban Areas

3.2.1 Domestic wastewater

Sixty-seven percent of urban households though have toilet facilities; only 34 percent of them are connected with closed drainage and 8 percent to the open drainage (ENPHO, 2004). Septic tanks and other pits are also used in urban household where there is not any drainage system. It covers about 10 percent. The septage from septic tanks or pits gets removed normally once a year then dumped into the nearby river or stream.

Separate drainage systems for storm water and wastewater are not practiced yet in Nepal. People are free to connect their wastewater into the drainage that ultimately drains into the rivers or streams without any treatment. Almost all municipalities in Nepal have lack of wastewater treatment facilities, except three municipalities in Kathmandu valley. Though some treatment plants exist in the valley none of them is functioning well and one has already been closed down.

3.2.2 Industrial wastewater

More than 90 % of the wastewater generated within the municipalities' area is domestic in origin except some industrial zones. Although Nepal is only in the early stages of industrialization, the pace of industrial development is increasing and pollution resulting from industrial discharges has been observed and documented (NPC/IUCN, 1991a; NPC/IUCN, 1991b). Fifty-seven out of hundred twenty-five surveyed industries were found to be polluting surface water significantly. The study also identified three geographic hot spot zones as Bagmati, Koshi and Narayani interms of pollution. It includes nine districts out of 75 districts in Nepal (NPC/IUCN, 1991b).

A detailed survey on 35 different pollution prone industries like carpet, pulp and paper, textile, oil and grease, tannery, iron and steel, soap, distillery, brewery, beverage and food processing was made by Industrial Pollution Control Management Project (Devkota, 1997), where none of them having

wastewater treatment plants. Primary treatment like sedimentation and aeration are reported only in two industries. Seventeen industries are discharging wastewater after sedimentation and 14 industries are discharging their wastewater without any treatment. The qualities of discharged wastewater from almost all industries are reported to be exceeded by HMG/NBSM, (1991) proposed standard. A detailed study had been conducted by NPC/IUCN in two industrial districts (Balaju Industrial Districts-BID and Hetauda Industrial District-HID) to control and recommend pollution control measures in 1991 and 1994. Several recommendations mainly on waste minimization and waste treatment technologies were proposed, but none of them has been implemented yet (NPC/IUCN, 1992 and 1994). BID and HID are discharge 600 m^3/d and 1800 m^3/d of wastewater respectively into the nearby stream. The wastewater contains the effluent from textile, leather, soap and chemical, paints, diary and brewery. Discharge of such a wastewater into river/stream has severe ecological impacts on the river and its surroundings, and poses a public health risk to the people who use the river water for various purposes (NPC, 1994). Effluent qualities of some of the carpet industries are shown in Table 6.16.

3.3 Wastewater treatment plant selection in Kathmandu valley

Shrestha, (2003) indicates that the implementation of wastewater management plan is often not easy as they require high investments costs and more importantly a system of good governance for the operation and management of the plants is essential. He mentioned that there are already speculations on the sustainability of the existing BASP. The system consists of an advanced wastewater treatment plant of oxidation ditch type. The overall project cost of the plant was around 8.8 million dollars. BASP was designed for a population of about 200,000 (13% of the total population in Kathmandu valley) and with a treatment capacity 16.4 MLD per day. It is estimated that the system needs more than 15 million US $ as operation and maintenance costs annually. Shrestha mentions that since there is a lack of good governance, lack of appropriate policies and no concrete plans for financing the operation and maintenance costs of the plant, the future of this system is uncertain.

The choice of the treatment method depends on various factors, mainly the effluent standards, cost of plants, operation and maintenance cost, and land area required. Based on the above all factors the treatment method of activated sludge process using oxidation ditches or mechanically aerated pond system are found to be more appropriate for the Kathmandu valley. The stabilization pond method is not appropriate due to high and difficult in obtaining land in the valley (ITECO, 2003).

In most cases, sewer and sewage treatment systems are lacking not functioning, or operating at far below the capacity and standards required for municipalities. In addition, many towns of the country are unable to operate schemes in a financially viable manner while providing the quality of service necessary to satisfy customer's expectations (Timilsina, 2004).

The increasing trend of construction of sewers by municipal authorities without considering treatment facilities is posing serious threats to the environment. All industrial wastewater in most cases are directly discharged into local water bodies without any treatment. So far rivers and streams in the Kathmandu valley receive raw domestic sewage and untreated industrial waste.

The Hindu religious considers the Bagmati River to be the most sacred river in the world.However this sacred river has become polluted due to raw domestic and industrial sewerage disposal. About 25 years back the river water quality was satisfactory and people were used the water even for drinking

purposes directly. As well the Hanumante River is highly polluted by Thimi and Bkakatapur Municipality directly disposing raw domestic and industrial sewerage.

The poor water quality of the river has created numerous detrimental problems including ecological, environmental, health social economic aesthetic and religious. Previous studies have estimated that 60% of all the deaths in the valley are caused by diseases transmitted by human faecal through water media and many as a result of contamination due to sanitation, solidwaste problems. Lack of public awareness is also an issue, more than 80% population in Nepal are affected by water–borne diseases, such as cholera, dysentery, typhoid, hepatitis and jaundice (WSSC, 1984). The study report mentioned that existing sewerage collection, convey and disposal system in the valley is completely unsatisfactory.

Proper sewerage system and drainage facilities are absent in the river corridor. In the previous reports drainage master plans, efforts were made to develop the sewerage system, but the plan has not been implemented. Untreated raw sewerage from the household connection the Kathmandu and Lalitpur municipalities is directly disposed into the river and industrial effluent from different industries is also disposed directly to the river course without pre-treatment, eventhough every factory should treat the wastewater before disposal to the river according to environment policy rules, 1997.

In view of the alarming urban and industrial growth in the developing countries, especially in Nepal, the pollution level in the water, air and soil has increased substantially over the years. Considering the magnitude of investment needed in wastewater treatment, government and private sector have only been able to mobilize funds towards construction of treatment plant employing conventional methods in few large towns, metropolitan, sub-metropolitan areas and industrial complexes. Further, it seems unlikely that financial resources would be available in future also for construction of such plants in towns, village, smaller residential and industrial complexes. Constructed wetlands promise to serve as an ideal alternative technology, which is simpler, economical and environmental-friendly. The concept of this technology has been taken from the natural wetlands, which are as old as our earth (Dharmendra, 2005). Conventionally, physical, chemical and biological processes accomplish wastewater treatment. Typically, these processes are supported by natural components such as microbial organisms, but in a complex array of energy-intensive mechanical equipment. BASP is located at the bank of the Bagmati River on the north-eastern part of Kathmandu City. It is constructed at the initiative of the government to clean up the Bagmati River. The WWTP consist mainly of grit chamber for screening, aeration tank with activated sludge and a settling tank. The treatment plant site covers an area of 5 hectares. The plant treats the untreated wastewater generated by the household, industries and other institutions of Gokarna, Chabahil, Bouddha and Jorpati. It serves an estimated population of around 200000. The operation cost of the plant is around Nrs 10 million a year and is currently being funded by the government (detail follow in discussion chapter). The plant intends to implement the polluters pay principle and expected to be self sustaining after the three years of support from the government and DRF Japan. Since the initial period the plant has been facing many problems and the plan to implement polluters pay principle and become self-sustaining seems to be a distance dream. New rules and regulations that would encourage private investment and participation could be and must be a solution of the problem. Assessing the multidimensional activities going on in this region and population growth, there is strong possibility in this direction (Dharmendra, 2005).

Rapid population growth, increasing urbanization and industrial development in developing countries have resulted in deterioration in the quality of the environment. Pollution abatement strategies in developing countries should be consistent with the nature of the environment and appropriate for the

local conditions. The problem is all the more complex in these countries due to the high rate of illiteracy, which indirectly affects public attitude towards pollution abetments measures, and also due to funding limitations in the part of local agencies. Beneficial meteorological and socioeconomic conditions i.e. utilizing the tropical climate and cheap labour prevalent in these countries should be taken advantage of in planning waste treatment systems. For economic reasons, employing low cost treatment alternatives in sophisticated technologies utilizing imported equipment will be preferable (ENSIC, 1981).

Appropriate methods of wastewater treatment and disposal in developing countries are those which focus on low cost options. So far developing countries in many situations have directly adopted conventional or non–conventional methods of wastewater treatment as being used in the developed countries with little or no modification, with the result that in many such cases they have not been cost-effective or efficient in treatment. Technology transfer from developed to developing countries would be feasible if they are properly modified to suit local conditions. Generally speaking a treatment system that is simple –yet capable of satisfactory at a minimum cost-should be considered for the adoption (ENSIC, 1981).

In recent years, constructed wetland systems have emerged as an attractive wastewater treatment alternative because of using locally available materials. Among the natural treatment systems, constructed wetland appears to be an appropriate alternative that can be employed both in develop and developing countries. Constructed wetland treatment systems have been in operation in many of the European and American countries for more than two decades now, and significant advances have been made in the engineering knowledge of creating wetlands. There is a growing interest also in Nepal to develop and adopt the technology for water pollution control to suit the local condition.

Conventional treatment systems, contribute to I) depletion of non-renewable fossil fuel sources and II) environmental degradation that occur due to extraction of non-renewable resources, and also due to the by-products/final products of these technologies, such as bio solids and sludge. The natural treatment system utilizes none or very little mechanical equipment. The main treatment components of these systems are the reed bed plants (ENPHO, 2005).

3.3.1 Sanitation in urban poor area

South Asia is experiencing a major demographic transition. During the last fifty years, India's total population more than doubled: the urban population grew by more than five times. In 1996, the urban population in Bangladesh was 23 million. By 2020, it will increase to 58 million. The urban population in Nepal, during the same period, will grow from 2.6 million to 7.7 million, and in Sri Lanka it will double to more than 8 million.

The rapidly growing urbanization has led to the severe sanitation problems in the cities and villages of South Asia. Sanitation problems range from lack of access to hygienic toilets, safe sewerage facilities and clean pavements, solid waste management. Besides, new sanitation issues attracting attention of policy makers and programme implementers are child and girl friendly toilets especially in the schools, toilets for the disabled, promotion of environment friendly toilets, innovating cheapest toilets, gender and governance issues in sanitation. Sanitation related issues are particularly impacting poor communities and slums and squatter areas in the rural and urban parts of the country. For example, less than half the urban population in India has access to adequate toilet facilities, and sewage treatment is virtually nonexistent, creating one of India's most serious environmental problems that will have an impact on surface and ground water leading to contamination, ill health, impact on productivity, and loss of life.

The World Bank states Nepal as one of the least developed countries in the world. It has the per capita income of US $ 230 per annum that is below the World Bank extreme poverty line of US $ 275. The official estimation is that 86% the country's 23 million population is still rural in based and only 14% live in urban areas (Lumanti, 2007). However, there have been a large number of people migrating to the cities since the violent Maoist insurgency began in 1996.

The growth rate of urban population in Nepal is estimated as 5% which is a very high figure. The urbanization process is leading to a constantly growing demand for the city to provid land, infrastructure, shelter, and services. The city's inability to meet the demand has resulted in the growth of urban slums and squatter settlements. The problems in these communities are vivid. The major problems in the urban poor communities are inadequate basic facilities including water and sanitation, security of tenure, poor quality of dwellings, poor health and hygiene, lack of awareness, and social discrimination among other things.

A recent study conducted by Lumanti in urban poor communities in three cities showed that at least half the households do not have access to toilets. In Bharatpur municipality, 50.1% of the urban poor families do not own toilets. Similarly in Birgunj municipality, 56.5% and in Dharan municipality 48.5% of the urban poor families do not have access to toilets at all while in Bharatpur only 24.0% and Dharan municipality 38.9% of urban poor families have access to temporary toilets. (Lumanti, 2007) This reveals a situation where a lot need to be done to help the poor families' access safe sanitation in the urban areas

Although only about 15 percent of Nepal's population live in urban areas, the rate of urbanization is very high. It is estimated that by the year 2035, 50 percent of the total population will live in urban areas. The rapid and haphazard urban growth is exerting immense pressure on urban environment and municipal mangers often do not have sufficient expertise and resources to deal with the rapid growth. In this context, urban sanitation has become a major challenge for municipalities and small towns in Nepal.

Although data shows that about 80 percent of urban households have access to some kind of toilets, waste from these toilets are not well managed. Only 12 percent of urban households are connected to the sewer systems and even where sewer systems exist, wastewater treatment is almost non-existent. In the area of solid waste management, studies show that more than half the waste that is generated is not collected and almost all of the collected waste is disposed in a haphazard manner along riverbanks or in forest areas. Only 45 percent of urban residents are served by waste collection systems.

The government of Nepal has formulated several policies and strategies on water and sanitation, including the Rural Water Supply and Sanitation National Policy as well as the Rural Water Supply and Sanitation National Strategy, which were prepared in 2004. However, urban sanitation has not received adequate attention from Nepal's policy makers. No policies exist for wastewater management and although the government formulated National Solid Waste Management Policy in 1996, this has not been followed up with appropriate plans and programs (ENPHO, 2003).

However, some very good efforts have taken place in Pune, Karachi, Mumbai, Colombo and Kathmandu to address sanitation issues in urban poor communities. A Pune and Mumbai Slum Sanitation Project, initiated by SPARC and implemented with the support of the local government and the communities on a contract basis, has successfully provided easy access to toilet facilities in a large number of slums. Maintenance of the community toilets have always been an issue. But these community managed toilets have been found well maintained and kept clean. This initiation has

brought change in the concept of 'toilet for the poor'. In addition, the toilets were constructed in the slums irrespective of land tenure (ENPHO, 2004).

3.4 Constructed Wetlands with Hybrid System

The horizontal flow constructed wetnalnds system has been well accepted as the approved way to remove BOD_5 and TSS for secondary wastewater treatment but not for nitrification due to the limited oxygen transfer capacity. As a result there has been a growing interest over the past 10 years in the vertical flow system because they have a much greater oxygen transfer capacity and considerably less area requirement than HF. But VF systems also have some limitation like less efficient in solids removal and can become clogged if the media selection is not correct (Cooper, 1996; Vymazal et al., 1998). Due to this reason, there has been a growing interest in combined system (Hybrid system) since the past five years (Cooper, 1998). In these systems the advantages and disadvantages of the HF and VF can be combined to complement each other. The VF beds have a very high nitrification capacity whereas the HF beds have very efficient denitrification even at low cleaning ratios. The combined system thus can produce an effluent low in BOD_5, fully nitrified and partly denitrified.

Design and Type of Combined System

There are basically two types of combined systems depending upon whether the HF or VF stage is placed at the front of the system Cooper and Maeseneer, (1996).

Horizontal Flow Bed followed by Vertical Flow Bed:

It is described by Johansen and Brix (1996) and later built by Ciupa, (1995 and 1996).

The schematic diagram of this system is as (Figure 3.2).

The system has large horizontal flow stages followed by a vertical flow stage at the end of the process sequence. The idea behind this system is that the BOD is removed in the HF bed to prevent interference with nitrification in the VF bed. If nitrate removal is needed it is then necessary to pump the effluent back to the front end of the system where denitrification can take place in the less aerobic horizontal flow bed using the raw feed as a source of carbon needed for denitrification (Cooper et al.,1996).

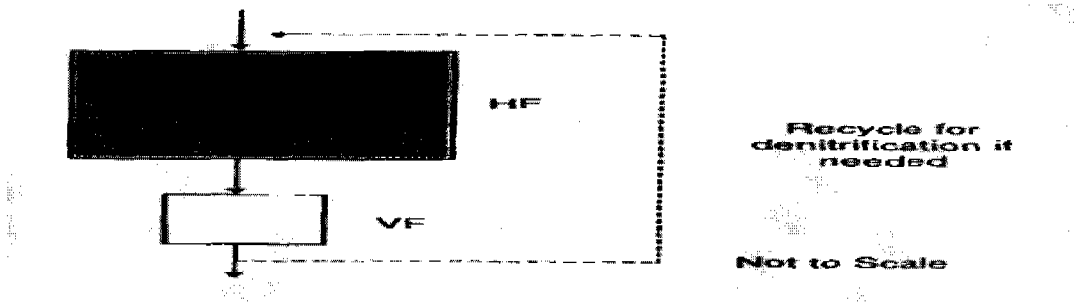


Figure 3.4 Hybrid system with a HF-stage followed by VF-Stage

The design recommends limiting the loading rate to the equivalent of a maximum oxygen transfer rate of 30 g O2/m2.d for VF beds and 15 g O2/m2.d for HF beds (Johansen and Brix, 1996; Birkedal, Brix and Johansen, 1993).

3.4.1 Wetlands Wastewater Treatment System

Wetlands have received wastewater discharge in numerous situations in the past but only recently have they been recognized as potentially cost–effective treatment system. Studies over the last few years have shown that both natural and constructed wetlands systems can provide high quality wastewater treatment at relatively low cost .The growing interest in wetland systems is in part due to recognition that natural treatment systems offer advantages over conventional concrete-and steel, equipment-intensive mechanical treatment plants. When the same biological and physical processes occur in a more natural environment instead of reactor tanks as basins, often resulting system consumes less energy, is more reliable, require less operation and maintenance –and as a result, cost less (Hammer, 1988).

Constructed wetland may provide a relatively simple and inexpensive solution for controlling many waste pollution problems without detrimentally affecting our natural wetlands resources. Although all of processes are not well understood, constructed wetlands are capable of moderating, removing or transforming a varity of waste pollutants while also providing wildlife and recreational benefits commonly associated with natural wetland systems (Gersberg et al.,1986).

3.4.2 Pollutant Removal Mechanism in Constructed Wetlands

Several physical, chemical and biological processes participate in the transformation of pollutants within the wetland. The major physical process is the settling and filtration of suspended particulate matter. The reduction in the particulate organic matter is a major cause of reduction in BOD of wastewater. The chemical processes include adsorption, cation exchange and precipitation which are responsible for the major removal of phosphorous and heavy metals. Among the biological processes, the most important are those mediated by the micro-organisms, and include the oxidation or reduction of carbon, nitrogen and sulphur depending upon the availability of oxygen. Generally, the reduction reactions dominate the system in the presence of high organic matter in the effluents, and most of nitrogen is lost through denitrification (Gale et al., 1993).

The transformation of nutrients in a wetland depends upon large number of variables which include the hydrological regime, nutrient concentrations in the influent, nutrients already present in the system, the kind of vegetation (annual or perennial, submerged or emergent), sediments (mineral or organic), and other biota (Mitsch and Gosselink, 1993). High runoff and low retention period may scour the sediments and release the nutrients and organic matter into the open water. In general, a system already saturated with nutrients has low potential to process the additional load (Gopal, 1998).

4 Methodology

4.1 Study Area

Kathmandu Valley

The estimated population of Nepal is now 26 million living in an area of about 147,181 Km^2. Eighty-eight percent of the total population are living in rural areas. Despite being rich in water resources, only 31 percent of rural population and 58 percent of urban population are served with piped water supply (CBS, 2005). However, many cities' water supply systems provide water for only a few hours each day (ADB, 1985). Therefore, per capita water consumption is low (less than 100 liter/day) in urban centres. Regarding sanitation facilities, only 22 percent of households use sanitary toilets. Covered drainage facilities are available only in parts of the urban areas and cater to 34 percents of the households in such areas (UNDP, 1998).

The study area is located within the Kathmandu valley, one of the most densely populated intermountain basins in the Himalayas (Fig 4.1 and Fig 4.2). The oval-shaped Kathmandu valley extends for about 30 km in the east–west and 25 km in the north–south directions. It occupies an area of about 650 sq km and ranges in altitude from 1220 to 1500 m.

Kathmandu Valley has five of the 58 municipalities in the country and is home to about 30% of the total urban population. The city of Kathmandu is by far the largest city in the country, with more than 20% of the total urban population.

The rapid urbanization in Kathmandu is elongating municipal boundaries and converting open spaces and agricultural fields into concrete jungles. Between 1984 and 2000, agricultural land in the valley decreased from 62 to 42%. If this trend continues, by 2025 there will be no agricultural fields left in this once fertile valley (CBS, 2001).

The Kathmandu Valley is urbanizing rapidly. Failure to manage and control this trend has led to an urban crisis and an increasing number of people living in sub-standard conditions. The valley is characterized by high population growth and household density, narrow roads, poor sanitation, congestion, unchecked migrations and increasing number of slum, squatter and renter communities, degradation of the environment and inadequate infrastructure services and basic amenities. The provision of basic urban infrastructure services viz. drinking water, road access, sewerage, electricity housing, household waste services etc, is far less than the rate of population and urban growth.

The sanitation situation in the Kathmandu valley is quite different as compared to most parts of Nepal. Kathmandu valley has the highest access to toilet facilities as compared to rest of the country. The district development profile shows that population with access to toilet facilities in Kathmandu, Bhakatapur and Lalitpur is 93%, 91% and 81% respectively (Gautam et al., 2004).

The study carried out by Nippon Koei (1999) in the five municipalities of Kathmandu valley shows that sewerage system is the main from of excreta disposal for the majority of population. The study shows that 74% of the population directly discharges wastewater from toilets into the drain, 21% use septic tanks and 45 use pit latrine. Open defecation in open land, riverside accounts to 1%. Similarly, and a survey carried out by NGO Forum during December 2003 in the five municipalities of

Kathamndu valley, shows that among 300 households sampled 292 households responded. Among the responses received 74% of the households' drained night soil into the sewer drains, 9% of the households drained their night soil into the municipal drain through septic tanks and 15% used only septic tank to discharge night soil (Joshi et al., 2003).

From these studies it is observed that the trend of discharging night soil directly into municipal drain has remained the same over the years. Similarly the percentage of population using septic tanks has also remained more or less the same, which is between 21% to 24% .Meanwhile the urban population of the Kathamdnu valley has been increasing rapidly .However, the means to address the wastewater management system has not improved and thus the situation is chaos.

Figure 4.1 Map of Nepal

Source: Nepal Atlas, (2001)

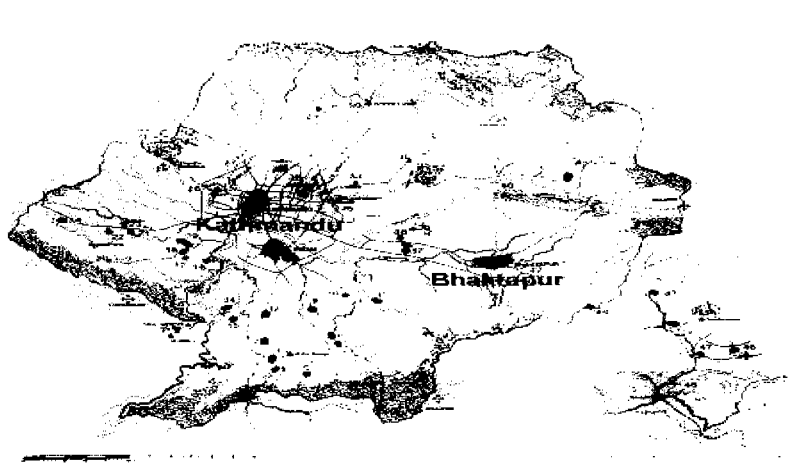


Figure 4.2 Map of Kathmandu Valley

Source: Nepal Atlas, (2001)

Lack of proper sanitation and drainage in urban and rural areas has resulted in dumping of sewage and garbage into the rivers. In most cases, the drainage system, which was designed for storm water only, is being used as a sewer; and the sewage directly flows into the river without any treatment.

Water in the Kathmandu valley is derived from two sources: surface water (rivers and ponds) and groundwater. They are basically fed with rainfall. Rivers are important running surface water in terms of water volume and potential development. Over time, requirements for water for drinking and personal hygiene, agriculture, religious activities, industrial production, and recreational activities, such as swimming and fishing, have increased in the valley. The Kathmandu valley hosts more than 72% of the country's water-polluting industries.

Most of the buildings in Kathmandu valley are vulnerable to even moderate earthquakes, and loss of life in earthquakes can often be attributed to inadequate buildings. More than 4,000 buildings are constructed every year by builders or owners, most without any knowledge of engineering (UNDP, 2007)

4.2 Research Framework

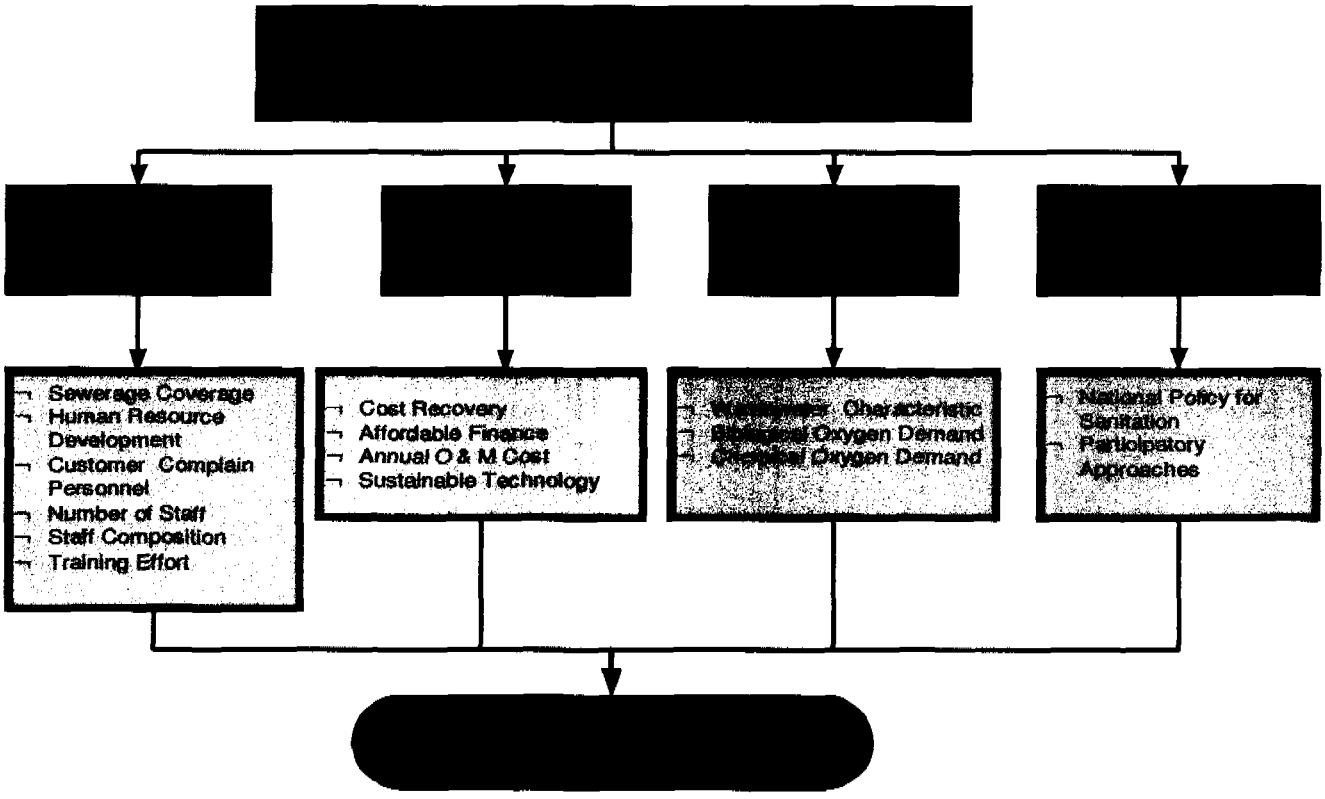


Figure 4.3 Framework of Research Methodology

BOX 4.1 Description of Indicators

I. Operation and Maintenance

Operation and Maintenance generally focus on coverage area from the system, Human Research Development, Customer complaints about the system, how many staffs are required for the treatment system and to know the capacity building training requirements for staff members.

II. Financial Indicator

After studying about income and expenditure of the system, it is easy to find out about the cost recovery from the treatment plant, affordable finance, annual operation and maintenance cost also provide insight about the financial sustainability of the adopted technology.

III. Quality of output

This indicator relates to quality of the output of the system which is directly related to the management sector of the system. In my assumption if the management is strong then quality of the output should be under the standard limit. Basically BOD and COD will be considered in the both types of wastewater systems to be studied.

IV.Rules and Regulation

This Indicator is a supprotive indicator which will inform about the national policy in wastewater treatment plants, what type of stakeholders are working in the systems and who is monitoring and what is lack for achieving good performance.

The above performance indicators Operation and Maintenance, Financial, Quality of Output and Rules and Regulation are applicable for answering the research question of my thesis.

Table 4.1 Data Matrix

Research Objective	Research Question	Where is the Information	How to get the Information
To find current operation and maintenance practices of BASP and SWTP independently.	What is effective management of the operation and maintenance system of two different wastewater treatment plants the Kathmandu Valley?	Official records(BASP and SWTP),NWSC,WHO documents, NPC	Literature review of previous studies about wastewater management in Kathmandu valley, semi-structure interview with key informants, focus group discussion and field observation
To find the existing role and responsibility of the government sector in the field of wastewater treatment plant particularly in BASP and SWTP.	What is the potential role of the governmental institutions, outsourcing parties, non-governmental organizations and other stakeholders in the development of wastewater treatment plant?	NWSC, MPPW, BASP, ENPHO, ADB,KMC ,legislation documents, consumer survey	Interview with key-informants, consumer survey, data from the central audit office, CBS data, previous research data, interview with management committee of BASP and SWTP.
To analyze the economic aspects of the different key players in both wastewater treatment plant.	What are the financial bases of the existing wastewater treatment plants in Kathmandu valley?	Consumer survey, annual revenue and annual cost, fees and taxes, operation expenditure	Annual budget report, semi-structure interview with key informants, industrial, community, household survey, and audit report, NPC documents
To find the environmental quality of the both wastewater treatment plants	What is the environmental quality output performance of the two separate wastewater treatment plants	Lab reports, previous performance evaluations thesis reports.	Laboratory data analysis, interview with key informants and interview with lab technicians in the project areas.

4.3 Emperical materials for answer the research questions

4.3.1 Literature and documents review

Literature, reports, publication and papers relating to management practice of both types of wastewater treatment plants were reviewed. Most of the literatures are based on management practices of wastewater treatment plant in developing countries. Summaries of fourteen different feasibility studies related to wastewater treatment plant in Kathmandu valley were reviewed(Annex A 13) which provides more ideas about the current need of wastewater treatment plants in Kathamndu valley. Similarly many relevant reports, documents, journals, articles; legal documents related to wastewater treatment plant were reviewed to find the answer of research questions.

Summary of the procedure
Chapter 5 section 5.1 illustrates the brief introduction of BASP and in Section 5.2 brief explanation about the SWTP.

I have done field surveyed in both areas and have contacted with 24 persons key informants list in *Annex A. 12*

Table 4.2 Number of Respondents

Number of respondents are listed as follows:

Domestic Household in Ward 6 ,7 and Jorpati VDC **	54
Industry (Small scale and carpet industry)	19
Community (Sunga Tole) ***	5
Key Informants	24
Total	**102**

** Household ---Household of BASP area only
*** Community---Household of SWTP are only

4.3.2 Consultation with Staffs Member of BASP and SWTP

Detail interviews with different staff members, community members and conducted discussion and meeting about the concerned wastewater treatment plant. Questions asked of key informants include: What is the institutional arrangement of the plant? What about the operation and maintenance of the system? What are the selection criteria of new staff members? What about the capacity building of the staff members? How much money is expending on the treatment plant? Where does the money come from? What about the revenue from the treatment plant? What is the performance output in terms of quality? Are you satisfied with the current management set up? Who is responsible for regulation and monitoring of the system? The answers to these questions provided key insight to help to find the answer of my research questions.

4.3.3 Consultation with institutions working in the water and sanitation sector

Government Institutions involved in the sanitation sector such as Nepal Water Supply Corporation (NWSC), Department of Drinking Water and Sewerage (DWSS), Ministry of Physical Planning and Works (MPPW), Ministry of Environment, Nepal Bureau and Standard Metrology (NBSM) and related consultant were consulted to collect information about the wastewater treatment plant in Kathmandu valley.

4.3.4 Household survey in wastewater treatment plant dominant areas

A total of 54 household were surveyed from the areas where high load of wastewater is mixing in the common sewer line of BASP. The sampled survey areas were carried out in Chabahil, Boudha and Jorpati. Similarly 19 Industries were selected randomly in the project areas of the BASP and 5 member of the Sunga Wastewater Treatment Committee in Thimi Municipality (Annex A3).The

surveys were carried out with the help of questionnaire (Annex A11). In which I asked invididuals how much they pay for wastewater treatment? Do they know about the industrial rules for waste water disposal? Do they have constructed pre-treatment plant in their boundary before disposing to common sewerage? Who is monitoring and testing the quality of the industrial effluents. How often have they visited the industrial area? Are they satisfied with the service of BASP? If not then what do they have to do to improving their performance? Do they know about the treatment system of wastewater? What is their responsibility for reducing quantity of the wastewater? What are they expecting from the concerned authorities? The answer of these questions supports the conclusions of my research questions. Collection of expert's opinions, knowledge of experts working in the field of water and sanitation were collected through personal meetings, communication and mass meetings. The list of consulted key informants during the study is in (Annex A12).

5 Case Study

5.1 Bagmati Area Sewerage Construction /Rehabilitation Project (BASP)

5.1.1 Introduction

The Bagmati River is the largest river in the capital city of Kathmandu valley which comprises fifty seven rivers and rivulets as its tributaries. It originated from Bagdwar, flow from the middle of Kathmandu valley dividing into two parts and crosses the valley at Chovar. There are many shrines and cemeteries located on its bank. Gokarneshowar, Guheshwari and Pashupatinath temples are famous shines enlisted in the World Heritage list which reflects its importance to all the races of human civilization. The Hindus and Buddhists, for whom the river water has special religious and spiritual values, consider the water of Bagmati as a holy water"JAL".

Although being a part of cultural and religious heritage, the activities of dumping of raw solid wastes and discharging of untreated liquid wastes in Bagmati river has made an assault on its sanctity. In order to curb further environmental degradation of the Bagmati River and adjoining area as well as to restore the condition of once pristine Bagmati River, the government formed a High Powered committee for implementation and monitoring of the Bagamti Area Sewerage Construction/Rehabilitation Project (BASP) in 1995 A.D. The project has developed the system laying the trunk main sewers and 16.4 million litres per day (MLD) wastewater treatment capacity. The problem of treating sewerage to the regulatory standards does not end with the construction of treatment plants. Effective operation and maintenance of the units developed is equally important to achieve the desired results in meeting regulatory standards as well as protection of the environment.

This project has been recently launched to improve the Bagmati River at the Pashupatinath area. Pashupatinath is one of the most important holy temples for Hindus from all over the world. It is lying just on the bank of river Bagmati located about 5 km north east from the city core area. The river at this site is more respected and regarding as spiritual water. Most of the religious people sprinkle this water on their body for the purpose of purification. Bagmati River was not much polluted up to this sector till 1989-90 (Disvi, 1988 and Shrestha, 1990). The river quality in this sector deteriorated significantly after establishment of huge number of carpet industries nearby this area. It is now becoming a big national/international issues and raising lot of public pressure to clean river in Pashupatinath area. Therefore government has initiated Bagmati Area Sewerage Construction and Rehabilitation Project. The main objective of this project was to build a sewerage treatment plant to treat all wastewater mixing into the river up to Pashupatinath area. An oxidation ditch has been selected as a treatment system for this plant. The first phase construction of sewer lines and all treatment systems were completed.

The project covers 537 hectares of residential, commercial, and industrial area with two phases working plan. The project has the capacity to treat of 190 l/s and 300 l/s in the first phase and second phase respectively. Major components of project are 6 kilometre (km) trunk main sewers, 10km secondary sewers, 572 meters length tunnel, roads and green belts with river training works with sewerage treatment plant (STP) (BASP Report,2002). This is clear from the salient feature of the BASP in Table 5.1.

Table 5.1 Salient Feature of Bagamti Area Sewerage Treatment Plant

Project Name:	**Bagmati Area Sewerage Project**
Location:	Geheshowari, Kathamndu Valley
Coverage Area:	Upper Bagmati Basin
	(Gokarna,Boudha,Jorpati,Chabahil,Gaurighat)
Operation By:	High Power Committee (Nepal Government)
Type:	Centralize Concept
Land used:	2.03 Hectares
Service Area:	537 Hectares
Design Period:	25 years
Present Population (1996)	58158
Design Year Population (2021)	198000
Sewer line	17 Kilometres
Wastewater Production	80 lpcd
Industrial Waste	14 l/s
Wastewater Treatment Plant	Extended Aeration Type
Sewer Tunnel	572 Meters (horseshoe shape)
Year of Construction	1996
Year of Operation	2002
Waste Characteristic	Combine Wastewater(Industrial, domestic, storm water)
Earthen Road:	11.5 Kilometres
Green Belt:	11.5 Kilometres
Capacity of Treatment Plant/day	16.4 MLD
Design Flow	
First phase	190 l/s
Second Phase	300 l/s
First Phase(Peak Factor)	1.7
Second Phase(Peak Factor)	1.5
Influent BOD (av.)	270 mg/l
Influent COD (av.)	1150 mg/l
Suspended Solid (av.)	216 mg/l
Effluent Suspended Solids	100 mg/l
Effluent BOD5	25 mg/l
Effluent COD	250 mg/l

Source: BASP, (2007).

5.1.2 Objective of the BASP

The main objective of the high powered committee is to keep Bagmati River and its tributaries clean by preventing the direct discharge of solid and liquid wastes to the river and to conserve the river system with in Kathmandu valley.

In order to achieve its objectives the committee has set of its mandatory as follows

- Construction of trunk sewer pipeline along both the banks of river
- Construction of secondary sewer pipelines.

- Construction of a wastewater treatment plant
- Construction of river training works
- Construction of roads and green belts along the banks of the river and
- Establishing a public awareness programme.

The working plans of the project are follows,

In the initial phase of its activities, the committee had prepared a master plan. As the Bagmati received heavy pollution down stream of the Gokarneshwor and of course referring to the cultural, religious and environmental importance of the river flowing through the area of world heritage, the committee has decided to start the task from Gokarna to Tilganga as a first phase. The cleaning of Bagmati River from Gokarna to Tilganga has been taken as the first part of the project. It has installed interceptor drains along the Bagmati "corridor" to check direct discharge of untreated sewerage into the Bagmati and treatment of sewerage prior to its disposal in the river. These trunk sewers are connected to the sewerage treatment plant at Guheswori.

The treated wastewater is then discharged into the 572 meter long tunnel which bypasses the holy shrines but joins the same Bagmati River at down stream of Aryaghat.

5.1.3 Major Components of the STP

The major components of the sewage treatment plant are:

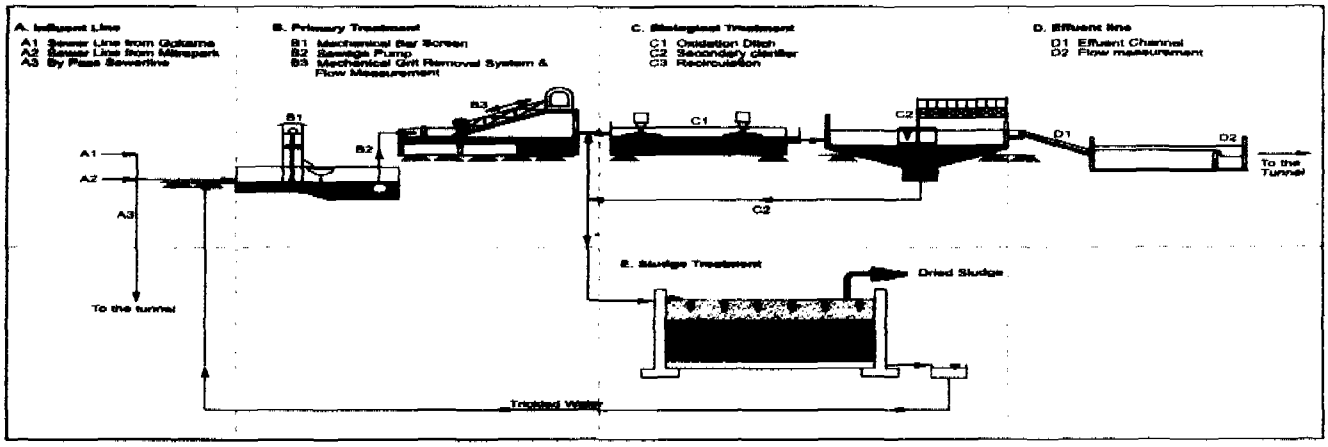
a. Primary operation unit

b. Biological operation unit

c. Secondary operation unit

d. Sludge treatment unit

Figure 5 1 BASP Treatment System



Source: BASP, (2007).

5.1.4 Primary Operation Unit

The primary operation unit consists of mechanical bar screen, sump well with submersible pumps, mechanical grit chamber with detritus mechanism. Mechanical bar screen is to remove the floating materials/ screens from the inflow. This vertical bar screen has spacing of 20mm between the two

bars has been provided for removal of screens mechanically. Sewage is pumped to the grit chamber from the sump well by submersible pumps of different capacities. One number of detritus tank, equipped with scrappers at the bottom and one classifier at the side has been provided for removing grit from the incoming wastewater at grit chamber.

A by-pass structure system is constructed for the collection and passage of storm water from road side drains and household yards and also for excess sewerage flow particularly in rainy season when the sewer will carry maximum 1000l/s total waste water including storm water and sewerage flow of 190 l/s in 1st phase and 300 l/s in 2nd phase, to by pass excess flow from by-pass collection structure, a RCC overflow structure with rack and sluice gate arrangement to prevent large particles being carried regulated by two sluice gates to be installed at just down stream of overflow structure and before the bar rack. The overflow water is carried out by two 1.0m dia hump pipe to some manholes and finally to last common large manhole for ultimate discharged to Tilganga through a tunnel sewer.

5.1.5 Biological Operation Unit

The biological operation unit consists of two numbers carrousel oxidation ditch fitted with 6 numbers of vertical aerators. The size of the each oxidation ditch is 80mx20mx3.25m. The two numbers of oxidation ditches have been constructed with a passage in between the two; each incorporated 4 numbers channels of size 5m widths and 3.25m total depth. The total volume of two ditches is 10400 m3 and hydraulic detention time is 15.12 hours. The total oxygen requirement for biological operation is 355 kg/hr. These aerators are supposed to run 24 hours a day to provide sufficient oxygen and velocity to the wastewater. Dissolved oxygen in the oxidation ditch is measured. MLSS present in the oxidation ditches indicates the degree of treatment. In a good quality mixed liquor, MLSS should be between 3000-5000mg/l.

5.1.6 Cost of Oxidation Ditch

The basic volume and footprint required for OD plants have traditionally been very large compared with other secondary treatment processes. Vertical reactors, in which process flow travels downward through the reactor, are generally more expensive than traditional horizontal reactors. However, because they require less land than more conventional horizontal reactors, they can significantly reduce overall capital costs where land costs are high.

The cost of an OD plant varies depending on treatment capacity size, design effluent limitations, land costs, local construction costs, and other site specific factors. Construction cost of ten plants were evaluated by EPA in 1991, with construction costs ranging from $0.52 to 3.17/liter per day treated (EPA, September 2000). The Blue Heron Water Reclamation Facility in Titusville, Florida has of capacity 15142 cubic meter per day, OD sludge handling facility began in 1996,was constructed for about $.80 litre per day (Kruger, 1996).

5.1.7 Secondary Operation Unit

Centrally driven and centrally feeding secondary clarifiers of diameter 27m each has been provided for the settlement or separation sludge, from the biologically treated sewage from corresponding oxidation ditch and for re-circulation (67-100%) of settled sludge to the oxidation ditch. The scraper mechanism of each clarifier spanning the entire diameter of the tank at the bottom, has been fitted the bridge with pathway and hand railing. The scraper is also fitted with scum removal surface skimmer and scum collection system. The treated effluent from secondary is collected in the main manhole checking its standard and passed treated sewerage through tunnel from Tambraganga to Tilganga

where two set of sludge transfer pumps transfer the settled sludge in drying beds or re-circulates into the oxidation ditches as per the requirement.

5.1.8 Sludge Treatment Unit

The sewerage treatment plant has two numbers of drying beds with perforated pipe and filter bed and of size of 27m X 74m. The sludge drying bed is divided into 7 numbers (Annex Photo 2). Drying beds consist of graded sand layer with finer sand at top, where sludge is spread. The sand layer is supported by assorted different layers of graded gravels through the bottom layer of which open jointed earthen pipes of 15 cm diameter at the spacing of 3 m apart has been laid as under drainage system. The filtered effluent from the drying beds, after passing through under ground, will pass to the manhole through a 400 mm diameter hume pipe, from where it will pass through sewer inlet collection chamber. The beds are open to the atmosphere and the dried sludge over the sand base can be removed manually and used for agriculture purposes. The following Table 5.2 shows the estimated amount of by-product of the treatment plant before the implementation but after the implementation, there is no proper significant of the by-product.

Table 5.2 Estimated by- product from the system

Organic Manure Production:	40 m3/day
Grit and Sand	3 m3/day
Screening	2-3 m3/day

Source: BASP, (2000)

5.1.9 Sewer Tunnel from Tamraganga to Tilganga

The tunnel is constructed to bypass treated or untreated sewerage directly to Tilganga (down stream of Lord Pashupatinath Temple) .The selection criterion for the construction of the tunnel is tabulated below. The constructed tunnel allows bypassing the excess sewerage entering the treatment plant.

Table 5.3 Selection Criteria of Tunnel

SN	Alternative	Description
1.	Enlarging the capacity of pumping station which was handled by NWSC and continuity of the pumping system.	24 hours electricity needed for pumping. If there is not electricity, at that period the on treated sewerage would mix at the Bagmati river without any treatment.
2.	To construct the sewerage line under the Bagmati river bed.	It was very difficult to construct sewer line in the river bed and there was not enough tools and equipment for excavation and installation of pipe line, no way to divert river during construction phase.
3.	To construct wastewater treatment plant near by pumping station and dispose the treated water to the upper part of the Guheshowari river.	Although this method is logical and seems good but the Hindu religious restricted to mix the treated water to the river, their argument was they have to use holy water called JAL to the god and still they don't have positive thinking to use of treated water in social and cultural activities.
4.	To construct gravitational flow type of tunnel from Tamraganga to Tilganga	This was the last alternative for passing treated water and by pass sewerage from the treatment plant. The construction tunnel was selected as Cut and Cover open excavated sewer could not be constructed because of the following reasons 1) For constructing open excavation there was challenging job to dig out 30 m depth and which will destroy the heritage and religious structures. 2) Negative impact on surrounding environment

Source: BASP, (2000)

According to the BASP Report, the selection committee had selected the horseshoe shape 2 m internal diameter tunnel having longitudinal Slope 0.17%.

Although there were four options were presented for the reason of constructing the tunnel in the project area in BASP the completion report suggest that they have selected the fourth option Table 5.3, but according to the annual report from register account office and from the field visit, I realized that the reason for construction tunnel is not satisfactory which will be discussed in the discussion section.

5.1.10 Construction of Road, Green Belt and River Training Works

BASP has already constructed 12 m green belt and 8 meter wide service along the banks of Bagmati Rivers from Gokarna to Guheshowari Temple. Both of the banks have also protected from the river training works. For the protection and sustainability of the green belt and controlling the sand extraction illegally from the upstream BASP has already constructed three nos of check post and it has formed sewer user committees (SUC) and mobilizes team. The performance of the team members will be discussed in discussion chapter.

5.1.11 Public Awareness Programme

As referring to the BASP report, the committee has understood that any activity to make Bagamati"clean"can not be successful without effective community participation. To make people aware of this fact and to acquaint them with the project activities, basic training on sanitation and pollution control training has been conducted to the communities of the project area. Rally, essay and art competitions etc have been organized which will be tested from my small community survey in project area.

5.1.12 Economy and Benefits of the project

So far as the economy of the project is concerned according to BASP annual report, the total investment on the project exceeds 9 millions US $.The pay back period of the project investment is justified in terms of environmental up gradation of the once pristine Bagmati River/Bagmati area. The residents of the valley and all religious Hindu people around the world will benefit as it has extensive social religious and cultural significance. This will be discussed further in the discussion chapter.

5.1.13 Operation and Maintenance of the Plant/Project

Ten members of staff are working at the treatment plant sector and remaining 28 persons are working in the administrative sector (Fig: 5.2). The average annual operation and maintenance cost of the project has been estimated to be 1.7 million US$.The monthly Expenses sheet is in Annex: A7.

5.1.14 Organization Structure of BASP

BASP comprises 38 members who are representing technical experts, socially and politically renewed persons and so called reputed administrators (BASP, 2007). According to the report the committee is fully devoted and committed to keep Bagmati clean with the support of the local people and its capable staff. On my observation, I found many weak and little positive aspect toward the project which is discussed in the discussion section.

The High Power Committee is different than Nepal Water Supply Corporation. It lies under the Ministry of Physical Planning and Works (MPPW). The annual budget comes from MPPW quarterly after the submission of detail account from the concern body of the project. Cost revenue from the project should be collected in the national account.

The post of chairperson is politically appointed and he has the power to control all the staff members of the project. For changing of any act and policy of the project he has to call board meeting including the selected members from user committee. The project Manager of the Project should be a technical person but it is not clear if he/she should be a staff member of government or if he/she can be appointed on a contractual basis. But the trend shows that all project managers are appointed by MPPW, most of them are shifted from NWSC. This will be discussed in the discussion session.

As referring to the organization structure of the project, the number of temporary and contact staff is higher than total permanent staffs (Annex 4). Fig 5.2 represents the organization charts of the BASP and mobilization of staffs in different sectors.

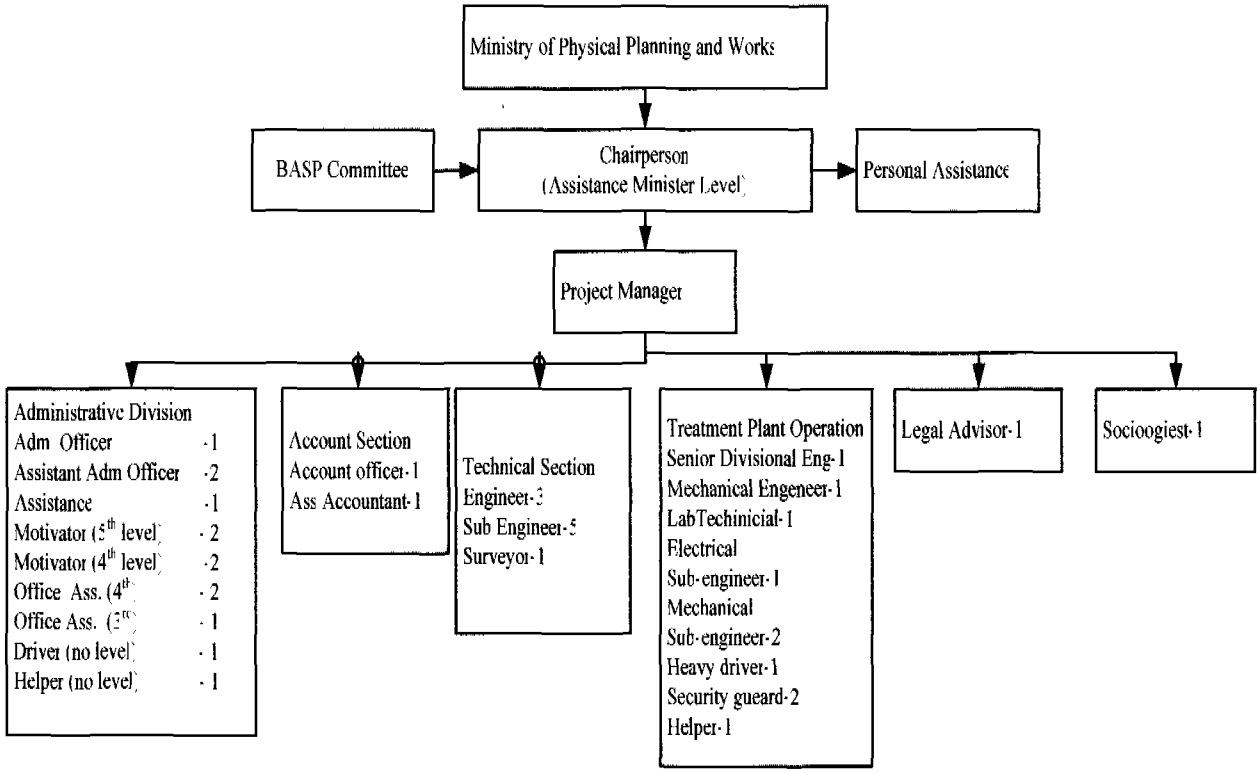


Figure 5.2 Organization Chart of BASP Including Staff Details

Table 5.4 Staff Details

Total Staff	
Permanente Staff	13
Temporary Staff	14
Contact Staff	11
Total	**38**

Source:BASP, (2007)

5.2 Sunga Wastewater Treatment Plant, Thimi Municipality (SWTP)

5.2.1 Introduction

Although, Thimi is one of the oldest settlements of Kathmandu valley in Bhaktpur district, it became a municipality only in March 1996.Therefore, most of the infrastructure development likes sewerage system, wastewater treatmetn plant and road network are still in the planning phase. A part of the municipality has been provided with sewer line connections; however, in the absence of treatment facilities, the municipal wastewater is discharged untreated into water bodies like streams which are serving as the main source of irrigation for the farmers of this settlement. There have been studies already carried out about the wastewater treatment by constructing oxidation ponds and some works like land acquisition and excavation of pond was started but the activities could not be completed maybe due to unavailability of the required funding.

Many developing countries are experiencing rapid urbanization of human settlements and in the meantime are also facing limited water supply. On the other hand, there is ever increasing quantity of waste and wastewater discharge. Now it is a time to put in place effective water management strategies for efficient use of the limited water resources. Moreover waste and wastewater management should be given prime focus to decrease the threats to water quality and ecosystem. Promoting effective water management policies and practice-"Operational research on decentralized wastewater management and its dissemination" is a Pilot and Demonstration Activities (PDA) program of the Asian Development Bank, co-funded by UN-HABITAT, Water Aid Nepal.

The Objective of PDA programs are

- Demonstrate appropriate technology for managing wastewater
- Demonstrate Ecological Sanitation(Ecosan) for conserving ,recovering and recycling of nutrients
- Demonstrate water optimizing technologies at household level
- Disseminate the finding to all key stakeholders, policy-makers and politicians.

The Pilot and Demonstration Activities (PDA) program for water in Nepal was lunched in June 2004 to promote effective water management policies and practices. Environment and Public Health Organization (ENPHO) has served as the implementing agency for the PDA. The PDA comprised the following main activities:

- Construct a community –based reed bed treatment system(RBTS) of wastewater management in Thimi
- Demonstrate Ecological Sanitation (Ecosan) system in peri-urban communities in Kathmandu Valley.
- Demonstrate ENPHO building as a water optimized house(model for RBTS, ecosan and rainwater harvesting)
- Conduct a national seminar to disseminate simple technologies for water optimization ;and
- Develop information, education and communication (IEC) materials.

5.2.2 Community scale Reed Bed Treatment System (RBTS) of municipal wastewater

Wastewater treatment through constructed wetland technology has gained wide popularity in various parts of Nepal. The role of private investment through PSP/PPP is increasing. This is obvious from the construction and operations of increasing number of such wastewater treatment plants. The details of few of them are fallow in Table 5.5.

Table 5 5 List of CW in Kathmandu Valley

SN	Place	Date of operation	Type of waste water	Treatment Capacity	CW configuration	Reason for construction
1	Private house ,Kathmandu	April,1998	Gray Water	500 lit/day	Vertical flow bed	Grey water Recycling
2	Kathmandu Metropolitan City	August,1998	Septage	40 m3/day	Sludge dying bed followed by vertical flow bed	Control of septage dumped into the river
3	Susma Koirala Memorial Plastic and Reconstructive Surgery Hospital ,Sankhu	Dec-2000	All Hospital Waste	15 m3/day	Horizontal flow bed followed by vertical flow bed	Local people restriction to discharge waste water into the river
4	ENPHO Laboratory	August ,2002	Lab and staff toilet waste	1 m3/day	Vertical flow bed	Demonstration
5	Kapan Monastry	July,2003	Hostel Tiolet	17 m3/day	Horizontal flow bed followed by vertical flow bed	Lack of sewer line outlet
6	Private House, Kathmandu	August.2002	Gray Water	500 lit/day	Vertical flow bed	Gray water recycling
7	Sunga waste water treatment plant	Oct-05	Community waste water	50 m3/day	Horizontal flow bed followed by vertical flow bed	Lack of sewer outlet and Balpremi school is using treated water for flushing

Source: Shrestha, (2003) and Metcalf and CEMAT, (2000)

There are several RBTS in Nepal currently operating. However, all these systems are associated with private properties and institutions. Sunga Wastewater Treatment Plant is the first community based treatment plant in Nepal, which is expected to set a valuable pilot precedent for larger systems that are envisaged under ADB-funded Urban Environment Improvement Project (ADB, 2002). RBTS system of wastewater treatment has been used effectively in many developing countries for municipal wastewater for their low operational cost, low energy demand and operational simplicity (EHPHO, 2004). SWTP is designed with two horizontal flow beds followed by two vertical flow reeds beds with are of 150 m2 respectively as secondary treatment units. The treatment plant can treat 50 m3 of wastewater per days from the Sungatole community. The total direct beneficiaries of the WWTP are about 1200 population from 200 households.

Except pollution removal efficiency, some of the advantages of the systems are listed as follow, (ENPHO, 2004).

- Operation and maintenance cost is negligible. It is simple to operate without chemical additives or complex electro-mechanical control
- Highly skilled people are not required.
- Wetlands beds are long lasting, wear free and naturally regenerative.
- Construction technology is simple in comparison to conventional treatment units.
- Systems are usually mere flexible and less susceptible to variations in loading rate than conventional treatment system.
- Local available materials are sufficient to construct the treatment plant
- This is an Eco- friendly system. The plant promotes greenery and improves the aesthetic of the environment
- There is no odour and nuisance compare with other systems
- This is a energy efficient system

As Nepal is a mountainous country, the treatment units can be built to run fully under gravity. Wetland plants use solar energy for the photosynthetic process. Sufficient electric energy is not required for the operation of the treatment units. This system can be applied in isolated communities and institutions. This technology can be adopted in rural areas of Nepal to promote sanitation in Schools and other public institutions (ADB, 2002). According to Shrestha, CW can be applicable in several pockets of big urban centres, where central sewer networks are not available (Shrestha, 1992)

5.2.3 Treatment Efficiency

The Sunga Wastewater Treatment Plant receives a highly concentrated wastewater with high nutrient contents. As regarding the laboratory analysis of the wastewater treatment plant done by ENPHO.In Fig. 5.3 the initial biological oxygen demand 5 days at 20°c at raw sewerage is 950 mg/l and 450 mg/l,165 mg/l and 30 mg/l in primary treatment, horizontal flow bed and vertical flow bed respectively that means from raw sewerage to primary treatment plant 52% of BOD is removed, similarly from primary treatment plant to horizontal flow bed 63 % and from horizontal to vertical bed 81 % BOD removal. Similarly the initial chemical oxygen demand (COD) is 1438 mg/l and 1188mg/l, 213 mg/l, are in primary treatment, horizontal flow bed and vertical flow bed respectively. That means 17%, 82 % and 76% of COD removal capacity in primary treatment, horizontal flow bed and vertical flow bed respectively. From the lab report the treatment system has removed 97% of BOD and 97 % of COD and about 98 % of Total Suspended Solid (TSS). More discussion about efficiency is in the discussion chapter. For lab Report see (Annex A .10).

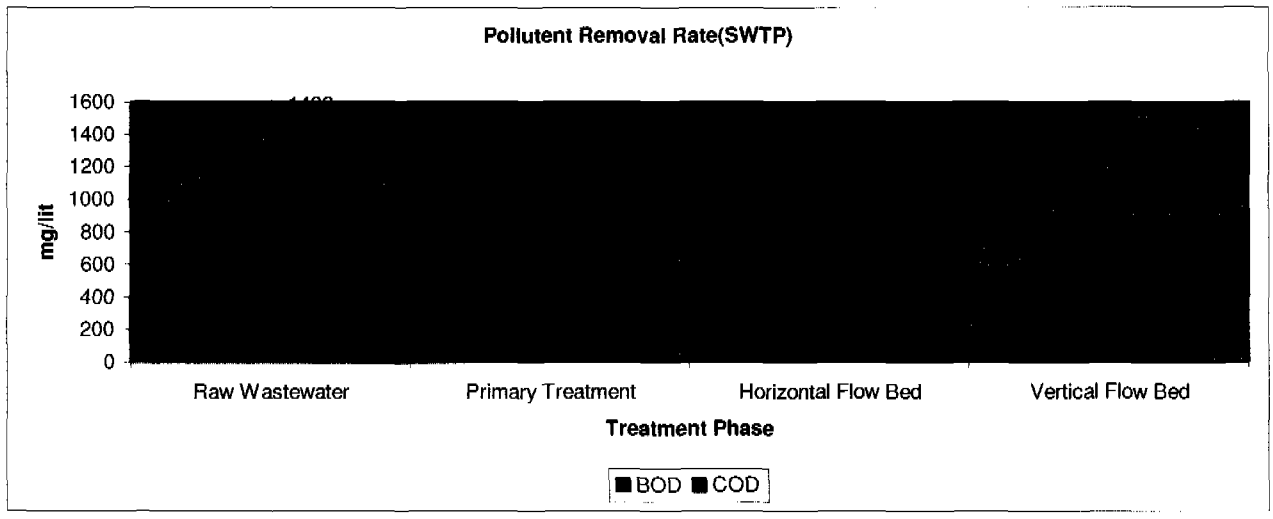


Figure 5.3 BOD and COD Removal Diagram of SWTP

Source: ENPHO (2006)

5.2.4 Social Acceptance

The formation of the Sunga Community is established from the desire of the community themselves. Before construction of Sunga Waste Treatment Plant, the waste water generating from the Sunga area was directly disposed into the Siddhakali stream later on it mixed to the Hanumante River,which is the tributary of Bagmati River, ultimately the wastewater from the Sunga area was also impacting the river quality of the Bagmati River. Before the project establishment the community people were not aware in the sector of health and care. In the presence of one of the NGOs called Environment and Public Health Organization (ENPHO) and some of the educated people from the community were able to convince the local people about the need of waste water treatment plant in their society, at the end they were able to create the Sunga Wastewater Management Committee. The community is formed after the acceptance of the all community member so SWTP is a socially accepted project. Table 5.6 represent the Salient Feature of the SWTP.

Table 5 6 Salient Feature of Sunga Wastewater treatment plant

Project Name:	**Sunga Wastewater Treatment Plant (SWTP)**
Location:	Sunga, Thimi Municipality , Kathamndu Valley
Coverage Area:	Sunga Community
Land used	1500 Square Meters
Operation By:	Community Management
Operation and Maintenance Cost	Thimi Municipality and Community Themselves
Type:	Decentralize Concept, Community Based
Management Committee:	17 members Management Committee
Beneficiaries:	1200 population from 200 households
Capacity of Treatment Plant/Day	50 Cubic Meter
Sludge Drying Bed:	55 m2
Baffle Reactor:	3 chambered anaerobic baffle reactor
Reed beds:	2 horizontal flow reed beds follow
	2 vertical flow reed bed 150m2 capacity each
Year of Construction	2005,May
Year of Operation	2005,Nov
Wastewater characteristic	Domestic ,Strom Water

Source: ENPHO, (2005)

5.2.5 Objectives

The objectives of the PDA were to demonstrate appropriate technology for managing domestic wastewater, recycling its nutrients and optimizing water at household level by carrying out operational research and to disseminate its findings at local to regional level. The aim of the PDA was to improve the health conditions especially for the urban poor, reduce pollution of the natural environment and provide opportunities for economic benefits through reuse and recycling. It has also aimed to generate information for the government, local authorities, planners and professionals with an interest in promoting improved sanitation and alternative options for decentralized wastewater management.
As following the previous study (Metcalf and Eddy, 2000) the implementing agency (IA) recommended to construct a community–based reed bed treatment system (RBTS) of community wastewater management in Sunga Tole.

5.2.6 Area Selection

The basic feature of RBTS is that they have bed of uniformly graded sand or gravel with plants such as reeds growing on it. Wastewater is evenly distributed on the bed and flows through it either horizontally or vertically. As the wastewater flows through the bed of sand and reeds, it gets treated

through natural processes like mechanical filtering, chemical transformations and biological consumption of pollutants in wastewater. (RR Shrestha, 2005). According to him, RBTS utilizes simple natural processes; it is effective, yet inexpensive and simple to operate. The RBTS are also known as Constructed Wetland (CW) system for Wastewater treatment.

Constructed Wetland (CW) is a biological wastewater treatment technology designed to mimic processes found in natural ecosystems which uses wetland plants and their micro-organisms to remove pollutants from wastewater. There are about a dozen RBTS currently functioning in Nepal. However, all these systems are privately owned (hospital, school and colleges). One of the community based wastewater treatment plant is operating at Sunga Tole, Thimi Municipility.

The initial design of the wastewater treatment plant was different location of the Thimi called Siddhikali area. This consisted of three units of 1st stage vertical flow each of 350 m^2 followed by two units of 2nd stage vertical flow bed each of 250 m^2. The total area used for the treatment is around 1500 m^2.The construction work was started during the preparation of project mid-term implementation report in December 2004.After materials were being carried out at site, some people in the local community interrupted in the works. They tried to convince the local people by changing the design and various discussions but it was impossible to convince them so the project of Siddhikali was cancelled. At the same moment the local people in Sunga Tole, another area within Madhypur Thimi Municipality, showed interest in the treatment plant, so after studies were carried out it was decided to construct the RBTS at the new site at the Sunga.

The wastewater treatment plant (WWTP) at Sunga is the community based WWTP in Nepal. It was designed by ENPHO and implemented by the local community with support from Asian Development Bank (ADB), UN HABITAT and Water Aid Nepal (WAN).Madhyapur Thimi Municipality provided the required land for WWTP and it has agreement to provide financial assistance for the operation and maintenance of the WWTP annually.

The RBTS was designed and constructed to serve about 1200 population from 200 households and to treat 50 m^3 of wastewater. Although the size of the RBTS was smaller than the previous design, it helped to convince the local people for future replication of this technology and the municipality has also expressed its commitment to implement additional decentralized wastewater treatment systems in future but there is still confuse about operation and maintenance cost of the system. Management committee has the dilemma for regular maintenance which will be question mark for sustainability of the system.

5.2.7 Process Design of WWTP

The process design of WWTP includes preliminary, primary, secondary and sludge treatment. The treatment plant was designed to accommodate maximum wastewater flow with optimum degree of wastewater treatment. The waste water treatment plant consists of following major components; Fig 5.4 is layout of the SWTP.

5.2.8 Preliminary Treatment

The preliminary treatment of the WWTP consists of a coarse screen followed by a grit chamber. The structures were designed for the full inflow to the WWTP.

5.2.9 Primary Treatment

The treatment consists of septic tank, anaerobic pond, Up-flow Anaerobic Sludge Blanket (UASB). A three chambered anaerobic baffle reactor with the capacity of $42m^3$ was designed as a primary treatment unit.

5.2.10 Secondary Treatment

The secondary treatment is the constructed wetlands. Among various types of constructed wetlands, surface flow wetlands, horizontal flow and vertical flow bed constructed wetlands were investigated (RR shrestha, 2005). A horizontal flow bed followed by vertical flow bed type was designed to accommodate maximum wastewater flow with in limited area and the required treatment efficiency. Each bed was designed with a total area of 150 m^2 respectively (Annex Photo P 3).

5.2.11 Sludge Treatment

There is 55 m^2 sludge drying bed at left side of secondary treatment plant. The sludge treatment unit was designed so that the treated sludge could be utilized as manure and after removing the sludge manually from the constructed wet land.This technology will increase the efficiency of horizontal and vertical bed filtration system.

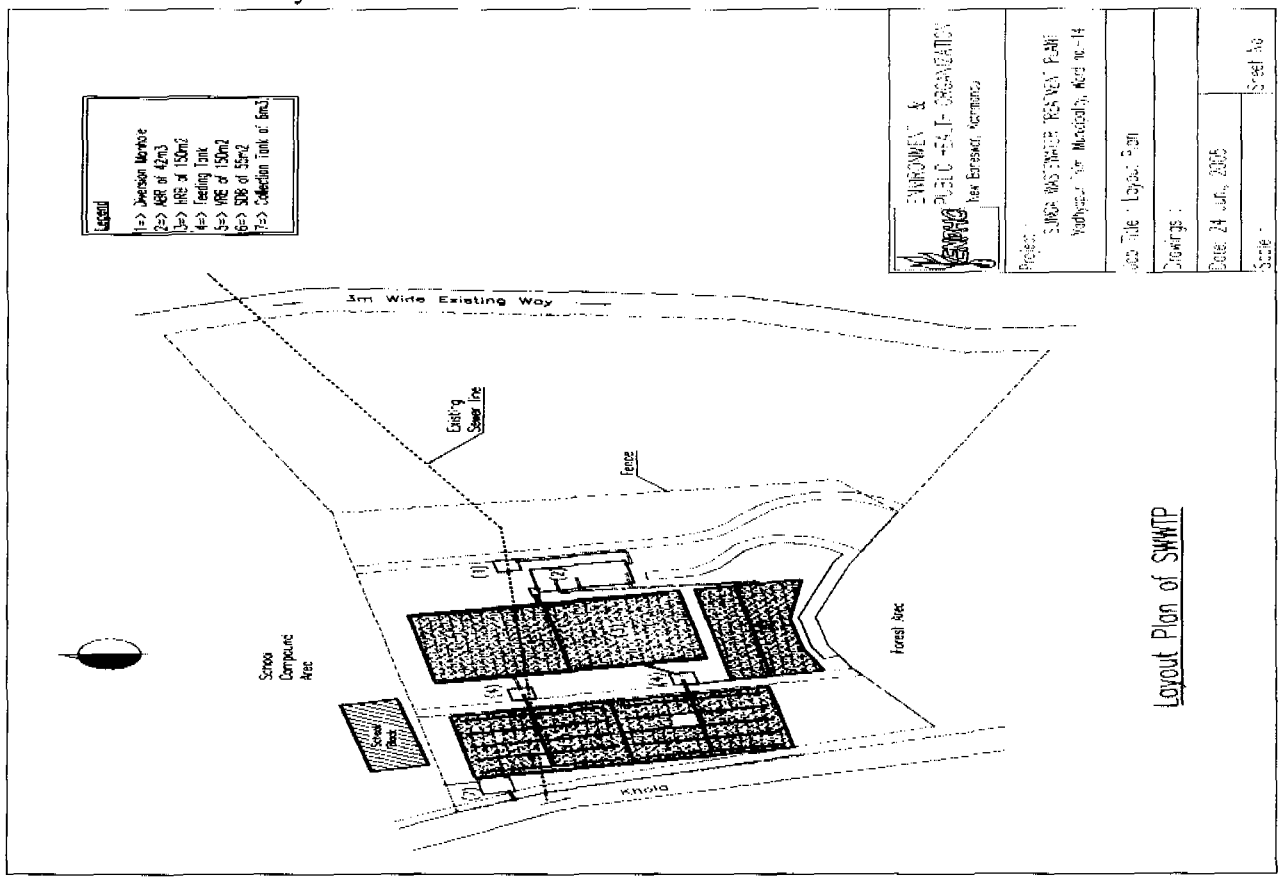


Figure 5.4 Layout of Sunga Wastewater Treatment Plant

Source: ENPHO, (2005)

5.2.12 Formation of management committee

Seventeen members of the management committee are consisting of reprehentive from the Thimi Municipality, a local school , CBOs and the users was formed for the overall implementation and management of the system. The management committee was formed by a community consultation meeting held on 28th May 2005. The management committee was named"Sunga Wastewater Treatment Plant Management Committee". The management committee was responsible for all aspects of construction materials and supervising construction works with technical support from implementing agency. The management committee was also responsible for the payments with the approval of the IA. A separate bank account was opened at the Sunga Wastewater Treatment Plant Management Committee. For the construction of "Sunga Wastewater Treatment Plant", a management Committee was formulated with the commanding of Chairman: Mr Krishana Lal Goja Shrestha (Annex A3).
The difficulties for formation of management committees and their merit and demerit will be discussed in the discussion section.

5.2.13 Financial Aspect

It is worth mentioning that during the detailed work of the PDA activities, some deficits in the budget were realized. Devaluation of the US dollar against the Nepalese Rupees, increase in the price of construction materials along with the labour charges, modifications/alterations in the technical design of the RBTS and delay in the construction of the RBTS have been the major reasons for the deficit of the allocated budget. In search of the deficit budget, the IA takes pride to link up this PDA with the Water for Asian Cities Programme (WAC), an initiative collaboration of the UN-HABITAT and ADB, and Water Aid Nepal, an INGO, which have come together to support the proper investments in urban sanitation with emphasis on serving the urban poor with formal sanitation facilities. The summary of the expenses and the contribution from the three sources are summarized in the following Table 5.7.

Table 5.7 Cost Share by Donor Agency

SN	Activities	Expenses		
		ADB-PDA (US $)	UN-HABITAT (US $)	Water Aid Nepal (US $)
1	Community Scale RBTS	28,000	10,000	6,000
2	Ecological Sanitation	4,000	-	-
3	Demonstrate Water Optimized House	1,000	-	-
4	National Seminar	2,000	-	-
5	IEC Materials	1,500	2,500	-
6	Professionals	8,850	-	-
7	Miscellaneous expenses	4,500	-	-
8	Monitoring & Evaluation	-	2,500	-
9	Sub total	49,850 (70%)	15,000 (21%)	6,000 (9%)
10	Total (US$)	70,850 (100%)		

Source: ENPHO, (2005)

6 Results and Discussion

6.1 General

Many corresponding institutional arrangements with their respective forms of ownership, organization and governance are capable of meeting the needs of customers, the community and the environments in a successful manner. For all institutional arrangements a system of informal or formal regulation is required to ensure that the public interest is served properly. In general, more formal regulation is required and useful as the degree of separation between the management entity and the responsible entity increases (van Dijk, Schoiuten, 2004).
This section provides the findings about the current management of the wastewater treatment plants in the Kathmandu valley. The different aspects associated with sanitation, including wastewater treatment such as existing legislation and policies, institutional set up of wastewater treatment plants, the role of different key players in WWTP, have been studied and discussed for two different wastewater treatment plants in Kathmandu. The indicators including operation indicators, financial indicators, quality of effluent, rules and regulations of concern authorities and an overview of tariff rates and structure as following the guideline of Yepes (Yepes, 1996) have been utilized for this analysis.
In this Chapter, in section 6.1.1 to 6.1.5 the government rules and regulation related to wastewater treatment plants are described and section 6.2 describs operation and maintenance, section 6.3 provides the financial indicators and 6.4 to 6.7 the quality of the two individual waste treatment plants. The section of the chapter 6.8 explains about management satisfaction and 6.9 explain the managerial problems of the BASP since its establishment.

6.1.1 Legislation for prevention of pollution

Due to very weak enforcement mechanism, several pollution prevention acts were paralyzed or nearly paralyzed. Many different agencies or institutions were authorized or made responsible by the acts to carry out activities of protecting and managing the ecology, environment and resources. This created confusion among the authorities and provided an easy way for them to shift their responsibilities to others.
After the establishment of the Ministry of Population and Environment in September 1995, the Environment Protection Act (EPA), 1996 and the Environment Protection Rules (EPR), 1997 came into existence. EPR states:
Nobody shall create pollution in such a manner as to cause significant adverse impacts on the environment or likely to be hazardous to public life and people's health, or dispose or cause to be disposed sound, heat, radioactive rays and wastes from any mechanical devices, industrial enterprises, or other places contrary to the prescribed standards
The EPA and EPR have been enforced since June 1997. Regarding pollution management, the EPR envisages an environmental standard. A maximum penalty of 0.1 million rupees may be imposed on anybody who implements a project without receiving approval for Environment Impact Assessment (EIA) report (HMG/MOPE, 1998)
The government has prepared its national standard on several environmental issues at the moment. A standard on industrial effluent discharged into the inland surface water has already been approved

since the law and enforcement mechanisms have only recently been developed, it will take a few more years still for them to come in to practice. At the moment, it is still functioning in a trial and error basis.
Some of the weaknesses and strengths of the selected projects, surround the rules and regulation that must be followed in the current situation. On this point rests the interest of my research.
Currently, there are many regulations in Nepal dealing with waste streams and there are a number of government agencies involved in the enforcement of these regulations, many of them overlapping in jurisdiction. The political situation is also impacting the development of such infrastructure.
Box 2 explains the current scenario of country and the ideas about prevention of problems.

BOX 6.1 Political conflict and its effects on waste and wastewater system

- We must realize that internal conflict and terrorism stem in large part from deprivation and discrimination and the resultant poverty and want. Conflicts, be they internal or external, can best be handled only when the root causes—the deprivation and discrimination—are addressed. Addressing deprivation and discrimination calls for political reasoning and political actions. The current focus on military solution to these problems is extremely faulty. There should be an immediate halt to building defence infrastructure. The resources being allocated for defence should be channelled to building basic infrastructure in LDCs (link-roads, schools, health posts, safe drinking water supplies, waste water treatment) and creating livelihood opportunities through which to mitigate the causes and effects of poverty. As long as discriminatory policies and structures exist to divide people between the rulers and the ruled, the causes of conflicts and wars cannot be eliminated.
- A matter of urgency is the **enhanced participation of and partnership** with civil society which is still seen a challenge and hence needs to be effectively mobilized as the civil society has immense wealth of experience to contribute based on their grass roots involvement. Both the LDC governments and development partners need to strengthen the much needed partnership with civil society and ensure their effective participation at all levels of the development process. Broad participation contributes to effective decision making and legitimacy of those decisions which in turn implies effective implementation and encouragement of further participation. A mechanism for the implementation, monitoring and evaluation of the Programme of Action should engage civil society at every level.

Representative of Rural Reconsctuction Nepal (rrn)

According to representative of rrn, Nepal has been suffering from the political conflict (Maoist problems in the past and current internal problems are created by different political parties. The Local Development Committee could not work in the proper way in the sector of water and sanitation. There is lack of the Role of concerned authority for monitoring the quality of existing wastewater. The government and development partners (NGOs, communities, private parties) need to strengthen at the level of development process.

Table 6 1 Strength and Weakness of Legislation for wwtp

Legislation and Policies	Strengths	Weaknesses
Environmental Protection Act and Rules 1997	It prohibits the disposal of wastes which cause pollution to the environment and damage public health. Provision of a penalty for the violation of rules	EPA does not separately address the categories of waster water There is lack of regulatory body for the implementation of the act There are no standards related to faecal sludge.
The Building Code	The building codes direct and promote construction of septic tanks in every building and require the construction of sewerage facilities in the complexes and commercial building to manage the wastewater.	The building code is not implemented well The regulatory body of the municipality are neglecting the code due to various reasons
The Local Self governance (LSGA)Act,1999	LSGA provides authority to local bodies such as municipalities to address water and sanitation needs in its area	The adoption of LSGA is weak in practice
The National Sanitation Policy (2002)	A separate policy on sanitation has been developed. It commits to improve sanitation at the national level. It promotes partnership between community User groups, private parties and NGOs. Educational institutions, local authorities should constitute the framework for effective sanitation facilities and services.	The policy does not properly address about the issue of wastewater treatment plants.

Source: Mingma, (2005)

From the interviews of key informants (Table 6.4) and summarize of the strenghth and weakness relates to rules and regulations in Table 6.1, studied by Mingma Sherpa in 2005, it reveals that the current legislation and policies associated to wastewater treatment systems in Kathmandu valley not effective There is no legal sanitation act, the only the National Water Plan (NPW) 2004, which is a framework plan to guide in an integrated and comprehensive manner to develop and manage water resources and water services. Although the plan has both long term and short term strategies, the only one sewerage branch of NWSC could not possibly be able to operate to serve the existing four

wastewater treatment plants which are converting to the play ground and grazing spot day by day. The following Fig 6.1 is the secondary wetlands ponds of Kodku Stabilization pond in Lalitpur district. This wastewater treatment plant is so called partially operating by the NWSC but the picture directly visualize that either there is any fence bar or cleaning of the pond regularly by the concern authorities is not taking seriously about the improving of the system. There is not any safety measure for the protection of wastewater treatment plant. Where I have found chlorine dosing station near the secondary pond, but it was not operating since the construction period, that is example of lacking in monitoring and mismanagement in the system of wastewater treatment plant in Kathmandu Valley.

Figure 6.1 Secondary Stabilization Pond at Kodku

Source: Field Visit, (2008)

The ex-project manager of the BASP has accepted the reality of the situation and he agrees that it is due to the negligence from the government sector in the field of the sanitation. He also added that this is happening due to the political pressure. Politicians are willing to spend huge amounts of budget on the drinking water supply but less on the sanitation sector. Therefore in the present situation it is found that there is a lack of appropriate standards and policies related to wastewater treatment plants and their management.

6.1.2 Short Term and Long Term Strategy

In the **short term strategy**, low cost technology has been proposed. The health of the people cannot be put into risk due to water pollution. Hence, the quick and economical option has been chosen for the short-term strategy.

Apart from the operation of rehabilitated treatment facilities conventional plants, (activated sludge process or oxidation ditch) in combination with anaerobic digester after primary sedimentation is proposed in long-term strategy. The combination of anaerobic digester is capable for the production of biogas. The biogas energy is used for various purposes. It will help to generate income. This is one of the ways to make treatment plant economically viable and sustainable. The technology using only

conventional technology e.g. activated sludge process and treatment plants with extended aeration will cost lots of money. The plant thus will not be sustainable in the context of countries with a poor economy. The operational as well as maintenance cost is very high in these processes. Likewise, the effluent quality would be better in terms of removal of Nitrogen unlike only using activated sludge process.

The conventional treatments plants are the ultimate alternative for urban areas, since land resources are usually expensive and conventional plants takes up less space and produce better effluent quality. Due to excessive land cost in Kathmandu valley, the existing lagoons are about 500% more expensive on per person basis than are conventional ones.

For the convenience of operation and maintenance, one treatment plant would have been the best alternative. But the geographical structure of the Kathmandu valley is a barrier for this alternative. Likewise, long interceptor is required for the sole purpose of reaching the site.

Several pumping stations may be required to lift the sewage. Therefore, to serve different catchments, number of plants should be built.

Production of bio-gas from the treatment plant is not impossible for the financial viability for the treatment system from conventional wastewater treatment plant. But in the context of Nepal the cost recovery even from drinking water supply is difficult. So full cost recovery from the wastewater treatment system is not easily possible.

A significant amount of additional wastewater facilities is needed. This begins with public toilets, septage hauling vehicles, includes interceptor sewers, local sewers, septage treatment plants and wastewater treatment plants. Immediate needs are great. But it is unrealistic to expect all needs to be met within a short period. There are lot of obstacles. So phase wise development program with concrete process for implementation need to be adopted while raising local interest and generating outside funding support for the longer term capital investments.

BOX 6.2 Wastewater management problems in Kathmandu Valley

Wastewater management in Kathmandu valley is poor. There is a lack of commitment from the side of the government on wastewater management issues. The sewer system is established without organized planning and most of them are combined with storm water drainage systems, which ultimately pour into the river. Reports indicate that only about 60% of the households are connected to sewer systems in Kathmandu. Septic tanks are a basic means of single building wastewater treatment. The extracted liquid, called 'Septage', is discharged directly either into the sewer systems or into the rivers once the septic tank is full and emptied. 'Septage' contains high concentration of solids, organic matter and large quantity of enteric micro organisms and grease. Septage contains almost 50 times higher the concentrations of organic matter and solids than in normal domestic sewage. A septage treatment plant, based on reed bed technology, was installed by Kathmandu Metropolitan Corporation in 1998. Previous performance data revealed that this system was efficient enough to bring the level of pollution significantly down. But, it is out of operation since last year merely due to managerial problems. There are four municipal wastewater treatment plants in Kathmandu established decades ago but most of them are either out of operation for years or partially operational. The reason behind it is the lack of proper **operation and maintenance, lack of educated and trained operating staffs and lack of enough budgets for operation and maintenance**. Recently, a new municipal wastewater treatment plant has been established in Guyheshwari (BASP), which will help to allow clean water flow in Aryaghat in order restore the cultural and religious value of Pashupatinath temple. Most of the industries are haphazardly spread all over the valley. Though industrial wastewater forms only 2% of the total wastewater generation, it may contain toxic chemicals and create nuisance such as smell problem. The industries, too, discharge their wastewater directly into the rivers without treatment.
Source:

SUNDAY POST
The Weekly Magazine of the Kathmandu Post
Kathmandu, Sunday, January 20, 2002

Box 6.2, it is pointed out that the condition of the wastewater treatment plant is not satisfactory. The condition of the existing wastewater treatment plant is most unpleasant. Sepetage is directly discharged either in the river or public sewer line which will be discussed in the quality of effluent session. Regarding to the above statement, there is a lack of commitment from the side of the government about the managerial issues in the sector of wastewater treatment plant. The comparison table 6.1.1 illustrates strengths and weaknesses of the national sanitation policy and environmental act. Regarding to the previous studies and various articles, we should easily accept that there is a lack of a regulatory body for the implementation of the act in the case of sanitation. The national sanitation policy also does not address the issue of WWTP.
Similarly, the building code shows a strong relation with septage management. The code, which in principle should be adopted by all the urban areas in the country, mandates the construction of septic tanks in each building with the absence of a sewerage system. If such a practice was followed in all the urban areas sludge management would be very necessary because it is highly effecting in the efficiency of the wastewater treatment plant. However, the current situation shows that mandates of the building code are not seriously followed.

6.1.3 Monitoring of Waste Water Management Systems

As regarding to Fig 6.2, at the household level less then 35 % out of 54 don't know who has to visit for the inspection their community wastewater system. Although it is mandatory that the municipality authority should inspect the site before providing a building completion certificate, on my field visit I found that many of the house owners don't inform to the municipality about the completion of their buildings. They don't care about the building completion certificate on the one hand and on another hand if the representative of the municipality had visited the site for approval, they don't care about the septic tank and sewerage line of the completed building. It seems there is lack of transparency.
The sewerage treatment system of the BASP is highly influenced by the industrial wastewater.BASP has created a monitoring team to provide encouragement at the household as well as the industrial level to dispose their effluent in the common sewer line after pre-treatment of wastewater in their periphery within the standard limit. Although BASP staff has visited several times, from the survey it was found that 89% of industry level agreed about their visit on industrial site that the monitoring team could not convince them. Similarly the BASP management committee could not penalize the household and industries sectors for disposing the wastewater quality maximum then the standard limit. According to a BASP engineer, regulation should be done by the Ministry of Industry in case of industrial wastewater. Asking the question to senior engineer of Ministry of Industry about the frequency of monitoring of Industry in the project areas, the representative of Ministry of Industry had visited the site only 1-2 times and they also said that it is the responsibility of BASP also because it has a high power of authority. So from the above discussion it can be concluded that the vision of the government sector for the wastewater treatment plant is not clear enough or overlapping.
The government has a responsibility to set and enforce regulations for environmental and natural resources protection. The government has a number of complementary applicable regulations; however there are conflicting and overlapping. In addition regulatory control over groundwater use citing of polluting facilities, and permitting of major wastewater discharge is lacking.

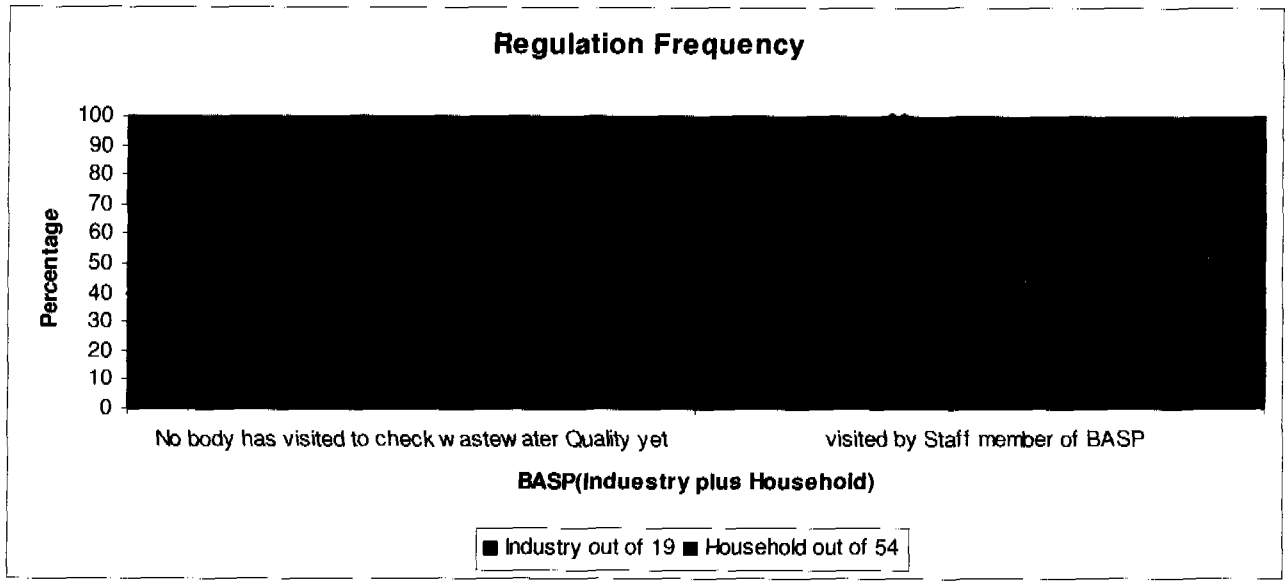


Figure 6.2 Monitoring By Concern Authority

Source (Field Survey, 2007)

6.1.4 Sanitation Target and Achievement (10th Year Plan) (2002-2007).

Table 6.2 Status of Water Supply and Sanitation up to 10th year plan

Description	Target	Achievement
Drinking water supply Total Population(in 000) Percentage	 22680 85	 20434 76.6
Sanitation Total Population(in 000) Percentage	 13341 50	 12232 45.8

Source: NPC, 2007

Table 6.3 Budget Allocation for 2007-08

Sn	Program	Amount in Million
1	New water supply project(production)	9310
2	Development of distribution	6120
3	Quality control	400
4	Maintenance and rehabilitation	130.8
[redacted]	[redacted]	[redacted]
6	Institutional Development	1000
	Total	17500.0

Source: (NPC, 2007).

Form the 10th year plan (Table 6.2), although the achievement percentage in sanitation at the end of 10th year plan is 45.8 percentage but there is not any expenditure either for rehabilitation of existing sewerage treatment plant in Kathmandu valley or new construction of sewerage treatment plant .So from the target and achievement table, the achievement percentage 45.8 is only for the construction of toilet in the household and limited sewerage line construction (NPC,2007) but it does not address about the wastewater treatment plant.

As regarding the budget allocation (Table 6.3) about 94 % of budgetary money is planning to invest in the drinking water supply sector and hardly 6 % is in the sector of sanitation distribution but among the 6 percentage there is not clear, how much amount will be expended for wastewater treatment system in the year of 2007-2008, Although it was announced that we are going to celebrate sanitation year in 2008 to know the stage of millennium development goals (MDGs).

The policies and commitment of the Government of Nepal have resulted in becoming a priority of multilateral aid agencies like the World Bank, Asian Development Bank (ADB), bilateral-assisted projects as well as international/ non-governmental organisations (I/NGOs) working in this field. In this regard, it is important to note that various approaches are being adopted by organisations working in this sector, but the goal is the same safe water and sanitation, but in practice overwhelming concern for maximum coverage and not quality. (Devkota, 2008)

Regarding this problem, as asked in related questions to the general sectary of MPPW, he agreed with the situation and replied that MPPW has big problems in funding. A huge amount of budgetary money has to be expended for security purposes to solve the political conflict on the one hand and on the other hand their first target is in drinking water supply and secondly that every household should have toilet. Less priority is given to the issue of wastewater treatment plants. That is one of the reasons that BASP has been receiving less of the annual budget for its operation and maintenance from the MPPW.

6.1.5 Opinions of key Informant on the Rules and Regulations for Wastewater Treatment Plants

Table 6.4 Rules and Regulations in wwt

Which organization is responsible for setting quality for wastewater in Kathmandu Valley?	MOPE,MOI and Concern Wastewater treatment plant	MOPE, MOI and Concern Wastewater treatment plants	
Do you have any Sanitation Act?	Not yet	Not yet	There is only Draft of Sanitation Act but not legalize yet.
Do you agree with the statement that : In Kathmandu valley, more propriety is given to drinking water and less in wastewater treatment plant?	Yes *	Yes	*government has given first priority to the drinking water and second on site sanitation

Questions	Common Answer from Government Authority	Common Answer from Private and Donor	Remarks
Why?	Drinking water is the most essential	Neglect from the government authority.	
How many wastewater treatment plants do you know in Kathmandu Valley	6 ,out of them Kodku is partially operating ,and BASP is only operating (Oxidisation Ditch Treatment plant)	7,among them 4 are operated by NWSC and one BASP which is operated by high Power committee, and there is only one small community treatment in Thimi	Many of the government key-Informant are unknown about the SWTP except Thimi Municipality
Which organization is responsible for the economic regulation of the waste water treatment plant	NWSC, Government Subsidy	Not clear mandate	Overlapping between NWSC, KMC and Local Ministry.
Is EIA or IEE is compulsory for establishing projects?	Yes after 1992, there is compulsory to do EIA or IEE for establishing industries.	Yes	Any EIA study was not done by BASP although it was started to construct in 1997.
Why the most of the industries have been disposing wastewater without pre-treatment	Less monitoring, not penalty and political interfere	Carelessness of concern authority	
Centralize or Decentralize which treatment plant is most feasible for monitoring and regulation	It depend on, but in the current situation(political instability) decentralize system will be stable	Decentralize concept, example, and success of Telecommunication in Kathmandu valley.	Before2000, telecommunication was in government sector but these days it is running in the PPP concept.

From the Table 6.4, summary of interviews with key informants, the policy of the government in wastewater treatment plant is not highly implemented and there is not sanitation act yet. Hence BASP and the Ministry of Industry and the Ministry the government body both are not sufficiently clear about the wastewater treatment in terms of environmental sustainability and operation and maintenance of the wastewater treatment plants.

6.2 Operation and maintenance of wastewater treatment plants

Wastewater treatment plants are not in full operation, with the exception of the treatment plants at Guheshwori (BASP and Thimi (SWTP) in the Kathmandu Valley. Huge amounts of money and effort have been invested in developing these treatment plants. Their status should be assessed and they should be repaired if necessary. Operation and maintenance of these plants will reduce the pollution of surface water significantly. Due to the problem of management, the Teku Wastewater Treatment plant is not operating in good condition (Dhundi, 2003)

6.2.1 Conditions of Sewerage System

There are still very old (18th century) sewerage systems in the Kathmandu Valley. At first they were designed only for the purpose of storm water but their use has been expanded with the rapid increase of the population in the valley (CBS, 2001). This has brought big problems with the blockage of sewerage even in the main road of the Kathmandu Valley. The population of BASP area was estimated in the design year 50,000 in 1996 and projection population up to 2021(25 years design period) is approximately 3.5 times more (Table 6.5).

Table 6.5 Population Projection

Projection Year	1996	2001	2006	2011	2016	2021
Population	50,000	64,000	82,000	105,000	134,000	171,000

Population Projection

$Pn = Po\ (1+r)^N$

Where,

Pn= New Projected Population

r = Growth Rate 5.1%

N= Projection Year

The total sewer line of BASP is 17 kilometres altogether

So the Number of people served (meters of pipes /person) by the BASP in the year 1996 was 0.34 meter of pipes /person as comparing with another country as Table 6.6

Table 6 6 Sewerage Serve per meter per person

Country/City	Year		mts/person
Brazil(Average)	1989		1.6
Brasilia	1989		1.2
Nepal(BASP area)	1996		34
Santiago	1990		1.4
Colombia,Bogota	1992		0.9

Source: Yapes and Dianderas, (1996)

BASP has lowest serve as compared to the other case studies, this is because the population of the project area is increasing rapidly and crossing the design limits. The numbers of industries are increasing in the project area due to insecurity in the rural areas. Most young people from rural areas are flocking to Kathamndu in search of jobs in these industries. The coverage area of BASP is not satisfactory and few people are taking advantage from the treatment plant. Where as SWTP can serve 1200 number of community people. Further here it is not possible for additional big industries to be

established in the surrounding area because Sunga is the old city and there is not enough space to construct industries in the upstream zone of the treatment plant in recent years.
So BASP has a big challenge to treat a heavy load or it has not capacity to treat heavy loaded influent but the probability of a heavy load in the sewerage in SWTP is comparatively low.

6.2.2 Blockage of the System

The blockage in the existing sewerage systems is a big problem in the study areas. In monsoon season there is heavy rainfall in the Kathmandu valley (1500 mm annual rainfall), but there is not any separate storm water drainage. So, almost average 55 % of industries, households and communities are affected by blockage problem of the sewerage system (Fig 6.3). The diameter of the sewer line in Sunga community is very small (18"). It was installed by Thimi municipality in 8 years ago. During the rainy season it is generally blocked due to the mixing of a heavy flow of storm water. However here due to the role of community management group, they will maintain the problem within a short period because they do not have to wait for approval from a higher level of authority. They have their one fund (bank account) from which they can arrange their fund with in a limit. If they have major problems in the design section then they have to consult either with the consultant or municipality but in the case of a centralized system such as a BASP there is much more difficulty for decision making even for minor maintenance.
In fig 6.3, Average 15 % of household and industry utilize the very old sewer system. People are not willing to spend money for the replacement of damaged sewer pipes even when they are suffering from the hazardous wastewater surrounding in the area. Although they are facing blockage problem more then once in a week, they are careless about health and impact that may be the result of a lack of public awareness. About 5 % of industries say that they have never had blockages in their areas. That means some of them have already installed big size sewer pipe, larger than the design flow and they are situated near the public sewer line and geographically these industries are at a higher elevation so they are not facing the same blockage problems.

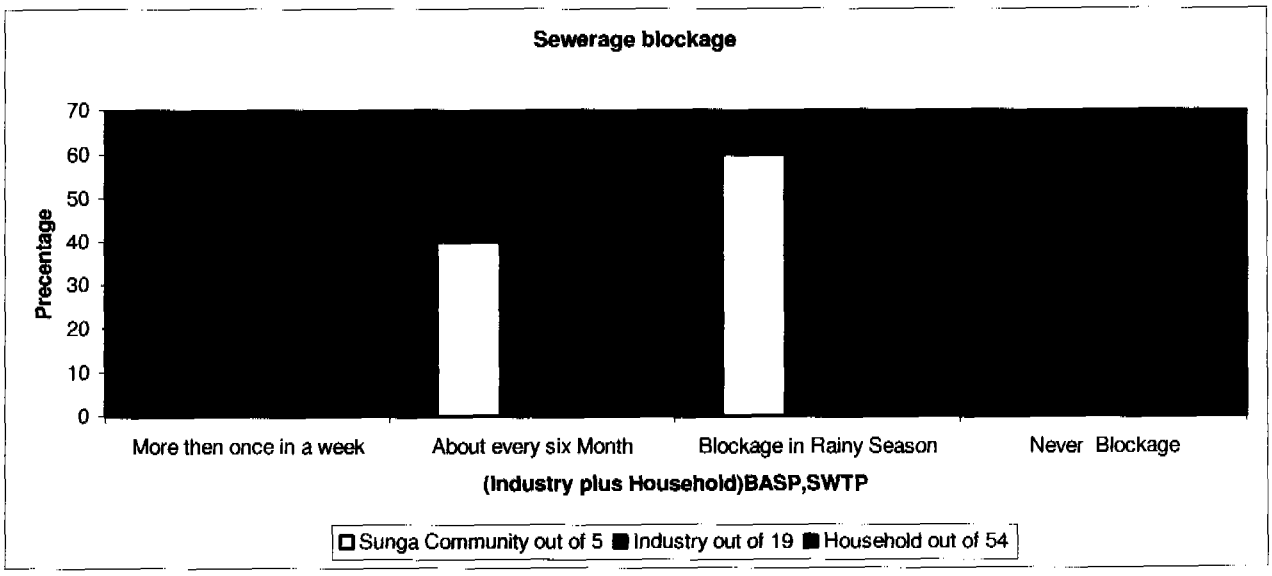


Figure 6.3 Clogging of the Sewerage System

Source: Field Survey,(2007)

The more we are advanced the more we utilize natural resources and consequently produce more waste products of various kinds. The local environment of urban areas in the country is worsening due to the lack of proper management of waste. Every citizen in the urban areas of the country is worrying about the littering of waste elsewhere. The problem is more serious in densely populated areas in Kathmandu Valley. The problem of waste is not only the concern of a group of people or a political party or the concerning ministry. It is the problem of all. Moreover, the policy maker and the waste management authority should take a more serious stance regarding the problem. The politicians and political parties are using the garbage of Kathmandu as a political tool to blame the rival parties for the mismanagement of the waste. What should not be happening is happening. There should be a strong political commitment to have an efficient waste management system.
Furthermore, garbage littering is the main problem causing the clogging of sewer pipes, which is a serious problem preventing the smooth running of the sewerage system in the highly urbanized areas such as the Kathmandu Valley.

I asked questions about the positive and negative views towards the existing wastewater treatment plant in the project areas. Since SWTP is operated by the community itself, all of the community members are delighted from the reed bed system in their community. Due to the support of EHPHO, people are aware how they can operate the system. If there is any problem in the community, on the leadership of the chairperson, a meeting is called immediately to solve the problems. However, there is a problem in urban areas such as the BASP project areas. Here people don't give time for such community works and on the other hand BASP does not provide good services to the household or even industrial sector.
Fig 6.4 shows that, in case of SWTP, all the community members have participated in the meeting and they formed the Sunga Wastewater Treatment Committee including 17 members of the community member. For this reason almost all community members are satisfied with the constructed wetlands (CWs) treatment plant. The conventional waste water treatment plant (BASP) is in the agriculture land areas and, the treatment plant had usurped the land of farmers with nominal governmental compensation rate and still many farmers have been unable to claim compensation from BASP. One farmer said that the management committee of the BASP is worst; their decision is not quite fair. He claimed that those persons with some political power had no problems for receiving compensation owed to them but that many of the poor farmers are still suffering from the project. So in the fig 6.4, 19 % of people household owner are against about the project.
The local people who have land surrounding the treatment area are mainly farmers and they have lost their land in the cheapest governmental rate for the project. These days also the farmers are complaining to BASP for the compensation of their land. Furthermore, even the BASP has been unable to widely motivate the industrial sector, so that 26 % of the industry does not want such a treatment plant sector in their area.

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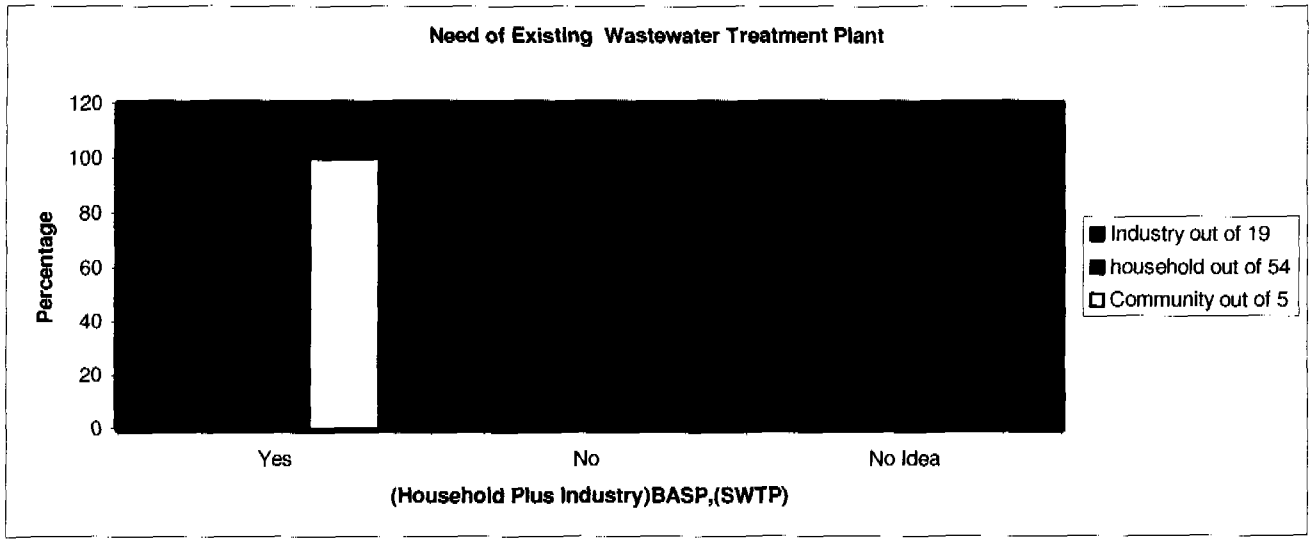

Figure 6.4 Necessary of the WastewaterTtreatment Plant in the BASP and SWTP

Source: Field Survey, (2007)

6.2.3 Human Resource Development

A lack of sound an institutional framework is the root cause of many failures in the service delivery and major causes of failed sanitation provision. Such institutional weaknesses often results from the lack of a clear institutional "home" for planning and management, together with limited capacity within institutions to co-ordinate and manage initiatives. Capacity building training is one of the most essential factors for achieving a well performing of system.

When I visited the laboratory of the BASP, the condition of the lab was not good, eventhough BASP is one to the biggest wastewater treatment plants. I asked the question to the head of lab about the capacity building training for the staffs of the laboratory. She replied that they don't know, even she hasn't followed any training for the operating of the lab. She has been doing the work according to what she knows .She was appointed on a contact basis. At that time she didn't know how long she would remain in the job because of the political pressure. The laboratory report was also not in good order. When I visited the Lab, even the Ph scale measuring instrument and temperature measuring instrument were not working properly. This raised fundamental questions for me. The BASP was established to treat wastewater, which should be their first priority. In order to perform this task with any degree of quality, it is essential that the daily lab report be accurate and maintained. Although the staff were completing laboratory works daily, without sufficient and accurately functioning measuring equipment, it would be difficult for them to find an accurate result and take the mitigation measures necessary to rectify the problems.

The mechanical engineer and mechanical overseers had also been appointed on a contractual basis. They have been carrying out their work, but didn't have sufficient knowledge about the operation of the treatment plant. According to them they had never followed any workshops or training in the related filed which could provide them more knowledge about how to better handle the system. The result is that if there are problems in the mechanical section, the BASP management committee has to either invite the expertise from the international market or the system should be stopped. At this

moment, two heavy pumps are not working properly; they are in need of expert help for their maintenance.

Even the sub engineers in the civil trade working for BASP have not followed any training concerning about wastewater treatment plant. Many of the systems are operating manually but I have noticed that BASP was even unable to provide even safety tools for the labourers in the treatment areas. I asked to the concerned authority about this problem and they replied that due to the financial burden they have a limited budget so they have to control in every sectors.
From the above discussion it is cleared that the human resource development policies in the BASP is not satisfactory.

6.2.4 Lack of management expertise

Even where policy makers accept the validity of the decentralized approach, a lack of capacity to plan, design, implement and operate decentralized systems is likely to be a severe constraint on efforts to ensure its wide adoption. Even in the United States, the Environmental Protection Agency concluded that lack of management was a major barrier to implementing decentralized systems. The management arrangements and responsibilities for operation and maintenance must be considered in relation to the capabilities of the individual householders, community groups or government departments. Therefore, where a system requires that ongoing operation and maintenance tasks are devolved to individual householders or community groups, it is essential that responsibilities are clearly explained at the outset. Planning and implementation of wastewater re-use systems at the neighbourhood/user level will only take place successfully when the need for improved systems has been "internalized" by members of households and communities.
The sustainable operation of decentralized wastewater management systems must be compatible with the knowledge and skills available at the local level. Although even the simplest technologies often fail in practice due to a lack of attention to operational and maintenance requirements, decentralized management may provide opportunities for these tasks to be carried out correctly by local stakeholders, who have a greater incentive to ensure that facilities continue to perform as intended.
The reed bed type wastewater treatment in the Sunga community is the natural flow type and there is not need of any mechanical equipments and even the flow is gravitational flow so no need of pumping for sewerage treatment. Local community people can handle operation and maintenance system after receiving some training from the concern authority.

6.2.5 Opinion of key informants on the operation and maintenance of wastewater treatment plants

Table 6.7 Operation and Maintenance

Questions	Common Answer from Government Authorities	Common Answer from Experts and Donor	Remarks
The percentage of the coverage in the sanitation sector and wastewater treatment plant in Kathmandu Valley.	As a whole we have about 46 % coverage in sanitation but in wastewater treatment plant ,BASP has so called capacity of 16.4 MLD not more then 4 MLD from another sector	About 33% wastewater is treated and remaining 67 % is disposed into the tributary of the Bagmati River.	Present conditions of the BASP are not satisfactory; the pumping mechanism is not working properly. Chemicals for the treatment process are not available sufficiently.
How often are the capacity building training courses offered regarding the operation and maintenance of the wastewater treatment plant?	No special training for operators, some workshop related about wastewater treatment plants were organized during the establishment period.	There is no special training package for human resource development focusing on the wastewater treatment plant, But in community based system NGOs are actively providing eco-friendly waste management in the peri-urban areas.	From the individuals interviewed from the BASP staffs, It is found that there are no permanent staffs who had taken safety and operating training neither externally nor internally.
Is there any complaint about the existing wastewater treatment plant from the local people?	Yes, in BASP, there are problems with the hydraulic pumps and grit chain causing heavy odour in the pick hour So many complains from local people about odour and compensation of their land.	In Sunga Community, the system is accepted by the community and characteristic of the waste is domestic so comparatively less odour. No complaints about the odour as they have to manage themselves.	Although BASP is the biggest wastewater treatment plant, due to unmanageable flow, the system is not performing well. But Sunga is small community presently so the flow can be controlled by the community themselves.
How many staff is required for the operation and maintenance of the treatment plants?	Out of 38 staffs at the BASP, 10 are engaged in the operation and maintenance of the treatment plant and the rest are in the administrative section.	Although 17 numbers of the management committee are there, only one regular staff is dedicated to operating the system that the community has to pay.	Although BASP is not comparable with SWTP, the purpose of the BASP is to treat wastewater; Politically appointed temporary staffs are more, not utilizing the staff in the productive output.
Is the staff arrangement in the project is satisfactory?	No, managerial sector is not perfect; There is a lack of well trainer and skilful operators.	Management committee is not perfect in decision making in BASP but ENPHO as well as donor agencies are supporting for the public awareness programs in SWTP.	The instability of the project manager and other staff is the main problem in the BASP; Arrangement of the staff is not properly managed.

Form the above evaluation Table 6.7 the operation and maintenance system is lack behinds in all operation and maintenance indicators but with the support of donor agencies, NGOs supporters and community group involvement, comparatively operation and maintenance system of community based seems more effective.

6.3 Revenue Generation

6.3.1 Financial Basis of WWTP

One of the previous researches has been done by Mr Pradeep; he had compared Kudku (wetland stabilization ponds) with BASP and another reed bed wastewater treatment plant system in Dhulikhel (Kathmandu University) in Table 6.8.

Table 6 8 Operation Cost of Different WWTP

S.No	Description	KODKU	BASP	KU
1	Operation cost in volume basic	.08	2.78	2.15
2	Operation cost per capita serve per annum(Nrs)	4.6	184	61
3	Land use(gross) per capita(m2)	3.3	0.37	5.4

Source: Pradip, (2005).

Higher power consumption and supplicated electromechanical components are required for operation and maintenance of oxidation ditch where as no such complexity are in wastewater stabilization ponds (WSPs) and reed beds systems. The O &M cost of CW is far higher than the WSPs. He recommended that in the developing countries like Nepal the WSP system seems to be the best option if the land is available. The land of the Kathmandu valley is very expensive and very difficult to find open spaces for constructing the WSPs type of wastewater treatment plant.

The already constructed wetlands treatment plant is not working properly and some of them have been already been closed. The main causes of aggravation of the systems in the Kathmandu valley are due to the lack of proper management and financial limitations which I can identify after consultation with more then 24 key informants.

Table 6.9 Operation and maintenance cost

Operation and Maintainance Cost	O & M in per cubic meter in US $,(Periz,1993)	O & M in per cubic meter in US $ (Kathmandu valley)
Mechanical Plant	0.0001 to .0007	0.0427
Constructed Wetland	.00006 to.0001	0.033

From the Table 6.9 the operation and maintenance cost of both systems in the Kathmandu valley is expensive as comparing with the standard cost rate (Periz, 1993). Although the labour charge is comperitively cheap in Nepal but all tools and equipments must have to taken from international markets and the Constructed watland has covered minimal areas so it seems expensive as comparing with standard limit.

The construction cost of the BASP sewerage treatment plant excluding tunnel construction was NRs 141,779,830 (2.02 million US $) (BASP, 2007) and the average annual operation and maintenance cost of the system is NRs.10, 624,000 (0.15 million US $ /year).

Similarly the construction cost of the SWTP is Nrs 20, 00,000 (0.02 million) and operation and maintenance of the SWTP is approximately Nrs 50,000 per year (0.0007 million US $/year).

It is very difficult to compare between two different systems, both are individually different technology and the waste characteristic are different and coverage area and capacity are quite

different (16.4 MLD by BASP and just 50 cubic meter in SWTP).The main interest of the chapter is to know what are financial sources to operate wastewater treatment system.
Regarding the technical audit report of BASP completed by the register auditor office 2001/2002, the total desired for expenditure of BASP was 548 million and 497 million has been already expended at the end of technical auditing period meaning that about 91 % had been expended earlier.
According to the report of the BASP, it has been spending Nrs10, 624,000(0.15 million US $ /year) in the office operation and maintenance items, among them it has been paying NRs 5.96 million per year (.08 million US $/year).for electricity charges That means more than 50 % of the total O&M cost has been spent on the electricity charges. Even the electricity authority office has been providing electricity at a subsidised rate for the high power committee.
Currently Nepal suffers from the insufficient electricity production. There is 6-8 hours electricity cut off per day, at that time BASP had to use a mechanical generator has run on using diesel fuel for the production of electricity. There is also a scarcity of diesel because Nepal has no fossil fuel sources leaving it fully dependent on the international market. In such crucial conditions there are big question marks about the sustainability of the BASP.
Energy Consumption
Plant equipment such as raw sewerage lift pumps, rotors, sludge pumps and the area lighting all consume electric power. The sewerage lift pump that pumps sewerage from the wet well to the grit chamber is runs 24 hours on and off depending on the sewerage level in the wet well. The rotors in the oxidation ditch are also run continuously. Sludge pumps are used occasionally to de-sludge the clarifiers and the oxidation ditch when required. For security purpose electric lights have to be provided in the plant area. Alternatively SWTP has not faced such problems because it has been operating in a natural way.
As far as the economy of the project is concerned, BASP investment on the project exceeds NRs 650 millions (9.28 US $). According to the Managing Director of the BASP, the pay back back period of the project investment is justified in terms of the environmental up grade of the once pristine Bagmati River/Bagmati area. The residents of the valley and all religious Hindu people around the world will benifit as it has extensive social religious and cultural significance. Moreover this project serves two prime purposes:

- Human Health
- Prevention of pollution

But here it is unclear after finishing of the project duration about who is responsible for sustainability in case of financial for operation and maintenance of the project. Millions of rupees have been spend on operation and maintenance of the system. But according to annual budget for 2007-2008, if there are any problems in the mechanical (heavy machine) or its replacement, then there will be budgetary problems. This is clear from the budgetary sheet in Annex 5. The account section has not sanctioned enough money even for acquiring chemicals and laboratory equipments as which I noted on my field visit.
Asking a question about tariffs of BASP to ex-project manager, He replied that BASP is fully relies on the subsidies.It is under the Ministry of Physical Planning and Works (see organization structure of BASP). The Ministry has been distributing the yearly budget to the BASP.BASP has to submit a detailed account to MPPW quarterly before being granted next installment budget. The detail monthly expenditure cost of BASP is in Annex 6.
The cost generation from the consumer group of BASP is not an easy way although this was the thinking in the design period. Separate wastewater treatment charges were foreseen to be collected from the individual household and industry level within the project area. However there were too many constraints for implementation of that type of purpose. Most of the people who have a NWSC

connection have been faced with 50% addition cost on their water meter reading cost or fixed cost as a sewerage cost to NWSC. From NWSC it goes to the MPPW account in an indirect way, so it is very difficult to determine how much money has been collected from BASP area for the use of the sewerage and wastewater treatment facilities.
I asked also the question about the tariff system to community groups of both project areas(see question in Annex A11),in Fig 6.5 ,about 56 % out of 54 domestic household in the BASP area are expecting either the support from the donor agency or support from the government subsidy for financial sustainability of the existing treatment system. Only 7 % of domestic consumers in the BASP area said that they didn't have any ideas because most of them have already paid the charge to NWSC with water metering (fig 6.9). The results of the industrial area and the household area in the BASP, 37 % of the respondents gave their logic about the polluter pay principle for the financial sustainability of the wastewater treatment plant. Similarly 40 % of the Sunga households are willing for the polluter pay principle.

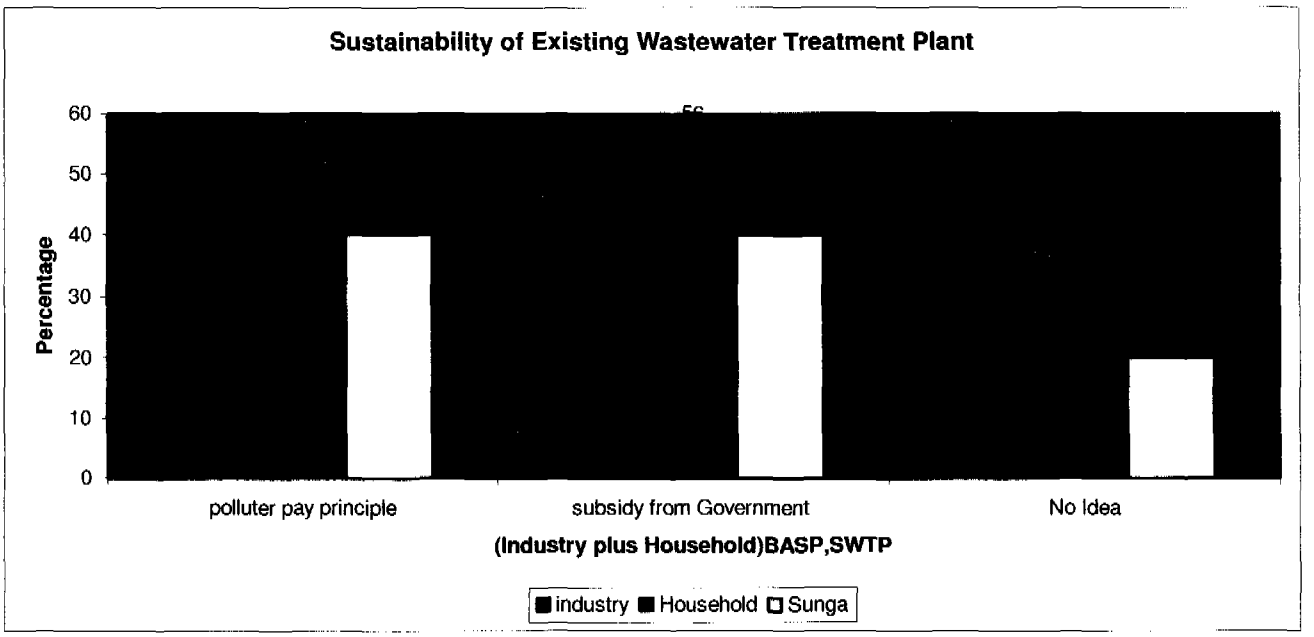

Figure 6.5 Sustainability of the WWTP in terms of cost recovery

Source: Field Surver, (2007)

BASP has to invest a monthly budget in operation and maintenance of the sewerage treatment plant, sewerage maintenance (Fig 6.6), staff salary in administrative and WWTP section, land acquisition, road and greenbelt maintenance. But the income of such a mega project (in the contest of WWTP BASP is the biggest WWTP in Nepal) there is significantly less amount of money generated by the selling of byproduct (sludge manure). This amount is negligible compared with the monthly operation and maintenance cost of the project.
Just how long the project will be able to operate if it has not enough money for operation and maintenance and there will be big problems in the maintenance and replacement of any costly mechanical equipment, is the most burning question about the project and a very difficult one to find the exact answer.

In the case of community based wastewater treatment, the monthly operation and maintenance expenditure of the project is much less and there is already agreement between Sunga wastewater management committee and Thimi Municipality which has been providing Nrs 50,000 (715 US $) per year for operation and maintenance services. From the field survey I have found that one of the BAL Premi Primary School is using the treated effluent is used for the flushing of school toilets and gardening, where 411 pupils are studying and there is also scarcity of water in that area (Fig 6.6).
So from the above discussion, the affordability of the BASP in the sector of O &M expenditure is challenging and it's necessary to think about the future of the project. Comparatively SWTP has fewer problems because it is a small project and uses of local materials for treatment purposes. There is no need of electricity and no need to highly skill operator. Although the coverage area of SWTP is vary small as comparing with BASP, the system of management is seems rather effective in decentralize system in the developing country like Nepal then centralize concept of the management.

Cost Expenses diagram

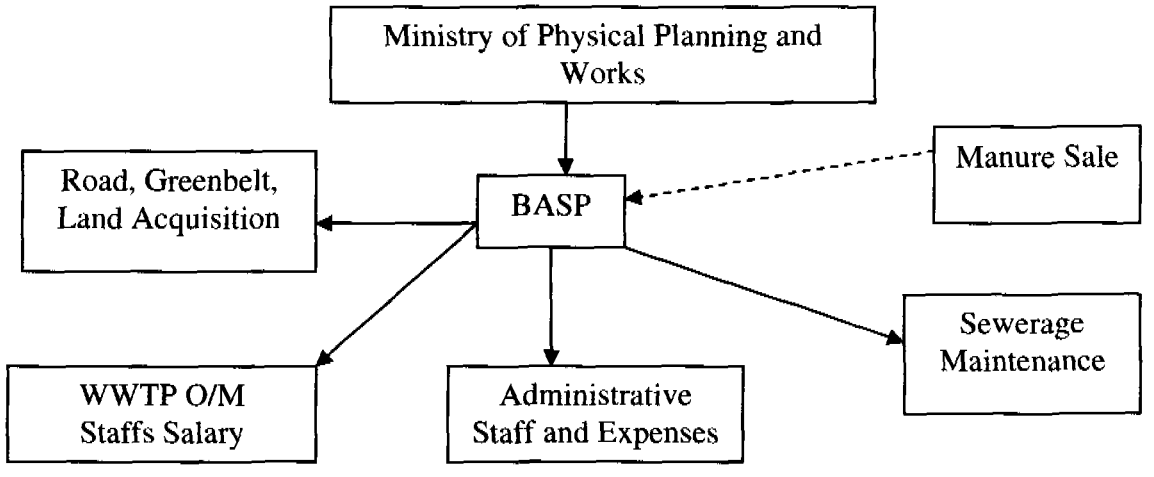

Figure 6.6BASP cost expenses

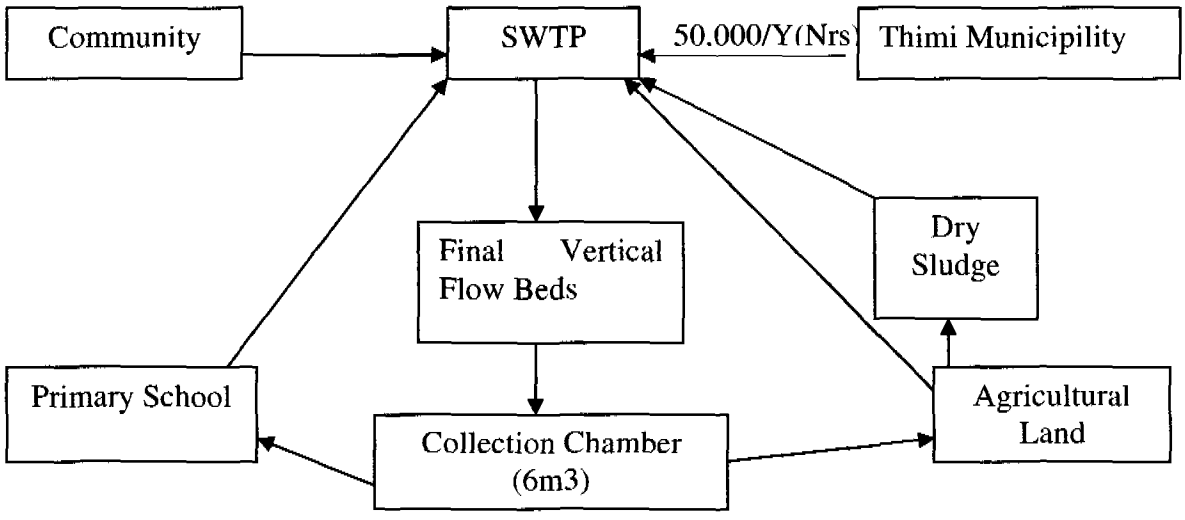

Figure 6.7 SWTP cost Expenses

In fig 6.7 there will be the option of the income generation of the wastewater treatment plant (SWTP). In the down stream there is agriculture land; farmers can use the treated water in their farms in the near future. The treatment plant is fully dependent on the decision of the community i.e. they have full authority to improve the performance of the treatment plant. The dry sludge can be used in the agriculture farm, similarly treated water can be used in the agriculture farm on one hand and the Bal Premi school can use the treated water in another hand in the school. So that the there are three opetions of income generation in the SWTP.

Construction Cost and Operation and Maintenance

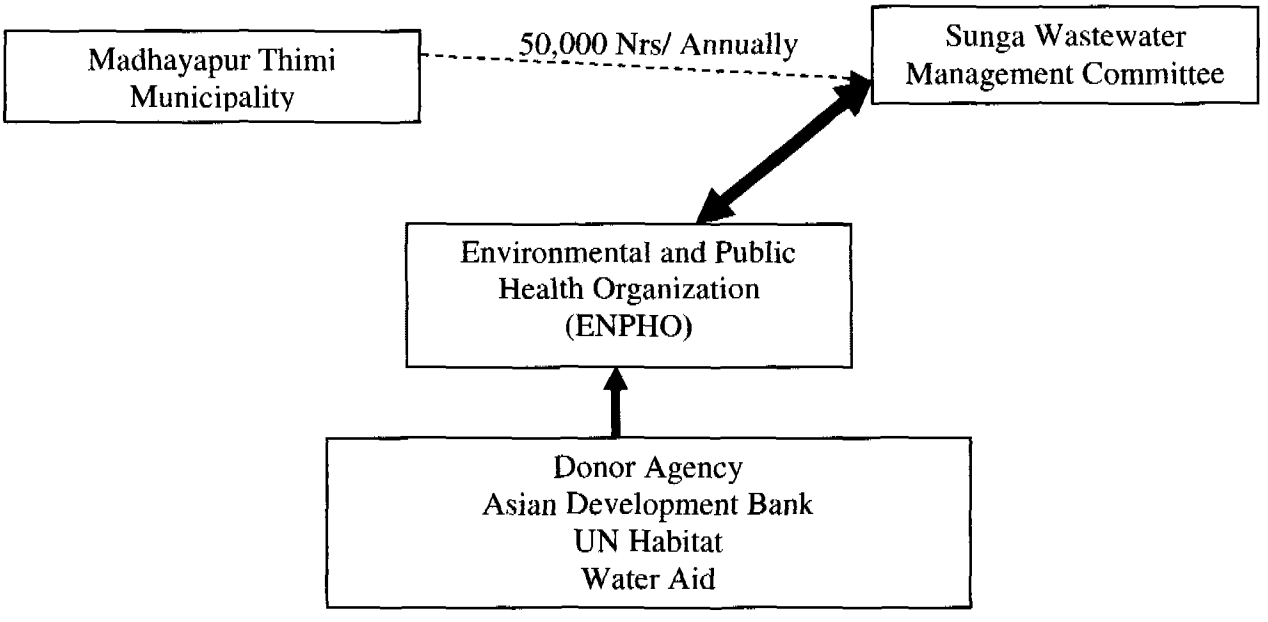

Figure 6.8 Construction Cost and O/M Cost

Fig 6.8 corresponds to how the financial income is generated for the construction and operation of the treatment plants (SWTP). ENPHO is playing the mediator role being the consultant in construction period and ADB, UN HABITAT and Water Aid are supported financially for the construction of the treatment plant and the Thimi Municipality has provided 1500 m^2 land. The municipility is ready to provide NRs 50,000 per year for the operation and maintainance of the wastewater treatment plant.

Table 6.10 Construction Cost for SWTP

Activities	ADB-PDA(US $)	UN-HABITAT(US $)	Water Aid Nepal(US $)
Community Scale RBTS	28,000	10,000	6,000

Source: ENPHO,(2005)

The fig 6.8 and Table 6.9 show that the community people of the SWTP are not paying for treatment plant, they have been providing the labor service that the management committee needs for the wastewater treatment but they have been paying water service either in water metering or none metering. ADB has provided 28,000 US $, UN- HABITAT 10,000 US$ and Water Aid 6,000 US $ for construction of WWTP. In the Fig 6.9 and 6.10, 70 % of the household people in the area of BASP are paying water tariff to the NWSC and they have paying the charge on the basic of water meter reading. Only 33 % in the industrial sector has meter connection and among them 58 % have paid the bill. Similarly in Sungatole 34 % has meter connection and only 20 % have paid bill amount. Most of the people of Sunga community used water from traditional public taps or extraction from the ground similarly industries are heavily extracting ground water even for their business purposes so they are using free water which is not legal.

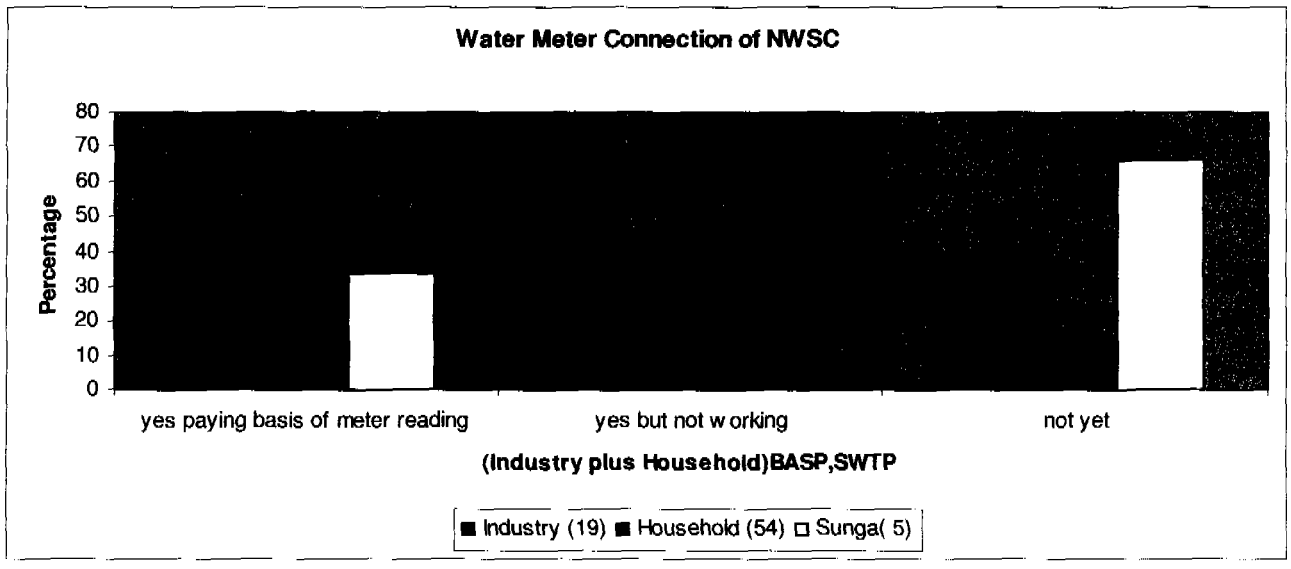

Figure 6.9 NWSC Connection

Source: Field Survey, (2007)

There is policy of the NWSC for the collection of wastewater treatment plant. It has been taking an extra 50% charge of on the water bill for the wastewater charge. In the average case of Kathmandu valley, there is unaccounted for water (UFW) value is more then 60 %. So there, the NWSC could not able to collect the operating and maintaining cost even in the drinking water sector. Therefore it is impossible for the cost recovery for wastewater treatment plant form the NWSC based on such scheme.

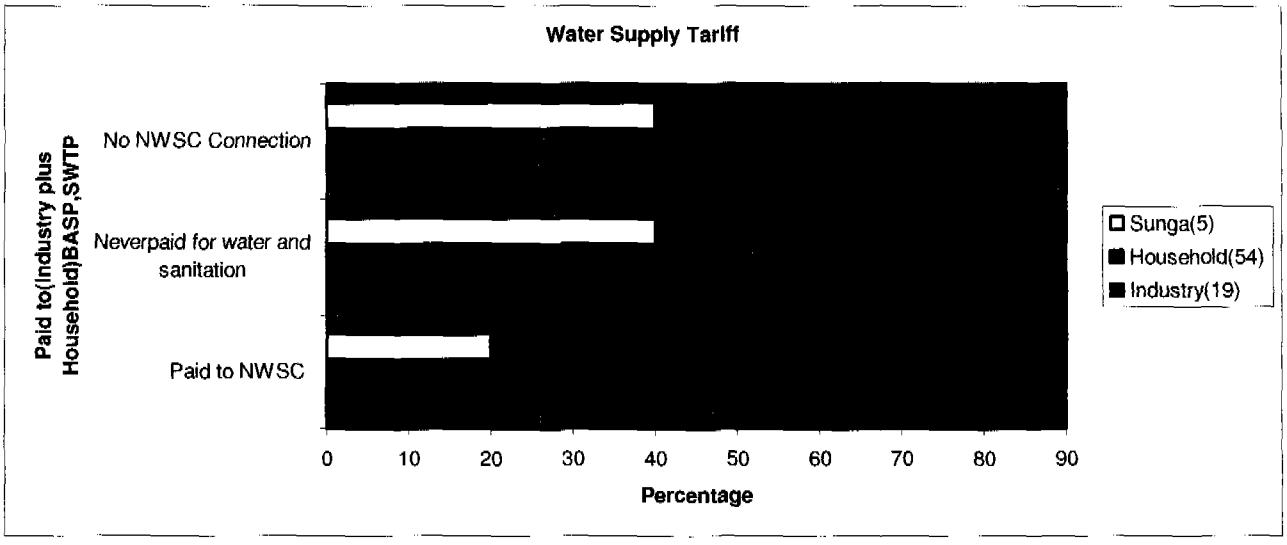

Figure 6.10 Water Supply Charge

Source: Field Survey, (2007)

The SWTP is functioning since November 2006. The reed bed plant collect wastewater from the community (200 household) in the Sunga Tole locality in the Thimi municipality as well as from a primary school where 411 students. On an average 60% of common household wastewater is grey water. The treated water from the vertical bed is collected in the 6 cubic meter collection chamber.
Besides the treatment efficiency of the septic tank, recycling and reusing the water and wastewater is now of growing interest around the world and very important in a city like Kathmandu. Drinking water demand in Kathmandu valley was 121 MLD in 1994 but Drinking Water Supply Corporation was able to supply only 88 MLD (Annual average). Due to 40 % losses in the supply system only an average 52.8 of MLD drinking water was available in the valley. The situation now is very bad since the demand was expected to be 209 MLD in 2001 (NPC/IUCN, 1995). In spite of having such a problem supplying drinking water is being used in several domestic purposes such as flushing the toilet, washing, bathing, watering in the garden, vehicle cleaning, etc. and also used by hotels and small industries in significant amount. It has been estimated that the star-rated hotels alone are using about 2.5 million liters of waters per day. Therefore, a huge quantity of supplied drinking water is being used for non drinkable purposes. In this respect, recycling of grey water could be an attractive solution to some extent.
Current levels of tariff collection are inadequate to build and operate wastewater facilities to serve the community. There is no broad based program for assessing fees to industrial, commercial or other large wastewater dischargers who stress the system. And finally, there are indications that there are wastewater system users who never pay anything either because they have their own water sources or because they have illegal connection. These aspects argue for reform in the ways in which users are charged for the wastewater services they receive now and for the services that will be needed in the future to protect the common environment.

6.3.2 Financial advantages of decentralized management of wastewater treatment plant

The capital investment for decentralized wastewater systems is generally less than for centralized systems in peri-urban areas, and they are also likely to be cheaper to construct and operate. By tackling wastewater problems close to the source, the large capital investment of trunk sewers and pumping costs associated with centralized systems can be reduced, thus increasing the affordability of wastewater management systems. Decentralized approaches to faecal sludge collection and disposal are particularly appropriate for Peri-urban areas, as they reduce haulage distances and thus reduce the cost of transportation. In some cases, the investment may require little more than improvements to existing informal wastewater collection systems and the introduction of an appropriate form of treatment prior to disposal or re-use.
Although economies of scale mean that decentralized treatment facilities will tend to have a higher cost per person served than centralized facilities, the incremental increase in per capita cost is likely to be fairly small where unsophisticated technologies are used.

6.3.3 Financial Comparison

It is attempted to compare two biological treatment plants located in the different city in Katmandu valley. The financial comparison was made between extended aeration type of oxidation ditch at BASP and constructed wetland (Reed Bed type) Treatment plant at SWTP.

Table 6.11 Financial Comparison between Treatment Systems (Just OD and CW)

SN	Description	BASP	SWTP
1	Flow (m3/day)	16416	50
2	Construction cost Rs. in thousand	141580	1500
3	Operation Cost per year in thousand	10600	50
4	Land use per m3(in sq meter)	.06	30

Although BASP has been providing the wastewater treatment service of about 100000 design populations (but unregistered more than 100%) that means approx 200000 populations (CBS 2001) similarly the flow of BASP is very high as comparing with SWTP. The yearly operating cost of BASP is very high but no cost generation. The land requirement for treating per cubic meter wastewater in SWTP is 50 times more then OD (Table 6.10)
Past experience shows that, if simple and cheap wastewater treatment process such as WSPs and CW are not properly maintained then it is very difficult to sustain and keep affordable for the expensive and sophisticated methods like oxidization ditch (BASP). This is very difficult to maintain with the self cost recovery from the project itself.

6.3.4 Opinions of Key Informants on the Financial Resources

Table 6.12 Financial Resources

Questions	Common Answer from Government Authority	Common Answer from Private and Donor	Remarks
What are the income sources of the existing wastewater treatment plant?	BASP was constructed with the financial support of the government sector (6.7 million US $) and DRF (Japan) (1.7 million US $).BASP does have not any bio-gas plant but only a dry sludge bed and a negligible amount is collected by selling dry sludge as a manure, All operating cost of BASP is received as a subsidy amount from the MPPW	There is no any income generation at the present condition.	Both treatment plants are not generating income. In the both areas customer are paying sewerage costs 50% extra to the water charge. But in the BASP area there are many industries, they are extracting ground water illegally and disposing huge quantity of wastewater but they are never paying any charge.
If the system doesn't not have an income source what is the financial sustainability of the system?	The payback period of the project investment is justified in terms of environmental upgraded of the once Pristine Bagmati River. The residents of the valley and all religious Hindu people around the world will benefit as it has extensive social religious and cultural significance. So BASP serves two prime Purposes Human Health, and Prevention of Pollution	The financial Sustainability of the BASP is uncertain. The performance of the operating system is declining day by day. The concentration of wastewater is increasing due to heavy load of industrial wastewater. But SWTP is a smaller plant that needs less money for operation and maintenance is required less	The treated water from the SWTP has been used in the primary school and can be used in agricultural farms; community can received certain amount from the users in near future.
How much money is needed for operation and maintenance of the projects?	BASP is more costly wastewater treatment plants. It has its own significant and bio-gas can be produce from the system. About .15 million US $ is expended per year as operation and maintenance cost. Among them approximately 50% charge has to be expended only in the electricity charge along per year	BASP need a huge amount of money but the output is not satisfactory. Less money about (715 US $) is sufficient for operation and maintenance of SWTP because community has been providing free labour services. The construction cost was provided by the donor agencies.	On the field visit to the BASP, it was noticed that there was financial deficiency, even for small laboratory equipment and chemicals. There was 36 hours load setting in a week, Heavy generator should be operated at that period which is comparatively high expensive and unaffordable by the BASP.

Which is the more sustainable wastewater treatment plant in terms of finance in the Kathmandu Valley?	Centralize wastewater treatment plant like BASP is essential in the city core areas where enough land is not available.	ADB has deducted 14 nos of purposed conventional wastewater treatment plant by the previous study and it recommended only 5 nos of such conventional wastewater treatment plant and gives more priority to reduce quantity of wastewater from the source and promote eco-friendly wastewater treatment plant.	The history of wastewater treatment plant presented that large scale of wastewater are not operating properly and NWSC has not handed the project successfully. But the reed bed treatment plant (RBTP) is operating in good a manner since 1992 in the Dhulikhel hospital is one example.

From the above comparison Table 6.11, the conditions for cost recovery of both treatment plants are not satisfied. They don't have their enough resources. BASP has to fully depend on subsidies from the government and SWTP has received support by Thimi Municipality for annual operation and maintenance cost. There is the possibility to find financial support from SWTP by selling the treated effluent water to the primary school and in agriculture farms. But the present condition about the financial basis of the BASP is worst, the treated water and by pass water(over flow) is mixed in a common manhole (M9) and from the river crossing the mixed effluent passed through the tunnel at the downstream of the Pashupatinath. Temple. In the present condition, due to the national economical scarcity (Ministry of Finance, 2008), the budget for water and sanitation is not sufficient there is national financial crisis, so chipset and eco-friendly type of wastewater treatment plant is the most stable.

6.4 Quality of the Wastewater Treatment Plant

The quality of the treatment plant is one of the main indicators to demonstrate the performance of the treatment plant. The management sectors also play an imperative role for the improvement of the quality of the wastewater treatment plant. I have studied the lab report of both wastewater treatment plants and have tried to find out which system is providing the best performance in terms of quality of the effluent.

6.4.1 Environmental and Economical Aspect

According to.ex-project manager of the BASP, localized system of wastewater treatment plant is most suitable in case of operation and maintenance cost and he also pointed out that the easily learned technology is more easily accepted by the local people as compared with the technology required for the centralized concept.

The programme coordinator of Environmental Science (Institurte of Engineering) agreed with the above statement and he said that enough land remains in Kathmandu Valley to construct the WSPs or CWs. He asked a question why the government is not seriously thinking about the existing WSPs treatment plants. They have a high capacity to treat wastewater of Kathmandu valley. The Project officer of Nepal Resident Mission (ADB) is worried about the present situation of the wastewater treatment plant. ADB has planned to construct 5 conventional type wastewater treatment plants and more CWs. According to her selection of the type of wastewater treatment plant depends on the location and availability of finances. She claimed that constructed wetlands are suitable for individual institutions and small communities whereas WSPs are suitable for the

industrial sector, semi- urban and urban area at least 500m away from settlement and oxidation ditch is suitable for urban area where enough land isn't available. The Managing Director of ENPHO, said that we need a conventional type of the treatment plant in the city core area where the land is not available but the service from the management committee should be good and it has to apply the polluter pay principle for financial sustainability. But in peri urban and rural area the WSPs and CWs concept is the better one.

Since the care of the community people and the concentration of wastewater are not very high as compared with BASP, about the question of odour in fig 6.11, 60 % out of 5 said that they don't notice the odour. On field visit, I also didn't notice a bad odour from the SWTP surrounding area but in the period of overflow in rainy seasons according to operator they feel quite smell. Average 78 % of industrial cum household are facing odour problems in the BASP. Only Average 23 % of BASP area people perception was not too much odour.

In the Early morning many people walk along the road near the girt chamber, but there are no any chemical treatment used as chlorination in inlet and outlet so in the peak flow period there is a high stink from the wastewater treatment plant. On fig 6.12 average 74 % population of the BASP area is facing most odour problems in the 9 am to 12 noon, peak flow period. But in case of SWTP, as in figure 6.11 in Sunga 40 % replied no too much smell. So From the above discussion, it can be concluded that the odour problems in BASP is comparatively higher then SWTP. So, BASP has to do lot of activities to build public support before rolling out the next steps

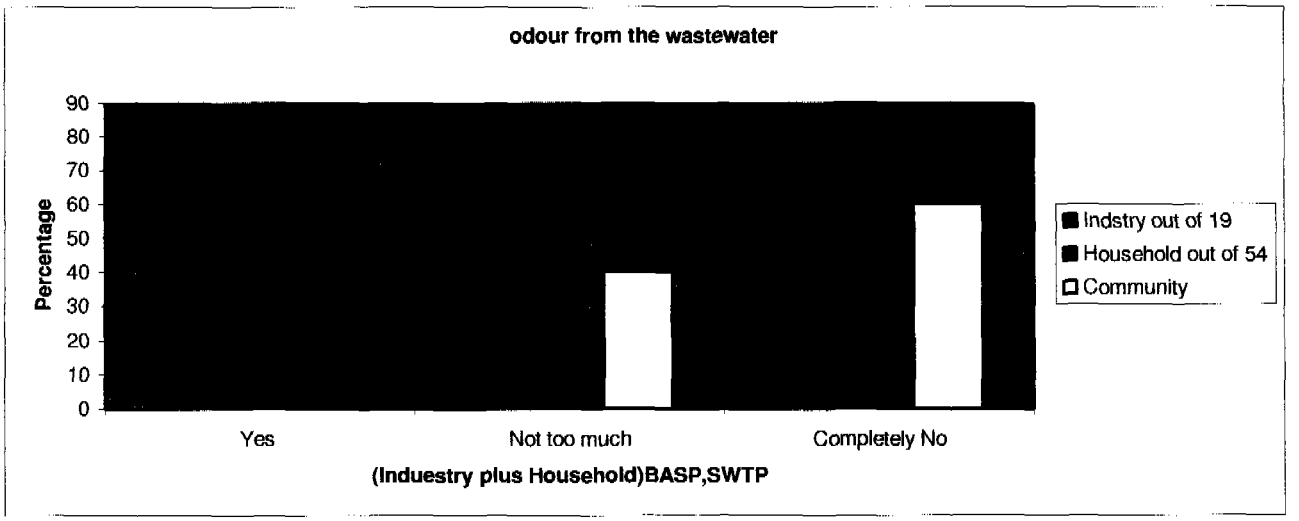

Figure 6 11 Odour Form Wastewater Treatment Plant
Source: Field Survey, (2007)

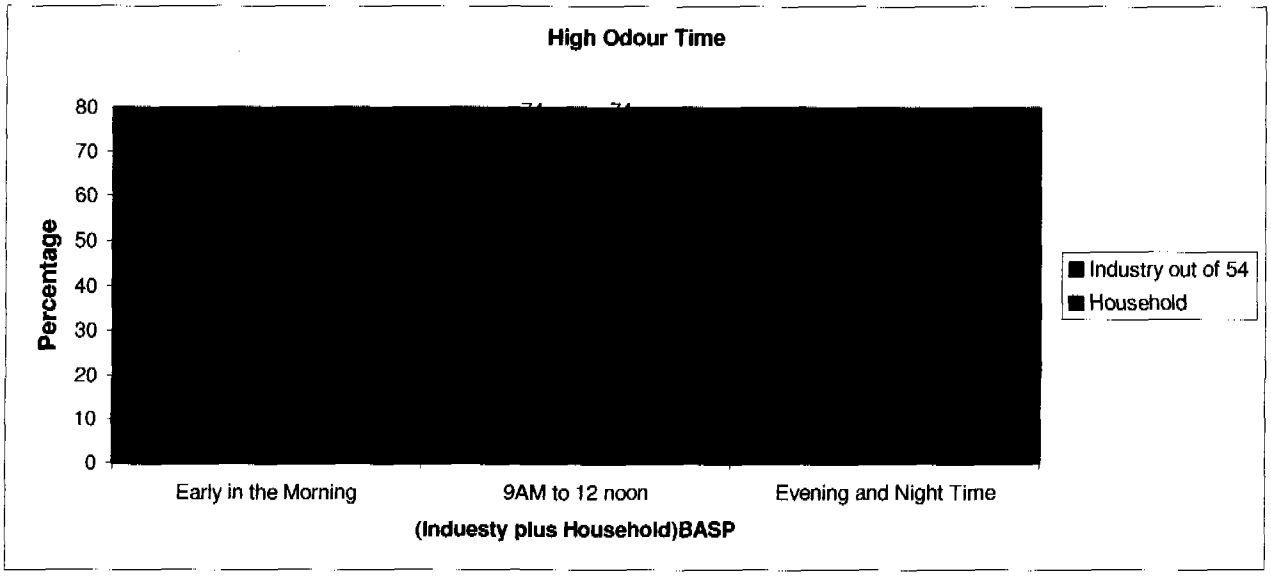

Figure 6.12 Level of Odour
Source: Field Survey, (2007)

For the prevention of offensive smell and reducing bacteria, it would be better to use chlorine dosing before and after the treatment of sewerage. This will also reduce the flies and helps to reduce the BOD of the sewerage. (Birde, 1998).However, on my inspection I found no signs of chlorine dosing in the treatment plant. And when asked to the lab in-charge then I got the answer that the BASP management committee is not concerned about such matter even though they know about chlorine dosing in the treatment plant is essential. It indicates that BASP has been careless to public health, although initial prospectus was over ambitious.

6.5 Option of the wastewater treatment plant

The lecturer in Institute of Engineering in sanitation sector who is also the team leader for doing the feasibility study and detailed engineering design to update the Master Plan for Bagmati Area Sewerage Project (Final Feasibility study,2003), explains a simple design and eco-friendly wastewater treatment plant is essential for Katmandu valley. Most of the industries are located near the Bagmati River are not doing pretreatment of their wastewater before disposing it in the main sewerage line of BASP,although there are already standard set about the quality of effluent from industry by MoEST. He is not satisfied from the action of monitoring activities from both ministry level and BASP. The regulatory body should monitor the project areas and they should be able to charge the industry and even at the household level if their effluent quality is not within the standard level. But according to him, he does not know of any induestries where the fines for breaking the standards have been yet. He also mentioned that the BASP is not functioning very well due to the lack of proper management. He has no suspicions about the technical design of the sewerage treatment system except for the tunnel which is being used for bypassing the treated or untreated sewerage from Tamraganga to Tilganga.
In regards to the unsatisfactory the tunnel construction he replied that if the efficiency of the treatment plant is satisfactory then the people should be aware that after treating wastewater in proper order, there is no any environmental and social problems for mixing the effluent in the Bagmati River

near treatment plant. He made the following recommendation about the wastewater treatment plant in Katmandu valley.

- Treatment should be natural required less human resources and less operation and maintenance cost
- Simple design and eco friendly waste water treatment is essential for Katmandu valley
- Proper and sufficient water, wastewater, solid waste management, pollution acts, raw treated drinking water quality standard,treated domestic and industrial effluent standard,air emission norms, should be established
- The government should give more priority to the human health sector, health and sanitation, portable water supply,proper waste water management
- Public awareness raising programs should be conducted through media, test book ,literature ,training seminars
- An integrated and system approach should be considered for project formulation and implementation for its sustainability
- Cost effective low O&M cost, highly efficient, environment friendly, durable, sustainable compacted, compatible, simple ,local material to be used and proven technology, structures, material should be used and promoted
- Effective rules and regulation should be developed and fine, revenue, tax systems should be strictly applied for pollution control ,polluters pay for pollution principle should be applied
- Decentralization policy should be forwarded, effectiveness of family planning,health and hygiene, sanitation ,solid waste management should be improved in planning way
- Individual head of the section,department and related government and non governmental organizations (GOS, Ingo's, NGO) should bear the responsibility for their decisions, work as a whole

From the above recommendation, the decentralized policy should be forwarded in the sector of water and sanitation. Cost effective and low operation and maintenance, high efficient and environmental friendly and sustainable structure is needed. His team has recommended constructing 14 more conventional type of wastewater treatment in Bagmati Catchments in the Kathmandu Valley. According to him Constructed wetlands is not a sustainable structure for the future generation. There is unclear statement, once he tried to recommended low cost operation and maintenance in one hand and an the other hand eco-friendly and decentralize concept but in his studies he has recommended 14 more conventional wastewater system needed in the Kathmandu valley so there is puzzlement in his statements

The technical advisor, UN-HABITAT, who is the promoter of the constructed wetland treatment plant, claimed that, CW is one of the best wastewater treatment technology in developing countries.The decentralization concept is more applicable in such a developing country. Financially viable, less operation and maintenance costs and easily handed technology is desired. He had introduced CWs in Nepal by constructing a treatment plant in Dhulikhel in 1992, which is still operating to this day. About the best option of the treatment plant, he replied that it depends on the location and availability of fund. The cost of construction of a conventional wastewater treatment plant is higher than CW excluding the land cost. He has raised a question for the financial sustainability in the operation and maintenance cost of the conventional type wastewater treatment plant like BASP. So he vigorously supports the decentralized type of wastewater treatment plant which is most suitable in the case of economical and easily operating and maintaining system in the developing world.

He has explained the CWs is a shallow basin filled with some sort of substrate, usually sand or gravel, planted with vegetation tolerant of saturating conditions. These systems utilize wetland plants, soil and their associated micro-organisms to remove contaminants from wastewater. The plants assist in the cleaning process by transporting oxygen to the micro-organisms in the bed through its root hair and taking up some nutrients and other substances.

Regarding why the constructed wetland which is constructed in the TEKU in Kathmandu Metropolitan city is not functioning in good order.he replied that this was due to the lack of proper management and commitment of the management team. The system was built in 1998 with the capacity of 40 cubic meter of septage treatment which was good operation for last two years (Shrestha, 2002). So he asserts that every system basically depends on the managerial unit. SWTP or BASP if not managed properly then the circumstances of the wastewater treatment plant will not be different then the pervious unsuccessful wastewater treatment plant.

According to him some advantage of the CW system as follow

- Low capital and operation cost
- The system can be run by relatively untrained personnel
- Natural process results in no by produce from the systems
- Utilizes local construction materials
- Systems are usually more flexible and less susceptible to variations in loading rate than conventional treatment system.
- The process is environmently friendly because it does not cause any smell or attract mosquitoes. In fact the plants promote greenery and attract birds and wildlife.

In our discussion, he has also given some suggestions at what has to be done by central government level, local government level, industries and citizens.

Role of the government level

- The government should be given top priority to treat wastewater before disposing into the river.
- Endorse the effluent standard discharging into the river.
- Encroachment of land along the river bank should be stopped and demarcate the land of the river system
- Initiate the decentralized small scale treatment plant for small community and villages around the valley
- Carry out the survey for potential sites for small scale treatment plants
- Rehabilitation of the existing stabilization ponds that were constructed 20 years before.

Role of Local Government

- Protect the land along the bank of river system; stop to provide the land along the river for social institutions.
- Stop allowing the river system to be used as dumping sites
- Stop the dumping Septic tank sludge into the river system.
- Several treatment plants (CW) should be built to treat sludge from the septic tanks.
- The sand mining activities at the upstream should be stopped
- Building permits should not be allowed without having either septic tank system or pretreatment system before disposing the wastewater into the public sewer.

Role about the industries

- Initiate in–house waste minimization program by introducing cleaner production plan
- Establish wastewater treatment facilities and discharge effluent as per national standards of effluent.

Roles of Citizen

- Put pressure to government and local government for improvement of wastewater treatment system
- Every citizen should act as a watchdog to control further destruction of the environment
- Awareness raising program about wastewater disposal should be conducted.

From the above discussion, it was concluded that for performing well in order by the systems, each and every concern authority should be conscious in their responsibilities.
The private household, industries, institutions are interested to construct wetlands these days because they can not afford huge amount o f money for operation and maintenance of the treatment system.

Some of the disadvantages of the constructed wetland wastewater treatment system from conventional system follow.

1) Relatively large area required for advanced treatment
2) Current imprecise design and operating criteria needed
3) Biological and hydrological complexity and lack of understanding of the imperative process dynamics.
4) Possible problems with pests. Steep topography, shallow soils, a high water table, or susceptibility to serve flooding may also limit their use. Mosquitoes or other insects could be a problem with wetlands systems that are improperly designed or managed.

Furthermore, function of the CW treatment system may require two or three growing seasons before optimal efficiencies are achieved. Completion of earth moving, concrete and pipe installation, and vegetation planting doesn't translate into fuel operational status. Since treatment efficiencies generally improve as above and below–surface plant compactness increases, fuel operational status will likely require several years after construction and planting are completed.
Probably the greatest problem is the lack of detailed information from the long term experience with the system. Although researchers and demonstration projects have shown that reed beds and wetlands can provide efficient treatment, this treatment option remains generally unknown outside the scientific community. The available information has been applied on a practical scale in only a few cases, and there have been few attempts to effectively document and communicate the details of the project design, construction, operation, maintenance and performance needed by regulating officials, engineering consultants, developers and community leaders. So we have to wait few years more to know the good or bad performance from the systems

6.5.1 Condition of another Conventiional Wastewater Treatment Plant

One of the Conventional wastewater treatments in Nepal which lies in the Hetauda district, that wastewater treatment plant was constructed by DANIDA (Dennis Donor Agency) in 2003. The target of the wastewater treatment plant is to treat the wastewater produces from the industrial zone not domestic area. I have met with the legal advisor of the Donar Agency, According to him the treatment plant is operating in 1/3 capacity and he is not satisfied with the performance in terms of quantity the treatment system. Fore three year it has been operating with donations, but after two years next there is agreement that the donor will leave the project after this there will be there is very difficult for operation and maintenance, although there is a plan to handover the project to Hetauda Industrial sector. However the concerned authority doesn't know where they will behave to collect money to run the costly wastewater treatment plant. The industry owner argued that there was unfair treatment between inside induestries in the induestrila zone and out site industries, which have been disposing

the waste water with out any treatment. They should not pay a charge for wastewater treatment disposing. But the inside industries should have to pay as polluter pay principle.
From the above discussion the management of the conventional wastewater treatment system is more complicated as comparing with the constructed wetland treatment plant.
The main problems of community based wastewater treatment plants are in the initial stage. In developing country where a high percentage of people are still uneducated, it is very difficult to convince them. Before the construction of the SWTP, Siddipur tole was to ready to construct the waste at Thimi municipality, due to the restriction by 2-3 people, the project had to shift from Siddipur to Sungatole after preliminary work was completed in the Siddipur tole.

6.6 Capacity of the BASP

Discharge of the wastewater in the inlet and discharge effluent at the outlet is essential parameter to know the quality of a wastewater treatment plant. But in the case BASP even the lab in-charge and the mechanical operator, are untrained about the discharge measure of wastewater influent. However, in the design period, there was estimated that the domestic and industrial waste quantity was 80 lpcd and 14 lpcd respectively but recently it is very difficult to say how much domestic waste and how much industrial waste is contained in the combined sewer. During the rainy season a high quantity of storm water is also mixed in the system. Although the technology of the BASP is so called sophisticated, due to the lack of proper management, it has been working like natural way, not in mechanical way.
The present population of the of BASP area is estimated 0.2 million but the total present population of the Kathmandu metropolitan city 1.08 million (excluding visitors) (CBS, 2001)
And the total estimated wastewater in the Kathmandu Metropolitan city is about 60 MLD but the full capacity of the BASP is only 16.4 MLD. If BASP is in a good functioning condition only 19% population can take advantage from the high costly wastewater treatment plant. Similarly BASP can treat only 27% of the total wastewater in the Kathmandu metropolitan city and the rest about 70 % of waste water is missing in the tributary of the Bagmati River. BASP has been investing high amounts of money in operation and maintenance but the service coverage from the project seems not to be satisfactory.

6.7 Efficiency of BASP and SWTP

I asked questions about the effectiveness of the wastewater treatment plant in Kathmandu valley to programme coordinator of environmental sector of institute of engineering campus; he replied that BASP is the only one biggest wastewater treatment plant in Nepal which is under the control of the government. According to him before designing the STP, a micro study should be carry out about the industries and the characteristic of the effluent which comes from the upstream part of the project area should be analyzed. Although BASP must have to check the quality of the effluent of the industries with in the standard limit, it has been accused by upstream industries to dispose of the industrial wastewater in the Bagmati River without pre-treatment. There should be clearly mention the criteria, condition/limitation, effectiveness, efficiency of the STP. On my visit to the office, I found no record of any model, demo test analysis, alternative analysis or risk analysis, before the construction of the STP.

According to the pro public studies 2007, during the initial operation period of the treatment plant, there was problem of foaming and bulking had been observed and the treatment plant system was not functioning as desired. The treatment plant had failed to meet its objectives of ensuring the discharge of only treated wastewater into the river as it had provision of diverting untreated wastewater directly to the river through tunnel from Tamraganga to Tilganga.

According to the lab Analysis done in ENPHO lab on Jan, 2007, the BOD for 5 days at 20°c was 1150 mg/l and the outlet 440 mg/l when it is compared with previous lab report done by BASP on FEB 2002 the BOD_5 of Influent is 310 mg/l and BOD_5 effluent is 110 mg/l. The standard limit of BOD_5 at 20°c of influent was 270 mg/l whereas effluent was 25 mg/l; similarly COD of influent at Jan 2007 was 2625 mg/l and 900 mg/lit influent and effluent respectively but the standard limit of influent is 1150mg/l and 250mg/l at effluent which is clear from the Table 6.12 and 6.13 respectively.

Table 6. 13 A Lab Report Feb 2002

Parameter	Influent (mg/l)				Effluent (mg/l)			
	Actual	Stand.	Variation	Var %	Actual	Stand.	Variation	Var. %
BOD	310	270	40	12.9	110	25	85	77.2
COD	572	1150	With In limit	None	160	250	With In limit	None

Source: BASP, (2007)

Table 6.14 Efficiency of BASP (Jan 2007)

Parameters	Samplings			Standard (Part III: effluent standard from common treatment plants)	Remark / Impression
	Inflow Sample	Outflow Sample	Final discharge sample		
	Date: Jan 3,07 Time: 1 PM	Date: Jan 4, 07 Time: 6:40	Date: Jan 4, 07 Time: 6:45		
Total Suspended solids, mg/L, Max	928	244	188	50	Not efficient
pH	7.05	7.4	7.34	5.5-9.0	No problem
Temperature (oC)	17	13	13	<40 oC	No problem
BOD_5 days	1150	440	365	50	Not efficient
Oils and grease, mg/L, Max	27.2	151.8	150.8	10	Not efficient
Phenolic Compounds, mg/L, Max	ND (<0.5)	ND (<0.5)	ND (<0.5)	1	No problem
Sulphides (as S), mg/L, Max	12	2	2	2	Efficient
Fluorides (as F), mg/L, Max	0.42	ND (<0.05)	0.27	2	No problem
Hexavalent chromium (as Cr), mg/L, Max	ND (<0.05)	ND (<0.05)	ND (<0.05)	0.10	No problem
Copper (as Cu), mg/L, Max	0.063	0.029	0.028	3	No problem
Lead (as Pb), mg/L, Max	0.018	0.038	ND (<0.01)	0.1	No problem
Mercury (as Hg), mg/L, Max	0.004	0.004	0.004	0.01	No problem
Zinc (as Zn), mg/L, Max	0.52	0.20	0.10	5	No Problem
Ammonical nitrogen, mg/L, Max	133.1	85.95	49.31	50	Not efficient
Chemical Oxygen Demand, mg/L, Max	2625	900	820	250	Not efficient

Source: ENPHO Lab analysis report

1. Parameters having more than standard value at intake sample are being considered as problem and hence lower values have been considered as "No Problem"
2. So the treatment plant is not efficient to treat parameters like TSS, BOD, COD, Oil and Grease, Ammonical Nitrogen as per the designed parameter.
3. Treatment plant is seems to be effective in reducing Sulphide (from 12 to 2) just complying with the standard value.

Table 6.15 Lab Report of SWTP

BOD of SWTP							
Raw	ST	% R	HFB2	% R	VFB2	% R	Total
950	450.00	53 %	165.00	63%	30.00	81.82	96.8 %

COD of SWTP

Raw	ST	% R	HFB2	% R	VFB2	% R	PE
1438	1187	18%	213	82.02	50	76.53	96.52%

Source: ENPHO, (2007)

As regarding the lab report of the SWTP in Table 6.14, the flow from settlement tank, horizontal flow bed, and vertical flow bed. The BOD and COD concentration are decreasing from raw wastewater to vertical flow bed. The average BOD reduction from the treatment system is 96.8% and average COD reduction is 96.52 % from inflow to out flow which is clear from the above table.

From the above tables and the remarks which I have noted on the basis of the tolerance limits for effluent discharged into inland surface water by industry prepared by NBSM (Annex A1). The overall performance in the field of wastewater quality of the BASP is not satisfactory.
As linking the laboratory performance with the management aspect, the management team is not providing sufficient chemicals and necessary equipment. There is no capacity building training even for mechanical operators and lab technicians.
As I visited on the site two pumps were not working properly and the grit chamber was not working in proper order, I founded different sizes of plastics and wooden loges etc were floating even in the secondary clarifier. (Photo P 1) These are not indicators of the good performance of the treatment plant.
The main problem of the treatment systems are,
High discharge of flow is containing high amount of BOD and COD which are crossing the design limit so that the biological oxygen ditch can not operate properly. To know what are the prime cause for increasing the BOD and COD out of design limit in the BASP areas. Then I found that there are main three rots for increasing high concentration in the sewerage quality.
1) Less monitoring from concern authority
2) Septage disposal in the public sewer by the private party illegally
3) Many Industries has been disposing Industrial Wastewater without pre-treatment.

6.7.1 Industrial wastewater

The industrial or the trade wastewater is mainly responsible for the pollution of the rivers, as wastewater from the industrial areas is directly discharged into river without treatment. In most cases the trade wastewater requires partial treatment before passing into the public sewer (Birde, 1998). In Kathmandu most of the river and stream have become ecologically dead due to the indiscriminate discharge of sewerage and other industrial effluent in the water course. Moreover the large fractions of number of industries in the country are set up in the Kathmandu valley. Among them more than 40% of the industries are of water polluting nature hence the overall industrial pollution in the Kathmandu Valley is very high and more serious (PRO PUBLIC,2007).

In addition to this, dumping of solid waste including hazardous medical waste water in the Bagmati River still continues today.

According to the project manager of the BASP, most of the dying industries are located at the upstream of the Bagmati River. Due to the high flow with high chemical contained wastewater, this impacts for performance of the BASP. So to understand the status of industries I had visited 19 industries and met with the responsible persons of the industries. Among them ten are dying and woollen industries that are disposing high concentration of BOD_5, COD and other parameters (Annex A 9)

I collected the individual lab reports and checked the parameters with the standard limit then noticed that BOD of the 9 industries (Table 6.15) are over the limit and among them the Sivakar enterprises has high BOD because it has mixed the sludge in the same sampling point. Similarly the concentrations of COD in the 8 industries are higher as comparing with the standard limit. Oil and grease content in the waste water from the industries are higher.

The lap report which is prepared by the ENPHO of the selected ten industries is in tabular from.

Table 6.16 Industrial Lab Report

Complaisance Monitoring Result of 10 Wool Dying Industries Pollution

Parameters	Units	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	MOEST's Standard	Remark
Suspended Solids	mg/L	66	52	258	310	6	38	68	48	348	9	100	3 Industries exceed the standard
Biochemical Oxygen Demand (5 days at 20° C)	mg/L	150	150	200	610	550	625	150	300	1750	40	100	9 Industries exceed the standard
Oil and grease	mg/L	102.8	65.8	107.8	38.8	60.8	74.8	66.8	22.4	190.6	19.8	10	All 10 Industries exceed the standard
Chemical Oxygen Demand	mg/L	300	375	425	1500	850	1000	212.5	400	2000	110	250	8 Industries exceed the standard
Total Chromium (as Cr)	mg/L	0.1	0.29	0.12	0.96	0.03	0.05	0.07	0.13	0.02	0.04	2	All 10 Industries comply the standard
Sulphide (as S).	mg/L	12	10	6	26	10	12	14	12	18	16	2	All 10 Industries exceed the standard
Phenolic compounds (as C_6H_5OH)	mg/L	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	ND (<0.5)	5	All 10 Industries Comply the standard
pH Value	-	7.2	7.56	6.66	11.17	4.61	4.47	3.71	6.75	4.45	7.05	5.5-9	5 Industries exceed the standard

Source: ENPHO Lab analysis report

Source: ENPHO, (2007)

ND: Not detectable

S1: Mount Everest Wool Dying and Carpet Industry

S2: Dantkali Wool Dying Industry

S3: Durga Wool Dying Industry

S4: Supath Wool Dying Industry

S5: Narayani Wool Dying Industry

S6: Kaman Wool Dying Industry

S7: Shree Wool Dying Industry

S8:RupaWoolDyingIndustry

S9: Sivakar Enterprises

S10: Buddha Designer Carpet Industry

6.7.2 Opinion of Key Informants on Quality of WWTP

Table 6.17 Quality Performance

Questions	Common Answer from Government Authority	Common Answer from Private and Donor	Remarks
What type of waste water flows in the systems	BASP lies in the central part of Kathmandu urban area; most of the carpet industries, slaughter houses are in upstream of the project areas so industrial as well as domestic waste and illegally dumping spetage are common in the inlet. In rainy season high stream water with sand causes problems for the treatment systems	Huge amounts of untreated industrial waste are the main problem of BASP and domestic wastewater from the small community in SWTP. In rainy season suspended solids ,sand and clay are a problem in the sedimentation tank of SWTP and grit Chamber of the BASP	Due to industrial waste foaming will be occur in the morning (according of lab technician), unexpected flow comes in the system. Grit chamber is not functioning properly in the BASP area.
Are you satisfied from the performance in terms of quality of the projects	At least BASP has reduced the BOD and COD from the wastewater and it helps to flow clean water in the Bagmati River from Gokarna to Pashipati Nath Temple. But the treated effluent is out of the standard limit so treated water could not be mixed in the river near BASP.That means the Quality performance of the BASP in the present condition is not satisfactory.	The performance of the BASP as comparred with the effluent standard is not satisfactory but the performance of SWTP in terms of BOD and COD of its out put in that period was satisfactory and acceptable.	Due the problems in pumps and problems in the grit chamber out put performance of the BASP is worst as comparing with standard limits, findings of wooden logs, plastics etc are the eye witness of the disorder of the systems, but low discharge and small scale project, performance of SWTP in terms of BOD and COD is quite satisfactory.

From the above Table 6.16 the industrial wastewater is the main problem of the BASP, quality output from the BASP is not satisfactory and the primary and secondary unit in the treatment plant in the BASP has to be maintained. On the field visit it was noticed about the smell from the treatment plant of the BASP is more.

6.7.3 Less Monitoring From Concern Authority

Kathmandu is the capital city of Nepal so people from the whole area of Nepal come to Kathmandu for various rationales activities like official works, document approval, visit as tourist, higher education etc. so the growth rate is increasing faster then the average growth rate (5 % growth rate in Kathmandu whereas 2.34% growth rate in average) (CBS, 2001). The capacity of the sewerage line and the wastewater treatment plant is not sufficient for the rapidly increasing population, as already discussed about performance of wastewater is declining because many

systems are failing due to heavy flow of uncontrollable quality (industrial wastewater) of wastewater. It is not easy to control to the rapidly urbanized population. People are migrating from rural areas to urban areas day by day (CBS, 2001). Concerning the building code discussed chapter two, Kathmandu metropolitan city has a building code, according to the building code it is obligatory that each newly constructed building should have a septic tank and they have to collect black water in the septic tank before disposing to the common sewer. Those is the law but in reality as shown with a survey of about 60 % of the people out of 54 in household level and 53 % of industries out of 19 in the BASP area have been disposing waste water directly in the public sewer without any pre-treatment. Only 22 % household and 37 % of the industries have constructed septic tank or pre-treatment plants respectively (fig 6.13 and 6.14) after that they dispose the effluent to the common sewer line. However the standard of the quality of the effluent is not monitored by the concerned authority regularly. Those industries and households who didn't have connected with public sewer line, they collected wastewater in septic tank and cleaned the septic tank with the support of either private party or KMC tanker.

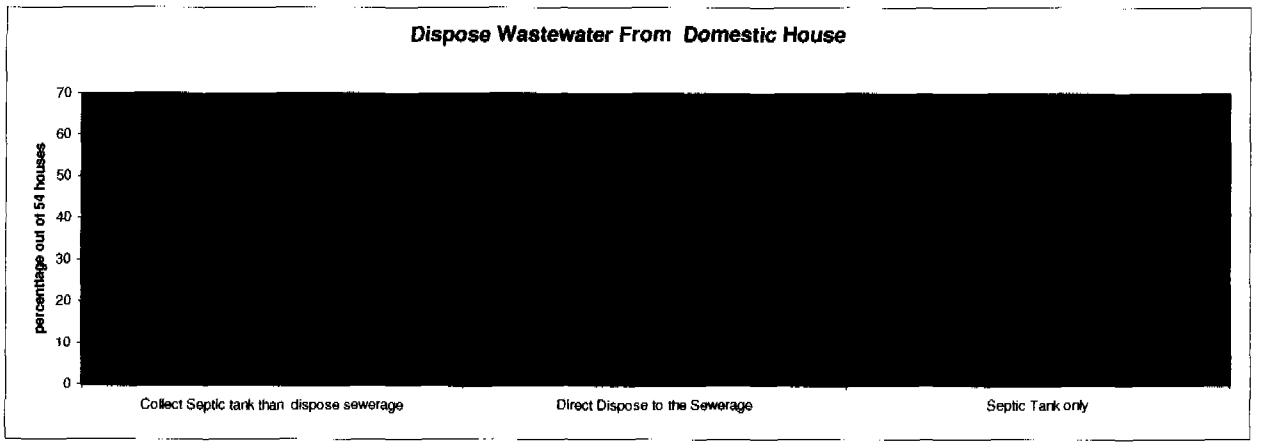

Figure 6.13 Dispose Pattern of Domestic Wastewater
Source: Field Survey, (2007)

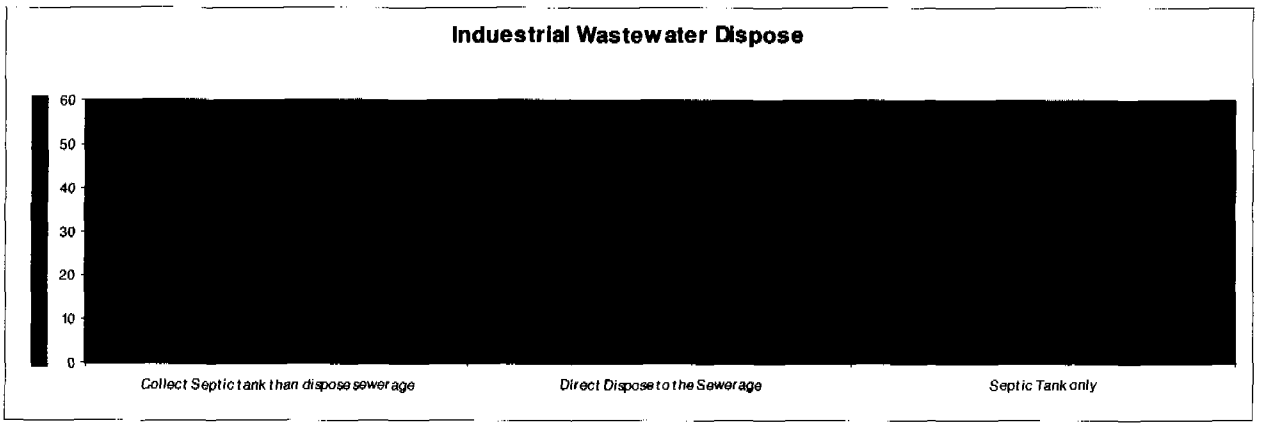

Figure 6.14 Dispose Pattern of Industrial Wastewater
Source: Field Survey (2007)

6.7.4 Concluding about the Management Committee of WWTP

In the case of Sunga Community there are no any mandates of Thimi municipality requiring the construction septic tanks. All houses in the community are disposing the common sewerage directly. But there is also the provision of Ecosan toilet in the community so the faecal sludge is comparatively less. The characteristic of the waste in the Sunga community is almost domestic waste. There is not any industry located in the project area.

The authority from the municipality should inspect the building construction site to check the constructing building including the septic tank and the sewerage systems. Similarly the representative from industrial ministry should inspect the industrial site and they have to enforce them to construct the pre-treatment plant for the wastewater before disposing to the common sewer line. They have also authority to punish the industries if they are not obeying the rules. As I have already discussed about this matter, I have not found any industries which has paid such a fine yet. BASP is one of the high power committee itself. It has also the full power to monitor the wastewater system in around the project areas. According to the technical staff of the BASP, BASP has set up a monitoring group but most of industry owners don't respect the monitoring body and they also do not permit them to visit the industry even when they have authorized letters from the BASP. This result also present that the decision making of the BASP management group seems very week.

According to the sociologist of the BASP, it has carried out many public awareness programs in the project areas, But I have faced with many people are still not convinced about the importance of the wastewater treatment plant in their area. They are disposing wastewater in the river stream directly. But when as asking the same question to the chairperson of the Sunga community, the whole community member are knowledgeable about the concept of wastewater treatment, they even know, not thing is waste. That is that all can be re-used resulting in the concept of" Zero "waste. Many of the houses even have Ecosan toilets.

From the above discussion, although BASP is situated in the urban areas, most the people either domestic or industrial level they are busy and neglect such wastewater treatment activities. They are thinking that all responsibility should be taken by the government or metropolitan city itself because they have been paying tax for all items directly or indirectly. But at the community level one NGO (ENPHO), has been consulting the awareness programme and donor agency has provided the financial support for the construction of the community based wastewater treatment plant. The community public are feeling SWTP is their project and it's their responsibility to run the project smoothly. Since Sunga lies in the peri- urban area, people are a bit free as compare to urban area. Due to the good message circulation from the ENPHO in the community, the number of woman participating in the management group is growing day by day.

According to the head of sewerage department office and the head of environmental sector of Kathmandu Metropolitan City, there is overlapping between municipality and NWSC. Municipality has been also investing a certain amount of money for sewerage line and septage treatment system whereas NWSC has also been doing the same work in the Kathmandu valley. The head of sewerage department said that the involvement of the different parties in the similar type of works may be good but the vision and the work should be clear. The overlapping work may affect the system. There will be confusion about who has to regulate the system. He has been working in the sewerage sector for more then 15 years in the higher level but he himself is annoyed about the wastewater management system of the Kathmandu Valley. According to him funding for the sewer and wastewater treatment system is less. It accounts for about 5 % of the

whole NWSC budget. This is hardly sustainable for staff salary and operation and maintenance of the sewerage system.
From the profit and loss account of NWSC (Annex 8) total amount of expenditure on fiscal year 2004/05, total expenditure 524,282,433.39 among them only 10,370,319.67 that means only about 2% for sewerage ,similarly at the fiscal year 2003/04 the total expenditure was 481,620,076.06 and expenditure on sewerage was only 10,724,460.01 that means 2.3 %.
So from the above calculation the cost expenditure, we conclude that NWSC have been spending very little money for sewerage and wastewater treatment system but more money is expending in the water supply sector.
In my case study BASP is a different sector from NWSC. But both BASP and NWSC are under the Ministry of Physical Planning and Works. In BASP there are more then 40 % staff shifted from the NWSC. The cost of sewerage is collected by NWSC as a part of the water service charge. So in my opinion directly or indirectly BASP has a relationship with NWSC (Fig 6.15).
There is a mega project Malachi Water Supply Project currently in the construction phase.The main endeavour of the project is to supply enough water to Kathmandu valley (MWSP, 2006). And enough water means enough wastewater, since MWSP is going to be run on a management contact and there is already KUKL (Kathmandu Upatayaka Khanepani Limited), which will be established on the basis of public private partnership. KUKL will address the financial problems of the BASP as well as the overall problems of sanitation in the Kathmandu Valley.

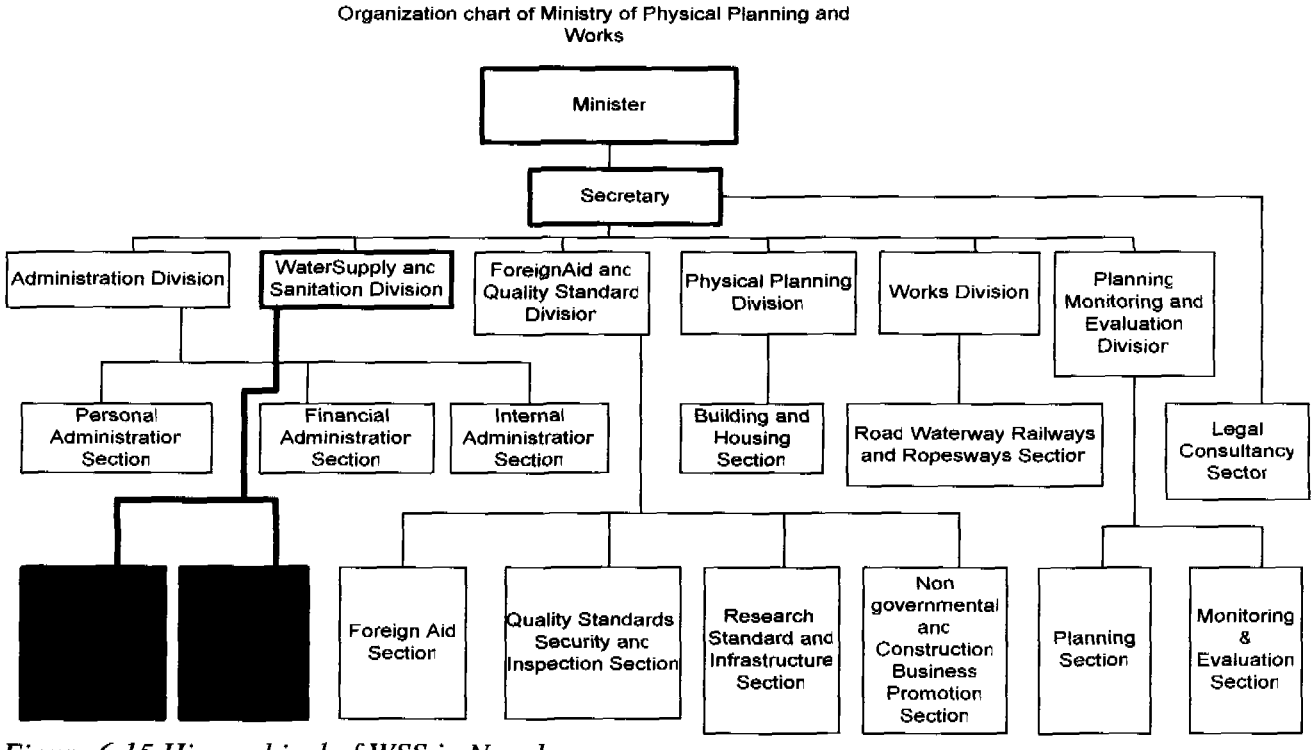

Figure 6.15 Hierarchical of WSS in Nepal
Source: MPPW, (2007)

6.7.5 Political pressure for staff selection

Many of the key informants agreed about the political pressure for the selection of the staff in the vital posts. They are either capable of the post or not. There is still a bad tradition in Nepal. After the change of minister, He/She try to change the secretary and chairperson in the related project as well as project manager. On my field visit I had noticed the same problems occurred even in the BASP. The chairperson of the BASP is appointed politically, there is no need either as he has to have technical knowledge or not about the treatment plant. But the project manager should be a technical person. On my visit I found that within about one year the project manager was changed four times, which is clear from the Table 6.17

Table 6 18 Appointed Project Manager

Name	In	Out
Kishor Shakya	15th April 2006	18th Sept 2006
Ram Deep Shah	20th Oct,2006	19th Nov 2006
Hareram Koirala	11th Dec,2006	15th June 2007
Raj Kumar Malla	17th June,2007	present

If one project manager could not work 2-3 years, how can he show his output and how can he manage the project. This raises serious questions about this method of trial and error utilized even for the selection of project manager. Such type of activities is also additional catalyst for the reduction of the performance of the treatment system.

6.7.6 Septage Disposal in the BASP Area

There is only one sewerage treatment plant in Kathmandu Valley, Which was constructed wetlands and operated by the KMC.Due to the lack of proper management septage treatment plant is not functioning very well (Shrestha 2003). Later on BASP has also constructed CW septage treatment system near the oxidation ditch for the purpose to treat faecal sludge carried by private vendor and it will also help to generate some money as well as the concentration on sewerage will be reduced. On my field visit, I noticed that many of the private faecal sludge collectors were disposing of sludge in the public sewerage system illegally. It has been estimated that there are more than 43,000 septic tanks in Kathmandu valley and more than 100 m3 /day of faecal being collected by different companies including KMC. KMC has been charging about NRs1200 to clean septic tanks depending on the size of tank but the private company are taking almost double (Mingma, 2005).

The BOD_5 and COD concentration of the project area of BASP is very high. It is estimated from the study of Shrestha that BOD concentration has increased 40 times higher and similarly COD concentration 100 times higher in Kathmandu Valley. High concentration in the sewer is the main problem of the BASP to decrease the performance in terms of quality.

So BASP has to take action immediately to the private party and enforce them to dispose the collected faecal sludge in the treatment plant and control the mix in public sewer. The regulatory body of the BASP should be activated. Although the body has full authority to punish such private party, they have not taken any action. This is also illustrated by the management committee which is not very strong for decision making.

I asked to the environmental engineer of MoEST about the Environmental Impact Assessment (EIA). She replied that BASP had not conducted any Environmental Impact Assessment before construction the treatment plant although there was already an environmental conservation act and

policy which was prepared in 1992. It seems that BASP had neglected rules and regulation .Without doing the EIA study of such big project; it is very difficult to say whether there has been a positive or negative impact on the society and surrounding area after the construction of tunnel and sewerage treatment plant.
Due to the lack of statistical data on the environmental sector, it is impossible to articulate how much of a reduction there has been to the water pollution in the surrounding area and what the positive benefit for the public health has been.

6.8 Management Satisfaction

The sanitation policy sets a target to increase the sanitation coverage and also mentions the need for safe disposal of domestic and industrial wastewater. But here it is not a clear vision about where the huge quantity of sewerage should be treated. Currently more than 60 MLD of wastewater is deposited in the tributaries of the Bagmati River in the Kathmandu valley and only about 20 MLD of the wastewater is treated per day. What about the remaining wastewater? It is directly disposed into the river or stream. This is providing a negative impact on the surrounding environment.
As I asked question about responsible authority of wastewater treatment sector in the Kathmandu valley, one of the key informants ex project manager of the BASP replied that BASP is operating since 2002 but it is not operating on full scale. During the construction phase He said that there was much difficulty in the construction phase. Due to the lack of technical knowledge in such conventional type of wastewater treatment plant BASP had to pay an extra burden in the construction phase to learn about this type of wastewater treatment which was a new concept in Nepal. When I analyzed the audit report (2000) of BASP, I found the following demerit of the BASP management since the establishment period which will be briefly discussed in the next section.

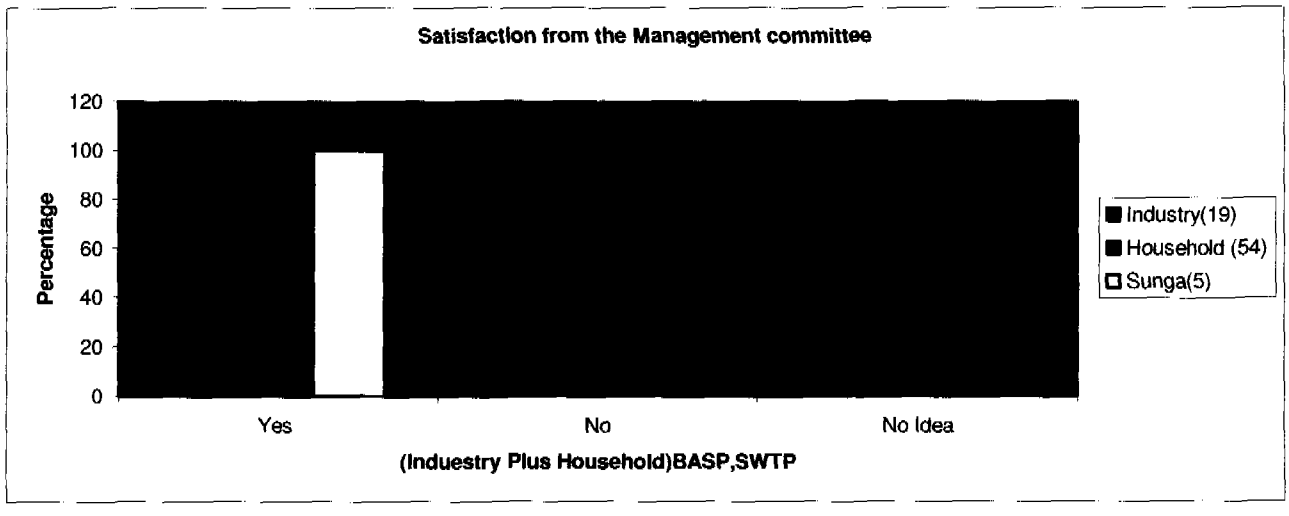

Figure 6.16 Satisfaction Rate from Consumer Group

Source: Field Survey, (2007)
From the fig 6.16 the community people of Sungatole are fully satisfied from the system otherwise there would be difficulties in creating the management committee. But an average of 47 % the population of the BASP area is not satisfied with the management committee of the BASP which was

already discussed in the previous chapter. Only average 35% of the respondents of the BASP are satisfied from the management committees of the BASP.

6.9 Management problems in BASP since Establishment

6.9.1 Geographical study of the project area

The geographical study prepared by one company NEPECON and the works has been started by following the report. According to the report including the cut and cover all together 522 m tunnel, 360 m is sandy clay and 80 m contained lime stone but after the bore–hole test done by soil Test (Pct) Ltd, National Drilling Company and Hydro Traids (P) Ltd it was found that there were not any lime stone along the alignment so the already prepared design and drawing had to be changed. Therefore the BASP should have charged the NEPECON Company for wrongful information but I have not found any charge and punishment to NEPECON yet.

6.9.2 Selection Criteria of Tunnel Construction Company

According to the financial administrative Act 2042, there were five companies in initial selection for bidding. Among them KHUMBU construction company had the lowest rate of Nrs 5,25,11,870,on the basis of lowest rate the construction company was selected and the agreement between BASP and the construction company was held on 5th of September 1996. The estimated agreement rate was 45.71% lower then the project estimated cost.
The company had to finish the provided task with in 15 month on a turnkey basis. But after constructing cut and coverage 65 m from Tamraganga side and 100 m from Tilganga side and 23 m tunnel altogether 188 m up to16th may 1998, the company could not continue the work although BASP had extended by adding 12 month additional times. The construction company had stopped the work on August 1998 without providing any information to the BASP. BASP has founded the following demerit of the construction company so the agreement was cancelled on 3rd September 1999.

- Incapability management,
- Lack of enough tools and equipment,
- Lack of well technical trained personal
- Little knowledge of construction of such a tunnel

BASP had already paid to the construction company Nrs 2, 09, 20,477 before cancellation of the agreement. To complete the remaining work BASP had to arrange more Nrs 4, 27, 36,933.expect the deposit amount Nrs 20,92,048 and performance bond Nrs 26,25,600, BASP could not able to charge KHUMBU construction company.
In my opinion, BASP had negligented to investigate the strength of the construction company. Clearly the wrong decision was made which caused further delay on the work being carried out as well as additional financial burdon.

6.9.3 New Construction Company Selection for Tunnel Construction

After the cancellation of the agreement with Khumbu Construction Company, BASP had selected China Shandong International Company among 5 different bidders to complete the construction of remaining 360 m tunnel on the turnkey basis. The agreement was made on 7th April 2000.

Considering the rate for construction of the tunnel there were 130% then Khumbu and 18% more then the estimated cost of BASP which is clear from the Table 6.18

Table 6.19 Rate for Tunnel Construction

Name of Party	Running cost per meter of Tunnel
China Shandong International	Nrs 2,48,144.00
BASP Estimate	Nrs 2,09,289.00
Khumbu Construction Company	Nrs. 1,07,521.00

Source: Audit Repert, (2000)

At that period I have found that BASP has selected SPAN as a consultant, for that it had additional Nrs. 16, 86,000/-. If there were really needed consultant then why BASP has not selected the consultant the working phase of Khumbu it would be checked the quality of Khumbu and guided them to do the proper task. That was also one demerit of the BASP, which could not take right decision on right time.

6.9.4 Treatment plant Design

Nepal Consultant had designed the oxidation ditch. According to the design the thickness of the base slab was 400 mm. BASP had selected ANDO JAPAN-GLOBAL NEPAL JV on a turnkey basis which was signed on 28th Oct. 1998 .The total agreement amount was Nrs. 9,32,66,444/-
Under the construction phase ANDO –Japan had submitted the new design but another consultant company Manohar Rajbhandari and Associate found that design was unsafe and it was recommended four options but without soil data test report, it was assuming that there should be Black Cotton Soil below the sand layer. But as the assumption was wrong then the design had to be changed again by another consultant ITECO Consult, it has recommended 500 mm base slab thickness. For the additional task BASP had to pay additional cost of Nrs1,17,68,950 for oxidation ditch and 53,49,346/- for Secondary Clarifier.
From the above discussion it is clear that BASP has taken a trial and error approach for the design of oxidation ditch. The technical management sound of BASP seems so week. They could not even able to provide soil test report to Manahar Rajbhandari and Associate for the design of the oxidation ditch although the Manahar Rajbhandari and Associate had requested BASP for the report before design but due to the inattention of the BASP activities, it has to pay extra consultant charge amount Nrs 34,72,200/- to ITECO. (Audit Report, 2001)
Another interesting matter which I have noticed that on the turnkey basis contact the consultant expenses has to be paid by the contractor. But in all contact BASP had paid the Consultant charge, which is not reliable and lack of proper knowledge of the technical and management unit of BASP.

6.9.5 Environmental and Social Sector

BASP had not conducted any Environmental Impact Assessment before constructing the treatment plant although there was already environmental conservation act and policy has been designed, it seems that BASP has neglected the Rules and Regulation .So it is difficult to say what is the positive and what is the negative impact on the construction of tunnel and sewerage treatment plant. Due to the lack of statically data on environment sector, it is very difficult to say how much reduce the water pollution in surrounding area after the construction of the treatment plant.

For the prevention of an offensive smell and reducing bacteria, it would be better to do chlorine dosing before and after the treatment of sewerage. This will also reduce the flies and help to reduce the BOD of the sewerage. But I haven't found any chlorine dosing in the treatment plant which will be providing negative impact for public health.

The purpose of above discussion about the history of the management committee of the BASP is to find out the grading of the management committee from its initial stage. The status of BASP management committee is reducing because of sometimes political interfere, lack of technical knowledge ,financial problems, not proper human resource development programmes, weakness in monitoring sector and over cross the rules and regulations are the main demerit part of BASP.

From the overall discussion and testing of all indicators, it is concluded that between the two different technologies for wastewater treatment plant, in the present condition although SWTP is very small scale, performing more better than the large conventional wastewater treatment plant BASP.

7 Findings, Conclusion and Recommendation

7.1 Findings

- There are very weak enforcement mechanism, several pollution prevention acts were paralyzed or nearly paralyzed.
- Many different agencies or institutions are authorized or made responsible by the acts to carry out activities of protecting and managing the ecology, environment and resources
- The law and enforcement mechanisms are recently being developed. But there is no any sanitation act yet.
- The political situations are also impacting the development of such infrastructure.
- More then 14 studies major studies have been already completed by different stakeholders but implementation is less.
- A huge amount of budgetary money has to be expended for security purposes to solve the political conflict on the one hand and on the other hand their first target is in drinking water supply and secondly that every household should have toilet. Less priority is given to the issue of wastewater treatment plants
- The quantity of the industrial influent concentration is over then design in the BASP. But not much industrial wastewater contains in the SWTP.
- The area coverage meter per person sewer line ratio is less.
- More then 60 % sewerage system in the project areas faced blockage in the rainy seasons.
- There are no any special capacity building training for operator in BASP but ENPHO as well as other donor agencies are providing many awareness programmes in urban and peri-urban areas.
- Lack of management expertises in the BASP
- The problems of operation and maintenance is more in the BASP area comparatively less in SWTP
- The operation cost of the conventional wastewater treatment systems is higher then constructed wetlands
- High electricity consumption and advanced mechanical equipments (hydraulic pumps, aerator etc are essential in BASP.
- Government MPPW is fully subsidies for the operation and maintenance cost of BASP. Similarly the Thimi Municipality is providing annual operation and maintenance cost of SWTP.
- There were no any special cost generation activities from the both systems.
- Average 56% respondents were still desired subsidy amount for the operation of the systems
- Average 46% of population of project areas are paying 50 % addition of their water meter reading charge as a sewerage charge to NWSC.
- There is no any Environment Impact Assessment had been conducted by BASP
- Quality output from the both wastewater treatment plant separately.
- Different key informants have different opinions about the option of wastewater treatment plants in Kathmandu valley.

7.2 Conclusions

The following conclusions have been drawn out from the present study:

A. Roles and Responsibility

- Some legislation in ralation to wastewater management such as the National Sanitation Policy, Nepal Water Resource Strategy and National Building Code under the Ministry of Physical Planning and works (MPPW) and bylaws such as Building Ordinance prepared by KMC mandates the need to construct septic tanks or pre-treatment plants in each house and induestry. Although various standards are set, compliance enforcement is weak. Strong and independent monitoring mechanisms is not be devised to ensure compliance with the standards and requirements laid down by legislation and permits.
- BASP,NWSC,KMC, the Ministry of Industry and the Ministry the Environment Science and Technology are not sufficiently clear about the wastewater treatment in terms of environmental sustainability and operation and maintenance of the wastewater treatment plants in the present situation
- Political interferance for the staff selection, system approval and financing mechanism are halting the infracture development programs.

B. Operation and Maintainance

- The operation and maintenance system is lack behinds in all operation and maintenance indicators but with the support of donor agencies, NGOs supporters and community group involvement, comparatively operation and maintenance system of community based seems more effective.
- There was lack of capacity building training for operators and not sufficient tools and equipments and chemicals in the BASP. For the minor maintainance of the system external expertiese should be invited for the maintainance in such mechanical wastewater treatment systems.
- The coverage areas of the both systems are minimal as comparing the problems of wastewater percentage in the current Kathamndu valley.
- The sewerage system is blockage in an average 54% in the BASP area and 60 % in the Sunga community in the rainy season.

C. Finincial Basis.

- BASP has to fully depend on subsidies from the government and SWTP has received support by Thimi Municipality for annual operation and maintenance cost. There is the possibility to find income generation from SWTP by selling the treated effluent water to the primary school and in agriculture farms. But the present condition about the financial basis of the BASP is worst, first in need a huge amount of money for operation and maintenance and the treated water and by pass water (over flow) is mixed in a common manhole (M9) and from the river crossing the mixed effluent passed through the tunnel at the downstream of the Pashupati Nath. Temple. That means the treatment significant is seems less.
- There is no any application of the pollution pay principle in both sectors.
- The capital investment for decentralized wastewater systems is generally less than for centralized systems in peri-urban areas, and they are also likely to be cheaper to construct and operate. By tackling wastewater problems close to the source, the large capital investment of trunk sewers and pumping costs associated with centralized systems can be reduced, thus increasing the affordability of wastewater management systems.
- Due to the lack of proper management and knowledge about the mechanical technology (conventional wastewater) BASP had been paying huge amount of extra money from the past story.

D. Quality of output

- Due to dropping of the quality performance and lack of well operation and maintenance, not proper monitoring and financial scarcity, an average 74 % respondents were feeling bad odour in pick period in the BASP area but the is no complaint from the Sunga community yet.
- An average 55% of the respondents in the BASP area where as 100% SWTP areas are disposing wastewater in the common sewer line without pre-treatment. This increases the high concentration of suspended solids, BOD and COD in the treatment plants. But the wastewater characteristic in SWTP is only domestic so comparatively less problems for the treatment.
- Nine carpet induestries among 10 has higher BOD_5 then standard limit .Similarly eight induestries has higher COD then Standard limit

7.3 Recommendations

This study suggests that the current conditions of wastewater treatment plants in Kathmandu valley is not satisfactory .There are too many obstacles. So to improve the performance of the wastewater existing wastewater treatments plants followings are the recommendations:

- Clearly define the roles and responsibilities of the Stakeholders
- Activated the sanitation acts as soon as possible.
- More priority should be given to the capacity building training for the staff of BASP in the operation and management sectors.
- Political interference and political appointment mechanism in such BASP project should be stopped.
- Public awareness and public pressure; critical analysis of the issues by involving all stakeholders; bold and appropriate decisions by the government; and planning and implementation by all stakeholders can ensure success
- Damaged pumps, grit chamber should be maintained and systems of data recording system in the lab should be well computerized.
- Small separate treatment plants for populated institutions such as army camps, hospitals, carpet industries and prisons have been recommended.
- It should try to find out new ways to continue the project, as the Government funding is not enough.
- It should aware the people living along the banks so that they may help the projects to perform its work.
- As far as possible, public-private partnership should be given preference, and the role of the local authorities such as the DDC and VDC and non-state bodies such as NGOs should be made clearer.

7.4 Recommendation for further study

In Kathmandu Valley, the upstream part of Manohara River(tributary of the Bagmati River),15 Carpet industries are under constructing phase so it is necessary to do the detail study about the effluents parameters of carpet industries and its pre-treatment procedure before disposing to the clean Manohara River.

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Annexes

Annex A.1 Tolerance limits for effluent discharged into surface water

S.no	Characteristic	Tolerance limit
	Total Suspended solids. mg/l	30-200
	Particle size of total suspended particles	Shall pass 850-microne sieve
	PH	5.5 to 9
	Temperature	Shall not exceed 40 degree centigrade in any section of the stream with in 15 meters down stream form the effluent outlet
	BOD 5	30-100
	Oils and grease .mg/L. Max	10
	Phenolic compounds, mg/L, Max	1.0
	Sulphides (as S) ,Mg/L, Max	2
	Radioactive materials 1) Alpha Emitters, c/ml, Max 2) Beta emitters, c/ml, Max	 10-7 10-8
	Insecticides	Absent
	Total residual chlorine ,mg/L	1
	Fluorides(as F) ,mg/L, max	2
	Arsenic (as As) ,mg/L. max	.2
	Ammonia Nitrogen, mg/L ,Max	50
	Mercury (as Hg) mg/L, Max	.01
	Lead (as pb) ,mg/L, Max	.1

Source: NBSM, (1998)

Annex A.2 Tolerance limits for effluent discharged into surface water

Annex 1.1 Tolerance Limits for Industrial Discharged into Inland Surface Waters - Nepal Standard (NBSM, 1991)

नेपाल राष्ट्रिय मापदण्ड विभाग
NBSM

नेपाल मापदण्ड
NEPAL STANDARD

1. SCOPE

1.1 This standard lays down the tolerance limits for effluents of all those industries discharged into inland surface waters

1.1.1 Effluents discharged on land, or into artificial channels or sewers or ground water or air not covered by this standard

2 TOLERANCE LIMITS

2.1 The tolerance limits for industrial effluents are given in table 1

3. SAMPLING

3.1 Representative samples of the industrial effluents shall be obtained according to NS .....

TABLE 1

S.C.No.	Characteristic	Tolerance Limit
i)	Total Suspended solids, mg/L	30 - 200
ii)	Particle size of total suspended particles	Shall pass 850-micron Sieve.
iii)	pH	5.5 to 9.0
iv)	Temperature	Shall not exceed 40° c in any section of the stream within 15 metres down-stream from the effluent outlet.
v)	Biochemical oxygen demand for 5 days at 20°c, mg/L	30 - 100
vi)	Oils and grease, mg/L, Max	10
vii)	Phenolic compounds, mg/L, Max	1.0
viii)	Cyanides (as CN), mg/L, Max	0.2
ix)	Sulphides (as S), mg/L, Max	2.0
x)	Radioactive materials:	
	a) Alpha emitters, c/ml, Max	10^{-9}
	b) Beta emitters, c/ml, Max	10^{-8}
xi)	Insecticides	Absent
xii)	Total residual chlorine, mg/L	1
xiii)	Fluorides (as F), mg/L, Max	2.0
xiv)	Arsenic (as As), mg/L, Max	0.2
xv)	Cadmium (as Cd), mg/L, Max	2.0
xvi)	Hexavalent chromium (as Cr), mg/L, Max	0.1
xvii)	Copper (as Cu), mg/L, Max	3.0
xviii)	Lead (as Pb), mg/L, Max	0.1
xix)	Mercury (as Hg), mg/L, Max	0.01
xx)	Nickel (as Ni), mg/L, Max	3.0
xxi)	Selenium (as Se), mg/L, Max	0.05
xxii)	Zinc (as Zn) mg/L, Max	5
xxiii)	Ammonical nitrogen, mg/L, Max	50
xxiv)	Chemical oxygen demand, mg/L, Max	250
xxv)	Silver, mg/L, Max	0.1

4. Methods of test

4.1 Characteristics given in this standard shall be tested by the methods in NS.....

Annex A.3 List of Management Committee (SWTP)

1.Chairman: Mr.Krishna Lal Goja Shrestha	9.Mr.Indra Narayan Shrestha
2. Vice Chaireman Dravya Lal Shrestha	10.Mr.Subarna Shrestha
3.Secretary: Mr Bharat Shrestha	11.Ms.Ram Keshari Shreshta
4) Treasurer:Mr Ram Krishna Shrestha	12.Ms.Laxmi Shrestha
Members:	13.Representative Bal Premi School
5.Mr.Indra Krishan Shrestha	14.Representative Madhyapur Thimi Engineering Society
6.Mr.Laxmi Bhakta Shrestha	15.Representative Madhyapur Thimi Municipality
7.Mr.Drabya Lal Shrestha	16.Representative Bal Kumari Area Development Committee
8.Mr.Tulis Bhakta Shrestha	17.Representative Community Forest Users Commitee

Annex A. 4 Staff Detail of BASP

Designation	Name	Category
Chairman	Krishna K.C	Temporary
Project Manger	Raj Kumar Malla	Permanent
S.D.E.	Anil Bhadra Khanal	Permanent
Section officer	Kiran Shakya	Permanent
Engineer	Jyoti Bhusan Pradhan	Permanent
Sociologist	Premnidhi K.C	Permanent
Account Officer	Sasindra Kesari Paudel	Permanent
Mechanical Engineer	Hari Darlami	Contract
Chemist	Anjeeta Rajbanshi	Contract
Personal Assistant(Chairman)	Bhai Kaji Ghimire	Temporary
Computer operator	Sita Dahal	Temporary
Legal Advisor	Nandu Acharya	Contract
Junior Officer	Kabita Bhattarai	Temporary
Junior Officer	Bhupendra Parajuli	Contract
Surveyer	Hari Krishana Tripathi	Permanent
Asst. Accountant	Bhubaneshwor Adhikari	Permanent
Sub- Engineer	Tost Raj Chheti	Permanent
Sub- Engineer	Rabindra Nath Dev	Permanent
Sub- Engineer	Bhima Nepal (Bhattarai)	Temporary
Kharidar	Chiranjivi Lamichane	Permanent
Mechanical Sub-engineer	Devendra Prakash Thapa	Contract
Mechanical Ast. Sub-engineer	Raj Kumar Shrestha	Temporary

Designation	Name	Category
Mechanical Ast. Sub-engineer	Amit Chaudhari	Contract
Mechanical Ast. Sub-engineer	Khadga Jung Shah	Contract
Electrical Ast. Sub-engineer	Narendra Nepal	Contract
Amin	Pradeep Shrestha	Permanent
Amin	Ram Bahadur Tamang	Permanent
Computer operator	Hemkumari Ghimire	Temporary
Motivetor	Mala Kharel	Contract
Lab Assistant	Raj Kishor Yadav	Temporary
Mukhiya	Yasodha Niraula	Temporary
Driver	Rakesh Lama	Temporary
Driver	Birjeet Lama	Contract
Mechanical Helper	Shiva Prasad Dhungana	Temporary
Asst Computer Operator	Yegya Adhikari	Contract
Peon	Shiva Kalika	Temporary
Peon	Shrijana Karki	Temporary
Peon	Basantu Adhikari	Contract
Peon	Geeta Devi Niraula	Temporary

Annex A. 5 Annual Bud. Serial no 48-3-711 (BASP)

Annual Budject Sheet of the BASP						
	Budget amount withdraw up to Nov	Budget No	Expenses title	Total Budget amount for 2007-2008	Expenses up to Nov(from July)	Remaining
382825.70	1915861.43	1.01	Salary	4650000	2298687.13	2351312.87
3000.00	720.00	1.02	Allowance	100000	3720.00	96280.00
0	0	1.03	Shifting Travel Allowance	10000	0	10000.00
1278.00	19672.88	2.01	Water/electricity	50000	20950.00	29049.12
17478.67	69952.43	2.02	Communication	150000	87431.10	62568.90
12722.00	214696.00	2.03	Office materials	675000	227418.00	447582.00
28797.85	208748.00	2.05	Maintenance	430000	237545.85	192454.15
57962.00	281520.00	2.06	Fuel	600000	339482.00	260518.00
0	0	2.07	Consultancy charge	30000	0	30000.00
16800.00	39940.00	2.08	Miscellaneous	150000	56740.00	93260.00
2200.00	194955.00	4.04	Program expenses	950000	197155.00	752845.00

	Budget amount withdraw up to Nov	Budget No	Expenses title	Total Budget amount for 2007-2008	Expenses up to Nov(from July)	Remaining
5424.00		4.05	Program travel expenses	30000	5424.00	24576.00
0		4.06	Regular maintenance	1000000	0	1000000.00
528488.22	2946065.74		Total	8825000	3474553.96	5350446.04

Funding Status
Name of Bank: Nepal Rastra Bank
Bank Account No: ----------
Total Budget Sanction up to Nov = 4346065.74
Total expenses = 3474553.96
An advance = 00
Total expenses = 3474553.96
Bank Balance: = 871511.78
Remaining tax pay = 818
Total amount = 872329.78
Bud serial no 48/4/711

Annex A. 6 Capital for maintenance

Expenses of November 07	Budget amount withdraw up to Nov	Budget No	Expenses title	Total Budget amount for 2007-2008	Expenses up to Nov(from July)	Remaining
0	0	6.03	Machinery tools	30000	0	30000
298813.00	2503624.61	6.05	Simple construction	13300000	2802437.61	10497562.39
298813.00	2503624.61		Total	13330000	2802437.61	10527562.39

Funding Status
Name of Bank: Nepal Rastra Bank
Bank Account No: ----------

Total Budget Sanction up to Nov	= 4703624.61
Total expenses	= 2802437.61
An advance	= 18500.00
Total expenses	= 2783937.61
Bank Balance:	= 1901187.00
Remaining tax amount	= 405.00
Total amount	= 1901592.00

Annex A.7 Expenses Detail

Serial no	Description	Annual Budget(Nrs)
1	Land Measurement (6km)	50000
1	Main Sewerage Maintenance	400000
1	Branch Sewerage Maintenance	400000
KA	Other Expenses	
1	Other Expenses including contingency	450000
2	Road and Green Belt	450000
	Yearly Program	
1	Operation and maintenance	8200000
2	Furniture	30000
3	Machinery Equipment	150000
9	Additional Program	
	Check posts(control illegal sand extraction from river)	1000000
Kha 2	Sundarijal Gokarna Sector	
1	Sanitaiton Improvement(sewerage construction)	100000
2	Land measurement and adjustment	600000
Kha 3	Til Ganga Skahkha Mul Sector	
	Public awareness programme	1000000
	Land measurement and adjustment	500000
	Total	**13330000**
Gha	Running yearly budget 8825000	
1	Use, office expenses, service and production, visit program	6875000
2	Public awareness and Green belt program	950000
3	Regular operation and maintainance	1000000
	Total	8825000
	Total Budget for the project	**22155000**

Source" BASP,(2007)

Annex A.8 Profit and Loss Account (NWSC)

Income	FY 2004/05 (Nrs)	FY 2003/04(Nrs)
Water Revenue(After Rebate)	662,410.173.78	530,813,591.07
Other Income	64,068,763.58	68,081,051.52
Total	726,478,937.36	598,894,642.59
Expenditure		
Production	167,584,062.89	156,808,121.94
Distribution	105,963,155.61	100,565,008.24
Quality Control	8,930,271.70	7,827,956.36
Electro-Mechanical	12,461,043.73	12,469,883.48
Sewerage	[redacted]	[redacted]
Consumer's Account	45,999,160.65	43,654,522.26
Adminstative Expenses	149,113,330.75	114,141,025.36
Write Off (Stock)	97,870.26	775,485.61
Provision for D/D	23,763,218.13	17,635,688.82
Provision for Gratuity Fund		17,017,923.98
Total	**524,282,433.39**	**481,620,076.06**
Operating Surplus (Deficit)	202,196,503.97	117,274,566.53
Interest Payble	(61755735.89	(56187592.71
Depreciation	(152,479,741.46	(151,716,772.02
Depreciation Transferred from Capital Reserved	47,737,901.97	47,715,477.27
Net Profit(loss)	35,698,928.59	(42,914,320.93
Last Year's Adjustment	1,447,582.39	42,114,878.30
Upto Previous Year (Net Loss)	(274,118,145.35	(273,318,702.72
Accmulated Loss Carried to B/S	236,971,634.37	(274,118,145.35

Source: NWSC, (2006)

Annex A.9 List of Industries selected for compliance Study

S.No.	Name of Industry	established	No. of employee	Current Production	Contact person and details
1	Mount Everest Dying and Carpet Industries, Jorpati	1992	45 (2 Indian)	25 tons/month	Mr. Birendra Jshi ,manager 9851060418
2	Dantakali Wool dying, jorpati	NA	10	10 ton /month	Mr. Madan Sharma, Supervisor ,Tel: 4485844
3	Durga Dying	NA	10-12	10 to 30 tons /month	Mr. Suman Das Rajbhandari, Incharge
4	Supath Wool Dying	1999	15	6 to 10 tons/month	Mr.Manoj Dhungana , Tel: 4477134
5	Narayni Wool Dying	2061 BS	15	8 to 10 tons/month	Mohan KC, Tel: 4471558

S.No.	Name of Industry	established	No. of employee	Current Production	Contact person and details
6	Kamna Wool Dying	2059 BS	16	12 tons/month	Mr.Deepak Rai, Tel: 4499027
7	Shree Dying P.Ltd		18 (4 Indian)	15 tons/month	Mr. Raj Kumar Yadav Tel: 4474674
8	Rupa Wool Dying	1986	6	2 tons/month	Mr. Chandra Kant Chaudhary (do not provide the owner name and contact himself)
9	Shivakar Enterprises , Jorpati 1	2061 BS	5 (1 Indian)	1 ton/month	Mr. Om Prakash Gupta, Dye Master , 9841213586
10	Bodhh Designer Carpet Industry	1991	8 people (1 Indian)	8 to 12 tons/month	Mr. Laxmi Gupta, Dye Master , 9841213586
Note: The raw wool were brought from Tibet and Netherlands The chemicals basically Acetic Acid, LYOZEN SMK, Yellow 2GLN, Metal Complex and several dying etc has been used for dying. NA : Not Available					

Annex A.10 Lab lest report of SWTP
Source:Field survey, (2007)

ENPHO

SWC Reg. 2838047/048

ENVIRONMENT AND PUBLIC HEALTH ORGANIZATION

ENPHO Research Laboratory

P.O. Box: 4102, New Baneshwor, Kathmandu, Nepal

Tel: 977-1-4468641, 4493188, Fax: 977-1-4491376 E-mail: enpho@mail.com.np

Nepal Laboratory Accreditation Council Accredited

WATER ANALYSIS REPORT

Lab Reg. No.: 1470/(061-062) **Code : RS** **Payment: T**

Client : Thimi Wetland	***Source of Sample : Wetland***
Address : Thimi	Date of Collection: 31st December 2004
Sampled By : ENPHO	Date of Analysis : 31 - 6th January 2005

PHYSICO-CHEMICAL ANALYSIS

Parameters	**Unit**	**Sample ID**
		LR - 1470
pH (14°C)	-	7.29
Electrical Conductivity	uS/cm	2260
Nitrogen - Ammonia	mg/L	234.5
Nitrogen - Nitrate	mg/L	0.84
Orthophosphate	mg/L	19.44
Dissolved Oxygen (DO)	mg/L	0
Chemical Oxygen Demand (COD)	mg/L	965.1
Biological Oxygen Demand (BOD)	mg/L	516.3
Total Suspended Solids (TSS)	mg/L	348.0
BACTERIOLOGICAL ANALYSIS		
Total Coliforms	CFU/1ml	$84X10^9$

Source: ENPHO (2005)

Annex A.11 Household, Industry and Community Survey Questions

54 domestic household
19 Induestry
5 community member

Questions	**Nos**	**Precentage**
How often the the concerned authority visit the Site?		
Household		
No body has visited to check wastewater Quality yet	35	65 %
visited by Staff member of BASP	19	35 %
Induestrial		
No body has visited to check wastewater Quality yet	2	11 %
visited by Staff member of BASP/Ministry of Industry	17	89 %

Where you Dispose your Waste water?		
Domestic		
Collect Septic tank than dispose sewerage	12	22 %
Direct Dispose to the Sewerage	32	59 %
Septic Tank only	10	19 %
Induestry		
Collect Septic tank than dispose sewerage	7	37 %
Direct Dispose to the Sewerage	10	53 %
Septic Tank only	2	10 %
How often you are facing sewerage blockage problems in your areas?		
Industry		
More then once in a week	4	21 %
About every six Month	5	26 %
Blockage in Rainy Season	9	48 %
Never Blockage	1	5 %
Household		
More then once in a week	7	13 %
About every six Month	15	28 %
Blockage in Rainy Season	32	59 %
Never Blockage	0	0 %
Sunga		
More then once in a week	0	0 %
About every six Month	2	40 %
Blockage in Rainy Season	3	60 %
Never Blockage	0	0 %
Do you know existing Wastewater Treatment Plant is funcing Well ?		
Induestry		
Yes	3	16 %
No	10	53 %
I Don't Know	6	31 %
Domestic		
Yes	10	18 %
No	10	18 %
I Don't Know	34	64 %

Have you participat in any public awareness programme conduct by BASP?		
Induestry		
Yes	12	63 %
No	3	16 %
They never Invite us	4	21 %
Domestic		
Yes	5	9 %
No	5	9 %
They never Invite us	44	82 %
Do you know where you are paying your wastewater treatment plant cost?		
Industry		
Paid to NWSC	11	58 %
Neverpaid for water and sanitation	4	21 %
No NWSC Connection	4	21 %
Domestic		
Paid to NWSC	42	78 %
Neverpaid for water and sanitation	4	7 %
No NWSC Connection	8	15 %
Sunga		
Paid to NWSC	1	20 %
Neverpaid for water and sanitation	2	40 %
No NWSC Connection	2	40 %
If you are NWSC connection Do you have Water Meter?		
Industry (15)		
yes paying basis of meter reading	5	33 %
yes but not working	4	27 %
not yet	6	40 %
Domestic(46)		
yes paying basis of meter reading	32	70 %
yes but not working	7	15 %
not yet	7	15 %
Sunga (3)		
yes paying basis of meter reading	1	34 %
yes but not working	0	0
not yet	2	66 %

What type of Wastewater treatment plant do you know ?		
Industry		
Only Own	7	36 %
Two Type/more than two	6	32 %
No Idea	6	32 %
Domestic		
Only Own	15	28 %
Two Type/more then two	10	19 %
No Idea	29	53 %
Sunga		
Only Own	4	80 %
Two Type/more then two	1	20 %
Do you feel such type of wastewater treatment plant is essential in your community?		
Induestry		
Yes	11	58 %
No	5	26 %
No Idea	3	16 %
Domestic		
Yes	25	46 %
No	10	19 %
No Idea	19	35 %
Sunga		
Yes	5	100 %
No	0	0 %
No Idea	0	0 %
When you pass near about wastewater treatment plant ,do you feel any odour ?		
Induestry		
Yes	14	74 %
Not too much	5	26 %
Completely No	0	0 %
Domestic		
Yes	44	81 %
Not too much	10	19 %
Completely No		
Sunga		
Yes	0	0 %
Not too much	2	40 %
Completely No	3	60 %

At what time the odour is High ?		
Industry		
Early in the Morning	2	11 %
9AM to 12 noon	14	74 %
Evening and Night Time	3	16 %
Domestic		
Early in the Morning	10	19 %
9AM to 12 noon	40	74 %
Evening and Night Time	4	7 5
Do you agree to pay additional wastewater charge if the service preformance is good ?		
Industry		
Yes	12	63 %
Not sure of improving performance form existing system	5	26.%
No	2	11.%
Domestic		
Yes	40	74 %
Not sure of improving performance form existing system	10	19 %
No	4	7 %
Sunga		
Yes	0	0 %
Not sure of improving performance form existing system	0	0 %
No	5	100 %
Do you have any Idea about the sustainability of Existing Wastewater Treatment Plant ?		
Industry		
polluter pay principle	7	37 %
subsidy from Government	8	42 %
No Idea	4	21 %
Domestic		
polluter pay principle	20	37 %
subsidy from Government	30	56 %
No Idea	4	7 %
Sunga		
polluter pay principle	2	40 %
subsidy from Government	2	40 %
No Idea	1	20 %

Are you satisfy with the management committee of the existing wastewater treatment plant ?		
Industry		
Yes	6	32 %
No	9	47 %
No Idea	4	21 %
Domestic		
Yes	20	37 %
No	25	46 %
No Idea	9	17 %
Sunga		
Yes	5	100 %
No	0	0 %
No Idea	0	0 %
If No what is your openion for the improment		
Industry		
The committee should be reformed	2	10 %
Political interfare for selection of staff should be stop	11	58 %
No Idea	6	32 %
Domestic		
The committee should be reformed	15	28 %
Political interfare for selection of staff should be stop	25	46 %
No Idea	14	26 %
The Manually Operating System in Diffrerent Parts of existing Wastewater Treatment System is Suitable in Nepal,Do you agree with this statement?please tick moer than one if you like		
Induestry(35 answers)		
No,because it is directly effect the health	4	11 %
Yes,because labour cost is cheap here	8	23 %
Yes ,because employment opportunity increase	8	23 %
Yes ,because cost of electricity is high and not regular	15	43 %
Domestic(71 answers)		
No,because it is directly effect the public Health	11	16 %
Yes,because labour cost is cheap here	25	35 %
Yes ,because employment opportunity increase	10	14 %
Yes ,because cost of electricity is high and not regular	25	35 %
Sunga(14 answers)		
No,because it is directly effect the public Health	0	0 %
Yes,because labour cost is cheap here	5	36 %

Yes ,because employment opportunity increase	5	36 %
Yes ,because cost of electricity is high and not regular	4	28 %

Annex A.12 List of contacted persons

SN	Names	Designation	Department
1	Ram Deep Shah	Divisional Engineer	NWSC
2	Dr Chet Bd Pariyar	Environment and Resource Managemetn Consultant	ERMC(P.)Ltd
3	Nawa Raj Khatiwada	Executive Director	Nepal Development Research Institute
4	Damodar Pradas Aryal	Assistant Auditor General	Office of the Auditor General
5	Dr Roshan Raj Shrastha	Chief Technical Advisor	UN-HABITAT
6	Bhusan Tuladhar	Managing Director	ENPHO
7	Padma Sundar Joshi	Executive Director	Centre for Integrated Urban Development
8	H.P.Dhakal	Manager	NWSC
9	Kiran Amatya	Manager	Sewerage Section
10	Pradeepp Amatya	Environmental Engineer	Lalitpur Sub-Metropolitan City
11	Manoj Kumar Pande	Lecturar	Institute of Engineering
12	Rajendra L.Shilpakar	Water Resource Analyst	ICIMOD
13	Suman Raj Sharma	General Secretery	MPPW
14	Meera Shrestha	Environmental Engineer	MOEST
15	Salil Devkota	Manager	Melemchi Water Supply Project
16	Raj Kumar Malla	Project Manager	BASP
17	Krishna KC	Chairman	BASP
18	Prajwal Shrestha	Program Manager	ENPHO
19	Laxmi Nepal	Project Officer	ADB
20	Dhundi Raj Dahal	Engineer	Departmetn of Water Supply and Sewerage (DWSS)
21	Rabin Man Shrastah	Head of Environmental section	KMC
22	Mrs.Romi Manandhar	Seniro Engineer	Ministry of Induestry
23	Gopal Baral	Ex-chairman/Member of BASP	Jorpati VDC
24	Navaraj Khatri	Seniro Engineer	Melemchi Water Supply Project

Annex A.13 Previous Studies about Existing Sewerage and WWTPs

Many studies have been carried out on the sewerage system of the Kathmandu Valley since 1973 to date and have proposed various recommendations. Following are the recommendations proposed by various studies.

1. Master Plan for the Water Supply and Sewerage of Greater Kathmandu and Bhaktapur, WHO, UNDP Project Nepal 0025, Binnie and Partners, 1973.

- The sewerage system shall be separate and the treatment methods shall be mechanically aerated stabilization ponds
- Two treatment plants, at Dhobighat and Kodku, will be sufficient to meet the requirement of Greater Kathmandu up to the year 2000 AD
- For Bhaktpur and Thimi area new treatment plants were proposed at the location midway between the two cities

2. Second Water Supply and Sewerage Project, WSSB/Bank, Engineering Science inc.1979

- The second Water Supply and Sewerage Project Study (known as Second Project) prepared the detailed design and construction drawings of the first stage of the works proposed by the 1973 Master Plan. While preparing the detailed design works, the study proposed some changes in the original 1973 Master Plan. The major change was the replacement of previously proposed box culvert interceptor mains with the RCC pipes.

3. Water Supply and Sewerage Studies, WSSC/World Bank, Protor & Redfern International Limited in associations with EAST, 1984

- The study recommended following the 1973 Master Plan and the design criteria adopted by the second Project.

4. Service improvement and Management Support to NWSC, the World Bank, Binnie and Partners in association with Multi, 1989.

- The study recommended the rehabilitation of the Dhobighat and Kodku treatment facilities. Cleaning of sewer mains and replacement of the undersized sanitary mains in the core areas of the Kathmandu and Patan cities.

5. Existing Master Plan, Greater Kathmandu Drainage Master Plan Studies (GKDMPS), HMG/DWSS. Snowy Mountains Engineering Corporation in association with CEMAT, 1990

- Separate sanitary sewer mains for the new construction works.
- Interceptor mains along the Tukucha, Bishnumati, Dhobi Khola and the Bagmati River.

- Six conventional type of treatment plants at Sanepa, Manohara, West bank of Bagmati at confluence of Bagmati and Bishnumati ,Dhobi Khola junction,Nakkhu Khola junction, Kodku. The Dhobighat treatment plant is recommend to be abandoned and land sold to buy land at other location. The Sanepa treatment plant is proposed to be placed in highest priority and construction scheduled for 1995.

6. Kathmandu Valley Urban Development Plan and Programs, HMG/DHUD and ADB, Halcrow Fox and association with PAK_POY and ECMAT, 1991.

- A feasibility study of a single large sewerage treatment lagoon, south of Chovar gorge, should be conducted before adopting the six treatment plant option proposed by GKDMPS (Snowy Mountain, 1990).Also the GKDMPS recommendation for separate sewerage system should be reviewed.

- The existing sewers and treatment plants should be under rehabilitation and its effectiveness enhances by the introduction of a program to encourage toilets and toilets connections.

Further the study proposed following strategy for the sewer system of the valley.

Phase -1

The existing sewerage discharge should be intercepted at discharge point along via trunk sewers place along the banks of the rivers. An interim measure for improvement of the rivers with the valley would be to discharge raw sewerage directly into the Bagmati River at location down stream of Kakamandu.The result would be greatly improved water quality within Kathmandu

Phase-2

A simple lagoon system a site south of Chovar is proposed

Phase-3

Upgrading of lagoon system to conventional treatment plant for the requirement to improve water quality .

Phase-4

The reticulated sewerage system should be upgraded throughout the urbanized areas to prevent the septic systems from pollution the shallow groundwater.

7. Bagmati Basin Water Management Strategy and Investment Program, the World Bank, Stanly International Ltd. in association with MOTT-MACDONALD and EAST, 1984

- Small separate treatment plants for most populated institution e.g. Army Camps, Hospitals, and Jails etc.
- Gaurighat wastewater treatment plant(BASP) for area upstream of the Pashupatinath temple
- Dhobi Khola sewerage treatment plant for covering the Dhobi Khola sewerage zone and upstream area of the Dhobi Khola and Bagmati Junction.
- Extension and rehabilitation of the existing Dhobighat (Sundrighat) treatment plant and the Kritipur pumping station for additional area of Patan south, Patan North, and Bishnumati west areas.
- Rehabilitation of the existing sewerage system and improvement works along the Tukucha Khola
- On site sanitation facilities for the Kathmandu –Bhaktapur Corriodr and other rural areas.

8. Urban Water Supply and Sewerage Rehabilitation Project (UWSSRP), NWSC/World Bank, CES in association with SILT and MULTI, 1992-ongoing.

- The major components of the sewerage works of project include the rehabilitation of the Dhobighat and Kodku treatment plants, rehabilitation of Kritipur Pumping station, rehabilitation and extension of existing sewer mains and replacement of existing under sixes main overflow structure at Tukucha Khola and at various locations along the banks of Bagmati and river. The contract of the works has already been awarded and the commencement of the construction work is scheduled for June, 1997.
- The study also proposed construction of covered concrete channel along the Tukucha Khola, converting the whole Khola into a combined Sewer. due to various reasons ,the proposal was removed form the contract package(IITECO,2003)

9. High Powered Committee for Implementation and Monitoring of the Bagmati Area Sewerage construction /Rehabilitation project.

- The Bagmati Area Sewerage Construction /Rehabilitation Project (BASP) is concentrating on construction of trunk sewers after the completion of sewerage treatment plant at Gaurighat area and construction of sewer mains from the treatment plant to the onwards downstream.

The Construction of the sewer main (including tunnel) has completed. The detail design of the treatment plant being conducted by the Nepal Consult (P) Ltd

10. Bhaktapur Development Project (BDP), HMG/GTZ, 1976

- Due to the failure of the existing WWTP of Bhaktapur, Hanumante and Manohora rivers are highly polluting. The urban Development through Local Efforts (UDLE) is being involved in rehabilitation of the sewerage works in the Bhaktapur Municipal area since 1991.The UDLE has already completed the rehabilitation works of the north collector and presently involved in the rehabilitation program of the south main collector.

11. Kathmandu Valley Map Planning (KVMP) is preparing the different types of maps of the Kathmandu valley which will give the picture of city development 2001-2003
12. High Powered Committee (HPC) for Implementation and Monitoring of Bagmati Area Sewerage Construction/ Rehabilitation Project, Conceptual Master Plan, 1997.

- Concept of Constructing roads and green belt on either side of the Bagmati Corridor from Sundarijal to Chovar.
- Conceptual master Plan was prepared on the basis of aerial photographs and field observation detailed master plan was recommended.

13. U.N.Park Development committee, Bagmati –Bishnumati Conservation programme Final Report of conservation and Development Master Plan for Bagmati-Bishnumati and Dhobi Khola Corridor, cosmos Engineering Services, 1999.

The Master Plan recommended as following.

- Sewer cleaning work
- Reed bed treatment plant
- Conventional Treatment Plant

14. U.N park development committee, detailed feasibility study and engineering design of sewerage system form Skahkhamul to Teku dovan, Wlink, 1997

- Recommended the detailed design of the interceptor mains beyond the Teku Dovan and pumping system
- Tukucha and Dhobi Khola pollution should be controlled.

Photo P 1 secondary clarifier of BASP

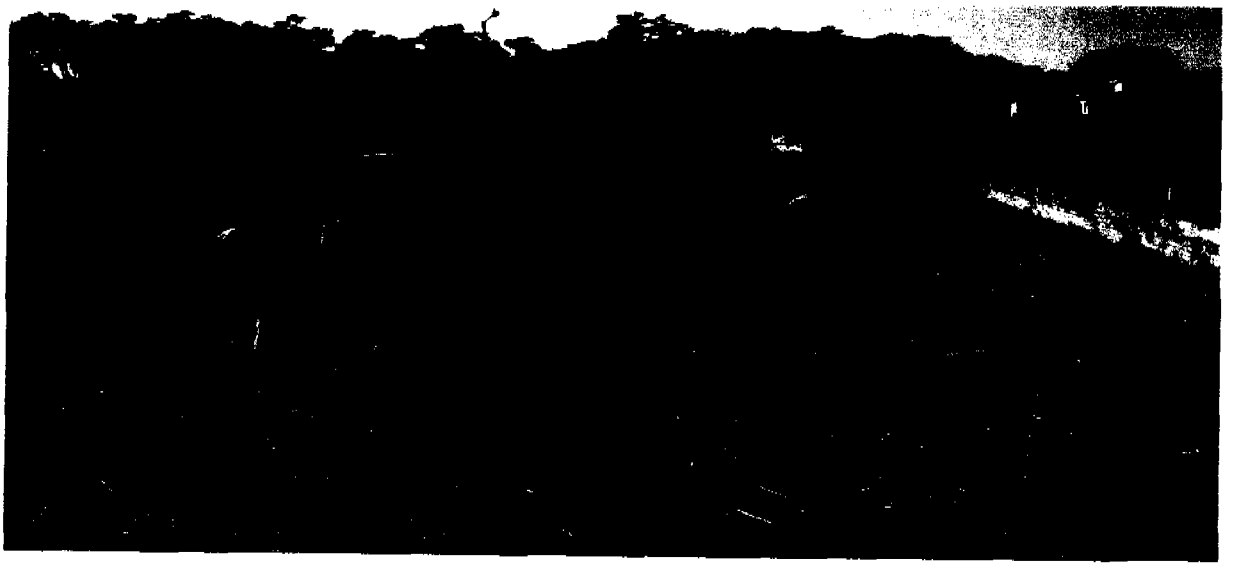

Photo P.2 Sludge drying bed BASP

Photo P.3 Vertical flow bed SWTP