



Baseline Study on Water Supply, Sanitation and Solid Waste in Upper Dharamsala, India

Cover picture: Main road and commercial area of Upper Dharamsala McLeod Ganj, September 2002 (photo Gabriela Friedl)

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Table of Contents

| | | |
|-------|---|----|
| 1 | Introduction | 8 |
| 2 | Executive Summary | 10 |
| 3 | Study Methodology | 12 |
| 3.1 | Preparation | 12 |
| 3.2 | Field work | 15 |
| 3.2.1 | Observation | 15 |
| 3.2.2 | Interviews with key persons | 15 |
| 3.2.3 | Household survey | 16 |
| 3.2.4 | Mapping | 17 |
| 4 | General | 20 |
| 4.1 | Situation | 20 |
| 4.1.1 | Geographic location and settlement structure | 20 |
| 4.1.2 | Climate | 21 |
| 4.1.3 | Socio-economic conditions and population dynamics | 22 |
| 4.2 | Stakeholder analysis | 22 |
| 5 | Water Supply | 26 |
| 5.1 | Situation | 26 |
| 5.1.1 | Institutional set-up and legal framework | 26 |
| 5.1.2 | Water resources | 26 |
| 5.1.3 | Central water supply system | 28 |
| 5.1.4 | Household level | 31 |
| 5.2 | Strength and weaknesses | 34 |
| 5.2.1 | Strengths | 34 |
| 5.2.2 | Weaknesses | 34 |
| 5.3 | Suggestions | 36 |
| 6 | Sanitation | 38 |
| 6.1 | Situation | 38 |
| 6.1.1 | Institutional set-up and legal framework | 38 |
| 6.1.2 | Household level | 38 |
| 6.1.3 | Public toilets | 41 |
| 6.1.4 | Central sewage system | 42 |
| 6.2 | Strengths and weaknesses | 44 |
| 6.2.1 | Strengths | 44 |
| 6.2.2 | Weaknesses | 44 |
| 6.3 | Suggestions | 47 |
| 7 | Drainage | 48 |
| 7.1 | Situation | 48 |
| 7.1.1 | Institutional set-up and legal framework | 48 |
| 7.1.2 | Open drainage system | 48 |
| 7.2 | Suggestions | 50 |
| 8 | Solid Waste | 52 |
| 8.1 | Situation | 52 |

| | |
|---|----|
| 8.1.1 History | 52 |
| 8.1.2 Institutional set-up and legal framework | 52 |
| 8.1.3 Indiscriminate dumping and public awareness | 53 |
| 8.1.4 Collection | 54 |
| 8.1.5 Households | 58 |
| 8.1.6 Recycling and disposal | 61 |
| 8.2 Strength and weaknesses | 63 |
| 8.2.1 Strengths | 63 |
| 8.2.2 Weaknesses | 64 |
| 8.3 Suggestions | 65 |
| 9 References | 68 |
| | |
| Annex 1 | 70 |
| Institutional Contacts | 70 |
| Survey Sampling | 70 |
| Geographic Features | 72 |
| Annex 2 | 74 |
| Public bins | 74 |
| Segregation centre of TWO | 74 |
| Sanitation Contract | 75 |
| Annex 3 | 76 |
| Household Questionnaire | 76 |

Tables

| | |
|--|----|
| Table 1: The classification of households was done according to the following criteria. | 17 |
| Table 2: Areas of main settlements in Upper Dharamsala based on digitized information from satellite imagery...21 | 21 |
| Table 3: Water resources of Upper Dharamsala. Estimated capacity corresponds to the dimension value of the water supply system (IPH). | 27 |
| Table 4: Water reservoirs in Upper Dharamsala..... | 30 |
| Table 5: Public toilets in Upper Dharamsala..... | 41 |
| Table 6: Technical parameter of the sewage treatment plant according to IPH. The hydraulic retention time is calculated from capacity flow and the volumes of the aeration tanks. | 43 |
| Table 7: Hot spots of inadequate sanitation in Upper Dharamsala..... | 46 |
| Table 8: Households included in the survey. | 71 |
| Table 9: Short description of the various public bins found in Upper Dharamsala. | 74 |
| Table 10: Waste categories sorted out in the segregation center under TWO. | 74 |

Figures

| | |
|---|----|
| Figure 1: General system of water supply. | 13 |
| Figure 2: General processes of wastewater management. | 13 |
| Figure 3: Solid waste management of Upper Dharamsala according to (Zurbrügg, 2001)..... | 14 |
| Figure 4: Water treatment on household level in Upper Dharamsala. | 33 |
| Figure 5: The proportion of people suffering from a water-related disease is larger in the urban settlements where water pipes can be found in the open drainage system more often. | 36 |
| Figure 6: Most greywater is discharged into the open drainage system or into the forest. | 40 |
| Figure 7: Flow scheme of the sewage treatment plant in Lower Dharamsala. | 43 |
| Figure 8: Waste collection services used by households in the urban settlements of Upper Dharamsala. “truck” means wet waste collection by the TWO, “tempu” dry waste collection. “Other” describes households which give dry waste to the TWO collection service or to waste pickers and feed all organic waste to cattle, and have no other waste to manage. | 59 |
| Figure 9: Waste collection services used by households in the rural settlements of Upper Dharamsala. “truck” means wet waste collection by the TWO, “tempu” dry waste collection. With “other” mostly households are meant that give dry waste to the TWO collection or to wastepickers and organic waste to their cattle, they do not have other wet waste. | 60 |

Maps

| | |
|---|----|
| Map 1: Location of Dharamsala (source: www.mapsofindia.com)..... | 8 |
| Map 2: Map of Upper Dharamsala. | 20 |
| Map 3: The water supply system of Upper Dharamsala. In some cases mapping was not possible and locations of pipe network were added to the map at a later stage manually. The figures next to the pipe describe the diameter of the pipes in meters. | 29 |
| Map 4: Most households treat the water in some way in the household before drinking..... | 32 |
| Map 5: Sanitation facilities of the households and location of public toilets..... | 39 |
| Map 6: Hot spots of sanitation in Upper Dharamsala. | 46 |
| Map 7: The drainage system of Upper Dharamsala. There are some central place in McLeod Ganj and in Bhagsunag where the drainage system is interrupted. | 49 |
| Map 8: Indiscriminate dumping is one of the major problems of solid waste management in Upper Dharamsala. This is illustrated by the numbers of hot spots (places where waste is accumulating in the environment).... | 55 |
| Map 9: Coverage of area of the two collection services. Dry and wet waste collection cover about the same area. | 55 |
| Map 10: Households, the collection services they use and the collection services. | 59 |

Pictures

| | |
|--|----|
| Picture 1: Water source intake structure. The intake pipe (enhanced in colour on the left had side) is fixed by stones into the river pool (centre)..... | 28 |
| Picture 2: Leaking pipes are often repaired with wooden sticks, cotton rags or stones. (Picture: Bettina Sterkele) | 30 |
| Picture 3: Many household pipes are going parallel as they have to, or prefer to connect on a high level of the main pipe. (Photo: Gabriela Friedl) | 31 |
| Picture 4: Open drain in McLeod Ganj in dry season. The drain is in a relatively good condition but the waste lying inside might block it in rainy season and the water pipes though relatively high might be flooded. (Picture: Gabriela Friedl)..... | 49 |
| Picture 5: Waste is thrown on hillsides. Here the hill next to a big hotel in Hotel Bhagsu Road is shown. (Picture: Gabriela Friedl)..... | 54 |
| Picture 6: The Municipal containers at the taxi stand of McLeod Ganj (north of main market) (Picture: Gabriela Friedl). | 56 |
| Picture 7: The disposal site in Lower Dharamsala. (Picture: Bettina Sterkele)..... | 61 |

1 Introduction

Background

Dharamsala is a town situated in the foothills of the Himalayas in the District of Kangra and State of Himachal Pradesh, India. Two distinct parts of Dharamsala are usually differentiated. Kotwali Bazaar and areas further down into the plains of the Kangra valley (at the average height of 1,250 metres) are called Lower Dharamsala, while McLeod Ganj (at the height of nearly 1,800 metres) and its surrounding areas on the hillsides are known as Upper Dharamsala. McLeod Ganj is nine kilometres by bus route and four kilometres by taxi route (shortcut road) from Kotwali Bazaar up the hillside. While inhabitants of Lower Dharamsala are almost all Indians, McLeod Ganj has a large Tibetan population. The area of Upper Dharamsala is an increasingly popular Western and Indian tourist destination as most wish to receive blessings and teachings from His Holiness the Dalai Lama.



Map 1: Location of Dharamsala (source: www.mapsofindia.com)

With the rapid increase in population, the pressure on the environment is continuously growing. According to the Tibetan Welfare Office (TWO, see chapter 4.2), Upper Dharamsala's environment is threatened by its rapid growth. The main threats are considered to be:

- Deforestation and erosion
- Forest fires
- Slates mining
- Uncontrolled construction and development
- Untreated sewage and open sewage
- Insufficient toilet facilities
- Insufficient supply of drinking water and its contamination
- Inadequate management of solid waste

Since 1994, the Tibetan Welfare Office has initiated the Solid Waste Management and Recycling Programme called Clean Upper Dharamsala project with the support and financial assistance of Swedish Organization for Individual Relief-IM, Sweden, the Royal Netherlands Embassy, India, Mr. Wilfried Pfeffer, Tibetischer Förderkreis, Germany, Tibet Welfare Group, Australia, Rick Hayman, USA, Eco-Tibet, France, Tibetan Community, Australia, and Ratna Tara Mission, Germany. To strengthen the services offered by the TWO, an environmental action plan was proposed to the Gere Foundation in early 2001. The Department of Water and Sanitation (SANDEC) of the Swiss Federal Institute of Environmental Science and Technology (EAWAG) was requested by the Gere Foundation to add comments regarding this proposal. In February 2001, based on the initial proposal and available reports and literature provided by Gere Foundation, SANDEC drafted an amended version of a project idea together with a summary document of the "environmental situation" in Dharamsala. In October 2001, during a visit to Dharamsala of four days, SANDEC together with TWO drafted a project proposal (Zurbrugg, October 2001) concerning improvements to the solid waste management services of Upper Dharamsala. After some further amendments by TWO regarding equipment needs and budget, TWO was able to raise funds for the project at Gere Foundation/ Initiatives Foundation and other sources.

The "solid waste management project" funded by Gere Foundation/ Initiatives Foundation took off in January 2001. One important task described in the project proposal involved conducting a baseline study of the water, sanitation and solid waste situation in Upper Dharamsala. This basis of knowledge concerning water supply and all aspects of cleanliness, liquid waste, as well as solid waste management, is regarded as an essential step for planning the next project phase, which might go beyond solid waste service improvements alone. This document represents the final report of this baseline study, for which the field work was conducted in Dharamsala during the months of September 2002 and December 2002 by TWO staff and Bettina Sterkele of SANDEC/EAWAG.

General Objectives

The overall objective of the baseline study project is to provide information which facilitates participatory decision-making in planning for investments, in further project development, and in day to day operational challenges for service delivery to the public in the field of water supply, sanitation, and solid waste management.

A further objective of the base line study project is rather more scientifically oriented and is in its methodology. A critical assessment and evaluation of the project methodology used, specifically concerning the potentials and challenges with using Geographical Information System (GIS) tools in such an urban, as well as developing country context, gives interesting insights which can be used by other actors engaged in similar baseline study projects. Thus the study shall contribute to a scientific product such as the development of a methodological approach which can be used by municipalities or research institutions or consultants confronted by similar tasks.

2 Executive Summary

Dharamsala is a small town located on the foothills of the Himalayas. Upper Dharamsala - the study area - includes typical urban settlement areas such as McLeod Ganj and Gankyi, in terms of housing types and population density, as well as the villages of Bhagsunag, Dharamkot, Forsythganj and Naddi with typical rural settlement structures. Various ethnic groups live in the study area of Upper Dharamsala. The Gaddis are the traditional Indian population of the area. After His Holiness the Dalai Lama made his home in exile in Upper Dharamsala and also moved the Central Tibetan Administration, (The Tibetan Government-in-Exile) from Mussoorie to Dharamsala in 1960, a large community of Tibetan refugees started to settle in Upper Dharamsala. With increasing Western and Indian tourism many Indians from other States have also moved to Dharamsala to live and trade.

Water supply

The main water resources of Dharamsala are streams. In the last years some water shortage occurred in summer (especially in summer 2001). In Upper Dharamsala there are no provisions set by the authorities for times of shortage and currently no thought is given to this problem.

Water from streams is collected, treated and distributed through a central water supply system run by the Department for Irrigation and Public Health (IPH). Some of the water obtained from streams, but not all, is treated by chlorination. The distribution pipe network has many leaks and water losses are high. In total, 86% of all households have access to piped water at household level. This percentage is somewhat higher in the rural settlements and lower in the densely populated urban settlements. Although water quality is not perceived as a problem, most households treat their water before drinking (boiling or filtration), especially during the rainy season. The main problems identified are the water shortages especially during summer and a certain degree of bribing linked to obtaining and maintaining individual water connections.

Sanitation

Although sanitation legislation and regulations are available, enforcement is lacking. Wastewater is most often discharged into the environment directly, or through the open drainage system with practically no treatment steps in place.

Until now no proper and satisfying solution for wastewater management has been developed. The local authorities leave the households to deal with the problem. Although most individual or shared toilets are connected to septic tanks, these are hardly or badly maintained. This is due mostly to lack of know-how. Institutions or individuals that have the financial means will preferably build a new septic tank instead of emptying the old one.

The new sewer system currently under construction may help solve some of the problems. However, the dense settlement structure in the urban areas of McLeod Ganj will not allow all houses to be connected to the sewer system. The Department for Irrigation and Public Health (IPH) responsible for planning and construction of the sewerage system is not providing for, or planning any alternative solutions for such households.

Open defecation is practiced mostly in the densely populated residential areas of McLeod Ganj as many households do not have their own toilet. Public toilets are perceived to be too far away and too expensive.

Solid Waste

Two different waste collection systems are in place in Upper Dharamsala. The Municipal Council provides central skip containers at designated collection points and the Tibetan Welfare Office collects household segregated waste from the doorstep or kerbside at regular intervals. Unfortunately there is almost no coordination and little cooperation between these two waste collection service providers.

Some households find it difficult to make their waste available and accessible for collection. They mention not hearing the collection truck of the Welfare Office arrive, thus missing the moment to bring their waste outside. Many residents live further away from the municipal containers as they are prepared to walk. The surroundings of the container collection points are often filthy due to littering by residents, animal scavenging, or lack of site maintenance by the responsible authorities. Indiscriminate dumping into open drains, down banks on the road side and down into gullies, is currently viewed as the most urgent problem. It results not only in a visually filthy environment but also in an increased health risk by physical contact, vector proliferation and infrastructure damage by flooding. Given the current service provision, littering is seen mostly as a consequence of lacking public awareness and willingness to collaborate and participate.

Resource recovery and recycling is given the necessary attention by TWO through separate collection of recyclable "dry" waste, and additional sorting in a "segregation centre". Recyclable waste is sold to various industries mostly in the State of Punjab. Organic waste is currently not recovered nor treated. Waste which has no market value is currently delivered to an uncontrolled - often burning - disposal site in Lower Dharamsala.

3 Study Methodology

The main task of a baseline study is collecting various data and information. The variation of data types includes details of technical systems from household systems up to centralised systems, information about household situations, as well as understanding of the institutional set-up and socio-economic dynamics. The preparation phase of the study includes identifying all stakeholders and working out a list of all required data and how the data may be obtained. Much data was collected through interviews with households, key persons from institutions, municipal, district, or state authorities or even local politicians. Another source of information and data was obtained by direct observation and mapping techniques.

3.1 Preparation

An initial detailed study of the process systems, allows setting up a draft checklist of required data. To achieve a complete overview of processes the concept of material fluxes – following the materials through from the source until disposal or consumption – was adhered to.

For the case of Upper Dharamsala the systems shown in the Figure 1, Figure 2 and Figure 3 were sketched out to gain a best possible overview.

To sketch such systems it is helpful to have some general information about the setup (e.g. whether there is a centralized water supply system or a waste collection scheme, etc.). The initial draft of systems as shown below, were sketched based on available documents and literature, field notes from the first visit to Dharamsala (Zurbrügg, 2001a), and general knowledge about water supply, sanitation and solid waste management systems typical for India. Based on these system sketches, the indicators needed to judge their quality and to identify their strengths and weaknesses were defined. Based on these rough assumptions, the necessary information needed to describe the systems and how to apply the qualitative indicators was then further developed. A matrix for every information category and its possible sources can be listed. Finally questionnaires for the different stakeholder groups are developed and checklist for direct observation and measurement can be developed (see page 75, Annex 3). The chapters below describe the systems as sketched during the preparation phase and the data requirements developed from these.

General

To identify the strengths and weaknesses of a system general data describing the framework and "environment" is essential. This includes data such as population and its dynamics, ethnic structure of a society, natural and geographical environment, climate data, housing and settlement characteristics, economic standing, socio-cultural values, and so on.

Water supply

Concerning the water supply system in Upper Dharamsala, initial information was available on the existence of a centralized supply system as well a number of public taps.

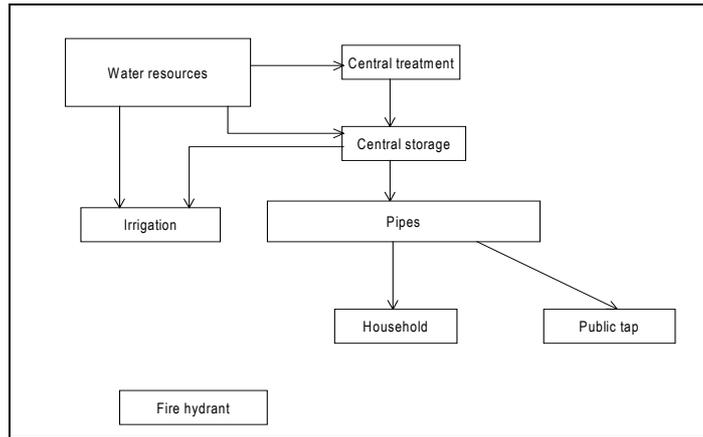


Figure 1: General system of water supply.

Based on the rough system analysis, the following information was perceived to be necessary to describe the water supply system. The main indicators for evaluating the systems appropriateness were through qualitative aspects determined by potential pollution threats and water quality information on household level as well as quantitative and qualitative management of the resources. The satisfaction of the users and stakeholders can be used to judge the functioning of a system, although sometimes it may not correlate to the experts view.

- Identify origin of water. Map and describe water resources. Identify pollution sources.
- Map and describe infrastructure of water supply (incl. centralized treatment and pipe system) and its condition. Identify pollution sources and potential damages.
- Map and describe water quality in households by simple criteria (use it untreated for drinking, cooking, personal hygiene; diseases).
- Estimate quantity demand based on water related activities in households (shower, garden, etc.).
- Identify needs, wishes, capacities, intentions, satisfaction.
- Understand the legal framework, institutional set-up, costs and economical capacity of stakeholders.

Sanitation

In Zurbrügg, (2001a) the existence of public toilets, an open drainage system and a sewage system under construction are mentioned. In most cases black- and greywater is discharged and treated separately independently for each other.

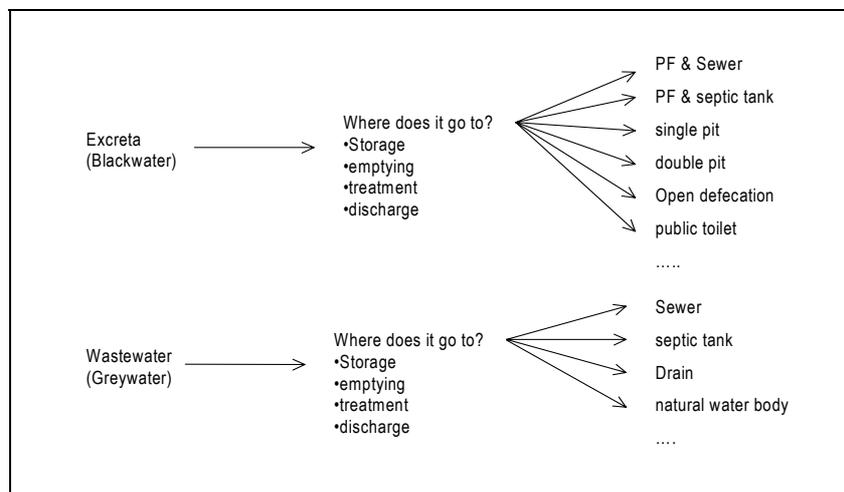


Figure 2: General processes of wastewater management.

Black- and greywater represent two "goods" of the sanitation material flux system. The flow (quantity) of such goods and its characteristics (quality) can be described systematically.

- Description of sanitation related infrastructure and class by type and function.
- Estimate percentage of adequately treated blackwater.
Estimate percentage of blackwater released untreated.
Use the criteria below.
- Estimate percentage of adequate treated greywater.
Estimate percentage of greywater released untreated.
Use the criteria below.
- Locate "hot spots" of untreated wastewater discharge and estimate danger to human health & environment.
- Identify needs wishes, capacities, intentions, satisfaction.
- Understand the legal framework, institutional set-up, costs and economical capacity of stakeholders.

Solid Waste

In Zurbrügg, (2001a) a good overview is given over the solid waste management situation in Upper Dharamsala.

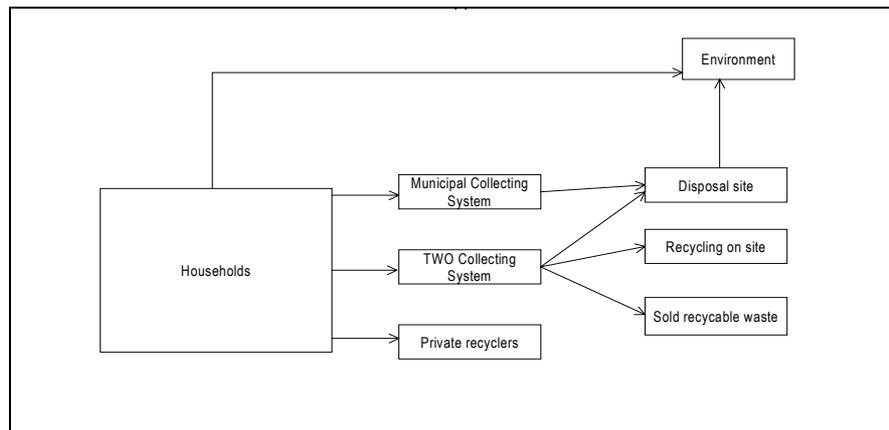


Figure 3: Solid waste management of Upper Dharamsala according to (Zurbrügg, 2001).

To describe and judge the solid waste management system the following tasks were developed:

- Estimate the amount of waste generated at the different sources. Determine waste categories.
- Identify and locate large waste producers (map).
- Service provision: determine area of coverage, waste amount collected and its composition. Describe method equipment and infrastructure.
- Describe methods and of recycling and the individual components (sorting, storage, collection, treatment and sales).
- Describe condition of disposal site. Estimate the potential capacity.
- Identify "hot spot" locations of indiscriminate dumping. Estimate the amount of indiscriminate disposed waste.
- Identify needs, wishes, capacities, intentions, satisfaction.
- Understand the legal framework, institutional set-up, costs and economical capacity of stakeholders.

3.2 Field work

3.2.1 Observation

Extended field visits to all parts of the study area give a good introduction to the local circumstances. A quick view of the state of the natural resources, of the technical systems and their condition, can easily be achieved. Basic information such as spatial orientation in the study area, settlement structure and the existence road and path networks is necessary to understand statements made later in discussion with interview partners. The mapping of the main roads (see Chapter 3.2.4) in the first week of the data collection was a good opportunity to become confident with the study area and to get a first overview over the local circumstances and the major properties of the different settlements and the large technical systems.

Visits to key sites such as water treatment plants, various household septic tanks, the construction site of the sewage treatment plant, and the water sources, is the best and quickest method to understand how the systems function and allows an experts view regarding their strengths and weaknesses. It is recommended to meet the responsible person for operation and maintenance of the system visited. It is these key people that know best about details of the installations, operation as well as temporary and seasonal challenges. Ask these key people about their problems and wishes gives valuable additional information to evaluate the system. An advantage of field visits and observation is that things can be seen with ones own eyes and not through the eyes of others who may unintentionally give a distorted image influenced by personal perceptions. The observed facts can be judged and classified based on the experts experience and using own assessment criteria as determined during the preparation phase. It is recommended to visit technical systems and installations such as the disposal site or a water treatment plant before discussing it in detail with one of the stakeholders as the visit helps to formulate questions, to identify the major problems and to judge the statements of the discussion partner.

Not only observation of infrastructure and natural circumstances but also of human behaviour is important to understand the causal relationships and the success and failure of the technical systems. Further, it is essential to know the demands and needs of a population to eventually develop new solutions or improve the old systems. Human behaviour related to water, sanitation or waste issues are not as easy to observe as motionless infrastructure. Such observations can unexpectedly be made at any time or any place and it is therefore necessary to always walk around with open eyes and ears.

Last but not least, by observation, a lot of information not directly related with one of the study subjects but nevertheless helpful to understand the present situation and dynamics of the system, can be obtained. Information that is natural to the interview partners and often not even considered worth mentioning although it might be essential for the understanding of the system can thus be revealed.

Photographs or videos assist with the documentation of observations. The pictures can be used to remind of certain facts and to illustrate the issue or information to others.

3.2.2 Interviews with key persons

Interviews with key persons is not only a powerful tool to get detailed information about the system but also helps to understand and get to know the stakeholders, their intentions, motivations and the involved decision-making processes. Especially meetings with different people on different hierarchical levels of an institution helps to understand the level communication in the institution as well the potential for cooperation with other institutions and stakeholders (for a list of interviewed key persons see Annex 1). Understanding the decision-making processes is an essential step in order to eventually recommend feasible suggestions for improvement.

As India is a country with strict hierarchies it is considered advisable to first meet a high level official in the institution in question although this person might not know the systems in detail. The goal is to introduce oneself and the project and to get the approval for further enquiries on a lower hierarchical level. Having a business card of a renowned Swiss research institution proved to be very valuable tool to show official status and thus facilitating information exchange.

Most of the interviewed officials were friendly and helpful and willing to provide any information asked for. Much of the information obtained was not needed directly for the study as assumptions of the tasks of many of the departments and institutions visited were not as expected. However no information was ever rejected. In spite of the friendliness found on all levels of hierarchy however, often the information given tried to give a favourable view the own institution often blaming other parties for deficiencies in the system. Some of this information was later found to be incorrect. In general all information obtained by interviews has to be examined very critically, and cross referencing questions. It is also helpful to make enquiry about an institution by other stakeholders.

3.2.3 Household survey

In a household survey 114 households in Upper Dharamsala were interviewed regarding their water, sanitation and solid waste situation, as well as their perceptions demand and needs (for survey sampling see Annex 1). Although the number of households interviewed is not sufficient for representative sample size, it nevertheless gives a good insight of the situation at household level and the individual personal opinions.

The situation at household level is one main key for judging the functioning and potential for improvement or upgrading of any technical system. As the households are producers of solid waste and wastewater, decisions on how to handle wastes are taken here. In the top-down approaches, which are typical for Indian city functioning, household perceptions and capacities have most probably hardly been considered. Information collected on this level is thus new and gives very valuable insights.

The included households were classified by their size and function. The four distinguished classes are private homes for families, homes for hotels and big institutions, shops and restaurants (for criteria of classification and an overview over the interviewed households see Table 1). It was found that also a classification according to the settlement characteristics, urban or rural, is relevant.

In McLeod Ganj and Gankyi students from TCV carried out the survey. Big institutions were interviewed by Bettina Sterkele and Namgyal Tsering as their systems and facilities are more complex. In the villages of Bhagsunag, Dharamkot, Forsythganj and Naddi the survey was carried out by Rajish Sharma, as it was perceived favourable to make the interviews in the local language, the Gaddi dialect. Experience showed that it requires a certain amount of knowledge on the aims and methodology of a baseline study as well as about the systems of water supply, sanitation and solid waste. It is therefore recommended that if the interviews can not be done by the person in charge, to employ only a small number of interviewing staff give them a very detailed introduction and briefing on the intentions of the survey and also a briefing on the systems of water supply, sanitation and solid waste. After giving this introductory briefing, one has to consider that it takes a certain numbers of interviews before the intentions of the questions in the questionnaire are understood and the questionnaires can therefore be filled out correctly. The advantage of completing the survey faster by employing a larger number of interviewers is less compared to the gain in quality and therefore final database by more competent interviewing staff.

Questions as those concerning willingness to pay, or such to ask for an identification of general problems were often not answered. Questions about willingness to pay are inconvenient and respondents do not want to "promise" a certain amount of money. Nevertheless refusing any collaboration by payment is also considered rude. Nevertheless, receiving no answer can also be valuable information and often shows that the household is not willing to pay. General questions such

as "what is considered the general problem in Upper Dharamsala" are hardly answered either. As probably most of the interviewed persons did never before reflect on such a topic and are simply overwhelmed by the question. In some interview situations one had the impression that the interview partner felt embarrassed that he did not know a proper answer and the atmosphere was similar to the one in a school examination. Nevertheless the few spontaneous answers received, do somewhat express the perceptions of the population and are therefore also considered important information.

Table 1: The classification of households was done according to the following criteria.

| Class | Description | | Characteristics | | |
|---------------------|--|----------------------------|---|---|------------------------------------|
| | | | Solid waste | Water supply | Sanitation |
| Private home | Home of a family | No. of family members | wet and dry waste | small amount (hygiene, cleaning, cooking, garden) | black- and greywater |
| Home | hotel (including restaurant), monasteries, Boarding schools... | No. of tourist nights | large amount, (similar composition as households ⁹) | large amount (hygiene, cleaning, cooking, garden) | black- and greywater |
| Restaurant | preparing and selling food | No. of guests | large amount, mostly wet | (cleaning, cooking) | blackwater, greywater concentrated |
| Shop | selling packed food and non-food articles | | large amount, mostly dry (packing materials) | small amount (cleaning) | mostly greywater |
| Offices | offices/ administration, day school | No. of employees, students | small amount, mostly dry (paper) | small amount (toilet, cleaning) | mostly blackwater |
| others | Clinics, public places, Market, small industries, | | various | | |

3.2.4 Mapping

As all infrastructure and technical devices can be spatially defined, the access of the households to those systems is also determined by their location. To relate all information in an information database to a spatial coordinate of a map can therefore give new insights, such as differences among areas information on which areas are not serviced.

Maps have one more big advantage: Most of the collected information can be easily illustrated visually. This characteristic is of great help when it is necessary to pass on the results of the study to somebody else. If the study results can be illustrated in a map, the strengths and weaknesses of a system can be discussed and the map is a powerful tool for negotiations and discussion on further improvement steps.

If no map or aerial photograph is available, it is convenient to use the main roads for orientation. As mentioned above, mapping these roads during the first phase of the project is also a great opportunity to visit all parts of the study area. All elements that are relevant for one of the studied systems should be recorded with its spatial information (coordinates). As may require too much time to map all

households (property plots) this study focussed on mapping at least those households interviewed during the survey. As some households may be difficult to locate later by address, it is important to map them during the survey or to have the interviewers lead the person mapping to the interviewed households at the end of the day.

Using a Global Positioning System (GPS) allows rapid mapping with sufficient precision. Some GPS software supports defining attributes for the mapped features. Features are the elements of the landscape which are mapped (e.g. public toilets, rivers, etc.). Attributes are the characteristics of those features for example number of squat pans and condition of the septic tank of a public toilet. It is important to think carefully about the number and type of attributes given to a feature though it is always possible to add or change attributes in the computer (for the used features and attributes defined see Annex 1). It may be helpful define a point feature that can be use if none of the others fit (e.g. a feature called "point" with a describing attribute to specify the mapped feature). To save time, some line and area features which do not have a high priority in the data and its analysis, however might supply good visual aid to the map, can also be digitized later, with the help of a reference map such as an aerial photograph or satellite image. In this study this was used for rivers and settlement areas. Although an ID allows clear identification of every individual feature it can be recommended to define an additional attribute as description of the location. This facilitates having a better overview as features can be identified by their description rather than having to plot them on the map first (e.g. the public toilet with ID 5 has a descriptive attribute "main market").

For data analysis and management, three different software programs were used. GPS¹ Pathfinder Office 2.90 allows the computer to communicate with the GPS (the Geoexplorer of Trimble was used). In the GPS the features mapped are grouped in one data file according to each data collection session (date and time). After transferring these files from the GPS recorder to Pathfinder Office on the computer, the individual files are converted into one. From Pathfinder Office the files are then exported to GIS² software (e.g. Arc View) which allows editing the attributes in tables and to create the different thematic maps to view. The database software Microsoft Access can be used to manage and organize the database and include and analyze non-spatial data. In some instances it may be helpful to define regional areas as an attribute to then use a Microsoft Access query for further analysis (e.g. to find the number of households having piped water for each regional area).

To obtain better precision all recorded GPS data can be corrected using differential correction. For this study this was not considered necessary as the map shall not serve to determine exact locations but rather used as a visualisation tool. In the case of Dharamsala, differential correction³ would have had to be done through the internet. As fast connections are hardly available this task would have been a very cumbersome one.

¹ GPS = Geographical Positioning System. Enables to determine ones position on the earth with the help of at least 4 satellites.

² GIS = Geographical Information System. Enables to work with spatial data and maps.

³ By comparing the GPS data with GPS data from a base station inaccuracy caused by atmospheric disturbance can be reduced. GPS software is able to carry out differential correction if the necessary files from the base station are downloaded from Internet.

4 General

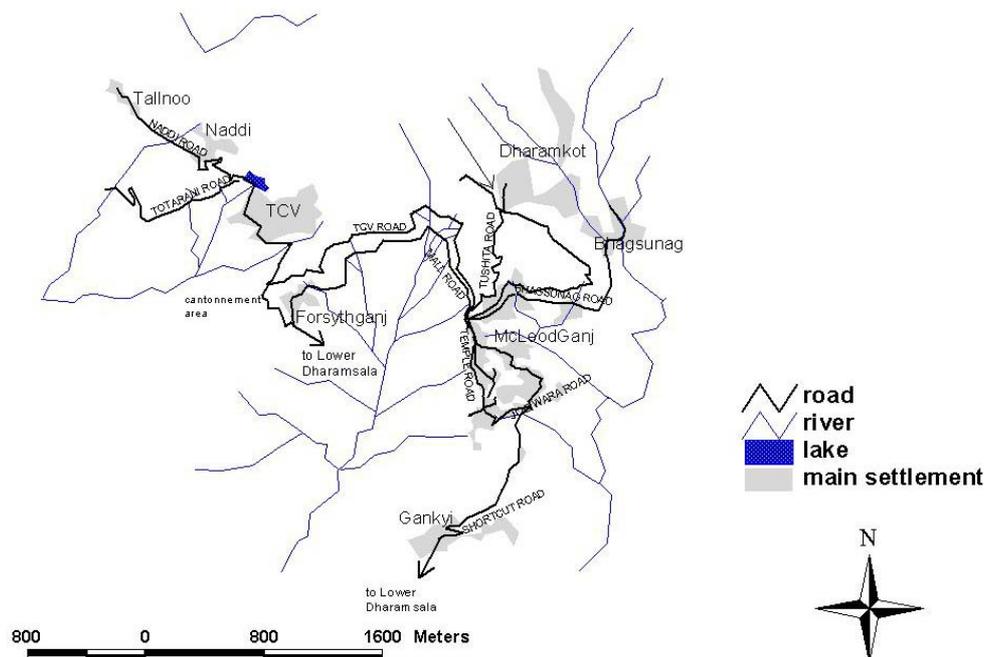
4.1 Situation

4.1.1 Geographic location and settlement structure

Dharamsala is situated in the foothills of the Himalayas in the State of Himachal Pradesh in Northern India. Most of the area is covered by coniferous forest.

In 1959 His Holiness the Dalai Lama, the spiritual and political leader of the Tibetan people took residence in exile on a ridge above Dharamsala, known as the British hill station of McLeod Ganj. Following their leader, many Tibetan refugees also settled in the upper part of Dharamsala. The Tibetan Welfare Office estimates the Tibetan population of Dharamsala to be around 10'000 people, most of them living in McLeod Ganj and Gankyi, where the Central Tibetan Administration⁴ (CTA) is located. Since 1989, after His Holiness the Dalai Lama was awarded the Nobel Prize of Peace, Dharamsala has become a very attractive tourist destination and more and more tourists are visiting Upper Dharamsala. Currently there are more than 70 hotels in Upper Dharamsala and in average about 350 tourists⁵ daily staying overnight.

Upper Dharamsala, the study area, includes Ward 1-3 of the Municipal area of Dharamsala. These wards include two settlements with urban characteristics: McLeod Ganj and Gankyi as well as four villages with more or less rural characteristics in terms of settlement structure, namely Bhagsunag, Dharamkot, Forsythganj and Naddi. Map 2 gives an overview over the settlements (see also Table 2).



Map 2: Map of Upper Dharamsala.

⁴ The Central Tibetan Administration is better known as the Tibetan Government in Exile.

⁵ Estimated based on data provided by the Tourist Department in McLeod Ganj.

The urban settlements of McLeod Ganj and Gankyi are characterized by their high population density and the often cramped housing situation. A family of 5-6 often share one or two rooms. Especially in McLeod Ganj, where unplanned development and construction resulted in a lack of space between the buildings, water supply and handling of waste and wastewater is difficult. A considerable number of the buildings are illegal or at least constructed without authorized⁶ construction permits. This is also due to the fact that Indian law restricts possession of land for non-Indians. McLeod Ganj and Gangkyi are predominately inhabited by Tibetans.

Although the four villages differ from each other, they show common features such as lower population density and more space between the buildings. This allows easier access to facilities of water supply, solid waste and wastewater. In Dharamkot and Naddi the roads stop at the village entrance. The villages therefore cannot be reached by car. Most village households practice farming of barley, maize, and potato for self-use and raise some cattle. The houses are mostly owned by the families that live in them. Bhagsunag used to be a village similar to Naddi and Dharamkot but now, due to tourism, 14 hotels and 3 guesthouses were newly opened. Forsythganj is located on the Mall Road, the main road connecting McLeod Ganj to Lower Dharamsala.

TCV, the Tibetan Children's Village, also has to be mentioned here as it represents a main settlement structure. TCV is a school and home for Tibetan children, boarding staff members and more than 2500 students. The TCV settlement has installed its own water supply, sanitation and solid waste system.

Table 2: Areas of main settlements in Upper Dharamsala based on digitized information from satellite imagery.

| settlement | area [ha] |
|---------------------|-----------|
| Bhagsunag | 8.44 |
| Dharamkot | 24.31 |
| Forsythganj | 3.25 |
| Naddi | 3.25 |
| Talnoo ⁷ | 4.00 |
| TCV | 14.57 |
| McLeod Ganj | 28.07 |
| Gankyi | 7.56 |

The present total population of Upper Dharamsala is hard to estimate as the newest population statistics at ward level, provided by the District Statistical Office in Lower Dharamsala, dates back to 1991 and takes only the Indian population into account. The best figure, provided by the Dhaulaudhar Public Education Society in a study of 1998, estimates the total population, excluding tourists, of around 16'000 for Upper Dharamsala (Ward 1, 2, 3). Based on the statistics of the Tourist Department in McLeod Ganj 350 tourists are estimated to stay in Upper Dharamsala in an average night. This number can be considered on the lower range as many families let rooms to tourists, which are thus not registered by the tourist board.

4.1.2 Climate

The climate is characterised by a rainy season from July to September when heavy rain falls. In fact Dharamsala registers the second highest annual rainfall of India with 2900 mm to 3800mm (Deputy Commissioner's Office). From October until June there is hardly any rainfall and the weather is quite sunny although temperatures may drop significantly in January, when snow may also fall in McLeod Ganj.

⁶ By the Department of Town Planning partly legalized illegal construction.

⁷ Talnoo is a Indian honeymoon resort and most buildings are hotels. As it is not part of the Municipal area of Dharamsala it was not included in the survey.

4.1.3 Socio-economic conditions and population dynamics

People with various nationalities and cultures live together in Upper Dharamsala. In McLeod Ganj and Gankyi predominately Tibetan refugees and in the villages the local ethnic group called Gaddis. A large number of Western, Israeli and Indian tourists also find their way to McLeod Ganj and Bhagsunag every year. Many Indians from other regions (especially from Kashmir) are attracted by business opportunities linked to tourism. These different ethnic and cultural groups live in relative harmony however do not mix much for social activities. Now and then tensions arise between the local Indian and the Tibetan population.

With a large share of Tibetan population living in Upper Dharamsala, especially in McLeod Ganj, Tibetan culture dominates the town life. A relatively high proportion of the Tibetan population are Buddhist monks and nuns as there are also many temples, monasteries, nunneries and an important Buddhist library located in Upper Dharamsala. McLeod Ganj is also the first stop for many Tibetan refugees who have just arrived in India. The Tibetan Government in Exile has set up many institutions to facilitate their arrival and quick integration into Indian society and economic life. The Reception Centre is a first home to most newly arrived refugees, and includes schools where English and Tibetan language is taught. The Tibetan Handicraft Centre and the Tibetan Institute of Performing Arts are examples of institutions that provide boarding as well as income opportunities. However space is rare and the present policy of the Tibetan government is to motivate the refugees to go back to Tibet after 2-3 years of education so they can spread the knowledge further in their homeland Tibet. After finishing schooling however, many Tibetans choose to settle down in other parts of the Indian subcontinent.

Increasing tourism and its infrastructure with shops, hotels, and restaurants, provide income to many families. Other employment opportunities to Tibetans are given by the Central Tibetan Administration and other Tibetan institutions. Many Tibetans also sell sweaters down in the plains during the wintertime. All in all however, the economic situation in and around Dharamsala is not easy, and young people are faced with great difficulties in finding jobs. In the surrounding villages little farming for self-use is practiced and many villagers take advantage of tourism to let some rooms for overnight stay.

The overall population fluctuates during the year. Highest Population in Upper Dharamsala can be observed during peak season of tourism in summer and autumn (April-July and September – October). In winter when temperatures drop, tourists usually prefer the Southern regions of India and tourism related residents usually also leave. During rainy season tourism is also minimal.

4.2 Stakeholder analysis

The decisions and actions of the main actors and stakeholders determine an interrelated system. In order to understand the situation in Upper Dharamsala regarding water supply, sanitation and solid waste the motivations, intentions and decision-making processes of the various stakeholders have to be considered.

In Upper Dharamsala the most influential stakeholder in the water and sanitation sector, besides the households, is the Department for Irrigation and Public Health of Kangra District (IPH). This is the department responsible for water supply and sewage systems. Two important stakeholders in solid waste management are the Tibetan Welfare Office and the Municipal Council of Dharamsala. A more detailed description of the main stakeholders is given in the chapters below. The households and their views and perceptions can be found in later chapters.

Department for Irrigation and Public Health of Kangra District (IPH)

The Department for Irrigation and Public Health of Kangra District (IPH) with an office located in Dharamsala is responsible for water supply and the provision of the new sewage system. This

department was also in charge of making the construction blueprints for many of the septic tanks in Upper Dharamsala.

Decision-making in this institutional framework follows a top-down approach, where the State Government Department of Himachal Pradesh located in Shimla makes decisions on large expenditures. There is some opportunity for the local bodies to apply for projects according to the needs they identify on site. The superintendent engineer of the department has decision power over expenses up to 1 million Rupees (Rs) and the chief engineer up to 5 million Rs.

The organizational setup of the department is strict and hierarchical. The Head of Department is the Chief Engineer, Mr. M. K. Guliani. He has the responsibility for one zone (Himachal Pradesh is divided into 3 zones) which is again subdivided into four "circles". The municipal area of Dharamsala is one of the four circles in this zone, which again is divided into administrative divisions. The Superintendent Engineer Mr. Y. P. Rana is responsible for the circle of Dharamsala. Under every Superintendent Engineer there are 4-5 Executive Engineers (one for each of the 3-4 administrative divisions of the circle and one for design issues). The Executive Engineers plan the technical systems and show the highest level of technical competence. The division of Dharamsala is again subdivided into four subdivisions, which are each under the guidance of an Assistant Engineer. The Assistant Engineer, assisted by Junior Engineers, is responsible for the household connections and complaints. Below the Junior Engineers follow a number of labourers with duties of operation and maintenance for the various technical systems as well as for the network of water pipes and water treatment plants. During the household survey residents mentioned that labourers consciously block or restrict water connections and then need to be bribed to do the necessary maintenance work, or construct new connections (see also Chapter 5).

The Municipal Council

The Municipal Council (MC) is the executive body of the Dharamsala Municipality and therefore represents the political body with decision-making power. The Executive Officer acts as link between the MC and the administrative body. This is the most powerful administrative officer.

The sanitary inspector is the supervisor of all municipal tasks concerning sanitation, encroachment on public places, food adulteration, stray animals, and of course solid waste management including street sweeping, waste collection and disposal. He is the only one person who has the authority to fine people for littering or unauthorized discharge of wastewater.

The Municipality also employs an Executive Engineer and three Junior Engineers. None of them – neither the engineers nor the Sanitary Inspector- seem to have a basic knowledge about waste management or treatment. The municipality operates a collection service with central containers (see also Chapter 8) as well as the dumpsite of Dharamsala. Based on the hierarchy of the Municipality, decisions are made from top to bottom and little coordination and communication between different staff members was observed.

According to the Sanitary Inspector, 44 labourers are employed for sanitation and solid waste management duties but only about 30% of them are part of the active workforce. The others are old or ill and not able to work, however - as government employees - they cannot be dismissed.

TWO has difficulties cooperating with the municipal authorities. The Municipal Council, represented in an interview by the MC President Mrs Patial, instead of taking responsibility for the deficiencies in waste services, blame the Tibetan community for the situation without taking appreciation or mention of the voluntary and functioning waste collection service of TWO.

The Tibetan Welfare Office

The Tibetan Welfare Office is part of the Central Tibetan Administration (CTA, also known as the Tibetan Government in Exile) assigned to the Department of Home. The people elect the Welfare Officer, the head of the Tibetan Welfare Office. If no candidate holds majority, the Department of Home appoints a Welfare Officer. Mr. Sonam Choephel Shosur the current Welfare Officer holds such an appointed position. The Welfare Office Secretary is appointed directly by CTA and acts as controlling body. All other staff is employed by the Welfare Officer directly. The Environment Coordinator currently Mr. Tsering Topgyal Golok is in charge of the Environment Section and acts as supervisor of the green workers and sweepers. Mr. Namgyal Tsering is the Assistant Environment Coordinator but also works in all other sections and drafts all English language documents. The office gives the impression of being understaffed.

The tasks of the Welfare Office are many. They issue administrative documents such as refugee papers and passports for Tibetans, organize and conduct cultural exchange programs, political actions, and most important for the topics covered in this report, they provide urban environmental management and welfare services such as running the Clean Upper Dharamsala Project. This includes curb side collection of dry and wet waste, street sweeping and a paper recycling unit. Since September 2002 the Tibetan Welfare Office holds the Sanitation Contract of the Municipality for Ward 1, 2, and 3.

The Clean Upper Dharamsala Project employs 24 green workers supervised by the Environment Coordinator Mr. Tsering Topgyal Golok. These 24 workers consist of 10 sweepers which previously worked for the Municipality to sweep the streets, 6 for dry waste collection, and 4 for wet waste collection. Finally 4 green workers are assigned to tasks at the segregation centre or used for various jobs now that the segregation centre is subcontracted to an Indian waste dealer. As nobody wishes to work in the waste business, it is hard to find new staff even though they have a comparatively high salary.

Discouraged by previous experiences, TWO attempts to act as independently as possible from the Municipality and Municipal Council.

5 Water Supply

5.1 Situation

5.1.1 Institutional set-up and legal framework

According to Indian law, water resources are common property and everybody is allowed to exploit them. Groundwater is property of the landowner and exploitation is not restricted and can only be stopped by the authorities if overexploitation or pollution can be proved. There is no need for permits for groundwater wells and thus they are not registered. The authorities have no general overview or control over groundwater use (S. N. Dulloo, Regional Director, Central Groundwater Board).

A central water supply system is in place which is run by the Department for Irrigation and Public Health of Kangra District (IPH)⁸. The IPH owns, operates and maintains the main supply pipes, which collect and transport the water from the source to the treatment plant and from there distribute it to the settlements, the central reservoirs and the two treatment plants. Small pipes connecting the houses to the main pipes are owned by the households. The IPH has the authority to shut down or restrict water supply in times of shortage.

Applying for a household connection to the central supply system is complicated and can take many months. The legal status of the building, property, and plot, as well as the quality of housing construction has to be verified. The house owner also has to obtain permission from all owners of the plots where the connection pipe will pass through. When all this is obtained and verified, the connection fees are paid and the pipes necessary are paid for, the IPH will construct the connection. Illegal connections identified by IPH will simply be disconnected with no further action as the IPH has no authority to fine in such cases.

There is a water charge levied by the IPH. As water meters are not working reliably a flat rate monthly fee of 40Rs per month is charged for private household connections. Large institutions are charged depending on the amount charged for the year before. It seems that in this case negotiations are possible.

Bribing is common practice. Most households bribe the IPH to get the official approval for a new connection. It was mentioned that workers of IPH block water pipes and demand bribes for their repair.

There are a number of public taps spread over the Municipal area of Dharamsala. They are owned and operated by the Municipal Council.

5.1.2 Water resources

Due to its location in the foothills of the Himalayas, the water resources of Dharamsala are quite abundant and in general of good quality. Dharamsala town registers the second highest annual rainfalls of India. Nevertheless, during the summer months of May, June and July, water shortages may occur after a snow-poor winter season, as the snow on the high peaks of Dhauladhar Range serves as the major water storage for the summer months. In summer 2001 water scarcity was serious and water had to be transported from the plains to Upper Dharamsala using tanker trucks. The scarcity of water in the

⁸ see also Chapter 4.2

last years is considered to be a consequence of climate change (IPH) and is aggravated by the fast population growth in both Lower and Upper Dharamsala. In this study it could not be determined which causes effect water scarcity most. The relevance and exceptionality of the year 2001 could also not be determined.

The main surface water resources of Dharamsala exploited by IPH are the two streams of Batherkhad and Chaurankhad. They are both perennial streams with alpine characteristics. Both streams are popular among tourists for bathing and sunbathing in or above the catchment area. Two spring sources also feed the central water supply system. The larger spring called Bhagsu is located in Bhagsunag and supplies the village of Bhagsunag and parts of McLeod Ganj. The spring at Glennmore is very small and its water is used to supply Forsythganj. Dopnallah is a non-perennial stream above Dharamkot and in the last years has always dried up in the summer months. There are a few groundwater wells in Upper Dharamsala but as they are owned by private individuals, nobody⁹ knows how big the exploitation is. Mr. S. N. Dulloo from the Central Groundwater Board does not estimate the groundwater potential of Upper Dharamsala to be very significant. The steep topographical features give reason to believe that groundwater consists mainly of some shallow subsurface slope drainage. In Lower Dharamsala however, larger groundwater aquifers are assumed and the IPH has plans to extend the exploration of this resource. There are no quantified estimations about the water resources available or used in Dharamsala. Table 3 gives an overview over the water resources of Upper Dharamsala. The estimated capacity corresponds to the design value of the water supply system. As most sources are located in the areas above the settlements (excluding Glennmore spring) protection strategies are not perceived necessary by the IPH.

During the study a number of smaller spring sources were observed, spread over the area (see Map 3). Some are privately owned and used as an alternative to the public taps in times of water shortage. As the water catchments are mostly open, this water is not considered suitable for direct drinking purpose.

The quality of all water supplied by the central water supply system is considered suitable for drinking (IPH). Nevertheless water from surface stream sources is chlorinated before distribution to the consumers. Water from the spring sources used by IPH and groundwater is not treated before distribution. During rainy season water turbidity is considerably higher due to high loads of suspended matter.

Table 3: Water resources of Upper Dharamsala. Estimated capacity corresponds to the dimension value of the water supply system (IPH).

| Source | Type | Estimated capacity [m ³ /d] | Supplied area | Remarks |
|---------------------|-------------------------|---|---------------------------------------|---------------|
| Batherkhad | perennial stream | 4200 | Naddi, Gankyi, Lower Dharamsala | |
| Chaurankhad | perennial stream | 1100 | McLeod Ganj, Forsythganj | |
| Dopnallah | non-perennial stream | 130 | Dharamkot | dry in summer |
| Bhagsu spring | spring | 360 | Bhagsunag, McLeod Ganj | |
| Glennmore spring | spring | 10 | Forsythganj | |

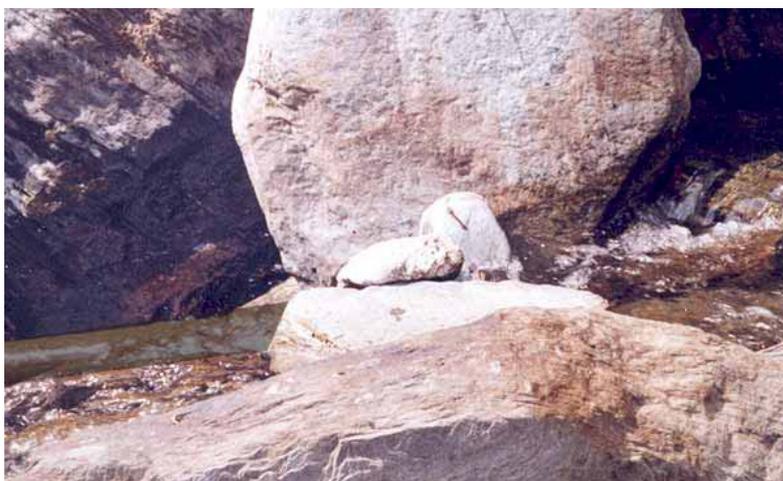
⁹ IPH and Central Groundwater Board

5.1.3 Central water supply system

Most households are supplied with water by the central water supply system, which is operated and maintained by the IPH. They are responsible for the exploitation of the resources, treatment, storage and rough distribution. The household connection is under the responsibility of the house owners.

Catchment

The information presented in the following paragraph was gathered by observation and field visits. The intake in the stream source usually consists of a pipe fixed with stones in one of the numerous natural basins the stream is forming.



Picture 1: Water source intake structure. The intake pipe (enhanced in colour on the left had side) is fixed by stones into the river pool (centre)

In the large sources of Batherkhad and Chaurankhad several pipes are fixed in the described way and lead parallel to each other to the treatment plants. For one pipe in each of the two main sources a small catchment chamber (Chaurankhad: 2x2x2 m, Batherkhad: 1x1x1 m) was built and in Chaurankhad a check dam protects the intake from the monsoon floods and another one was under construction. In Dognallah there is just one pipe laid in a natural basin. Above the catchment there is a pipe by-passing a spot where water is seeping into the ground. The intake of Bhagsu spring is under a temple and could therefore not be visited.

Water treatment

Although the water is perceived to be of excellent quality and suitable for drinking, according to IPH water of the stream sources is treated at by chlorination before consumption. The chlorine concentration should be between 0.2-0.5 mg/l. Treatment of spring water is not considered necessary (IPH). Bacterial analysis are conducted for the effluent of the treatment plants every 4 – 7 days and a complete analysis of the water quality including chemical and physical parameters once or twice a year for the treatment plant effluent and the household taps. Examples of analysis results show bacterial contamination for the stream of Chaurankhad but not for a tap in McLeod Ganj (Laboratory of IPH, Lower Dharamsala).

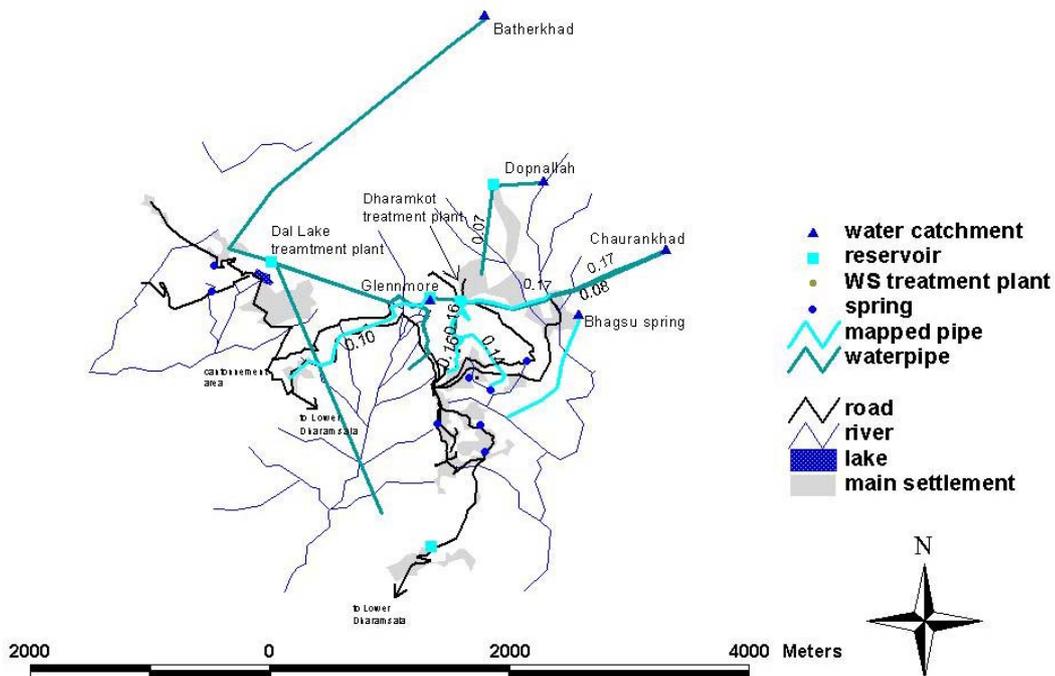
There are two treatment plants in Dharamsala. One is located above Dal Lake and treats the water of Batherkhad. Two pipelines enter two parallel treatment lines. One additional pipe bypasses the treatment facility and is only chlorinated. A second treatment plant is located in Dharamkot and treats

the water of Chaurankhad. The water of Dopnallah is not treated. Neither is the water from Batherkhad and Bhagsunag for Naddi or the Bhagsu spring source for Bhagsunag (see Map 3).

The two parallel treatment lines of the Dal Lake treatment tank consist of three pressure tanks. A series of sand and gravel layers with different diameters act as iron removal filter. In this filter water flows from top to bottom and first through fine sand then coarser sand. An activated carbon filter contains a similar series of fine and coarse sand like in the iron removal filter, but additionally also a layer of activated carbon. Here flow is from bottom to top. Finally, after the filters, chlorine is added in the form of dissolved bleaching powder by a thin pipe entering the water pipe leaving the treatment plant.

The treatment plant at Dharamkot has two open reactors, a coagulation tank and a raw filter. The coagulation tank is a double cylinder with a height of 6 m, an outer diameter of 6 m and an inner of 2 m. There is a stirring device in the central cylinder where the water is flowing in. Currently there is no addition of chemicals for coagulation and stirring is only practiced during rainy season. The water overflows into the outer cylinder, where sediments settle at the bottom. The last phase of treatment is conducted by two parallel sand filters where water flows from top to bottom. The fine sand fraction is at the top and the coarser fraction at the bottom. This is contrary to the effective setup of a filtration system. After these treatment steps and a subsequent chlorination, the water flows into the reservoir.

Pipe network and central storage



Map 3: The water supply system of Upper Dharamsala. In some cases mapping was not possible and locations of pipe network were added to the map at a later stage manually. The figures next to the pipe describe the diameter of the pipes in meters.

Water is released 3 times a day, in total for a duration of 5 - 6 hours¹⁰. Water is stored in the reservoirs until time of release (see Map 3). Their volume is between 110 – 635 m³ according to the IPH (see Table 4).

¹⁰ hours of water release (worker of IPH): 6-8am, 12am-1pm, 5-7pm

Table 4: Water reservoirs in Upper Dharamsala.

| location | volume [m ³] |
|-----------|--------------------------|
| Dharamkot | 635 |
| Gankyi | 313 |
| Glenmore | 141 |
| Dopnallah | 110 |
| Dal Lake | 454 |

The main pipes deliver water from the sources to the treatment plants and central storage reservoirs and from there on to the households (Map 3). The water is transported by gravity flow only. The diameter of the main pipes varies between 7 cm and 17 cm. The pipes are made of cast iron and often leak especially at the joints. The leakage is mostly repaired by inserting wooden sticks, cotton rags or overlaying stones (Picture 2). The water losses are considerably high. The IPH estimates them to 20 - 25%, but realistic estimates are much higher. After interviews with four households, water consumption was estimated not much higher than 30 litres per capita and day, while the IPH estimates a water supply of 120 litres per capita and day¹¹

(see also chapter 5.1.4). Even if water consumption were higher than the estimated 30 litres per capita and day, losses would still be more than 50%. As there are no water meters, neither on household level nor in a central location, a proper estimation of water use and losses is not possible.



Picture 2: Leaking pipes are often repaired with wooden sticks, cotton rags or stones. (Picture: Bettina Sterkele)

The households are responsible for the financing of the connection pipe and its operation. The planning and maintenance is done by the IPH (see Chapter 5.1.1).

It was observed that with individual connection pipes there seems to be an advantage in connecting to the main pipe as high up on the hillside as possible. This can be explained by the fact that in the hours of no water supply and in areas where the gradient of the main pipe is not set ideally, air may enter the pipe network. Thus, connecting above that deficient spot in the network may be preferable in order to obtain sure access to water. However, as its needs the permission of each land owner where the connection pipe would cross a plot, often more complicated topographical solutions are sought in order to avoid complicated negotiations. Thus in many instances pipes can be observed which follow each other parallel over a long distance down the hillside (Picture 3).

¹¹ dimension value

The household pipes usually have a diameter¹² of 1.3 cm and losses through leakage are high. As all pipes are above ground and unprotected, the danger of mechanical damage and consequential leakage, as well as risk of contamination is high. The small household pipe networks are especially threatened by pollution as they are often lying in the open drainage system where wastewater or contaminated surface runoff flows (see Chapter 7). Men also often urinate into the open drains and also onto the water pipes lying inside. In the hours when no water is distributed and water pressure decreases, drainage water may easily enter the water pipe leaks.



Picture 3: Many household pipes are going parallel as they have to, or prefer to connect on a high level of the main pipe. (Photo: Gabriela Friedl)

5.1.4 Household level

Access to water

According to the household survey 86 % of the private households are connected to the central water supply system and 12 % depend on the public taps. In Naddi and McLeod Ganj a higher proportion of the population depends on the public taps (33 % and 23 %). In Gankyi all households have piped water as the Central Tibetan Administration and the Mentsekhang Institution finance their water supply. In McLeod Ganj and Gankyi water connections are usually shared by 5-6 households while in the Indian villages most households have their own pipe. This may be a consequence of the economic situation of the households as also of the fact that in the Indian villages people usually own the house, the construction is legal and therefore it is easier to get a water connection permission (see Chapter 4.1.1). The Tibetan Children's Village (TCV) runs its own water supply system and has a pipe withdrawing water from Batherkhad.

As water supply is limited in duration, most households which have piped water also have a storage tank, mostly made out of black plastic, on their roof. In the urban settlements of McLeod Ganj and Gankyi this proportion is 79% and in the surrounding villages only 35%.

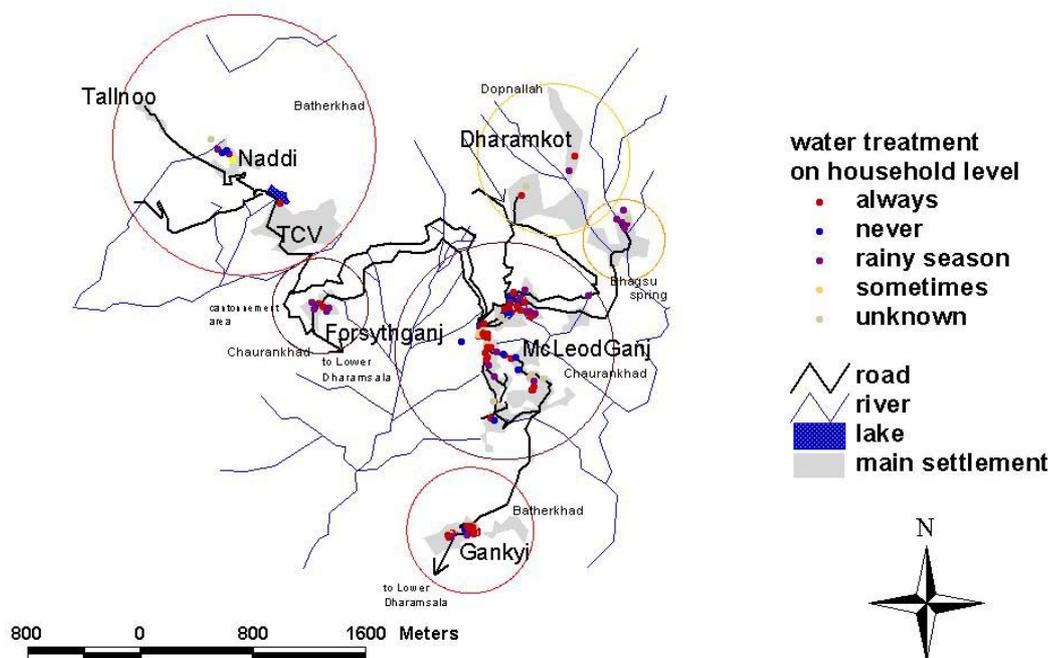
According to interviews with four households in McLeod Ganj, less than 30 litres per capita and day are used in McLeod Ganj. This number is comparatively small compared to the design value of the IPH of

¹² 1/2 inch = 1.27cm

120 l/(cap*d). As the estimates based on the interviews are not particularly precise (using number of buckets or duration of the tap running) the effective consumption may be higher especially if hotels and restaurants are taken into account. Nevertheless, the comparison of the two figures 30 and 120 litres per capita and day, gives an idea of the amount of water lost by leakage. Additionally to leakage losses in the pipes, the main losses on household level may occur by overflow of the small storage tanks when the tap is not closed after the tank is full.

After the water shortage in summer 2001 many households started to exploit alternative water resources. Institutions with appropriate financial resources are drilling for groundwater. As groundwater exploitation does not have to be registered there is no overview on the current number of wells. However it can be assumed that based on the limited financial possibilities of the households and the modest groundwater potential of Upper Dharamsala, groundwater use is probably small. A private pipe has recently been constructed from Batherkhad to the temple complex¹³. As there are no public provisions in Upper Dharamsala for times of water shortage, in future private, individual systems may be installed more frequently. Thus in future, water accessibility might rely on economic status and financial possibilities.

According to IPH a flat rate for water supply of 40 Rupees per month is charged per connection. However, based on data from the household survey, expenditures for water for the households vary between 15 to 330 Rupees per month. This may be a consequence of the widespread bribing practices.



Map 4: Most households treat the water in some way in the household before drinking.

Water quality

Although the water is usually perceived to be of good quality, 39% of the interviewed households mentioned always treating the water in the household in some way before drinking it (Map 4). Additionally, 29% mentioned treating their water only during rainy season, and 2% treat water only sporadically. Only 17% mentioned that they do not treat their drinking water (Figure 4), while another 17% did not answer the question. Those households treating their water usually boil (78%) or filter it (18%).

¹³ The pipe is shared by the Namgyal Monastery, His Holiness' residence and IBD.

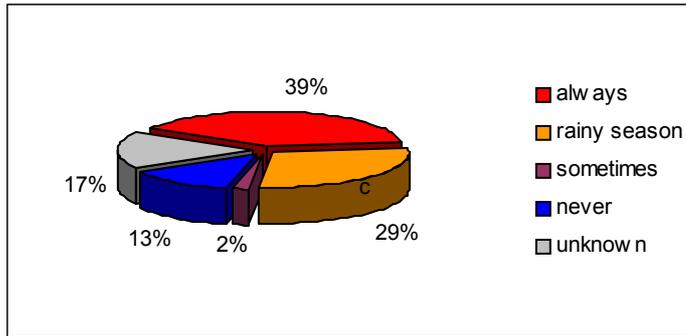


Figure 4: Water treatment on household level in Upper Dharamsala.

21% say to have suffered from a water-related disease. While this proportion is 25% in McLeod Ganj and Gankyi, it is only 13% in the Indian villages. It is noticeable that Dharamkot has the highest proportion of people which mention having suffered from water-related diseases. Dharamkot is supplied by the untreated water of the Dopnallah stream source.

Irrigation

Although many of the farmers interviewed during in the household survey mentioned that irrigation would be favourable, irrigation systems were hardly observed.

Public taps

Public taps are set up, maintained and financed by the Municipal Council. A proper overview over their number and spatial distribution in Upper Dharamsala (according to IPH there are 115 in the Municipal area of Dharamsala) could not be established as they are between the buildings and it is not always obvious whether it is a public or a private tap. Public taps usually consist of a tap installed at the end of a ½-inch pipe (household connection pipe) and sometimes a basin suitable for washing is included.

Perception and satisfaction

For many households water supply is one of the most urgent problems. Institutions mentioned that their needs for water can not be met. When asked about their highest priority wish regarding the three subjects (water, sanitation and solid waste), 19% mentioned an improvement related to water supply (only 68% of the interviewed households answered the question). In McLeod Ganj the availability of water seems to be the main problem as most of the interviewed households demand additional water infrastructure. In Gankyi all the water related problems are handled by CTA. In Dharamkot the stream source of Dopnallah and the water treatment are perceived as insufficient. In Naddi and Forsythganj improved facilities for central storage (volume and cleanliness) are demanded. In Bhagsunag most households do not mention any problems.

5.2 Strength and weaknesses

5.2.1 Strengths

Water resources

- The main water sources of Dharamsala are in mostly reliable in quantity and in general have natural good quality.

Water treatment

- There are two mechanical treatment plants.
- There are chlorination facilities for all water from stream sources.
- According to IPH, monitoring of bacterial pollution from sample taken after the treatment plant is done once or twice a week.

Central water supply system

- The restriction in duration of water supply helps to reduce the losses.

Household level

- The majority of households have piped water at their disposal, namely 86%.

5.2.2 Weaknesses

Water resources

- In the last few years, shortage of water occurred during summer. It is not clear whether the extreme shortage of summer 2001 is an exceptional event or a consequence of population growth and increasing demand. The responsible authorities are not attempting to find out how serious the problem of summer shortage is and what the main cause is.
- There are no estimations on the present and future potential on the water resources of Upper Dharamsala.
- There is no management strategy for the resources, as nobody has a detailed overview over exploitation (especially over the groundwater resource) and the local authorities do not have the legal power to restrict exploitation in order to protect the resource.
- The area around the intake at the source, or the source itself upstream of the intake, is not protected and many tourists bathe there.
- Surface water is common property and groundwater is property of the landowner and therefore there are no restrictions on exploitation. Private exploitation infrastructures such as wells are not registered.

Water treatment

- Not all the water released to the consumers is treated in a plant with sedimentation facilities and mechanical filtration. During rainy season there is a higher risk of contamination and a muddy colour of tap water is often observed. Residents know this and many treat their water before drinking (68% of all households treat the water during rainy season).

- Water consumers notice a fluctuation in chlorine concentration by smell and taste. This factor gives doubt to the reliability of the water treatment or may also give an image of false security to the consumers.
- Operation of the treatment plants is lacking. The layers of the filter beds are set up in a way that fine sands are on top instead of on the bottom (with top to bottom flow), and mechanical filtration cannot take place.

Central water supply system

- Pipes are not protected against mechanical impacts. Therefore many of the pipes are leaking and water losses are quite high.
- Pipes are only repaired in a rough way with plastic bags, cotton rags, wooden sticks and stones. In many cases losses are only modestly reduced and often only for a limited time (see **Error! Reference source not found.**).
- In the (urban) settlements where space is limited, pipes are often found lying in the open drainage system where greywater (and blackwater) flows. Men urinate in the drains and therefore also onto the water pipes. A decrease in water pressure during the hours of no water supply can allow drainage water to enter especially at locations where the pipes leak. A higher percentage of people have suffered from water-related diseases in the urban areas of McLeod Ganj and Gankyi where such pipes often are placed in the drainage system.
- There are no secondary distribution pipes in the water supply network. Connection of the individual pipes to the main pipe is sought as topographically high as possible. Thus individual household pipes are very long and lie parallel with many others along the main pipe. As the water has to be transported over a relatively long distance in these small pipes instead of the in the main pipe, energy losses are quite high. Small pipes are also more prone to damage caused by mechanical impacts.
- The reservoirs are not covered or covers are damaged or missing. Therefore there is a risk of water contamination in the reservoir.

Household level

- The main problem regarding access and availability of water seems to be corruption. Bribing officials in order to obtain a household connection is frequent and expensive. Labourers block pipes in order to obtain bribes to fix them again.
- Most households perceive it necessary to treat the water at some time during the year (see Figure 4).
- 21% of all households in McLeod Ganj mention having suffered from a water-related disease, but the percentage might be higher as diarrhoea is usually perceived to be related to food problems. The fact that in McLeod Ganj and Gankyi (urban settlements) the percentage is higher than in the rural settlements may be an effect of population density when water pipes often lie in open drainage channels. As the pipe system is not always under pressure, greywater and urine flowing in the drainage system (see Chapter 6 and 7) may enter the water supply pipes.

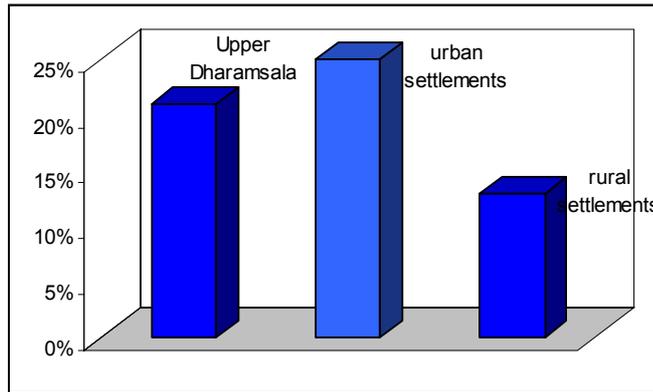


Figure 5: The proportion of people suffering from a water-related disease is larger in the urban settlements where water pipes can be found in the open drainage system more often.

- Water is supplied only 6 hours a day. This makes water storage on household level necessary, which always involves the risk of contamination.
- Water costs for households do not depend on the consumed amount and the motivation to reduce the water losses in the connection pipe is low.
- In McLeod Ganj there are no public provisions for times of shortage.
- Public taps are often leaking or not closed properly so during the hours of supply there are great water losses.

5.3 Suggestions

It is essential to determine the extent of the shortages occurring in the last summers. The answers to the following questions have to be found:

- Was summer 2001 a great exception?
- Are the available water resources declining (due to climate change) or is it the population growth which sets most pressure on the limited water availability?

The problem of summer shortage in Dharamsala is serious and a next shortage similar to the one in summer 2001 may be expected in short- or mid-term period. Suitable provisions should be taken. Public provisions and strategies are essential to grant an equal distribution of the available quantity of water between all areas and households of Dharamsala.

For a proper management of all water resources there should be an overview over all exploitations. Private wells and pipes should be registered including measuring the withdrawn water amount.

Access to the areas upstream of the water catchments should be restricted. At least a signboard should point out the possible consequences of swimming in an area where water is used for drinking purposes.

Secondary distribution pipes in the settlement areas would allow the households to connect closer to their house. As bigger pipes are more robust, damages would be less and maintenance would be easier. Water losses through leaking pipes could be reduced. Distribution pipes could be laid in a sufficient distance from the open drainage system, where there is a great danger of pollution by greywater or urine. Further energy losses would be significantly smaller if the same amount of water would flow in one big, rather than in many small pipes.

Proper methods of pipe repair should be taught to the staff and the necessary equipment should be provided as the current temporary solutions used are insufficient. This in combination with regular

check-ups can reduce water losses. If the pipe system was airtight the problem of air hampering water flow could be eliminated.

Water charges for households based on the used amount, would provide an incentive to use water more economically

6 Sanitation

6.1 Situation

6.1.1 Institutional set-up and legal framework

Regulations for the release of wastewater can be found in the Himachal Pradesh Municipal Act, 1994 section 134: "Whoever, without the permission of the municipality, causes or knowingly or negligently allows the contents of any sink, sewer or cesspool or any other offensive matter to flow, drain or be put upon any street or public place, or into any irrigation channel or any sewer or drain not set apart from the purpose, shall be punishable with a fine which shall not be less than twenty-five rupees and more than two hundred rupees."

The Himachal Pradesh State Pollution Control Board in Jasur supervises proper operation and maintenance of a centralized waste system (solid waste and wastewater) while the Municipal Council, namely the Sanitary Inspector supervises the handling of solid waste and wastewater on household level. In Upper Dharamsala the enforcement of the legislation is lacking.

The Department for Irrigation and Public Health of Kangra District (IPH) (see also 4.2) is responsible for construction, operation and maintenance of the new sewage system, which is currently under construction. It is planned to hand over operation and maintenance of the sewer system to the Municipal Council after an introduction phase of operation in March 2003. The new sewage system will partly aid the deficient situation however, due to the dense construction of buildings to the lack of space for the connection pipes IPH estimates that only 60% of all households will be able to connect to the sewage system. The IPH does not have the power to force households to connect to the sewer system. As with the water supply pipes, the permission of all landowners will be required to lay a connection pipe across plot to the main sewage channel, thus creating difficult negotiation issues.

The engineers of IPH established the blueprints for many of the septic tanks in Upper Dharamsala. Maintenance of septic tanks and handling of septage is the responsibility of the households who most often do not have the required expertise or the equipment.

6.1.2 Household level

Public awareness

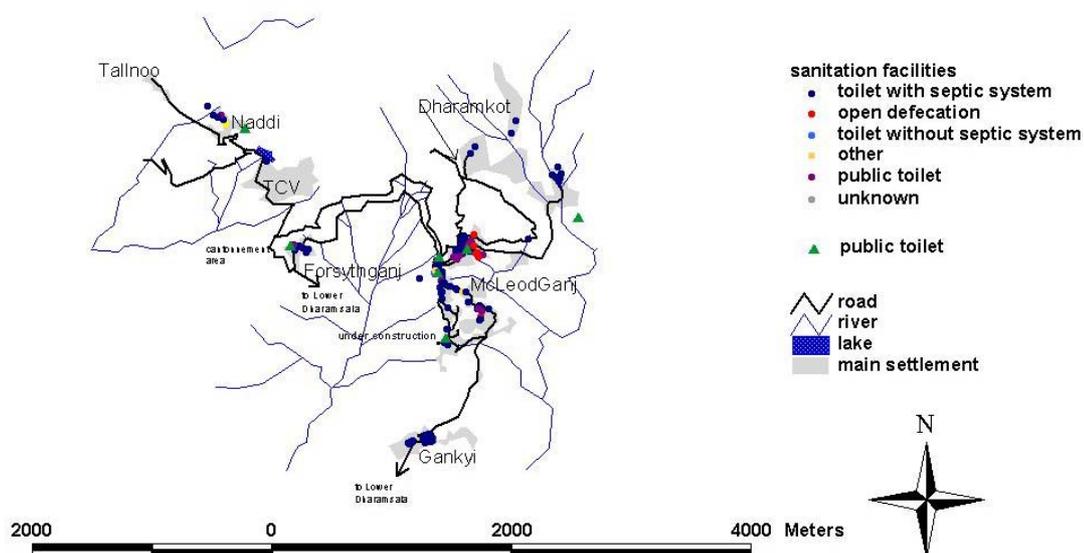
26% of all interviewed households perceive sanitation as their most urgent problem. In this question on the main problems of the households, 68% of the respondents felt that neither sanitation, nor water supply nor solid waste management was an issue. Based on the household survey 71% of all interviewed persons identified a danger to human health by the present sanitary situation. Most of these respondents also see a danger to the environment however neither the danger to the environment nor to human health could be described more in detail.

Open defecation is seen as a problem especially in McLeod Ganj, where it is practiced by at least 16% of the households (see Chapter "Sanitation facilities" below) as well as men urinating on to the water pipes in the open drainage system.

According to the survey about half of the households (46%) in Upper Dharamsala are satisfied with their personal sanitary situation. Desirable improvements are more and cheaper public toilets, cleaner toilets and a private toilet for all households.

Sanitation facilities

In the whole survey area 77% of the households surveyed have private toilets. In McLeod Ganj it was observed that 50% of the private homes have a private toilet, 5 of 6 shops and 5 of 6 restaurants (however not necessarily accessible to customers) and all the hotels and institutions with boarding facilities. 34% of the households mention using the public toilets while 16% admit to practicing open defecation. It can be assumed that also households mentioning using public toilets may also be defecating openly. Mapping these factors shows that most people who do not have a private toilet live in Mitanal, between Bhagsu and TIPA Road or in Thardoling, in the big corner of Jogiwara Road (Map 2). In Gankyi all households have access to private toilets as the sanitation facilities are financed by the CTA. In the villages 91% have private toilets, the others use public toilets. In villages nobody mentions open defecation.



Map 5: Sanitation facilities of the households and location of public toilets.

The forest is used as location for open defecation and while walking through the small paths in the forest in the densely populated area near Tushita Road, human faeces were observed even directly on the path itself. It seems that especially for elderly people the distance to the public toilets is perceived as too far.

Most the public toilets charge 2 Rupees (see Chapter 6.1.3). Many people complained that this is too expensive for families which depend on them. A simple estimate with a family of 4 members shows that the family will spend 480 Rupees per month if all use the public toilets twice a day (without cost of urinating only). For comparison purpose, a green worker employed by TWO earns 2000 Rupees per month and minimal wages are approximately 1200 Rupees per month. It can therefore be assumed that the proportion of people practicing open defecation is higher than 16% whereby men urinating at the roadside or into the open drainage system is very frequent.

Wastewater treatment on household level

Based on information from the household survey, in Upper Dharamsala most toilets are connected to a septic system (90%). While in the villages all toilets are connected to a septic tank, in McLeod Ganj only 85% are connected to some kind of septic system. This may be a consequence of the limited space and

the dense housing situation. Most septic tanks are planned by the IPH and in some of them a soak way is included. However, according to interviews with the workers paid for emptying septic tanks, soak ways are rare. Many septic tanks are ventilated but ventilation pipes are often short, thus restricting wind circulation. For some sanitation systems the term septic tank is used however can not be described as such. As an example, the Reception Centre, which supplies transient dorm facilities for newly arrived Tibetan refugees, has constructed a vault where septage is stored for approximately a month before it is then flushed down the open drainage during night time.

Operation and maintenance of the septic tanks is the responsibility of the owners, although the households do not know what proper maintenance involves. No recommendations from the IPH or any other experts are available and no awareness campaigns have yet been conducted in this regard. Most septic tanks have never been emptied or are only emptied when the bad smell is unsupportable. In fact it seems more convenient for many households to build a new septic tank if money and space is available.

There is a private group of 3 workers that can be hired to empty septic tanks or build a new one according to the plans of an engineer (of IPH). They work at night time or during heavy rainfall because of the strong smell. The contents of the tank are stirred manually and then removed by buckets. After adding phenol the septage is then poured into the soak pit or into an open drain. If this is not possible septage is carried to the forest or to the stream close to the segregation centre and discharged there. A jeep with a small tank is available to this purpose. If the septic tank has not been emptied for a longer time the septage at the bottom of the tank has hardened and has to be removed with shovels. When soak pits clog, the contents are removed with buckets and poured into the next drain or buried in the neighbourhood. The bad smell during the emptying causes burning eyes and breathing problems to the workers. The workers also don't wear any protective clothing (only shorts and slippers).

Greywater

Greywater is generally not perceived to be wastewater at all or requiring any kind of treatment. 86% of the interviewed households mention that it is discharged into the open drainage system, into the forest, or into a nearby river. 8% of the households discharge their greywater into their septic system (Figure 6). No difference between the different settlements could be determined.

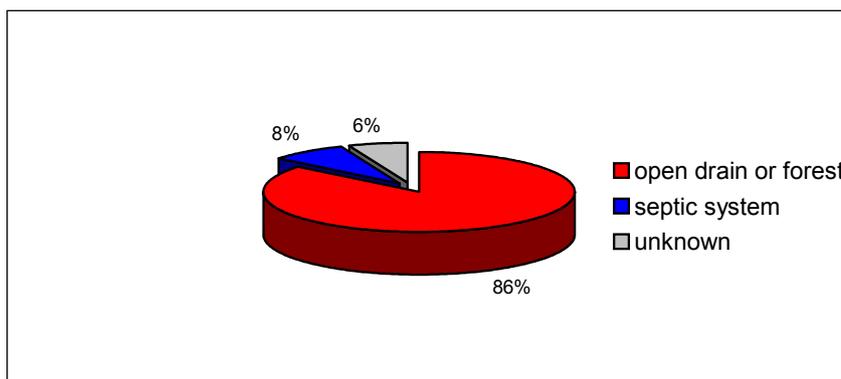


Figure 6: Most greywater is discharged into the open drainage system or into the forest.

6.1.3 Public toilets

There are six public toilets in Upper Dharamsala. Five of them are operated by Sulabh and charge 2 Rupees per use. The public toilet in Naddi is owned by the Municipal Council and operated and maintained by the village people.

The locations of the public toilets and especially their spatial distribution in McLeod Ganj are unfortunate (Map 5). There are two public toilets very close to each other (in the main market and at the taxi stand). The toilet at the taxi stand is mostly used by the taxi drivers and is hidden from view from the commercial area of the main market. The surroundings are very filthy due to nearby inadequately maintained solid waste containers. There is no public toilet close enough for the households in the densely populated areas above TIPPA Road and in Jogiwara Road (Map 2).

Table 5: Public toilets in Upper Dharamsala.

| | no. of toilets | no. of urinals | taps for flush | paying customers ¹⁴ | septic system |
|-------------|----------------|----------------|----------------|--------------------------------|--|
| main market | 4 | 0 | yes | 50-80 | septic tank not known |
| taxi stand | 12 | 4 | yes | 50-75 | septic tank |
| Bhagsu Road | 8 | 1 | yes | 30-35 | septic tank |
| Bhagsunag | 6 | 3 | yes | 20, village people free | septic tank with overflowing septage |
| Forsythganj | 8 | | no | | septic tank, effluent in drain in village centre |
| Naddi | 4 | | | no charge | septic tank with overflowing septage |

There is a seventh public toilet under construction on the junction in front of the temple complex. It will not have less than 40 squat toilets, 4 complete bathrooms with seat toilet and shower, 9 urinals and various facilities for washing. This toilet will also be operated by Sulabh and charge shall be 2 Rupees. Under the toilet there is a big vault to store the septage. According to the supervisor of Sulabh toilets in McLeod Ganj, the vault shall be emptied by tanker-truck. It seems that the permission to discharge the vault effluent onto the hillside behind the toilet was refused by the Municipal Council.

All septic tanks of the (existing) public toilets are hardly maintained. The septic tank of the public toilet in Bhagsunag is overflowing with septage and smelling badly. There is a family living in a small, self-constructed house on top of the septic tank. It could not be determined were the septage of the public toilet in the main market is flowing as the Municipal Council has constructed the toilet and Sulabh is only in charge of operation. It can be assumed that the septage flows into the drainage channel at the backside of the toilet.

There is predefined emptying procedure for the septic tanks, which however is never applied. This prescribes adding a powder called "DDC" which shall give the septage a similar condition of soil which can then be easily removed and transported for discharge into the forest.

¹⁴ based on daily income according to the operators of the different toilets

6.1.4 Central sewage system

A sewer system and a sewage plant are currently under construction. According to IPH the operation of the whole system will start in March 2003 with the households applying for individual connections. It does not seem probable that the whole system will be completed until the date given, however first applications for individual household connections may nevertheless be possible. Planned investment costs are around 168.7 Million Rupees and annual costs for operation and maintenance are estimated to be about 3% of the investment costs (amounting to 5 Million Rupees yearly).

Household connections

As mentioned above, the IPH has no legal authority to force the households to connect to the sewer system. After the expected start of operation in March households can start applying for a connection. Some staff of IPH estimate that realistically only 60% of the households in McLeod Ganj will be able to connect to the main sewage line due to the dense housing structure (see Chapter 6.1.1).

Connecting to the main sewage line with an individual connection shall proceed as follows:

The households will have to pay the first 10 m of the connection pipe (diameter 16 cm) as well as the manhole needed. This individual manhole will be used to connect to a manhole in the main sewer line which is already provisioned with connection facilities. Septic tanks shall not be constructed anymore. The option of connecting to a septic tank outlet is possible however the sewer is said to be designed for solids as well and therefore is not necessary. Although connections to the main sewer line without using the existing manholes shall not be allowed, the IPH expects this to happen.

Sewer system

The trunk sewers will generally follow the main roads.

The sewage system is constructed for backwater but experience from other towns shows that 80% of all wastewater discharged will probably flow into the sewage system. The sewage system is designed for a future population of 58'421 (about 30000 permanent residents) in the year 2015. The applied peak factor for daily peak flow is 2.5.

Sewage treatment plant

The sewage plant is located in Lower Dharamsala below the town itself. The technological approach is based on an activated sludge system. The flow scheme of the plant is shown in Figure 7. There are two parallel lines of aeration and settling tanks to manage the variations in population throughout the year. Additionally to the treatment plant a chlorine contact tank is planned as a last treatment step before discharging the effluent into the river (Chaurankhad). According to IPH this is seen as a precautionary measure to protect possible existing intakes of water supply systems further downstream.

The three sludge drying beds are for alternate use. The sludge shall dry in each bed for approximately 20 - 25 days before it can then be used in agriculture. During the rainy season one of the drying beds may be covered but nevertheless problems in operation have to be expected. The solids removed by the screen will be disposed in a dump directly at the sewage plant.

The technical parameters of the plant are given in Table 6. The guidelines for operation of the return sludge are the MLSS content (mixed liquor suspended solids, all suspended solids) in the aeration tank. The value should be 3000 MLSS.

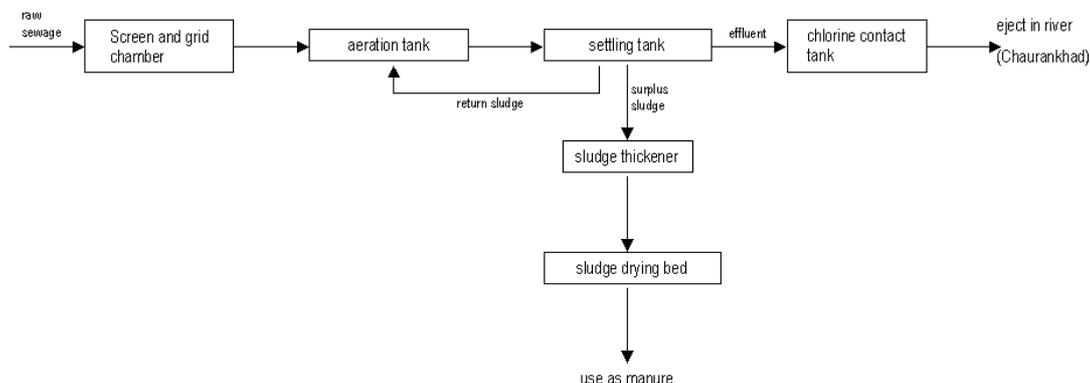


Figure 7: Flow scheme of the sewage treatment plant in Lower Dharamsala.

Table 6: Technical parameter of the sewage treatment plant according to IPH. The hydraulic retention time is calculated from capacity flow and the volumes of the aeration tanks.

| Parameter | Value | Units |
|---|-------|----------------------------------|
| capacity | 5150 | m ³ /d |
| hydraulic retention time for capacity flow | 17 | h |
| achieved concentration of microorganisms in the aeration tank | 3000 | MLSS ¹⁵ |
| retention time in settling tanks | 1.9 | h |
| expected BOD ¹⁶ of raw sewage | 300 | g _{BOD} /m ³ |
| expected SS ¹⁷ of raw sewage | 400 | g _{SS} /m ³ |
| expected BOD ¹⁸ of plant effluent | 20 | g _{BOD} /m ³ |
| expected SS of plant effluent | 30 | g _{SS} /m ³ |

A laboratory located at the sewage plant will monitor the BOD (Biological Oxygen Demand) and the SS (Suspended Solids) concentrations of the raw sewage as well as the effluent.

During a visit to Palampur where a similar plant has been operating since 2 - 3 years, the following problems were observed which the planned site in Dharamsala may also face in future.

¹⁵ MLSS = mixed liquor suspended solids [g/m³]. Includes all suspended solids.

¹⁶ BOD = biological oxygen demand. Usually the oxygen demand for microbiological decomposition within 5 days.

¹⁷ SS = suspended solids.

- In the offices of IPH, staff changes quite frequently. The black boards in every office show that staff is usually posted for 3 to a maximum of 5 years in the same position and then leave for another position often in another location. Such staff will often leave with all the knowledge and experience gained including the operational aspects of the system in place. For the successor operation of the system can then be as often specific expertise in wastewater management is lacking.
- A lacking diving wall at the settling tank combined with its partly anaerobic condition can result in a lot of floating sludge which will be directly discharged into the river together with the effluent.

6.2 Strengths and weaknesses

6.2.1 Strengths

Household level

- There are 6 public toilets with a total number of 40 squatting pans in Upper Dharamsala. They are, with one exception, all operated and maintained by Sulabh International. An additional one is under construction.
- Most of the toilets are attached to septic tanks or septic tanks combined with soak ways.
- There is a private service available to empty the septic tanks.

Central sewage system

- The sewage system and the sewage plant are under construction and should start operation in March 2003 (IPH).
- The system under construction and will relieve the households of their responsibilities regarding wastewater treatment and discharge.
- The sewerage plant has two parallel lines of treatment, which allows the flexibility to adapt to the variations in quantities or qualities depending on seasonal or population changes.

6.2.2 Weaknesses

Household level

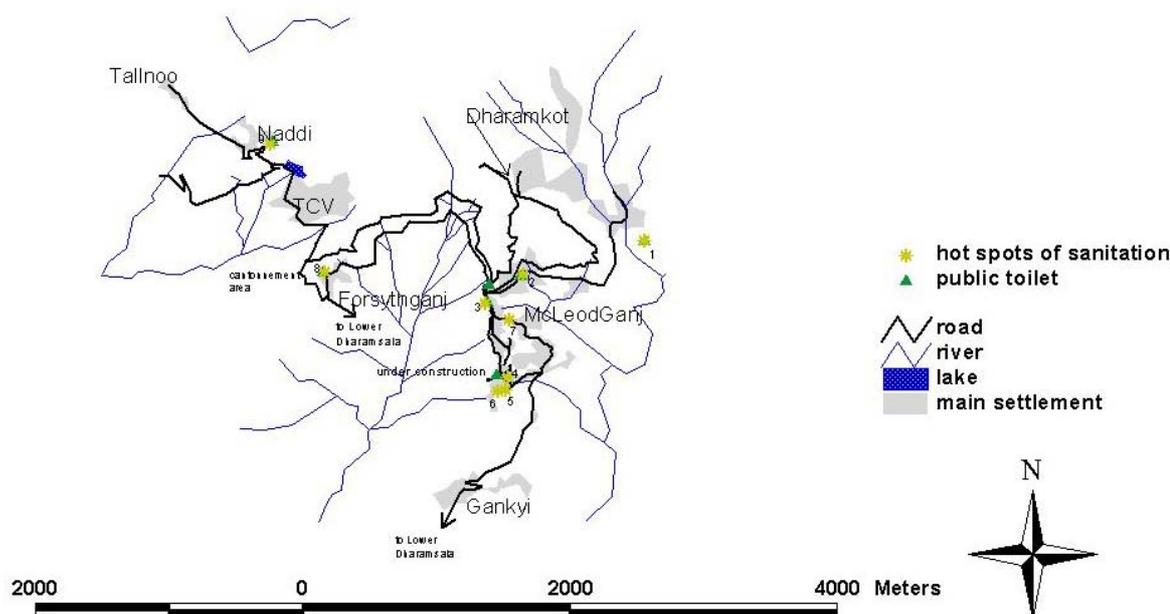
- According to the household survey only 50% of the private homes in McLeod Ganj have a private toilet. The others depend on public toilets or practice open defecation. A spatial analysis of the data collected in the household survey shows that these households are situated mainly in the area around Bhagsu Road or in Thardoling. Both areas are densely populated residential areas.
- According to the household survey 16% of the private homes in McLeod Ganj practice open defecation. 34% mention using public toilets, which are perceived as expensive and often too

far away from the households. The realistic estimate of people practicing open defecation is probably higher than 16%.

- Areas of open defecation are the neighbouring forest spaces. Faeces can also be observed on paths in the densely populated areas near Tushita Road.
- Most men do not hesitate to urinate in the open drains where the water pipes are also located.
- Maintenance of the septic tanks is often insufficient or non-existent due to lack of know-how and equipment. If septic tanks are emptied, it is often too late. Most septage is flushed down the open drains or into a stream after adding phenol.
- Most greywater flows without treatment into the open drainage system and/or into the forest or stream.
- Due to the dense housing facilities, some households will not be able to connect to the sewerage system. There is no alternative solution planned and the IPH does not provide help or advice for operation and maintenance of household centred solutions such as septic tanks.

Central sewage system

- There is no supervision on adequate handling of wastewater by the households. Enforcement of the existing legislation is lacking (see chapter 6.1.1). The IPH has no authority to enforce household connections to the newly planned sewage system.
- There are plans to hand over operation and maintenance of the sewage system to the Municipal Council, who has no practical experience in this thematic sector.
- The present staff of the Department for Irrigation and Public Health has gained knowledge on sewage collection and treatment systems that allows a proper management of these systems. There is a risk that this knowledge is lost to the department when staff changes.
- As there are no diving walls in the settling tank there is a risk that floating sludge is discharged together with the effluent.
- Operation of the sludge drying beds might be significantly hindered during the rainy season and no provision and plans for sludge use in agriculture have been developed.



Map 6: Hot spots of sanitation in Upper Dharamsala.

Locations of inadequate sanitation

Hot spots of inadequate sanitation are defined as locations where there is a serious threat to human health or environment caused by inadequate sanitation aspects. The list in Table 7 gives some examples which were observed during the study period and can not be regarded as complete (see Map 6).

Table 7: Hot spots of inadequate sanitation in Upper Dharamsala.

| Hot spot ID | Description |
|-------------|--|
| 1 | Overflowing septic tank of the public toilet in Bhagsunag. |
| 2 | Behind public toilet in Bhagsu Road, McLeod Ganj as a location where open defecation was observed frequently. |
| 3 | Near Om Hotel, as a place where open defecation was observed most frequently. |
| 4 | Septic tank of IBD, effluent in frequented area between the institute buildings. |
| 5,6 | Discharge from HH's residence and the Namgyal monastery. High turbidity with fine brown sediments can be observed as well as a bad smell of excreta. |
| 7 | Every month the Reception Centre discharges the contents of their septage vault into the open drainage system which is located in a strongly frequented road. |
| 8 | The effluent of the septic tank of the public toilet in Forsythganj is releases in an open drain heading to the village centre. |
| 9 | The septage of the septic tank in Naddi is overflowing. The Municipal Council, as the owner of the toilet, does not react to the complaints of the village population. |

6.3 Suggestions

The suggestions given below are based on a general overview of the situation. For planning and specific implementation, further detailed data and an intensive dialog with all stakeholders will be required.

- A reason for open defecation may be the high fees charged for public toilets and the far distances of the households to the toilets. The construction of additional public toilets in the residential areas and an alternative payment system may relieve this inadequate situation. The introduction of user cards, which would allow the residential population (households) unrestricted use of public toilets for a monthly fee, may improve the sanitary situation.
- The introduction of the sewage system should be combined with enforcement existing of law to ensure that all wastewater is handled properly.
- Public education should be enhanced to make people aware of the risks of open defecation, urinating over water pipes, and release of untreated wastewater and septage into the environment. The residents need to be informed on the proper use of the new sewage system to prevent frequent blockage of the pipes.
- As not all households can be connected to the sewerage system, it is essential to provide alternative technical solutions and advice to such households. An example may be in providing expertise and advice for the proper construction and maintenance of septic tanks.
- A proper location for the treatment and disposal of septage, far away from water bodies and human activities should be determined. Septage in the open drainage system or in a stream can pose a serious health hazard.
- An alternative solution of handling dried sludge from the drying bed in the sewage plant should be found in case the demand of dried sludge for agriculture is small.

7 Drainage

In Upper Dharamsala drainage is closely linked with sanitation issues as greywater is discharged into the open drainage system. It is also important to realise that water pipes are laid in the open drains where all discharge flows. This is especially the case where there is a lack of space in dense housing situations, mostly in McLeod Ganj. Details of the drainage system provide essential background information which directly influences water supply and sanitation issues.

7.1 Situation

7.1.1 Institutional set-up and legal framework

The drainage system in the settlements is set up and maintained by the Municipal Council. In Upper Dharamsala cleaning of the drains is subject of the Sanitation Contract for Ward 1, 2, and 3 of the Municipal Council which is currently held by the Tibetan Welfare Office. Drain cleaning is conducted by sweepers employed at TWO. At the household level (in proximity of the house) street drainage is the responsibility of the house owners. The Public Work Department is responsible for the drainage system between the settlements.

7.1.2 Open drainage system

The open drainage system is designed for drainage of greywater¹⁹ and rainwater. The drains are mostly situated on the uphill side of the road. In the main market of Dharamsala where there are no diagonal gradient, drains are available on both sides of the road. Usually, the drains in settlement areas are constructed as concrete channels. In areas with more space or where there is less risk of mechanical damage drains are constructed as plain ditches. In certain locations interrupted were observed (Map 7). An amazingly good drainage system is in place in the densely populated area between Tushita and TIPA Road. In Thardoling (in the big corner of Jogiwara Road) however, the drainage system is not continuous and drainage water often flows on the footpaths between the houses.

The drainage system is only designed for grey- and rainwater but often blackwater is also discharged into the drains (see Chapter 6). The effluent of septic tanks is discharged into the open drainage system when there is no soak way in place. Men often urinate into the drainage system. Often, especially in the commercial areas, waste is found lying in the drains and causes significant clogging. In these areas drains are cleaned every second day (see Chapter 8).

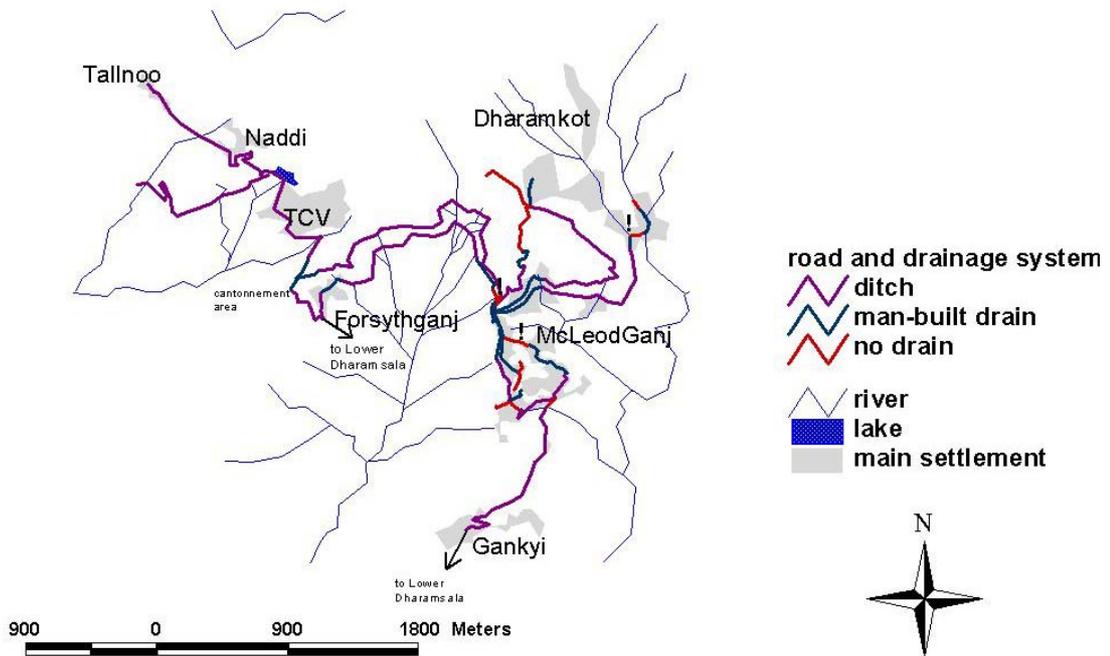
During dry season when water flow is low, in drains with low gradients and high retention times many insects can be observed in and on the water.

In some densely populated locations where the drainage system is not continuous, drainage water flows on the footpaths and poses a serious health hazard to the residents of these areas.

During monsoon with heavy rains, some streets are regularly flooded (e.g. in the main market of McLeod Ganj) due to waste clogged drains. This occurs even though during this season they are cleaned daily (mentioned by the supervisor of the sweepers). It was observed that for discharge of intense monsoon rains the design size of the drains are quite small. During the rainy season many drains are

¹⁹ wastewater not containing excreta for example wastewater from kitchen, bathroom or cleaning

damaged by high flow combined with blockage by waste or by cars or animals covering them. Some buildings or market stands are located so close to the drains that often they block them. Very often temporary building materials such as sand or bricks are dumped into drains preventing their functioning as drainage structures.



Map 7: The drainage system of Upper Dharamsala. There are some central places in McLeod Ganj and in Bhagsunag where the drainage system is interrupted.



Picture 4: Open drain in McLeod Ganj in dry season. The drain is in a relatively good condition but the waste lying inside might block it in rainy season and the water pipes though relatively high might be flooded. (Picture: Gabriela Friedl)

Locations of inadequate drainage systems

According to the sweepers some hot spots of inadequate drainage are:

- Drains often block in the market area near the post office where there are a number of vegetable stands as well as opposite the Welfare Office.
- Clogged drains are frequent in Forsythganj.
- Roads are often flooded near the taxi stand where drains are small and badly damaged, as well as near the vegetable stands at the post office. At peak rainfall, flooding was observed in the whole market area.
- Drains are often found to be damaged near the post office. The lack of space does not allow bigger drains and when crossing streets the drains are covered by metal bars. However also here drainage capacity is too small. Broken drains are a common occurrence and can be found all over Upper Dharamsala.

7.2 Suggestions

- An open drainage system discharging grey- and blackwater can be a serious health hazard. As a first step of improvement the water flowing in the drains should be carefully controlled. Enforcement of legislation regarding discharge of wastewater and the removal of blackwater from the drains (Himachal Pradesh Municipal Act, 1994 section 134) would limit this risk significantly. The option of greywater discharge into the planned sewage system or into septic tanks connected to the sewer should be looked at more in detail.
- Enforcement of the Municipal Solid Waste (Management and Handling) Rules, 2000, Schedule II, which prohibits littering, would improve some of the problems drains clogging due to solid waste.
- It might be necessary to check the design capacity of certain drains in the areas with low gradients, e. g. in the main market, to ensure appropriate drainage of heavy rains. Damaged drains should be repaired as quickly as possible to hinder further damage and health risk and the above-mentioned hot spots need to be tended to.

8 Solid Waste

8.1 Situation

8.1.1 History

Since His Holiness the Dalai Lama received the Nobel Prize for peace in 1989, more and more tourists are visiting McLeod Ganj. In the early nineties an increasing amount of consumer goods of industrial production were sold in Dharamsala and generation of non-biodegradable waste increased. A lacking waste collection system resulted in waste accumulating in streams and on hillsides by individuals littering. In 1994, the Tibetan Welfare Office (TWO) (see Chapter 4.2) initiated the "Clean Upper Dharamsala" project. One of the main objects of the project was - and still is - to enable a clean environment in McLeod Ganj. The project started in McLeod Ganj with three so called "green workers" that collected recyclable waste (also referred to as "dry" waste) from individual doorsteps. Later, an open truck was purchased in order to collect and transport non-recyclable (referred to as "wet" waste) and other mixed waste to the disposal site in Lower Dharamsala. (Tibetan Welfare Office, 2002)

In 2000 the Environmental Education Centre was set up (see Chapter 8.1.3). Its permanent exhibition and its teachings for school classes on environmental issues, is meant to increase public awareness. After it was destroyed by a storm it was rebuilt in 2002. From time to time, "mass clean-up" events were organized to help increase public awareness, whereby indiscriminate dumped waste was collected from hillsides and streams by the participating population.

In 2002 the waste collection service of TWO was able to be expanded its service with the help of a grant from Gere Foundation/ Initiatives Foundation. An additional truck and two three-wheelers were purchased and more "green workers" were employed. This reflects the current situation which is described below.

According to frequent visitors of Dharamsala in the last two years the detrimental situation regarding waste dumps on the hillsides and in streams around McLeod Ganj has been improved. Nevertheless, the town still has an unclean and unattractive appearance and the TWO and its associated supporters in Upper Dharamsala, such as Mrs. Jetsun Pema-La, President of TCV, are committed to implementing further improvements.

The collection service of the Municipal Council as it is currently observed was set up five years ago (in 1997). A dump site is being used since 1998 in Lower Dharamsala which receives mixed waste for disposal. At the moment there are further plans to initiate a system of waste processing (including recycling and composting) at the disposal site. The following chapters give more details on these plans of the Municipal Council.

8.1.2 Institutional set-up and legal framework

There are two providers of solid waste collection services in Upper Dharamsala: the Municipal Council and the Tibetan Welfare Office. The Municipal Council is the legal authority and officially responsible for collection, processing and disposal of solid waste in the municipal area (Municipal Solid Waste (Management and Handling) Rules, 2000 section 4). The Municipality collects mixed waste using central collection points with yellow containers and also runs the disposal site in Lower Dharamsala. The Tibetan Welfare Office runs two different collection schemes, one for recyclable waste (collection

from doorstep) and one for the other so called “wet” waste (curbside collection). It also operated a segregation (waste sorting) centre until recently as a voluntary contribution to the solid waste management of Upper Dharamsala. Since September 2002 the TWO holds the Sanitation Contract with the Municipal Council for Ward No 1, 2, and 3. They are therefore given the responsibility for street sweeping and the cleaning of the open drainage system in Upper Dharamsala (see Annex 2). Unfortunately there is little or no communication and cooperation between these two actors in solid waste management. The only cooperative element which was identified is the Sanitation Contract which does not specify clearly the responsibilities of neither contract partners and depends only on the goodwill of TWO.

Decision-making processes in the Municipal Council as well as in the Tibetan Welfare Office are orientated from top to bottom. This may result in higher officers taking decisions without consulting or involving the staff which has experience with the every day solid waste aspects. It is especially the Welfare Office which has very motivated staff that has good knowledge on waste collection issues and experience from the last years of service provided. It could be greatly benefiting to involve this experienced staff in all discussions concerning solid waste in order to gain from their on-site experience and insights.

Indiscriminate dumping of household waste is prohibited by law and can be enforced by fines. It is the Sanitary Inspector of the Municipal Council who has the responsibility to ensure the enforcement of this law and is the only one who has the authority to confer fines in the whole Municipal area of Dharamsala. All other actors (worker of the Municipal Council or private individuals) are only allowed to file complaints regarding somebody littering in order to initiate a trial which can then be brought to the Chief Magistrate. Enforcement of the legislation concerning littering is severely lacking and no cases of fining have ever been reported.

8.1.3 Indiscriminate dumping and public awareness

Although a certain degree of waste collection service is provided, waste is found lying in the drainage system of the roads and at some locations on the hillsides and in riverbeds. This is regarded as the result of lacking public awareness. Indiscriminate dumping of household waste (throwing waste on hillsides and in riverbeds) as well as littering (dropping of cigarette packages and similar things in the streets) was observed frequently (Picture 5). Often it was noted that residential areas are cleaner than commercial areas. In residential areas there is less waste in the drains and fewer places where waste accumulates in dumps. Locations where much waste is continuously dumped have been mapped and are described as solid waste “hot spots”. The large number of hot spots mapped (Map 8) shows the seriousness of the problem in most impressive manner.

Indiscriminate dumping and littering is prohibited by Indian law but the enforcement of this law (responsibility of Sanitary Inspector of Municipal Council) is lacking (see Chapter 8.1.2).

Since the “Clean Upper Dharamsala” project was set up by TWO in the early nineties, public education has been conducted in many forms. “Mass clean-ups” where the population of Upper Dharamsala is gathered to clean up indiscriminate dumped waste on hillsides and streams, have been conducted from time to time and with the introduction of the new collection systems continuous information is given to all households at the doorstep by people with good knowledge of the subject. Additionally, signboards were set up to inform people, pamphlets were distributed, and at public gatherings a video tape with a speech of His Holiness the Dalai Lama on the subject is often shown.

Nevertheless, in the household survey, not less than 6% in the urban settlements of McLeod Ganj and Gankyi and 30% in the villages mentioned indiscriminate dumping of their waste. Observation also show a lot of waste dumped on hillsides and in stream beds. According to Jan Willem van den Besten (former staff of TWO, who set up the first phase of the Clean Upper Dharamsala Project) the main problem of lacking public awareness and education in solid waste issues results from the organizational structure of

the households. There are two common types of households in Upper Dharamsala. The first household type consists of a housewife who is in charge of the household (~40%). These households are mostly very willing to cooperate with the TWO. Another type of households (~60%) consists of friends living together, where household members come and leave again in frequent succession. Here a lack of cooperation and education of environmental issues is noticeable as often the household members are difficult to reach and may not be at home when waste is collected.

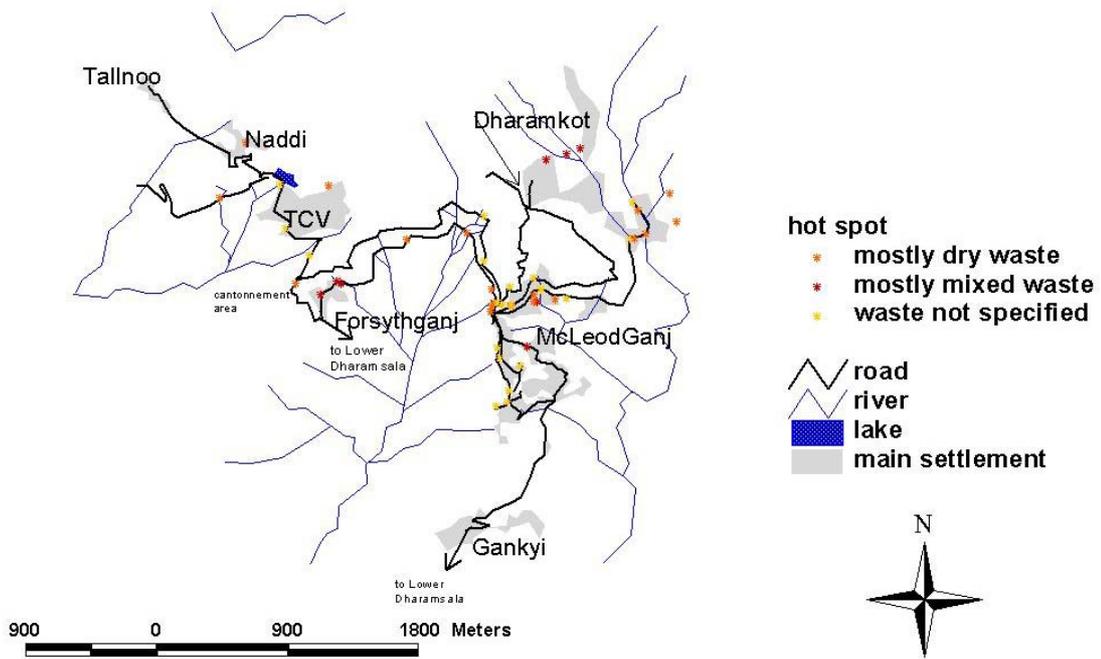


Picture 5: Waste is thrown on hillsides. Here the hill next to a big hotel in Hotel Bhagsu Road is shown. (Picture: Gabriela Friedl)

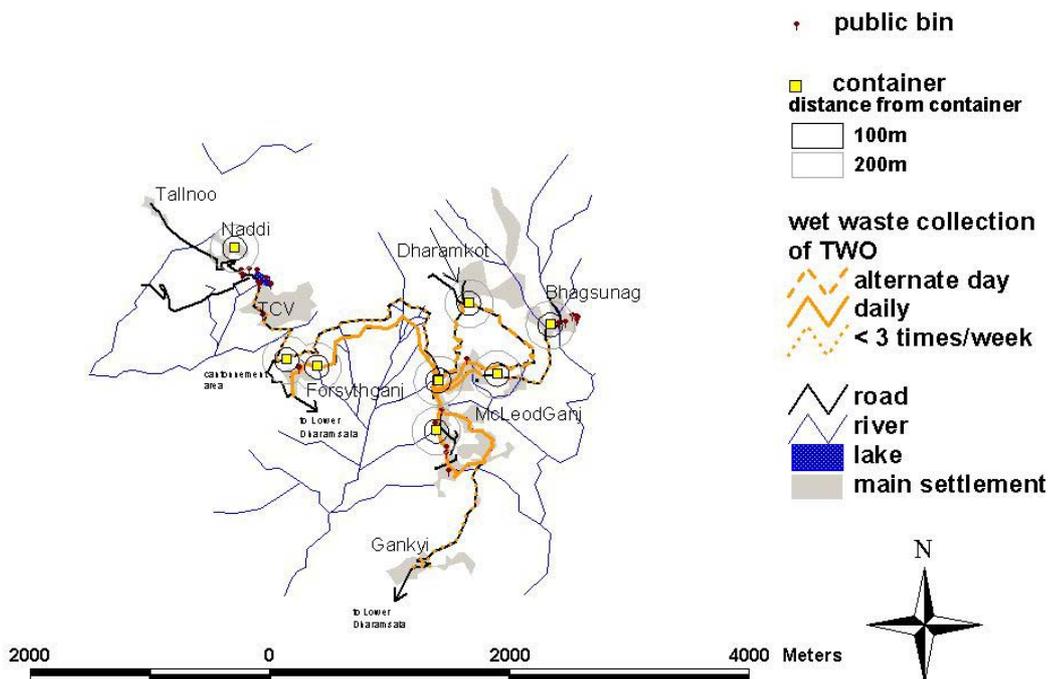
TWO runs the Environmental Education Centre, set up by Tibetan Welfare Office jointly with volunteers from a Swedish NGO called Swedish Organization for Individual Relief-IM, where a permanent exhibition informs about environmental issues and waste management in Upper Dharamsala. Further teachings for school classes are held by volunteers and the staff of TWO on a regular basis. The centre which was set up in 2000 was renewed in 2002 after its destruction by a severe storm.

8.1.4 Collection

There are two waste collection systems in place in Upper Dharamsala. The Municipal Council provides central collection points and the Tibetan Welfare Office (TWO) collects wet waste from the curb side and dry waste from the doorstep.



Map 8: Indiscriminate dumping is one of the major problems of solid waste management in Upper Dharamsala. This is illustrated by the numbers of hot spots (places where waste is accumulating in the environment).



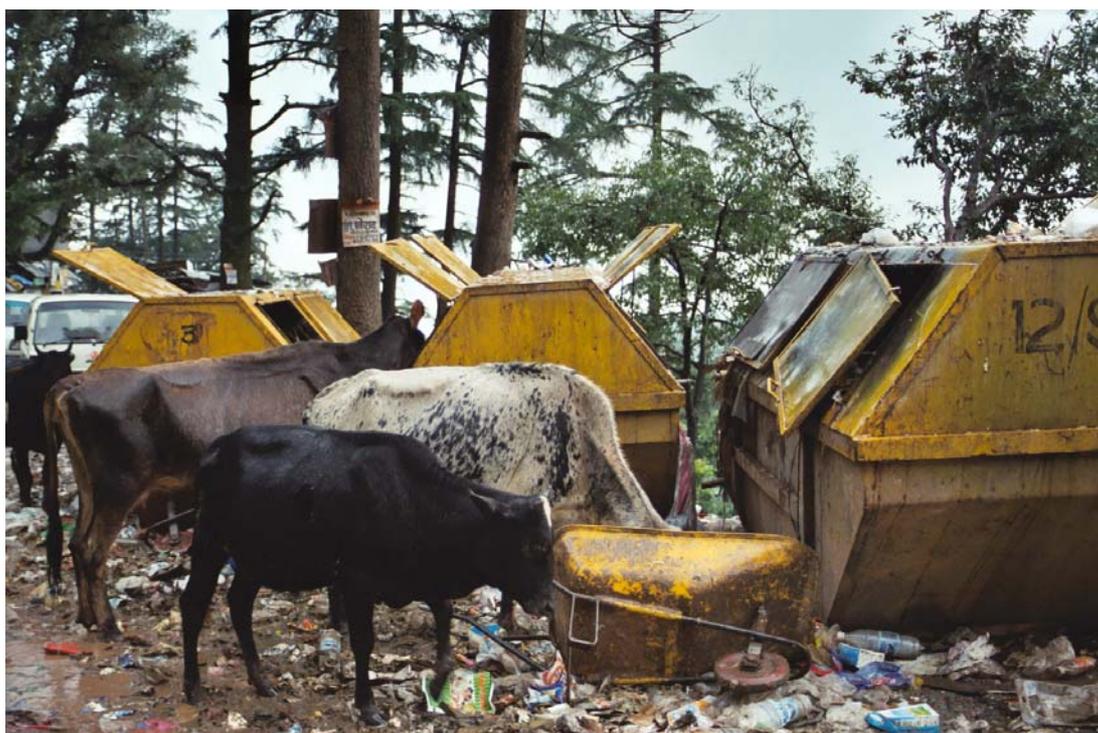
Map 9: Coverage of area of the two collection services. Dry and wet waste collection cover about the same area.

Municipal collection service

The municipal collection service is based on 13 central containers (volume ~8 m³), which are spread out at different locations around Upper Dharamsala. The containers are emptied by the municipal waste

collection truck between 1 and 2 times per week²⁰. As the containers have to be placed on flat area they are often not very close to the settlements (see Map 9). All of the containers have four flaps located at the sides but these are often left open or were observed to be damaged. Often feeding animals (cows and monkeys) scatter the waste from the containers. All this results in a filthy conditions around the container locations and many people prefer to throw the waste from the distance, making the situation even worse (see Picture 6), instead of disposing their waste properly into the containers, as this would mean approaching the container. Frequent overflow of the containers was reported some time ago but has significantly improved since TWO initiated the curb side collection service for wet waste. The Municipality has one truck equipped with lifting device to collect and empty the containers at the dump site. The truck arrives with an empty container, sets it down at the collection site and then lifts the full container to transport it to the disposal site in Lower Dharamsala. The driver is responsible for emptying all the 37 containers in the Municipal area of Dharamsala. According to the driver he is able to empty a total of 3 - 4 containers in a day which on a general average would result in an emptying frequency of 2 weeks per containers. However, not all containers are emptied with the same frequency as some fill more rapidly then others. Travel time from Upper Dharamsala to the disposal site (11 – 12 km) is about 30 minutes and from locations in Lower Dharamsala less then 15 minutes. It is therefore not obvious why the Municipal truck is not able to empty more containers per day, especially in Lower Dharamsala about 1 – 2 km distance from the dump site. The driver also mentioned emptying 2-3 containers located in Upper Dharamsala on a daily basis.

In some containers such as the ones in Temple Road, the owners of the surrounding shops incinerate the waste to avoid overflow.



Picture 6: The Municipal containers at the taxi stand of McLeod Ganj (north of main market) (Picture: Gabriela Friedl).

Collection service of the Tibetan Welfare Office (TWO)

The Tibetan Welfare Office provides door-to-door collection of household segregated waste six days a week. Dry waste includes all kinds of recyclable waste such as plastic, glass, paper, cardboard and metal. Plastic bottles are also collected but unfortunately can no longer be sold due to a change in their

²⁰ information obtained by shopkeepers and an operator of public toilets

material quality which has no value for recyclers and industries. Wet waste is all waste which is considered non-recyclable. This includes dirty plastic bags and organic biodegradable waste.

Two three-wheelers of TWO are available for the collection of recyclable waste (called dry waste) from the doorsteps of households. Each three wheeler is accompanied by two green workers who collect the dry waste stored outside the house or else knock at each door to obtain the waste. The green workers however do not focus on motivating residents to improve waste segregation. Dry waste is transported in small and big bags, the small ones (~25 litres) can be carried by the green workers (collection staff of TWO) and the big ones (~500 litres) are use to store the waste on the three-wheeler. The morning schedule is identical every day, whereas in the afternoon more remote areas or institutions are served in a rotating manner and on Friday afternoons the green workers conduct other special tasks such as cleaning up some indiscriminately dumped waste sites.

The following areas are serviced on a daily basis: main market, Jogiwara Road, Temple Road, Bhagsu Road, TIPA Road, Dharamkot (where the vehicle waits at the water treatment plant) and Tushita Road. Thardoling (at the corner of Jogiwara Road) and the area opposite the main temple is served every alternating day (see Map 9).

Two trucks collect wet and mixed waste. This waste is transported and disposed at the dump site in Lower Dharamsala. For collection, households bring their waste to the truck while it is passing along the main roads sounding its horn to attire attention. There is always a green worker accompanying the truck to assist people in lifting their waste into the truck. Sometimes people do not hear the truck and then they may miss the truck. Others also dump their waste directly into the truck while it is parked for the night. The larger truck parks near the public toilet on Bhagsu Road and the smaller one in front of the main temple complex. The morning schedule is repeated on a daily basis while in the afternoon more distant areas and institutions are served. Additionally even some institutions down in the plains of the Kangra valley are serviced by the truck as they pay well. The areas served daily are: Temple Road, main market, Jogiwara Road, Bhagsu Road, and TIPA Road. Tushita Road is served every alternate day.

The larger truck has a loading space of 5.6 m³. Due to its age it increasingly has technical problems and does not start in cold mornings. TWO has some plans to replace it, possibly with a container lifting truck similar to the one of the Municipal Council. The collection schedule is not always followed strictly as there are many holidays interrupting the routine and the afternoons are often used for the most urgent jobs regardless of the schedule. The Environment Coordinator as the supervisor of the environment section of TWO takes this decision each day. The Tibetan Welfare Office is presently trying to improve their collection schedule and the overall coverage of the Upper Dharamsala area.

In Upper Dharamsala there are also a number of waste pickers who buy dry waste from the households directly and sell the waste to recycling industries in the state of Punjab.

Street sweeping

The Tibetan Welfare Office holds the Sanitation Contract for Ward 1, 2, and 3 (see Annex 2) of the Municipal Council and is therefore responsible for street sweeping and cleaning of the drains in Upper Dharamsala. For that purpose TWO employs 10 sweepers. In McLeod Ganj, the street sweeping is carried out daily and the drains are cleaned every second day, in rainy season on a daily basis. One of the workers is responsible for sweeping the streets and cleaning the drains in Bhagsunag and one for Forsythganj. In Dharamkot streets are swept 2 - 3 times per week and in Naddi once by the sweepers of McLeod Ganj.

Public bins for litter

There are also some public bins where people can dispose waste generated on the streets like cigarette packages and fruit peels. However there are none in the market area. The only bins found in McLeod Ganj were set up by the Tibetan Welfare Office to collect dry waste. It is difficult to find locations for bins in the market area due to limited space and lacking willingness of the residents to accept public bins in their neighbourhood. Also, TWO does not have the legal power to set up bins and depends on the goodwill of the Municipal Council for their permission. The bins which were recently set up in Temple Road had to be removed by order of the Municipal Council for the above reasons. Feeding animals often scatter the waste from the bins and cause filthy surroundings. At the moment there is a new project financed by an English sponsor which plans to set up bins in McLeod Ganj. The project proposal was submitted to the Municipal Council just at the time when the field work for this study was completed (December 2002).

There are also some public bins which were set up by the Municipal Council. It could not be determined who is in charge of emptying them, the municipal council worker or the TWO green workers.

For a description of the public bins see Annex 2.

8.1.5 Households

Waste production

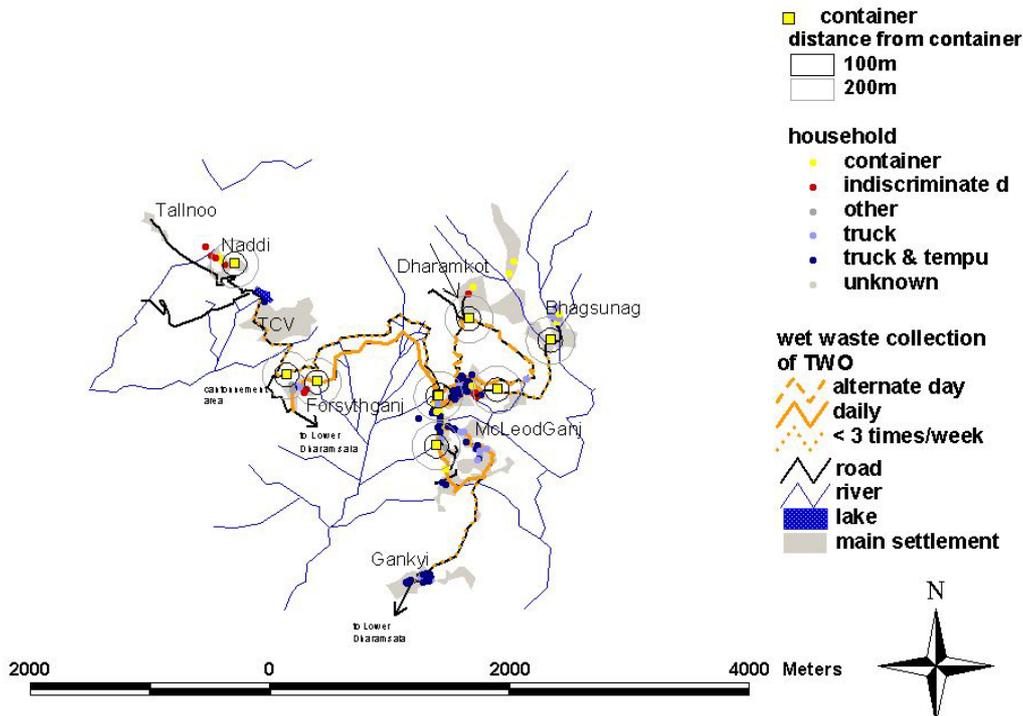
In an attempt to estimate waste generation rates, the amount of wet waste collected by TWO was weighed on the 5th November 2002, an ordinary working day in Dharamsala. The average weight of wet waste of 23 households in TIPA and TIPA Road is around 5 kg per household. The household survey shows that an average household in McLeod Ganj has 5 members. According to the people bringing their wet waste to the truck, the waste is often stored in the household for a few days before bringing it to the truck. Storage time at household level can be up to 5 days although an average time of storage in households may be about 2 to 3 days. Based on these assumptions the daily per capita production of wet waste can be estimated to 300 – 500 grams per capita and day. A similar survey of 7 households in Gankyi served to estimate dry waste generation. At the moment of measurement, the previous dry waste collection in Gankyi had been one week ago. The average measured weight per household was around 700 grams per household. The survey showed that assuming an average number of household members for Gankyi of 3, the daily per capita dry waste production amounts to less than 50 grams per capita and day. This relatively small fraction of dry waste may result from the fact that segregation is not conducted by all households or is often not well done and therefore incomplete. Additionally the heavy dry waste such as glass or metal are easily sold to the waste pickers and are thus not accounted for in the dry waste collection of TWO.

Segregation of waste is practiced by 70% of all households in the urban settlements. There are no noticeable differences between residential and commercial households. In the villages most households (one exception) segregate organic from dry waste. The organic waste is fed to the cattle.

Collection

The variety and quality of waste collection service available, depends mainly on the location of the household. While for a household located on one of the main streets of McLeod Ganj the wet waste curbside collection service by TWO is available, a household in the upper parts of Dharamkot has to carry its waste to container close which may be quite far away. Limited collection service for these

areas is mainly a consequence of the lacking roads such as in some villages like Dharamkot, Naddi, but also in parts of Bhagsunag.



Map 10: Households, the collection services they use and the collection services.

According to the household survey it seems that private homes have other preferences and needs, concerning a waste collection service than restaurants, shops or hotels. In McLeod Ganj, where both services are relatively well consolidated, the central containers provided by the Municipal Council are hardly used by private homes (only 2%) while many restaurants, shops and hotels use them. While 95% of the private homes use either dry or wet waste collection services of TWO, 68% use both collection services. 65% of all restaurants, shops and hotels use one of the two services. In McLeod Ganj 6% of all households admit to indiscriminate dumping.

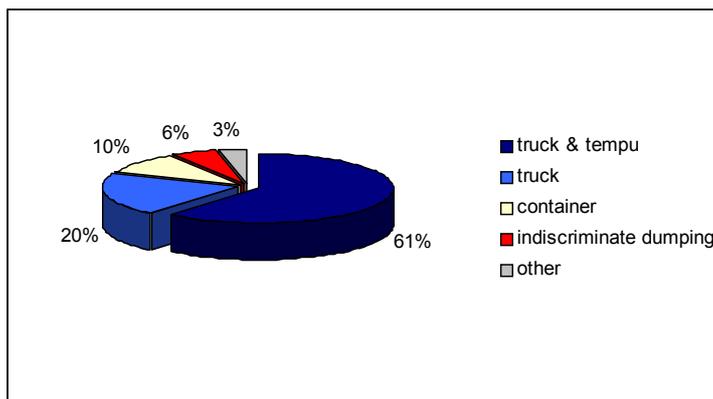


Figure 8: Waste collection services used by households in the urban settlements of Upper Dharamsala. “truck” means wet waste collection by the TWO, “tempu” dry waste collection. “Other” describes households which give dry waste to the TWO collection service or to waste pickers and feed all organic waste to cattle, and have no other waste to manage.

Private homes are willing to store wet waste 2 – 3 days before collection. On the other hand, for dry waste duration of storage is significantly higher (6 days average) as such waste is less disturbing and smelly. Restaurants, shops and hotels mentioned needing a daily waste collection service and do not seem prepared to store waste longer than one day²¹.

²¹ It is possible that many households misunderstood this question and mentioned the actual collection frequency rather than the least frequency of service possible.

In Gankyi households depend entirely on the collection service by TWO as there is no central container of the Municipal Council located in the area. Indiscriminate dumping was not mentioned as an existing waste management practice.

In Forsythganj and Bhagsunag where a curb side collection service of TWO is available, 54% of the interviewed households mention using it. The percentage of indiscriminate dumped waste is higher in the village settlements (30%) specifically in Naddi where the only container is very seldom emptied and badly maintained 60% of the households mentioned throwing their waste into the river.

Valuable recyclable waste such as glass and metal is sold to the waste pickers directly while the other "dry" waste (plastic, paper) is given to the dry waste collection of TWO.

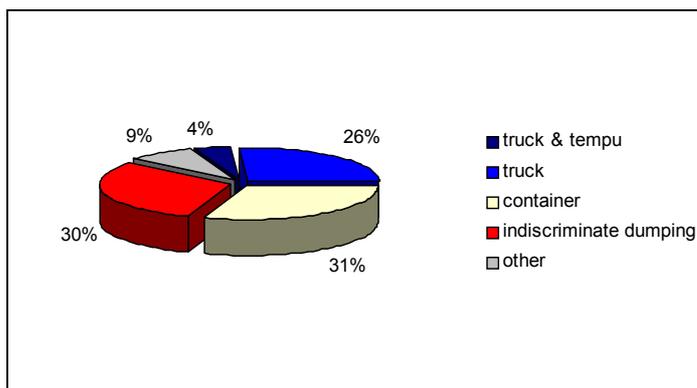


Figure 9: Waste collection services used by households in the rural settlements of Upper Dharamsala. "truck" means wet waste collection by the TWO, "tempu" dry waste collection. With "other" mostly households are meant that give dry waste to the TWO collection or to wastepickers and organic waste to their cattle, they do not have other wet waste.

Willingness to pay

TWO levies a voluntary collection fee of 10 Rupees per month from every private household. In McLeod Ganj and Gankyi where TWO operates, around 23% of the private homes mention paying this amount. Many households (48%) even mentioned that they would be willing to pay between 10 and 50 Rupees per month for reliable service. Unfortunately, in June when TWO visited about 75% of all households in McLeod Ganj and asked for the yearly fee of 120Rs, they were only able to collect a quarter of the annual budgeted amount of 200'000 Rupees (Zurbrügg, 2001b). Whereas the Tibetan Refugee Shopkeeper Association and the Tibetan Hotel & Restaurant Association pay their contribution for waste collection services the Indian Hotel & Restaurant Association and the Indian Shopkeepers Association do not. According to the household survey there seems to be no correlation between the willingness to pay and the type of service used.

Perceptions and satisfaction

Of the interviewed households, 18% identify the major environmental problems in the topic of solid waste management. Among the 68% that answered this question, there is equal distribution of answers identifying either solid waste, water supply or sanitation as the major issue. The largest proportion of households that are satisfied with their personal situation can be found in Forsythganj (86%), McLeod Ganj (69%) and Gankyi (68%). In Bhagsunag every second household is satisfied while in Naddi and Dharamkot, where service delivery is problematic due to the lacking roads, nobody is satisfied. In the villages of Forsythganj, Bhagsunag and Dharamkot a door-to-door collection is desired.

In general the filthy surroundings and the lacking frequency of emptying the municipal containers is criticized most often. Additionally the collection frequency of the TWO system is also criticized although in rather general terms without being specific.

8.1.6 Recycling and disposal

Wet and mixed waste is delivered to the disposal site in Lower Dharamsala. Dry waste is taken to the segregation centre, which is located at a stream on the main road between McLeod Ganj and Forsythganj. Although the Centre was set up by the Tibetan Welfare Office (TWO), since December 2002 the centre is now run by a private Indian waste dealer (see Annex 2). At the segregation centre dry waste is sorted into the different fractions and then transported and sold to the industries of Punjab. As already mentioned above, there are a number of individual waste pickers that move from doorstep to doorstep to buy dry waste from the households. This recyclable fraction is then also sold to the industries in the State of Punjab. TWO also runs a paper recycling unit where cotton rags (which are purchased) and paper is recycled into notebooks, diaries, files and writing paper.

Disposal site

The municipal disposal site is an open dump just below the bus stand of Lower Dharamsala (see Picture 7), approximately 11 - 12 km from McLeod Ganj. The plot was given to the Municipal Council by the Forest Department in 1998. The Sanitary Inspector estimates that the site will be used for another 10 years. There is an entrance gate and a fence around the whole site. However the main gate was observed to always be open during daytime without any entrance control. The total size of the dump covers an area of around 100 x 100 m (Municipal Engineer). Currently however only a part of the site is used for dumping as the other areas on the plot cannot be accessed with the trucks due to the steep gradient. Recycling at the dump site is practiced by few waste pickers that recover valuable wastes with the permission of the Municipal Council. During dry season the dump can often be seen burning and the dense cloud of smoke is clearly visible from the distance. The smell of burning waste can also be perceived at the main bus stand of Lower Dharamsala. It was mentioned that the fire is set by the workers of the Municipal Council in order to incinerate non-biodegradable waste and reduced waste volume (Sanitary Inspector).



Picture 7: The disposal site in Lower Dharamsala. (Picture: Bettina Sterkele)

On the site of waste disposal there is a hut and a sheltered platform which is presently used by the waste pickers to store the recovered waste. This platform and shed was built with the intention to set up a waste processing system including recycling and composting (to be operated by Sulabh International). The Municipal Council was able to give only very little information about this planned project. Only the Municipal Engineer had some idea of the processing systems which Sulabh intends to set up. Manual waste sorting shall be performed on the provided platform. Composting of the organic fraction shall take place using a stack system with five containers each with a capacity of 5 tonnes and 10 containers with a capacity of one ton. The containers shall be made of iron and have a solid cover. After filling the containers with waste, "germs", probably EM (Effective Microorganisms) shall be added to speed the decomposition process. Plans are that composting will produce good manure within 2 to 3 weeks²². The manure is worth 10-15Rs/kg but this price will probably not be reached. A machine will shred plastic bottles to increase their market value.

The Municipal Council to set up a new disposal site in Upper Dharamsala between Forsythganj and McLeod Ganj to shorten the transport routes of waste.

Segregation centre

The segregation centre is currently being run by a private Indian waste dealer, Mr. Raju. TWO delivers the dry waste free of charge to the Centre. A monthly rent is charged by TWO for the storage facilities, which includes one room above the crematorium of McLeod Ganj. Mr. Raju employs two workers to sort the waste.

The prices for glass, metal and plastics are fairly stable, whereas the price for cardboard and paper drops significantly during the rainy season when the waste is wet. There is also a seasonal pattern in dry waste production: during rainy season when the waste gets wet production goes down, during summer (April, May; June) the tourist peak season it increases.

Unfortunately just at the final phase of this study, the segregation centre was handed over to this new management. Thus, there is only little information on its performance. Indications show that the sorting categories are now much finer and the revenues should also increase accordingly. The Tibetan Welfare Office is satisfied with its new partner and the way he operates the centre. The room rent paid by the contractor Mr. Raju is more than the previous income of TWO through sales of recyclable waste.

There is some waste lying in the river next to the segregation centre. It consists mostly of plastic cups used by guests during funerals. The TWO waste truck is supposed to collect the residual (non-recyclable) waste from the segregation centre every alternate day, however this can not always be achieved and waste is then burnt directly on site.

Paper-recycling unit

The paper-recycling unit was set up by TWO to recycle waste paper. Since the paper making process was adapted to achieve a better paper quality and therefore financial sustainability, cotton rags are purchased as additives to the paper making process. Per year 1around 5 - 16 bags of cotton rags (corresponding to one truck-load) and 24 bags of clean waste paper (mostly from the offices of CTA (Central Tibetan Administration) are processed into new products. The income of the paper-recycling unit covers the costs of labour and raw materials and the plant is therefore regarded as being financially sustainable.

The quantity of paper recycled in the paper-making unit still seems to be small compared to the large quantities of paper waste collected by the green workers.

²² from an experts view, these composting plans are very questionable and do not seem very feasible

Waste pickers

There are some waste pickers buying recyclable waste at the doorstep of households. Household obviously prefer selling more valuable recyclable waste such as glass or metal to the waste pickers and deliver less valuable waste like plastic or paper to the dry waste collectors of TWO.

Composting

Until now TWO has initiated two composting projects, which both failed. The first one was set up in 2000 at TIPA (Tibetan Institute of Performing Arts), one of the big institutions in McLeod Ganj where 200 people live in apartments. The composting project failed because of the following two reasons: Household segregation was insufficient and lacking quality of the raw material for composting (especially contaminated by plastic) resulted in bad compost. The compost generated strong odour emissions, especially during the rainy season. Staff at TWO also mentioned the problem of greasy food waste of the Tibetan kitchen causing odour problems. The second composting project started in 2001 in Gankyi and failed because of the same reasons. Further problems occurred as the compost heap was located near to staff quarters, offices and the general mess, and odour complaints and dogs feeding from the heap caused the project to be terminated.

8.2 Strength and weaknesses

The main aesthetic problem concerning waste in Upper Dharamsala is the indiscriminate dumping and the filthy surrounding of every waste storage facility. To improve the appearance of Upper Dharamsala public awareness has to be increased and waste collection has to improve. To reduce the environmental and health hazard, options for proper processing and disposal of waste as well as waste minimisation programmes have to be initiated. Below, a more detailed list of strengths and weaknesses of the system are mentioned which take the two main goals of waste management into account – a pleasant environment and reduction of environmental and health hazards.

8.2.1 Strengths

- The two collection services by the Municipal Council and the Tibetan Welfare Office have the potential to complement each other. While the curb side collection of TWO is able to cover a large area and collect the waste close to the place of generation at the household level, the central containers of the Municipal Council are always available even if in larger distance to many homes (see Map 9).
- The collection service of the Tibetan Welfare Office is continuously expanding and improving since its first steps in 1994. Presently, the Tibetan Welfare Office still aims to improve the collection schedule to achieve full coverage of the area.
- There is a framework in place which allows recycling of dry waste with a separate collection system.

8.2.2 Weaknesses

Institutional set-up and legal framework

- Due to the lack of cooperation between Municipal Council and the Tibetan Welfare Office, the combined capacity of these two waste collection services can not be used.
- In the Municipal Council as well as in the Tibetan Welfare Office decision-making processes are orientated from top to down and staff experience of coordination and execution in every day waste business can not be used efficiently.
- The Sanitation Contract for Ward 1, 2 and 3 given to the Tibetan Welfare Office by the Municipal Council is not clearly formulated and the tasks of the contractor are not specified.
- Lacking public awareness and lacking enforcement of the legislation causes littering to be a common occurrence and waste accumulates in the open drainage system, on hillsides and in riverbeds.
- In the Municipal Council nobody could be identified with knowledge on the details of the project of Sulabh International concerning recycling at the disposal site. This is somewhat astonishing as the Municipality would be responsible for operation and maintenance of the system.

Collection

- Maintenance and regular emptying of the municipal containers is lacking. The area around the container is often very filthy and task of emptying the container does not including cleaning around the container site. Animals (especially monkeys) remove waste from the container and scatter it around the immediate surroundings.
- Often the containers are located far away from the households which are supposed to be using them (especially in village settlements).
- In densely populated settings, finding an adequate site for the containers which is also close enough to the households is difficult.
- Many households do not perceive to have adequate collection service despite the two collection services provided. Waste collection by the Tibetan Welfare Office may not reach households as residents do not hear the truck coming or are not at home during the time the truck passes. In village settlements where accessibility by truck is difficult, no curb side waste collection is provided.
- Lack of public bins in the market area enhances littering and disposal of waste in the drains.

Recycling and disposal

- Large amounts of recyclable waste is not recovered and dumped at the disposal site in Lower Dharamsala. Lack of household segregation or insufficient segregation hinders effective recycling.
- Plastic (water) bottles are currently not recycled, as there is no demand for such materials.
- Lacking operation and management of the dump site in Lower Dharamsala is a constant threat to human health.

- The composting project for the dump site is not well developed at this stage. Although some infrastructure has already been built, little is known regarding the details and operation and the information given raises serious doubts on the feasibility of the project.

8.3 Suggestions

The list of possible improvements given below is a "wish list". What, how and when is something that should be discussed by all the stakeholders of solid waste management in Upper Dharamsala. The goal of a participative approach involving all is to agree on the priority of the problems and only then to initiate approaches and solutions for improvement. The list below does not intend to be comprehensive.

Whatever actions and improvements are decided upon, to enable the success, proper coordination of the activities and definition of responsibilities of the different stakeholders are essential. Detailed planning and communication with the residents is important to assure their education, understanding and participation.

- To achieve improved collection service, better cooperation of the Municipal Council with the Tibetan Welfare Office is essential. Neither of the two collection systems has the capacity to serve the whole area and serve all households. However coordination of efforts can enable best possible service. It is currently not possible to set up a sufficient number location with containers in order to provide an ideal collection point for all households. At the same time the truck will not be able to reach all households, as the current system of curb side collection requires the presence of a household member. However both collection systems can complement each other and should not compete against each other.
- A proper waste service contract should be formulated which clearly defines the duties of the contractor (in this case TWO) and of the Municipality. According to Indian legislation the Municipal Council remains the responsible body for all solid waste management issues. All activities of the Tibetan Welfare Office which are not specified in the contract must be considered as a voluntary contribution of the Tibetan Government in Exile and should be appreciated as such. The contract should allow commitment for a few years at least to allow both partners to plan their activities and investments. The contract should also include a financial arrangement that values the services of both partners adequately.
- Waste management activities should always include programmes to raise public awareness among all population groups, which includes Tibetans, local Indians, and Indians from other parts of the country residents of Upper Dharamsala. Such programmes can also be specified in the waste management contract. Further there should also be an agreement on the areas covered by the two collection services, on the frequency of collection and on the kind of waste collected.
- Both services can improve. The Municipal Council can improve the operation and maintenance of the collection points which includes a sufficient emptying frequency and cleaning of the container surroundings. The Tibetan Welfare Office can increase coverage of the area by ensuring regular timely waste collection where the population is informed and knows when the truck can be expected. Dry and the wet waste collection routing could be organized to collect at the same time in order to benefit from synergies of using staff more efficiently. Green workers can move through the streets from house to house together, could also call the people in the houses farther from the road to bring dry and wet waste to the road side, help old and handicapped people with waste delivery, and continuously motivate, educate and encourage people to segregate their waste appropriately.
- The public education program should be based on the presence and the repetition of the message. It is not enough to teach people on one evening at a place were they visit. Staff of

the collection service (green workers) could spread the message. Leaflets to each household informing on the scheduled time and day of waste collection as well as their nearest communal waste container would help.

- The implementation of the littering act should be enforced as a part of the public education program. It might be necessary for the Municipal Council to find new ways of implementing this law as presently there is only one person which has the authority to fine for littering. The staff of the collection services would be ideal partners to assist enforcing this law.
- The waste accumulation on hillsides and in riverbeds should be minimised. Residents must be involved in a one time clean up and the current dumping locations can be given beautified by planting trees or by installing park benches for resting. Old brick collection containers of Tibetan Welfare Office which are no longer being used should be removed. Signboards at these locations shall inform people not to litter, show the possible consequences for themselves (fines) and for the society and environment of Dharamsala as a whole. Additionally options for proper handling of household waste must be mentioned which could include the collection schedule as well as the nearest location of the next container.
- Programmes to minimise waste production can be initiated. Consequent use of alternatives to plastic or even banning of the use of plastic bags could be considered.
- Fires at the dumpsite should be stopped. To limit eye sore, water pollution, and proliferation of disease vectors a disposal plan can be set up and older parts of the dump covered with a soil layer.
- To enable efficient recycling of the different waste fractions household segregation should be promoted more consequentially. Recovery and reuse of the organic fraction might be an option from locations where much organic waste is generated,(e.g. school kitchens, restaurants, etc.) The failures of the previous composting programs should be analyzed and detailed plans for alternative solutions could be developed

9 References

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(2001). Report on Liquid and Solid Waste Management Survey of Dharamsala Town. Dhaulaudhar Public Education Society.

Annex 1

Institutional Contacts

The following key persons of the local authorities were interviewed:

| | |
|--|---|
| Department for Irrigation and Public Health of Kangra District (IPH) | Chief Engineer M. K. Guliani Superintended Engineer Y. P. Rana Executive Engineer Arshwani Gupta Assistant Engineer K. K. Kapoor |
| Municipal Council | Pardan of Ward 1,2,3 Mrs. Patial, President of Municipal Council Sanitary Inspector Municipal Engineer |
| Tibetan Welfare Office | Welfare Officer Sonam Choephel Shosur Environment Coordinator Tsering Topgyal Golok |
| Department of Town Planning | Assistant Town Planner P. P. Rana |
| Central Groundwater Board | Regional Director S. N. Dulloo |
| divers | private group of workers maintaining septic tanks Jan Willem van den Besten, former staff of TWO |

Survey Sampling

The included households were classified by their size and function. The four distinguished classes are private homes for families, homes for hotels and big institutions, shops and restaurants (for criteria of classification see Chapter 3). It was found that also a classification according to the settlement characteristics, urban or rural, is relevant for the study.

A total number of 114 households were interviewed. The distribution among the different classes and settlements is shown in Table 8.

The database can be made available in a separate document for those interested. Please contact the authors.

Table 8: Households included in the survey.

| settlement | settlement characteristics | private home | home | shop | restaurant | total |
|-------------|----------------------------|--------------|------|------|------------|-------|
| McLeod Ganj | urban | 44 | 16 | 6 | 6 | 72 |
| Gankyi | urban | 18 | 1 | | | 19 |
| Bhagsunag | rural | 3 | | 1 | | 4 |
| Dharamkot | rural | 4 | | | 2 | 6 |
| Forsythganj | rural | 4 | | 3 | | 7 |
| Naddi | rural | 6 | | | | 6 |
| total | | 79 | 17 | 10 | 8 | 114 |

Geographic Features

The following feature and attribute definitions were used to create the maps of this study:

General

Roads (line)

ID
name
paved y-n
suitable for large or small trucks, cars, footpath
condition of road
drain 1 (man-built, natural, water on road, none)
condition of drain 1
drain 2 (man-built, natural, water on road, none)
condition of drain 2
sewer

Hot spots of traffic (point)

ID
Congestion (daily, sometimes)

Household (point)

ID
street name

Water supply

Spring (point)

ID
location
obvious pollution
perennial

Lake (area)

ID
name
condition obvious pollution
perennial
storage capacity

WS treatment plant (point)

ID (increment)
name
owner
condition
capacity

quality of release

Man-built storage (point)

ID
Type (drinking, irrigation, electricity, multiple purposes)
Condition
Volume
Inflow (type and ID)

Water catchment (point)

ID
location
owner
condition
volume
catchment ID
spring ID

Central pipe system (line)

ID
location
diameter [m]
condition

Public tap (point)

ID
catchment ID
condition
number of taps
number of household using it

Sanitation

Public toilets (point)

ID
location
number of toilets
condition
type of latrine
FS emptying (sewer, release, onsite treatment, service provider, other)
effluent (where does it go)
service provider
O & M sufficient y-n

price of use
water flush
rainwater entering
income of toilet
remarks

Solid waste management

Container (point)

ID
location
emptying frequency
O & M satisfying

Treatment plants (point)

ID
Owner
Storage capacity
Input flows: *amount of wet waste*
 amount of dry waste
 amount of mixed waste
Condition of infrastructure
function

Annex 2

Public bins

A number of public bins were observed in Upper Dharamsala. Their location is shown on Map 9. A description is given in Table 9.

Table 9: Short description of the various public bins found in Upper Dharamsala.

| Operator | Type | Volume | Shape |
|-------------------|-------|--------|---|
| TWO | big | 120l | cylinders with half circle flap on top |
| TWO | small | | "letterbox" with small flap for disposing waste and bigger flap for emptying. |
| Municipal Council | big | 360l | open cuboids |
| Municipal Council | small | 120l | cylinders with opening in side wall |

Segregation centre of TWO

TWO set up the segregation centre which it has been operating until December 2002.

TWO sorted the waste into the different categories as described in Table 10 and was able to sell for the listed prices to a waste dealer middleman, who is now the operator of the segregation centre. Storage volume was scarce and a problem when the waste was not collected regularly by the waste dealer. According to TWO payments of the waste dealer often were delayed.

Table 10: Waste categories sorted out in the segregation centre under TWO.

| category | components | price |
|----------------------|--|-----------|
| corrugated cardboard | corrugated cardboard | 1 Rs/kg |
| cardboard | cardboard without plastic layer as egg cardboard, tissue paper rolls,... | ½ Rs/kg |
| metal | | 3 Rs/kg |
| glass | bottles and jars | ½ Rs/kg |
| paper | all kinds without plastic layer | ½ Rs/kg |
| colourless plastic | milk bags, colourless soft plastic bags | 2 Rs/kg |
| plastic bottles | mostly from mineral water | no market |

Sanitation Contract

The Tibetan Welfare Office holds the Sanitation Contract for Ward 1, 2, and 3 of the Municipal Council and are therefore responsible to sweep the streets and clean the open drains in Upper Dharamsala.

OFFICE OF THE MUNICIPAL COUNCIL DHARAMSHALA.

To,

The Tibetan Welfare Officer
Meclodganj

No. 1473 /MCD

Dated the Dharamshala 4th, September, 2002

Subject:-

Sanitation Contractor of Ward No. 1,2, and 3

Memo:-

With reference to the Meeting held on 4.5.2002 under the Chairmanship of Worthy Deputy Commissioner Kangra at Dharamshala. Moreover, the M.C. has unanimously resolved in general meeting to execute the agreement of Sanitation Contract.

Keeping in view the meeting item No.3, you are hereby given the Sanitation Contract for one year i.e. 1.09.2002 to 31.08.2003 of Ward No 1,2 and 3. You are also requested to execute an agreement deed strict accordance with the rules.


Executive Officer,
Municipal Council Dharamshala

Annex 3

Household Questionnaire

The household interviews were held based on the following questionnaire.

Questionnaire: Household

For the interviewer

| |
|---|
| Name of Interviewer: |
| Date of Interview: |
| How do you judge the standard of the household: <input type="radio"/> low class <input type="radio"/> middle class <input type="radio"/> high class |

General

1. Nationality of household: Indian Tibetan other (specify):
2. Address (Block and house number):
3. Interview partner (role in household):
4. How many people live in your household?
5. Farming as main activity? No Yes: Include questionnaire for farmers in interview (page 81).

Solid Waste

6. Which of the following options is true (circle):
 I segregate the solid waste:

What do you do with the following components:

Kitchen waste (left-over food & peels):

Plastic:

Paper:

Metal:

Glass:

Plastic bottles:

Batteries:

Old clothes:

- I don't segregate the waste.

What do you do with it

Would you segregate it if you were asked to.

Yes

No. Why not:

Go on with the question corresponding to the answers that you received in question 1.

The waste or some components are brought to a central container. ☞ (Go to question 7.)

The waste or some components are collected either by truck or by tempu. ☞ (Go to question 3.)

There is no waste service. ☞ (Go to question 4.)

7. Where is the container?
 taxi stand Baghsu Road Forsythganj Bhagsunat
 Dharamkot below TCV TCV Road else:
8. Who operates it: Municipality TWO
9. Are you satisfied with the service? (more than one choice possible)
 Yes. Its good organised.
 I would prefer a door-to-door collection.
 The container is too far.
 The area around the container is too dirty.
 Other:
 How much would you pay for a good waste collection service? 10Rs 20Rs
10. Who collects it: TWO Municipality other
11. How long could you store dry waste:
12. How long could you store wet waste:
13. Is the service reliable? Yes No
14. How much des the service cost:
 Is this: high, all right or low to you?
15. How much could you afford to pay if TWO loses support of foreign organisations?
 20 Rs 35 Rs 50 Rs
16. Are you satisfied with the service?
 Yes. They mainly do a good job.
 Frequency too low.
 I would prefer another system. Which:
 Other:
17. What do you do with your waste?
 I bring it somewhere else. Where? (distance and location)?
 Why there?
 I drop it behind around my house.
18. Are you satisfied with the waste situation of your household?
 Yes.
 No, I would like to have a central container in my neighbourhood.
 No, I would like door-to-door collection.
 Other:
 How much would you pay for that? 10 20 35 50

Now go on with question 5.

19. What are the waste problems in Upper Dharamsala?
20. What should been done to solve them?
 Who should do that?
 Who should pay that?
21. Do you have any idea how you or others can reduce the amount of waste generated?

Water Supply

22. Do you have a tap in your house?
 There is a tap in my house. (Go to question 23.)
 There is no tap in my house. (Go to question 31.)
23. Where is the water from?
 Dharamkot water reservoir
 Glenmore reservoir
 reservoir above Gankyi
 other (where):
24. Do you share one pipe with other households? Yes No.
If Yes: With how many households?
How many people are this altogether?
25. Do you have a storage tank? Yes. Volume: No.
26. Do you share this tank with other households? Yes No.
If Yes: With how many households?
How many people are this altogether?
27. Do you need a pumping station to get the water from the reservoir into your house?
 Yes. No.
28. Who built the pipe system, well, taps..?
29. Who conducts maintenance of pipe system, well, taps..?
30. How much money do you spend about for water in a month?
For your household:
For all the households sharing the pipe:
31. Do you have hot water? Yes. No.(Go on with question 12.)
32. Why not? too expensive not available in my neighbourhood other:
33. Where else do you get your water from:
 public tap.
Which one: taxi stand Bhagsu road TIPA Bhagsunat
 TCV teacher training centre in Tibetan Government area
 Naddi Main Square Lower Naddi Forsythganj
 other (which):
 river. Which: distance:
 other: distance:
34. Who fetches the water (role in household)?
How (buckets, trolley..)?
35. Do you pay for water? Yes. How much? No.(Go on with question 12.)
36. Do you treat it before drinking? always in rainy season never
37. How do you treat it before drinking? boiling filtering none
38. Did you ever suffer from any disease related with insufficient water quality (for example diarrhoea)?
39. Are there times when you do not have enough water? (Why? When? How often?)
40. What are the problems of water supply in Upper Dharamsala regarding:
amount: quality: other:
41. What improvements do you wish? Who should pay them?

Sanitation

42. Which of the following options is true:
 There is a toilet in my house. (Go to question 18.)
 There is no toilet in my house. (Go to question 19.)
43. Do you share it with other households? Yes. No.
If Yes: With how many households altogether?
How many people are those?
How many toilets are there?
44. How do you judge the condition of your toilet (not cleanliness)?
 Good. Bad. Needs repairing in the next year.
45. Does it smell? Never. Sometime. Often.
Why?
46. Who is the owner of the toilet?
47. Who built it?
48. Who conducts operation and maintenance?
49. Do you flush with water? Estimate amount of water per flush (size of bucket, full or not or button)?
50. Can rainwater get into the toilet?
51. What gets into the toilet:
 paper
 hygienic articles (of women)
 kitchen waste
 other:
52. Where does the toilet waste go to:
 open drain
 jungle
 bucket latrine
 single soak pit
 ventilated
 double soak pit
 ventilated alternate use of the two pits (minimum time out of use for one pit: 2 years)
 septic tank/ aqua privy
 soak way subdivided ventilated outlet (pipe where water is coming out)
 other:
53. Emptying: Describe procedure
Who does it?
How?
Where does the waste go):
Frequency:
When do you empty it (season)?
54. Is the toilet accessible by a small truck?
55. Is there space for a soak way?
56. Costs of the whole toilet system:
building: operation (repairs, emptying):

57. Are you satisfied with your sanitary situation?
Improvements wished:
How much would you pay for that:
(price for shower incl. hot water: 50.000-60.000Rs)
58. Do you use public toilets sometimes?
Which one: taxi stand Bhagsu Road Market Street
 Forsythganj Bhagsunat
59. How often do you use it: regular (daily) rarely/ never
60. Condition of infrastructure sufficient?
61. Cleanliness sufficient?
62. If there were a residential card allowing all family members to use the public toilet next to your house, how much would you pay for that? 20Rs 30Rs 40Rs
63. Where else do you go for defecation?
Distance:
64. Are you satisfied with your sanitary situation?
Improvements:
How much would you pay for that:
(two-step toilet with pour-flush: 15.000-20.000)
65. Sanitary infrastructure and habits
 bucket washing
 bathroom with tap how often is it used (all household members together):
 bathroom with shower how often is it used (all household members together):
 bath how often is it used (all household members together):
66. Where does the wastewater from kitchen, bath and cleaning go to?
 in open drain.
 in the jungle.
 in a river. Which one:
 septic tank
 I reuse it. What for:
 else where:
67. Judge sanitation situation in Upper Dharamsala:
Do you see danger for human health? Where:
Do you see danger for the environment? Where:
68. Who is responsible for the sanitation situation?
69. What improvement would you wish for Upper Dharamsala?
70. Who should pay that?

Economics

71. If you had the money to change something in your household concerning solid waste, water supply and sanitation, what would you change?
72. Would you accept a credit for that if there were good conditions?
 I don't need anything.
 I don't buy anything on credit.
 I would accept a credit, if its conditions were good.

Farm

73. Arable area (size, location)
74. Crop
75. Do you have good soil?
76. Irrigation necessary?
How much?
When (month)?
77. Describe irrigation infrastructure and water source:
78. Do you use fertilisers? Artificial fertiliser Manure
79. Could you imagine using human excreta (if adequately treated)? Yes No
80. Are there erosion problems? Yes No