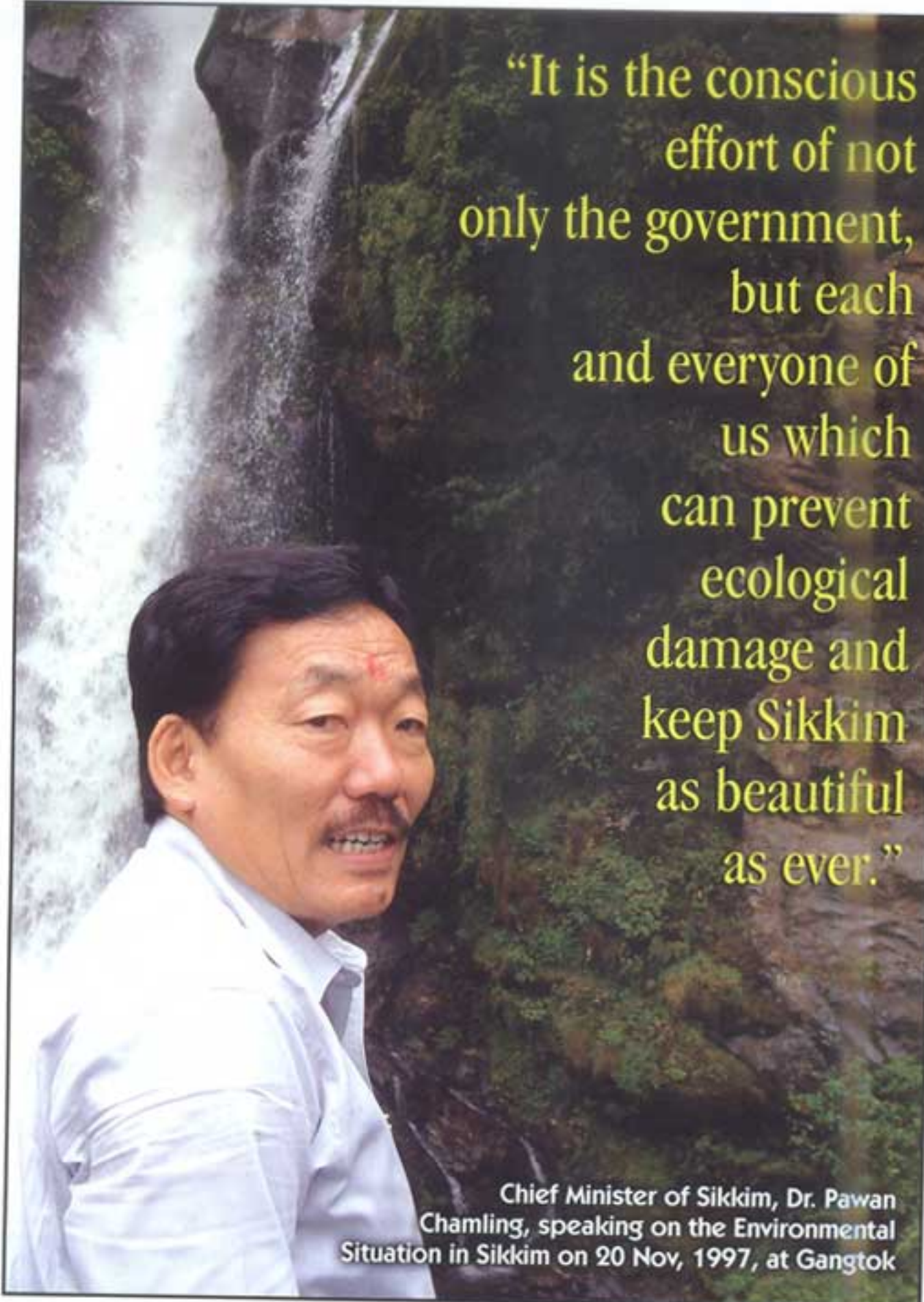


State Pollution Control Board
Department of Forest, Environment & Wildlife Management
Government of Sikkim
Deorali, Gangtok.

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A photograph of Dr. Pawan Chamling, the Chief Minister of Sikkim, speaking in front of a waterfall. He is wearing a white shirt and has a red tilak on his forehead. The background shows a lush green forest and a rocky waterfall.

“It is the conscious effort of not only the government, but each and everyone of us which can prevent ecological damage and keep Sikkim as beautiful as ever.”

Chief Minister of Sikkim, Dr. Pawan Chamling, speaking on the Environmental Situation in Sikkim on 20 Nov, 1997, at Gangtok



S. B. Subedi
Minister

*Forest, Environment & Wildlife Management,
Mines, Minerals & Geology, Science &
Technology Department*
Government of Sikkim
Tashiling, 737 101, Gangtok - Sikkim



M E S S A G E

I am happy to learn that the State Pollution Control Board, Sikkim, has produced a "State of Environmental Pollution Report, Sikkim, 2004." For a Himalayan State like ours, which is known the world over as a bio-diversity hot-spot, such a report was not only essential, but also urgent given the effects of unchecked environmental pollution that we get to see in other places.

From a layman's point of view, Sikkim is still untouched by the kind of environmental despoilation we get to see in other places. There is no denying, however, that pollution works at various levels and can explode from unexpected sectors. It is for this reason that I believe that the present Report is so special. This Report will provide the baseline information on the environment of Sikkim and I am confident that it will be of immense help to the planners, managers and policy makers of the State in charting the future course of development in Sikkim keeping special consideration for the need for environmental protection of our precious resources.

The contents of this document are well researched and incisive and congratulations are due to the team at SPCB. I wish them well and hope that they will continue with their efforts at keeping an eye on the environmental status of Sikkim so that everything that happens here is tempered with environmental consciousness.

**(S. B. Subedi),
Minister**

***Forest, Environment & Wildlife Management,
Mines, Minerals & Geology, Science & Technology Department***
Government of Sikkim
Tashiling, 737 101, Gangtok - Sikkim



STATE POLLUTION CONTROL BOARD
DEPARTMENT OF FOREST, ENVIRONMENT & WILDLIFE MANAGEMENT
GOVERNMENT OF SIKKIM
DEORALI, GANGTOK-737102

M E S S A G E

I am happy to learn that the State Pollution Control Board- Sikkim is bringing out a **“State of Environment Pollution Report - Sikkim - 2004.”** The report has been carefully researched and laid out bringing out to a large extent the true status of environment of the State of Sikkim. It is unique in many ways as it is the first ever report of this kind and it includes various aspects of environment.

I have no doubt about the useful purpose of the report and I sincerely hope that all the developmental activities of the State are carried out with reference to this environmental report.

I extend my gratitude to the team at State Pollution Control Board- Sikkim and wish them well & hope that they shall strive to do their best in bringing out such reports in future which will help in preserving the fragile eco-system and environment of the State.

With best wishes,

(G. M. Bhujel),
Chairman,
State Land Use & Environment Board.





GOVERNMENT OF SIKKIM

Office of the Principal Chief Conservator of Forests-cum-Secretary
DEPARTMENT OF FOREST, ENVIRONMENT & WILDLIFE MANAGEMENT
GOVERNMENT OF SIKKIM
DEORALI, GANGTOK-737102

M E S S A G E

I am immensely pleased to know that the Sikkim State Pollution Control Board is bringing out the “**State of Environmental Pollution Report - Sikkim - 2004**” for the first time since its inception.

It highlights the major events, initiatives and the projects taken up by the State Pollution Control Board- Sikkim and further it projects the State of Environment of the State of Sikkim in a comprehensive manner.



The report has been carefully researched and thoughtfully laid out so as to cover the major environmental issues of the state. The report provides to the best possible extent information, environmental trends & changes and their significance for effective, efficient environmental planning and management.

The present report is the outcome of the efforts put in by the State Pollution Control Board- Sikkim in assessing the contamination of air & water resources arising out of industrial activities, population explosion, and urbanisation. I hope this report will provide the reader with a reasonable idea regarding the state of Environment of the state.

The scope of work in the field of environment is never-ending & diverse and I wish them well in bringing out the true picture of changing environment of the State and hope that they will continue with their humble effort to update the information on environmental status in future also.

With best wishes,

(T. R. Sharma, IFS),
PCCF-cum-Secretary,
Deptt of Forest, Env. & W/L Management
Deorali-Gangtok - 737 102

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“Let us keep Sikkim free from Pollution
Let Our children inherit a
Pollution free Sikkim.”

State Pollution Control Board - Sikkim
Department of Forest, Environment &
Wildlife Management

Introduction

Our quest for a healthy environment is a never-ending process. In the last millennium, and particularly in the last century, realizing this has proved to be a great challenge. Never in the history of mankind have we done so much, in so little time, to destroy the wonderful eco-system that sustain us. Despite great strides made in recognizing that development must co-exist with the environment, we continue to search for economic progress in ways that erode the ecological foundations of our existence.

Environmental pollution is one of the major problems the world is facing and pollutants are byproducts of man's own action. In developed countries, the lakes and rivers are polluted with wastes from industries, pesticides, herbicides, fertilizer and chemicals and with exhaust gases of automobiles and chimneys smoke etc. In under developed countries, pollution is mainly caused by population explosion, unplanned dumping of wastes & sewage, and as well due to unhygienic and poor mode of living.

The rapid growth of urbanization has encouraged the migration of population from village to urban areas. This in turn has given way to environmental problems like waste water generation and their disposal, garbage (solid waste) generation and their disposal, air pollution due to increase in vehicular traffic and industrialization which resulted in contamination of water bodies.

Degradation of environment has been a known- problem throughout the country. There has been many efforts from various authorities concern to reduce the pollution level, which is the major factor for environmental degradation. Sikkim the 22nd State of the Indian Union is also not free from pollution point of view. But the level may not be as high as other states of India. The problem in the towns of the State is increasing day-by-day due to increase in town population and also due to increase in vehicular traffic. As such, it would be difficult for the concern authorities to check the pollution level; if a well-planned strategy to reduce it is not developed within next few years. So, steps must be initiated to prevent further growth of pollution and to save the health and environment of the state in general.

Sikkim is sandwiched between the kingdom of Nepal in the West and the Kingdom of Bhutan in the East. On its northern border towers the plateau of Tibet whereas it shares its southern border with West Bengal (another state of India). On the world map it is just a speck with an approximate latitude of 27° North and longitude of 88° East but its size belies its richness of culture, customs, heritage, flora and fauna.

Sikkim, the Himalayan Kingdom was earlier a protectorate of India with a monarchy Government but in 1975 it metamorphised as the 22nd State of Indian Union. The population of the state is about 5.4 lakhs as per the 2001 census. The state consist of four districts with North district with the district headquarters at Mangan, South District with district headquarters at Namchi, West district with headquarters at Gyalshing and East District with headquarters at Gangtok which is also the capital of Sikkim.

Sikkim is entirely a hilly region and indescribably magnificent with an area of about 7096 sq. km. Geographically the state can be divided into five zones:

a) Lower hills where the altitude ranges from 270m to 1500m, b) Mid-hills, altitude ranges from 1500m to 2000m, c) Higher hills, altitude ranges from 2000m to 3000m, d) Alpine zone altitude above 3000m with vegetation and e) Snow-land very high mountains which are usually without any vegetation and with perpetual snow cover up to 8580m. Out of the total area of 7,09,600 ha., 44.1% is under forest. The density and the percentage increase in population here are comparatively lower than other parts of the Country.



The contribution of industries, to the environmental problem of Sikkim is low as there are very few industries but, there are other factors which contribute substantially to environmental problem, though the level may not be high as compared to other towns and cities of India. The factors which contribute to environmental degradation are the absence of proper handling facilities as well as management for the treatment, segregation and disposal of Municipal Solid waste, bio-medical waste that are the most harmful and dangerous, Vehicular Pollution, Noise Pollution etc. As such it would be difficult for the concerned authorities to check the pollution levels if a well-planned strategy to reduce it is implemented within next few years. So, the major steps must be initiated to prevent the further environmental degradation in Sikkim.

Temperature:

The mean temperature in the lower altitudinal zones varies between 4.5°C to the 8.5°C whereas at higher altitudinal zones, it varies from 1.5°C to 9.5°C. Temperature varies with altitude and slope. The maximum temperature is recorded usually during July and August and minimum during December and January.

Rainfall:

The mean annual rainfall is minimum at Thangu (820mm) and maximum at Gangtok (3490mm). The intensity of rainfall during South-West monsoon season decreases from South to North, while the distribution of winter rainfall is in the opposite order. The highest annual rainfall in a particular station may exceed 5,000mm. Average rainy days range from 100 days at Thangu to 184 days at Gangtok.

Demographic Features:

The population of Sikkim in 2001 was 540493 consisting of 288217 males and 252276 females. District-wise population of Sikkim indicates that the district with the largest population is in the East with 244790 and North is the least populated district with a population of 41022. The provisional population of South and West districts are recorded as 131506 and 123177 respectively.

The percentage decadal growth rate of 1991-2001 (32.98%) when compared to the growth rate of the previous decade of 1981-1991 (28.47%) reveals that it has increased by 5% for the state as a whole.

As per 2001 census, the sex ratio in Sikkim is 875 as against 878 females per 1000 males in the 1991 census. The density of population as per the 2001 census is 76 for the state as against 57 in 1991.

During the last decade, parallel with rapidly developing technology, increasing population and urbanization, we have been witnessing alarming phenomena all over the world. In almost every country air, water and soil pollution, the decreases in arable land, the danger of radiation, the accumulation of solid wastes, the depletion of energy and of mineral resources, the death of parts of the plants and animal kingdoms have been becoming dominant problems almost in every cities and towns in the country and are facing the common problem of pollution. However, the magnitude of the problem differs from city to city because of quantum of waste generated is different which also corresponds to the human population, other than this there are those factors which contribute to environmental degradation i.e. absence of proper facilities for the treatment and disposal of these wastes.

Although it was thought that nature would take care of the environmental problems of Sikkim but due to rapid developmental programmes the pace of development exceeded the facilities and the infrastructure available in the state. To tackle the problem of environmental degradation created by various sources, the State Pollution Control Board- Sikkim was created and entrusted with the implementation of different Acts and Rules in vogue for the prevention and control of environmental pollution. And accordingly various projects were implemented to find out the base line information on the present status of environmental pollution in Sikkim.

The Land Use & Environment Board was constituted vide notification no. 51(7) Home /81 dated March 1983 under the chairmanship of Chief Secretary, Govt. of Sikkim. The rules for the purpose of effective functioning of the Land use & Env. Board was framed vide notification no. 51(7) Home/81 dt.11th Oct 1984. The Board consisted of the following members:

1.	Development Commissioner	-	Member
2.	Secretary, Land Revenue	-	"
3.	Secretary Forest	-	"
4.	Secretary Rural Development	-	"
5.	Director, Animal Husbandry	-	"
6.	Director, Agriculture	-	"
7.	Chief Engineer (Roads)	-	"
8.	Joint Director/Director, Land Use & Environment Department	-	Member Secretary

The Land Use & Environment Board was entrusted the Implementation of Water (Prevention & Control of Pollution) Act, 1974 with effect from the date of said Act being adopted in the State of Sikkim vide Notification no. 51(7) Home/88/868 dated 21st July 1988.

The Sikkim Legislature Assembly passed a resolution for adoption of the Water (Prevention & Control of Pollution) Act, 1974 (6 of /1977) the Water (Prevention & Control of Pollution) Amendment Act, 1978 (44of /1978) and the Water (Prevention & Control of Pollution) Amendment Act, 1988(53 of 1988) in the State of Sikkim with effect from 25th Feb 1989.

In exercise of the power conferred by section 64 of the Water (Prevention & Control of Pollution) Act, 1974 (6 of 1974) the State Government of Sikkim made Sikkim Water (Prevention & Control of Pollution) Rule, 1991 which came into force in the 21st of Sept 1992 vide notification no. 1/LU & E/ F dated 21/09/92.

The Pollution Control Laboratory Forest Secretariat Annexe, Forest Department was declared as the State Water & Air Laboratory to carry out the functions entrusted to the State Water Laboratory & the State Air Laboratory under the Water (Prevention & Control of Pollution) Act, 1974 & Air (Prevention & Control of Pollution) Act, 1981.

The State Government reconstituted the State Board as Land Use & Environment Board vide Notification no 50/Home/2003 dated 30/07/2003 consisting of the following members for a period of three years:-

1. Chairman, Land Use & Env. Board - Chairman
2. **Following Official members representing the State Government.**
 - i. Development Commissioner -cum- Secretary, Planning & Development Deptt. - Member
 - ii. Secretary, Transport Deptt. - "

- iii. Secretary, Urban Development & Housing Department. - "
- iv. Principal Chief Engineer-cum- Secretary, Public Health Engineering Deptt. - Member
- v. Principal CCF-cum-Secretary, Forests, Env. & Wildlife Deptt. - "
- vi. Secretary, Industries Department - "

Members as Health Expert, Academician, Legal Expert & Technocrat

- vii. Dr. S. Palzor (Health Expert) - "
- viii. Dr. M.P. Thapa, (Academician) - "
- ix. Law Office-Forest Env. & WL Management, (Legal Expert) - "
- x. Head Deptt. Chemical Engineering/ Chemistry - "

3. Following members from amongst members of the local authorities functioning within the State.

- i. Panchayat member from East.
- ii. Panchayat member from North.
- iii. Panchayat " " South
- iv. Panchayat " " West.

4. Non- official members representing the interest of agriculture, fisheries or industries or trade or labour of any other interest.

- i. Shri. K. C. Pradhan, IAS, Retired Chief Secretary, Govt. of Sikkim - Member
- ii. Shri S. T. Lachungpa, IFS, Chief Conservator of Forest - Member Secretary (full time)

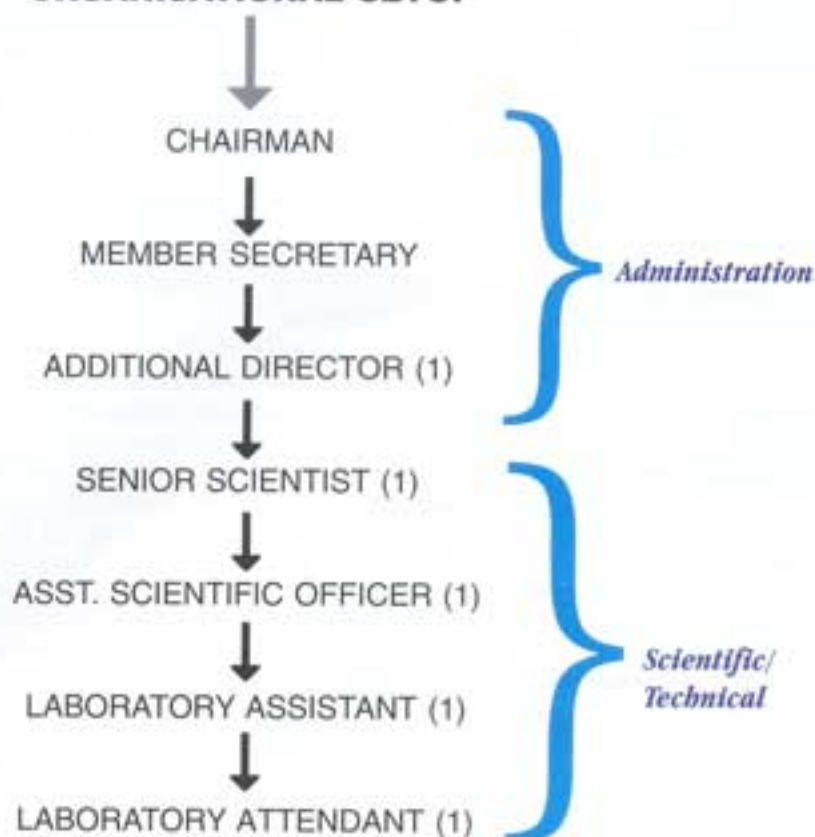
The State Pollution Control Board Sikkim is entrusted with the implementation of following Acts & Rules:

01. Water (Prevention & Control of Pollution) Act, 1974
02. Water (Prevention & Control of Pollution) Cess Act, 1977
03. Air (Prevention & Control of Pollution) Act, 1981
04. The Environment (Protection) Act, 1986
05. Hazardous Waste (Management & Handling) Rules, 1989
06. Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989
07. Public Liability Insurance Act, 1991
08. Bio-Medical Waste (Management & Handling) Rules, 1998
09. The Recycled Plastics Manufacture and Usage Rules, 1999
10. Environment (Protection) (Second Amendment) Rules, 1999 regarding standard of fire works.
11. Noise Pollution (Regulation and Control) Rules, 2000
12. The Municipal Solid Wastes (Management & Handling) Rules, 2000.
13. Ozone Depleting Substances (Regulation & Control) Rules, 2000.

MEETING OF THE STATE LAND USE & ENV. BOARD

Sl.No.	Date	Venue
1.	07/09/1989	Conference Hall, Forest Deptt.
2.	30/06/1990	Conference Hall, Forest Deptt.
3.	26/09/1994	Conference Hall, Forest Deptt.
4.	23/05/2001	Conference Hall, Forest Deptt.
5.	07/02/2003	Conference Hall, Forest Deptt.

ORGANISATIONAL SETUP



TENURE OF CHAIRMAN

State Land Use & Environment Board

Govt of Sikkim

SL.NO.	NAME	DATE
1.	Shri M.P. Pradhan	01. 01.1982 to 30.10.1982
2.	Shri K.M.L. Chhabra	01.12.1982 to 30.10.1983
3.	Shri Jagat Bandhu Pradhan	01.11.1984 to 31.12.1988
4.	Shri Namkha Gyaltsen	01. 01.1998 to 30.11.1998
5.	Shri Hangu Tshering Bhutia	01. 01.1990 to 31.11.1991
6.	Shri Ugen Pintso	06.12.1991 to 30.11.1993
7.	Smt. Chewang Lhamu	07.12.1993 to 30. 05.1994
8.	Shri Dorjee Tshering	01. 06.1994 to 30.11.1994
9.	Shri M.B. Rai	30.12.1994 to 08.10.1995
10.	Shri Gopal Lamichaney	11.11.1995 to 06. 08.1996
11.	Shri Dawa Sherpa	29. 04.1997 to 05. 08 .1997
12.	Shri Nim Tshering Lepcha	06. 08.1997 to 26. 04. 2004
13.	Shri G.M. Bhujel	23. 06.04 to -

FINANCES:-

Yearwise

A. Grants received from State Government	
Year	Amount
1997-1998	Rs. 1.6 lac.
1998-1999	Rs. 1.0 lac.
1999-2000	Rs. 1.0 lac.
2000-2001	Rs. 1.0 lac.
2001-2002	Rs. 2.27 lac.
2002-2003	Rs. 2.60 lac.
2003-2004	Rs. 5.0 lac.
B. Receipts of SPCB out of consent fees, authorization fee.	
1999-2000	Rs. 65,500.00
2000-2001	Rs. 67,500.00
2001-2002	Rs. 69,250.00
2002-2003	Rs. 1,91,750.00
2003-2004	Rs. 1,97,000.00

TRAINING PROGRAMME ATTENDED BY THE BOARD OFFICIALS

Course	Organization	Venue	From	To	Name & Designation
1. Training on Environmental Management & Laws	Indian Institute of Administration	New Delhi	1993 9 th August 1993	1993 14 th August 1993	Dr. Gopal Pradhan, Senior Scientist
2. Indo- British Training on Environmental Impact Assessment & Environmental Audit.	NEERI	Nagpur	1994	1994	Dr. Gopal Pradhan, Senior Scientist
3. Analysis of Water Quality and Ambient Air Quality.	Central Pollution Control Board Regional Referral Laboratory	Calcutta (West Bengal)	31 st Nov 1994	9 th Dec 1994	Shri Bindey Kr. Chettri, Assistant Scientific Officer
4. Training on Management of Public Sector undertaking	AATI	Gangtok	1997, 6 th May 1997	1997, 21 st May 1997	Dr. Gopal Pradhan, Senior Scientist
5. Air Quality Monitoring & Management	Pollution Control Board in collaboration with Envirotech Centre for Research Development	Shillong (Meghalaya)	1 st Dec 1999	4 th Dec 1999	i) Shri Bindey Kr. Chettri, Assistant Scientific Officer ii) Mrs. Kunzang Zangmo Bhutia, Laboratory Assistant
6. Bio-monitoring & Water Quality	Central Pollution Control Board	Shillong (Meghalaya)	17/01/2000	21/01/2000	Shri S.Z. Lukhsom, Addl. Director, Env. & Eco-tourism
7. Training on issues related to Env. & Environmental Economics under World Bank Aided Environmental capacity building technical assistance.	7. Training on issues related to Env. & Environmental Economic under World Bank Aided Environmental capacity building technical assistance.	Shillong	26 th June 2000	30 th June 2000	Dr. Gopal Pradhan, Senior Scientist
8. Training on Management of Bio-Medical Waste by World Health Organization & Central Pollution Control Board	Central Pollution Control Board	Calcutta	2001	28 th April 2001	Dr. Gopal Pradhan, Senior Scientist
9. Water & Waste Water Analysis Training Course	Public Health Engineering Deptt. in collaborating with Ministry of Urban Development & Poverty Alleviation.	Jaipur, Rajasthan	27 th April 2001	28 th Feb 2003	Shri Bindey Kr. Chettri, Scientific Assistant

Schemes completed by SPCB:

a) Schemes Completed

Sl. No	Name of schemes	Status
1.	Establishment of Pollution awareness and assistance center.	Completed
2.	Study of the hot water spring of Sikkim	Completed and (report submitted)
3.	Study of water quality of 3 revered lakes of east Sikkim.	Completed and (report submitted)
4.	Environment Assessment of Urban Settlement	Completed and (report submitted)
5.	Assessment of Pollution and formulation of action plan.	Completed and (report submitted)
6.	Strengthening of SPCB for implementation of rules other than Water & Air Acts.	Completed and (report submitted)
7.	Establishment of 2nos. of Ambient Air Quality Monitoring Stations at Gangtok.	Completed and (report submitted)
8.	Strengthening of SPCB, Sikkim upgradation of laboratories	Completed and (report submitted)
9.	Public Hearing on 510 MW, Teesta HE Project	Completed and (report submitted)
10.	Public Hearing on 36 MW, Rolep Hydro-electric Power Project, East Sikkim	Completed and (report submitted)
11.	Public Hearing on Municipal Solid Waste Treatment Plant, Lower Martam, East Sikkim	Completed and (report submitted)
12.	Abatement of Pollution through cleaning of jhoras in and around Gangtok	Completed and (report submitted)
13.	Public Hearing on construction of Airport at Pakyong, East Sikkim	Completed and (report submitted)
14.	Mass Environment Awareness Campaign.	Completed

Ongoing projects of SPCB Sikkim

Sl. No.	Name of Schemes	Status
1.	Setting up National Green Corps	Under implementation
2.	Strengthening of State Pollution Control Board	Under implementation
3.	Air and Water Quality Monitoring of Namchi.	Under implementation
4.	Bio-monitoring of Gurudongmar lake	*
5.	MINARS	*
6.	NAAQM	*
7.	Public Hearing of 100 MW Chujachen HE Project	*
8.	National Environment Awareness Campaign (NEAC)	ongoing



Inauguration of Ambient Air Quality Monitoring Station at White Hall, Gk., by Hon'ble Minister, Forest Env. & Wildlife Management, D. T. Lepcha

Environmental Monitoring

The State Pollution Control Board has a regular Ambient Air and Water Quality Monitoring Programme to assess the status of pollution in the natural environment. These monitoring programme are funded by the Central Pollution Control Board, Ministry of Environment & Forest, Govt. of India.

A. AIR QUALITY MONITORING

Introduction

To prevent, control and abate air pollution in the country, the Government of India enacted Central legislation called the Air (Prevention & Control of Pollution) Act, 1981 (referred to as the Air Act, 1981).

The main function of the State Board described in the Air Act, 1981 is that,

The State Pollution Control Board are entrusted with the direct implementation of the provisions of the Air Act, 1981 in their respective States.

Every polluting industry must obtain a consent from the State Pollution Control Board for the discharge of air pollutants in any form through chimney or otherwise.

The State Board may lay down suitable conditions while giving consent to discharge air pollutants in the light of emission standards developed by the Central Board, subsequently notified through the rules framed under the Environment (Pro-

TABLE 1.2.1 NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

Pollutant	SULPHUR DIOXIDE (SO ₂)		Oxides of nitrogen (NO _x)		SUSPENDED PARTICULATE MATTER (SPM)	
	Annual* Average	24 hours** Average	Annual* Average	24 hours** Average	Annual* Average	24 hours** Average
Industrial Area	80ug/m ³	120ug/m ³	80 ug/m ³	120 ug/m ³	360 ug/m ³	500 ug/m ³
Residential, Rural and other Area	60 ug/m ³	80 ug/m ³	60 ug/m ³	80 ug/m ³	140 ug/m ³	200 ug/m ³
Sensitive Area	15 ug/m ³	30 ug/m ³	15 ug/m ³	30 ug/m ³	70 ug/m ³	100 ug/m ³

tection) Act, 1986 Rules.

The State Boards are also empowered to take legal action against any industrial unit not meeting the conditions of the consent.

The other activities of the State Board include:

- To plan a comprehensive programme for air pollution prevention, control and abatement
- To advise the State government on any matter concerning air pollution prevention and control and
- To inspect air pollution control equipment and give such directions as may be considered necessary for pollution control.

Ambient Air Quality Standards

The primary aim of the ambient air quality standard is to provide a basis for protecting public health from adverse effects of air pollution and for eliminating or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human being, animals, vegetation & historical monuments.

Different standards have been laid down for industrial, residential and sensitive areas to protect human health and our national resources from the effects of air pollution. Table 1.2.1 presents the notified air quality standards, 1994.

* Annual Arithmetic Mean of minimum 104 measurements in a year taken twice a week 24-hourly at uniform interval.

** 24-hourly/8 hourly values should be met 98% of the time in a year. However 2% of the time, it may exceed but not on two consecutive days.

Note: 1. National Ambient Air Quality Standards: The levels of air quality necessary with an adequate margin of safety, to protect the public health, vegetation and property.

2. Whenever and wherever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.

3. The State Government/State Boards shall notify the sensitive and other areas in the respective states.

Ambient Air Quality Monitoring

The air quality surveillance and monitoring is under taken detect any deterioration in air quality arising from industrial, vehicular, residential and natural sources of pollution, as there are large seasonal variation in the concentration of various pollutants.

Air quality monitoring is the measurement of various pollutants to study the pattern and movement of air masses and deterioration of air quality. Monitoring programme helps estimating the dynamic concentration levels of various pollutants from time to time, based on dispersal mode of origin concentration at sources and at receptor end.

Air quality monitoring are basically needed due to the following reasons:-

- To generate database in air quality for rapidly growing urban areas

It is essential to keep the record of development of urban areas to assess its impact on general trend of air quality and its change.

Compliance with air quality standards

The regular monitoring of air quality is necessary to assess concentration, that exceeds the stipulated air quality standards at their exposure to general population. The monitoring network is therefore set up for regular assessment before the control measures are adopted.

Data base for land use planning

The development of new land use is assessed from pollution angle to develop for its proper development for new developing activities. The air quality monitoring is necessary to register the quality of air at its initial state, later the regular monitoring in the area provide assessment of air quality trends.

The major objectives for ambient air quality monitoring are as below:

(i) Background Data

In order to generate background data, air quality monitoring is conducted to assess existing level of contamination and possible effects occurring in future.

(ii) Status and trend Evaluation

To determine sources of pollution status and trend information

tion from any continuously ongoing air quality monitoring programme. The information is used to determine, whether programme control activities are providing measurable lowering of pollution levels or new or additional control are required to achieve acceptable levels.

(iii) Environment Exposure level Determination

The air quality monitoring and survey concern itself with systematic study of considerable segment of environment to define inter-relationship of source of pollution, atmospheric parameter and measurable manifestations, in order to evaluate the character and magnitude of existing problem.

(iv) Correlation Between Air Quality and Health

To assess the effect of various air pollutants, their intensity and duration of exposure and health status of the exposed population in air pollution control for the protection of human health.

(v) Scavenging Behavior of Environment

To understand natural scavenging or cleansing process undergoing in the environment through pollution dilution, dispersion, wind movement, dry deposition, precipitation and chemical transformation of pollutants generated.

(vi) Air Quality Management

To assess the present status to adjudge effectiveness of air pollution control strategies and long term management of air quality.

NATIONAL AMBIENT AIR QUALITY MONITORING

The Central Pollution Control Board initiated a National Ambient Air Quality Monitoring Network in the year 1984 besides other activities to control & abate the air pollution of the country.

Under the National Ambient Air Quality Monitoring programme sponsored by Central Pollution Control Board, MoEF, New Delhi, the State Pollution Control Board monitors the air quality of Gangtok town at two recently established stations one at White Hall Complex (Sensitive zone) & the other at Hospital Point (Commercial zone).

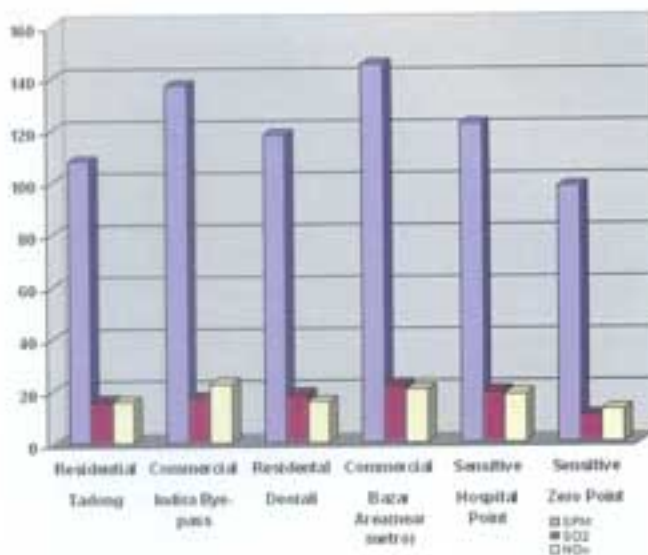
Air sampling is done and the sample is analyzed in the State Pollution Control Board Laboratory for various pollutants like SPM, Oxide of Nitrogen & Sulphur di-oxide. The data generated is forwarded to Central Pollution Control Board for compilation and further use.

AIR QUALITY OF GANGTOK.

Air quality monitoring of Gangtok town was initiated under the project "Assessment of Pollution & Formulation of Action Plan" during the year 2000-2001 and as per the report the air quality of Gangtok town is represented in the table.

Table 1... Ambient Air Quality in and Around Gangtok (Yearly average) in ($\mu\text{g}/\text{m}^3$).

Sl.no	Name of sites	Category	SPM	SO ₂	NO _x
1	Tadong	Residential	108	16.2	15.7
2	Indira bye-pass	Commercial	137	17.4	22.6
3	Deorali	Residential	118	18.6	16.1
4	Bazar area (near Metro point)	Commercial	145	22.3	20.4
5	Hospital point	Sensitive	122	19.6	18.6
6	Zero point	Sensitive	98	10.2	12.3



Eight hourly sulphur dioxide concentration of the sample shows that Bazar area with $22.3 \mu\text{g}/\text{m}^3$ has highest concentration on yearly average while the zero point shows minimum concentration with $10.2 \mu\text{g}/\text{m}^3$. The other stations viz: Tadong ($16.2 \mu\text{g}/\text{m}^3$), Indira bye-pass ($17.4 \mu\text{g}/\text{m}^3$), Deorali ($18.6 \mu\text{g}/\text{m}^3$), and Hospital Point ($19.6 \mu\text{g}/\text{m}^3$). All the values are, however, within the prescribed limit.

Oxides of Nitrogen-

The Eight hourly averages of Nitrogen oxides samples were collected and further analyzed in the lab. the result is presented in the table above. The highest concentration of oxides of Nitrogen as NO_2 was recorded from Indira Bye-pass with $22.6 \mu\text{g}/\text{m}^3$ followed by Bazar area ($20.4 \mu\text{g}/\text{m}^3$), Hospital Point ($18.6 \mu\text{g}/\text{m}^3$), Deorali ($16.1 \mu\text{g}/\text{m}^3$), Tadong ($15.7 \mu\text{g}/\text{m}^3$) and lowest was recorded from zero point with $12.3 \mu\text{g}/\text{m}^3$. All the values are however, within Indian standard.

The yearly average of suspended particulate matter is presented in table above, along with sulphur dioxide and oxide of nitrogen. It can be inferred that Bazar area (near metro point) with $145 \mu\text{g}/\text{m}^3$ of SPM has highest concentration while zero point with $98 \mu\text{g}/\text{m}^3$ shows minimum concentration of SPM. The highest value in Bazar area is mainly due to heavy vehicular movement in this area. Tadong monitoring site recorded $108 \mu\text{g}/\text{m}^3$ of SPM and like-wise Indira bye-pass ($137 \mu\text{g}/\text{m}^3$), Deorali ($118 \mu\text{g}/\text{m}^3$) and Hospital point ($122 \mu\text{g}/\text{m}^3$).

Air pollutants and Health effects:

Particulate matter: Particulate is a term used to designate minute particles of solid or semi-solid material dispersed in the atmosphere. Particulates that range in size less than $0.1 \mu\text{m}$ up to $45 \mu\text{m}$ are designated as dust or total suspended particles.

The human nostrils filter out 90% of the inhaled large and medium sized particles (Table 4) The rest may enter the windpipe and lungs where some inhalable particulates cling to protective mucous and are removed. Some of the smallest particles,

called respirable particulates may tend to be deposited in the alveoli (tiny air sacs in the lungs). In the lungs, particles slow down the exchange of oxygen with carbon dioxide in the blood, causing shortness of breath. The heart gets strained, because it works harder to compensate for oxygen loss. Usually, people most sensitive to these conditions have respiratory diseases like emphysema, bronchitis, asthma or heart problems. Particles themselves may be poisonous if inhaled, damaging remote organs like the kidneys or liver. Swallowed mucous that is laden with hazardous particulate matter may damage the stomach.

In addition, particulates may be the carriers of hazardous liquid or gaseous substances. Sulphur dioxide, a major air pollutant, is frequently absorbed by particulates and can react with moisture to form sulphates. Sulphates react with moisture in the air or in the respiratory tract form a corrosive liquid (sulphuric acid) that irritates delicate membranes and slow down the body's ability to remove harmful bacteria, increasing the possibility of infection.

Table 4. Summary of Health Effects of Basic Air Pollutants

Pollutant	Health Effects
Carbon Monoxide	(i) Poor reflexes (ii) Ringing in the ears (iii) Headache (iv) Dizziness (v) Nausea (vi) Breathing Difficulties (vii) Drowsiness (viii) Reduced work capacity (ix) Comatose state (can lead to death)
Lead (Pb)	(i) Kidney Damage (ii) Reproductive system damage (iii) Nervous system damage (including brain dysfunction and altered neurophysical behaviors)
Oxides of Nitrogen (NO _x)	(i) Increased risk of viral infections (ii) Lung irritation (including pulmonary fibrosis and emphysema) (iii) Higher respiratory illness rates (iv) Airway resistance (v) Chest tightness and discomfort (vi) Eye burning (vii) Headache
Ozone (O ₃)	(i) Respiratory system damage (lung damage from free radicals) (ii) Reduces mental activity (iii) Damage to cell lining (especially in nasal passage) (iv) Reduces effectiveness of the immune system (v) Headache (vi) Eye irritation (vii) Chest discomfort (viii) Breathing difficulties (ix) Chronic lung diseases (including asthma and emphysema) (x) Nausea
Sulphur dioxide (SO ₂)	(i) Aggravates heart and lung diseases (ii) Increases the risk for respiratory illness (including chronic bronchitis, asthma, pulmonary emphysema). (iii) Cancer (may not show for decades after exposure)
Respirable Particulate Matter (PM ₁₀)	(i) Respiratory illness (including chronic bronchitis, increased asthma attacks, pulmonary emphysema) (ii) Aggravates heart disease.

HEALTH EFFECTS OF AMBIENT AIR PARTICULATES

Respiratory Symptoms: The symptoms of the upper respiratory tract include stuffy or runny nose, sinusitis, sore throat, wet cough, hay fever and burning or red eyes. Symptoms of the lower respiratory system include wheezing, dry cough, phlegm, shortness of breath (dyspnoea), chest discomfort and pain.

Bronchitis: Increased particulate exposure enhances incidence of bronchitis in exposed population. Acute bronchitis and bronchiolitis may be misdiagnosed as asthma, and may get further complicated in the people with myocardial infarction and increased left arterial pressure. Bronchiolitis or pneumonia induced by air pollution in the presence of pre-existing heart problems might precipitate congestive heart failure and cardiovascular mortality.

Pneumoconiosis: Certain respirable dust causes group of diseases that lead to appreciable fibrotic changes in the lung.

Cancer: Certain airborne particles like arsenic and its compounds, chromates, particles bearing PAHs, nickel-bearing and radioactive particles may act on lung tissue and cause carcinoma. They may be transported from lung to other parts of the body, if the inhaled particles are soluble carcinogens.

A study conducted in the United States during 1994 indicates that increase in PM₁₀ (particles less than 10 micron diameter) by 10 mg/m³ on daily basis results in increase in mortality rate by 10-3.2%. The corresponding increase in hospital admissions is 2%. United Kingdom study concludes that PM₁₀ contributes to 1.9% mortality and additional hospital admissions. In another study, it was found that the total mortality is observed to increase by approximately 1.0% per mg/m³ of PM₁₀, while about 1% cardiovascular mortality has been observed per 10 mg/m³ increase in PM₁₀. The hospital admissions and emergency department visit increase by 0.8% and 1.0% per 10 mg/m³ increase of PM₁₀ respectively.

SULPHUR DIOXIDE AND ITS HEALTH EFFECTS

Sulphur dioxide (SO₂) is a colourless gas readily soluble in water. Natural sources such as sulphur bacteria activities, volcanoes, forest fires and contribute to environmental levels of SO₂. Man made contributions include the use of sulphur containing fuels for transportation, domestic purposes and power generation. There is greater interest, with respect to outdoor air quality are effects

health, of the lower concentration to which human beings may be exposed in the ambient air. The effects have been studied in a number of different ways, including exposure of volunteers to sulphur dioxide in the air, which they breath and by examination of effects on members of the population who have been exposed to episodes of atmospheric pollution.

Sulphur dioxide caused its irritant effects by stimulating nerves in the lining of the nose, throat and the lung airways. This later affects the people suffering from asthma and chronic lung disease, whose airways get inflamed and easily irritated. Studies of normal healthy volunteers, exposed to sulphur dioxide in chambers have shown that measurable narrowing of the airways may occur after breathing the gas for 5 minutes at concentration of 4-5 ppm but the effects were not detectable at concentrations below 1ppm. The most common acute exposure to SO₂ concentrations ≥ 0.4 ppm is indication of bronchoconstriction in asthmatics after exposure lasting only 5 minute. The effects of SO₂ on airway of asthmatics are reversible with recovery occurring within one hour. Exposure at lower levels can cause increased upper respiratory symptoms such as cough, sore throat and changes in lung function. The morbidity effects are associated with longterm exposure to particulates and or sulphur dioxide. The acidic aerosols composed of particulate matter and acids cause inflammation of airways and lungs and reduce the ability of small airways to clear mucous and particles. The health morbidity indices are lung function decrement, upper and lower respiratory disease symptoms, increase in rates for cough, bronchitis and other health problems.

NITROGEN DIOXIDE AND ITS HEALTH EFFECTS

Oxides of nitrogen are released in all the types of combustion as they are formed by the oxidation of atmospheric nitrogen at high temperature. Nitric oxide usually emitted from the automobile exhaust is oxidized to nitrogen dioxide (NO₂) by reaction with oxidants (Prominently ozone) present in the ambient air. Nitrogen dioxide is a reddish brown gas with a characteristic pungent odour. It is corrosive and a strong oxidizing agent.

Nitrogen dioxide is the predecessor of gaseous nitric acid and nitrate aerosols, which has the biggest health impact. The major sources of NO₂ are combustion-associated processes, such as motor vehicles, power plants as well as any high temperature combustion process used in industrial work. Oxides of nitrogen particularly nitrogen dioxide are toxic gases. The uptake of these gases in human body occur during breathing. Large percentage of inhaled NO₂ is removed in the respiratory tract, which depend on mode of breathing, ventilation rate, increased penetration of NO₂ to lower respiratory tract. Some of the major health effects of NO₂ exposure are as follows:

Airway Reactivity and Pulmonary Effects

Nitrogen dioxide exposure can cause decrement in lung function (i.e. increased airway resistance), increased airway responsiveness to broncho-constrictions in healthy subjects at concentration exceeding 1ppm. Below 1 ppm level, there are evidences of change in lung volume, flow volume, characteristics of lung or airway resistance in healthy persons. It has been established that continuous exposure with as little as 0.1 ppm NO₂ over a period of one to three years, increase incidence of bronchitis, emphysema and have adverse effect on lung performance.

Respiratory Morbidity in Children

The dysfunction of host defence, increased susceptibility to infections at generally caused due to affects on muco-ciliary clearance, functional and bio-chemical activity of alveolar macrophages and immunological competence. Exposure to excessive NO₂, affect the defence mechanism leaving the host susceptible to respiratory illness.

Chronic Lung Disease

Nitrogen dioxide exposure may lead to chronic lung disease and Variety of structural/monopological changes in lung epithelium conducting airways and air-gas exchange region. Exposure to high levels (>1.0 ppm) of NO₂ cause estuation of bronchiolar and alveolar epithelium, inflammation of epithelium an definite emphysema.

MAJOR AIR POLLUTION RELATED DISEASES IN INDIA

- (1) **ACUTE RESPIRATORY DISEASE:**
12% of Deaths; 13% of NBD. Largest fraction in the world, Indian AIR in children alone under 5 is responsible for more than 2% of entire GBD
- (2) **CHRONIC OBSTRUCTIVE PULMONARY DISEASE (COPD):**
1.5% of Deaths; 0.9% of NBD
- (3) **LUNG CANCER:**
0.4% of Deaths; 0.1% NBD
- (4) **ASTHMA:**
0.2% of Deaths; 0.5% of NBD
- (5) **TUBERCULOSIS:**
8% of Deaths; 5% of NBD; Largest in the world.
- (6) **PERINATAL:**
6% of Deaths; 7.5% of NBD; Largest in the world.
- (7) **CARDIO VASCULAR DISEASE:**
17% of Deaths; 5% of NBD
- (8) **BLINDNESS:**
0% of Deaths; 1% of NBD; largest in the world. NBD/GBD; National/Global Burden of Disease

Source: Kirk Smith, Proceedings of the Second Fogarty Indo-U's Workshop on Diesel Particles, Oct-2000.

Effects on immune system and Host Defence

Nitrogen dioxide in large doses can result in dysfunction of host defences by causing structural alteration in ciliated mucociliary escalator, in alveolar macrophages, decrease in phagocytosis, morphological and metabolic changes. The respiratory tract provide first time protective barrier against inhaled, viable and non-viable airborne agent. Breaches in defence system might increase the risk of diseases.

COMMON RESPIRATORY DISEASES RELATED TO AIR POLLUTION

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) which encompasses chronic bronchitis and emphysema is one of the commonest respiratory disease. In the western world, COPD is probably the fourth commonest cause of death in middle aged to elderly men after ischemic heart disease,

lung cancer and cardiovascular disease. Accordingly to Dutch Hypothesis; asthma, emphysema and chronic bronchitis are different manifestations of a single disease.

Bronchitis

Bronchitis is a type of swelling in the bronchial tubes which are the air passages leading from the windpipe to the lungs. When these passages become clogged with thick mucus that prevent air from flowing freely to and from the lungs the body's natural reflex is to try to cough up this mucus to clear the airways.

Acute Bronchitis

Acute bronchitis is usually a short, serene illness that may show up along with cold or follow other viral infections such as measles or whooping cough.

Chronic Bronchitis

Chronic bronchitis is a long term; serious condition characterized by frequent coughing and mucus production and often happens along with another lung disease called emphysema. In severe cases, when the bronchial tubes become narrowed and clogged with mucous, the resulting lack of oxygen in the blood may give the skin a bluish colour.

Emphysema

Emphysema is a condition in which there is over inflation of structure in the lungs known as alveoli or air sacs. This over inflation results from a breakdown of the walls of the alveoli, which causes a decrease in respiratory function and often breathlessness. Early symptoms of emphysema include shortness of breath and cancer.

Emphysema begins with the destruction of air sacs (alveoli) in the lungs where oxygen from the air is exchanged for carbon dioxide in the blood. The walls of the air sacs are thin and fragile. Damage to the air sacs is irreversible and results in permanent "holes" in the tissues of the lower lungs. As air sacs are destroyed the lungs are able to transfer less and less oxygen to the bloodstream, causing shortness of breath. The lungs also lose their elasticity. Emphysema doesn't develop suddenly, it comes on very gradually, and years of exposure to the air pollutants or cigarette smoke usually precede the development of emphysema.

INDOOR AIR POLLUTION:

There are four principal sources of pollutants in indoor air viz. combustion, building material, the ground under the building and biological agents. As dangerous as polluted outdoor air can be to health, indoor air pollutants can pose even a greater health risk. Indoor air pollution is a concern where energy efficiency improvements sometimes makes the house relatively air tight thereby reducing ventilation and raising indoor pollutant levels. Indoor air pollution is usually associated with occupational situation particularly through combustion of biomass fuels. The greatest threat of indoor pollution exists where the people continue to rely on traditional fuels for cooking and heating. Burning such fuels produces large amounts of

smoke and other air pollutants in the confined space of hot a perfect recipe for high exposures. Liquid and gaseous fuels such as kerosene and bottled gas although not completely pollution free is many times less polluting than unprocessed solid fuels. In these circumstances, exposure to pollutant often far higher indoors than outdoors. The health problems due to indoor air pollutants are more widespread than those caused by outdoor air pollutants for the following reasons.

- The exposed persons are in close proximity to the source of indoor air pollutants.
- A recent report of WHO asserts 'the rule of 1000' which states that a pollutant released indoors is one thousand times more likely to reach the lungs than pollutant released outdoors.
- Women and children, particularly those in rural sector spend more time indoors than outdoors.
- In rural areas, indoor air pollution is responsible for more greater mortality than ambient air pollution.

Epidemiological studies have linked exposure to indoor pollution from dirty fuels with at least four major categories of illness. These are:

- Acute respiratory infections (ARI) in children
- Chronic obstructive pulmonary disease (COPD) such as asthma and bronchitis;
- Lung cancer and
- Pregnancy related problems. Of these, ARI appears to have the greatest health impact in terms of the number of people affected.

Traditional biomass fuels amount for 80% of domestic energy consumption in our country. When these fuels are burnt in simple cook stoves during meal preparation, air inside hot gets heavily polluted with smoke that contains large amount of toxic pollutants such as carbon monoxide, oxides of nitrogen (NOx), sulphur dioxide (SO₂), aldehydes, dioxins, polycyclic aromatic hydrocarbons and respirable particulate matter. These resulting human exposures exceed the permissible norms by a factor in multiples.

Table 1. Annual Deaths Due To Air Pollution in Urban and Rural Areas:

Region	Urban outdoors	Urban Indoors	Rural Indoors	Total
Developed Countries	14 (0%)	252(8.4)	28 (0.9)	294 (9.8)
Developing Countries	186 (6.2)	644 (21.5)	1876 (62.5)	2706 (90.2)
Total	200 (6.7)	896 (29.9)	1904(63.5)	3000(100)

B. WATER QUALITY MONITORING

The Central Pollution Control Board, Delhi initiated the National Water Quality Monitoring Programme to consistently monitor the water quality in a systematic manner to know the nature and extent of water quality degradations and the existing quality of water in the water bodies. The national programme is also termed as Monitoring of Indian National Aquatic Resources MINARS.

The major objectives of Water quality monitoring are:

- To warrant appropriate pollution control on the discharge reaching the water bodies.
- To identify any deficiency in the water quality and to implement water pollution control strategies.
- To determine affect of water quality the intensity and exposure of various pollution on human health.
- To determine long term trends in water quality.

Primary water Quality Criteria

Designated Best Use	Nomenclature (class of water)	Primary Water Quality Criteria
1	2	3
Drinking water source Without Conventional Treatment But After Disinfection	A	6.5 to 8.5 (1); 6 or more (2); 2 or less (3); 50, 5% - 200, and 20% - 50 (4); Nil (5); Nil (6); Nil (7); and Nil (8)
Outdoor Bathing (organised)	B	6.5 to 8.5 (1); 5 or more (2); 3 or less (3); 500, 5%-2000, and 20%-500 (4); Nil (5); Nil (6); Nil (7); and Nil (8)
Drinking Water Source With Conventional Treatment Followed by Disinfection	C	6.5 to 8.5 (1); 4 or more (2); 3 or less (3); 5000, 5%-20000; and 20%-5000 (4); Nil (5); Nil (6); Nil (7); and Nil (8)
Propagation of Wildlife and Fisheries	D	6.5 to 8.5 (1); 4 or more (2); Nil (3); Nil (4); 1.2 (5); Nil (6); Nil (7); and Nil (8)
Irrigation, Industrial Cooling and Controlled Water Disposal	E	6.0 to 8.5 (1); Nil (2); Nil (3); Nil (4); Nil (5); 2250 (6); 26 (7); and 2 (8)

(1) pH; (2) Dissolved Oxygen, mg/l (3) BOD (20°C), mg/l; (4) if, MPN/100 ml count exceeds P then regular tests should be conducted in which 5% of sample shall not exceed Q and 20% of sample shall not exceed P; (5) Free Ammonia, mg/l; (6) Electrical Conductivity in μ mhos/cm at 20°C; (7) Sodium Absorption Ratio 26 or less; and (8) Boron, mg/l.

MINARS

Under the MINARS programme the State Pollution Control Board, Sikkim collects water samples from River Teesta and its tributaries at nine stations. This programme is totally funded by Central Pollution Control Board. The details of sampling Stations are as follows:

ESTABLISHMENT OF NEW WATER QUALITY MONITORING STATIONS BY STATE POLLUTION CONTROL BOARD, SIKKIM, UNDER MINARS.

Sl. No. (station code)	Name of Station	Location (Latitude & Longitude)
1.	Chungthang (1801)	Lat.88°39'0" Long. 27°36'0"
2.	Dikchu (1802)	Lat.88°31'30" Long. 27°23'44"
3.	Burtuk (1803)	Lat. 88°31'30" Long. 27°21'30"
4.	Adampool (1804)	Lat. 88°35'15" Long. 27°18'30"
5.	Ranipool (1805)	Lat. 88°35'45" Long. 27°17'15"
6.	Singtam (1806)	Lat. 88°29'45" Long. 27°13'45"
7.	Singtam D.S (1807)	Lat. 88°29'44" Long. 27°13'44"
8.	Rangpo (1808)	Lat. 88°31'45" Long. 27°10'8"
9.	Melli (1809)	Lat. 88°37'30" Long. 27°5'15"

PARAMETERS AND THEIR METHODS OF DETERMINATION

1.	Temperature	Thermometric method
2.	pH	Electrometric method
3.	Turbidity	Nephelometric method
4.	Velocity of flow	1) Current method 2) Float method 3) Chemical method
5.	Dissolved Oxygen	Iodometric method
6.	Bio-chemical Oxygen Demand	Dilution method
7.	Total Kjeldahl Nitrogen	a) Digestion b) Distillation c) Ammonia estimation i) Titration method (> 5mg/l) ii) Nesslerization Method (< 5 mg/l)
8.	Nitrogen, nitrate + nitrite	Amalgamated Cadmium Reduction method for reduction of nitrate to nitrite by diazotisation method.
9.	Total Coliform (MPN)	Multiple Tube Dilution technique.
10.	Faecal Coliform (MPN)	Multiple Tube Dilution technique.
11.	Conductivity	Conductometric method
12.	Chloride*	i) Argentometric method ii) Mercurimetric method
13.	Hardness	EDTA Titrimetric method
14.	Calcium	EDTA Titrimetric method
15.	Magnesium	By difference of 13 & 14
16.	Alkalinity	i.) Electrometric method ii) Visual titration method.
17.	Sulphate**	Turbidimetric method
18.	Sodium	Flame Photometric method
19.	Chemical Oxygen Demand	Dichromate reflux method
20.	Chemical Dissolved Solids & Fixed Dissolved Solids	Gravimetric method.
21.	Phosphate	Molybdate method (Colorimetry)
22.	Boron	Curcume method (Colorimetry)

* Argentometric method has been given first preference but if the colour of the sample interferes with the chromate end point then mercurimetric method should be used.

** Usually sulphate concentration is low in surface waters and hence gravimetric method may not be accurate as turbidimetric method, therefore, turbidimetric method is suggested.

Note: Whenever more than one methods are given, they are in order of preference.

WATER QUALITY OF LAKES:

Sikkim is bestowed with abundant hydrological resources primarily because of its geomorphology and its location in the Eastern Himalayas. The Himalayas obstruct the rain bearing winds of the south-west monsoon resulting the Himalayas to receive annual rainfall which ranks as the highest in the world, making the Himalayas a source of a large number of mighty rivers perennial streams and snow cover mountains.

The geomorphological conditions providing high amount of rainfall has gifted the state of Sikkim with abundant wetlands. The state presents a picturesque panorama of about 150 lakes situated at different altitudes with varying shape, size and depth. Most of the lakes are regarded highly sacred and attract a large number of tourist and pilgrims.

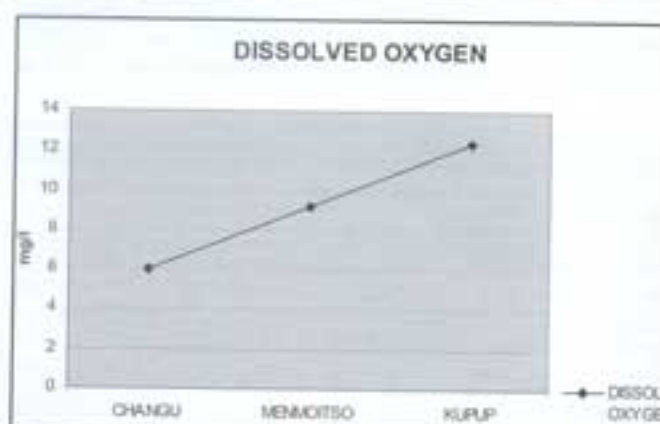
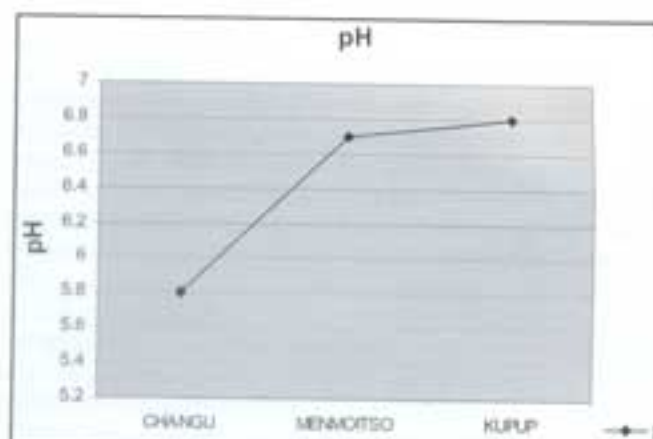
Of all the Lakes of Sikkim the study on the Environment status of the three revered lakes of East Sikkim, Viz., Changu, Menmoitso, & Kupuk Lakes have been carried out under the Central sponsored scheme Prevention & Abatement of Pollution. The Changu, Menmoitso, Kupuk Lakes are regarded as extremely sacred & are places of Tourist interest besides military base is situated in their vicinity. These lakes form an important stopover for various ducks besides being home to resident brahminy ducks (*Tringoides ferruginea*). These lakes also form the habitat for introduced browntrout (*Salmo trutta*).

The scenic beauty and sanctity of these holy lakes have been drawing large number of tourists and pilgrims. There is heavy movement of different vehicles and also there is biotic interference. Keeping these activities in mind the study was conducted to assess the status of these fragile eco-systems, which fall under the category of high altitude lakes as all of them lie 2500 mtr. above mean sea level belonging to the category of wetland type 14 according to Directory of Indian wetlands 1993. Classification.

Comparative Water analysis of lakes is shown in the following table:

Comparative Study of Physico- Chemical parameters of Three lakes

Sl. no	Parameters	CHANGU		MENMOITSO		KUPUP	
		Ave	Range	Ave	Range	Ave	Range
1	pH	5.8	5.0-6.4	6.7	6.1-7.4	6.8	6.1-7.2
2	Dissolved Oxygen (mg/l)	6.00	3.7-8.6	9.2	6.1-14.1	12.41	7.6-8.2
3	Calcium mg/l	1.57	.890-2.125	1.890	1.025-2.225	1.73	1.00-3.00
4	Sodium mg/l	0.011	0.003-0.022	0.012	0.002-0.037	0.013	0.002-0.023
5	Potassium mg/l	0.023	0.002-0.132	0.069	0.016-0.146	0.039	0.009-0.146
6	Nitrate mg/l	0.966	0.911-1.4	1.290	0.900-2.025	1.08	0.750-1.475
7	Phosphate mg/l	1.023	0.113-1.720	0.750	0.250-1.025	1.67	0.500-1.800
8	B.O.D mg/l	13.90	8.6-18.6	7.00	4.6-9.2	4.98	6-7.2
9	C.O.D mg/l	56.58	23.1-90.4	27.37	16.10-14.20	34.69	22.5-47.2
10	Total Solid mg/l	484.80	270.1-673.4	328.90	142.10-473.8	299.8	255.9-298
11	Total Kjeldahl Nitrogen mg/l	0.021	0.011-0.037	0.018	0.006-0.025	0.029	0.015-0.050
12	Sulphate mg/l	ND	ND	ND	ND	ND	ND
13	Water Temperature °C	3.9°C	2°C-6°C	6.1°C	3°C-8°C	3.4°C	2°C-4°C
14	Air Temp °C	9.7°C	3°C-14°C	5.7°C	1°C-9°C	-	1°C-8°C



B.O.D



COMPARATIVE STUDY OF THE THREE LAKES

Table shows comparative study of physico-chemical parameters of three lakes namely Changu, Menmoitso and Kupup.

pH- The annual average pH of Changu was lowest with 5.8 compared to Menmoitso and Kupup which had approximately the same value in average. Lower pH value in Changu may be attributed to religious offerings and the impact of flow of tourists during tourist season whereas in Menmoitso and Kupup flow of tourist is comparatively low.

Dissolved oxygen: The highest annual average of dissolved oxygen was observed at Kupup with 12.41 mg/l and the lowest D.O. at Changu with 6.00 mg/l. The low D.O. Value of Changu shows the tendency towards eutrophic condition of the lake. In all the sites D.O. content shows a marked seasonality with oxygen levels decreasing during winter months which might be due to cumulative influence of low insolation, low temperature, over turn of lake water and minimal photo synthetic activity.

Calcium, sodium, Potassium, Nitrate and Phosphate values are approximately same in all the study sites. The average calcium value of Changu was 1.57 mg/l as that of 1.890 mg/l in Menmoitso and 1.73 mg/l in Kupup. It has been found that calcium concentration increased from summer to winter. Phosphate concentration was highest in Kupup with 1.67 mg/l in average whereas in Menmoitso mg/l and 1.023 mg/l in Changu.

B.O.D & C.O.D: The annual average B.O.D. value of Changu was 13.9 mg/l which is comparatively higher than other two study sites. Menmoitso shows 7.00 mg/l whereas lowest B.O.D. value was observed in Kupup with 4.98 mg/l. More or less the same pattern was followed by C.O.D. Changu showed C.O.D. 56.5 mg/l followed by Kupup 34.6 mg/l and Menmoitso 27.2 mg/l. Maximum values of B.O.D and C.O.D. was observed during rainy season which may be due to heavy input of Variety of nutrients along with eroded material and prevalence of favourable environmental conditions for microbial activities. The highest total solids was found in Changu with 484.8 mg/l followed by Menmoitso 328.9 mg/l and Kupup 299.8mg/l. Total Kjeldal Nitrogen was approximately same at all sites. The higher B.O.D. & C.O.D. values infer to the pollution potential. Thus it can be inferred that Changu lake has suffered undesirable change than the other two lakes.

Drinking Water:

The surveillance and monitoring of water and waste water quality is very important to evaluate their adverse effect on human health and surrounding environment. The available water may be unfit for drinking purpose due to chemical and micro-biological contaminations and therefore apart from MINARS the SPCB, Sikkim monitors drinking water of Gangtok along with water quality of some high altitude lakes and hot waste springs and water quality of streams encompassing Gangtok town.

The drinking water source of Gangtok is Tamzey at an altitude of 14,000ft. above mean sea level. The Public Health Engineering Department supplies and maintains the drinkingwater supply to Gangtok. The water from the source Tamzey is stored at 10th & 4th mile Rateychu tank and before distribution it is stored and chlorinated at salap tank (6000 ft.). From this storage and chlorination point water is distributed to Gangtok as per the detailed network.

Details of water supply distribution lines at Gangtok.

From Selep to Enchey- 6" dia G.I. Line 4 nos and 8" dia C.I. line
From Enchey 2" dia G.I. line to Cottage industries.

21/2"	.....do.....	Tathangchen
3"	.....do.....	Kazi Road.
3"	.....do.....	Palace Tank.
3"	.....do.....	T.N.A. Tank
21/2"	.....do.....	Tathangchen
21/2"	.....do.....	Kazi Road.
2"	.....do.....	Old Secretariat.
2"	.....do.....	Community Hall.
21/2"	.....do.....	Sichey tank.
21/2"	.....do.....	Development Area.
4"	.....do.....	Fire line to Bazar area
4"	.....do.....	Housing tank.
2"	.....do.....	Paljor stadium.
4"	.....do.....	Press tank.
4"	.....do.....	Bazar tank.
2"	.....do.....	Old Post office
11/2"	.....do.....	Palace
21/2"	.....do.....	Chandmari.

6" C.I. Line to 90,000 gallon tank at Chorten.

6" C.I. Line to Nam Nam and Lal Market.

4" C.I. .. Arithang

6" G.I. .. Bazar zone tank and old market.

4" G.I. .. Nirman Bhawan.

6" G.I. .. to 55,000 gallon tank above point

4" G.I. .. Bazar zone.

From Bazar zone tank.

6" G.I. line to M.G. Marg. carpark. Old market, Tibet Road.

21/2" G.I. line Hospital reservoir line.

2" G.I. Line hospital.

11/2" G.I. line Police barrack.

2" G.I. line Tibet Road.

3" G.I. line old market

21/2" Ring line for bazaar.

21/2 G.I. line at old west point school and arithang

3" G.I. High Court tank.

From High Court tank.

3" G.I. line D.P.H.S. P.N.G.H. School

21/2 G.I. line Norkhill hotel

2" G.I. line Post office and Tibet road.

From old selep 11/2

G.I. line Girl's School

Tank 1,00,000.

Gallons.

21/2" dia G.I. Line to Raj Bhawan.

2" dia G.I. line S.S.B. Office

2" dia G.I. line below CPED Office.

21/2 dia G.I. line to SIB Office and quarters.

1" dia G.I. line to Botanical office and quarters.

11/2 dia G.I. line P & T quarters

3" dia G.I. line to sona tank.

From Palace tank (above Mintokgang).

1" dia G.I. line to Mintokgang.

21/2 dia G.I. line to Tathangchen.

21/2" dia G.I. Line to Police barrack.

1" dia G.I. line to C.O. bungalow (below D.G.P. bungalow)

2" dia G.I. line to Kazi Road (old).

	2" dia G.I. to Bulbuley line (Below Bhanu path)	
	21/2 dia G.I. line to Post Office and diesel power area.	
	2" dia G.I. line to near secretariat (Annexure Building)	
	11/4" dia G.I. line Yatayat Bhawan.	
Post Office tank.	11/2" dia G.I. line to T.N.A Quarter.	
	2" dia G.I. to below Nirman Bhawan and Chetry building.	
	21/2 dia G.I. line to Old Post Office quarter.	
	2" dia G.I. line to Sangram Hall area.	
	2" dia G.I. line to old assembly area.	
	2" dia G.I. line to T.N.A hostel and school.	
G.I.C.I Tank.	11/2" dia G.I. line to Cottage industry.	
	2" dia G.I. to Sangram hall and development area.	
	1" dia G.I. line to Assembly area (Old)	
55,000 galls tank (above 'o' Point).	6" dia G.I. line to development area upto TNHS School.	
Sichey tank	11/2" dia G.I. line to cooperative area.	
	11/2" dia G.I. line to Rai gaon.	
From Sona tank.	1" dia G.I. line to T.N.H.S area.	
	1" dia G.I. line to Chief Justice bungalow area.	
	11/2 dia G.I. line to T.N.H.S School.	
From 45,000 galls tank.	6" dia G.I. line to 3,00,000 galls tank at Development Area.	
From upper Development area.	11/2" dia G.I. Line to Mandar Hotel area.	
	11/2" dia G.I. line to Puspa garage area at development area.	
	2" dia G.I. line to Fire line at Development area.	
	1" dia G.I. to G.I.C.I quarters.	
From press tank.	3" dia G.I. line to Deorali tank.	
	11/2" dia G.I. line at Nam Nam.	
	11/2" dia G.I. line at Chorsten.	
	2" dia G.I. line to Housing tank.	
	2" dia G.I. to Pani house.	
From Deorali tank.	6" dia G.I. line to 90,000 gall tank at Chorsten.	
	4" dia G.I. line to Deorali Bazar.	
	4" dia G.I. line to STCS.	
	4" dia G.I. line to Syari.	
	2" dia G.I. line to housing tank.	
	2" dia G.I. line to Syari Govt. Quarter.	
	2" dia G.I. line to Gaito gaon.	
	21/2" dia G.I. line to below Deorali school road.	
	11/2" dia G.I. to A.G. Quarter.	
	11/2" dia G.I. to Deorali Bazar.	
	11/2" dia G.I. to Vety. Area complex.	
	11/2" dia G.I. to Dairy farm.	
	11/2" dia G.I. to Housing tank.	
Form 90,000 gall on tank Chorsten.	3" dia G.I. line to Army cantt.	
	4" dia G.I. line to C.R.H.	
	4" dia G.I. line to Defence Auditorium area.	
	4" dia G.I. line to Ando Gofai.	
	11/2" dia G.I. line to 5 th mile Tadong.	
	6" dia G.I. line to Housing tank.	
Housing tank to	2" dia G.I. ring line.	
	2" dia G.I. line to Bahai School area.	
	2" dia G.I. to Housing Board.	
	11/2" dia G.I. to SNT Colony.	
	11/2" dia G.I. to Vety. Area complex.	
	11/2" dia G.I. to SNT Colony.	
	1" dia G.I. line to Jewels.	
	1" dia G.I. to Holy Cross.	
	6" dia G.I. line to Upper and lower Tadong.	
	4" dia G.I. to Bhai School road line.	
From Bye-pass line of housing tank.	11/2" dia G.I. to ring line.	
	11/2" dia G.I. to ring line.	
	11/2" dia G.I. to Bhai School line.	
	11/2" dia G.I. line to housing line.	
	11/4 Dia G.I line to Bhai school.	
The main trunk lines from Ratychu to selep treatment plant are as under:-		
14" partial C.I and partial G.I. line	1no.	
8" C.I. line	1 no.	
6" G.I line	3 nos.	

Drinking Water quality

The drinking water has direct impact on human health and considering this fact regular monitoring of water is carried out at different points.

Emphasis is given on the analysis of physico-chemical and micro-biological parameters, as the surface sources are prone to biological contamination resulting in the prevalence of water borne diseases caused by contamination of bacteria, amoeba, viruses or various worms.

Characteristics of Drinking Water

Sl. No.	Parameter	Unit	IS 10500-1983	
			Limit	Relaxation allowed if alternate sources are not available
1.	Colour	Hazen, max.	10	
2.	Odour		Unobjectionable	
3.	Taste		Agreeable	
4.	Turbidity	NTU, max.	10	25
5.	Dissolved solids	mg/l, max.	500	3000
6.	pH	6.5 to 8.5	9.2	39
7.	Total hardness (as CaCO ₃)	mg/l, max	300	600
8.	Calcium (as Ca)	"	75	200
9.	Magnesium (as Mg)	"	30	100
10.	Copper (as Cu)	"	0.05	1.5
11.	Iron (as Fe)	"	0.3	1
12.	Manganese (as Mn)	"	0.1	0.5
13.	Chlorides (as Cl)	"	250	1000
14.	Sulphates (as Co ₃)	"	150	400
	(provided magnesium (as Mg) does not exceed 30)			
15.	Nitrates (as NO ₃)	"	45	-
16.	Fluorides (as F)	"	0.6 to 1.20	1.5
17.	Phenolic compounds as C ₆ H ₅ OH	"	0.001	0.002
18.	Mercury (as Hg)	"	0.001	-
19.	Cadmium (as Cd)	"	0.01	-
20.	Selenium (as Se)	"	0.01	-
21.	Arsenic (as As)	"	0.05	-
22.	Cyanides (as CN)	"	0.05	-
23.	Lead (as Pb)	"	0.1	-
24.	Zinc (as Zn)	"	5	-
25.	Anionic detergents (as MBAS)	"	0.2	-
26.	Hexavalent chromium (as Cr ⁶⁺)	"	0.05	-
27.	Mineral oil	"	0.01	0.03
28.	Residual free chlorine	mg/l, min.	0.02	-
29.	Pesticides		absent	
30.	Radioactive materials			
	Alpha emitters	µCi/ml, max.	10 ⁶	
	Beta emitters	"	10 ⁷	

Drinking water quality

Water is the fundamental basis of life. The drinking water has a direct impact on human health and considering this fact the regular monitoring of drinking water supplied to Gangtok town at different localities reveals the following facts. A detail study under taken by Pollution Control Board assesses the quality of the urban water supply network. As a very little work has been carried out on the water quality of the other parts of the State hence the information's provided under are based on the detail study of the water quality of the capital town only.

Drinking water is supplied to Gangtok town by the Public Health and Engineering Department. The source of drinking water is at Tamzey at an altitude of 14,000ft. above mean sea

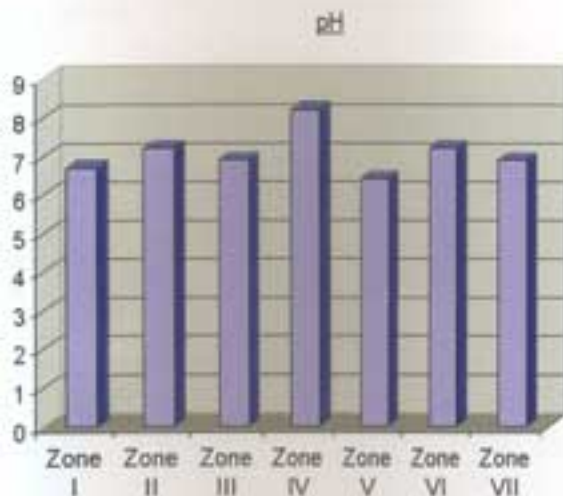
level. An army base camp is also situated besides this stream. The water from Tamzey is stored at 10th mile and 4th mile Rateychu tanks and before distribution it is stored at Salep tank(6,000ft.) where chlorination takes place after which the water is supplied through pipeline network to different parts of the capital town Gangtok.

The water quality is under continuous monitoring at various points from where it is used for consumption and for this purpose seven localities have been identified by SPCB which are designated as follows:

- Zone1: Deorali: (Syari, Panihouse, Deorali bazaar).
 Zone2: Lall Market(Lall market, Sundari gaon, Old Secretariat, Bishal gaon).
 Zone3: New Market:(Nam Nang, New Market area and Kazi Road).
 Zone 4: Old Market:(Arithang, Old Market area and Kazi Road).
 Zone5: Hospital Point:(Hospital complex, Diesel Power House, Palzor Stadium complex).
 Zone6: Development Area:(Residential area, TNHS Road, Shopping complex).
 Zone7: Balwakhani Area (Vajra complex, Forest Colony, P&T Colony, Zero point area).

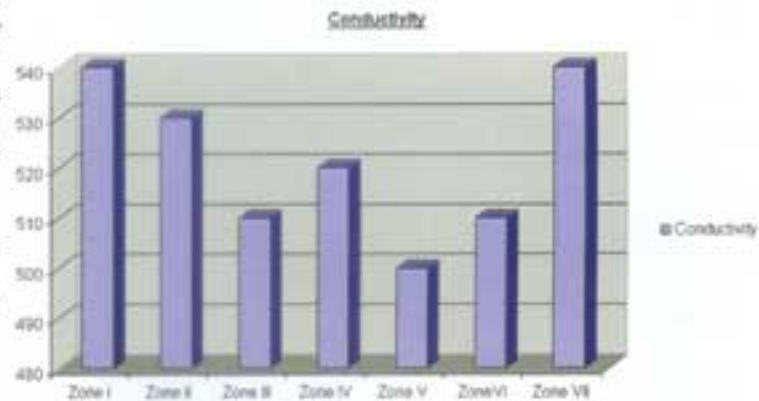
Drinking water samples are collected from the zones specified by State Pollution Control Board (SPCB). At least three samples are collected from each zones on weekly basis. The methodology for laboratory analyses of the parameters are adopted from the "Standard methods for Examination of water and waste water" 18th Edition 1992 prepared and published by American Public Health Association, American Water Works Association and Water Pollution Control Federation. The collected samples after necessary analysis in the water lab of SPCB reveals

PH
 pH is the negative logarithm of hydrogen ion concentration, pH is used to measure the alkalinity and acidity of water. The pH values of all the stations lie within the Indian standard of 6.5 to 8.5. The pH value is between 6.4 to 8.2. The zone V (Hospital point) shows minimal pH (6.4) whereas in zone IV (old market) pH is 8.2.



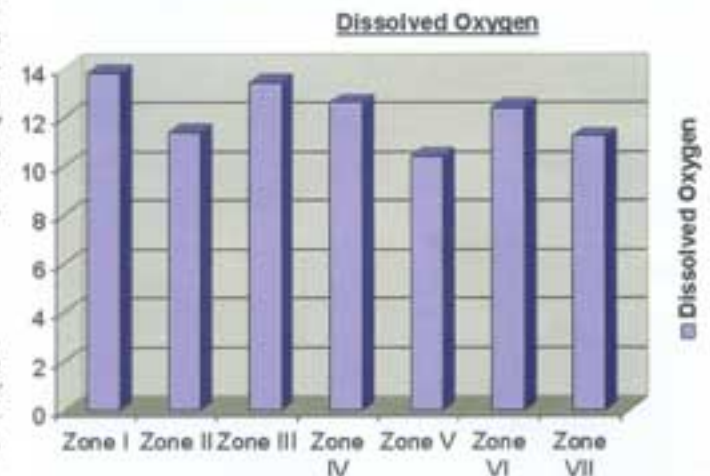
Conductivity

The highest conductivity of 540 umhos/cm² was observed at zone I and zone VII whereas zone V shows lowest.



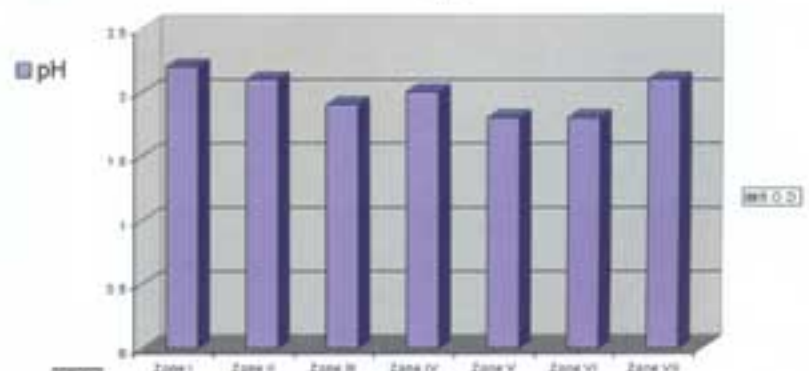
Dissolved Oxygen

The collected samples are analyzed within 24hrs of collection in lab. of SPCB. The lowest D.O value was recorded in 11.2 mg/ltr. at zone VI while the highest 13.4 mg/ltr. was observed at zone III. The dissolved oxygen of all the samples is above 6mg/ ltr. Which is the prescribed value.



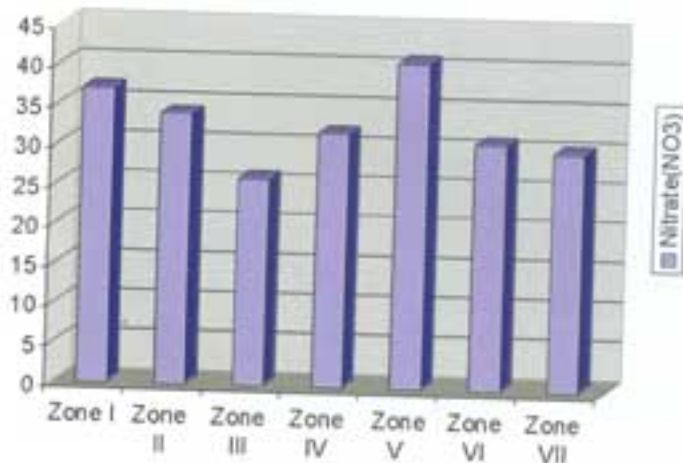
B.O.D (Biochemical Oxygen Demand)

The highest B.O.D value was found to be 2.2 mg/ltr.at zone I and lowest 1.8mg/ltr. at zone V & VI. Three study zones viz zone I, zone II and zone VII shows B.O.D value more than prescribed limit of 2mg/ltr. And other zone lie within the permissible limit. The quality of water is determined by B.O.D value, the higher the value of B.O.D worse the quality of water.



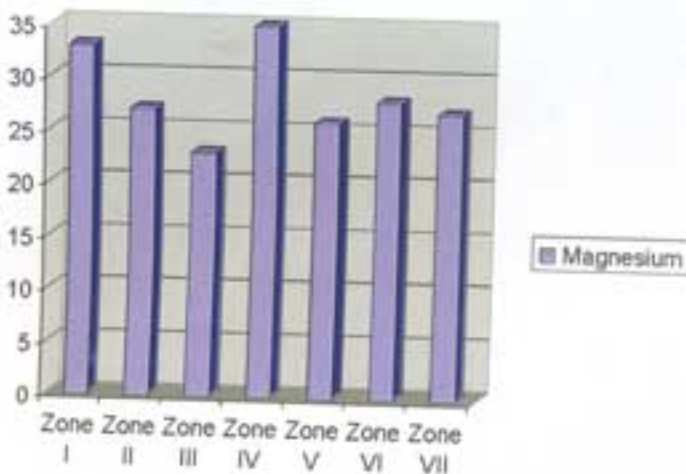
Nitrate (NO₃)

All the study zones show that the values of nitrate fall within the prescribed level of 45 mg/ltr. With the lowest nitrate value of 26 mg/ltr. at zone III and highest 41mg/ltr.at zone V.

Nitrate(NO₃)**Magnesium**

The national standard for Magnesium concentration is 30 mg/ltr. Two study zones viz zone I and zone IV shows concentration more than national standard whereas other zone lies below standard. The highest Mg-concentration of 35 mg/ltr. was recorded at zone IV while lowest 23mg/ltr. at zone III.

Magnesium

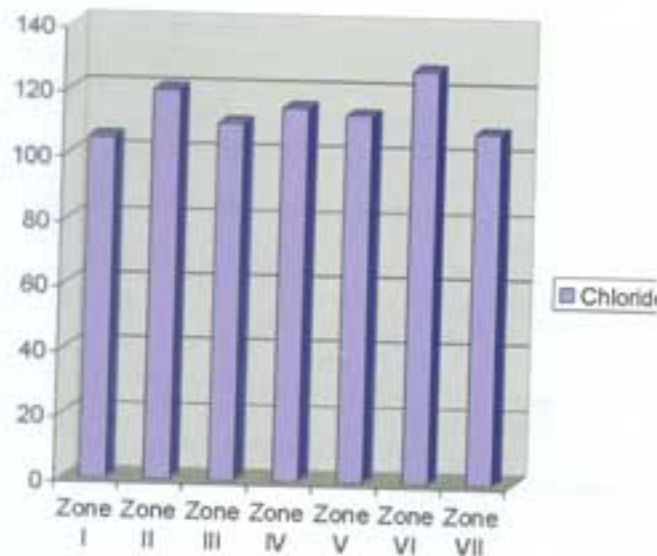
**Free CO₂**

The lowest free Co₂ was recorded at zone III with 0.7 mg/ltr.and highest 1.2 mg/ltr. At zone IV.

Chlorides (as chlorine)

The chlorides concentration in all the zones were below th national standard of 250 mg/ltr. The highest concentration o chloride was found to be 127mg/ltr at zone VI whereas th lowest was recorded at zone I with 105 mg/ltr.

Chlorides

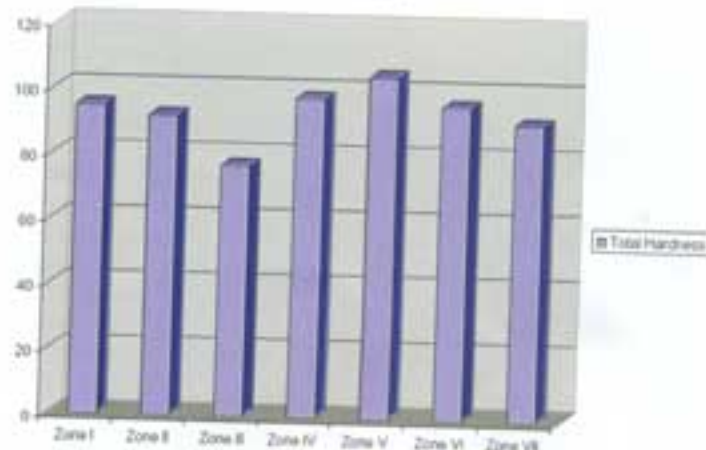
**Sulphate (SO₄)**

The highest Sulphate content was recorded at zone V (24mg/ltr.) while lowest value was observed at zone I (16mg/ltr.). The sulphate content of zone II, zone III, zone V, zone V, zone VI, Zone VII were found to be 19 mg/ltr. 18mg/ltr. 22 mg/ltr 24mg/ltr,18mg/ltr and 17 mg/ltr respectively.

Total Hardness (as CaCO₃)

The total hardness value of all the study zones lie within the prescribed national standard of 300 mg/ltr. With highest at zone V(105mg/ltr.) and lowest concentration of 77 mg/ltr.at zone III. In other study zones viz ; zone II, zone IV, zone VI, and zone VII, 95mg/ltr, 92mg/ltr., 98mg/ltr., 96mg/ltr., and 91mg/ltr. were observed respectively.

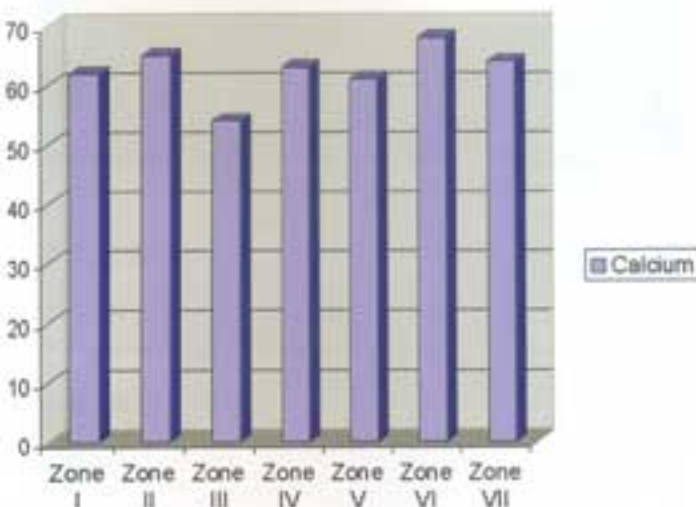
Total Hardness



Calcium as CaCO₃

The national standard for calcium is 75mg/ltr. In all the study zones the calcium concentration was found to be within the national standard. The highest calcium concentration with 68 mg/ltr. was recorded at zone VI and lowest concentration of 54 mg/ltr. at zone III.

Calcium

**T.D.S & T.S.S**

The national standard of total dissolved solids is 500mg/ltr. The total dissolved solids value is the highest in the zone VII with 43 mg/ltr. and lowest at zone III with total dissolved solids value of 26 mg/ltr.

Similarly, total suspended solids concentration lies highest at zone II, zone IV, zone VII with 104 mg/ltr. and lowest 1.1 mg/ltr. at zone I.

The analysis of drinking water of Gangtok town shows variation in concentration of some parameters in different study zones. This can be attributed to chances of leakage due to rusting and improper fitting of pipeline network passing through the drains.

STREAM/JHORA WATER QUALITY

A preliminary study on the water quality of streams and jhoras encompassing Gangtok was carried out in collaboration with the Department of Zoology, Sikkim Govt. College and the result of physico-chemical analysis is shown in the following tables.



Jhora Cleaning Drive

Source Name	Source	Scr.	Temp. (A) C	Temp. (W) C	pH	Cond	Sal.	Odr.	Cor.
Godkhan Jhora	Spring	12.10(gm)	13.5	12°C	5.3	650	0.5 %	Toxic	Blackish
Hospital Jhora	Spring	12.20(gm)	10.5	10°C	6.8	300	-	Toxic	Muddy
Paljor Stadium Jhora	Spring	12.10(gm)	17°C	14°C	5.5	200	-	Toxic	Yellowish
Fisheries Jhora	Spring	1.00(gm)	18°C	15°C	5.4	200	-	Toxic	Darkish
Rani Khola	Stream	1.35(gm)	19°C	12.5°C	6.1	60	5.3	-	Clear
Adam Pool Khola	Stream	3.10(gm)	19°C	17°C	6.3	100	5.3	Toxic	Muddy

CHEMICAL ANALYSIS

Source Name	Source	D.O	D.CO ²	Cl.	Alk	Ac.	Hard.
G.J	Spring	5.332	89.34	4.496	201.83	49.67	199.460
H.J	Spring	8.532	20.66	2.596	118.67	15.17	93.476
P.S.J	Spring	8.132	27.34	1.659	84.67	11.33	68.260
F.J	Spring	8.468	7.34	11.418	72.33	4.33	75.436
D.J	Spring	7.868	11.34	18.907	58.67	6.83	63.844
R.KH	Stream	8.468	4.34	6.624	16.33	1.33	14.164
A.KH.	Stream	6.868	9.34	8.269	20.67	5.33	12.884

PO ⁴	NO ³	SiO ⁴	T.S	T.D.S	T.S.S
67.101	0.0002	25.252	428.000	332.600	95.400
4.111	0.0154	18.499	455.200	384.200	71.000
7.921	0.013	11.601	240.200	202.000	38.200
6.542	0.009	10.997	104.360	83.700	20.660
4.195	0.010	12.952	23008.100	22629.500	378.600
0.248	0.001	13.720	563.000	455.600	107.400
2.431	0.003	131.940	531.600	302.200	229.400

METAL ANALYSIS

Source Name	Source	Ca	Mg	Fe	Na	K
G.J	Spring	38.613	ND	2.120	51.155	92.902
H.J	Spring	28.320	ND	0.008	35.478	57.322
P.S.J	Spring	22.709	ND	0.179	41.749	33.603
F.J	Spring	27.118	ND	0.024	37.046	37.556
D.J	Spring	24.713	ND	0.204	28.977	37.556
R.KH.	Stream	4.545	ND	0.139	13.036	9.883
A.KH.	Stream	8.954	ND	10.351	29.868	17.790

HOT SPRINGS OF SIKKIM.

The Himalayas is one of the largest geo-thermal areas of the world. The Himalayan belt is 150km wide, extending 3000 km through parts of Tibet, India, China, Myanmar and Thailand. It is the birth place of more than 1000 hot spring's.

Hot Spring

Sikkim is a part of Himalayan geo-thermal belt and is blessed with a number of Hot springs which are believed to have high medicinal values. These springs are believed to cure skin diseases, digestive disorder, rheumatism, leprosy etc.

The hot water spring of Sikkim are also considered to be a place of worship and are frequented by a large number of domestic and foreign visitors.

As a result of rapid increase in the flow of people in these hot springs, it is feared that the water quality of the springs may be deteriorating. Taking this factor into consideration the study of the Hot springs of Sikkim was carried out to assess the chemical composition of the hot springs water under the centrally funded scheme "Abatement of Pollution".

Under the scheme the hot springs viz. Legship Hot Spring, Yumthang Hot spring, Yume-samdong hot spring, Ralong Hot spring and Borong hot spring were studied.

COMPARATIVE STUDY OF THE HOT SPRINGS OF SIKKIM HIMALAYAS

Sl. no.	Parameters	Sampling Site				
		I	II	III	IV	V
1	Colour (Hazen Unit)	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5
2	Appearance	Clear	Clear	Clear	Clear	Clear
3	Turbidity (NTU)	22	20	15	20	16
4	Conductivity μ MHOS/cm	950	960	1000	1000	1020
5	Total Dissolved Solids (Dried at 105°C)	280	250	600	580	580
6	pH	8	8.2	8.5	8	7.6
7	Temperature at source °C	50	40	34	40	35
8	Temperature at bathing pool °C	45	38	32	38	34
9	Dissolved Oxygen mg/l	1.5	4	ND	ND	ND
10	Carbonate hardness as CaCO_3 mg/l	ND	ND	ND	ND	ND
11	Calcium Hardness as CaCO_3 mg/l	ND	ND	ND	ND	ND
12	Chlorides as Cl mg/l	7.2	7.0	3.5	3	8.0
13	Silica as SiO_2 mg/l	22	26	24	22	14
14	Chromium as Cr mg/l	ND	ND	ND	ND	ND
15	Fluorides as F mg/l	ND	ND	ND	ND	ND
16	Sodium as Na mg/l	40	44	81.6	85	100
17	Potassium as K mg/l	4.2	4.0	1.5	1.8	1.8
18	Manganese as Mn mg/l	ND	ND	ND	ND	ND
19	Sodium chloride as NaCl mg/l	80	90	100	95	140
20	Nitrates as N mg/l	0.8	0.7	0.3	0.3	0.2
21	Phosphate as PO_4 mg/l	ND	ND	ND	ND	ND
22	Sulphates as SO_4 mg/l	38	41	25	28	20

Sampling Site Code

Number:	Name of Sampling Site
I	Ralong Hot Spring
II	Borong Hot Spring
III	Yumthang Hot Spring
IV	Yume-Samdong Hot Spring
V	Legship Hot Spring

COMPARATIVE STUDY OF THE HOT SPRINGS

The table shows the comparative study of the physico-chemical characteristics of five Hot Springs namely Legship (Reshi), Ralong, Borong, Yumthang and Yume Samdong.

COLOUR:

The colour of water in all the hot springs in Hazen unit is less than 5 (five).

APPEARANCE:

The water of all the hot springs is clear in appearance.



Pilgrims taking a dip in hot water spring

TURBIDITY:

The turbidity of hot water is highest at Ralong Hot Spring with the turbidity value of 22 NTU followed by Borong and Yume Samdong Hot Springs with the turbidity value of 20 NTU each and then by Legship and Yumthang Hot Springs with turbidity value of 16 NTU and 15 NTU respectively.

CONDUCTIVITY:

The conductivity values were found to be highest in Legship hot spring with conductivity value of 1020 μ MHOS/cm followed by Yumthang and Yume Samdong Hot springs with conductivity value of 1000 μ MHOS/cm and 950 μ MHOS/cm respectively.

TOTAL DISSOLVED SOLIDS (Dried at 105°C)

The total dissolved solids dried at 105°C was found to be highest at Legship with TDS value 680 mg/l, followed by Yumthang 600mg/l and Yume samdong 580mg/l. The lower values were observed at Ralong with concentration value 280mg/l and the lowest concentration value 250 mg/l at Borong Hot Spring.

pH:

The pH values of the hot springs was found to be lowest at Legship with pH value 7.6 and the highest pH value was observed at Yumthang with pH 8.5 Ralong and Yume Samdong hot springs showed pH value 8 each followed by Borong hot spring with pH value 8.2.

TEMPERATURE AT SOURCE °C

The temperature of hot water at the source/point of origin of the hot spring was found to be highest at Ralong 50°C followed by Borong and Yume Samdong Hot Spring 40°C each and Legship hot spring 35°C and the lowest water temperature at Yumthang hot spring 34°C.

DISSOLVED OXYGEN:

The dissolved oxygen was found only in the hot water of Ralong and Borong Hot Springs with D.O. values 1.5 mg/l and 4mg/l, respectively. Dissolved oxygen was not detected in the other three Hot water springs of Legship, Yumthang and Yume Samdong.

CARBONATE HARDNESS AS CaCO_3

Carbonate hardness was detected only at Legship Hot Spring with concentration value 244 mg/l. Carbonate hardness as CaCO_3 was not detected at other Hot springs (Ralong, Borong,

Yumthang and Yume Samdong).

CALCIUM HARDNESS AS CaCO₃

Calcium Hardness of 130mg/l was detected at Legship whereas the other Hot Springs of Ralong, Borong, Yumthang and Yume Samdong did not show the presence of Calcium Hardness.

CHLORIDE AS Cl

The concentration of chlorides as Cl was found to be highest at Legship with concentration value 8.0 mg/l, followed by Ralong, Borong, Yumthang and Yume-Samdong with concentration values 7.2mg/l, 7.0mg/l, 3.5 mg/l and 3 mg/l, respectively.

SILICA AS SiO₂

Silica concentration was found to be highest at Borong hot spring with concentration value 26mg/l followed by Yumthang hot spring with concentration value 24 mg/l. Silica concentration was found to be 22 mg/l each at Ralong and Yume Samdong Hot springs. The lowest Silica concentration was found at Legship with concentration value of 14 mg/l.

BACTERIOLOGICAL ANALYSIS OF THE HOT SPRING WATER

The bacteriological analysis of water at source (point of origin) of all the hot water springs indicate that aerobic pathogenic bacteria are absent. This may be attributed to the deep scaled origin of the water. Colourless filamentous sulphur bacteria is present in all the hot springs.

ALGAL COMPOSITION OF HOT SPRING

A luxuriant growth of the algal species (spirogyra) is seen thriving over the rocks where the hot water flow. This is typically seen in the hot springs of Ralong and Borong. Whereas the other hot springs of Yumthang, Yume-samdong and Legship is devoid of any algal growth this may be due to excess human interference at Legship whereas at Yumthang and Yume-samdong it may be due to the adverse climatic conditions.

DISTURBANCE AND THREATS

The increase in human activities in the hot spring areas has led to various ecological stress. The people demand on the surrounding forests for firewood due to lack of alternative fuel. There is a lack of proper solid waste disposal as huge quantity of solid wastes are generated during the peak season. Waste materials lie scattered along the surrounding huts and the river banks. The sanitary facilities available is unhygienic and insufficient as temporary toilets are constructed on the river bank where the faecal matter is directly discharged into the river without any treatment. The demand for meat and meat products had further accelerated the rate of fishing in the rivers. The large number of patients with various communicable diseases frequenting this hot spring may further spread these diseases. It is feared that due to the unhygienic conditions prevailing around these hot springs, the people on their way back may be infected by new diseases.

REMEDIAL MEASURES:

1. Proper management of the area.
2. Proper sanitary facilities to be provided.
3. A detailed microbiological study to be carried out.
4. Regular monitoring of these hot springs to assess their im-

pact on the river eco-system.

5. Detail study on radioactivity and micro-elements to be carried out.
6. Detail evaluation study of the people visiting these areas.

The hot springs in Sikkim are regarded as place of worship and holds a high religious esteem in the hearts of the local people. The people drink the hot water and bathe in it, considering these factors detailed microbiological and radio-activity study of these water is felt essential taking into account, the study of the geomorphological aspect of these hot springs and their economic exploitation.

The findings of the present study reveals that the Hot springs of Legship (which is the highest frequented area among the five Hot Springs) is facing a potential pollution problem.

NOISE POLLUTION MONITORING

Noise has rapidly become a source of environmental pollution with increasing industrialization, urbanization and the rapid expansion of the means of transportation. The ambient noise level termed as the total noise associated within a given environment and usually comprise of sounds from many sources both near and far.

To assess the Noise Pollution of Gangtok and to judge the quality of environment with respect to noise pollution, survey is conducted by the State Pollution Control Board. In this survey 7 numbers of locations falling under different categories of Land Use were selected for monitoring. Observations are made throughout the day at different time frame to cover peak hours and lean hours at night for noise levels.

Following methodology have been adopted to measure the noise level:-

- (i) Noise levels are measured using sound level meter (CYG-NET 2031) with A-weighted frequency filters.
- (ii) Measurements are taken around the selected location avoiding any specific and direct noise source.
- (iii) Measurements are taken in slow mode of sound level meter.
- (iv) The measurement of sound level are taken at a height of 1.5-2 meter from Ground level (human hearing height).

NATIONAL STANDARD FOR AMBIENT NOISE LEVEL

Zone category	Leq. DB (A) Day limit	Leq. DB(A) Night limit
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

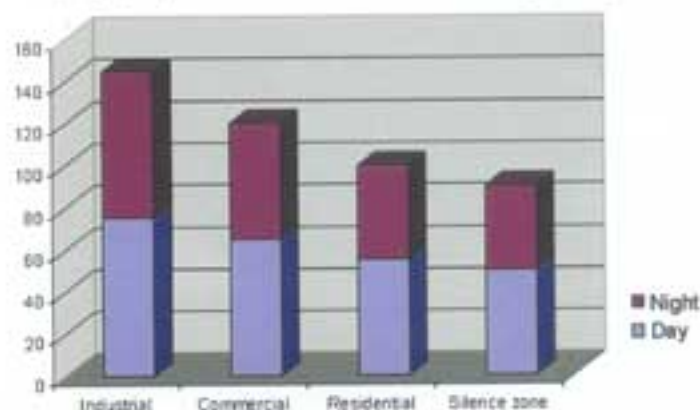
Table 4. AMBIENT NOISE QUALITY STANDARDS

Category of area	Limits in decibels	
	DAY	NIGHT
Industrial area	75	70
Commercial area	65	55
Residential area	55	45
Silence zone	50	40

Sources of Noise

The sources of noise pollution are many. Major ones of these are vehicular sources, commercial activities, construction activities and others. The present chapter deals with the noise pollution status in an around Gangtok. As there are no such big industrial units the main source of noise pollution in the capital town is from the vehicular traffic. The other sources of noise includes-

- Noise from loud speakers in and around music vendors.
- Noise from commercial activities.
- Noise from generators in almost all the areas during power-off



STUDY AREA

For the assessment of noise pollution, different locations within Gangtok has been considered which has been categorized into Residential, Commercial and Silence zone as per Environment (Protection) Act, 1986. As there are no industrial units within the town as such, industrial area category has been skipped.

RESIDENTIAL AREA

The residential area may be defined as an area, which is devoid of any commercial activities, industrial units, and meant for residence only. For the assessment of noise pollution in and around Gangtok three different locations viz: College Valley-Tadong, Deorali Govt. Quarters and Development area has been taken into account.

COMMERCIAL AREA

Commercial area is an area where most of the commercial activities take place for example Market place, shopping complex. To measure the noise level Bazar area and Indira Bye-pass were selected.

SILENCE ZONE

Silence zone include area up to 100 meters around certain premises like hospital, educational institutions, Courts, parks etc. Hospital point and District Court premises had been selected as measuring sites.

Table 5. NOISE MONITORING LOCATIONS IN GANGTOK

SLNo	TYPES OF AREA	MONITORING LOCATIONS
1.	Residential area	1. College valley, Tadong. 2. Deorali Govt. quarter. 3. Development area.
2.	Commercial area	1. Bazar (M.G. Marg). 2. Indira Bye-Pass.
3.	Silence zone	1. Hospital Point. 2. District Court.

The measurement of ambient noise level was done by Sound Level Meter 2031 A (Cygnet). The measurements which were taken for seven consecutive days in each sites were in three slots i.e., morning 8.00 a.m. -10.00 a.m., afternoon 14.00 p.m.-16.00p.m., and night 18.00-20.00p.m. The details of the measurements are reflected at table 6.

RESIDENTIAL AREA

Table 6. Ambient Noise Level in dB (A) at Residential area in Gangtok.

Sl. no	Place	Time	Lmax	Lmin	Leq
1.	College valley, Tadong	Morning	74.2	34.3	51.6
		Afternoon	78.4	42.2	60.8
		Night	76.3	39.5	58.4
2.	Deorali Govt. Qtr.	Morning	71.5	35.1	55.3
		Afternoon	76.3	39.9	61.4
		Night	73.4	36.2	57.2
3.	Development Area	Morning	78.4	35.5	51.6
		Afternoon	85.3	41.7	65.8
		Night	71.5	34.6	50.7

Morning 8:00 a.m. - 10:00 a.m. Afternoon 2:00- 4:00 p.m.
Night 6:00 - 8:00.

College Valley, Tadong

Tadong is situated in South- East of Gangtok. The sampling site was located near Sikkim Govt. College. The major source of noise pollution in this residential area are vehicles plying in National Highway 31-A. The other sources include music system, noise from construction sites etc.

The Leq. Value represents the average energy for the total measured time. The average minimum Leq. 51.6dB(A) was recorded in the morning and average maximum Leq. 60.8dB(A) was observed in the afternoon hours. At night time Leq. 58.4 dB (A) was recorded. Afternoon was found to be noisier than morning and night. The values are higher than the permissible limit of 55dB(A) in daytime and 45dB(A) in nighttime.

The instantaneous values were found to be a minimum of 34.3dB(A) and maximum 74.2dB(A) in morning and minimum 42.2dB(A) and maximum 78.4dB(A) in afternoon, whereas minimum and maximum value at night is 39.5dB(A) and 76.3dB(A) respectively.

Deorali Govt. Quarters

Deorali Govt. quarter is situated 3 Km away South-East of Gangtok. The sampling site was located at Govt. quarter. This area is covered mostly by residence. The major contribution of noise is by music system and construction activities.

The average minimum Leq. 55.3 dB (A) was observed in the morning and average maximum Leq. 61.4dB (A) was recorded in afternoon. The average Leq. 57.2 dB (A) was recorded during night. The instantaneous values were found to be a minimum of 35.1dB(A) in morning and maximum 76.3 dB (A) in afternoon. The minimum instantaneous value in afternoon and night was observed as 39.4 dB (A) and 36.2 dB (A) respectively. The maximum instantaneous value of 71.3 dB (A) was recorded in the morning and 73.4 dB (A) at night.

Development area,

Development area is located in west of Gangtok town. The sampling was located near the Sangram hall. This area is covered mostly by residence. The major source of noise is vehicles plying in streets, noise from music system from residence and

other activities.

The average min. Leq. 50.7 dB (A) was observed during night. The average max. Leq. 65.8 dB (A) was observed during afternoon. The average Leq. 51.6 dB (A) was recorded in morning. The instantaneous values found were a minimum of 34.6 dB (A) during night whereas maximum 85.3dB(A) during afternoon. The minimum instantaneous values were found to be a minimum of 34.6 dB (A) during night and maximum of 85.3dB(A) during afternoon. The minimum instantaneous values during morning and afternoon were recorded as 35.5 dB (A) and 41.7dB(A) respectively whereas maximum instantaneous 78.4dB(A) and 71.5dB(A) was recorded in morning and night respectively.

COMMERCIAL AREA

Table 7. Ambient noise level in dB (A) at commercial areas in Gangtok.

Sl.no	Place	Time	Lmax	Lmin	Leq
1.	Bazar Area(M.G Marg)	Morning	97.1	58.4	70.4
		Afternoon	105.2	61.0	74.3
		Night	85.4	56.2	62.1
2.	Indira Bye-pass	Morning	93.0	52.0	68.5
		Afternoon	97.0	57.4	73.2
		Night	88.0	43.8	69.4

Morning 8.00-10.00a.m, Afternoon 2.00-4.00p.m, Night 6.00-8.00p.m.

Bazar area(M.G. Marg)

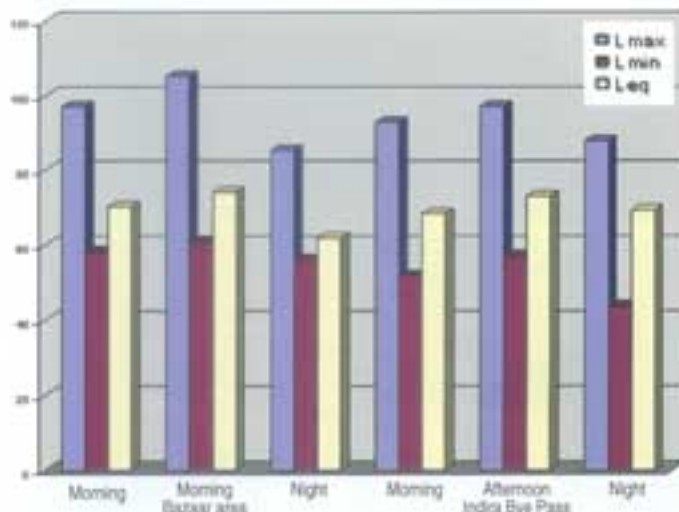
This is situated at the heart of town. This area is full of shops and vendors. The sampling site was located at Metro point where traffic has highest movement. The major source of noise in these areas are vehicles. Also noise from vendors and pressure horns used in the vehicles add to the noise pollution. Movement of people are also found to be contributing to noise pollution.

The Leq. Value represents the average energy for the total measured time. The average minimum Leq. 62.1dB(A) was recorded in the night and average maximum Leq. 74.3 dB(A) was observed in the afternoon hours. In morning Leq. 70.4 were recorded. The instantaneous value was found to be a minimum Leq. 56.2 dB (A) at night whereas 58.4 dB (A) and 61.0 dB (A) was recorded in morning and afternoon respectively. The maximum instantaneous value was found to be 105.2 dB (A) in afternoon while 85.4dB(A) and 97.1dB(A) at night and morning respectively. The higher noise was found in afternoon and it may be due to more traffic congestion during this time. All the values are much higher than prescribed permissible limit.

Indira Bye-pass is situated 4km away from Gangtok. The sampling site was located near Motor Vehicle Department. The major source of noise pollution is large number of Garages and workshops, and handling of metal goods, and other commercial activities. Almost all the workshops are located in this area.

The average minimum Leq. 68.5dB(A) was recorded in the morning and average maximum Leq. 73.2 dB (A) was observed during afternoon. The average Leq. 69.4 dB (A) was found at night. 43.8 dB (A) was the minimum instantaneous value re-

corded during night whereas 52.0dB(A) and 57.4dB(A) were recorded as minimum instantaneous values during morning and night respectively. The maximum instantaneous value 97.0dB(A) was recorded in the afternoon while 88.0dB(A) and 93.0dB(A) at night and morning respectively. Thus, highest minimum, maximum and Leq. Value was observed during afternoon. This may be attributed to more activities in that particular time.



SILENCE ZONE

Table 8. Ambient noise level in dB(A) at silence zone in Gangtok

Sl. No.	Location	Source	Before Government 2004
1.	Hindustan Bazar M. Chini, Jhoni	Heavy traffic	Leq= 65.0 dB(A)
		Heavy traffic	Leq= 63.0 dB(A)
		Heavy traffic	Leq= 62.0 dB(A)
2.	Hindustan Bazar M. Hindustan Bazar	Heavy traffic	Leq= 64.0 dB(A)
		Heavy traffic	Leq= 63.0 dB(A)
		Heavy traffic	Leq= 62.0 dB(A)
3.	Government Bazar M. M.G. Marg	Heavy traffic	Leq= 63.0 dB(A)
		Heavy traffic	Leq= 62.0 dB(A)
		Heavy traffic	Leq= 61.0 dB(A)
4.	M.G. Marg	Heavy traffic	Leq= 62.0 dB(A)
		Heavy traffic	Leq= 61.0 dB(A)
		Heavy traffic	Leq= 60.0 dB(A)

Morning-8.00 a.m.-10.00 p.m, Afternoon-2.00p.m.-4.00 p.m,
Night-6.00 p.m.-8.00 p.m.

HOSPITAL POINT (STNM)

This area is situated at the heart of city and measurement was taken near the entrance gate of OPD ward. The major source of noise pollution was vehicular traffic because National Highway runs through the Hospital area. Moreover almost all buildings of hospital are within 100m from road.

The average minimum Leq. 50.1 dB(A) was observed in morning whereas night was found to be 63.2 dB(A). The average Leq. 62.5 dB(A) was recorded during afternoon period. Here, night time showed higher Leq. value than morning and afternoon. The instantaneous value was found to be a minimum of 38.2 dB(A) during morning whereas maximum of 85.1 dB(A) during night. The minimum instantaneous values during afternoon and night was recorded as 40.8dB(A) and 41.6 dB(A) respectively whereas maximum instantaneous during morning was found to be 74.3 dB(A) and 84.2 dB(A) in the afternoon.

DISTRICT COURT

This area is located in South of Gangtok. The sampling was done at the premise of District Court. The source of noise is occasional plying of vehicles, movement of people and honking

of vehicles.

The average minimum Leq.44.6dB (A) was recorded in the night and average maximum Leq.49.2dB (A) was observed in the afternoon. In morning Leq.47.1 dB (A) was recorded. The instantaneous value was found to be a minimum of 34.2 dB (A) and maximum of 72.5dB(A) in morning and afternoon respectively. The minimum instantaneous value for afternoon and night was recorded as 38.6 dB (A) and 34.6dB(A) respectively. The maximum instantaneous value for morning was 68.1dB(A) while for night it was 64.2 dB (A).

Ambient Noise Level at various places in Gangtok.

Sl. No.	Place	Day Average leg. in dB (A)	Night Average leg. in dB (A)
SILENCE ZONE			
1.	Hospital Point	62	63
2.	District Court	50	44
RESIDENTIAL ZONE			
1.	Tadong	61	58
2.	Deorali Govt. Quarter	61	57
3.	Development Area	66	50.7
COMMERCIAL ZONE			
1.	M.G. Marg	70	62
2.	Indria Bye-Pass	73	69

Inference

It is clear from the table that the noise level of silence zone Hospital point far exceeds the national standards. This may be attributed to vehicular noise continuous traffic this point account of its location along the busy national highway and traffic intersection.

All the residential areas have noise level higher than the national standards due to continuous traffic, as these areas are exposed to high noise level from vehicles.

Commercial zone also records high noise level than the national standards due to continuous traffic and commercial activity.

The Board has been carrying out study on the noise level generated during the Diwali to study the impact of bursting of crackers.

ASSESSMENT OF NOISE POLLUTION IN AND AROUND GANGTOK TOWN DURING DEEPAWALI 2003.

Noise is defined as an "unwanted sound". Noise as a pollutant contributes to a deterioration of the environment as a potential hazard to health, communication interference and nuisance. Noise causes temporary or permanent hearing loss depending upon the intensity and duration of the sound level.

In view of the detrimental affects of noise pollution, Ministry of Environment & Forest, Govt. of India, has issued a notification no. GSR. 682 (E) dated the 5th Oct 1999 & 2000 prescribing environmental standards for the manufacture, sale or use of firecrackers. As per the notification, fire crackers generating noise level exceeding 125 dB (AF) or 145 dB (C) pK at 4 mtrs. Distance from the point of bursting shall be prohibited. For strict compliance of the same, direction has been issued to regulate the noise level before and on the Deepawali day (Laxmi puja) by the Hon'ble Supreme Court of India.

In accordance to the interim direction of the Hon'ble Supreme

Court, State Pollution Control Board, Deptt. of Forest, Env. & Wildlife, Govt. of Sikkim has been conducting survey to assess the level of noise pollution before and on the Deepawali day in and around Gangtok town.

Machine Used:

Sound Level Meter 2031 A (Cygnet)

Results

The results of the studies has been provided as follows:

Table -1 showing the data collected on 25th of October 2003 (a day before Deepawali).

Sl. no.	Location	Period	Before Deepawali 25 th Oct. 2003.
1	Residential Area. a. Dev. Area	Day time	Lmin -49.0 dB. Lmax-100.2 dB.
		Night time	Lmin- 37.4dB. Lmax- 95.2dB.
	b. Panihouse to Tadong Area	Day time	Lmin -51.9 dB. Lmax-93.6 dB.
		Night time	Lmin- 49.4dB. Lmax- 90.2dB.
2	Silence Zone a. Hospital Area	Day time	Lmin -49.4 dB. Lmax-115.3 dB
		Night time	Lmin-42.6 dB. Lmax- 92.4 dB.
3	Commercial Zone a. M.G. Marg	Day Time	Lmin -57.2 dB. Lmax-94.0 dB.
		Night time	Lmin- 47.5 dB. Lmax- 91.3 dB.
	b. Lal Market	Day time	Lmin - 51.7dB Lmax-91.7 dB.
		Night time	Lmin-38.7 dB. Lmax- 85.4 dB.

Table -2 showing the data collected on 26th of October 2003 (on Deepawali day).

Sl. no.	Location	Period	On Deepawali 26 th Oct. 2003.
1	Residential Area. a. Dev. Area	Day time	Lmin -52.6 dB. Lmax-81.3 dB.
		Night time	Lmin- 57.5 dB. Lmax- 91.2 dB.
	b. Panihouse to Tadong Area	Day time	Lmin -51.5 dB. Lmax-90.2 dB.
		Night time	Lmin- 39.9 dB. Lmax- 94.5 dB.
2	Silence Zone a. Hospital Area	Day time	Lmin -47.2 dB. Lmax-105.4 dB
		Night time	Lmin- 36.8 dB. Lmax- 94.4 dB.
3	Commercial Zone a. M.G. Marg	Day Time	Lmin -52.7 dB. Lmax-92.4 dB.
		Night time	Lmin- 57.5 dB. Lmax- 90.4 dB.
	b. Lal Market	Day time	Lmin - 43.6 dB Lmax- 89.3 dB.
		Night time	Lmin-58.5 dB. Lmax- 95.5 dB.

INFERENCE:

An assessment of the noise pollution in and around Gangtok town before and on the Deepawali day revealed that in all where the data has been recorded were found to be within the prescribed limit of 125 dB (AF) for the fire crackers. The Max. value recorded on the day before Deepawali (i.e., 25th Oct. 2003) was 115.3 dB. Interestingly this was recorded at Hospital area which falls under Salience zone. The values recorded during day time for all the areas were found to be higher than the value recorded at night time. The max. value recorded at night was 95.2 dB at Development area.

The values recorded for the noise level on the Deepawali day (i.e., 26th Oct. 2003) also showed the same trend with Hospital area recording the Max of 105.4 dB during day time. The Lal market area on the Deepawali night recorded the Max. value of 95.5 dB. However, despite sporadic bursting of fire crackers the noise / sound generated by the crackers were found to be within the prescribed limit for all the areas under study.

Though the values recorded before and on the Deepawali day were found to be within the prescribed limit of 125 dB(AF) for bursting of fire crackers. However, when these values are taken on day to day basis it was found to be on the higher side as per the general standard.

The State Pollution Control Board, Deptt. of Forest, Env. & Wildlife, Sikkim had given wide publicity for compliance to the direction of Hon'ble Supreme Court of India through different media. The results of the present study indicates the success of the steps taken by the Board in generating awareness in this subject and further the public had respected the direction of the interim order with a concern for safe environment.



Environment Awareness procession led by Shri S. B. Subedi, Minister, FE&WM



Environment Awareness procession led by Hon'ble Minister D. T. Lepcha



Celebration of World Environment Day on 5 June 2001.



A glimpse from World Environment Day celebrations



Sixth International Day for the Preservation of the Ozone Layer

ENVIRONMENTAL AWARENESS

The State Pollution Control Board, Sikkim is conducting awareness programmes to create awareness among the public about the importance of prevention and control of pollution at all levels.

High priority is accorded by the State Pollution Control Board to build awareness on environmental issues by involving target groups students, teachers and NGOs and general public at large.

The following activities are celebrated by the State Pollution Control Board, Sikkim to create awareness:

- 1) World Environment Day on 5th June.
- 2) International Ozone Day on 16th September.
- 3) National Science Day.

During these celebrations the following activities are carried out:

- (i) Organizing Seminars/Workshop on the subjects among public, students and the workers of Industrial units.
- (ii) Encouraging awareness among children by holding rallies, competitions and awarding prizes (Essay/ elocution/ painting etc. on the theme).
- (iii) Issue of pamphlets/ notices/ posters/ banners/ stickers etc. on Environmental protection.
- (iv) Involving Non-Governmental Organizations in these activities, and encouraging them to take up their own



A Street Play on the harmful effects of pollution

initiatives in these areas.

- (v) Encouraging tree plantation programme among students and public in their schools and localities.

Besides the above celebrations the State Pollution Control Board also produced;

- i.) documentaries and telecast them in the local cable T.V. network on environmental issues.
- ii) Regular environmental reports
- iii) Advertisement in the local paper.
- iv) The State Pollution Control Board also acts as a nodal agency in the Implementation of National Environmental Awareness Campaign funded by Ministry of Environment and Forest, Govt. of India.

LIST OF AWARENESS PROGRAMMES CARRIED OUT BY SPCB

- "JAI PARYAVARAN" - Advertisement film telecast through local cable T.V.
- "BEAUTY QUEEN" - Advertisement film advertisement telecast through local cable T.V.
- YO SIKKIM TIMRO MERO - Env. Song telecast through local cable T.V.
- Banners/ Hoardings
- World Env. Day Celebration
- National Science Day Celebration
- International Ozone Layer Prevention Day
- Radio Programmes
- School Awareness
- National Green Corps
- Environmental Awareness to Defence Personnels
- Public Hearings
- Advertisements
- Drawing Competition
- Extempore Speech Competition
- Slogan Competition
- Essay Competition
- Street Play
- Water Quality Analysis Demonstration
- National Environmental Awareness Campaign (NEAC)



Release function of the Environment Song CD

BIO-MEDICAL WASTE

The over crowding of the present day cities in our country may be contributed to rapid urbanization and haphazard urban development. Our capital town Gangtok is no exception. A continuous flow of population to urban areas for easy and better living has posed much problems.

The stress and strain of modern life has carried grievous injury to our health and social well being.

For the restoration of the community's health there has been a rapid growth of various hospitals, laboratories, clinics etc. both in the private and public sector. This rise in the number of health related services has aggravated the problem of Bio-medical waste and their management.

Bio-medical waste may be defined as any solid, fluid or liquid waste, including its container and any intermediate product which is generated during the diagnosis, treatment or immunization of human beings or animals in research pertaining thereto, or in the production or testing of biological and the animals waste from slaughter houses or any other like establishment.

Sophisticated instruments are being used in the field of health and medical practice and rapid advances are being made in this field. It is interesting to note that though these hospitals are intended to restore human health, the disposal of hospital wastes is a major problem as they cause serious health hazard.

Exposure to improperly handled bio-medical waste results in spreading of communicable diseases through skin contact, injection and inhalation are the possible route of exposure. Clinical waste has an adverse impact on human health if the waste comes into contact with individuals. This area of waste management is grossly neglected. Large number of hospitals, nursing homes, pathology labs and health care centers are situated in the urban areas but they do not discharge their duties for the safe disposal of hospital wastes. This infectious waste and sharps gets carried away with domestic solid waste and deposited at the common disposal site. Many hospitals dispose off their mixed wastes within the hospital premises where waste resources remain in the open for a long time unattended. The disposed, infectious and non-infectious wastes which are generally in the ratio of 1:9 are not segregated at source and instead these are mixed and disposed off in a very un-hygienic manner.

There is an urgent need to plan & implement updated procedures at different levels for the management of medical wastes like storage, segregation, transfer, treatment and disposal.

The Ministry of Environment & Forest, Govt. of India has notified the Bio-medical waste (Management & Handling) Rules 1998 subsequently amended in March 2000. These rules apply to all persons, who generate, collect, receive, store, transport, treat, dispose, or handle Bio-medical waste in any manner. These rules also specify methods of proper treatment and disposal of the wastes and prescribe standards for doing so. The rules have also specified target dates for the setting up of the treatment facilities like incinerators/microwave systems etc.

INVENTORIZATION OF HOSPITALS

The State Pollution Control Board, Sikkim under the project "Implementation of Acts & Rules other than Air & Water" till date has surveyed the following hospitals (Table) to understand the present status of handling and disposal practice and to assess the quantum of bio-medical waste generated in the state.

Government Hospitals

Sl.#	Name of hospitals
1.	STNM, Gangtok
2.	Singtam District Hospital.
3.	Namchi District hospital.
4.	Gyalshing District hospital.
5.	Mangan district hospital.

Primary Health Centres

1.	Pakyong, PHC
2.	Rhenock, PHC.
3.	Rongli, PHC
4.	Rangpo, PHC.
5.	Jorethang, PHC.
6.	Ravangla, PHC.
7.	Soreng, PHC.

Private Hospital.

1.	Central Referral Hospital.
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Private Clinics.

1.	Ruchi Diagnostics
2.	Care Diagnostics

The SPCB has undertaken a centrally sponsored project "Implementation of Acts & Rules other than Air & Water" Acts in Sikkim and accordingly inventorization and assessment of bio-medical waste generated in the state of Sikkim was carried out.

A total of 5 Government hospitals 7 Government PHCs, 1 private hospital and 2 private clinics were surveyed by the SPCB, Sikkim. The survey was carried out to understand the quantum of bio-medical waste generated and the status of handling and disposal practice of these waste generating bodies.

Monthly Quantification of BIO-MEDICAL WASTE.

Sl. No.	Hospitals	No. of beds.	Total Waste Kg/Month
1.	Central Referral Hospital	300	939
2.	STNM Hospital	300	9600
3.	District Hospital Singtam	100	683
4.	District Hospital Namchi	120	2055
5.	District Hospital Gyalshing	50	708
6.	Rangpo, PHC	08	855
7.	Soreng, PHC	12	115
8.	Jorethang, PHC	10	75
9.	Pakyong, PHC	10	75
10.	Ruchi Diagonastics	NA	75
11.	Care Diagonastics	NA	75

INFERENCE

The study reveals that the total bio-medical waste generated by the health care establishments in Sikkim is estimated to be approximate 15,255 kg/month. These establishments were found not following uniform method for the management, handling and disposal of bio-medical waste.

Most of these establishment were found to be unaware of the existence of any legislations applicable to hospital waste management, they do not have copies of manual on management and hospital waste or even waste management plan. Most of the personal involved in the management of hospital solid waste are untrained.

The two main hospitals the STNM and Central Referral Hospital have incineration facilities and their efficiency needs to be ascertained. The largest volume of bio-medical waste is being generated by STNM hospital 9600 kg/month followed by Namchi District Hospital 2055 kg/month. Even though the Central Referral Hospital and STNM hospital are both 300 bedded Central Referral Hospital generates only 939 kg/month bio-medical waste.

The following hospitals and PHCs and Private Clinics have applied for grant of authorization for bio-medical waste management and handling.

Hospitals

- 1) STNM
- 2) Gyalshing district hospital
- 3) Mangan district hospital
- 4) Singtam district hospital

PHCs

- 1) Soreng, PHC
- 2) Rangpo, PHC
- 3) Pakyong, PHC

Private Clinics

- 1) Ruchi Diagonastics
- 2) Care Diagonastics

TRANSPORTATION OF BIO-MEDICAL WASTE

The instruction of Government of India, ministry of Environment and Forests issued under the Environment Protection Act, 1986 is to be followed and accordingly it may be ensured that the bio-medical waste stored in polythene bags in the hospitals and nursing homes is transported in closed body light motor vehicle depending on number of such establishment to be covered.

Comparative account of districts hospitals of Sikkim
(Management and Handling of Bio-medical Waste)

Sl.no.	Types of Hospitals/Health care facility	No. of beds	Total estimated qty. of waste generated kg/day	Segregation of waste taking place (yes/no)	Containers/bags used to segregate waste.	Colour coded or labelled containers are used (yes/no)	Persons who handles the segregated waste.	Containers or bags used for collection of waste.
1.	District Hospital Singtam	100	22.75 kg/day	Yes	Metal containers	No	Safai Karmachari	Wheel barrows
2.	District Hospital Namchi	120	68.5 kg/day	Yes	Plastic buckets	Yes	Safai Karmachari	Plastics buckets
3.	District Hospital Gyalshing	50	20 kg/day	Yes	Plastic & Metal containers	No	Sweepers	Plastics & Metal containers
4.	District Hospital Mangan	50	18 kg/day	Yes	Plastic buckets	No	Sweepers	Plastics buckets

Table 1.

Sl. No.	Type of hospitals/health care facility	Waste handlers are provided with protective apparel/gloves during waste handling. (Y/N)	Final disposal of segregated waste.	Person responsible for organization & management of waste [Administrative level]	Aware of any legislation applicable to the Hospital waste management. (Y/N)	Follows any manual or guidance on management of BMW available. (Y/N)	Any Hospital waste management plan? (Y/N)
1.	District Hospital Singtam	Yes, gloves	Open burned/collected by UD & HD vehicles	No designated person	Yes	No	No
2.	District Hospital Namchi	Yes, gloves	Incinerated/taken to municipal landfill by UD & HD	No	No	Yes	No
3.	District Hospital Gyalshing	Yes, gloves	Buried/taken by UD & HD	CMO, DMO	Yes	Yes	No
4.	District Hospital Mangang	Yes, gloves	Buried/taken by UD & HD	CMO, DMO	Yes	No	No

Comparative account of Primary Health Centres of Sikkim (Management and Handling of Biomedical Waste)

Table 1.

Sl.no.	Types of Hospitals/Health care facility	No. of beds	Total estimated qty. of waste generated kg/day	Segregation of waste taking place (yes/no)	Containers/bags used to segregate waste.	Colour coded or labelled containers are used (yes/no)	Persons who handles the segregated waste.	Containers or bags used for collection of waste.
1.	Primary Health Centre, Pakyong	10	2-3 kg/day	Yes	Tin bins	No	Sweepers	Tin bins
2.	Primary Health Centre, Jorethang	10	2-3 kg/day	Yes	Dust bins	No	Sweeper	Dust bin
3.	Primary Health Centre, Rangpo	08	5-8 kg/day	Yes	Plastic containers	No	Sweeper	Plastic containers
4.	Primary Health Centre, Rhenock	10	4-5 kgs/day	Yes	Plastic buckets	No	Sweeper	Plastic bucket
5.	Primary Health Centre, Rongli	10	2-3 kg/day	Yes	Metal buckets	No	Sweeper	Metal bucket
6.	Primary Health Centre, Ravangla	12	2-3 kg/day	Yes	Plastic buckets	No	Sweeper	Plastic bucket
7.	Primary Health Centre, Soreng	15	4-5 kgs/day	Yes	Plastic & tin container	No	Sweeper	Plastic & tin container

Full cost may be recovered from the beneficiary if this arrangement is not made by the medical establishment and they may request the Municipal Authorities to assist them in creating their facility.

DISPOSAL OF WASTE

Incineration: This is a process of burning the waste at a very high temperature. Incineration requires high calorific value of the waste which could burn without any external fuels.

Although incineration of unassailable waste is not recommended as a method of Municipal Solid Waste dispose but incineration of bio-medical waste is however strongly recommend for the maintenance of health of the citizens.

Sl. No.	Type of hospitals/health care facility	Waste handlers are provided with protective apparel/gloves during waste handling. (Y/N)	Final disposal of segregated waste.	Person responsible for organization & management of waste [Administrative level]	Aware of any legislation applicable to the Hospital waste management. (Y/N)	Follows any manual or guidance on management of BMW available. (Y/N)	Any Hospital waste management plan? (Y/N)
1.	Primary Health Centre, Pakyong	No	Open burn	Medical Officer(M.O)	No	No	No
2.	Primary Health Centre, Jorethang	No	Open burn	Medical Officer	No	No	No
3.	Primary Health Centre, Rangpo	Yes, Gloves	Open burn/Incinerated	-	Yes	No	No
4.	Primary Health Centre, Rhenock	Yes, Gloves	Open burn	M.O.	Yes	No	No
5.	Primary Health Centre, Rongli	No	Open burn/buried	M.O.	Yes	No	No
6.	Primary Health Centre, Ravangla	Yes, Gloves	Open Burn	M.O.	Yes	No	No
7.	Primary Health Centre, Soreng	Yes, Gloves	Open burn/buried	M.O.	Yes	No	No

INDUSTRIES

Industrial activity in the state of Sikkim is negligible, due to inherent problems like hilly terrains, non availability of plain lands, lack of local entrepreneurship, lack of raw materials and market, high transportation and marketing costs.

The state has been mainly engaged in traditional activities like carpet weaving, wood carving, painting, manufacture of jewellery, liquors, fruit squashes, cane and bamboo works.

Attempts are being made by the government to introduce modern and sophisticated industries like assembly of watches, electronic goods, cosmetics, pharmaceuticals, cement spur pipes, hollow blocks, printing press, etc.

The State Government is taking active interest in setting up of small scale industries service institutes and also industrial financial institutions for the development of industries in the state.

The local registration issued SSI Units district wise is give in the following table:

YEARWISE PERMANENT REGISTRATION ISSUED TO SSI UNITS OF SOUTH DISTRICT

Name of Unit Year wise	Address	Item	Total Invest. (Rs. in lakhs)
1978-79			
Sikkim Biscuit Factory	Jorethang	Biscuit	1.01
Pawan Biscuit & Lozence	Jorethang	Biscuit	0.62
1980-81			
Mukhia Atta Chakki	Jorethang	Mill	0.27
1981-82			
Kesu Oil Mill	Melli Bazaar	Oil Mill	0.75
1982-83			
Chamling Printing Press	Jorethang	Printing	0.55
1983-84			
Mukhia Bakery	Jorethang	Bakery	0.68
1986-87			
P.M. Studio	Namchi Photo Studio		0.20
Sri Jana Tailors	Namchi	Garments	0.15
1987-88			
Kunphenling Tibetan Refugee Handicraft	Ravongla Handicrafts		1.87
Atta Chakki and Rice Huller	Ravongla	Mill	0.72
1988-99			
Too Good Tailors	Ravongla	Garments	0.45
Lama & Co. (P) Ltd.	Melli	Corrugated box	0.70
1989-90			
Frost Ice Cream	Jorethang	Ice Cream	0.73
Kanchenzonga Traditional Paint & Handicrafts	Namchi	Handicrafts	0.65
Ganesh Aluminium Industry	Jorethang	Works	5.72

Name of Unit Year wise	Address	Item	Total Invest. (Rs. in lakhs)
Labott (P) Ltd.	Manpur	Bottle	137.49
Chauhan Dry Cleaner	Tintek	Dry cleaner	0.19
Raju Watch & Radio repairing	Namchi	Watch	0.04
Vajra Carpet Centres	Ravongla	Carpet	1.90
Nilam Studio	Jorethang	Photo Studio	3.48
1990-91			
Baba Mills	Rateypani	Mill	0.30
Vijaya Agro (P) Ltd.	Jorethang	Masala	6.30
Mahendra Engineering Works	Namchi	Fabrication	0.41
Sherpa Carpet Weaving Centre	Maniram Banjang	Carpet	0.10
Praveen Enterprises	Jorethang	Radio repair	0.50
Sikkim Packaging & Marketing (P) Ltd.	Rolu	Packaging	31.80
Sikkim Snaks Food (P) Ltd.	Rolley	Cracks	36.00
Prakash Iron Works	Temi		
	Bazar	Fabrication	0.15
Maskey Atta & Rice Mill	Namthang	Mill	0.25
1991-92			
Sakun Knitwear	Namchi	Knitting	0.41
Rangit Valley Enterprises (P) Ltd.	Manpur	Mosaic tiles	1.31
Sikkim Food Products (P) Ltd.	Melli	Bakery	67.01
Himalayan Furniture Corner	Jorethang	Furniture	41.50
1992-93			
Pradhan Bakery	Namchi	Bakery	0.45
Janga Chunarey	Melli	Chunarey Prdt.	0.15
M.N.C. Motor Works	Chisopani	Auto Workshop	0.87
Bishal Printing Press	Majigaon	Printing	1.89
Kumar Tyres	Majigoan	Tyre resoling	0.24
1995-96			
Mainam Candle Factory	Ravongla	Candle	0.30
Jorethang Aluminum Works	Jorethang	Allmn. utensils	1.10
1996-97			
Denzong Food Products (P) Ltd.	Jorethang	Biscuit	31.77
1997-98			
Khati Engineering	Namchi	Fabrication	0.35
D.T. Wood carving	Rong	Wood crafts	0.15
Mickey Food Products	Melli	Bakery	2.00
Chandra Iron Works	Namthang	Agr. Tools	0.18
Sadam Ricw Mill	Sadam	Mill	0.90
Angel Candle Factory	Jorethang	Candle	3.45
Sangam Beauty Pariour	Namchi	Saloon	0.41
Prem Arts	Jorethang	Painting	0.16
1998-99			
High Altitude Spices	Ravongla	Ginger paste	-
1999-2000			
Khaling Iron Works	Jorethang	Fabrication	0.35

Name of Unit Year wise	Address	Item	Total Invest. (Rs. In lakhs)	Name of Unit Year wise	Address	Item	Total Invest. (Rs. In lakhs)
Sai STD Centre	Ravangla	-	-	Khawas Furniture Shop	Gtk.	Garments	0.18
Nawa Knitting	Ravangla	Knitting	0.50	Chusang Noodle Factory	PS Road Gtk.	Furnitures Noodle	0.15 0.37
2000-2001				1986-87			
Mohan Brothers	Jorethang	Noodle	0.50	Kanchanzonga	Bagey		
Nehanrika Furniture House	Namchi	Food Products	0.50	Ladaki industries	Khola	AAC & ACSR	26.39
Munal Food Products	Namchi	Food products	1.50	Dzongri Enterprise	Near Star Cinema	Bakery	1.00
2001-2002				Wangchuk Furniture House	PS Road Gtk.	Furnitures	0.181
Sherwali Species Industry	Melli	Species	0.50	1987-88			
Jindal Industry	Jorethang	Bakery	-	Sikkim Commercial Co.	Supre Market Gtk.	Registers	0.96
Shree R.D. Mill	Jorethang	Wheat Mill	-	Sharma Masala Factory	Duga Rangpo	Masala	0.20
Sikkim Snow Bear Tea	Namchi	Tea packaging	0.35	Merry Printers	Deorali	Printing	1.00
2002-2003				Panaroma Colour Lab.	New Market Gtk.	Photo Studio	5.00
Sukhim Engineering	Jorethang	Fabrication	0.90	Om Printing Press	Arithang	Printing	0.26
				Guru Engineering Works	Baluwakhani	Lather machine	12.00
YEARWISE PERMANENT REGISTRATION ISSUED TO SSI UNITS OF EAST DISTRICT							
Name of Unit Year wise	Address	Item	Total Invest. (Rs. In lakhs)	Name of Unit Year wise	Address	Item	Total Invest. (Rs. In lakhs)
1975-76				Sikkim Flour Mill	Tadong	Mill	42.98
Durga Printing Works	Church Road Gangtok.	Printing	0.92	Chung Tshering Tailor	Denzong Hall Road	Garments	0.50
Sikkim Tannery	Majitar	Leather	5.39	Mahabir Mill	Rongali	Mill	0.25
Sikkim Leather Product Impression	Paradise Hotel Gangtok	Leather	0.58	Hingiri Press	Tibet Road Gtk.	Printing	0.80
Sikkim Candle Factory	Below Tashi Delek Star Cinema	Printing	0.50	Sritali Mill	West Pandam	Mill	0.35
Iron Works	Hall	Candle	0.56	Sikkim Battery House	Enchey Compound	Battery	0.25
Denzong Leather Goods	Rangpo	Fabrication	0.35	1988-89			
Motib Bakery	Gangtok	Leather	0.05	Shiv K. Agarwal Rice Mill	Singtam	Mill	0.51
Yeten Wood Works	Tibet Road Gangtok	Bakery	0.50	Rangpo Wood Industries	Singtam	Wood	1.00
Dursolo Tyre	Rangpo	Furniture	0.15	Dzongri Industries (P) Ltd.	New Market	Knitting	1.00
Bhim Lozenges	Deorali	Tyre	0.29	Hill Media Publication	Gangtok	Printing	0.95
		rethreading	0.29	Mandria Enterprises	Deorali	Fibre glass prd.	1.35
	Singtam	Confectionery	0.35	Carpet mfg. Centre	Kazi Road	Carpet	0.20
1977-78				Sangey & sons Rice Mill	Singtam	Mill	0.30
Himal India Printers (P) Ltd.	Nam Nam	Printing	0.52	Centre Computer Data Processing	Tadong Gangtok	Data Processing	0.70
1978-79				N.S. Radio	Gangtok	Radio repairing	0.10
Sarda Atta Rice Mill	Old Market Gangtok	Mill	0.24	Janta Noodle Factory	Rangpo	Printing	1.20
1980-81				Denzong Stationary & Printing	Tadong	Printing	0.70
Denzong Oil Mill	Simik Lingey	Oil Mill	0.43	Sharma Rice Mill	Sangnong busy, Sang	Mill	0.20
Ladaki Hume Pipe	Bagey Khola, Singtam	Pipe	8.00	Rajesh Battery	Taxi stand, Gtk.	Battery	0.15
Pawan Chaki	Singtam	Mill	0.22	1989-90			
Gangtok Praakashan Sikkim Paper Industries	Baluwakhani Near Paradise Hotel	Printing File, etc.	2.00 51.00	Linkey Grinding Mill	Linkey	Mill	0.32
1982-83				Sikkim Confectionery	Tibet Road, Gtk.	Bakery	1.25
S.I.T.C.O	Deorali	Watches	857.54	Sikkim Emporium	Old Market	Photo copying	1.30
1985-86				Trokhang Handcraft Centre	Dev. Area Gtk.	Handcrafts	0.25
Denzong Electrical	P.S.Road, Gtk.	Fabrication	1.00	Tadong Oil Enterprises	Tadong	Oil Mill	0.50
Orient Studio	Gangtok	Photo Studio	2.00	Trend Aperial (P) Ltd.	New Market	Shirts	9.50
Rice Dehusking Mill	Tareything	Mill	0.42	S.Kumar	Singtam	Ice Candy	0.35
Step-in Style	New Market,						

Name of Unit Year wise	Address	Item	Total Invest. (Rs. In lakhs)	Name of Unit Year wise	Address	Item	Total Invest. (Rs. In lakhs)
Abu Kazi Sakya Sons	New Market	Statue	0.35	1992-93			
Pradhan Noodles	Rhenock	Noodle	0.30	Carnation Tailoring House	Arithang	Garments	0.12
Samdup Norling	Tibet Road	Noodle	0.22	Karma Carpet Weaving unit	Deorali	Carpet	0.15
Snow Lion Enterprises	Nam Nam	Jackets	1.00	Savana Printers	Arithang	Printing	0.39
Sitam Enterprises	Diesel Power House	Fabrication	0.30	Aden Cotton & Woolen mfg. Works	Nam-Nam	Shocks	2.00
Soma Knitting Centre	Chandmari	Knitting	0.40	Kurseong Handicrafts	Tathangchen	Handicrafts	0.29
Srena Industrial Co. (P) Ltd.	Tadong	Printing	19.50	Atlas Mfg. Co.	Shop No. 9 Super Mkt.	Tent, Jackets	0.25
Siran Electro Copier	New Market	Photo Copying	1.25	Denzong Chalks	Tathangchen	Chalks	0.70
Sarma Auto Works	Lower Tadong	Auto Workshop	0.60	Sukhim Handloom Ind. (P) Ltd.	Gauge & Bandage	Arithang	0.00
Shawani Shoe Factory	P.S. Road, Gtk.	Shoe	0.10	Sikkim Shoe Factory	Dev. Area, Gangtok.	Shoe	2.00
Shandi Villa Mill	Rumtek	Mill	0.35	Sarpeth Electronic Ind. Co-op Soc. Ltd.	Bye-pass	T.V	0.00
Shakadeep Press & Publication	PNG Road	Printing	0.35	Aho Yangtam Rice Mill	Ranipool	Rice Mill	0.40
Sharin Rice Atta & Chewra Mill	Samdong	Mill	0.30	Pratibimba Prakashan	Hotel Himalchuli	Printing	0.53
Sip & Sip Pepsi	Rangpo	Ice Candy	0.25	1993-94			
Saicksmithy Industrial Automobile	Taxi Stand Gtk.	Fabrication	0.30	Laxmi Rice Mill	Rhenock	Rice mill	0.58
1990-91				Aritar Rice mill	Aritar	Rice mill	0.55
Sikkim Pangden Centre	Baluwakhani	Pangden	0.12	Rngzare (P) Ltd.	Tadong	Shirts	14.16
Bijoy Furniture	Pani House, Gtk.	Furniture	0.10	Ramesh & Brothers	Tibet Road, Gangtok	Elec. Servicing	2.45
Shanti Knitting House	Deorali	Knitting	0.20	Eastern Computer & System (P) Ltd.	PS Raod, Gtk.	Data Processing	1.54
Kanchenzonga Steel Furniture Industries	Singtam	Furniture	2.00	Sikkim Food Processing Ind.	Deorali	Meat products	17.55
Shiva Printers	Diesel Power House	Printing	1.50	Mehnam Commercial Co. (P) Ltd.	Bagey Khola Singtam	Dolomite Ice Cream	7.78 1.20
Laxmi Furnitures	Raleykhasey	Furniture	0.30	Nyeupaney	Tadong	Ice Cream	1.20
Sidhant Prakasan	Deorali	Printing	0.85	Inderhill Paper works & Printing	P.S. Road, Gtk.	Printing	2.19
Ruth Enterprises	Singtam	Tarpoline	1.75	Baldas Rice mill	Khamdong	Rice mill	0.40
Pradhan Species Mill	Duga Busty	Masala	0.40	Ruth Karthak	Singtam	Bakery	4.25
Samuna Knitting House	Arithang	Knitting	0.70	Kanchenzonga Tibetan Med.& Herbs	Arithang	Tibetan Med.	2.90
Samro Auto Works	Arithang	Auto Workshop	1.10	Susimarts	Tibet Road	Arts	0.07
Cosmic Carpet	Rumtek	Carpet	0.15	Rajen Enterprise	Tibet Road	Ice candy	0.72
SKM Informatics Centre	Church Road Gtk.	Data Processing	1.00	Phempo Thukpa Lhasa Tailors	Tibet Road Childrens Park	Noodle	0.37
1991-92						Garments	0.45
Saiga Handicrafts Centre	Chandmari	Handicrafts	1.00	Sikkim Traders	Tadong	Rubber stamp	0.09
Pines Printers	Chruch Road, Gtk.	Printing	0.41	Guru Thanka	Chandmari	Thanka	0.07
Ranzong Noodle Factory	Diesel Power House	Noodle	0.21	Bijoy Printers	Tibet Road	Printing	5.20
Shankar Rice Mill	Below Ranka	Rice Mill	0.39	Dikkery Ind. (P) Ltd.	Deroali	Rice mill	0.50
Samdong Rice Mill	Samdong	Rice Mill	0.69	Hill Construction (P)Ltd.	Bordong, Singtam	Stone chips	7.50
Everest Steels (P) Ltd.	Singtam	Steel furniture	13.20	G.P.S Masala	Sichey Busty	Masala	0.23
Sikkim Ispat Udyog (P) Ltd.	Majitar	Rods	93.00	Garg mill	Rhenock	Rice mill	0.73
Serdup Soft Drinks	Kazi Road, Gangtok.	Cold Drinks	0.00	Extender Food Processing (P) Ltd.	Tadong	Extuder Food	63.00
Gangtok International Handicrafts	Kazi Road	Handicrafts	0.15	Pentaprism Colour Lab.	New Market	Colour Lab.	0.00
Baichung & Bros Mill	Pakyong	Rice mill	0.95	1994-95			
Himalayan Printing Press	Deorali	Printing	1.35	Singnotron (SKM) (P) Ltd.	Dev. Area, Gtk.	Calculator	3.00
Horbuling Tibetan Tailor	Tibet Road	Garment	0.31	Essel Cable	Tibet Road	Cable TV	0.00
Devika Enterprise	Below Krishi Bhawan	Sign Boards	0.50	Himalayan truck body builder	Majitar	Truck body	0.54
Rainbow Printing Press	Arithang	Printing	0.42	Thapa Mill	Makha	Rice mill	0.35
Tashi Carpet Centre	Burtuk	Carpet	0.42	Bereah Printing &			

Name of Unit			Total Invest.	Name of Unit			Total Invest.
Year wise	Address	Item	(Rs. In lakhs)	Year wise	Address	Item	(Rs. In lakhs)
Stationery	Deorali	Printing	0.47		Singtam	Automobile	0.65
D.P. Watch	Tadong	Watch repair	0.17	1996-97			
Rupshree	Above, church,			Thupden Cable	Tathangchen	Cable TV	0.85
Enterprise	Gtk.	Fabrication	0.60	Zigden Carpet Weaving	Chandmari	Carpet	0.16
Mayal Cotton Mills (P) Ltd.	Andhery	Khada	0.00	Ruchi Diagnostics & Clinics (P) Ltd.	Gangtok	X-Ray Clinic	15.75
Samrat Furniture	Upper Sichey	Furniture	0.88	United Tyre Resole	Singtam	Tyre resole	4.85
Tripti's (P) Ltd.	Deorali	Bakery	11.00	Kancherzonga Electrical Works	Tibet Road	Tyre resole	0.65
Rai Auto Electricals Workshop	Tibet	Battery		T.T. Auto Works	Bye-pass	Automobile	1.10
Saru Trunk House	Tadong	Zink trunk	0.02	Galaxy Cable TV			
Frontier Publication	Tibet Road	Printing	0.00	Net works	PNG Road	Cable TV	4.85
Climatic Zone	Baluwakhani	Jackets, etc.	0.21	Ongcuk Cable	Tathangchen	Cable TV	1.10
Silicon informatics System Ltd.	Tadong	Computer	0.00	Lama mill	Pakyong	Rice mill	0.82
Karma Rice & Oil Mill	Ranka	Rice mill	0.80	Eminence India Ltd.	Gangtok	Tea Packaging	0.20
Silvanas Enterprise	Deorali	Printing	0.00	SBL (SKM) (P) Ltd.	Majitar	Herbal Shampoo	10.20
Tenzing Wooden Furnitures	Cahngey	Furniture	0.07	Cyber Print & System	Children Park, Gangtok	Data Processing	7.80
Unique	Gangtok	Sweets	0.00	Big Byte Computer System	Tibet Road	Computer	3.55
1995-96				L.N Cable TV Network	Rangpo	Cable TV	1.85
Sarala Carpet Unit	Rhenock	Carpet	0.00	L.D Enterprise	Deorali	Fabrication	0.76
Sikkim Carpet International (P) Ltd.	Singtam	Carpet	6.28	SC Cutting & Tailoring Co. Soc. Ltd.	Tibet Road	Garments	0.67
Pretty Printing Press	Tibet Road	Printing	1.30	Ladaki Agro Chem (P) Ltd.	Bagey Khola	Dolomite Powder	9.10
Candle Light Industries	Tadong	Candle	0.13	Kalpna Creations	Housing Colony	5 th mile Bed cover	0.85
Shree Ganesh Candle Industry	Rhenock	Candle	1.35	Somani Enterprises	New Market	Photo Lab	9.55
Bhawani Mill	Chujachen	Rice mill	0.55	1997-98			
Jungdhari Shoe Factory	Tibet Road	Shoe	0.17	North East Agencies	Old Market	Garments	1.55
Loday Factory	Lal Market	Thanka	0.20	Orient Xerox Centre	P.S. Road	Photo copying	1.95
Dilliram Electronics Repairing Center	Singtam	Watch repair	0.06	Shyam Madia Enterprises	Sonam Gyatso Marg	Painting	0.25
Lakhi Enterprise	Tibet Road	Garments	0.30	1998-99			
Sonu Enterprise	Development Area, Gangtok.	Printing	1.00	Kancherzonga Chemicals (P) Ltd.	Majitar, Rangpo	Paint Thinner	6.00
Metro print	Gangtok	Data processing	7.00	Star Computer & Communication System	SG Marg, Gtk.	Software Dev., etc.	5.51
Amritta Knitting Centre	Deorali	Knitting	0.20	France Himalayan Foods	Mando Bazar, Singtam	Noodle	1.15
Gupta Cold Drinks	Mandi, Rangpo	Cold drinks	0.20	Nancy's Queen Koshilee	Singtam	Automobile	0.60
Khanal Enterprise	Pachey Khani, Pakyong	Envelope	0.80	Kancherzonga Floor Mills	Tadong	Mill	38.83
Simpal's press	Tibet Road	Printing	0.70	Bishwakarma Furniture House	Near SBI, Tadong	Furniture	0.68
Deep printers	Lower Burtuk	Printing	1.55	Profile Beauty Parlour	MG Marg, Gangtok	Parlour	2.00
Jai Enterprises	Tibet Road	Printing	1.10	1999-2000			
Kancherzonga Noodle Factory	Nam Nam	Noodle	0.85	Mount Distilleries Ltd.	Majitar	Liquors	
Bonny Chips	Gangtok	Potato Chips	1.35	Himalaya Distilleries	Majitar	Liquors	
Tenzing Furniture	Arithang	Furniture	0.20	National Cable TV	Singtam	Cable TV	
Rajala Tea	Rangpo	Tea Packaging	0.95	Paras Manufacture Co.	Middle Camp	Liquors	
Champion Shoe Factory	Gangtok	Shoe	0.45	Gyasaan Thangkas	Arithang	Thankas	
Popular Ice Cream	Ranipool	Ice cream	0.60	Pradhan Mill	Pakyong	Mill	
Tshering Diki Steel Furniture Enterprise	Tadong	Steel Furniture	0.45	Deepak Mill	Rangpo	Mill	
Zeekay Publishers	Arithang	Printing	2.20	STP Pharmaceuticals (P) Ltd.,	Sangkholo, Singtam	Pharmaceuticals	
Karma Candle Factory	Singtam	Candle	0.60	Envision (P) Ltd.	P.N.G Road	Computer	
Sanjivani Services (P) Ltd.	31 National Highway, Gtk.	Data Processing	1.10	Rahul Tyres	Ranipool	Tyre Resoling	
Triveni Prakashan	Dev. Area	Printing	0.85	Denzong Laboratories			
Bhuchok Tailor	Lal Market	Garments	0.20				
Sharma Auto Works	Goletar,						

Name of Unit Year wise	Address	Item	Total Invest. (Rs. In lakhs)
(P) Ltd.	Majitar	Lab.	
Bhawana Food Product	Kamarey	Busty Confectionery	
Quality Photocopy	Rongli	Photocopy	
Utam Cold Storage	Bazar Majitar	Cold Storage	
2000-2001			
Sinex (P) Ltd	Dev. Area	Watch	
Naya Haichal Prakhari	Tadong	Printing	
Kwality Stores	Gangtok	Printing	
Kasturi Engineering Works	Pani House, Gnk.	Fabrication Fruit	
Govt. Fruit Preservation Factory	Singtam	Processing	
Srishti Samiti	Jalipool	Jute Processing	
2001-2002			
Yang Lha Tailor	M.G. Road, Gangtok	Tailoring	0.30
Thanka Centre	Fatak, Bhojogari	Thanka paining	0.60
Zoom Colour	M.G. Marg, Gangtok	Photo Lab.	794.00
Acefal Pvt.Ltd.	P.S. Road, Gangtok	Computer	
Sumis Atta Mills	Radong Busty, Ranipool	Mill	0.80



Member Secretary, SPCB, S. T. Lachungpa, IFS, addressing a gathering



Assistant Scientific Officer Shri B. K. Chetri carrying out on-the-spot analysis



Senior Scientist Dr. Gopal Pradhan explaining the board members



Public Hearing on construction of airport at Pakyong



Environment Awareness programme at School



Vehicular emission check

VEHICULAR POLLUTION CONTROL

The commercial, tourism, defence and day to day activities has caused an exponential growth in the increase in the vehicular population. The total number of vehicles at present is 20807 and the year wise increase in growth is shown in the table:

Sl no.	Classification of Vehicles	YEAR			
		1994	1999	2000	2003
1.	Two wheelers (scooter and Motor cycle)	-	-	-	4617
2.	Private and Govt. Vehicles	-	-	-	8846
3.	Goods carrier/construct carrier	-	-	-	2214
		6945	14688	19,017	20807

VEHICULAR EXHAUST EXCLUSION STANDARD.

The Automobile manufacturing industries has been directed by the MoEF " that the vehicles manufacturers by them is capable of complying with the mass emission standard notified by the Govt. of India under the motor vehicle Act, 1988".

Section 115 (2) of the Central Motor Vehicle Rules, 1989 Specifies the following automobile exhaust standards :

Emission	Pollutants	Health Effects	
Unburnt Hydrogen	Oxidants	Difficulty in Breathing	Impaired Lung functions
Nitrogen Oxides	NO ₂	Sore throat, and coughing	Lung cancer
Sulfur dioxides	SO ₂	Asthma	Lung cancer
Particulate matter	SPM	Asthama	Silicoses
Carbon monoxide	CO	Asphyxiation level of 2.5%	Fatal at COHb
In-organic Lead	Pb	Disorders of Kidney and Lever, Gastro intestinal damage.	Mental impairment

VEHICULAR EXHAUST MONITORING

The State of Sikkim has two automobile smoke testing centers. One for petrol at Deorali and the other for diesel vehicles at SNT complex, Gangtok.

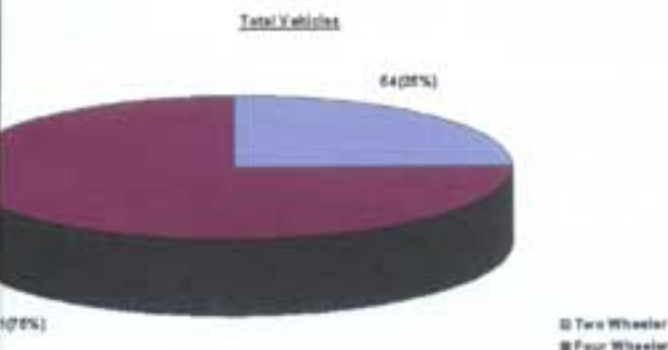
The State Pollution Control Board has procured a instrument (gas check 2000) to monitor the emission of petrol under the centrally sponsored scheme "Strengthening of State Pollution Control Board".

The State Pollution Control Board, Sikkim has been carrying out vehicular emission checks to assess the percentage of vehicle complying with the standard. A sample check result has been provided.

Petrol driven vehicles monitored for CO%

Sl. no.	Type of Vehicle	Total Vehicle Monitored	CO	
			Total Vehicle Complying the Standards	Total Vehicle Not-complying the standards
1.	Two wheeler	54	48	06
2.	Four wheeler	161	132	29
	Total	215	180	35

Altogether 83.72% of the petrol driven vehicles were meeting the specified standards and 16.27% of the petrol driven vehicles were not meeting the stipulated standards.



DIESEL DRIVEN VEHICLES

A total number of 90 diesel driven vehicles were monitored which included Buses, Lorries, Mini Lorries, Commander jeeps etc., of different makes at peak hour in commercial and traffic area. It was observed that 78 vehicles (86.66%) were meeting the standards. However, 12 vehicles (13.33%) failed to meet the standards. Details of the above data are shown in the table below.

Petrol driven vehicles monitored for Smoke density in HSU.

Type of Vehicle	Total Vehicle Monitored	Smoke Density (HSU)	
		Total Vehicle Complying the Standards	Total Vehicle Not-complying the Standards
Four wheeler	90	78 (86.66%)	12 (13.33%)
Total	90	78 (86.66%)	12 (13.33%)



AUTOMOBILE EXHAUST

Schl.IV, E(P) Rules, GSR 54(E) dt. 5.2.90

Petrol driven vehicles

- Idling CO emission limit for all four wheeled petrol driven vehicles shall not exceed 3 percent by volume.
- Idling CO emission limit for all two and three wheeled petrol driven vehicles shall not exceed 4.5 percent by volume.

Diesel Driven Vehicles

Test method	Maximum smoke density		
	Light absorption Co-efficient (M)	Bosch unit	Hartridge unit
(A) Full load at a speed of 60% to 70% of maximum engine rated speed declared by the manufacturer.	3.1	5.2	75
(B) Free Acceleration	2.3	-	65

1.2.4(77)* Specifications of Petrol E(P) Rules Schl. -VI, GSR 176 (E) dt. 2.4.96

Sl. No.	Characteristics	Requirement	Method of Test Page of I.S. 1448
(i)	Reid vapour pressure at 38°C, Kpa	35 to 70	P:39
(ii)	Benzene, percent by volume, max.	5.0*	P: 104
(iii)	Lead content (as Pb), g/l. max.	0.15 (low leaded)** 0.013 (unleaded)	P: 38
(iv)	Sulphur, percent by mass, max.	0.10 (unleaded) 0.20 (leaded)	P: 34
(v)	Potential gum, g/m ³ , max.	50	ASTM 873:8
(vi)	Gum (solvent washed), g/m ³ , max.	40	P: 29
(vii)	Oxygenates Content Ether (MTBE, ETBE) Alcohol, percent by volume, max.	15	
(viii)	Phosphorus	***	ASTMD 3231

* 3.0 percent by volume maximum in metro cities by 2000 AD

** 0.15 g/l by 31st December, 1996 (for entire country)

0.013 g/l by 1st April 1995 (in four metro cities);
by 1st December, 1998 (for all State capitals/UTs and major metro cities) and by 1st April, 2000 for the entire country.

*** Phosphorus containing additives shall be absent.

Note:

(a) Above specifications apply to leaded as well as unleaded petrol except lead content.

(b) For new refineries coming up during or after 1997 the specification applicable by 2000 for existing refineries shall be applicable by 1997.

1.2.5(78)* Specifications of Diesel E(P) Rules, Schl.- VI, GSR 176 (E) dt. 2.4.96.

Sl. No.	Characteristics	Requirement	Methods of Test Page of IS: 1448
(i)	Density at 15°C, Kg/m ³	820 to 880*	P : 32
(ii)	Cetane number, min.	45.0**	P : 9
(iii)	Distillation 85 percent by volume recovery at 0°C, max	350	P : 18
		95 percent by volume recovery at 0°C, max.		370
(iv)	Sulphur, percent by mass, Max.	0.50***	P : 33

Note:

- (a) Above specifications apply to HSD only.
 (b) For new refineries coming up during or after 1997 specifications applicable by the year 2000 for existing refineries shall be applicable by 1997.

*Number within bracket, in all cases, is the serial number in the notification of the Govt. of India

DIESEL EXHAUST PARTICLES AND ITS HEALTH EFFECTS

The popularity of the diesel engine in heavy duty applications in trucking, rail road, marine transport, DG sets and construction industry is due to both its fuel efficiency and long service life relative to the gasoline engine. Compared with gasoline engine, diesel emissions are lower in carbon monoxide (CO), hydrocarbon (HC) and carbon dioxide (CO₂), but higher in oxides of nitrogen (NO_x) and particulate and gaseous phase. Diesel exhaust has particulate with mass median diameter of 0.05 to 1.00 micrometer, a size rendering them easily respirable and capable of depositing in the airways and alveoli. The particles consist of a carbonaceous core with a large surface area to which various hydrocarbons are absorbed, including carcinogenic polycyclic aromatic hydrocarbons (PAHs) and Nitro-PAHs that have elicited the most concern with respect to human health. The gaseous phase contains various products of combustion and hydrocarbons including some of the PAHs present in the particle phase. Once emitted, components of diesel exhaust undergo atmospheric transformation in ways that may be relevant to human health. For example, nitro-PAHs, created by the reaction of directly emitted PAHs with hydroxyl radicals in the atmosphere can be more potent mutagens and carcinogens and more bio-available than their precursors. A study undertaken by a Swedish Consultancy, Ecotrafic (Peter Ahlvik and Ake Branberg, 1999) has shown that the cancer potency of diesel vehicles is more than two times than that of petrol vehicles in India. But if only most harmful of the exhaust

Health Effects of Diesel Exhaust

Emission Component	Atmospheric Reaction Products	Biological Impact
VAPOUR PHASE EMISSIONS		
Carbon dioxide	-	Major contributor in global warming
Carbon monoxide	-	Highly toxic to humans, blocks oxygen uptake.
Oxides of nitrogen	Nitric acid, ozone	Nitrogen dioxide is a respiratory tract irritant and major ozone precursor. Nitric acid contributes to acid rain.
Sulphur dioxide	Sulphuric acid	Respiratory tract irritation. Contribution to acid rain.
Hydrocarbons	-	-
Alkanes (<C ₁₄)	Aldehydes, Alkyl nitrates, ketones	Respiratory tract irritation. Reaction products are ozone precursors (in the presence of NO _x)
Formaldehyde	Carbon monoxide hydroperoxy radicals	Formaldehyde is a probable human carcinogen and an ozone precursor (in the presence of NO _x)
Acrolein (Higher Aldehydes)	Peroxyacyl nitrates	Respiratory tract and eye irritation, causes plant damage.
Monocyclic aromatic hydrocarbons (e.g benzene, toluene)	Hydroxylated and hydroxylated nitro derivatives.	Benzene is toxic and carcinogenic in human. Some reaction products are mutagenic in bacteria (Ames assay)
PAHs (< 4 rings) (e.g phenanthrene, fluoranthene)	Nitro PAHs (< 4 rings)	Some of these PAHs and nitro PAHs are known mutagens and carcinogens.
Nitro PAHs (2 & 3 rings) e.g nitronaphthalene	Quinones and hydroxylated nitro derivatives.	Some reaction products are mutagenic in bacteria (Ames assay)

PARTICLE PHASE EMISSIONS

Elemental Carbon	-	Nuclei adsorb organic compounds; size permits its transport deep into the lungs (alveoli).
Inorganic sulphate	-	Respiratory tract irritation
Hydrocarbons (C ₁₀ -C ₂₈)	Little formation, possibly aldehydes, ketones and alkyl nitrates.	Unknown
PAHs (> 4 rings) e.g. perylene, benzo (a) pyrene)	Nitro-PAHs (> 4 rings), Nitro-PAH lactones	Larger PAHs are major contributors of carcinogens in combustion emissions. Many nitro-PAHs are potent mutagens and carcinogens.
Nitro-PAHs (> 4 rings) e.g nitropyrenes	Hydroxylated nitro derivatives	Many nitro-PAHs are potent mutagens and carcinogens. Some reaction products are mutagenic in bacteria (Ames assay).

emissions, that is particulate emission is considered, the carcinogenic effect of one new diesel car is equivalent to 24 petrol cars and 84 new CNG cars on the road.

The monthly consumption of Pol & LPG within the State and the statement showing the detail of forest produce extracted by the Forest Deptt., (Utilization Division) Govt. of Sikkim that contribute to air pollution is shown in the corresponding tables.

**MONTHLY UPLIFTMENT OF POL FROM RANGPO DEPOT IN THE STATE OF SIKKIM,
(THE UPLIFTMENT INCLUDED WITH LOC, IBP & HPC ONLY)**

MONTH YEAR	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	TOTAL
1999-00													
MS	576	540	477	405	354	462	483	540	703	366	375	450	5731
SKO	690	1449	1248	1230	1347	1293	1314	1722	1534	1392	1338	1830	16387
HSD	1375	1396	1260	1194	1521	1253	1189	1255	1467	1282	1325	1815	16332
2000-01													
MS	543	462	375	363	339	668	414	435	501	297	240	606	5243
SKO	1098	1344	1158	1161	1121	1392	1671	1698	972	1848	1218	1461	16142
HSD	1264	1502	1269	1058	1114	1234	1088	1302	1257	1300	1135	1439	14962
2001-02													
MS	291	414	516	201	243	348	309	306	240	366	348	460	4042
SKO	1317	1221	876	1056	1029	1095	1242	1239	752	1398	1338	773	13336
HSD	1253	1464	1504	1002	1085	1045	1207	1357	1306	1651	1395	1696	15965
2002-03													
MS	555	543	453	357	312	271	369	469	303	300	387	461	4773
SKO	1410	1338	527	1155	864	1256	1023	1329	1123	993	804	969	12791
HSD	1712	1954	1625	1411	1577	1507	1907	1708	1698	1706	1495	1849	20149

LPG CONSUMPTION IN SIKKIM

Year	Month	No. of Cylinders
1996	November	352
	December	7042
1997	January	11408
	February	12606
	March	12606
	April	15391
	May	15989
	June	12413
	July	15189
	August	15006
	September	8393
	October	16579
	November	18230
	December	16997
1998	January	16809
	February	17202
	March	16996
	April	12198
	May	13338
	June	15194
	July	20204
	August	14803
	September	7192
	October	22213
	November	18787
	December	16601
1999	January	17975
	February	18760
	March	18885
	April	18303
	May	19408
	June	17814
	July	19407
	August	18804
	September	18802
	October	16414
	November	22405
	December	24405

Year	Month	No. of Cylinders
2000	January	20196
	February	23612
	March	26193
	April	20200
	May	24600
	June	21999
	July	21611
	August	22391
	September	23201
	October	21590
	November	26797
	December	26596
2001	January	24609
	February	22405
	March	30587
	April	21993
	May	31790
	June	26208
	July	24412
	August	26585
	September	25783
	October	28185
	November	33170
	December	30787
2002	January	28594
	February	30794
	March	30776
	April	29571
	May	34946
	June	34181
	July	30198
	August	30793
	September	31620
	October	31000
	November	38318
	December	35968
2003	January	38977
	February	36166
	March	40152

Financial year	Total (No. of Cylinders)	Percentage increase % (annual)
April 1996 to March 1997	44014	-
" 1997 to " 1998	185213	321%
" 1998 to " 1999	196150	6%
" 1999 to " 2000	245756	25%
" 2000 to " 2001	286585	17%
" 2001 to " 2002	339077	18%
April 2002 to March 2003	411895	17%

STATEMENT SHOWING THE DETAIL OF CHARCOAL & FIREWOOD EXTRACTED DURING THE YEAR UNDER UTILISATION DIVISION

Sl.no.	Year	Charcoal	Firewood	Timber
1	1998-99	180 bags	58 piles	1004.75 cf
2	1999-00	620 "	151 "	1535.52 "
3	2000-01	245 "	800 "	4500.00 "
4	2001-02	77 "	1500 "	20.100 "
5	2002-2003	131 "	569.4 "	12.125 "

Consumption/ Utilization of Water For Domestic and industrial purpose through P.H.E.

Sl. No.	Name of Towns	Projected population including floating population 1990		Utility Capacity MLD (1992)	Service Level LPCD (1992)	Covered population 1992	Projected population including floating population 2001		Desired utility capacity	Projected population 2020		Remarks				
		Population 1990	Institution 30%				Population 2001	Institution 30%		Population 2020	Institution -n 30%		Balance Population (Augmentation)			
													Total	Total	2001	2020
1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18
1	Gangtok	63257	19377	84634	10.156	50000	180195	50004	10254	20.090	233188	75656	328144	74501	278291	
2	Jorethang	10393	2119	12512	1.400	20%	11158	2531	13389	1.879	19666	4664	27986	9529	17955	
3	Singtam	8897	1777	10674	0.970	110	6932	1352	9313	1.300	13609	3013	23479	6424	16514	
4	Baramba	6182	1236	7418	2.500	237	5418	1152	6570	1.400	8722	2722	16331	5276	12284	
5	Namchi	5679	1136	6815	1.820	262	8519	2643	11453	1.900	22262	6679	29941	-	15951	
6	Gyalshing	2629	615	3244	0.180	37	4079	1224	5303	0.740	10307	3092	13389	4013	12113	
7	Naya Itanagar	1763	337	2100	0.200	70	3461	772	4633	0.650	6770	1354	8124	2792	6283	
8	Mangan	5828	-	5828	0.130	61	2766	83	3590	0.500	6966	2097	9087	2650	6437	
	Total	58828	-	64594	7.268	35315	51375	-	63647	8.890	102826	-	137747	27086	89246	
	Rural Marketing Centers															
1	North-South	837	165	992	0.180	992	1283	237	1840	0.210	3241	648	3889	255	2603	
2	Changthang	1690	338	2028	0.560	2028	2122	424	2546	0.360	3721	744	4465	-	454	
3	Old & New	118	63	179	0.038	179	347	79	476	0.068	696	139	835	204	563	
	Total	118	63	179	0.038	179	347	79	476	0.068	696	139	835	204	563	

Sl. No.	Name of Towns	Projected population including floating population 1990		Utility Capacity MLD (1990)	Service Level LPCD (1990)	Covered population 1990	Projected population including floating population 2001		Desired utility capacity	Projected population 2020		Remarks				
		Population 1990	Institution 30%				Population 2001	Institution 30%		Population 2020	Institution 30%		Balance Population (Augmentation)			
													Total	Total	2001	2020
1	2	3	4	5	6	8	9	10	11	12	13	14	15	16	17	18
1	Lachung	1528	306	1834	0.140	996	1918	384	2302	0.322	3363	673	4036	1304	3038	
4	Lachen	1134	227	1361	0.060	44	1424	283	1709	0.238	2407	499	2906	1277	2504	
5	Pingthang	1422	284	1706	0.313	1386	1765	357	2142	0.299	3129	262	3355	1322	2935	
6	Pentong	386	77	463	0.043	321	434	87	561	0.080	648	170	1019	253	691	
7	Rangpoel	1279	256	1535	0.575	1535	1666	321	1927	0.308	2818	563	3379	-	682	
8	Pakyong	1279	256	1535	0.500	1535	1666	321	1927	0.360	2613	504	3117	438	4376	
9	Rhenok	2157	471	2628	0.350	2501	2928	592	3531	0.400	5189	1038	6227	1062	4258	
10	Rangsi	1333	271	1624	0.200	1426	1698	340	2038	0.280	2977	595	3572	610	2144	
11	Sang	1372	284	1656	0.156	974	1471	294	1765	0.247	2579	516	3095	779	2390	
12	Rovang	1172	234	1406	0.090	643	1471	294	1765	0.247	2579	516	3095	1114	2444	
13	Mithali	1172	234	1406	0.103	733	1471	294	1765	0.247	2579	516	3095	1013	2333	
14	Camp	1172	234	1406	0.136	974	1471	294	1765	0.247	2579	516	3095	795	2123	
15	Makha	1172	234	1406	0.136	974	1471	294	1765	0.247	2579	516	3095	1883	-	
16	Baramba	713	143	856	-	-	801	179	1074	0.130	1569	314	1883	-	4034	
17	Arjar	2224	443	2669	0.237	66	2792	558	3350	0.469	4904	978	5873	1711	4034	
18	Marian	1084	399	1483	-	-	2504	501	3005	0.420	4390	878	5285	-	-	

Sl. No.	Name of Town	Projected population including floating population 1990			Utility Capacity MLD (1990)	Service Level LPFD (1990)	Covered population 1990	Projected population including floating population 2001			Desired utility capacity	Projected population 2020			Balance Population (Augmentation)		Remarks
		Population 1990	Institution 30%	Total				Population 2001	Institution 30%	Total		Population 2020	Institution 30%	Total	2001	2020	
1	2 (WEST)	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	Changu	1258	251	1508	0.160	186	1142	1578	316	1994	0.203	2768	553	3319	743	2176	
20	Fingthip	1069	214	1283	0.150	117	1072	1342	268	1610	0.555	2353	471	2824	816	1705	
21	Southbata	969	214	1283	0.131	150	915	1342	268	1610	0.222	2353	471	2824	816	1705	
22	Duonem	402	80	482	0.113	78	482	805	101	606	0.084	885	172	1062	-	252	
23	Kalok	1072	214	1286	0.241	302	882	1343	269	1614	0.235	2358	472	2830	-	-	
24	Soring	1970	394	2364	0.116	68	1722	3056	611	3667	0.051	722	1444	956	1952	7551	
25	Hre	1419	284	1703	0.110	78	827	1791	356	2137	0.299	3122	624	3746	1303	2912	
26	Himachong	1719	344	2063	0.160	110	1149	1652	330	1982	0.327	2806	560	3476	816	2359	
27	Himachong	1136	227	1363	0.124	96	1071	1425	285	1710	0.239	2408	471	2879	622	1010	
28	Utarey	1071	214	1285	0.200	133	803	1344	269	1613	0.275	2356	471	2827	728	1942	
29	Kashi	1256	250	1506	0.200	133	1435	1569	314	1883	0.283	2780	550	3330	454	1871	
30	Dumachin	1072	214	1286	-	-	-	1343	269	1614	0.225	2358	472	2830	-	-	

Sl. No.	Name of Town	Projected population including floating population 1990			Utility Capacity MLD (1990)	Service Level LPFD (1990)	Covered population 1990	Projected population including floating population 2001			Desired utility capacity	Projected population 2020			Balance Population (Augmentation)		Remarks
		Population 1990	Institution 30%	Total				Population 2001	Institution 30%	Total		Population 2020	Institution 30%	Total	2001	2020	
1	2 South	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
31	Melli	2636	527	3163	0.205	96	2169	3509	662	3971	0.555	5303	1160	6463	1791	4781	
32	Rabongla	838	168	1006	0.183	183	1066	1790	260	2050	0.218	3283	657	3942	238	3610	
33	Dumachong	327	65	392	0.034	87	244	413	82	495	0.068	720	144	864	247	618	
34	Taru	723	145	868	0.084	96	603	906	182	1090	0.152	1592	318	1910	892	1312	
35	Mazitar (s)	807	161	968	0.093	96	664	1013	203	1216	0.170	1776	353	2129	945	1464	
36	Kertaru	433	87	520	-	-	-	544	109	653	0.031	854	191	1045	-	-	
37	Kewang	588	118	706	0.086	96	484	738	148	886	0.124	1264	254	1518	808	1087	
38	Yongthang	1018	204	1222	0.140	115	1004	1277	255	1532	0.214	2299	448	2847	335	1650	
39	Namthang	807	161	968	-	-	-	1013	203	1216	0.170	1776	353	2129	-	-	
40	Mamcan	591	118	709	-	-	-	657	130	787	0.100	1143	229	1372	-	-	
	Total:	46464	-	55755	6	4882	36656	59184	-	71219	8	109658	-	112092	23992	75438	