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ENVIRONMENTAL SURVEY AND AUDIT OF A CORPORATE TRAINING CENTRE AT LONAVLA, INDIA

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ABSTRACT

A comprehensive environmental study was carried out at for a corporate training centre at Lonavala, India. The baseline environmental status was assessed based on primary and secondary data collected through on-site field observations. Attributes of the physical environment like air, water, soil, air microflora and noise quality in the surrounding area were assessed, primarily through field studies, and by undertaking monitoring and analysis of samples collected from the field. Various methods have been used for environmental auditing namely report collection and interviews and site survey was used for the audit of compliance with National Laws and regulations on Health, Safety and Pollution Prevention Systems. The following environmental components were focused during this study: a. Air Environment (Ambient Air Quality, Stack monitoring, Microflora diversity etc.); b. Noise monitoring; c. Water Environment (Drinking water, Municipal water, Municipal sewage wastewater); d. Water leakage and Mold infection; e. Land Environment (Land use, Solid Waste generation and characteristics, Heavy Metals contents in soil/plant); f. Water consumption minimization and Electricity consumption. The extensive environmental survey including selection of site for sampling were carried out to understand the environment prevailing in the area. Information on various aspects such as electricity consumption, DG sets, solar energy, Municipal sewage water, drinking water, water treatment technology, solid waste transportation, etc have been reported.

INTRODUCTION

Maintaining a clean environment with regard to water, air and soil around any Industrial complex or supporting facilities is prime responsibility of Industries, which is not only required to meet various legislations in force but also as responsibility towards health of employees and surrounding public. With this objective in mind a detailed Environmental Survey and Audit was carried out in a large Corporate Training Centre at Lonavala, India during 2011.

MAIN OBJECTIVES

The study (Audit and Survey) was carried out keeping following objectives:

a. Ambient air monitoring at representative location in and outside the premises for all necessary parameters as per revised and latest norms of Ministry of

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Environment and Forests, Govt. of India.
b. Stack monitoring on all the existing stacks for all parameters as specified in the latest Guidelines by State Pollution Control Board.
c. Noise monitoring inside the campus.
d. The air pollution monitoring for all DG(Diesel Generators) sets stacks
e. Indoor air monitoring at all representative sites in the industry for physico- chemical and biological parameters
f. Drinking water quality check-up at representative sites and points for all parameters as per IS standards including heavy metals, all toxic compounds and comprehensive biological and /microbiological contamination
g. Quantification of all wastewater and characterization for all necessary parameters relevant and legally binding to the type of operation, flow measurement, composite sample analysis for all parameters
h. Detailed study of all existing wastewater treatment plants (sewage and industrial) for their performance by repeated sampling for all necessary parameters and a complete review of state of treatment plants for civil, mechanical and electrical compnents. This will also include complete study of past performance from the existing data
i. Detailed study of all treated wastewater (sewage and industrial) disposal practices and their impact on environment. Detailed study of soils where treated wastewater is used for gardening
j. Detailed study of all sludge disposal methods and their impact on local environment.
k. Complete water and wastewater audit by detailed study of water consumption, waste generation patterns, treatment, reuse etc
l. Detailed study of solid waste generation (hazardous and non- hazardous) from the concerned industry, quantification and characterization
m. Complete study of disposal /treatment practices for all solid wastes
n. Preparation of a comprehensive Environmental status / audit report for the concerned industry and suggestions for improvement for every component. This will includes suggestions for future environmental monitoring schedules for legal compliance, water consumption minimization/reuse opportunities, waste minimization (solids and liquids), steps necessary for improving the performance of existing air pollution control system, wastewater treatment and solids disposal, protection of indoor environment and ambient air, water and land environment, capacity building initiates needed for long term environment protection and need improving/ creating environmental infrastructure including manpower.

Lonavla and the adjacent Khandala are twin hill stations well known for tourism, 622 metres (2,041 ft) above sea level, in the Sahyadri ranges that demarcate the Deccan Plateau and the Konkan coast. The hill stations sprawl over an approximate area of 38 square kilometres. The hill stations at Lonaval spread out over an approximate area of 38 square kilometres. The area has rich flora and fauna diversity.

METHODOLOGY

Various methods have been used for environmental auditing namely site survey, report collection and interviews for the audit of the management system. Site survey for representative sampling was carried out.

The soil samples, air micro flora collection (on selective nutrient media), solid waste from ounding and survey of nursery were completed on 8th February, 2011.

The soil samples were collected from Nursery, Garden and outside (New Tungarali road, near Bridges Hotel) for physico-chemical parameters. The collected air microflora on selective media in Petri plates were maintained at 4°C during transportation as per standard method and incubated at the respective temperature.

The air sampling including ambient and stack monitoring (DG set) were carried out on 9th February, 2011.

The collection of water samples and survey for Municipal Water and Sewage Municipal Wastewater treatment plants and Noise pollution were also carried out

The existing quality of the air environment serves as an index for assessing the pollution load and the assimilative capacity of any region. Ambient air quality data was collected for winter season to understand the air quality in the region and to assess the impacts on air environment.

Ambient air quality in study area

An assessment of air quality was undertaken to establish the status of exposure of the receptors. This assessment was accomplished by examining sources of air emissions within the study area, and by conducting a site–specific background–sampling program. Three sampling region:
a. Near Main gate of the centre (for ambient air sam-

Table 1. Air analysis report at the Training Centre.

S.No.	Parameters	Unit	Location		Limits Max.
			Near main gate (Ambient Air Sample)	Blue Sky Hall (Work zone Air Sample)	[CMOEF] (Trivedy, 2010)
1.	Time duration	24 hrs.			
2.	Ambient Temperature	°C	32	30	---
3.	Sulphur Dioxide (SO_2)	µg/m³	6.9	5.9	80
4.	Oxides of Nitrogen (NO_x)	µg/m³	Absent	2.5	80
5.	Suspended Particulate matter (SPM) (less than 10 micron)	µg/m³	49	40	100
6.	Suspended Particulate matter (SPM) (less than 2.5 micron)	µg/m³	07	06	60
7.	Lead (Pb)	µg/m³	Absent	Absent	1.0
8.	Carbon Monoxide (CO)	mg/m³	Absent	Absent	04
9.	Ammonia as (NH3)	µg/m³	Absent	Absent	400
10.	Benzene (C_6H_6)	µg/m³	Absent	Absent	05
11.	Arsenic (As)	µg/m³	Absent	Absent	06
12.	Nickel (Ni)	µg/m³	Absent	Absent	20

pling)
b. Inside Conference Hall (for work zone air sampling) (Figure 2) and
c. D.G. sets (for stack monitoring) were located in the study area to provide the surrounding air quality. The background-monitoring program was carried out as per standard methodologies and accepted protocols as detailed by the MoEF. Ambient Air quality was monitored with high volume samplers, for 4 hours. Stack monitoring of D.G. set was recorded with gas analyzer model (ACE-9000).

In this manner, all pollutants were collected at each of the three locations. Sources of air pollution affecting the region currently are vehicular traffic, dust arising from constructions and roads. Therefore, ambient air quality is quite good in and around the area. SPM and RSPM levels were observed to be normal. All the other parameters were observed to be well within the prescribed standards.

Study of microbial contamination in the indoor air

Monitoring and Enumeration of Air Micro-Flora

Microflora monitoring is a rapidly emerging area of industrial hygiene. Monitoring for microflora in the occupational environment is one of the many tools the industrial hygienist uses in the assessment of indoor environmental quality, infectious disease outbreaks and agricultural health. Microflora monitoring includes the measurement of viable (culturable and nonculturable) and nonviable microorganisms in both indoor (e.g., industrial, office or residential) and outdoor (e.g., agricultural and general air quality) environments. When sampling for culturable bacteria and fungi, the microflora is generally collected by impaction onto the surface of a broad spectrum solid medium (agar). Organisms collected by impaction onto an agar surface may be incubated for a short time, replica-plated (transferred) onto selective or differential media, and incubated at different temperatures for identification and enumeration of microorganisms. Culturable microorganisms are identified by using microscopy and classical microbiology, Classical microbiology techniques include observation of growth characteristics; cellular or spore morphology; simple and differential staining; and biochemical, physiological, and nutritional testing for culturable bacteria.

Sampling and Analysis

In the present study, outdoor and indoor airborne microflora (bacteria) at different locations Fig. 1 was investigated during winter season on 8th February, 2011. Temperature and relative humidity (RH) were recorded over the sampling period (Table 3). The bacteria were collected by impaction onto an agar medium, for 2 to 8 minutes, placing above the surface, to simulate the human breathing zone. Before or after each sampling, surface was disinfected with a 70% ethyl alcohol solution. Sampling was carried out for all the sampling points during daylight hours 09.00 and 17.00 hrs.

Observations

The following salient observations were made by us:

a. High indoor humidity (50 to 60% plus)
b. Inadequate ventilation
c. Leaky roof, venting lacking in kitchen etc.

Culture Media

General detection and enumeration media are normally used in the collection of fungi, bacteria, and thermophilic Actinomycetes. Plates were replicated on selective media for identification after the organisms have been collected. The following nutrients media were used for the micro-flora sampling:

1. Fungi - Malt extract agar (MEA) media was used for the collection and enumeration of fungi

2. Bacteria - Tryptic soy agar (TSA)/nutrient agar (NA) media was used for the collection and enumeration of bacteria.

3. Thermophilic - Standard plate count agar (SPCA) media was used for the collection and enumeration of thermophilic Actinomycetes.

Sampled Nutrient agar plates were incubated at 30 to 32 °C (room temperature with natural light), 25 to 30 °C and 50 to 56 °C for fungi, environmental bacteria and thermophilic Actinomycetes respectively.

Enumeration

Concentrations of culturable microflora (Table 3) were reported as colony forming units (CFU).

Among the microorganisms present in the study area, bacteria were high in number as compared to fungi and actinomycetes, despite their high death rate due to environmental factors pro- ducing stress of various kinds, of that major being dehydration stress.

Solid waste management in the campus

Unsorted Municipal Waste, density of incoming waste, waste composition, organics, non-organic, etc and were carried out. Solid Wastes including pre-consumer food residuals were collected from the kitchen, pantry etc were segregated by us and then processed separately. A large quantity of organic waste is generated from the kitchens. This waste is collected every morning and evening. As shown in Table 4 the MSW physical composition were of high portion of organic waste (96.75%) and the remaining inorganic waste comprised of recyclables and non- recyclables materials. Table 5 shows the physicochemical composition of MSW collected from the MDC campus, Lonavala.

The Composition and Sources of Solid Wastes

Implementing environmental monitoring and management of solid waste also depends on its composition (e.g. recyclable vs non-recyclable wastes). Food and vegetable wastes comprise 30% of the total generated followed by recyclable items (paper, metal, and plastics) that account for an additional 22%. About 30% is organic waste and can be composted. Composting solid wastes reduces:
a. The level of leachate production by recycling the organic fraction of the waste stream
b. The total amount of waste by diverting some for alternative use
c. The overall cost of SWM and protecting the urban and nearby environment

Disposal/treatment practices for all solid wastes

Solid Waste Management

An audit was carried out to assess to what extent are the necessary conditions for the successful implementation of the waste wise policy in place. The management and control of the dump was investigated with regard to national health legislation and technical regulations. Reports and questionnaires were used for the audit. At present the solid waste collected at the training centre is taken by Municipal Corporation on regular basis whereas the recyclable waste including paper etc is segregated for re-use. The Management is highly concerned using eco-friendly technology to make efficient use of organic waste collected from kitchen, pantry, backyard, lawn etc. by vermicomposting. The pilot scale methane gas plant set up is on progress (for the cooking purpose) by using kitchen and household organic waste.

Observations

From this audit it was observed that:
a. The total waste was not routinely collected
b. The microbial degradation process in the food (collected from the kitchen, dining hall) starts on the same day
c. The Municipal truck was not covered with a mesh and a polythene sheet to prevent scattering
d. Solid waste treatment/disposal facilities -no treatment facility exists
e. Recyclable waste is segregated for re-use
f. The general housekeeping was found to be satisfactory.

Potential environmental impacts from solid waste

Potential hazards of solid wastes are numerous to the

Table 2. Average level of meteorological factors during the microflora sampling

S.No.	Location	Temperature (°C)	Relative humidity (%)
1.	Out side the main gate	28.8	55
2.	Office (Room no- 8)	27.6	51
3.	Indigo Mountain Conference Hall	27.1	46
4.	Kitchen	30	44

Table 3. Air micro-flora analysis/enumeration at the training centre

S.No.	Location	Microorganisms		
		Bacteria	Fungi	Actinomycetes
1.	Out side the main gate (Management Training Centre)	Present Colony: 13 cfu	Present Colony: 7 mold	Present Colony: 8 cfu
2.	Office (Room no- 8) (Management Training Centre) (No colony observed)	Present Colony: 12 cfu	Present Colony: 3 mold	Absent Colony: 0 cfu
3.	Indigo Mountain Conference Hall (Management Training Centre)	Present Colony: 6 cfu	Present Colony: 11 mold	Present Colony: 3 cfu
4.	Kitchen (Management Training Centre)	Present Colony: 21 cfu	Present Colony: 11 mold	Present Colony: 1 cfu

Table 4. Physical composition of MSW at the training centre

S. No.	Parameters	Results %
1.	Total composted	96.75
2.	Plastics	2.25
3.	Coal	0.25
4.	Misc	0.75

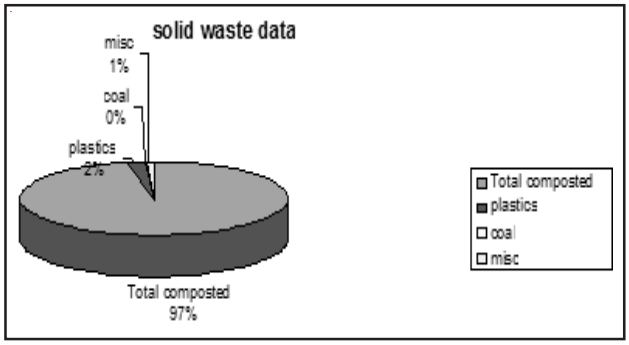

Fig. 1 Microflora sampling -different locations at the training centre

living community when it is improperly managed. Solid wastes have the potential to pollute all the vital components of living environment (i.e., air, land and water). Some of the hazards caused by solid wastes are listed below:

a. Uncollected wastes often end up in drains, causing blockages that result in flooding and unsanitary conditions

Table 5. Physicochemical composition of Solid at the training centre

S.No.	Parameters	Results
1.	pH	6.2
2.	Moisture %	50.19
3.	Organic matter %	58.26
5.	Carbon %	34
6.	Total Nitrogen %	0.90
7.	Total Phosphorus %	0.47
8.	C/N Ration	37

b. Flies breed in some constituents of solid wastes, and flies are very effective vectors that spread disease

c. Mosquitoes breed in blocked drains and in rainwater that is retained in discarded cans, tire and other objects. Mosquitoes spread disease, including malaria and dengue

d. Rats find shelter and food in waste dumps. Rats consume and spoil food, spread disease, damage electrical cables and other materials and inflict unpleasant bites

e. The open burning of waste causes air pollution; the products of combustion include dioxins that are particularly hazardous

f. Aerosols and dusts can spread fungi and pathogens from uncollected and decomposing wastes

g. Uncollected waste degrades the environment. Plastic bags are in particular an aesthetic nuisance

h. Waste collection workers face particular occupational hazards, including strains from lifting, injuries

from sharp objects and contact with pathogens when manually handling the waste

i. Dangerous items (such as broken glass, razor blades, hypodermic needles and other healthcare wastes, aerosol cans) may pose risks of injury or poisoning, particularly to children and people who sort through the waste

j. Waste items that are reused without being cleaned effectively or sterilized can transmit infection to later users

k. Polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of water supplies, ponds and lakes

l. Waste that is treated or disposed of in unsatisfactory ways can cause a severe aesthetic nuisance in terms of smell and appearance

m. Liquids and fumes, escaping from deposits of wastes (perhaps formed as a result of chemical reactions between components in the wastes), can have fatal or other serious effects

n. Methane (one of the main components of landfill gas) is much more effective than carbon dioxide as a greenhouse gas, leading to climate change

o. Fires on disposal sites can cause major air pollution, causing illness and reducing visibility, making disposal sites dangerously unstable, causing explosions of cans, and possibly spreading to adjacent property

To implement proper waste management, various aspects have to be considered such as waste generation (source reduction), waste handling and sorting, storage and processing at the source (onsite storage), collection, sorting, processing and transformation, transfer and transport, and disposal.

Suggested techniques for solid waste management

The different types of processing techniques for solid waste management suitable at the training centre are given below:

1. Biogasification/ Biomethanisation
2. Bio-chemical conversion
3. Pits method
4. Indore method
5. Windrow composting
6. Vermicomposting

Noise monitoring

Noise monitoring was conducted at four locations within the study area. These monitoring locations and result were provided in Table 6.

The results of the monitoring program indicated that the morning, afternoon and evening time levels of noise were within the prescribed standards on all locations (except at Garden) at the training centre. The Morning, Afternoon and Evening time noise levels monitoring exceeded the prescribed standards at Garden.

Water environment

Best Practices to Minimize Wastewater

a. Leaks through preventive maintenance (check for excessive drift and splash) should be minimized

b. Proper level of corrosion inhibitors should be maintained to extend life of solutions.

c. All float valves should be set within operating ranges

d. Alternative sources of grey water should be consider (i.e. rainwater harvesting)

e. Water should be reused in the process to achieve zero discharge

f. Many sites produce waste water condensate from compressor which may often be discharged straight to a water sewer, this water should be re-used and used as make-up water for cooling towers

g. Label or color-code should be used to all drains surface water and effluent

Table 6. Noise monitoring results at the training centre.

S.No.	Location	Date	Morning Time		Afternoon Time		Evening Time	
			Reading Leq dB(A)	Limit Leq dB(A)	Reading Leq dB(A)	Limit Leq dB(A)	Reading Leq dB(A)	Limit Leq dB(A)
1.	Reception (Main gate, MDC)	10/02/11	62.3	65	59.2	65	61.7	65
2.	Account Section	10/02/11	63.0	65	55.3	65	55	65
3.	Programmer coordinator office	10/02/11	64.2	65	62.0	65	55.2	65
4.	Garden	10/02/11	73.2	65	74.4	65	69.3	65

It is realized that for many existing buildings, appropriate metering equipment for water consumption in various parts at the training centre is not available, making it impossible for an audit on water consumption to be carried out. Therefore, to have appropriate water flow meters with sufficient accuracy should be installed in various water consuming areas such as kitchen, all the guest house, training centre and is a prerequisite for carrying out a valid water conservation program.

Water quality and sampling locations

The primary objective of water quality assessment is to determine water quality conditions and the nature and extent of present impacts. All samples collected were stored in pre-cleaned 1 L polyethylene bottles. Bacterial samples are collected in sterilized 100 mL (glass bottles). Water testing was done by using certified methodology from Standard Methods for Water and Wastewater Analyses (APHA, 1995, 19th edition). Sampling has been done following standard guidelines for physical, chemical and bacteriological parameters (Table 7).

Physico-chemical and Microbiological Parameters of Drinking Water (Bottled water)

Table 8, shows the physicochemical and microbiological characteristics of Drinking Water (bottled water) as compared with the standards (IS 10500: Indian Standards/Specifications for Drinking Water) reference values. All the parameters were within the prescribed limits as per IS: 10500 (Specifications for drinking water). Drinking water (bottled water) shows the absence of Total Coliform, *E. coli*, *S. aureus* and *Pseudomonas* spp.

Physico-chemical and Microbiological Parameters of Kitchen Drinking Water -before and after Aqua Guard filter Treatment

Table 9 shows the physicochemical and microbiological characteristics of Kitchen Drinking Water before and after aqua guard filter treatment as compared with the standard (IS 10500: Indian Standards/Specifications for Drinking Water) reference values. All the parameters were within the prescribed limits as per IS: 10500 (Specifications for drinking water). The microbiological parameter of Kitchen Drinking Water shows the presence of Total Coliform and *E. coli* before aqua guard treatment.

Suggestions

a. Disinfection by chlorination is required for Municipal Drinking Water and regular quality checks are necessary.

Physico-chemical and Microbiological Parameters of Municipal Drinking Water before and after Treatment at the training Centre

Table 10 shows the physicochemical and microbiological characteristics of Municipal Drinking Water before and after conventional treatment and compared with the standard (IS 10500: Indian Standards/Specifications for Drinking Water) reference values. All the parameters were within the prescribed limits as per IS: 10500 (Specifications for drinking water). The microbiological parameter of Municipal Drinking Water shows the presence of Total Coliform and *E. coli* before and after conventional treatment.

Physico-chemical Parameter of Municipal Sewage Wastewater before and after Treatment at the Training Centre

Table 11 shows the physicochemical characteristics of Municipal Sewage Wastewater before and after conventional treatment followed by disinfections and were compared with the standards IS 3025 and APHA (American Public Health Association) for wastewater reference values. All the parameters were within the prescribed limits as per MPCB, IS 3025 and APHA. The microbiological parameter of Municipal Sewage Wastewater shows the presence of Total Coliform and *E. coli* before and after conventional treatment. The treated Municipal Sewage Wastewater characteristic meets the Maharashtra Pollution Control Board criteria.

Study of Sewage Waste Treatment Plants

Table 11 gives the characteristics of sewage treatment plant before and after treatment based on our analysis.

Observations and Recommendations

The following salient observations and recommendations are made by us:

a. The municipal sewage wastewater source is not clean containing mosquito larva and is an ideal breeding media for certain mosquitoes, and thus the perfect way to spread filariasis

b. The municipal sewage wastewater source contains

algal blooms which indicate Eutrophication (accumulation of heavy metals)
c. The sand filter media is not installed
d. No flow measurement is done for intake & outlet
e. Flow meters, not in existence
f. The chemicals are store in open space near the treatment plant having inadequate storage capacity
g. It was also observed that municipal sewage wastewater was microbiologically contaminated as indicated by high counts of Total Coliform. This observation clearly identifies the need for critical evaluation of unit process to meet the best performance.
h. The pipes were found to be rusted due to pre-chlorination
i. It is essential to install flow meters to define exact quantity of inflow and outflow of the plant for proper control of chemical dosing, treatment and water audit
j. Improvement in chemical feeding is needed. The liquid coagulant should be added through perforated pipe placed along the length of the mixing chamber
k. Proper testing of chlorine demand is essential to avoid overdosing
l. The existing system of storage of chlorine cylinders is not scientific and safe and may lead to accidents. While storing chemicals, the instruction for safety measured should be displayed and followed
m. Possible solutions to reduce mosquitoes by placing fish to eat the larvae in the last sink
n. Quality of supplied Alum should also be tested in laboratory
o. Barricading along the raw water channel is suggested
p. Sedimentation unit is overloaded resulting in poor efficiency. Engineering evaluation is required to find out the extent of overloading
q. All staff should be well acquainted with dos and don'ts in emergency conditions while handling hazardous chemicals
r. Well-operated alarm or siren system must be implemented. Safety norms are to be adopted. The existing safety program needs to be review and strengthen to overcome gaps and shortfalls
s. In house training program to the staff at all levels should be organized for better performance. Also staff should be deputed for proper training program
t. The combination of the existing Municipal wastewater sewage plant at the training centre and the sand filter will provide effluent of a high quality. This system is a low maintenance biological system that will produce high quality effluent after it is filtered through a sand filter
u. Implementation of Quality assessment and Quality control program

Treated wastewater (sewage and industial) disposal practices and their impact on environment

Wastewater irrigation is becoming a global phenomenon, as a result of global water scarcity and increased pollution of water sources. While this practice offers many opportunities, human health risks from contaminated soils and crops irrigated with wastewater pose the greatest challenges to this practice. A number of low-cost technological options and health protection measures exist to address the contamination challenges. These include irrigation methods, farm-based measures for improving water quality, choice of crop, water application techniques, phytoremediation, zoning, and postharvest measures.

Soils, as filters of toxic chemicals, may adsorb and retain heavy metals from wastewater. But when the capacity of soils to retain toxic metals is reduced due to continuous loading of pollutants or changes in pH, soils can release heavy metals into groundwater or soil solution available for plant uptake. Heavy metals contribute to environmental pollution because of their unique properties, mainly that they are non-biodegradable, non-thermo-degradable and generally do not leach from the topsoil. The duration of contamination by heavy metals may be for hundreds or thousands of years, even after their addition to soils had been stopped. The times taken for Cd, Cu and Pb to reach half their concentrations (half lives) in soil were found to be 15–1100, 310–1500 and 740–5900 years, respectively, depending on soil type and physiochemical parameters. With repeated wastewater applications, heavy metals can accumulate in soil to toxic concentrations for plant growth.

Health and Environmental Effects

The value of wastewater as a substitute of organic manure in agriculture (also of water in arid regions) has been recognized for over a century but its use has been restricted by the constraints of social acceptability and the high incidence of diseases in human beings. Employees may suffer from ill health because of their direct contact with wastewater – the lack of footwear or gloves makes them vulnerable to infection by parasites, transmitted either orally (placing unwashed hands in the mouth) or through the skin (parasites burrowing directly into the body). The most common parasites are Ascaris ascaris (roundworm), Trichuris trichiura (whipworm), and Strongyloides stercoraltis

Table 7. Water Sampling for Physico-chemical and Microbiological parameters

S.No.	Water Samples
1.	Drinking Water (Kingfisher packed bottled)
2.	Kitchen Drinking Water before and after aqua guard treatment
3.	Municipal Drinking Water before and after treatment
4.	Municipal Sewage Wastewater before and after treatment

Table 8. Physico-chemical and Microbiological parameters of Drinking Water (Bottled water)

S.No.	Parameters	Drinking Water Bottled water mg/L	Limit mg/L	Method IS 10500
1.	pH	6.98	6.5 to 8.5	10500
2.	Taste	Agreeable	-	10500
3.	Odor	Unobjectionable	-	10500
2.	Conductivity	79.5 µS/cm	-	10500
3.	Total suspended solids (TSS)	Nil	-	10500
4.	Total Dissolved solids (TDS)	Nil	500	10500
5.	Chloride	3 mg/L	250	10500
6.	Fluoride	0.034 mg/L	1.0	10500
7.	Sulphate	Nil	200	10500
8.	Total Hardness	8 mg/L	300	10500
9.	Calcium	6 mg/L	75	10500
10.	Magnesium	2 mg/L	30	10500
11.	Sodium	11.98 mg/L	-	10500
12.	Potassium	1.53 mg/L	-	10500
14.	Nitrate	Nil	45	10500
15.	Inorganic Phosphorus	Nil		10500
16.	Heavy metals			
	a) Pb	< 0.1 mg/L	0.1	10500
	b) As	< 0.1 mg/L	0.1	10500
	c) Zn	< 0.1 mg/L	5	10500
	d) Cu	< 0.1 mg/L	0.1	10500
	e) Fe	< 0.1 mg/L	0.3	10500
	f) Cd	< 0.05 mg/L	0.1	10500
17.	Microbiology			
	a) Plate count	< 10 cfu/mL		10500
	b) *E. coli*	Absent		
	c) *Pseudomonas*	Absent		
	d) *S. aureus*	Absent		

(threadworm). The eggs or larvae of all three worms, which live in the intestine, are passed through the faeces. In the case of roundworm and whipworm, re-infection is then oral, by ingesting food contaminated by the infective eggs. Threadworm, like hookworm infects by penetrating the skin of the feet or hands of farmers working in fields irrigated with wastewater. The training centre is using municipal sewage wastewater (after conventional treatment) for irrigation, but the procedure practice has following constraints:

a. Application of raw (untreated) sewage on land causes serious problems of stinking odour, water logging and mosquito breeding

b. Long term application of sewage effluents and/or sludge results in accumulation of chlorides, sulphates and toxic elements like cadmium, Nickel, copper, chromium, manganese, arsenic and mercury in the soil, and consequently reduce crop growth

c. Irrigation generally results in gradual building up of salinity and this is accelerated by the use of municipal wastewater

d. Changes in soil texture and consequent water logging also may occur in certain areas

e. Depending upon the soil texture and the flow velocity of water through the soil layers, the nutrients (especially nitrates), organic toxic substances and also

the pathogens (bacteria and viruses) move to the groundwater

f. Employee engaged in agriculture with municipal wastewater and sludge is directly exposed to the pathogens

g. Further risks to human health arise from the consumption of food contaminated with pathogens and toxic substances directly or through the food chain

h. Irrigation with untreated wastewater can represent a major threat to public health (of both humans, and livestock), food safety, and environmental quality

i. The microbial quality of wastewater is usually measured by the concentration of the two primary sources of water-borne infection – faecal coliforms and nematode eggs. A range of viruses and protozoa pose additional health risks

j. Additionally wastewater irrigation of vegetables and fodder may serve as the transmission route for heavy metals in the human food chain.

Study of soils where treated wastewater is used for gardening

Soil Quality and Sampling Locations

Soil sampling was done to establish the characteristics and to evaluate the anticipated impacts due to contamination caused by Municipal sewage waste water etc. Soil samples were extracted to a depth of 18-24 cm using a shovel. Soil samples collected were mixed to make composite sample that were analyzed. Stones and plant tissues were carefully removed from the soil prior to drying process under laboratory condition. The soil was screened through 2 mm stainless steel sieve, and stored in a plastic bag at room temperature until use. The soil samples were collected

Table 9. Physico-chemical and Microbiological parameter of Kitchen Drinking Water - before and after aqua guard treatment at the training centre

S.No.	Parameters	Kitchen Drinking Water (before treatment)	Kitchen Drinking Water (after treatment)	Limit	Method IS 10500
1.	pH	7.32	7.25	6.5 to 8.5	10500
2.	Taste	Agreeable	Agreeable	-	
3.	Odor	Unobjectionable	Unobjectionable	-	
4.	Conductivity	57.3 µS/cm	57.3 µS/cm	-	10500
5.	Total suspended solids (TSS)	2 mg/L	ND	-	10500
6	Total Dissolved solids (TDS)	2 mg/L	ND	500	10500
7	Chloride	9 mg/L	8 mg/L	250	10500
8	Fluoride	0.047 mg/L	0.038 mg/L	1.0	10500
9	Sulphate	ND	ND	200	10500
10	Total Hardness	16 mg/L	15 mg/L	300	10500
11.	Calcium	10 mg/L	8 mg/L	75	10500
12	Magnesium	6 mg/L	7 mg/L	30	10500
13	Sodium	2.29 mg/L	0.26 mg/L		10500
14	Potassium	2.31 mg/L	0.22 mg/L		10500
15	Nitrate	ND	ND	45	10500
16	Inorganic Phosphorus	ND	ND	-	10500
17	Heavy metals				
a)	Pb	< 0.1 mg/L	< 0.1 mg/L	0.1	10500
	b) As	< 0.1 mg/L	< 0.1 mg/L	0.1	10500
	c) Zn	< 0.1 mg/L	< 0.1 mg/L	5	10500
	d) Cu	< 0.1 mg/L	< 0.1 mg/L	0.1	10500
	e) Fe	< 0.1 mg/L	< 0.1 mg/L	0.3	10500
	f) Cd	< 0.05 mg/L	< 0.05 mg/L	0.1	10500
18.	Microbiology				
	e) Plate count	TNTC	284 cfu/mL		10500
	f) *E. coli*	Present	Absent		
	g) *Pseudomonas*	Absent	Absent		
	h) *S. aureus*	Absent	Absent		

*TNTC – Too numerous to count

Table 10. Physico-chemical and Microbiological parameter of Municipal Drinking Water before and after treatment at the training centre

S.No.	Parameters	Before treatment	After treatment	Limit	Method IS 10500
1.	pH	7.38	7.27	6.5 to 8.5	10500
2.	Test	Agreeable	Agreeable	-	
3.	Odor	Unobjectionable	Unobjectionable	-	
2.	Conductivity	57.1 µS/cm	56.9 µS/cm	-	10500
3.	Total suspended solids (TSS)	5 mg/L	2 mg/L	-	10500
4.	Total Dissolved solids (TDS)	6 mg/L	4 mg/L	500	10500
5.	Chloride	8 mg/L	7 mg/L	250	10500
6.	Fluoride	0.063 mg/L	0.073 mg/L	1.0	10500
7.	Sulphate	ND	ND	200	10500
8.	Total Hardness	13 mg/L	11 mg/L	300	10500
9.	Calcium	11 mg/L	8 mg/L75	10500	
10.	Magnesium	2 mg/L	3 mg/L	30	10500
11.	Sodium	2.51 mg/L	2.32 mg/v	-	10500
12.	Potassium	0.43 mg/L	0.23 mg/L	-	10500
14.	Nitrate	ND	ND	45	10500
15.	Inorganic Phosphorus	ND	ND	-	10500
16.	Heavy metals				
	a) Pb	< 0.1 mg/L	< 0.1 mg/L	0.1	10500
	b) As	< 0.1 mg/L	< 0.1 mg/L	0.1	10500
	c) Zn	< 0.1 mg/L	0.17 mg/L	5	10500
	d) Cu	< 0.1 mg/L	< 0.1 mg/L	0.1	10500
	e) Fe	< 0.1 mg/L	< 0.1 mg/L	0.3	10500
	f) Cd	< 0.05 mg/L	< 0.05 mg/L	0.1	10500
17.	Microbiology				
	i) Plate count	93 cfu/mL	84 cfu/mL		10500
	j) *E. coli*	Present	Present		
	k) *Pseudomonas*	Absent	Absent		
	l) *S. aureus*	Absent	Absent		

** ND = Not detected

from different locations Nursery and Outside soil.

The physicochemical parameters were measured by standard methods of the American Public Health Association (1998). The moisture content of soil was calculated by the mass difference before and after drying at 105 °C to a constant mass. The pH and electrical conductivity (EC) were measured after 20 min of vigorous mixing samples at 1: 2.5: : solid : deionized water ratio using digital meters with a combination pH electrode and a 1-cm platinum conductivity cell respectively. The dried samples were digested with concentrated nitric acid and 30% hydrogen peroxide and then determined by an atomic absorption spectrophotometer [AAS, Perkin Elmer] (APHA, 1998).

The plant samples were washed with distilled water and air dried. The plant samples were again dried in an oven at 70 °C for 3 days, after these samples were stored in the brown paper bags. The samples were considered for analysis of metal content digested with concentrated nitric acid and 30% hydrogen peroxide and then the heavy metal content was determined by an atomic absorption spectrophotometer [AAS, Perkin Elmer] (APHA, 1998).

Nursery soil contained higher concentrations of Zn Cu, Fe, as compared Garden and Outside soil (Table 12). The continuous application of sewage effluent results a remarkable increased of heavy metal. These elements are generally very difficult to remove and had a potentially harmful effects that may arise in the future should not be ignored and subsequent problems may include toxicity to the plants growing on the contaminated soil.

RECOMMENDATIONS

The extensive environmental survey including selection of site for sampling were carried out at the training centre. Various methods have been used for envi-

Table 11. Physico-chemical parameter of Municipal Swage Wastewater before and after treatment at the training centre

S.No.	Parameters	Before treatment	After treatment	Limit USEPA	MPCB Limit	Method APHA
1.	pH	7.27	7.21	5.5 to 9	6.5 to 6.9	APHA
2.	Total suspended solids (TSS)	33 mg/L	28 mg/L	100	250	APHA
3.	Chloride	180.94 mg/L	177.95 mg/L			APHA
4.	Fluoride	0.13 mg/L	0.12 mg/L	15		APHA
5.	Sulphate	0.063 mg/L	0.073 mg/L	-		APHA
6.	Calcium	27.6	20.26	-		APHA
7.	Magnesium	5.99 mg/L	4.34 mg/L	-		APHA
8.	Sodium	19.61 mg/L	14.73 mg/L			APHA
9.	Potassium	7.03 mg/L	5.23 mg/L	-		APHA
10.	Total Nitrogen	5.71 mg/L	3.58 mg/L	-		APHA
11.	Total Phosphorus	3.46 mg/L	1.68 mg/L			APHA
12.	COD	172. 48 mg/L	117.6 mg/L	250	250	APHA
13.	BOD	18 mg/L	10 mg/L	350	100	APHA
14.	Heavy metals					
	a) Pb	< 0.1 mg/L	< 0.1 mg/L	1.0		APHA
	b) As	< 0.1 mg/L	< 0.1 mg/L	0.2		APHA
	c) Zn	< 0.1 mg/L	<0.1 mg/L	15		APHA
	d) Cu	< 0.1 mg/L	< 0.1 mg/L	3		APHA
	e) Fe	< 0.1 mg/L	< 0.1 mg/L	-		APHA
	f) Cd	< 0.05 mg/L	< 0.05 mg/L	2		APHA
	g) Hg	< 0.1 mg/L	< 0.1 mg/L			APHA

Table 12. Physico-chemical parameter of Soil Samples at the training centre

S.No.	Parameters	Nursery Soil mg/kg	Garden Soil mg/kg	Outside Soil mg/kg
1.	pH	5.73	5.09	5.90
2.	Conductivity	84.6 µS/cm	104.1 µS/cm	80.21µS/cm
3.	Chloride	25	42.98	23
4.	Calcium	29.11	19.88	25.12
5.	Magnesium	12.0	19.89	10.25
6.	Sodium	1446.39	202.47	1108
7.	Potassium	1789.91	95.45	3947.11
8.	Total Nitrogen	306.16	32.09	135.91
9.	Total Phosphorus	55.42	38.21	41.21
10.	Heavy metals			
	a) Pb	< 0.1	0.94	<0.1
	b) As	< 0.1	< 0.1	< 0.1
	c) Zn	184.14	12.60	51.53
	d) Cu	84.98	24.45	77.58
	e) Fe	12.53 %	2.45 %	9.59 %
	f) Cd	< 0.05	< 0.05	< 0.1
	g) Hg	< 0.1	< 0.1	< 0.1

ronmental auditing namely report collection and interviews for the audit of the management system, site survey was used for the audit. Information on various aspects such as electricity consumption, DG set, solar energy, Municipal sewage water, drinking water, water treatment technology, solid waste transportation, etc have been collected from the Management Development Centre authorities. The air, water, land, solid waste and ecological environmental components were focused during the study. Site survey and representative sampling for air (including ambient and stack monitoring- DG sets), noise, air micro flora collection, soil, solid waste, water leakage, mold infection etc.

Table 13. Vegetables grown in nursery at (MDC), L&T, Lonavala

S.No.	Vegetable
1.	Tomato
2.	Bottleguard
3.	Brinjal
4.	Ladyfinger
5.	Coriander
6.	Luffa
7.	Sweet pepper
8.	Spinach
9.	Coriander

Air environment

The air environment around the site is free from any significant pollution source. Therefore, ambient air quality is quite good in and around the area. SPM and RSPM levels were observed to be normal. However, for DG set, the training centre should make the arrangement of the installation of the sampling port so that the air sampling can be carried out in future at this point.

Airborne microflora

The outdoor and indoor airborne microflora at different locations the training centre was investigated. Among the microorganisms present in the study area, bacteria were the highest in number as compared with fungi and actinomycetes. Appropriate hygienic condition, dust control, bactericidal vapours, and fumigation should be carried out periodically.

Noise monitoring program

The results of the noise monitoring program indicated that the morning, afternoon and evening time levels of noise were within the prescribed standards on all locations (except at Garden) at the training centre.

Solid waste Management

Solid Wastes including pre-consumer food residuals were collected from kitchen, pantry etc were segregated by us and then processed separately. A large quantity of organic waste is generated from the kitchens. Physical compositions of solid waste were of high portion of organic waste (96.75%) and the remaining inorganic waste comprised of recyclables and non-recyclables materials. Proper solid waste receptacles and storage containers should be provided, particularly for the disposal of lunch and drink boxes so as to prevent littering of the site. Therefore to implement proper waste management, various aspects should be considered such as waste generation (source reduction), waste handling and sorting, storage and processing at the source (onsite storage), collection, sorting, processing and transformation, transfer and transport, and disposal. The different types of processing techniques for solid waste management suitable at the training centre should be considered i.e. Biogasification, composting and vermicomposting.

The physicochemical characteristics of water

The physicochemical characteristics of water Drinking water (bottled water), Kitchen Drinking water - before and after aqua guard treatment, Municipal Drinking water before and after conventional treatment were within the prescribed limits as per IS: 10500 (Specifications for drinking water). Drinking water (bottled water) shows the absence of Total Coliform, *E. coli, S. aureus* and *Pseudomonas* spp. The microbiological parameter of Kitchen Drinking water shows the presence of Total Coliform and *E. coli* before aqua guard treatment. The microbiological parameter of Municipal Drinking water shows the presence of Total Coliform and *E. coli* before and after conventional treatment. The municipal sewage wastewater source contains algal blooms which indicate Eutrophication (accumulation of heavy metals). It was also observed that municipal sewage wastewater was microbiologically contaminated as indicated by high counts of Total Coliform. The municipal wastewater treatment plant did not appear in good shape/ design. Therefore measures should be taken to maintain the plant regularly henceforth. The Municipal sewage wastewater after conventional treatment is utilized in Nursery as well as in Garden for irrigation. Although it is good practice using sewage wastewater for irrigation. However, the vegetables show toxic effects such as stunting retarded growth of roots/shoots, very poor secondary root development, absence of root hairs and brownish red color roots due to contamination. These observations clearly identify the need for critical evaluation of unit process to meet the best performance.

Study of soils and vegetables

Soil sampling was done to establish the characteristics and to evaluate the anticipated impacts due to contamination caused by Municipal sewage wastewater etc. The result shows that Nursery soil contained higher concentrations of Zn Cu, Fe, as compared Garden and out side soil. The study area shows that major portion of the garden is under cultivated shrubs/ bushes/grasses. Roots were the main accumulation

Table 14. Concentrations of Heavy metals in Vegetables grown in nursery by using municipal sewage wastewater at (MDC, Lonavala

S.No	Samples	Heavy metals					
		Pb (mg/kg)	As(mg/kg)	Cd (mg/kg)	Hg (mg/kg)	Zn (mg/kg)	Cu (mg/kg)
1.	Methi Shoot	< 0.1	< 0.1	< 0.05	< 0.1	41.68	11.46
2.	Methi Root	< 0.1	< 0.1	< 0.05	< 0.1	520.29	52.03
3.	Flower Shoot	< 0.1	< 0.1	< 0.05	< 0.1	49.09	4.27
4.	Flower Root	< 0.1	< 0.1	< 0.05	< 0.1	76.63	116.77
5.	Grass Shoot	< 0.1	< 0.1	< 0.05	< 0.1	100.61	9.78
6.	Grass Root	< 0.1	< 0.1	< 0.05	< 0.1	93.92	20.42
7.	Coriander Shoot	< 0.1	< 0.1	< 0.05	< 0.1	90.87	14.82
8.	Coriander Root	< 0.1	< 0.1	< 0.05	< 0.1	220.70	38.05
9.	Mix Veg. Shoot	< 0.1	< 0.1	< 0.05	< 0.1	67.32	102.65
10.	Mix Veg. Root	< 0.1	< 0.1	< 0.05	< 0.1	84.34	12.11
11.	Lotus plant	< 0.1	< 0.1	< 0.05	< 0.1	81.77	< 0.1
12.	Fruit (shimla)	< 0.1	< 0.1	< 0.05	< 0.1	72.78	14.24

Table 15. Environmental monitoring program on regular basis at the training centre

S.No.	Parameter	Duration
1.	Air environment	Quarterly
2.	Micro-flora analysis	Quarterly
3.	Noise monitoring	Monthly
4.	Water quality	Quarterly
5.	Soil quality	Yearly
6.	Leakage/mold infection	Quarterly
7.	Solid waste	Yearly
8.	Health status of workers/ employees	Quarterly
9.	Floral biodiversity	Yearly
10.	Electricity Management	Yearly

site for heavy metals in all vegetables (with dense root systems) studied. The concentration of heavy metals in roots was recorded higher then shoots. The vegetable shows stunting, retarded growth of roots/ shoots, very poor secondary root development, absence of root hairs and brownish red color roots due to contamination form municipal sewage wastewater. The continuous application of sewage effluent results a remarkable increased of heavy metal. These elements are generally very difficult to remove and had a potentially harmful effects that may arise in the future should not be ignored and subsequent problems may include toxicity to the plants growing on the contaminated soil, and the uptake resulting in a high heavy metals level in the plant tissue considered to be harmful to the health of humans and animal that consume it. The Phytoremediation, which is an economical, effective, pleasing, and environmentally compatible technology for removing heavy metals from contaminated sites, is suggested. Intertek are ready to assist in these works.

Leakage/Mold infection

The extensive environmental survey including water leakage (in bathrooms, toilets, wash basin, AC, kitchen), mold infection and presence of parasites were conducted at the entire training centre, Kitchen, Store room, Dinning hall, A-Block (1-38 rooms), B-Block (1-32 rooms), C-Block (1-32 rooms), Duplex A and B, Officer Bungalow and Staff quarter. The mold were found on across to the ceiling, side walls of bedrooms, square of mold on walls, the adjacent room, the bathroom/ shower, passages, near stepladder etc. Our team observed the cause of infections due to Leakage and High indoor humidity Table 15 gives a proposed monitoring by us.

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