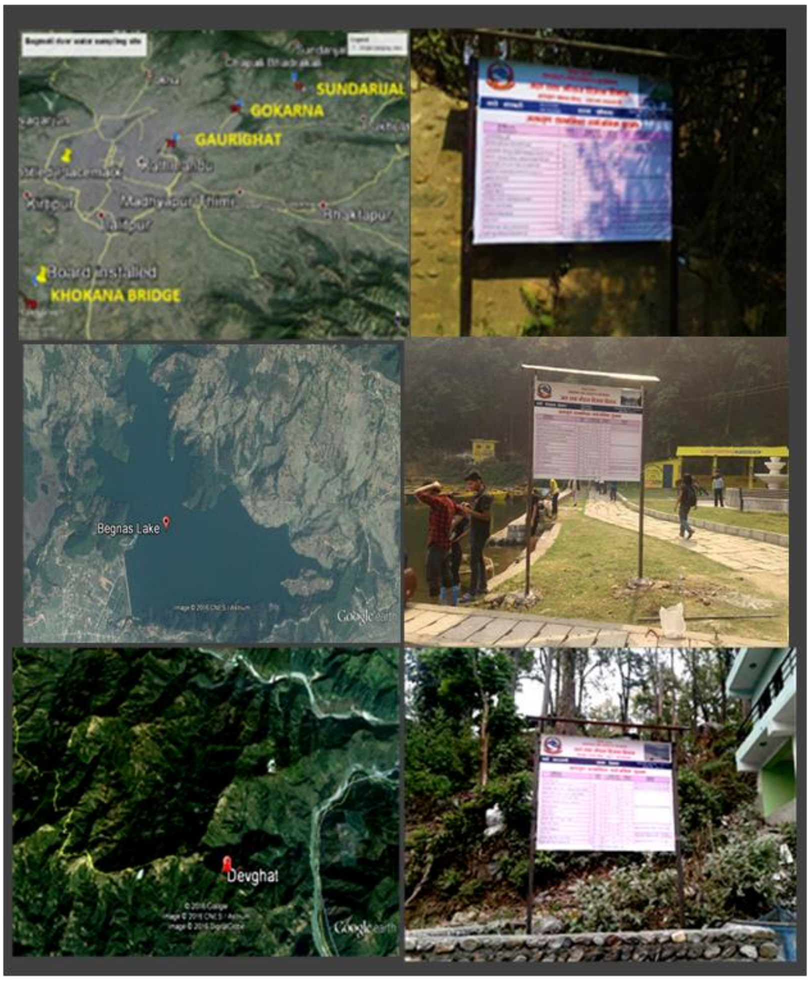
Government of Nepal
Ministry of Population and Environment
Department of Hydrology and Meteorology

Final Report

WATER QUALITY MEASUREMENT AND HOARDING BOARD INSTALLATION



Lifeline Enterprises Pvt. Ltd.
Kupondole, Lalitpur, Nepal
Baisakh, 2073 (April, 2016)

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Final Report on

Water Quality Measurement and Hoarding Board Installation

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Lifeline Enterprises Pvt. Ltd.
Kupondole, Lalitpur.

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Acronyms

Abs	Absorbance
$AgSO_4$	Silver sulphate
BOD	Biochemical Oxygen Demand
$CaCl_2$	Calcium chloride
$CaCO_3$	Calcium carbonate
COD	Chemical Oxygen Demand
Conc.	Concentrated
DHM	Department of Hydrology and Meteorology
DO	Dissolved Oxygen
EC	Electrical Conductivity
EDTA	Ethylenediaminetetraacetic acid
FAS	Ferric Ammonium Sulphate
Fe	Iron
$FeCl_3$	Ferric chloride
Gm	Gram
H_2O	Water
H_2SO_4	Sulphuric acid
$HgSO_4$	Mercuric Sulphate
$K_2Cr_2O_7$	Potassium Dichromate
KI	Potassium iodide
l	Litre
Mg	Milligram
$MgSO_4$	Magnesium sulphate
Min	Minute
Ml	Millilitre
MOPE	Ministry of Population and Environment
MPN	Most Probable Number
Na_2SO_3	Sodium thiosulphate
NaCl	Sodium chloride
NaOH	Sodium hydroxide
NDWQS	National Drinking Water Quality Standard
NH_3	Ammonia
NH_4Cl	Ammonium chloride
NO_2	Nitrite
NO_3	Nitrate
ppm	Parts per million
TDS	Total Dissolved Solid
TOC	Total Organic Carbon

Chapter 1: Introduction

1.1 Background

Water, in fact is a life giving as well as life maintain element. It is considered as" molecule of life", vital for survival of all plants and animals. It is not only vital environmental factor to all forms of life, but also play a great role in socio-economic development of human population. But increased human mobility, industrialization and urbanization has resulted in water pollution. The presence of safe and reliable source of water is thus an essential prerequisite for the establishment of a stable community. It is the most important natural resources for all living organism and plays a vital role in our life as it is used for domestic supply, industries and agriculture all over the world. Monitoring of the quality of water for safe use requires a continuous check on physical, chemical and biological factors in order to get information about suitability of water and set standard for the intended purposes.

1.2 Water Quality

Definition: The term water qualityis used to describe the physical, chemical, biological and aesthetic properties of water that determine its fitness for a variety of uses and for the protection of aquatic ecosystems. Many of these properties are controlled or influenced by constituents which are either dissolved or suspended in water.

Constituents: The term constituent is used generically for any of the properties of water and/or the substances suspended or dissolved in it. In the international and local literature, several other terms are also used to define the properties of water or for the substances dissolved or suspended in it. Water quality criteria are scientific and technical information provided for a particular water quality constituent in the form of numerical data and/or narrative descriptions of its effects on the fitness of water for a particular use or for the maintenance of the health of aquatic ecosystems. For evaluation of water quality the water quality criteria for specific use is required against which the parameter values obtained by testing the sample is compared. Only by comparing with the specified criteria judgment can be made about the acceptability of water for a particular purpose.

Fitness for Use: Four broad categories of water use are recognized, namely the use of water for: domestic purposes; industrial purposes; agricultural purposes; recreational purposes

1.3 River water quality and pollution

A river is defined as a large natural stream of water emptying into an ocean, lake, or other body of water and usually fed along its course by converging tributaries. Rivers and streams drain water that falls in upland areas. Moving water dilutes and decomposes pollutants more rapidly than standing water, but many rivers and streams are significantly polluted all around the world.

A primary reason for this is that all three major sources of pollution (industry, agriculture and domestic) are concentrated along the rivers. Industries and cities have historically been located along rivers because the rivers provide transportation and have traditionally been a convenient place to discharge waste. Agricultural activities have tended to be concentrated near rivers, because river floodplains are exceptionally fertile due to the many nutrients that are deposited in the soil when the river overflows.

Sources of pollution: Farmers put fertilizers and pesticides on their crops so that they grow better. But these fertilizers and pesticides can be washed through the soil by rain, to end up in rivers. If large amounts of fertilizers or farm waste drain into a river the concentration of nitrate and phosphate in the water increases considerably. Algae use these substances to grow and multiply rapidly turning the water green. This massive growth of algae, called eutrophication, leads to pollution. When the algae die they are broken down by the action of the bacteria which quickly multiply, using up all the oxygen in the water which leads to the death of many animals. Chemical waste products from industrial processes are sometimes accidentally discharged into rivers. Examples of such pollutants include cyanide, zinc, lead, copper, cadmium and mercury. These substances may enter the water in such high concentrations that fish and other animals are killed immediately. Sometimes the pollutants enter a food chain and accumulate until they reach toxic levels, eventually killing birds, fish and mammals.

Factories use water from rivers to power machinery or to cool down machinery. Dirty water containing chemicals is put back in the river. Water used for cooling is warmer than the river itself. Raising the temperature of the water lowers the level of dissolved oxygen and upsets the balance of life in the water. People are sometimes careless and throw rubbish directly into rivers. As the river course particularly in major urban areas has become the site for urban drainage and waste dumping, it undoubtedly causes the deterioration of the river water quality. This has caused not only in degradation, displacement or diminishing of aquatic organism, but in poor health condition of general people and in the overall environmental quality as well.

The world population is growing rapidly over last few decades. The Bagmati River is principal river in the Kathmandu Valley river system. It drains the entire valley with its six major tributaries, the Bishnumati, Manohara, Dhobikhola, Nakhhu, Balkhu and Tukucha. The river basin covers an area of 595.4 km2 with an altitude varying from 1,178-2,723 m above sea level. The average annual rainfall is 1,900 mm of which about 80% occurs only during the monsoon (July-Sept). The river basin currently faces a number of serious environmental and ecological challenges. Urbanization and industrialization of the basin headwaters in Kathmandu contribute to deterioration in water quality, with regional consequences for the aquatic ecosystem and the health of downstream sub-basin user groups. Solid wastes like kitchen waste, dead animals, hospital waste, and industrial waste have been dumped by the riverside. In addition, sewer lines for domestic and industrial wastewater have been connected to the river (UN-HABITAT, 2008). These activities have caused serious pollution and the production of foul odors near the riverside. River system water entering the core urban area is visibly black with filth stinks badly, and no tests are really needed to verify its quality. Several governmental and non-governmental institutions, civil society organizations and other stakeholders are working to improve the environmental conditions of rivers in the Kathmandu Valley. The number of parties becoming involved is growing, but the status of the rivers is further deteriorating every day. As part of the river restoration activities, work is in progress to construct sewage diversion structures, concretize river banks for bank stabilization, divert and modify river flows, and construct sewage lines.

1.4 WORLD WATER QUALITY FACTS AND STATISTICS

Global Water Pollution

● Every day, 2 million tons of sewage and industrial and agricultural waste are discharged into the world's water (UN WWAP, 2003), the equivalent of the weight of the entire human population of 6.8 billion people.
● The UN estimates that the amount of wastewater produced annually is about 1,500 km^3, six times more water than exists in all the rivers of the world. (UN WWAP ,2003) Human Waste.
● Lack of adequate sanitation contaminates water courses worldwide and is one of the most significant forms of water pollution. Worldwide, 2.5 billion people live without improved sanitation. (UNICEF WHO, 2008)
● Over 70% of these people who lack sanitation, or 1.8 billion people, live in Asia.
● Sub-Saharan Africa is slowest of the world's regions in achieving improved sanitation: only 31 percent of residents had access to improved sanitation in 2006.
● 18% of the world's population, or 1.2 billion people (1 out of 3 in rural areas), defecate in the open. Open defecation significantly compromises quality in nearby water bodies and poses an extreme human health risk. (UNICEF WHO, 2008)
● In Southern Asia, 63% of rural people – 778 million people – practice open defecation.
Human Health Impacts
● Worldwide, infectious diseases such as waterborne diseases are the number one killer of children under five years old and more people die from unsafe water annually than from all forms of violence, including war. (WHO, 2002)
● Unsafe or inadequate water, sanitation, and hygiene cause approximately 3.1 percent of all deaths worldwide, and 3.7 percent of DALYs (disability adjusted life years) worldwide. (WHO, 2002)

● Unsafe water causes 4 billion cases of diarrhea each year, and results in 2.2 million deaths, mostly of children under five. This means that 15% of child deaths each year are attributable to diarrhea – a child dying every 15 seconds. In India alone, the single largest cause of ill health and death among children is diarrhea, which kills nearly half a million children each year. (WHO and UNICEF,2000)

Ecosystem Impacts

● There has been widespread decline in biological health in inland (non-coastal) waters. Globally, 24 percent of mammals and 12 percent of birds connected to inland waters are considered threatened. (UNWWAP,2003)
● In some regions, more than 50% of native freshwater fish species are at risk of extinction, and nearly one third of the world's amphibians are at risk of extinction. (Vié et al., 2009)
● Freshwater species face an estimated extinction rate five times greater than that of terrestrial species. (Ricciardi and Rasmussen,1999)
● Freshwater ecosystems sustain a disproportionately large number of identified species, including a quarter of known vertebrates. Such systems provide more than US$75 billion in goods and ecosystem services for people, but are increasingly threatened by a host of water quality problems. (Vié et al., 2009)
● The greatest single service freshwater ecosystems provide—marshes in particular—is water purification and the assimilation of wastes, valued at US$ 400 billion (Costanza et al.,1997).
● With the Millennium Development Goals, the international community committed to halving the proportion of people without access to safe water and sanitation by 2015. Meeting this goal means some 322 million working days per year gained, at a value of nearly US$ 750 million (SIWI ,2005), and an annual health sector cost saving of US$ 7 billion. Overall, the total economic benefits of meeting the MDG target have been estimated at US$ 84 billion (SIWI ,2005).
● Poor countries with access to clean water and sanitation services experienced faster economic growth than those without: one study found the annual economic growth rate of 3.7 percent among poor countries with better access to improved water and sanitation services, while similarly poor countries without access had annual growth of just 0.1 percent (Sachs ,2001).

Pollution from Industry and Mining

● 70% of industrial wastes in developing countries are disposed of untreated into waters where they contaminate existing water supplies. (UN-Water, 2009)
● An estimated 500,000 abandoned mines in the U.S. will cost $20 billion in management and remediation of pollution; many of these sites will require management in perpetuity.
● In the U.S. state of Colorado alone, some 23,000 abandoned mines have polluted 2,300 km of streams. (Banks et al., 1997)
● Chlorinated solvents were found in 30 percent of groundwater supplies in 15 Japanese cities, sometimes traveling as much as 10 km from the source of pollution. (UNEP, 1996)
● Roughly one unit of mercury is emitted into the environment for every unit of gold produced by small scale miners, a total of as much as 1000 tons of mercury emitted each year.

Pollution from Agriculture

● In a recent comparison of domestic, industrial, and agricultural sources of pollution from the coastal zone of Mediterranean countries, agriculture was the leading source of phosphorus compounds and sediment. (UNEP,1996) Nutrient enrichment, most often associated with nitrogen and phosphorus from agricultural runoff, can deplete oxygen levels and eliminate species with higher oxygen requirements, affecting the structure and diversity of ecosystems.
● Nitrate* is the most common chemical contaminant in the world's groundwater aquifers. (Spalding and Exner,1993) And mean nitrate levels have risen by an estimated 36% in global waterways since 1990 with the most dramatic increases seen in the Eastern Mediterranean and Africa, where nitrate contamination has more than doubled. (GEMS,2004)
● According to various surveys in India and Africa, 20-50% of wells contain nitrate1 levels greater than 50 mg/1 and in some cases as high as several hundred milligrams per liter. (cited in FAO,1996) Groundwater Impacts
● In Chennai, India, over-extraction of groundwater has resulted in saline groundwater nearly 10 km inland of the sea and similar problems can be found in populated coastal areas around the world. (UNEP,1996)

Infrastructure Affects Water Quality

● Sixty percent of the world's 227 biggest rivers have interrupted stream flows due to dams and other infrastructure. Interruptions in stream flow dramatically decrease sediment and nutrient transport to downstream stretches, reducing water quality and impairing ecosystem health. (UNWWAP, 2003) 1 The USEPA (2002) has established a maximum contaminant level of 10 mg/l nitrate because of concerns that ingestion of nitrate in drinking water by infants can cause low oxygen levels in their blood. Long-term exposure to nitrate at concentrations as low as 2 - 4 mg/l in community water supplies has been linked to bladder and ovarian cancer (Weyer et al., 2001) and non-Hodgkins lymphoma. (Ward et al.,1996)

Rapid population growth, urbanization and industries have put pressure on already diminishing water resources. The quality of water is declining day by day due to the encroachment of the river banks and anthropogenic activities in the river banks. The Department of Hydrology and Meteorology (DHM) under the Ministry of Population and Environment (MOPE), Government of Nepal has initiated the water quality measurement and hoarding board installation which is important to provide the basis for detecting trends and to provide the information enabling the awareness through hoarding board. The aim behind is to summarize the current water quality status of the Kathmandu Valley and few outside valley river systems and describe areas in which further research is needed.

1.5Objectives of the project

The main objective of this study wasas follows;

- Monitor the water qualityat different Sites in riversand lakesof Nepal as shown in table no 1.

- Installation of hoarding boards including the information of water quality on three points at Khokana, Devghat and Begnas.

Table 1: Location of sampling site

Kathmandu
Bagmati-Sundarijal,Gaurighat,Khokana,Gokarna.
Bishnumati-Budanilkantha,Balaju Bridge, Shobhabhagwati, Teku Dovan.
Manohara-Pepsicola, Mulpani bridge, Sankhu, Balkumari.
Taudaha-1,2,3
Nakkhu-Nakkhu, Bhaisepati, Saibu.
Hanumante-Sallaghari,Kausaltar, Thimi.
Dhobikhola-Bijulibazar, Kalopul,Chabahil.
Pokhara
Phewa-HalanchowkTemple site, Gaurighat,Damp site.
Seti-Mardi, Setidoban,P N College,Dobila
Begnas-Centre, End,South side,Outlet.
Butwal
Tinau-Jhumsa bridge,Siddhibaba,Purano buspark,Radhakrishna tole.
Birgunj
Sirsiya -Parwanipur,Bridge,Miteri bridge, Ghadiharwa Pokhara
Narayanghat
Narayani-Bridge,Near Buddha stupa, Devghatunmixed, Devghat mixed.

1.6 Location map/ Description of sample site

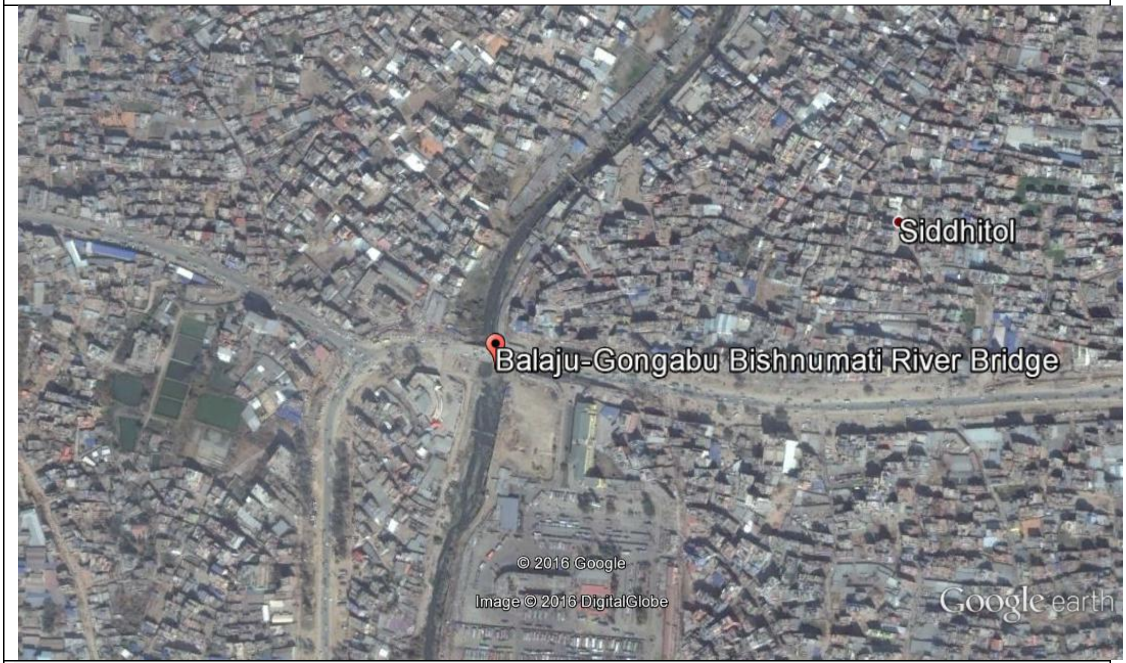
Bagmati River

Sample site	Latitude^0	Longitude^0
Sundarijal	27.762	85.423
Gokarna	27.739	85.388
Gaurighat	27.713	85.351
Khokana	27.632	85.292

The Bagmati River runs through the Kathmandu Valley of Nepal and separates Kathmandu from Patan. It is considered holy by both Hindus and Buddhists. A number of Hindu temples are located on its banks. The importance of Bagmati also lies in the fact that Hindus are cremated on the banks of this holy river, and Karats are buried in the hills by its side. According to the Nepalese Hindu tradition, the dead body must be dipped three times into the Bagmati River before cremation. The Bagmati River purifies the people spiritually. The Bagmati River is considered the source of Nepalese civilization and urbanization. The Bagmati River contains large amounts of untreated sewage, and large levels of pollution of the river exist due primarily to the region's large population. Many residents in Kathmandu empty personal garbage and waste into the river.

Bishnumati River

Sample site	Latitude^0	Longitude^0
Budanilkanth	27.784	85.356
Balaju Bridge	27.715	85.302
Sobhabhagwati	27.692	85.301
TekuDovan	27.440	85.180



River Bishnumati, a tributary of Bagmati, originates at Tokha on Sivapuri Mountain, north of Kathmandu, flows through western part of old Kathmandu city. It provides water for drinking, cultivating agriculture and ritual purposes of the local citizens. It has rich ritual cultural values. Encroachment on the river with diversion of its water has occurred. For that surrounding environment should be improved. Large volume of water is diverted near the foothills of the source area for water supply. Diversion is also done from its tributaries Sangla and Mahadevkhola. Water Sewer discharge through storm water drains are common in core areas like Manamaiju, Nepal Tar, Balaju, Mhepi, Khusibu, Shovabhagwati, Dallu, Kankeswori, Kalimati. Squatter settlements in different locations along the river have connected their toilet outlets directly into river. Most of banks along the river is used for dumping the solid waste generated by city dwellers. River side along the Kankeswori,Tekubridgeused as a dumping site for waste from slaughter house. Squatter settlements are situated in DhikureChouki, KumaristhanBuddhajyotiMarga, BalajuJagritiTole, SangamTole, Ranibari in this river. River banks along the New Bus Park, Gongabu are widely used for commercial purpose. Religiously,culturally important sites such as Shovabhagwati, Indrayani, Kanakeshwori, Ram Mandir,TankeshworiShivadevBasaha, Budhanilkantha are located along the Bishnumati River. Many cremation sites are also located along this river especially in the river confluences.

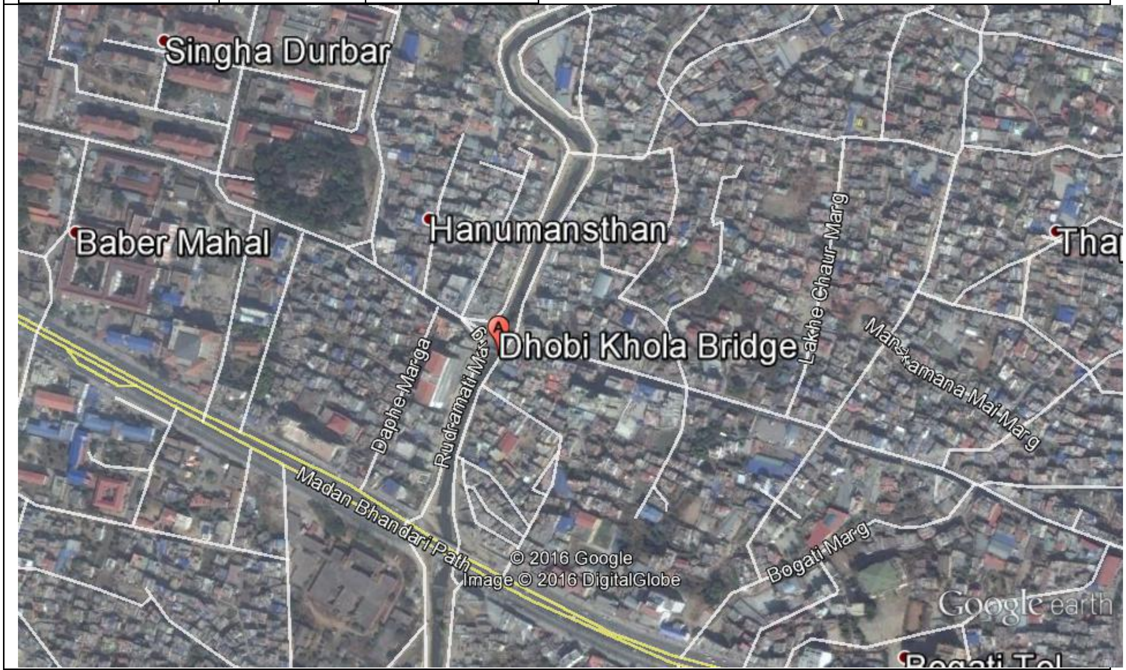
Manohara River

Sample site	Latitude^0	Longitude^0
Pepsicola	27.689	85.360
Mulpani bridge	27.703	85.394
Sankhu	27.705	85.396
Balkumari	27.670	85.339

Manahara River originates from ManichaurDanda in e north east and flows towards southwest- longest tributary of e Bagmati, having length of 23.4 km (Pradhan, B., 1996). Total catchment area of the Manahara River 285.35 sq. km. The major tributaries are Hanumante, SaliNadi, GodaworiKhola, KodkuKhola and GhatteKhola. Manahara River meets Bagmati River at Chasal. Majority of catchments land like Sankhu, Thali, Mulpani are covered by the agricultural land. Diversion of water using pumps for agricultural are seen at different locations. Riparain vegetation is still intact in Sankhu but decreases downstream. Manahara River located in northeast part of the Kathmandu Valley has been disturbed for last one decade by several anthropogenic activities and natural causes thereby deteriorating its recreational functions and stream habitat. Major disturbances, which affect river habitat and surface water quality of Manohara River were destruction of riparian buffer zones, excavation excessive amount of sand from the river, encroachment of floodplains and bars, solid waste and sewer effluent, and tendency of landuse change. Sewerage connection into the river is not seen upstream from Mulpani but towards the downstream direct discharge of sewer is rampan. New sewer lines are connecting to discharge waste water directly into the rivers in newly urbanizing areas. A small collection chamber found constructed near Sano Thimi Bridge to collect waste water from Pepsicola planning area for reducing the organic load in the river to some extent. Solid waste dumping is comparatively less in Manohara River. Squatter settlements are observed near the bridge at Jadibuti. Some sand mining activities observed from Mulpani to Koteshwor. Bank erosions are also seen in some locations along the river. Culturally and historically important sites such as Bajrayogini, SalinadiTirtha and Changunara are situated in the banks of this river and they are still in good condition.

Dhobi Khola (Rudramati)

Sample site	Latitude⁰	Longitude⁰
Bijulibazar	27.693	85.328
Kalopul	27.710	85.337
Chabahil	27.716	85.339



The Dhobikhola also known as Rudramati River originates from the ShivapuriDanda, and flows towards the south through the heart of the city. The length is about 18.2 km (Pradhan, B., 1996). The total catchment area of the Dhobikhola is about 31.20 sq.km. KhahareKhola and ChakhunchaKhola are the major tributaries of the Dhobikhola. The upstream section passes through agricultural land has clear water. Water in upstream are used for washing utensil, clothes and animal, river is free from sewerage connection in these sections. The river has similar problems of discharge of raw sewage and solid waste dumping as it flows downstream from Kapan. Mandikatar, Maitidevi, Anamnagar and the junction of Dhobikhola and Bagmati are found most common place dumping waste in this river stretch. Weirs constructed across the river being a place for collecting garbage in the river bed. Thick black color water with foul smell clearly visualizing from Sawaswoti Nagar, Mandikatar and the junction of Dhobi Khola with Bagmati and Bijulibazar indicating the level of water pollution in the river. Most affected stretches are Chabahil, Siphal, Maitidevi, Baneswor, Anamnagar, Babarmahal. River banks are encroached by squatters also in this river.

Nakhukhola

Sample site	Latitude^0	Longitude^0
Nakhu	27.662	85.306
Bhaisipati	27.649	85.307
Saibu	27.650	85.310

NakhuKhola flows from the south and meets Bagmati near the Chobhar gorge. It originates from the ridge of Bhardeu and the total. catchment area of the watershed is around 51.44 sq. km. 14 NalluKhola and LeleKhola meet together at Tikabhairab to form NakhuKhola. River water is diverted from the upstream of Nallukhola at Basuki for drinking and irrigation. Raj Kulo, an irrigation canal constructed during the Malla period and fed by NalluKhola is no more functional in many areas. From NakhuKhola water is diverted for irrigation at Champi . A water treatment and distribution plant is present near the confluence of the NakkhuKhola and Bagmati. Sewerage pipes discharge directly from individual houses right from Bhardev, the TamangGau. The condition of the sewer pipe is in poor condition in certain area. Though solid waste dumping is absent in the upstream, it is observed downstream from Kusunti onwards. Industrial waste is comparatively more than the household waste. Some sand mining activity (medium scale) can be observed (BASP, 2008) near the confluence of Bagmati and NakkhuKhola. Some small scale extraction is practiced by few people directly from the river. The places of culturally importance are the temples of TikaBhairab which lies at the confluence where three days Jatra is celebrated on the occasion of Ram Navami. Nakhhu River is also important for the festival of RatoMachindranath celebrated every twelve years (BarabarseMela).

Hanumante Khola

Sample site	Latitude^0	Longitude^0
Sallaghari	27.672	85.407
Kausaltar	27.673	85.365
Thimi	27.674	85.387

HanumanteKhola is the tributary of Manohara and originates from MahadevDanda in the eastern part of valley. Untreated sewerage of Bhaktapur is directly discharged into the river at Hanuman Ghat. Hanuman Ghat is one of the cremation sites of Bhaktapur. The banks of the river are treated as dumping site of the municipality. The waste is strewn everywhere at crematory, bridges and besides river banks. Urbanization is very dense in the upstream and downstream at Bhaktpaur and Thimi but slightly less in between. Few squatter settlements are seen in the river banks, there is one settlement according to Lumanti8 (2008). Some sand mining activities are observed around the confluence of Hanumante with Manohara. Hanuman Ghat the confluence Tabyakhusi and ChakhuKhola is culturally important location. An important temple of Mahalaxmi is also located here.

Taudaha Lake

Site	Latitude^0	Longitude^0
Taudaha-1	27.649	85.281
Taudaha-2	27.648	85.282
Taudaha-3	27.647	85.282

Taudaha Lake is a small lake in the outskirts of Kathmandu, in Nepal. The name comes from a combination of Newari words 'Ta', meaning snake and 'Daha', which means lake.

The Taudaha Lake is believed to be a remnant pool of the huge lake that once existed where now the city of Kathmandu sits. According to mythology, a Buddhist mythical character Manjushree cut the hill in the valley's south, allowing the lake's water to drain off, thereby creating land that was duly occupied by people. Folklore suggests that that "cut" in the hill is the Chobar Gorge, a narrow passage from which the Bagmati River exits the Kathmandu Valley. After the water of the ancient lake drained away, a few small lakes and ponds were created beyond the hills. Taudaha is believed to be one of those ponds.

Narayani River

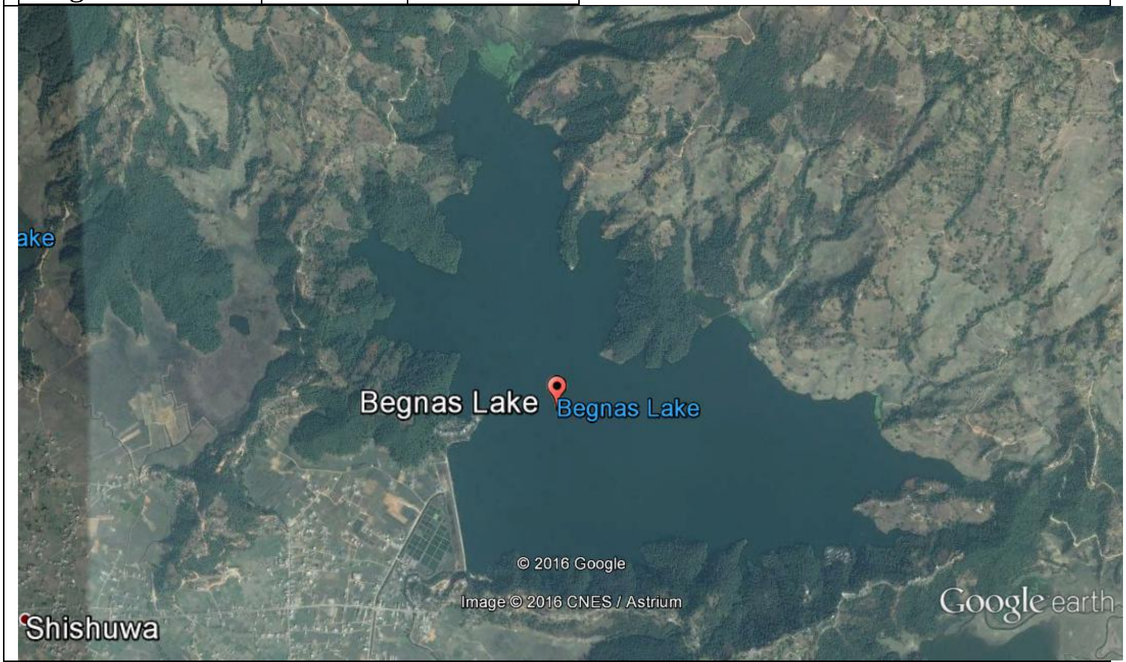
Sample site	Latitude^{0}	Longitude^{0}
Narayani-Bridge	27.697	84.426
Narayani-near Buddha stupa	27.709	84.419
Narayani-Devghat unmixed	27.801	84.407
Narayani-Devghat mixed	27.802	84.407

The Narayani River is one of the largest rivers in Nepal. It is the final collector of seven extremely complex drainage systems of the Trans-Himalaya and consists of countless creeks, hill streams, rivers, forest lakes, wetlands, floodplains and oxbows. The Kaligandaki is the main feeder system of the Narayani. It originates on the Tibetan plateau and cuts through the Nepal Himalayas between Dhaulagiri and Annapurna, forming the world's deepest gorge. After joining the Trishuli (also called Trisuli) River in Deoghat it is called the Narayani.

Nepal's third largest river is the source of fresh water for the western reaches of the park, sustaining its aquatic life, attracting indigenous and migratory birds, and replenishing its wetlands. However, the population growth in Chitwan valley, the use of agro-chemicals, and the location directly upstream of polluting paper mills, breweries, distilleries and other factories now seriously threatens Nepal's best-known nature sanctuary.

Begnas Lake

Sample site	Latitude^0	Longitude^0
Begnas-centre	28.175	85.101
Begnas-End	28.179	84.092
Begnas-South side	28.166	84.094
Begnas-Outlet	28.174	84.097



Begnas Lake is a freshwater lake in Lekhnath municipality of Kaski district of Nepal located in the south-east of the Pokhara Valley. The lake is the second largest, after Phewa lake, among the eight lakes in Pokhara Valley. Water level in the lake fluctuates seasonally due to rain, and utilization for irrigation. The water level is regulated through a dam constructed in 1988 on the western outlet stream, *Khudi Khola*.

Begnas Lake area with a number of resorts is a popular destination for tourists visiting Pokhara. The water from the lake is used for irrigation and some parts of the lake are used as caged fisheries. The Begnas lake area has a number of swampy areas around it, many of which have been converted to paddy fields day by day.

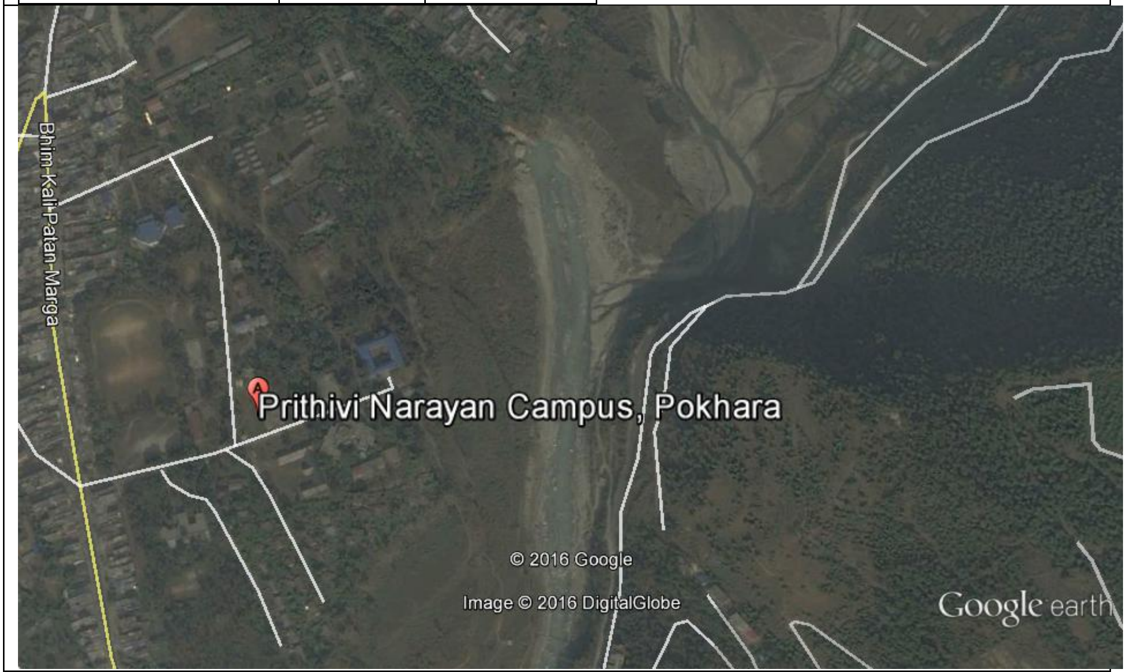
Phewa (Fewa) Lake

Sample site	Latitude^0	Longitude^0
Phewa-Halanchowk	28.215	83.945
Phewa-Temple site	28.208	83.953
Phewa-Gaurighat	28.211	83.951
Phewa-Damp site	28.216	83.953

Phewa Lake is a freshwater lake in Nepal located in the south of the Pokhara Valley that includes Pokhara city; parts of Sarangkot and Kaskikot. The lake is stream-fed but a dam regulates the water reserve, therefore, the lake is classified as semi-natural freshwater lake. It is the second largest lake in Nepal, the largest in Gandaki Zone followed by Begnas Lake. Phewalake is located at an altitude of 742 m (2,434 ft) and covers an area of about 5.23 km^2 (2.0 sq mi). It has an average depth of about 8.6 m (28 ft) and a maximum depth of 24 m (79 ft).The Annapurna range on the north is only about 28 km (linear distance) away from the lake. The lake is also famous for the reflection of mount Machhapuchhre and other mountain peaks of the Annapurna and Dhaulagiri ranges on its surface. The TaalBarahi Temple is situated on an island in the lake.

Seti Gandaki River

Sample site	Latitude^0	Longitude^0
Seti-Mardi	28.335	83.823
Seti-Setidobhan	28.163	83.822
Seti-PN college	28.239	83.982
Seti-Dobila	28.209	83.693



The Seti Gandaki River, also known as the Seti River or the Seti Khola, is a river of western Nepal, a left tributary of the Trishuli River. It is one of the holiest rivers of Nepal, worshipped in Hinduism as a form of Vishnu. The river is also famous because it is close to some Holy places and is the central point of many stories of Hindu mythology, such as the Mahabharata, one of longest books of Hinduism, written by Vyasa, who was born near the confluence of the Gandaki and Madi rivers near Damauli, Tanahun, Nepal.Gandaki River . It rises from the base of the Annapurna massif, and flows south and south-east past Pokhara and Damauli to join the Trishuli River near Devghat.In May 2012 a devastating flood on the river killed more than 60 people north of Pokhara and changed the course of the river.

Tinau river

Sample site	Latitude^0	Longitude^0
Jhumsa bridge	27.700	83.499
Siddhi baba butwal	27.749	83.400
Purano bus park	27.701	83.463
Radhakrishnatole	27.702	83.463

Tinau is a Class- II category River originating from the Mahabharat Mountains and flowing through the Siwalik Hills and Terai Plain at Butwal, Nepal before entering the Indian Territory to join the Ganges.The length of the Tinau is 95 km starting from Palpa to Indo-Nepal Border at Marchawar. The catchment area of the river is about 1081 sq. km up to the border.

Sirsiya River

Sample site	Latitude^0	Longitude^0
Sirsiya-Parwanipur	27.120802°	85.735897°
Sirsiya-bridge	27.077805	84.921789
Sirsiya-Miteri bridge	26.800570°	84.996945°
Sirsiya-Ghadiarwa Pokhara	27.013816°	84.874871°

The river Sirsiya, a tributary of the BurhiGandak, originates from Pathlahia hill of the dense Ramban forests in Nepal, its course roaming through the subdivision cutting through Bara and Parsa districts in Nepal and Raxaul in Bihar, India. It flows southwards from the place of its origin for about 15 km in Nepal and then enters India at Raxaul. From here, the river flows about 20 km in India and joins BurhiGandak near Sugauli in East Champaran district. The water is pure in its contents and have full of medicinal values like other Himalayan rivers. It maintains its valuable contents till Parwanipur. But after it, unrestrained untreated wastes are being dumped by the 46 factories situated at Birgunj (Nepal) which make this river contaminated. The colour of the river turned into black besides, emanating foul smell has made the life of the people, who dwell near the river, a nightmare.Birgunj and surrounding area of Parsa district have direct connection with Sirsiya river. It is the centre of industrial hub and known as Bara/Parsa industrial corridor. The government of Nepal has declared this area as Special Economic Zone(SEZ). There are more than 250 industrial buildups in this corridor and all the industrial wastewaters from there is directly/indirectly discharged into Sirsiya river.

Chapter 2: Methodology

2.1 Project activities

Primary data on water quality has been collected through sampling of river water from various locations to assess the urban water quality within and outside the valley. Similarly, review of secondary data and related literature from various sources, field observation, interaction and discussion with concerned stakeholders of various governments and non-governmental line agencies were carried out to perceive the existing water environment situation.

2.1.1 Sample collection

The physical parameters like pH, conductivity and DO were measured at the site by DHM staff andsamples were collected from site for analysis of chemical parameters. The collected samples were transported to the laboratory by keeping in ice box. Follow up for the proper collection of water samples and its safe delivery to the laboratory was done on a regular basis.

Sampling Method

- The sample was collected from the middle of the bridge. Most of the samples were taken from the downstream side of the bridge, so the sampling bucket did not get washed under the bridge.
- The primary sampling point was in the surface water layer (0-5 cm from the surface) at the centre of the main flow. However, the top 1-2 cm of this surface layer was avoided so as not to collect floating dust, oil, etc. In addition, further samples were collected through the full depth of the water column to meet the purpose of the study.
- Equipment List
    a. Bucket and rope
    b. Ice box
    c. Sampling bottles
- The bucket was rinsed with three separate bucketful of river water. Keeping hand inside water was avoided as it can contaminate samples. Rinsed each sample bottle 3 times before filling.
- For lakes, the sampling point was selected after taking into consideration such factors as geography, whether there are freshwater (rivers or streams) or wastewater inflows, depth.
- The type of water sampling tool was used depending on the sampling site and the type of sample to be taken.
- The size and type of sample was taken as the type of sample container.
- Sampling tools and containers were contamination free.
- Sample containers were washed 3-4 times with water from the exact site of sampling prior to taking the sample.
- Field records- On a form which has been prepared in advance, recorded all pertinent details – pH, and DO, EC

- Labeled each sample unambiguously, i.e. written on the sample bottle in water-resistant ink details of the name or code of the sample, the sampling date, the sampling site name etc.
- Transport and storage of samples- all samples were cooled in ice soon after collection, and then transported to the laboratory packed in ice.

2.1.2The laboratory analysis of the samples

Analysis was done for the pre-defined chemical and biological parameters of the water sample using accepted tools and techniques. Following parameters was analysed for water quality of each specified rivers and lakes:

A.Biological Oxygen Demand(BOD)

Biological Oxygen Demand (BOD) test is used to determine the effects of discharges on receiving waters. When a measurement is made of all oxygen consuming materials in a sample, the result is termed "Total Biochemical Oxygen Demand" (TBOD), or often just simply "Biochemical Oxygen Demand" (BOD). Because the test is performed over a five day period, it is often referred to as a "Five Day BOD", or a BOD5.The method consists of filling with sample, to overflowing, an airtight bottle of the specified size and incubating it at the specified temperature for 5 days. Dissolved oxygen is measured initially and after incubation, the BOD is computed from the difference between initial and final DO. Because the initial DO is determined shortly after the dilution is made, all oxygen uptake occurring after this measurement is included in the BOD measurement.

Sampling and storage: Samples for BOD analysis may degrade significantly during storage between collection and analysis, resulting in low BOD values. Minimize reduction of BOD was done by analyzing sample promptly or by cooling it to near-freezing temperature during storage. Chilled samples were then warmed to 20 ± 3°C before analysis.

Reagents: Reagents were prepared in advance but discarded if there was any sign of precipitation or biological growth in the stock bottles.

Phosphate buffer solution: Dissolved 8.5g KH_2PO_4, 21.75 g K_2HPO_4, 33.4 g $Na_2HPO_4.7H_2O$, and 1.7 g NH_4Cl in about 500 mL distilled water and dilute to 1 L. The pH -7.2 without further adjustment. Alternatively, dissolved-2.5 g KH_2PO4 or 54.3 g K_2HPO_4 in about 700 mL distilled water. Adjust-pH to 7.2 with 30% NaOH and diluted-to1 L.

Magnesium sulphate solution: Dissolve 22.5 g $MgSO_4. 7H_2O$ in distilled water and dilute to 1 L.

Calcium chloride solution: Dissolve 27.5 g $CaCl_2$ in distilled water and dilute to 1 L.

Ferric chloride solution: Dissolve 0.25 g $FeCl_3.H_2O$ in distilled water and dilute to 1 L.

Acid and alkali solutions, 1N, for neutralization of caustic or acidic waste samples.

1) Acid—slowly and while stirring, add 28 ml conc. sulfuric acid to distilled water. Dilute to 1 L.
2) Alkali—Dissolve 40 g sodium hydroxide in distilled water. Dilute to 1 L.
Sodium sulphite solution: Dissolve 1.575 g Na_2SO_3 in 1000 ml distilled water. This solution is not stable; prepare daily.
Nitrification inhibitor, 2-chloro-6-(trichloromethyl) pyridine
Glucose-glutamic acid solution: Dry reagent-grade glucose and reagent-grade glutamic acid at 103°C for 1 h. Add 150 mg glucose and 150 mg glutamic acid to distilled water and dilute to 1 L. Prepare fresh immediately before use.
Ammonium chloride solution: Dissolve 1.15 g NH_4Cl in about 500 ml distilled water, adjust pH to 7.2 with NaOH solution, and dilute to 1 L. Solution contains 0.3 mg N/mL.
Dilution water: Use demineralized, distilled, tap, or natural water for making sample dilution.

Procedure:
Preparation of dilution water: Place desired volume of water in a suitable bottle and add 1 ml. Each of phosphate buffer, $MgSO_4$, $CaCl_2$, and $FeCl_3$ solutions/L of water. Seed dilution water, if desired, as described in. Test dilution water as described in so that water of assured quality always is on hand.

Before use bring dilution water temperature to 20 ± 3°C. Saturate with DO by shaking in a partially filled bottle or by aerating with organic-free filtered air. Alternatively, store in cotton-plugged bottles long enough for water to become saturated with DO. Protect water quality by using clean glassware, tubing, and bottles.

Dilution water storage: Source water may be stored before use as long as the prepared dilution water meets quality control criteria in the dilution water blank .Such storage may improve the quality of some source waters but may allow biological growth to cause deterioration in others. Preferably do not store prepared dilution water for more than 24 h after adding nutrients, minerals, and buffer unless dilution water blanks consistently meet quality control limits. Discard stored source water if dilution water blank shows more than 0.2 mg/L DO depletion in 5 d.

Determination of initial DO: If the sample contains materials that react rapidly with DO, determine initial DO immediately after filling BOD bottle with diluted sample. If rapid initial DO uptake is insignificant, the time period between preparing dilution and measuring initial DO is not critical but should not exceed 30 min.

Dilution water blank: Use a dilution water blank as a rough check on quality of unseeded dilution water and cleanliness of incubation bottles. Together with each batch of samples incubate a bottle of unseeded dilution water. Determine initial and final DO .The DO uptake should not be more than 0.2 mg/L and preferably not more than 0.1 mg/L Discard all dilution water having a DO uptake greater than 0.2 mg/L and either eliminate source of contamination or select an alternate dilution water source.

Incubation: Incubated at 20°C ± 1°C BOD bottles. Determination of final DO: After incubation determine DO in sample dilutions, blanks.

Calculation

BOD_5 (mg/L) = (D_0- D_5) X Dilution factor
D1 = DO of diluted sample immediately after preparation, mg/L
D2 = DO of diluted sample after 5 days incubation at 20°C, mg/L

B. Dissolved oxygen (DO)

Oxygen is dissolved in most waters in varying concentrations. Oxygen dissolved in water is often referred as dissolved oxygen (DO). When manganous sulphate is added to the sample containing alkaline potassium iodide, manganous hydroxide is formed which is oxidized by the DO of the sample to basic manganic oxide. On addition of sulphuric acid, the basic manganic oxide liberates iodine equivalent to that of DO originally present in the sample. The liberated iodine is titrated with a standard solution of sodium thiosulphate using starch as indicator.

Reagents: Manganoussulphate solution: Dissolved 480 g $MnSO_4 \cdot 4H_2O$, 400 g $MnSO4 \cdot 2H_2O$, or 364 g $MnSO4 \cdot H_2O$ in distilled water, filter, and dilute to 1 L.
The $MnSO_4$ solution should not give a color with starch when added to an acidified potassium iodide (KI) solution.
Alkali-iodide-azide reagent

Procedure: Collected the sample in a 300 ml BOD bottle with utmost care.
Added 2ml manganous sulphate solution, followed by the addition of 2ml of alkaline KI solution. The tip of the pipette should be below the surface of liquid.
Stoppered the bottle without entrainment of air and mix by inverting the bottle at least 10 times.
Allowed the precipitate to settle water completely leaving a clear supernatant layer.
Carefully removed the stopper and add 2ml conc. H_2SO_4 by the sides of bottle.
Titrated the whole content or par with sodium thiosulphate using starch as an indicator.
At the end point, initial dark blue color changed to colorless.

Calculation:

$$DO\ (mg/L) = \frac{(Vol \times Normality)\ of\ titrant \times 8 \times 1000}{V_2 \frac{(V_1 - V)}{V_1}}$$

V_1 = Volume of sample bottle
V_2 = Volume of part of content titrated
V = Volume of manganous sulphate and potassium iodide added

C.Chemical oxygen demand (COD)

In environmental chemistry, the chemical oxygen demand test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers) or wastewater, making COD a useful measure of water quality. It is expressed in milligrams per liter (mg/L), which indicates the mass of oxygen consumed per liter of solution.

Most types of organic matter are oxidized by a boiling mixture of chromic and sulfuric acids. A sample is refluxed in strongly acid solution with a known excess of potassium dichromate ($K_2Cr_2O_7$). After digestion, the remaining unreduced $K_2Cr_2O_7$ is titrated with ferrous ammonium sulfate to determine the amount of $K_2Cr_2O_7$ consumed and the oxidizable matter is calculated in terms of oxygen equivalent. Keep ratios of reagent weights, volumes, and strengths constant when sample volumes other than 50 ml are used. The standard 2-h reflux time may be reduced if it has been shown that a shorter period yields the same results. Some samples with very low COD or with highly heterogeneous solids content may need to be analyzed in replicate to yield the most reliable data. Results are further enhanced by reacting a maximum quantity of dichromate, provided that some residual dichromate remains.

Apparatus:
Reflux apparatus, consisting of 500- or 250-mlErlenmeyer flasks with ground-glass 24/40 neck and 300-mm jacket Liebig, West, or equivalent condenser with 24/40 ground-glass joint, and a hot plate having sufficient power to produce at least 1.4 W/cm2 of heating surface, or equivalent.
Blender.
Pipets, Class A and wide-bore.

Reagents
Standard potassium dichromate solution, 0.04167M: Dissolved 12.259g $K_2Cr_2O_7$, primary standard grade, previously dried at 150°C for 2 h, in distilled water and dilute to 1000 ml. This reagent undergoes a six-electron reduction reaction; the equivalent concentration is 6 × 0.04167M or 0.2500N.
Sulfuric acid reagent: Added Ag_2SO_4, reagent or technical grade, crystals or powder, toconc H_2SO_4 at the rate of 5.5 g Ag_2SO_4/kg H_2SO_4. Let stand 1 to 2 d to dissolve. Mix.
Ferroin indicator solution: Dissolved 1.485 g 1,10-phenanthroline monohydrate and 695 mg $FeSO_4.7H_2O$ in distilled water and diluted to 100 ml.
Standard ferrous ammonium sulfate (FAS) titrant, approximately 0.25M: Dissolved 98 g $Fe(NH_4)_2(SO_4)_2.6H_2O$ in distilled water. Added 20 ml conc H_2SO_4, cool, and diluted to 1000 mL. Standardized this solution daily against standard $K_2Cr_2O_7$ solution as follows: Diluted 25.00 mL standard $K_2Cr_2O_7$ to about 100 ml. Added 30 ml conc H_2SO_4 and cooled. Titrated with FAS titrant using 0.10 to 0.15 ml (2 to 3 drops) ferroin indicator.
Mercuric sulfate, $HgSO_4$, crystals or powder**.**

Calculation

$$\text{COD (mg/L)} = \frac{\text{(b-a) x normality of ferrous ammonium sulphate x 8 x 1000}}{\text{Volume of sample}}$$

b = Blank titre value

a= Sample titre value

D.Total Iron

Iron is abundant in the earth's crust. Concentrations are normally low (<0.1 mg/L) in surface waters but can be higher in groundwater (up to 10 mg/L or more). Elevated concentrations of iron in drinking water can cause problems due to staining of laundry - unpleasant appearance - unpleasant taste. India limits on iron are: - 0.3 mg/L for water to be used for drinking without treatment - 50 mg/L for raw water to be used for drinking after conventional treatment. Phenanthroline Spectrophotometric Method: - Relies on the fact that iron ion forms a stable complex with phenanthroline - The absorbance of the red complex produced is measured in a spectrophotometer at a wave length of 510 nm - Iron concentration is read from a calibration curve.

Any solution which is colored or can be made to be colored by adding a complexing agent can be analyzed using a spectrophotometer. Solutions containing iron ions are colorless but, with the addition of ortho-phenanthroline, the iron (II) ions in the sample are immediately complexed to produce a species which is orange in color. More iron (II) ions in a sample will result in a deeper orange color. From data obtained from a series of iron (II) standards, it is possible to be able to determine the amount of iron in an unknown sample.

Procedure
Measurement of Iron
Phenanthroline Spectrophotometric Method
This method relies on the fact that iron, when converted to its ferrous state by reaction with acidified hydroxylamine, forms a colour-stable complex with phenanthroline. The red coloured complex formed can then be measured with a spectrophotometer at a wavelength of 510 nm.

E.Ammonia

Ammonia is listed as a toxic compound in aquatic environment. Ammonia exists in water in two forms (NH_4^+ - ammonium ion and NH_3 – unionized ammonia), which together are called the Total Ammonia Nitrogen (TAN), depending on pH, temperature and salinity. In natural water, total ammonia concentration of only 0.25 mg/L could be hazard to fish and other aquatic animals. High concentrations of ammonia in drinking water and other water resources can lead to adverse effects for man and environment. For this reason, ammonia is one of substances necessarily controlled following the environmental standards. The allowable levels of ammonia concentration in fresh and drinking water is in the range from 0.5 to 3.0 mg/L depend on the local regulation of states and certain areas in the World. There are several methods commonly used for determination and assessment of ammonia contamination in water. Generally water samples were collected and ammonia was analyzed in laboratory. However, since ammonia concentration easily changed with time during the storage of the samples, fresh samples should be analyzed immediately after collection.

Reagents:
Distilled water should be free of ammonia. Such water is best prepared by passage through an ion exchange column containing a strongly acidic cation exchange resin mixed with a strongly basic anion exchange resin. Regeneration of the column should be carried out according to the manufacturer's instructions. NOTE 1: All solutions must be made with ammonia-free water.
Ammonium chloride, stock solution: 1.0 mL = 1.0 mg NH_3-N. Dissolve 3.819 g NH_4Cl in distilled water and bring to volume in a 1 liter volumetric flask.
Nessler reagent: Dissolve 100 g of mercuric iodide and 70 g of potassium iodide in a small amount of water. Add this mixture slowly, with stirring, to a cooled solution of 160 g of NaOH in 500 mL of water. Dilute the mixture to 1 liter. If this reagent is stored in a Pyrex bottle out of direct sunlight, it will remain stable for a period of up to 1 year. NOTE 3: This reagent should give the characteristic color with ammonia within 10 minutes after addition, and should not produce a precipitate with small amounts of ammonia (0.04 mg in a 50 mL volume).
Working Ammonia Standard Solution: Prepare series of 10,20 and 30 microgram/ml ammonia-N standard solutions with ammonia free distilled water.

Procedure:
Took 50 ml filtrate sample or a portion diluted to 50 mL with ammonia free distilled water in 50 ml volumetric flask.
Took 0ml, 1ml, 2ml, 3ml of 10mg/l standard ammonia-N solution separately into four 50ml volumetric flasks and make volume 50 ml with water.
Added1.0 mL of Nessler reagent and mix.
After 20 minutes read the absorbance at 425 nm against the blank.
From the values obtained plot absorbance vs. mg NH_3-N for the standard curve.
For turbid sample, 100ml sample was treated with 1ml zinc sulphate solution followed by addition of 0.4 -06ml 6N sulphuric acid. The aliquot is filtered off through whatman filter paper no 42 and the ammonia is determined in the filtrate by adopting the above procedure.

F. NITRATE

Nitrate generally occurs in trace quantities surface water but may attain high levels in groundwater. In excessive amounts, it contributes to methemoglobinemia in infants. The higher concentration of nitrogen is found in wastewaters. The significant sources of nitrate are chemical fertilizers, decayed vegetables and animal matters, domestic effluent, sewage sludge to land, industrial discharge, and leachates. The growth stimulation of plants, especially of algae may cause objectionable eutrophication.

Procedure
50 ml of filtrate sample will be taken in a porcelain basin and evaporate to dryness.
It will be cooled and residue will be dissolved in 2 mL of phenol disulphonic acid and dilute to 50 ml.
6 mL of liquor ammonia will be added to develop yellow color.
Then the reading will be taken at 410 nm on spectrophotometer.
Same procedure will be repeated for the standard solution of different concentration and for distilled water.

Then the concentration of Nitrate-N will be determined from the standard curve obtained by plotting standard value against absorbance.

G. NITRITE

Nitrite (intermediate compound both in the oxidation of ammonia to nitrogen and in the reduction of nitrate) in water is either due to oxidation of ammonium compounds or reduction of nitrate. As an intermediate stage in the nitrogen cycle, this is unstable. The higher concentrations are present in industrial wastes, sewage and biologically purified effluents and in polluted streams. The very high nitrite levels are usually associated with water of unsatisfactory microbial activity. It is an actual etiologic agent of methemoglobinemia.

Nitrite (NO) is determined through formation of a reddish purple azo dye produced at pH 2.0 to 2.5 by coupling diazotized sulfanilamide with N-(l-naphthyl)-ethylenediaminedihydrogen chloride). Photometric measurements of the color dye is done at 540nm.

Storage of sample: Never use acid preservation for samples to be analyzed for $N0_2$. Make the determination promptly on fresh samples to prevent bacterial conversion of $N0_2$ to $N0_3$

Reagents

Distilled water free of nitrite and nitrate is to be used in preparation of allreagents and standards.

Buffer-color reagent: To 250 ml of distilled water, add 105 mlconc.hydrochloric acid, 5.0 g sulfanilamide and 0.5 g N-(1-naphthyl) ethylenediaminedihydrochloride. Stir until dissolved. Add 136 g of sodium acetate (CH $COONa^3$ HO) and again stir until dissolved. Dilute to 500 mlwith distilled water. This solution is stable for several weeks if stored in thedark.

Nitrite stock solution: 1.0 mL = 0.10 mg NO -N. Dissolve 0.1493 g of dried to anhydrous sodium nitrite (24 hours in desiccator) in distilled water and dilute to 1000 ml. Preserve with 2ml chloroform per liter.

Working Nitrite standard solution: Prepare 1 ppm nitrite standard (NO_2-N) from the stock solution by dilution technique. Further prepare 0.5, 1.0, & 1.5 µg working standard solutions at the time of use.

Procedure

Place 50 mL of sample, or an aliquot diluted to 50 ml, in a 50 mL Nessler tube; hold until preparation of standards is completed.

At the same time prepared a series of standards in 50 mL Nessler tubes.

Added 2 mL of buffer-color reagent to each standard and sample, mix and allow color to develop for at least 15 minutes. The color reaction medium should be between pH 1.5 and 2.0.

Read the color in the spectrophotometer at 540 nm against the blank and plot concentration of NO_2 -N against absorbance.

Calculation

1. Read the concentration of NO_2 -N directly from the curve.
2. Nitrite-N (mg/l) = $\frac{A X F}{D}$

A=Sample concentration
F= Dilution factor
D= Sample volume taken from measurement

H. Total Hardness

Ethylenediaminetetraacetic acid and its sodium salts (abbreviated EDTA) form a chelated soluble complex when added to a solution of certain metal cations. If a small amount of a dye such as Erichrome Black is added to an aqueous solution containing calcium and magnesium ions at a pHof 10.0 ± 0.1, the solution becomes wine red. If EDTA is added as a titrant, the calcium and magnesium will be complexed, and when all of the magnesium and calcium has been complexed the solution turns from wine red to blue, marking the end point of the titration. Magnesium ion must be present to yield a satisfactory end point. To insure this, a small amount of neutral magnesium salt of EDTA is added to the buffer; this automatically introduces sufficient magnesium and obviates the need for a blank correction. The sharpness of the end point increases with increasing pH. However, the pH cannot be increased indefinitely because of the danger of precipitating calcium carbonate, $CaCO_3$, or magnesium hydroxide, $Mg(OH)_2$, and because the dye changes color at high pH values. Calcium and magnesium salts dissolved in water cause water hardness.
Water hardness can be measured using a titration with ethylenediaminetetraacetic acid (EDTA). EDTA dissolved in water forms a colourless solution.
At pH 10, calcium and magnesium ions form colourless, water soluble, complexes with EDTA: calcium ion complexed by EDTA : $CaEDTA^{2-}$ magnesium ion complexed by EDTA : $MgEDTA^{2-}$
An indicator, known as a metal ion indicator, is required for the titration. This indicator can be used to detect the presence or absence of free EDTA ions in solution.
Endpoint of the titration is when all the Ca^{2+} and Mg^{2+} ions have been complexed by the EDTA. Before the endpoint, Ca^{2+} and Mg^{2+} are in excess, there is no free EDTA in solution. Immediately after the endpoint, there is an excess of EDTA.
It is essential that deionised water (water in which ions have been removed) is used in preparing all solutions, and in rinsing the conical flask. Ca^{2+} and Mg^{2+} ions must NOT be present in the water used to prepare the solutions, or in rinsing.

Reagents

Buffer solution: Dissolved 16.9 g ammonium chloride (NH_4Cl) in 143 mL conc ammonium hydroxide (NH_4OH). Added 1.25 g magnesium salt of EDTA (available commercially) and diluted to 250 mL with distilled water.
Eriochrome Black T: Sodium salt of 1-(1-hydroxy-2-naphthylazo)-5-nitro-2-naphthol-4-sulfonic acid. Dissolved 0.5 g dye in 100 g 2,2,2 -nitrilotriethanol (also called triethanolamine) or 2-methoxymethanol (also called ethylene glycol monomethyl ether). Added 2 drops per 50 mL solution to be titrated.
Hydroxylamine Hydrochloride: Dissolveed 3 gm. of hydroxylamine hydrochloride in 100ml distilled water

Experimental Determination of Ca^{2+} and Mg^{2+} in Hard Water

There are 3 steps to determining the concentration of calcium and magnesium ions in hard water using the complexometric titration method with EDTA:

a. Make a standard EDTA solution.
b. Use the standard EDTA solution to titrate the hard water.
c. Perform calculations to determine the concentration of calcium and magnesium ions in the hard water.

Preparing the Standard EDTA solution

EDTA of an analytical reagent purity is available so it can be used as a primary standard.

To prepare the EDTA standard solution:

Dried some EDTA at 80°C to remove any moisture. Accurately weigh out the required amount of EDTA onto a watchglass.

For example, to prepare 250 mL of a 0.010 mol L^{-1} solution of EDTA:

Determine the moles of EDTA required: concentration of EDTA solution = 0.010 mol L^{-1} volume of EDTA solution = 250.0 mL = 250.0 x 10^{-3} = 0.2500 L moles EDTA = concentration (mol L^{-1})x volume (L) = 0.010 x 0.2500 = 2.500 x 10^{-3} mol Calculate the mass of EDTA required to make 250.0 mL of 0.010 mol L^{-1} solution molar mass EDTA = 372.244 g mol^{-1} mass EDTA required = moles x molar mass = 2.500 x 10^{-3} x 372.244 = 0.9306 g

Carefully transferred the EDTA to the volumetric flask. Placed a clean, dry, glass funnel in the neck of the volumetric flask. Used a clean, dry spatula to transfer some of the EDTA from the watchglass to the funnel. Used a small amount of water from a wash bottle filled with deionised water to wash the EDTA out of the funnel and into the flask. Continued this process until no more EDTA is left on the watch glass. Used the wash bottle to wash the spatula over the funnel to transfer any remaining EDTA into the flask. Used the wash bottle to wash any remaining EDTA off the watch glass and into the funnel. Used the wash bottle to give the funnel itself a final wash to ensure any remaining EDTA is washed into the flask.

Fill the volumetric flask to the mark with deionised water. Deionised water can be poured into the flask using the funnel until the volume of solution in the flask is a bit below the mark on the flask. Use a Pasteur pipette to add deionised water dropwise until the bottom of the meniscus sits exactly on the mark on the flask when viewed at eye level.

Using the Standard EDTA Solution to Titrate the Hard Water

Filled a 50.0 mL burette with the standard EDTA solution. Rinse a clean, dry, burette with a small amount of the EDTA solution first. Filled the burette with the EDTA solution to well above the 0.00 mL mark. Placed a beaker under the burette, and run the EDTA solution slowly and carefully through the burette until the bottom of the meniscus sitsexactly on the 0.00 mL mark on the burette when viewed at eye level. Checked that there are no air bubbles in the solution in the burette, and that there is no "air pocket" at the tip of the burette. Removed the beaker and dispose of its contents appropriately.

Rinsed a 10.0 mL pipette with some of the hard water sample then pipette 10.0 mL of the hard water into a clean conical flask. Used a clean conical flask that has been rinsed with deionised water.Added 5 mL of ammonia based pH 10 buffer using a pipette. Added 2 drops of indicator which will turn wine-red in the ammoniated water.
Run some EDTA through the burette and into the flask until the indicator turns sky-blue. Keep swirling the conical flask during the titration to mix the contents. Note the approximate endpoint of the titration.Refilled the burette if necessary, and repeat the titration. Used the rough titration above as a guide as to where the endpoint is.
Run the EDTA through the burette quickly until about 10 mL before the expected endpoint. Slowly add the EDTA 1 mL at a time until you start to see indications of a colour change in the solution, that is, a spot of blue appears before disappearing. At this point the endpoints close. Slowly add the EDTA dropwise until the first permanent colour change (that is, the solution goes blue and stays blue). Record this volume of EDTA. Used this volume of EDTA as a guide in repeating the titration. Repeat the titration until you have 3 results (EDTA volumes) that agree to with 0.05 mL (these results are said to be concordant).

I. Magnesium

When EDTA (ethylenediaminetetraacetic acid or its salts) is added to water containing both calcium and magnesium, it combines first with the calcium. Calcium can be determined directly, with EDTA, when the pH is made sufficiently high that the magnesium is largely precipitated as the hydroxide and an indicator is used that combines with calcium only. Several indicators give a color change when all of the calcium has been complexed by the EDTA at a pH of 12 to 13.

Reagents
Sodium hydroxide, NaOH, 1N
Murexide (ammonium purpurate) indicator: This indicator changes from pink to purple at the end point. Prepare by dissolving 150 mg dye in 100 g absolute ethylene glycol. Water solutions of the dye are not stable for longer than 1 d. A ground mixture of dye powder and sodium chloride (NaCl) provides a stable form of the indicator. Prepare by mixing 200 mg murexide with 100 g solid NaCl and grinding the mixture to 40 to 50 mesh. Titrate immediately after adding indicator because it is unstable under alkaline conditions. Facilitate end-point recognition by preparing a color comparison blank containing 2.0 mL NaOH solution, 0.2 g solid indicator mixture (or 1 to 2 drops if a solution is used), and sufficient standard EDTA titrant (0.05 to 0.10 mL) to produce an unchanging color.

Eriochrome Blue Black R indicator: Prepared a stable form of the indicator by grinding together in a mortar 200 mg powdered dye and 100 g solid NaCl to 40 to 50 mesh. Store in a tightly stoppered bottle. Use 0.2 g of ground mixture for the titration in the same manner as murexide indicator. During titration the color changes from red through purple to bluish purple to a pure blue with no trace of reddish or purple tint. The pH of some (not all) waters must be raised to 14 (rather than 12 to 13) by the use of 8N NaOH to get a good color change.

Standard EDTA titrant, 0.01M: Prepared standard EDTA titrant as described for the EDTA total-hardness method (Section 2340). Standard EDTA titrant, 0.0100M, is equivalent to 400.8 µgCa/1.00 mL.

Procedure

Sample preparation: Because of the high pH used in this procedure, titrated immediately after adding alkali and indicator. Used 50.0 mL sample, or a smaller portion diluted to 50 mL so that the calcium content is about 5 to 10 mg. Analyzed hard waters with alkalinity higher than 300 mg $CaCO_3$/L by taking a smaller portion and diluting to 50 mL. or by neutralizing the alkalinity with acid, boiling 1 min, and cooling before beginning the titration.

Titration: Added 2.0 mL NaOH solution or a volume sufficient to produce a pH of 12 to 13. Stir. Added 0.1 to 0.2 g indicator mixture selected (or 1 to 2 drops if a solution is used). Added EDTA titrant slowly, with continuous stirring to the proper end point. When using murexide, check end point by adding 1 to 2 drops of titrant in excess to make certain that no further color change occurs.

Calculation

$$\text{Calcium, mg/l (as } CaCO_3) = \frac{\text{Volume of 0.01 M EDTA used X 1000}}{\text{Volume of sample in ml}}$$

Magnesium hardness,mg/l (as $CaCO_3$) = Total Hardness (as mg/l $CaCO_3$) - Calcium Hardness (as mg/l $CaCO_3$)

Magnesium,mg/ l (as Mg) = Total Hardness (as mg/l $CaCO_3$) - Calcium Hardness (as mg/l $CaCO_3$) X 0.244

J. Total Organic Carbon

Total organic carbon is the amount of carbon found in an organic compound and is often used as a non-specific indicator of water quality. The organic matter is the altered and rather resistant organic residues of plants and animals and microorganisms and little altered organic residues of plants and animals, living and dead microorganisms favorable for rapid decomposition in the soils.The carbon dioxide evolved by wet oxidation with chromic acid corresponds closely with the quantity of reduction of chromic acid, suggest a near balance of organic oxygen and hydrogen effects. The lesser heating largely differentiates soil humus matter from extraneous sources of organic carbon such as graphite and charcoal, a distinct advantage.

Reagents:

Sodium fluoride: use powder sodium fluoride.

1 N $K_2Cr_2O_7$ solution: Dissolve 49.04g of AR $K_2Cr_2O_7$ (dried at 105^0C) in 1000ml V.F and dilute to the mark.

0.5 N FAS (Ferrous ammonium sulphate): Dissolve 196g of FAS in 800ml distilled water and add 20 ml of conc.H2SO4 and cool and dilute to 100 ml.

Diphenylamine Indicator: Weigh approximately 0.5g of reagent grade diphenylamine in 20ml distilled water add 100ml of Conc. H_2SO_4.

Procedure:

Weigh 1ml of sample in 500ml Erlymner flask.

Added 10ml $K_2Cr_2O_7$ solution and 20ml of concentrated H_2SO_4 and mixed with gentle rotation for one minute.

Let the mixture stand for 30 minutes at 150^0C.

Run the blank in the same way.

After cooling add about 200ml of distilled water and 30 drops of diphenylamine indicator.

Further add 0.2g of NaF.

Titrated the amount of $K_2Cr_2O_7$ left against 0.5N FAS solution from burette.

Note the volume of FAS consumed for back titration with brilliant green end point.

Calculation

TOC = .67 * N of FAS * Volume of FAS /1.724*sample concentration

K. Total coliform

Multiple-tube method for coliforms

In the multiple-tube method, a series of tubes containing a suitable selective broth culture medium is inoculated with test portions of a water sample. After a specified incubation time at a given temperature, each tube showing gas formation is regarded as "presumptive positive" since the gas indicates the possible presence of coliforms. However, gas may also be produced by other organisms, and so a subsequent confirmatory test is essential. The two tests are known respectively as the presumptive test and the confirmatory test. For the confirmatory test, a more selective culture medium is inoculated with material taken from the positive tubes. After an appropriate incubation time, the tubes are examined for gas formation as before. The most probable number (MPN) of bacteria present can then be estimated from the number of tubes inoculated and the number of positive tubes obtained in the confirmatory test, using specially devised statistical tables. This technique is known as the MPN method.

1 Inoculation Different test portions to provide tenfold serial dilution steps may be used, the dilutions being based on the anticipated number of coliform bacteria in the water sample being tested. The reliability of the result obtained depends on the number of tubes inoculated with each test portion; in certain instances, the number can be reduced to three in each dilution step. Each combination of inoculated tubes will have its own table of MPN values.

2 Unpolluted and treated water in or entering the distribution system may generally be assumed to contain little or no pollution. In this case, it is recommended that one 50-ml plus five 10- ml volumes of water sample should be inoculated into the tubes; five tubes should each contain 10ml and one tube 50ml of double-strength medium.

3 Polluted water suspected to be more highly contaminated, e.g. untreated water from certain raw water sources, should be examined using different inoculation vol umes in tenfold dilution steps. The following inoculations are normally made:

— 10ml of sample to each of five tubes containing 10ml of double-strength medium;

— 1.0ml of sample to each of five tubes containing 10ml of single-strength medium;

— 1.0ml of a 1:10 dilution of sample (i.e. 0.1ml of sample) to each of five tubes containing 10ml of single-strength medium.

If the sample is expected to be highly contaminated, aliquots of 1.0ml of tenfold serial dilutions from each dilution step are inoculated into five tubes that each contain 10ml of single-strength medium. If the workload is very heavy and the time available is limited, the number of tubes can be reduced to three in each series. Statistically, however, inoculation of five tubes with each sample volume produces a more reliable MPN result.

Procedure

A. Removed the cap from the sample bottle.
B. With the stopper in position, shook the bottle vigorously to achieve a homogeneous dispersion of bacteria. (If the bottle is completely full, remove the stopper and dis- card about 20–30ml of water; then replace the stopper and shake. This ensures thorough mixing.)
C. With a sterile 10-ml pipette, inoculate 10ml of the sample into each of five tubes containing 10ml of presumptive broth (double strength). Added 50ml of sample to a tube containing 50ml of presumptive broth. It is advisable to shake the tubes gently to distribute the sample uniformly throughout the medium.
D. Incubated the tubes at 35°C or 37°C for 24 hours.
E. At the end of the 24-hour incubation period, examine each tube for the presence of gas. If present, gas can be seen in the Durham tube. If none is visible, gently shake the tube; if any effervescence (streams of tiny bubbles) is observed, the tube should be considered positive.
F. Using a table like the one shown here, record the number of positive tubes after 24 hours.
G. Reincubate negative tubes for a further 24-hour period. At the end of this period, check the tubes again for gas production as in E above. Gas production at the end of either 24 or 48 hours' incubation is presumed to be due to the presence of coliforms in the sample.
H. Record the number of positive tubes after 48 hours.
I. The confirmatory test should be carried out at the end of both the 24-hour and the 48-hour incubation. Using a sterile loop, transfer one or two drops from each presumptive positive tube into two tubes containing respectively confirmatory broth and tryptone water. (Sterilize the inoculation loop before each transfer by flaming and allow to cool.)
J. To confirm the presence of thermo tolerant coliforms, incubated the subculture tubes from each presumptive positive tube for 24 hours at 44 6 0.5°C.
K. At the end of 24 hours' incubation, examine each broth tube for growth and the presence of gas in the Durham tube. Enter the results on the table as shown.
L. To each tube of tryptone water, added approximately 0.1ml of Kovacs reagent and mix gently. The presence of indole is indicated by a red colour in the Kovacs reagent, forming a film over the aqueous phase of the medium.
M. Confirmatory tests positive for indole, growth, and gas production show the presence of E. coli. Growth and gas production in the absence of indole confirms thermotolerant coliforms.

L. Escherichia coli

Total Coliform is a group of bacteria present all around us, most of which are not dangerous to human health. However, these bacteria are not naturally present in groundwater and are an indication that more harmful organisms might be present. Fecal Coliform and E. coli are subgroups within the Total Coliform group which primarily come from the feces of warm blooded animals. Presence of E. coli indicates that the water has been exposed to feces and an immediate risk to human health exists.

a.MPN - Confirmed test for coliforms

From each gassing LST or lactose broth tube, transfer a loopful of suspension to a tube of BGLB broth, avoiding pellicle if present. (a sterile wooden applicator stick may also be used for these transfers). Incubate BGLB tubes at 35°C± 0.5°C and examine for gas production at 48 ± 3 h. Calculate most probable number (MPN) of coliforms based on proportion of confirmed gassing LST tubes for 3 consecutive dilutions.

b.MPN - Confirmed test for fecal coliforms and *E. coli*

From each gassing LST or Lactose broth tube from the Presumptive test, transfer a loopful of each suspension to a tube of EC broth (a sterile wooden applicator stick may also be used for these transfers). Incubate EC tubes 24 ± 2 h at 45.5 °C and examine for gas production. If negative, reincubate and examine again at 48 ± 2 h. Use results of this test to calculate fecal coliform MPN. To continue with *E. coli* analysis, proceed to Section F below. The EC broth MPN method may be used for seawater and shellfish since it conforms to recommended procedures (**NOTE:** Fecal coliform analyses are done at 45.5± 0.2°C for all foods, except for water testing and in shellfish and shellfish harvest water analysis, which uses an incubation temperature of 44.5± 0.2°C

c.MPN - Completed test for *E. coli*.

To perform the completed test for *E. coli*, gently agitate each gassing EC tube, remove a loopful of broth and streak for isolation on a L-EMB agar plate and incubate for 18-24 h at 35°C± 0.5°C . Examine plates for suspicious *E. coli* colonies, i.e., dark centered and flat, with or without metallic sheen. Transfer up to 5 suspicious colonies from each L-EMB plate to PCA slants, incubate them for 18-24 h at 35°C± 0.5°C and use for further testing.

NOTE: Identification of any 1 of the 5 colonies as *E. coli* is sufficient to regard that EC tube as positive; hence, not all 5 isolates may need to be tested.
Perform Gram stain. All cultures appearing as Gram-negative, short rods should be tested for the IMViC reactions below and also re-inoculated back into LST to confirm gas production.

Indole production. Inoculate tube of tryptone broth and incubate 24 ± 2 h at 35°C± 0.5°C . Test for indole by adding 0.2-0.3 mL of Kovacs' reagent. Appearance of distinct red color in upper layer is positive test.

Voges-Proskauer (VP)-reactive compounds. Inoculate tube of MR-VP broth and incubate 48 ± 2 h at 35°C± 0.5°C. Transfer 1 mL to 13 × 100 mm tube. Add 0.6 mL α-naphthol solution and 0.2 mL 40% KOH, and shake. Add a few crystals of creatine. Shake and let stand 2 h. Test is positive if eosin pink color develops.

Methyl red-reactive compounds. After VP test, incubate MR-VP tube additional 48 ± 2 h at 35°C± 0.5°C. Add 5 drops of methyl red solution to each tube. Distinct red color is positive test. Yellow is negative reaction.

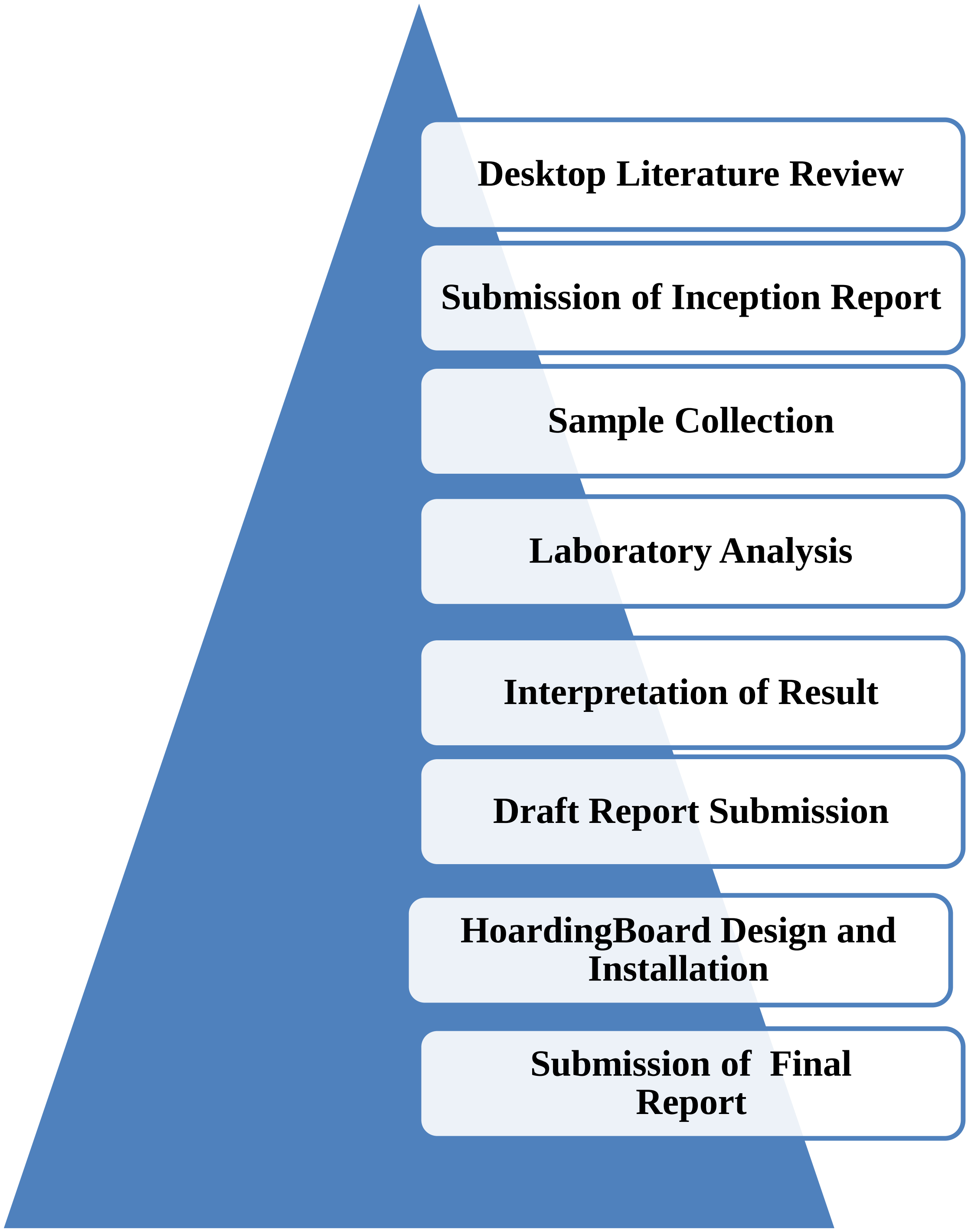
Citrate. Lightly inoculate tube of Koser's citrate broth; avoid detectable turbidity. Incubate for 96 h at 35°C± 0.5°C. Development of distinct turbidity is positive reaction.
Gas from lactose. Inoculate a tube of LST and incubate 48 ± 2 h at 35°C± 0.5°C. Gas production (displacement of medium from inner vial) or effervescence after gentle agitation is positive reaction.

Interpretation: All cultures that (a) ferment lactose with gas production within 48 h at 35°C, (b) appear as Gram-negative nonsporeforming rods and (c) give IMViC patterns of ++-- (biotype 1) or -+-- (biotype 2) are considered to be *E. coli*. Calculate MPN (see Appendix 2) of *E. coli* based on proportion of EC tubes in 3 successive dilutions that contain *E. coli*.

2.1.3 Installation of hoarding boards

The hoarding board- installed in three places namely Khokana bridge, Begnas Lake and Devghat including information about water quality, date, site and other defined by DHM.
The size of board - 4ft. X 5ft.
The hoarding board - made of Galvanized iron frame and stood at least 3ft. above the ground level with plain sheet and flex board of good quality.
The foundation of board stand - made at least 3ft. under the ground with solid concrete cement foundation if it is free of any other supporting structure.
The inverted V-shaped roof top - made to cover the entire board vertically.

Flow Chart of Methodology



Chapter 3: Result and discussion

A total of 48 water samples were collected from 48 different sites within and outside Kathmandu valley during the month of March and April i.e. spring season. The physical parameters like pH, conductivity and DO were measured at the site by DHM staff and water samples were collected from site for the analysis of chemical and bacteriological parameters in the laboratory. The site specification i.e. latitude and longitude, specified sample collection date and analysis date along with the air and water temperature and also the methods, observation and calculation used in the analysis are given in the annex 1,2 and 3.

Table 2: Analysis of water samples collected from four points of Bagmati River at Kathmandu

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	*E.coli*
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Bagmati-Sundarijal	6.6	14.8	9.6	24.8	380	460	10	0.1	0.1	6.8	140	21.1	0.5	500	40
Bagmati-Gokarna	7	7.1	4.7	18.6	100	150	20	0.1	0.1	5.7	150	34	11.6	1600	80
Bagmati-Gaurighat	6.7	3.2	4.1	12.3	120	160	70	0.4	0.09	20.7	130	22.8	7.3	1600	70
Bagmati-Khokana	7.4	1.2	90.5	192	810	970	70	0.3	0.1	30	90	10.6	3.9	900	50

*NDWQS 2062

According to the study done at four sites of Bagmati river i.e. Sundarijal, Gokarna, Gaurighat, Khokana bridge (table no.2), it was observed that the water parameters such as pH, total dissolved solid, electrical conductivity, nitrate, total hardness, magnesium were within the desired limit given by national drinking water quality standard, 2062. However as the river flows downstream from Sundarijal to Gokarna, then to Gaurighat, the river seems more polluted and by the time the river reached Khokana, the river water quality contains less dissolved oxygen and high level of biological oxygen demand, total organic carbon and ammonia. This spatial variation indicated the influence of agriculture and residential activities. The addition of ammonia fertilizers in the field can also be one of the major causes in the downstream sites. Biological oxygen demand and chemical oxygen demand are pollution indicator parameters mainly derived from organic wastes. The decrease in dissolved oxygen with the increase in biological oxygen demand and chemical oxygen demand can be credited to the use up of oxygen in the oxidation of the wastes. The dissolved oxygen concentration below 5 mg/l in water is anoxic and such water is not good for aquatic lives.

The above result of water analysis shows that the iron content was also beyond the desired limit with Gokarna being the highest among four sites. Making up at least 5 percent of the earth's crust, iron is one of the earth's most plentiful resources. Iron is occurred naturally as iron minerals such as magnetite, hematite, goethite and siderite. Weathering processes release these element into waters. The deposition of those elements due to less flow of water may give higher result in particular place. Concentrations of iron as low as 0.3 mg/L will leave reddish brown stains on fixtures, tableware and laundry that are very hard to remove. When these deposits break loose from water piping, rusty water will flow through the faucet. Iron is not hazardous to health, but it is considered a secondary or aesthetic contaminant.

Table 3:Analysis of water samples collected from four points of Bishnumati River at Kathmandu

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Bishnumati-Budanilkanth	7	12.5	15.4	36.7	120	187	90	0.5	0.2	22.6	160	24.5	0.5	900	110
Bishnumati-Balaju Bridge	7.2	0.2	123	154	550	780	20	0.1	0.01	32.7	200	28.9	7.2	1600	220
Bishnumati-Sobhabhagwati	7.3	0.3	110	150	760	1100	30	0.2	0.1	31.1	190	34.8	5.6	1600	220
Bishnumati-Teku Dovan	7.5	0.9	167	178	920	1360	90	0.5	0.1	34.6	130	43.7	5.7	1600	170

*NDWQS 2062

According to the study done at four sites of Bishnumati river i.e. Budanilkanth, Balaju bridge, Sobhabhagwati, Teku Dovan (table no 3), it was observed that the water parameters such as pH, total dissolved solid, electrical conductivity, nitrate, total hardness, magnesium were within the desired limit given by national drinking water quality standard, 2062. Looking at the dissolved oxygen, it was good only in Budanilkanth site, rest all other 3 sites, i.e. Balaju Bridge, Sobhabhagwati and Teku Dovan had less value and high level of biological oxygen demand, total organic carbon and ammonia. In case of ammonia, iron, total coliform and *E.coli*, all the four sites were beyond the desired limit. This indicates the influence of agriculture and residential activities as described for Bagmati river water quality.

Table 4: Analysis of water samples collected from three points of Tuadaha at Kathmandu

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Taudaha-1	8.2	8.9	17.1	24.5	90	175	50	0.3	0.1	10.1	160	12.8	0.9	900	70
Taudaha-2	8	9	26.7	37.6	100	180	45.3	0.6	0.09	11.4	120	11.6	1	1600	90
Taudaha-3	8.1	8.9	25.9	33.8	85	167	37.8	1	0.1	13.8	130	19.4	0.8	500	40

*NDWQS 2062

According to the study done at three sites within Taudaha lake (table no 4), it was observed that the water parameters such as pH, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total dissolved solid, electrical conductivity, nitrate, total hardness, magnesium were within the desired limit given by national drinking water quality standard, 2062. In case of ammonia, iron, total coliform and *E.coli*, all the four sites were beyond the desired limit. The presence of ammonia and coliform indicates sanitary pollution.

Table 5: Analysis of water samples collected from three points of Nakhu at Kathmandu

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Nakhu	8	2.1	40.5	78	510	650	90	0.5	0.13	12.1	100	12.3	4.2	1600	110
Nakhu-Bhaisipati	7.9	5.6	12.8	17.8	360	450	40	0.2	0.1	2.3	120	23.6	3.4	900	90
Nakhu-Saibu	8.1	7.1	5.4	15.9	280	300	30	0.2	<0.1	3.6	120	24.7	2.8	900	70

*NDWQS 2062

According to table no 5, it was observed that the water parameters such as pH, total dissolved solid, electrical conductivity, nitrate, total hardness, magnesium in all three study sites of Nakhu Khola were within the desired limit given by national drinking water quality standard, 2062. In case of dissolved oxygen and biological oxygen demand, it was less in Nakhu site but good in Bhaisipati and Saibu site. In case of ammonia, iron, total coliform and *E.coli*, all the three sites were beyond the desired limit. In addition to agriculture activities, as sewerage pipes discharge directly from individual houses, condition of the sewer pipe in certain area, solid waste dumping may influence the higher pollution level in Nakhu site than Bhaisipati and Saibu site.

Table 6:Analysis of water samples from three points of Dhobikhola at Kathmandu

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Dhobikhola-Bijulibazar	8	4.9	123	430	730	890	120	0.7	0.1	34.5	130	12.5	5.6	1600	120
Dhobikhola-Kalopul	8.5	0.6	235	330	850	1100	170	4.2	0.3	45.7	100	9.8	5.6	1600	140
Dhobikhola-Chabahil	8.2	0.5	324	450	750	1450	120	0.7	<0.1	30.5	180	23.6	6.2	1600	110

*NDWQS 2062

According to table no 6, it was observed that the water parameters such as pH, total dissolved solid, electrical conductivity, nitrate, total hardness, magnesium in all three study sites of Dhobikhola were within the desired limit given by national drinking water quality standard, 2062. In case of dissolved oxygen, it was good in Bijulibazar site than Kalopul and Chabahil site but higher biological oxygen demand in all the sites. In case of ammonia, iron, total coliform and *E.coli*, all the three sites were beyond the desired limit.

Water in upstream are used for washing utensil, clothes and animal, river is free from sewerage connection in these sections. The river has similar problems of discharge of raw sewage and solid waste dumping as it flows downstream from Kapan, Mandikatar, Maitidevi, Anamnagar and the junction of Dhobikhola indicating the level of water pollution in the river.

Table 7: Analysis of water samples from three points of Hanumante at Kathmandu

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Hanumante-Sallaghari	8.5	1.8	33	120	1530	1800	160	2.4	0.2	45.6	80	9.8	6.4	1600	120
Hanumante-Kausaltar	7.6	7.5	35	58.9	1200	1560	190	3.6	0.2	34.5	80	9.9	3.4	900	70
Hanumante-Thimi	7.3	15.1	48.9	90.7	1290	1600	180	2.7	0.1	26.7	120	10.2	6.5	1600	90

*NDWQS 2062

According to table no 7, it was observed that the water parameters such as pH, nitrate, total hardness, magnesium in all three study sites of Hanumante Khola were within the desired limit given by national drinking water quality standard, 2062. In case of dissolved oxygen and biological oxygen demand, it was good in Kausaltar and Thimi site than Sallaghari site. However in case of biological oxygen demand, total dissolved solid, electrical conductivity, ammonia, iron, total coliform and *E.coli*, all the three sites were beyond the desired limit.

Untreated sewerage of Bhaktapur is directly discharged into the river at Hanuman Ghat. Hanuman Ghat is one of the cremation sites of Bhaktapur. The banks of the river are treated as dumping site of the municipality. The waste is strewn everywhere at crematory, bridges and besides river banks. Urbanization is very dense in the upstream and downstream at Bhaktapur and Thimi but slightly less in between. Some sand mining activities are observed around the confluence of Hanumante with Manohara.

Table 8: Analysis of water samples from three points of Manohara at Kathmandu

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit	mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Manohara-pepsikola	7.4	7	14.5	23.7	620	870	60	2.3	0.2	4.5	60	7.8	4.9	1600	140
Manohara-Mulpani bridge	7.2	8.9	11.1	12.3	100	160	20	1.4	0.1	2	120	23.7	0.3	900	80
Manohara-Sankhu	7	15.7	5.4	12.4	60	78	20	1.6	0.1	6.7	130	12.5	0.4	1600	120
Manahara-Balkumari	7.6	3.9	23.8	40.5	980	1450	60	2	0.2	12.8	80	11.8	6.1	500	40

*NDWQS 2062

According to table no 8, it was observed that the water parameters such as pH, total dissolved solid, electrical conductivity, nitrate, total hardness, magnesium in all four study sites of Manohara Khola were within the desired limit given by national drinking water quality standard, 2062. In case of dissolved oxygen, it was good in Pepsicola, Mulpani Bridge, Sankhu site except Balkumari site however biological oxygen demand value was found to be good in all sites. In case of ammonia, iron, total coliform and *E.coli*, all the four sites were beyond the desired limit except iron being in the border line in Mulpani Bridge.

Manohara River located in northeast part of the Kathmandu Valley has been disturbed by several anthropogenic activities and natural causes thereby deteriorating its recreational functions and stream habitat. Sewerage connection into the river, solid waste dumping may be the reason behind water pollution.

Table 9:Analysis of water samples from four points of Phewa Lake at Pokhara

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit		mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Phewa-Halanchowk	7.5	7.9	2.5	5.7	50	50	1.6	0.11	0.07	5	120	6.7	0.1	900	70
Phewa-Temple site	7.6	8.1	2.6	5.8	40	50	1.4	0.13	0.06	2	150	7.8	0.2	500	40
Phewa-gaurighat	7.5	9.6	2.7	5.4	40	50	1.4	0.15	0.06	3	140	12.3	0.1	500	40
Phewa-Damp site	7.6	8	2.1	5.7	50	60	1.6	0.16	0.07	4	120	11.1	0.1	900	70

*NDWQS 2062

According to table no 9, it was observed that the water parameters such as pH, electrical conductivity, dissolved oxygen, biological oxygen demand, total dissolved solid, iron, nitrate, total hardness, magnesium in all four study sites of Phewa Lake were within the desired limit given by national drinking water quality standard, 2062. In case of total coliform and *E.coli*, all the sites were beyond the desired limit. The lake water may get polluted by not maintaining the cleanliness of lake as number of tourists visit the lake frequently.

Table 10:Analysis of water samples from four points of Seti River at Pokhara

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit		mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Seti-Mardi	7.4	8.1	1.2	2.4	110	130.o	1.5	0.13	0.05	2	120	9.8	0.3	500	50
Seti-Setidoban	7.5	9.4	1.5	3.3	170	200	4.5	0.15	0.03	2	160	9.5	4.1	900	80
Seti-PN college	7.5	14.5	1.2	2.5	160	180	3.2	0.11	0.02	2	110	5.6	3.4	1600	120
Seti-Dobila	7.6	8.7	1.3	2.6	150	170	2.8	0.1	0.01	2	170	6.9	3.8	500	40

*NDWQS 2062

According to table no 10, it was observed that the water parameters such as pH, electrical conductivity, dissolved oxygen, biological oxygen demand, total dissolved solid, nitrate, total hardness, magnesium in all four study sites of Seti River were within the desired limit given by national drinking water quality standard, 2062. In case of ammonia and iron content, Mardi site was better than Setidovan, PN College and Dobila site. In case of total coliform and *E.coli*, all the sites were beyond the desired limit.

Table 11:Analysis of water samples from four points of Begnas Lake at Pokhara

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit		mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Begnas-centre	7.6	6.5	1.1	2.8	20	20	1.1	0.12	0.01	2	220	14.3	0.4	1600	70
Begnas-End	7.6	5.8	1.2	2.3	10	20	1.1	0.13	0.02	2	220	12.4	0.1	900	50
Begnas-South side	7.6	6.5	1.1	2.5	10	10	1	0.11	0.01	2	120	9.7	0.1	500	20
Begnas-Outlet	7.6	6.6	1.3	2.6	20	35	0.8	0.14	0.01	2	80	4.7	0.2	900	20

*NDWQS 2062

According to table no 11, it was observed that the water parameters such as pH, electrical conductivity, dissolved oxygen, biological oxygen demand, total dissolved solid, nitrate, ammonia, total hardness, magnesium in all four study sites of Begnas Lake were within the desired limit given by national drinking water quality standard, 2062.

In case of iron content, it was slightly higher in the centre of Begnas lake (reason behind may be the less movement of water at the centre). Iron occurs naturally as iron minerals such as magnetite, hematite, goethite and siderite. Weathering processes release these element into waters. The deposition of those elements may give higher result in particular place. In case of total coliform and *E.coli*, all the sites were beyond the desired limit. As Begnas Lake area with a number of resorts is a popular destination for tourists visiting Pokhara, it may be the main reason behind the pollution.

Table 12: Analysis of water samples from four points of Narayani River at Narayanghat

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg.	Fe.	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Units		mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Narayani-Bridge	7.3	11.2	0.88	2.5	170	200	2	3.5	0.1	2	340	25.6	0.2	900	60
Narayani-near Buddha stupa	6.9	10.3	0.9	2.2	160	180	1.2	4.6	0.2	3	160	22.3	0.4	500	30
Narayani-Devghat unmixed	6.9	9.8	1	3	150	170	0.9	3.4	0.1	2	100	25.7	0.4	900	40
Narayani-Devghat mixed	7.1	9.7	1.5	3.5	160	180	1.1	3.9	0.1	5	180	22.9	0.3	900	70

*NDWQS 2062

According to table no 12, it was observed that the water parameters such as pH, electrical conductivity, dissolved oxygen, biological oxygen demand, total dissolved solid, ammonia, nitrate, total hardness, magnesium in all four study sites of Narayani River were within the desired limit given by national drinking water quality standard, 2062. In case of iron content, Bridge site was better than other sites. In case of total coliform and *E.coli*, all the sites were beyond the desired limit.

Table 13:Analysis of water samples from four points of Sirsiya at Birgunj

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Units	-	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Sirsiya-Parwanipur	6.5	1.1	87.3	123.1	390	410	80	8.9	0.2	23	300	24.6	3.9	1600	170
Sirsiya-bridge	7	1.2	76.8	110	760	700	70	5.7	0.1	35	250	20.8	4.3	500	80
Sirsiya-Miteri bridge	6.8	1	70.6	90	590	550	100	4.7	0.4	45	340	22.8	2.1	1600	140
Sirsiya-Ghadi harwa Pokhara	6.6	1.1	88.6	78	750	710	90	3.6	0.2	33	240	25.9	3.7	900	110

*NDWQS 2062

According to table no 13, it was observed that the water parameters such as pH, total dissolved solid, electrical conductivity, nitrate, total hardness, magnesium in all four study sites of Sirsiya River were within the desired limit given by national drinking water quality standard, 2062. However, low dissolved oxygen, high biological oxygen demand, ammonia, iron, total coliform and *E.coli*, were seen in all four sites.

The water is pure in its contents like other Himalayan rivers. However it has not maintained its valuable contents at all the study sites i.e. Parwanipur, bridge site, Miteri Bridge and Ghadiharwa Pokhara. The unrestrained untreated wastes are being dumped by the various factories situated at Birgunj which made this river contaminated. Birgunj and surrounding area of Parsa district have direct connection with Sirsiya River. It is the centre of industrial hub and known as Bara/Parsa industrial corridor. There are more than 250 industrial buildups in this corridor and all the industrial wastewaters from there is directly/indirectly discharged into Sirsiya River.

Table 14: Analysis of water samples from four points of Tinau at Butwal

Parameters	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	E.coli
Desired Value	6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Units	-	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Tinau-Jhumsa bridge	7.2	10.4	1.6	2.6	200	220	0.9	0.5	0.02	4	200	14.5	0.1	900	70
Tinau-Siddhi baba butwal	7.4	8.3	2	2.1	200	220	1.4	0.6	0.05	5	240	15.4	0.1	500	40
Tinau-Purano bus park	7.4	9.3	1.6	3.3	200	250	1	0.3	0.01	3	120	11.2	0.1	900	50
Tinau-Radhakrishna tole	7.5	9.5	1.5	3.9	220	220	1	0.5	0.01	4	200	9.8	0.1	500	30

*NDWQS 2062

According to table no 14, it was observed that the water parameters such as pH, electrical conductivity, dissolved oxygen, biological oxygen demand, total dissolved solid, iron, nitrate, total hardness, magnesium in all four study sites of Tinau River were within the desired limit given by national drinking water quality standard, 2062 except total coliform and *E.coli*. The presence of bacterial contamination may be due to natural or anthropogenic activities.

Chapter 4: Conclusion and Recommendation

4.1 Conclusion

Water is a massive network of branching rivers, springs, streams, swamps, estuaries, wetlands, lakes etc. Our water resources are of major environmental, social and economic value, and if water quality becomes degraded, it is not just the environment that will suffer but the commercial and recreational value of our water resources will also diminish. So the more we monitor the quality of water the better we will be able to recognize and prevent contamination problems. Hence, the Department of Hydrology and Meteorology initiated the water quality measurement and hoarding board installation to identify the current water quality status of the study sites and provide the information through hoarding board.

The water quality analysis of all study sites shows spatial variation within various rivers and lakes of Kathmandu Valley, Narayanghat, Pokhara, Butwal and Birgunj. The water qualityof Bagmati River was found to be deteriorated as it flew from Sundarijal, Gokarna, Gaurighat and in particular the water of khokana site was the most polluted. This increased pollution from urban made this flow available less fit for human use. The Bagmati River flows south until joined by the larger west-flowing Manohara River then turns west itself. The water quality analysis showed that the organic load of Balkumari and Pepsicola site was higher than Mulpani and Sankhu. After entering Kathmandu's urban area more tributaries enter, relatively polluted Dhobikhola. The study of Dhobikhola also showed higher amount of organic pollution, similar problems of raw sewage discharge and solid waste dumping as it flows downstream. Then the river bends south and the Bishnumati enters from the right at Teku Dovan. The water quality analysis shows that as it passes the centre of Kathmandu, this tributary becomes heavily polluted in Balaju Bridge, Sobhabhagwati and Teku Dovan except Budanilkanth site.

The water of river Sirsiya at Birgunj is said to be pure in its contents and have full of medicinal values like other Himalayan rivers. However the present study has shown that it has not been able to maintain its valuable contents most probably due to uncontrolled industrial wastes especially at Parwanipur. In another study done atTinau River, Butwal, Narayani River, Narayanghat, Begnas and Phewa lakes, Pokhara, most of the physico-chemical parameters are within the desired limit.The present study also shows that none of the rivers and lakes are free from bacterial load. Coliforms are bacteria that are always present in the digestive tracts of animals, including humans, and are found in their wastes. They are also found in plant and soil material. As a result, testing for coliform bacteria can be a reasonable indication of whether other pathogenic bacteria are present or not.

Considering the results of the measured physico-chemical and biological water parameters of all the various rivers and lakes within and outside Kathmandu valley, it can be concluded that the agriculture and urban land use are the most contributing factors to the pollution of our river and lake water system.

4.2 Recommendation

Deteriorating quality of river and lake water can cause frequent cases of water borne diseases such as diarrhea, dysentery, cholera, and skin diseases among people living in riverside areas. It can reduce the religious, recreational and aesthetic value of rivers. The water containing chemical and bacterial pollutants can accumulate in the soil and crops and thereby pose hazards. Hence the present study has done certain recommendations which are as follows;

- Effective management plan with appropriate water quality improvement measures such as installation of more numbers of sewerage treatment plant is necessary to overcome the problem of untreated sewerage discharge into the river water.

- The adoption of good agricultural practice is essential for the sustainable water environment.

- The present study has shown the spatial variation in its water quality, however, temporal variation largely affects the quality of water. Thus it is preferred to do the analysis accordingly. It will help to know the exact status of water quality of rivers and lakes and recommend the necessary remedial actions in case of high pollution.

- There are various test parameters other than those included in this study. Hence specific tests need to be included according to the pollution level of that particular site.

- There is also a basic requirement of education for all stakeholders to understand the risks of poor water quality for irrigation water, drinking and other domestic purposes. Hence the hoarding board with water quality information should be installed in all the study sites.

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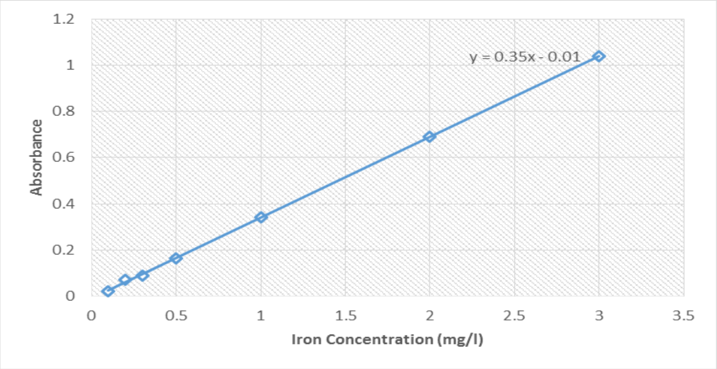
Annex 1: Method of laboratory analysis

Parameters	**Method**	**References**
Biological Oxygen Demand	Winkler Azide Modification	5210 B, APHA-AWWA-WPCF,2005 21st Edition
Chemical Oxygen Demand	Potassium dichromate reflux	5200 B APHA-AWWA-WPCF, 2005 21st Edition/JIS K 0102 Procedure No.20
Ammonia	Direct Nesslerization	4500-NH3 C APHA-AWWA-WPCF
Nitrate	Spectrophotometric	4500 NO3 B, APHA-AWWA-WPCF,2005 21st Edition
Nitrite	Spectrophotometric	4500 NO2 B, APHA-AWWA-WPCF,2005 21st Edition
Organic carbon	Reflux	Walkley and Black
Total Hardness	EDTA titrimetric	2340 C, APHA-AWWA-WPCF,2005 21st Edition
Magnesium	EDTA titrimetric	3500-Mg B APHA-AWWA-WPCF, 2005 21st Edition
Iron	Phenanthroline	4500-Fe C APHA-AWWA-WPCF
Total Coliform	Multiple Tube Fermentation	9221 B, APHA-AWWA-WPCF, 2005 21st Edition
Escherichia coli	Multiple Tube Fermentation	9221 E, APHA-AWWA-WPCF, 2005 21st Edition
Dissolved Oxygen	Winkler Azide Modification	4500 P E, APHA-AWWA-WPCF,2005 21st Edition
pH	Electrometric	4501 H B, APHA-AWWA-WPCF,2005 21st Edition
Conductivity	Conductivity meter	2510 B, APHA-AWWA-WPCF, 2005 21st Edition

Annex 2:Table showing observation and calculation of analyzedparameters

(a) Table showing measurement of iron using given absorbance vs. concentration chart

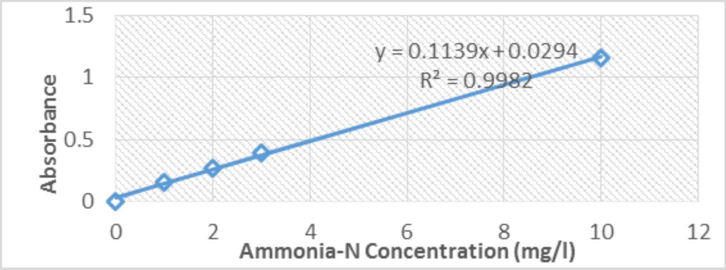


S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Absorbance (510 nm)	Total iron (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	0.17	0.5
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	4.07	11.6
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	2.57	7.3
4	Bagmati-Khokana	27.632	85.292	19/3/2016	1.38	3.9
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	0.19	0.5
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	2.53	7.2
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	1.97	5.6
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	2.01	5.7
9	Taudaha-1	27.649	85.281	19/3/2016	0.33	0.9
10	Taudaha-2	27.648	85.282	19/3/2016	0.36	1
11	Taudaha-3	27.647	85.283	19/3/2016	0.29	0.8
12	Nakhu	27.662	85.306	18/3/2016	1.48	4.2
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	1.20	3.4
14	Nakhu-Saibu	27.650	85.310	18/3/2016	0.99	2.8
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	1.97	5.6
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	1.97	5.6
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	2.18	6.2
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	2.25	6.4
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	1.20	3.4
20	Hanumante-Thimi	27.674	85.387	18/3/2016	2.29	6.5
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	1.73	4.9
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	0.12	0.3
23	Manohara-Sankhu	27.705	85.396	22/3/2016	0.15	0.4
24	Manahara-Balkumari	27.670	85.339	22/3/2016	2.15	6.1

(a) Table showing measurement of iron using given absorbance vs. concentration chart cont.

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Absorbance (510 nm)	Total iron (mg/l)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	0.05	0.1
26	Fewa-Temple site	28.208	83.953	2/4/2016	0.08	0.2
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	0.05	0.1
28	Fewa-Damp site	28.216	83.953	2/4/2016	0.05	0.1
29	Seti-Mardi	28.335	83.823	1/4/2016	0.12	0.3
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	1.45	4.1
31	Seti-PN college	28.239	83.982	1/4/2016	1.20	3.4
32	Seti-Dobila	28.209	83.693	1/4/2016	1.34	3.8
33	Begnas-Centre	28.175	85.101	1/4/2016	0.15	0.4
34	Begnas-End	28.179	84.092	1/4/2016	0.05	0.1
35	Begnas-South side	28.166	84.094	1/4/2016	0.05	0.1
36	Begnas-Outlet	28.174	84.097	1/4/2016	0.08	0.2
37	Narayani-Bridge	27.697	84.426	12/4/2016	0.08	0.2
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	0.15	0.4
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	0.15	0.4
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	0.12	0.3
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	1.38	3.9
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	1.52	4.3
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	0.75	2.1
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	1.31	3.7
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	0.05	0.1
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	0.05	0.1
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	0.05	0.1
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	0.05	0.1

(b) Table showing measurement of ammonia using given absorbance vs. concentration chart



S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Absorbance (420 nm)	Total ammonia (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	1.2	10.0
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	2.3	20.0
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	8.0	70.0
4	Bagmati-Khokana	27.632	85.292	19/3/2016	8.0	70.0
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	10.3	90.0
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	2.3	20.0
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	3.4	30.0
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	10.3	90.0
9	Taudaha-1	27.649	85.281	19/3/2016	5.7	50.0
10	Taudaha-2	27.648	85.282	19/3/2016	5.2	45.3
11	Taudaha-3	27.647	85.283	19/3/2016	4.3	37.8
12	Nakhu	27.662	85.306	18/3/2016	10.3	90.0
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	4.6	40.0
14	Nakhu-Saibu	27.650	85.310	18/3/2016	3.4	30.0
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	13.7	120.0
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	19.4	170.0
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	13.7	120.0
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	18.3	160.0
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	21.7	190.0
20	Hanumante-Thimi	27.674	85.387	18/3/2016	20.5	180.0
21	Manohara-pepsikola	27.689	85.360	22/3/2016	6.9	60.0
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	2.3	20.0
23	Manohara-Sankhu	27.705	85.396	22/3/2016	2.3	20.0
24	Manahara-Balkumari	27.670	85.339	22/3/2016	6.9	60.0

(b) Table showing measurement of ammonia using given absorbance vs. concentration chartcont...

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Absorbance (420 nm)	Total ammonia (mg/l)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	0.2	1.6
26	Fewa-Temple site	28.208	83.953	2/4/2016	0.2	1.4
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	0.2	1.4
28	Fewa-Damp site	28.216	83.953	2/4/2016	0.2	1.6
29	Seti-Mardi	28.335	83.823	1/4/2016	0.2	1.5
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	0.5	4.5
31	Seti-PN college	28.239	83.982	1/4/2016	0.4	3.2
32	Seti-Dobila	28.209	83.693	1/4/2016	0.3	2.8
33	Begnas-Centre	28.175	85.101	1/4/2016	0.2	1.1
34	Begnas-End	28.179	84.092	1/4/2016	0.2	1.1
35	Begnas-South side	28.166	84.094	1/4/2016	0.1	1.0
36	Begnas-Outlet	28.174	84.097	1/4/2016	0.1	0.8
37	Narayani-Bridge	27.697	84.426	12/4/2016	0.3	2.0
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	0.2	1.2
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	0.1	0.9
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	0.2	1.1
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	9.1	80.0
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	8.0	70.0
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	11.4	100.0
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	10.3	90.0
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	0.1	0.9
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	0.2	1.4
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	0.1	1.0
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	0.1	1.0

(c) Table showing measurement of total hardness and magnesium using given formula

Total Hardness, mg/l (as $CaCO_3$) = Volume of 0.01 M EDTA used X 1000 / Volume of sample in ml

Magnesium hardness, mg/l (as $CaCO_3$) = Total Hardness, mg/l (as $CaCO_3$) - Calcium Hardness, mg/l (as $CaCO_3$)

Magnesium, mg/ l (as Mg) = Total Hardness (as mg/l $CaCO_3$) - Calcium Hardness (as mg/l $CaCO_3$) X 0.244

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Volume of EDTA (ml)	Total Hardness (mg/l)	Calcium hardness (mg/l)	Magnesium (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	7.0	140.0	53.1	21.1
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	7.5	150.0	9.9	34.0
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	6.5	130.0	36.1	22.8
4	Bagmati-Khokana	27.632	85.292	19/3/2016	4.5	90.0	46.3	10.6
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	8.0	160.0	59.1	24.5
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	10.0	200.0	80.9	28.9
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	9.5	190.0	46.6	34.8
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	6.5	130.0	-50.0	43.7
9	Taudaha-1	27.649	85.281	19/3/2016	8.0	160.0	107.3	12.8
10	Taudaha-2	27.648	85.282	19/3/2016	6.0	120.0	72.2	11.6
11	Taudaha-3	27.647	85.283	19/3/2016	6.5	130.0	50.1	19.4
12	Nakhu	27.662	85.306	18/3/2016	5.0	100.0	49.3	12.3
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	6.0	120.0	22.8	23.6
14	Nakhu-Saibu	27.650	85.310	18/3/2016	6.0	120.0	18.2	24.7
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	6.5	130.0	78.5	12.5
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	5.0	100.0	59.6	9.8
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	9.0	180.0	82.8	23.6
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	4.0	80.0	39.6	9.8
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	4.0	80.0	39.2	9.9
20	Hanumante-Thimi	27.674	85.387	18/3/2016	6.0	120.0	78.0	10.2
21	Manohara-pepsikola	27.689	85.360	22/3/2016	3.0	60.0	27.9	7.8
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	6.0	120.0	22.4	23.7
23	Manohara-Sankhu	27.705	85.396	22/3/2016	6.5	130.0	78.5	12.5
24	Manahara-Balkumari	27.670	85.339	22/3/2016	4.0	80.0	31.4	11.8

(c) Table showing measurement of total hardness and magnesium using given formula cont...

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Volume of EDTA (ml)	Total Hardness (mg/l)	Calcium hardness (mg/l)	Magnesium (mg/l)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	6.0	120.0	92.4	6.7
26	Fewa-Temple site	28.208	83.953	2/4/2016	7.5	150.0	117.9	7.8
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	7.0	140.0	89.3	12.3
28	Fewa-Damp site	28.216	83.953	2/4/2016	6.0	120.0	74.3	11.1
29	Seti-Mardi	28.335	83.823	1/4/2016	6.0	120.0	79.6	9.8
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	8.0	160.0	120.9	9.5
31	Seti-PN college	28.239	83.982	1/4/2016	5.5	110.0	86.9	5.6
32	Seti-Dobila	28.209	83.693	1/4/2016	8.5	170.0	141.6	6.9
33	Begnas-Centre	28.175	85.101	1/4/2016	11.0	220.0	161.1	14.3
34	Begnas-End	28.179	84.092	1/4/2016	11.0	220.0	168.9	12.4
35	Begnas-South side	28.166	84.094	1/4/2016	6.0	120.0	80.0	9.7
36	Begnas-Outlet	28.174	84.097	1/4/2016	4.0	80.0	60.6	4.7
37	Narayani-Bridge	27.697	84.426	12/4/2016	17.0	340.0	234.5	25.6
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	8.0	160.0	68.1	22.3
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	5.0	100.0	-5.9	25.7
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	9.0	180.0	85.7	22.9
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	15.0	300.0	198.6	24.6
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	12.5	250.0	164.3	20.8
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	17.0	340.0	246.1	22.8
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	12.0	240.0	133.3	25.9
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	10.0	200.0	140.3	14.5
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	12.0	240.0	176.6	15.4
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	6.0	120.0	73.9	11.2
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	10.0	200.0	159.6	9.8

(d) Table showing measurement of coliform using most probable number chart

TABLE 9221.IV. MPN INDEX AND 95% CONFIDENCE LIMITS FOR VARIOUS COMBINATIONS OF POSITIVE RESULTS WHEN FIVE TUBES ARE USED PER DILUTION (10 mL, 1.0 mL, 0.1 mL)

Combination of Positives	MPN Index/ 100 mL	95% Confidence Limits		Combination of Positives	MPN Index/ 100 mL	95% Confidence Limits	
		Lower	Upper			Lower	Upper
0-0-0	<2	—	—	4-2-0	22	9.0	56
0-0-1	2	1.0	10	4-2-1	26	12	65
0-1-0	2	1.0	10	4-3-0	27	12	67
0-2-0	4	1.0	13	4-3-1	33	15	77
				4-4-0	34	16	80
1-0-0	2	1.0	11	5-0-0	23	9.0	86
1-0-1	4	1.0	15	5-0-1	30	10	110
1-1-0	4	1.0	15	5-0-2	40	20	140
1-1-1	6	2.0	18	5-1-0	30	10	120
1-2-0	6	2.0	18	5-1-1	50	20	150
				5-1-2	60	30	180
2-0-0	4	1.0	17	5-2-0	50	20	170
2-0-1	7	2.0	20	5-2-1	70	30	210
2-1-0	7	2.0	21	5-2-2	90	40	250
2-1-1	9	3.0	24	5-3-0	80	30	250
2-2-0	9	3.0	25	5-3-1	110	40	300
2-3-0	12	5.0	29	5-3-2	140	60	360
3-0-0	8	3.0	24	5-3-3	170	80	410
3-0-1	11	4.0	29	5-4-0	130	50	390
3-1-0	11	4.0	29	5-4-1	170	70	480
3-1-1	14	6.0	35	5-4-2	220	100	580
3-2-0	14	6.0	35	5-4-3	280	120	690
3-2-1	17	7.0	40	5-4-4	350	160	820
				5-5-0	240	100	940
4-0-0	13	5.0	38	5-5-1	300	100	1300
4-0-1	17	7.0	45	5-5-2	500	200	2000
4-1-0	17	7.0	46	5-5-3	900	300	2900
4-1-1	21	9.0	55	5-5-4	1600	600	5300
4-1-2	26	12	63	5-5-5	≥1600	—	—

Source: Guidelines for drinking water quality, WHO

(d) Table showing measurement of coliform using most probable number chart cont...

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Positive tube-No.	Positive tube-No.	Positive tube-No.	Total Coliform (MPN/100ml)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	5	5	2	500
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	5	5	4	1600
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	5	5	4	1600
4	Bagmati-Khokana	27.632	85.292	19/3/2016	5	5	3	900
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	5	5	3	900
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	5	5	4	1600
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	5	5	4	1600
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	5	5	4	1600
9	Taudaha-1	27.649	85.281	19/3/2016	5	5	3	900
10	Taudaha-2	27.648	85.282	19/3/2016	5	5	4	1600
11	Taudaha-3	27.647	85.283	19/3/2016	5	5	2	500
12	Nakhu	27.662	85.306	18/3/2016	5	5	4	1600
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	5	5	3	900
14	Nakhu-Saibu	27.650	85.310	18/3/2016	5	5	3	900
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	5	5	4	1600
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	5	5	4	1600
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	5	5	4	1600
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	5	5	4	1600
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	5	5	3	900
20	Hanumante-Thimi	27.674	85.387	18/3/2016	5	5	4	1600
21	Manohara-pepsikola	27.689	85.360	22/3/2016	5	5	4	1600
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	5	5	3	900
23	Manohara-Sankhu	27.705	85.396	22/3/2016	5	5	4	1600
24	Manahara-Balkumari	27.670	85.339	22/3/2016	5	5	2	500

(d) Table showing measurement of coliform using most probable number chart cont...

S.No.	Sample site	Latitude⁰	Longitude⁰	Sample collection date (dd/mm/yy A.D.)	Positive tube-No.	Positive tube-No.	Positive tube-No.	Total Coliform (MPN/100ml)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	5	5	3	900
26	Fewa-Temple site	28.208	83.953	2/4/2016	5	5	2	500
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	5	5	2	500
28	Fewa-Damp site	28.216	83.953	2/4/2016	5	5	3	900
29	Seti-Mardi	28.335	83.823	1/4/2016	5	5	2	500
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	5	5	3	900
31	Seti-PN college	28.239	83.982	1/4/2016	5	5	4	1600
32	Seti-Dobila	28.209	83.693	1/4/2016	5	5	2	500
33	Begnas-Centre	28.175	85.101	1/4/2016	5	5	4	1600
34	Begnas-End	28.179	84.092	1/4/2016	5	5	3	900
35	Begnas-South side	28.166	84.094	1/4/2016	5	5	2	500
36	Begnas-Outlet	28.174	84.097	1/4/2016	5	5	3	900
37	Narayani-Bridge	27.697	84.426	12/4/2016	5	5	3	900
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	5	5	2	500
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	5	5	3	900
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	5	5	3	900
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	5	5	4	1600
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	5	5	2	500
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	5	5	4	1600
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	5	5	3	900
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	5	5	3	900
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	5	5	2	500
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	5	5	3	900
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	5	5	2	500

(d) Table showing measurement of coliform using most probable number chart cont...

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Positive tube-No.	Positive tube-No.	Positive tube-No.	E.Coli (MPN/100ml)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	5	0	2	40
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	5	3	0	80
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	5	2	1	70
4	Bagmati-Khokana	27.632	85.292	19/3/2016	5	2	0	50
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	5	3	1	110
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	5	1	2	220
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	5	1	2	220
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	5	3	3	170
9	Taudaha-1	27.649	85.281	19/3/2016	5	2	1	70
10	Taudaha-2	27.648	85.282	19/3/2016	5	2	2	90
11	Taudaha-3	27.647	85.283	19/3/2016	5	0	2	40
12	Nakhu	27.662	85.306	18/3/2016	5	3	1	110
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	5	2	2	90
14	Nakhu-Saibu	27.650	85.310	18/3/2016	5	2	1	70
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	5	1	0	120
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	5	3	2	140
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	5	3	1	110
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	5	1	0	120
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	5	2	1	70
20	Hanumante-Thimi	27.674	85.387	18/3/2016	5	2	2	90
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	5	3	2	140
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	5	3	0	80
23	Manohara-Sankhu	27.705	85.396	22/3/2016	5	1	0	120
24	Manahara-Balkumari	27.670	85.339	22/3/2016	5	0	2	40

(d) Table showing measurement of coliform using most probable number chart cont...

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Positive tube-No.	Positive tube-No.	Positive tube-No.	E.coli (MPN/100ml)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	5	2	1	70
26	Fewa-Temple site	28.208	83.953	2/4/2016	5	0	2	40
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	5	0	2	40
28	Fewa-Damp site	28.216	83.953	2/4/2016	5	2	1	70
29	Seti-Mardi	28.335	83.823	1/4/2016	5	2	0	50
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	5	3	0	80
31	Seti-PN college	28.239	83.982	1/4/2016	5	1	0	120
32	Seti-Dobila	28.209	83.693	1/4/2016	5	0	2	40
33	Begnas-Centre	28.175	85.101	1/4/2016	5	2	1	70
34	Begnas-End	28.179	84.092	1/4/2016	5	2	0	50
35	Begnas-South side	28.166	84.094	1/4/2016	4	1	1	20
36	Begnas-Outlet	28.174	84.097	1/4/2016	4	1	1	20
37	Narayani-Bridge	27.697	84.426	12/4/2016	5	1	2	60
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	5	0	1	30
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	5	0	2	40
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	5	2	1	70
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	5	3	3	170
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	5	3	0	80
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	5	3	2	140
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	5	3	1	110
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	5	2	1	70
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	5	0	2	40
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	5	2	0	50
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	5	0	1	30

(e) Table showing measurement of COD using given formula

$$COD\ (mg/l) = \frac{(b-a) \times \text{normality of ferrous ammonium sulphate} \times 8 \times 1000}{\text{Volume of sample}}$$

Where, Sample titre value, ml (a), Volume of sample = 20 ml
Blank titre value, ml (b) = 60 .Normality = .025

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Sample titre value, a (ml)	COD (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	2.5	24.8
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	1.9	18.6
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	1.2	12.3
4	Bagmati-Khokana	27.632	85.292	19/3/2016	19.2	192.0
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	3.7	36.7
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	15.4	154.0
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	15.0	150.0
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	17.8	178.0
9	Taudaha-1	27.649	85.281	19/3/2016	2.5	24.5
10	Taudaha-2	27.648	85.282	19/3/2016	3.8	37.6
11	Taudaha-3	27.647	85.283	19/3/2016	3.4	33.8
12	Nakhu	27.662	85.306	18/3/2016	7.8	78.0
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	1.8	17.8
14	Nakhu-Saibu	27.650	85.310	18/3/2016	1.6	15.9
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	43.0	430.0
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	33.0	330.0
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	45.0	450.0
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	12.0	120.0
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	5.9	58.9
20	Hanumante-Thimi	27.674	85.387	18/3/2016	9.1	90.7
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	2.4	23.7
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	1.2	12.3
23	Manohara-Sankhu	27.705	85.396	22/3/2016	1.2	12.4
24	Manahara-Balkumari	27.670	85.339	22/3/2016	4.1	40.5

(e) Table showing measurement of COD using given formula contd…

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Sample titre value, a (ml)	COD (mg/l)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	0.6	5.7
26	Fewa-Temple site	28.208	83.953	2/4/2016	0.6	5.8
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	0.5	5.4
28	Fewa-Damp site	28.216	83.953	2/4/2016	0.6	5.7
29	Seti-Mardi	28.335	83.823	1/4/2016	0.2	2.4
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	0.3	3.3
31	Seti-PN college	28.239	83.982	1/4/2016	0.3	2.5
32	Seti-Dobila	28.209	83.693	1/4/2016	0.3	2.6
33	Begnas-Centre	28.175	85.101	1/4/2016	0.3	2.8
34	Begnas-End	28.179	84.092	1/4/2016	0.2	2.3
35	Begnas-South side	28.166	84.094	1/4/2016	0.3	2.5
36	Begnas-Outlet	28.174	84.097	1/4/2016	0.3	2.6
37	Narayani-Bridge	27.697	84.426	12/4/2016	0.3	2.5
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	0.2	2.2
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	0.3	3.0
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	0.4	3.5
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	12.3	123.1
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	11.0	110.0
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	9.0	90.0
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	7.8	78.0
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	0.3	2.6
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	0.2	2.1
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	0.3	3.3
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	0.4	3.9

(f) Table showing measurement of TOC using given formula

TOC = 0.67 * 0.5 * Vol. of FAS (ml) / 1.724

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Vol. of FAS (ml)	TOC conc. (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	35.0	6.8
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	29.3	5.7
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	106.5	20.7
4	Bagmati-Khokana	27.632	85.292	19/3/2016	154.4	30.0
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	116.3	22.6
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	168.3	32.7
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	160.0	31.1
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	178.1	34.6
9	Taudaha-1	27.649	85.281	19/3/2016	52.0	10.1
10	Taudaha-2	27.648	85.282	19/3/2016	58.7	11.4
11	Taudaha-3	27.647	85.283	19/3/2016	71.0	13.8
12	Nakhu	27.662	85.306	18/3/2016	62.3	12.1
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	11.8	2.3
14	Nakhu-Saibu	27.650	85.310	18/3/2016	18.5	3.6
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	177.5	34.5
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	235.2	45.7
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	157.0	30.5
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	234.7	45.6
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	177.5	34.5
20	Hanumante-Thimi	27.674	85.387	18/3/2016	137.4	26.7
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	23.2	4.5
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	10.3	2.0
23	Manohara-Sankhu	27.705	85.396	22/3/2016	34.5	6.7
24	Manahara-Balkumari	27.670	85.339	22/3/2016	65.9	12.8

(f) Table showing measurement of TOC using given formula cont..

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Vol. of FAS (ml)	TOC conc. (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	35.0	6.8
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	29.3	5.7
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	106.5	20.7
4	Bagmati-Khokana	27.632	85.292	19/3/2016	154.4	30.0
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	116.3	22.6
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	168.3	32.7
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	160.0	31.1
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	178.1	34.6
9	Taudaha-1	27.649	85.281	19/3/2016	52.0	10.1
10	Taudaha-2	27.648	85.282	19/3/2016	58.7	11.4
11	Taudaha-3	27.647	85.283	19/3/2016	71.0	13.8
12	Nakhu	27.662	85.306	18/3/2016	62.3	12.1
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	11.8	2.3
14	Nakhu-Saibu	27.650	85.310	18/3/2016	18.5	3.6
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	177.5	34.5
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	235.2	45.7
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	157.0	30.5
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	234.7	45.6
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	177.5	34.5
20	Hanumante-Thimi	27.674	85.387	18/3/2016	137.4	26.7
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	23.2	4.5
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	10.3	2.0
23	Manohara-Sankhu	27.705	85.396	22/3/2016	34.5	6.7
24	Manahara-Balkumari	27.670	85.339	22/3/2016	65.9	12.8

(g) Table showing measurement of BOD using given formula

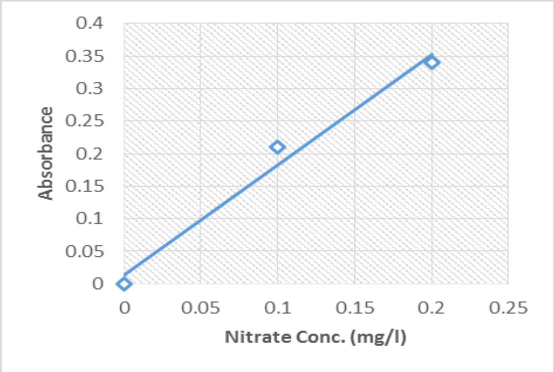
Calculation formula: BOD_5 (mg/l) = (DO_1-DO_5) X Dilution factor

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	DO_1 (mg/l)	Dilution factor	DO_5 (mg/l)	BOD_5 (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	14.8	2	10.0	9.6
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	7.1	2	5.1	4.1
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	3.2	2	0.9	4.7
4	Bagmati-Khokana	27.632	85.292	19/3/2016	1.2	100	0.3	90.5
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	12.5	2	4.8	15.4
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	0.2	100	-1.0	123.0
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	0.3	100	-0.8	110.0
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	0.9	100	-0.8	167.0
9	Taudaha-1	27.649	85.281	19/3/2016	8.9	50	8.6	17.1
10	Taudaha-2	27.648	85.282	19/3/2016	9.0	50	8.5	26.7
11	Taudaha-3	27.647	85.283	19/3/2016	8.9	50	8.4	25.9
12	Nakhu	27.662	85.306	18/3/2016	2.1	50	1.3	40.5
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	5.6	50	5.3	12.8
14	Nakhu-Saibu	27.650	85.310	18/3/2016	7.1	2	4.4	5.4
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	4.9	50	2.4	123.0
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	0.6	100	-1.8	235.0
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	0.5	100	-2.7	324.0
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	1.8	50	1.1	33.0
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	7.5	50	6.8	35.0
20	Hanumante-Thimi	27.674	85.387	18/3/2016	15.1	50	14.1	48.9
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	7.0	50	6.7	14.5
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	8.9	2	3.4	11.1
23	Manohara-Sankhu	27.705	85.396	22/3/2016	15.7	2	13.0	5.4
24	Manahara-Balkumari	27.670	85.339	22/3/2016	3.9	20	2.7	23.8

(g) Table showing measurement of BOD using given formula cont...

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	DO_1 (mg/l)	Dilution factor	DO_5 (mg/l)	BOD_5 (mg/l)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	7.9	2	6.7	2.5
26	Fewa-Temple site	28.208	83.953	2/4/2016	8.1	2	6.8	2.6
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	9.6	2	8.3	2.7
28	Fewa-Damp site	28.216	83.953	2/4/2016	8.0	2	7.0	2.1
29	Seti-Mardi	28.335	83.823	1/4/2016	12.5	2	4.8	15.4
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	8.1	2	7.5	1.2
31	Seti-PN college	28.239	83.982	1/4/2016	9.4	2	8.7	1.5
32	Seti-Dobila	28.209	83.693	1/4/2016	14.5	2	13.9	1.2
33	Begnas-Centre	28.175	85.101	1/4/2016	6.5	2	6.0	1.1
34	Begnas-End	28.179	84.092	1/4/2016	5.8	2	5.2	1.2
35	Begnas-South side	28.166	84.094	1/4/2016	6.5	2	6.0	1.1
36	Begnas-Outlet	28.174	84.097	1/4/2016	6.6	2	6.0	1.3
37	Narayani-Bridge	27.697	84.426	12/4/2016	5.6	50	5.3	12.8
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	7.1	2	4.4	5.4
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	11.2	2	10.8	0.9
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	10.3	2	9.9	0.9
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	1.1	100	0.2	87.3
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	1.2	100	0.4	76.8
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	1.0	100	0.3	70.6
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	1.1	100	0.2	88.6
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	10.4	2	9.6	1.6
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	8.3	2	7.3	2.0
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	9.3	2	8.5	1.6
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	9.5	2	8.8	1.5

(h) Table showing measurement of Nitrate using given chart

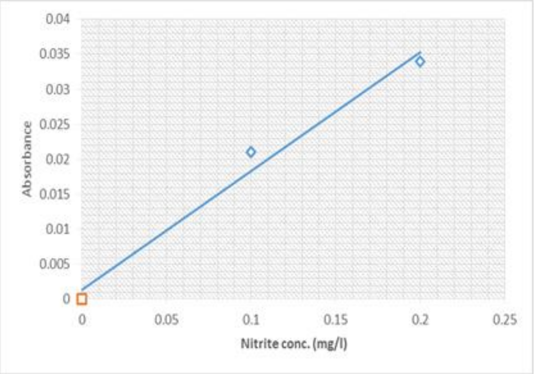


S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Absorbance (410 nm)	Nitrate Conc. (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	0.092	0.1
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	0.092	0.1
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	0.392	0.4
4	Bagmati-Khokana	27.632	85.292	19/3/2016	0.292	0.3
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	0.492	0.5
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	0.092	0.1
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	0.192	0.2
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	0.492	0.5
9	Taudaha-1	27.649	85.281	19/3/2016	0.292	0.3
10	Taudaha-2	27.648	85.282	19/3/2016	0.592	0.6
11	Taudaha-3	27.647	85.283	19/3/2016	0.092	0.1
12	Nakhu	27.662	85.306	18/3/2016	0.492	0.5
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	0.192	0.2
14	Nakhu-Saibu	27.650	85.310	18/3/2016	0.192	0.2
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	0.692	0.7
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	4.192	4.2
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	0.692	0.7
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	2.392	2.4
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	3.592	3.6
20	Hanumante-Thimi	27.674	85.387	18/3/2016	2.692	2.7
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	2.292	2.3
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	1.392	1.4
23	Manohara-Sankhu	27.705	85.396	22/3/2016	1.592	1.6
24	Manahara-Balkumari	27.670	85.339	22/3/2016	1.992	2.0

(h) Table showing measurement of Nitrate using given chart cont..

S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date(dd/mm/yy A.D.)	Absorbance (410 nm)	Nitrate Conc. (mg/l)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	0.110	0.11
26	Fewa-Temple site	28.208	83.953	2/4/2016	0.130	0.13
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	0.150	0.15
28	Fewa-Damp site	28.216	83.953	2/4/2016	0.160	0.16
29	Seti-Mardi	28.335	83.823	1/4/2016	0.130	0.13
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	0.150	0.15
31	Seti-PN college	28.239	83.982	1/4/2016	0.110	0.11
32	Seti-Dobila	28.209	83.693	1/4/2016	0.100	0.1
33	Begnas-Centre	28.175	85.101	1/4/2016	0.120	0.12
34	Begnas-End	28.179	84.092	1/4/2016	0.130	0.13
35	Begnas-South side	28.166	84.094	1/4/2016	0.110	0.11
36	Begnas-Outlet	28.174	84.097	1/4/2016	0.140	0.14
37	Narayani-Bridge	27.697	84.426	12/4/2016	3.500	3.5
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	4.600	4.6
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	3.400	3.4
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	3.900	3.9
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	8.900	8.9
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	5.700	5.7
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	4.700	4.7
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	3.600	3.6
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	0.500	0.5
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	0.600	0.6
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	0.300	0.3
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	0.500	0.5

(i) Table showing measurement of Nitrite using given chart



S.No.	Sample site	Latitude^0	Longitude^0	Sample collection date (dd/mm/yy A.D.)	Absorbance (540 nm)	Nitrite Conc. (mg/l)
1	Bagmati-Sundarijal	27.762	85.423	21/3/2016	0.018	0.10
2	Bagmati-Gokarna	27.739	85.388	21/3/2016	0.018	0.10
3	Bagmati-Gaurighat	27.713	85.351	21/3/2016	0.017	0.09
4	Bagmati-Khokana	27.632	85.292	19/3/2016	0.018	0.10
5	Bishnumati-Budanilkanth	27.784	85.356	21/3/2016	0.035	0.20
6	Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	0.003	0.01
7	Bishnumati-Sobhabhagwati	27.692	85.301	21/3/2016	0.018	0.10
8	Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	0.018	0.10
9	Taudaha-1	27.649	85.281	19/3/2016	0.018	0.10
10	Taudaha-2	27.648	85.282	19/3/2016	0.017	0.09
11	Taudaha-3	27.647	85.283	19/3/2016	0.018	0.10
12	Nakhu	27.662	85.306	18/3/2016	0.023	0.13
13	Nakhu-Bhaisipati	27.649	85.307	18/3/2016	0.018	0.10
14	Nakhu-Saibu	27.650	85.310	18/3/2016	0.005	0.02
15	Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	0.018	0.10
16	Dhobikhola-Kalopul	27.710	85.337	19/3/2016	0.052	0.30
17	Dhobikhola-Chabahil	27.716	85.339	19/3/2016	0.005	0.02
18	Hanumante-Sallaghari	27.672	85.407	18/3/2016	0.035	0.20
19	Hanumante-Kausaltar	27.673	85.365	18/3/2016	0.035	0.20
20	Hanumante-Thimi	27.674	85.387	18/3/2016	0.018	0.10
21	Manohara-Pepsicola	27.689	85.360	22/3/2016	0.035	0.20
22	Manohara-Mulpani bridge	27.703	85.394	22/3/2016	0.018	0.10
23	Manohara-Sankhu	27.705	85.396	22/3/2016	0.018	0.10
24	Manahara-Balkumari	27.670	85.339	22/3/2016	0.035	0.20

(i) Table showing measurement of Nitrite using given chart Contd.

S.No.	Sample site	Latitude⁰	Longitude⁰	Sample collection date(dd/mm/yy A.D.)	Absorbance (540 nm)	Nitrite Conc. (mg/l)
25	Fewa-Halanchowk	28.215	83.945	2/4/2016	0.018	0.10
26	Fewa-Temple site	28.208	83.953	2/4/2016	0.018	0.10
27	Fewa-Gaurighat	28.211	83.951	2/4/2016	0.035	0.20
28	Fewa-Damp site	28.216	83.953	2/4/2016	0.035	0.20
29	Seti-Mardi	28.335	83.823	1/4/2016	0.018	0.10
30	Seti-Seti Dovan	28.163	83.822	1/4/2016	0.035	0.20
31	Seti-PN college	28.239	83.982	1/4/2016	0.018	0.10
32	Seti-Dobila	28.209	83.693	1/4/2016	0.018	0.10
33	Begnas-Centre	28.175	85.101	1/4/2016	0.018	0.10
34	Begnas-End	28.179	84.092	1/4/2016	0.018	0.10
35	Begnas-South side	28.166	84.094	1/4/2016	0.018	0.10
36	Begnas-Outlet	28.174	84.097	1/4/2016	0.018	0.10
37	Narayani-Bridge	27.697	84.426	12/4/2016	0.018	0.10
38	Narayani-Near Stupa	27.709	84.419	12/4/2016	0.035	0.20
39	Narayani-Devghat unmixed	27.801	84.407	12/4/2016	0.018	0.10
40	Narayani-Devghat mixed	27.802	84.407	12/4/2016	0.018	0.10
41	Sirsiya-Parwanipur	27.121	85.736	11/4/2016	0.035	0.20
42	Sirsiya-Bridge	27.078	84.922	11/4/2016	0.018	0.10
43	Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	0.069	0.40
44	Sirsiya-Ghadiharwapokhara	27.014	84.875	11/4/2016	0.035	0.20
45	Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	0.005	0.02
46	Tinau-Siddhi Baba	27.749	83.400	10/4/2016	0.010	0.05
47	Tinau-Purano Buspark	27.701	83.463	10/4/2016	0.003	0.01
48	Tinau-Radha krishna tole	27.702	83.463	10/4/2016	0.003	0.01

Annex 3: Detail information of study sites

(a) Table showing detail information of various study sites at Bagmati River, Bishnumati River and Taudaha Lake within Kathmandu Valley

Detail information about study sites of rivers and lakes in Kathmandu Valley

Parameters	Latitude^0	Longitude^0	Sample collection date	Sample collection time	Water temp.	Air temp.	Sample analysis date	Color	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	*E.coli*
Desired Value*									6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit			dd/mm/yy(A.D.)		°C		dd/mm/yy (A.D.)		mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Bagmati-Sundarijal	27.762	85.423	21/3/2016	10.00 A.M.	16.2	18.1	22/3/2016	Yellowish	6.6	15	9.6	24.8	380.0	460.0	10.0	0.1	0.10	6.8	140.0	21.1	0.5	500	40
Bagmati-Gokarna	27.739	85.388	21/3/2016	11.00 A.M.	20.7	24.8	22/3/2016	Grey	7.0	7.1	4.7	18.6	100.0	150.0	20.0	0.1	0.10	5.7	150.0	34.0	11.6	1600	80
Bagmati-Gaurighat	27.713	85.351	21/3/2016	12.35 P.M.	26.7	29.6	22/3/2016	Dark grey	6.7	3.2	4.1	12.3	120.0	160.0	70.0	0.4	0.09	20.7	130.0	22.8	7.3	1600	70
Bagmati-Khokana bridge	27.632	85.292	19/3/2016	4.00 P.M.	20.6	26.0	20/3/2016	Black	7.4	1.2	90.5	192.0	810.0	970.0	70.0	0.3	0.10	30.0	90.0	10.6	3.9	900	50
Bishnumati-Budhanilkanth	27.784	85.356	21/3/2016	1.35 P.M.	23.0	23.1	22/3/2016	Yellowish	7.0	13	15.4	36.7	120.0	187.0	90.0	0.5	0.20	22.6	160.0	24.5	0.5	900	110
Bishnumati-Balaju Bridge	27.715	85.302	21/3/2016	2.30 P.M.	30.7	31.2	22/3/2016	Grey	7.2	0.2	123.0	154.0	550.0	780.0	20.0	0.1	0.01	32.7	200.0	28.9	7.2	1600	220
Bishnumati-Sobhabhagawat	27.692	85.301	21/3/2016	2.50 P.M.	27.2	27.5	22/3/2016	Dark grey	7.3	0.3	110	150.0	760.0	1100.0	30.0	0.2	0.10	31.1	190.0	34.8	5.6	1600	220
Bishnumati-Teku Dovan	27.440	85.180	21/3/2016	3.15 P.M.	25.1	27.00	22/3/2016	Dark grey	7.5	0.9	167	178.0	920.0	1360.0	90.0	0.5	0.10	34.6	130.0	43.7	5.7	1600	170
Taudaha-1	27.649	85.281	19/3/2016	4.00 P.M.	20.7	26.7	20/3/2016	Grey	8.2	8.9	17.1	24.5	90.0	175.0	50.0	0.3	0.10	10.1	160.0	12.8	0.9	900	70
Taudaha-2	27.648	85.282	19/3/2016	4.15 P.M.	19.7	25.7	20/3/2016	Grey	8.0	9.0	26.7	37.6	100.0	180.0	45.3	0.6	0.09	11.4	120.0	11.6	1.0	1600	90
Taudaha-3	27.647	85.283	19/3/2016	4.30 P.M.	19.0	25.0	20/3/2016	Grey	8.1	8.9	25.9	33.8	85.0	167.0	37.8	1.0	0.10	13.8	130.0	19.4	0.8	500	40
*NDWQS,2062																							

(b) Table showing detail information of various study sites at Nakhu, Dhobikhola, Hanumante and Manohara River within Kathmandu Valley

Detail information about study sites of rivers and lakes in Kathmandu Valley

Parameters	Latitude°	Longitude°	Sample collection date	Sample collection time	Water temp.	Air temp.	Sample analysis date	Color	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	*E.coli*
Desired Value*									6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit			dd/mm/yy (A.D.)		°C		dd/mm/yy (A.D.)		mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Nakhu	27.662	85.306	18/3/2016	5.30P.M.	20.7	25.2	19/3/2016	Dark grey	8.0	2.1	40.5	78.0	510.0	650.0	90.0	0.5	0.13	12.1	100.0	12.3	4.2	1600	110
Nakhu-Bhaisipati	27.649	85.307	18/3/2016	4.00P.M.	25.2	28.2	19/3/2016	Yellowish	7.9	5.6	12.8	17.8	360.0	450.0	40.0	0.2	0.10	2.3	120.0	23.6	3.4	900	90
Nakhu-Saibu	27.650	85.310	18/3/2016	4.10P.M.	23.2	25.3	19/3/2016	Yellowish	8.1	7.1	5.4	15.9	280.0	300.0	30.0	0.2	0.02	3.6	120.0	24.7	2.8	900	70
Dhobikhola-Bijulibazar	27.693	85.328	19/3/2016	6.00P.M.	20.5	21.5	20/3/2016	Dark grey	8.0	4.9	123.0	430.0	730.0	890.0	120.0	0.7	0.10	34.5	130.0	12.5	5.6	1600	120
Dhobikhola-Kalopul	27.710	85.337	19/3/2016	5.40P.M.	23.4	28.7	20/3/2016	Dark grey	8.5	0.6	235.0	330.0	850.0	1100.0	170.0	4.2	0.30	45.7	100.0	9.8	5.6	1600	140
Dhobikhola-Chabahil	27.716	85.339	19/3/2016	4.31P.M.	23.6	26.3	20/3/2016	Dark grey	8.2	0.5	324.0	450.0	750.0	1450.0	120.0	0.7	0.02	30.5	180.0	23.6	6.2	1600	110
Hanumante-Sallaghari	27.672	85.407	18/3/2016	1.40P.M.	23.6	32.3	19/3/2016	Dark grey	8.5	1.8	33.0	120.0	1530.0	1800.0	160.0	2.4	0.20	45.6	80.0	9.8	6.4	1600	120
Hanumante-Kausaltar	27.673	85.365	18/3/2016	1.24P.M.	24.0	29.7	19/3/2016	Dark grey	7.6	7.5	35.0	58.9	1200.0	1560.0	190.0	3.6	0.20	34.5	80.0	9.9	3.4	900	70
Hanumante-Thimi	27.674	85.387	18/3/2016	2.00P.M.	23.2`	28.9	19/3/2016	Dark grey	7.3	15.1	48.9	90.7	1290.0	1600.0	180.0	2.7	0.10	26.7	120.0	10.2	6.5	1600	90
Manohara-pepsikola	27.689	85.360	22/3/2016	2.30P.M.	27.0	30.5	23/3/2016	Grey	7.4	7.0	14.5	23.7	620.0	870.0	60.0	2.3	0.20	4.5	60.0	7.8	4.9	1600	140
Manohara-Mulpani bridge	27.703	85.394	22/3/2016	3.00P.M.	25.8	31.0	23/3/2016	Dark grey	7.2	8.9	11.1	12.3	100.0	160.0	20.0	1.4	0.10	2.0	120.0	23.7	0.3	900	80
Manohara-Sankhu	27.703	85.394	22/3/2016	3.15P.M.	27.5	31.1	23/3/2016	Light grey	7.0	15.7	5.4	12.4	60.0	78.0	20.0	1.6	0.10	6.7	130.0	12.5	0.4	1600	120
Manahara-Balkumari	27.670	85.339	22/3/2016	3.45P.M.	21.6	22.3	23/3/2016	Dark grey	7.6	3.9	23.8	40.5	980.0	1450.0	60.0	2.0	0.20	12.8	80.0	11.8	6.1	500	40

*NDWQS,2062

(c) Table showing detail information of various study sites at Phewa Lake, Begnas Lake and Seti River within Pokhara.

Detail information about study sites of rivers and lakes in Pokhara

Parameters	Latitude^0	Longitude^0	Sample collection date	Sample collection time	Water temp.	Air temp.	Sample analysis date	Color	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	*E.coli*
Desired Value*									6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit			dd/mm/yy (A.D.)		°C		dd/mm/yy (A.D.)		mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Phewa-Halanchowk	28.215	83.945	2/4/2016	9.22 A.M.	21.2	21.1	3/4/2016	Yellowish	7.5	7.9	2.5	5.7	50.0	50.0	1.6	0.1	0.1	5.0	120.0	6.7	0.1	900	70
Phewa-Temple site	28.208	83.953	2/4/2016	10.15 A.M.	21.7	21.8	3/4/2016	Yellowish	7.6	8.1	2.6	5.8	40.0	50.0	1.4	0.1	0.1	2.0	150.0	7.8	0.2	500	40
Phewa-gaurighat	28.211	83.951	2/4/2016	10.3 A.M.	21.8	23.0	3/4/2016	Yellowish	7.5	9.6	2.7	5.4	40.0	50.0	1.4	0.2	0.1	3.0	140.0	12.3	0.1	500	40
Phewa-Damp site	28.216	83.953	2/4/2016	11.4 A.M.	21.5	21.5	3/4/2016	Yellowish	7.6	8.0	2.1	5.7	50.0	60.0	1.6	0.2	0.1	4.0	120.0	11.1	0.1	900	70
Seti-Mardi	28.335	83.823	1/4/2016	8.16 A.M.	15.7	19.1	2/4/2016	Grey	7.4	8.1	1.2	2.4	110.0	130.0	1.5	0.1	0.1	2.0	120.0	9.8	0.3	500	50
Seti-Setidoban	28.163	83.822	1/4/2016	9.00 A.M.	15.9	18.0	2/4/2016	Clear	7.5	9.4	1.5	3.3	170.0	200.0	4.5	0.2	0.03	2.0	160.0	9.5	4.1	900	80
Seti-PN college	28.239	83.982	1/4/2016	9.30 A.M.	15.8	18.0	2/4/2016	Clear	7.5	14.5	1.2	2.5	160.0	180.0	3.2	0.1	0.02	2.0	110.0	5.6	3.4	1600	120
Seti-Dobila	28.209	83.693	1/4/2016	10.16 A.M.	16.6	22.8	2/4/2016	Clear	7.6	8.7	1.3	2.6	150.0	170.0	2.8	0.1	0.01	2.0	170.0	6.9	3.8	500	40
Begnas-Centre	28.175	85.101	1/4/2016	9.55 A.M.	22.8	22.5	2/4/2016	Yellowish	7.6	6.5	1.1	2.8	20.0	20.0	1.1	0.1	0.01	2.0	220.0	14.3	0.4	1600	70
Begnas-End	28.179	84.092	1/4/2016	10.4 A.M.	22.5	22.1	2/4/2016	Yellowish	7.6	5.8	1.2	2.3	10.0	20.0	1.1	0.1	0.02	2.0	220.0	12.4	0.1	900	50
Begnas-South side	28.166	84.094	1/4/2016	10.55 A.M.	23.3	23.5	2/4/2016	Yellowish	7.6	6.5	1.1	2.5	10.0	10.0	1.0	0.1	0.01	2.0	120.0	9.7	0.1	500	20
Begnas-Outlet	28.174	84.097	1/4/2016	11.25 A.M.	24.2	24.6	2/4/2016	Yellowish	7.6	6.6	1.3	2.6	20.0	35.0	0.8	0.1	0.01	2.0	80.0	4.7	0.2	900	20

*NDWQS,2062

(d) Table showing detail information of various study sites at Narayani River,Sirsiya River and Tinau River

Detail information about study sites of rivers in Narayanghat, Birgunj and Butwal

Parameters	Latitude⁰	Longitude⁰	Sample collection date	Sample collection time	Water temp.	Air temp.	Sample analysis date	Color	pH	DO	BOD	COD	TDS	EC	NH_3-N	NO_3-N	NO_2-N	TOC	TH	Mg	Fe	TC	*E.coli*
Desired Value*									6.5-8.5*	>5	<30	<250	<1000*	<1500*	<1.5*	<50*	-	-	<500*	<100	<0.3(3.0)*	0*	0*
Unit			dd/mm/yy (A.D.)		°C		dd/mm/yy (A.D.)		mg/l	mg/l	mg/l	mg/l	mg/l	µS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100ml	MPN/100ml
Narayanghat																							
Narayani-Bridge	27.697	84.426	12/4/2016	9.17A.M.	24.00	30.80	13/4/2016	Grey	7.3	11.2	0.9	2.5	170.0	200.0	2.0	3.5	0.10	2.0	340.0	25.6	0.2	900	60
Narayani-near Buddha stupa	27.709	84.419	12/4/2016	9.45A.M.	24.00	28.50	13/4/2016	Light grey	6.9	10.3	0.9	2.2	160.0	180.0	1.2	4.6	0.20	3.0	160.0	22.3	0.4	500	30
Narayani-Devghat unmixed	27.801	84.407	12/4/2016	10.15A.M.	21.00	30.00	13/4/2016	Grey	6.9	9.8	1.0	3.0	150.0	170.0	0.9	3.4	0.10	2.0	100.0	25.7	0.4	900	40
Narayani-Devghat mixed	27.802	84.407	12/4/2016	10.3P.M.	23.80	30.00	13/4/2016	Grey	7.1	9.7	1.5	3.5	160.0	180.0	1.1	3.9	0.10	5.0	180.0	22.9	0.3	900	70
Birgunj																							
Sirsiya-Parwanipur	27.121	85.736	11/4/2016	2.15P.M.	36.00	41.00	12/4/2016	Dark grey	6.5	1.1	87.3	123.1	390.0	410.0	80.0	8.9	0.20	23.0	300.0	24.6	3.9	1600	170
Sirsiya-bridge	27.078	84.922	11/4/2016	1.45P.M.	33.00	41.00	12/4/2016	Dark grey	7.0	1.2	76.8	110.0	760.0	700.0	70.0	5.7	0.10	35.0	250.0	20.8	4.3	500	80
Sirsiya-Miteri bridge	26.801	84.997	11/4/2016	3.40P.M.	33.00	42.00	12/4/2016	Dark grey	6.8	1.0	70.6	90.0	590.0	550.0	100.0	4.7	0.40	45.0	340.0	22.8	2.1	1600	140
Sirsiya-Ghadi harwa Pokhara	27.014	84.875	11/4/2016	4.18P.M.	31.30	42.00	12/4/2016	Green	6.6	1.1	88.6	78.0	750.0	710.0	90.0	3.6	0.20	33.0	240.0	25.9	3.7	900	110
Butwal																							
Tinau-Jhumsa bridge	27.700	83.499	10/4/2016	7.00A.M.	20.00	22.50	11/4/2016	Clear	7.2	10.4	1.6	2.6	200.0	220.0	0.9	0.5	0.02	4.0	200.0	14.5	0.1	900	70
Tinau-Siddhi baba butwal	27.749	83.400	10/4/2016	7.11A.M.	25.00	30.00	11/4/2016	Clear	7.4	8.3	2.0	2.1	200.0	220.0	1.4	0.6	0.05	5.0	240.0	15.4	0.1	500	40
Tinau-Purano bus park	27.701	83.463	10/4/2016	8.30A.M.	22.60	29.00	11/4/2016	Grey	7.4	9.3	1.6	3.3	200.0	250.0	1.0	0.3	0.01	3.0	120.0	11.2	0.1	900	50
Tinau-Radhakrishna tole	27.702	83.463	10/4/2016	7.50A.M.	22.00	28.00	11/4/2016	Grey	7.5	9.5	1.5	3.9	220.0	220.0	1.0	0.5	0.01	4.0	200.0	9.8	0.1	500	30

*NDWQS,2062

Photo 1:Photos of sample collection and field analysis by DHM staffs

Photo 2: Photos of laboratory analysis

Photo 3: Hoarding board installation at Khokana

Hoarding board installed at Khokana Bridge

नेपाल सरकार
जनसंख्या तथा वातावरण मन्त्रालय
जल तथा मौसम विज्ञान विभाग
जलगुण मापन केन्द्र : ५५०.०५ काठमाडौं

नदी : बाग्मती | लंग ८५.२९२०४७ ल्याट २७.६३१७७३ | स्थान : खोकना पूल | संकलन मिति (नमुना संख्या : ३) २०७२-१२-०७ विश्लेषण मिति : २०७२-१२-०८

जलगुण सम्बन्धित सार्वजनिक सूचना

पेरामिटरहरू (Parameters)	इकाई (Unit)	उपयुक्त मात्रा (Desirable Value)	परिमाण (Concentration)	असरहरू (Effects)
अम्लता/क्षरियता (pH)	—	६.५-८.५*	७.४	उपयुक्त मात्रा भन्दा कम वा बढी भएमा हानिकारक असर गर्दछ ।
घुलनशील अक्सिजन (Dissolved Oxygen)	मिलि.ग्रा./लि.	५ भन्दा बढी	१.२	उपयुक्त मात्रा भन्दा कम भएमा पानी दुषित भएको संकेत गर्दछ ।
बायोलोजिकल अक्सिजन डिमान्ड (Biological Oxygen Demand)	मिलि.ग्रा./लि.	३० भन्दा कम	९०.५	उपयुक्त मात्रा भन्दा बढी भएमा पानी दुषित भएको संकेत गर्दछ ।
केमिकल अक्सिजन डिमान्ड (Chemical Oxygen Demand)	मिलि.ग्रा./लि.	२५० भन्दा कम	१९२.०	
पूर्ण घुलनशील ठोस पदार्थ (Total Dissolved Solid)	मिलि.ग्रा./लि.	१००० भन्दा कम*	८१०.०	
इलेक्ट्रिकल कन्डक्टिभिटि (Electrical Conductivity)	माइ.सी/से.मि	१५०० भन्दा कम*	९७०.०	
अमोनिया (Ammonia)	मिलि.ग्रा./लि.	१.५ भन्दा कम*	७०.०	
नाइट्रेट (Nitrate)	मिलि.ग्रा./लि.	५० भन्दा कम*	०.३	
नाइट्राइट (Nitrite)	मिलि.ग्रा./लि.	—	०.१	
पूर्ण जैविक कार्बन (Total Organic Carbon)	मिलि.ग्रा./लि.	—	३०.०	
कडापन (Total Hardness)	मिलि.ग्रा./लि.	५०० भन्दा कम*	९०.०	उपयुक्त मात्रा बढी भएमा औद्योगिक क्षेत्रमा असर गर्दछ ।
मेग्नेसियम (Magnesium)	मिलि.ग्रा./लि.	१०० भन्दा कम	१०.६	
आइरन (Iron)	मिलि.ग्रा./लि.	०.३ भन्दा कम*	३.९	उपयुक्त मात्रा भन्दा बढी भएमा लुगामा पहेलो दाग तथा फलाममा सिया लाग्न सक्छ । वैकल्पिक श्रोत नभएमा ३.० सम्म उपयुक्त हुन्छ ।
कोलिफोर्म सुक्ष्म जिवाणु (Total Coliform)	एम.पीन./१०० मिलि.	शुन्य*	९४०.०	उपयुक्त मात्रा भन्दा बढी भएमा रोग लाग्न सक्छ ।
इ.कोलि सुक्ष्म जिवाणु *(Escherichia Coli)*	एम.पीन./१०० मिलि.	शुन्य*	३८.०	

*नेपाल खानेपानी गुणस्तर मापदण्ड २०६२

Photo 4: Hoarding board installation at Begnas lake

Hoarding board installed at Begnas Lake

नेपाल सरकार
जनसंख्या तथा वातावरण मन्त्रालय
जल तथा मौसम बिज्ञान बिभाग
जलगुण मापन केन्द्र : ४५०.०५ नारायणघाट

नदी : बेगनास, पोखरा

लंग ८४.०९७३
ल्याट २८.१७३९

संकलन मिति (नमुना संख्या : ३) २०७२-१२-२१
विश्लेषण मिति : २००२-१२-२२

जलगुण सम्बन्धित सार्वजनिक सूचना

परिमितिहरू (Parameters)	इकाई (Unit)	उपयुक्त मात्रा (Desirable Unit)	परिणाम (Result)	असरहरू (Effects)
अम्लता/क्षरियता (pH)	—	६.५-८.५*	७.६	उपयुक्त मात्रा भन्दा कम वा बढी भएमा हानिकारक असर गर्दछ ।
घुलनशील अक्सिजन (Dissolved Oxygen)	मिलि.ग्रा./लि.	५ भन्दा बढी	६६	उपयुक्त मात्रा भन्दा कम भएमा पानी दुषित भएको संकेत गर्दछ ।
बायोलोजिकल अक्सिजन डिमान्ड (Biological Oxygen Demand)	मिलि.ग्रा./लि.	४ भन्दा कम	१३	उपयुक्त मात्रा भन्दा बढी भएमा पानी दुषित भएको संकेत गर्दछ ।
केमिकल अक्सिजन डिमान्ड (Chemical Oxygen Demand)	मिलि.ग्रा./लि.	२५० भन्दा कम	२.६	
पूर्ण घुलनशील ठोस पदार्थ (Total Dissolved Solid)	मिलि.ग्रा./लि.	१००० भन्दा कम*	२०.०	
इलेक्ट्रिकल कन्डक्टिभिटि (Electrical COnductivity)	माइ.सी/से.मि	१५०० भन्दा कम*	३५.०	
अमोनिया (Ammonia)	मिलि.ग्रा./लि.	१.५ भन्दा कम*	०.८	
नाइट्रेट (Nitrate)	मिलि.ग्रा./लि.	५० भन्दा कम*	०.१४	
नाइट्राइट (Nitrite)	मिलि.ग्रा./लि.	—	०.१	
पूर्ण जैविक कार्बन (Total Organic Carbon)	मिलि.ग्रा./लि.	—	२.०	
कडापन (Total Hardness)	मिलि.ग्रा./लि.	५०० भन्दा कम*	८०.०	उपयुक्त मात्रा बढी भएमा औद्योगिक क्षेत्रमा असर गर्दछ ।
मेग्नेसियम (Magnesium)	मिलि.ग्रा./लि.	१०० भन्दा कम	४.७	
आइरन (Iron)	मिलि.ग्रा./लि.	०.३ भन्दा कम*	०.२	उपयुक्त मात्रा भन्दा बढी भएमा लुगामा पहेलो दाग तथा फलामका सिया लाग्न सक्छ । बैकल्पिक श्रोत नभएमा ३.० सम्म उपयुक्त मात्र ।
कोलिफोर्म सुक्ष्म जिवाणु (Total Coliform)	एम.पीन./१०० मिलि.	शुन्य*	९००.०	उपयुक्त मात्रा भन्दा बढी भएमा रोग लाग्न सक्छ ।
इ.कोलि सुक्ष्म जिवाणु *(Escherichia Coli)*	एम.पीन./१०० मिलि.	शुन्य*	२०.०	

*नेपाल खानेपानी गुणस्तर मापदण्ड २०६२

Photo 5: Hoarding board installation at Devghat

<u>Hoarding board installed at Devghat</u>

नेपाल सरकार
जनसंख्या तथा वातावरण मन्त्रालय
जल तथा मौसम बिज्ञान बिभाग
जलगुण मापन केन्द्र : ४५०.० नारायणघाट

नदी : नारायणी | स्थान : देवघाट | संकलन मिति (नमुना संख्या : ३) २०७२-१२-२९ विश्लेषण मिति : २०७२-१२-३०

जलगुण सम्बन्धित सार्वजनिक सूचना

पेरामिटरहरू (Parameters)	इकाई (Unit)	उपयुक्त मात्रा (Desirable Value)	परिमाण (Concentration)	असरहरू (Effects)
अम्लता/क्षरियता (pH)	—	६.५-८.५*	६.९	उपयुक्त मात्रा भन्दा कम वा बढी भएमा हानिकारक असर गर्दछ ।
घुलनशील अक्सिजन (Dissolved Oxygen)	मिलि.ग्रा./लि.	५ भन्दा बढी	९.८	उपयुक्त मात्रा भन्दा कम भएमा पानी दुषित भएको संकेत गर्दछ ।
बायोलोजिकल अक्सिजन डिमाण्ड (Biological Oxygen Demand)	मिलि.ग्रा./लि.	४ भन्दा कम	१.०	उपयुक्त मात्रा भन्दा बढी भएमा पानी दुषित भएको संकेत गर्दछ ।
केमिकल अक्सिजन डिमाण्ड (Chemical Oxygen Demand)	मिलि.ग्रा./लि.	२५० भन्दा कम	३.०	
पूर्ण घुलनशील ठोस पदार्थ (Total Dissolved Solid)	मिलि.ग्रा./लि.	१००० भन्दा कम*	१५०.०	
इलेक्ट्रिकल कण्डक्टिभिटि (Electrical Conductivity)	माइ.सी/से.मि	१५०० भन्दा कम*	१६०.०	
अमोनिया (Ammonia)	मिलि.ग्रा./लि.	१.५ भन्दा कम*	०.९	
नाइट्रेट (Nitrate)	मिलि.ग्रा./लि.	५० भन्दा कम*	३.४	
नाइट्राइट (Nitrite)	मिलि.ग्रा./लि.	—	०.१	
पूर्ण जैविक कार्बन (Total Organic Carbon)	मिलि.ग्रा./लि.	—	२.०	
कडापन (Total Hardness)	मिलि.ग्रा./लि.	५०० भन्दा कम*	१००.०	उपयुक्त मात्रा बढी भएमा औद्योगिक क्षेत्रमा असर गर्दछ ।
मेग्नेसियम (Magnesium)	मिलि.ग्रा./लि.	१०० भन्दा कम	२५.७	
आइरन (Iron)	मिलि.ग्रा./लि.	०.३ भन्दा कम*	०.४	उपयुक्त मात्रा भन्दा बढी भएमा लुगामा पहेंलो दाग तथा [illegible] लाग्न सक्छ । वैकल्पिक श्रोत नभएमा ३.० सम्म उपयुक्त हुन्छ ।
कोलिफोर्म सुक्ष्म जिवाणु (Total Coliform)	एम.पी.एन./१०० मिलि.	शुन्य*	२००.०	उपयुक्त मात्रा भन्दा बढी भएमा रोग लाग्न सक्छ ।
इ.कोलि सुक्ष्म जिवाणु *(Escherichia Coli)*	एम.पी.एन./१०० मिलि.	शुन्य*	४०.०	

*नेपाल खानेपानी गुणस्तर मापदण्ड २०६२