Ground Water Quality, Standards - Leh District

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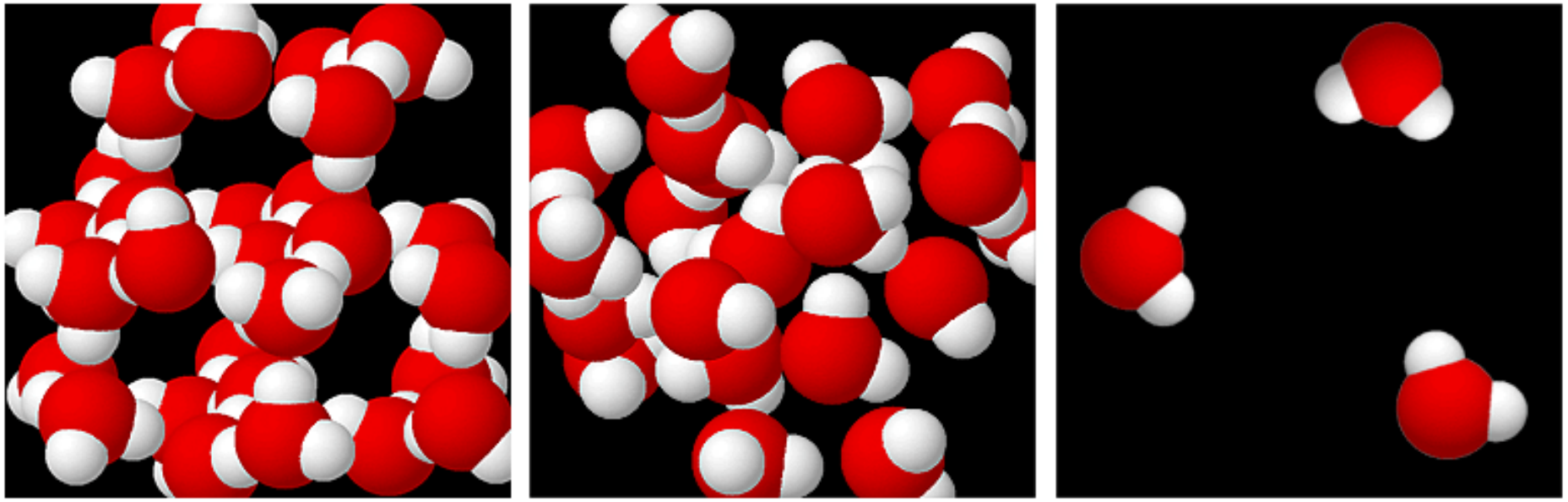
CENTRAL GROUND WATER BOARD

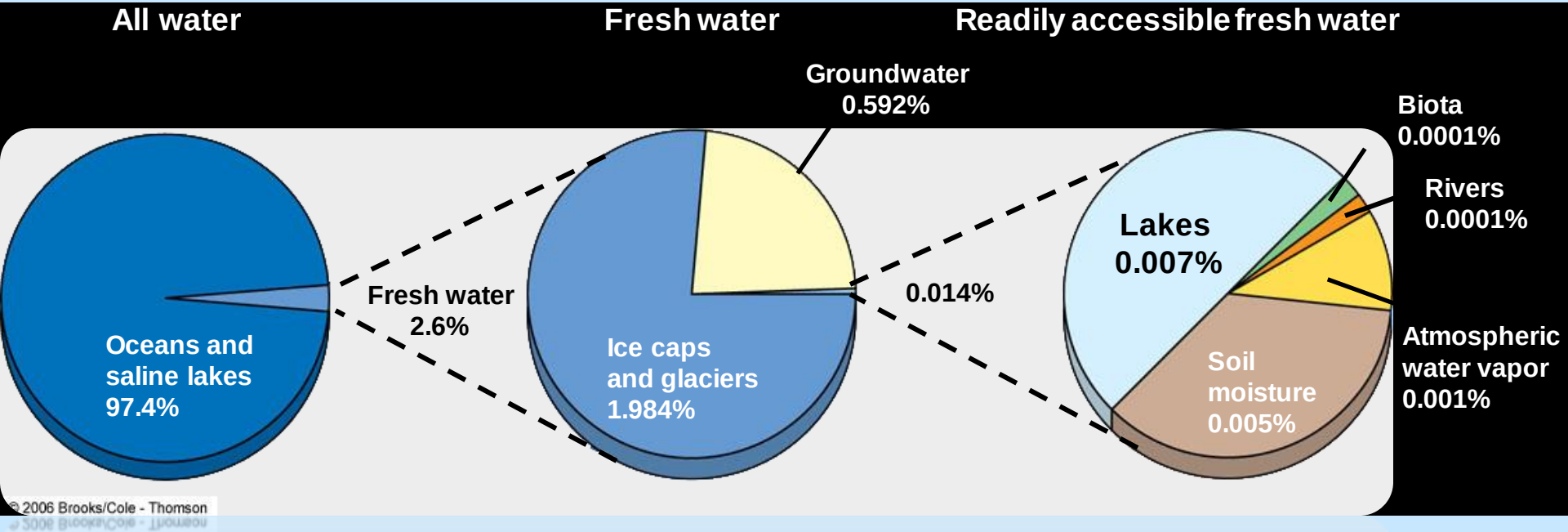
Ministry of Water Resources, River Development & Ganga Rejuevanation

Govt of India

Ice, water, vapor



Earth's Water Budget



Major Water Quality Issues

Common issues of Surface and Ground water

- Pathogenic (Bacteriological) Pollution
- Salinity
- Toxicity (micro-pollutants and other industrial pollutants)

Surface Water

- Eutrophication
- Oxygen depletion
- Ecological health

Ground Water

- Fluoride
- Nitrate
- Arsenic
- Iron
- Salinity

Major cause for water quality degradation

- **Point Sources of Pollution**
  - Domestic Wastewater
  - Industrial Wastewater
- **Non-Point Sources of Pollution**
  - Rural and Slum Population, open defecation, garbage etc
  - Wastewaters and Pollutants from Unsewered Towns
  - Industrial Pollutants
  - Pollutants in Agricultural Run-off and Drainage Waters
  - Deposition of Air- Pollutants

Point source examples

Non-point source pollutants - nutrients

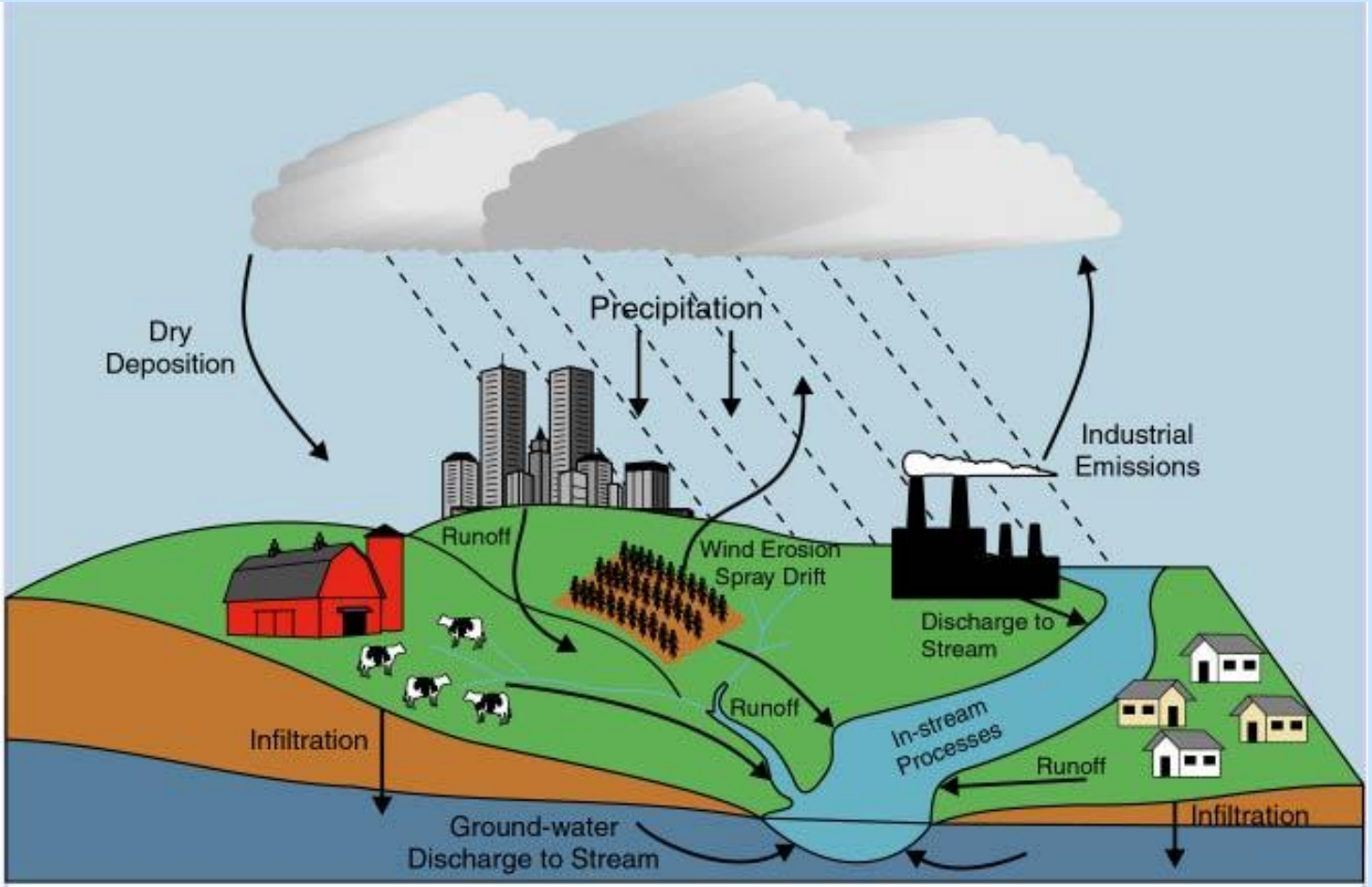
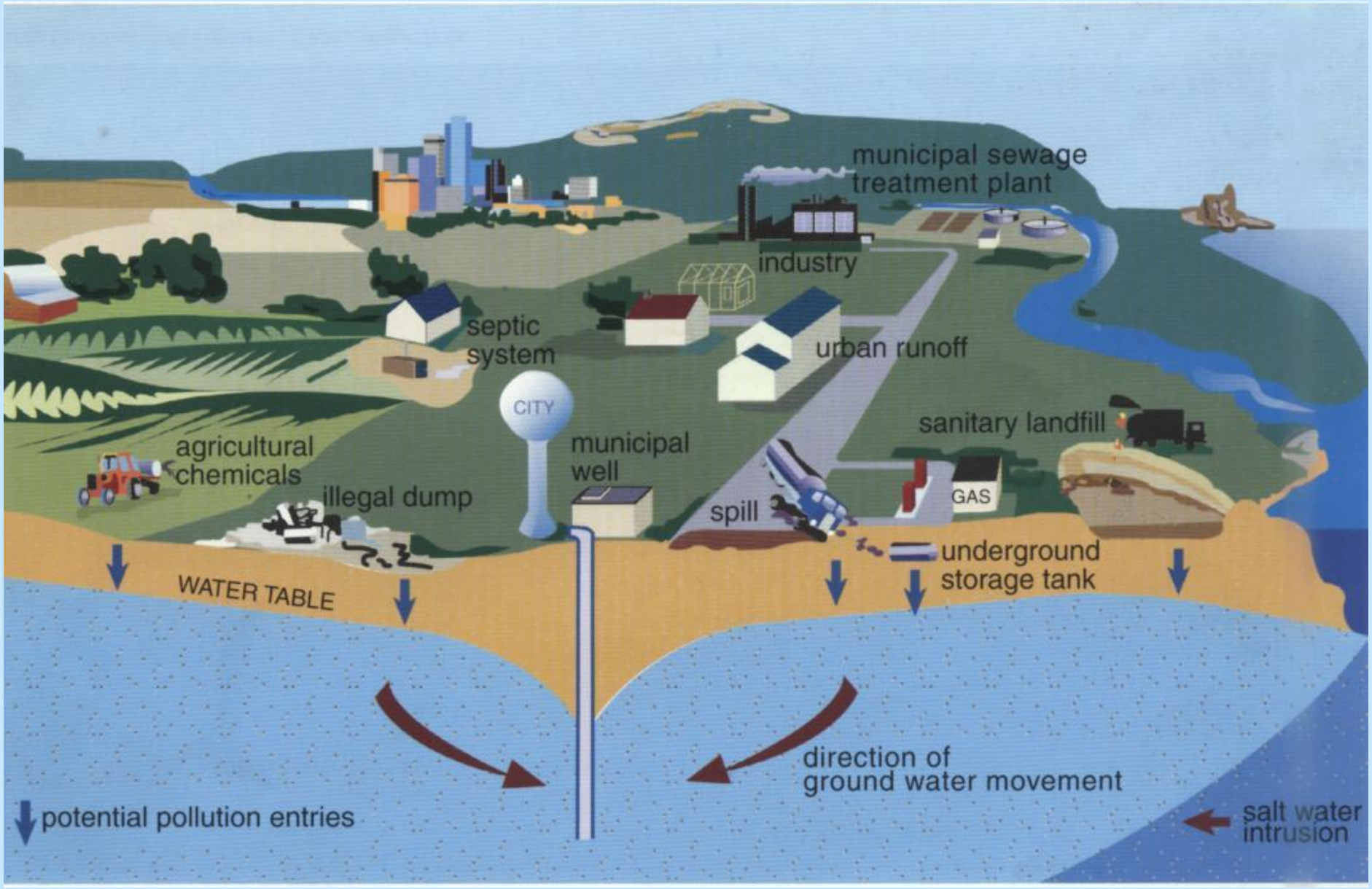


Figure 2. Nutrient movement in the hydrologic cycle.

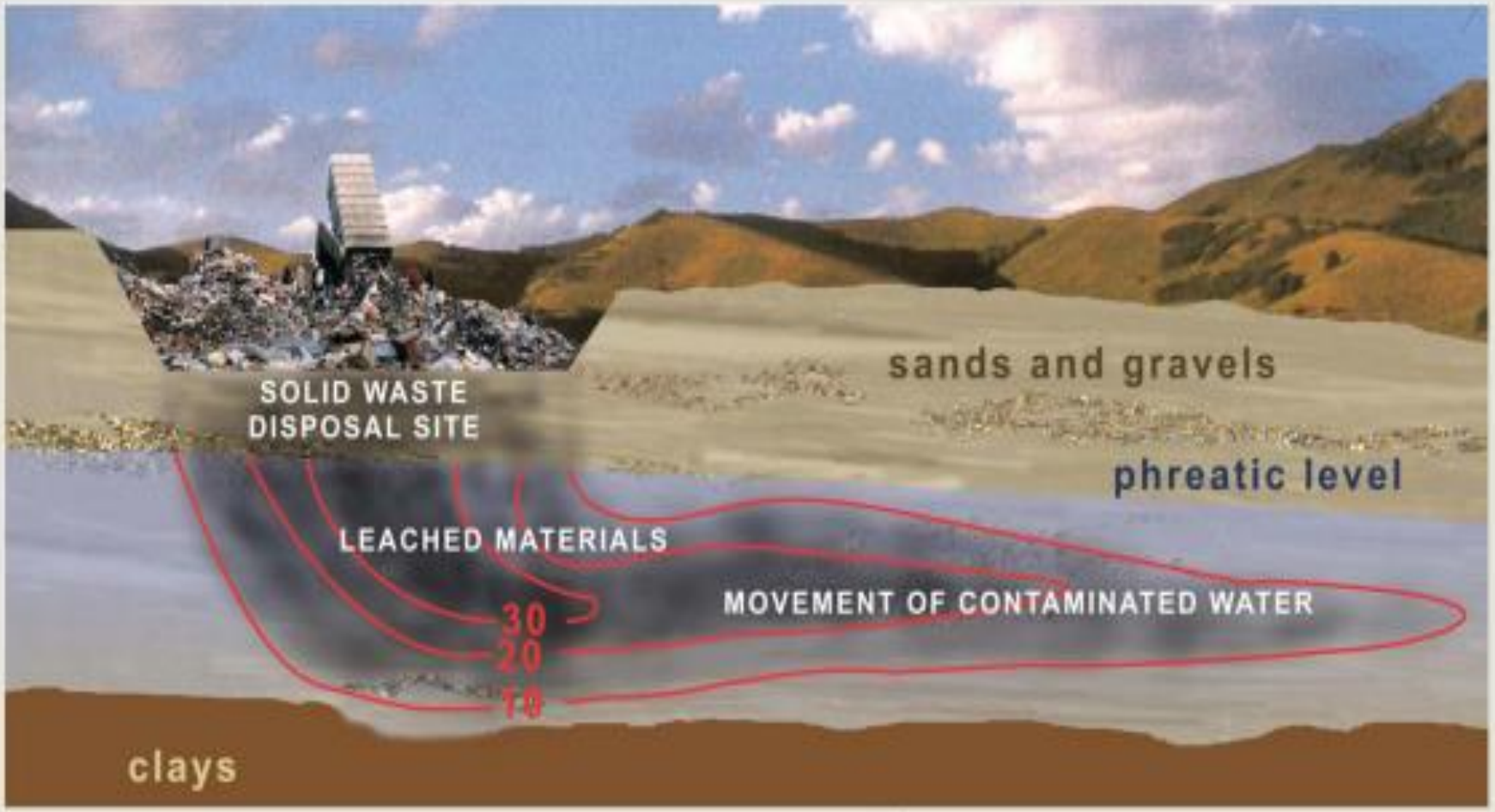
Stress on groundwater, both in terms of quality and quantity, are increasing rapidly to growing demands, significant changes in land use pattern, sea water intrusion, industrial effluents, domestic effluent etc.

The need to assess the groundwater quality is becoming increasingly important as groundwater sources become more and more contaminated by seawater intrusion, industrial effluents and unsustainable agricultural practices.

SCHEMATIC REPRESENTATION OF SOURCES OF GROUND WATER POLLUTION



Contaminant Load – Pollution Hazard



Contaminant plume in a waste disposal site with leaking of leached materials

•GROUNDWATER POLLUTION

•Input of untreated **domestic wastewater** (BOD, Suspended solids, nutrients, bacteria and viruses, *etc.)*

• **Industrial** spills; **mining** (BOD, SS, micropollutants)

• **Agriculture** (NO_3^- , pesticides, Cl^- ....)

• **Pit latrines** and other on-site sanitation systems

• **Waste dumps** (domestic and hazardous wastes)

•Treatment: slow, difficult and very expensive --> prevention!

NATIONAL STANDARDS

FOR DRINKING WATER

- ICMR STANDARDS (1975)
- BIS STANDARDS (IS:10500)
- Packaged Natural Mineral Water (IS:13428)
- Packaged Drinking Water (others) (IS:14543)
- Water for Building Construction (IS 456:2000)
- WHO (International)

DRINKING WATER STANDARD-IS:10500

Sl No.	Parameters	Prescribed limits		Probable effects
		Desirable	Permissible	
1	Color (Hazen Unit)	5	25	Makes Water aesthetically undesirable.
2	Odour	Essentially free from objectionable odour		Makes Water aesthetically undesirable.
3	Taste	Agreeable		Makes Water aesthetically undesirable.
4	Turbidity (NTU)	5	10	High turbidity indicates contamination / pollution.
5	pH	6.5	8.5	Indicative of acidic or alkaline water, affects taste, corrosivity and water supply system.
6	Hardness as $CaCO_3$(mg/l)	300	600	Affect water supply system (scaling) Excessive soap consumption, calcification of arteries.
7	Iron (mg/l)	0.3	1.0	Give bitter sweet astringent taste, causing staining of laundry and porcelain
8	Chloride (mg/l)	250	1000	May be injurious to some people suffering from heart and kidneys. Taste, indigestion, corrosion and palatability are affected.
9	Residual Chlorine(mg/l)	0.20	--	Excessive chlorination may cause asthma, colitis and eczema.
10	TDS (mg/l)	500	2000	Palatability decreases and may cause gastro-intestinal irritation in human, may have laxative effect particularly upon transits.
11	Calcium (mg/l)	75	200	Causes encrustation in water supply system excess causes concretions in the body such as kidney or bladder stones and irritation in urinary passage.
12	Magnesium (mg/l)	30	100	High concentration may have laxative effects. Its salts are cathartics and diuretic.
13	Copper(mg/l)	0.05	1.50	Large amount may result in liver damage, causes central nervous system irritation and depression.
14	Sulfate (mg/l)	200	400	Causes gastro intestinal irritation along with Mg or Na can have a cathartic effect on users.

Contd.,

DRINKING WATER STANDARD-IS:10500

15	Nitrate (mg/l)	45	45	Cause infant Methaemoglobinaemia at very high concentration, causes gastric cancer and affects cardiovascular system.
16	Fluoride (mg/l)	1.0	1.5	Reduces dental carries, very high concentration may cause crippling skeletal fluorosis.
17	Cadmium (mg/l)	0.01	--	Acute toxicity may be associated with renal arterial hypertension. Causes cramps, nausea, vomiting and diarrhea.
18	Lead (mg/l)	0.05	--	Burning in the mouth, chronic toxicity produces nausea, severe abdominal pain, paralysis, mental confusion, and visual disturbance.
19	Zinc (mg/l)	5	15	High concentrations impart astringent taste.
20	ChromiumCr^{+6} (mg/l)	0.05	--	Produces lung tumors, coetaneous and nasal ulcers and dermatitis.
21	Boron (mg/l)	1.0	5	Effects central nervous system and may cause nausea, cramps, convulsions, coma etc.,
22	Alkalinity as $CaCO_3$(mg/l)	200	600	Imparts unpleasant taste.
23	Arsenic (mg/l)	0.01	0.01	Skin lesions, Arsenicosis, carcarcinogenic
24	Pesticides (g/l)	Absent	0.001	Effects immune and nervous system.
25	Phosphate(mg/l)	No guideline		High concentration may cause vomiting, diarrhea and bone loss.
26	Sodium (mg/l)	No guideline		Harmful for cardiac, renal and circulatory diseases.
27	Potassium (mg/l)	No guideline		Excessive amount is cathartic.
28	Silica (SiO_2) (mg/l)	No guideline		
29	Nickel (mg/l)	No guideline		Non-toxic element but may be carcinogenic in animals, can react with DNA resulting in DNA damage in animals.
	Pathogens (Total + Faecal)	1	10	Cause water borne diseases like coliform Jaundice, Cholera, Typhoid etc.,

Water Quality parameter

- **Physical parameters** – Temperature, Color, Turbidity, Odor, Taste

- **Chemical parameters** –• Acidity • Alkalinity • Hardness • Solids Harmful Chemicals • Chlorides • Sulphates • Iron • Nitrates • Major ions, Minor ions, Trace element / Heavy Metals • Pesticides

- **Biological parameters** – E coli, Viruses, Bacteria, Protozoa & Helminthes etc.(Mostly in Surface Water)

SAMPLING

Analysis Starts from sampling so:

- Wash your hands thoroughly before collecting samples.
- Label the bottle before sampling.
- Collect microbiological samples before collecting other samples.
- For Ground Water Sampling Purging must be done

Sample container

Analysis	Material
General	Glass, PE
Hg & P	Glass
Pesticide	Glass, Teflon
DO	BOD bottle
Coliforms	Glass/ PE sterilised

Spot Analysis

pH, EC, TDS, Temperature, DO(in SW)

Sample Preservation and Transportation

Submitting Samples in the Laboratory

Sample collection

- Standard method of water sample collection special care must be take.
- Changes takes place during
- sampling,
- transport and
- storage.

Sample preservation

Analysis	Preservation
BOD	4 ^{o}C, dark
COD, NH_3, NO_2^-, NO_3^-	< pH 2, H_2SO_4
Coli forms	4 ^{o}C, dark
DO	DO fixing chemicals, dark
Fe++	O-phenanthroline
Heavy metals	< pH 2, HNO_3
As	< pH 2_{HCl}

pH

pH of a solution is the negative logarithm of Hydrogen ion concentration

$pH = - \log[H^+]$

Since pH is a logerthemic function a change of one pH unit represents a ten fold change in Hydrogen ion concentration.

pH

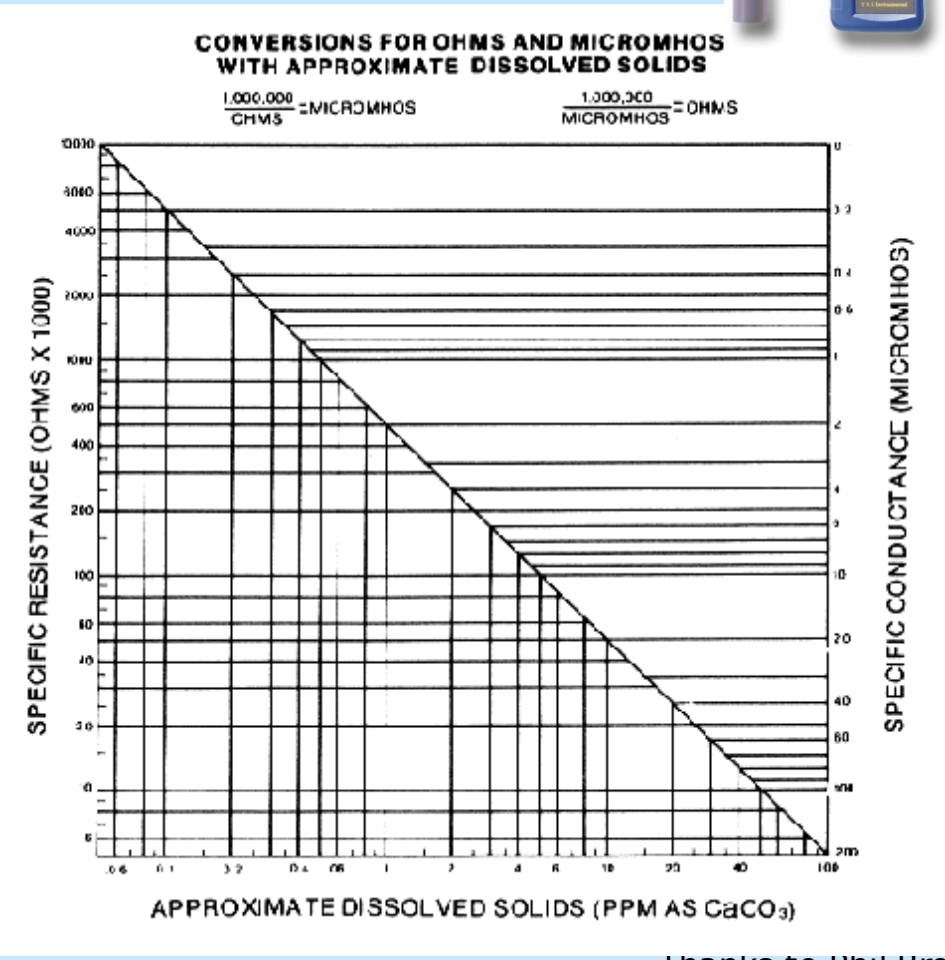
- Measures hydrogen ion concentration
- Negative log of hydrogen ion concentration
- Ranges from 0 to 14 std. units
- pH
  - 7 neutral
  - 0 - 7 acidic
  - 7 - 14 alkaline

Concentration of Hydrogen ions compared to distilled water		Examples of solutions at this pH
10,000,000	pH= 0	Battery acid, Strong Hydrofluoric Acid
1,000,000	pH = 1	Hydrochloric acid secreted by stomach lining
100,000	pH = 2	Lemon Juice, Gastric Acid Vineger
10,000	pH = 3	Grapefruit, Orange Juice, Soda
1,000	pH = 4	Acid rain Tomato Juice
100	pH = 5	Soft drinking water Black Coffee
10	pH = 6	Urine Saliva
1	pH = 7	"Pure" water
1/10	pH = 8	Sea water
1/100	pH = 9	Baking soda
1/1,000	pH = 10	Great Salt Lake Milk of Magnesia
1/10,000	pH = 11	Ammonia solution
1/100,000	pH = 12	Soapy water
1/1,000,000	pH =13	Bleaches Oven cleaner
1/10,000,000	pH = 14	Liquid drain cleaner

Thanks to Phil Brown

Conductivity

- Measures electric conductivity (EC) of water
- Higher value means water is a better electrical conductor
- Increases when more salt (e.g., sodium chloride) is dissolved in water
- Indirect measure of salinity
- Units are µmhos/cm at 25° C or µsiemens/cm



Thanks to Phil Brown

List of constituents being analysed

- **Major Constituents (BASIC ANALYSIS)**
  - pH, EC,HCO3,CO3,Cl,Ca,Mg,TH,Na,K, NO3, F,SO4, SiO2, PO4
- **Minor and Trace elements**
  - Cu, Fe, Ni, Mn, Zn, Al, As, Ag, Cr, Co, Cd, Mo, Pb, Sn, U etc
- **Pesticides**
  - (α, β ,γ, δ &Total- HCH), (4,4'-DDT, 2,4'-DDE, 4,4'-DDE, 4,4'- DDD, Total DDT, Total DDT, Chlorpyrifos, Aldrin, Atrazine, Aldicarb, Carbofuran, Chlorpyrifos.

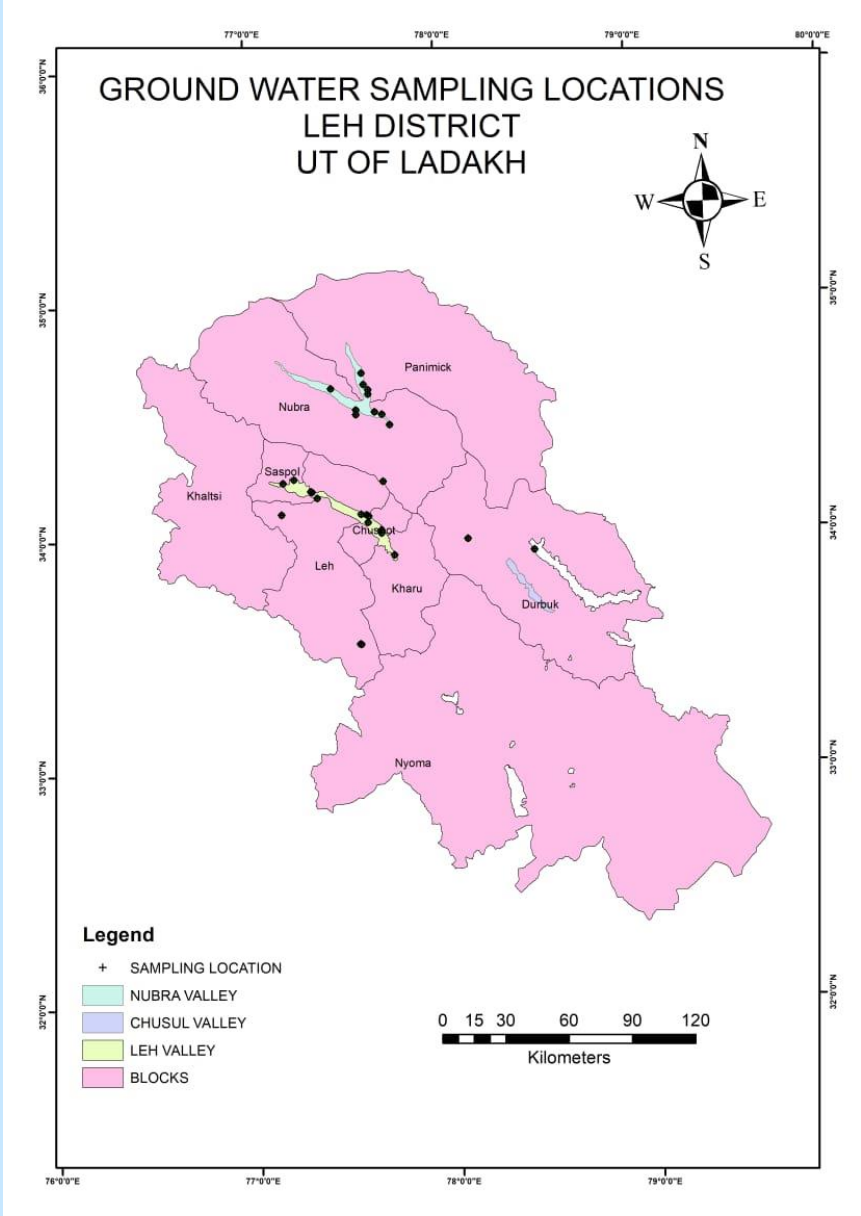
Available Equipments

Types of Equipment
pH meter
Electrical Conductivity meter
Flame photometer
UV-Visible Spectrophotometer (UV-VIS)
Atomic Absorption Spectrophotometers (AAS)
Gas Chromatograph (GC)
Ion meter
Ultra Pure /Distillation / Double Distillation Plant
ICP-MS
Ion Chromatograph

Ground Water Quality of Leh District

Central Ground water Board has collected 35 water samples in 2019 from various water bodies-

- Springs samples 09
- Hand Pumps samples 17
- Tube wells samples 08
- Lake sample 01



Chemical Quality of Springs in Leh District

Location	Type Source	pH	E C	CO_3	HCO_3	Alkalinity	Cl	SO_4	NO_3	F	Ca	Mg	Na	K	TH	TDS
Chushul	Spring	8.22	310	0	98	80	17.8	90	2.3	2.22	22	9	50.1	1.4	90	161
Parma TCP	Spring	8.22	280	0	73	60	7.1	14	1.8	0.36	28	12	7	0.9	120	146
Pinchimik Spring	Spring	7.83	350	0	189	155	7.1	39	0.4	0.3	52	12	6.3	9.4	180	182
Thirisha	Spring	8.12	680	0	342	280	14.2	62	1.2	6.37	28	13	107	6.5	125	354
Panamic	Spring	8.27	710	0	287	235	14.2	125	0	11.3	90	18	38.4	1.24	300	369
Surguk	Spring	8.37	370	24	128	145	24.9	43	2.4	0.4	26	21	31.4	6.8	150	192
Tsogstog	Spring	8.38	300	12	43	55	21.3	94	0.1	0.26	30	13	22	4	130	156
Hemis	Spring	8.20	240	0	140	115	7.1	15	2.8	0.05	32	13	3.3	0.7	135	125
Stokma	Spring	8.39	190	9	73	75	7.1	36	1.2	0.06	34	7	1.96	2.9	115	99

Chemical Quality of Shallow Hand Pumps in Leh District

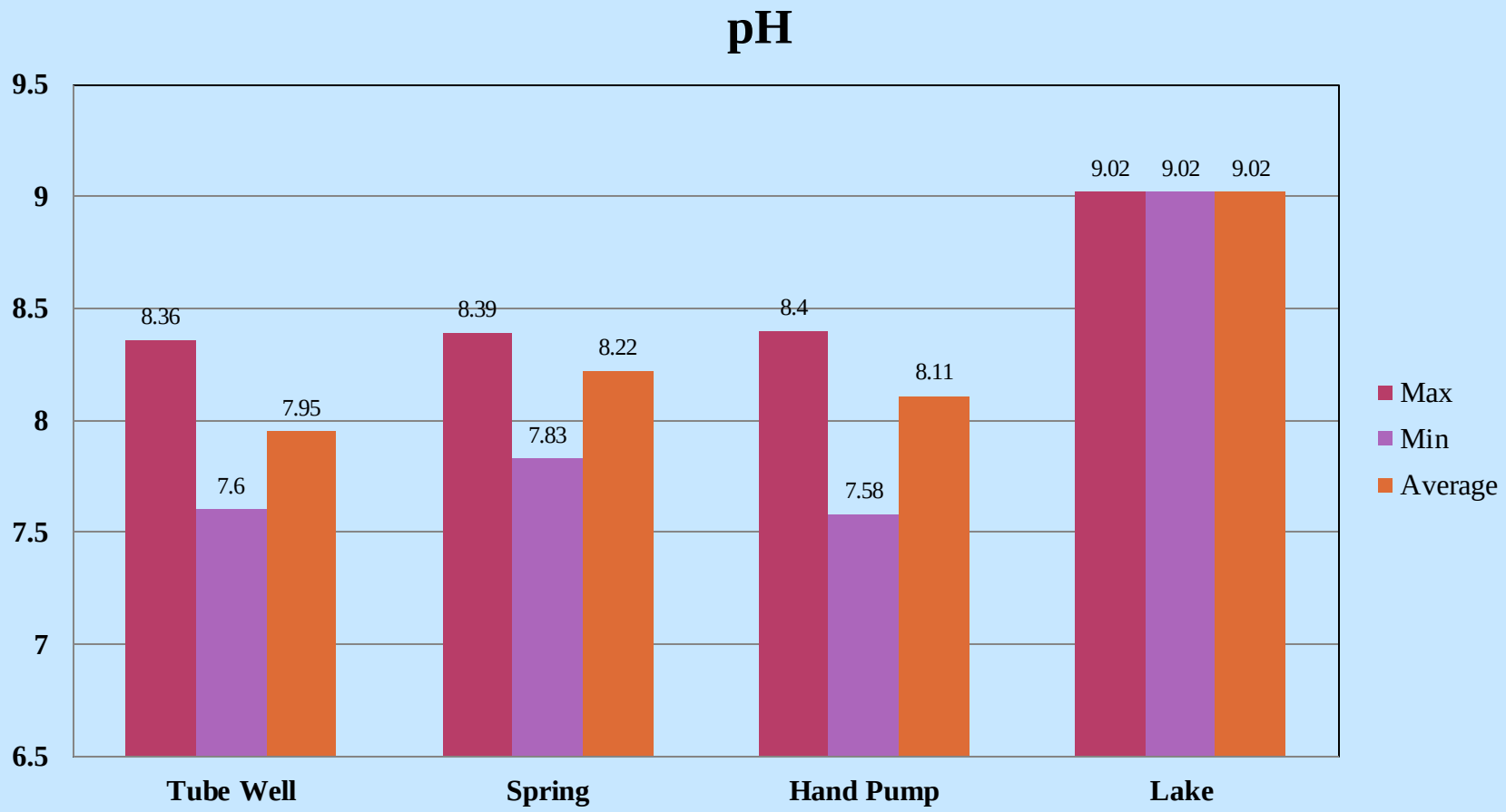
Location	Type of Source	pH	Sp Cond ms/cm 25°C	CO_3	HCO_3	Alkalinity	Cl	SO_4	NO_3	F	Ca	Mg	Na	K	TH	TDS
Billasalsal	Hand Pump	7.80	460	0	305	250	24.9	1	0.1	0.13	54	15.8	36.5	5.6	200	239
Sathoo	Hand Pump	8.10	140	0	73	60	7.1	14	1.4	0.11	18	7.3	4.21	1.6	75	73
Parma	Hand Pump	7.99	120	0	55	45	14.2	11	0	0.1	22	3.6	2.3	1.2	70	62
Chushul	Hand Pump	8.30	310	0	104	85	14.2	92	1.4	1.66	28	7.3	46	1.5	100	161
Terche	Hand Pump	7.58	240	0	128	105	14.2	18	0.3	0.16	34	10.9	2.4	2.8	130	125
Lakjong	Hand Pump	7.84	460	0	275	225	17.8	28	0.3	0.15	60	18.2	21.3	5.9	225	239
Pinchimik	Hand Pump	7.77	390	0	244	200	7.1	20	0.4	0.32	54	17.0	6.2	10.04	205	203
Hargam	Hand Pump	8.01	300	0	183	150	7.1	6	1.4	0.67	38	13.4	4	6.4	150	156
Sumur	Hand Pump	8.20	200	0	134	110	7.1	13	0	0.16	26	12.2	5.6	5.1	115	104
Tirith	Hand Pump	8.22	220	0	140	115	7.1	12	0	0.1	36	8.5	1.9	6.3	125	114
Khalsar	Hand Pump	8.24	230	0	159	130	7.1	12	2.3	0.14	42	9.7	3.7	1.3	145	120
Karu chowk	Hand Pump	8.22	390	0	201	165	21.3	47	5.4	0.17	56	15.8	18.3	2.8	205	203
Changa	Hand Pump	8.20	380	0	220	180	7.1	45	2.3	0.07	58	14.6	14.2	1.9	205	198
Matho Russian	Hand Pump	8.40	180	24	73	100	7.1	8	0.7	0.05	28	8.5	5.9	0.9	105	94
Sheh	Hand Pump	8.34	220	9	67	70	7.1	65	2.1	0.07	38	9.7	4.4	3.4	135	114
Palam	Hand Pump	8.24	430	0	256	210	17.8	48	0.8	0.17	64	13.4	31.3	1.9	215	224
Spituk-Parka	Hand Pump	8.36	500	30	238	245	14.2	79	1.9	0.27	78	19.5	31.1	5	275	260

Chemical Quality of TW in Leh District

Location	Type of Source	pH	Sp Cond ms/cm 25°C	CO_3	HCO_3	Alkalinity	Cl	SO_4	NO_3	F	Ca	Mg	Na	K	TH	TDS
Thoise Air Force	Tube well	7.78	200	0	79	65	21.3	-	-	-	28	4	3.3	1.1	80	104
Hunder BRO	Tube well	7.69	150	0	79	65	7.1	4	2.1	0.04	26	4	2	1.3	75	78
Parthapur DRDO	Tube well	7.86	180	0	104	85	10.7	3	2.1	0.09	28	10	3.5	1.9	95	94
Parthapur MES	Tube well	7.90	170	0	104	85	7.1	12	1.3	0.1	30	10	2.8	1.5	100	88
Karu	Tube well	8.10	390	0	201	165	21.3	17	1.7	0.1	50	24	12.4	1.6	185	203
ThikseyChamba	Tube well	7.60	270	0	122	100	10.7	50	2.6	0.12	40	16	6.7	3.9	140	140
753-BRTF	Tube well	8.36	340	42	104	155	14.2	59	4.6	0.7	52	20	24	6.3	180	177
ChushotYogmaCamel	Tube well	8.27	260	6	153	135	7.1	27	2.7	0.04	46	18	6.6	0.8	160	135

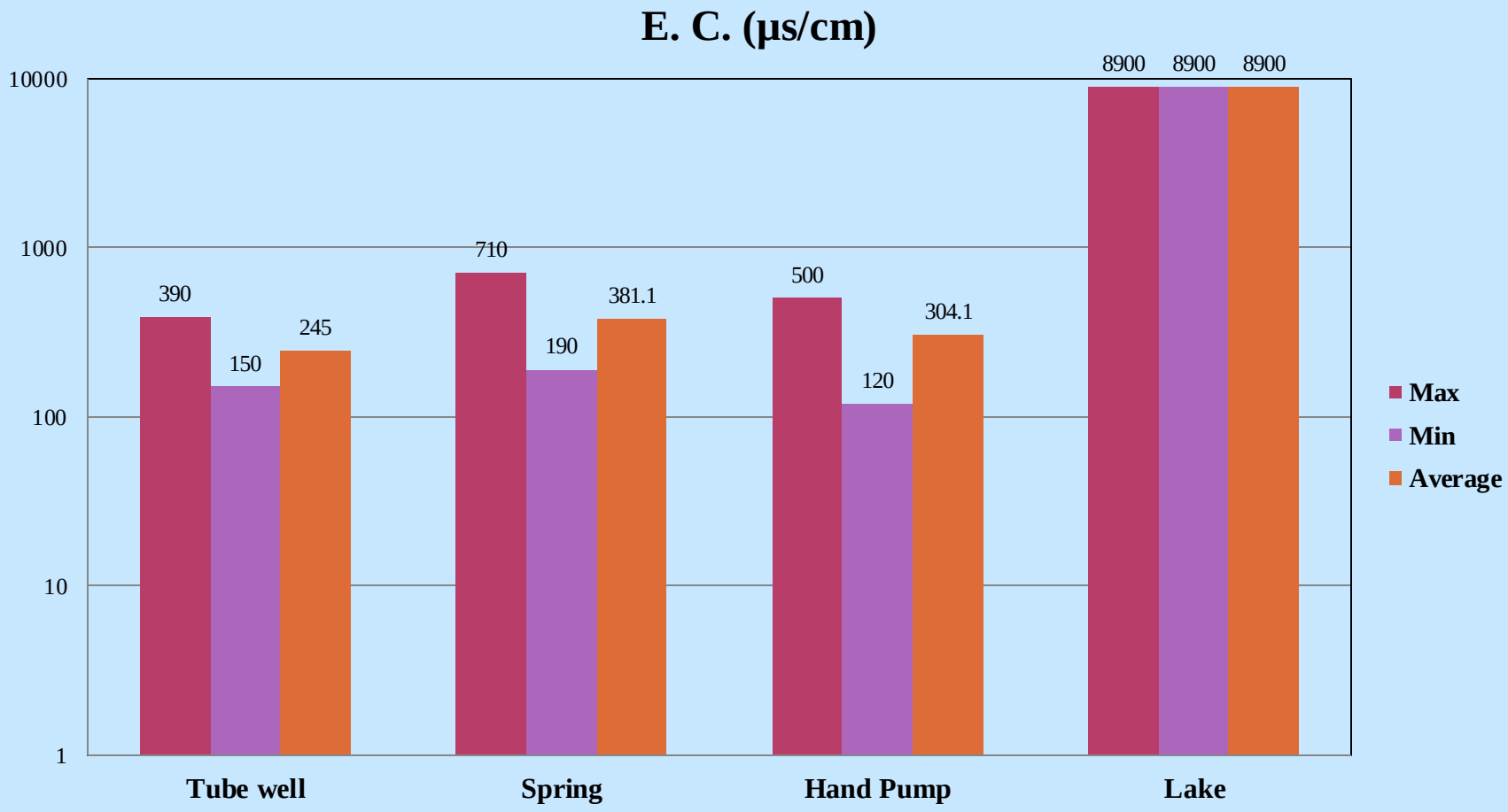
Location	Type of Source	pH	Sp Cond ms/cm 25°C	CO_3	HCO_3	Alkalinity	Cl	SO_4	NO_3	F	Ca	Mg	Na	K	TH	TDS
Lukung	Lake	9.02	8900	60	2196	1900	2698	3302	5.9	0.22	800	146	**2875**	**230**	2600	4628

pH of Water in Leh District



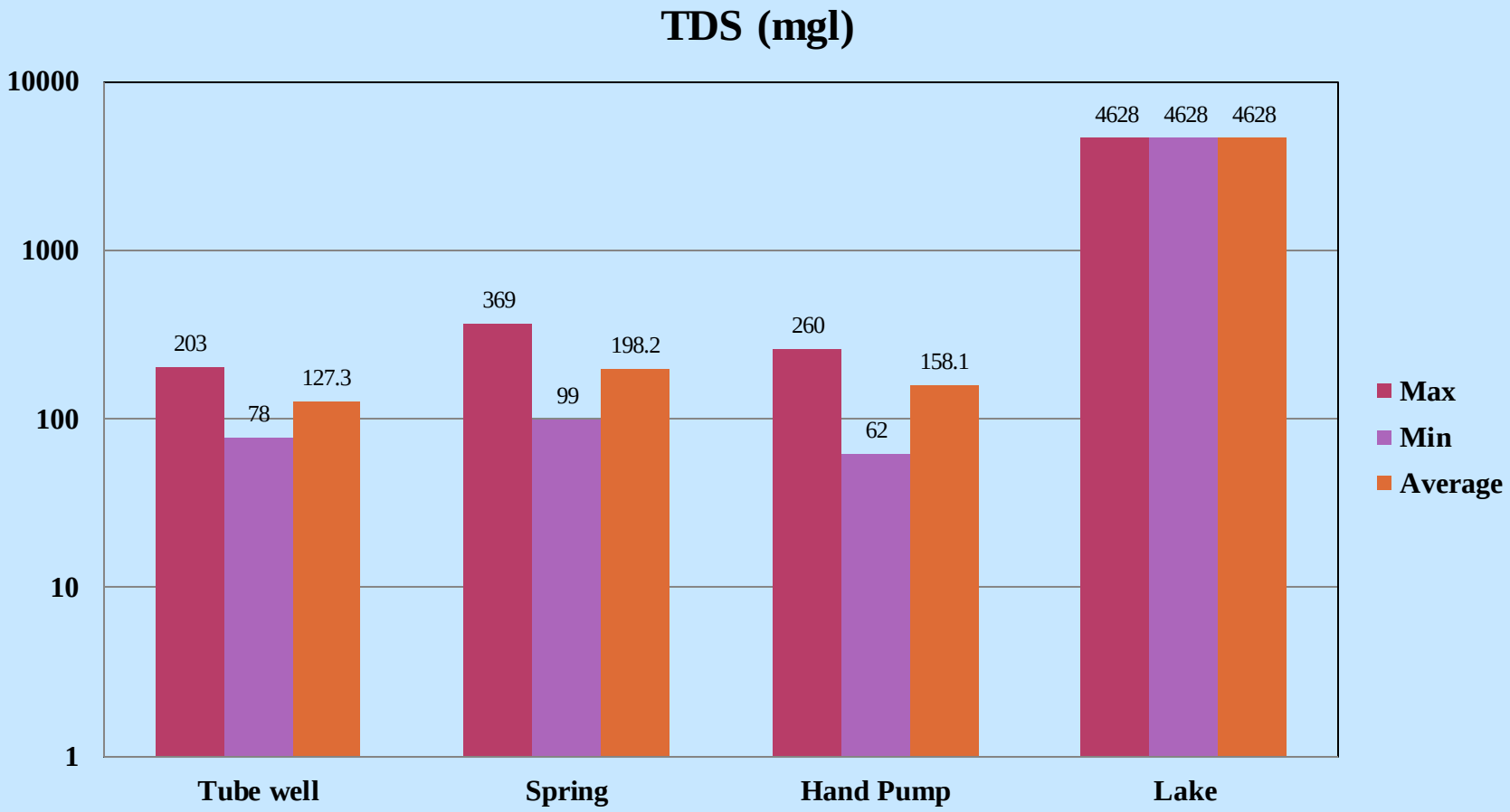
BIS Limit : 6.5 – 8.5

Specific Conductance of Water in Leh District



BIS Limit : 500-200(TDS) ~750 – 3000(EC)

Total Dissolved Solids of water in Leh District



BIS Limit : 500-200(TDS)

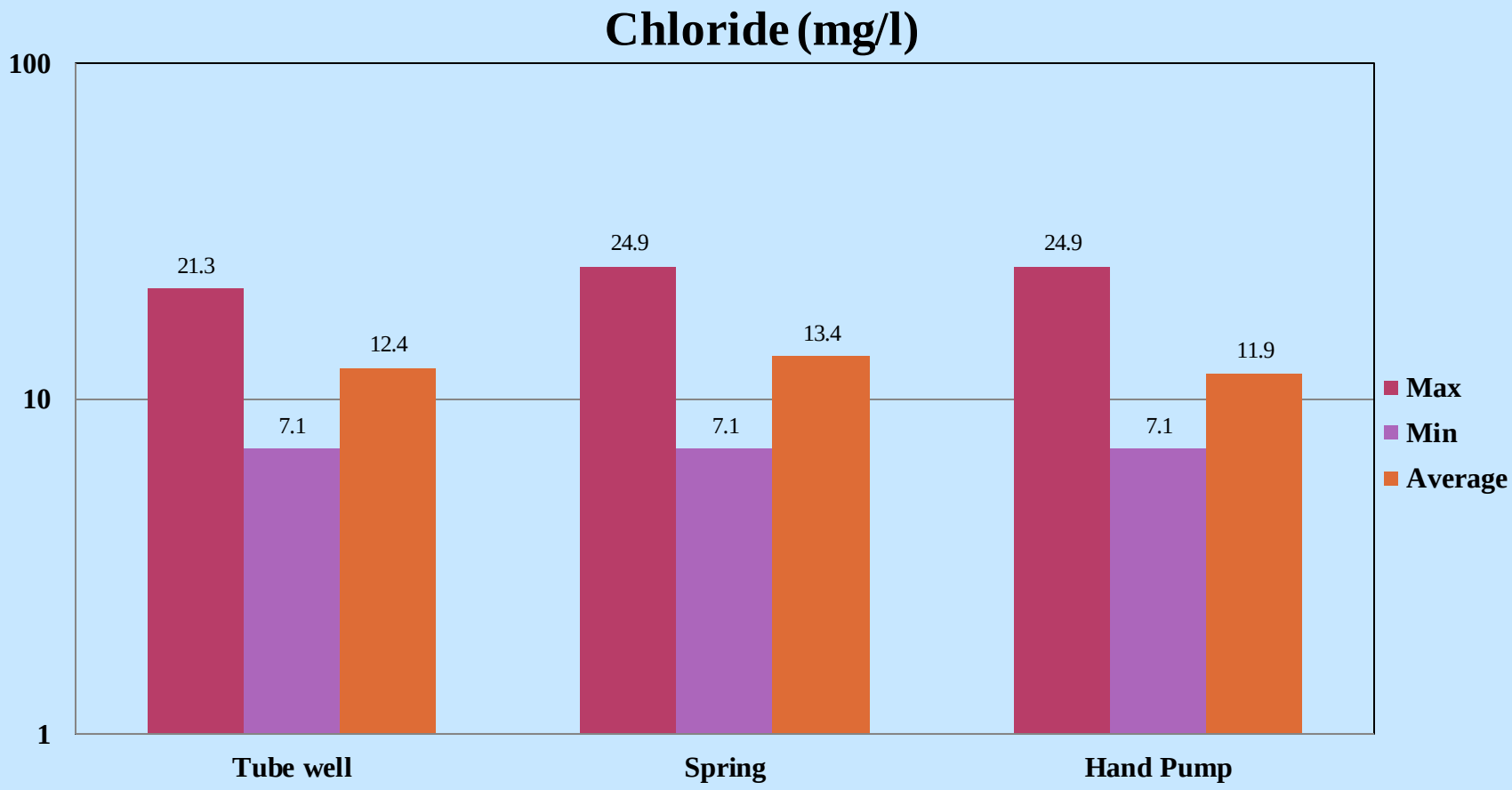
- **TDS :** Palatability decreases and may cause gastro-intestinal irritation in human, may have laxative effect particularly upon transits.

(Limit 500 -2000 mg/l)

- **Chloride :-** May be injurious to some people suffering from heart and kidneys. Taste, indigestion, corrosion and palatability are affected.

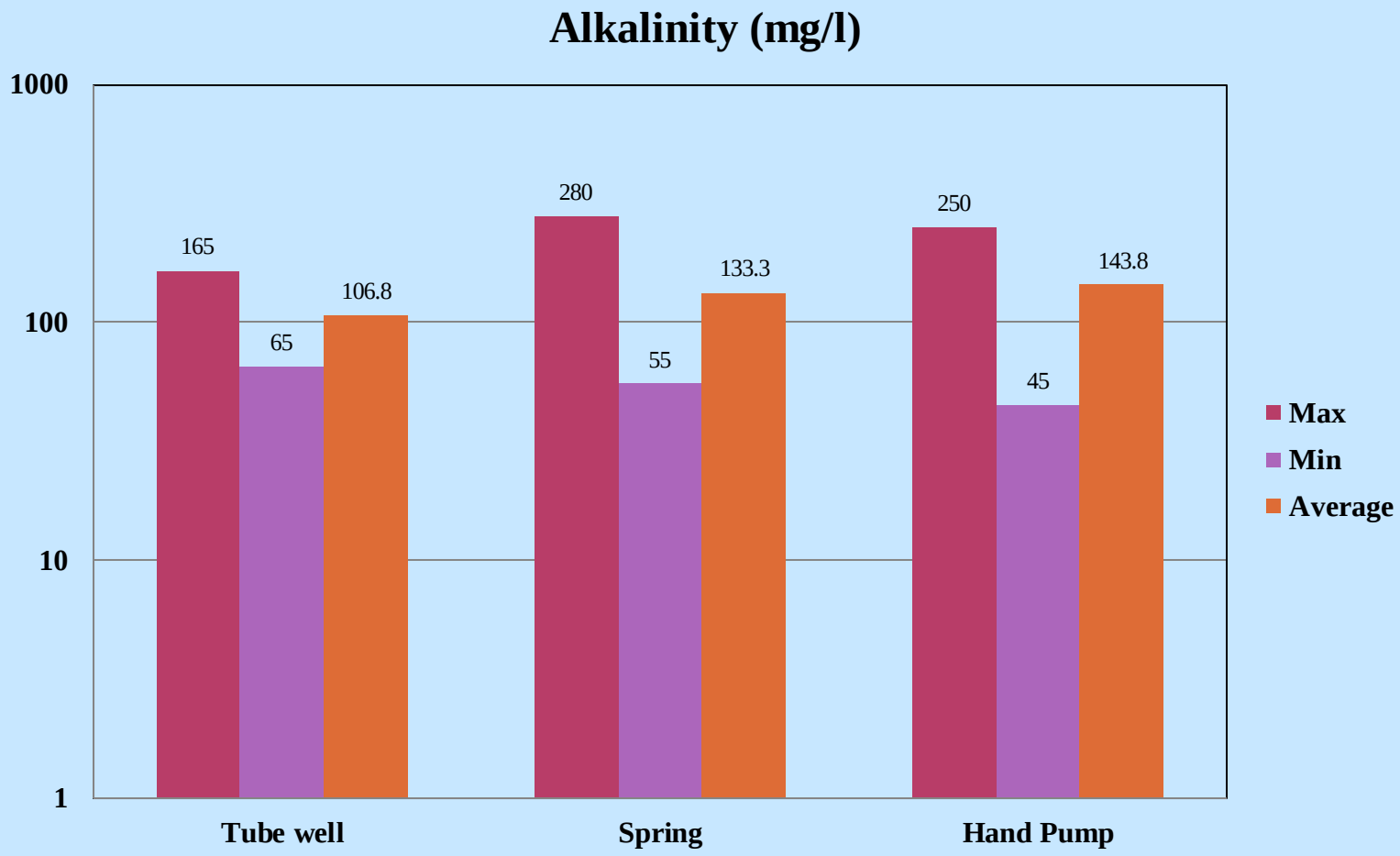
(Limit 250 -1000 mg/l)

Chloride of Water in Leh District



BIS Limit : 250 – 1000 mg/l

Alkalinity of Water in Leh District

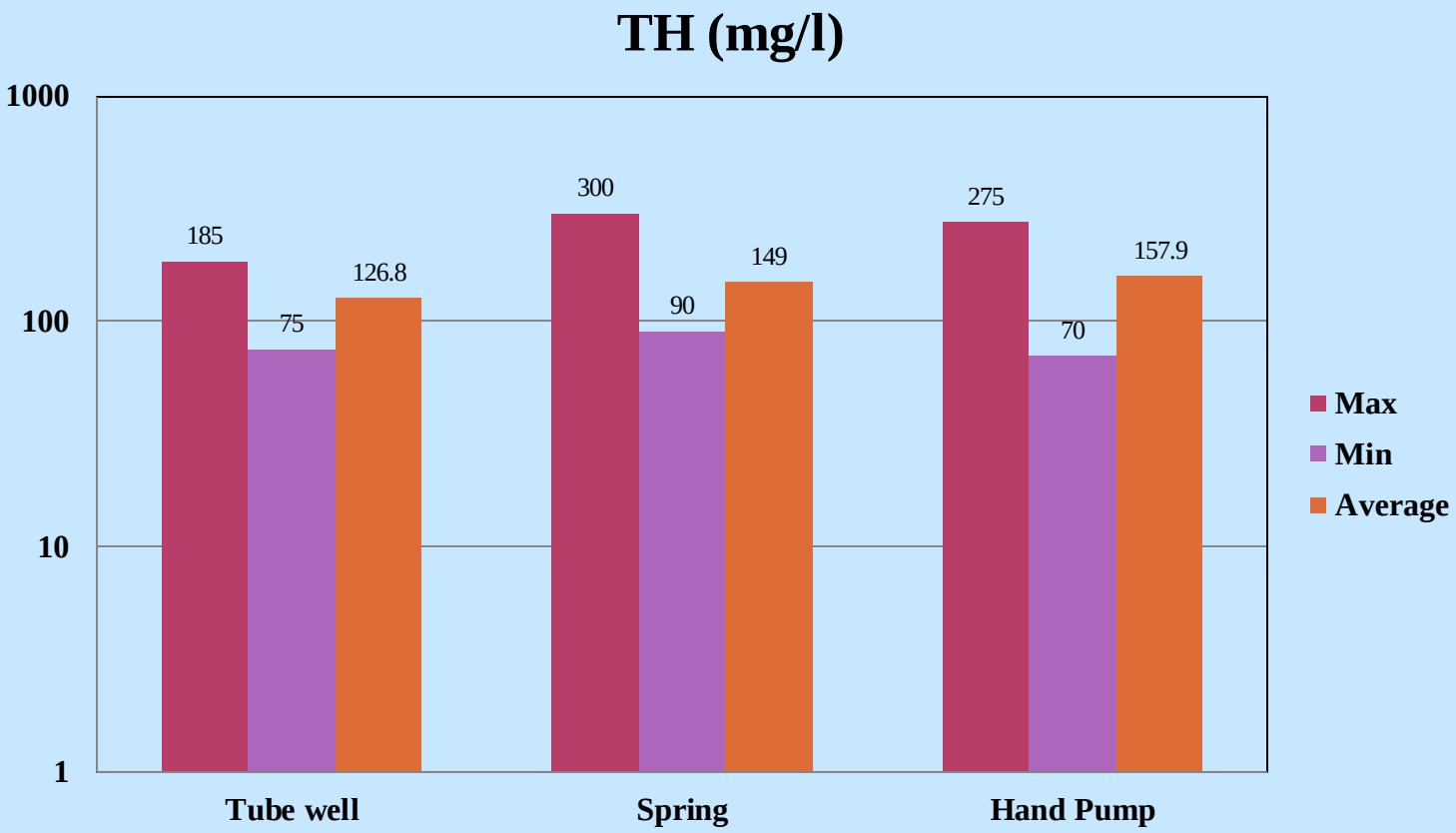


BIS Limit : 200 – 600 mg/l

Alkalinity

Values of P & T	OH	CO3	HCO3
P = 0	0	0	T
P<1/2 T	0	2P	T – 2 P
P = ½ T	0	2P	0
P > 1/2 T	2P - T	2 (T – P)	0
P = T	T	0	0

Total Hardness of Water in Leh District



BIS Limit : 200 – 600 mg/l

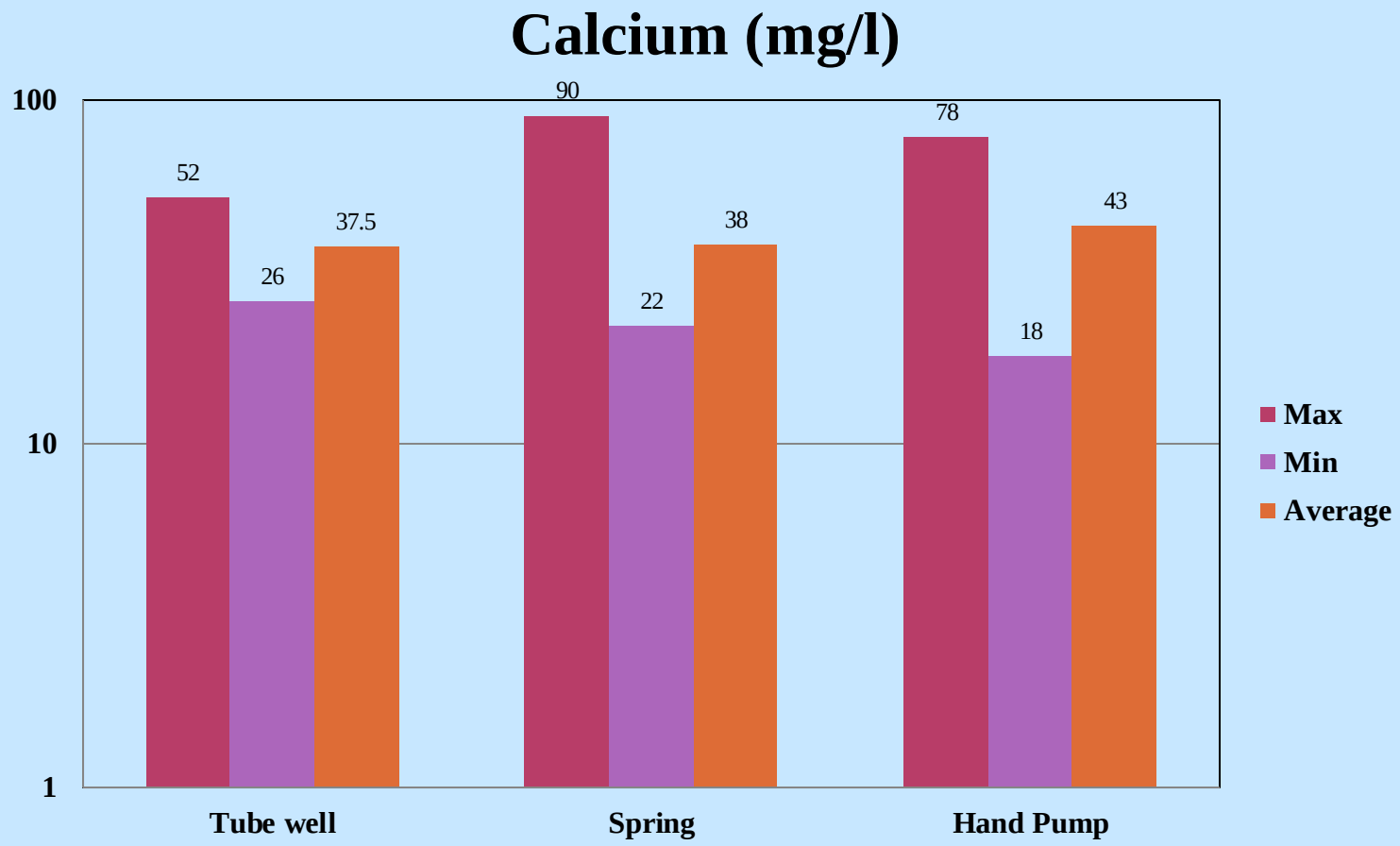
Hardness

Hardness Range (mg/L of $CaCO_3$)	**Water Category**
0-60	Soft
61-120	Moderately Hard
121-180	Hard
More than 180	Very Hard

Alkalinity vs. Hardness

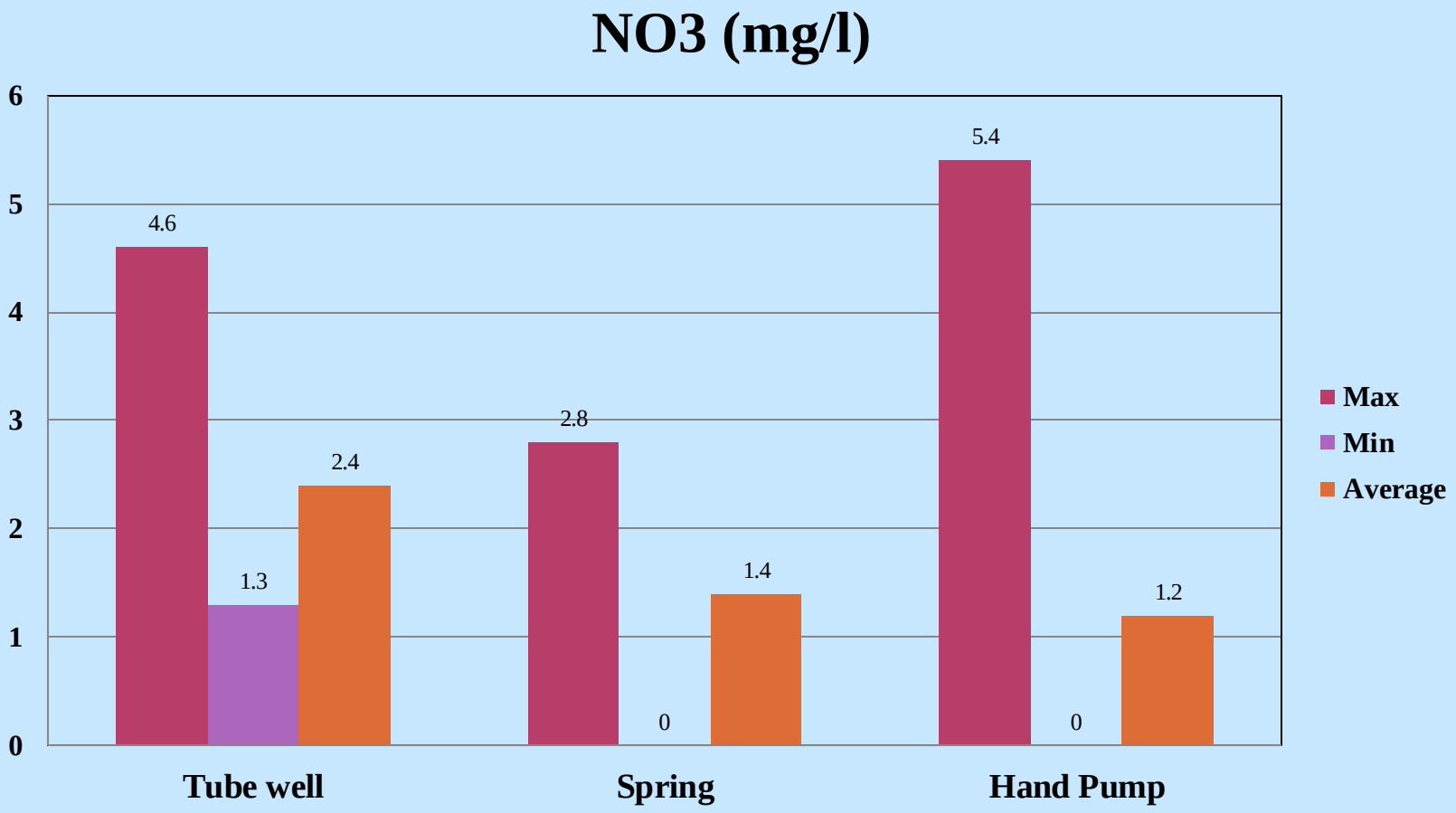
- Possibility of 3 cases
- Alkalinity = Hardness
  - Ca and Mg salts are present
- Alkalinity > Hardness –
  - presence of basic salts, Na, K along with Ca and Mg
- Alkalinity < Hardness –
  - neutral salts of Ca & Mg present

Calcium of Water in Leh District



BIS Limit : 75 - 200 mg/l

Nitrate of Water in Leh District

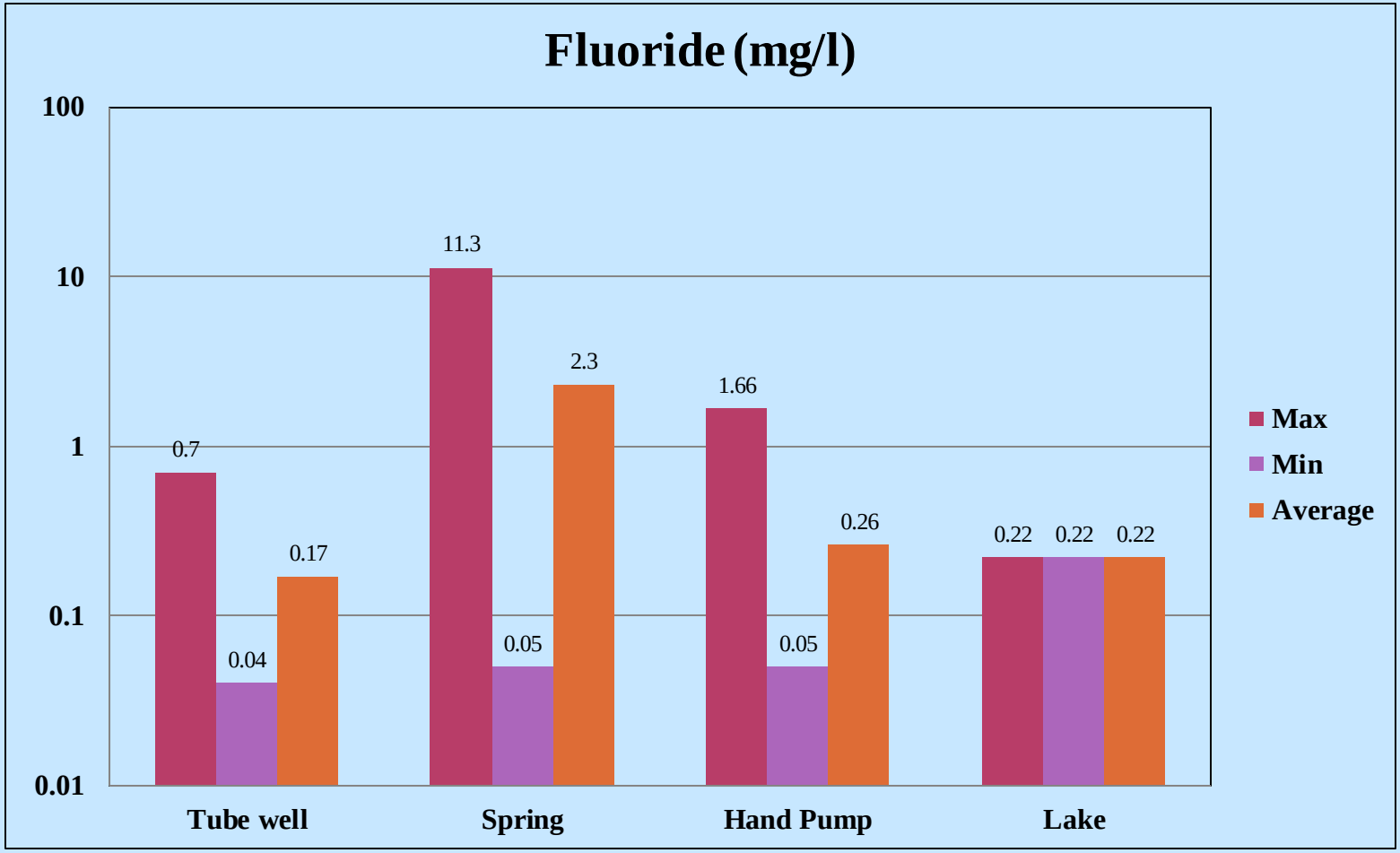


BIS Limit : 45 mg/l

Nitrate

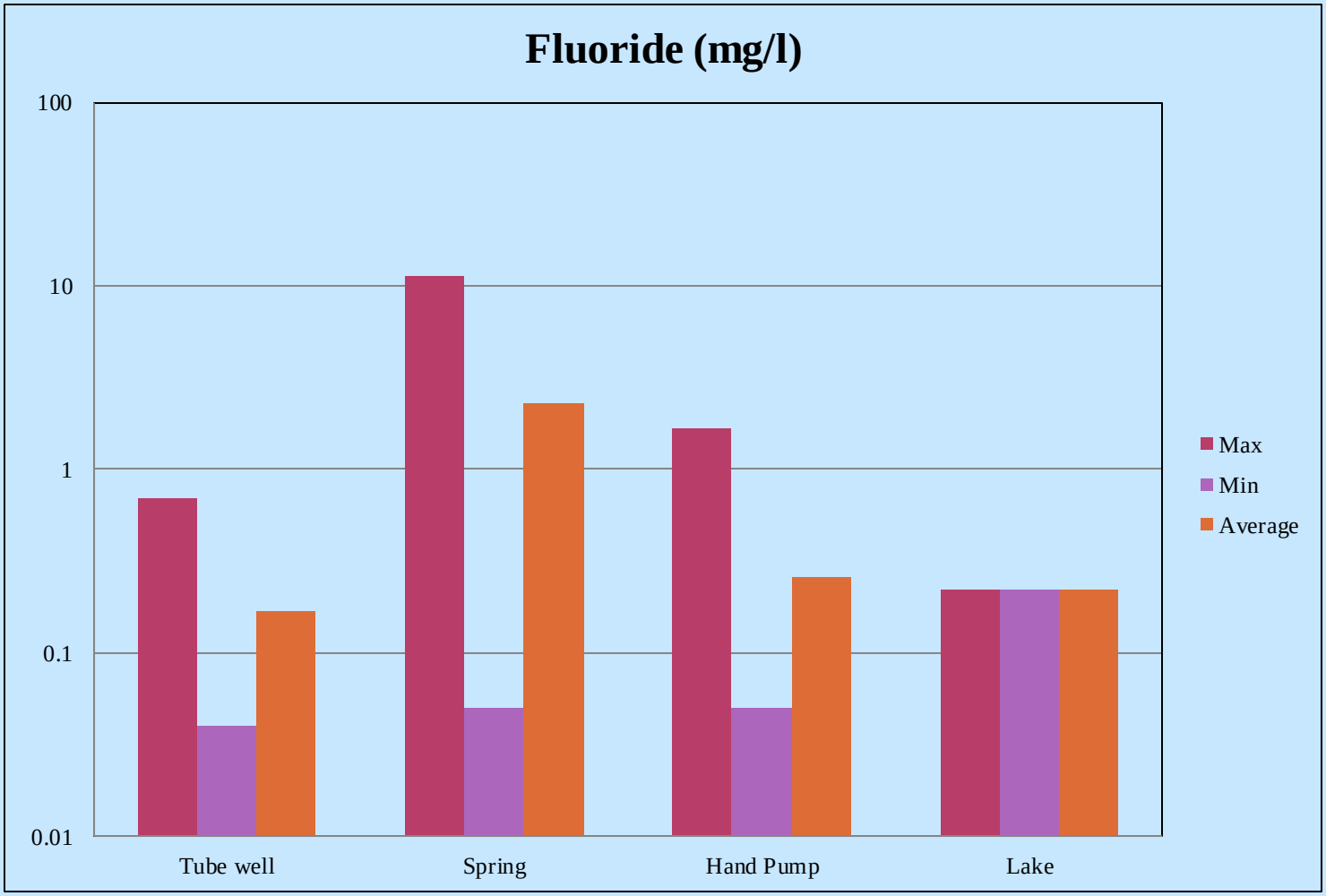
- Ingestion of NO_3 in drinking water has caused Methemoglobinemia (Blue Baby Syndrome) disease in infants under 6 months of age.
- This disease is caused by the bacterial reduction of Nitrate to Nitrite in the intestinal tract.
- The Nitrite then enters the blood-stream and combines with the hemoglobin to form methemoglobin, which reduces the blood's capacity to transport oxygen.
- Severe Methemoglobinemia may result brain damage and death.
- Prolonged intake of high level of Nitrate is linked to gastric problems due to the formation of nitrosamines in adult human. Nitrosamines compounds have been shown to cause cancer in test animals.

Fluoride of Water in Leh District



BIS Limit : 1.0 – 1.5 mg/l

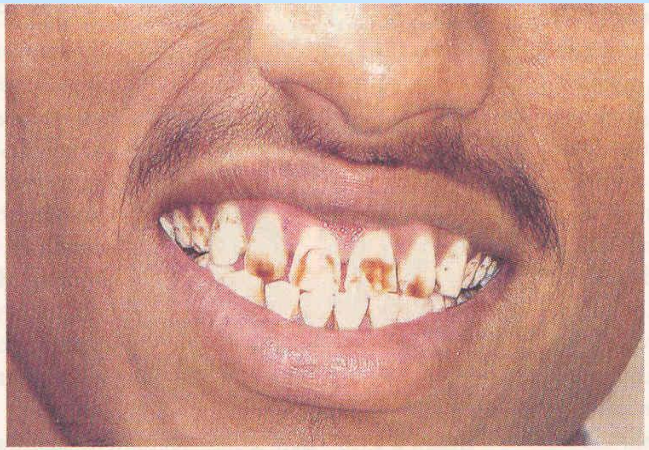
Fluoride of Water in Leh District



BIS Limit : 1.0 – 1.5 mg/l

Fluoride: BIS Limit - 1.5 mg/l in drinking water

Restriction of spine movements is an early feature of skeletal fluorosis



A victim of dental fluorosis

Even standing is very difficult for those with skeletal fluorosis

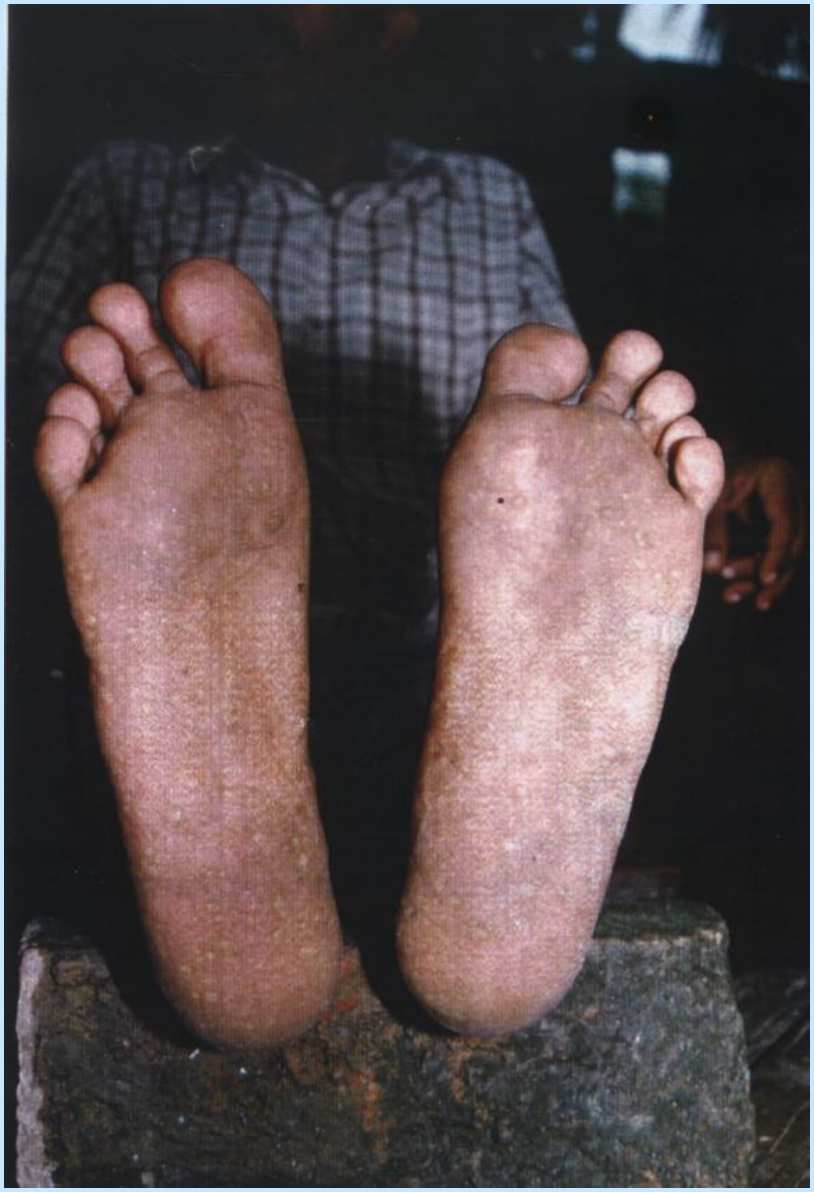
Aniket Alam

Arsenic:- As(III) is more toxic than As(V). Toxicity depends on state, route of transmission, dose and duration of exposure. Chronic exposure over the years leads to Arsenicosis (Dark Spots on skin, body, limbs, palms, soles with nodule formation) , Conjunctivitis, Liver enlargement, Chronic Cough, Ulcers, Gangrene and Cancer may result.100 mg single dose is enough for poisoning, takes 10 days for complete disappearance.

BIS Limit - 0.01 mg/l in drinking water

SKIN DISORDERS DUE TO ARSENIC POLLUTION

SKIN DISORDERS DUE TO ARSENIC POLLUTION



Arsenic

Patients with hyperkeratosis

TOXIC EFFECT OF ARSENIC

Photograph of one arsenic patient with severe diffuse and spotted keratosis

Photograph of an arsenic patient with suspected cancer

Ex-situ Remedial Measures

a) Precipitation processes Aeration causes oxidation and precipitation of iron. Arsenic may be removed by direct adsorption onto iron precipitate or oxidised by bacteria growing on filter

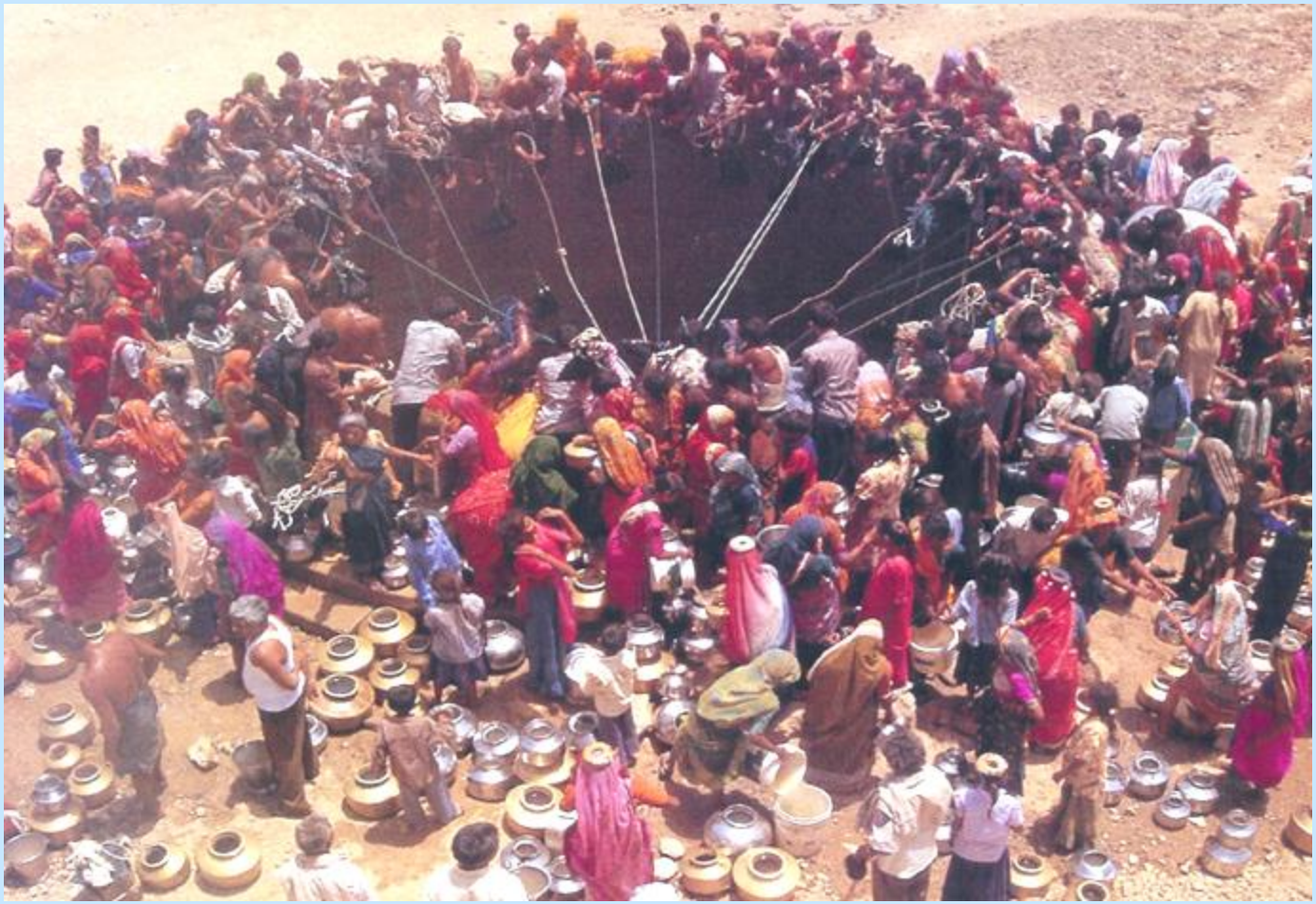
b) Adsorptive processes Adsorption of arsenic onto the surfaces of adsorbents such as activated alumina, synthetic iron hydroxides, iron oxide coated sands, greensand filtration, manganese oxides, titanium oxide, cerium oxide, biological adsorptive filtration and water hyacinth.

c) Ion-exchange processes Ion exchange resins are only effective for charged ions and so only works well for arsenic in the form of arsenates (As(V)).

d) Membrane processes Reverse osmosis and Nanofiltration.

e) Arsenic safe alternate aquifers Central Ground Water Board has come out with technology to construct Arsenic free wells tapping deeper aquifers.

A Fact of Life……!



Do You want This……..

SO, IF YOU DO'NT WANT THIS …

THEN…PLEASE

PROTECT,

CONSERVE

AND RECHARGE

GROUND WATER RESOURCES

Thanks