Water in Liveable Leh!

Report on **Water Supply and Usage** in the highest town of India

LEDeG

BORDA

Published by:
Bremen Overseas Research and Development Association, South Asia (BORDA-SA),
December 2019

ACKNOWLEDGEMENT

This report published by **BORDA-SA** and **LEDeG** was possible with generous inputs from **Public Health Engineering (PHE), Department of Leh.** BORDA-SA and LEDeG extend their gratitude to Mr Tsering Phunchok, Assistant Executive Engineer, PHE Leh and Mr Iftiqar Ahmad, Assistant Engineer, PHE Leh for providing valuable inputs.

AUTHORS

Parth Gohel, LEDeG
Iftiqar Ahmed, PHE
Tsering Punchok, PHE
Manas Rath, BORDA
Stanzin Tsephal, BORDA
Tatjana Schellenberg, BORDA
Thinless Dorjay, LEDeG
Snehit Parkash, BORDA
Salma V, Independent Consultant

Photographs

All photographs are courtesy of BORDA-SA unless indicated otherwise.
Front Cover : *Confluence of Rivers Indus and Zanskar, Ladakh*. Photo by AYANDRALI DUTTA on Unsplash

Design by: Studio Inspira, Mumbai, India and Twist Open Innovations, Bangalore, India
Printed in Mumbai, India

Printed on FSC-certified, recyclable, chlorine-free, wood-free paper

Water in Liveable **Leh!**

Report on **Water Supply and Usage** in the highest town of India

LEDeG

BORDA

རྒྱལ་པོ་དབང་རྒྱལ།
GYAL P. WANGYAL
Chairman/Chief Executive Councillor
(Status of Cabinet Minister)
(M) 9419178545
E-mail: gyalpw@gmail.com

LAHDC LEH

སྤྱི་དཔོན།
ལ་དྭགས་རང་སྐྱོང་རི་ཁུལ་ཡར་རྒྱས་ལྷན་ཚོགས། གླེ།
LADAKH AUTONOMOUS HILL DEVELOPMENT COUNCIL, LEH
LEH LADAKH - 194101 (INDIA)
Tel.: (O) 01982-252212 (R) 260360 Fax 01982-257187
E-mail: ceclahdc@gmail.com

2nd December, 2019

Forward

As Leh is becoming one of the most popular tourist destinations in India, and globally, it is urbanising rapidly to provide the services and experiences that tourists expects. With this urbanisation and population growth, has come the challenge of managing our environment and scarce resources, especially water, carefully and responsibly. Water security is one of the biggest concerns for people and the Government, as the complexity and scale of the issue will only grow with time.

I am very happy that LEDeG and BORDA, two organizations that for many decades have supported the sustainable development of Leh and well-being of our people, have conducted much needed research and are publishing this descriptive research report on water supply in Leh. PHE Leh has conducted a comprehensive app based survey in Leh City geo tagging all the consumers this summer to get a perspective on the situation of water supply in Leh. I am sure the survey report will be helpful in preparing the report.

Once this report is published, LAHDC Leh will encourage all stakeholders from Government, civil society and local businesses, to come together to analyse the research report and provide feedback, so that a follow up report can be published incorporating the views of all stakeholders. Secondly, I request that we deepen our understanding and also produce a roadmap on how to improve water supply for all people of Leh, particularly migrant workers and the economically weaker groups who are often excluded from good quality public services.

I commend and appreciate the pro-active role of the PHE Department who has engaged with civil society to produce this important piece of research, and request them to take the lead in analysing this report and preparing a roadmap for the future.

In the past, Ladakhi society has been very sustainable, self-sufficient and equitable. We must not lose these admirable characteristics of our culture, in our drive towards modernity. Economic development, social equality and environmental protection must all go hand-in-hand, for our culture to thrive in the next thousand years. Only in this way can we grow wealthy and successful in the truest sense.

My heartfelt congratulations to all involved in this effort. I look forward to reading the final report and participating in deliberations on this most important issue facing us today.

02/12/19
(Gyal P Wangyal)

Table of Contents

List of Abbreviations

AMRUT	Atal Mission for Rejuvenation and Urban Transformation
BMZ	Federal Ministry of Economic Development & Cooperation Germany
BOD	Biological Oxygen Demand
BORDA	Bremen Overseas Research & Development Association
BWC	Blue Water Company
CAPEX	Capital Expenditure
CDD Society	Consortium of DEWATS Dissemination Society
COD	Chemical Oxygen Demand
CPHEEO	Central Public Health & Environmental Engineering Organization
DPR	Detailed Project Report
EC	European Commission
FSM	Faecal Sludge Management
FSTP	Faecal Sludge Treatment Plant
HH	Household
HP	Horsepower
LAHDC	Ladakh Autonomous Hill Development Council
LEDeG	Ladakh Ecological Development Group
LPCD	Litres per capita per day
LPS	Litres per second
MCL	Municipal Committee Leh
MLD	Million Litres per day
MoHUA	Ministry of Housing and Urban Affairs
NGO	Non-Governmental Organization
NRDWP	National Rural Drinking Water Program
O&M	Operations and Maintenance
OPEX	Operations Expenditure
PHE	Public Health Engineering, a department
PSP	Public Stand Post (for collecting water)
RD	Running distance
RL	Reduced Level
Rs.	Indian Rupees
SR	Service Reservoirs
STP	Sewage Treatment Plant
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
TUM	Technical University of Munich
TW	Tube well

List of Figures

List of Tables

Executive **Summary**

This report describes various aspects of the drinking water supply system for Leh town. Even though water shortage is the leading concern and fear of people, and large water projects are being implemented, there is a general lack of information and clarity about water demand and supply, and management of water systems in Leh. The research team, other stakeholders, and experts, had varied opinions on this topic and also many ideas on how it should be improved or changed, but **the purpose of this report is to describe the system as it is**.

This report is meant to separate facts from fiction and opinions, and therefore, ideas and suggestions for the future have not been reflected in this report. We believe that once a shared factual basis is established across all key stakeholders in this matter, then ideas and opinions can be discussed in a more objective manner, to determine a path to improve water security and sustainability in Leh. **The research highlighted a few important facts and conclusions:**

1. **Leh is not facing water crisis, but a water management crisis**: This is a very important nuance. It has been reported in the media and the common perception is that Leh is facing water crisis—a scarcity of water. While we found that presently, water supply is inadequate in some parts of town and is sometimes disrupted, causing great inconvenience, there is no real shortage of water.

   On the contrary, the town has access to multiple sources of water which are being under-utilized. In fact, the town already has infrastructure to supply close to 8 MLD of water while water required is about 5 MLD (during the peak summer tourist season) but due to some gaps in the Leh water supply system, supply is only 2.1 MLD. By 2020, new infrastructure will increase the Leh water supply capacity to 12 MLD; the new pipe network will reach 5,800 households. Today's supply of 2.1 MLD is only 17.5% of its eventual capacity. Hence, **it seems to be a water management crisis, not a water crisis.**

2. **Excessive dependence on underground water which is becoming polluted:** Traditionally, snow melted water through surface streams, locally called *Yuras*, provided 90% of water used by people of Leh, and the remaining 10% came from natural springs. Today, however, 92% of domestic water is from underground sources, of which 70% is from Leh's aquifers. This water is being increasingly contaminated with biological and chemical contaminants, yet there is no effort or plan to monitor groundwater quality or any intense effort to prevent its pollution. This can lead to a **public health and a livelihood problem,** as the local economy is largely dependent on tourism.

3. **Inequity in access to water:** Our estimates

show while tourists and local residents get about 100 and 75 liters per capita per day (LPCD) respectively, **poor migrant workers get as little as 25-35 LPCD** which is insufficient for personal health and hygiene. Nearly 2,000 households depend on water tankers for daily supply that can be unreliable and unpredictable. Current water consumption is about 5.0MLD in summer and would increase to about 7.4MLD, nearly 50% higher, if everyone got enough water to meet their daily needs comfortably (water for gardening and construction, and extracted by the army is not computed here).

The report also points out some gaps that should be urgently addressed:

i **An Operating Cost problem:** While the new water distribution network has been built at a capital investment of Rs. 70.5Cr. (Rs. 20,033 per capita considering 2018 resident population of 35,200), the government's operating cost for providing water is likely to increase from Rs. 1.65 Cr. to Rs. 3.94 Cr per year or even higher, to run the new, expanded system. Current tariffs collect only Rs. 9.5 Lakhs, or under 6% of present operating cost. The higher operating cost will be a burden for the MCL and a new tariff structure has to be developed and implemented quickly to ensure funds are available for proper operations and maintenance, without which the service levels will be low and the system will not be properly operated, reducing its effective lifespan.

ii **Ineffective Water Pricing and no water meters:** Currently, the town charges a fixed tariff per household or commercial customer. While one problem is that the tariff is too low, the bigger problem could be that fixed pricing creates no incentive to save water. Volumetric pricing is the fairest way to charge people as everyone pays for how much they use, and special incentives can be offered through pricing and discounts, to encourage saving water.

For this, however, meters need to be installed in pipelines (to track leakages) and at

customer locations (to track usage for billing). However, no steps have been taken so far to test and evaluate meters that can work in the cold and extreme climate of Leh. The cost of procuring and installing them would be another challenge to overcome.

iii **Huge water losses:** As much as 25% of water supplied by the PHE may be lost due to pipeline leaks and overflowing storage tanks, but cannot be monitored or reduced without water meters in pipelines and at the customers' end. This indicates a loss of about Rs. 40 Lakhs per year, considering total cost of water delivery is Rs. 1.65Cr.

iv **No effort to save water:** There are no visible, concerted efforts to reduce consumption and eliminate wastage of water, even by large users such as hotels.

v **Whose job is it anyway?:** Currently, the PHE and MCL share vaguely defined responsibilities of operating the water system, without a stable and qualified team that is held responsible for its long-term management. The experience of other Indian towns shows clearly that water systems degrade quickly due to lack of accountability, budgets and technical expertise. Taking these lessons, Leh should decide on an appropriate management model for its new water supply system.

Thus, it is clear that while Leh may not face an imminent water crisis, there are several hurdles to cross before Leh has an equitable, safe, reliable and financially sustainable water supply system.

The last chapter of this study summarizes the key findings of this research. Due to lack of data and limited time frame to complete this study, we expect debate and feedback about the information here. We look forward to feedback, which will help strengthen this report before its next version is released in 2020.

01 | Background

Leh town located in the rocky terrain of the majestic Himalayas is the highest major habitation of India—and one of the largest towns globally above the altitude of 3,500 meters. Situated in the Union Territory of Ladakh, which until August 2019 was a district in the state of Jammu & Kashmir, it is one of the coldest places in the world with winter temperature reaching -30^{0}C, due to which it is isolated for almost five months of the year. The Ladakh region is also very dry, a cold desert, with under 100mm of precipitation every year, and over 300 days of bright sunlight.

The Public Health Engineering Department (PHED) operates the water supply systems in Leh. Water is a vital resource in this region, and access to water is the top concern for people. In a 2017 survey by local NGO LEDeG, 73% of people said they were concerned or very concerned about quantity of water available in the future. Increasing demand for water, changing climate patterns along with natural disasters, and risk of water contamination due to faecal waste, have created a fear about safe access to water in the future – both in terms of quality and quantity. Addressing these issues is a major challenge for local authorities.

The '**Liveable Leh**' project, co-funded by the European Commission and Federal Ministry of Economic Development and Cooperation, Germany (BMZ), aims to strengthen capacities of the local government to make Leh more inclusive, environmentally friendly, resilient and economically robust, so it becomes a symbol of sustainable urban development that serves the needs of all its residents, especially the poor, while building a diverse economy.

Therefore, as part of the Project, this report studies the entire water system, covering water sources, storage capacities, supply systems, demand, and institutional mechanisms that manage the water supply system of the town. The aim is to clarify and quantify the water supply situation, which has created worries and fears due to lack of clear data and information.

Leh is a major defense outpost and while the Army has its own water infrastructure, its facilities and personnel use the common underground water resources. This report excludes water used by the Army and its impact on water security, as this data is not available and Leh's local administration is not responsible for supplying water to the Army.

1.1 About Leh

Leh District:

The Ladakh Union Territory has two districts, Leh and Kargil. Leh district is in the north-eastern corner and is the second largest district of India with an area of 45,100 km^2. It is a cold desert with temperatures rising to 35°C in the summers and falling to as low as -24°C in the winters, and below -30°C with wind chill. The average elevation of the district is between 2,900m to 6,000m above mean sea level. The region is ecologically sensitive and diverse with mountains and several rivers and streams covering the landscape.

Leh Town:

The district and its main town share the same name. The town has 13 municipal wards with a total resident population of 30,870 (2011 census), and current population is estimated at about 35,200.[1] The municipal area is ~9 km^2 with an average population density of 3,888 persons/km^2. There are peri-urban towns and villages just outside the town's municipal boundaries, whose people often work in Leh and share natural resources with the town. The total internal road network is 163 km long. The literacy rate is high at 90% and most people are engaged in hospitality service and self-employment. The major driver of the town's economy is tourism.

The Ladakh Autonomous Hill Development Council (LAHDC)—Leh is the highest politico-administrative body of the district and town. The Municipal Committee, Leh (MCL) is the urban local body that provides some basic services and administers Leh town. The MCL had its first ever municipal elections in 2018. Presently, it has a small budget and limited staff that are inadequate to properly manage the urban infrastructure and services for the town. Only about half of MCL's budget is earned through local taxes and tariffs, while the rest is received as grants from the State Government.

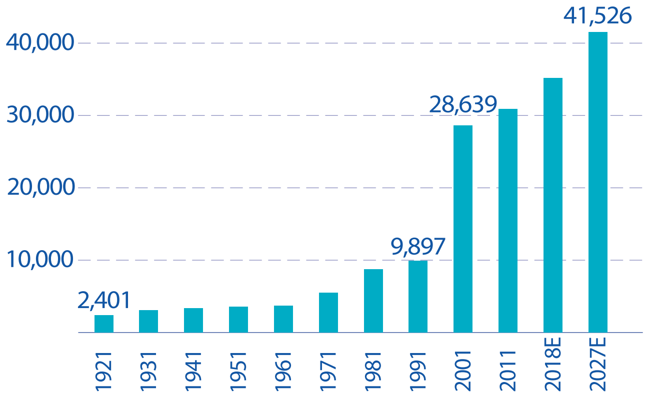
1 Authors' estimate

1.2 Summer Population

Residents:

From 2,401 residents in 1921, the population increased to 30,870 in 2011. The current population is estimated at 35,200 but an exact figure is difficult to arrive at due to significant rural-urban migration within Leh district particularly from nearby villages, in the summer.

Figure 1:
Population Growth of Leh Town, Census of India

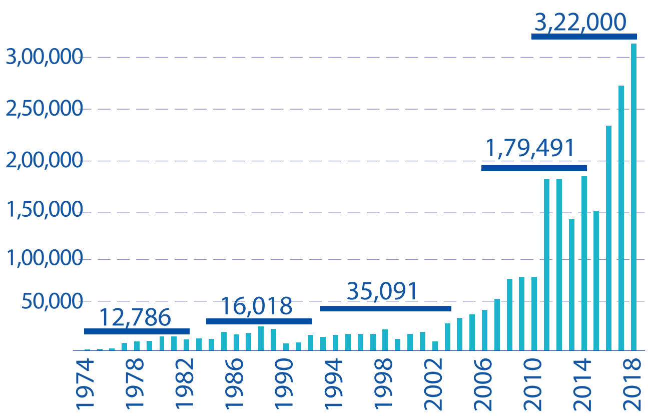


Note: The sharp jump in population from 1991 to 2001 is partly due to expansion of administrative boundaries of the town.

Tourists:

In the last decade, there has been a sharp increase in the number of foreign and domestic tourists visiting Leh during the peak season from May to September. According to the Tourism Department, 277,255 tourists visited Leh in 2017 and around 322,000 in 2018 (Figure 2), while in 2007 only 54,346 tourists visited—a 6x growth in 11 years, or annualized growth of 18%. A tourist spends around 4 days in Leh. Therefore, on any day during the summer season (May-September), around 8,587 tourists are in town (= 322,000 visitors * 4 days per visitor/150 days of tourist season).

Figure 2:
Tourists visiting Leh, Tourism Department



Migrant Workers:

Tourism has led to a construction boom in hotels (people are developing their property into hotels and guest houses) and infrastructure (roads, water and sewerage networks etc), as well as created demand for hotel and restaurant staff, shop assistants, drivers etc. There are no exact figures, but local authorities estimate that about 100,000 migrant workers come to Leh each summer of which 50,000 stay in Leh town. This is larger than the local resident population.

About 25,000-30,000 army personnel are stationed in Leh or in transit from other parts of Leh and Kargil districts on any given day. Even though MCL or PHE are not responsible for supplying water to the armed forces and their share of water consumption is not taken for computation in this report, the fact that a large amount of groundwater is being withdrawn by the army deserves attention.

1.3 Winter Population

Residents:

In winter (mid-October to mid-April), many local residents either go back to their village home or temporarily move out of Leh to places like Jammu, Chandigarh and New Delhi to avoid the cold. As per a Detailed Project Report (DPR) by the PHED, 12-14% of the local population move out, though this figure could be 20-25%.

Tourists:

In the past, no one visited in Leh in winter. Now, the Chadar trek in Zanskar valley does attract adventure tourists, so perhaps 200-300 tourists are in Leh on any given day during winters and very few hotels and shops remain open.

Migrant Workers:

Workers arrive in early April as most construction work commences during this period. The work continues till middle of November after which workers leave for other places to seek work.

Figure 3:
Peak Summer Population

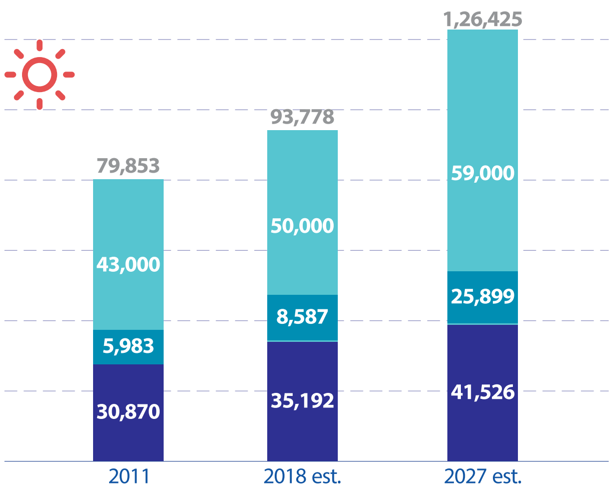


Figure 4:
Winter Population

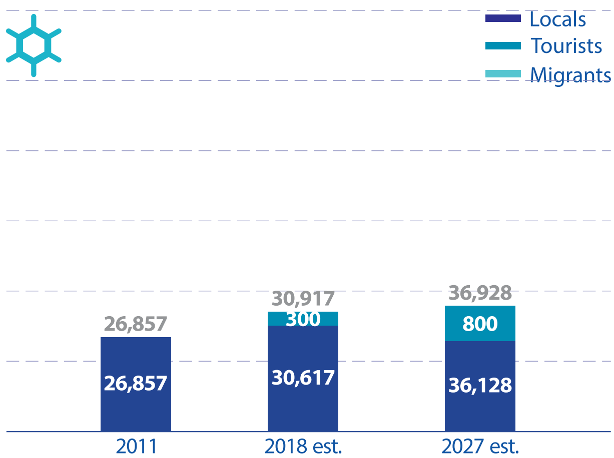


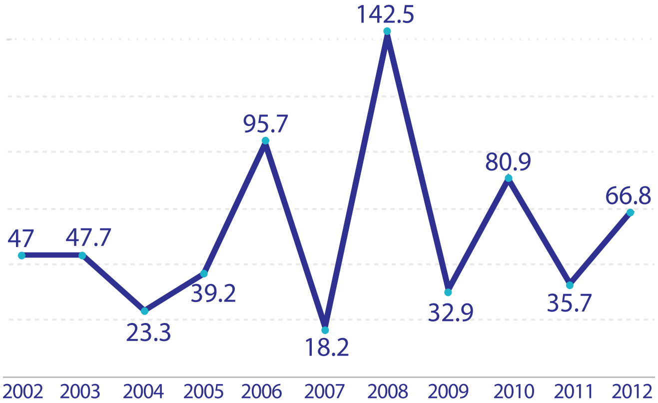
Table 1:
Summary of seasonal variation in population

Category	Summer			Winter		
	2011	2018E	2027E	2011	2018E	2027E
Locals	30,870	35,192	41,526	26,857	30,617	36,128
Tourists	5,983	8,587	25,899	-	300	800
Migrants	43,000	50,000	59,000	-	-	-
Total	**79,853**	**93,778**	**1,26,425**	**26,857**	**30,917**	**36,928**

1.4 Climate Conditions

Ladakh has more than 300 sunny days in a year with a high average solar radiation of 6.44 kWh/sqm/day.[3] Being a cold desert, the area has low vegetation and resultantly low humidity levels as well. With intensive sunlight and low moisture contents, the evapotranspiration[4] rate in this area is high. The annual precipitation in Leh is less than 100mm on average. There are also high annual deviations ranging from 142.5mm to only 18.2mm in 2007 as illustrated below in Figure 5.

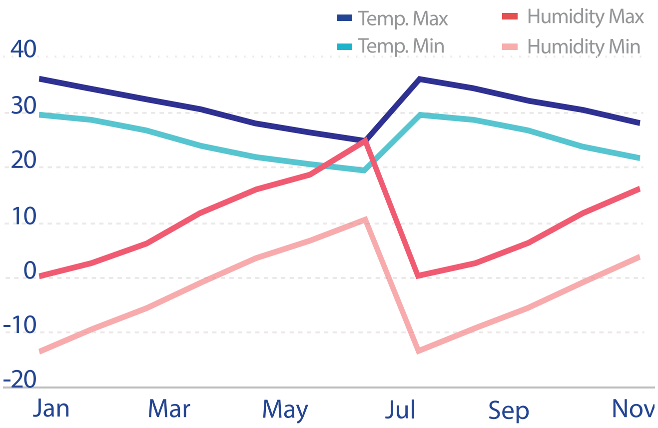
Figure 5:
Annual Rainfall of Leh area**2002 to 2012**
Source: Meteorological Department, Indian Air Force Station, Leh;



Traditionally, water resources were mainly a result of melted snow water forming rivulets merging into streams in the valleys of this region. This abundant surface water supply from glaciers has given these dry areas reserves of ground water as well because the soil in Leh is highly porous and coarse grained in nature.

1.5 Hydrogeology of Leh

Figure 6:
Temperature and Humidity in 2015, Leh
(Source: Handbook LAHDC, data by Defense Institute of High-Altitude Research C/o 56 APO)



An independent study conducted by Balamurugan et al in 2017 highlights the following key points about the Leh catchment area, which is different from Leh municipal area. (as shown in fig 7)

1 The cultivable land in upper parts of Leh town has very high groundwater reserves, as the soil strata facilitates high percolation of irrigation water and recharges the underground aquifer.[5]
2 Majority of the Leh catchment comprises of rocky terrain unsuitable for agriculture and groundwater extraction.
3 Only 3.2% of the total catchment area of Leh has scope for groundwater extraction (highlighted in purple).

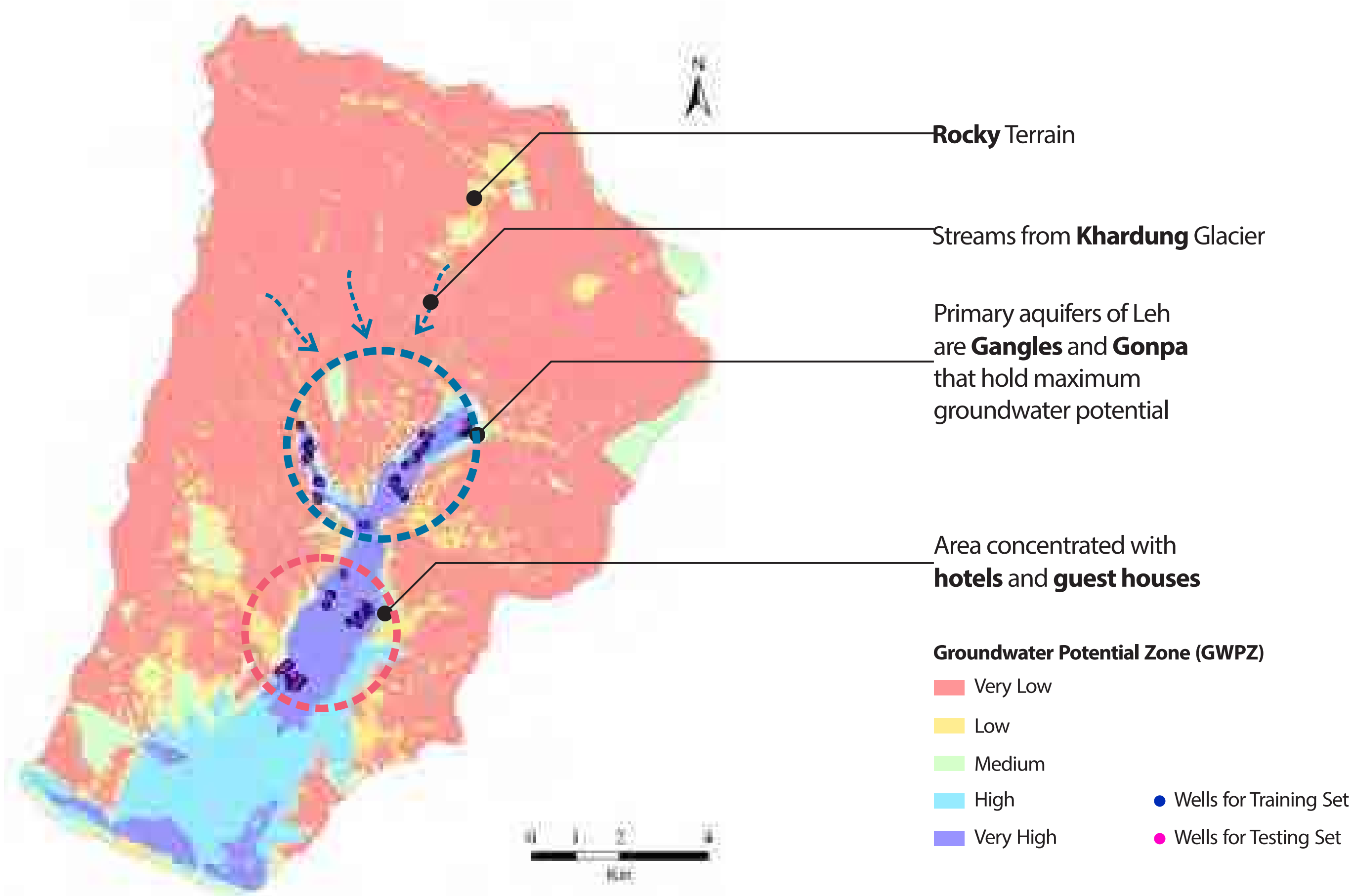
Given that only a small area has good groundwater potential, the hydrogeology must be studied more carefully to fully understand the dynamics of this source, especially as 60% of water is drawn from borewells and tubewells in the city.

3 Synergy Enviro Engineers, Hyderabad 2018

4 Evapotranspiration is the process by which water moves from the earth to the air through evaporation and transpiration is the water lost through evaporation from the soil or transpiration from the leaves

5 Aquifer is an underground layer of water-bearing permeable rock, fractures or unconsolidated material. Water can be extracted from aquifer by drilling tube wells.

Figure 7:
Groundwater Potential Zone of the Leh Valley Catchment
(Balamurugan et al., 2017)



Key Takeaways

Leh's **hydrogeology** needs to be better understood, as **groundwater** is an important water source and must be **sustainably managed**.

The number of **tourists** and **migrant workers** is much higher than the **local population** during summer months.

As a **cold desert** with **little precipitation**, and being affected by **climate change**, adequate **water supply** is a key concern of residents of Leh.

02 | **Demand** for Water

Water consumption is influenced by availability of water. As per the Central Public Health & Environmental Engineering Organization (CPHEEO) of Government of India, in urban towns with access to underground sewerage network, an average individual requires 135 liters of water per day for comfortable and healthy living: (refer Table 2 for breakup).

Table 2:
Water Usage per person per day, IS 1172: 1993

Category of Use	Water Needed (liters/day)
Drinking	5
Cooking	5
Bathing	55
Washing clothes	20
Washing utensils	10
Floor washing	10
Flush	30
Total requirement/day	**135**

This does not include water for gardening or washing vehicles, and does not include commercial demands such as restaurants, shops and offices, construction, industry or agriculture.

In Leh, water availability is limited. According to Akhtar et al, and as per our own observations, during summer, locals use about 75 Liters of water per day, tourists use 100 L/day and migrants get only 25-35 L/day. In winter the consumption decreases with locals and tourists at 50L and 60L per day respectively. The daily water usage of different categories of users across seasons is estimated below.

Table 3:
Comparison of Water Usage across Users and Seasons

	Summer		Winter	
Type of User	Current usage	CPHEEO	Current usage	CPHEEO
Locals	75 L	135 L	50 L	135 L
Tourists	100 L	135 L	60 L	135 L
Migrant Workers	30 L	135 L	-	-

Based on current usage, **the total summer and winter domestic water usage in2018 is 5.0 and 1.6 MLD[6] respectively.** Applying CPHEEO standards, the total summer and winter domestic water requirement in 2018 would be 12.7 and 4.2 MLD respectively. In above computation, water extracted by army and used for agriculture and construction is not taken.

If we assume that given the climate and lifestyle of Ladakhis, that Residents and Tourists ideally need 100 LPCD while Workers need 60 LPCD, then the summer water requirement will be 7.4 MLD, 48% higher than current usage.

As discussed later, due to losses from pipelines and wastage by users, the actual water supplied / extracted is higher than the water consumption estimated above.

Table 4:
Current Water Usage

	Summer			Winter		
Category	**Population**	**LPCD**	**Usage (MLD)**	**Population**	**LPCD**	**Usage (MLD)**
Residents	35,192	75	2.64	30,617	50	1.53
Tourists	8,587	100	0.86	300	60	0.02
Workers	50,000	30	1.50	0		
Total	**93,778**	**53**	**5.00**	**30,917**	**50**	**1.55**

Table 5:
Water Requirement based on **CPHEEO standards**

	Summer			Winter		
Category	**Population**	**LPCD**	**Usage (MLD)**	**Population**	**LPCD**	**Usage (MLD)**
Residents	35,192	135	4.75	30,617	135	4.13
Tourists	8,587	135	1.16	300	135	0.04
Workers	50,000	135	6.75			
Total	**93,778**	**135**	**12.66**	**30,917**	**135**	**4.17**

Table 6:
Ideal Water Requirement to meet needs comfortably

	Summer			Winter		
Category	**Population**	**LPCD**	**Usage (MLD)**	**Population**	**LPCD**	**Usage (MLD)**
Residents	35,192	100	3.52	30,617	60	1.84
Tourists	8,587	100	0.86	300	60	0.02
Workers	50,000	60	3.00		-	
Total	**93,778**		**7.38**	**30,917**		**1.86**

6 Million Liters per day, 1 million = 10 Lakh

Key Takeaways

Water usage is constrained by **availability**, particularly for the **poorest** who get as little as **25-35 liters per day**.

Total water used for **domestic purposes** (excluding gardening and construction) is about **5.0MLD** in **summer** (peak tourist season), or **53 liters per person per day**—actual demand may be **7.4MLD** or even higher if everyone used enough water to comfortably meet their needs.

Water consumption in **winter** is only **1.55MLD** due to much lower population and lower consumption per capita due to cold weather.

03 | Water **Sources**

3.1 Water Quantity by Source

Traditionally, 90% of residents depended on snow melted water in the form of surface streams, locally called *Yuras*, and extracted the remaining 10% from *Natural Springs.* Today, however, in Leh, approximately 90% of domestic requirement of water for the town is from underground sources.

Leh gets its water from **five** major sources:

I. Surface Water Sources
(~10% of Water Supply)

1. **Natural Springs**
   - ***a. Gyalung***
   - ***b. Gangles***
   - ***c. T-Trench***
2. **Surface Streams**

II. Groundwater Sources
(~90% of Water Supply)

3. **Public Tube Wells in Leh**
4. **Private Tube Wells**
5. **Indus River Tube Wells** (8km away)

I. Surface Water Sources

1. Natural Springs:

a. Gyalung Spring
Located in the upper part of Leh on the way to Khardung La pass (elevation 17,600 feet), it is the oldest spring in Leh town. The melted water from the Khardung glacier flows down to the Lamdon Service Reservoir, from where it is released under gravity to Public Stand Posts (PSP) and Household (HH) taps in Khakshal and some parts of Gonpa. The daily discharge is about 0.2 MLD.

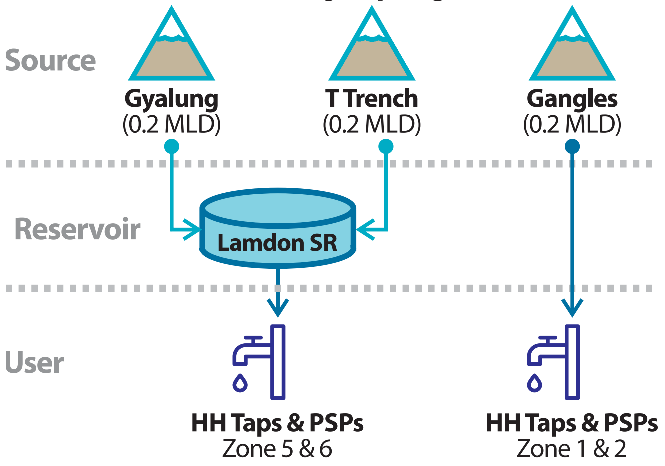
b. Gangles Spring
Located behind Gonpa monastery, this source supplies water to Gonpa village. The total discharge from this source is ~0.1 MLD. The water from the spring is transferred to a storage tank from where the water is supplied primarily through Public Stand Posts.

c. T-Trench
It is the second oldest source of water for Leh town, also located in the Gonpa area. The trench is T-shaped (hence the name), about 200 x 50 feet with depth varying from 10-15 feet. It gets water from multiple underground springs, and average discharge is ~0.2 MLD. The trench act as a storage reservoir and the water is transferred to Lamdon reservoir for further distribution to Chubi, Lamdon, Chutey Rantek and old Leh.

The total discharge of all spring sources is about 0.5 MLD or 10% of the current usage.

Exact data about daily water quantity from each source is not maintained and hence variations through the year and over time cannot be accurately studied. The general sense is that water from springs has been decreasing gradually.

Figure 8:
Schematic diagram of
Water Distribution through **Spring sources**



2. Surface Streams:
Until about 10-15 years ago, streams that flow throughout Leh had been the traditional source of water for a majority of residents. As these streams are now largely obstructed (by construction, debris and roads) or polluted (due to unregulated discharge of wastewater from restaurants and guesthouses, and solid waste), people have reduced dependency on them and have limited usage mainly to irrigation and washing clothes—which further pollutes the water.

II. Groundwater Sources

The other 90% of water supply is met by underground sources in and outside Leh. As underground water is not visible, it is harder to understand, monitor or use in a sustainable or responsible manner, commonly resulting in over-extraction and surprises when the level suddenly falls or aquifers go dry.

3. Public Tube Wells in Leh:
There are eight public tube wells located across Leh that are owned and operated by the PHE Department. Two of these (Sankar and Murtsey) are primarily used for filling eight water tankers operated by PHE to serve areas without pipelines or public taps.

About 2.05 MLD is extracted and supplied from these tube wells, from where it is pumped to Service Reservoirs (SR) and then supplied under gravity to various localities through PSPs and household connections.

These tube wells were developed during the old Leh water supply scheme in the mid-1990s. As per PHE, these tube wells will continue to supplement the new water supply scheme from the Indus river (described below).

In winter, the extraction from public tube wells drops significantly and only Sankar and Murtsey tube wells are operational.

The quantity of water supplied can vary each day depending on how long the pumps are run. The PHE does not measure or track the daily water quantity. These volumes were estimated based on direct observations by this project team.

Table 7:
Details of **PHE Tube wells** in Leh

Parameter	Pump Capacity	Number	Hours	Discharge (LPS)	Est. Quantity(MLD)
Murtsey TW (Tanker)	52 HP	1	12	10	0.43
Khakshal TW	33 HP	1	12	8	0.35
Tukcha TW	33 HP	1	12	8	0.35
Jumabagh TW	10 HP	1	9	6	0.35
Lamdon TW	10 HP	1	9	6	0.19
Sankar TW (Tanker)	10 HP	1	7	6	0.15
Badami Bagh TW	10 HP	1	9	6	0.19
Skara TW	10 HP	1	9	6	0.19
Gompa TW	25 HP	1	9	10	New
Total					**2.05**

4. Tube Wells on banks of Indus river:

Under the new water supply project that is currently being further expanded, the banks of the river Indus have been considered a sustainable source of water for Leh town's current and future requirements.

A total of 5 tube wells were planned along the Indus river banks in Choglamsar (a peri-urban village 7 km from Leh) under the old water supply scheme in the mid-1990s. Currently, three of the five tube wells (2 for Leh and 1 for Choglamsar) are in operation.

Water from these tube wells is lifted from a depth of 120 feet below the ground and then transported through rising main pipes to reservoirs across Leh town, up to 9km away at elevations of up to 400 meters. The water is lifted in four stages from Choglamsar to Skampari villages through a 250mm diameter Mild Steel (MS) rising main pipe (as shown in figure 9).

The total water extracted and supplied through Indus tube wells is 2.10 MLD, contributing to about 32% of total water supply.

The PHE department will develop additional tube wells along the Indus river banks in 2019-21 to achieve peak supply capacity of 12.8 MLD as recommended in its DPR.

It is proposed that the water from stage 4 Skampari would be lifted up to Khakshal Service Reservoir via Lamdon Service Reservoir. This part of the network has not been built yet.

Figure 9:
Indus Water Supply **Lift Scheme**

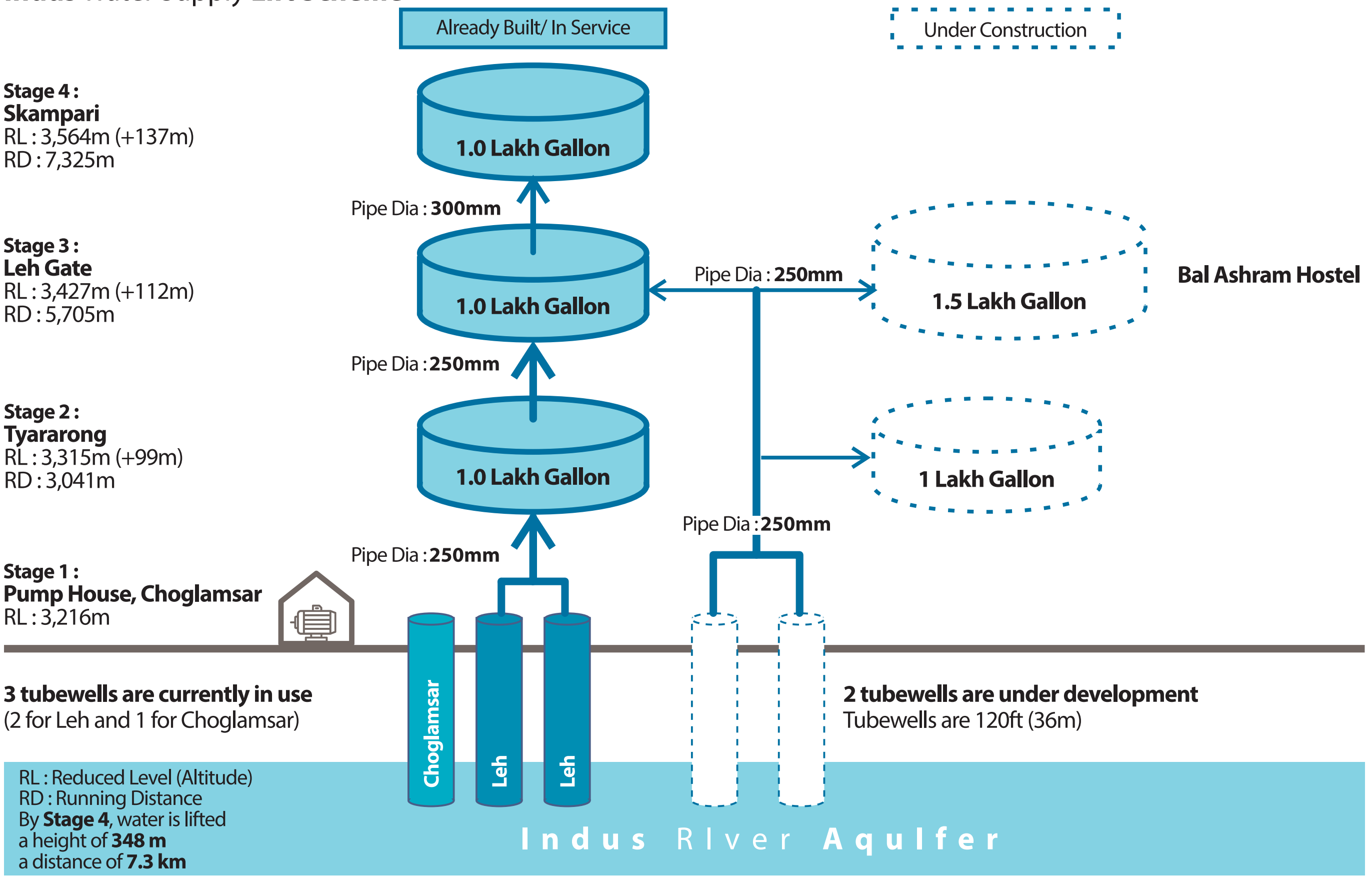


Table 8:
Details of **PHE Tube wells**at **Indus Banks**

Parameter	Pump capacity	Number	Pumping Hours/day	Discharge (LPS)	Quantity (MLD)
Choglamsar Stage 1	65 HP	2	16	18	2.10
Tyararong (Manali Road) Stage 2	75 HP	2	16	18	2.10
Leh Gate (Manetselding) Stage 3	65 HP	2	14	12	1.21*
Skampari Stage 4	Last point (No further pumping)				

***The balanced 0.86 ML of water is supplied directly to citizens near the Tyararong area.**

5. Private Tube Wells:
No permit or fee is required to dig a borewell in Leh. Hence, there is no consensus on the number of private tube wells within the Leh municipal boundary, but estimates and discussions with tube well drillers suggest that hotels, guesthouses and homes have drilled 1,200 - 1,700 borewells to supplement the PHE's supplies.

There are around 515 hotels and guest houses with a cumulative bed capacity of 9,980 beds registered with the Tourism Department. Almost all of these have at least one borewell and many have more than one. Many households also have borewells to augment PHE's water supply for domestic and agricultural purposes, or for convenient supply in winter.

Table 9:
Estimate of **Water Extracted by Private Borewells**

	Category	MLD
a.	Water from Indus tubewells	2.10
b.	Water from PHE tubewells in Leh	2.05
c.	Water from Springs	0.55
d.	**Total (a+b+c)**	**4.70**
e.	Losses @ 25%*	1.17
f.	Net Water supplied by PHE (d-e)	3.53
g.	Current water usage	5.00
h.	Hence, water from private borewells (g-f)	1.47
i.	Wastage of water from private borewells (8%)	0.13
j.	Water extracted from private borewells	1.60

Thus, water from private borewells is seen as a balancing factor between total water usage and water supplied by the PHE. Adding water required by construction and for gardening will increase the estimate of water extracted through private tubewells.

* Significant water losses happens from the public stand posts and from leakages in distribution pipe network. Water losses in the rising mains are negligible as water is lifted from the Indus tube wells at high pressure and any major leak could burst the pipe. Water drawn from private borewells has low wastage (estimated 7-10%) primarily from overflowing storage tanks.

Summary:

The total water extracted from all public water sources is 4.7 MLD but about 1.17 MLD is estimated to be lost due to leaking pipelines and PSPs. The water extracted from private tube wells is 1.6 MLD and most of this water is used except for some overflow from storage tanks. With a peak population of 94,433, a person gets an average of 54 liters of water per day, but this varies widely from 75-100 LPD for locals and tourists, to 25-30 LPD for migrant workers and the poor.

Figure 10:
Sources of Water in Leh

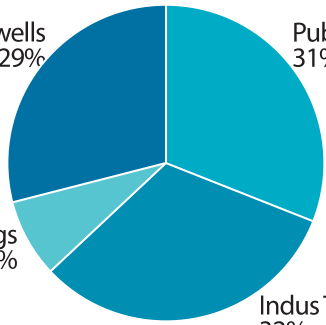


Table 10:
Summary of **Water supplied by Various Sources**

Source	Water Extracted (MLD)	Estimated Wastage (MLD)	*% of Total Estimate Wastage*	Water Used (MLD)	*% of Total Water Used*
Indus Tubewells	2.10	0.53	*40%*	1.58	*32%*
PHE Tubewells in Leh	2.05	0.51	*39%*	1.54	*31%*
Natural Springs	0.55	0.14	*11%*	0.41	*8%*
Total PHE Supply	**4.70**	**1.17**		**3.53**	***71%***
Private borewells	1.60	0.13	*10%*	1.47	*29%*
Total	**6.30**	**1.30**		**5.00**	***100%***

Table 11:
Current **Extraction v/s Capacity** of PHE water sources

Source	Current Extraction (MLD)	Theoretical Capacity (MLD)
Indus Tube wells	2.10	4.15
Public Tube wells	2.05	3.46
Natural Springs	0.55	0.55
Total	**4.70**	**8.16**

It must be noted, however, that while the PHE has the theoretical capacity to pump 8.16 MLD of water, operational *constraints such as* ***lack of proper machinery, inadequate manpower and minor but nonetheless missing pieces of infrastructure, hamper the utilization and efficiency of the assets.***

3.2 Water Quality

There is no official report on the quality of water. However, in recent years, a number of independent studies have been carried out as an attempt to understand the quality of water in Leh town.

According to the *National Rural Drinking Water Program*, certain water samples have been collected from Choglamsar (source of Indus water scheme) and are shown below;

Table 12:
Water Quality test results from **Choglamsar** by **NRDWP**, Government of India

Parameter	Average Result
Nitrate (mg/L)	0.00
Fluoride (mg/L)	0.70
Iron (mg/L)	0.04
Chloride (mg/L)	15.57
pH	7.57
TDS (mg/L)	203.00
Turbidity (NTU)	2.82
Sulphates (mg/L)	175.00
Manganese (mg/L)	0.03

The quality of water from different government and private sources taken from Leh and analyzed by Consortium for DEWATS Dissemination (CDD) Society, Bengaluru on various parameters is shown in table 11.

It shows that water from Murtsey tube well is above the permissible limit with regards to

Table 13:
Water Quality test results,**January 2019, CDD Society**

Parameters	Units	Acceptable Limits (IS Standards)	Murtsey PHE Tubewell	PHE Indus Lift Choglamser	Chang Spa Spring	Private Tubewell, Hotel	Sankar Hand Pump	Chutey-rantek PSP	**Gyalung Spring Lamdon**
Color	-	Colorless	Colorless	Colorless	Colorless	Colorless	L. Brown	Colorless	Colorless
Odour	-	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
Ph	-	6.5 – 8.5	6.8	7.7	7.1	7.1	7	7.4	7.1
Total Dissolved Solids	Mg/L	500	144	113	114	98	126	123	133
Turbidity	NTU	1	**12**	0.4	0.6	1	**31**	0.5	0.7
Nitrates as NO_3	Mg/L	45	**61**	10	18	7	4	15	10
Chloride as Cl	Mg/L	250	58	10	14	9	6	14	10
Sulfate as SO_4	Mg/L	200	90	36	12	13	9	41	16
Total Hardness as $CaCo_3$	Mg/L	200	**500**	**320**	**220**	180	200	**310**	**280**
Fluoride As F-	Mg/L	1	**5**	0.3	0.2	0.2	0.08	0.3	0.2
Magnesium as Mg	Mg/L	30	16.3	7.7	0.3	0.6	1.6	2.1	BDL
Manganese as Mn	Mg/L	0.1	0.03	0.01	BDL	BDL	0.1	0.02	0.02
Iron as Fe	Mg/L	0.3	0.01	0.02	0.01	0.09	1.5	0.01	0.02
Lead as Pb	Mg/L	0.01	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc as Zn	Mg/L	5	0.02	0.17	0.22	0.8	3.1	0.05	0.07
Escherichia Coli	MPN/100ml	Nil/100 Ml	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Total Coliform Bacteria	MPN/100ml	Nil/100 Ml	NIL	NIL	NIL	NIL	NIL	NIL	NIL

Table 14:
Water Quality test results by **Technical University of Munich, 2017**

Parameters	Units	Acceptable Limits (IS Standards)	Murtsey area (handpump)	Changspa area	Sankar area (hotel)	Chutey Rantek area (spring)
Ph	-	6.5 – 8.5	7.0	7.0	7.0	7.0
Total Dissolved Solids	Mg/L	500	263	122	88	300
Turbidity	NTU	1	**6.35**	<1	**1.67**	<1
Nitrates as NO_3	Mg/L	45	25.0	10.0	0.0	10.0
Chloride as Cl	Mg/L	250	19.0	4.0	1	19.0
Total Hardness as $CaCO_3$	Mg/L	200	**250**	120	NA	**250**
Escherichia Coli	MPN/100ml	Nil/100 Ml	0	0	0	**1333**

turbidity, nitrates, total hardness and fluoride. Murtsey tube well is a major source of water as almost 40% of tankers that ply in Leh town get their water here, catering to Murtsey colony and other areas that do not have water pipes. Similarly, the Sankar tube well, another source for public water tankers, has also surpassed the permissible limit with respect to iron and turbidity. Highly turbid water correlates to infectious elements in water, such as parasites, bacteria and other viruses. Both these tubewells cater to relatively poorer parts of town, possibly compounding the health and nutritional

problems those populations already face due to socio-economic status. Locals also do find white flakes inside vessels in which they boil water from their borewells—thus, it is indisputable that much of the groundwater is hard.

Another research study by The Technical University of Munich (TUM) pointed out that from 110 samples collected from tube wells, hand pumps and small springs across middle and lower Leh, **almost 90% of the samples had traces of E. coli bacteria and nitrates**.

The water tests conducted by TUM and CDD have very different results, especially in pathogen levels. This could be due to the time of the year—CDD's study was done in January 2019 while TUM's study was conducted in the summer of 2017. Cold winter water is an unfavorable environment for E. coli bacteria to multiply. Also, as tourism reduces sharply after September and stops after October, pollutants from the septic tanks and soak pits of hotels and guesthouses seeping into the ground will be very low or zero by January, when CDD conducted its tests. Many locals also switch to using dry toilets in the winter as it uses no water. On the other hand, wastewater and faecal matter discharge into ground water would be highest during the summer tourist season.

As summer is when maximum number of people are in Leh and the maximum water is being drawn from private borewells, TUM's results are important from a public health perspective.

A more structured, year-round study is needed to properly understand the water quality through the year and in different parts of Leh, as this can be a serious public health issue.

3.3 Water Conservation

Even though security of water supply is the top concern for people, there are no clear efforts being made to reduce water consumption or manage wastage. Several measures are possible, especially to reduce consumption by bulk users such as hotels, guesthouses and large restaurants, including messages to guests to save water, installing low water taps and flushes, and restricting or even eliminating showers.

Key Takeaways

Shift of dependency over the past 15-20 years from **90% snow melted** surface water to **92% groundwater** sources.

The PHE department is expanding the system for **peak supply capacity** of **12.8 MLD**.

PHE's current **installed capacity is 8.16 MLD**, and about **4.7 MLD is supplied**.

Private borewells supply about **29%** of water used, or about **1.5 MLD**.

Groundwater quality varies seasonally as influx of **pollutants** is **highest in summer** .

Murtsey tube well is a major source of water as it supplies almost **40% of tankers**, and has **high turbidity, nitrates** and **fluorides**.

04 | Water **Storage**

Under the *old water supply scheme*[7], multiple **Service Reservoirs (SRs)** were constructed across the town. Most reservoirs were constructed near the tube well source. As part of *Indus Lift Scheme*, **Stage Reservoirs**[8] were constructed to lift water to required heights for distribution. Currently, additional reservoirs are being constructed to augment storage capacity to expand water distribution.

The primary objective of SRs is to take the water at sufficient height and supply it under gravity to its service zones/areas. The pressure of water at each consumer tap would be different due to the topographic gradient so the system has to be designed to ensure adequate pressure even at the last tap.

There are **total of 16 Service Reservoirs across Leh town with a cumulative daily storage capacity of 16,25,000 gallons or 6.18 Million Liters**[9]. Collectively, these can supply *65 liters per person per day*. However, as ***12 of the 18 are currently operational,*** *the current cumulative daily storage capacity is 13,50,000 gallons or 5.13 ML, which can supply 54 liters per person per day, though filling these reservoirs multiple times per day can increase water supply manifold.* The remaining 4 non-operational SRs are under construction.

Reservoirs are of four different capacities; 25,000 gallons (0.09 ML), 50,000 gallons (0.19 ML), 1,00,000 gallons (0.38 ML) and 1,50,000 gallons (0.57 ML). The SRs are located in almost all the water zones demarcated by the PHE department.

The limited storage capacity is not a bottleneck to increase water supply to Leh town. In fact, an additional volume of water can be supplied by ***increasing the number of hours of pump operations and subsequent supply from SRs****. Therefore, even with the same storage capacity, with* **35% increase in pumping and supply hours, 135 LPCD water can be supplied, provided losses in the network are checked.**

7 Old water supply scheme was conceived in mid 90s where tube wells along Indus river banks and within Leh catchment were developed. Along with the tube wells, the PHE was also dependent on spring sources for drinking water supply

8 The Indus lift scheme consists of different stage reservoirs which transport the water lifted from the tube wells to higher elevation stages of Leh town

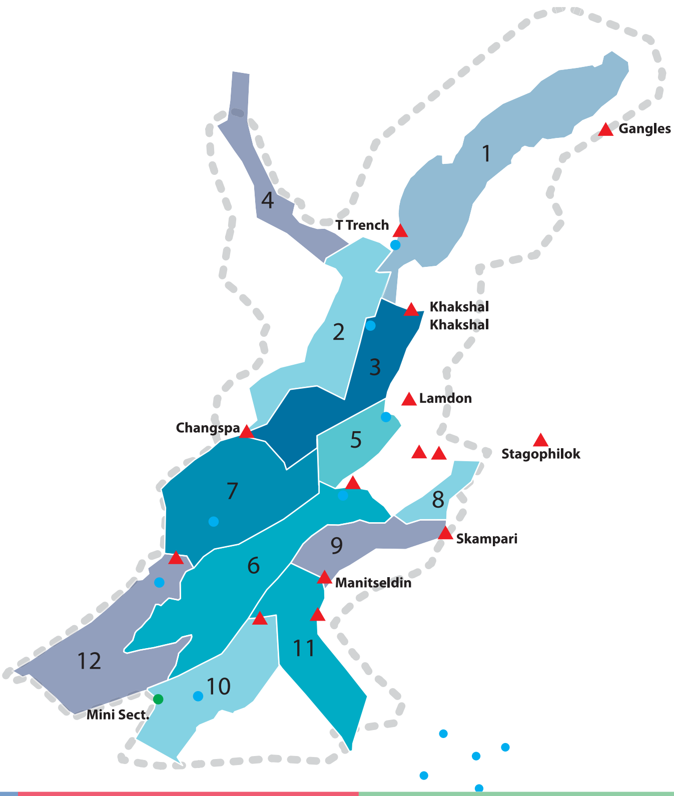
9 1 US Gallon = 3.8 Litres

Table 15:
List of Service Reservoirs

Sr No	Name of Reservoir	Status	Capacity (Gallons)	Zone Catered
1	Lamdon	Operational	1,50,000	Zone 5
2	Khakshal	Operational	1,50,000	Zone 3
3	Skampari	Operational	1,50,000	Zone 9
4	Stok Flow (old)	Operational	25,000	Zone 6-I
5	Badami Bagh	Operational	50,000	Zone 11
6	Skara (opp. Hospital)	Built, not Operational	50,000	Zone 12
7	Balashram	Operational	1,50,000	Zone 11
8	Mini secretariat	Operational	1,00,000	Zone 10
9	Manetseling	Operational	1,00,000	Zone 10 & Stage Lift
10	Changspa	Operational	1,00,000	Zone 7
11	Gyalung SR	Operational	1,50,000	Zone 2
12	Jumabagh	Operational	50,000	Zone 6
13	Kartse	Under Construction	50,000	Zone 12
14	Stok Flow (new)	Under Construction	50,000	Zone 6-I
15	Gonpa	Operational	50,000	Zone 1
16	AMRUT	Under Construction	1,50,000	Bombguard
17	Skampari Phu	Built, not Operational	50,000	Zone 8
18	Skara	Built, not Operational	25,000	Zone 12
	Total		**16,00,000**	

Figure 11:
PHE Zones of Leh

- ▲ Service Reservoir
- ● Service Reservoir
- ● Service Reservoir



It needs to be mentioned that the quality of water gets affected by the storage system as rusted staircases or corroded walls release cement and iron particulates into the water. **A regular cleaning and disinfecting schedule should be maintained to reduce risk of contamination.**

Currently, there are no meters to monitor the amount of water received and discharged from each SR each day. In the absence of even such basic data, it becomes difficult to identify sources of water loss or the reasons for water shortages that people may complain about. It will be very helpful to install such bulk water meters at each SR.

Key Takeaways

There are **16 Service Reservoirs** (4 including those under-construction) across Leh with cumulative daily storage capacity of **16,25,000 gallons** or **6.18 Million Liter**.

Storage capacity is **not a bottleneck** to increase water supply to Leh town.

Water quality in reservoirs is **not monitored.**

Quantity of **water discharged each day** is also **not monitored** making it impossible to accurately track water consumption and wastage/losses.

05 | Water **Distribution** Network

5.1 Old Network

Leh has an old water supply distribution network, which was commissioned in the mid-1990s. The total length of the network was about 60kms and it covered the entire town with 20-80mm diameter Galvanized Iron (GI) pipes. The town had 462 Public Stand Posts (PSP), public taps to which people could bring containers and collect water. Gradually, some households like in the Murtsey area were given direct water connections with 15mm GI pipes and some PSPs broke and became dysfunctional. Today, about 100 PSPs are operational. Gradually, these will be replaced by household connections.

Water is released from reservoirs for about 2 hours each day and it flows to household connections and through the PSPs freely, whether anyone is collecting the water or not. Thus, water is wasted at the PSPs, though this water flows through the canals across town (and is used for washing clothes and utensils) and ultimately percolates into the ground or gets discharged in streams.

Nonetheless, given the shortage of water and cost of supply, it is expensive to let water flow unchecked and unused from taps. The reason for this is to ensure that the entire water pipeline system is empty each day because if water is left in the pipelines, they can burst if temperatures drop below freezing point. Therefore, taps were not put on the PSPs.

Currently, **only 100 PSPs are operational** in the town. In coming days, *all existing PSPs will be converted into HH connections.*

5.2 The New Network

As part of source augmentation and reorganization of water supply network, a new water supply network is being built in Leh town. **The PHE has divided Leh town into 12 zones** Zone division was decided on following 2 factors:

a) Location of old reservoirs;

b) Reach of pressure gradient till last serviceable point as the water supply is gravity-based

The new pipe network comprises of following:

i. Rising Mains
The water from the *Indus tube wells* is transferred to different Service Reservoirs through Rising Mains that comprises of 350 – 150 mm diameter Mild Steel (MS) pipes of a total length of 9.5 km. The size of pipe depends on the volume of water and the altitude up to which it is required to be pumped. The Rising Mains are designed to supply 12 MLD of water with average discharge of 140 Liters per second (LPS). Currently, 2.1 MLD of water is pushed through the line. Therefore, *only 18% of the capacity is currently utilized.*

ii. Distribution Network:
Comprising of 100mm diameter Ductile Iron (DI) pipes, the total length of the network is 98 km out of which 78 km is laid i.e. 79% of the

Table 16:
Status of distribution network as of Nov 2018

WZ #	Locality	Total pipe Length (km)	Total PipesLaid (km)	% Completed	Est. Summer Population
Zone 1	Gangles	6.5	5.5	85%	915
Zone 2	T Trench	6.9	4.3	62%	1,564
Zone 3	Khakshal	10.0	7.0	70%	3,128
Zone 4	Gonpa/Gyamtsa	2.9	2.9	100%	-
Zone 5	Lamdon	5.0	4.0	80%	6,400
Zone 6 I	Jumabagh	9.2	9.2	100%	9,514
Zone 6 II	Old Leh	6.0	6.0	100%	
Zone 7	Changspa	8.3	8.3	100%	5,071
Zone 8	Stok Flow	6.9	5.6	81%	26,173
Zone 9	Skampari	10.9	10.0	92%	28,128
Zone 10	Mini secretariat	7.5	7.3	97%	7,820
	Ibex colony	5.5	5.0	91%	
	Agling	1.7	1.7	100%	
Zone 11	Housing Colony	9.5	9.5	100%	2,909
Zone 12	Badamibagh	8.0	7.0	88%	1,955
	Total	**104.8**	**93.3**	**89%**	**93,577**

Main **Migrant** Housing
Main **Tourist** Areas

work is completed as of November 2018. **The network will serve around 5,800 households.** Leh is the only town in the erstwhile state of J&K where for the first time DI pipes have been used for the distribution network. Earlier, pipelines were made with Poly-Vinyl Chloride (PVC) and Galvanized Iron (GI). DI has the advantage of strength and durability.

Zone 4, 6-I, 6-II, 7 & 11 have been 100% covered under the new network and Zone 11 has been tested and commissioned for water supply. Zone 4 has sparse habitation and therefore less population and less network length. Zones 5, 6-I, 6-II and 7 are the main tourist areas with large numbers of hotels and guesthouses, while Zones 8 and 9 are ones where most migrant workers stay.

5.3 Insulation and Winter Supply– Options and Methods

Freezing pipes in winters is a major challenge in providing uninterrupted drinking water supply in Leh's extreme cold climate. The main water pipes are therefore laid 1.5-2 meters below the ground, which is below the frost line (1.25m) to ensure that water does not freeze and burst the pipes.

However, the following components are laid less deep or even along the ground and therefore are certain to freeze in winter:

- Diversion junction
- Valve junction outside SRs
- House service connections – ferrules

Glass wool[10] is commonly used in Leh to cover

10 Glasswool is an insulating material made from fibers of glass arranged using a binder into a texture similar to wool. The process traps many small pockets of air between the glass, and these small air pockets result in high thermal insulation properties.

exposed pipes but these may not always guarantee that pipes won't freeze and burst, as these components may not be adequately and uniformly insulated, or the insulation can tear. While the Leh water system is supposed to be a 24x7 water supply system, this seems unlikely unless the issue of proper household connections and insulation is addressed.

As per the system design, the entire network can be drained of water so that water is not left in the pipes as the temperature falls. However, this will waste a lot of water which is expensive to produce in the first place.

Key Takeaways

The Rising Mains are designed to supply **12 MLD** of water with average discharge of **140 Liters per second** (LPS). Currently, 2.1 MLD of water is supplied - ***only 18% of the capacity is currently utilized***.

The **new distribution network** comprising is **98 km long** with 100 mm diameter Ductile Iron (DI) pipes. **78 km is already** laid reaching about **5,800 houses**.

The **PSPs will be de-commissioned** and converted into household connections.

Lack of insulation on parts of the network makes it **vulnerable to freezing and bursting**—therefore 24x7 water supply is not feasible unless this is addressed.

06 | Public **Water Tankers**

Eight public tankers, owned and operated by the PHE supply water to residents in areas without household connections or Public Stand Posts in areas like Skampari, Agling, Gangles, Gonpa, Skara and Khakshal.

One tanker makes about 6-7 trips per day, traveling 50-70 km. All the tankers together make about 52 trips per day and deliver around 0.5 ML of water, **serving around 2,000 households**. Residents have installed storage tanks outside or near their homes which the tankers fill.

Residents sometimes complain that tanks are not filled completely, water is wasted due to spillage and tanks can get contaminated or dirty, causing inconvenience, health risks and wastage.

In summer, Sankar and Murtsey tube wells are mainly used to fill tankers. In winter, dependency on tanker supply increases, creating immense opportunities for private players and increasing the cost of water. During summer, these private tankers primarily serve construction sites and hotels. In the past, there have been disruptions in services due to non-payment of fuel bills or wages.

The estimated O&M costs computed by BORDA and PHE is shown below.*

Table 17:
Comparison of O&M for tanker and piped system

O&M Head	Public Tanker	Piped system
Fuel or Electricity	51,50,880	68,49,120
Labour	10,65,800	14,34,200
Maintenance & Repairs	14,60,000	5,40,000
Annual O&M Cost	76,76,680	88,23,320
Annual water supplied (KL)	1,57,680	7,96,032
Cost per KL	**Rs. 49**	**Rs. 11**

* Estimate figures as the PHE does not split expenses between tankers and the pipe system. Does not include capital costs such as purchase of trucks, installing pipelines etc.

At **Rs 49 per KL**, tanker water is **4.5x more expensive** than the piped water system to operate. Leh could **save about Rs 60 Lacs annually** if tankers were replaced by piped water (capital cost not considered).

It costs about Rs 2,629 to operate a 9,000L capacity tanker for one day.

Key Takeaways

8 public tankers, owned and operated by PHE, supply water to about **2,000 households** in areas that do not have household connections or Public Stand Posts.

Tanker supply costs 4.5 times more than piped water supply: **Rs 49/KL vs Rs 11/KL**.

07 | **Household** Connections & **Metering**

The PHE department is responsible for providing house water connections. Under the old scheme, a total of 833 household and 116 commercial connections were authorized and registered by the department. Similarly, in the new project as well, the PHE department has allotted new connections and registered the same.

As per the project design, 100% of the households are planned to be connected with the new water supply scheme. However, **till November 2018, around 66% of households have been connected i.e. around 3,818 households out of 5,800 have been connected. However, water is not yet flowing in most of these areas**, hence there is some frustration amongst residents who have connections but not water.

Service Connection Process:

Each household is required to provide

- Proof of property ownership
- Proof of Identity

The PHE asks each household unit to fill up a water connection form indicating number of habitants in household with their details. This form is submitted to the concerned Junior Engineer at PHE office. The PHE is responsible for providing the connection to all households. Currently, no connection fee is charged by the PHE and the cost of material (including pipes and other accessories) and labour for connecting the household to the nearest pipe is borne by the household.

Issue of Unregistered (but legitimate) Connections:

Leh has a short construction period between May-October due to the extreme winters. This is also the tourist season, and digging roads for the water distribution and sewer projects causes huge inconvenience to people. In these circumstances, the Roads & Bridges (R&B) and PHE departments are under tremendous pressure to complete the work and restore roads for traffic, as quickly as possible.

Due to this situation, people have taken connection to the network even without the formal process and documentation as listed above.

The two major outcomes of this are:

a. Large number of connections are given but not officially recorded

b. The method of connection may not be standardized, making it vulnerable to damage and leakage

Table 18:
Overview of Piped Water Connections

Type of Connection	# of HH
Registered Connections	833
Unregistered but legitimate connection	2,985
Not yet connected	1,982
Operational PSPs	100

7.1 Water Meters: Conservation and Pricing

Consumer and Bulk Meters are useful at user locations and in the main pipelines respectively, to:

- Monitor water flows and thus usage by each user
- Calculate water losses and identify leakages or illegal / unmetered connections
- Calculate and charge water tariffs to generate revenue
- Reduce water consumption and wastage by users as tariffs based on actual water used result in careful use

No bulk or consumer meters have been installed to measure the actual quantum of water supplied or lost in transit.

While local officials and engineers believe there is tremendous benefit in installing meters and charging tariffs based on volume of water used, they also believe that regular conventional water meters will not work in Leh as they are vulnerable to freezing and damage. No research or tests have been conducted thus far.

A closer look of current water supply at the zonal level is shown below:

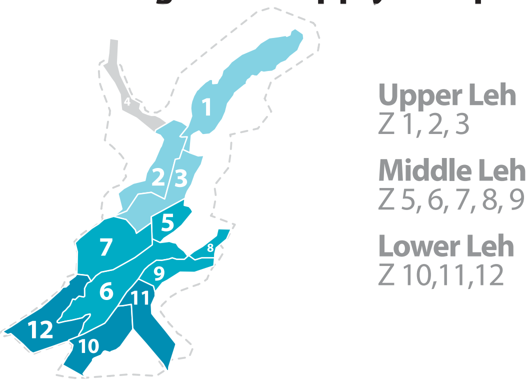
Table 19:
Current water supply by Zone*

Zone	Estimated Population	Total PHE Supply (MLD)	Water Usage (MLD)	Avg LPCD	Source	Notes
Z1: Gangles	915	0.08	0.0	82	Gyalung	
Z2: T-Trench	1,564	0.23	0.1	144	T-Trench	Large scale agriculture practiced
Z3: Khakshal	3,128	0.26	0.2	84	Khakshal TW	Few hotels but large gardens
Z4: Gyamtsa / Gompa	235	0.01	0.0	62	Gompa TW	Sparse population
Z5: Chubi	6,400	0.44	0.6	67	Gyalung, T Trench and Lamdon TW	High tourist zone, lot of pvt TWs
Z6: Old Leh/ Jumabagh	9,514	0.32	0.8	33	Jumabagh TW	High tourist zone, lot of pvt TWs
Z7: Tukcha	5,071	0.38	0.5	69	Tukcha TW	High tourist zone, lot of pvt TWs
Z8: Skampari	26,173	0.47	0.8	18	Gyalung spring and Indus TW	Migrant zone, high population density
Z9: Nimoling	28,128	0.45	1.0	16	Indus TW	Migrant zone, high population density
Z10: Murtsey	7,820	0.41	0.6	52	Murtsey TW and Indus	
Z11: Housing Colony	2,909	0.29	0.2	101	Indus TW	Dedicated Indus supply line
Z12: Skara	1,955	0.29	0.1	146	Badamibagh and Skara TW	Hotels and army settlements
Total	**94,433**	**3.60**	**5.0**	**38**		

* The water supply at zonal level has been obtained through monitoring the discharge from service reservoirs and spring source. Due to limited availability of time, the discharge has been observed for just one day. Therefore, the actual zonal supply may vary from the given values.

In the above table, we can see that Zone 8 and 9 where migrant workers live, gets very little water. Those areas with significant agricultural land or hotels either use lots of water (zone 2, 3 and 12) or have many private borewells (zone 5, 6, 7).

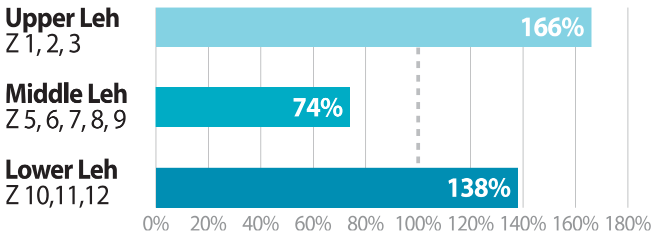
7.2 Usage and Supply Comparison



It can be seen from Figure 11 that Middle Leh, which is concentrated with hotels/guest houses and migrant workers, receives only 74% of its summer water requirement from the PHE, while Lower and Upper Leh have excess water supply—the excess probably being water wasted at the PSPs or used for gardens and farms. Hence, middle Leh is also the region with most borewells.

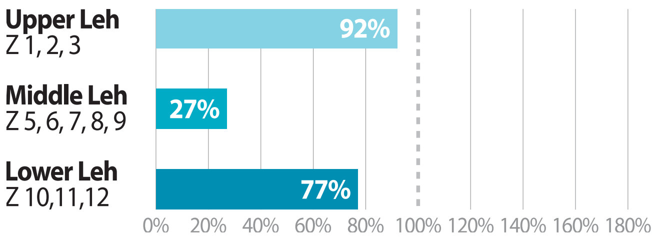
As mentioned earlier in Section 3.1, the PHE can increase water supply once certain roadblocks are removed and missing parts of infrastructure are completed, which is expected to happen in 2020 or 2021. This should then ease water shortage through additional supply from the Indus system.

Figure 12:
Current Summer Water Usage
as % of PHE Supply
Source: Analysis by authors



If the CPHEEO norm of 135 LPCD is applied, then each part of Leh is short on supply, with middle Leh having supply equal to only 27% of its requirement.

Figure 13:
Projected Summer Demand
based on CPHEEO norms as % of current PHE Supply
Source: Analysis by authors



Key Takeaways

There are **no bulk or consumer meter installed** to measure the actual quantum of water supplied, consumed and lost in transit.

Till November 2018, around **66% of households have been connected** i.e. around **3,818 out of 5,800** households have been connected to the new network.

Middle Leh, with its concentration of hotels, guest houses and migrant workers, has a **significant gap between water usage and supply** from PHE, resulting in large number of private borewells.

Most connections are taken without the formal process and documentation.

Drinking water supply shortage appears to be due to **operational constraints** including the incomplete **distribution network**, which should be completed in **2020**.

08 | Wastewater & Faecal Sludge Management

Currently in Leh, with a population of 93,778 persons in the summer and assuming 80% of water supplied is discharged as wastewater, a total of about 4.0 MLD is discharged as wastewater, or around 445 tankers per day[11] (peak generation). The quantum of wastewater will increase as population and water supply increase.

8.1 New Sewerage Network and STP

Today, wastewater mostly flows into septic tanks and soak pits and into the ground. As the water table is high in many areas, this is leading to groundwater pollution as discussed in Section 3.2. A contract has been awarded to build a new *Sewage Treatment Plant (STP)* of capacity 3.0 MLD at a cost of Rs. 14 crores, including 3 years of operations and maintenance. The PHE decided to use the Sequential Batch Reactor (SBR) technology which is suitable for variable flows, and the design elements consider the extreme cold of the winter.

The new sewerage network that is under construction is 56km long and has a project cost of Rs 48 Crores to build. However, it connects only about 40% of the town, but covers all the high density population areas. It is unclear how much wastewater will ultimately flow into the sewerage network, as buildings in areas covered by the network but located at an elevation lower than the main road, will not be able to connect to it. Many streets in Leh are very narrow and laying a pipe up to the trunk sewerage line may not be feasible.

As water consumption significantly varies across summer and winter, so does wastewater generated. In summers, most hotels, guest houses and households use flush toilets, while in winter, nearly all hotels close down, people have baths infrequently and households mostly use dry toilets as water supply becomes limited. Thus, very little wastewater will be generated in winter which can create challenges for the STP and blockages in the sewerage network due to low water flow.

The STP is located close to the Indus river, a few kilometers outside Leh. Due to its location, the treated water cannot easily be re-used for any productive purpose, and will be released into the river. Monitoring output characteristics will be very important to ensure the clean waters of the Indus are not polluted by the STP.

11 Tanker capacity 9,000 liters

Table 20:
Technical Specifications for the **Sewage Treatment Plant**

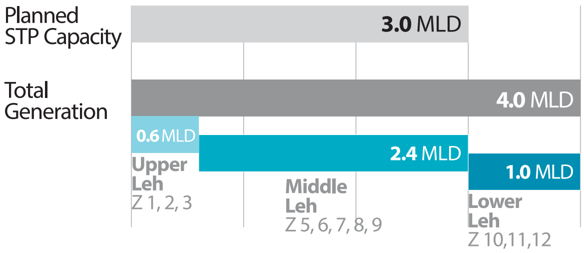
Parameters	Typical characteristic of Wastewater	Expected characteristic of Leh Wastewater	Expected treatment output of Leh STP
pH	6.5 – 8.0	6.5 – 8.5	2.5 – 9.0
COD (mg/L)	500 – 600	450	Less than 50
BOD (mg/L)	250 – 300	250	Less than 10
TSS (mg/L)	300 – 350	500	Less than 50
NH_4 (mg/L)	35 – 40	25	Less than 5
Total Coliform (MPN/100 ml)		$1x10^7$	
Fecal Coliform (MPN/100 ml)		$1x10^6$	Less than 100
Total Phosphorous (mg/L)	5 – 7	5	Less than 2

The length of underground drainage network is 56 kms, of which 90% or around 50 km is laid. As the STP is not built, households should not connect to it, though some have—and their sewage is collecting at certain junctions and lying untreated, causing problems for people near those locations. Details of length of sewer network at zonal level is not clear. The table below shows coverage at zonal level.

Table 21:
Current **Status of Sewerage Network** in Leh

Zone	Coverage
Z1: Gangles	Partly covered
Z2: T Trench	Not Covered
Z3: Khakshal	Partly covered
Z4: Gyamtsa	Not Covered
Z5: Chubi	Partly covered
Z6: Old Leh/Jumabagh	Partially covered
Z7: Tukcha	Partly covered
Z8: Skampari	Not Covered
Z9: Nimoling	Partially Covered
Z10: Murtsey	*Fully Covered*
Z11: Housing Colony	*Fully Covered*
Z12: Skara	Not covered

Figure 14:
Estimated **Wastewater Generated** in Leh, **2018**



Since only 50% of the town is connected, actual sewage would be less than current capacity - it would be okay.

Waste dump site where faecal sludge was discharged before the FSTP

8.2 Faecal Sludge Treatment Plant in Leh

In April 2017, LAHDC and MCL invited BORDA, a sanitation-focused non-profit organization to design a Faecal Sludge Management system that can be quickly established in Leh to scientifically clean septic tanks and soak pits, and treat the septage and faecal sludge from these.

Leh's water table is very high in many places and risk of contamination is very high. Local authorities wanted to take immediate steps towards minimizing the pollution of ground water. In the long-run, this FSM system will complement the upcoming sewerage network by serving areas not covered by the sewerage network.

Faecal sludge can contain thousands of times more pollutants and pathogens than normal sewage, hence it is very important to manage and control it to protect water bodies.

India's first Public-Private Partnership for FSM was set up between the Blue Water Company (BWC) and MCL, wherein BWC invested in designing and building the faecal sludge treatment plant at a cost of about Rs 1 Crore, with a treatment capacity of 12,000 liters per day. The MCL mandated that all hotels and guesthouses have to clean their tanks and pits every year to minimize leakage of faecal matter into the ground. Very few septic tanks are properly designed and meet specified standards—hence, they are more likely to leach contaminants into the soil and groundwater.

In May 2017, BORDA did a survey of 182 hotels and guesthouses, and found the following :

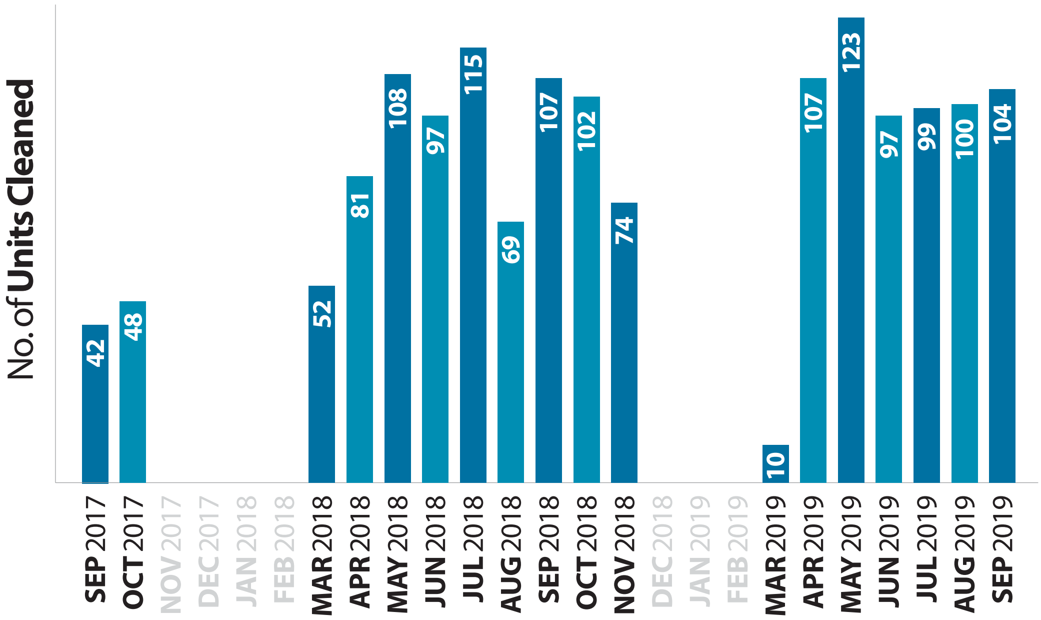
Table 22:
Overview of **Survey by BORDA**

No. of hotels + guesthouses surveyed	182
No. of septic tanks + soak pits	680
Average per property	3.7
% of soak pits	56%
% of septic tanks	44%
% with convenient manhole access	24%
Completely inaccessible units	7%
% of properties with borewells	83%

These were the larger hotels, so across all the hotels and guesthouses in Leh, the average number of soak pits or septic tanks will be fewer, but more are likely to be simple soak pits and not septic tanks.

As per the agreement between MCL and BWC, all septic tank owners have to pay MCL a cleaning fee of Rs.3,500 per tank, and MCL pays 90% of this fee to BWC for cleaning the tanks and operating the FSTP. BWC schedules the cleaning in advance and also responds to urgent calls from customers, thus providing a turn-key, integrated solution to MCL from scheduling, cleaning and treating the

Figure 15:
Faecal Sludge Collected and Treated in Leh by Blue Water Company under contract from MCL



faecal waste. The land for this plant was provided by MCL, which also enforces all regulations in the FSM system.

The plant has been operational since September 2017 and ran from mid-March until mid-November in 2018, and re-opened in March 2019. Services are suspended from Nov-Mar as septic tanks freeze in the cold and are impossible to clean. Until now, over 600 tanks and pits have been cleaned and 1,600 loads (of about 3,000 liters each, the capacity of the suction truck) collected—thus, an average of 2.6 loads per septic tank. The plant has prevented around 5 million liters of concentrated faecal sludge from being discharged into the environment.

There are several challenges in providing FSM services in Leh:

1. Streets are narrow and its difficult for the suction truck to reach septic tanks
2. Low air pressure reduces efficiency of motors, making it difficult to pull sludge long distances
3. In summer, due to tourist traffic, cleaning activities are usually scheduled at night

BWC developed **a double-booster pump mechanism** to overcome problem 1 and 2, by using off-board pumps in combination with the suction truck. This **innovation won the AMRUT Technology Challenge in 2018 from the Ministry of Housing and Urban Affairs (MoHUA),** Government of India.

The next 2-3 years will be critical to establish a good quality wastewater management system that is robust, reliable and cost effective.

Key Takeaways

A **sewerage network** is **under construction** but at a cost of **Rs 98 Crores**, will cover only about **40% of the town**.

Underground **drainage network** is **56 kms** long, of which 90% or around **50 km is laid**.

The **sewage treatment plant** of **3MLD** capacity is located close to the Indus river outside Leh. The treated water cannot easily be re-used and will be released into the river. **Monitoring** will be very important to ensure the **clean waters of the Indus** are not polluted by the STP.

Low water usage makes sewage more concentrated. The STP must be designed accordingly or will not function properly.

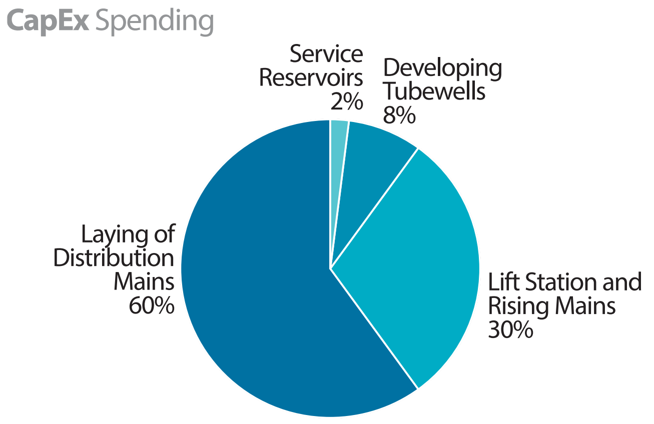
In 2017, Leh entered into **India's first PPP for integrated FSM services** on a pure revenue sharing basis with no fixed costs for the local authorities —over 5 Million liters faecal sludge has been safely collected and treated since.

09 | **Cost** of Water Supply

9.1 Capital Cost

The **total capital cost** of the new water supply project is **Rs.70.5 crores**. This includes construction of new Service Reservoirs, development of Tube Wells along the Indus river, installation of pumping machinery, laying of distribution network and rising mains, and other miscellaneous items. The total capital cost is shared between the Government of India, the Government of Jammu & Kashmir and LAHDC, Leh in the ratio 80:10:10. The executing agency on behalf of the Municipal Committee of Leh is PHE department of LAHDC.

Figure 16:
Capital Cost of the new **Indus Water Supply Scheme**



The major chunk of the Capital Expenditure (CapEx) was incurred for the distribution lines, followed by 30% for the lift station and the rising mains; 8% for the tube wells development and the remaining 2% for the construction of service reservoirs. Most Service Reservoirs constructed as part of the old water supply scheme have been retained for current operation, and three new ones are being built.

Considering that the system was designed to serve a peak 2042 population of 82,275 (as per the DPR), it comes to Rs. 8,569 per capita. At the time of construction, the local resident population is 35,192 hence per capita investment is Rs. 20,033 but if we consider the current effective population served of 93,778, it will be Rs. 7,518 per person.

If we add the cost of the sewerage system, which is an important complement to the water distribution system, the total investment is **Rs 70.5 Crores for water distribution** and **Rs 62 Crores for sewerage network and STP,** a **total of Rs 132.5 Crores.** This corresponds to Rs 16,104 per capita (using 2042 population in the DPR), Rs 37,650 per capita using current resident population and Rs 14,129 per capita based on current effective summer population served.

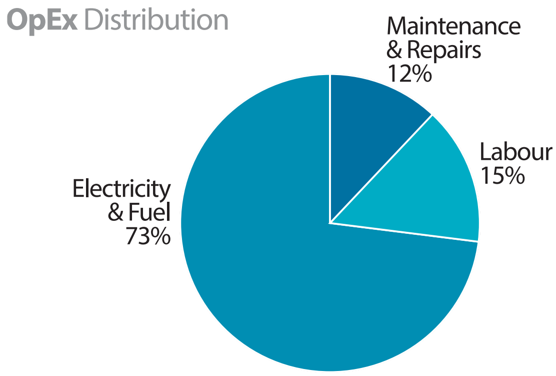
Table 23:
Overview of **CapEx for Water and Sanitation Infrastructure** in Leh

	CapEx (INR Cr.)	Per Capita investment based on Population served (INR)		
		82,275 (as per DPR in 2042)	35,192 (current residents)	93,778 (current peak in summer)
Water Distribution System	70.5	8,569	20,033	7,518
Sewerage System incl. STP	62.0	7,536	17,618	6,611
Total Water + Sanitation Investment	**132.5**	**16,104**	**37,650**	**14,129**

9.2 Operating Costs

The total operating cost (OpEx) per year for drinking water supply is currently Rs. 1.65 crores, including the pipe network and tankers. About 75% of this expense is on electricity and fuel for trucks. Labor represent 15% of the total OpEx. Most of the staff are casual daily wage labourers; if they are engaged formally as employees of PHE or MCL, the cost will go up significantly.

Figure 17:
Operating Cost of the current Water Supply System



Around 47% of the current OpEx is spent on tankers while remaining 53% is for piped system. Based on the amount of water supplied, it costs around Rs 49 to supply 1,000L of water by tanker while only Rs 11 through the pipe system (as calculated in Section 6). Assuming a family of five uses about 375 liters per day (75L per person), it comes to Rs. 4 per day, or Rs 1,500 per year (Rs 125 per month per family)—which is affordable. These computations assume that hotels will pay a proportionately higher tariff for the water these use. Some sort of meter will be needed to ensure people do not use much more water than what they are paying for, or pay higher amounts for using more.

The operating costs of the new water supply system will be significantly higher than current costs due to the high electricity cost of pumping water from the Indus river to Leh, and manpower increase to run a network of over 5,800 customers. The expected O&M cost has not been estimated by the PHE or MCL, but preliminary calculations indicate an **annual O&M cost of Rs 3.94 Crores**.

9.3 Tariffs and Revenue

Only 833 households and 116 commercial installations pay an annual water tariff of Rs.945 and Rs. 1440 respectively at this time. No tariff has been announced since the new water distribution system was started, and the ~3,000 households that have recently gotten connections (that are not properly registered yet) are not yet paying a tariff even if some of them are receiving water supply.

The plan is to roll out a water tariff structure once the entire network is completed in 2019-20. Tariffs are likely to be a fixed as a monthly or annual fee, either a fixed amount or based on the size of the building. Volumetric pricing cannot be introduced currently as meters are not installed.

In 2017, the total billing for drinking water supply from registered connections was Rs. 9,54,225, based on the established tariff mentioned earlier. It is not clear if this entire amount was actually collected or not. Tanker water and PSPs are free.

Thus, presently, while the government spends Rs 1.65 Crores providing water services, its collections are only 5.8% of operating expenses or lower.

If O&M costs increase to Rs 3.94 Crores as estimated earlier and the PHE / MCL impose the same tariffs as present, expected revenue will be:

Table 24:
O&M Expenses and **Cost Recovery** of Water Supply Services in Leh

	Present Scenario		Future Scenario	
	No. of Paying Customers	Annual Tariff	No. of Paying Customers[1]	Assumed Annual Tariff
Households	833	945	6,100[2]	945
Commercial (hotels etc)	116	1,440	800[3]	1,440
Total Billing (Rs)	9,54,225		66,33,000	
O&M Expenditure (Rs)	1.65 Crores		3.94 Crores[4]	
Net Deficit (Rs)	1.55 Crores		3.28 Crores	
Expenditure Recovery %[5]	5.78%		16.84%	

1: These figures are estimates by research team, as the exact number of likely customers is not yet known
2: Includes 5,800 households and 300 small cafes and commercial establishments with low water requirement, who can be charged the domestic tariff
3: Estimated number of hotels, guesthouses and larger restaurants with high water usage
4: This amount is computed by the project team with assistance of PHE's staff
5: This assumes 100% of billed amount is collected

As is clear from the above computations, **the tariff structure will have to be revised**, as sustained losses from water services tends to result in cost-cutting which reduces quality of service and neglect of assets, which in turn reduces the effective lifespan of the system and increases maintenance costs in the future.

Volumetric pricing is the fairest way to charge people for water, as everyone pays for how much they use. Special incentives can be offered through pricing and discounts, to encourage saving water, and other measures can be implemented to both reduce costs and boost revenue and the sustainability of the water distribution system. The issue of household meters has to be addressed to achieve this.

9.4 Private Borewells

Currently, there is no permit, licensee fee or tariff for owning a private borewell. While it is an entirely private investment, borewells owners are using a common resource, the underground water, for free. While there is a general acceptance that private borewells should be registered so the government knows how many there are, there is no consensus on whether borewells should be charged a tariff as well. It typically costs Rs 1,50,000 - 2,40,000 to dig a borewell in Leh.

Key Takeaways

The total **Capital Cost** of the new water supply project is **Rs. 70.5 crores**.

At time of construction, local resident population is **35,192** hence per capita investment is **Rs 20,033**.

Cost of water is **Rs 11/KL** for **piped water** and **Rs 49/KL** for **tankers**.

Operating Cost of drinking water supply system is **Rs 1.65 Crores** (73% for electricity), while only Rs 9.54 Lakhs is collected —only **5.8% cost recovery**.

The **new water distribution system** may cost **3.94 Crore per year** or more to operate.

Volumetric pricing is the fairest way to charge for water, so everyone pays for how much they use and price incentives can be offered to save water. But **household meters must be installed** to do this.

Tariffs or fees for private borewells also need to be decided upon.

Photo by **Vamsi Konduri** on Unsplash

10 | Institutional Responsibility for Water Supply

The Secretary (PHE) oversees the department for entire Ladakh, including Leh and Kargil, and reports to the Advisor to the Lieutenant Governor of the Union Territory of Ladakh.

The Municipal Committee of Leh (MCL), the urban local body, manages public services. MCL had its first elections in Oct 2018 in which 13 councilors were elected directly by the people. The Administrator

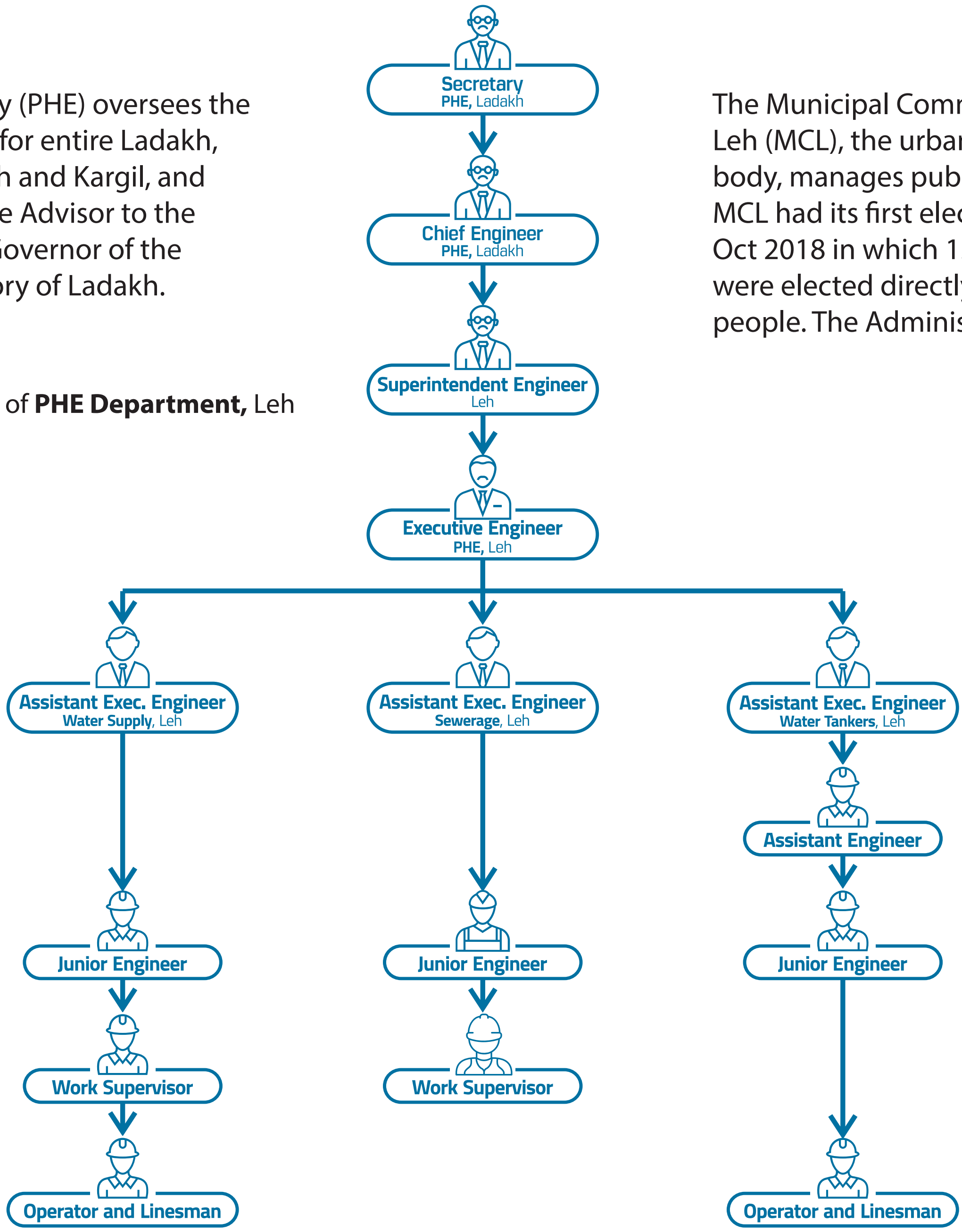


Figure 18:
Organogram of **PHE Department,** Leh

of MCL runs day-to-day operations.

The Public Health Engineering (PHE) Department of the government is the technical department primarily responsible for designing and building water and sewer systems across Ladakh, in rural and urban areas. As it has the technical staff, it often also operates these systems for the local municipality.

Role of PHE

As per the DPR, PHE is the executing agency on behalf of the MCL and therefore has been tasked to undertake following responsibilities:

- Asset creation and operations until handover to MCL
- Registration of connections
- Collection of connection fees, if any

Long-term Accountability and Responsibility

In the future, MCL is expected to take over all Operations & Management activities, though it does not currently have the technical expertise or personnel to manage the entire system. MCL will also set and collect tariffs.

The experience of Indian towns and cities indicates that ULBs usually do not have the internal organization structure, staff or financial systems to maintain large, complex technical systems, resulting in accelerated depreciation of the infrastructure, as well as poor service levels. Frequent change of municipal personnel is one of the major issues as this reduces accountability and responsibility.

Currently, there are no performance metrics that are tracked regularly to ensure that the system is working as expected. A robust administration should have Key Performance Indicators (KPIs) that are set and tracked to ensure performance is in line with expectations of residents and officials.

Decisions have to be taken on how the responsibility for the water and sewerage system will be managed, to ensure the system is well operated and managed to ensure proper service to residents, and proper maintenance to prevent accelerated wear and tear.

Key Takeaways

PHE is responsible for designing and building the water supply infrastructure and handing it over to **MCL**.

Role of MCL and PHE in operating the system needs to be finalized in terms of **technical O&M activities, setting tariffs, collecting fees, customer services** etc.

MCL does not have the **skills and personnel** for operating the water system.

The system should be maintained well to **reduce wear and tear, increase lifespan and minimize overall cost** of producing and delivering water.

A **clearly defined management model** for the water system should be developed as quickly as possible, else services to people will suffer.



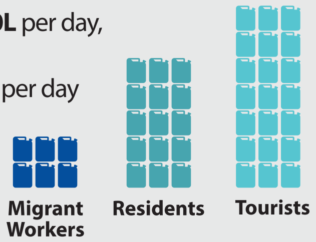


11 | Key Facts about Water Supply in Leh

3. Water Usage

Water used daily during the summer:
About **5 million liters per day**
(excluding construction, agriculture and the armed forces).

Tourists use about **100L** per day,
Residents use **75L** and
Migrants get only **30L** per day
on average.



4. Water Sources

Water is supplied through 4 sources:
(i) Borewells owned by PHE in Leh (**31%** of total water used);
(ii) Borewells in the Indus river (**32%**);
(iii) Natural Springs (**8%**); and
{iv) Private Borewells (**29%**).
Estimated water wasted due to leaking pipes and reservoirs, and overflowing storage tanks: 25%

7. Faecal Sludge Management

Leh has entered into India's first Public Private Partnership for a turnkey, scheduled **Faecal Sludge Management System**

A sewerage system is also being built that will cover about **40% of the town** and should be **completed in 2021-22**.

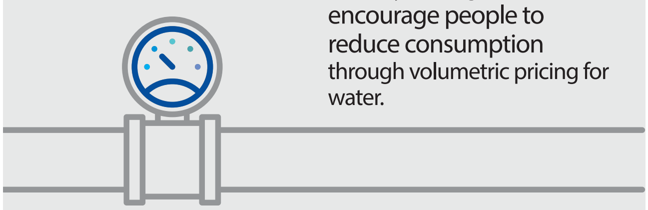
Volume of faecal sludge collected and treated since **Sep-2017**:
Over 5 million liters

8. Water Distribution Network

The PHE should complete installing a **new household water distribution network in 2019-20.**

New water distribution system already completed: **78km of 98km (79%)**

11. Water Meters



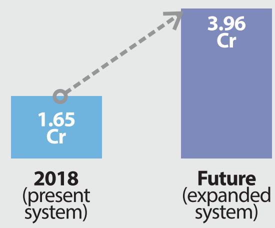
Installing water meters is important to effectively manage water supply, reduce wastage, identify leakages and encourage people to reduce consumption through volumetric pricing for water.

12. Cost of Operating Water Network

Cost of operating water distribution system likely to increase from **Rs 1.65 Crores in 2017** to **Rs 3.96 Crores** for the new system .

New tariff structure is required to improve cost recovery.

O&M Cost of operating water distribution network (INR Crores)



1. **Design Population**

Design population in 2018 for new water supply system :
48,831

Actual estimated summer population in 2018:
93,788

Design population estimated in 2042:
82,275

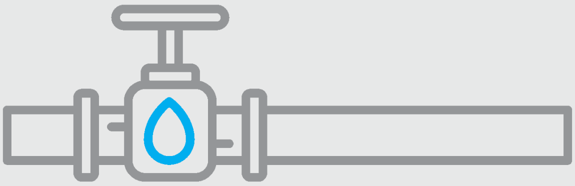
Estimated actual population in 2027:
1,26,425 or higher

2. **Private Borewells**

Number of **private borewells** in Leh: 1,500-2,500
Exact number unknown as no permits are needed to dig one.

Private Borewells
in Leh
1,200-1,700

5. **Infrastructure Capacity**



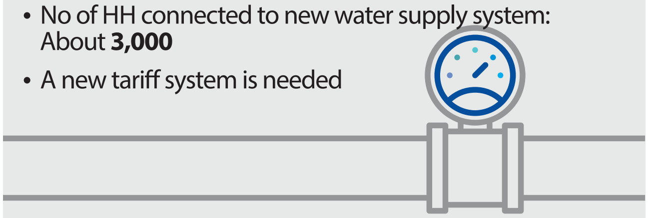
The PHE's infrastructure can supply up to **8.16MLD** if certain roadblocks are addressed, which should be resolved in **2020 and 2021** as part of the new **Indus river water supply system**.

6. **Public Health & Environment**

In 2017, **E. coli** was found in tests of underground water samples, posing a public health and environmental hazard, with potential impact on the local tourism economy and livelihoods.

9. **Water Connections & Tariff**

- Authorized water connections:
  - 833 out of 5,800 HH
    Tariff is **Rs 945 per year**
  - 116 out of 515 registered hotels-guesthouses
    Tariff **Rs 1,440 per year**
- No of HH connected to new water supply system:
  About **3,000**
- A new tariff system is needed

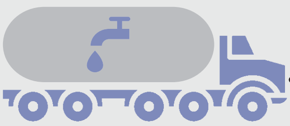


10. **New Sewerage System**

About 50km of the new **56km underground sewerage network** costing **Rs 48 Cr.** and connecting 40% of the town is already laid.

The STP costing **14 Cr.** will be built by **2021-22,** so the sewerage system can be used only then.

13. **Water Tankers**



- The PHE operates **8 water tankers** that cost **Rs 77 Lakhs** to operate per year.
- **1,000 liters of water** costs **Rs 49** to deliver through tankers, versus only **Rs 11** through the pipe system due to higher fuel and manpower costs.
- About **2,000 households** are served through tankers.

Photo by **Joseph Gatto** on Unsplash

12 | Conclusion

Is Leh on the brink of a drinking water crisis? Based on this report finding, we can conclusively say there is sufficient quantity of water available and the networks to deliver this water to people are being put in place. It is likely that by 2021, water stress will have eased significantly, though many factors remain unaddressed and can create problems in the future. Six important issues are:

1. **Formalization of connections:** Water connections should be properly registered—over 3,000 connections are without proper paperwork, for reasons explained in Section 7.
2. **Management model for operating the system:** There is an urgent need to define the management model with clear roles and responsibilities and decision making framework, with emphasis on long-term planning and robust Key Performance Indicators (KPIs) to meet the goal of: (i) safe and sufficient water supply to all residents, and (ii) recovery of O&M cost.
3. **Installation of household and bulk meters:** Without measurement and data, it will be impossible to (i) charge users a fair price for water they use; (ii) incentivize users to save water (which reduces environment stress and O&M costs), and (iii) identify leaks in the system and reduce wastage.
4. **Volumetric based tariffs:** Charging a fixed monthly water fee leads to wastage . A low fixed fee leads to financial losses for the government and negligence in maintenance. A high fixed is unfair for the poor and politically difficult to implement. Volumetric pricing will reduce water consumption and hence O&M costs, thereby improving government finances (potentially 100% of O&M costs can be recovered).
5. **Monitor Groundwater Quality:** A proper hydro-geological study is necessary to ensure sustainable extraction of groundwater by private users and the PHE. Water quality must also be monitored continuously.
6. **Limited Reach of Water System:** Physical boundaries and settled areas of Leh have grown considerably over time but the new water supply system does not reach areas like higher Skampari, Maneytselding and Nimoling. An expansion plan is required to keep up with the town's growth.

Addressing these issues requires, above all else, continuous and long-term focus on the infrastructure, customers and the environment, as reliable and safe water supply and protecting water resources is a health, economic, livelihood and climate resilience matter for Leh. Good data and information is needed to ensure good policies are formed, but this is a major gap at this time.

This report should serve as a step in bringing all stakeholders together, to form a common vision of the current reality and future requirements, and chart a path in the right direction.

Notes

BORDA

BORDA

LEDeG

with support from:

german cooperation

BORDA South Asia
ECO House
#284, Health Society Layout,
Annapporneshwari Nagar,
Bangalore 560091 Karnataka, India
T : +91-80-28482194
bangalore@borda-sa.org
www.borda-sa.org

LEDeG
Ladakh Ecological Development Group
Karzoo, Leh
Ladakh 194101, India

T: +91-1982 253221 / 252284
mail@ledeg.org
www.ledeg.org