LEARNING BRIEF

School Water Quality in a Changing City: Lessons from Kolkata

Splash

The city of Kolkata in India's West Bengal is home to over 14 million people with over 400,000 students in over 1,700 government schools.

Since 2013, Splash has championed improving water quality through the installation of filtration systems in hundreds of primary and secondary schools. Splash uses Antunes Ultra Filtration Systems, which are compact, robust membrane filters that remove bacteria and other contaminants to provide safe drinking water on-site at schools.

In parallel to Splash's support of school water quality, the city of Kolkata invested heavily in water and wastewater infrastructure including pumping stations, pipe networks and water treatment facilities [1].

Kolkata's water supply is primarily surface water from the Hooghly river, supplemented by groundwater. As groundwater holds high salinity and elevated arsenic levels, the municipality is focused on improving surface water use [2].

Together these improvements have significantly improved water quality within schools. This work has been done as part of the Indian "Right to Children" under the Right to Education (RTE) Act 2009, which ensures that all schools must have adequate safe drinking water, sanitation facilities including separate toilets for boys and girls and facilities for hygiene.

This brief outlines Splash's contribution to improvements in water quality in schools and provides recommendations for future school-based water quality initiatives.

BACKGROUND: WATER QUALITY IN SCHOOLS

What is the impact of school water quality?

Global evidence has highlighted the potential of improving health and education outcomes for students by improving water, sanitation and hygiene (WASH) within schools [4, 5]

→ Potential **health impacts** include reduction of gastrointestinal and respiratory illnesses, reduction in infections, and improved growth.

→ Potential **education impacts** include improvements and enrolment and completion rates, reductions in absenteeism, and improvements in testing results.

However, these outcomes are not guaranteed, and positive outcomes are more pronounced in water insecure contexts [5].

- In Kenya evidence has highlighted the potential of water, sanitation and improvements in schools positively affecting the health younger siblings [7].
- In India, a 39-district study indicated fecal coliform have a stronger negative impact than nitrate levels in water sources on reading and writing test scores [8].
- In Addis Ababa, Ethiopia, evidence from Splash's Project WISE indicated a higher impact on respiratory illness than diarrheal diseases [9].
- In rural Mozambique and Uganda, access to a close-by water point and handwashing systems also decreased fecal contamination of water [10].

Overall, the evidence highlights that students benefit most from tailored solutions which address both water quality and quantity [5, 6]. Additionally, while fecal contamination is of wider concern in many emerging economies, contaminates such as heavy metals and chemicals are critical and are not limited to emerging economies [6].

What is being done to address water quality?

To address water quality concerns, many school WASH programs leverage interventions such as water supply improvements, water treatment, safe water storage, handwashing, WASH education and regular monitoring. In particular, Indian government has spearheaded two initiatives to support water access and clean schools.

- The Jal Jeevan Mission (JJM) "Water To Every Household" has aimed to ensure rural households have access to safe and adequate drinking water through functional tap connections. This included establishing water quality laboratories and conducting large-scale monitoring [11].
- The Swachh Bharat: Swachh Vidyalaya (SBSV) "Clean India: Clean Schools" nation-wide campaign in rural and urban schools aimed to improved drinking water, sanitation and hygiene facilities alongside operations and maintenance through capacity strengthening [12].

From 2019 to 2024, Splash has supported 361 schools across Kolkata (**Figure 1**) with improved WASH infrastructure, including pre-filtration – to reduce heavy metals – and on-site water filtration.

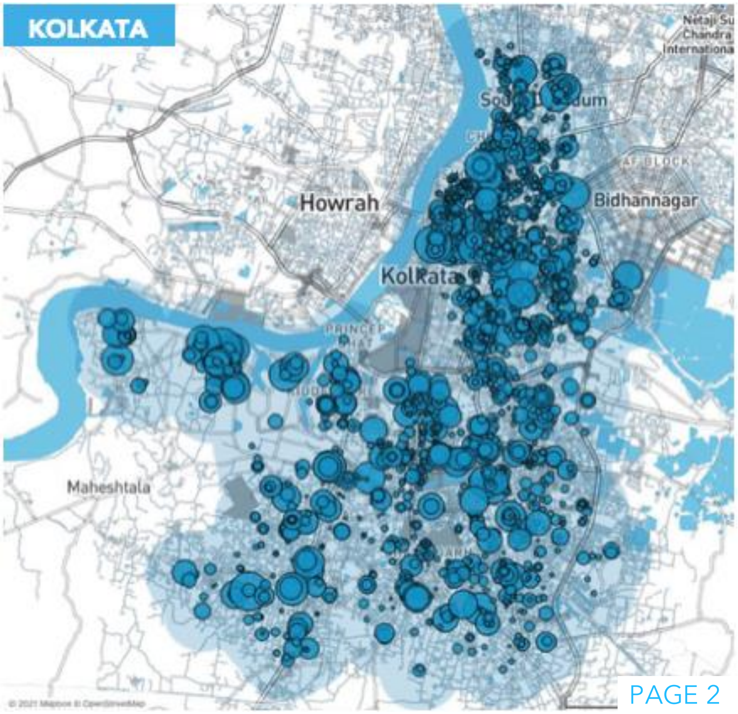

Figure 1: Map of Splash supported schools in Kolkata indicating school size and catchment area.

CONTEXT: WATER SUPPLY IMPROVEMENTS IN KOLKATA

Since 2013, the Kolkata Municipal Corporation (KMC) has led significant improvements in water supply infrastructure and management. In particular, the Kolkata Environmental Improvement Project (KEIP, 2000-2013) and the Kolkata Environmental Improvement Investment Program (KEIIP, 2014-2023) supported by the Asian Development Bank (ADB) were critical [1,2]. The city has an ambitious to radically reduce water loss and create a pressurized, 24/7 metered, billable water supply. These changes are illustrated in **Figure 2**.

- → Rehabilitation of aging infrastructure including water treatment plants and pipe networks
- → Construction of booster stations to improve continuous pressure
- → Laying of new water supply pipeline and reduction in water leaks
- → Introduction of metering for water consumption and billing

Despite these municipal infrastructure improvements, there continue to be challenges with ensuring water quality at the school due to breakages and contamination within the school compound itself – either from water storage (underground or above-ground) or at the point of use (handwashing or drinking stations). Additionally, some schools rely on non-municipal supply sources, which introduces other possible contaminants – requiring on-site water treatment solutions.

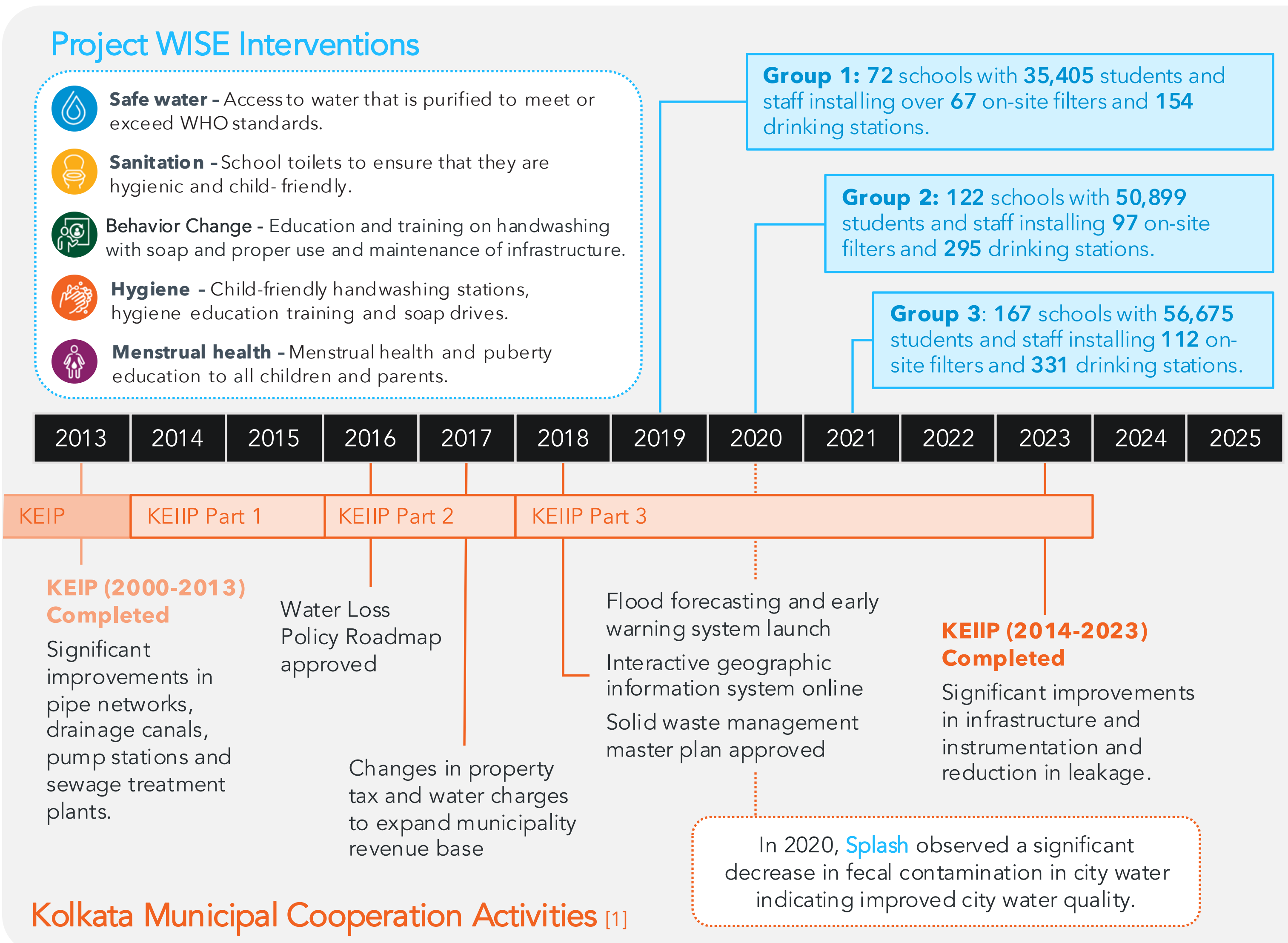

Figure 2: Timeline of Splash and KMC Activities

RESULTS: WATER QUALITY OVER TIME

About these charts

A Beeswarm chart has been used to visualize the distribution of sample results across time and school groups. This chart allows for individual data points to be displayed without overlap, making it easy to detect clusters, trends, and outliers in contamination levels.

Between 2015 and 2024, water quality sampling was conducted at government-funded schools to monitor the presence of total coliform and E. coli bacteria (**Figure 3**). This long-term monitoring initiative aimed to ensure safe drinking water for students and staff. Sampling data was collected regularly, and the results were analyzed to identify trends and problem areas. These results include both filtered and unfiltered, city water.

Throughout the sampling period, the data showed a significant improvement in water quality. In the early years more than half of schools recorded elevated levels of total coliform and E. coli contamination, promoting the installation of filtration systems and improved maintenance schedules. Over time, however, the city's water quality improvement projects resulted in reductions in both contaminants.

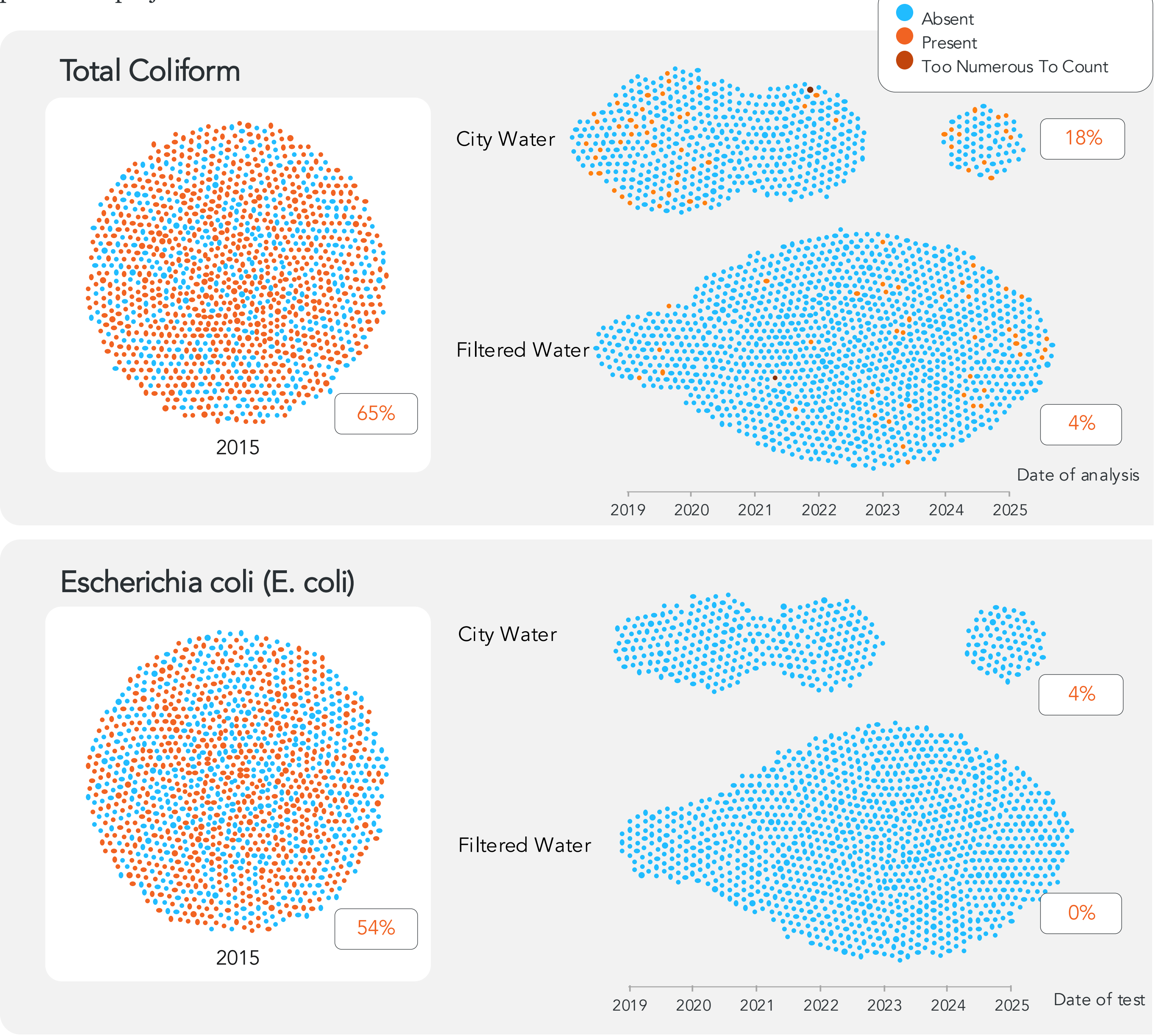

Figure 3: Beeswarm plots of Total Coliform and E.coli test results over time, by project group.

RESULTS: WATER QUALIY OVER SEASONS

Seasonal water quality monitoring during Project WISE revealed significant variation across the year, when considering both filtered and unfiltered, city water focused on total coliform. These trends are illustrated using both a *Beeswarm* plot (**Figure 4**) and a stacked bar chart (**Figure 5**) below.

Total coliform was most prominent leading up to and during the monsoon (March–May) and continued through the summer (June–August). The two indications of "Too Numerous To Count" both occurred during the winter months (October and November). However broadly the winter season showed improved water quality.

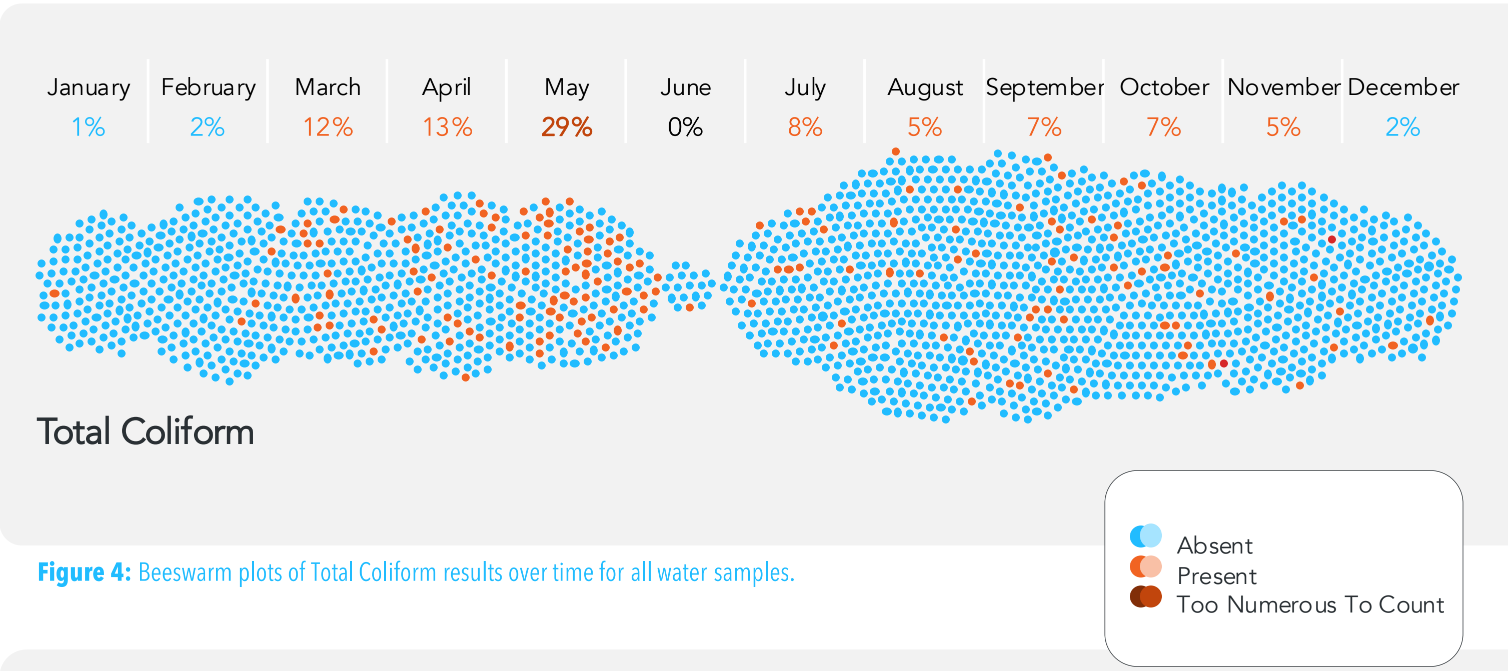

Figure 4: Beeswarm plots of Total Coliform results over time for all water samples.

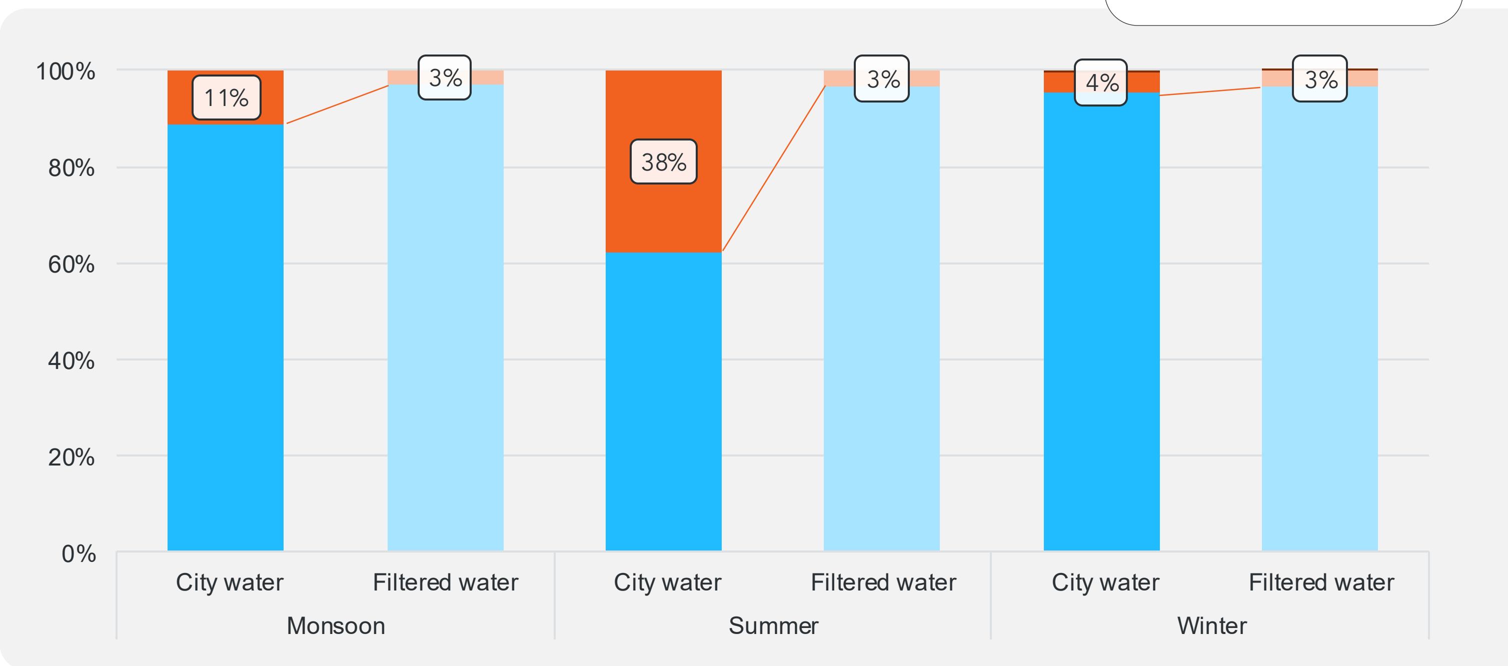

Figure 5: Stacked bar chart of Total Coliform results by sample type and season.

RESULTS: WATER CONTAMINANTS

Water quality monitoring in schools showed most samples met World Health Organization (WHO) guidelines [13]. Arsenic, nitrate, fluoride, free chlorine, and manganese levels were within limits. Iron exceeded limits in 3% of samples but improved after interventions. Total coliforms were found in 8% of samples, mostly in unfiltered water, with increased contamination in 2024. This increase also included filtered samples. E. coli was rare (0.1%), found only in unfiltered water. Filtered water generally had lower contaminant levels, especially for nitrates and iron. Free chlorine levels remained stable, confirming water disinfection. Overall, filtration reduced contaminants and improved water safety.

Total Coliform

Presence of total coliforms:

- **Pre-project WISE**: *65%*
- **Unfiltered**: *18%*
- **Filtered**: *4%*

Unfiltered, city water was more contaminated before Project WISE indicating city-wide improvements were successful.

There was a significant difference in the number of positive tests between filtered and unfiltered water at Project WISE sites.

n=3246

E.Coli

Presence of E.coli:

- **Pre-project WISE**: *54%*
- **Unfiltered**: *4%*
- **Filtered**: *0%*

Unfiltered, city water was more contaminated before Project WISE indicating city-wide improvements were successful.

There was a significant difference in the number of positive tests between filtered and unfiltered water at Project WISE sites.

n=2874

Arsenic

All samples were under the WHO guideline of 0.01 mg/L.

Average level unfiltered: *0.002 mg/L*

Average level filtered: *0.002 mg/L*

There was no difference in arsenic levels between filtered and unfiltered water.

There was no change in arsenic levels over time.

n=1373

Iron

3% of samples were over the WHO threshold of 0.3 mg/L.

Average level unfiltered: *0.14 mg/L*

Average level filtered: *0.07 mg/L*

There was a difference in iron levels between filtered and unfiltered water where Splash installed prefilters.

Iron levels in unfiltered water were variable but dropped significantly in 2024.

n=1730

Nitrate

All samples were under the WHO guideline of 50 mg/L.

Average level unfiltered: *2.31 mg/L*

Average level filtered: *1.79 mg/L*

There was a significant difference in nitrate levels between filtered and unfiltered water.

Nitrate levels in both filtered and unfiltered water fluctuated over time as anticipated.

n=1917

Free Chlorine

All samples were under the guideline of 5 mg/L.

Average level unfiltered: *0.09 mg/L*

Average level filtered: *0.10 mg/L*

There was a minimal difference in free chlorine levels between filtered and unfiltered water indicating that municipal water is chlorinated.

There was no variation in chlorination levels over time.

n=1553

Fluoride

All samples were under the WHO guideline of 1.5 mg/L.

Average level unfiltered: *0.31 mg/L*

Average level filtered: *0.29 mg/L*

There was minimal difference in fluoride levels between filtered and unfiltered water.

Fluoride levels in unfiltered water dropped after 2018.

n=1727

Manganese

1% of samples were over the WHO guideline of 0.4 mg/L.

Average level unfiltered: *0.06 mg/L*

Average level filtered: *0.06 mg/L*

There was no difference in manganese levels between filtered and unfiltered water.

Broadly Manganese levels remained low.

n=1329

Iron: The WHO does not provide a health-based guideline for iron, rather a threshold for taste/color.
Manganese: The WHO provides two guidelines: 0.4 mg/L for health and 0.1 mg/L for taste acceptability.

RESULTS: IMPACTS OF ON-SITE FILTRATION

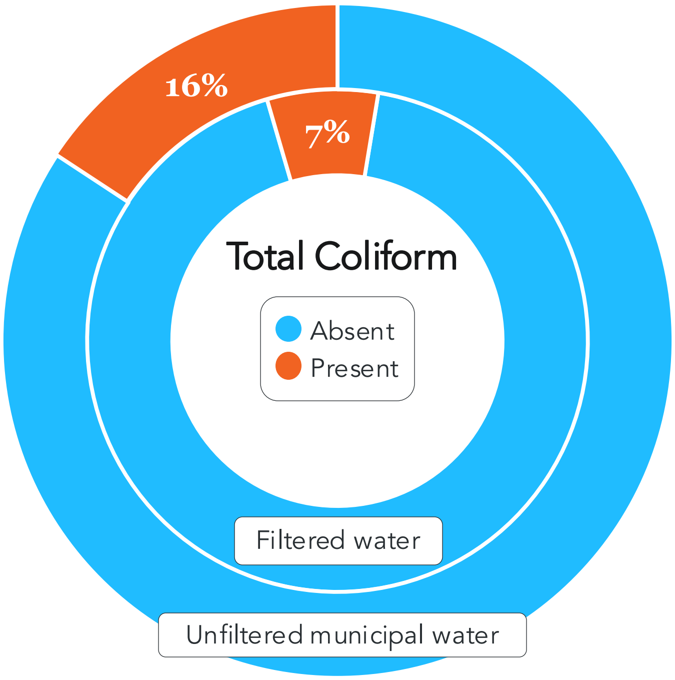

Figure 6: Donut chart of Total Coliform presence and absence before (outer) and after (inner) filtration

In 2024, the team conducted water sampling for 70 schools sampling both handwashing stations (unfiltered water from the municipal water supply) and drinking water stations (filtered water) to explore the efficacy of the water filters. These differences are illustrated in **Figure 6**. Total Coliform is presented here as an indicator of filter efficacy. The inside of the donut is filtered water, the outside unfiltered.

Overall, the Splash's on-site filtration was very effective. In 16% of the schools, the municipal water had presence of coliforms before filtration. Whereas only 7% of schools had contamination after filtration:

- In 4% of schools there was **still** contamination after filtration.
- In 3% of schools there was **new** contamination after filtration.

LESSONS & RECOMMENDATIONS

Drawing on Splash's experiences of supporting improved water quality in a changing urban water context, we have identifiedd eight key lessons and recommendations:

- **Standardize testing & reporting**: Inconsistent lab methods (e.g., reporting arsenic differently) complicated analysis. Future efforts should align protocols, thresholds, and number precision.
- **Monitor seasonally:** Water quality varied significantly by season, underscoring the need for regular monitoring, especially during warm and wet periods.
- **Maintain on-site treatment:** Even with improved municipal supplies, risks from pipeline leaks, poor storage, and point-of-use behaviors mean on-site filtration remains essential.
- **Sustain annual testing**: As Splash phases out, schools must continue required annual water quality tests and act on results, mirroring practices during project implementation.
- **Prioritize storage tank hygiene:** Many schools rarely clean underground reservoirs or overhead tanks, which often lack covers, leading to contamination; routine cleaning is critical.
- **Address pipeline vulnerabilities:** Leaks and breakages in water supply lines—especially during monsoons—serve as contamination points and require proactive inspection and maintenance.
- **Strengthen end-point behaviors:** Improper use of drinking taps for handwashing or other tasks contaminates outlets; continued emphasis on proper use and regular tap disinfection is needed.
- **Tailor treatment to water sources:** Not all schools receive municipal water; borewells and mixed sources may have high iron, nitrates, or arsenic, requiring specific pre-treatment solutions.

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Further information:
splash.org/our-work/project-wise

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