With funding from the Conrad N. Hilton Foundation, the Aquaya Institute tested for chemicals and heavy metals in drinking water in Asutifi North District, Ghana, in October 2024. Aquaya analyzed water samples from 50 water points serving schools and healthcare facilities. This testing was part of the WaterTRACS initiative.

WaterTRACS
(Testing, Research, and Capacity Strengthening) Initiative

CHEMICALS AND HEAVY METALS IN DRINKING WATER IN ASUTIFI NORTH DISTRICT, GHANA

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SUMMARY

- We tested water quality parameters at 50 water points from schools and healthcare facilities.
- Some water points exceeded drinking water standards for parameters with low health implications, like pH, turbidity, and iron. These parameters do not directly affect health but may be unpleasant to users and can interfere with treatment efforts.
- All samples met drinking water standards for arsenic, cadmium, cyanide, and mercury, indicating no measurable negative impacts from mining activities. Fluoride and nitrogen were also within safe limits.
- Lead levels exceeded drinking water standards in a few water points, which may have severe health implications.

RECOMMENDATIONS

- To address lead in drinking water:
  - Water suppliers should construct new infrastructure using certified lead-free parts.
  - National authorities should mandate regular lead testing of drinking water.
  - Local authorities should raise awareness of lead-contaminated supplies and alternative water sources among consumers.
  - New research should identify low-cost and practical lead removal strategies.
- While chemical contamination can be of great concern, most water-related health problems arise from microbial contamination; therefore, microbial surveillance should be prioritized.

BACKGROUND

Globally, microbial drinking water quality remains a top health concern in low- and middle-income countries.[1] There are also health risks associated with chemicals like fluoride, arsenic, and nitrates, which may be present in drinking water.[1] Further, growing evidence indicates widespread lead contamination in drinking water supplies, often being introduced through lead-containing water system components.[2] In Ghana, including Asutifi North District, mining operations have also significantly contributed to environmental and drinking water contamination.[3]

Enumerators in Asutifi North conducting water quality tests on drinking water

With funding from the Conrad N. Hilton Foundation, The Aquaya Institute is monitoring microbial water quality over time in two districts in Ghana (see prior research briefs). In October 2024, Aquaya also tested chemical water parameters at a subset of water points to get a more comprehensive picture of water quality, including contaminants with known health risks and physiochemical parameters affecting user acceptability.

METHODS

Aquaya visited primary water points at 58 institutions, randomly selected from all public schools and healthcare facilities in the Asutifi North district. Eight (16%) were unavailable for testing due to breakdown or other reasons. We collected drinking water samples from the remaining 50 water points — 42 at schools and 8 at healthcare facilities.

DRINKING WATER SAMPLES TESTED IN ASUTIFI NORTH

50 Water points tested, including:

42 at **Schools**

8 at **Healthcare facilities**

Aquaya tested physicochemical parameters (pH, turbidity, and electrical conductivity) on-site with portable meters and collected samples to be tested for arsenic, cadmium, cyanide, fluoride, iron, lead, mercury, and total oxidized nitrogen (TON) by SGS Laboratory Services Ghana Limited in Tarkwa and Tema, Ghana. Cyanide, fluoride, and TON were measured using an ion-selective electrode following APHA 4500 Methods, and heavy metals (arsenic, cadmium, iron, lead, and mercury) were measured using inductively-coupled plasma mass spectroscopy (ICP-MS) following EPA 200.8 Methods. Samples for metals analysis were acidified with concentrated nitric acid.

For water points that could be shut off (e.g., piped systems, handpumps, rainwater collection), we asked operators to close water points overnight (for 8-18 hours[4]) and collect "first-draw" samples of the first water leaving the system in the morning. These samples were tested for lead, with the purpose of identifying whether excess lead may be leaching from water system components after a period of water stagnation. We tested lead concentrations in 47 first-draw samples.

RESULTS

PARAMETERS WITH LOW HEALTH IMPLICATIONS

Four-fifths of samples (80%) had pH below the Ghana drinking water standard minimum value of 6.5, which may cause corrosion of metal parts in the water system. One-tenth of samples (10%) had turbidity above the standard of 5 NTU, which may reduce chlorine's treatment effectiveness and may be visually unpleasant to water consumers. One sample (2%) had iron levels above the standard of 0.3 mg/L. Elevated iron does not represent a known health risk, but water consumers may not like the water's taste or appearance. All samples had electrical conductivity within the standard range.

Table 1: Summary of drinking water standards and test results for parameters with low health implications

	Limit (Ghana Standards Authority[5])	% outside of limits (n=50)	Likely origin	Implication of being outside limits
pH	6.5 – 8.5	**80% (all below)**	pH is determined from source water characteristics and treatment processes, and may be influenced by human activities such as mining	Low pH may corrode water system hardware; high pH may reduce effectiveness of chlorine treatment
Turbidity	5 NTU, max	**10%**	Naturally suspended or dissolved materials	High turbidity may be visually unpleasant, indicate presence of other contaminants, and reduce effectiveness of chlorine treatment
Electrical Conductivity	1500 µS/cm, max	**0%**	Dissolved salts, minerals, and metals	Water with high electrical conductivity may be visually unpleasant or may have an unpleasant (salty) taste
Iron	0.3 mg/L, max	**2%**	Naturally occurring in earth deposits; corrosion of iron-containing materials in water point components	High iron may be visually unpleasant, may taste unpleasant, and may reduce effectiveness of chlorine treatment

PARAMETERS WITH HIGH HEALTH IMPLICATIONS

We analyzed a set of chemicals (cyanide, fluoride, TON) and heavy metals (arsenic, cadmium, lead, mercury) that have known negative health impacts. Several of these may be introduced by gold mining activities in Asutifi North District, including cyanide, arsenic, cadmium, lead, and mercury. Fluoride and arsenic were included due to their recognition as priority chemicals by the international WHO/UNICEF Joint Monitoring Programme, and nitrogen was included due to its persistence in rural areas.

All samples met the Ghana drinking water standard for cyanide, fluoride, TON, arsenic, cadmium, and mercury. This implies that gold mining operations have not negatively impacted drinking water supplies at the institutions included in our sample.

Overall, **4% of samples had lead levels above the Ghana standard** of 10 µg/L, or 10 parts per billion (ppb). Because of its health impacts, we include more information about lead in the following section.

Table 2: Summary of drinking water standards and test results for parameters with high health implications

	Limit (Ghana Standards Authority[5])	% outside of limits (n=50)	Likely origin	Implication of being outside limits
Cyanide	70 µg/L, max	**0%**	Contamination from mining activities	High cyanide may lead to negative neurological and thyroid effects
Fluoride	1.5 mg/L, max	**0%**	Naturally occurring in earth deposits	High fluoride may cause dental and skeletal fluorosis
Total Oxidized Nitrogen (TON)	50 mg/L, max	**0%**	Contamination from agricultural activities (fertilizers) or poorly-sited or maintained latrines or septic tanks	High TON may lead to negative blood or thyroid effects, especially in infants
Arsenic	10 µg/L, max	**0%**	Naturally occurring in earth deposits; contamination from mining activities	High arsenic is carcinogenic and may lead to negative cardiovascular and neurodevelopmental effects
Cadmium	3 µg/L, max	**0%**	Contamination from mining activities	High cadmium may lead to kidney and bone damage
Lead	10 µg/L, max	**4%**	Most commonly from lead-containing materials in water system components	High lead may lead to negative neurodevelopmental effects, particularly in children
Mercury	1 µg/L, max	**0%**	Contamination from mining activities	High mercury may lead to neurological and behavioral disorders

SPOTLIGHT: LEAD IN DRINKING WATER

In some cases, lead is present in drinking water from naturally-occurring sources. However, in most cases, **lead contamination in drinking water comes from lead-containing components in water systems, such as pipes, faucets, and plumbing fixtures.** Exposure to lead in drinking water may lead to negative neurodevelopment effects, with infants and children being most vulnerable.[2]

Enumerators in Asutifi North conducting water quality tests on drinking water

There is no safe level of lead in drinking water.[2] In this brief, we define detectable lead as above 5 µg/L (ppb) due to the reporting limit of the analytical method used (ICP-MS, USEPA Method 200.8). We also report lead values above 10 ppb, which is the maximum level allowed by the Ghana Standards Authority and is the WHO provisional guideline value for lead in drinking water.

More than one-in-ten (12%) drinking water samples had detectable lead (>5 ppb) and 4% exceeded the Ghana drinking water standard limit of ppb, including **2% of school samples and 12% of healthcare facility samples**. Piped system taps had more detectable lead (16%, n=31) than handpumps (5%, n=19), but no difference was observed in samples exceeding the drinking water standard of 10 ppb.

Elevated lead in drinking water was more common when pH was low. Among samples with pH below 6.5, 15% had detectable lead (>5 ppb), while no samples with pH above 6.5 had detectable lead. Low pH promotes corrosion of water system components, which can release metals into the water, including lead, if present.

FIRST-DRAW SAMPLES

We tested 47 first-draw samples – 30 from piped system taps and 17 from boreholes with handpumps. Overall, 6% of first-draw samples exceeded 10 ppb, compared to 4% of random daytime samples. Lead levels were not statistically different between first-draw samples and daytime samples for any water point type, though sample sizes were too small for a robust comparison.

DEFINITIONS

First draw samples *refer to those taken from a water source after it has been turned off for a period of 8 to 18 hours.*

Daytime samples *are collected randomly during regular usage.*

SUMMARY

PARAMETERS WITH LOW HEALTH IMPLICATIONS

Some water points did not meet the limits defined by Ghana Standards Authority. Most water points had acidic water (pH below 6.5); one-tenth of water points were turbid, or cloudy; and one sample had high iron. While these exceedances do not have direct negative health implications, they may be unpleasant to water users, may suggest presence of other contaminants, may interfere with treatment processes, and should continue to be monitored. All samples met drinking water standards for electrical conductivity.

PARAMETERS WITH HIGH HEALTH IMPLICATIONS

All samples met drinking water standards for cyanide, fluoride, TON, arsenic, cadmium, and mercury, but 4% exceeded recommended lead levels, which may have severe health implications.

RECOMMENDATIONS

1 To address lead in drinking water:

- Water suppliers should construct new infrastructure using certified **lead-free parts.**
- National authorities should mandate **regular lead testing of drinking water.**
- Local authorities should **raise awareness of lead-contaminated supplies and alternative water sources among consumers**
- New research should identify low-cost and practical lead removal strategies.

2 While chemical contamination can be of great concern, most water-related health problems arise from microbial contamination[1]; therefore, **microbial surveillance should be prioritized.**

REFERENCES

1. WHO. *Guidelines for Drinking-water Quality: Fourth Edition Incorporating the First and Second Addenda.* (World Health Organization, 2022).
2. World Health Organization. Lead in drinking-water: health risks, monitoring, and corrective actions. (2022).
3. Ewool, J., Blankson, E. R., Quartey, J. K., Kyerematen, R. & Gbogbo, F. Heavy metal concentrations in drinking water sources in two mining districts in Ghana. *Heliyon* **10**, e33296 (2024).
4. US EPA. Lead Sample Collection Field Guide for Schools and Child Care Facilities. (2022).
5. Ghana Standards Authority. Draft Ghana Standard DGS 175:2021. Water Quality – Specification for drinking water. (2021).
6. Tam, Y. S. & Elefsiniotis, P. Corrosion control in water supply systems: Effect of pH, alkalinity, and orthophosphate on lead and copper leaching from brass plumbing. *J. Environ. Sci. Health Part A* **44**, 1251–1260 (2009).