Arizona Wastewater Monitoring Program

Arizona's wastewater monitoring program has rapidly evolved from its pandemic-era origins into a cornerstone of the state's broader infectious disease surveillance strategy. Managed by the Arizona Department of Health Services (ADHS) in partnership with the Arizona State Public Health Laboratory, academic researchers, and local utilities, the program provides near real-time insights into circulating pathogens and emerging threats.

Wastewater samples are collected twice weekly from multiple counties, representing 50% of the state's population. Most collections come from municipal water resource recovery facility influent using 24-hour composite sampling, although selected upstream sites provide more granular, community-level data. Currently, the program is tracking SARS-CoV-2, influenza A (including the H5 subtype), influenza B, and respiratory syncytial virus (RSV). Validation efforts are underway to expand capacity to include the emerging threats presented by mpox and arboviruses.

In late 2024, Arizona experienced an outbreak of highly pathogenic avian influenza (H5N1). Following the confirmation of H5N1 on a commercial poultry farm in Pinal County on November 11, wastewater detections quickly followed across disparate parts of the state. The first signal appeared in Flagstaff on November 14, followed by detections in Tempe, Phoenix, and elsewhere later that month.

These findings prompted engagement among ADHS, county health departments, laboratory partners — including the Hepp Lab at the Translational Genomics Research Institute (TGen) — and wastewater utilities to investigate potential sources contributing to detections in wastewater. TGen performed cytochrome oxidase testing on positive wastewater samples to detect species-specific DNA, confirming that wild bird and chicken DNA were present in selected samples. This molecular evidence strengthened confidence in the wastewater signals and provided valuable ecological context. Based on evidence resulting from the surveillance system, Coconino and Maricopa Counties issued public press releases to inform residents about H5 Avian Influenza detections in wastewater.

Notably, this marked the first instance since the COVID-19 pandemic in which Arizona's wastewater surveillance program directly informed timely public health action. By offering a geographically broad and relatively low-cost surveillance tool, the system filled information gaps and provided state and local agencies critical insights to guide their response to an emerging threat.

The Arizona program still is expanding, with plans to onboard new sites and eventually capture a greater proportion of the state's population. As infrastructure matures,

ADHS envisions wastewater surveillance as a flexible platform capable of detecting not just seasonal respiratory viruses, but also pathogens of agricultural and zoonotic concern.

Learn more about the Arizona Wastewater Monitoring Program and explore its latest data at the ADHS website.

Hawaii Department of Health

Since its launch in June 2022, the Hawaii Department of Health's (DOH) wastewater surveillance program has steadily evolved from a means to track SARS-CoV-2 into a flexible platform promising early detection of a range of infectious diseases throughout the Hawaiian Islands. Supported by the U.S. Centers for Disease Control and Prevention's National Wastewater Surveillance System (NWSS), the program tracks key public health threats such as influenza, RSV, and norovirus at both the community and facility level.

The backbone of the program is weekly sampling from water resource recovery facilities (WRRFs) and long-term healthcare facilities (LTCFs). Sampling consists of 24-hour composite grabs collected via autosamplers from WRRFs. For LTCFs, where flow rates are lower and sampling can be more nuanced, staff deploy both autosamplers and passive Moore swabs to capture representative data.

Participation is voluntary both for WRRFs and LTCFs, but once onboard, LTCFs undergo a field assessment to identify viable manholes with proper discharge flow, and families of residents are asked to provide consent.

In laboratories, researchers analyze samples via digital PCR using molecular assays. While routine sequencing is not yet part of the workflow, the team has begun validating workflows using a respiratory viral panel and also is exploring opportunities in metagenomic sequencing, laying the groundwork for future capabilities.

Hawaii's geography presents distinct challenges for sample transportation, especially for inter-island shipping. While samples are typically delivered overnight, delays — particularly during holidays — have led to temperature excursions and discarded samples. Despite efforts to resolve this with couriers, Hawaii DOH has had to accept this as part of the logistical reality and factor it into planning.

The payoff, however, has been significant. In one LTCF, persistent SARS-CoV-2 signals in wastewater preceded a confirmed outbreak by 3 weeks, allowing staff to ramp up screening, isolate residents, and tighten visitor policies — steps that likely curbed wider transmission. In another case, a WRRF sample tested positive for H5 influenza A on November 7, 2024, triggering rapid, cross-agency coordination. The Hawaii Department of Agriculture traced the signal to a backyard flock in the same sewershed. Within 2 weeks, a full response was underway — including sequencing, contact tracing, and epidemiologic investigation — ultimately linking the strain to a lineage first detected in Alaskan wild birds in 2022.

Looking ahead, the DOH is focused on adding new pathogenic targets into its program, automating lab workflows, developing sequencing capacity, and rolling out a live data dashboard for partners and the public.

Visit the Hawaii DOH website for the program's latest wastewater surveillance results.

Oregon State University/Oregon Health Authority

A wastewater-based surveillance program managed by Oregon State University (OSU) in collaboration with the Oregon Health Authority (OHA) supports routine public health surveillance at scales ranging from individual buildings to international sporting events.

What began in March 2020 with a U.S. National Science Foundation grant to monitor SARS-CoV-2 in four communities has since expanded into a statewide and multi-scale system. The program has informed public health decisions across multiple domains, from identifying hotspots of respiratory viruses to detecting emerging fungal pathogens in healthcare facilities.

The scope of Oregon's targets has grown substantially. Beginning with SARS-CoV-2, the program now monitors influenza A and B, RSV, norovirus, *Cryptosporidium*, and high-concern flu strains like H5. Specialized surveillance projects also have tracked pathogens such as measles, MERS, adenoviruses, and hepatitis viruses. In long-term care facilities, the team screens for *Candida auris* and carbapenemase-producing organisms (CPOs) using both molecular (digital PCR) and culture-based methods. In parallel, a U.S. Environmental Protection Agency-funded initiative that began in August 2024 sees the OSU/OHA team examining antibiotic resistance in wastewater nationwide, targeting resistance genes (e.g., *intI1*, *blaCTX-M*, *vanA*) and quantifying resistant *E. coli* and *Enterobacter* strains.

During the 2022 World Athletic Championships in Eugene, Oregon, the program monitored wastewater in the competition area for pathogens like adenovirus 40-41, SARS, MERS, influenza, and hepatitis, as well as performance-enhancing drugs.

Sampling strategies are tailored by scale. Citywide surveillance relies on 24-hour time-weighted composite samples from WRRF influent. In these instances, samples are filtered, stabilized in a DNA/RNA shield, bead-beaten, and undergo DNA/RNA extraction.

Neighborhood and building-level sampling takes place at carefully selected manholes or lift stations that isolate sewershed segments, with signal subtraction techniques used when complete isolation is not feasible. Filtration and stabilization procedures ensure consistent extraction protocols, and OSU has also piloted low-cost passive samplers to improve sustainability and scalability.

Communication has been one of the program's most important — and challenging — components. The team maintains direct relationships with participating utilities, who filter and stabilize samples onsite before mailing them to OSU. At the building and neighborhood scale, OSU staff and students handle field collection. A dedicated logistics

coordinator ensures samples are correctly labeled, tracked, and entered into the laboratory information management system. Proactive follow-up with utilities has helped maintain participation and data quality.

Program evaluation includes statewide feedback tours — bringing together wastewater, hospital, and public health representatives in each county. These meetings have improved cross-sector understanding and shaped plans for methodological and communication improvements.

Critically, Oregon's WBS data does not sit idle. Positive signals of *Candida auris* trigger immediate clinical testing in healthcare settings. Partners have undertaken campus surveillance to initiate dorm-wide testing when asymptomatic SARS-CoV-2 signals appeared. Statewide data feeds public dashboards, informs hospital staffing and supply needs, and guides local public health planning. A weekly, county-specific newsletter, sent to wastewater personnel, health officials, and hospital staff, contextualizes local data, shares success stories, and strengthens stakeholder engagement.

Learn more about the OSU/OHA Wastewater Surveillance program at its website, or visit the partnership's weekly, statewide respiratory viral pathogen wastewater monitoring dashboard.

San Mateo County Wastewater Surveillance Program

San Mateo County, California, has built a comprehensive wastewater-based surveillance system that not only strengthens pandemic preparedness, but also provides real-time insights into a broad range of infectious disease threats.

The surveillance effort draws a robust set of samples from eight water resource recovery facilities (WRRFs) countywide. Testing is distributed across three programmatic partnerships but relies on two laboratories. WastewaterSCAN and the U.S. Centers for Disease Control and Prevention's National Wastewater Surveillance System (NWSS) both contract testing through private laboratories, while the San Mateo County Public Health Laboratory (PHL) performs in-house analysis. Sampling occurs up to five days each week depending on the program and WRRF: one facility participates with WastewaterSCAN daily, two contribute twice weekly to NWSS, and four are sampled three times weekly with the PHL. A private courier transports samples directly from WRRFs to testing facilities.

The testing menu has expanded far beyond the needs of the COVID-19 pandemic. WastewaterSCAN now tracks influenza A (H1, H3, H5), influenza B, respiratory syncytial virus (RSV), human metapneumovirus (HMPV), enterovirus D68, norovirus GII, *Candida auris*, hepatitis A, and multiple mpox clades, in addition to SARS-CoV-2. The NWSS panels include similar pathogens, with emphasis on influenza, RSV, and mpox. San Mateo's PHL currently tests for SARS-CoV-2, influenza A (including H5), influenza B, and RSV, with plans to add more pathogens as capacity grows. All results are normalized to pepper mild mottle virus (PMMoV), improving comparability across sites and time.

While the data provide basic situational awareness, the county has developed mechanisms to take further action when unusual signals appear. For example, an H5 influenza detection in county wastewater raised immediate concern given the absence of local dairy or poultry operations. In response, public health leaders collaborated with a neighboring county to cross-check results, secured grant funding to purchase autosamplers, and conducted site visits at each WRRF to trace potential sources. The signal ultimately dissipated, but the incident led to stronger relationships with WRRF personnel and a greater familiarity with wastewater infrastructure, which facilitates future data interpretation.

San Mateo County shares wastewater-surveillance findings weekly with county leadership, with plans to integrate the data more formally into other local public-health reporting tools.

San Mateo's system has benefited from comparing notes with wastewater-monitoring colleagues in other jurisdictions. Through the National Association of County &

City Health Officials Wastewater Monitoring Mentorship program, the county first participated as a mentee in 2023, then returned as a mentor in 2024 and 2025. These exchanges have enabled local health jurisdictions with limited staffing and funding to share solutions, troubleshoot challenges, and co-develop best practices that would be difficult to achieve in isolation.

Though San Mateo County's surveillance program does not yet have a public-facing website, development is underway, with plans to create a dashboard for respiratory pathogen risks informed by wastewater data. Visit the San Mateo County Health website for updates.

Texas Wastewater Environmental Biomonitoring (TexWEB)

The Texas Wastewater Environmental Biomonitoring (TexWEB) program integrates broad sequencing coverage with direct collaboration between local and state health agencies to offer an unprecedented view of viral circulation in Texas communities. The program is a partnership between Baylor College of Medicine (BCM) and the UTHealth Houston School of Public Health, in collaboration with the Texas Epidemic Public Health Institute (TEPHI).

TexWEB currently collects weekly samples from 40 water resource recovery facilities (WRRFs) across 15 Texas cities, with coverage expanding statewide. Samples are processed at BCM using a capture enrichment method that enables simultaneous detection of more than 3,150 viruses, as well as over 15,000 distinct viral strains. Unlike traditional PCR-based approaches that rely on preselected targets, TexWEB's sequencing platform can detect all known viruses in a single reaction.

Every wastewater sample undergoes Illumina short-read sequencing and an in-house competitive read-mapping approach that assigns each read to a viral taxonomy and species, quantifies abundance, and tracks trends over time. Data are normalized using a quantitative index called RPKM (reads per kilobase per million mapped reads), allowing for standardized comparisons both across pathogens and between sequencing runs. Control viruses spiked into each assay provide additional quality checks and normalization. The result is a dataset that is both quantitative and taxonomically specific, capable of identifying not only which viruses are present, but which lineages or variants are emerging.

TexWEB monitors more than 550 viral targets weekly, including respiratory viruses (SARS-CoV-2, influenza A & B, RSV, avian H5N1); enteric pathogens (norovirus, rotavirus, enterovirus D68); vaccine-preventable diseases (measles, mumps, rubella, poliovirus); vector-borne threats (West Nile, dengue, chikungunya, Zika); and emerging pathogens such as mpox, Oropouche virus, and hemorrhagic viruses. Plans are also underway to extend surveillance to antimicrobial-resistant bacteria, including drug-resistant tuberculosis.

The program's impact is already evident. In 2024, TexWEB identified widespread H5N1 avian influenza RNA in 100 wastewater samples across 22 of 23 monitored sites, accounting for 10 Texas cities. Sequencing showed multiple origins aligning with bird and mammal genomes. While the analysis showed no mutations that would signal adaptation to humans, it prompted state and federal agencies to enhance preparedness and communication. Other TexWEB success stories include detection of elevated norovirus levels in schools which drove new hand-washing campaigns, identification of rising flu and COVID-19 signals at the Texas Medical Center that resulted in staffing adjustments, and

early measles detections in Houston's wastewater that prompted alerts to state and local health officials.

TexWEB provides a framework that offers thorough oversight of the process as well as smooth communication of its results. Dedicated working groups — including purpose-built teams for validation, action, modeling, and ethics — bring together experts across public health, environmental health, and data science. The TexWEB Public Data Dashboard provides transparency and statewide access to sequencing-based wastewater data.

Learn more about TexWEB at the TEPHI website.