

Wastewater Surveillance Program Overview & Implementation for COVID-19 and Fentanyl

VA Public Health Preparedness Summit
October 24, 2023

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Agenda

- WWS Background
- VDH WWS Program
 - COVID-19
 - Other Applications
- EO-26: Fentanyl

WWS Background

“Wastewater surveillance involves systematic sample collection, processing, and analysis followed by interpretation of wastewater data to inform public health practice.” [\(NWBE\)](#)

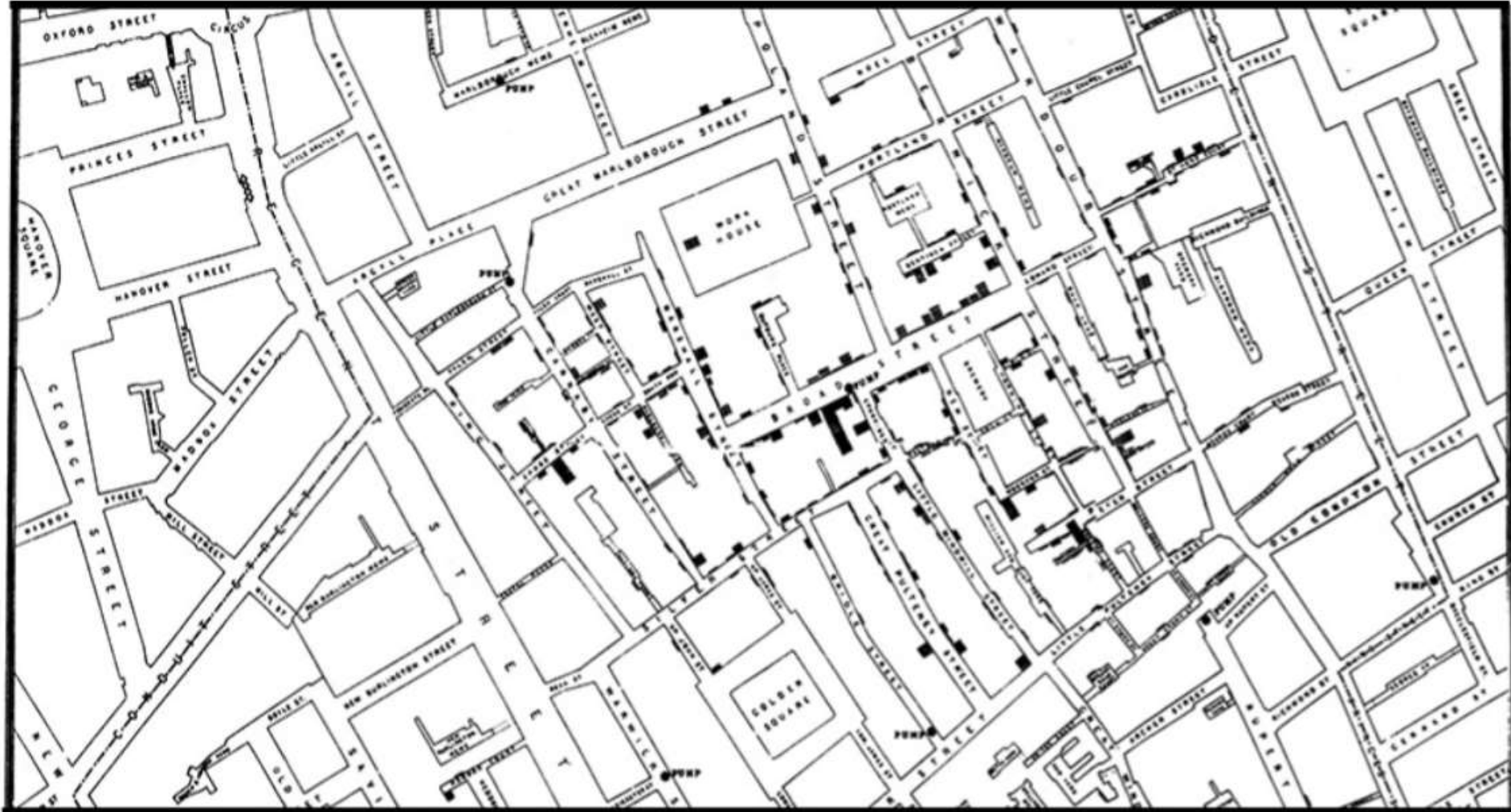
AKA, Wastewater-Based Epidemiology

AKA, Sewer Epidemiology

AKA, Environmental Surveillance

History of WWS

London, 1854



Map of cholera cases in Soho, London, 1854. Source: Wikimedia Commons.

CDC Blog, 2017

WWS Research Trends Through Time

Rise of Bacteriology

Late 1920's – *Bacilli typhosus* & *paratyphosus B* in community sewage (Wilson, 1933)

Rise of Virology

1939 – Polio in city wastewater (Paul et al., 1940)

1954 – Cell Culturing invented

1959 – 27 months of WWS to identify/isolate enteric viruses in Michigan (Bloom et al., 1959)

Environmental Concern

1974 – (U.S.) Safe Drinking Water Act,

1977 – (U.S.) Federal Water Pollution Control Act

1979 – WHO releases lengthy report on need for greater research into human viral fecal shedding into wastewater (WHO, 1979); EPA confirms (Safferman, 1982)

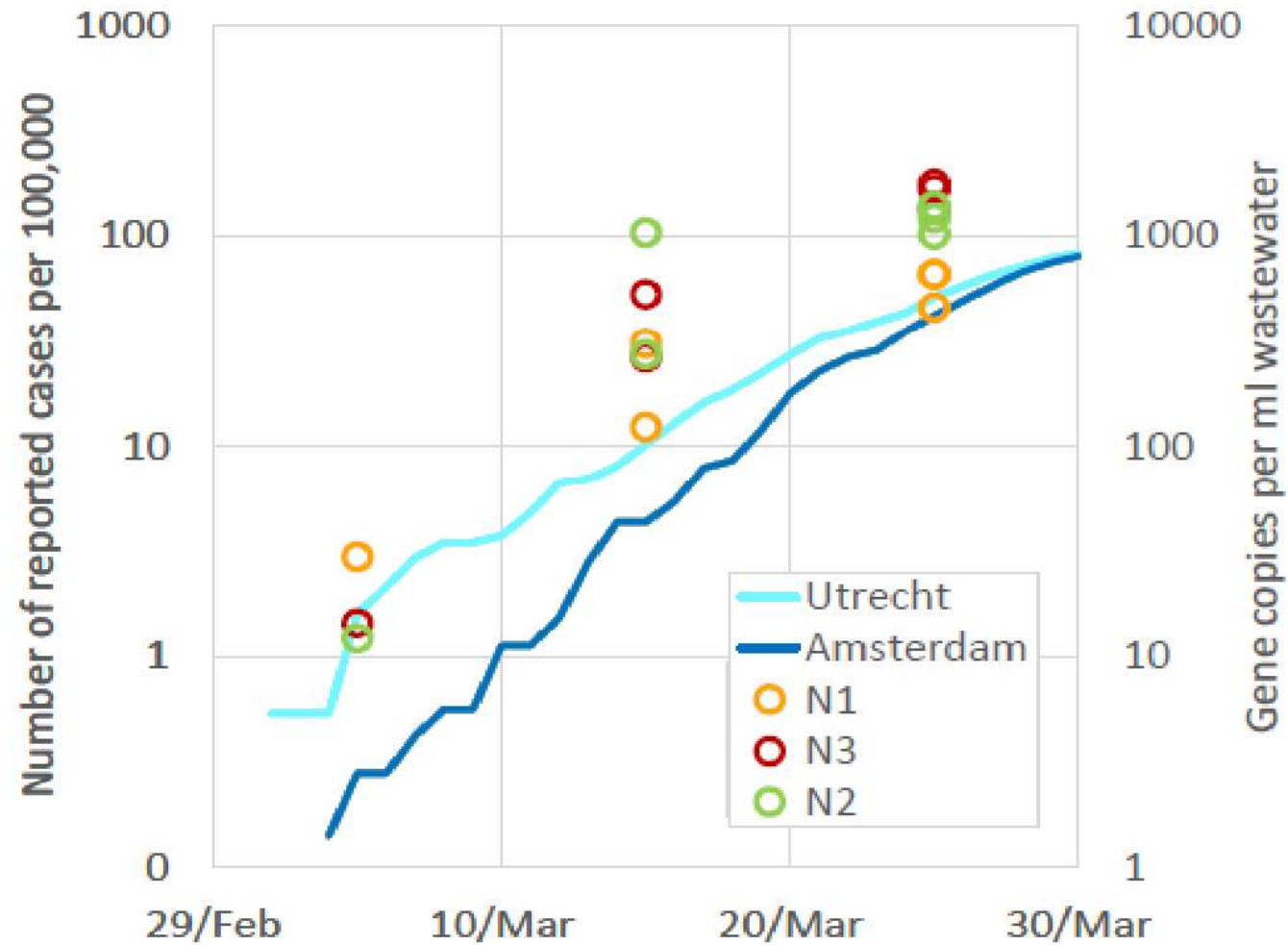
1983 – PCR invented

Public Health Applications

[Mostly enteric diseases and polio]

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COVID-19 Netherlands Study



Gertjan Medema, KWR Water Research Institute,
2020, Virtual International Research Summit

*COVID-19

[Coronavirus Disease 2019]

To date (10/4/23):

U.S. deaths: **1,144,539**

U.S. hospitalizations: **6,368,333**

*SARS-CoV-2

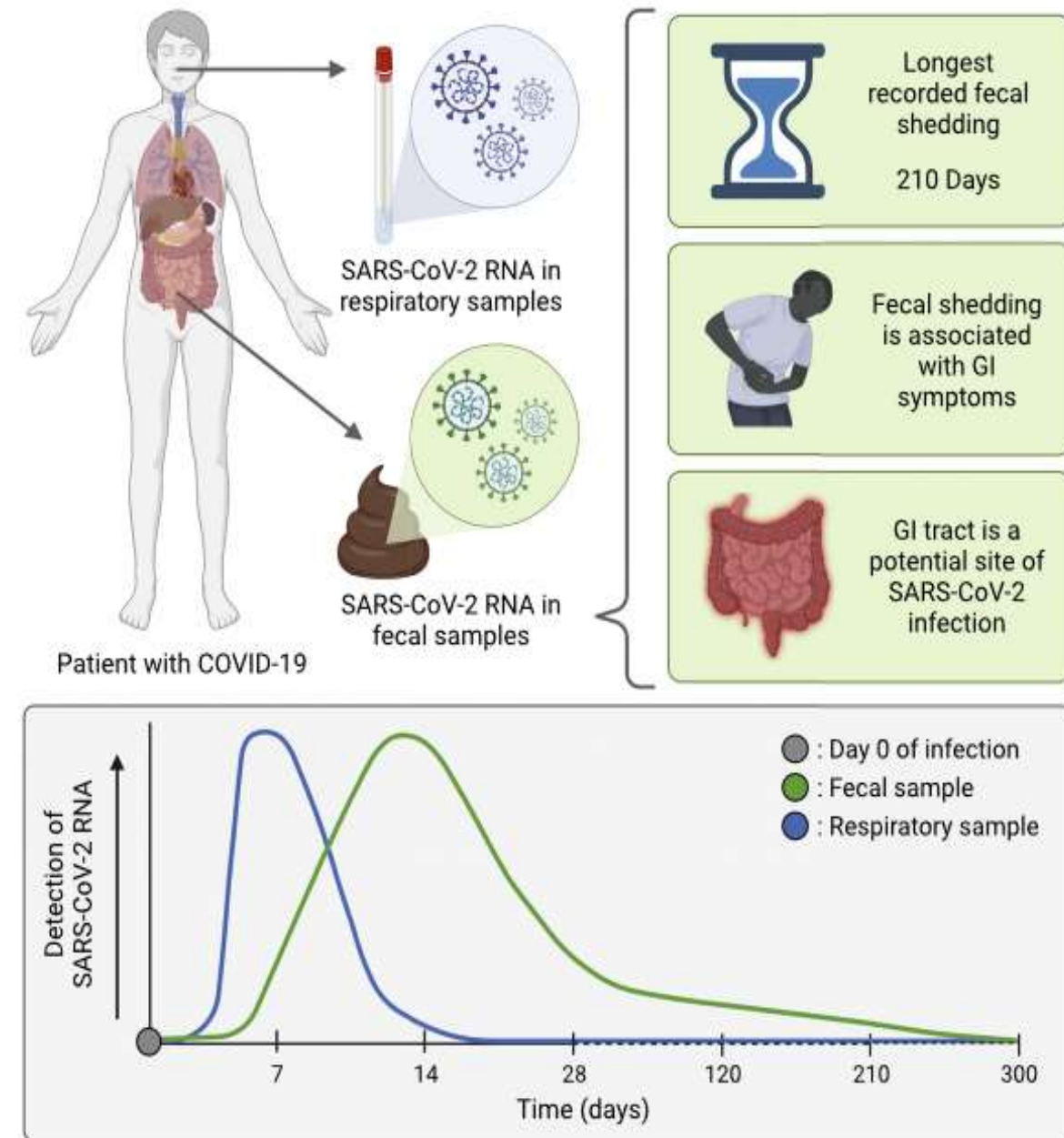
[Severe Acute Respiratory Syndrome Coronavirus-2]

Enveloped, single-stranded RNA virus with surface spike proteins

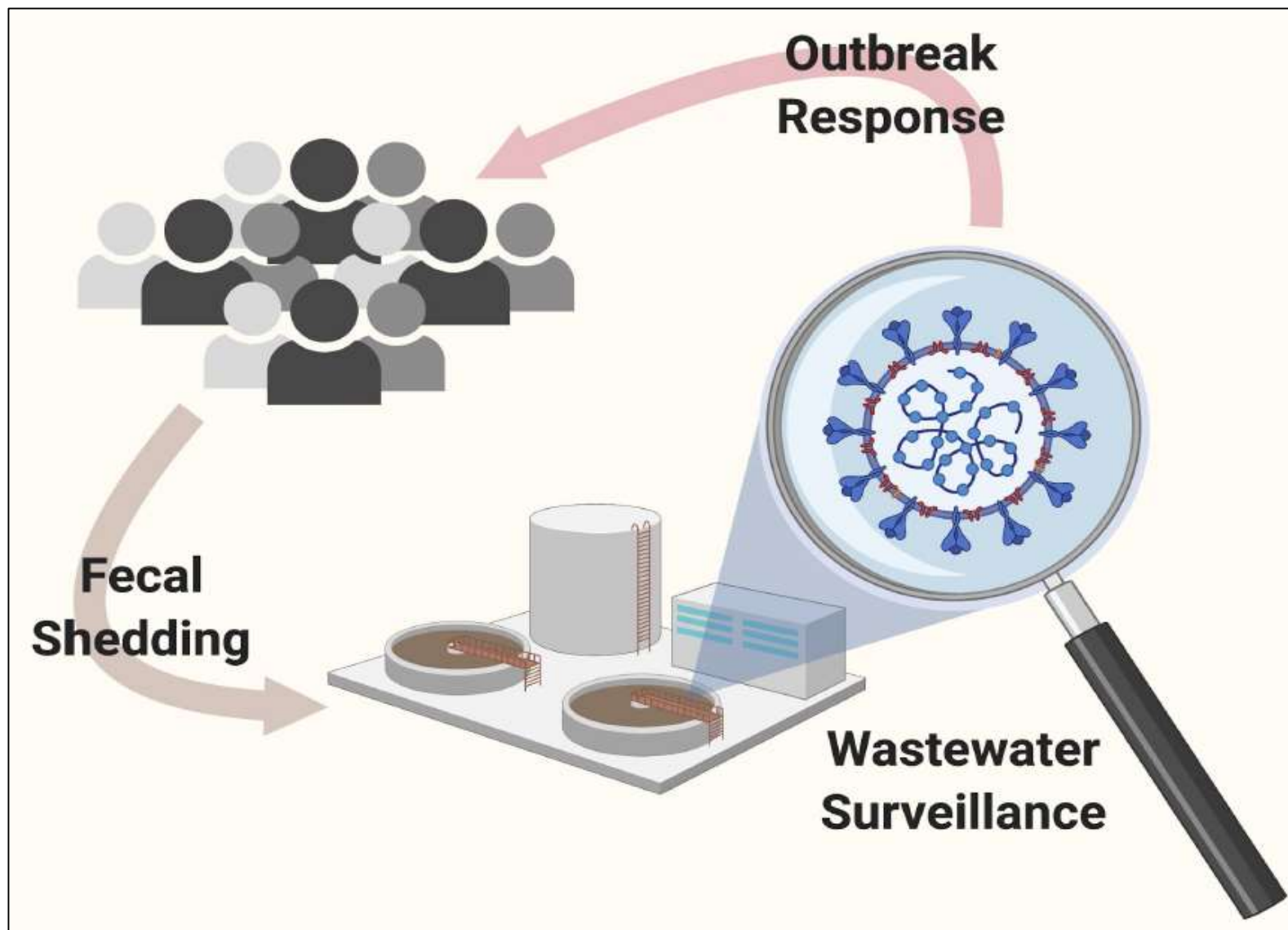
*Viral Binding Targets:

Host angiotensin converting enzyme 2 & transmembrane serine protease (lung, esophageal, intestinal cells) (Zhang et al., 2020)

*Viral Shedding



Natarajan et al. Gastrointestinal symptoms and fecal shedding of SARS-CoV-2 RNA suggest prolonged gastrointestinal infection. *Med*, 2022.



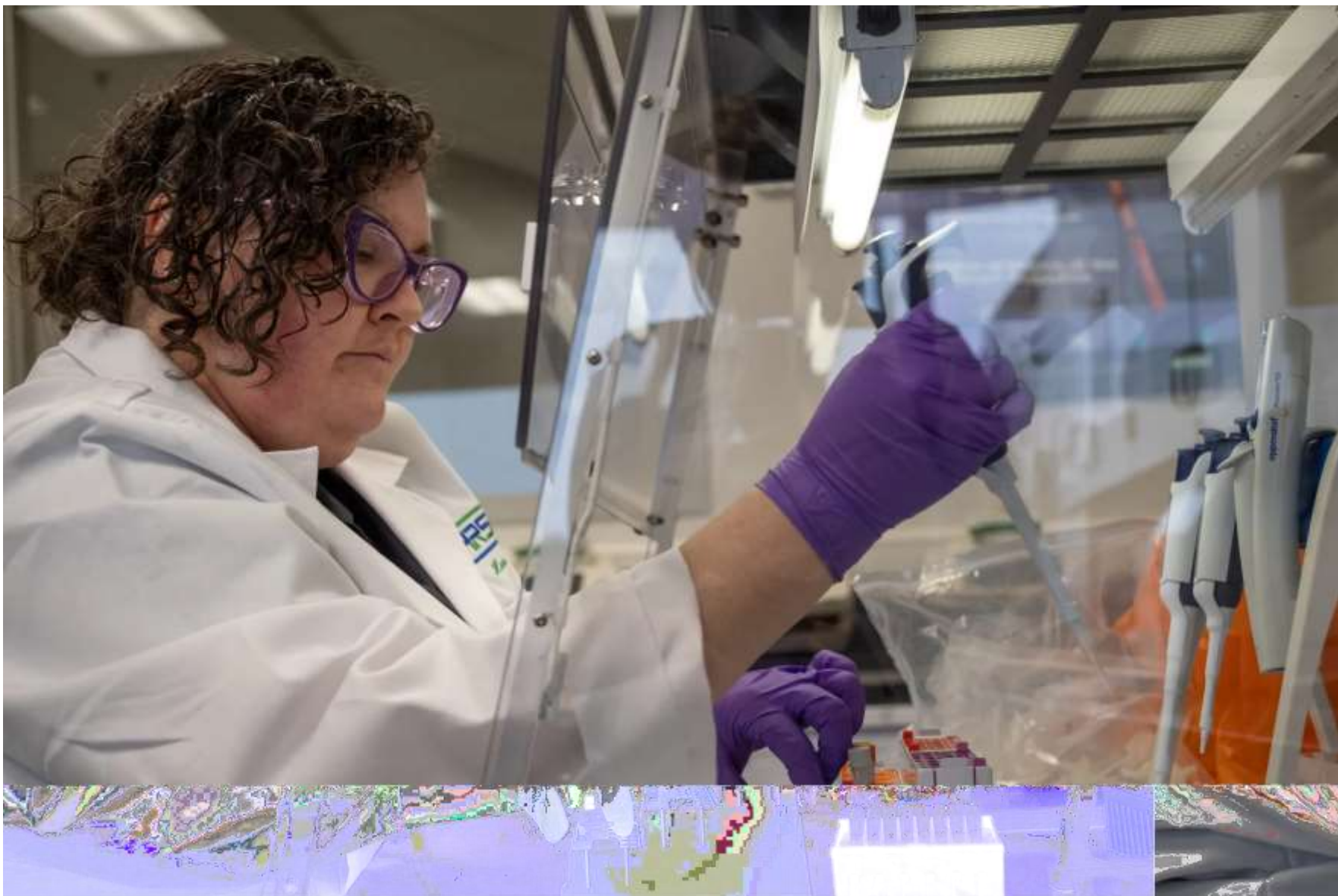
Aaron Bivins et al. Wastewater-Based Epidemiology: Global Collaborative to Maximize Contributions in the Fight Against COVID-19 *Environmental Science & Technology* 2020 54 (13), 7754-7757



Andy Fell. Wastewater Monitoring for Public Health.
UCDavis, Feb 7, 2022.



Huang and Rizzo. Tracking health threats, one sewage sample at a time. *NPR*, April 24, 2023.



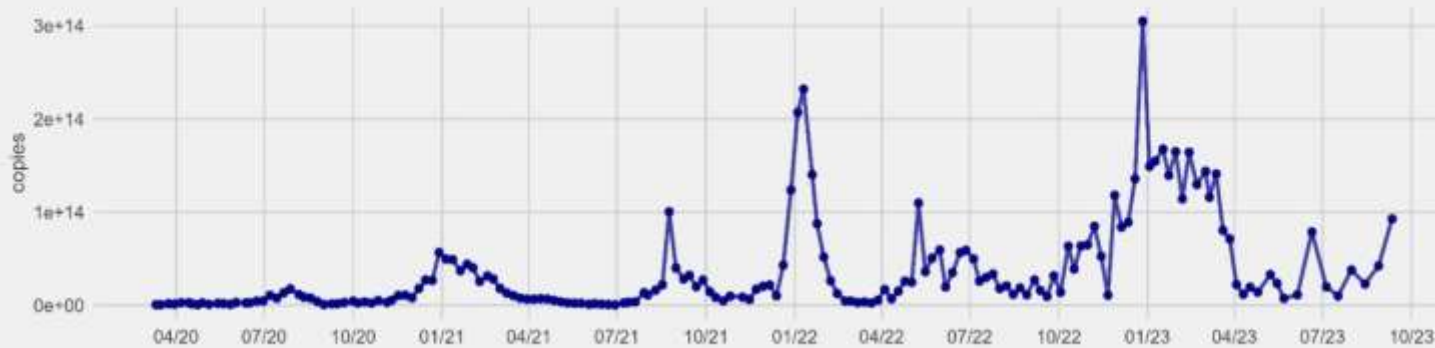
Huang and Rizzo. Tracking health threats, one sewage sample at a time. *NPR*, April 24, 2023.

Hampton Roads Sanitation District

Time Series – Regional Loading

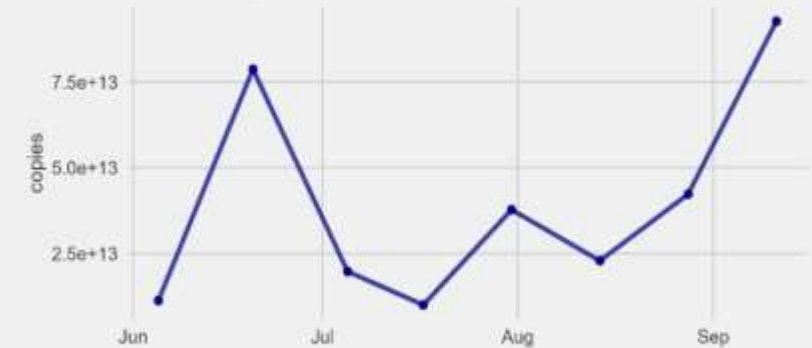
COVID-19

Aggregate Viral Load for HRSD Treatment Facilities



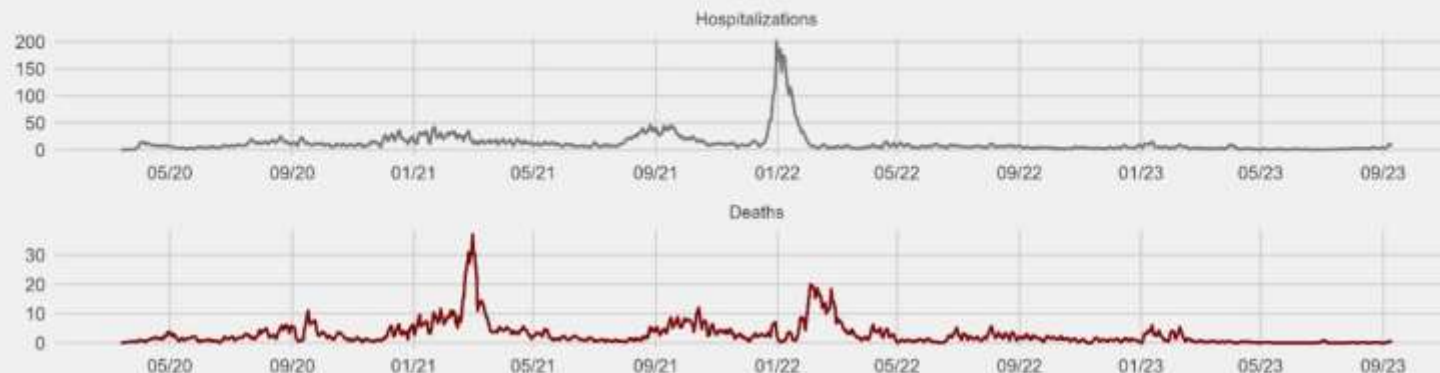
Wastewater Data HRSD Facilities

Most Recent 8 Weeks



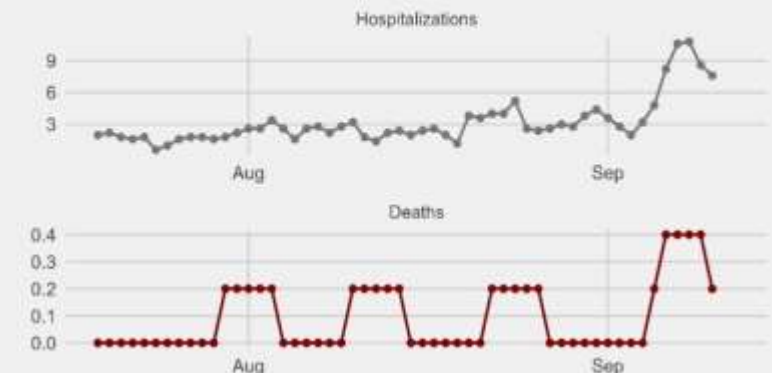
COVID-19 Hospitalizations and Deaths

Hampton Roads 5 Day Rolling Mean



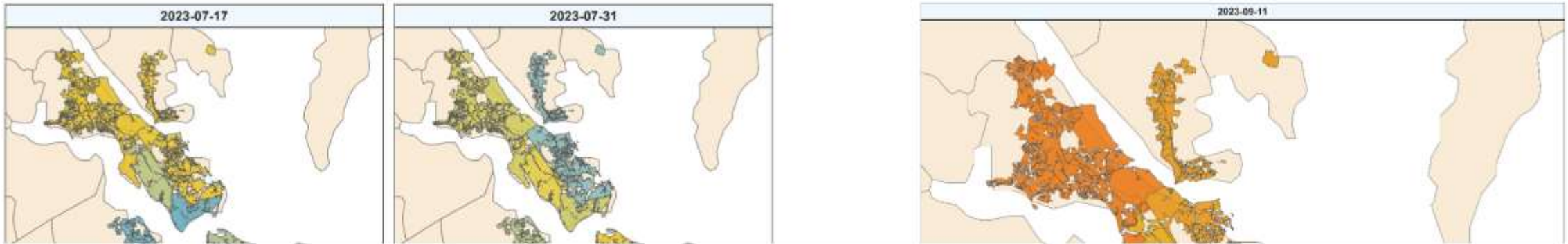
COVID-19 Hospitalizations and Deaths

Most Recent 8 Weeks



Hampton Roads Sanitation District

COVID-19 Heat Map – Spatialized Look at Normalized COVID-19 Loading

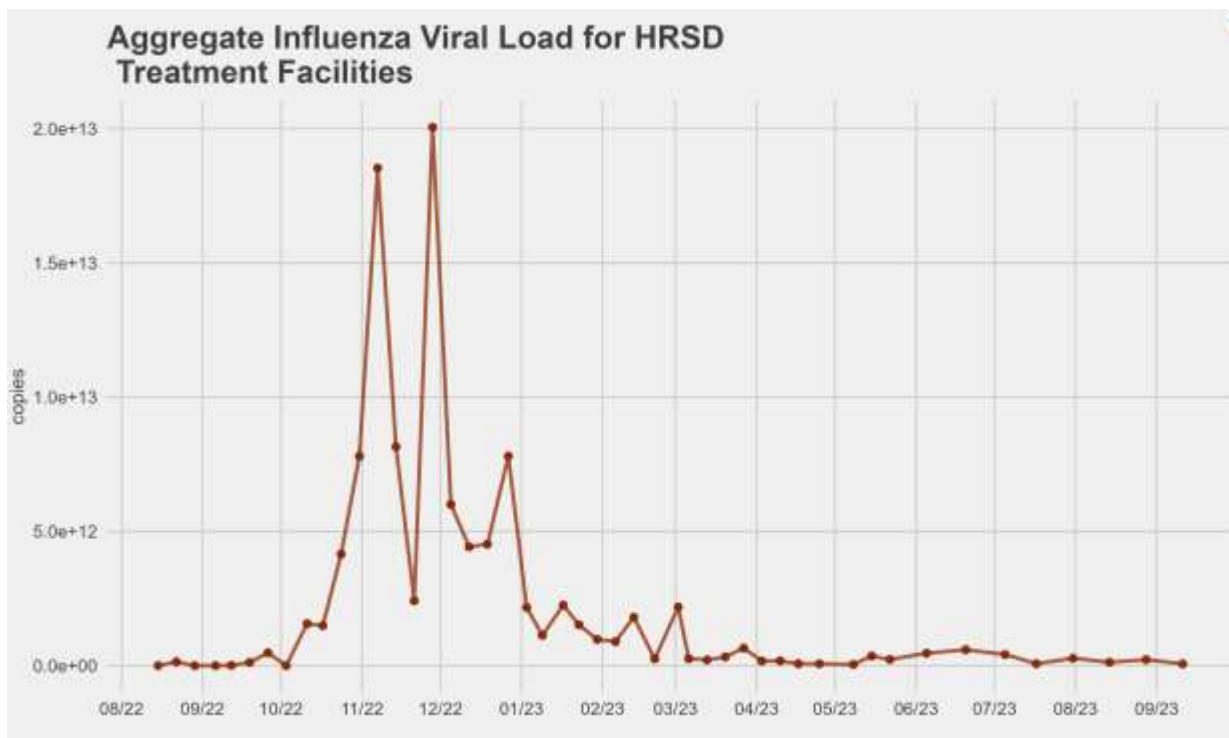


Hampton Roads Sanitation District. HRSD Wastewater Surveillance.
Accessed Oct 4, 2023. [HRSD Wastewater Surveillance | HRSD.com](https://www.hrsd.com/hrsd-wastewater-surveillance)

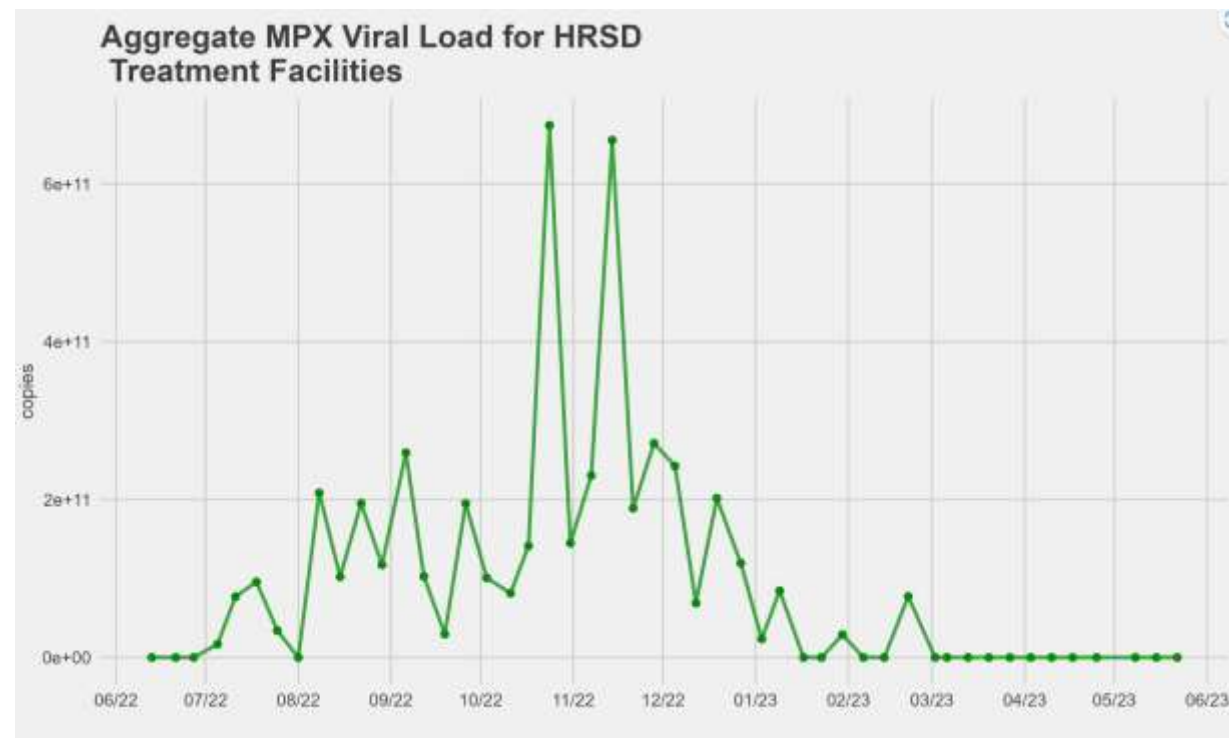
Hampton Roads Sanitation District

Time Series – Regional Viral Loading

Influenza



Monkeypox



Hampton Roads Sanitation District. HRSD Wastewater Surveillance. Accessed Oct 4, 2023. [HRSD Wastewater Surveillance | HRSD.com](https://www.hrdsd.com/hrsd-wastewater-surveillance)

VDH WWS Program

COVID-19 Sewage Surveillance | Public Health Toolbox

- Sewage is an efficient pooled sample of community (or sub-community) infection prevalence
- Captures sub-clinical infections
- Independent of healthcare-seeking behavior and testing access
- Data available within days of shedding onset versus up to 2-week lag for other surveillance data

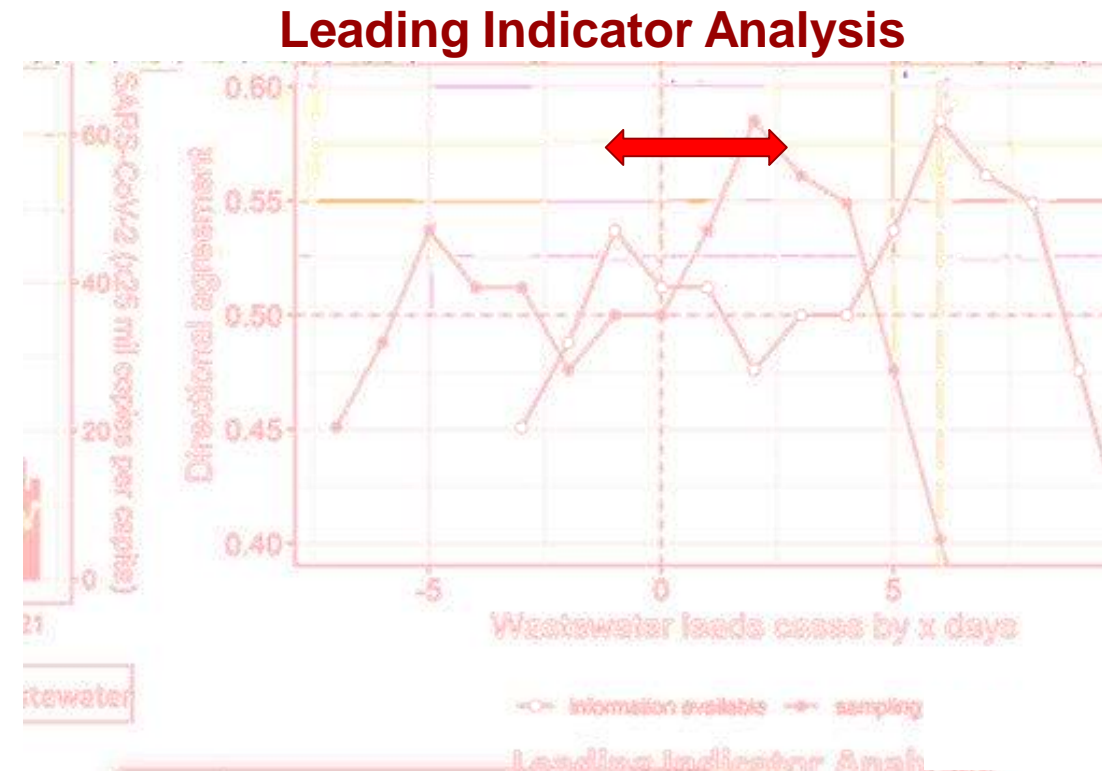


Source: Centers for Disease Control and Prevention

Use of Wastewater Data in Response Decisions

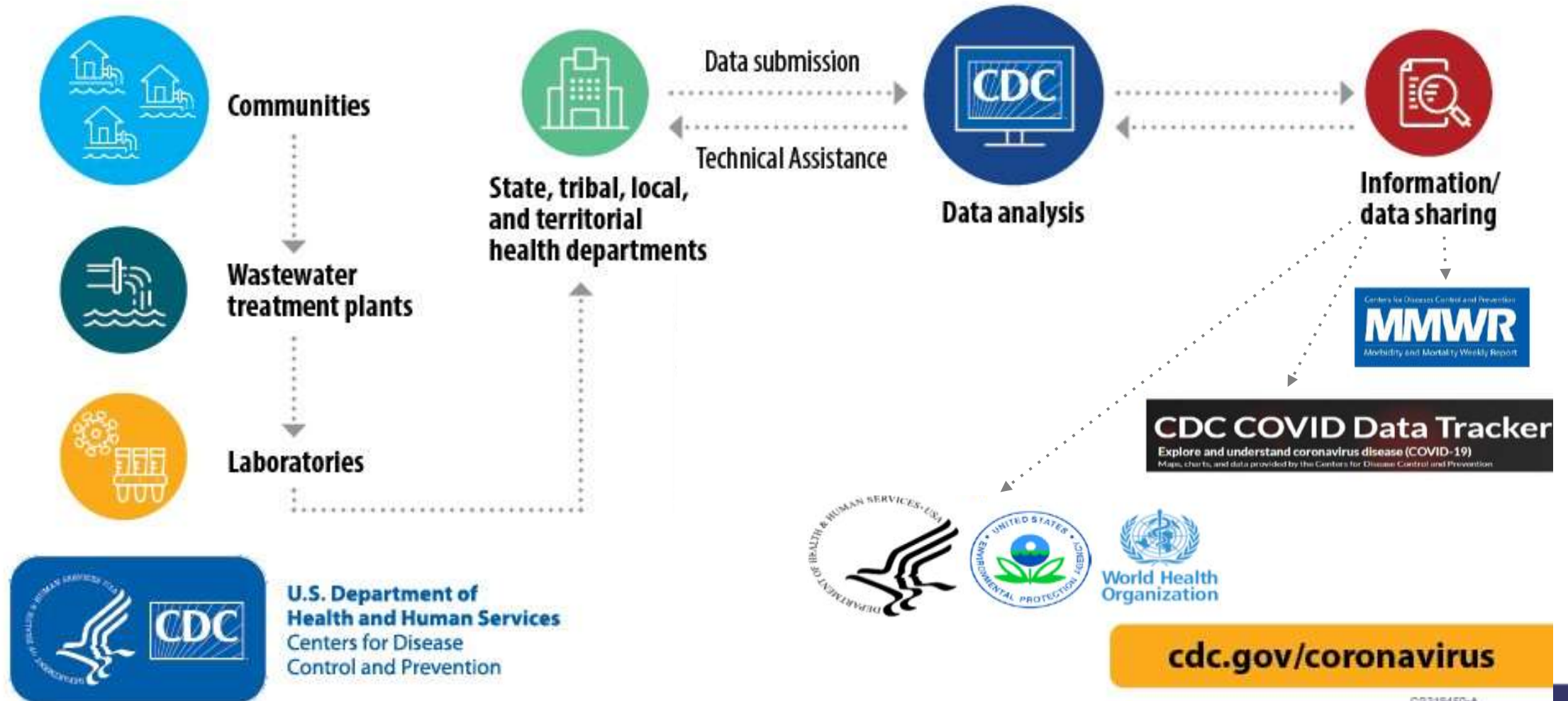
Sewage data will help with:

- Measuring **scope** of the outbreak
- Providing **decision support**
- Anticipating likely impact on **hospital capacity**, etc.
- Tracking effectiveness of **interventions**
- Providing **early warning** for reemergence



Source: Centers for Disease Control and Prevention

NATIONAL WASTEWATER SURVEILLANCE SYSTEM (NWSS)



CS315450-A

Early Adopters – Special COVID-19 Project Funded by CDC

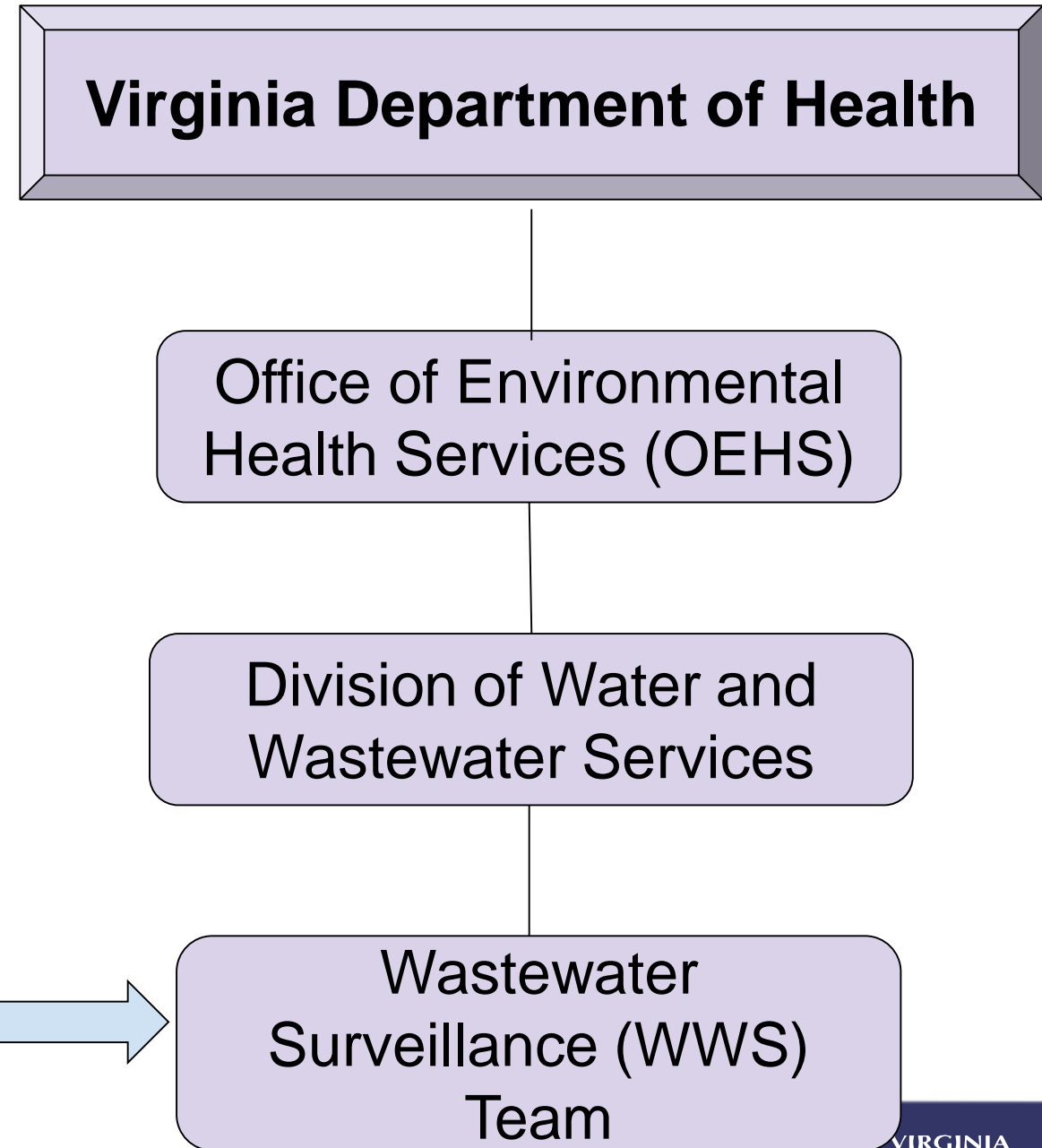
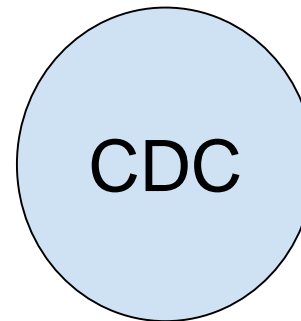
\$2.5 Million Awarded to 8 Early Adopter States (late 2020)

- Washington
- California
- Utah
- Wisconsin
- Ohio
- North Carolina
- South Carolina
- Virginia \$300,000



VDH WWS Program

- Funded by CDC ELC grant
 - Until 2025+
- Purpose:
 - Increase WWS in Virginia
 - Support CDC's *National Wastewater Surveillance System* (NWSS)
- Our Nature:
 - Interdisciplinary
 - Interdepartmental
 - Community-focused



Partnerships

Utilities

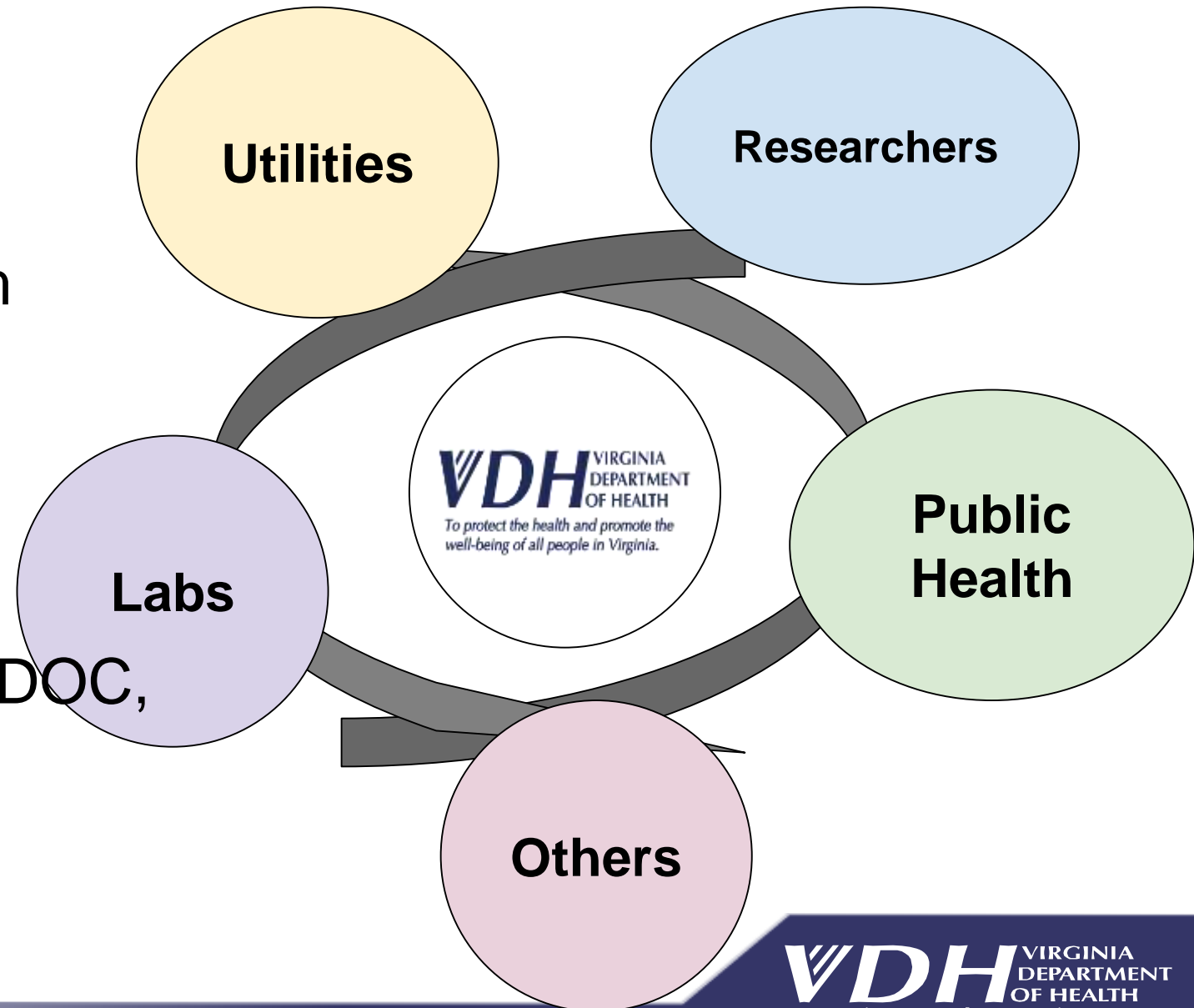
- Historical
- Sentinel Monitoring Program

Laboratories

- DCLS, HRSD

Localized Projects

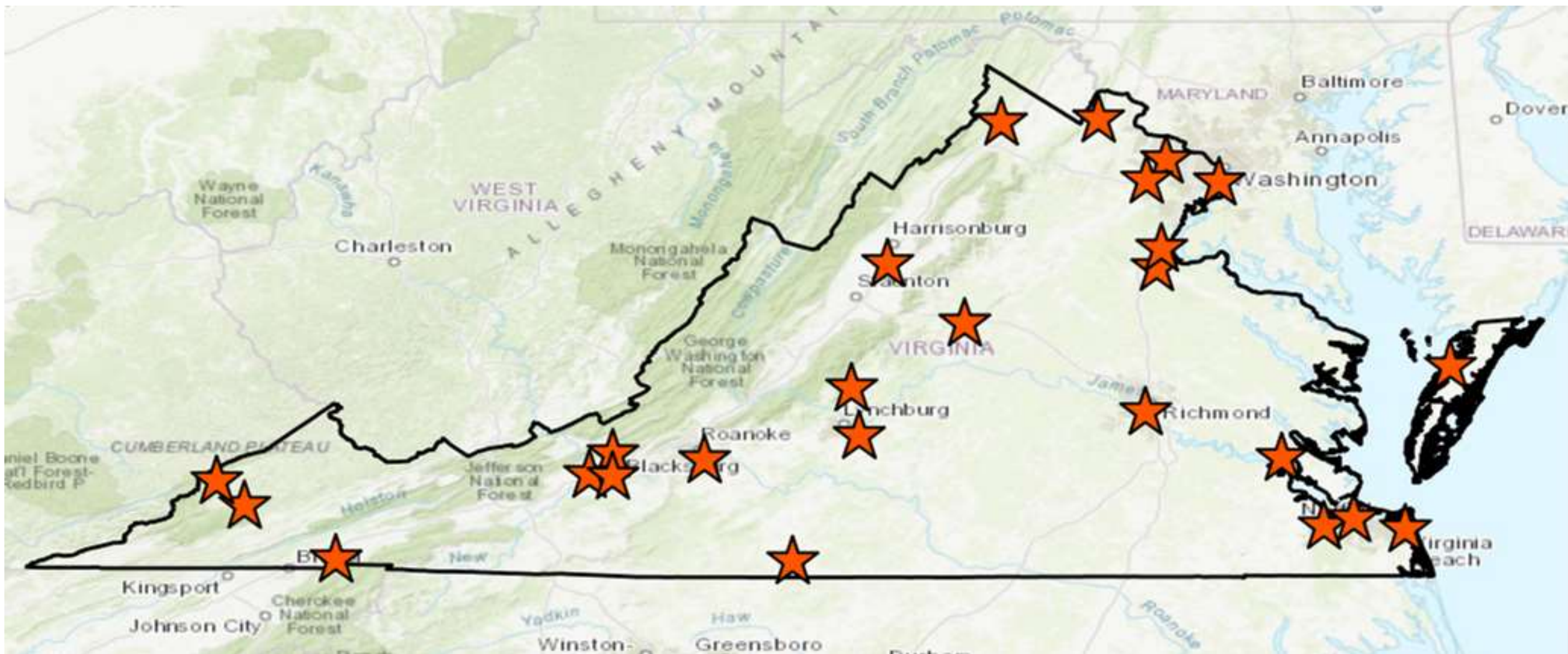
Chesapeake, Roanoke, FDA, DOC,
Schools, Research Projects...



Active Workgroups in VA

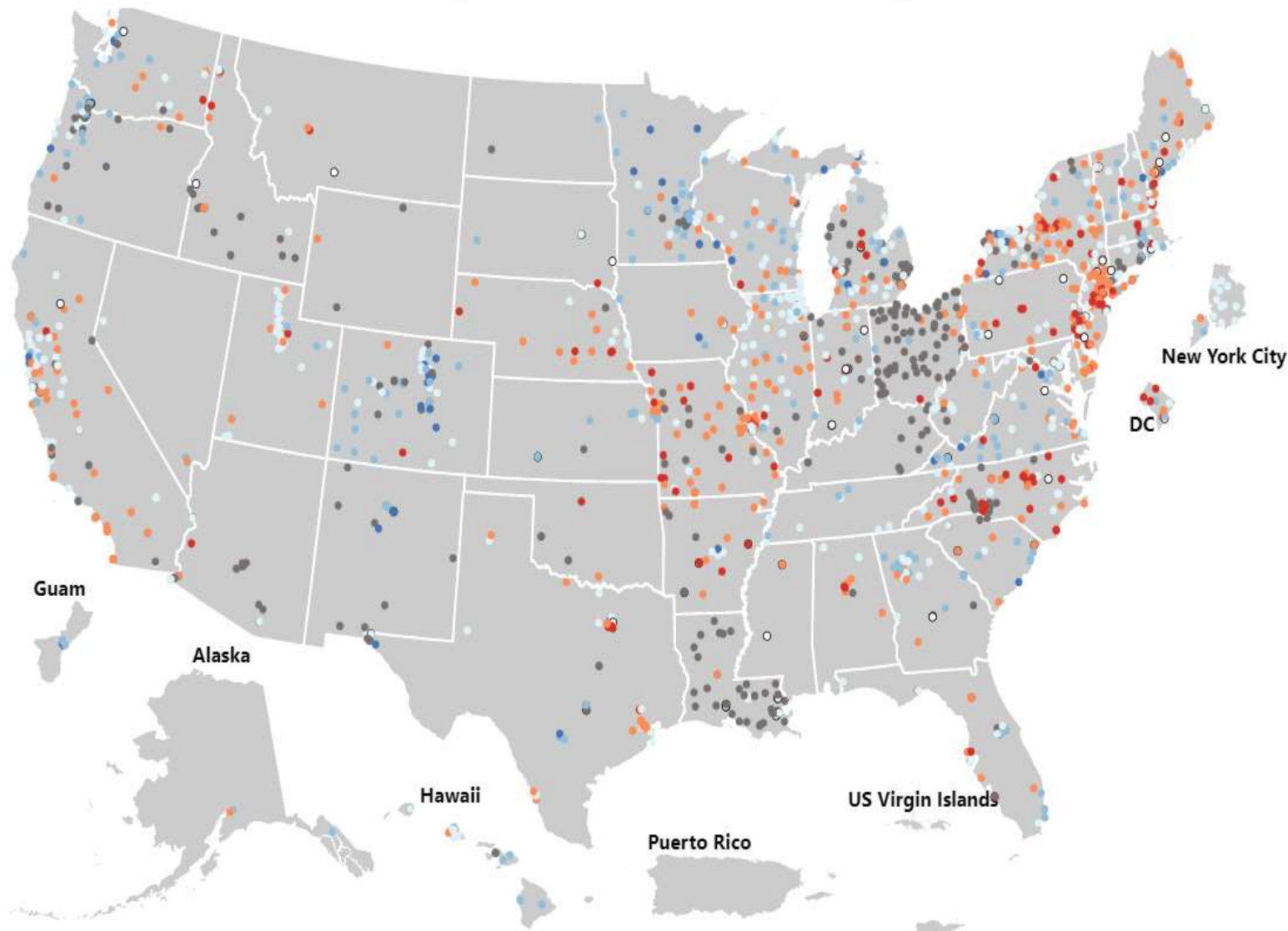


Sentinel Monitoring Sites – Original 25



Current SARS-CoV-2 Virus Levels in Wastewater by Site, United States

Time Period: Sep 11, 2023 – Sep 25, 2023



Current SARS-CoV-2 virus levels by site, United States

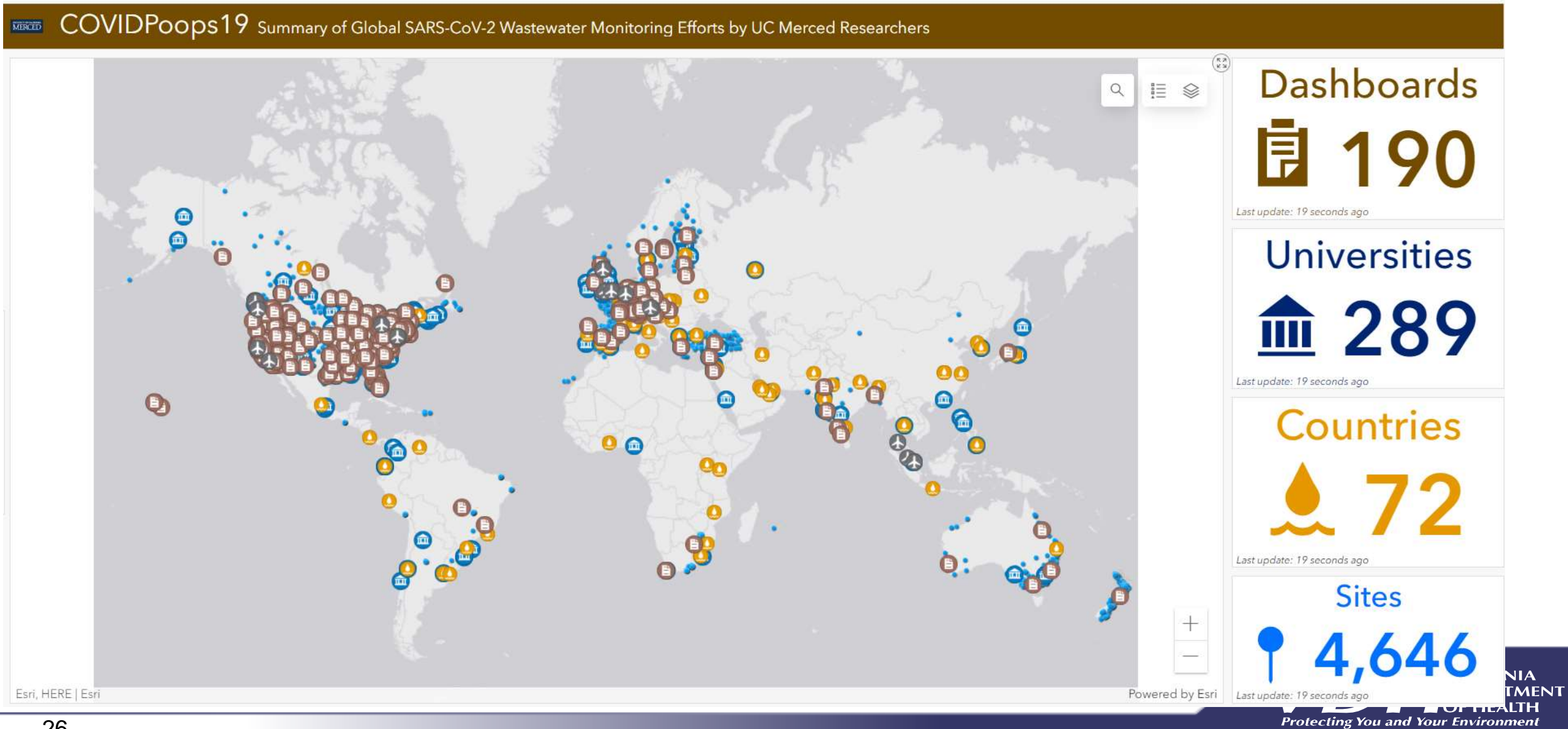
Current virus levels category	Num. sites	% sites	Category change in last 7 days
New Site	72	5	3%
0% to 19%	56	4	– 20%
20% to 39%	248	18	– 8%
40% to 59%	459	33	– 8%
60% to 79%	400	29	– 9%
80% to 100%	141	10	– 7%

Total sites with current data: 1376

Total number of wastewater sampling sites: 1728

CDC NWSS
COVID Data Tracker
pulled: Oct 4, 2023

WWS Resources (as of 10/4/23)





ENHANCED BY Google



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[Virginia Department of Health](#) > [Coronavirus](#) > [See the Numbers](#) > [COVID-19 Data Insights](#) > [SARS-CoV-2 in Wastewater](#)

- [COVID-19 in Virginia Homepage](#)
- [Request Your COVID-19 Vaccination Record](#)
- [See the Numbers](#)
 - [COVID-19 Data In Virginia](#)
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SARS-CoV-2 in Wastewater

COVID-19 Trends

- [Summary](#)
- [COVID-Like Illness Visits](#)
- [SARS-CoV-2 in Wastewater](#)
- [COVID-19 Modeling](#)
- [Health Equity](#)
- [Cases](#)
- [Case Demographics](#)

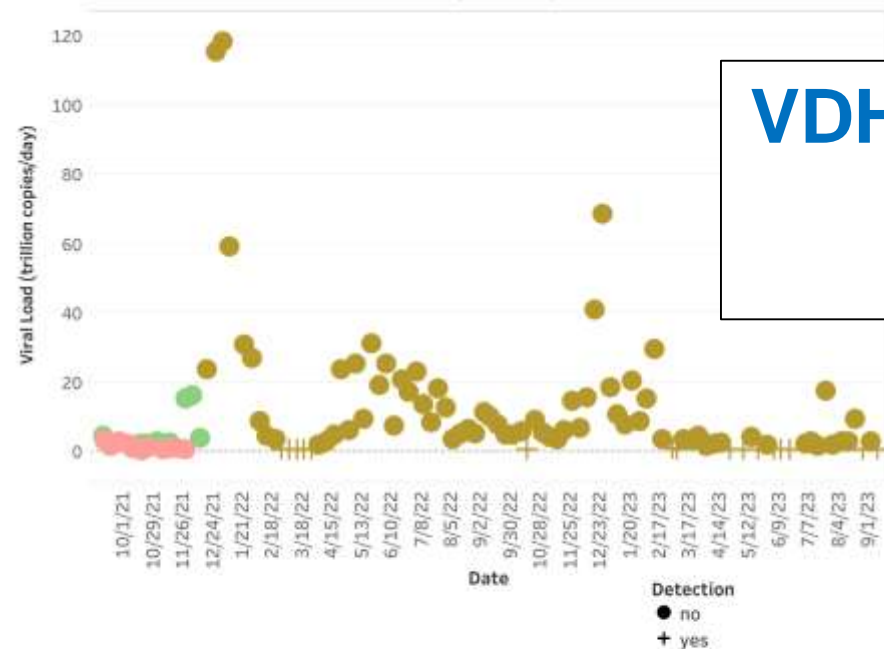
COVID-19 Vaccine

- [Vaccine Summary](#)
- [Vaccine Demographics](#)

As a reminder: All data are preliminary and subject to change.
Dashboard Updated: Weekly on Tuesday

COVID-19 Wastewater Surveillance

[Email this page](#)



VDH WSS Program: Public Dashboard Viral Loads and Case Counts

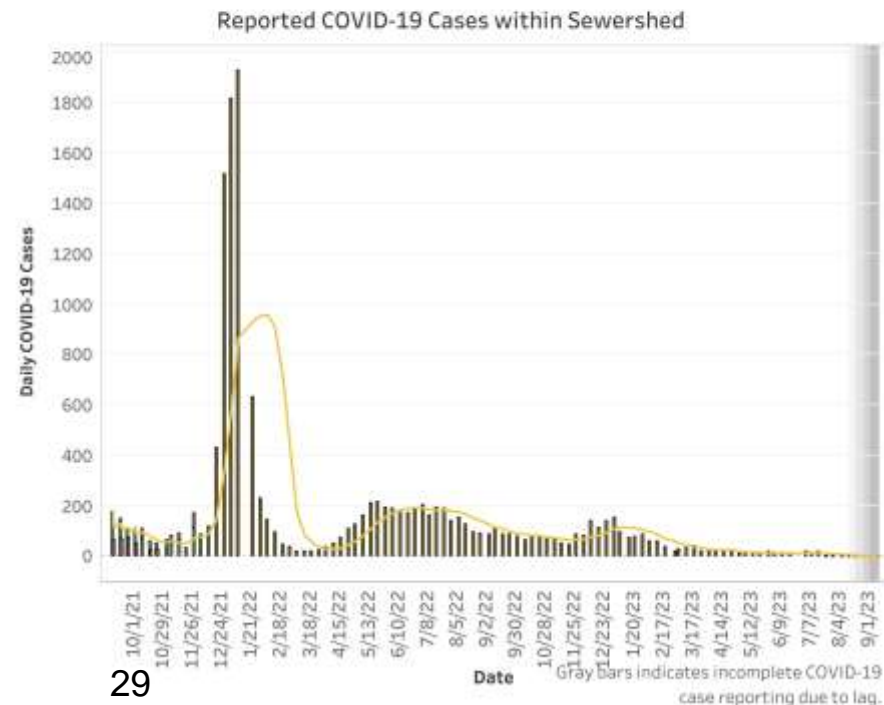
pulled: Oct 4, 2023

Sewershed Mapping

Sewersheds: define the geographical extent of the area served by the utilities.

Sewersheds + Case Data = Sewershed Case Counts

Sewershed Case Counts: the number of cases per week, per sewershed. Counts in the 1-4 range are suppressed to 2.



Sentinel Monitoring Program



About the Sites:

- ❖ Currently **36** wastewater treatment plants (influent)

Sampling:

- ❖ Start date: September 13, 2021
- ❖ Year 2 sampling end date: July 31, 2023
- ❖ Frequency: Once or Twice weekly

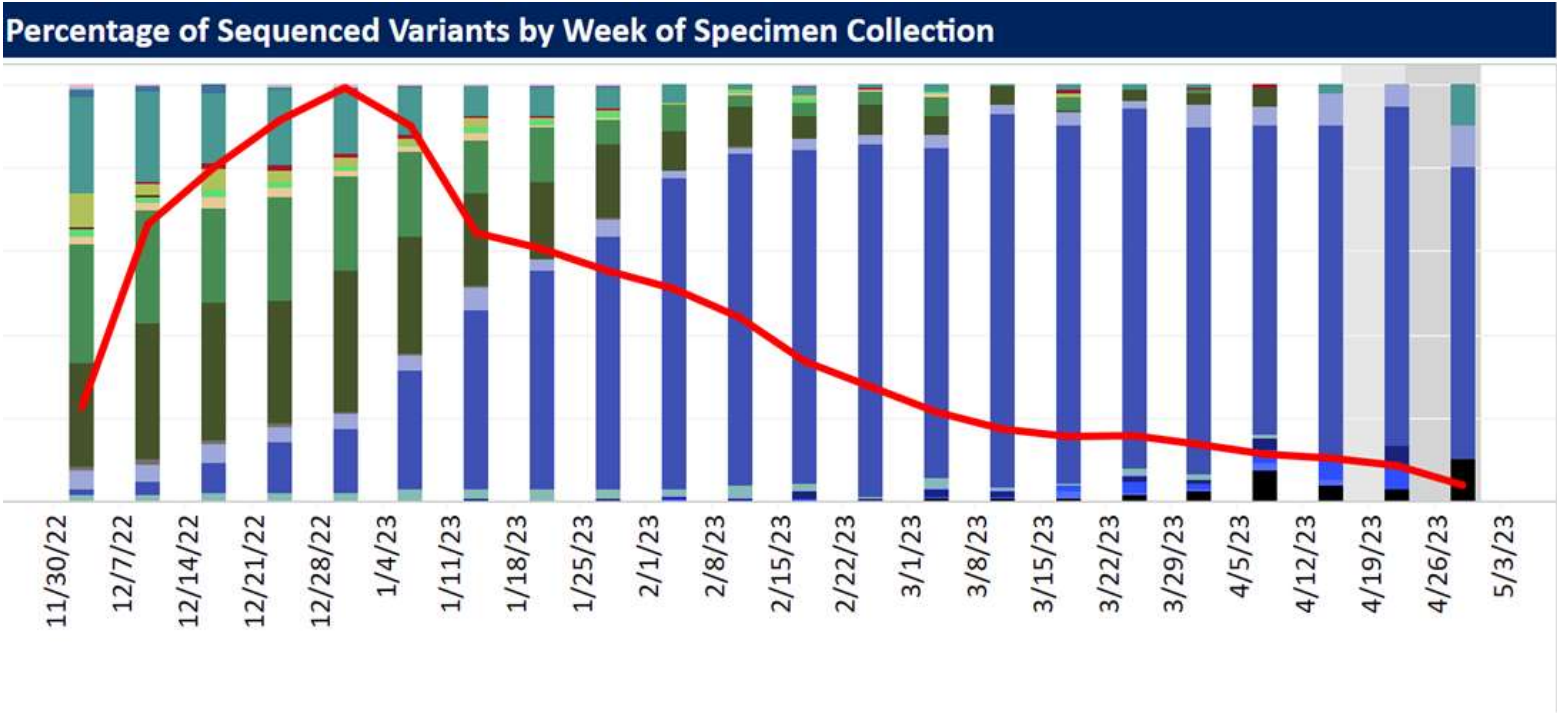
Analysis:

- ❖ PCR, SARS-CoV-2 N and E genes

Additional Targets:

- ❖ **Mpox** (Mar – Sept 2023)
- ❖ **Influenza A & B** (Mar 2023 – present)
- ❖ **RSV** (Sept 2023 – present)

Sentinel Monitoring Program



Sequencing:

- ❖ ~20 sites per week
- ❖ Started 50 weeks ago (Aug 2022)
- ❖ Continues to date

Future Uses

One comprehensive literature review (Choi et al., 2018) explored current and potential future applications for WWS:

- **Licit Drugs** (e.g., caffeine, alcohol, nicotine)
- **Illicit Drugs** (e.g., psychoactive substances, performance enhancers)
- **Pharmaceuticals and Personal Care Products** (e.g., antihistamines, microplastics, UV filters)
- **Population Markers** (e.g., exogenous markers, endogenous markers)
- **Industrial Chemical Markers** (e.g., pesticides, flame retardants, plasticisers)
- **Stress, Food, and Diet Markers** (e.g., oxidative stress markers)
- **Biologicals** (e.g., pathogens, antibiotic resistance markers)

Executive Order 26

Executive Order 26



Commonwealth of Virginia
Office of the Governor

Executive Order

NUMBER 26 (2023)

CRUSHING THE FENTANYL EPIDEMIC: STRENGTHENING VIRGINIA'S INTERDICTION AND ENFORCEMENT RESPONSE TO FENTANYL CRISIS

Importance of the Initiative

Fentanyl poisoning has devastated families and communities across the nation and in Virginia. The Commonwealth must do more to combat this deadly fentanyl poisoning crisis.

Fentanyl is a synthetic opioid that is approximately fifty times more potent than heroin and one hundred times stronger than morphine. The number of fentanyl overdose deaths in the Commonwealth has grown over 20-fold since 2013, with 1,951 Virginians killed by fentanyl in 2022. Since 2020, more Virginians have died from fatal drug overdoses than motor vehicle and gun-related deaths combined. Drug overdose is the leading cause of unnatural death in Virginia.

The scope of the problem has not only grown over the past decade, but the communities hit hardest have also changed. Historically, white males regularly had the highest rates of fatal opioid overdoses in Virginia. In 2019, however, black males had the highest rate of fatal opioid overdoses in the Commonwealth. From the latest available data, in 2022 black males fatally overdosed on fentanyl 1.9 times as often as white males (rate of 60.4 and 31.4 per 100,000, respectively). More must be done to reach these communities and connect them to a pathway to recovery and renewal.

To combat this scourge on Virginia's families and communities, I am directing executive branch agencies to enact a first-of-its-kind comprehensive fentanyl strategy as part of the *Right Help, Right Now* behavioral health transformation to (1) enhance public safety measures to counteract activity by illicit drug manufacturers and distributors; (2) invest in and enhance prevention and recovery efforts (3) educate our communities for action to address fentanyl and opioid abuse and

Governor Signed: May 9th, 2023

Directives:

[Prevention & Treatment] [Public Safety & Drug Interdiction]

1. HHR: assign Special Advisor to Governor (90 days)
2. General Services/VDH: Request for Proposals for naloxone kits (60 days)
3. **VDH: develop cost-effective plan for WWS (120 days)**
4. Social Services: develop plan for children (120 days)

[Public Safety & Drug Interdiction]

5. Public Safety/Homeland Security: assign Special Advisor to Governor (90 days)
6. PS/HS & VSP: develop strategic plan for law enforcement (120 days)
7. PS/HS & Transportation: secure Federal grants for border control
8. PS/HS: establish workgroup for released prisoner drug prevention (90 days)
9. **Multiple health/law enforcement agencies: develop plan for data sharing/collaboration with VSP, FAACT (DCJS), and ODGA (120 days)**

[Organization of Government & Data Collection]

10. VDH: establish locality Overdose Fatality Review teams for law enforcement assistance (180 days)

Executive Order 26

Directive 3:

“I direct the Department of Health to develop a cost-effective plan to utilize and fund wastewater surveillance to detect the frequency, potency, and occurrences of fentanyl use in specific locations. This plan shall include a response strategy that includes increased naloxone distribution, targeted public awareness campaigns, and other cost-effective strategies to reduce fentanyl’s prevalence in those communities where surveillance warrants increased response. The plan shall be sent to the Secretary of Health and Human Resources within 120 days of the date of this order.”

Executive Order 26

Directive 9:

“I direct the agencies listed below to send a plan to me to report, in accordance with federal and state law, their data to and work with the Virginia State Police’s fusion center and to participate in the Framework for Addiction Analysis and Community Transformation (FAACT), a secure data-sharing project led by the Department of Criminal Justice Services (DCJS) in collaboration with the Office of Data Governance and Analytics (ODGA), within 120 days of the date of this order. This effort will create the most cohesive and timely data on fatal and non-fatal overdoses in the Commonwealth to allow for immediate interdiction, education, and abatement efforts in the neighborhoods where spikes in overdoses are observed.

- Department of Health
- Department of Health Professions
- Department of Social Services
- Department of Medical Assistance Services
- Department of Behavioral Health and Developmental Services
- Department of Corrections
- Department of Criminal Justice”

WWS Data Ethics

WWS raises privacy & ethical concerns (Jacobs et al, 2021)

- Especially with stigmatized behaviors w/ punitive consequences
- Population sample size is considered the 'lynchpin' of the privacy issue
- Harms reduced with greater anonymity (Hall et al, 2012)

4th Amendment concerns (Hering, 2009)

- Protects against unwarranted search and seizure
- Societal expectation of flushing privacy?

Anonymity safeguards

- CDC COVID-19 Data Tracker will not post WWS data with:
 - sewersheds < 3,000 people
 - case counts in the 1-4 range (posted as '2')

Public Health Ethics

The Public Health Leadership Society's twelve *Principles of the Ethical Practice of Public Health* (2002) were originally created and drawn from other known ethical concepts, including individual human rights, distributive justice, duty, human interdependence, and autonomy.

"Principles of the Ethical Practice of Public Health"

1. Public health should address principally the fundamental causes of disease and requirements for health, aiming to prevent adverse health outcomes.
2. Public health should achieve community health in a way that respects the rights of individuals in the community.
3. Public health policies, programs, and priorities should be developed and evaluated through processes that ensure an opportunity for input from community members.
4. Public health should advocate for, or work for the empowerment of, disenfranchised community members, ensuring that the basic resources and conditions necessary for health are accessible to all people in the community.
5. Public health should seek the information needed to implement effective policies and programs that protect and promote health.
6. Public health institutions should provide communities with the information they have that is needed for decisions on policies or programs and should obtain the community's consent for their implementation.
7. Public health institutions should act in a timely manner on the information they have within the resources and the mandate given to them by the public.
8. Public health programs and policies should incorporate a variety of approaches that anticipate and respect diverse values, beliefs, and cultures in the community.
9. Public health programs and policies should be implemented in a manner that most enhances the physical and social environment.
10. Public health institutions should protect the confidentiality of information that can bring harm to an individual or community if made public. Exceptions must be justified on the basis of the high likelihood of significant harm to the individual or others.
11. Public health institutions should ensure the professional competence of their employees.
12. Public health institutions and their employees should engage in collaborations and affiliations in ways that build the public's trust and the institution's effectiveness." (Public Health Leadership Society, 2002)

Executive Order 26: Developing the Plan

- Executive Order 26 directed the Virginia Department of Health (VDH) to develop a cost-effective plan to use and fund wastewater surveillance to detect the frequency, potency, and occurrences of fentanyl use in specific locations.
- Fentanyl Wastewater Surveillance (WWS) Workgroup
- Background Research
- The Plan
- The Budget

Workgroup

- Multiple agencies:
 - Virginia Department of Health
 - Department of Environmental Quality
 - Department of General Services, Division of Consolidated Laboratory Services (DCLS)
- First meeting held May 30, 2023.
- Weekly meetings until July 7, 2023.

Background Research

- Met with Office of the Chief Medical Examiner and Department of Forensic Science on types of fentanyl compounds affiliated with deaths:
 - Pure fentanyl is the predominant drug.
 - Selected fentanyl and its metabolite norfentanyl.
 - Cannot analytically distinguish between illicit and prescribed fentanyl.
- Web research of opioid WWS programs.
- Met with various researchers and third party contractors.
- DCLS researching extraction and analytical.
 - Some lead time to refine and validate methodology.

Plan Development

- Applied for Opioid Abatement Authority (OAA) funding - June 21, 2023.
- Created OAA plan and budget.
- OAA plan served as basis for formal plan.
- Unsuccessful in obtaining OAA funding.
- Surveyed utilities regarding interest in participating.
 - 2/3 to 3/4 interested in participating.
 - 2/3 would help with identifying subsewershed sites.
 - About 50% could help with subsewershed monitoring.

Plan Options

Contingent upon funding.

Two-step approach:

- 1) Influent monitoring at wastewater treatment plants (WWTP's).
 - 2) Subsewershed monitoring at select sites.
- Fentanyl and norfentanyl to be monitored.
 - Step One: Influent Monitoring.
 - Up to 40 sites, based on existing network of WWTP's.
 - Three month start up period.

Plan Options Continued

Contingent upon funding.

- Step Two: Subsewershed Monitoring.
 - Pilot subsewershed monitoring project subcontracted to third party.
 - Year 1 pilot – 1 site with up to four subsewersheds.
 - Subsewersheds of at least 3,000 population.
 - Pilot to evaluate efficacy of several factors (e.g. composite vs. grab samples).
 - 2 to 5 sites with up to 20 subsewersheds in subsequent years.
- DCLS average cost per sample = \$207; competitive with private lab cost.
- Alternative to subcontract sentinel and subsewershed monitoring to a third party; estimate approximately \$611 per sample with collection and shipping costs.

Mobilization

- **Sentinel monitoring**
 - 3 months start up to hire new staff, identify cooperating utilities, set up shipping.
- **Subsewershed monitoring**
 - 6 months to create RFP, contract process, and start pilot.

Budget

VDH Items	Year 1	Year 2	Year 3	Year 4	Year 5
Staff (2)	\$287,862	\$287,862	\$287,862	\$287,862	\$287,862
Supplies	\$13,864	\$13,864	\$13,864	\$13,864	\$13,864
Travel	\$3,770	\$3,770	\$3,770	\$3,770	\$3,770
Pilot Study	\$204,000	\$1,320,000	\$1,320,000	\$1,320,000	\$1,320,000
DCLS Items					
Staff (5)	\$425,750	\$425,750	\$508,950	\$534,398	\$534,398
Equipment	\$153,172	\$156,800	\$413,425	\$59,000	\$61,000
Supplies	\$52,500	\$86,500	\$88,000	\$92,000	\$96,000
Travel	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000
Contractual	\$0	\$0	\$279,968	\$279,968	\$279,968
Total	\$1,148,918	\$2,302,546	\$2,923,839	\$2,598,862	\$2,604,862

Thank you!

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