

Wastewater Surveillance of SARS-CoV-2 in Southern Nevada

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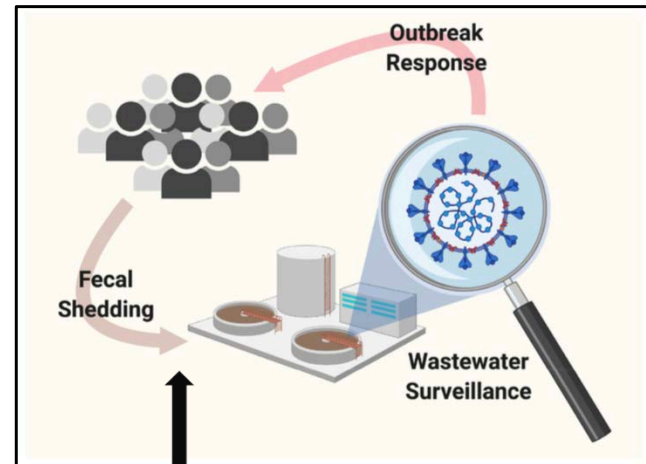
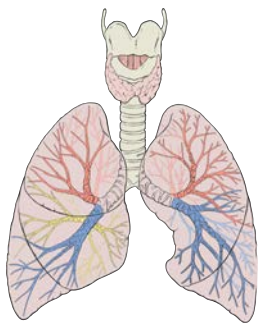
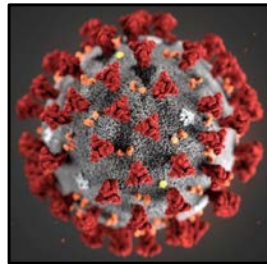


Wastewater-Based Epidemiology: Overview



Wastewater-Based Epidemiology for COVID-19

Severe Acute **Respiratory**
Syndrome Coronavirus 2
(SARS-CoV-2)



≈ 200 billion
SARS-CoV-2
viral particles
per infection



Wastewater Surveillance in Southern Nevada



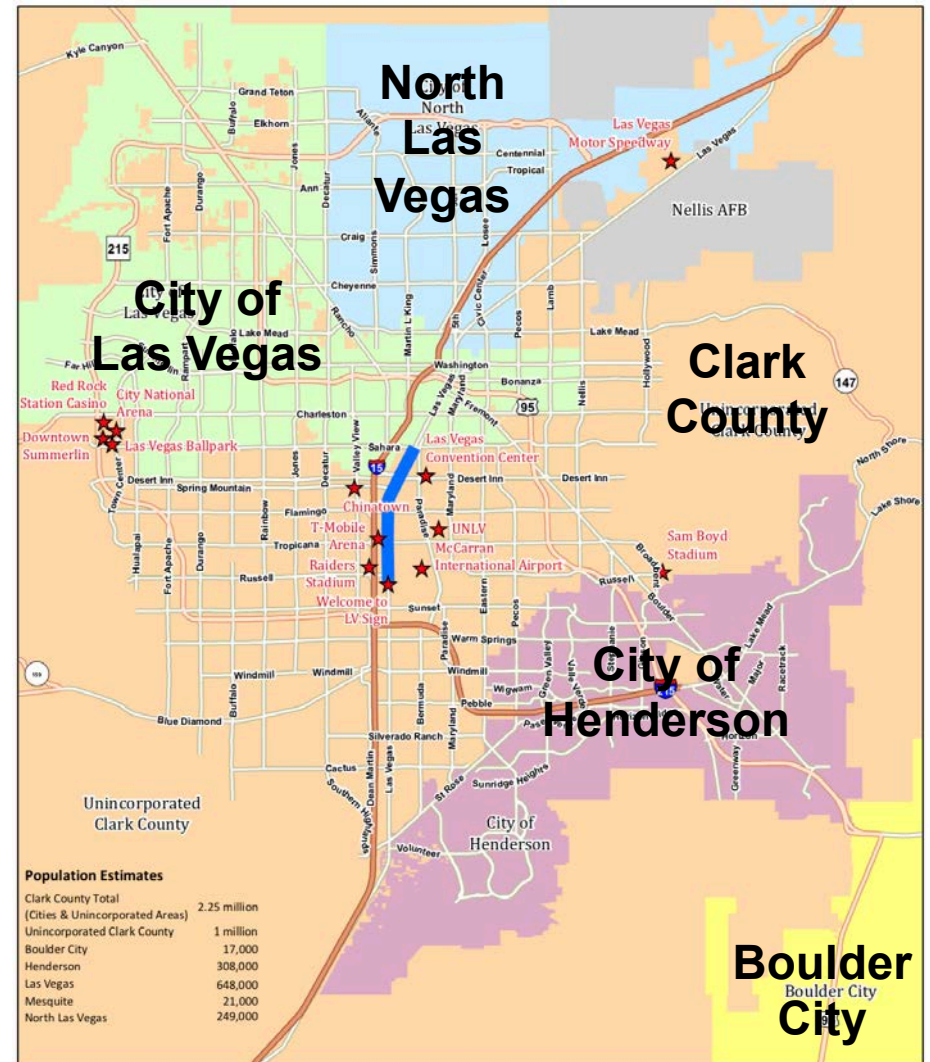
SNWA/UNLV Study:

- Samples collected every Monday morning
- 2 sites since onset of pandemic, 4 since August, 1 since December
- **No hits in treated wastewater (WW), Las Vegas Wash, Lake Mead**
- UK variant of concern detected in WW before clinical samples
- Participated in Water Research Foundation methods comparison



Southern Nevada Study

Facility	Flow (mgd)	Population	Sample Type
1	100	872k	Grab Primary Eff.
2	42	86k	Composite Influent
3	20	757k	Composite Influent
4	5	134k	Grab Influent
5	15	115k	Grab Influent
6	6	255k	Composite Influent
7	0.8	16k	Grab Influent



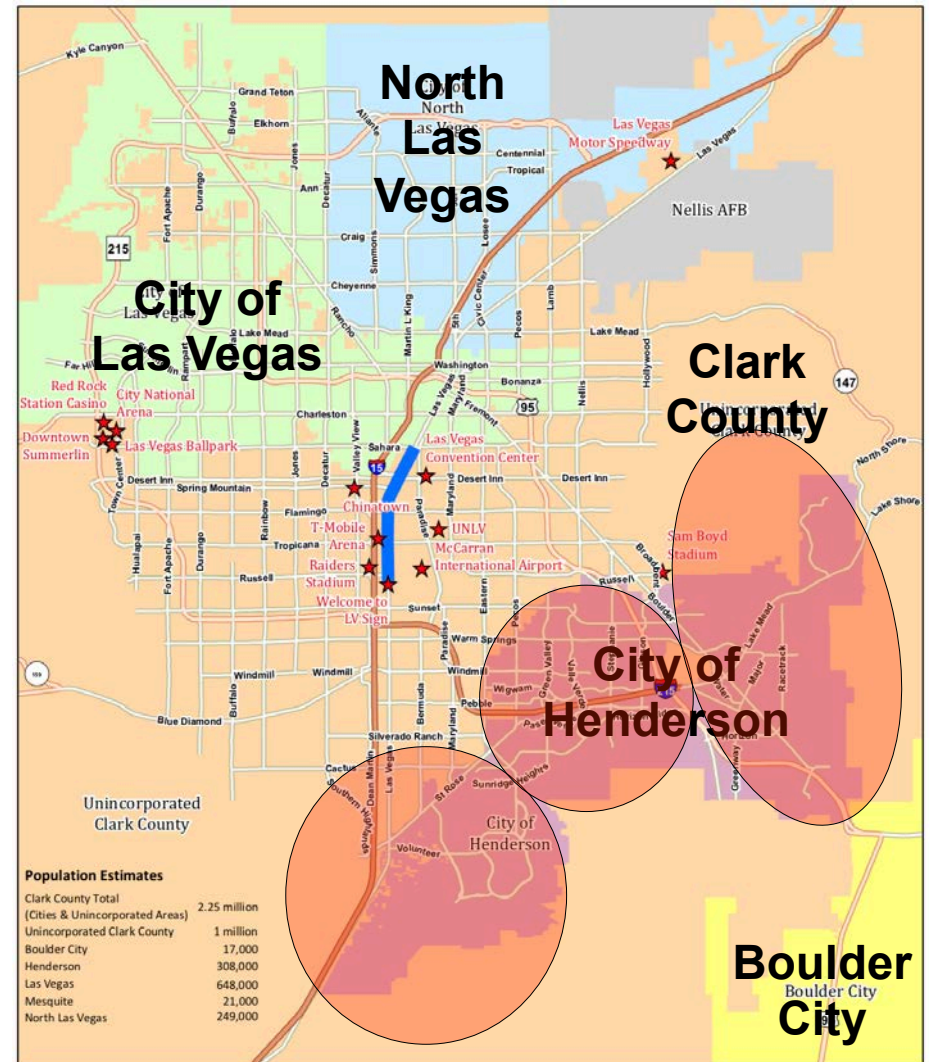


Southern Nevada Study

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7	0.8	16k	Grab Influent

Additional Manhole Sites:

- Homeless Shelter
 - Sampling aligned with ongoing outbreak
- Public Schools (led by UNLV)
 - Evaluation of health disparities by location
 - Schools categorized based on reduced lunch rate

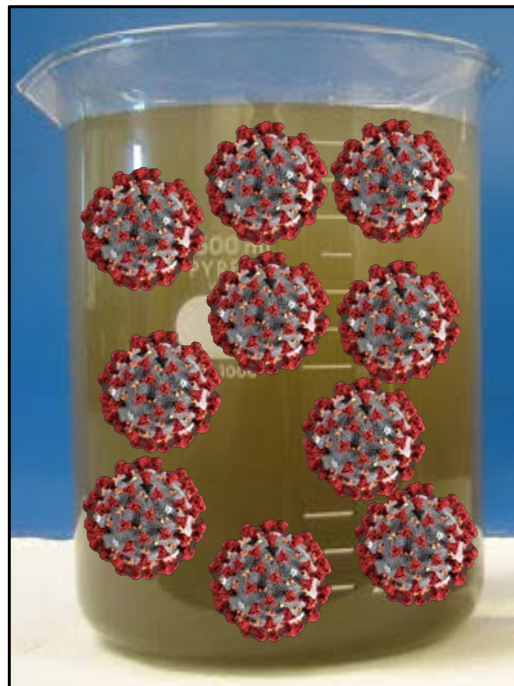




SARS-CoV-2 Concentrations vs. Sequences



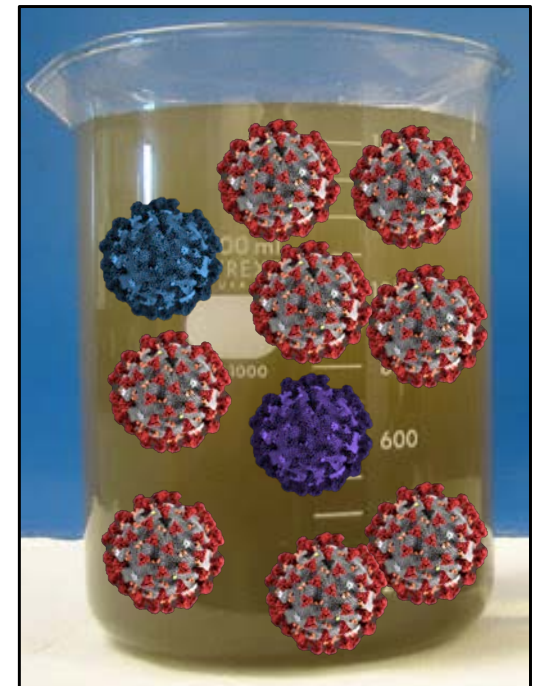
Dr. Katerina Papp
Postdoc
SNWA



**Example: 10 genome copies
(viruses) per liter
of sewage**



Dr. Edwin Oh
Associate Professor
UNLV



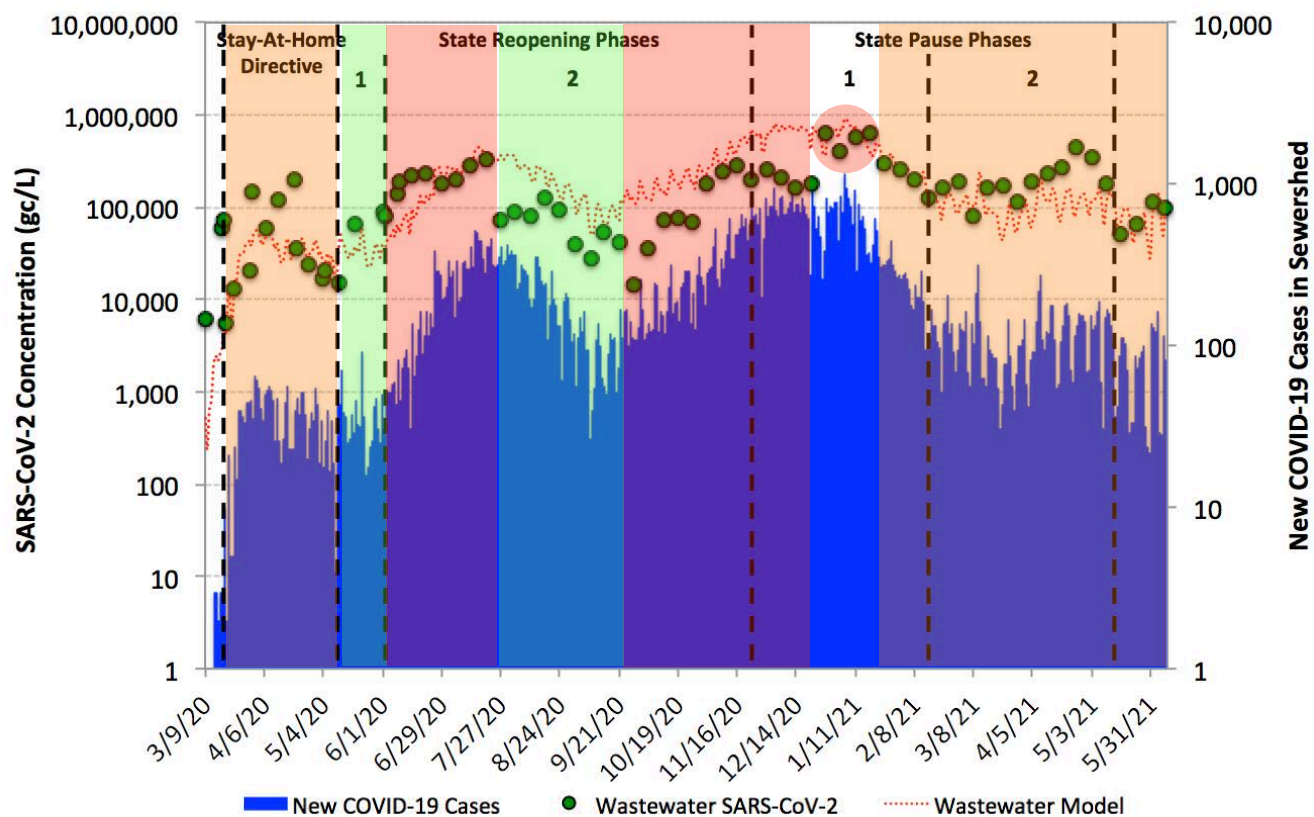
**Example: 80% Wild Type
10% UK Variant
10% California Variant**

Wastewater Surveillance in Southern Nevada: Data Summary



Community Trend Analysis

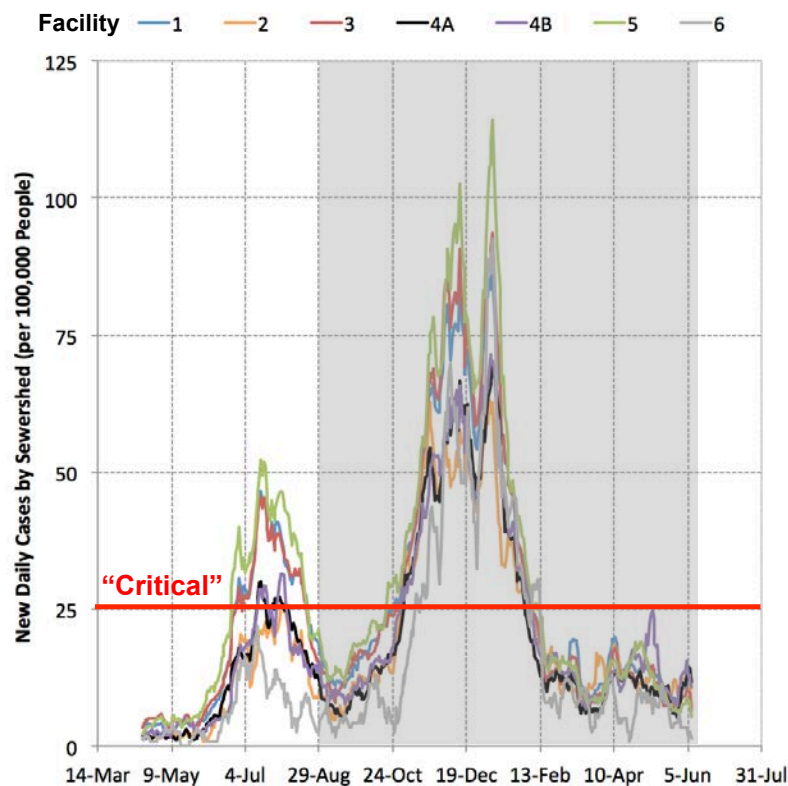
Facility 1: 100 mgd and ~1 million people





Sewershed Trend Analysis

Sewershed COVID-19 Cases
(per 100,000 people)



Sewershed SARS-CoV-2 Concentrations
(log₁₀ gc/L)

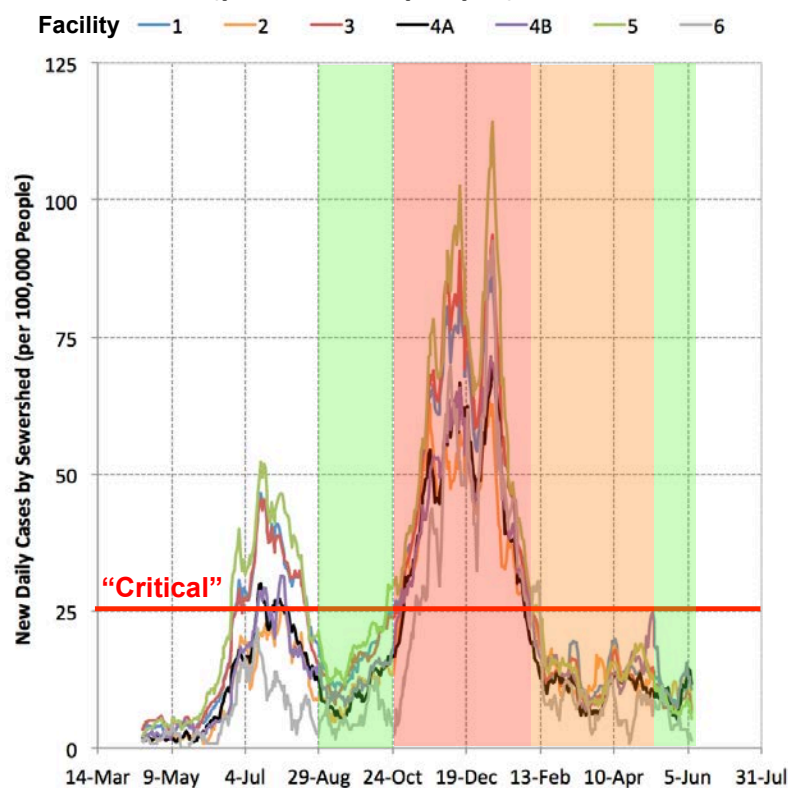
Date	Facility 1	Facility 2	Facility 3	Facility 4	Facility 5	Facility 6	Facility 7
Sample	Grab Prim.	Comp. Inf.	Comp. Inf.	Grab Inf.	Grab Inf.	Comp. Inf.	Grab Inf.
Mon. 8/24	5.0	4.4	5.3	No Sample	No Sample	No Sample	No Sample
Mon. 8/31	4.6	4.4	5.2	5.3	7.2	5.8	No Sample
Tue. 9/8	4.5	5.1	5.4	4.8	4.4	5.3	No Sample
Mon. 9/14	4.7	4.9	5.8	5.1	5.9	5.8	No Sample
Mon. 9/21	4.6	5.1	5.2	5.3	5.4	5.4	No Sample
Mon. 9/28	4.2	5.0	5.3	5.2	6.4	5.4	No Sample
Mon. 10/5	4.6	No Sample	5.8	No Sample	No Sample	No Sample	No Sample
Mon. 10/12	4.9	4.9	5.8	5.9	5.9	5.8	No Sample
Mon. 10/19	4.9	4.8	5.9	5.6	6.2	5.6	No Sample
Mon. 10/26	4.8	5.1	5.8	5.5	5.5	5.6	No Sample
Mon. 11/2	5.3	5.2	6.3	6.5	5.6	6.3	No Sample
Mon. 11/9	5.4	5.4	6.0	6.7	6.0	6.0	No Sample
Mon. 11/16	5.5	5.6	6.4	5.8	7.1	6.0	No Sample
Mon. 11/23	5.3	5.6	6.4	6.3	No Sample	6.2	No Sample
Mon. 11/30	5.4	5.4	6.2	5.9	6.5	6.0	No Sample
Mon. 12/7	5.3	5.5	6.3	6.3	7.0	6.3	No Sample
Mon. 12/14	5.2	5.6	6.2	6.5	6.7	6.4	No Sample
Mon. 12/21	5.2	5.6	5.9	5.9	6.4	6.1	5.9
Mon. 12/28	5.8	5.9	6.6	6.4	6.9	6.4	8.7
Mon. 1/4	5.6	6.1	6.6	6.6	6.5	6.3	6.4
Mon. 1/11	5.8	5.8	6.3	6.2	6.4	6.5	6.0
Mon. 1/18	5.8	5.8	6.1	5.9	6.4	6.0	6.1
Mon. 1/25	5.5	5.9	6.1	6.2	6.2	5.9	6.3
Mon. 2/1	5.4	5.4	6.1	5.7	6.1	5.9	5.5
Mon. 2/8	5.3	5.4	6.0	6.1	6.0	5.3	6.2
Mon. 2/15	5.1	5.1	6.5	5.6	5.9	6.1	6.3
Mon. 2/22	5.2	5.4	5.6	6.0	6.0	5.7	5.4
Mon. 3/1	5.3	5.0	5.8	5.8	5.4	6.1	5.3
Mon. 3/8	4.9	4.9	5.5	5.5	5.4	5.6	5.5
Mon. 3/15	5.2	5.5	5.9	5.2	6.4	Non-Detect	6.4
Mon. 3/22	5.2	5.2	5.9	5.5	5.8	Inconclusive*	6.8
Mon. 3/29	5.1	5.0	5.8	6.0	5.1	5.6	5.0
Mon. 4/5	5.3	5.0	5.9	5.2	6.2	6.3	5.5
Mon. 4/12	5.4	5.1	5.7	6.2	5.4	5.9	5.4
Mon. 4/19	5.4	5.1	6.0	5.9	6.3	6.0	5.6
Mon. 4/26	5.6	5.2	6.1	6.1	5.5	5.5	5.4
Mon. 5/3	5.5	5.4	5.9	6.3	6.1	5.8	5.5
Mon. 5/10	5.2	4.9	5.8	6.3	5.8	5.5	Non-Detect
Mon. 5/17	4.7	4.8	5.5	5.5	5.6	5.5	Non-Detect
Mon. 5/24	4.8	5.1	5.3	4.6	5.5	5.6	4.8
Tue. 6/1	5.1	4.7	5.1	5.3	5.2	4.8	4.8
Mon. 6/7	5.0	5.5	5.2	5.9	5.9	5.2	4.5

*Only 1 of 8 analytical replicates positive



Sewershed Trend Analysis

Sewershed COVID-19 Cases
(per 100,000 people)



Sewershed SARS-CoV-2 Concentrations
(log₁₀ gc/L)

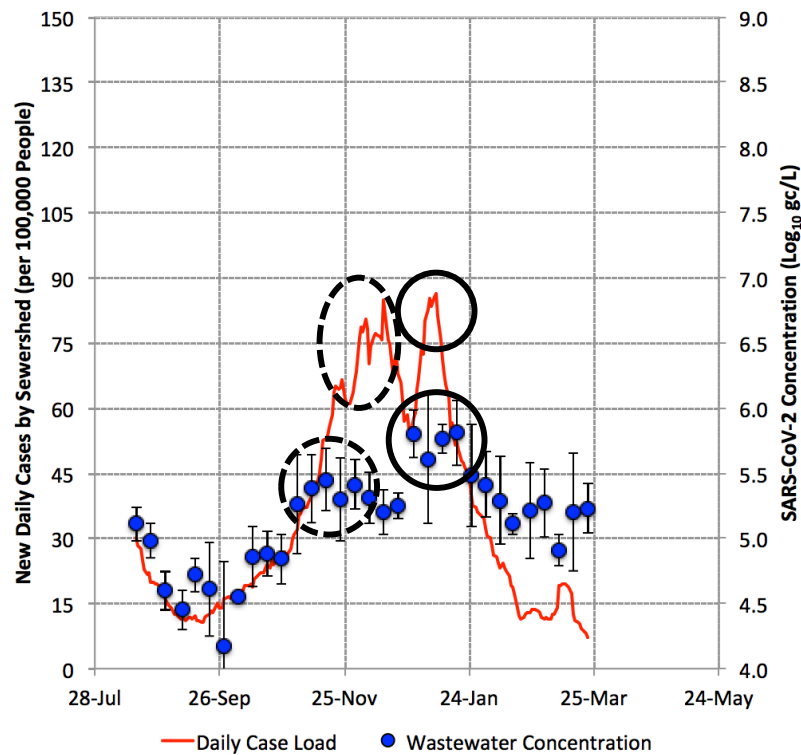
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Mon. 10/12	4.9	4.9	5.8	5.9	5.9	5.8	No Sample
Mon. 10/19	4.9	4.8	5.9	5.6	6.2	5.6	No Sample
Mon. 10/26	4.8	5.1	5.8	5.5	5.5	5.6	No Sample
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Mon. 1/11	5.8	5.8	6.3	6.2	6.4	6.5	6.0
Mon. 1/18	5.8	5.8	6.1	5.9	6.4	6.0	6.1
Mon. 1/25	5.5	5.9	6.1	6.2	6.2	5.9	6.3
Mon. 2/1	5.4	5.4	6.1	5.7	6.1	5.9	5.5
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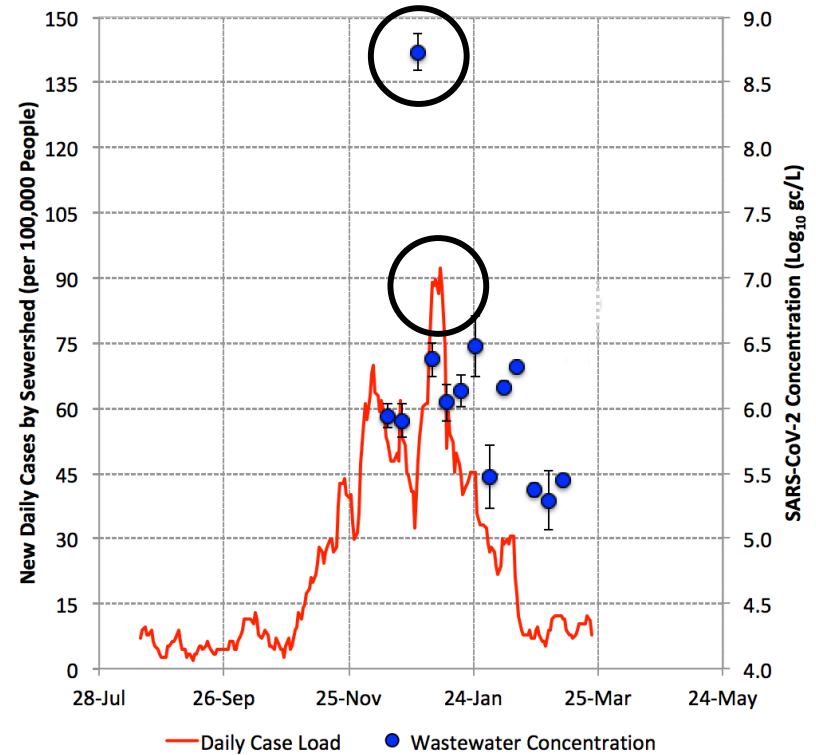


Predicting the Holiday Surge

Facility 1



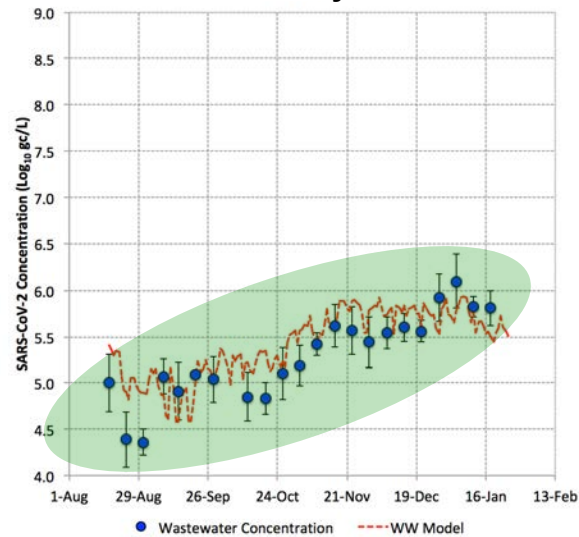
Facility 7



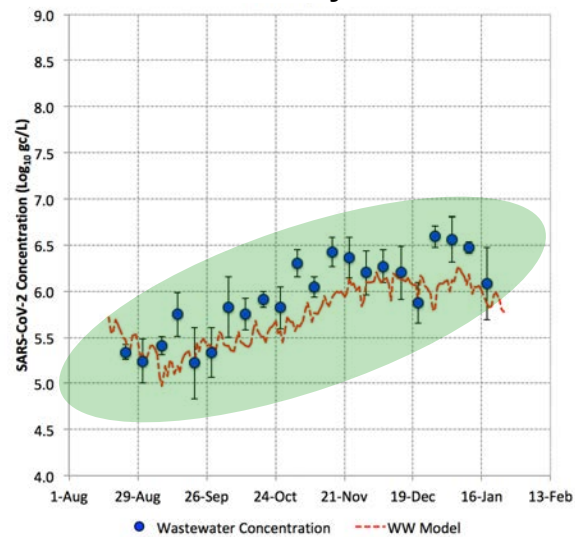


Are the Data Actionable?

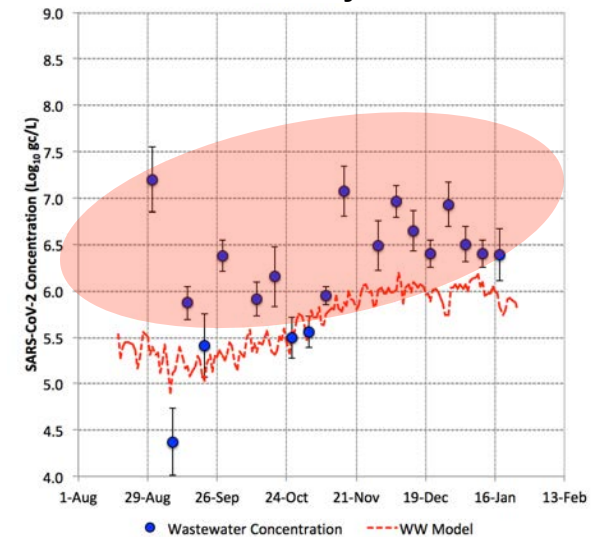
Facility 2



Facility 3



Facility 5

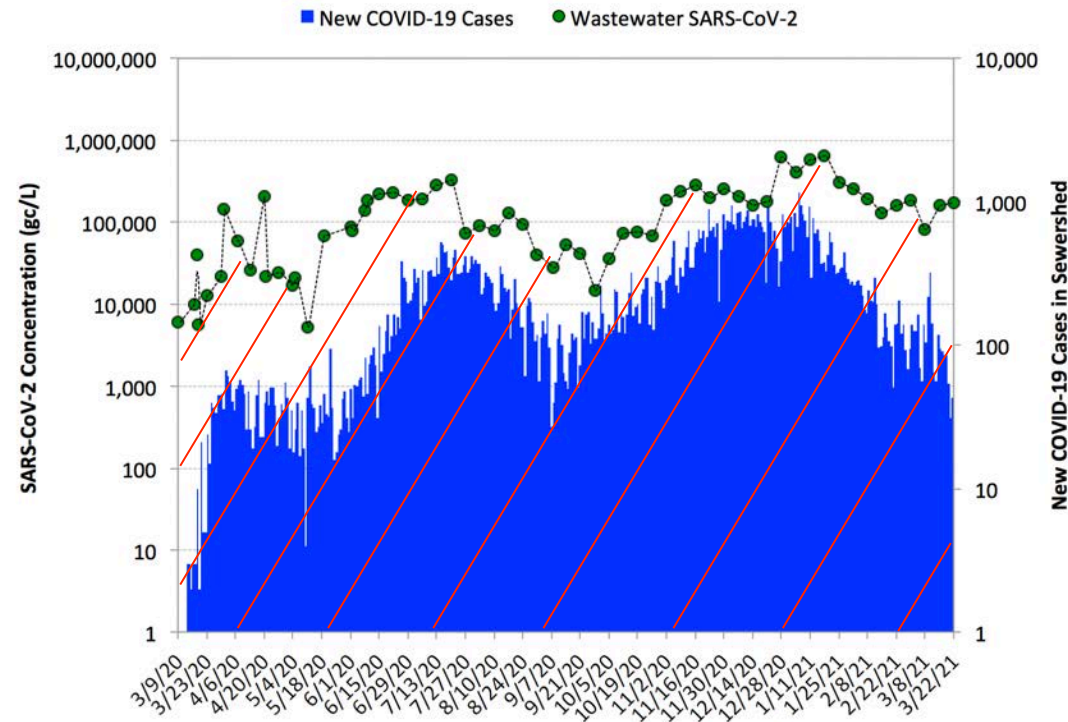


Facility 5: Greater discrepancy between wastewater concentrations and clinical case data (i.e., model)





Retrospective Infection Estimate



Area under wastewater curve = total SARS-CoV-2 in wastewater since March 2020

Flow rate = 100 million gallons per day | Concentrations adjusted for diurnal variability

= 9.4×10^{16} gene copies into Facility 1 from March 2020 – May 2021



Retrospective Infection Estimate

Based on Facility 1 (as of May 2021):

- $A = \text{Total SARS-CoV-2 into WWTP} = 9.42 \times 10^{16} \text{ gc}$
- $B = \text{Total SARS-CoV-2 per Infection} = 2.42 \times 10^{11} \text{ gc/infection} \rightarrow \text{still somewhat uncertain}$
- $A/B = \text{Estimated Total Infections since March 2020} = 389,445 \text{ infections}$

All Sewersheds (as of May 2021):

- WW Estimated Infections in Southern Nevada = **915,493 = ~40% of Southern NV**
- Antibody Estimated Infections in Southern Nevada = **575,000 = ~25% of Southern NV**
- Confirmed Infections in Southern Nevada = **239,702 = ~10% of Southern NV**
- Assume 90% for herd immunity $\rightarrow$ **2.1 million infections + vaccinations**
- 'Non-Infected' Vaccinations Needed = **1.2 million | 1.5 million | 1.9 million**
- Vaccinations Completed/Initiated = **0.8 million | 1.1 million (some vax previously infected)**

Wastewater-Based Epidemiology: Path Forward



Increasing Accessibility/Leveraging Momentum

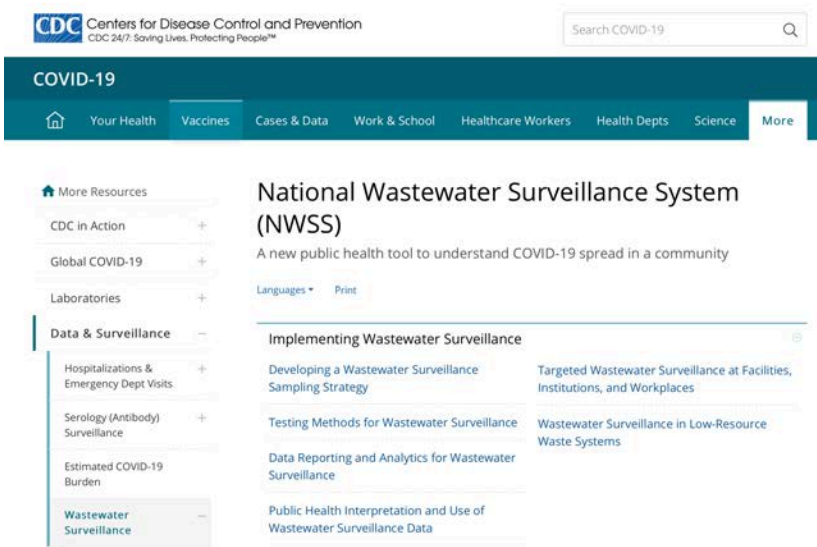
SNWA Collaboration with Hach/Luminultra

- Portable qPCR Instrument ≈ \$16,000
- SARS-CoV-2 Kit ≈ \$40/sample



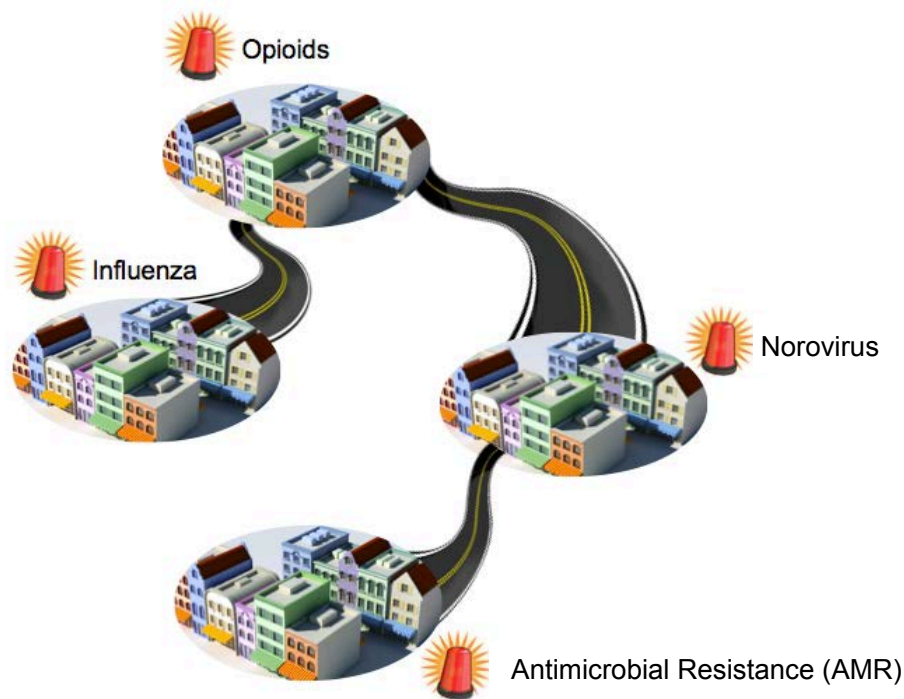
CDC National Wastewater Surveillance System (NWSS)

- Developing national database for SARS-CoV-2
- Expand to other targets in the future?



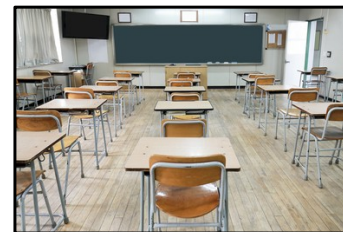


Path Forward for Wastewater Epidemiology



Alternative Data Sources

♥ **CVS** pharmacy®





Acknowledgments

- Staff at the collaborating wastewater agencies: Clark County Water Reclamation District, City of Henderson, City of Las Vegas, City of North Las Vegas, Boulder City
- Staff at the Southern Nevada Water Authority for ensuring a safe work environment during the pandemic
- Countless research colleagues for their guidance
- This work was partially supported by the National Science Foundation under Grant No. 1832713
- **For additional information:**
 - SNWA Podcast: Poops Don't Lie – Tracking a Pandemic Using Wastewater^a
 - Email: Daniel.Gerrity@snwa.com

^a<https://watersmarts.buzzsprout.com/1568941/8125328-poops-don-t-lie-tracking-a-pandemic-using-wastewater>