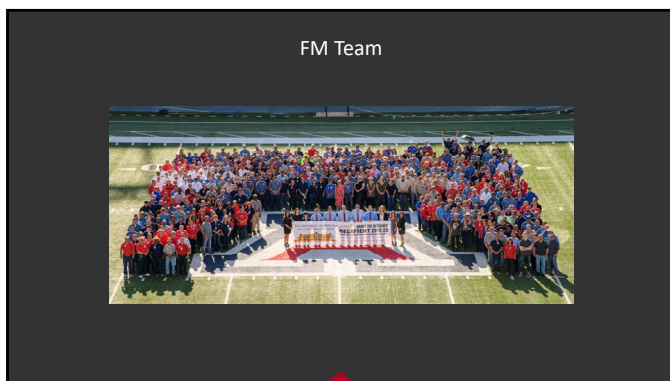


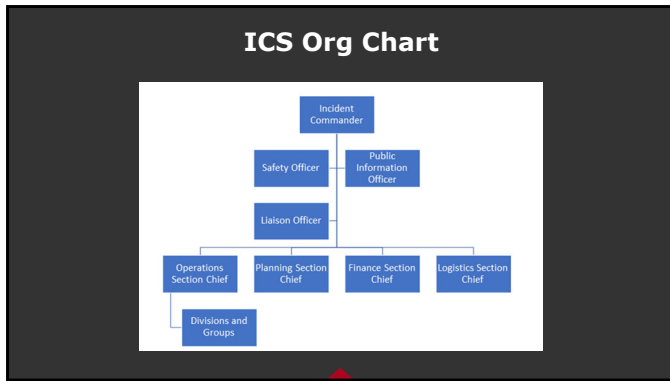
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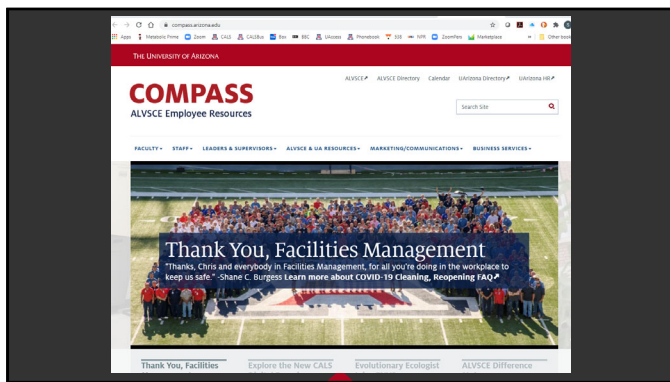
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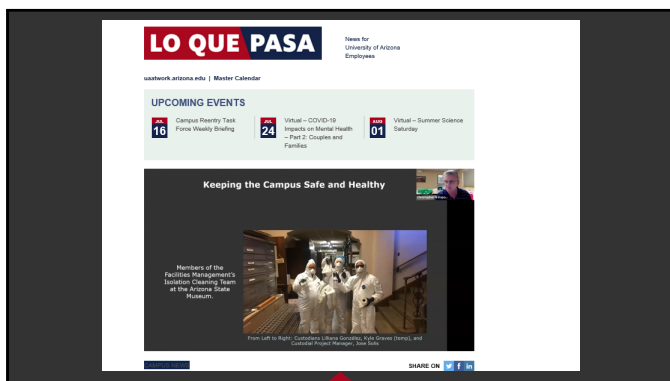
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5



6

What Has FM Done Over the Last 7 Months?



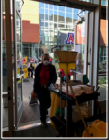


- Ramped up cleaning and disinfecting beginning in January as is custom due to the cold/flu season
 - Using Quat which kills the COVID-19 virus
- Following CDC guidelines to ensure the health and safety of our employees and the campus community
- Trained members of our Custodial Staff on strict isolation, including PPE and proper cleaning techniques
- Handling PPE purchasing and storage for several units on campus
- Our Small Engine Shop has been converted to a disinfecting station, filling and replacing thousands of bottles of disinfectant to share across campus
- Reviewing the possibility of hands-free items on campus:
 - Faucets
 - Paper towel dispensers
 - Soap dispensers
 - Door opening devices
- Other items under review:
 - Hand sanitizing stations at entrances to buildings
 - Reviewing classrooms to ensure social distancing practices remain in place for the Fall Semester
 - Plastic shields

7

Assisting Residence Life

- 78 Facilities Management employees assisted the Residence Life Department by cleaning out the Arizona Sonora and Mexico College Dorms and moving approximately 600 students from all across campus to either the Arizona College or Coronado Dorms.
- Facilities Management also assisted with transporting about 1,000 students personal items from 22 dorms on campus to the 34th St. Warehouse for safe storage.

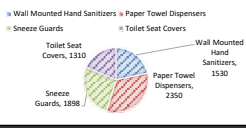
Custodial Staff outside of dorms on campus

8

Items Completed to Date:

- 1,898 Sneeze Guards Installed
- Signage Completed in 100 Buildings
- 1,530 Wall Mounted Hand Sanitizers Installed
- 2,350 Touch-Free Paper Towel Dispensers Installed
- 1,310 Toilet Seat Covers Installed

CAMPUS RE-ENTRY



Wall Mounted Hand Sanitizers 1,530
Paper Towel Dispensers 2,350
Toilet Seat Covers 1,310
Sneeze Guards 1,898

9

Wastewater-Based Epidemiology for Averting COVID-19 Outbreaks on The University of Arizona Campus



10

WASTEWATER-BASED EPIDEMIOLOGY (WBE)

- Rapidly growing discipline formerly known as “sewage surveillance”
- Relies on testing wastewater from a given community for the presence of a particular virus
- Answers the questions: “Is the virus in that community?” “Is there a pandemic?”
- Concentration of the virus gives an indication of the severity of the pandemic

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WBE: CONCEPT FOR CORONAVIRUS

- Infected individual shed the virus in feces which then enters wastewater (sewage)
- **Shedding occurs up to 7 days prior to visible symptoms**
- Shedding at a maximum at onset of symptoms
- **Shedding continues 2-4 weeks after disappearance of symptoms**

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BENEFITS OF WBE

- One test monitors defined community such as wastewater treatment plant service area or student dorm
- Highly sensitive: can detect 1 infection in 10,000 individuals
- Gives total virus load shed into wastewater including virus from symptomatic and asymptomatic individuals
- Is a leading indicator – can be detected in sewage up to 7 days prior to symptoms developing

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ADDITIONAL BENEFITS OF WBE

- Useful for detecting onset of a pandemic
- Quantitative data over time determines if pandemic is \uparrow or \downarrow
- Allows determination of whether or not a community could/should return to work
- Can be used to evaluate the success (or lack thereof) of interventions such as mandated mask usage or social distancing
- Correlation of virus wastewater concentration (gene copies) with the number of clinical cases allows for future predictions of #s of infections

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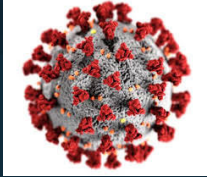
LIMITATIONS WITH CLINICAL DATA

- Limited test availability
- Test negative on Monday – What about Tuesday?
- Asymptomatic carriers often not tested
- Lag in reporting cases
- Test efficacy: False –ve and False +ve results

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COVID-19 DISEASE

Coronavirus



COVID-19 Disease Symptoms

Common	Uncommon	Rare
Fever	Headache	High fever
Dry cough	Nasal congestion	Coughing up blood
Fatigue	Sore throat	Decreased white blood cells
	Shortness of breath	Kidney failure
	Pain in muscles/joints	
	Chills	
	Nausea and/or vomiting	
	Diarrhea	
	More recently: long haulers?	

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BUT

- 70-80% only mild symptoms or asymptomatic (we think!)
- Hence, mortality rate compared to number of infections is unknown
- Young individuals are infected less frequently and with milder symptoms (usually!)

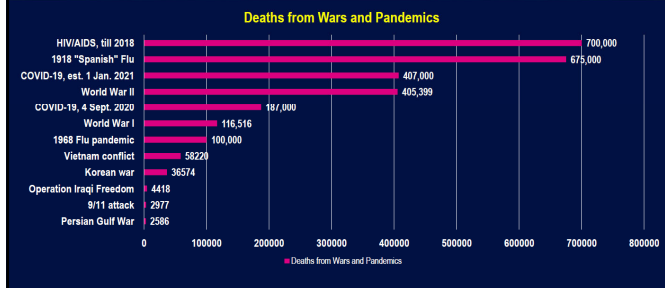
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COVID-19 CASES WORLDWIDE

Most Cumulative Cases	Most Cases per Capita
U.S.	U.S.
Brazil	South America
India	Europe

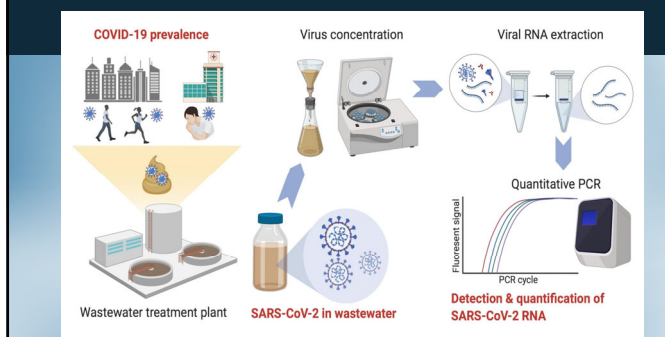
18

DEATHS FROM COVID-19 AND OTHER PANDEMICS AND WARS, US



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WASTEWATER-BASED EPIDEMIOLOGY



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WEST CENTER MONITORING OF COVID IN SEWAGE FROM WASTEWATER TREATMENT PLANTS

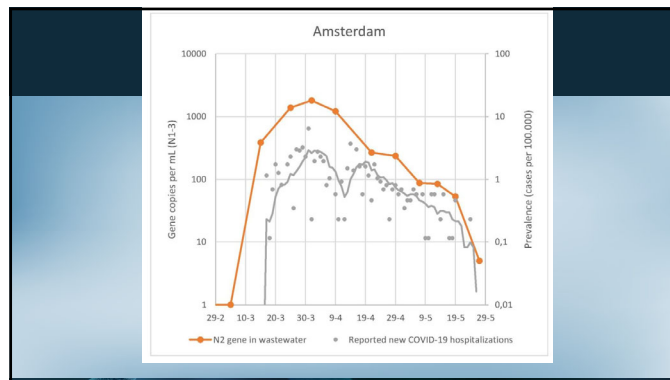
- WEST WEBSITE (March 2020): offer to test samples nationwide for a fee
- March → August 2020, over 300 samples analysed
- Samples from all over U.S. including Los Angeles, New York, Seattle Jacksonville (FL)
- Raw wastewater samples often +ve
- Always -ve after 2° treatment and disinfection

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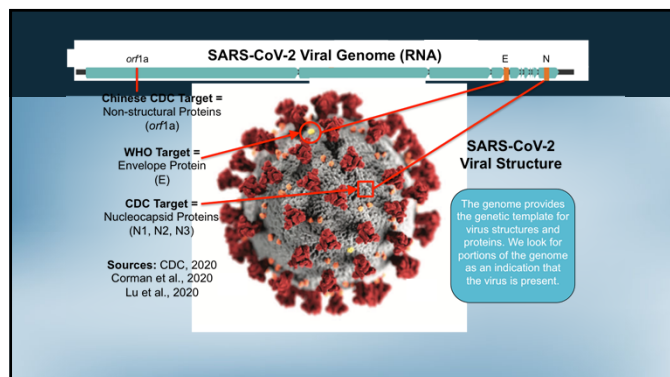
META DATA

- Basic collection data: date, time, location
- Type of sample: raw sewage or after treatment
- WWTP service area
- Number of individuals served
- Number of cases in service area (on that date)
- Number of deaths (on that date)
- Look for correlations with virus concentration in wastewater

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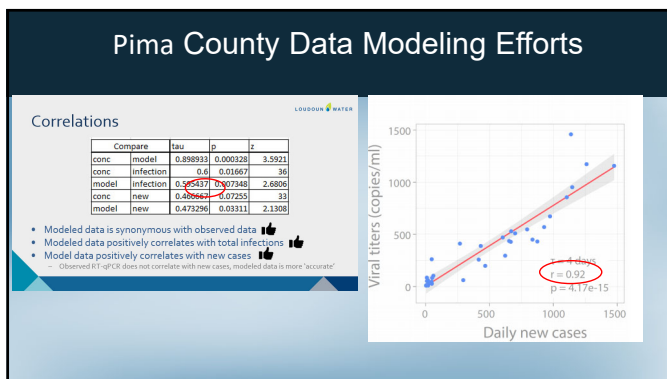


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SENSITIVITY OF WBE: AGUA NUEVA WWTP

- “Stay at home” order in Arizona
 - Approximately 2-4 weeks later, virus concentrations and case count decrease
- “Re-open economy” order in Arizona
 - Approximately 7 days later virus concentrations increase
 - Approximately 2 weeks later, case count increases
- Three National holidays: Memorial Day, Independence Day, Labor Day
 - Approximately 1 week after each holiday virus concentrations increase
 - Approximately 2 weeks after each holiday case count increases

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CORRELATIONS

Compare	tau	p	z
conc model	0.898933	0.000328	3.5921
conc infection	0.6	0.01667	36
model infection	0.595437	0.007348	2.6806
conc new	0.466667	0.07255	33
model new	0.473296	0.03311	2.1308

- Modeled data is synonymous with observed data 👍
- Modeled data positively correlates with total infections 👍
- Model data positively correlates with new cases 👍
 - Observed RT-qPCR does not correlate with new cases, modeled data is more 'accurate'

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UNIVERSITY OF ARIZONA STUDENT RE-ENTRY PLANS FOR FALL 2020

7 teams established:

- COVID-19 testing of humans (RT PCR)
- Antibody testing (Elisa IgG Antibody Test)
- Contact tracing (In person and app. Based)
- Isolation (segregated dorms or hotels)
- Health Data Management and Communication (HIPAA and FERPA compliant data management)
- Thermometry (temperature measurement of individuals)
- WBE: US! (Dormitory testing for early detection of in-house infections)**

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CURRENT DORMS TESTED

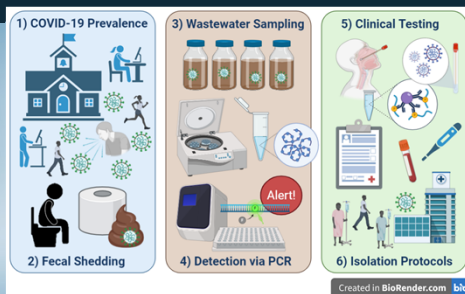
• Maricopa	• La Paz
• Kaibab/Huachuca/Arizona	• La Cienega
• Sonora	• San Pedro
• Arbol de la Vita	• Santa Cruz
• Graham/Greenlee	• LIKINS

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Collecting Wastewater from Dorms



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HOW WBE REDUCED EXPONENTIAL SPREAD OF COVID-19



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HOW WBE REDUCED EXPONENTIAL SPREAD OF COVID-19

- The two infected students were asymptomatic
- Without WBE detection and isolation, they would have spread COVID-19 to other students
- This scenario has been repeated multiple times
- Now in 8th week of the semester: case count minimal
- University has successfully remained open
- Influence of “Shelter in Place” reflected in wastewater virus concentrations

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EFFICACY OF WBE

- To date, false positives rare
 - Positive wastewater = someone infected
- False negatives can occur more frequently
 - No shedding or low shedding rates
 - PCR inhibition

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OVERALL STORY RESULTED IN MEDIA FRENZY!

- Broadcasts with CNN, NPR, CBS, NBC, ABC
- Publications in “The Atlantic” and “Politico”
- 300 media hits in September

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National Headlines

The University of Arizona says it caught a dorm's covid-19 outbreak before it started. Its secret weapon: Poop.

University Of Arizona Prevented Coronavirus Outbreak On Campus By Testing Wastewater

How the University of Arizona used No. 2 to solve its No. 1 problem: The coronavirus

Poop tests stop COVID-19 outbreak at University of Arizona

University of Arizona's wastewater testing halts potential surge in COVID-19 cases at dorm

UA wastewater testing finds COVID-19 cases in dorm

University of Arizona wastewater testing finds virus at dorm, prevents outbreak

Researchers at the University of Arizona say they stopped a coronavirus outbreak before it spread by testing students' poop

Wastewater helps find positive COVID-19 cases at UA dorm

University of Arizona catches asymptomatic coronavirus cases through wastewater testing

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What have we learned – sewage monitoring for SARS-CoV-2 at the University of Arizona and Tucson

- Grab samples collected in the morning work sufficient – no need for composite sampling
- Can identify as few as 2 infected student dorms of ~300
- No viruses detected in sewage after infected students removed
- Four-day lead on identifying cases before positive clinical test by student health center
- Concentration of virus increases in community sewage after Memorial Day, 4th of July and Labor Day before increase seen in clinical cases
- Social distancing and use of masks decreased concentration of virus

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ESTIMATION OF # OF ASYMPTOMATIC CASES^{4, 13}


$$\frac{\text{Theoretical \# Infected People}}{\text{Amount of feces x fecal shedding rate}} = \frac{\text{Sewage concentration x Wastewater flow rate}}{\text{Amount of feces x fecal shedding rate}}$$

Theoretical # infected people minus actual reported cases = # asymptomatic cases

- Big unknown – fecal shedding rate
- BUT from Student Dorm Study
 - # cases known (clinical tests)
 - Back calculate shedding rate
 - Use equation to predict total # cases
 - Limitation = issues with clinical testing

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**WASTEWATER-BASED
EPIDEMIOLOGY**



POOP NEVER LIES!
University of Arizona
