



# Norovirus Outbreak at a Ranch in Coconino County

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# Where did the Outbreak Occur?

- The wedding was held at a ranch that was rented to the public via a website
- 188 acre property 15 miles west of Flagstaff
- Rented cabins, barns and equestrian facilities
- Rentals included a Main Cabin, Bunk House, Guest House and a Caretaker Cabin which are fed by wells
- No food or catering is offered at the ranch



# County Health Notification

- On August 17 CCPHSD received a call that guests became ill with:

Vomiting

Diarrhea

Nausea

Fever

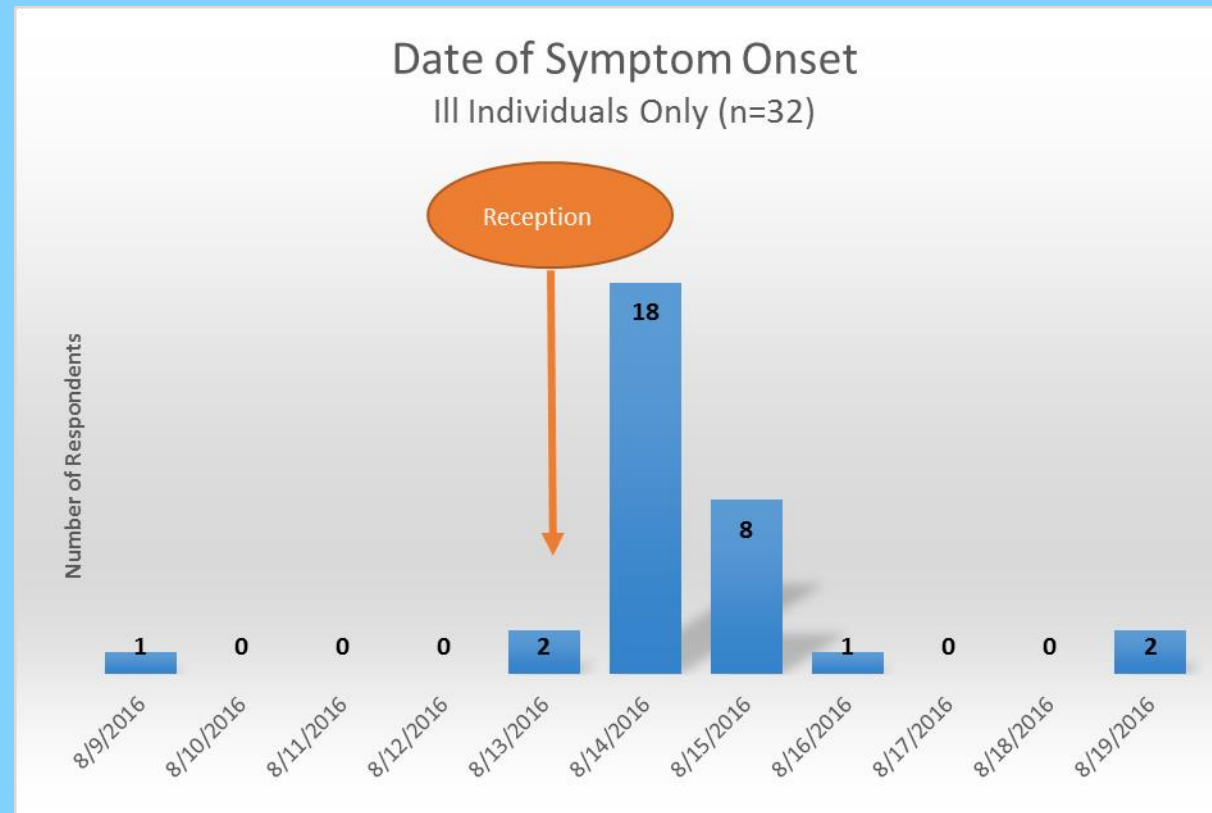


# Event Information

- The wedding was held at the ranch starting Friday August 12<sup>th</sup> through Sunday the 14<sup>th</sup>
- Wedding reception took place the evening of Saturday August 13<sup>th</sup> at the Bunk House with 90 guests
- Food for the reception was provided by a friend
- Water for the Caretaker's Cabin, Guest House & Bunk House is provided by a well located near the Bunk House
- Main House water supply is from a separate well

# Outbreak Information

- 59 of the 90 wedding attendees completed the survey
- Illness attack rate was 35% (32 became ill after the wedding reception with diarrhea & vomiting)
- 87% had onset within 2 days after reception



# Food Survey Results

<b>Association between becoming ill and events attended or items consumed.</b>	
	<b>Statistical significance</b>
<i>Events Attended</i>	
Potluck (Aug 12)	Not significant
Pizza in the Park (Aug 13)	Not significant
Reception (Aug 13)	Not significant
<i>Items Consumed</i>	
Water from Well #1 (either cucumber mint or from cabin tap)	<b>Significant</b> <i>Odds ratio = 38.8 (4.6, 326.4)</i> <i>p=.000005</i>
Water directly from Well #1 cabin tap at any point during the weekend only (NO cucumber mint)	<b>Significant</b> <i>Odds ratio = 3.9 (1.1, 14.1)</i> <i>p=.027713</i>
Cucumber-mint water only (made with Bunk House tap water)	<b>Significant</b> <i>Odds ratio = 5.1 (1.7, 15.6)</i> <i>p=.003524</i>
Corn on the Cob	Not significant
Meat	Not significant
Grilled vegetables	Not significant
Greens	Not significant
Pasta	Not significant
Tabouli	Not significant
Main Cabin water (venue for potluck)	Not significant
Beer from keg	Not significant

# Survey Results

- Survey results pointed to the water and the cucumber mint water



# Environmental Investigation August 26

- ADWR well information
  - 3 wells
  - 2 in use
  - The well for the Bunk House, Guest House and the Caretaker's Cabin was drilled:
    - In 1955,
    - Well depth 40-feet and
    - Static water level 20-feet



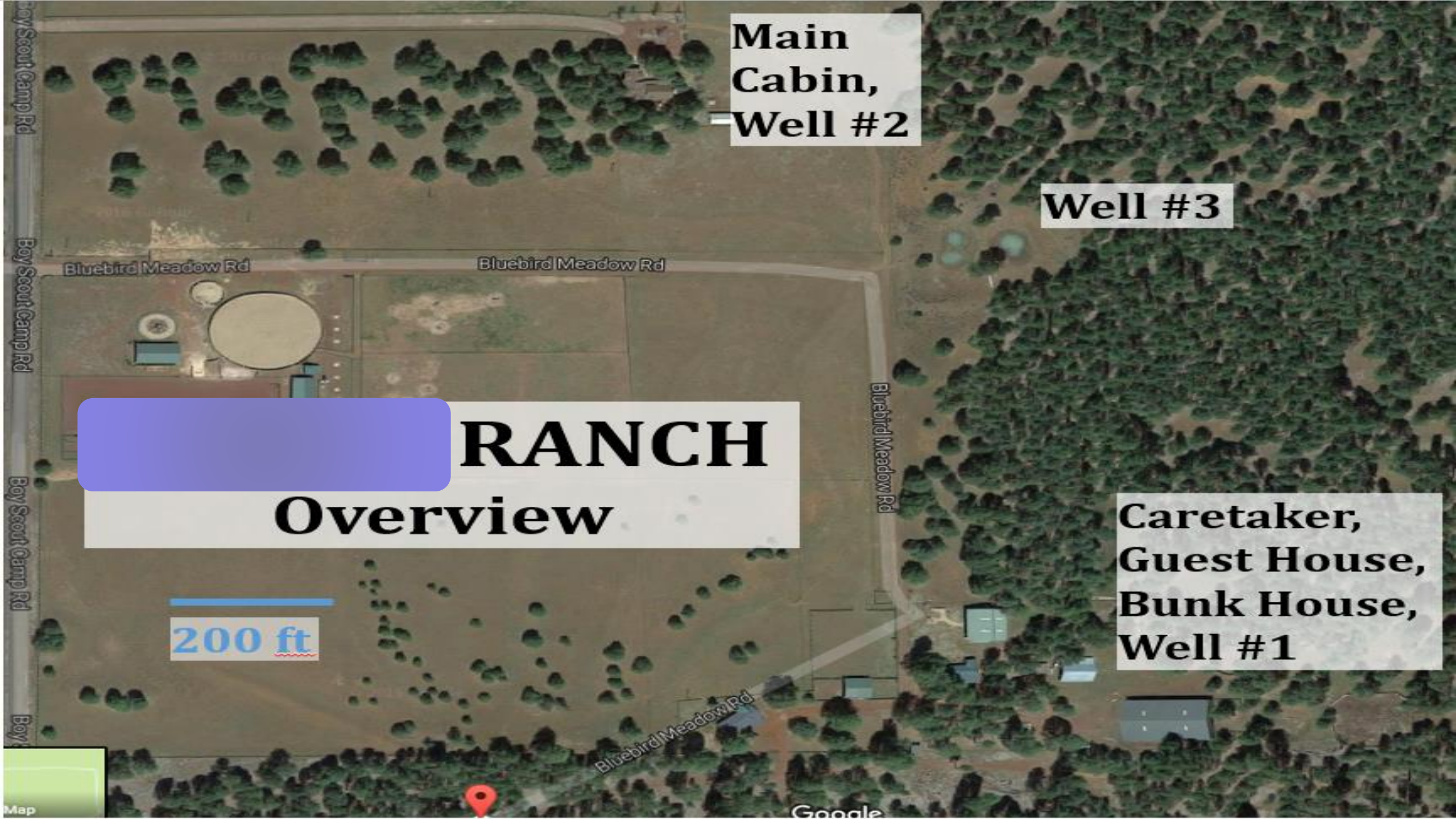
**Main Cabin,  
Well #2**

**Well #3**

**RANCH  
Overview**

**Caretaker,  
Guest House,  
Bunk House,  
Well #1**

**200 ft**



# Water Sampling

- Water samples collected on Friday August 26<sup>th</sup> after receiving permission to enter property and collect samples

Note: Property manager indicated that water from wells had been tested by property owners and that she would forward the results to me – never received them

- 7 Water samples were collected from:
  - Bunk House inside sink and outdoor spigot
  - Caretaker cabin inside sink and outdoor spigot
  - Guest House inside sink and outdoor spigot
  - Main House outdoor spigot

# Water samples at Bunk House



# Water samples at Caretaker's



# Water sample outside Guest House



## Sample Results Received the Following Day

- ✓ All samples from Guest House, Bunk House and Caretaker's Cabin inside and out tested positive for both Coliforms and *Escherichia coli*

*(Note: Rumors indicated that the results were + that the property owners had submitted months prior)*

- ✓ The one sample from the main house was negative for both indicator bacteria – Main House on separate well

# Main House at different location from Bunk House



# Actions Taken August 29th

- The Health District issued a Cease & Desist order to the property manager to stop operating a transient dwelling.
- Environmental Quality issued a NOV for installing a wastewater system without a permit.





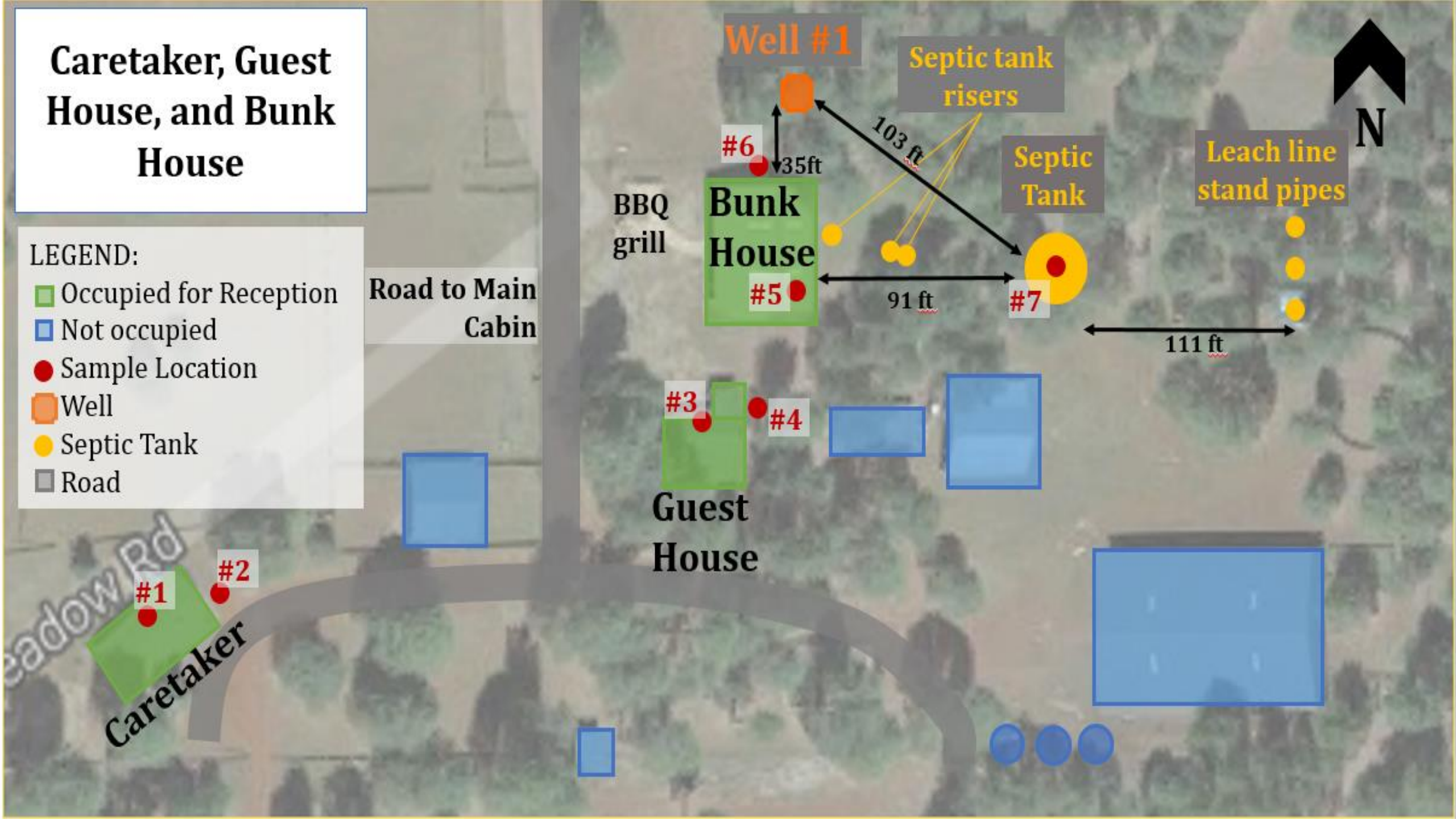
# What was the contamination source?



# Caretaker, Guest House, and Bunk House

## LEGEND:

- Occupied for Reception
- Not occupied
- Sample Location
- Well
- Septic Tank
- Road



Well by Bunk House ~103 feet from septic





# Septic System and discharge pipe for overflow



# Septic System/Bunk House/Well House





# Next Step: Test the well for norovirus.

- Received permission from property owners to sample Bunk House well for norovirus and well was sampled on Sept 16, 2016
- Dr. Gerba from University of Arizona provided the sampling equipment and filters





Sample collected directly from the well house



# Sampling Equipment



# Nano-Ceram VS2.5-5 Filter

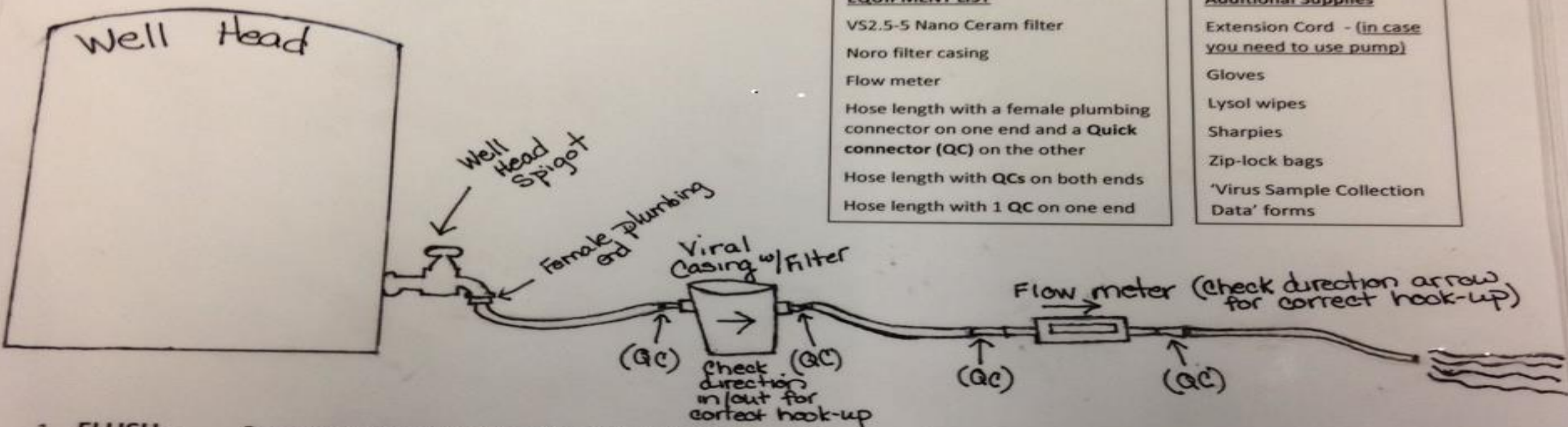
## Sampling Procedures:

- Flush equipment with 50 gals of well water
- Install filter in filter housing
- And run 500 liters or 132 gals of well water through filter
- Double bag filter, label and refrigerate
- Ship overnight in cooler with ice packs



# Water sampling for norovirus

## Operation w/out pump



### EQUIPMENT LIST

VS2.5-5 Nano Ceram filter  
Noro filter casing  
Flow meter  
Hose length with a female plumbing connector on one end and a **Quick connector (QC)** on the other  
Hose length with **QCs** on both ends  
Hose length with 1 **QC** on one end

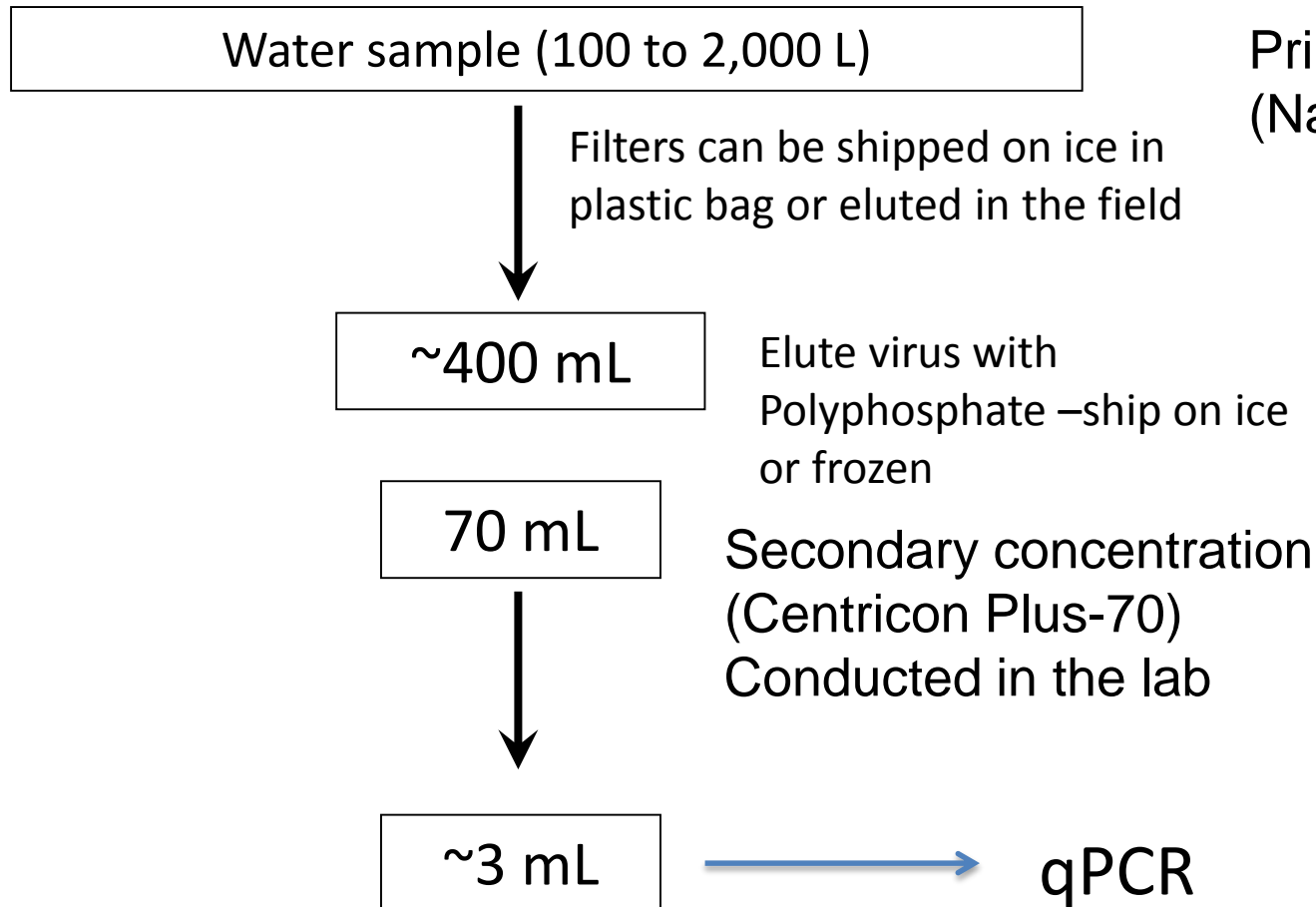
### Additional Supplies

Extension Cord - (in case you need to use pump)  
Gloves  
Lysol wipes  
Sharpies  
Zip-lock bags  
'Virus Sample Collection Data' forms

1. **FLUSH** - Connect equipment according to picture above and run 50 gallons of water from the well through the hoses and apparatus without the Nano Ceram filter in the Noro filter casing.
2. **SAMPLING** - After the flush, wearing gloves, insert the Nano Ceram filter in the Noro filter casing and run 500 liters (~132 gallons) of water from the well through the hoses and apparatus to obtain your sample. Remove filter from housing with gloves and place in labeled zip-lock ad double bag.
3. **DISINFECTION AFTER TESTING** - Wearing gloves, disconnect hoses and connectors, remove filter housing and flow meter, and soak equipment in 150-200ppm Chlorine for 30 minutes.

# Virus Concentration Method -NanoCeram Filter Method – Negatively charge virus adsorbs to positively charged filter

- To concentrate large volumes of freshwater
- Two-step concentration procedure



Primary concentration  
(NanoCeram Filter)



# Well Sample & Stool Sample Results

- Well sample and water spigot results + for both norovirus G1 & G2
- Two of the 5 stool samples were + for G1.3B



# Viruses Detected per Liter

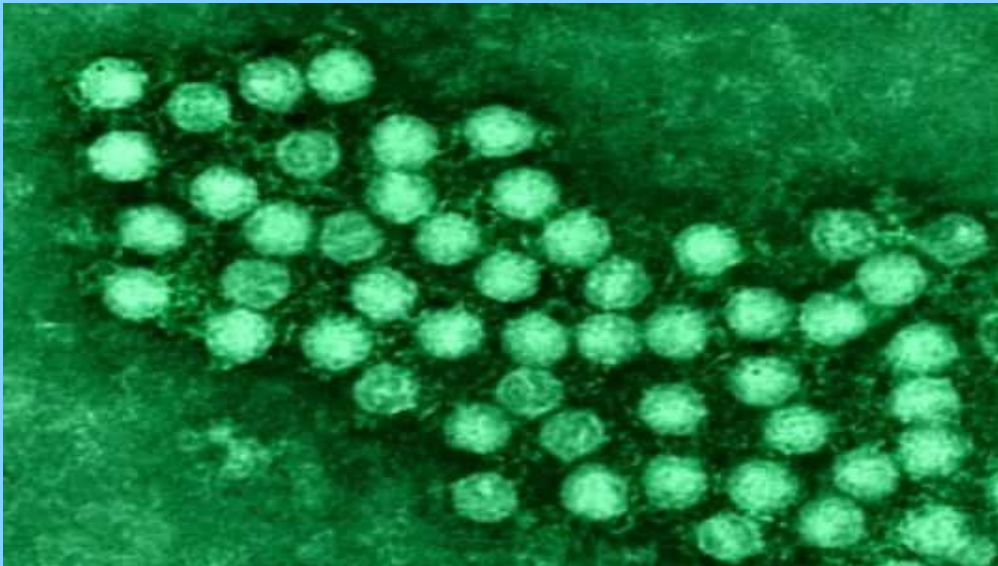
Site	Noro GI	Noro GII	Enteroviruses	PMMoV*	Coliphage GII**
Spigot	5,688	114	40	17,800	579
Wellhead	4,490	10	35	13,300	393

\*pepper mild mottle virus

\*\*only found in humans

# What are enteroviruses

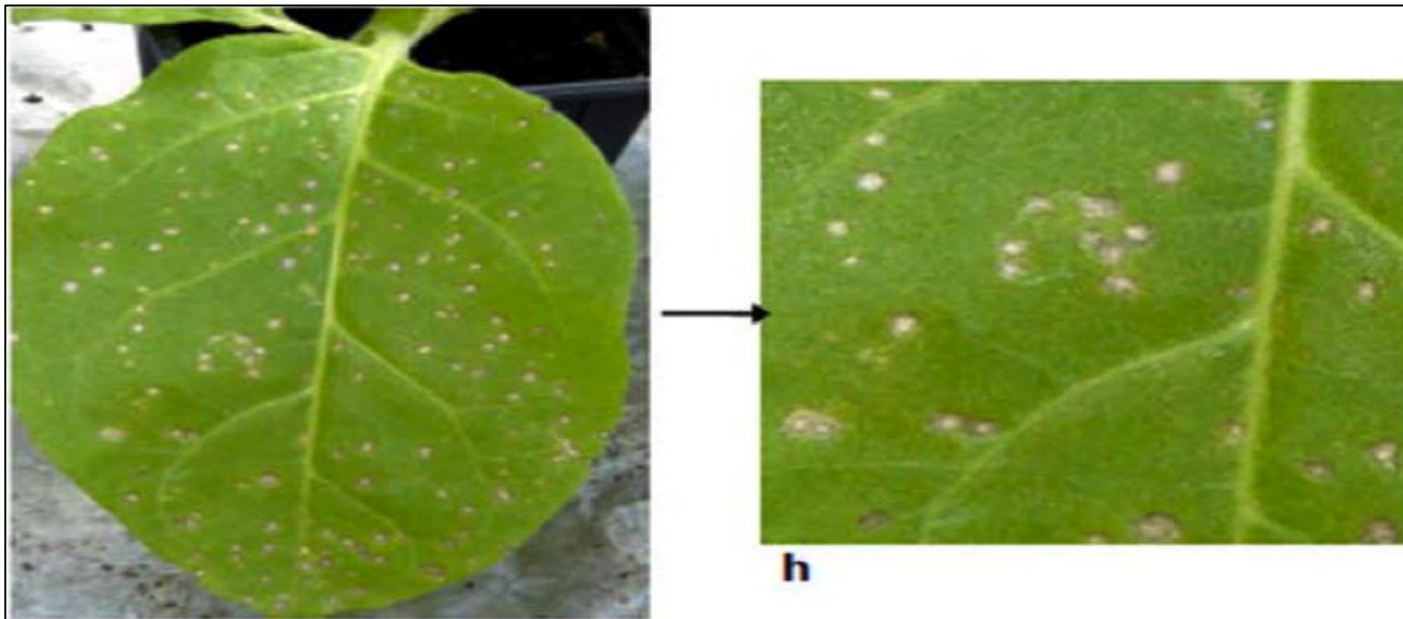
- Polioviruses
- Echoviruses
- Coxsackieviruses
- Paraechoviruses
- Enteroviruses 71-119
- Fever
- Rash
- Hand, foot, and mouth disease
- Myocarditis
- Meningitis
- Gastroenteritis
- Paralysis
- Alice in wonderland syndrome





# What is Pepper Mild Mottle Virus?

- ◆ Plant virus that infects hot, bell, and ornamental peppers and tobacco plants.
  - Causes mosaic diseases (“mild mottles”)
  - Does NOT infect humans? We excrete more than we ingest. May cause irritation in the gut. **Extremely stable in the environment**
  - Dietary origin
    - e.g., up to  $10^7$  virus/ml in Tabasco sauce.
    - **Occurs in the highest concentration of all viruses in domestic sewage ( $10^9$ /L)**

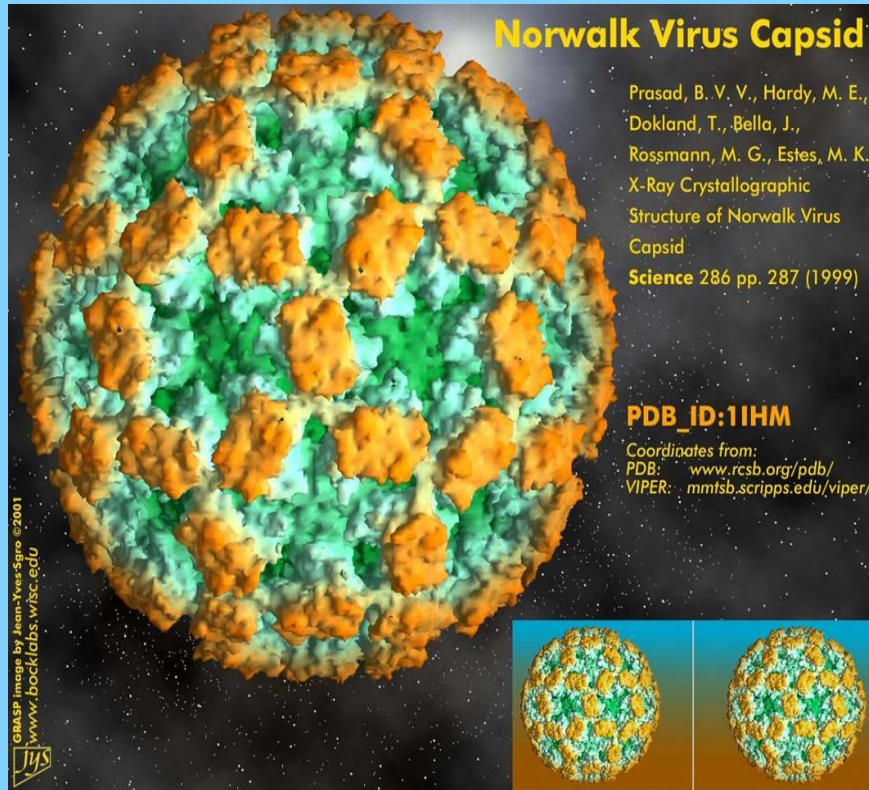


## This is the 2<sup>nd</sup> well in AZ that has tested + for Norovirus

- First well that tested + for norovirus was in Sedona during a dental convention in 1986 where 80 plus people became ill.
- Source was the leach field that was ~ 100 feet from well but installed in sandy soil.



# What is Norovirus?



- The genus contains multiple strains
- Single-stranded RNA, non-enveloped, cannot be cultured
- Family Caliciviridae (used to be known as Norwalk-like virus)

Reference: Gerba, 2004

# What do we know about Norovirus?

- Causes acute gastrointestinal illness in humans
- Noroviruses are highly contagious (both diarrhea and vomit contain the virus)
- Infective dose may be as few as 10 viral particles

Reference: CDC, 2006

# 2011 FB Pathogen Ranking by University of Florida

- Ranked 5<sup>th</sup> in the Annual Disease Burden Caused by 14 Foodborne Pathogens
- Leading cause of AGI illnesses – 5,461,731 ill
- Fatalities – 149
- Noroviruses are most common cause of AGI and result in at least 50% of all AGI worldwide.

Reference: Batz, M.B., Hoffman, S., Morris, J.G. 2011. Ranking the Risk: The 10 Pathogen-Food Combinations With The Greatest Burden on Public

CDC. 2001. Updated Norovirus Outbreak Management and Disease Prevention. Retrieved 1/5/2016.  
<https://www.cdc.gov/mmwr/preview/mmwrhtml/rr6003a1.htm>

# Symptoms of Norovirus

- Onset: Often begins suddenly within 1 to 2 days after exposure, but can occur w/in 12 hours and lasts 1 to 2 days
- Symptoms: Abdominal cramps, nausea, projectile vomiting and diarrhea – some may experience low-grade fever, chills, headache & muscle aches
- Death is rare

Reference: CDC, 2006

# Treatment

- To date, there is no antiviral treatment or vaccine for norovirus

Reference: CDC, 2006

# Is there immunity to norovirus?

- There is evidence that suggests that immunity may be strain specific and lasts for only a few months
- Individuals are likely to be repeatedly infected throughout their lifetimes
- Recent evidence also suggests that susceptibility may be genetically determined with people of “O” blood type experiencing more severe infections

Reference: CDC, 2006



# How Does Norovirus Spread?

- Transmission: Fecal/oral route involving food, water, person-to-person, and surfaces (fomites)
- Evidence exists for transmission to occur through aerosolization of vomitus that results in droplets contaminating surfaces or entering the oral mucosa and being swallowed
- A person will begin shedding the virus with the start of symptoms and **continue to shed the virus for two weeks after recovery**

Reference: CDC, 2006

# Carriers of Norovirus

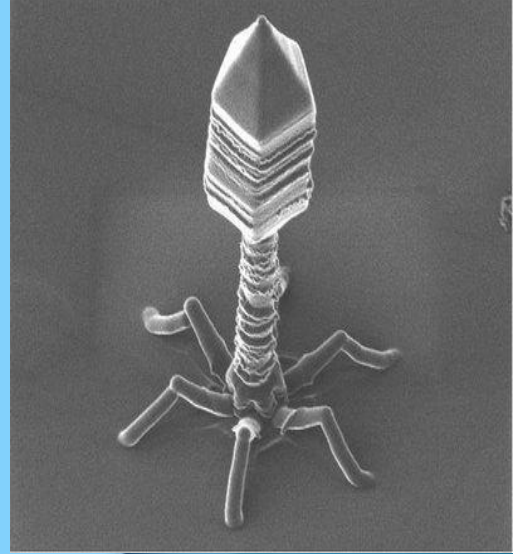
- Studies with volunteers given stool filtrates have shown that asymptomatic infection may occur in as many 30%

“The walking ill”

Reference: CDC, 2006

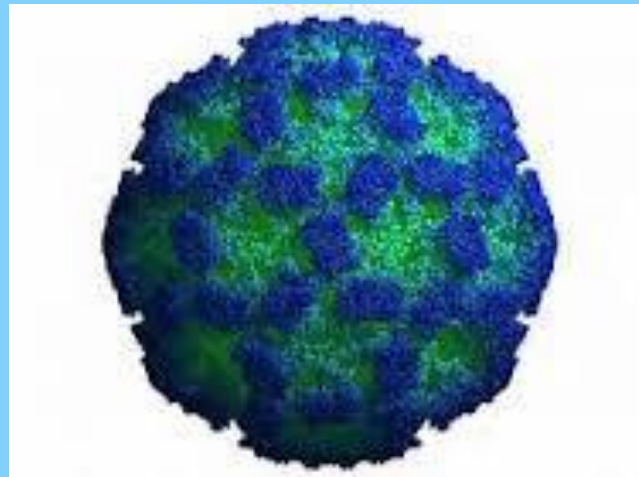
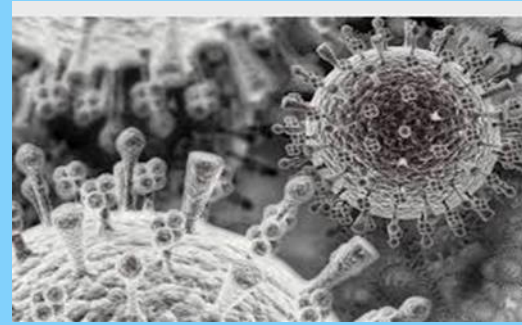
# What is the difference between GI & GII?

- Noroviruses belong to Caliciviridae Family and there are 5 genogroups:
  - GI, GII, GIII, GIV & GV (GI, GII & GIV – infect humans) GIII & GV infect cows, dogs & mice
  - These groups are further divided into at least 34 genotypes
- GI & GII cause the majority of disease in humans with most outbreaks in U.S. caused by genogroup GII type 4 – GII.4
- During last decade new GII.4 strains have emerged (e.g. Sydney strain)



# Norovirus Identification

- First norovirus identified in U.S. in Norwalk, Ohio in 1968 identified using electronmicroscopy
- Polymerase Chain Reaction (PCR) method invented in 1983 revolutionized testing for viruses



# Norovirus in Groundwater

- ✓ Study in Wisconsin 2012 of non-disinfected drinking water
  - Households completed weekly health diaries
  - Water samples collected monthly
  - Association was found between AGI and norovirus GI
- ✓ Study in Arizona 2009 of individual wells and small water systems
  - 10 small public water systems and 39 individual wells were tested
  - Norovirus was not detected but 16% (+) for fecal coliforms and 4% (+) for *Escherichia coli*



Gerba, Riley, Karpiscak, Morrero-Orotiz. 2009. Groundwater quality of individual wells and small systems in Arizona. American Water Works Association  
Borchardt, Spencer, Kieke Jr., Lambertini, Loge. 2012. Viruses in Nondisinfected Drinking Water from Municipal Wells and Community Incidence of Acute Gastrointestinal Illness. Environmental Health Perspectives. Vol 120. Issue 9.

# Viruses in Groundwater

- Can survive at least two years in groundwater at 10 °C
- Can be transported 100's of meters under the right conditions
- Travel faster than solutes (e.g. nitrates)
- Risk of contamination increases after
  - rainfall events (majority of outbreaks related to rainfall events)
  - Snow melts

# Question – Is non-treated drinking water safe?

- Arizona has more non-disinfected drinking water supplies than any other state in U.S.
- Arizona Small System Project was created to address contamination issues

Goals of Arizona Small System Project (AZSSP) are:

1. Assess microbial presence in small water systems
2. Identify potential sources
3. Find technology for enhancing drinking water quality



# Control of Viruses for Small Systems

- While currently no data exists for human norovirus, existing data with the use of surrogates indicate it can be removed from groundwater by
  - Chlorination (Ct 2 at 5 °C)
  - UV 40,000 microwatts/sec/cm<sup>2</sup>
  - Reverse Osmosis membranes



Questions?

