



Water

3 minutes without air
3 hours without shelter
3 days without water
3 weeks without food

Water - Agenda

- How Much
- Storage
- Collection
- Purification

Water – How Much

- Life saving minimum
 - 1 quart per person per day
- More realistic for an emergency
 - 1 gallon per person per day
 - May need more to sustain strenuous activity
 - May need more if it is hot weather
 - Will need more if someone is ill or injured
 - Generally will provide enough to prepare food
 - Will probably provide enough for hygiene if very frugal

Water - Storage

- Volume
 - 7.5 gallons per cubic foot
- Weight
 - 1 gallon weighs 8 pounds
 - 5 gallon jug weighs 40 pounds
 - 1 cubic foot weighs 60 pounds

Water - Storage

- Containers
- 1 gallon water jug
- Water bottle
- Cooler bottle
- Refilled bottle
 - 2 liter
 - Milk jugs – Just say no!
- 5 gallon jug
- 5 gallon Water Box kit
- Water Bricks
- 55 gallon drum

Water – Storage - Containers

- 1 gallon water jug
 - About \$1
 - Easy to get
 - Biodegradable
 - not good for more than 1 year
 - Not stackable
 - Not volume efficient
 - Cheesy lid
 - Limited reusability



Water – Storage - Containers

- Water bottles
 - Cheap
 - Easy to get
 - Portable single serving
 - Fits under a bed
 - Need a lot of them
 - Limited stack ability – not too many high
 - Not volume efficient
 - Cheesy lid
 - Trash takes up a lot of space
 - Limited reusability



Water – Storage - Containers

- Cooler bottle
 - Cheap
 - Easy to get
 - Holds enough water for a family of 5 for 1 day
 - Heavy
 - Limited stack ability – not too many high
 - Not volume efficient
 - Refillable
 - Can use without the cooler



Water – Storage - Containers

- Re-fillable bottle
 - Expensive
 - Not stackable
 - Most not volume efficient
 - Refillable



Water – Storage - Containers

- Re-used bottle
 - Cheap
 - Easy to get
 - PET – make sure!
 - Juice bottle
 - Pop bottle
 - Milk jug – Just say no!
 - Difficult to clean
 - Not stackable
 - Not volume efficient
 - Refillable



Water – Storage - Containers

- 5 Gallon Carboy
 - Expensive
 - Blue one is \$18
 - Easy to get
 - Heavy
 - Many are stackable
 - Holds enough water for a family of 5 for 1 day
 - Volume efficient
 - Can get various spouts, pumps & siphons
 - Refillable



Water – Storage - Containers

- 5 Gallon Water Box Kit

- Expensive
 - This one is \$14
- Hard to get
- Heavy
- Stackable
- Holds enough water for a family of 5 for 1 day
- Volume efficient
- Refillable a few times
- Hard to move – no handle
- More fragile than a carboy



Water – Storage - Containers

- 3.5 Gallon Brick
 - Expensive
 - This set of 10 is \$166
 - Hard to get
 - Heavy
 - Stackable
 - 1 Holds enough water for 3 people for 1 day
 - This stack holds enough for a family of 5 for 1 week
 - Volume efficient
 - Refillable



Water – Storage - Containers

- 55 Gallon Drum
 - Expensive
 - This one is \$120
 - Can probably find it cheaper
 - Hard to get - shipping
 - Heavy 440 lbs
 - Stackable – 2 high
 - 1 Holds enough water for 5 people for 11 days
 - Volume efficient – not as good as stacking square containers
 - Can get various pumps & siphons
 - Refillable



Water – Storage - Containers

- Water Heater
 - Already in your house
 - Tankless could be an issue
 - Maintenance
 - Should be draining it twice a year
 - No one does that
 - Could be difficult to open the drain valve
 - Could be difficult to close the drain valve
 - Open a faucet to allow the water to drain



Water – Storage - Containers

- Toilet Tank
 - **Just say no!**
 - They are nasty
 - Go look in yours and see if you want a drink
 - They don't hold much anyway



Water - Collection

- Sources
 - Your existing well
 - Rain
 - Surface
 - Ground water (shallow well)
 - Requires a container to collect the water into

Water - Collection

- Your existing well
 - Known clean water?
 - Have you tested your water recently?
 - Before it goes through your house's treatment system?
 - Deep
 - Narrow
 - Fishing out water with a bucket will be a lot of work.
 - Need a special bucket to fit
 - Don't allow the well to be contaminated
 - The existing pump requires a significant amount of power to start and run
 - Pumps around here usually require around 1kW to 2.5kW to run
 - They require 2 to 3 times that to start.
 - They also run on 240V
 - That requires a rather large generator.
 - It is difficult to safely hook up the generator
 - A generator this big uses a lot of fuel

Water - Collection

- Rain
 - Not always available when you want it
 - No rain
 - Winter
 - Always contaminated
 - Roof
 - Roof & rain gutters are nasty
 - Will include unfilterable components
 - Easy to adapt to fill containers
 - Plastic sheet
 - Cleaner than a roof
 - Temporary – the sheet won't last long
 - Difficult to fill containers

Water - Collection

- Surface
 - Some sources are intermittent
 - Dry
 - Frozen
 - Takes a lot of energy to thaw
 - Always contaminated
 - Will include unfilterable components
 - You need to haul the water
 - Water is heavy
 - 5 gallon daily minimum for a family of 5 is 40 lbs.

Water - Collection

- Ground Water – Shallow Well
 - Depth may be an issue
 - Digging a well is labor intensive
 - Digging a well is not always feasible
 - Always contaminated
 - Will include unfilterable components

Water - Purification

- Contamination

- Unless it comes from a known clean source, all water is contaminated
- Debris
- Chemical contamination
 - Heavy metals
 - Dissolved Solids
 - Chemicals in solution
- Biological
 - Parasites
 - Bacteria
 - Viruses

Water - Purification

- Standards

- NSF P231
- NSF/ANSI 53
- NSF/ANSI standard 55
- **Note that NSF/ANSI 42 is an aesthetics standard. It is not a water safety standard.**

Water - Purification

- Pre-filtering
 - Removes large particles
 - Cleaner water is easier to decontaminate
 - **Doesn't purify the water!**
 - Pour through a coffee filter or cloth etc.
 - A layered filter made with gravel and sand, charcoal or both:
 - Cloth on the bottom
 - A layer of Charcoal
 - A layer of sand
 - A layer of fine gravel on the top



Top cut to allow water to be poured into filtration system

Gravel to filter out larger sediment

Sand to filter out fine impurities. Organisms and particles collect in the top layers of the sand, gradually forming a biological zone to filter out bacteria, viruses, and parasites

Activated carbon to remove contaminants and impurities, utilizing chemical adsorption

Cloth to hold back carbon and let purified water through

Removable cap

Water - Purification

- Flocculation

- Removes suspended particles
- **Doesn't purify the water!**
- Aluminum sulfate (Alum)
 - Used in water treatment plants
 - Was used to remove cloudiness in swimming pools
 - Amazon has a 15 lb. bag for \$25
- Causes small particles to clump together and sink to the bottom
- Method:
 - Add 1 tablespoon aluminum sulfate to 5 gallons of water
 - Stir until dissolved
 - Stir again in 10 minutes
 - Wait 1 or 2 hours for the particles to sink
 - Carefully separate the clear water from the sludge on the bottom of the container

Water - Purification

- Distilling
 - Provides cleanest water
 - Removes heavy metal contamination
 - Removes desirable minerals
 - Requires a lot of energy
 - Requires equipment

Water - Purification

- Simple Solar Distilling
- This will take a long time & a lot of bottles
- https://www.youtube.com/watch?v=GF9yYGwPcNw&ab_channel=desertsun02



Water - Purification

- DIY Water Distiller
- This will take a lot of fuel
- <https://papaswamp.com/2011/09/12/water-distillationthe-quick-way/>



Water - Purification

- Boiling

- Generally considered the safest practical method
- Kills most biological contaminants
- Doesn't remove dissolved solids
- May remove chemicals in solution
 - If they boil at a lower temperature than the water
- Requires a lot of energy
 - About 1 lb. of firewood to boil about 1 lb. of water
 - This is apocryphal as I haven't seen measured data. It seems reasonable.

Water - Purification

- Filtering
 - Doesn't remove dissolved solids
 - Won't remove any chemicals in solution
 - Removes Parasites & bacteria
 - Doesn't remove viruses
 - **Keep them from freezing**

Water - Purification

- Filtering
 - Contaminate Size
 - Protozoa (*Giardia*, *Cryptosporidium*)
 - **General Size:** 5 microns or larger
 - **Filter Type:** Water filter
 - **Particle Size Rating:** 1.0–4.0 microns
 - Bacteria (*Cholera*, *E. coli*, *Salmonella*)
 - **General Size:** 0.2–0.5 microns
 - **Filter Type:** Microfilter
 - **Particle Size Rating:** 0.2–1.0 microns
 - Viruses (*Hepatitis A*, *rotavirus*, *Norwalk virus*)
 - **General Size:** 0.004 microns
 - **Filter Type:** Water purifier
 - **Particle Size Rating:** to 0.004 microns

Water - Purification

- Filter examples
 - Life Straw
 - Cheap - \$17 on Amazon
 - Light
 - .2 micron
 - 1000 liters



Water - Purification

- Filter examples

- LifeStraw Go

- More expensive - \$76 on Amazon
 - Handy – Fill and drink
 - 4000 liters
 - Removes 99.999999% of waterborne bacteria, and 99.999% of waterborne protozoan parasites



Water - Purification

- Filter examples
 - Sawyer Mini
 - Cheap - \$20 on Amazon
 - Light
 - 99.99999% of all bacteria (salmonella, cholera, and E. coli); removes 99.9999% of all protozoa
 - Attaches to water bottle
 - 100,000 gallons (Cleanable element)



Water - Purification

- Filter examples
 - Katadyn Vario
 - More expensive - \$72 on Amazon
 - Portable enough for hiking
 - Hand pump for faster filtering
 - .2 micron
 - 500 gallons per element



Water - Purification

- Filter examples
 - MSR MiniWorks
 - More expensive - \$67 on Amazon
 - Pump for faster filtering
 - 2000 liters per cartridge (replaceable)
 - Meets NSF protocol P231 for removal of bacteria (99.9999%) and protozoa (99.9%)



Water - Purification

- Filter examples

- Big Berkey

- Expensive - \$280
 - Gravity flow
 - 3000 gallons per cartridge (replaceable)
 - Comes configured with 2 cartridges – 3.5 gallons per hour
 - Up to 4 cartridges in one unit - 7 gallons per hour
 - Virus: Removed to >99.999%
 - Pathogenic Bacteria (And Surrogates): Removed to >99.9999%
 - Es: Removed to >99.999%



Water - Purification

- Filter examples
 - DIY Big Berkey Clone
 - About \$150 using 1 Berkey filter
 - https://www.youtube.com/watch?v=067-gfUcotc&feature=emb_logo&ab_channel=SurvivalDispatch
 - Gravity flow
 - Can use Berkey filters
 - Other perhaps cheaper filters may be used
 - Look at the filter specifications



Water - Purification

- Ultraviolet Disinfection
 - Ultraviolet (UV) is used in small to medium water treatment facilities – Home to small business sized
 - Water is exposed to high intensity Ultraviolet light to kill biological contaminants
 - Doesn't remove anything

Water - Purification

- Whole House UV Disinfection Example
 - Bluonics Ultraviolet Disinfection Example
 - Costs \$217 on Amazon
 - Delivers 12 gallons per minute
 - Requires 55W at 110V



Water - Purification

- Portable UV Disinfection example
 - SteriPEN Adventurer example
 - Costs \$100 on Amazon
 - Delivers 1 liter in 90 seconds
 - Destroys over 99.9% of viruses and bacteria
 - Up to 50 liters of water using (2) CR123 batteries



Water - Purification

- Solar UV Disinfection example (SoDis)
 - <https://www.cdc.gov/safewater/solardisinfection.html>
 - Uses clear plastic bottles
 - Fill bottle with low-turbidity water
 - Shake to oxygenate
 - Place in the sun for at least 6 hours (2 days if cloudy)



Water - Purification

- Chemical Treatment
 - Removes bacteria, viruses, giardia
 - Not effective against Cryptosporidium or Cyclosporum
 - Tablets are lightweight and compact
 - Must wait 30 minutes for effectiveness

Water - Purification

- Chlorine Bleach
 - Shelf life is 6 months to 1 year
 - <https://www.epa.gov/ground-water-and-drinking-water/emergency-disinfection-drinking-water>
 - make sure that the bleach only contains sodium hypochlorite and not any perfumes or other additives



Water - Purification

- Chlorine Bleach

- Use the table on the following slide to determine the amount of bleach to use.
- Double the amount of bleach if the water is cloudy, colored, or very cold.
- Stir and let stand for 30 minutes. The water should have a slight chlorine odor. If it doesn't, repeat the dosage and let stand for another 15 minutes before use.
- If the chlorine taste is too strong, pour the water from one clean container to another and let it stand for a few hours before use.



Water - Purification

- Chlorine Bleach

Volume of Water	Amount of 6% Bleach to Add*	Amount of 8.25% Bleach to Add*
1 quart/liter	2 drops	2 drops
1 gallon	8 drops	6 drops
2 gallons	16 drops (1/4 tsp)	12 drops (1/8 teaspoon)
4 gallons	1/3 teaspoon	1/4 teaspoon
8 gallons	2/3 teaspoon	1/2 teaspoon

*Bleach may contain 6 or 8.25% sodium hypochlorite.



Water - Purification

- Chlorine Tablets
 - Meets EPA purifier standard for the neutralization of viruses, protozoa, bacteria and giardia cysts
 - Follow the directions
 - Treatment time is 30 minutes

