
Disinfecting Your System

2013 Advance Small Water System Course



PUBLIC HEALTH DIVISION
Center for Health Protection, Drinking Water Services

Reasons to Disinfect

Here is a recent example...

- Water system has *E. coli* positive routine distribution sample
- Drinking Water Services regulator contacted to discuss
- Boil water notice immediately provided to customers
- Contamination identified and removed, system disinfected and flushed
- Follow-up sampling verified problem was corrected
- Customers notified that drinking water is again safe

Sample Date	# Samples	Sample Type	Coliform Type	Results-ID	Repeat of Sample ID	Sample Site	Facility
Jul 06, 2011	1	RT	Total	Absent-513308-4			DIST-A
Jul 06, 2011	1	RT	Total	Absent-513308-3			DIST-A
Jul 06, 2011	1	RT	Total	Absent-513308-2			DIST-A
Jul 06, 2011	1	RT	Total	Absent-513308-1			DIST-A
Jun 20, 2011	1	RP	Total	Absent-512419	511664	211 water st sink	DIST-A
Jun 20, 2011	1	RP	Total	Absent-512418	511664	1st st sample statio	DIST-A
Jun 09, 2011	1	TG	Total	Absent-511864	511664	well #4	SRC-AA
Jun 09, 2011	1	RP	Total	POSITIVE-511863	511664	504 Franklin sink	DIST-A
Jun 09, 2011	1	RP	E.coli	POSITIVE-511863	511664	504 Franklin sink	DIST-A
Jun 09, 2011	1	RP	Total	POSITIVE-511862	511664	First St. ss	DIST-A
Jun 09, 2011	1	RP	E.coli	POSITIVE-511862	511664	First St. ss	DIST-A
Jun 09, 2011	1	RP	Total	POSITIVE-511861	511664	413 Franklin sink	DIST-A
Jun 09, 2011	1	RP	E.coli	POSITIVE-511861	511664	413 Franklin sink	DIST-A
Jun 07, 2011	1	RT	Total	POSITIVE-511664		first street sample	DIST-A
Jun 07, 2011	1	RT	E.coli	POSITIVE-511664		first street sample	DIST-A
May 03, 2011	1	RT	Total	Absent-509735			DIST-A
Apr 05, 2011	1	RT	Total	Absent-508133			DIST-A
Mar 02, 2011	1	RT	Total	Absent-506369			DIST-A
Feb 01, 2011	1	RT	Total	Absent-504582			DIST-A
Jan 04, 2011	1	RT	Total	Absent-502938			DIST-A



PUBLIC HEALTH DIVISION 
Center For Health Protection, Drinking Water Services

Oregon
Health
Authority

What System Components to Disinfect

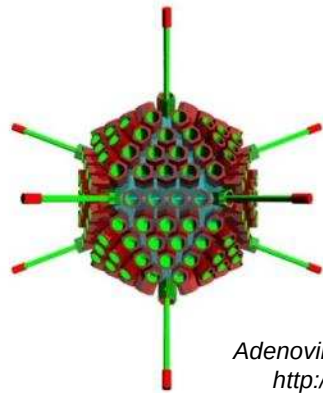
- Source water (wells, springs)
- Storage facilities (reservoirs, pressure tanks)
- Distribution system piping
- New or repaired wetted system components (e.g. pipes, fittings, valves, pumps)



Why we Disinfect

To kill or inactivate pathogens (protozoa, bacteria and viruses) that may cause illness or effect human health.

- Types of contamination events that require disinfection
 - o Total coliform or *E. coli* in distribution system
 - o Total coliform or *E. coli* in source water



Adenovirus photo credit:
<http://cronodon.com/>



E. coli photo credit: photobucket

How Disinfectants Work

- Disinfectants most commonly used are oxidants.
 - o Oxidants take electrons in a chemical reaction.
 - o This reaction inactivates bacteria or viruses.
 - o A commonly used oxidant is chlorine (hypochlorite).

Events Requiring Well Disinfection

Well Disinfection is recommended after:

- o Construction of a new well
- o Maintenance activities (e.g. broken pipe repair)
- o A positive coliform sample or other contamination event
- o As a preventative measure to kill biofilm built up in the well casing



Determining the Correct Approach

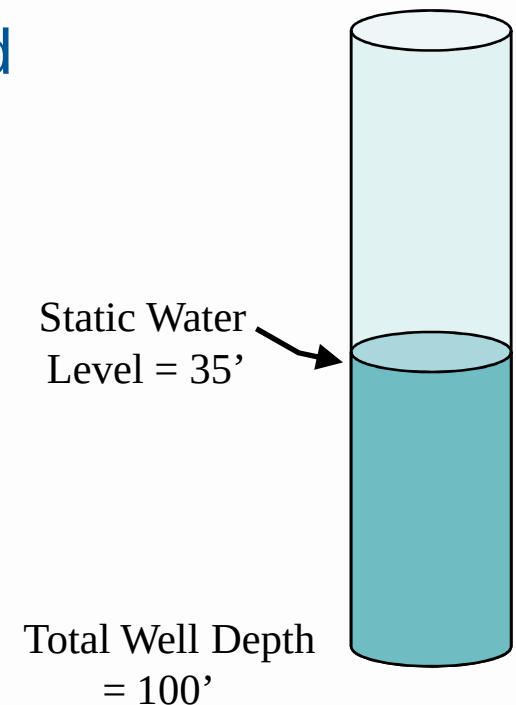
- What level of disinfection should be achieved?
 - High level or “shock” chlorination
 - o 50 mg/L for wells (target dose may vary for storage and distribution system applications)
 - Low level chlorination (< 4.0 mg/L, MRDL)
 - o Service can be maintained during disinfection process
 - o Good strategy when total coliform is only concern (no *E. coli*)

mg/L = milligrams per liter = ppm = parts per million
MRDL = maximum residual disinfectant level

Disinfecting a Well

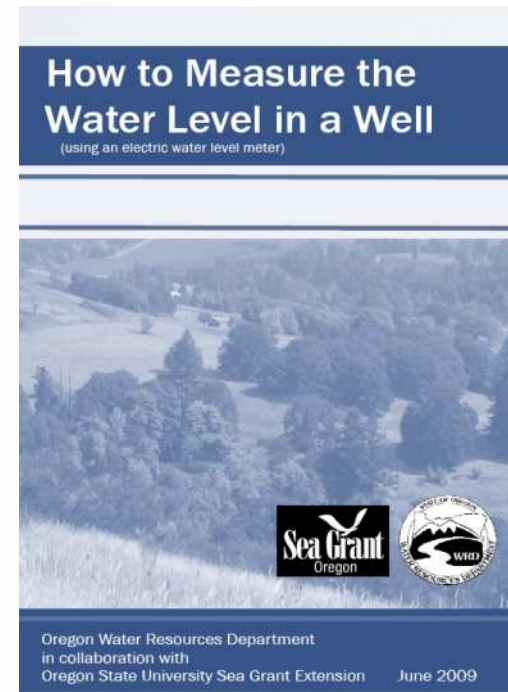
(Modified AWWA Standard C654-03)

- To determine the volume of water to disinfect you will need the total depth and static water level of the well.
- Determine the static water level by:
 - o Taking a current measurement
 - o Using a recent measurement
 - o Using the well log
 - o Use the total depth (worst-case)
 - o *Note: SWL can vary seasonally*



Measuring Static Water Level

- Borrow or rent equipment from:
 - o Water Resources Department
 - o Environmental consultants
 - o Drillers
 - o Laboratories



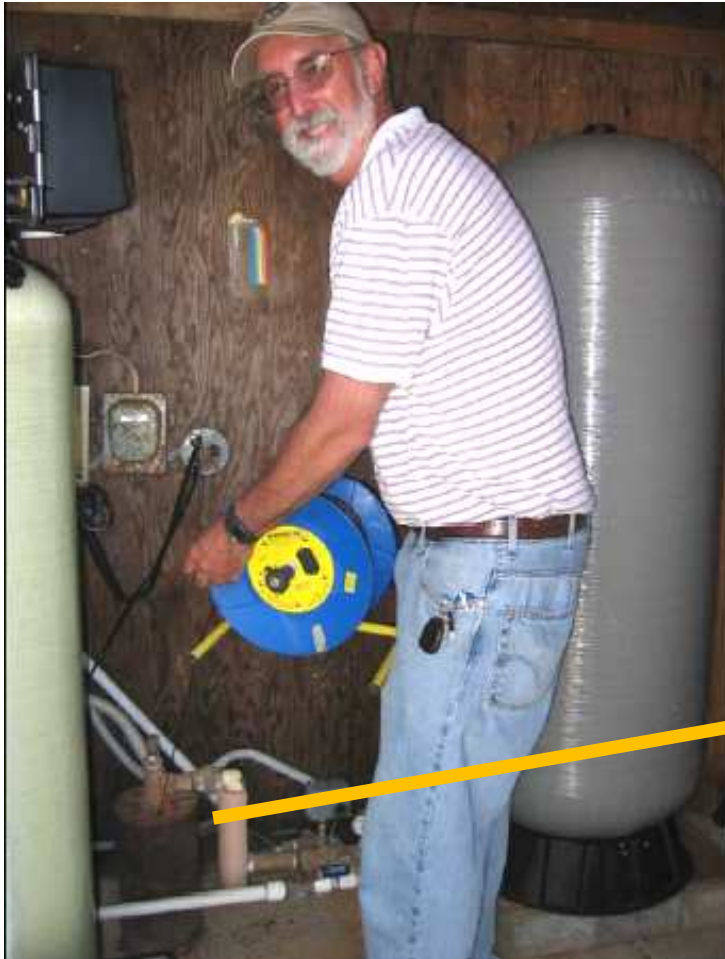
Oregon Department of Water Resources:

http://www.oregon.gov/owrd/gw/docs/water_level_booklet.pdf

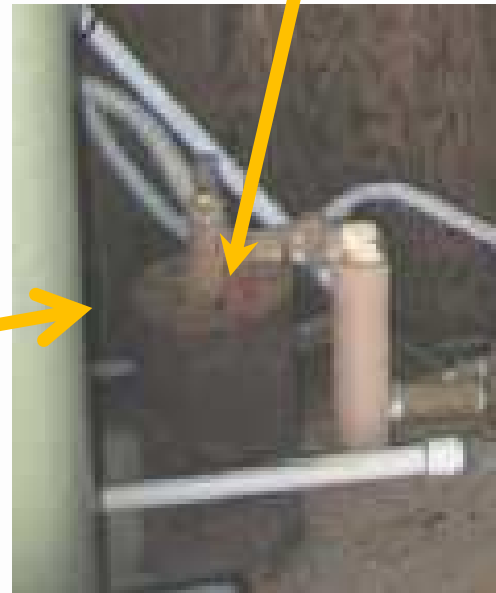
Oregon State University Extension Service:

<http://extension.oregonstate.edu/catalog/pdf/ec/ec1368.pdf>

Measuring Static Water Level



Go very slow to avoid getting your water level meter stuck in the well



NOTICE TO WATER WELL CONTRACTOR

The original and first copy of this report
are to be filed with the

WATER RESOURCES DEPARTMENT,
SALEM, OREGON 97310
within 30 days from the date
of well completion.

RECEIVED **WATER WELL REPORT**
STATE OF OREGON

AUG 6 1979 (Please type or print)
(Do not write above this line)

WATER RESOURCES DEPT

State Well No. 365/1W-21

State Permit No. _____

(1) OWNER:

Name: _____

Address: _____

(2) TYPE OF WORK (check):

New Well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐

If abandonment, describe material and procedure in Item 12.

(3) TYPE OF WELL:

Rotary ☒ Driven ☐
Cable ☐ Jetted ☐
Bored ☐

(4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

CASING INSTALLED:

6" Diam. from +2 ft. to 38 ft. Gage 250

" Diam. from _____ ft. to _____ ft. Gage _____

" Diam. from _____ ft. to _____ ft. Gage _____

PERFORATIONS:

Perforated? ☐ Yes ☒ No.

Type of perforator used _____

Size of perforations _____ in. by _____ in.

_____ perforations from _____ ft. to _____ ft.

_____ perforations from _____ ft. to _____ ft.

_____ perforations from _____ ft. to _____ ft.

(10) LOCATION OF WELL:

County JACKSON Driller's well number 61-79

$\frac{1}{4}$ $\frac{1}{4}$ Section 21A T. 36 R. 1W W.M.

Bearing and distance from section or subdivision corner

TAX LOT 400 AVE C & 29TH
WHITE CITY, OR

(11) WATER LEVEL: Completed well.

Depth at which water was first found 69 ft.

Static level 10 ft. below land surface. Date 7-30-79

Artesian pressure _____ lbs. per square inch. Date _____

(12) WELL LOG:

Diameter of well below casing 6"

Depth drilled 180 ft. Depth of completed well 180 ft.

Formation: Describe color, texture, grain size and structure of materials; and show thickness and nature of each stratum and aquifer penetrated, with at least one entry for each change of formation. Report each change in position of Static Water Level and indicate principal water-bearing strata.

MATERIAL	From	To	SWL
SOIL-BROWN	0	3	
CLAY-BROWN			
W/GRAVEL	3	16	
CLAY-BROWN	16	33	

Searching for Well Log

OREGON

advanced site map

 Water Resources Department

menu

- [About Us](#)
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- [News and Events](#)
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- [Commission](#)
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- [Maps](#)
- [Publications](#)
- [Surface Water](#)
- [Water Law](#)
- [Water Management](#)
- [Water Rights](#)

Well Log Query

Township: South
Range: West

Sections

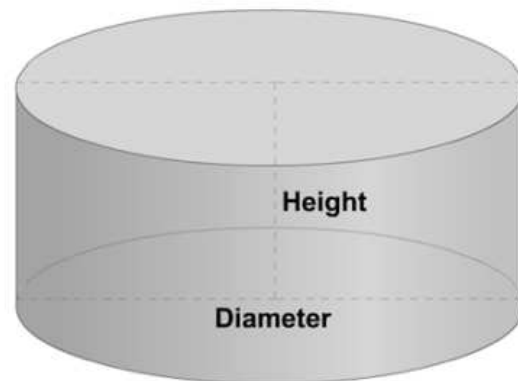
6	5	4	3	2	1
☐	☐	☐	☐	☐	☐
7	8	9	10	11	12
☐	☐	☐	☐	☐	☐
18	17	16	15	14	13
☐	☐	☐	☐	☐	☐
19	20	21	22	23	24
☐	☐	☐	☐	☐	☐
30	29	28	27	26	25
☐	☐	☐	☐	☐	☐
31	32	33	34	35	36
☐	☐	☐	☐	☐	☐

Well Log: UMAT 2974
Startcard:
Well Tag: L
Completed Date to
Received Date to
County
Bonded License# [Find a Driller](#)
Owner Last Name
Company Name
Completed Depth to
Taxlot
Type of Log

Records per Page: 10
[Frequently Asked Questions](#)

Calculating Well Volume

- Determine well volume to be disinfected using the following formulas:



Area (ft²) = length (ft) x width (ft)

Volume (ft³) = area (ft²) x h (ft)

$V = 3.14 \times r^2 \times h$, or

$V = d^2 \times 0.785 \times h$

Where:

r = Radius (ft)

d = Diameter (ft)

h = Height or Depth (ft)

Be sure all units of measure are the same

Calculating Well Volume

- The *Well Disinfection Technical Bulletin* on the Drinking Water Services website is also a good reference.

<http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Documents/welldisinfection.pdf>

PUBLIC HEALTH DIVISION 
Center For Health Protection, Drinking Water Services

Oregon Department of Human Services

Office of Public Health Systems
800 NE Oregon Street #640
Portland, OR 97232-2162

(503) 731-4030 Emergency
(971) 673-0405
(971) 673-0694 FAX
(971) 673-0372 TTY-Nonvoice

TECHNICAL BULLETIN

WELL DISINFECTION

Prepared by:
Department of Human Services
DRINKING WATER PROGRAM

March 2010

WELL DISINFECTION

For More Information Contact:

Department of Human Services

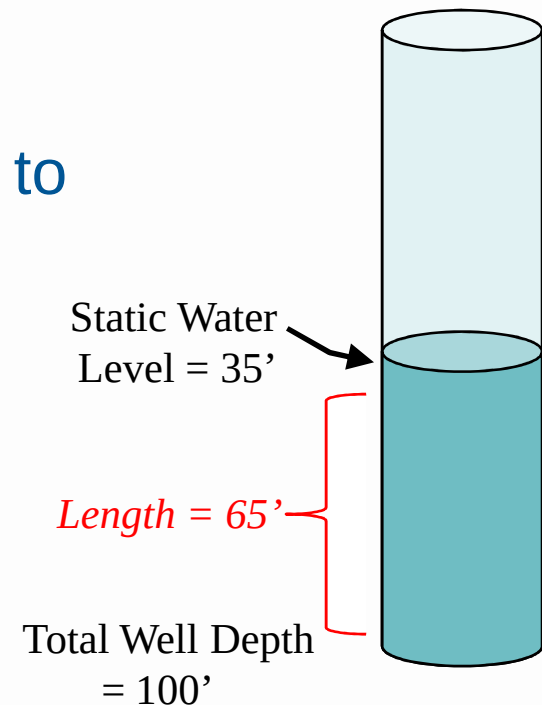
Drinking Water Section
(971) 673-0405

 Oregon Health Authority

Disinfecting a Well

(Modified AWWA Standard C654-03)

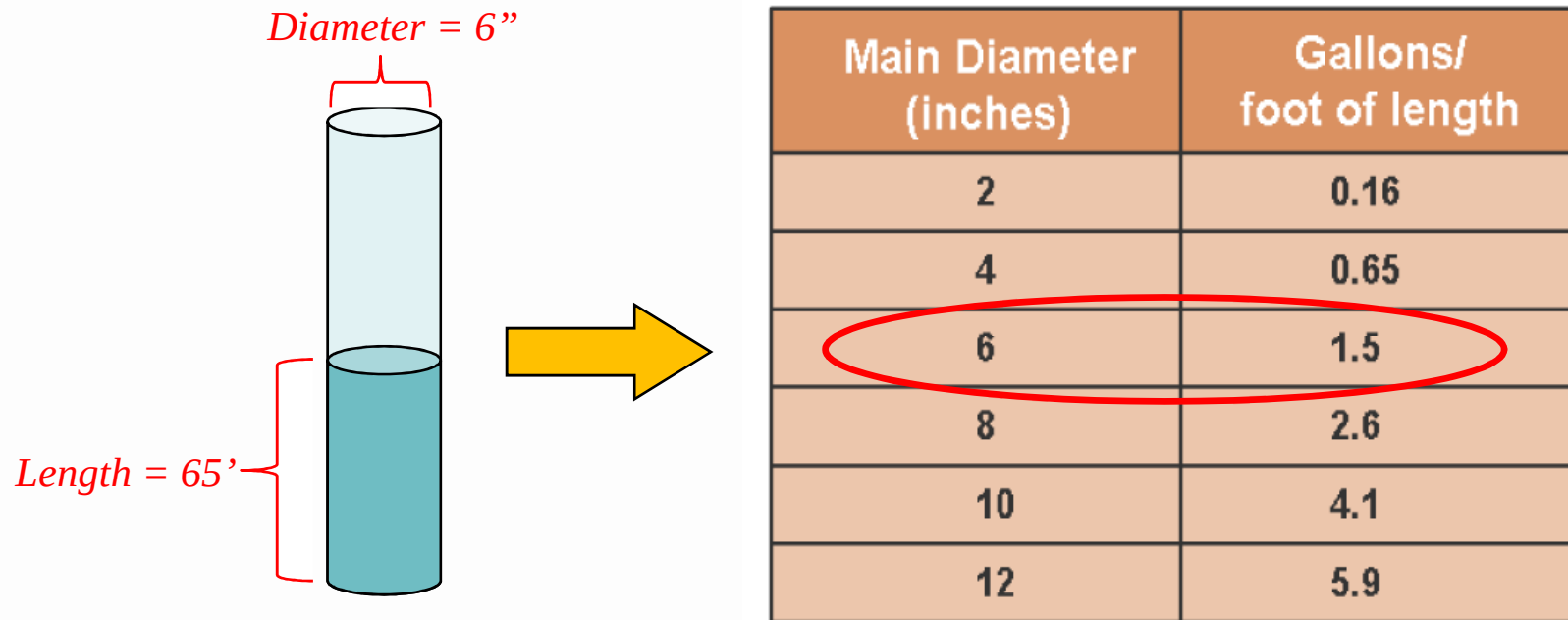
- Example: determining depth of water to disinfect:
 - o Total depth = 100 ft
 - o Static water level = 35 ft
 - o Depth to disinfect = X



$$\begin{aligned} \text{Length} &= 100 \text{ ft (total depth)} - 35 \text{ ft (SWL)} \\ &= 65 \text{ ft} \end{aligned}$$

Determining Volume to Disinfect

Example: You have a 6-inch diameter well that contains 65 feet of water. What is the volume in gallons?



Formula to use: (*Length*) x (Gallons/foot of length) = Gallons in well

$$65 \text{ ft} \times 1.5 \text{ gal/ft} = 97.5 \text{ gallons of water in well}$$

Type of Chlorine to Use

- **Sodium hypochlorite** (liquid)
 - Strength varies from 5% (household bleach) to 12.5%
- **Calcium hypochlorite** (dry powder/pellet)
 - Usually 45% strength
 - Used for deep wells & storage tanks
- Avoid **stabilized chlorine** (e.g. dichlor, trichlor) used for swimming pools and spas



Sodium Hypochlorite
(NaOCl)



Calcium Hypochlorite
(Ca(OCl)₂)



NSF Standard 60

- The National Sanitation Foundation certifies products for use in public drinking water
- Look for NSF logo – Recommended but not required for shock chlorination if system is flushed before use
- **Clorox® Regular Bleach** and **Clorox® Ultra Bleach** meet NSF Standard 60 (no NSF logo on package but certified by WQA).
- Summer 2009 Pipeline article discusses bleach products and NSF 60 certification.
<http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Documents/pipeline/pipesu09.pdf>
- When ordering chemicals ask for product that is safe for drinking water
- Go to www.wqa.org/ or other ANSI-accredited organizations to verify product as certified





Scented

Keep in mind:

- Chlorine loses its strength over time
- Bleach stored at about 70°F maintains the strength noted on the product label for about 3 to 5 months

Half life of 12.5% sodium hypochlorite at various temperatures

Degrees F	Number of Days
77°	220
87°	110
97°	55
107°	27

Safety Considerations When Using Chlorine

- Chlorine is a strong oxidant
- Highly corrosive
 - Especially at levels over 100 mg/L
- May cause skin and eye irritation or damage
- Use goggles and rubber gloves when handling
- Wear protective clothing (i.e. splash apron and rubber boots)
- Provide good ventilation when using. Remember, chlorine is heavier than air.



Calculating Chlorine Needed

- Wells are commonly chlorinated to achieve 50 mg/L for 12 - 24 hours
- Guideline – Target concentration of **50 mg/L** equals about 1.6 cups of 5% bleach per 100 gallons of water
- Solution strength in “%” is not synonymous with mg/L



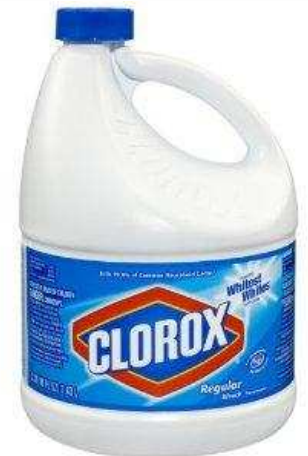
Calculating Chlorine Needed

Formula to determine amount of bleach needed =

$$\frac{(\text{target concentration in mg/L})(\text{volume to be disinfected in gal})(16 \text{ cups/gal})}{(\text{chlorine concentration as \%})(10,000 \text{ mg/L/\%})}$$

- Target Concentration = **50 mg/L**
- Volume = 97.5 gallons round up to **100 gallons**
- Chlorine concentration = **5%** (*Note: product strength varies*)
- Bleach amount = $\frac{(50 \text{ mg/L})(100 \text{ gal})(16 \text{ cups/gal})}{(5\%)(10,000 \text{ mg/L/\%})}$

= 1.6 cups



Calculating Chlorine Needed

Calculate amount of calcium hypochlorite needed (solid) =

Using the Pounds Formula:

(volume in MG) x (8.34 lb/gal) x (target concentration in mg/L)

- Volume = **5,000 gallons/1 million = 0.005 MG**
- Target Concentration = **2 mg/L**
- Available chlorine = **45% (or 0.45)**
- Lbs of chlorine =
$$\frac{(0.005 \text{ MG}) \times (8.34 \text{ lb/gal}) \times (2 \text{ mg/L})}{0.45}$$

= 0.185 lbs or 2.96 ounces

**Don't forget to verify the available chlorine in product.*



Help with Conversions

Basics for Small Water Systems in Oregon

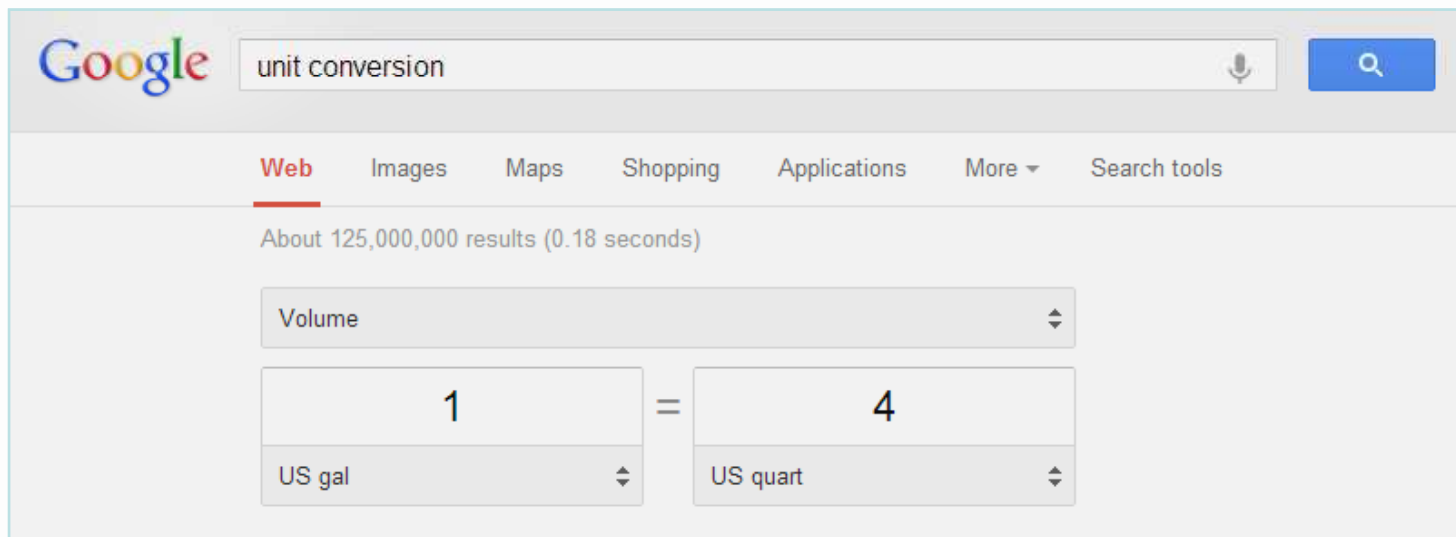
FACT SHEET 4.7 – Basic Math: Common Calculations for Small Water Systems

Abbreviations:					
ft	=	Feet	lb	=	pounds
gpd	=	gallons per day	mg/L	=	milligrams per liter
gpm	=	gallons per minute	mL	=	milliliter
MGD	=	million gallons per day	L	=	liter

Conversion Factors:		
1 acre	=	43,560 square feet
1 acre foot	=	43,560 cubic feet
1 cubic foot	=	7.48 gallons
1 foot	=	0.305 meters
1 gallon	=	3.79 liters
1 gallon of water	=	8.34 pounds
1 horsepower	=	0.746 kilowatts
1 million gallons per day	=	694 gallons per minute
1 pound	=	0.454 kilograms (454 grams)
1 Liter	=	1000 mL
1 Liter of water	=	1000 grams
1 gram	=	1000 kg
1 pound per square inch (psi)	=	2.31 feet of water (head)
1%	=	10,000 mg/L
Degrees Celsius	=	$(\text{Degrees Fahrenheit} - 32)(\frac{5}{9})$
Degrees Fahrenheit	=	$(\text{Degrees Celsius})(\frac{9}{5}) + 32$
π	=	3.14

Online Conversion Tools

- Use any number of online conversion tools by doing a search on “unit conversion”, or
- Type the value to be converted into the Google search bar (e.g., “25 tablespoons to cups” yields a result of “25 US tablespoons = 1.5625 US cups”).



The screenshot shows a Google search interface. The search bar contains the text "unit conversion". Below the search bar, the "Web" tab is selected. The search results show "About 125,000,000 results (0.18 seconds)". A conversion tool is displayed, showing a dropdown menu for "Volume". Below this, there are two input fields: the first contains the number "1" and is labeled "US gal" below it; the second contains the number "4" and is labeled "US quart" below it. An equals sign "=" is placed between the two input fields.

How to Measure Higher Concentrations

Using Dilution Method

1. Achieve target of 50 mg/L chlorine solution in a 5 gallon bucket
2. Cut solution to 1:25 to get to 2 mg/L (mid-range of chlorine colorimeter)
3. 1 Tbsp:25 Tbsp = 1 Tbsp solution to 1.5 cups + 1 Tbsp water



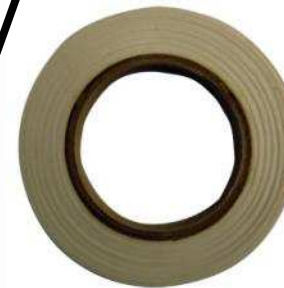
Chlorine Sampling Methods

- DPD (or other EPA approved) method required unless doing gross evaluation of chlorine levels
- Know instrument ranges
- Verify equipment can be calibration
- Beware of fading color wheels

Drinking water approved methods



Unapproved methods for drinking water



← Restaurant inspector's tape

High Dosage Considerations

- Adding excessive amounts of chlorine to a well is not a good idea
- Raises pH which lowers chlorine effectiveness
- Take too long to flush out
- Can damage/corrode equipment
- Disposal can be difficult
 - o Safety considerations
 - o Hazardous to wildlife



Disposal of Chlorinated Water

- DEQ has requirements discharging super-chlorinated water (above 4 mg/L total chlorine residual)
- Regardless of volume, super-chlorinated water **must not be discharged to surface waters or storm sewers.**
- Non-discharge alternatives:
 - o sanitary sewer disposal (either by connecting to a sanitary sewer or by hauling to a sewage treatment plant)
 - o Land disposal or irrigation.
- Discharging chlorinated water into on-site septic systems can cause damage by inactivate microbes



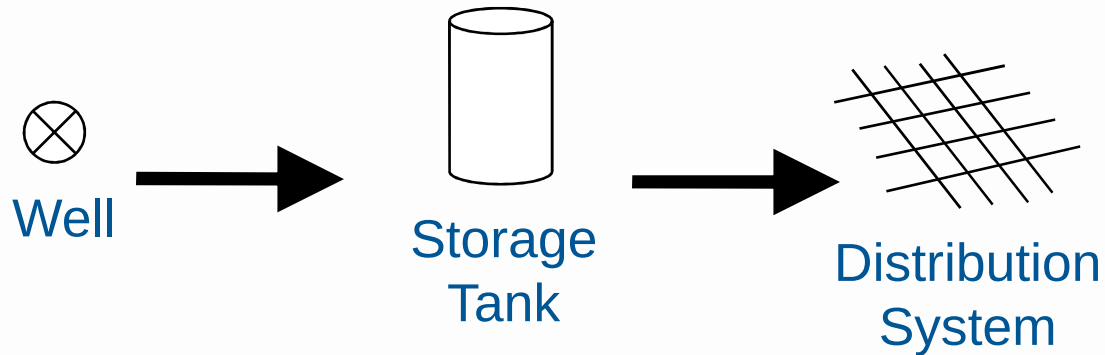
DEQ Memorandum & Decision Matrix on Chlorinated Water Discharges:

<http://www.deq.state.or.us/wq/pubs/bmps/chlorwaterdisp.pdf>

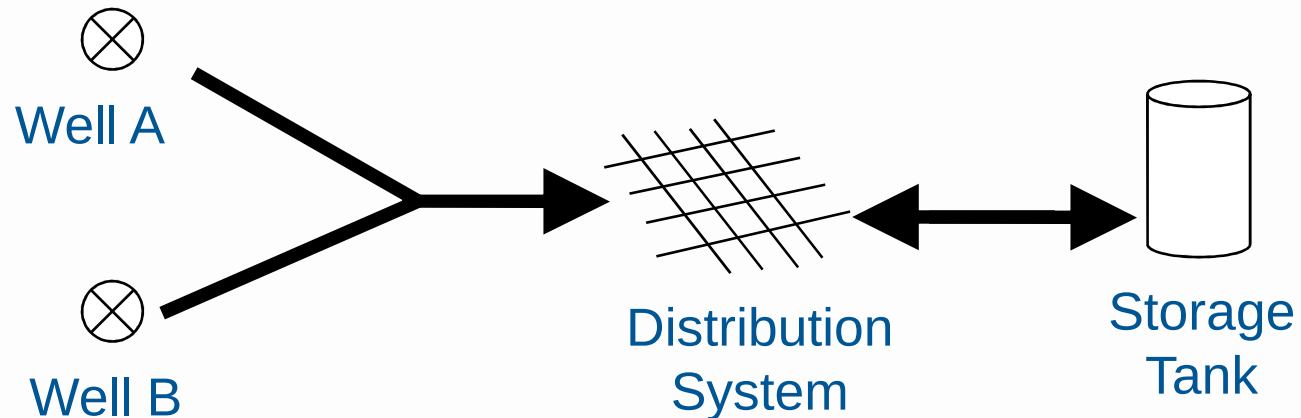
Water System Disinfection

What components will require disinfection?

Scenario 1:



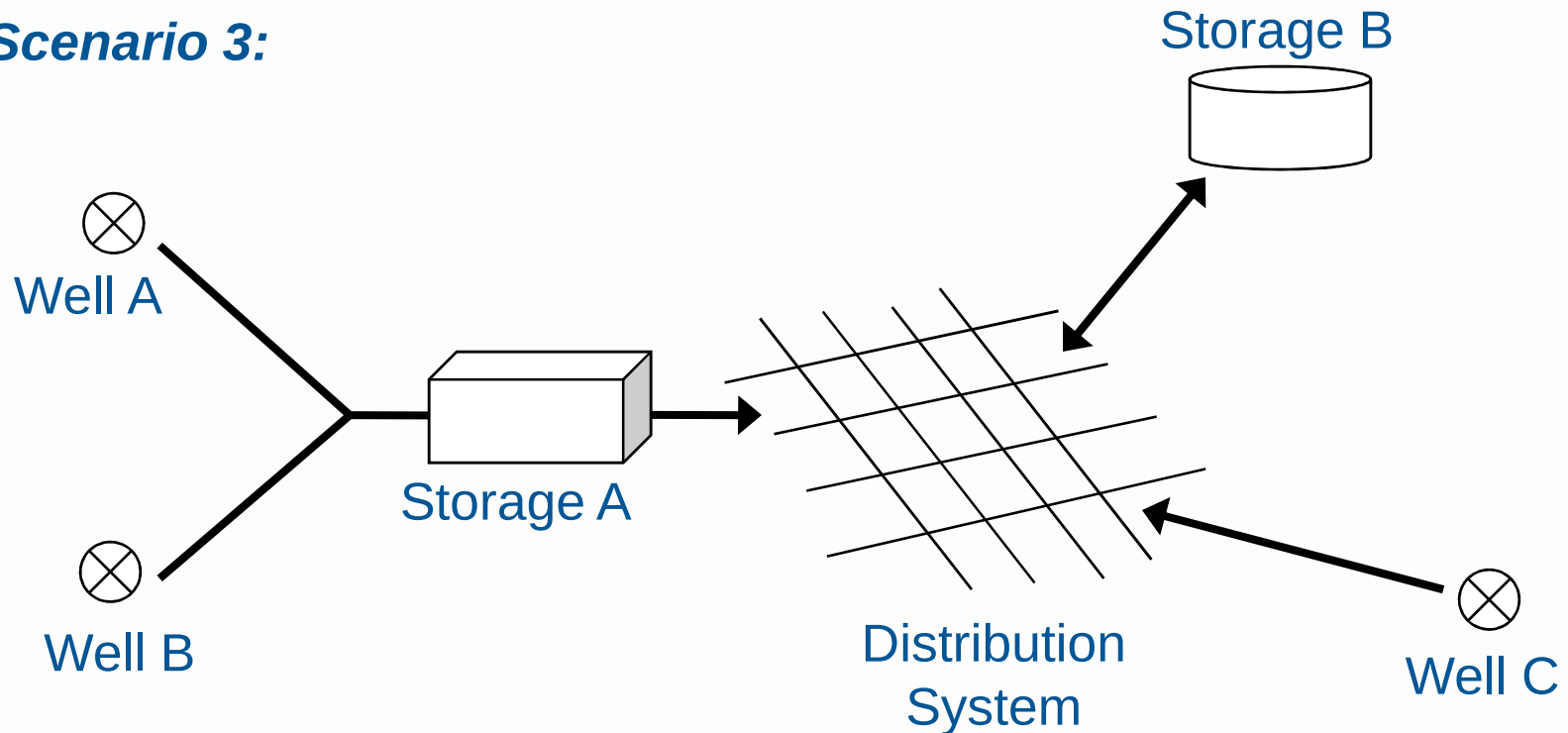
Scenario 2:



Water System Disinfection

What components will require disinfection?

Scenario 3:



Well Chlorination

Option 1 – “Bottom Up Injection”

1. Ideal method to achieve **50 mg/L** throughout water column
2. Run tube into casing to bottom of well
3. Withdraw tube while injecting chlorine solution

Option 2 – “Down-Hole Method”

1. If bottom-up injection method is not feasible, dilute chlorine into at least 5 gallons of (warm) water and mix
2. Make sure chlorine mixes thoroughly with dilution water
3. Pour into well with a funnel through a plug or casing vent hole at the top of the sanitary seal



Disinfecting through Well Caps

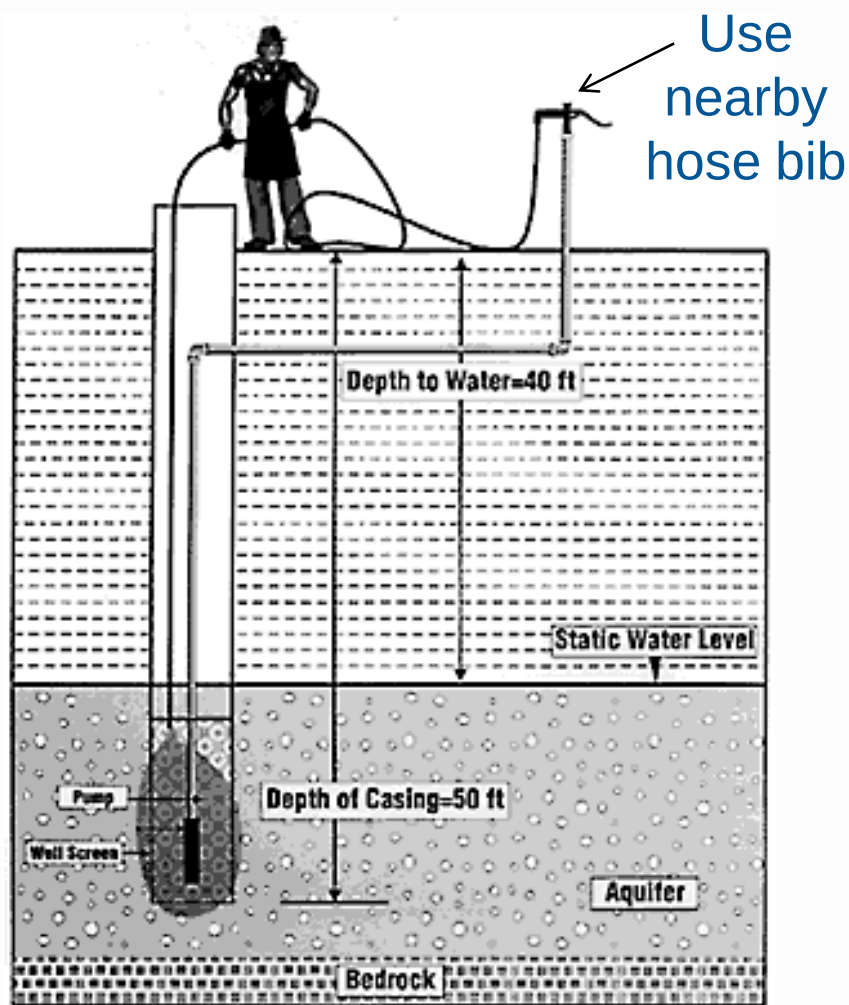
- Three common types of well caps:
 - o *Turtle Back* with access plug
 - o *Turtle Back* without access plug
 - o Sanitary well cap
- You will need the right tools to unbolt the well cap.
- Be careful with exposed wiring to prevent damage.



Well Chlorination

4. To mix solution within well, attach a hose to nearest downstream tap (before any unpressurized storage tanks).
5. Recirculate water from tap back into well for at least 15 minutes. *Note:* When restricting pump's outflow to one hose (during recirculation), back pressure on pump could cause damage or trip it off. If necessary, use a buffer tank and siphon it back into well in batches.
6. Verify target dose and let mixed disinfectant remain in the well for 12-24 hours.
7. Flush by using a flow splitter and re-circulate half the water down the casing while pumping half to waste until no chlorine is detected. Be sure to flush inside well casing and other internal components to prevent corrosion.

Example of how to recirculation water down a well



<http://infohouse.p2ric.org/ref/20/19703.htm#SHOCKCHLORINATE>

Steps After Flushing

8. Pump to waste for 15 minutes after verifying zero chlorine residual.
9. Collect at least 2 coliform samples a minimum of 30 minutes apart.
10. If samples are positive, pump to waste for another 15 minutes and collect at least 2 more samples a minimum of 30 minutes apart.
11. If samples are still positive, repeat chlorination and retest or take other corrective action in consultation with a well professional.

Note: For newly constructed wells, use solution strengths of up to 100 mg/L for 24 hours (AWWA Standard A100-06)

Water System Disinfection

- Wells, storage tanks and piping may need to be disinfected independently.
- Coordinate timing for storage and distribution system disinfection.
- Calculate volume of water in storage or use tank dimensions.

Rectangular Tank Volume Formula:

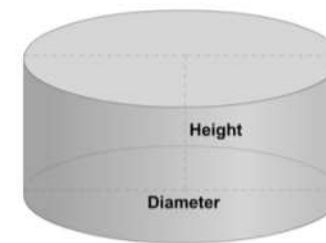
$$V \text{ (gal)} = L \text{ (ft)} \times W \text{ (ft)} \times H \text{ (ft)} \times 7.48 \text{ gal/ft}^3$$

- For H, use height to overflow
- To be conservative use total height

Cylindrical Tank Formula:

$$V \text{ (gal)} = d^2 \text{ (ft)} \times 0.785 \times H \text{ (ft)} \times 7.48 \text{ gal/ft}^3$$

- Can also use formula $V = 3.14 \times r^2 \times h$

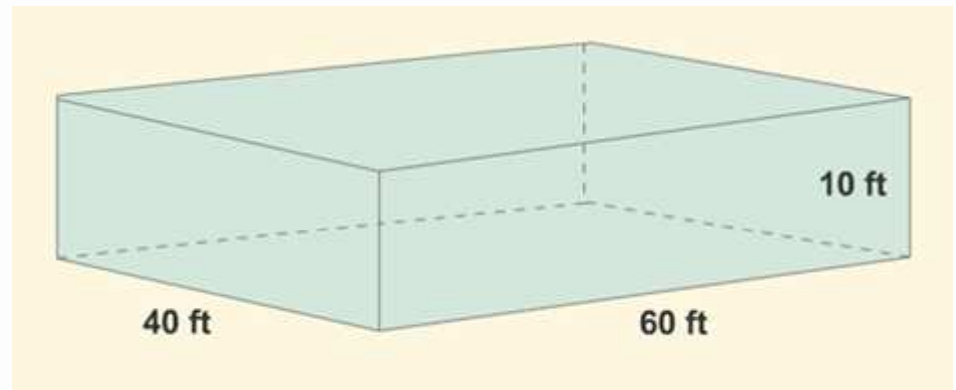


Calculating Volume of Rectangular Basin

Example 1: 60' long, by 40' wide, by 10' deep (at overflow).
What is the total volume this reservoir can hold in cubic feet?

Formula: $V = L \times W \times H$

$$60' \times 40' \times 10' = 24,000 \text{ ft}^3$$



Convert cubic feet to gallons:

$$\begin{aligned} &24,000 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 \\ &= 179,520 \text{ gal (round to 180,000 gal)} \end{aligned}$$

Calculating Volume of Cylindrical Basin

Example 2: A tank has a diameter of 40 feet and is 10 feet deep at the overflow. How many gallons can the tank hold?

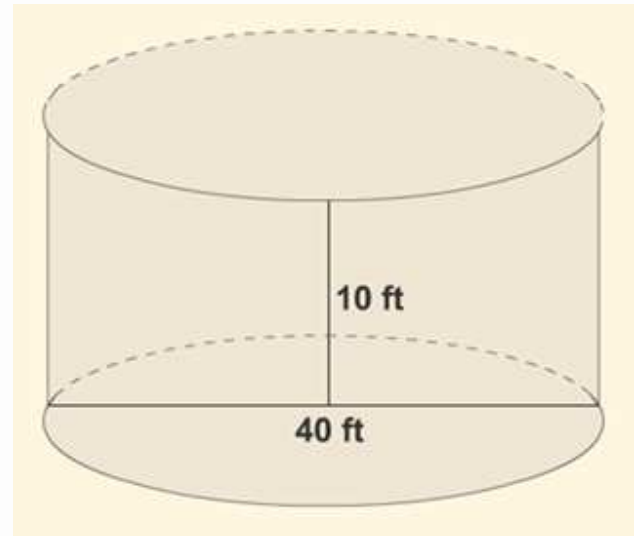
Calculate the volume:

$$d^2 \times 0.785 \times h = \text{Volume (ft}^3\text{)}$$

$$40' \times 40' \times 0.785 \times 10' = 12,560 \text{ ft}^3$$

Convert cubic feet to gallons:

$$12,560 \text{ ft}^3 \times 7.48 \text{ gal/ft}^3 = 93,949 \text{ gallons}$$



Reservoir Chlorination

- Determine timeframe (*method exposure time*) using AWWA exposure timeframes of 3, 6, and 24 hours.
- Method exposure time depends on chlorine concentration and whether chlorine can be added simultaneously with reservoir filling to improve mixing.
- Combining time and concentration is referred to as a *method* (Per the AWWA Standard C652-02)
- Longer exposure times are more conservative and may improve disinfection.

Reservoir Chlorination Tool

Basics for Small Water Systems in Oregon: Storage Tank Chlorination

Disinfection concentrations and times are based on AWWA Standard C652 for storage tanks cited in: OAR 333-061-0050 "Construction Standards" (10)(d) dated 19 Apr 2010, page 297

Question: How much chlorine is added to a tank?

Volume to be disinfected = 500 gallons

(input tank volume above in yellow shaded cell)

Chlorination Dose for Storage Tank of Volume Specified Above	Method A ^b	Method B ^c	Units
Chlorine Concentration	10	50	mg/L
Method Exposure Time	6 ^a or 24	6	hours
Chlorine Source Material...			
Bleach 5% Solution	0.10	0.50	gallons ^d
Bleach 12.5% Solution	0.04	0.20	gallons
Dry Chlorine (65% by wt)	0.06	0.32	pounds
	0.029	0.147	kilograms

^a Six (6) hours for addition by continuous feed during tank filling.

^b For Pipes, Method A using 24 hours is applicable (shorter time at higher dose may be allowed, see Guidance).

^c For Wells, Method B using 24 hours is applicable (shorter time at higher dose may be allowed, see Guidance).

^d Gallons to Cups conversion:

(gal x 16 = cups)

Gallons	Cups
1.6	25.6

Options for Disinfection by Chlorination:

Method A. Filling the tank or reservoir with a **10 mg/L** chlorine solution and allowing it to remain for **6^a** or **24 hours** (see Table).

Method B. Filling the reservoir with a **50 mg/L** chlorine solution and allowing it to stand for **6 hours** (see Table).

Method C. Spraying or brushing on a **200 mg/L** chlorine solution and allowing it to remain for 3 hours (calculation not provided).

(Chlorine Concentration values [yellow, or grey, cells] can be changed for custom calculations)

⇒ Note that to achieve Method concentration **add more** chlorine than specified here.

Important: The chlorine concentration should be measured to confirm Method's target concentration is reached. May need to dilute sample to test kit range.

Weight of dry chlorine with a lower percentage than 65% can be calculated by dividing 65% by the product's % chlorine (e.g., 65%/47%) times result in table.

<http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Documents/ShockChloroCalc.xls>

Reservoir Chlorination Tool

1. Enter *Volume to be disinfected*.
2. *Chlorine Source Material* values automatically change to achieve target chlorine dose based on volume entered.
3. Chlorine concentrations are also calculated as a function of *method*.
4. Amount of chlorine material needed is in **red** text.

**Basics for Small Water Systems in Oregon:
Storage Tank Chlorination**

Disinfection concentrations and times are based on AWWA Standard C652 for storage tanks cited in: OAR 333-061-0050 "Construction Standards" (10)(d) dated 19 Apr 2010, page 297

Question: How much chlorine is added to a tank?

Volume to be disinfected = **500** gallons
(input tank volume above in yellow shaded cell)

Chlorination Dose for Storage Tank of Volume Specified Above	Method A ^b	Method B ^c	Units
Chlorine Concentration	10	50	mg/L
Method Exposure Time	6 ^a or 24	6	hours
Chlorine Source Material...			
Bleach 5% Solution	0.10	0.50	gallons ^d
Bleach 12.5% Solution	0.04	0.20	gallons
Dry Chlorine (65% by wt)	0.06	0.32	pounds
	0.029	0.147	kilograms

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Reservoir Chlorination Tool

- The target dose is either 10 or 50 mg/L, unless the *method* is *spray application* at 200 mg/L.
- Wait the full duration of *method* disinfection time listed in the spreadsheet.

(input tank volume above in yellow shaded)

Chlorination Dose for Storage Tank of Volume Specified Above	Method A ^b	Method B ^c	Units
Chlorine Concentration	10	50	mg/L
Method Exposure Time	6 ^a or 24	6	hours
Chlorine Source Material...			
Bleach 5% Solution	0.10	0.50	gallons ^d
Bleach 12.5% Solution	0.04	0.20	gallons
Dry Chlorine (65% by wt)	0.06	0.32	pounds
	0.029	0.147	kilograms

Options for Disinfection by Chlorination:
Method A. Filling the tank or reservoir with a 10 mg/L chlorine solution and allowing it to remain for 6^a or 24 hours (see Table).
Method B. Filling the reservoir with a 50 mg/L chlorine solution and allowing it to stand for 6 hours (see Table).
Method C. Spraying or brushing on a 200 mg/L chlorine solution and allowing it to remain for 3 hours (calculation not provided).

Reservoir Chlorination Example

- The reservoir water volume is 10,000 gallons and there is no other storage.
- The target dose is 50 mg/L and a 6-hour time frame will be used (Method B) to minimize service interruption.
- How much normal (5%) household bleach is needed to disinfect the reservoir?

Answer:

Add 10 gallons of normal household (5%) bleach to the reservoir and mix by recirculating. Measure the chlorine concentration. If the solution mixed in tank measures a bit low (e.g. 45 mg/L), add about 10% of original dose, or 1 gallon of bleach and mix again. If concentration is now > than 50 mg/L, start clock on the 6-hour interval.

Reservoir and Distribution Chlorination

1. Flush storage volume through distribution until chlorine concentration is achieved and detected at distribution taps.
2. Once contact time has been achieved in distribution (12-24 hours) begin flushing entire system.
3. Flushing may need to occur in multiple phases depending on source yield and distribution volume (refilling storage with hauled water may be necessary).
4. After zero chlorine residual is detected at all distribution taps, collect a representative number of coliform samples using sites designated in the coliform sampling plan.
5. Repeat disinfection process as necessary if any samples are coliform positive.

Water System Disinfection

Low Level Chlorination

- This method may be a good choice if bacteria levels (total coliform only) are thought to be low, and/or it is important to maintain service during the disinfection process.
- Chlorine residual must be kept below 4.0 mg/L – maximum for human consumption (MRDL).
- The amount of time to maintain chlorine level is an estimation.
- The procedure may not work if there is extensive bacteria and/or biofilm. It may not be enough to break through biofilm protecting bacteria growth.
- Mechanics: A continuous feed pump is ideal, batch dosing into a storage tank can work with consistent application and good math.

Frequent chlorine monitoring in distribution is critical!

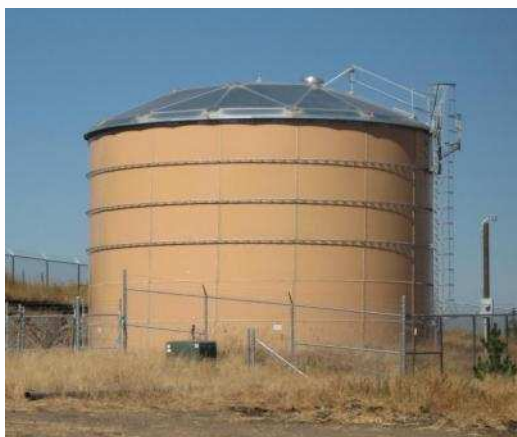
Potential Disinfection Complications

- The process is not an exact science.
- Dosing calculations address a worst case scenario. Chlorination may not even be needed.
- There is no way to know the extent of bacteria colonization. Heterotrophic plate counts (HPC) can help determine this.
- High-volume (unidirectional) flushing alone may solve the problem.
- Each situation may have mechanical and electrical challenges:
 - Overloading well pumps
 - Overriding storage tank float switches
 - Inadequate taps and valves for effective recirculation
 - Other issues?

Class Exercise (Part 1):

Calculate system volumes for your water system

Determine
well, storage,
& distribution
pipe volumes



Shock Chlorination Worksheet

Water System Name: _____

Well disinfection Casing Diameter (in) _____ Total Well Depth _____ ft
minus Static Water Level _____ ft
= Well water depth _____ ft

Gallons in well = Depth of water (ft) X Gallons per foot of depth (based on table with casing diameter)
= _____ X _____ = _____ gallons of water to be treated in well

How much bleach product would you need to add to the well to achieve at least 50 ppm?
(Use excel form or this formula)

Cups of bleach product = $\frac{(\text{target concntr., ppm})(\text{water vol., gal})(16 \text{ cups/gal})}{(\text{bleach concentration as \%})(10,000 \text{ ppm/\%})}$
= $\frac{50 \text{ ppm} \times \text{gals in well} \times 16}{\% \text{ bleach product} \times 10,000}$
= _____ cups



(Also, remember the rule of thumb of approximately 1 cup of 5% bleach per 100 gallons to get 50 ppm.)

Storage Tank Same question, to achieve 50 ppm in the storage tank you would need....

Gallons to be disinfected in tank: _____
Gallons of bleach product = $50 \text{ ppm} \times \text{gals in tank}$
_____ % bleach product X 10,000
= _____ gallons bleach product

(Notice we skipped the gallons-to-cups conversion this time, because a storage tank usually has a large enough volume to use gallons units for the bleach product)

Mixing is important – recirculate in tank!



Distribution System Disinfect pipes to achieve 50 ppm...

- Length of pipe (L) from point of disinfection to first user: _____ feet
- Diameter of pipe (D) between point of disinfection and first user: _____ inches
- Volume of pipe (V) = $(L \times D^2) \div 24.5$ or $(L \times D \times D) \div 24.5$ or $(\text{Line 1} \times \text{Line 2} \times \text{Line 2}) \div 24.5 =$ _____ gallons
- Repeat calculations if additional lengths of pipe
Volume of pipe (V₂) = $(L_2 \times D_2 \times D_2) \div 24.5 =$ _____ gallons
- Total Volume of pipes (V_{total}) = V₁ + V₂ + ... = _____ gallons
- Gallons of bleach product = $50 \text{ ppm} \times \text{gals in tank}$, or multiply by 16 to get _____ cups
_____ % bleach product X 10,000



Class Exercise (Part 2):

Design Your Own Disinfection Process

1. Determine chlorine amount needed based on your system's volume.
2. Develop a strategy in steps (e.g. add chlorine to well and then batch dose from the reservoir into distribution, etc.).
3. Plan the public notification process.
 - o Customers must be informed of timelines and water use restrictions to protect their health.
 - o Dishes and household cleaning are about the only things you can do with shock chlorinated water.
 - o Notify customers when it's all over.
4. Document chlorination events.
 - o What worked and ways to improve the process

Helpful Links

- *How to disinfect a well:*
<http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Documents/welldisinfection.pdf>
- *Shock Chlorination for Storage Tank, Well and Distribution System - Procedure and Volume Calculation:*
<http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/Operations/Pages/shockchlorination.aspx>
- *Basics for Small Water Systems in Oregon*
<http://public.health.oregon.gov/HealthyEnvironments/DrinkingWater/OperatorCertification/SmallWaterSystems/Documents/BasicsForSmallPWS.pdf>
- *American Water Works Association:* <http://www.awwa.org/>

Resources Available on DWS Website

The screenshot shows the Oregon Health Authority website. The browser address bar displays `public.health.oregon.gov/healthyenvironments/drinkingwater/operations/pages/shockchlorination.aspx`. The page header includes the Oregon.gov logo, navigation links (Most Visited, Outlook Web App, Data Online, SDWIS/STATE Login, Well Log Query, Water Use, Water Rights, US EPA SM Framework, Surface Wtr Rpts, NSF Certified Pro), and a search bar. The main navigation bar features links for About Us, Using This Site, and a dropdown menu for All Public Health. The left sidebar lists various resources under the heading 'Drinking Water', with 'Water System Operations' highlighted. The main content area displays the title 'Shock Chlorination for Storage Tank, Well and Distribution System - Procedure and Volume Calculation' and an introduction. The introduction states that the page focuses on assisting water system operators in utilizing the shock chlorination procedure, including the Shock Chlorination Calculation tool (xls), for disinfecting drinking water storage facilities. It also provides contact information for Drinking Water Services (DWS). The right sidebar contains links for More Resources (Drinking Water Data Online, Site Map, For Consumers) and Contact Us (Drinking Water Services, Center for Health Protection).

public.health.oregon.gov/healthyenvironments/drinkingwater/operations/pages/shockchlorination.aspx

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Cross Connection & Backflow Prevention

Emergency Preparedness & Security

Groundwater & Source Water Protection

Monitoring & Reporting

Operator Certification

Plan Review

Rules & Implementation Guidance

Safe Drinking Water Revolving Loan Fund

Water System Operations

Advisory Committee

Public Health > Healthy Environments > Drinking Water > Water System Operations > Shock Chlorination for Storage Tank, Well and Distribution System - Procedure and Volume Calculation

SHARE

Shock Chlorination for Storage Tank, Well and Distribution System - Procedure and Volume Calculation

Introduction

This Web page focus on assisting water system operators in utilizing the shock chlorination procedure, including the [Shock Chlorination Calculation tool \(xls\)](#), for disinfecting drinking water storage facilities. For more information about this procedure, please [contact Drinking Water Services \(DWS\)](#).

- Shock chlorination is a procedure used whenever there is a need for emergency disinfection of tanks, wells and/or distribution systems where there is confirmed evidence of microbiological contamination (i.e., positive [coliform](#) or [E. coli \(pdf\)](#) samples). Again, this procedure is for emergency purposes only and should not to be used on a regular basis.
- See the DWS [Well Disinfection \(pdf\)](#) technical bulletin for shock chlorinating a well and small distribution system (no storage tank).
- Shock chlorination of a storage tank or reservoir consists of the following steps:
 1. Calculate tank water volume
 2. Determine the time frame or "Method Exposure"
 3. Add the correct amount of bleach using the [Shock Chlorination Calculation tool \(xls\)](#)
 4. Wait for disinfection to occur

More Resources

[Drinking Water Data Online](#)

[Site Map](#)

[For Consumers](#)

Contact Us

[Drinking Water Services](#)

[Center for Health Protection](#)

Questions & Discussion