

# Managing Water Chemistry in the Beaver Lake Water District

Salt, Pepper & Lemon



# Agenda

- Beaver Water District water
- Water report
- What is pH and why does it matter
- Residual Alkalinity – WTF?
- What Beer Styles does our water favor?
- Water adjustment ideas
- Questions and ~~Answers~~ Bullshit



# Beaver Water District

The 2nd Best Water in the World for Home Brewing?

Location	Calcium	Magnesium	Sodium	Sulfate	Chloride	Alkalinity
Burton	275	40	25	610	35	270
Dortmund	230	15	40	330	130	20
Dublin	120	4	12	55	19	170
Edinburgh	100	20	55	140	50	285
London	70	6	15	40	38	166
Munich	77	17	4	18	8	295
Pilsen	7	2	2	8	6	16
Vienna	75	15	10	60	15	225
<b>BWD</b>	<b>26</b>	<b>2</b>	<b>7</b>	<b>24</b>	<b>6</b>	<b>53</b>
General Recommendations	50 - 150	10 - 30	0 - 150	50 - 350	0 - 250	Lower is Better



# What is What in a Water Report?

Assuming water is clean, really just five things matter:

Finished Water Quality Results	
January 11, 2022	
Alkalinity, Bicarbonate (as CaCO3)	44 mg/L
Alkalinity, Carbonate (as CaCO3)	0 mg/L
Alkalinity, Total (as CaCO3)	44 mg/L
Calcium (as CaCO3)	58 mg/L
Calcium (as Ca)	23.2 mg/L
Chloride	7.0 mg/L
Chlorine, Total	1.47 mg/L
Conductivity	178 µS/cm
Hardness (as CaCO3)	66 mg/L
Iron	<0.01 mg/L
Magnesium (Mg)	1.9 mg/L
pH	8.59
Sulfate	26.0 mg/L
Total Dissolved Solids (TDS)	111 mg/L
Total Organic Carbon (TOC)	1.92 mg/L
Turbidity	0.06 NTU

- Hardness (Calcium + Magnesium)
  - Alkalinity (mostly Bicarbonate)
- } pH and Flavor

- Chloride
  - Sulfate
  - Sodium
- } Flavor

Common approach to managing water:

1. Get the pH of the mash into optimum range
2. Add other minerals as necessary to adjust flavor

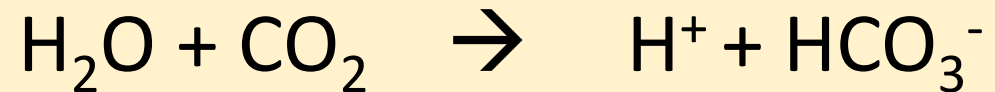


# Water, pH, and Alkalinity

- Water naturally disassociates:



- Carbon dioxide from atmosphere dissolves in water, creating acidity:

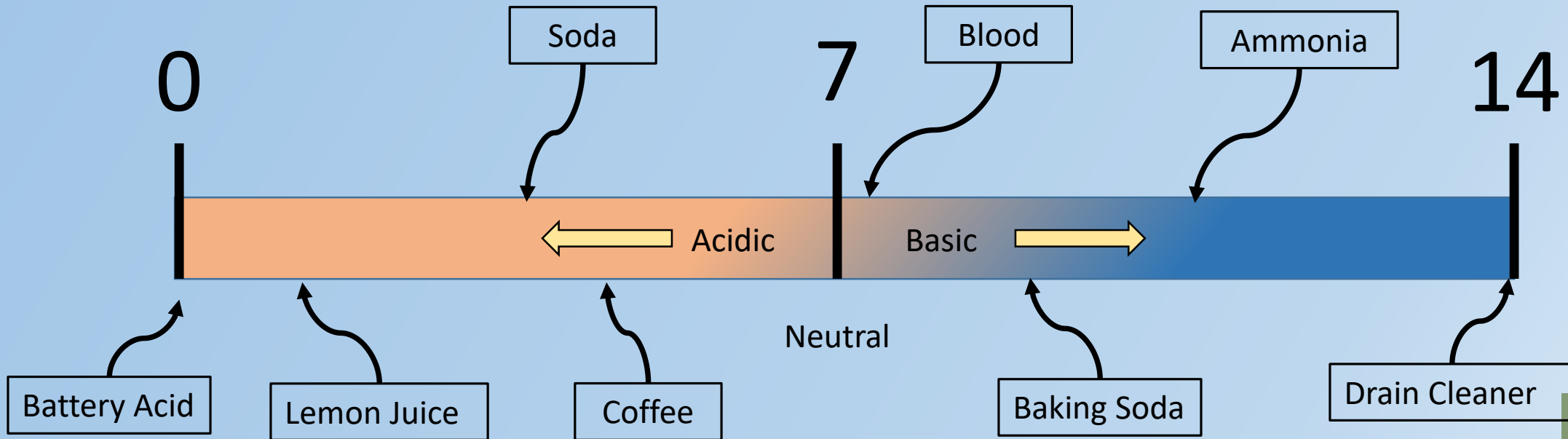


- Water flows over limestone, creating alkalinity:



# The pH Scale

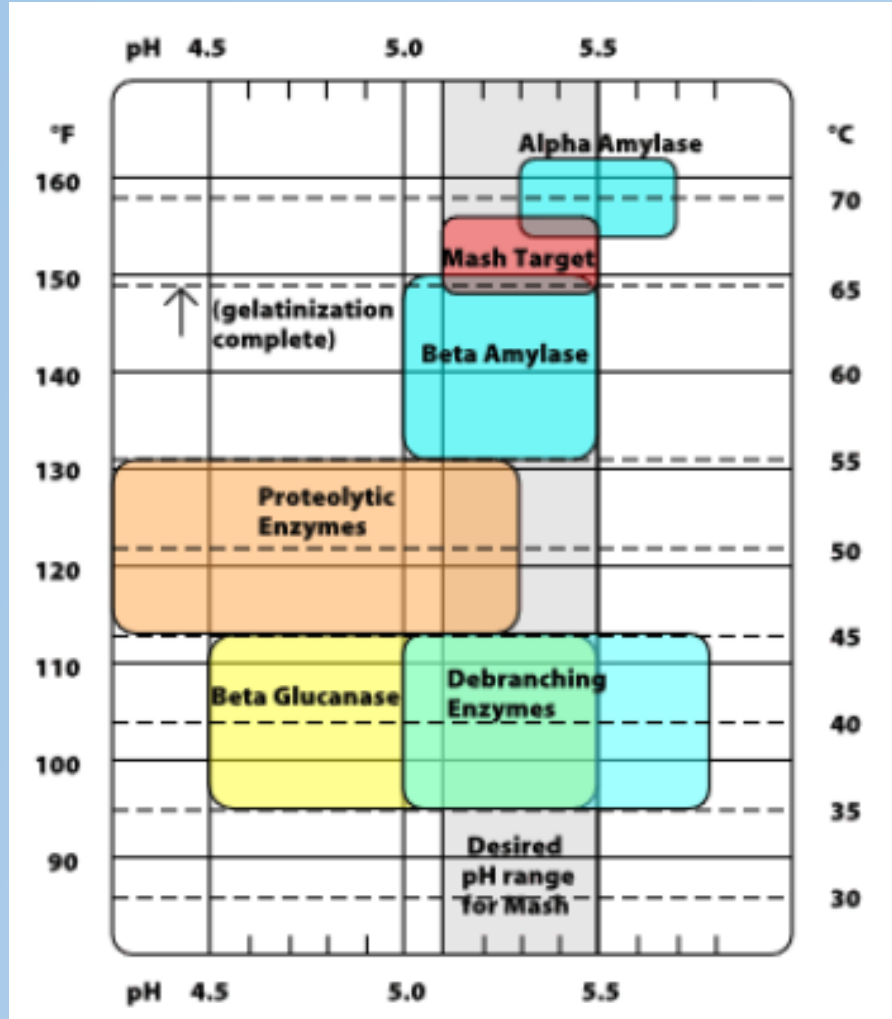
- It is measurement of the acidity (how many  $H^+$  are in solution)



Note: Alkalinity is a measure of how strongly water resists acidification

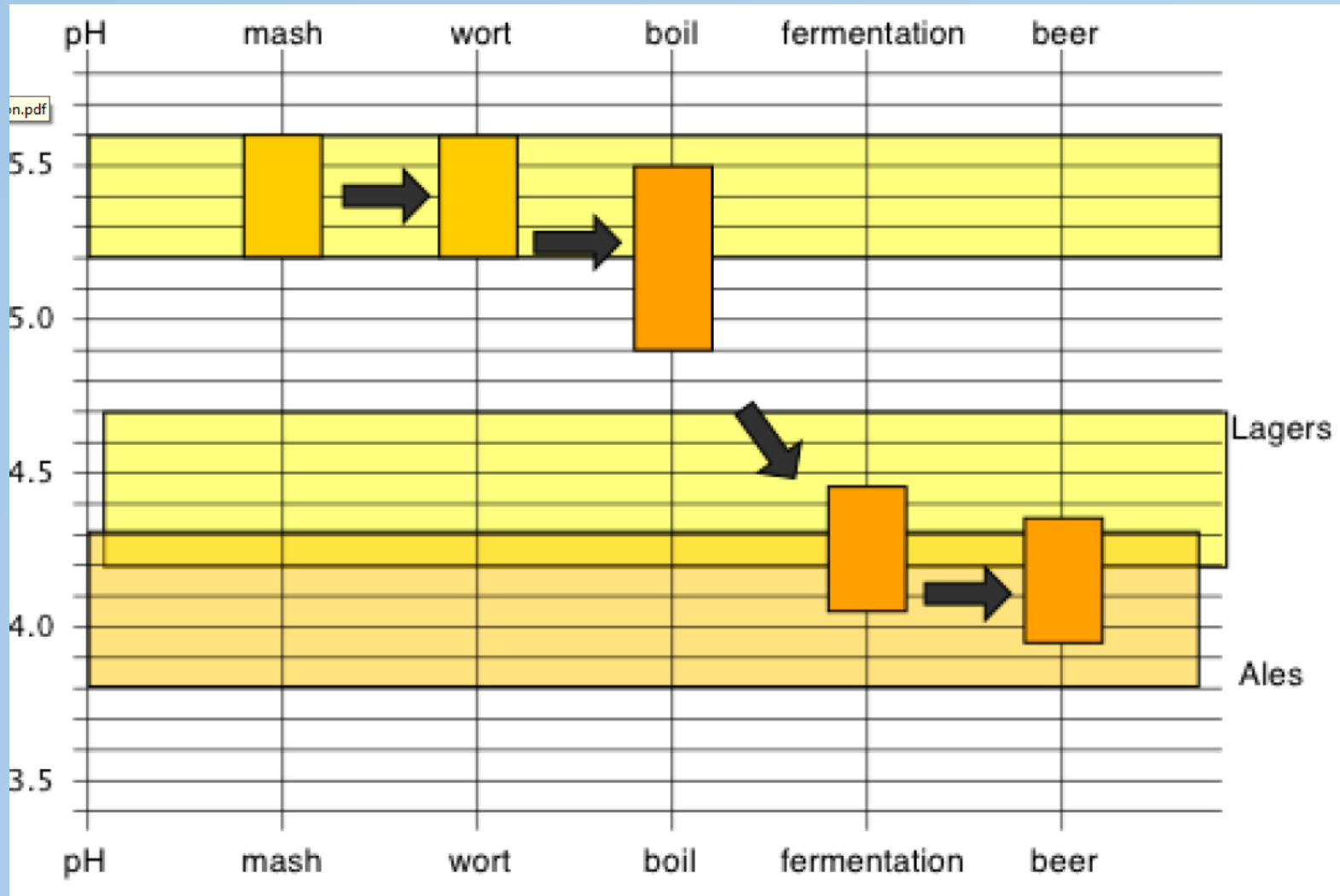


# Why Care About pH?



- Like temperature, pH affects mash enzyme performance
- Practically no impact at the homebrewing level
- Let InBev worry...

# Mash pH Sets Up Beer pH





# And Beer pH Influences Flavor Perceptions...

- “Every beer recipe has an ideal pH, where its flavors are best expressed” - John Palmer, 2014 NHC
- Think about adding a squeeze of lemon or a pinch of salt or some freshly ground black pepper to your food
- General guidelines:
  - Lower pH creates perception of crispness (lagers, light colored beer)
  - Higher pH creates perception of fullness (stouts, porters, darker beers)



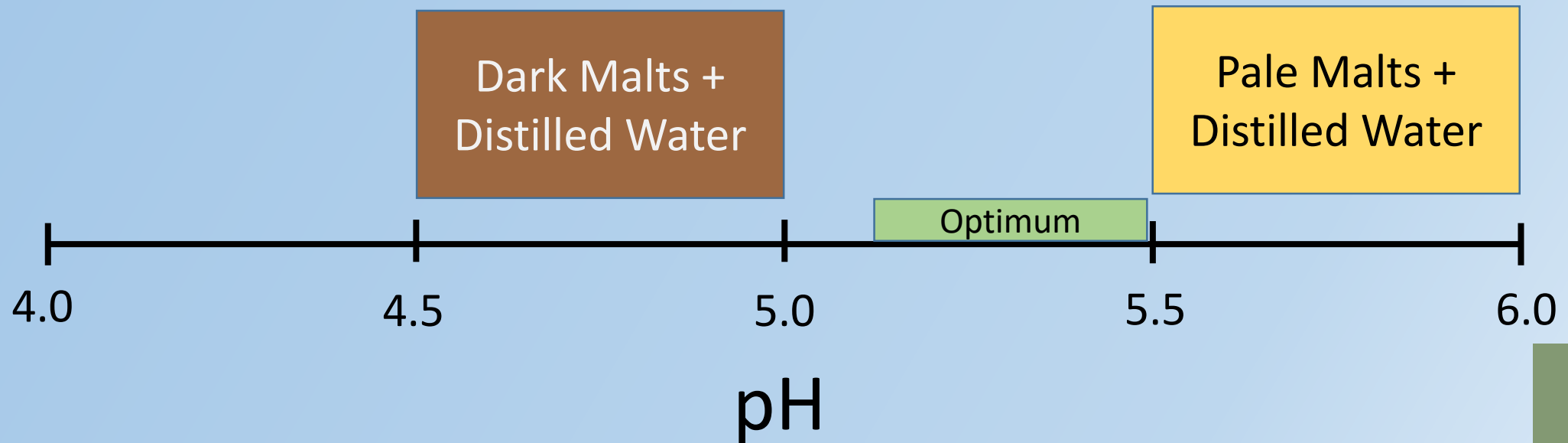


# Residual Alkalinity

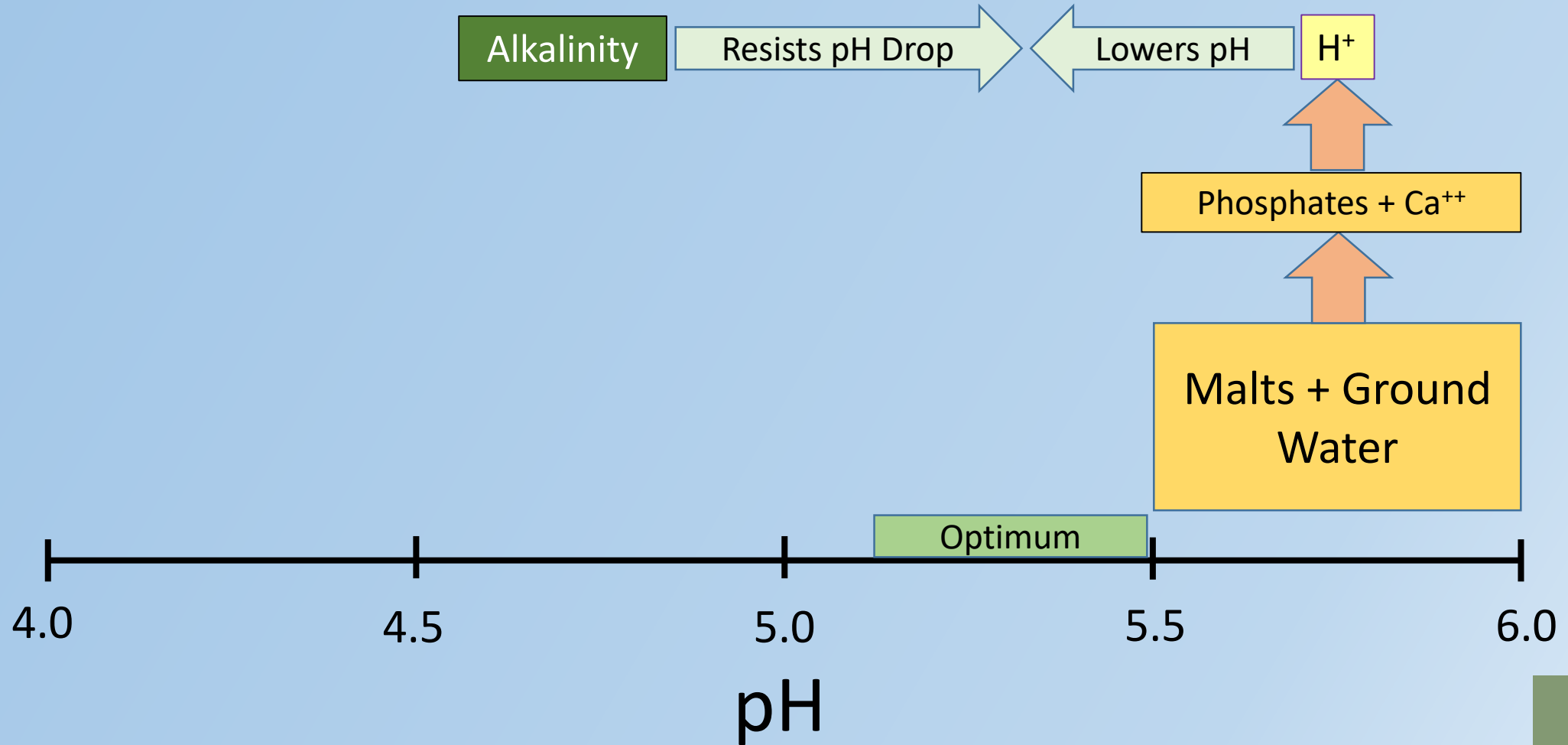
Or How I Learned to Stop Worrying (about pH) and Love the Beer



# What Happens in a Mash with Distilled Water



# What Happens in a Mash with Ground Water

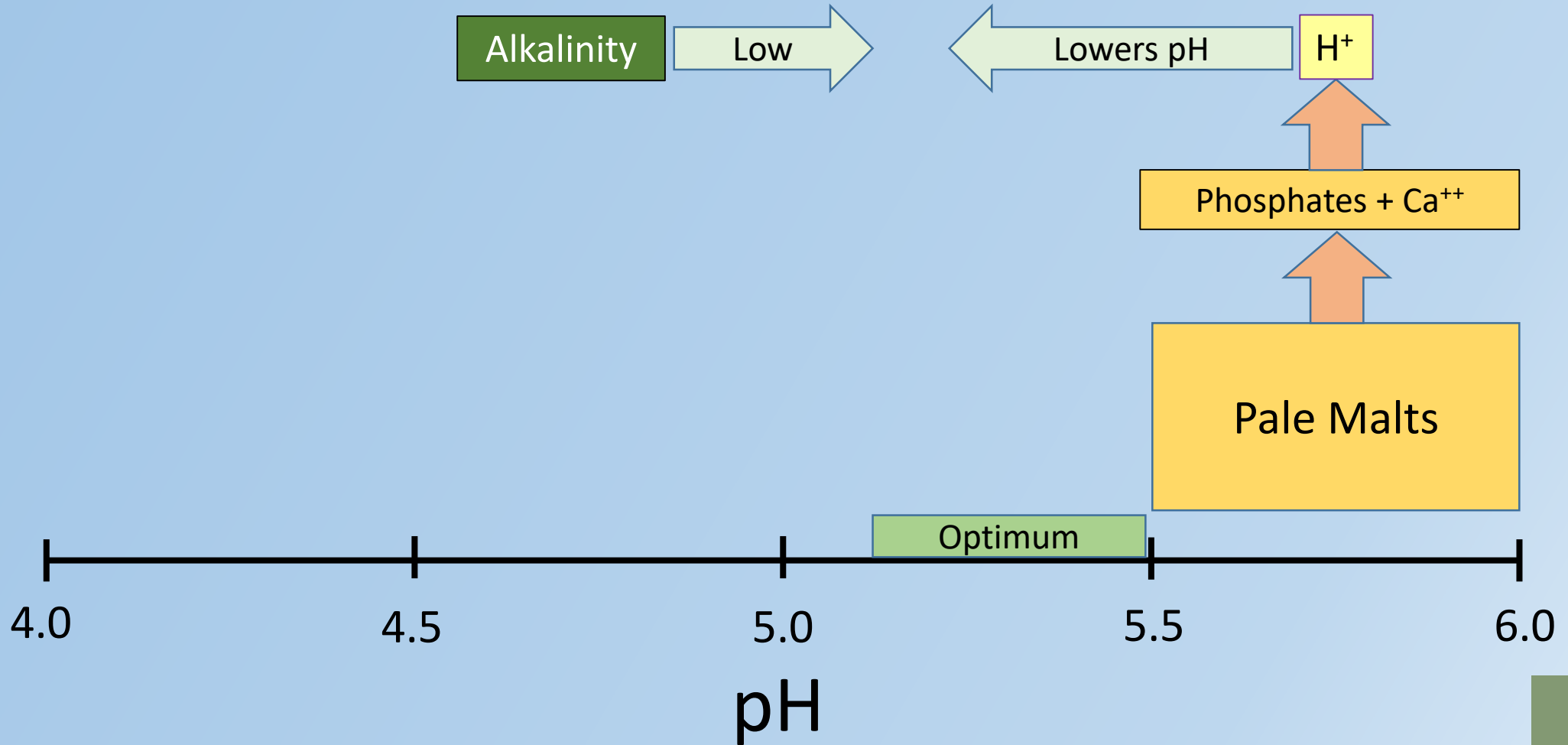


# Residual Alkalinity

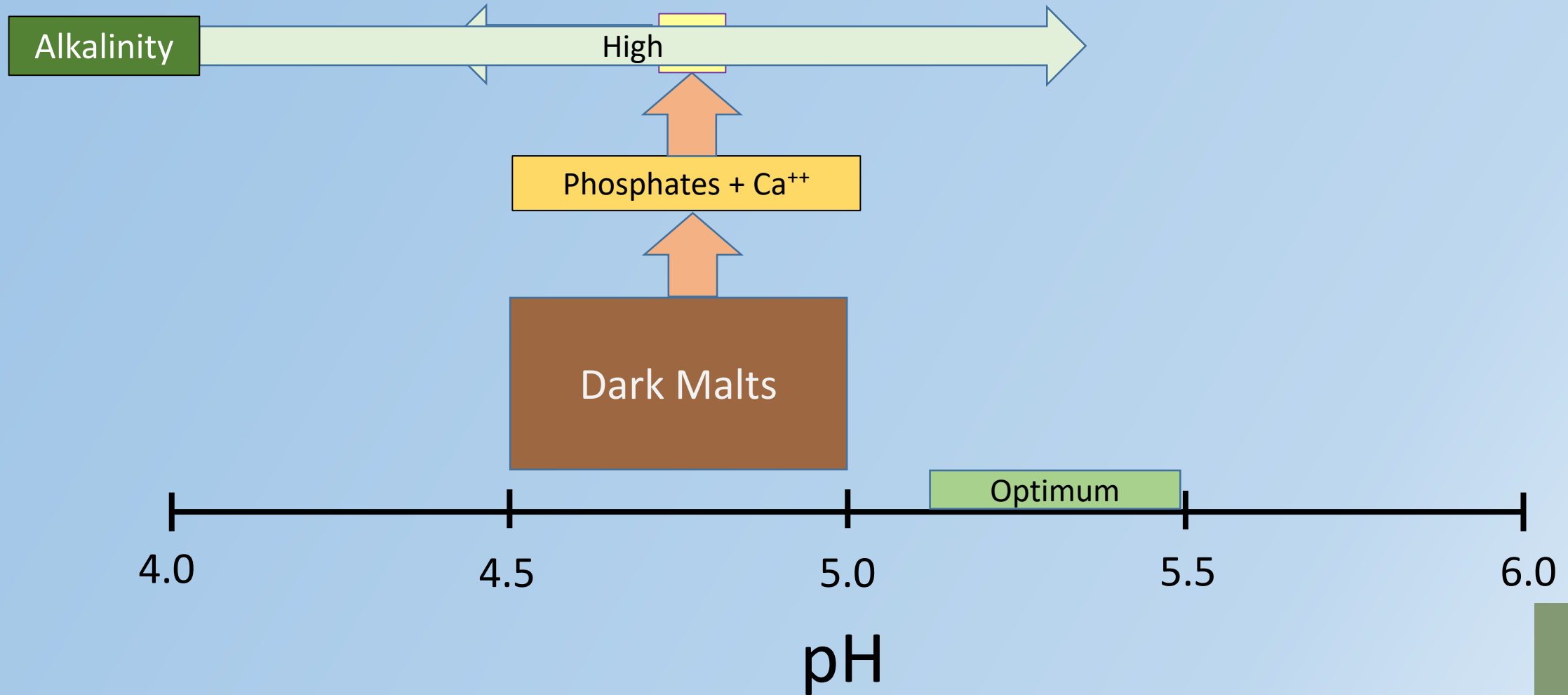
- Amount of alkalinity that remains in the water after the reaction with  $H^+$  generated from the mash
- Residual alkalinity can be negative (excess  $H^+$ )



# When do We want Low RA?



# When do We want High RA?





Still there?  
What Kinds of Beers  
are Suited to the  
BWD?





# Calculating Residual Alkalinity for the BWD

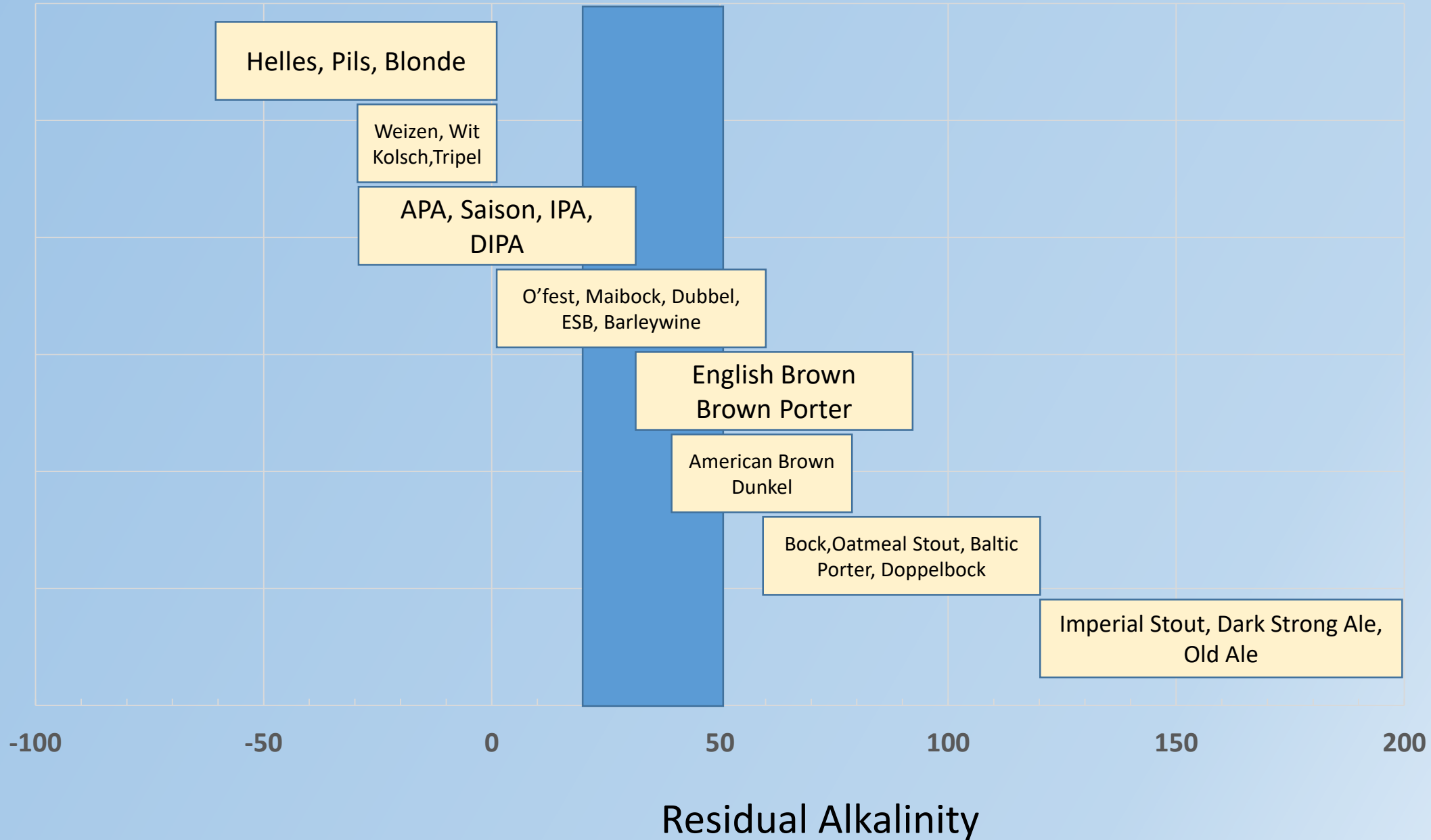
$$RA = \text{Total Alkalinity} - \left[ \frac{\text{Ca (ppm)}}{1.4} + \frac{\text{Mg (ppm)}}{1.7} \right]$$

$$RA = 53 - \left[ \frac{26}{1.4} + \frac{2}{1.7} \right] = 33^*$$

\*Seasonally, 20 to 50



# Residual Alkalinity Recommendations



# So Now What?

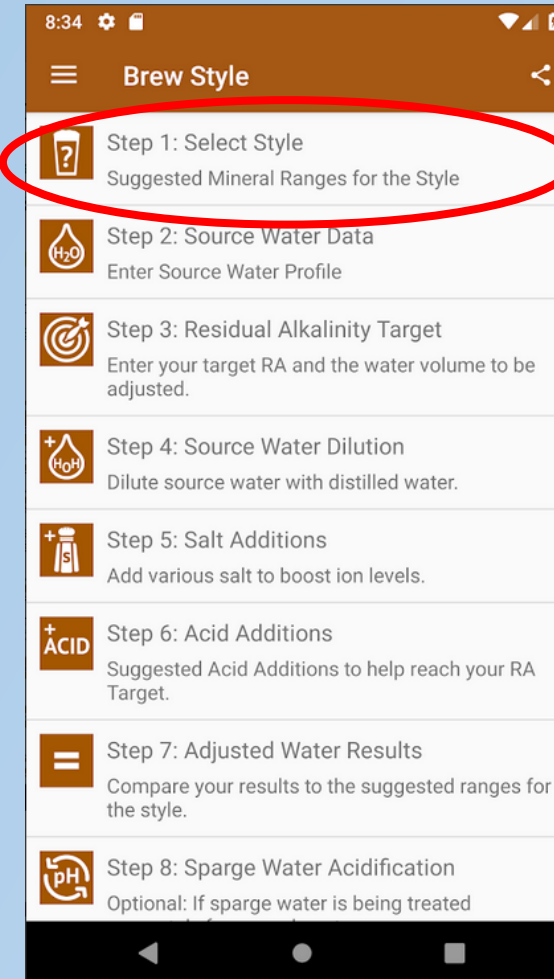
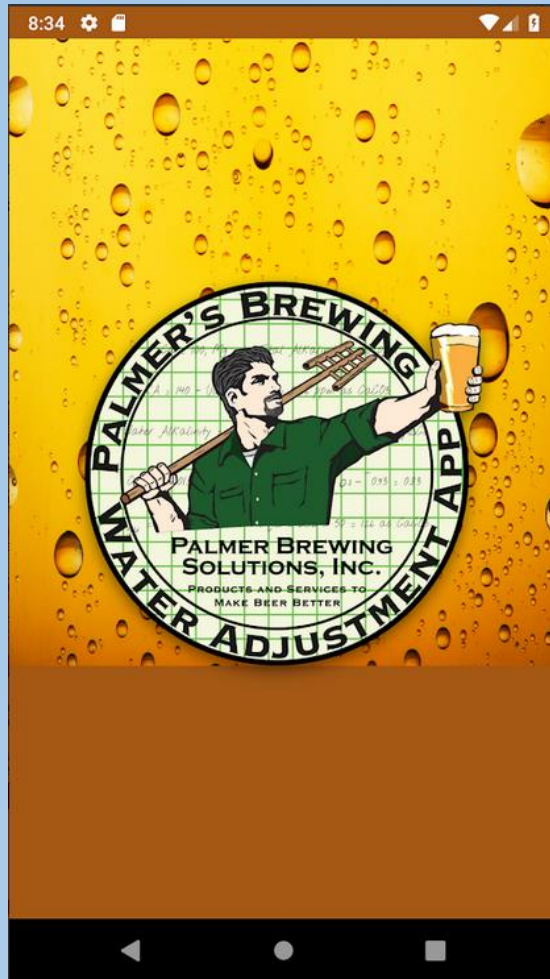


I just wanna brew some beer...



# Water Guidelines by Style

“If you don't know where you are going,  
you'll end up someplace else.”  
— Yogi Berra



Style	Change
1C. Premium American	Change
Calcium (ppm)	50-75
Magnesium (ppm)	0-30
Alkalinity as CaCO3	0-40
Sulfate (ppm)	50-150
Chloride (ppm)	50-100
Sodium (ppm)	<100
Residual Alkalinity	(-)60-0
Color (SRM)	2-6

# You can't always add what you want...



	ppm added per gram per gallon				
	Calcium	Chloride	Sodium	Sulfate	Magnesium
Calcium Chloride	72	127			
Gypsum	61			147	
Epsom Salt				103	26
Table Salt		160	104		
Baking Soda			72		
Pickling Lime	143				
Chalk (Calcium Carbonate)	Not recommended				
Lactic Acid (88%)	Reduces RA by about 95				
Phosphoric Acid (10%)	Reduces RA by about 13				
Acid Malt	1% in grain bill reduces RA by about 20				



# Water Adjustment Ideas - IPA

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	50-150	0-30	< 100	< 100	100 - 400	40 - 120	(-30) - 30
Calcium Sulfate (Gypsum)			10 grams, to boil kettle				
Magnesium Sulfate (Epsom Salts)			5 grams, to boil Kettle				
Finish	126	<del>X</del> 23	6	7	<del>26</del> 350	53	33



# Water Adjustment Ideas – Blond Ale

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	50-100	0-30	< 100	50 - 100	100 - 200	0 - 80	(-60) – 0
Calcium Chloride			4 grams in mash				
Magnesium Sulfate (Epsom salts)			6 grams in mash				
Finish	67	24	7	79	115	44	-50



# Water Adjustment Ideas – Imperial Stout

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	50-75	0-30	< 100	50 - 150	50 - 150	120 - 200	120 - 200
Calcium Chloride			3 grams in mash				
Calcium Sulfate (Gypsum)			2 grams in mash				
Baking Soda (Sodium Bicarbonate)			7 grams in mash				
Finish	69	2	72	55	72	254	181





# Water Adjustment Ideas – Czech Pils

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	26	2	7	6	26	53	33
Target	7	2	2	6	8	16	-60
Dilute water			67% distilled / 33% BWD				
Lactic Acid			2.5 gram in mash				
Finish	9	1	2	2	9	16	-55



# Water Calculators

## Bru'n Water

[Link to Bru'n Water website for updates and to donate](#)

### Water Adjustment Summary

Hover cursor over cells w/ red corner marks to display helpful information

Amber Balanced	Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Sulfate (ppm)	Chloride (ppm)	Bicarbonate (ppm)
Existing Water Profile	26	2	7	21	7	71
Mashing Water Profile	26	2	7	21	7	71
Recommended Ranges	40 to 150	0 to 30	0 to 150	0 to 350	0 to 100	as needed

### Mash Parameters

Batch Volume (liters)	3.0	Hardness (ppm as CaCO <sub>3</sub> )	
Estimated Mash pH	5.82	Alkalinity (ppm as CaCO <sub>3</sub> )	59

### Additions

	Total Mash Water Vol (L)	Mash Water Vol (L)	Sparge Water Vol (L)
	3.0	0.0	0.0

Additions	Minerals (grams)	Sparge Water
Gypsum (CaSO <sub>4</sub> x 2H <sub>2</sub> O)	0.0	
Calcium Chloride (CaCl <sub>2</sub> )	0.0	
Epsom Salt (MgSO <sub>4</sub> x 7H <sub>2</sub> O)	0.0	
Magnesium Chloride (MgCl <sub>2</sub> )	0.0	
Canning Salt (NaCl)	0.0	
Baking Soda (NaHCO <sub>3</sub> )	0.0	Not Rec
Chalk (CaCO <sub>3</sub> )	0.0	Not Rec
Pickling Lime (Ca(OH) <sub>2</sub> )	0.0	Not Rec

## Palmer's Water Calculator

Palmer's Brewing Water Adjustment App Version 4.0 (Liters, EBC)

by John Palmer All Rights Reserved 2015  
Units are grams, Liters and milliliters.

Note: Estimated Beer Color (EBC) ranges are a rough estimate at best.

Step 1: Choose the desired beer style from the list to see recommended mineral ranges.

Style: 1B. Standard American

Suggested Water Mineral Ranges for the Style	Calcium (ppm)	Magnesium (ppm)	Alkalinity as CaCO <sub>3</sub> (ppm)	Sulfate (ppm)	Chloride (ppm)	Sodium (ppm)	Residual Alkalinity (ppm)	Color (EBC)
	50-60	0-30	0-40	0-50	50-100	<100	(-)60-0	4-8

Step 2: Enter Source Water Profile. (Choose "Bicarbonate" or "Alkalinity" in E14.)

Source Water Data	Calcium (ppm)	Magnesium (ppm)	Alkalinity as CaCO <sub>3</sub> (ppm)	Sulfate (ppm)	Chloride (ppm)	Sodium (ppm)	Water pH
	0	0	50	20	6	6	8.4

Source Data Diagnostics	Cation Sum	Anion Sum	Residual Alkalinity as CaCO <sub>3</sub>	Sulfate to Chloride Ratio	Est. EBC (Low)	Est. EBC (High)
	0.3	1.6	50	3.3	18	36

Step 3: Enter a Target Residual Alkalinity Value, based on Step 1, and the volume of water you are trying to adjust.

Target Residual Alkalinity	Mash Water Volume (L)	Alkalinity to be Reduced	Additional Alkalinity Needed	Target RA Est. EBC (Low)	Target RA Est. EBC (High)
0	1.00	50	0	7	16

## Brewer's Friend

Water report: Full

Calcium: 26 mg/l Ca<sup>2+</sup>

Magnesium: 2 mg/l Mg<sup>2+</sup>

Sodium: 6 mg/l Na<sup>+</sup>

Chloride: 7 mg/l Cl<sup>-</sup>

Sulfate: 21 mg/l SO<sub>4</sub><sup>2-</sup>

Alkalinity As: Bicarbonate Alkalinity

Alkalinity: 56 ppm as CaCO<sub>3</sub>

pH: 8.0

Mineral Levels in mg/l (ppm):		ion balance mEq/l	
cations (+)	anions (-)		
Ca <sup>2+</sup> 26.0	Mg <sup>2+</sup> 2.0	Na <sup>+</sup> 6.0	Cl <sup>-</sup> 7.0
		SO <sub>4</sub> <sup>2-</sup> 21.0	HCO <sub>3</sub> <sup>-</sup> 65.175
			CO <sub>3</sub> <sup>2-</sup> 0.300
		0.01	

ppm as CaCO <sub>3</sub>		pCO <sub>2</sub>	CaCO <sub>3</sub>
GH 73.1	GH <sub>p</sub> 19.2	atm 0.00070	ppm 0.0
	GH <sub>t</sub> 53.9		
	Alkalinity 56.0		
	RA 36.3		
	pH 8.0		

## EZ Water Calculator Spreadsheet 3.0 - METRIC

Step 1: Enter Existing Water Profile

Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Chloride (ppm)	Sulfate (ppm)	Bicarbonate (ppm)
26	2	7	7	21	71

Step 2: Enter Mash Info

Batch Volume (L)	Mash Water Volume (L)	Sparge Water Volume (L)
3.0	0.0	0.0

Step 3: View Mash pH

Estimated Mash pH: 5.74

Step 4: Adjust Mash pH DOWN

Step 5: View Brewing Water Profile

Calcium (ppm)	Magnesium (ppm)	Sodium (ppm)	Chloride (ppm)	Sulfate (ppm)	Bicarbonate (ppm)
26	2	7	7	21	71

## Kaiser Water Calculator

Water analysis

mg/l	mmx	Ca mg/l	Ca d
0	36.1	6.1	0.6
0	2.4	0.6	0.6
0	8.0	1.0	0.6
0	25.0	4.4	0.6
0	8.0	0.6	0.6
0	103.7	4.8	0.6
0	85.0	3.2	0.6
58	as CaCO <sub>3</sub>		

Place Your Recipe's Name Here

Pre-Adjustment Mash Water Alkalinity (mg/L)	Mash Water Ca++ (mg/L)	Mash Water Mg++ (mg/L)
200.0	125.0	9.0

Step 1: Choose the desired beer style from the list to see recommended mineral ranges.

Style: 1B. Standard American

Step 2: Enter Source Water Profile. (Choose "Bicarbonate" or "Alkalinity" in E14.)

Source Water Data	Calcium (ppm)	Magnesium (ppm)	Alkalinity as CaCO <sub>3</sub> (ppm)	Sulfate (ppm)	Chloride (ppm)	Sodium (ppm)	Water pH
	0	0	50	20	6	6	8.4

Step 3: Enter a Target Residual Alkalinity Value, based on Step 1, and the volume of water you are trying to adjust.

Target Residual Alkalinity	Mash Water Volume (L)	Alkalinity to be Reduced	Additional Alkalinity Needed	Target RA Est. EBC (Low)	Target RA Est. EBC (High)
0	1.00	50	0	7	16

## Mash Made Easy V\_11.30 Metric

By: MashRite LLC (All Rights Reserved) 12/29/2021

Pre-Adjustment Mash Water Alkalinity (mg/L)	Mash Water Ca++ (mg/L)	Mash Water Mg++ (mg/L)
200.0	125.0	9.0

Malt/Grain Classification (Drop Down)	Grain Bill (Names / Descriptions)	Grains EBC Color	Grains Quantity (Kgs.)	Grains Calculated DI Mash pH	DI Mash pH Manual Override	Grains Calculated Post Mineral Additions Mash pH	Buffering Coefficient Manual Override
	Swaen Pilsner	3.7	5.44	5.71		6.35	

Grists Total Malts/Grains/Sugars & Non-fermentables Weight (Kgs.)	Pre Acid/Base Addition Mash pH	Desired Target Mash pH @ 20 C.
5.44	6.35	5.40

Sugars & Non-Fermentables Weight (Kgs.)	88% Lactic (mL)	10% Phos (mL)	Acid Malt (g)	Acid Malt (g)	Citric Acid (g)	CRS/AMS (mL)
0	13.39	140.59	474.47	12.13	41.94	

Drop Down User Input | User Input

Calculated Output | Text

## Mash Made Easy

Mash Water Mineral Additions					
Gypsum (CaSO <sub>4</sub> )	CaCl <sub>2</sub> Prills/Crystal at 75.5 Percent	Epsom Salt (MgSO <sub>4</sub> )	Table or Pickling Salt (NaCl)	Baking Soda (NaHCO <sub>3</sub> )	Slaked Lime Ca(OH) <sub>2</sub>
0.00	0.00	0.00	0.00	0.00	0.00

Sparge Water Mineral Additions					
Gypsum (CaSO <sub>4</sub> )	CaCl <sub>2</sub> Prills/Crystal at 75.5 Percent	Epsom Salt (MgSO <sub>4</sub> )	Table or Pickling Salt (NaCl)	Baking Soda (NaHCO <sub>3</sub> )	Slaked Lime Ca(OH) <sub>2</sub>
0.00	0.00	0.00	0.00	N/A	N/A

Mash Water (Liters)	Sparge Water (Liters)	Total Batch Water (Liters)	Water to Grist Ratio (L./Kg.)	Mineral Modified Grist Buffer as mEq/Kg. #	Aggregate Grist Buffer as mEq/Kg. #
	34	67.7	6.19	153.29	29.77

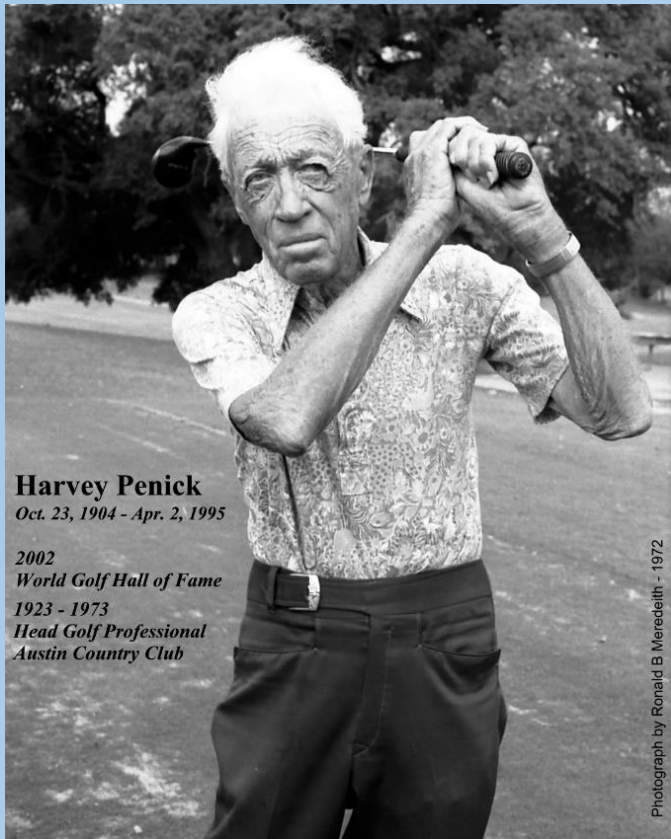
Finished Batch Mineralization					
Chloride (mg/L)	Sulfate (mg/L)	Sodium (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Total Hardness as CaCO <sub>3</sub>
80.0	245.0	100.0	125.0	9.0	349.2

Cooled post boil volume (Liters)	Estimated Batch Color (SRM)	Effective Ca++ and Mg++ mEq/L	Mash H <sub>2</sub> O Alkalinity mEq/L	Ca and Mg induced pH Shift	Alkalinity induced pH Shift
24.6	6.9	-31.813	134.683	-0.393	+1.028

NOTE: If using CRS/AMS to adj, Mash pH set to "Yes" to account for Cl & SO<sub>4</sub> | CRS/AMS = No

# In Closing...

~~Golf~~ *Brewing* tips are like aspirin. One may do you good, but if you swallow the whole bottle you will be lucky to survive.



- Harvey Penick



# The Beer Tonight

	Calcium	Magnesium	Sodium	Chloride	Sulfate	Alkalinity	RA (Mash)
Starting	24	2	7	7	25	44	26
Target	50-75	0-30	< 100	50 - 100	50 - 150	80-150	120 - 200
Control	14	2	4	4	15	26	15
Adjusted	67	8	62	80	99	118	66



# Cheers !

