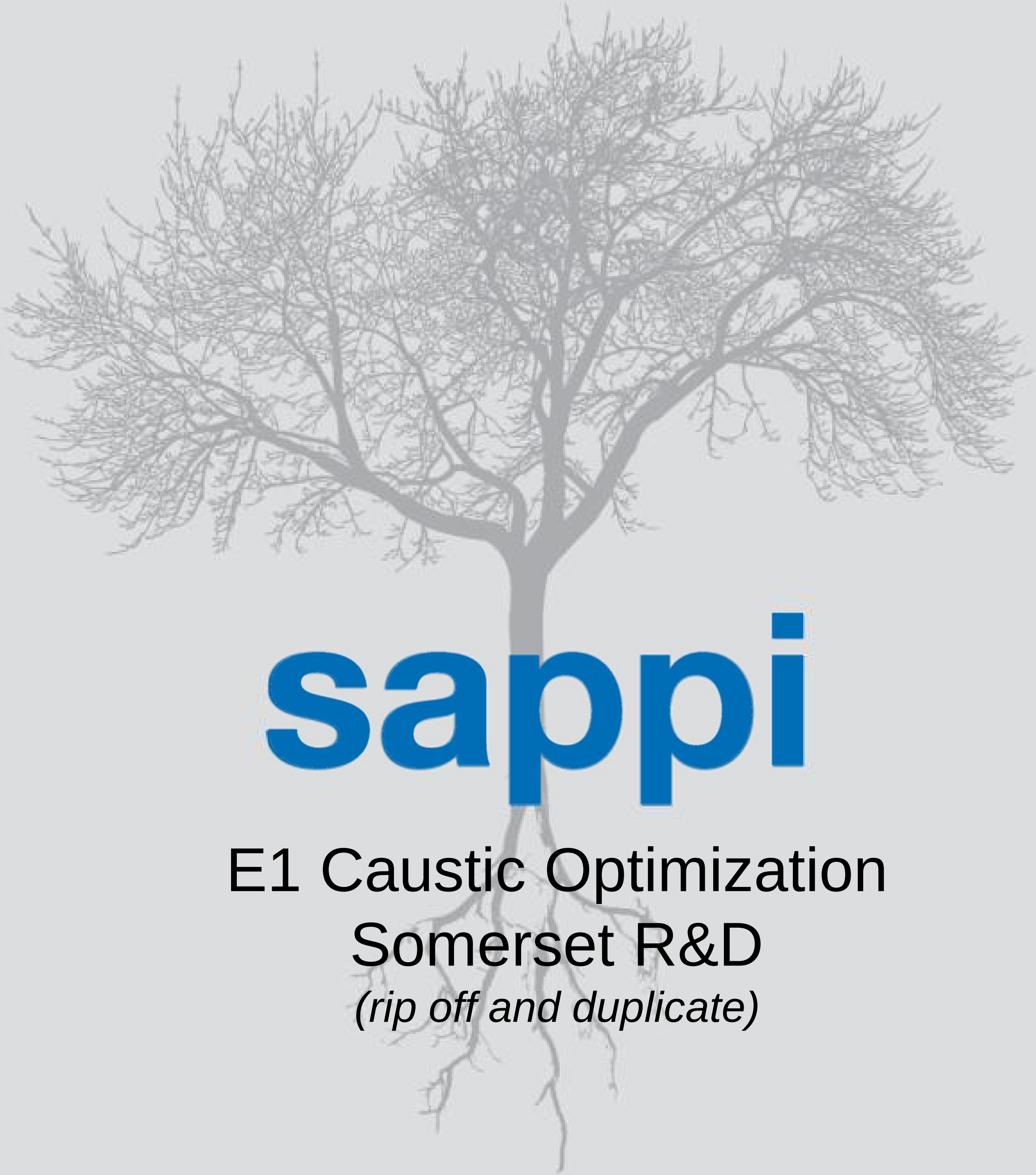
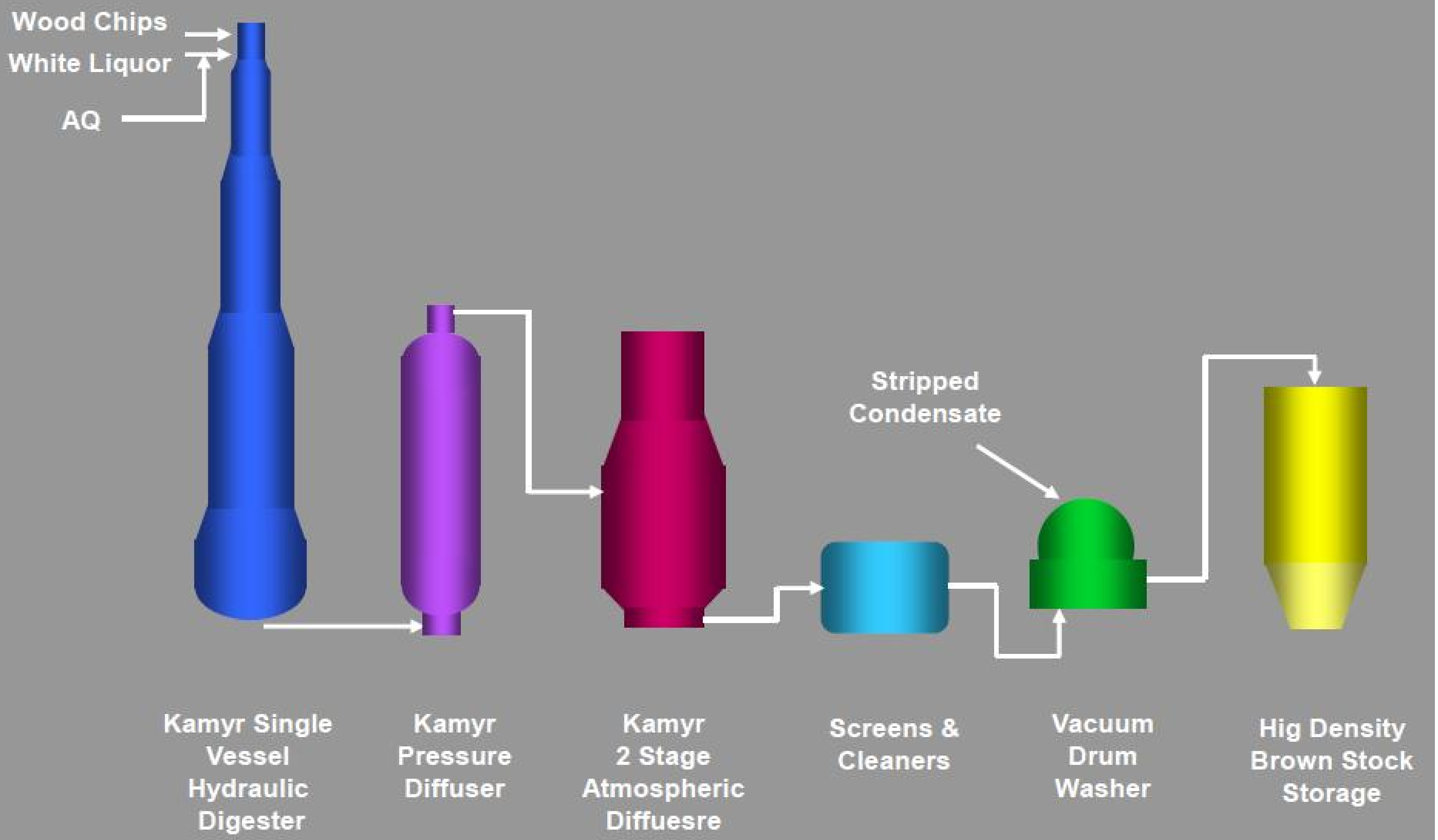


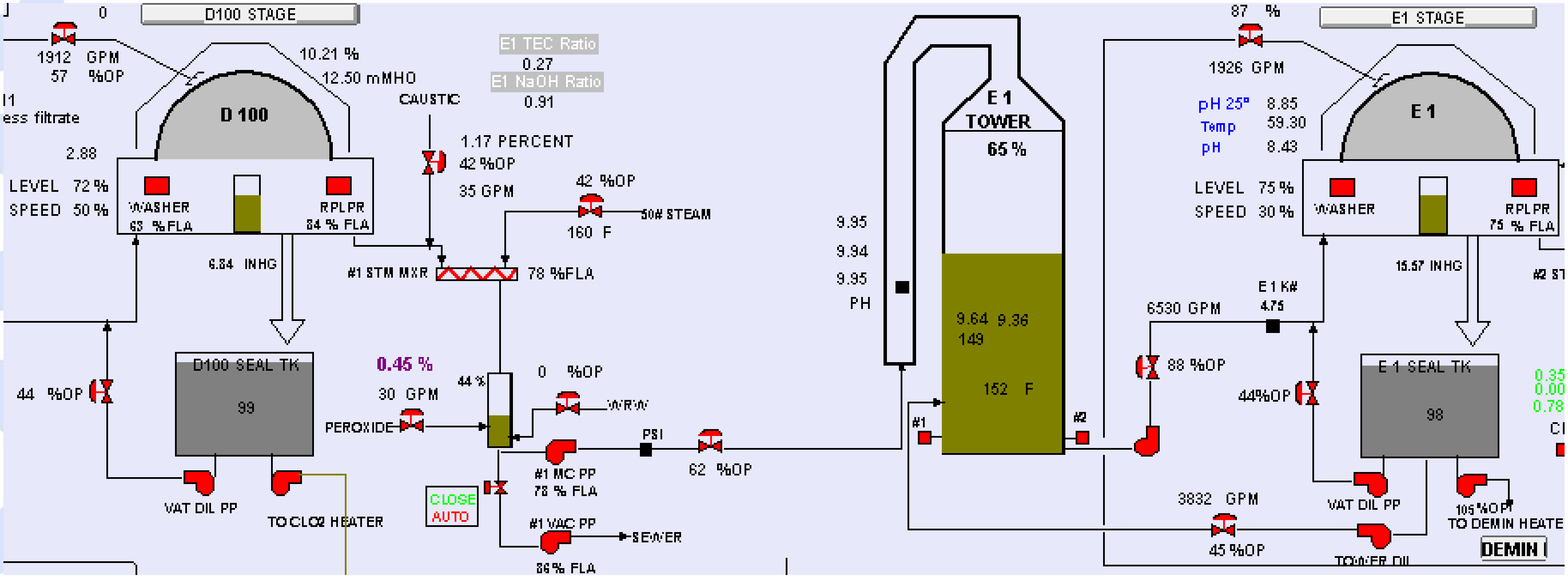
E1 Caustic Optimization

Somerset R&D

(rip off and duplicate)

Current Brown Stock Configuration





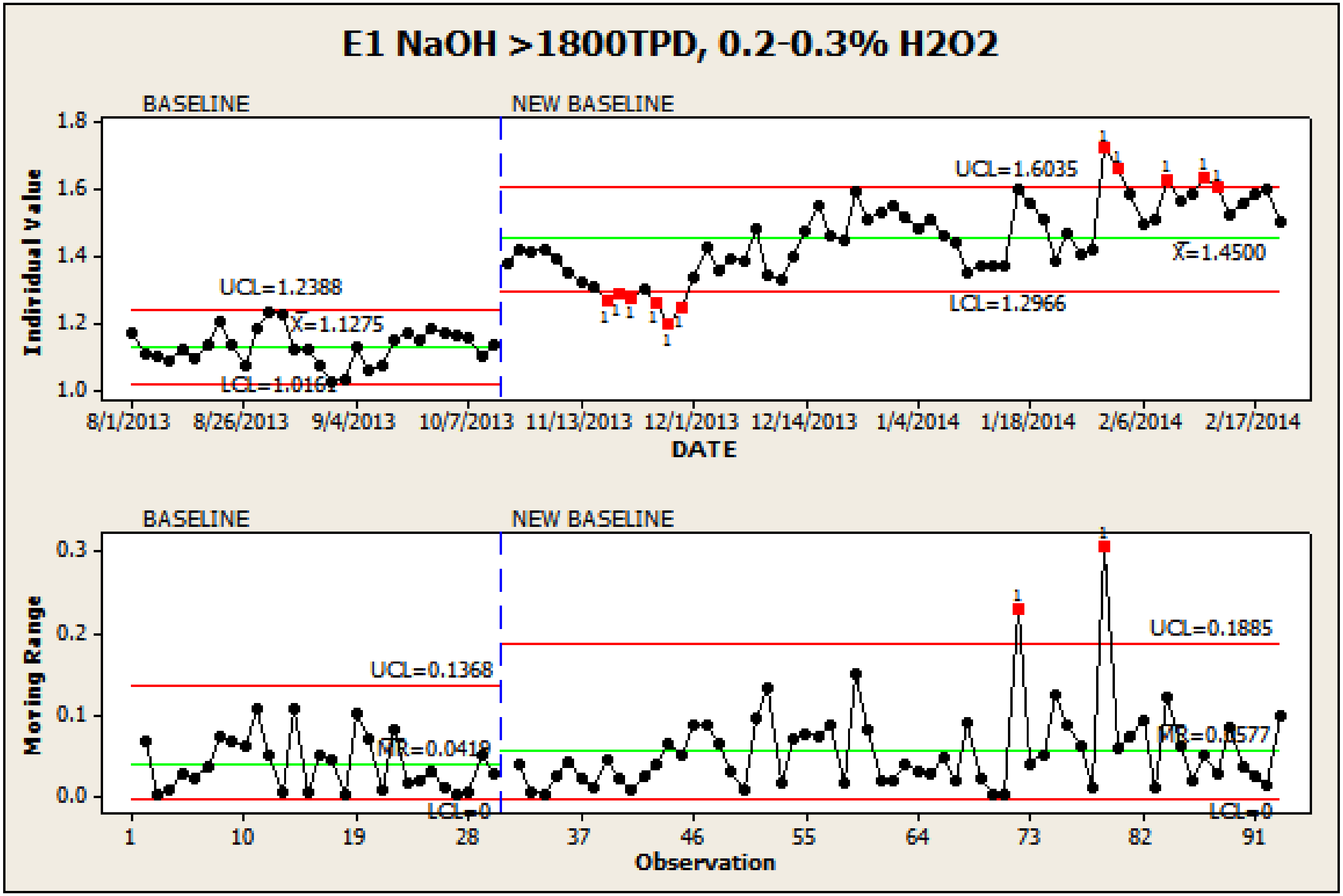
- Somerset runs a 5-stage bleach plant: D Ep D Ep D
- Approximately 1700 TPD Kraft CoPulp bleached to 88.7% ISO
- Total Bleach Plant residence time is approximately 5 hours at normal rate
- Shower water for the E1 washer is 100% D1 filtrate, D100 shower water is a combination of warm raw water sources, pulp machine white water, & a few hundred gallons of D2 excess filtrate

What are the chances?

- Required to perform a Lean Six Sigma project in my area
- Bleaching costs were rising and were under extreme scrutiny
- I was full of knowledge from attending the PAPTAC Bleaching committee meeting in New Bern

- Why not pick a project that I know can be completed successfully and on time…

- Effect of washing efficiency and carryover shown in signification chemical usage increase



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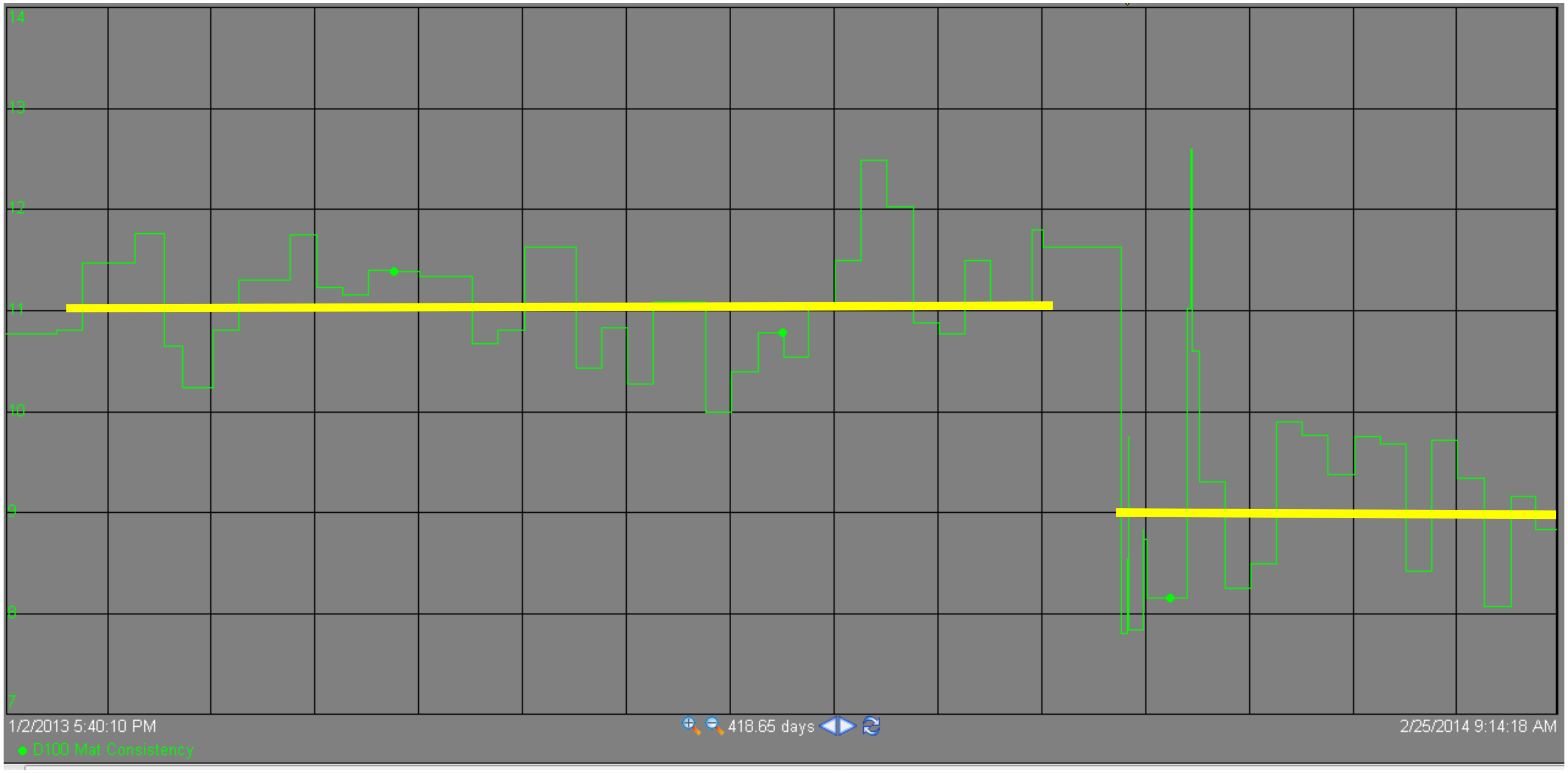


- It is shown clearly the drop in D100 washer discharge consistency from 11% down to 9%
- Operationally it was difficult to run the drum without sealing over
- Operators had to compensate by running extremely low drum speeds which resulted in thick wet mats
- With all the extra D100 filtrate, and the control scheme we were using for E1 caustic, usage skyrocketed

- Since some baseline data had already been collected for the Lean Six Sigma project to “Optimize E1 NaOH usage” we were able to lower our caustic usage and start running to a lab sample of “Tower pH”

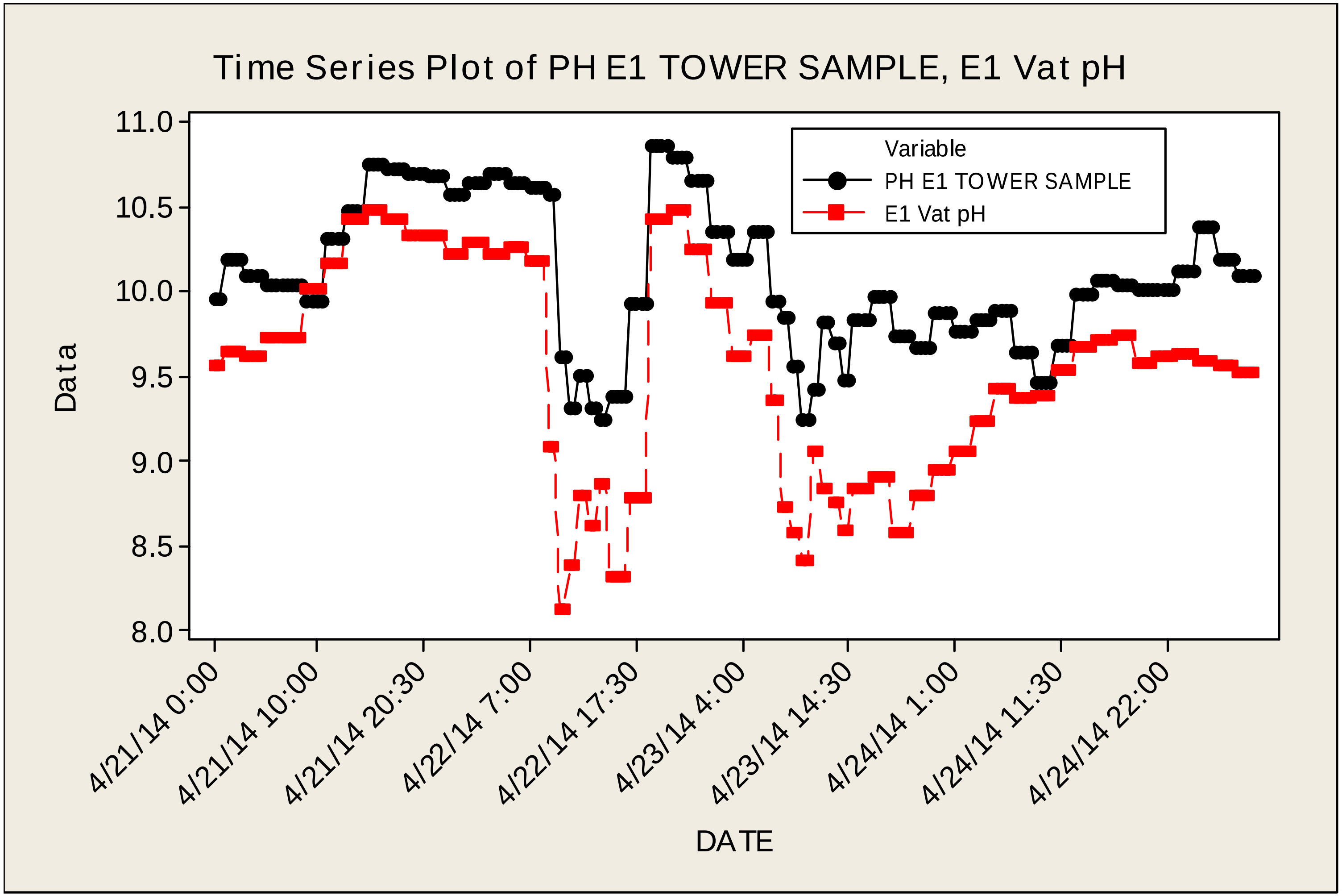
- This immediately dropped the stage pH by 0.5 as we targeted 10pH in the tower, where we had been targeting 10pH in the vat

- There was no increase in ClO2 usage in any stage

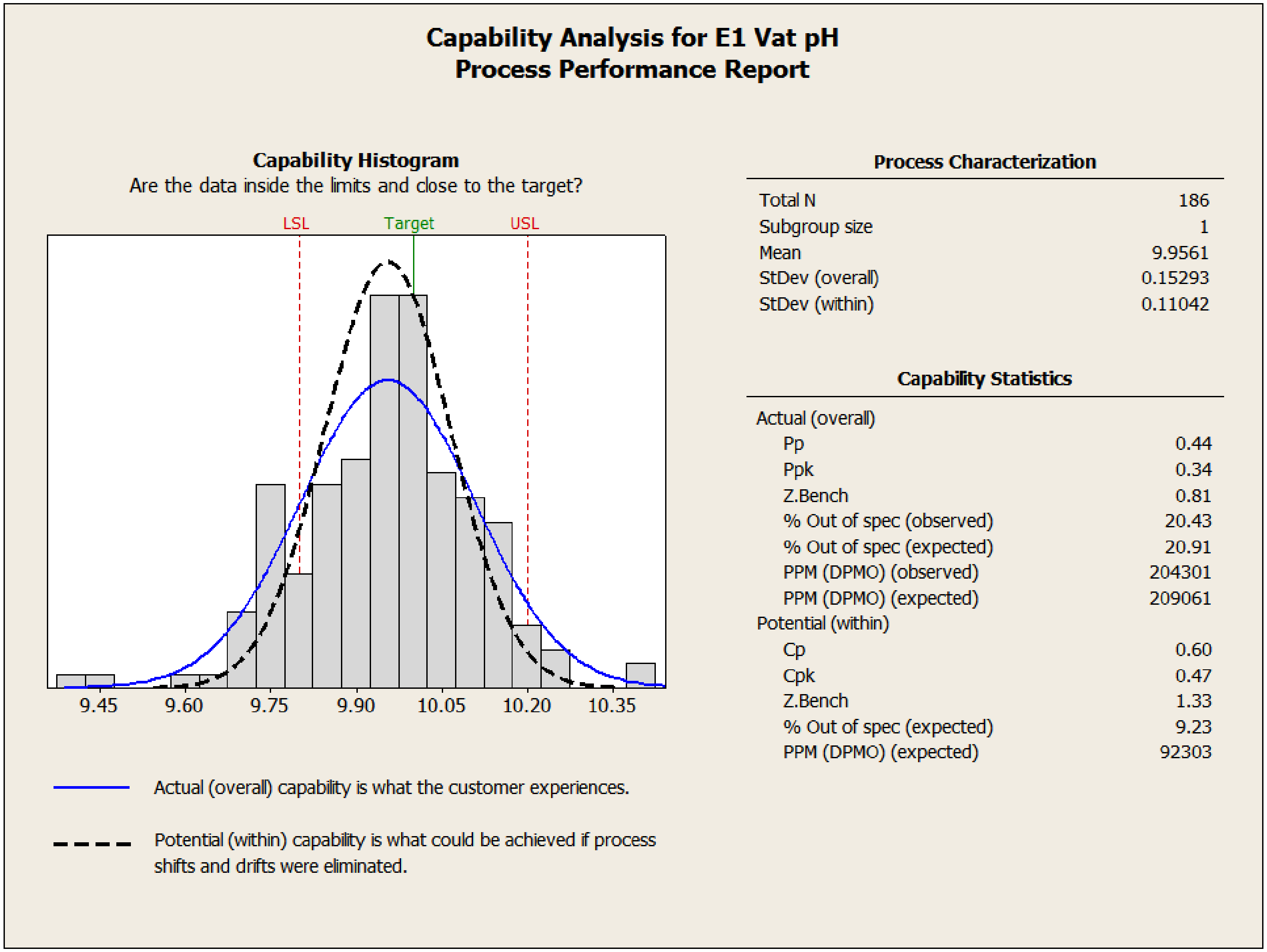
- We continued to run to the 10pH in the tower until taking a department shut down to have maintenance evaluate the washer.

- The center valve was found to be the issue and was replaced.

Not only were we dealing with the temperature issue, but a sampling location issue complicated by countercurrent washing. A vat sample is STANDARD sample location for vacuum drum washers, direct countercurrent washing is not. This study shows the difference in measurement locations.



Process Normality



Capability Analysis for E1 Vat pH
Process Performance Report

Capability Histogram
Are the data inside the limits and close to the target?

Process Characterization

Total N	186
Subgroup size	1
Mean	9.9561
StDev (overall)	0.15293
StDev (within)	0.11042

Capability Statistics

Actual (overall)	
Pp	0.44
Ppk	0.34
Z.Bench	0.81
% Out of spec (observed)	20.43
% Out of spec (expected)	20.91
PPM (DPMO) (observed)	204301
PPM (DPMO) (expected)	209061
Potential (within)	
Cp	0.60
Cpk	0.47
Z.Bench	1.33
% Out of spec (expected)	9.23
PPM (DPMO) (expected)	92303

Actual (overall) capability is what the customer experiences.

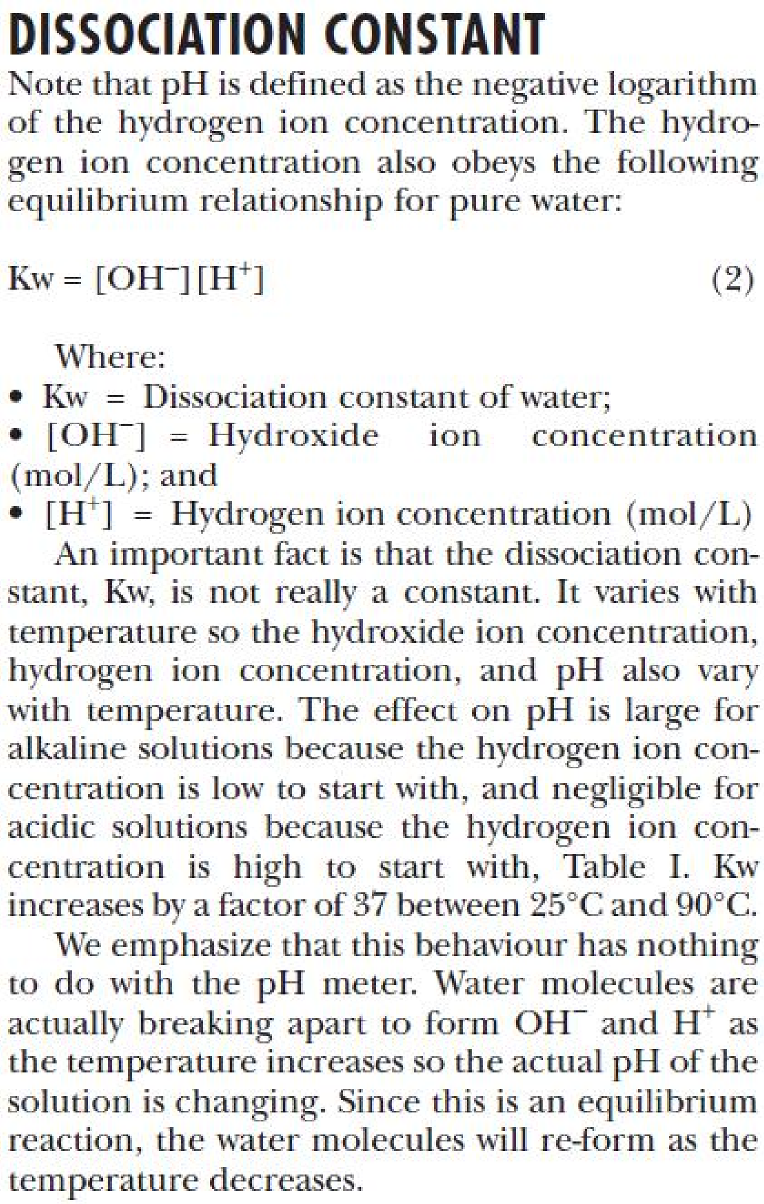
Potential (within) capability is what could be achieved if process shifts and drifts were eliminated.

Doesn’t a pH meter already have a temperature compensation?

Yes – and…

Research shows that alkaline samples are severely affected by the temperature at which they are measured

Old news to PAPTAC…new news to our E&I folks and Operations folks at the Mill



DISSOCIATION CONSTANT

Note that pH is defined as the negative logarithm of the hydrogen ion concentration. The hydrogen ion concentration also obeys the following equilibrium relationship for pure water:

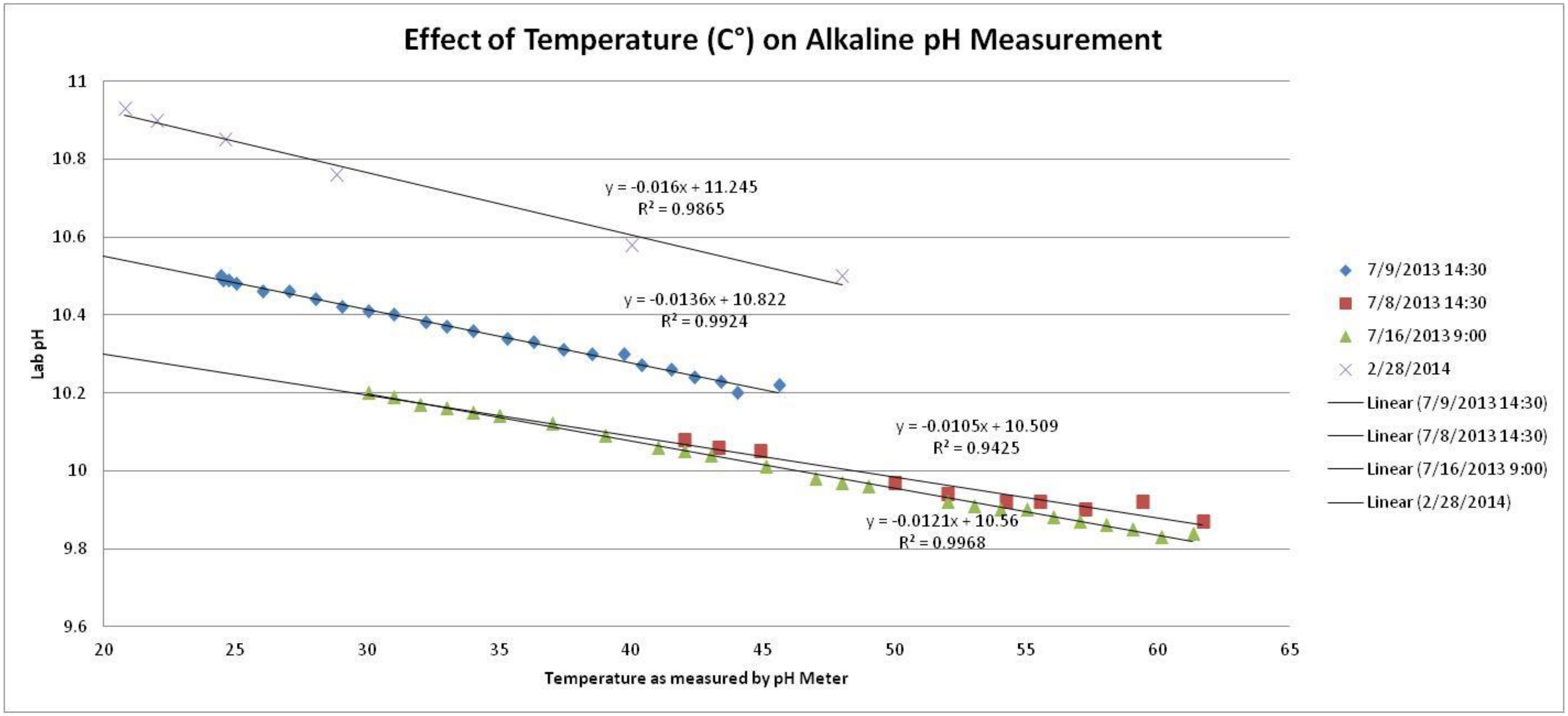
$$Kw = [OH^-][H^+] \qquad (2)$$

Where:

- Kw = Dissociation constant of water;
- $[OH^-]$ = Hydroxide ion concentration (mol/L); and
- $[H^+]$ = Hydrogen ion concentration (mol/L)

An important fact is that the dissociation constant, Kw, is not really a constant. It varies with temperature so the hydroxide ion concentration, hydrogen ion concentration, and pH also vary with temperature. The effect on pH is large for alkaline solutions because the hydrogen ion concentration is low to start with, and negligible for acidic solutions because the hydrogen ion concentration is high to start with, Table I. Kw increases by a factor of 37 between 25°C and 90°C.

We emphasize that this behaviour has nothing to do with the pH meter. Water molecules are actually breaking apart to form OH^- and H^+ as the temperature increases so the actual pH of the solution is changing. Since this is an equilibrium reaction, the water molecules will re-form as the temperature decreases.



- The effect of cooling on Alkaline pH measurement has been documented (ref. Reid and Morissette) and proven at Somerset
- A study here shows that an average slope of ~ 0.012 can be used to calculate a 25C° corrected pH
- With a dual output probe, this can be automatically compensated

The difference between 10.5 and 10.0 in the tower has been estimated to save 0.2% Applied of NaOH with no detrimental effect to D1 ClO2 usage.

Due to the upsets during several of the trial phases we should repeat the 9.8 target for a longer period of time to fully understand the effect on D1 ClO2 usage.

Example:
D100 conditions constant, E), and Production rate constant:

- Target 9.5 at the E1 towe
- Target 10.0 at the E1 tow
- Return to 9.5 for 2 days
- Return to 10.0 for 2 days.

If 9.5 appears to be a viable week to evaluate normal incoming K# variability.

Even though we measured a trace of 'low' pH we still need to evaluate a sustained period of time at a pH. We did not see any evidence of 'falling off the cliff" where we reached such a low alkalinity that the oxidized lignin was insoluble.

Install a filtrate extractor:

- •BTG FXS1300 Filtrate Extractor to be installed at E1 and E2 above the Tower Dilution header

- •Provides a ‘true’ end of stage pH that does not have countercurrent dilution influence

- •To be installed in October 2014

- •Will provide pH and temperature results

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- Filtrate extractor installed 5 feet above the tower dilution nozzles

- VCU, pH probe pot, and sample point located at the base of the tower with the filtrate piped into the nearby sewer
- Endress Hauser dual-output pH and temperature probe

- Extractors installed into E1 and E2 tower *October* 2014

- E&I support available to set them up and complete associated piping work in *February* 2015

- Data available and on Honeywell graphics *March* 2015

- Trial work ongoing *April* 2015

Summary:

- No issues with installation or runnability.
- Extractor has not plugged since going on-line.
- Longer life out of pH probes as they are in a much gentler environment
- Trial work continuing

The slow march - How low can you go?

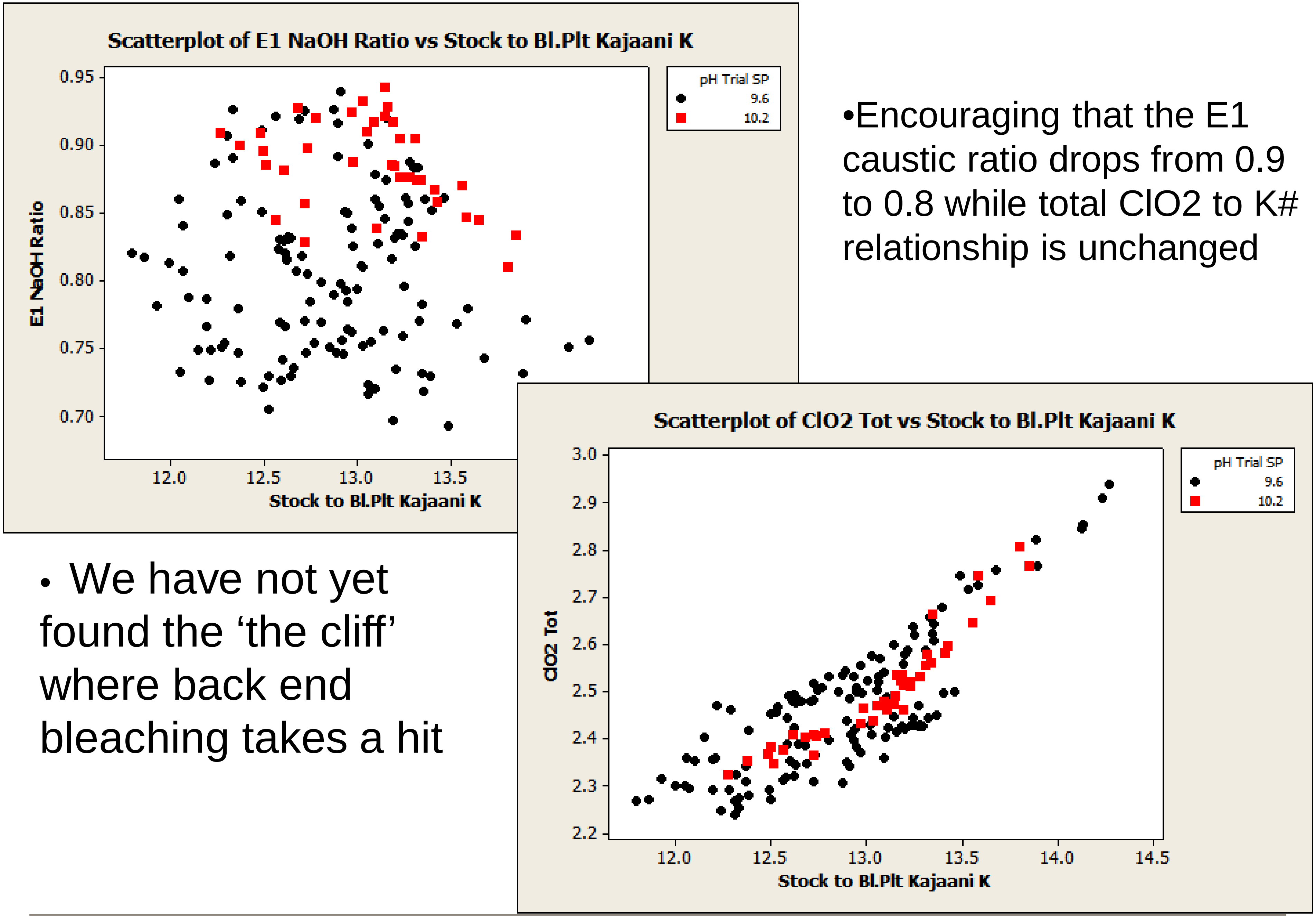
Start

- 10.0 Vat pH target (~10.5 tower)
- Lab Testing every 2hrs

- 10.0 Tower pH target
- Lab Testing every 2hrs

End?

- 9.6 ‘hot’ Tower (10pH @ 25C)
- Filtrate extractor



- Encouraging that the E1 caustic ratio drops from 0.9 to 0.8 while total ClO2 to K# relationship is unchanged

- We have not yet found the ‘the cliff’ where back end bleaching takes a hit

What Next?

- Complete the trial work – including a determination of how low we can go with the E1 and E2 tower pH before we see detrimental effects

- Determine which control method provides the most stable operation

- Compare the longevity of the pH probes in the sample pot to those in the upflow tubes? Are there other application points where we could use filtrate extractors?