

MUCH ADO ABOUT NEXT TO NOTHING

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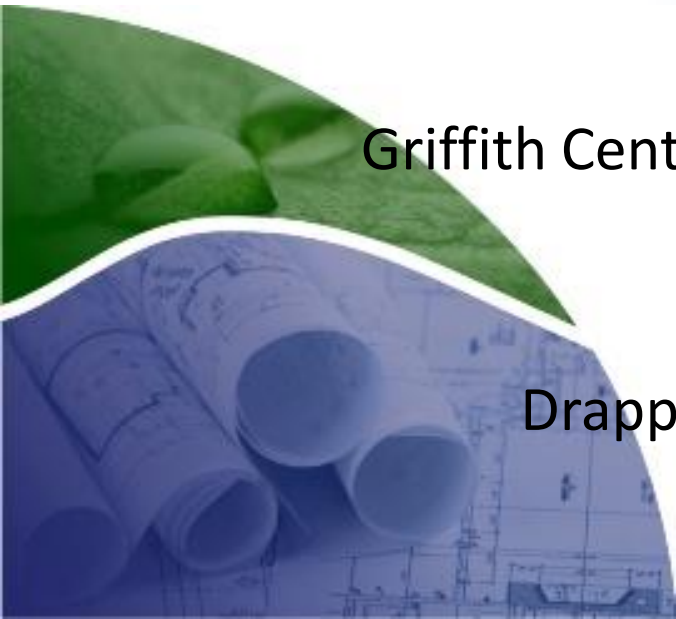
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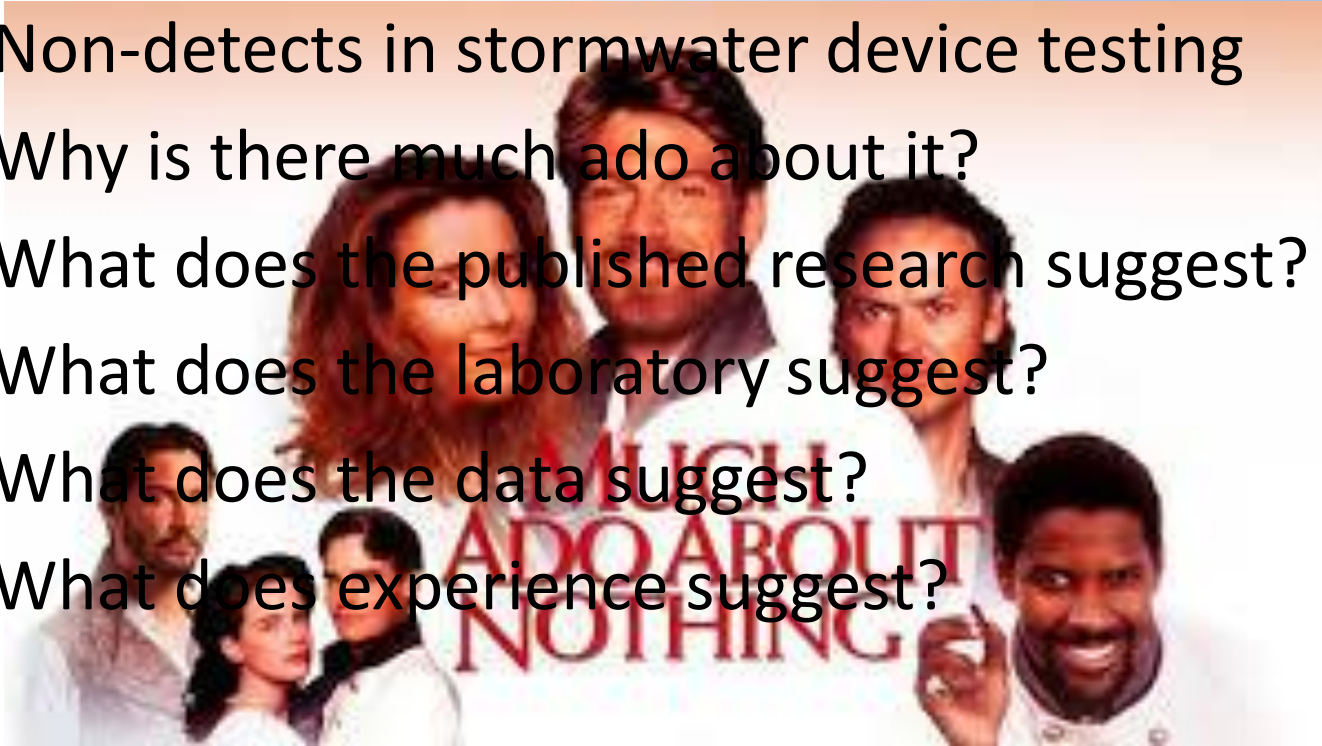
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Introduction

- Non-detects in stormwater device testing
- Why is there much ado about it?
- What does the published research suggest?
- What does the laboratory suggest?
- What does the data suggest?
- What does experience suggest?



Acknowledgements

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Some preliminary maths

$$\bar{x} = \frac{\sum_{i=1}^n x_i}{n} \quad (\text{Arithmetic mean})$$

$$g = \sqrt[n]{(x_1 \cdot x_2 \cdot x_3 \dots \dots x_n)}$$

(geometric mean)



Historical methods

- Using the LOD itself (for example, 5 mg/L);
- Replacing the non-detect result with 50% of the LOD;
- Replacement of the non-detect with $\text{LOD}/\sqrt{2}$ value (eg. 3.535 mg/L);
- Replacement of the <LOD result with 0 mg/L; and
- Replacement of the <LOD result with a Random number between LOD and zero.



Influence

Influent (mg/L)	Estimated Effluent, replacing <LOD value (mg/L)	Reduction (mg/L)	Percent reduction
10	5 (LOD)	5	50%
	2.5 (50%LOD)	7.5	75%
	3.5 (LOD/ $\sqrt{2}$)	6.5	65%
	0	10	100%



Influence – Real Data

- SEQ site
- Field testing over 5 years
- 22 protocol compliant events, 11 non-detects on outlet

TSS	LOD/2		LOD			LOD/ $\sqrt{2}$			Zero			
Average	24.77	5.70		24.77	6.95		24.77	6.22		24.77	4.45	
Geometric mean	19.66	4.50		19.66	6.36		19.66	5.35		19.66	-	
Average C R E	71%		62%			67%			80%			
Efficiency ratio (ER)	77%		72%			75%			82%			
Geometric ER	77%		68%			73%			-			



Results & Discussion

- Testing a theory – all data

Statistic	5 mg/L	1 mg/L	% difference
Nbr. of observations	343	343	
Minimum	5.000	1.000	
Maximum	211.000	200.000	
Range	206.000	199.000	
Median	20.000	15.000	33.3%
Arithmetic Mean	28.873	25.891	11.5%
Standard deviation (n-1)	29.466	28.870	
Lower bound on mean (90%)	26.028	23.300	
Upper bound on mean (90%)	31.719	28.481	
Geometric mean	20.030	16.301	22.9%

Results & Discussion

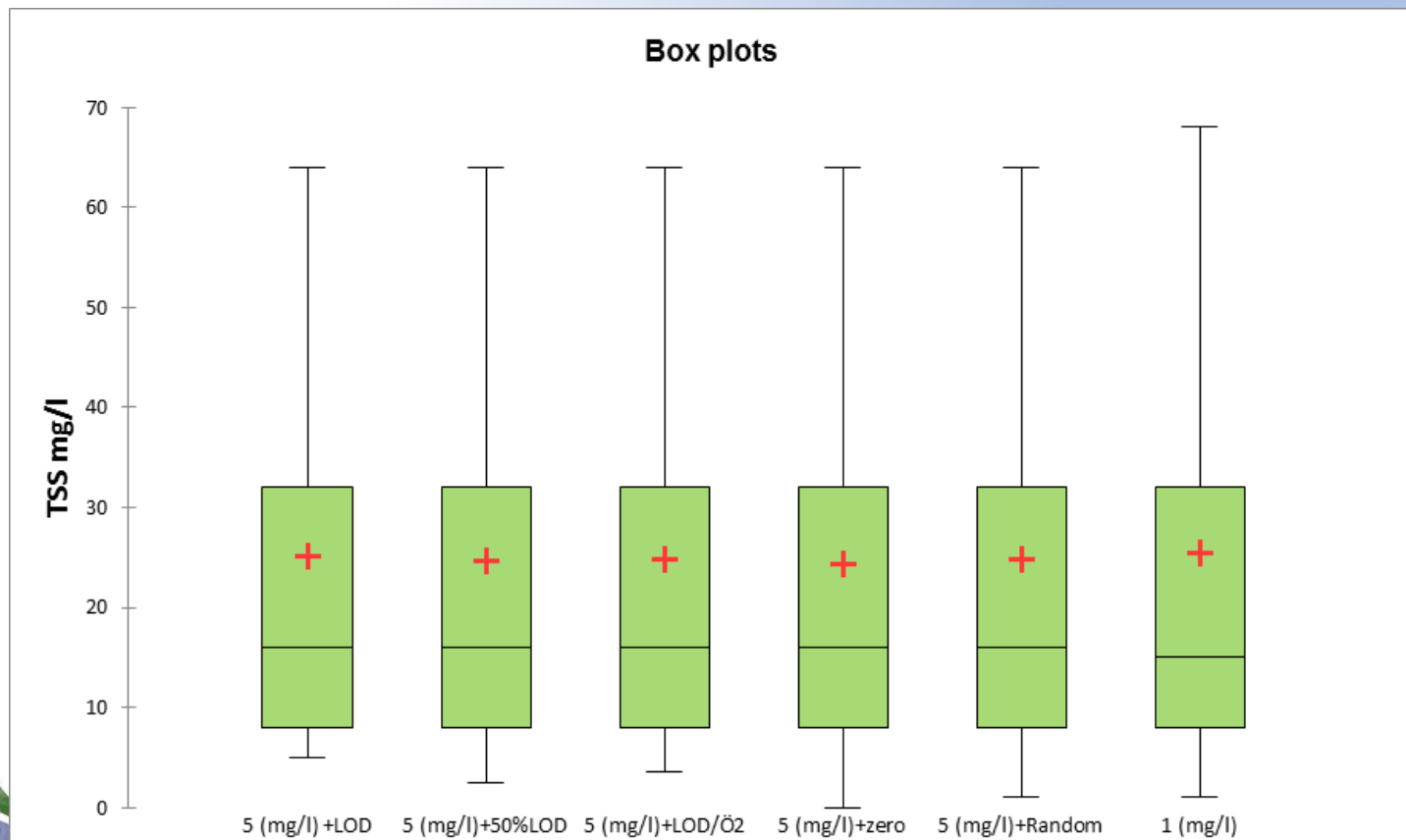
- Testing a theory – only <LOD results

Statistic	<LOD - 1mg/L
Number of observations	46
Minimum	1.0
Maximum	10.0
Range	9.0
Median	5.0
Arithmetic Mean	4.652
Standard deviation (n-1)	1.90
Lower bound on mean (90%)	4.182
Upper bound on mean (90%)	5.123
Geometric mean	4.246



Results & Discussion

- Testing a theory – only <LOD results

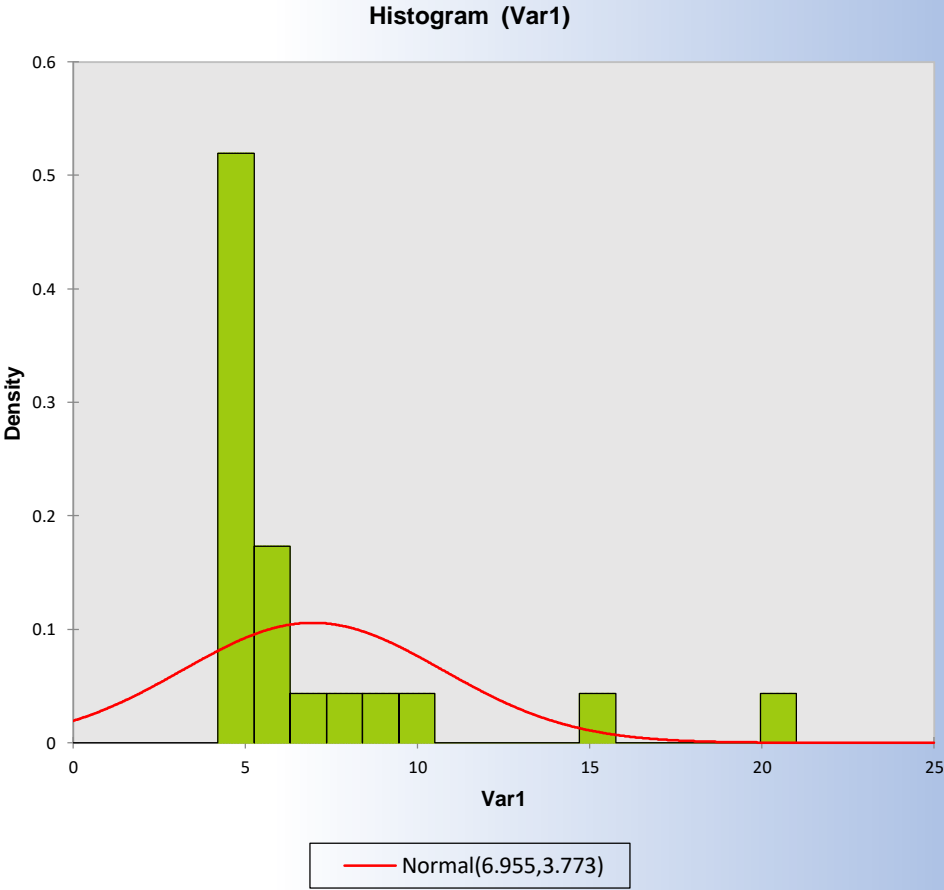


Results & Discussion

- Testing a theory – only <LOD results

Statistic	+LOD	+50%LOD	+LOD/ $\sqrt{2}$	+zero	+Random	1 mg/L
Nbr. of observations	343	343	343	343	343	343
Minimum	5.000	2.500	3.536	0.0	0.0	1.0
Maximum	211	211	211	211	211	200
Range	206.0	208.5	207.464	211	211	199
Median	16.0	16.0	16.0	16.0	16.0	15.0
Arithmetic Mean	25.624	25.284	25.425	24.944	25.320	25.891
Standard deviation (n-1)	28.582	28.840	28.731	29.121	28.821	28.870
Geometric Mean	16.583	15.090	15.819	-	15.054	16.302
Abs. % difference – Median ¹	6.7%	6.7%	6.7%	6.7%	6.7%	
Abs. % difference – Arithmetic Mean	1.0%	2.3%	1.8%	3.7%	2.1%	
Abs. % difference – Geometric Mean	1.7%	7.4%	3.0%	-	7.2%	

Results & Discussion



Results & Discussion

- Testing a theory – only <LOD results

Statistic	+LOD	+50%LOD	+LOD/ $\sqrt{2}$	+zero	+Random
p value	0.846	0.033	0.168	0.001	0.086
Significantly different	✘	✓	✘	✓	✓



Conclusion

- <LOD (non-detects) often observed in environmental data
- Comparison of non-detects from 5mg/L analysis against 1mg/L analysis
- On stormwater data;
 - Substitution with LOD or $\text{LOD}/\sqrt{2}$ statistically same
 - But laboratory advises that if result was at LOD, then would be reported as LOD (e.g. 5mg/L)
 - Therefore, recommend substitution with $\text{LOD}/\sqrt{2}$ for all non-detects in statistical evaluation.



Questions?

