



BARRIERS TO BEST PRACTICE: VARIABILITY IN MEASUREMENT IN GOLD PROCESSING PLANTS

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Peter Leckie Customer Solutions Lead - NaCN

Greg Zwolak Cyanide Leaching Specialist

OUR JOURNEY TO CONVERT INDUSTRY VISIBILITY TO BEST PRACTICE GUIDANCE

2014

- Started analysing Orica & industry data to define 'best practice in leaching' – Process Health Check conceptualised

2015

- PRO Service aims set: 'create tools to enable best practice leaching' - LeachIT software development commenced

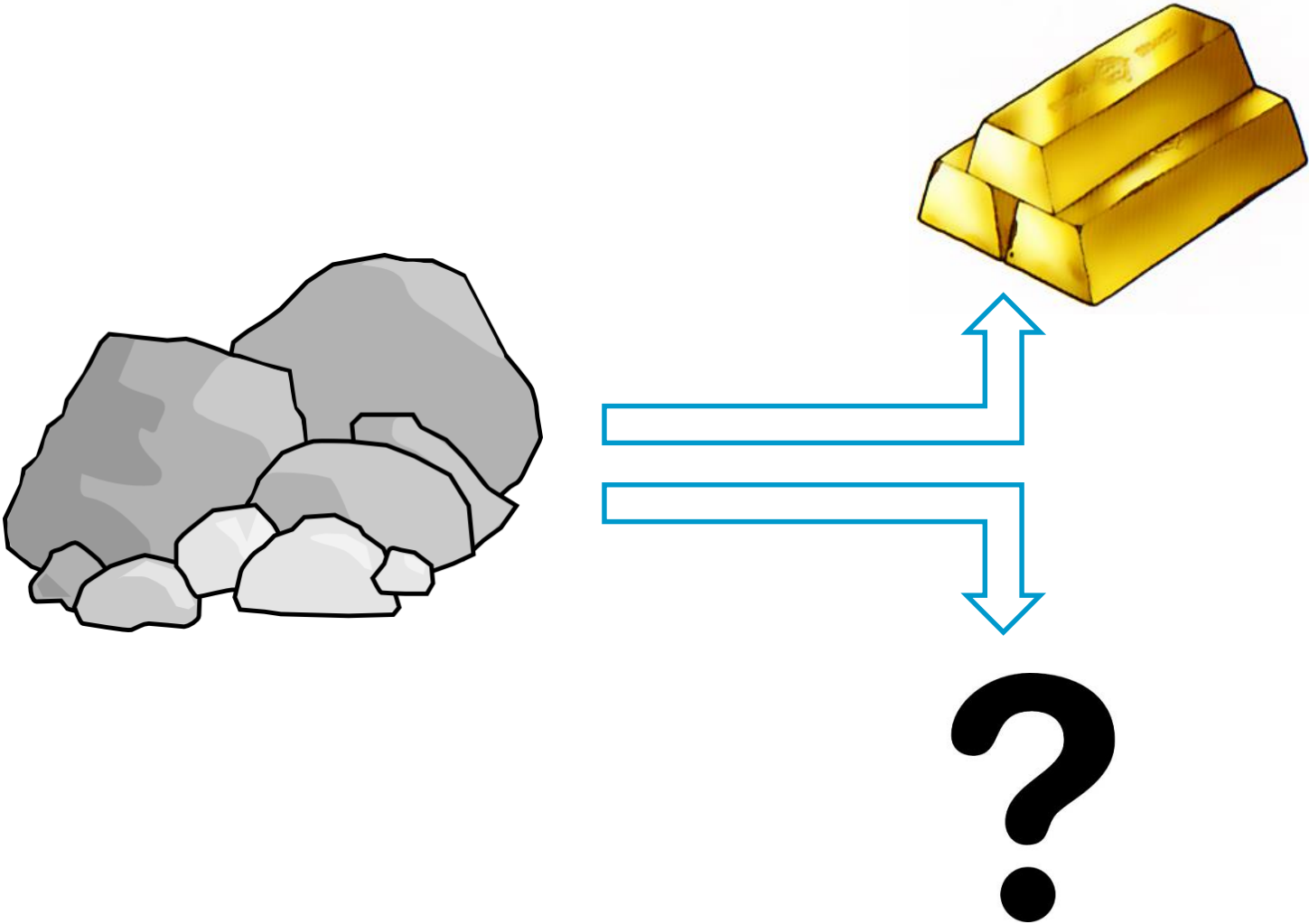
2016

- LeachIT previewed at ALTA: May 2016
- Process Health Check (Benchmark) program accelerated

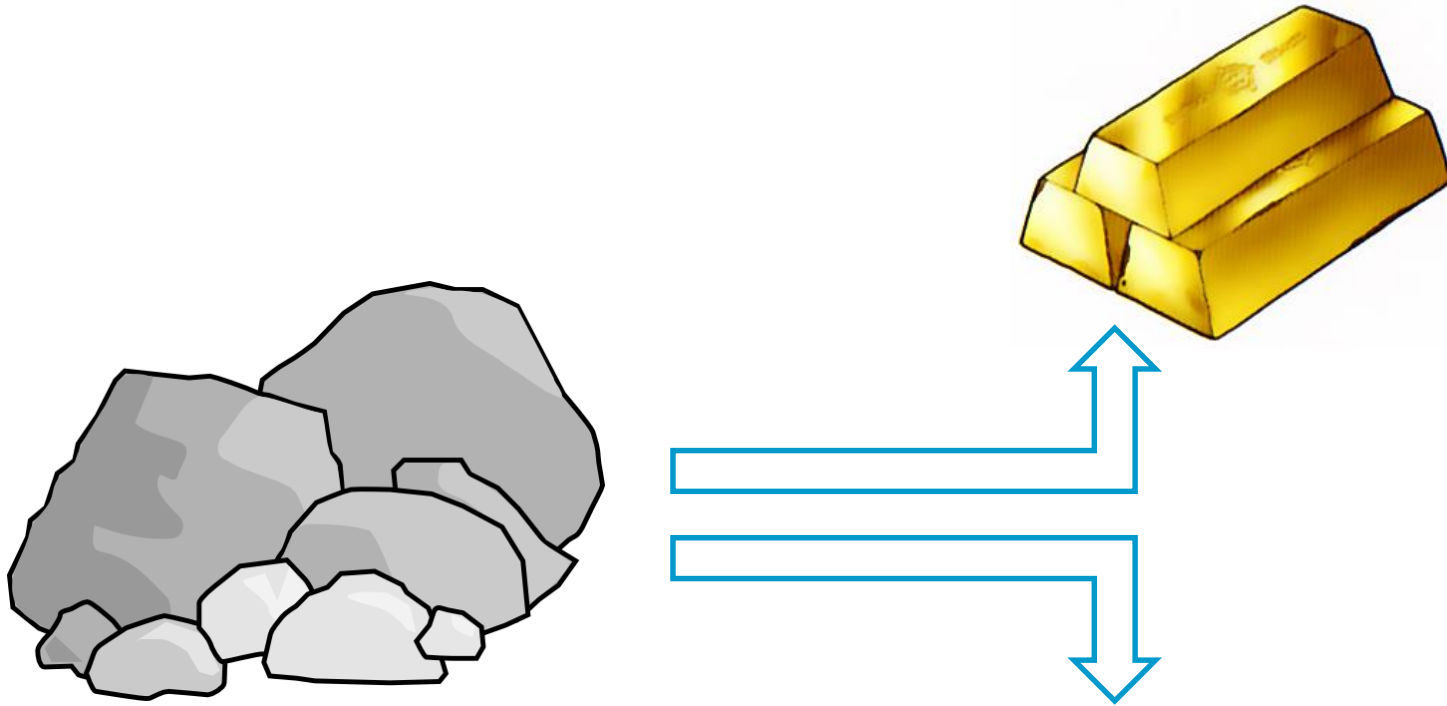
2017

- LeachIT application throughout Australia & Latam
- PRO Service 'v2' tools under development

THE 'BEST PRACTICE' OPPORTUNITY IS BIGGER THAN YOU THINK IT IS



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**\$US16 – 20B of gold
lost to tailings***

DATA COLLECTED SINCE 2014 APPEARS TO VALIDATE THIS HIGH LEVEL ESTIMATE

2014 Estimate

\$US16 – 20B of global tails losses.

Estimated \$2-5B is 'liberated'¹ and considered avoidable

Site Data Validation

Sample of >30 CIL/CIP sites:

Assuming 600 sites in globe:

\$12B global losses (exc. Heap Leach operations)

\$4B of liberated losses

OUR VIEW IS THAT VARIABLE MEASUREMENT IS A MEANINGFUL CONTRIBUTOR TO THESE LOSSES

All processes are different, but the ultimate aim is the same:
Maximise Economic Recovery

Most easy wins are taken but avoidable losses are still in the \$Billions

Comparative analysis can highlight 'hidden' areas of underperformance

Standardised methods enable comparison of more than recovery

VARIABLE METHODS CAUSE VARIABLE DECISIONS AND VARIABLE LOSSES



Common Measurement

Bottle Roll Test

Leach feed or tail?

Spot or composite?

With or without extra NaCN
or both?

LeachWell tablet or NaCN
solution?

2 – 24+ hours?



Variable methods

VARIABLE INTERPRETATION OF RESULTS ADDS COMPLEXITY, AND CAN ADD COST!

2 Tails Bottle Roll samples

One with residual cyanide, one with added cyanide

More gold dissolved in sample with added cyanide

What action is taken?

More cyanide added.

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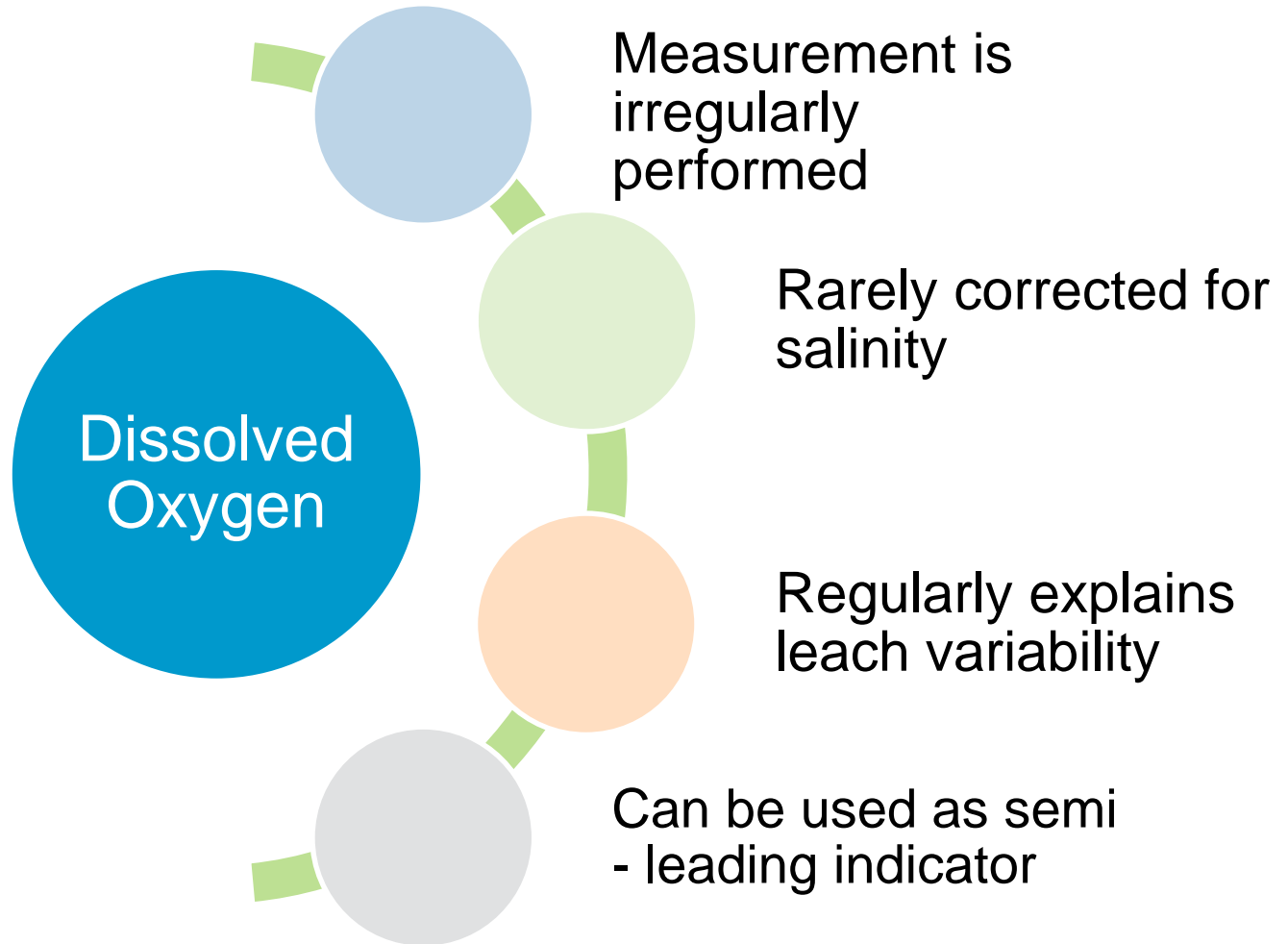
What action is taken?

More cyanide added.

What was required in this case?

More Oxygen

OXYGEN IS AS IMPORTANT AS CYANIDE BUT RARELY GIVEN THE SAME FOCUS



WHEN DAILY ROUTINES OBSCURE GOLD LOSSES: A REAL EXAMPLE



Operators prepare a shift composite sample

Sample tested for $[Au_{soln}]$, tracked and reported at daily meeting

Results ~0.02ppm



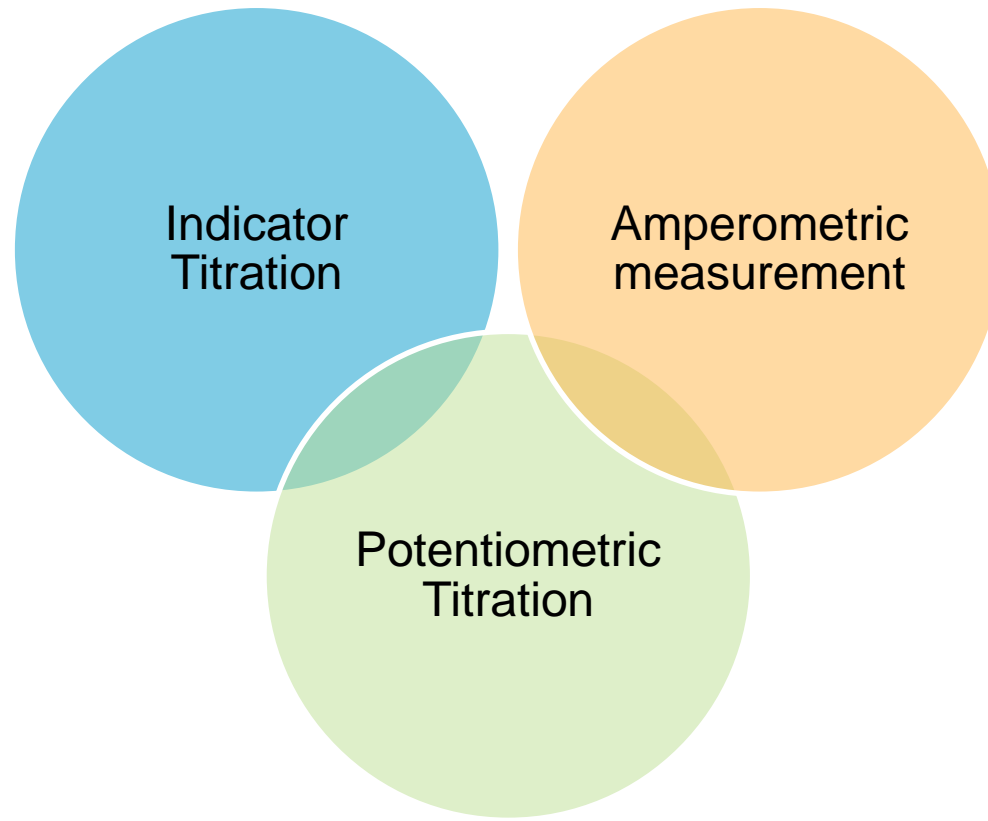
Lab takes a spot sample every shift

Tested for $[Au_{soln}]$ but infrequently compared to composites.

Results ~0.06ppm!

CYANIDE MEASUREMENT: KNOW YOUR METHOD

How you measure is less important than understanding how the measurement relates to how much cyanide is really driving your reaction: particularly in complex ores



CALCULATE CARBON ACTIVITY INCORRECTLY AND IT WILL COST GOLD

- Carbon activity as calculated assuming gold adsorption is a linear process vs pseudo first-order process

<u>Carbon activity results</u>	<u>Carbon activity as calculated on-site (%)</u>	<u>Carbon activity as calc. using first-order plot (% of fresh carbon)</u>
<u>Average</u>	<u>97.4</u>	<u>53.0</u>
<u>Minimum</u>	<u>80.7</u>	<u>23.8</u>
<u>Maximum</u>	<u>99.9</u>	<u>100</u>

- Although the method is consistent and comparable internally, scale of the problem is obscured

STANDARD DATA COLLECTION: A PROPOSAL

This table outlines the ideal set of measurements (and measurement frequency) for CIP/CIL process control and LeachIT: More measurements = better model accuracy

Test	I perform this test (Y/N)	Manual Tests, Frequency, Sample Type			
		Automated	Daily / per shift	Weekly	Monthly
Au Head Grade		Recommended	Composite	Spot	Spot
Sizing			P80, Composite	Full, composite	
Au in Tails (solid)		Recommended	Composite, spot	Spot	Spot
Au in Tails (solution)		Recommended	Composite, spot	Spot	Spot
Leach tail Bottle Roll ¹			Spot		
Free CN		At dose point(s) and tails	Spot at dose point(s)	Each tank, spot test	
pH		First tank	Spot in first tank	Spot test, each tank	
DO		At dose point(s)	Spot at dose point(s)	Spot test, each tank	
WAD CN		At tailings	Spot test		
Pulp Density		At cyclone overflow or	Hourly spot test		
Gold Accounting ²				Spot, each tank	
Carbon Activity ³				Spot	
Carbon Concentration		Using Carbon Scout or	2 hourly, each tank		
Diagnostic tails leach					Composite

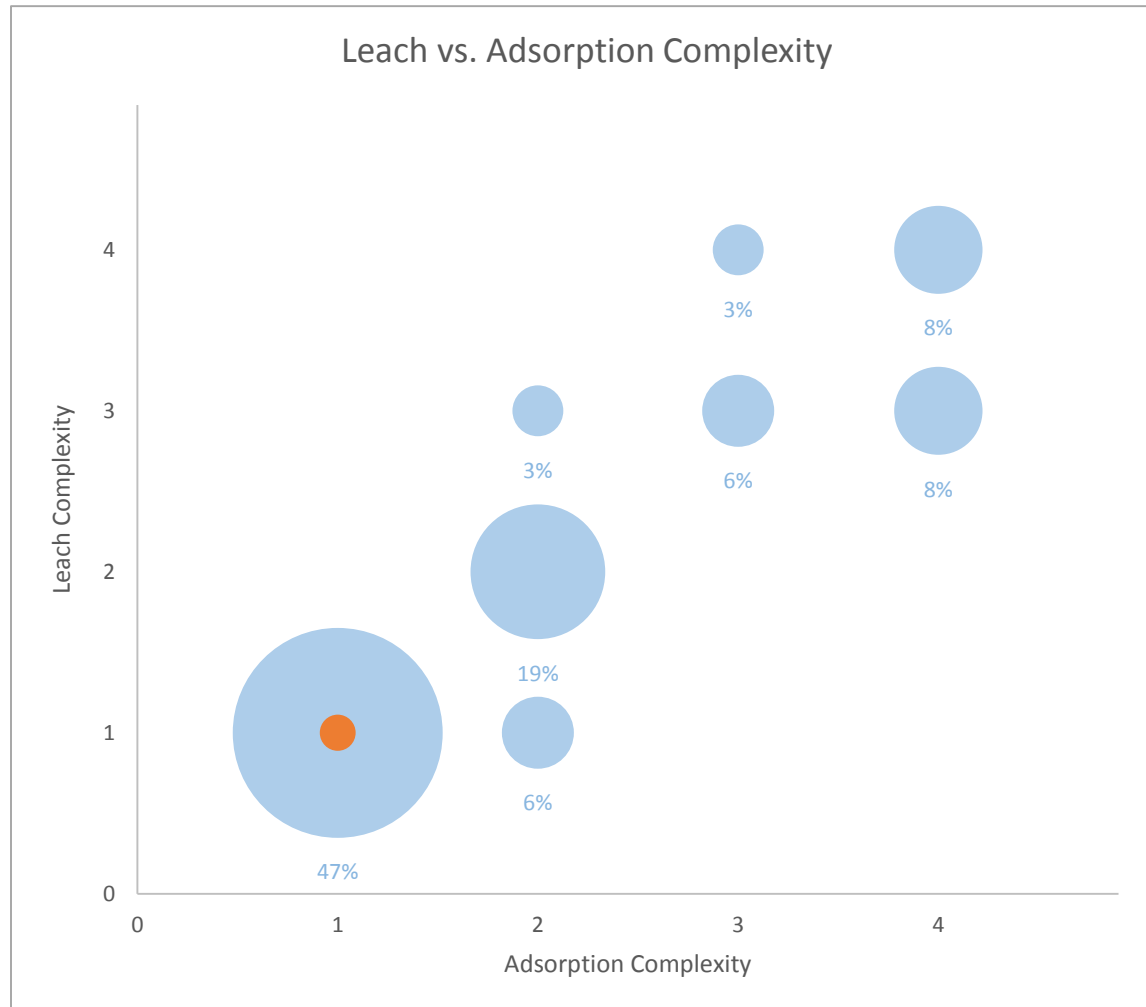
If you have Cu, or S, you should add them to the Head Grade, tailings, and accounting measurements, and also measure CN speciation at tails. Gold particle distribution tests are optional but can improve model performance

1: 24 hour test, no DO addition, one sample rolled as collected from process, one spiked to 500ppm CN. Solution assayed then solid grade back calculated

2: Au on solids, in solution, on carbon

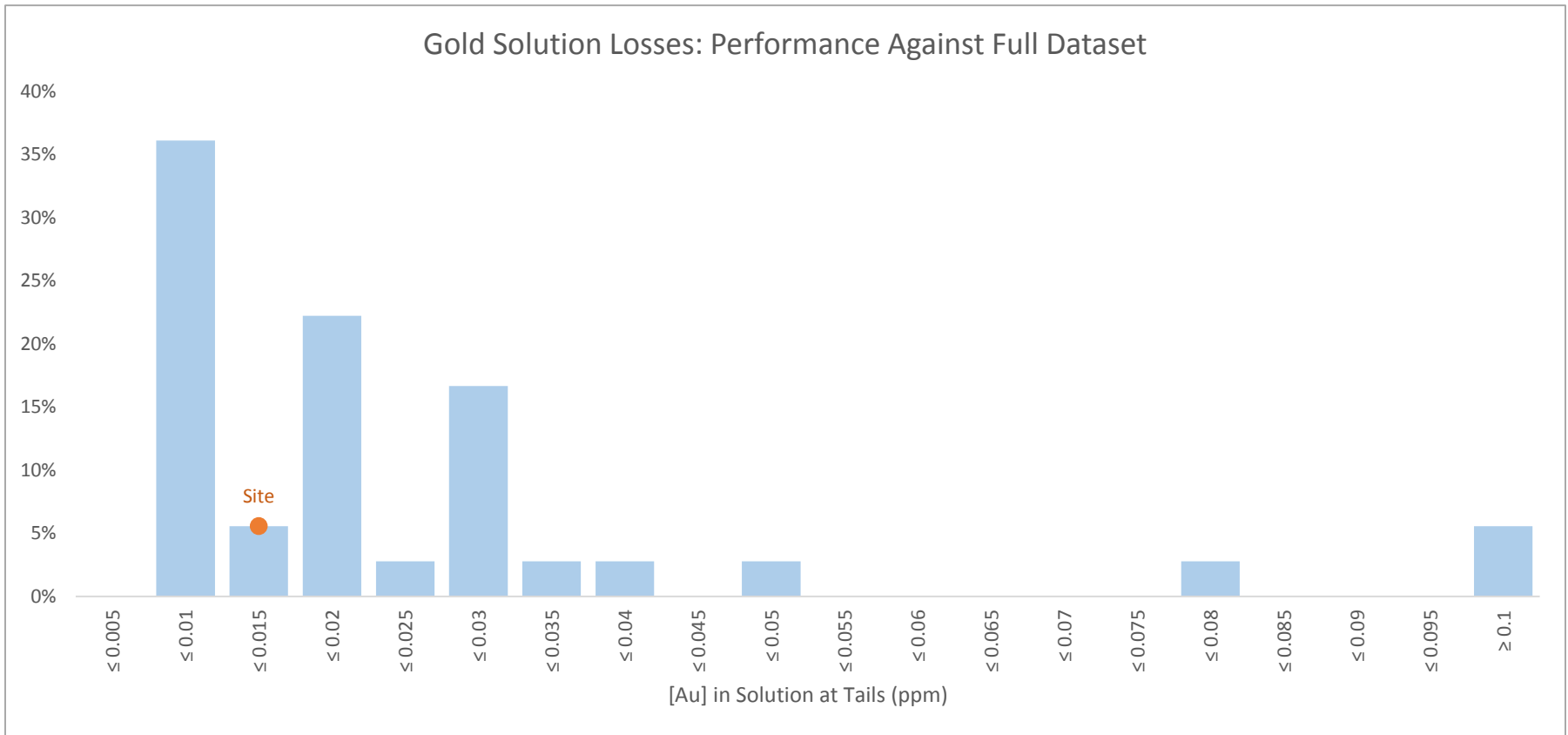
3: Loaded, acid washed, eluted, barren, regenerated: activity rate (**not % adsorbed**) expressed as a % of fresh

COMPARATIVE PERFORMANCE DATABASE



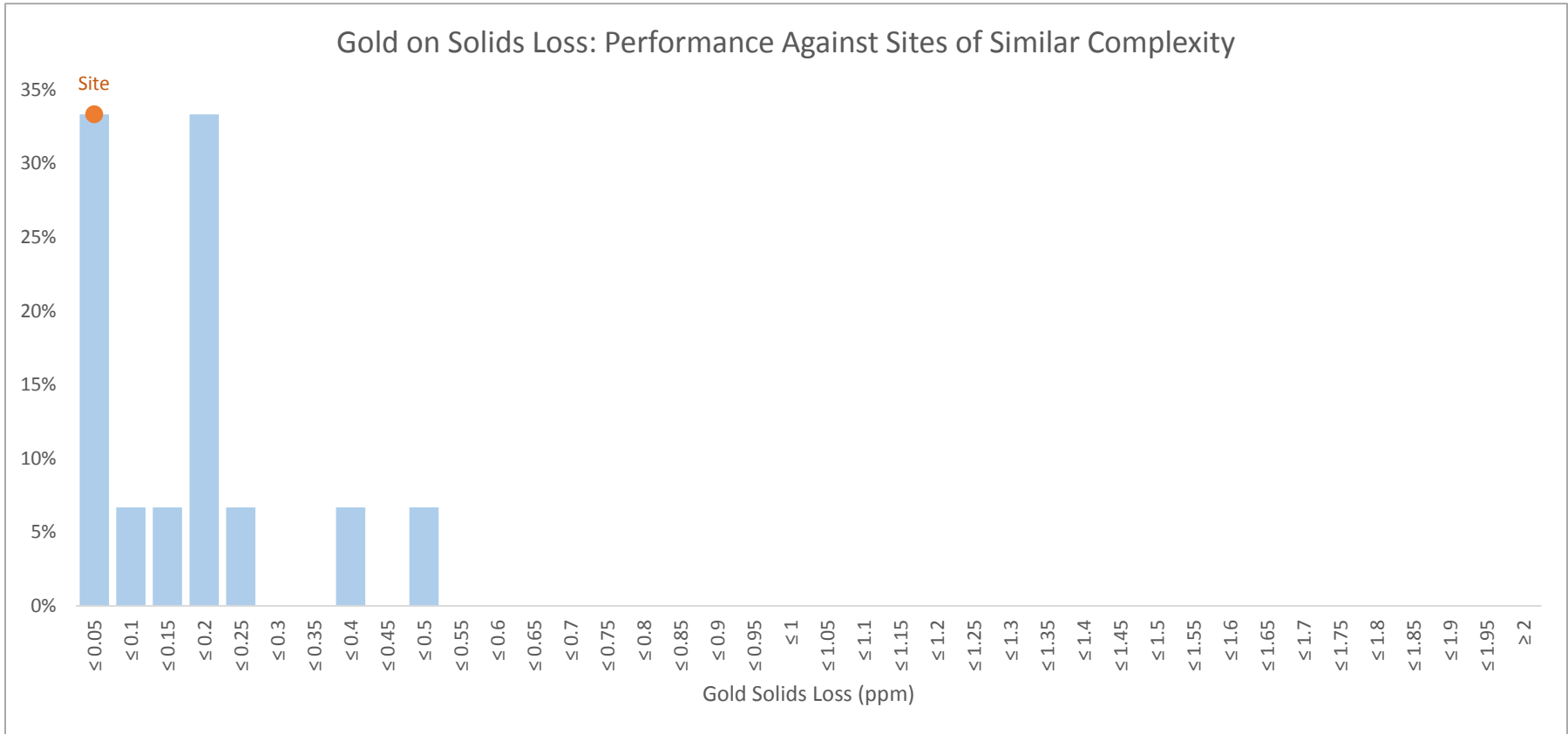
COMPARATIVE PERFORMANCE DATABASE

Gold Solution Losses: Performance Against Full Dataset



COMPARATIVE PERFORMANCE DATABASE

Gold on Solids Loss: Performance Against Sites of Similar Complexity





THANK YOU!