Lithium Analysis White Paper

The 2S Water LiValid sensor is an accurate and effective tool for real-time lithium detection in brines and aqueous solutions. Using our patented testing method, lithium can be identified and quantified down to 1 PPM in brine and as high as 10,000 ppm. Depending on application, additional metals can also be detected and quantified.

The system is still in pilot testing, however, extensive testing on both North American and South American brines to validate the technology have been completed to date. Specific data regarding the location and sources of these brines is proprietary. General information on efficacy is shared here.

Fully Automated Results

The unit is capable of handling direct brine input. Many real world samples have also been tested allowing for quantitative comparison data.

The current dilution system is able to dilute even the strongest samples, containing 200,000 PPM sodium, to a quantifiable state. This allowed us to begin testing around continuous running of concentrated samples. **Figure 1** shows the Li signal from an extended trial of a brine sample. The analytical statistics of this test are shown in **Table 1**. With a relative standard deviation of 1.90% and 1.22%, we can conclude that the error on all future measurements will be +/- 4.68%.

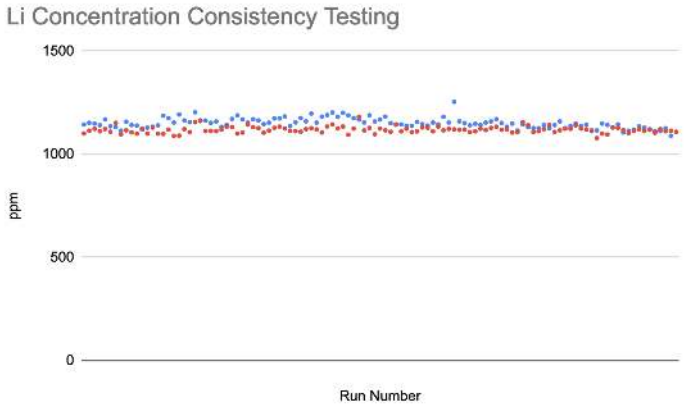

Figure 1: Li signal from South American Brine sample run over two days. The blue data corresponds to Day 1 and the red data corresponds to Day 2

Date	Average Concentration (ppm)	%RSD
Day 1	1145	1.90
Day 2	1119	1.22

Table 1: Analytical statistics for the extended trial.

2S Water Inc.
www.2SWater.com
#102, 17510-102 Ave, Edmonton, Alberta
1-780-483-3459
asargeaunt@2swater.com

The real world sampling that has been conducted has involved a variety of brines from around the world. A few studies and the analytical performance of each are provided in **Table 2**.

Element	LiValid (ppm)	Third Party (ppm)	%Recovery
Ca	3948	3553.39	111.1%
Li	333	339.59	98.1%
Mg	<LOD	3.39	N/A
Na	7025	7200.71	97.6%

Table 2a: Analytical performance of Lithium Brine sample.

The system is also capable of multielement analysis in other brines. A potash brine is here analyzed.

Element	LiValid (g/L)	Third Party Analysis (g/L)	%Recovery
$CaCl_2$	3.187	3.97	80.3%
$MgCl_2$	8.536	8.88	96.1%
NaCl	223.96	219.54	102.0%
KCl	193.04	178.05	108.4%

Table 2b: Analytical performance of Potash brine sample.

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Manual Dilution

Before the unit was fully automated, a great deal of testing was completed based on manual dilution. Each test performed was a separate manual dilution, outside of the system. This increases the error in testing, however still provides accurate readings based on the sensor technology.

Synthetic Brine Analysis Summary:

An analysis of the system was performed by an independent laboratory at the University of Alberta. Three synthetic samples were prepared and tested. Two samples were high TDS, with levels of dissolved solids at 150,000 ppm (sample 1) and 200,000 ppm (sample 3). The samples were hand diluted at 10,000 to 1, and then tested multiple times each.

Analysis of the 3 different synthetic brines was performed and validated against ICP-MS measurements. LiValid shows from 11% higher than the validate to 16% lower than the validation with an average of 0.5% lower than the validation value.

North American Brine Analysis Summary:

North American real-world samples from two sites have been tested, with concentrations around 70 ppm and 215 ppm, respectively.

Real world brines have a more complex matrix than synthetic brines. The North American Brines from two sites were tested and compared to the ICP-MS validation. LiValid shows from 7% high to 8% lower than validation with an average of 0.3% low.

South American Brine Analysis Summary:

Samples from 8 different South American sources have been tested with the LiValid system.

South American Brines from two sites were tested and compares to ICP-MS validation. LiValid shows from 8% high to 10% lower than the validation, with an average of 1.3% low.

Conclusion:

Based on the testing done to validate the LiValid system we have an average error of less than 1% with an error bar of approximately +/- 10% when using manual dilutions.

All of these tests were run using manual dilution. An automated dilution system is currently in testing and expected to reduce the error range found with manual dilution.

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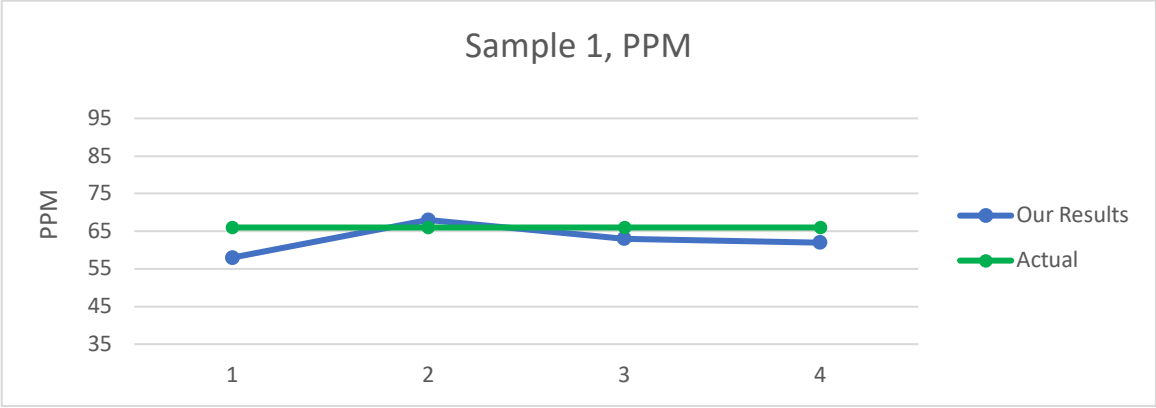
Synthetic Brine Analysis Details:

The following charts and graphs show specific data variance from synthetic sample tests, where amounts were known by the sample preparer. 2S Water tested the samples blind. Multiple test-runs through the sensor system were performed to validate variance across time. Please note these samples were analyzed before automated dilution was implemented, allowing for a slightly higher error range.

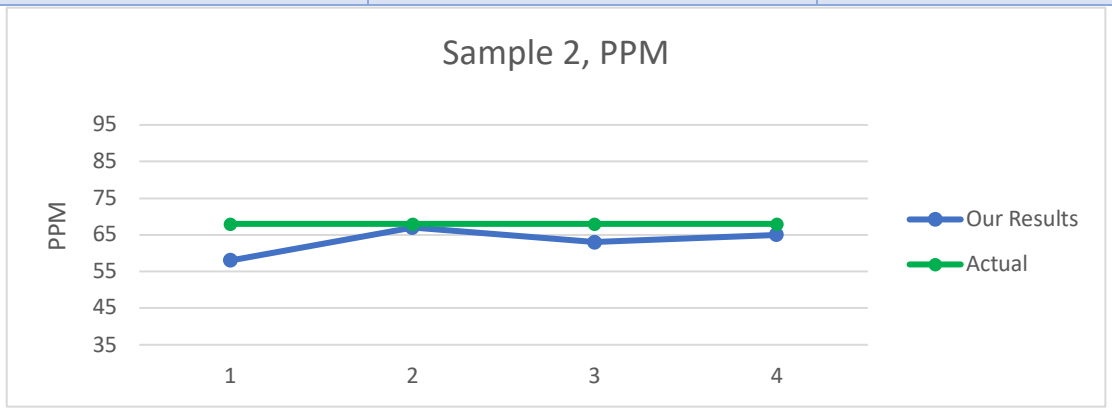
Synthetic Sample 1, 66 PPM Actual

Sample 1 Test Results – 66 PPM Actual		
Test #	2S Water Reading (PPM)	Variance (%)
1	58	-12%
2	68	3%
3	63	-5%
4	62	-6%



Synthetic Sample 2, 68 PPM Actual

Sample 2 Test Results – 68 PPM Actual		
Test #	2S Water Reading (PPM)	Variance (%)
1	58	-16%
2	67	-3%
3	63	-9%
4	65	-6%



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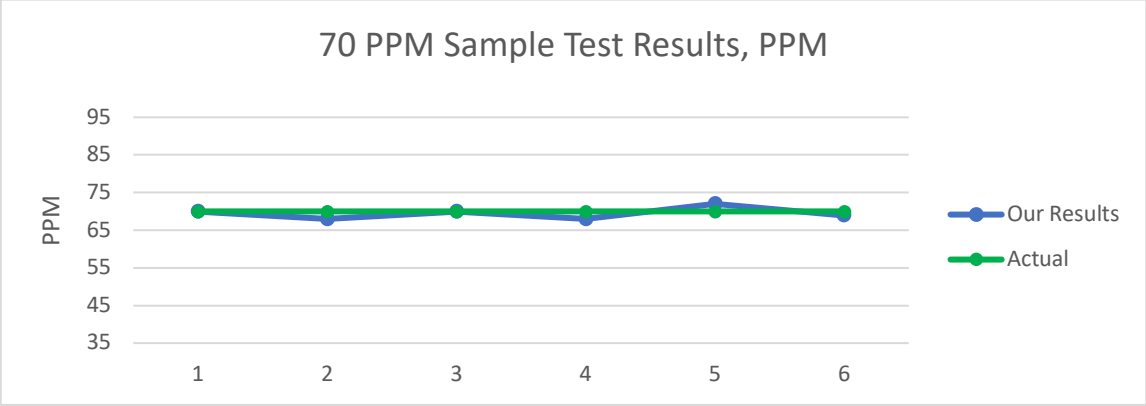
North American Brine Analysis Details:

The following charts and graphs show specific data variance from actual sample tests. Multiple test runs through the sensor system were performed to validate variance across time.

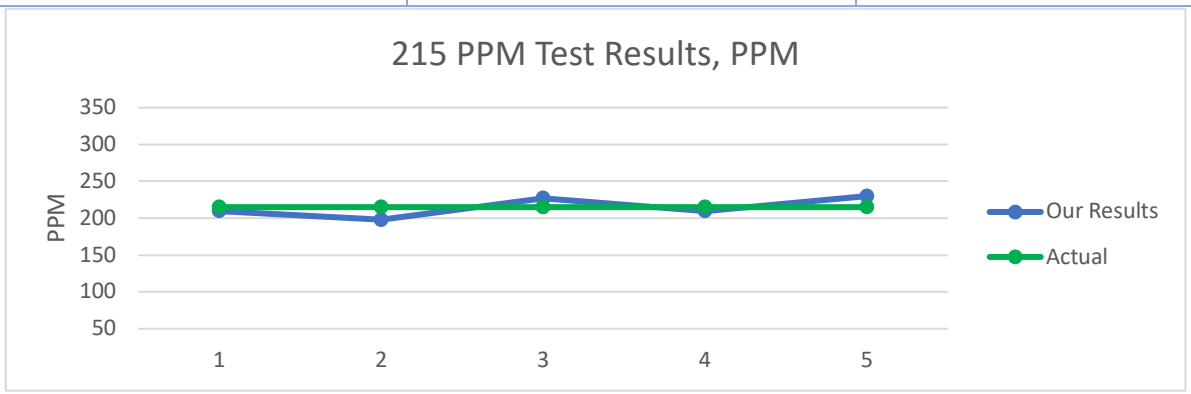
Sample 1, 70 PPM Lithium Concentration.

70 PPM Actual Sample Testing		
Test Run #	2S Water Reading (PPM)	Variance (%)
1	70	0%
2	68	-3%
3	70	0%
4	68	-3%
5	72	3%
6	69	-1%



Sample 2, 215 PPM Lithium Concentration.

215 PPM Actual		
Sample #	2S Water Reading (PPM)	Variance (%)
1	210	-2%
2	198	-8%
3	227	6%
4	210	-2%
5	230	7%



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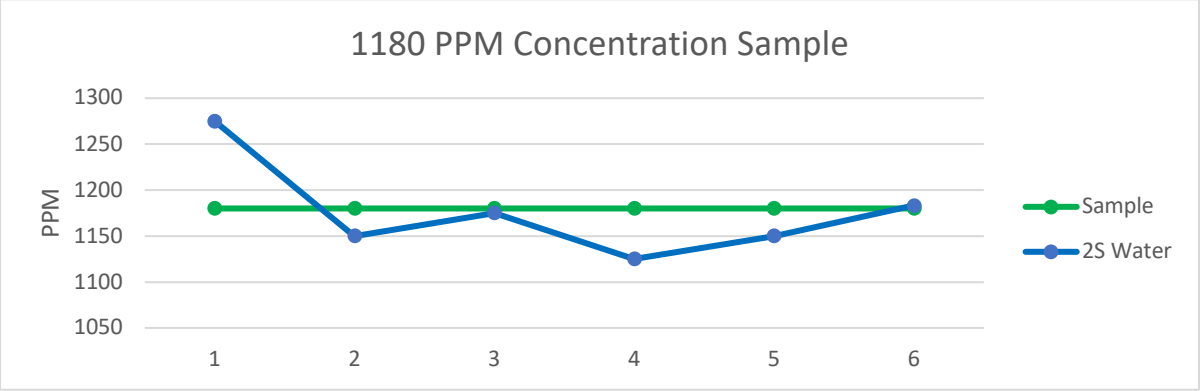
South American Brine Analysis Details:

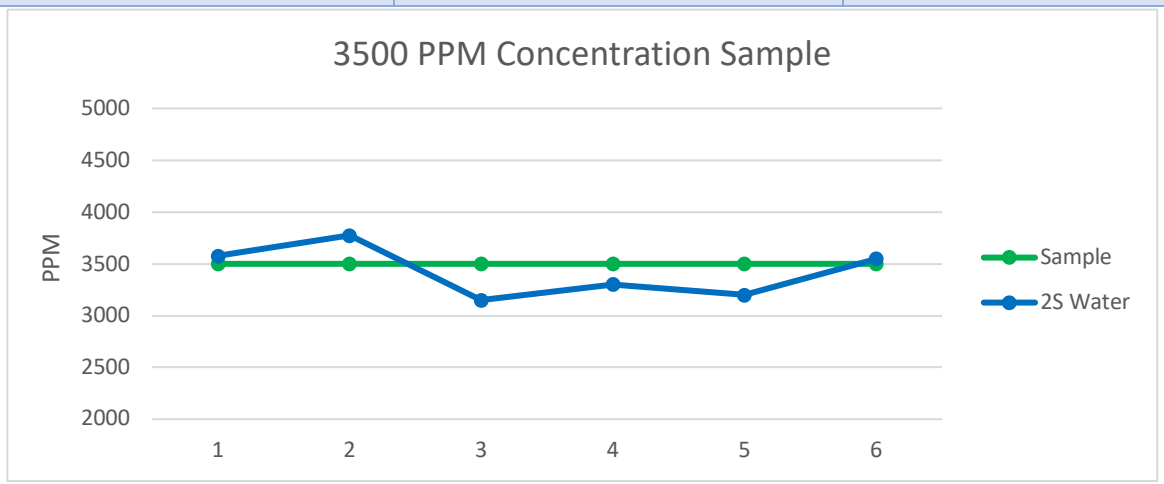
Sample 1, 1180 PPM Lithium Concentration.

1180 PPM Actual		
Sample #	2S Water Reading (PPM)	Variance (%)
1	1275	8%
2	1150	-3%
3	1175	0%
4	1125	-5%
5	1150	-3%
6	1183	0%



Sample 2, 3500 PPM Lithium Concentration.

3500 PPM Actual		
Sample #	2S Water Reading (PPM)	Variance (%)
1	3575	2%
2	3775	8%
3	3000	-10%
4	3300	-6%
5	3150	-9%
6	3550	1%



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