

Coal-Fired Power Plant Configuration and Operation Impact On Plant Effluent Contaminants Conditions

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Objective

Characterize coal contaminants in coal-fired power plant wastewater based on:

Coal Types

- Bituminous
- Sub-Bituminous
- Lignite

Plant Operational Profile

- Baseload
- Cycling

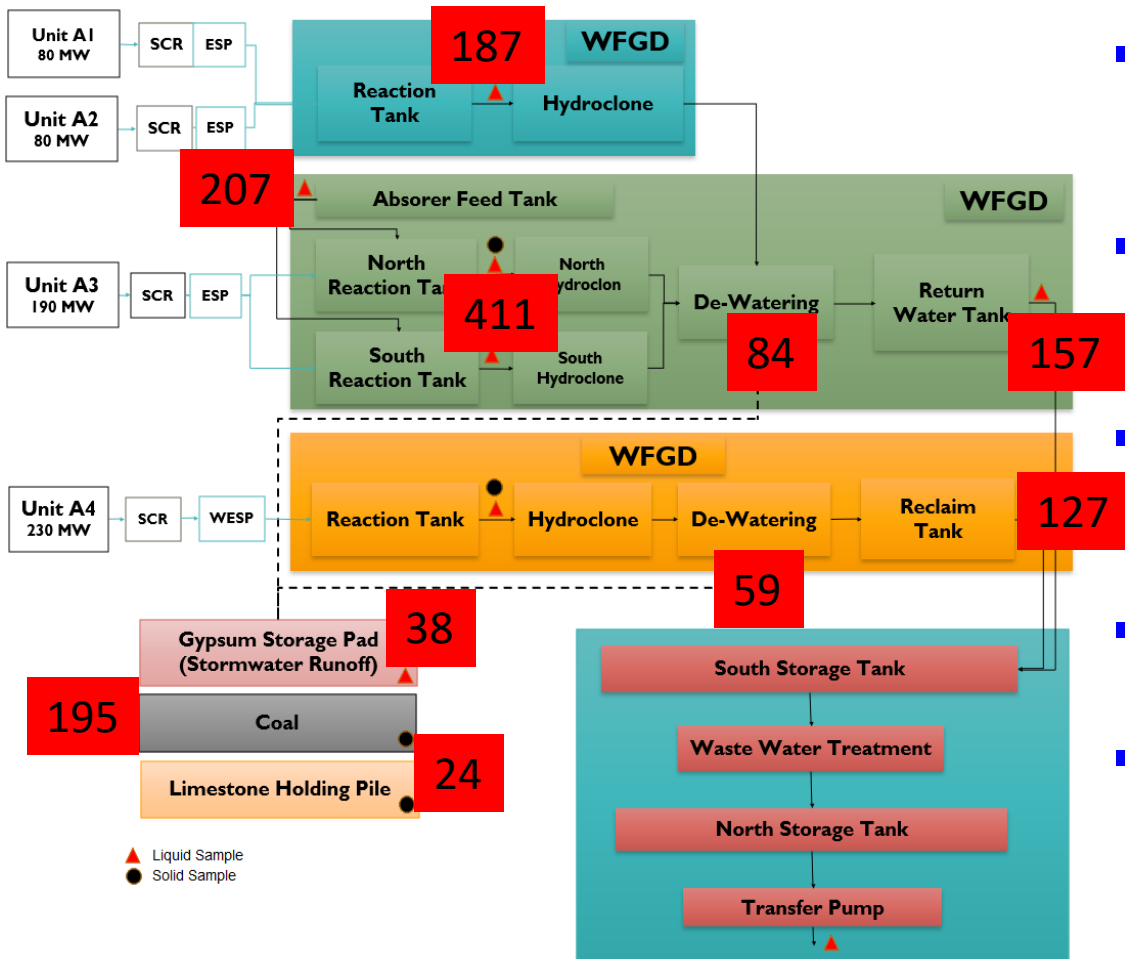
Wastewater Treatment Technology

- Chemical Precipitation
- Biological

Effluent Species

- Mercury
- Arsenic
- Selenium
- Nitrate/Nitrite
- Bromide

Power Plant A Configuration and Sampling Details

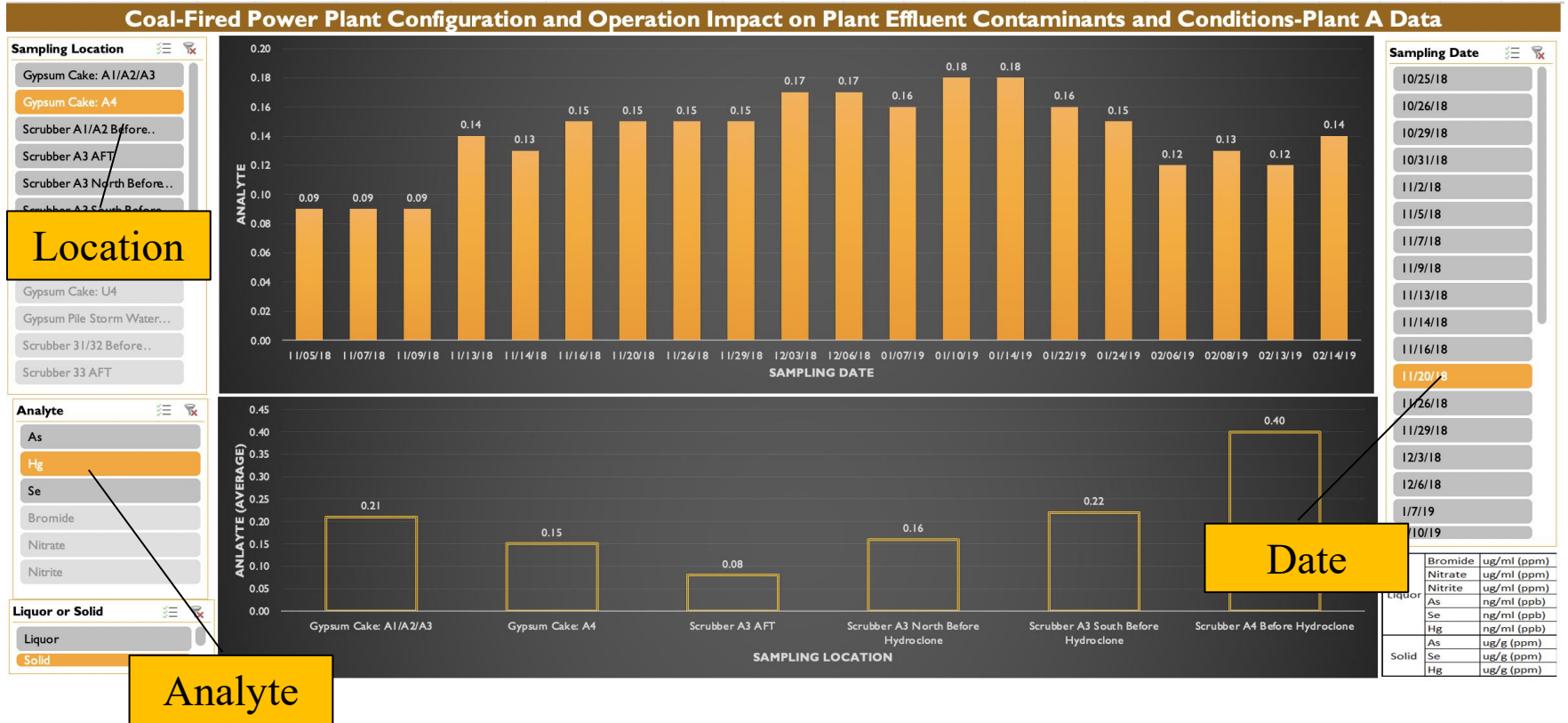


- Sampling Duration: 10/2018 – 02/2019
- 753 Samples Collected (liquid and solid)
- Solid samples: Coal, limestone, gypsum
- 1835 analysis results
- Analyte include: Mercury, Arsenic, Selenium, Bromide, Nitrate, Nitrite, Coal Proximate Analysis and Ultimate Analysis.

- Sub-bituminous coal
- Physical/chemical treatment of wastewater

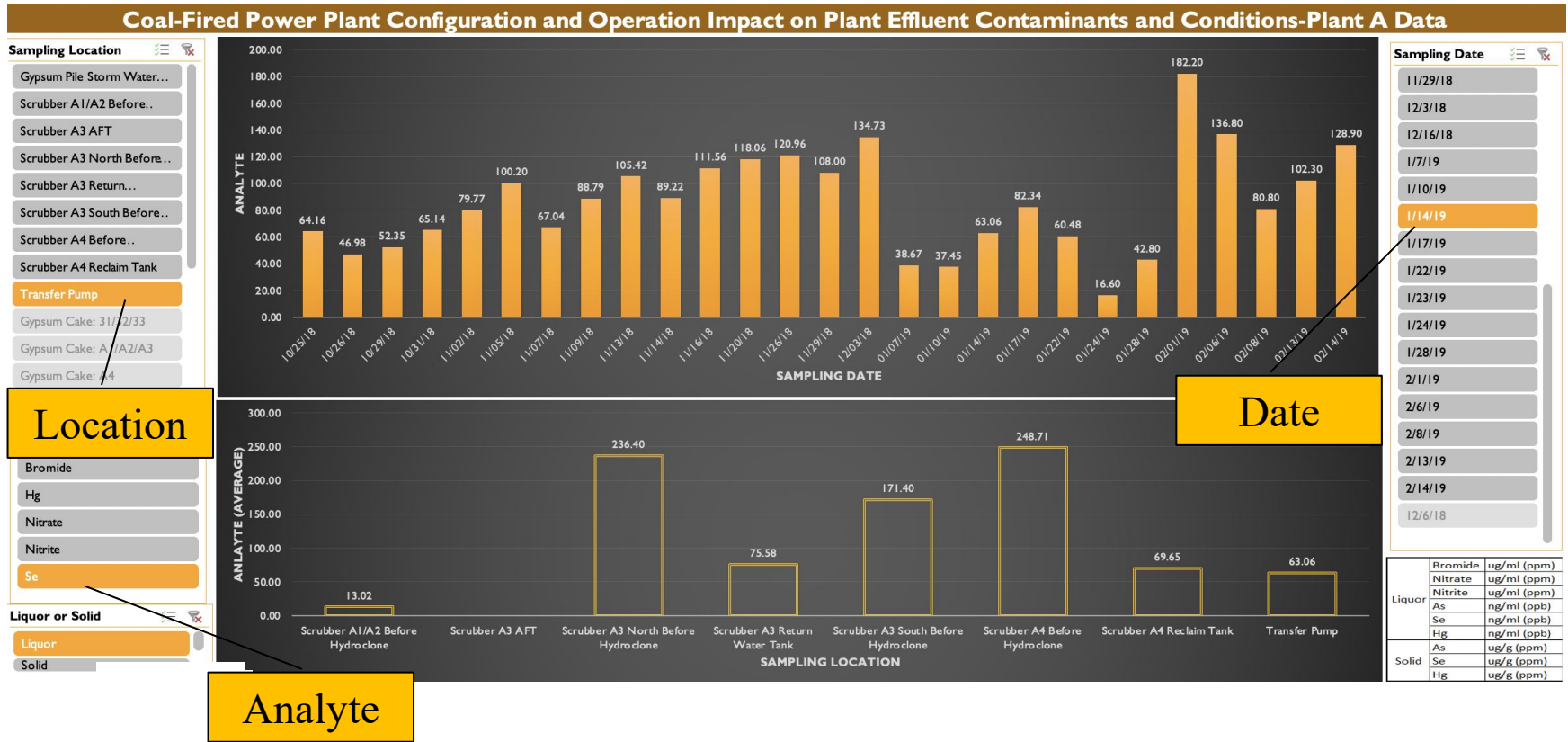
Plant A Database Main Dashboard

Showing Hg in Solids at Unit A4 Gypsum

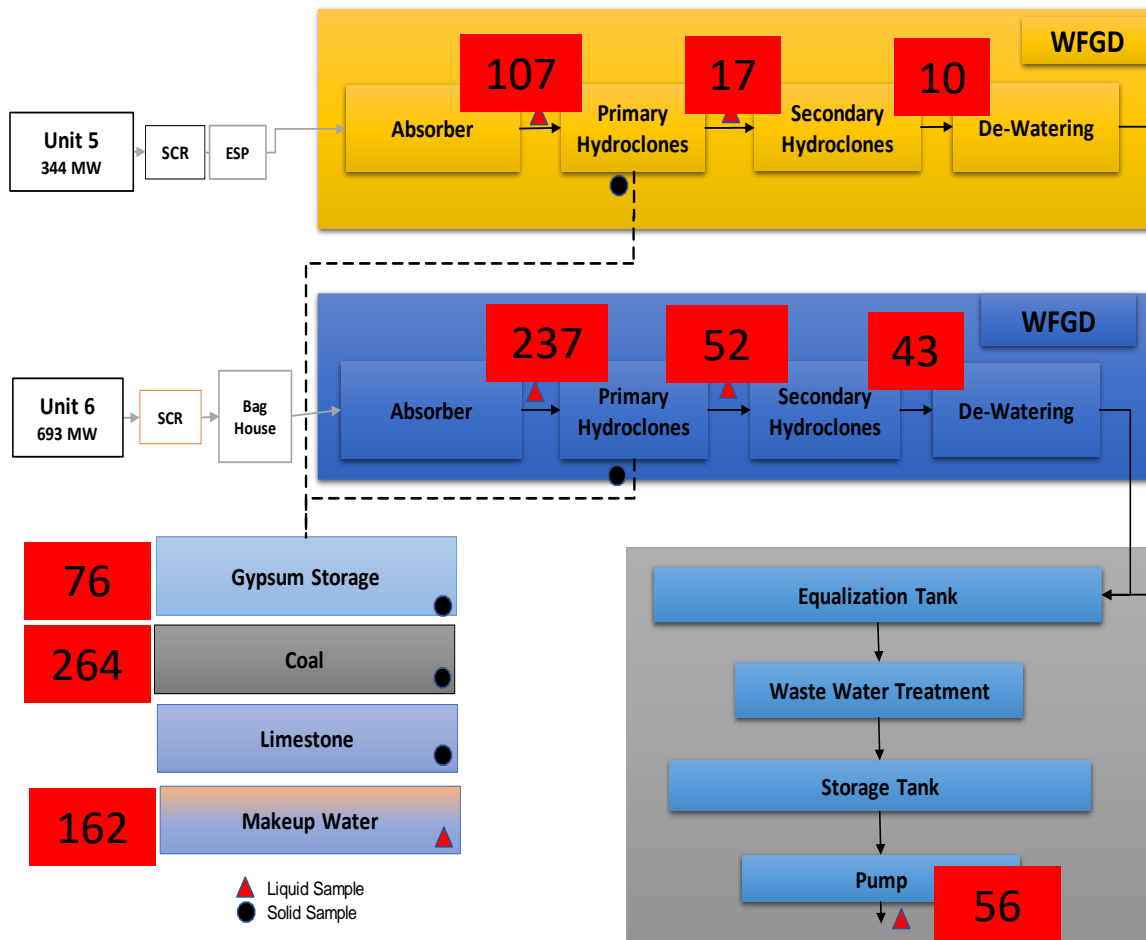


Plant A Database Main Dashboard

Showing Se in Liquor at Transfer Pump



Power Plant B Configuration and Sampling Details

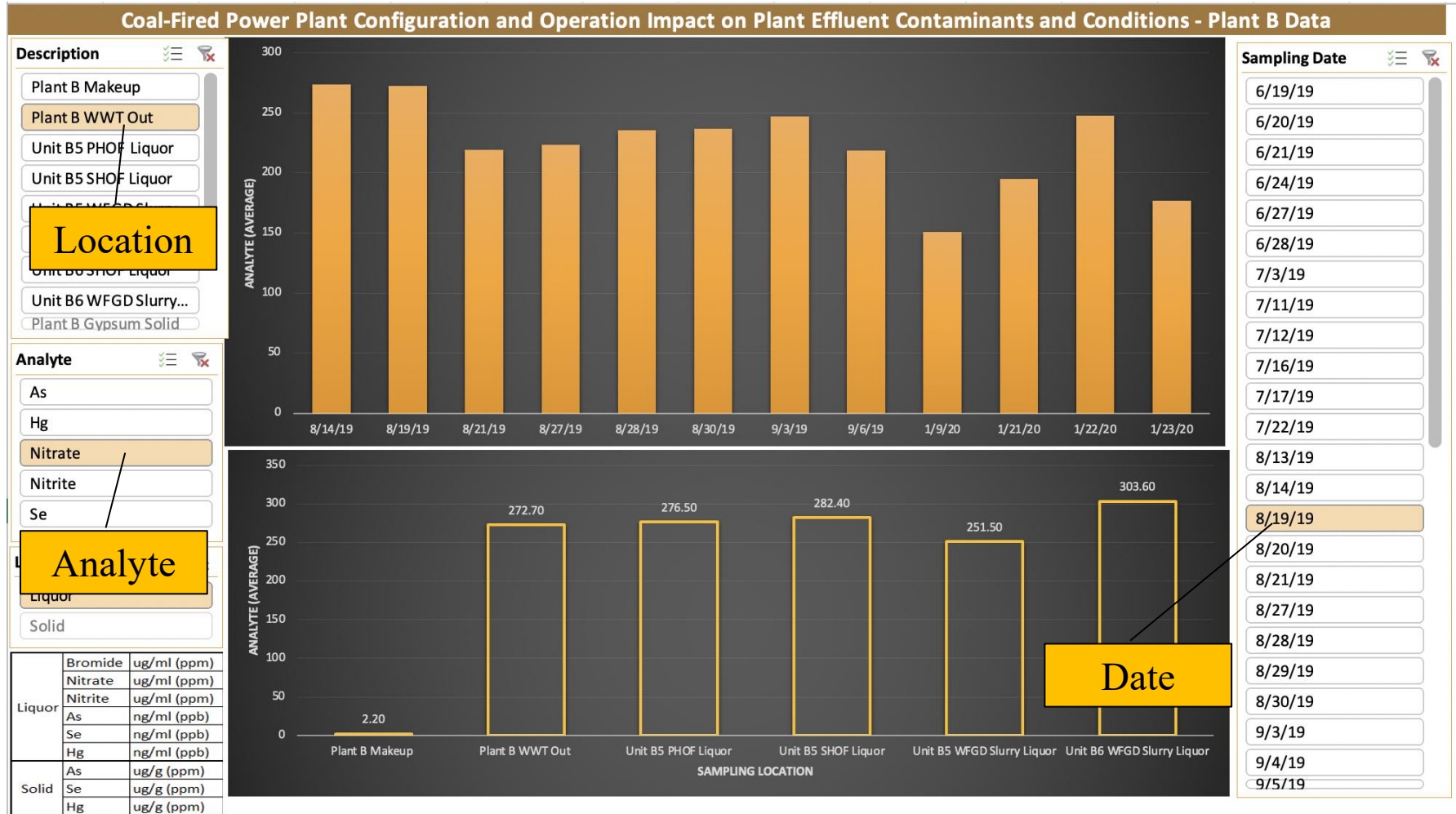


- Sampling duration: 06/2019 - 02/2020
- 452 samples collected (liquid and solid)
- Solid samples: coal, limestone, gypsum
- 1024 analysis results
- Analyte include: Mercury, Arsenic, Selenium, Nitrate, Nitrite, Coal Proximate Analysis and Ultimate Analysis

- Bituminous Coal
- Physical/chemical treatment of wastewater

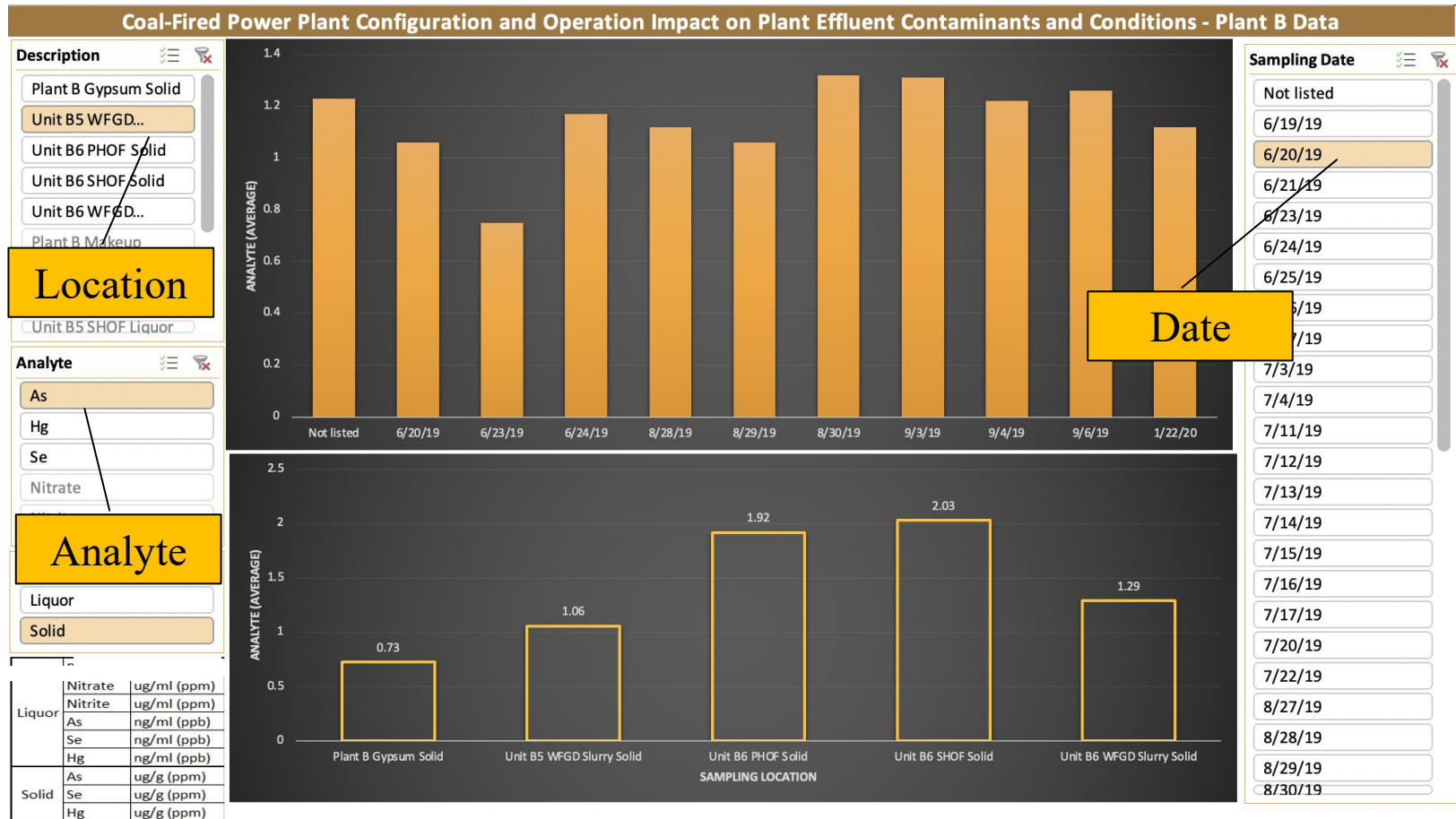
Plant B Database Main Dashboard

Showing Nitrate in Liquor at WWT Out

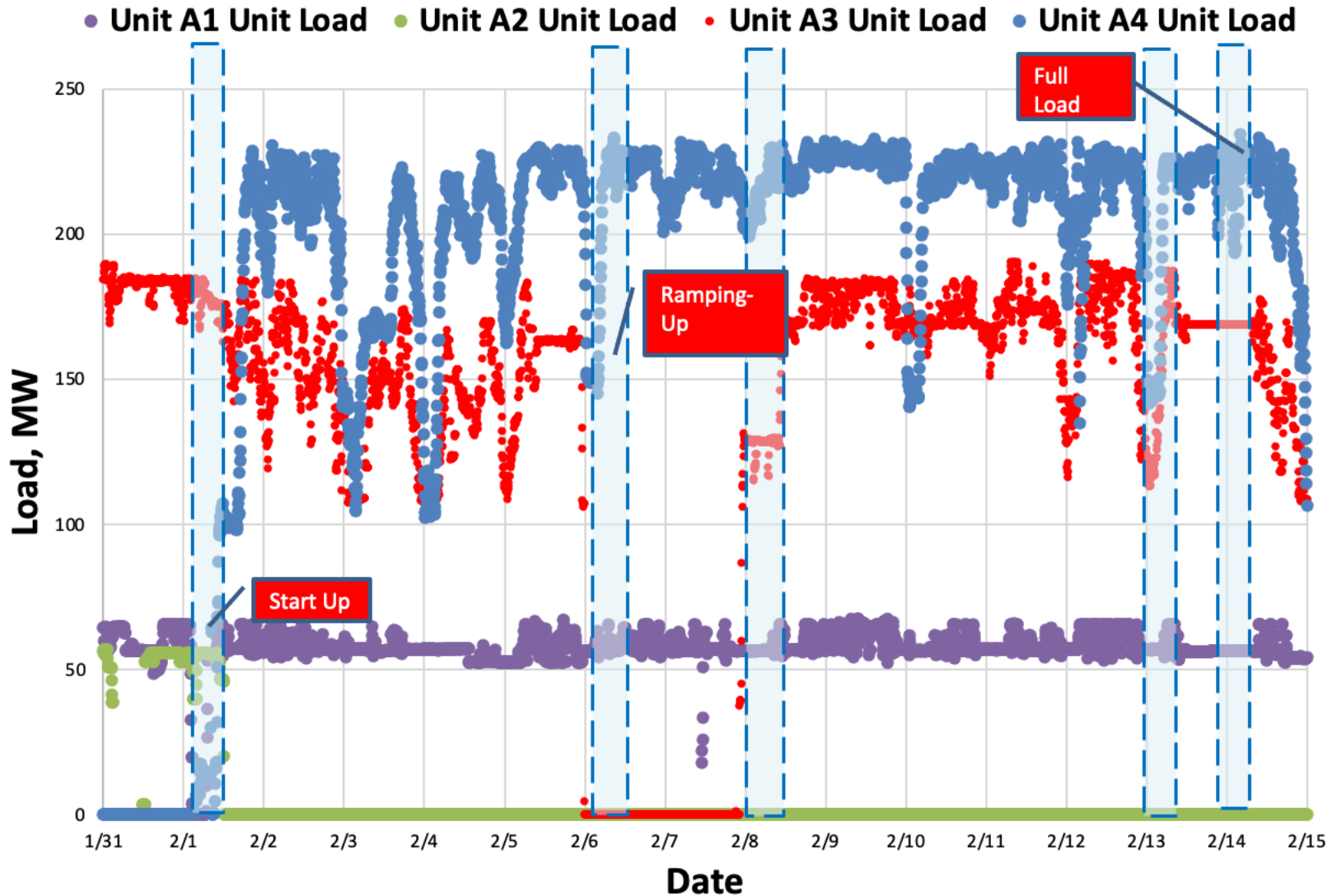


Plant B Database Main Dashboard

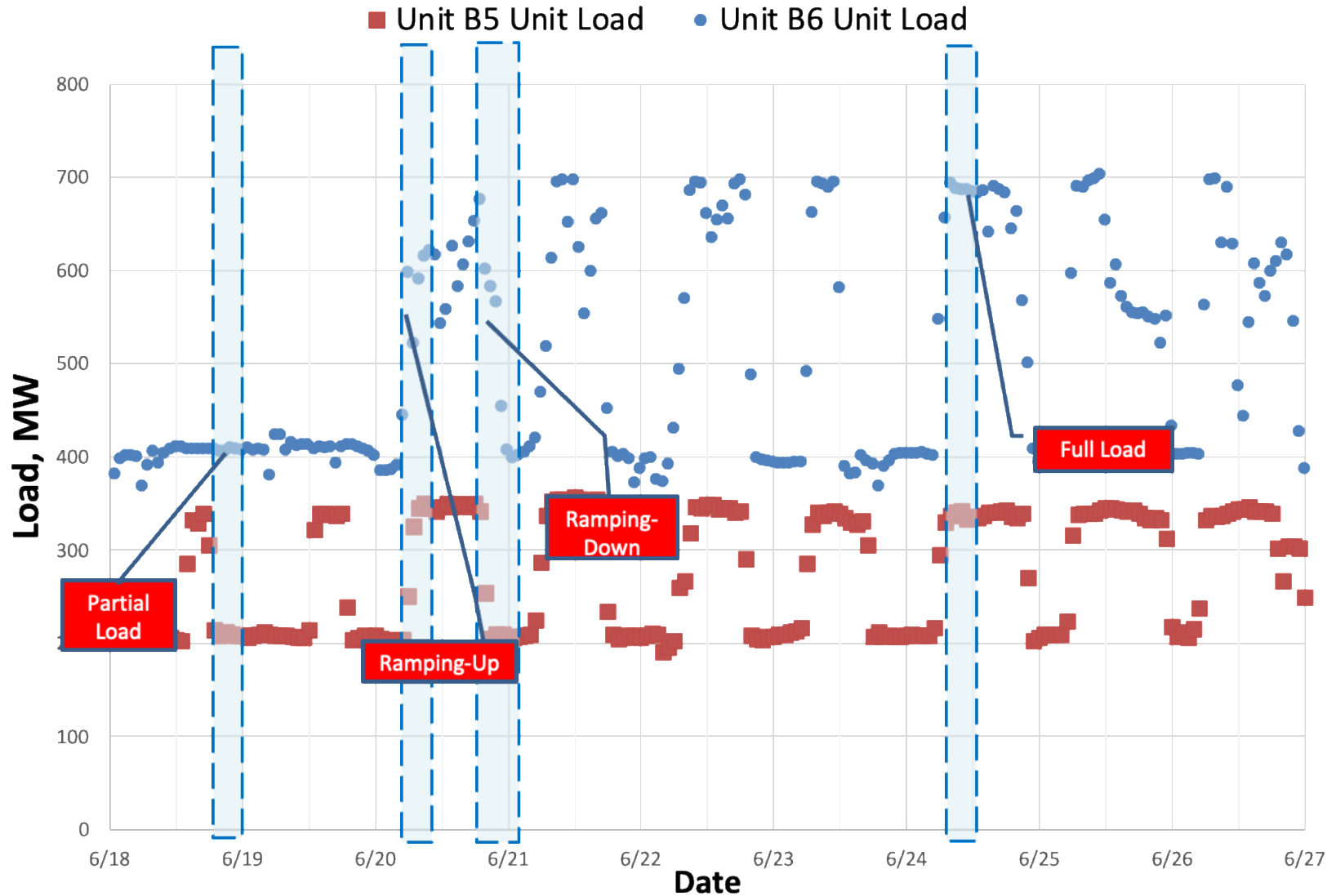
Showing Arsenic in Solid at Unit B5 WFGD Slurry



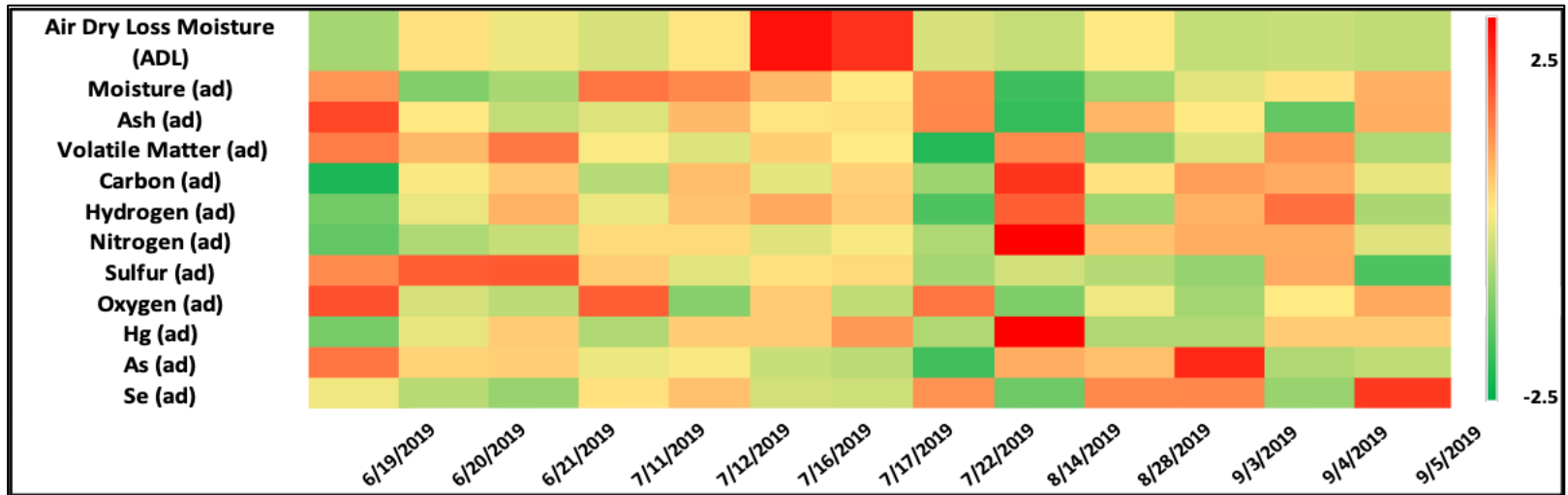
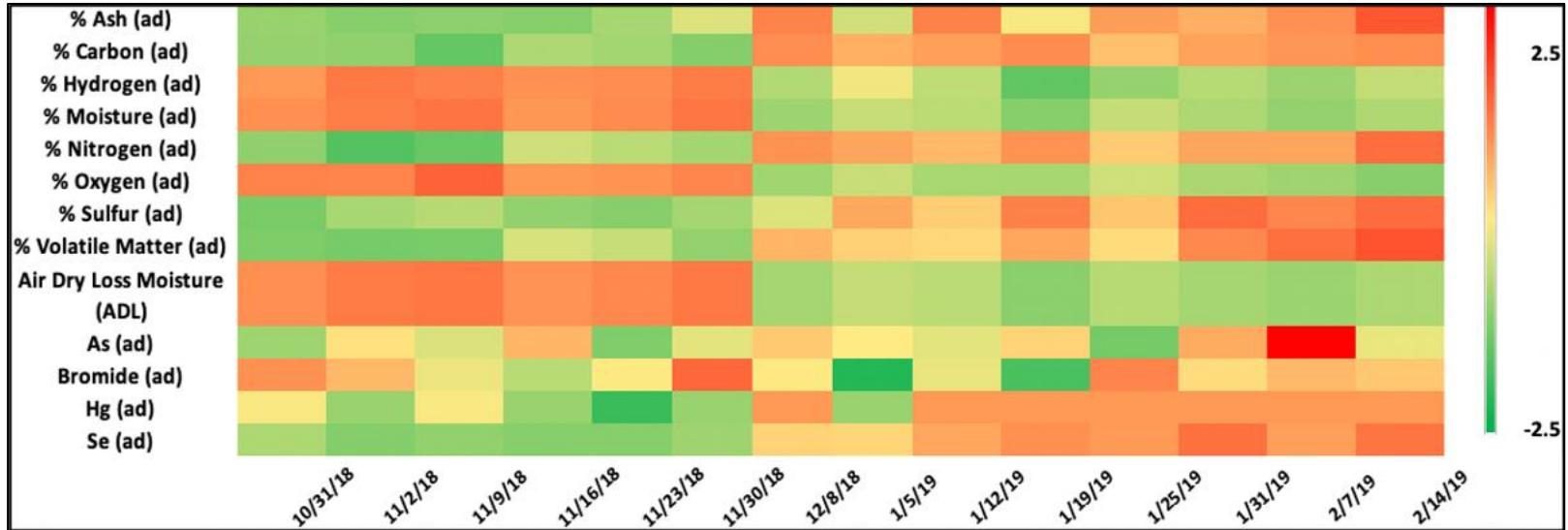
Power Plant A Cycling Profile



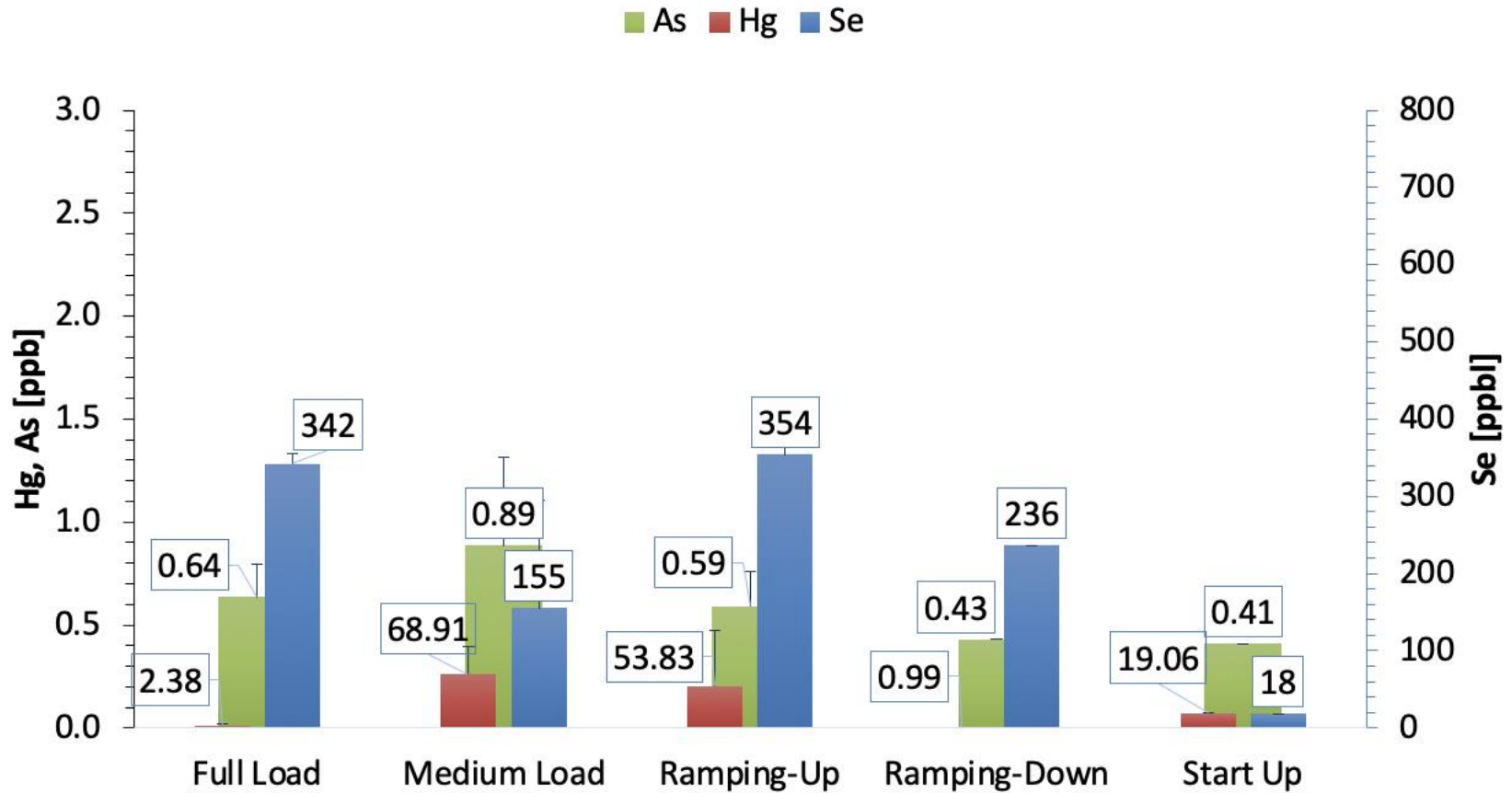
Power Plant B Cycling Profile



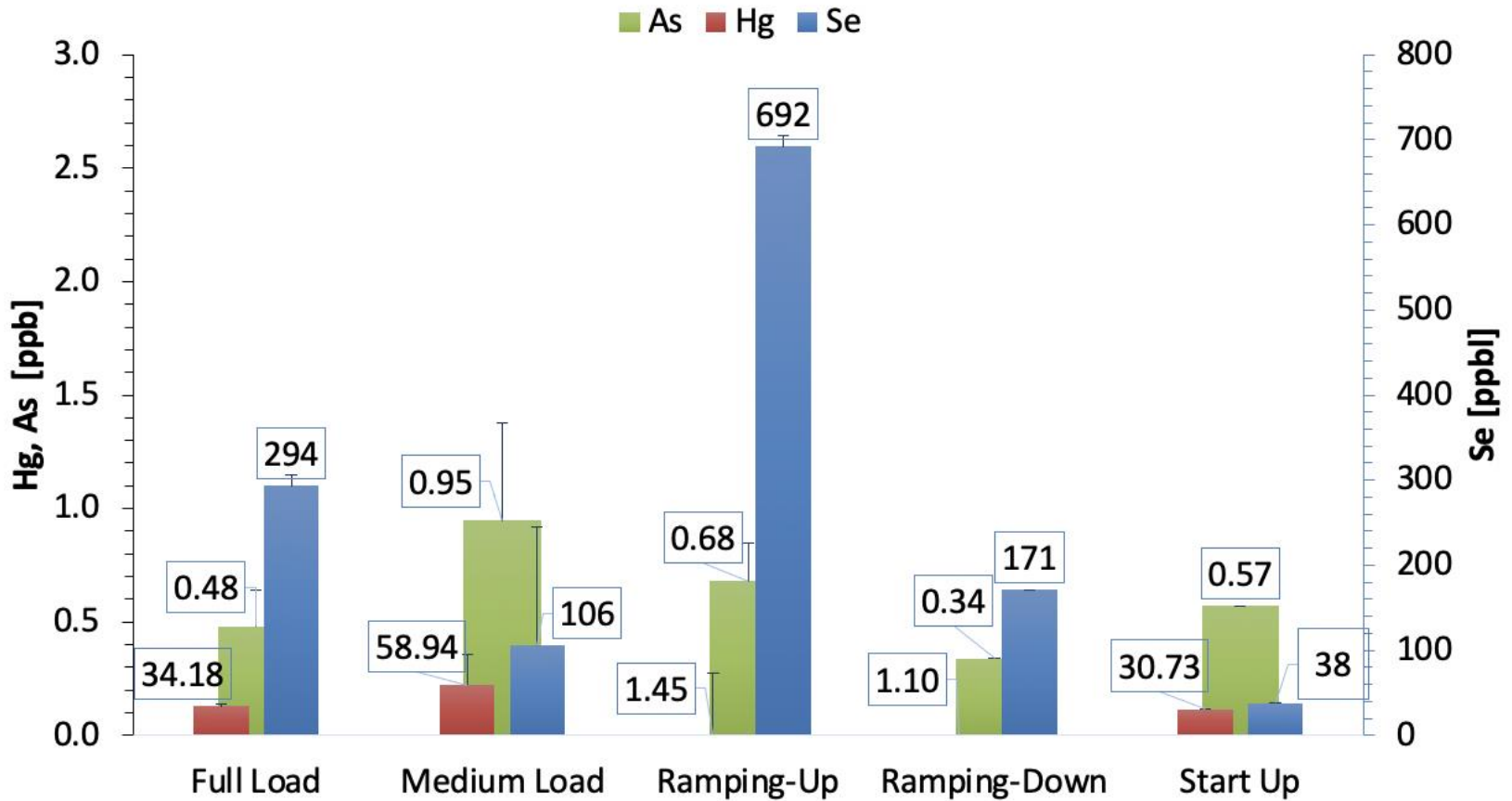
Coal Quality Heat Map: Plant A (top) and Plant B (bottom)



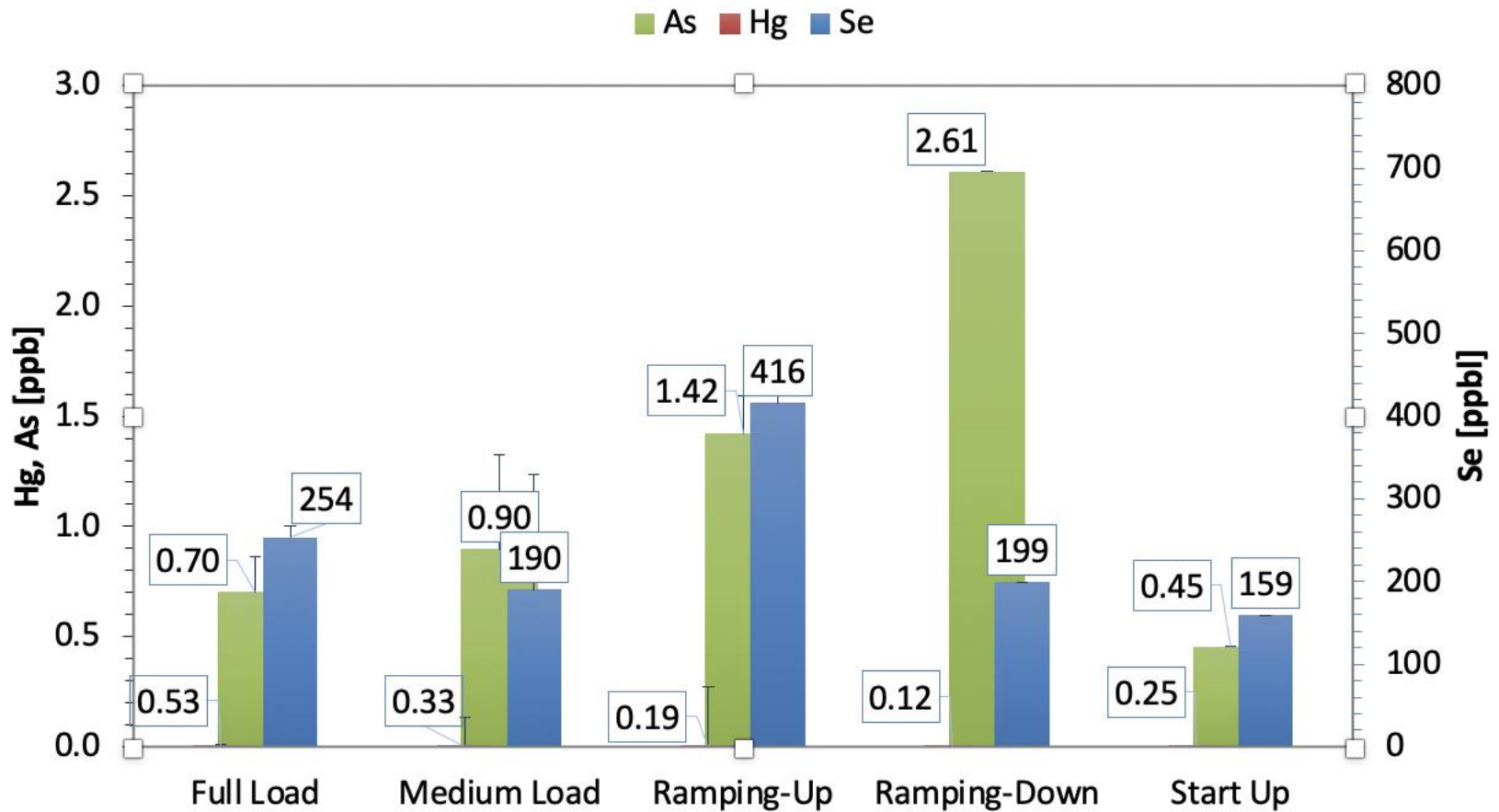
Plant A: Average Hg, As, Se concentration in Liquor at Unit A3 North Before Hydroclone with respect to Unit Cycling



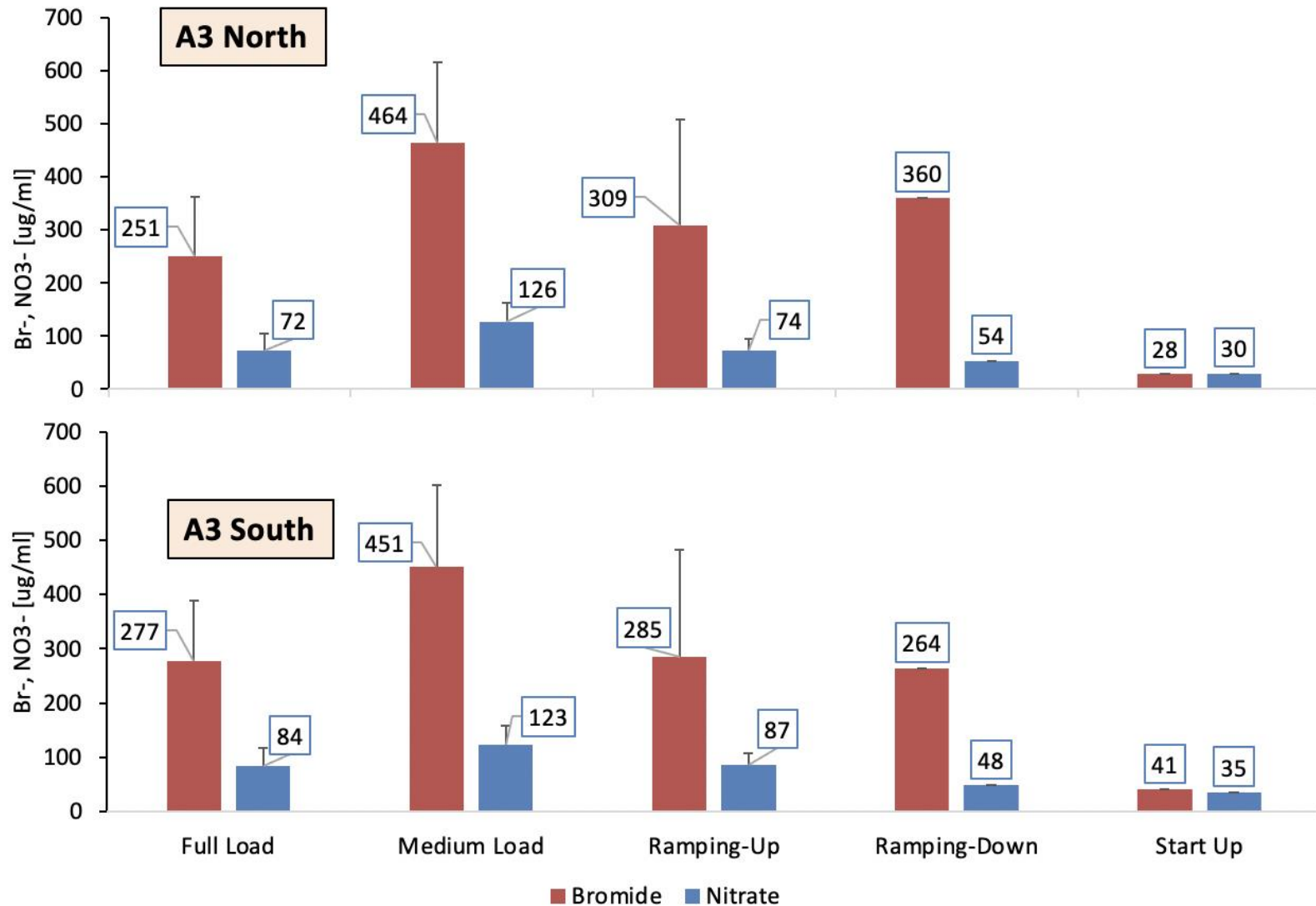
Plant A: Average Hg, As, Se concentration in Liquor at Unit A3 South before Hydroclone with respect to Unit Cycling



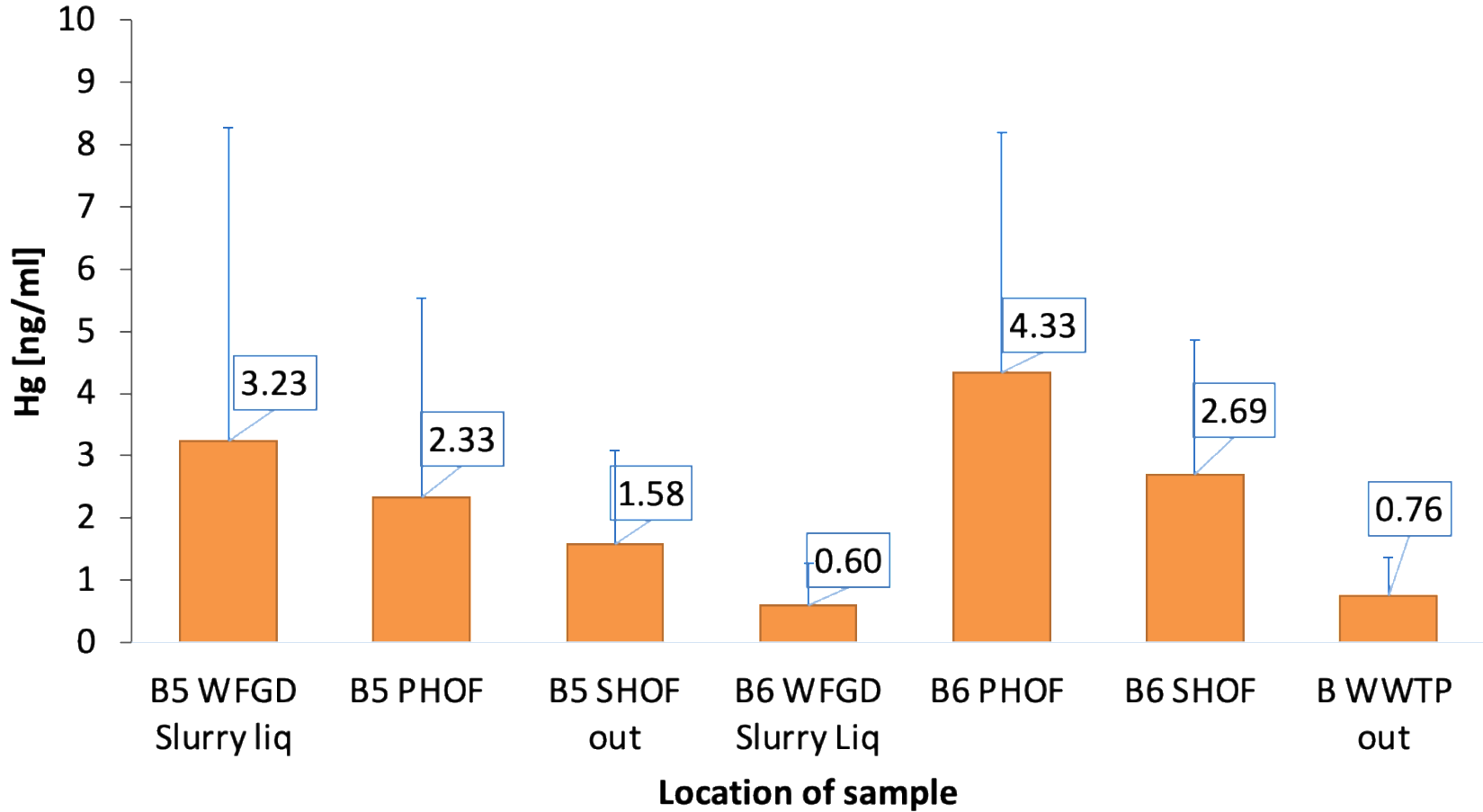
Plant A: Average Hg, As, Se concentration in Liquor at Unit A4 before Hydroclone with respect to Unit Cycling



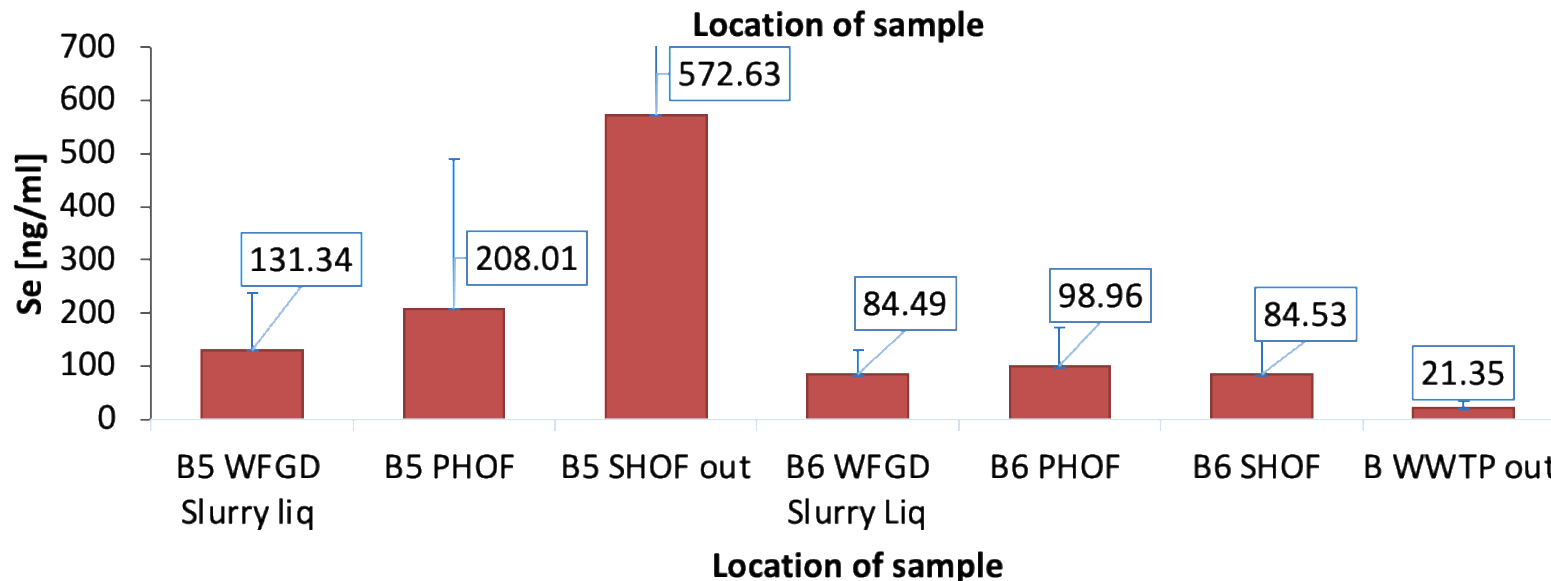
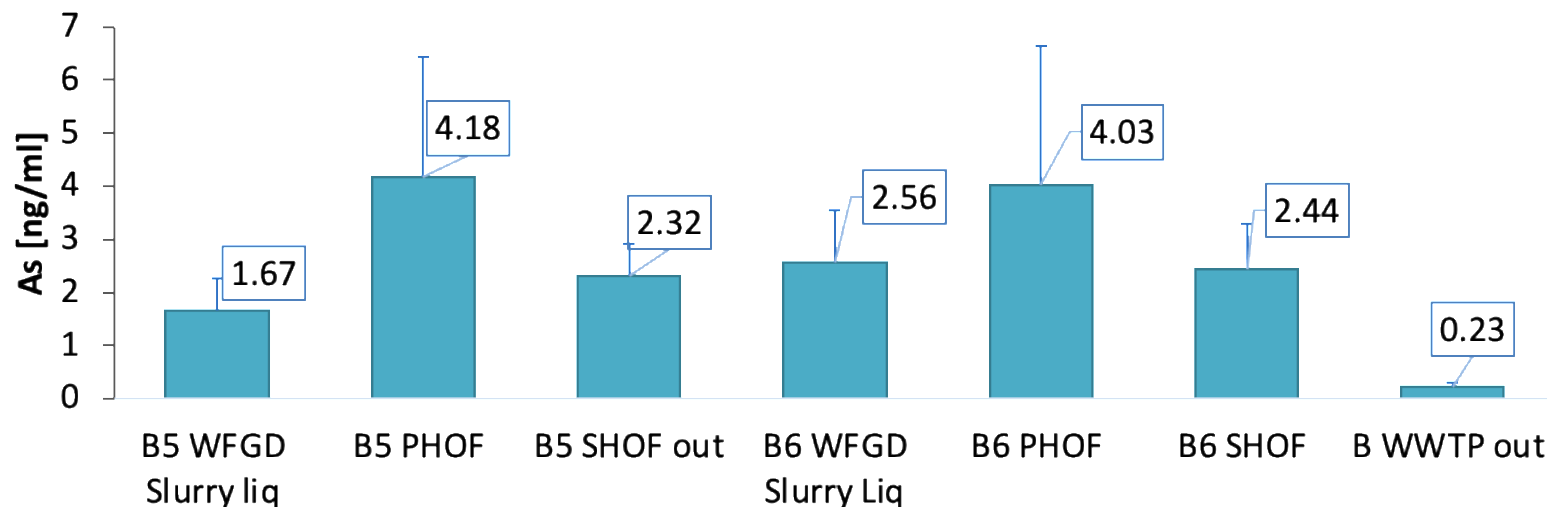
Plant A: Average Br- and NO3- Concentration in Liquor at Unit A3 North (top) and South (bottom) with respect to Unit Cycling



Plant B: Average Hg Concentration in Liquor across sampling locations

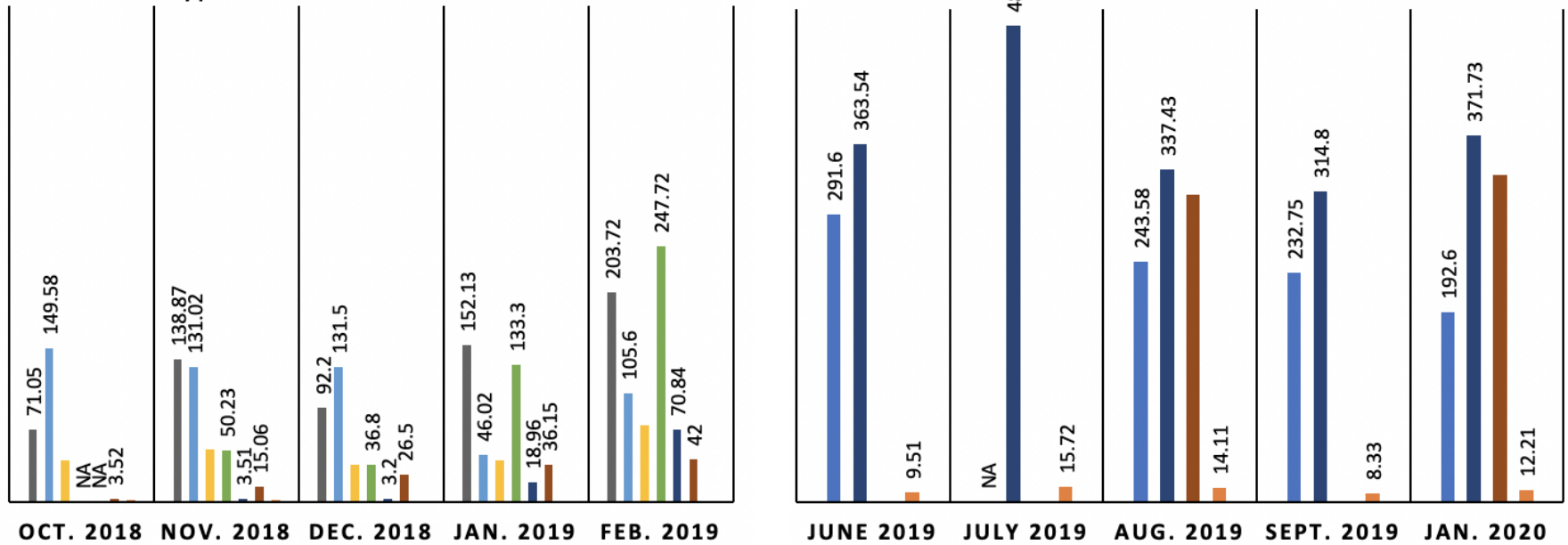


Plant B: Average As (top) and Se (Bottom) in Liquor across locations



Concentration of NO_3^- in liquor (ppm) averaged by month sampled along the influent and effluent streams at Plant A (left) and Plant B (right).

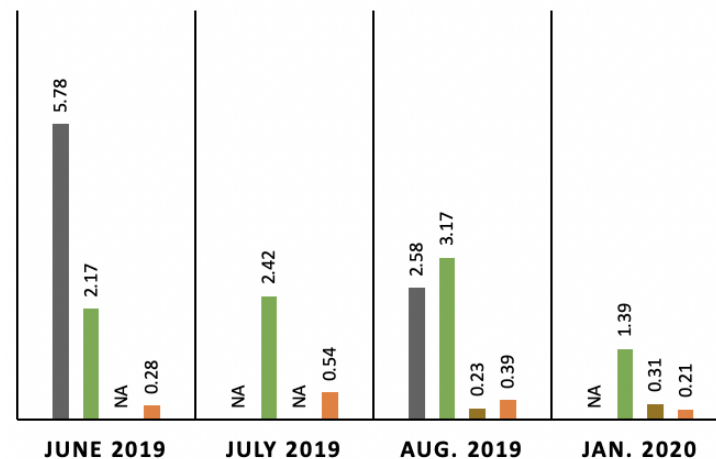
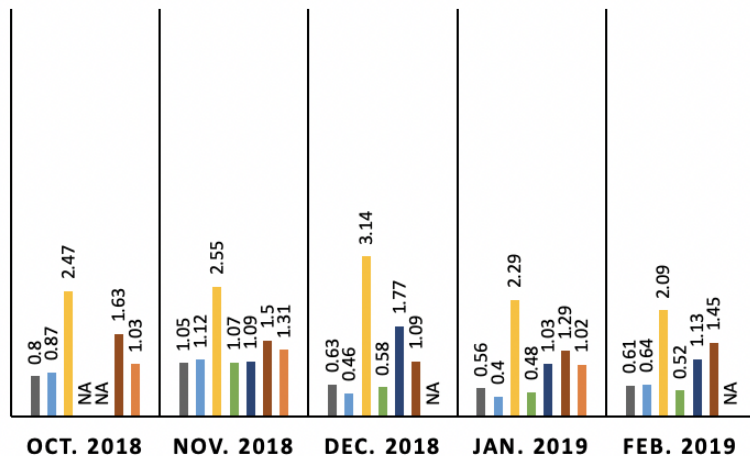
- 1-Scrubber A1/A2 Before Hydroclone
- 2-Scrubber A3 South Before Hydroclone
- 3-Scrubber A3 Return Water Tank
- 4-Scrubber A4 Before Hydroclone
- 5-Scrubber A4 Reclaim Tank
- 6-Transfer Pump
- 7-Gypsum Pile Storm Water Run Off
- 1-Unit B5 PHOF
- 2-Unit B6 WFGD Slurry
- 3-WWT Out
- 4-Makeup



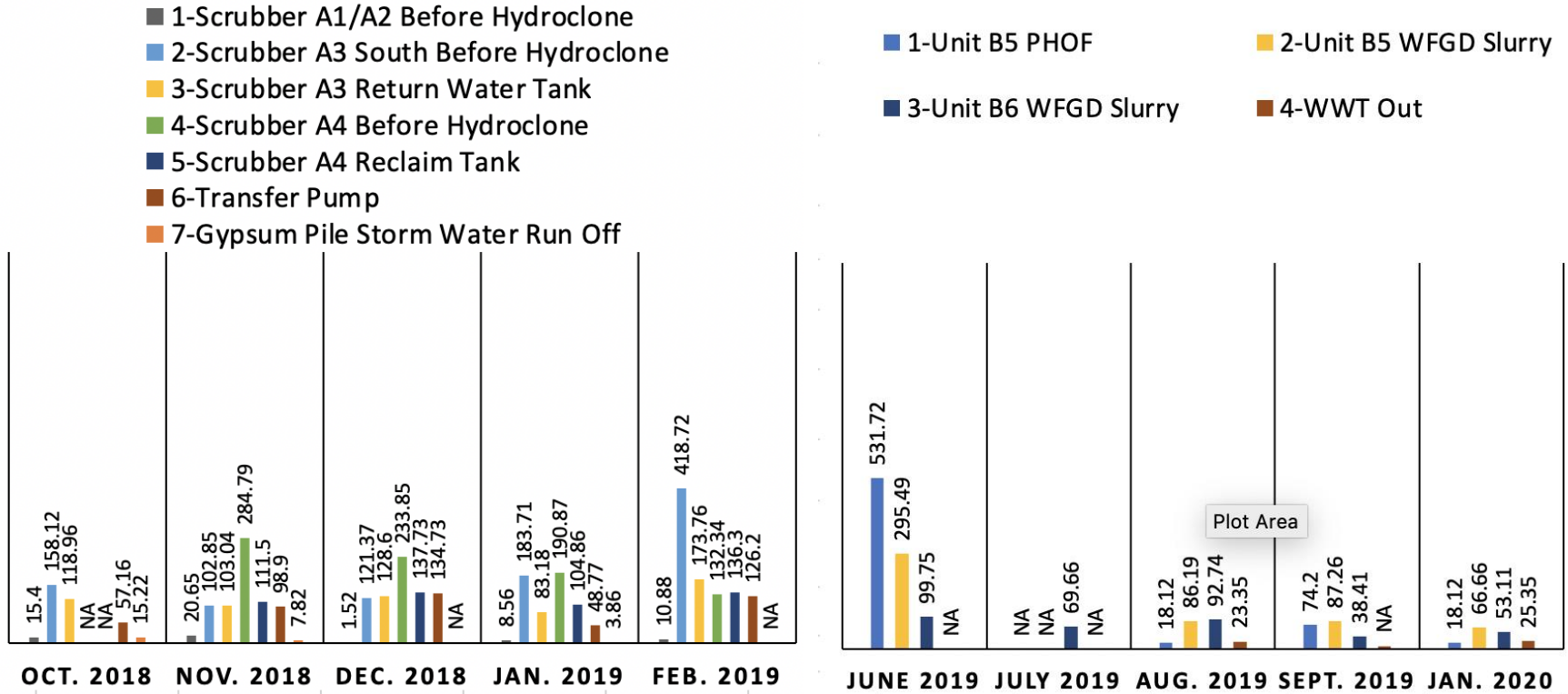
Concentration of As in liquor (ppb) averaged by month sampled along the influent and effluent streams at Plant A (left) and Plant B (right).

- 1-Scrubber A1/A2 Before Hydroclone
- 2-Scrubber A3 South Before Hydroclone
- 3-Scrubber A3 Return Water Tank
- 4-Scrubber A4 Before Hydroclone
- 5-Scrubber A4 Reclaim Tank
- 6-Transfer Pump
- 7-Gypsum Pile Storm Water Run Off

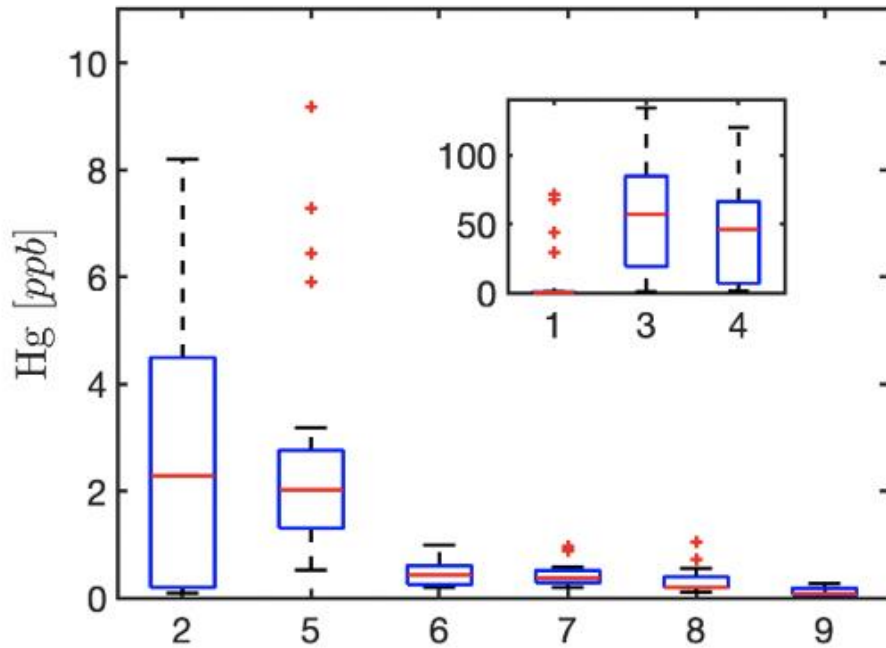
- 1-Unit B5 PHOF
- 2-Unit B6 WFGD Slurry
- 3-WWT Outlet
- 4-Makeup



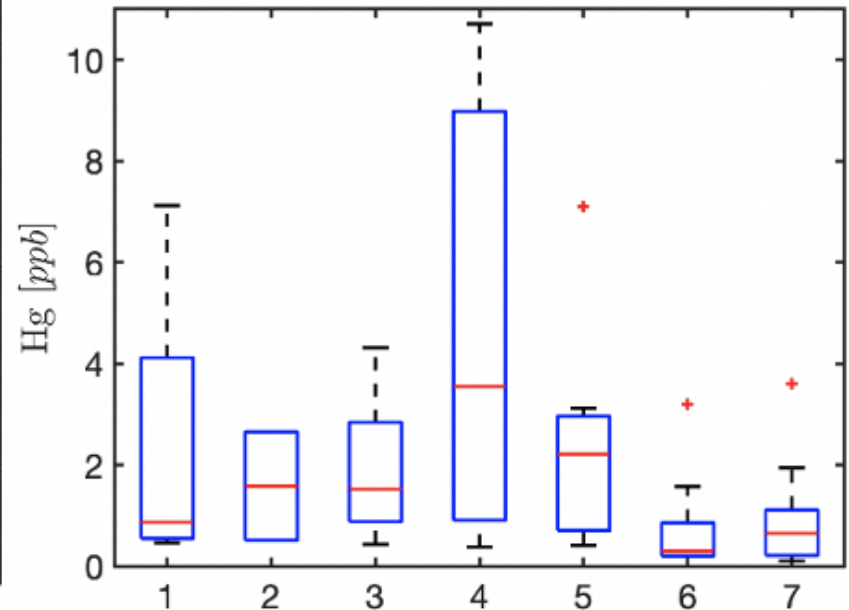
Concentration of Se in liquor (ppb) averaged by month sampled along the influent and effluent streams at Plant A (left) and Plant B (right).



Concentration of Hg in liquor (ppb) sampled along the influent and effluent streams at Plant A (left) and Plant B (right). The central red lines of the boxes indicate the median, the bottom and top edges of the box indicate the 25th and 75th percentiles, respectively. The red crosses represent outliers defined as IQRs



- 1-Scrubber A1/A2 Before Hydroclone
- 2-Scrubber A3 AFT
- 3-Scrubber A3 North Before Hydroclone
- 4-Scrubber A3 South Before Hydroclone
- 5-Scrubber A3 Return Water Tank
- 6-Scrubber A4 Before Hydroclone
- 7-Scrubber A4 Reclaim Tank
- 8-Transfer Pump
- 9-Gypsum Pile Storm Water Run Off



- 1-Unit B5 PHOF
- 2-Unit B5 SHOF
- 3-Unit B5 WFGD Slurry
- 4-Unit B6 PHOF
- 5-Unit B6 SHOF
- 6-Unit B6 WFGD Slurry
- 7-WWT Out

Conclusion

- Proximate Analysis and Ultimate Analysis (Carbon, Hydrogen, Nitrogen, Sulfur, ash and fixed Carbon), the Effluent Analysis (Mercury, Arsenic, Selenium, Nitrate, Nitrite, Bromide) were conducted for samples collected from two coal power plants.
- Samples across the wastewater process stream from Plant A were collected between October 2018 and February 2019 and from Plant B between June 2019 and January 2020.
- Characterization of emissions demonstrated profound influences of the plant operational profile and configuration on the content of contaminants in the wastewater streams.
- The lowest concentration of Arsenic, Selenium, and Mercury were observed at Scrubber A1/A2 Before Hydroclone and Gypsum Pile Storm Water Run-Off for Plant A and WWT Outlet for Plant B .
- An increased plant unit load was directly correlated with an increased Mercury concentration in liquor for Plant A, such as detected at Unit A4 for Plant A. Such a trend was not observed at other units of Plant A.
- An increased plant unit load was directly correlated with an increased Arsenic concentration in solid and Selenium concentration in liquor for Plant B.
- The range of effluent concentration varied greatly across dates and unit operation.
- To better understand effluents' behavior in the process streams, a further study, including more detailed analysis based on plant information data, is needed. As such, Plant C is scheduled to be incorporated into the project.

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Thank you!



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