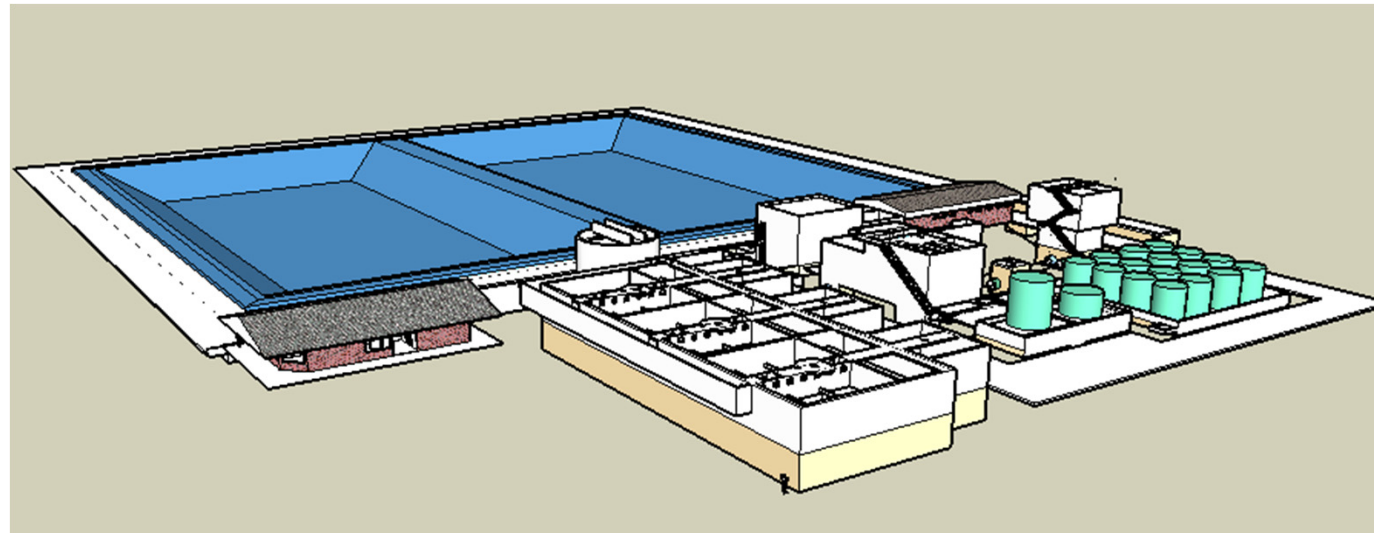


Molybdenum Treatment at Codelco El Teniente

Presented by Bernard Aubé, AMEC

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presidency of projects



- The Name Codelco represents the Corporación Nacional del Cobre de Chile, an autonomous company owned by the Chilean State.
- Codelco is the largest copper producer in the world. The Corporation controls approximately 20% of the world copper reserves.
- In 2009, Codelco produced 1.78 million metric tons of refined copper, equivalent to 11% of the world copper production.

- El Teniente, a mine of CODELCO, is the world's largest underground copper mine, is located 100 kms from Santiago, Chile.
- Tailings are stored in Carén tailings impoundment, 80 km from the mine.
- The tailings water is alkaline and meets discharge requirements for all but molybdenum.
- The Mo concentrations in the Carén overflow can be as high as 5 mg/L.
- The Mo discharge limit is 1.0 mg/L (Decreto N° 90)

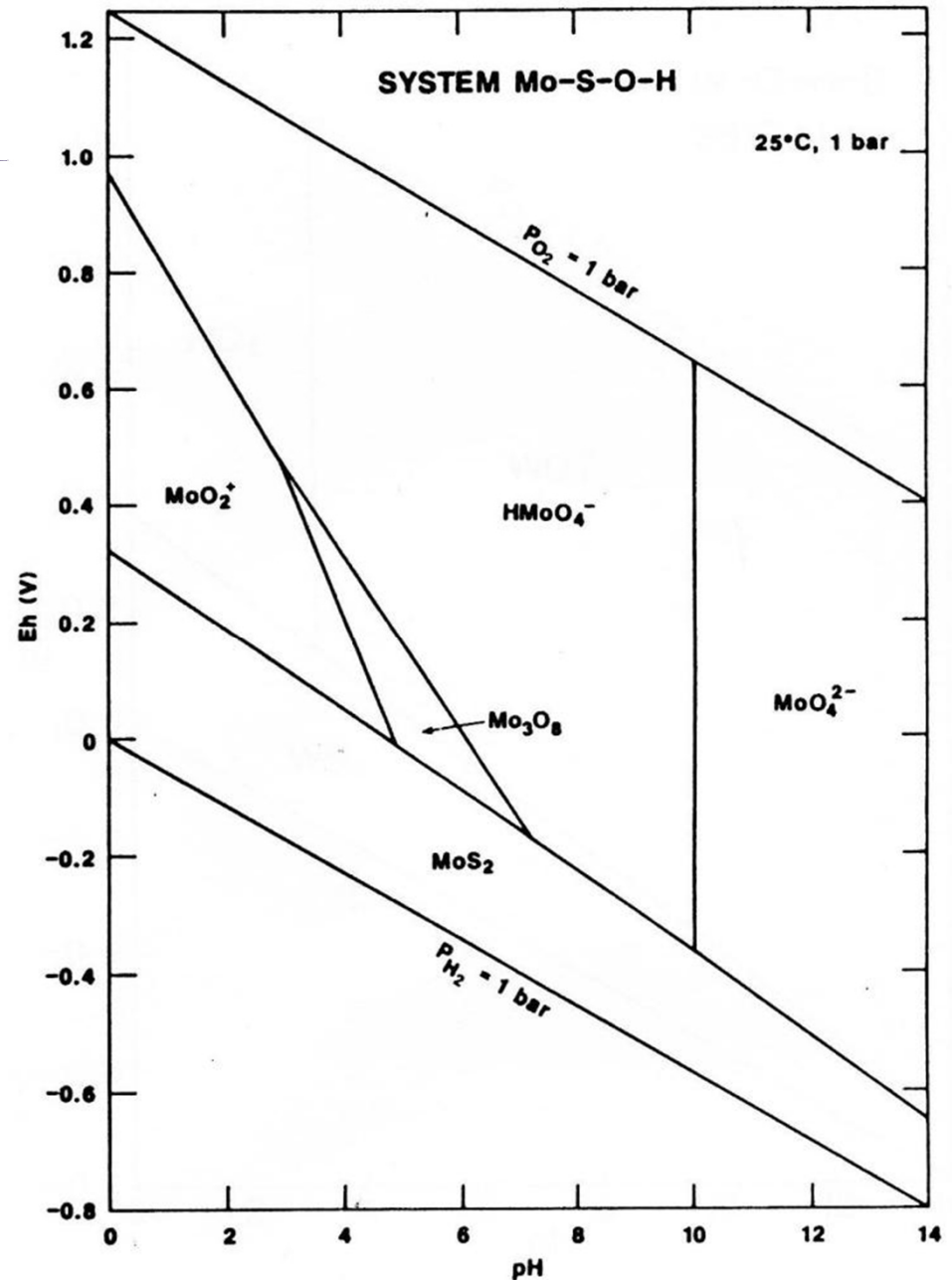
General Description



- Not a typical contaminant - requires specific treatment different from most mine drainages
- Can be removed by passive treatment systems if concentrations and flowrates are relatively low
- Active treatment generally requires co-precipitation
- Cannot be treated by simple precipitation as it is present as an anion and therefore will not precipitate as a hydroxide...

Pourbaix (Eh-pH) Diagram

Present in normal
conditions as
 HMoO_4^-

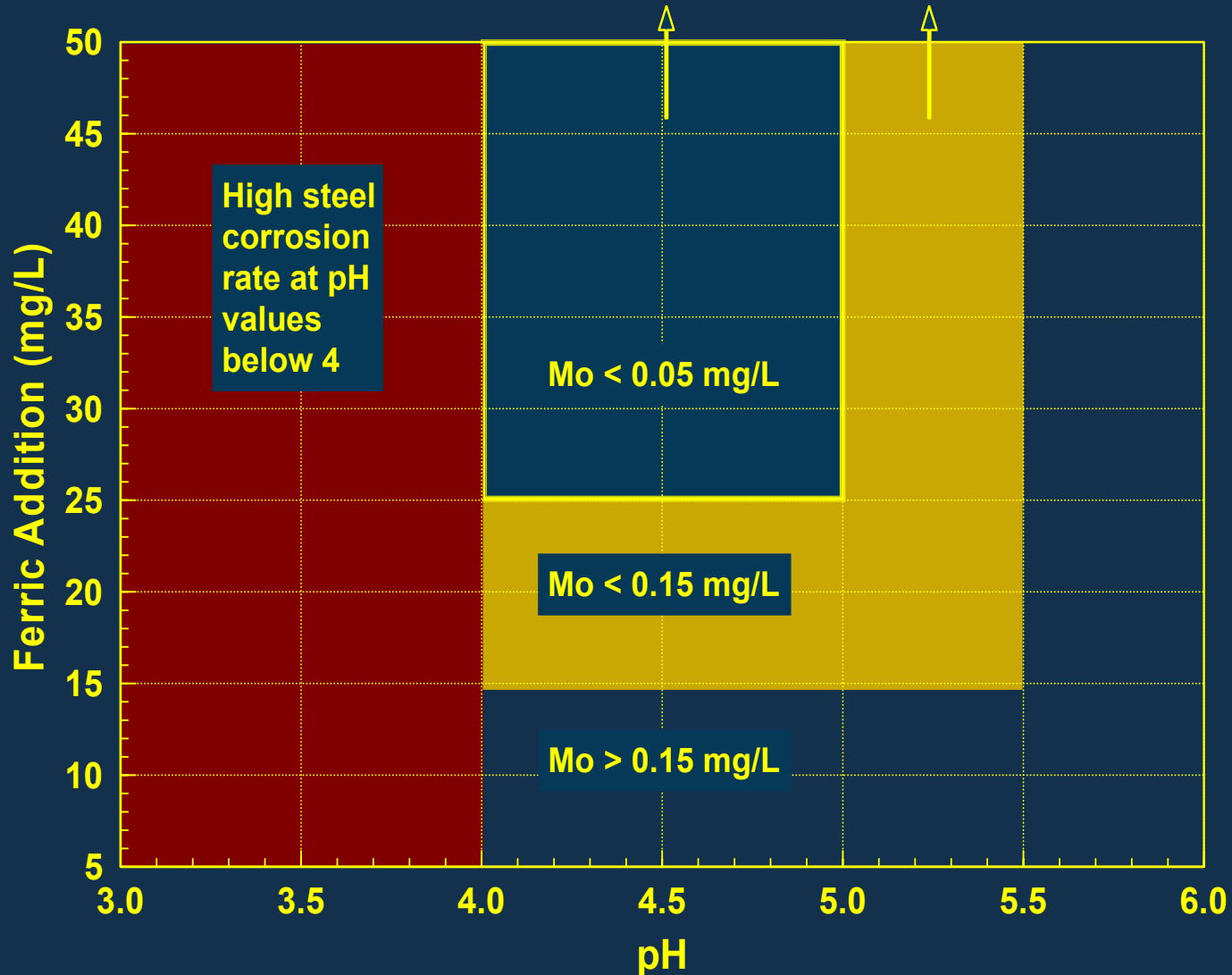


- Codelco completed many laboratory tests for the evaluation of different technologies including:
 - Iron co-precipitation/adsorption
 - Ion exchange
 - Reverse osmosis
 - Electrodialysis
 - Solvent extraction
 - Sulphide precipitation/sulphate reduction

- Consistent economical results from Fe adsorption tests only
- Many trials completed, including pilot plants using different methods of solid/liquid separation:
 - Dissolved air flotation (DAF)
 - Conventional reactor-clarifier
 - Tube settlers (Densadeg)

- Treatment process tested was similar to Xstrata Copper's Brenda Mine in British Columbia
 - Iron is added as ferric sulphate to co-precipitate molybdenum (ferric chloride at Codelco)
 - For Brenda, it was shown that a mass ratio of 10:1 was efficient (30 mg/L Fe for 3 mg/L Mo)
 - The pH was also critical to the treatment of Mo
- See next slide...

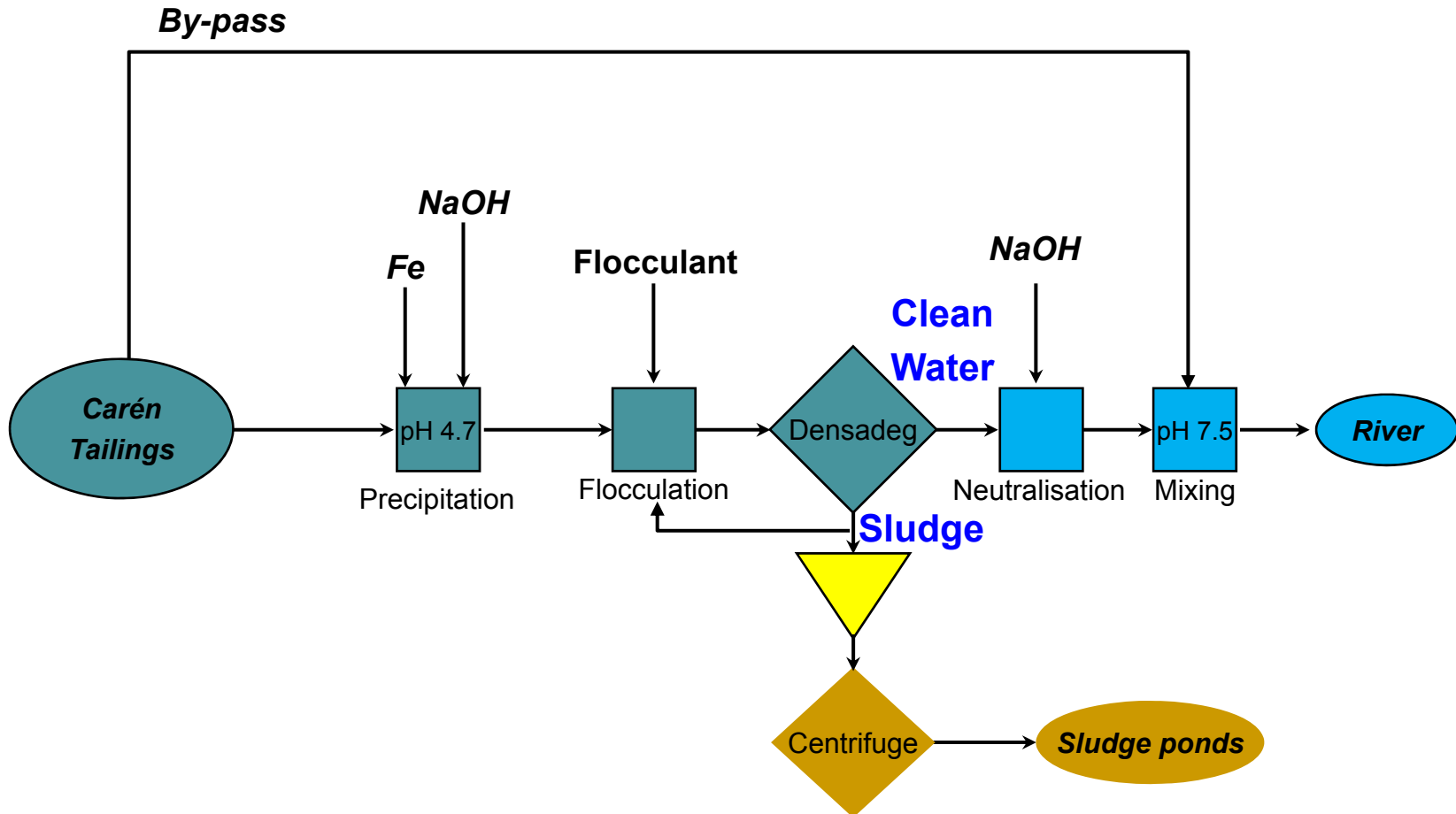
Molybdenum Treatment at Brenda

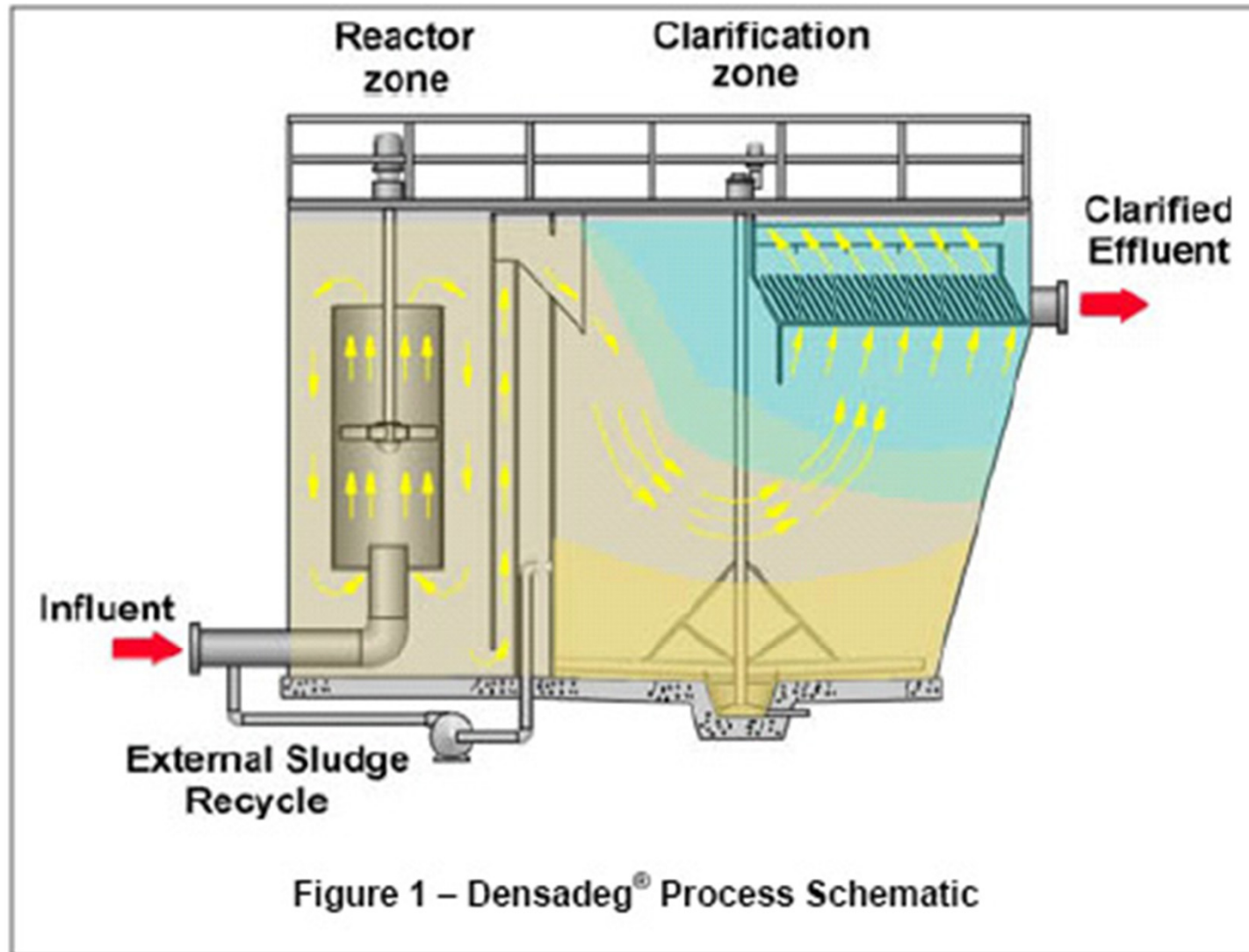


- Feed Mo from 1 to 5 mg/L and limit at 1 mg/L
 - Ferric chloride added at a 10:1 ratio (Fe:Mo),
 - pH near 4.7,
 - flocculant addition, solid-liquid separation,
 - pH correction and release.
- Plant constructed in two stages
 - Stage 1 – 3 Degrémont Densadegs
 - Stage 2 – 2 additional Densadegs
- Currently, plant contains 5 Densadegs of 500 L/s each for a total of 2.5 m³/s (150,000 L/min)
- Total capital costs near US\$33 Million

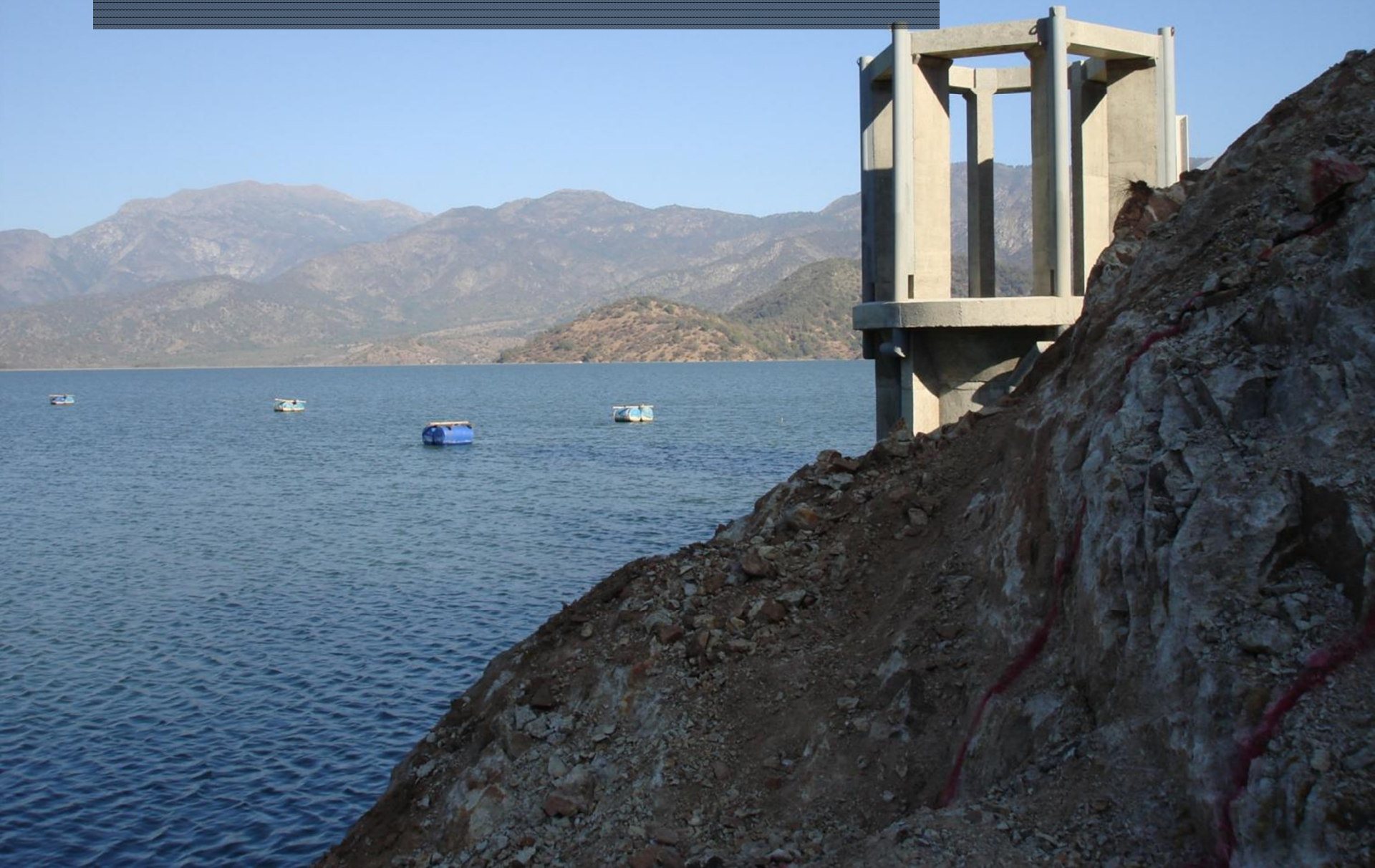
- The PAMo (Planta de Abatimiento de Molibdeno) started operations in November of 2007
- Water from the Carén tailings pond is treated and released into a canal which is the starting point of a small river.
- The point of discharge for regulatory purposes, or the final effluent, is more than 1 kilometre downstream of the discharge canal.

PAMo Flowsheet





Carén Tailings and Inlet Tower to PAMo



Satellite View of PAMo



General View of PAMo



PAMo Feed Tower



30.04.2008 11:16

Reagent Storage



Feed Tower and Flow to Reactors



Reactors



30.04.2008 11:08

Floc Tank (Draft Tube)



Densadeg Overflow



Tube Settler and Sludge Pond



Sludge Centrifuges



Sludge Storage



PAMo Discharge into Canal



Receiving Waters near Control Point



- Since start-up, the plant has easily met targets for Mo concentration and all other requirements for final effluent.
- Overall, the treatment plant has been recognised to be a complete success.