

Outotec

Towards Minimum Impact Cu Concentrator a conceptual study

IMPC

19-23th of October 2014, Santiago Chile

Kaj Jansson

Director, Mineral Processing Site Water Management

Project background

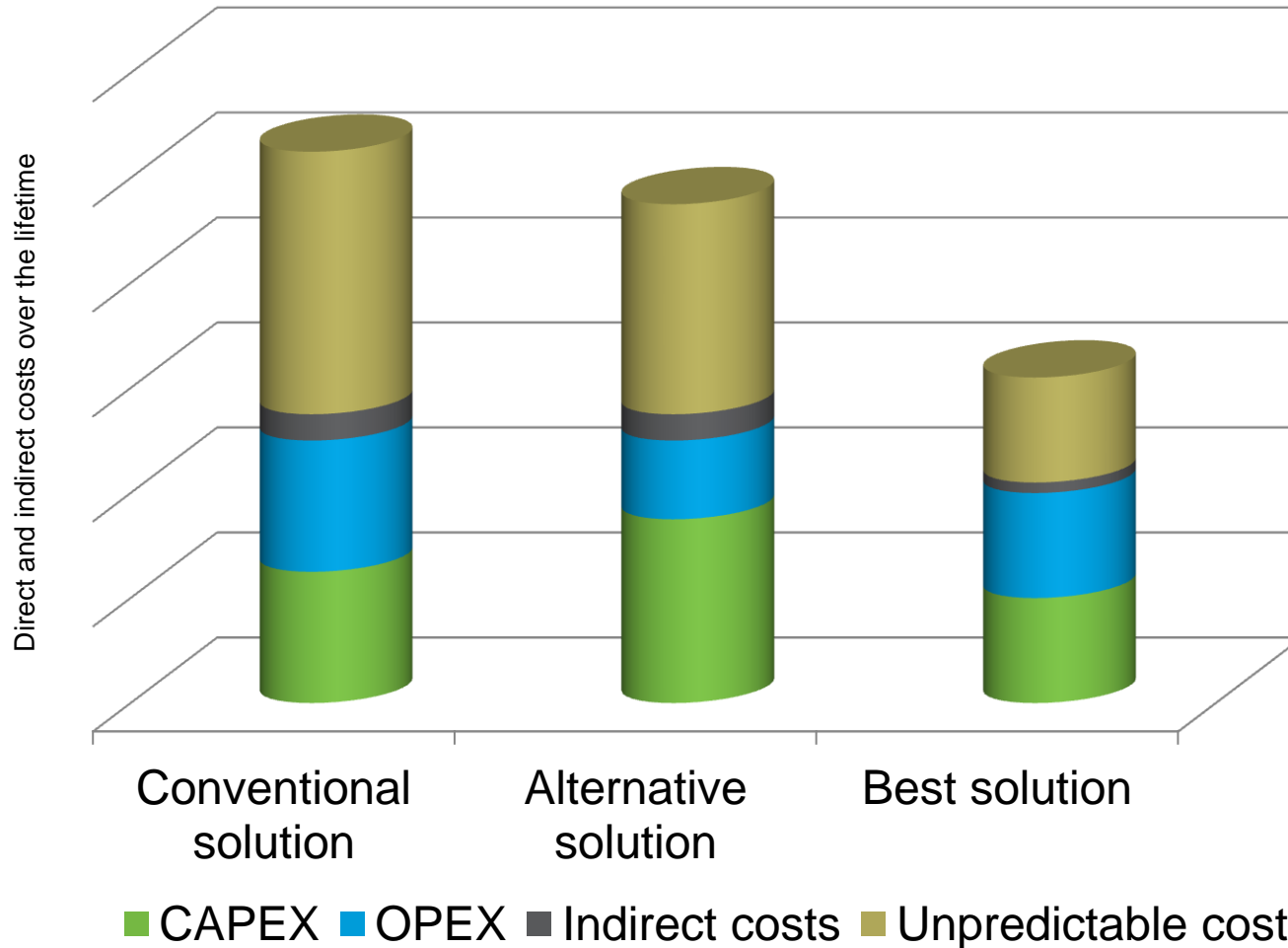
-Setting up the scene-

- **Project scope**
 - Total site costs of conventional, thickened, paste and filtered tailings
 - concentrator + tailings mgmt (variable) + water mgmt (variable)
 - Finnish cost basis
 - Costs are based on net present costs – no financing costs included
 - Accuracy +/- 30%
- **Concentrator**
 - Cu (porphyry copper)
 - Capacity 20 Mt/a
 - 15 years mine lifetime
 - Fresh water distance 10km, static head 25m
 - Tailings distance 10km, static head 25m
- **Site conditions**
 - Located in temperate climate
 - Flat mine site
 - No mine water, freezing, dust control or earth quakes events are taken into account



Target: The smallest total cost

-The true cost of operating a mineral process over its lifetime -



Unpredictable cost

- Operational risks
 - E.g. production loss due to water stress
- Regulation / Environmental / Rehabilitation
- Reputation
- Financial risks

Indirect costs

- Legal
- Official procedures
- Etc.

Alternatives for tailings & water mgmt:

- Risk matrix -



- **Conventional tailings mgmt** (yellow circle)
- **Paste mgmt** (brown circle)
- **Filtered mgmt** (blue circle)

1. Dam wall breakage (upstream)
2. Pollution of both surface and ground water through seepage
3. Socio political acceptance
4. Image risk for whole group
5. Water shortage during dry months
6. Risk of total operation

Environmental conditions

- Selecting the tailings dam design 16km², 30m high

- **Upstream**
 - Lowest initial cost and most popular design in low risk seismic areas.
 - Highest risk
- **Downstream**
 - Most stable design, should be used in areas with higher seismic risks
 - Lowest risk
- **Centerline**
 - Compromise between both the upstream and downstream designs
 - More stable than the upstream model
 - Cannot be used as a large water retention facility
- **Modified Centerline**
 - Compromise between the upstream and centerline methods to reduce the volume of construction material

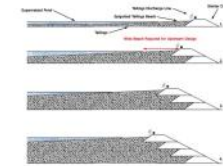


Figure 2. Upstream method of embankment construction (© Jon Engels)

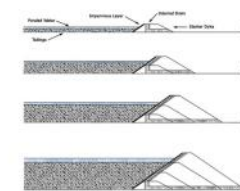


Figure 3. Downstream method of embankment construction (© Jon Engels)

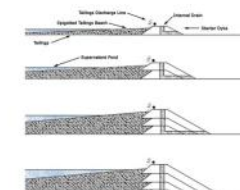


Figure 4. Centerline method of embankment construction (© Jon Engels)

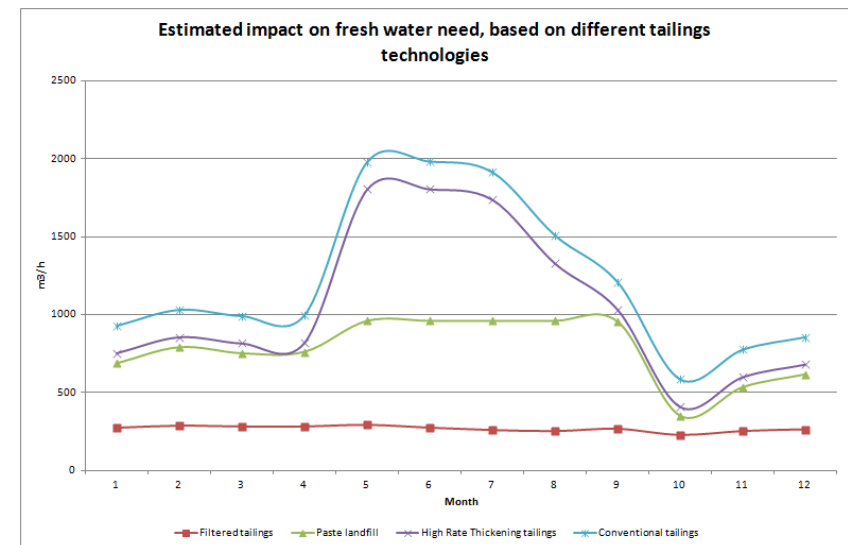
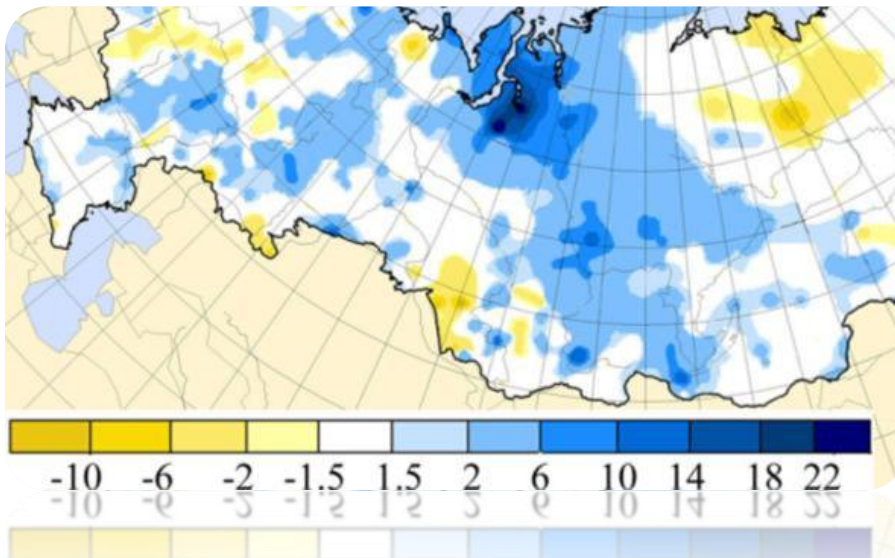


Figure 5. Modified centerline raise of a tailings storage facility (© Jon Engels)

Environmental conditions

- Impact of local weather pattern -

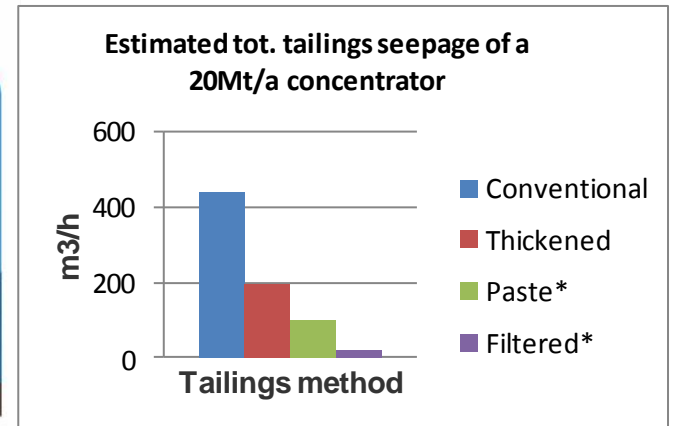
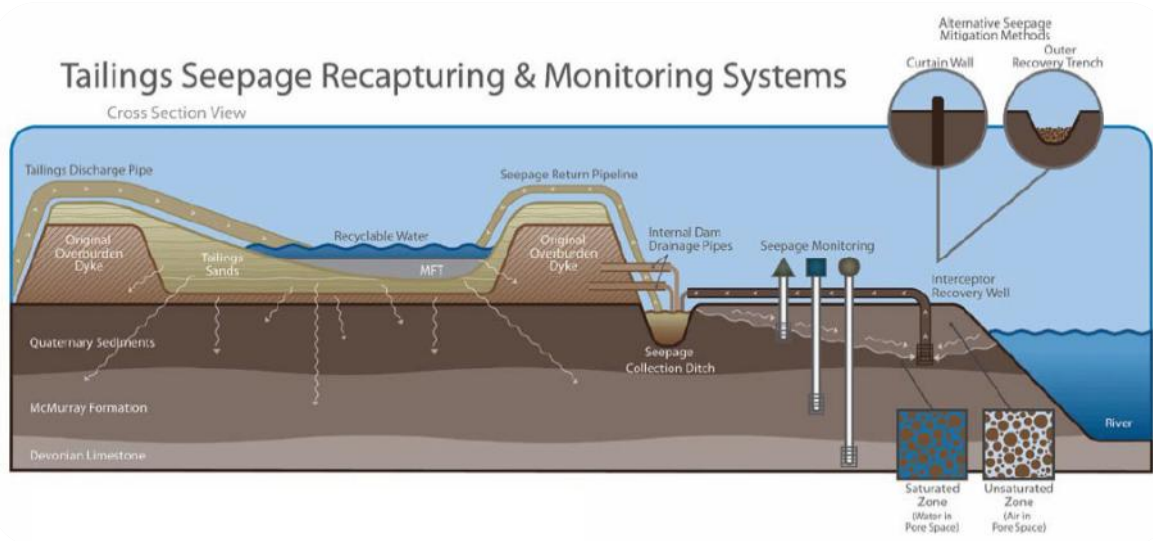
- Water shortage and quality risks should be evaluated together:
 - Fresh water quality and quantity is changing during the year,
 - Poor reuse water quality can mix pH control loops
 - Formation of harmful chemical components in tailings dams
 - Seasonal and annual rainfall change – pond volume risk



Environmental conditions

- Risk related to tailings seepage /water mgmt risk -

- Possible surface and ground water pollution
- Active pond area is calculations basis for seepage loss
- Collected seepage – potential AMD/ARD that needs a treatment/monitoring

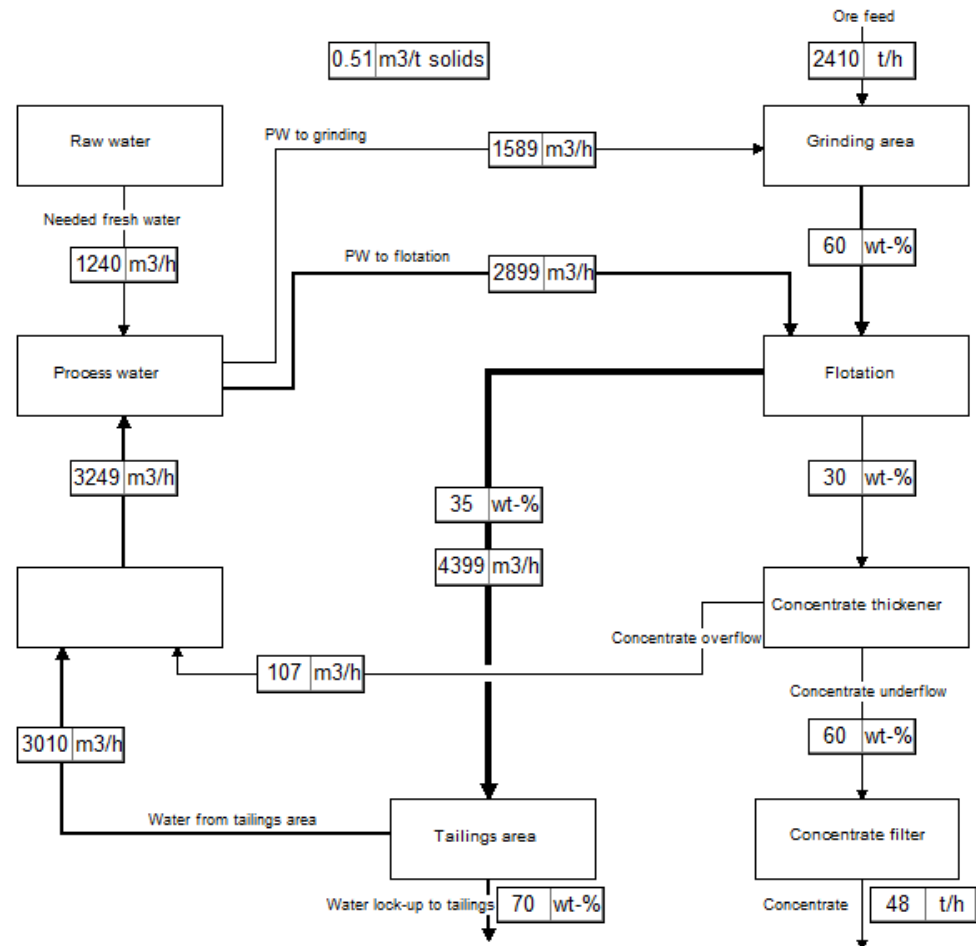


* During heavy rain conditions

Water balance: Conventional tailings mgmt

- 20Mt/a – Optimal steady state -

- Fresh water usage
 - 0,6-0,9 m³/t ore
 - Raw water need
 - Avg 1 400 m³/h (+15%)
 - ETP needed
- Risk mgmt
 - Dam risks
 - Water mgmt issues
 - Environmental risks
 - Socio political issues
 - Vulnerable to weather conditions (negative, positive water balance)
- Disadvantages
 - Huge tailings dam
 - Very costly to own and operate
- Benefits
 - Known technology



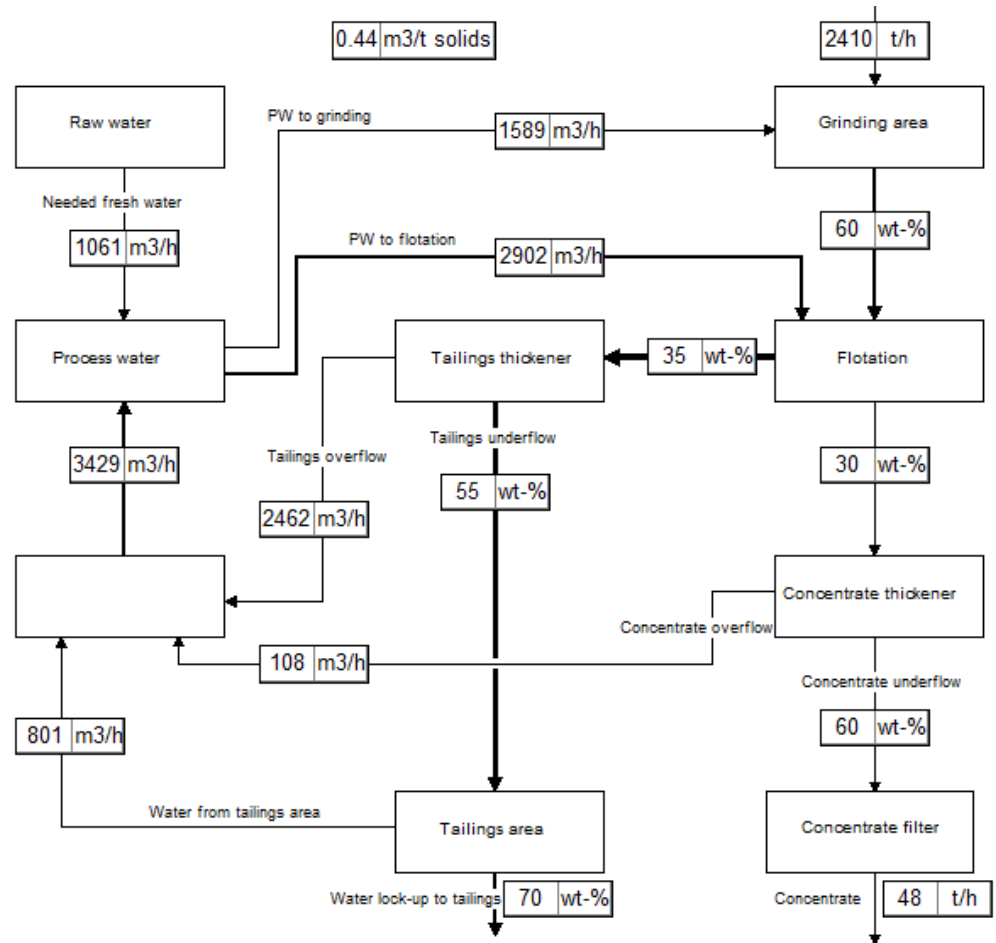
Outotec HSC Sim

Operational: Seepage, rainfall and evaporation may mix the water balance and increase fresh water input drastically

Water balance: Thickened tailings mgmt

- 20Mt/a – Optimal steady state -

- Fresh water usage
 - 0,5-0,8m³/t ore
 - Raw water need
 - Avg 1 200m³/h (+15%)
 - ETP needed
- Risk mgmt
 - Dam risks
 - Water mgmt issues
 - Environmental risks
 - Socio political issues
 - Vulnerable to weather conditions (negative, positive water balance)
- Disadvantages
 - Huge tailings dam
 - Very costly to own and operate
- Benefits
 - Known technology



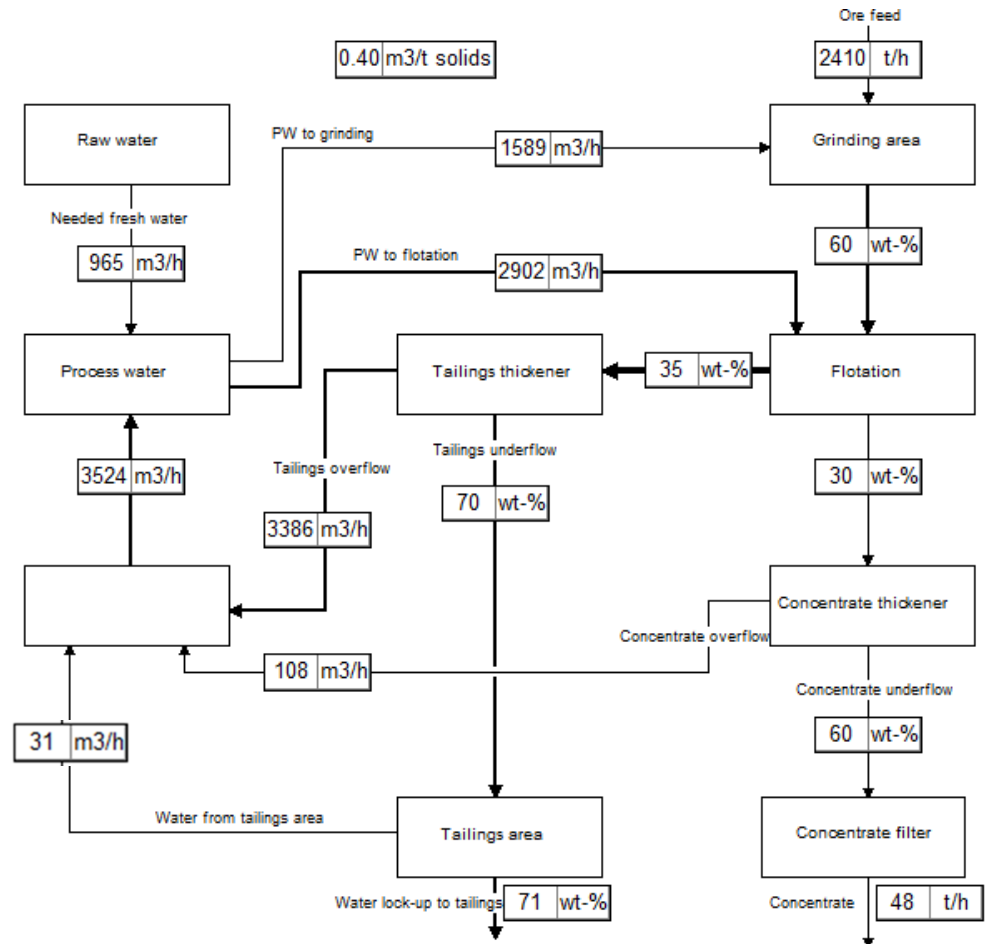
Outotec HSC Sim

Operational: Seepage, rainfall and evaporation may mix the water balance and increase fresh water input drastically

Water balance: Paste thickening mgmt

- 20Mt/a - Optimal steady state -

- Fresh water usage
 - 0,45-0,6m³/t ore
 - Raw water need
 - Avg 1 100m³/h (+15%)
 - Small ETP needed
- Risk mgmt
 - Reduced dam risks
 - Reduced water mgmt issues
- Disadvantages
 - Paste pumping
- Benefits
 - Smaller tailings area needed than previous ones
 - Smaller water usage than previous ones



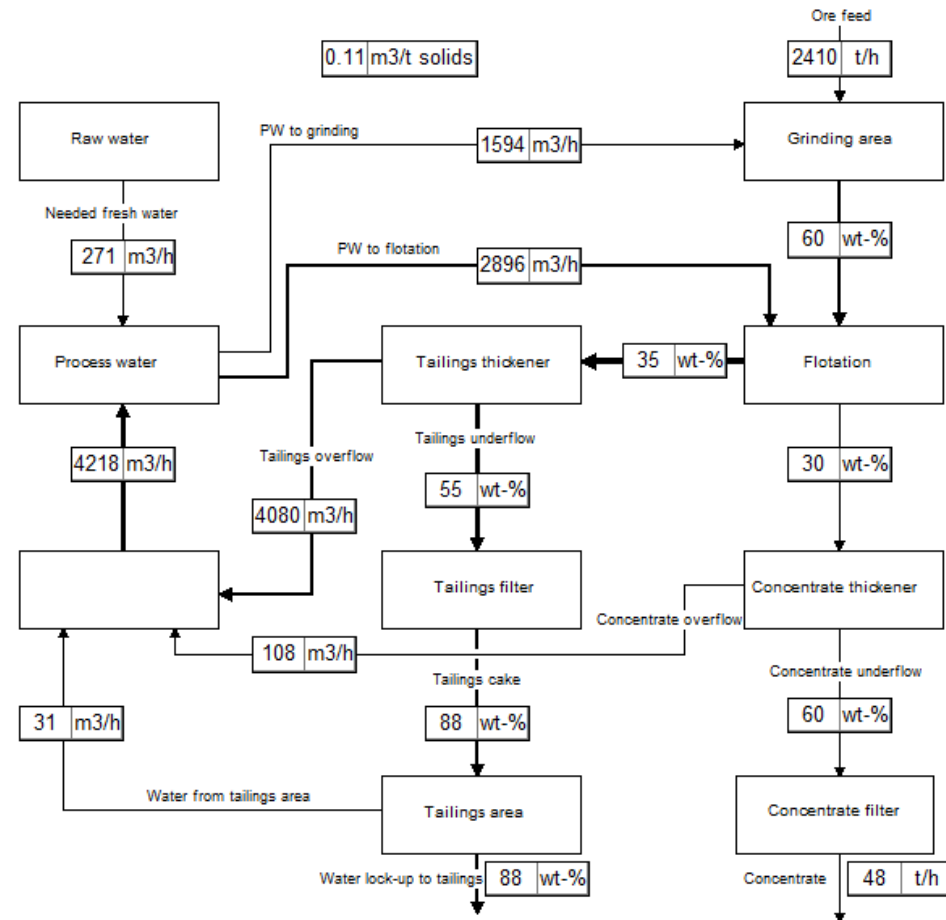
Outotec HSC Sim

Operational: Seepage, rainfall and evaporation do not influence on water balance and fresh water storage can be minimised

Water balance: Filtered tailings mgmt

– 20Mt/a - Optimal steady state -

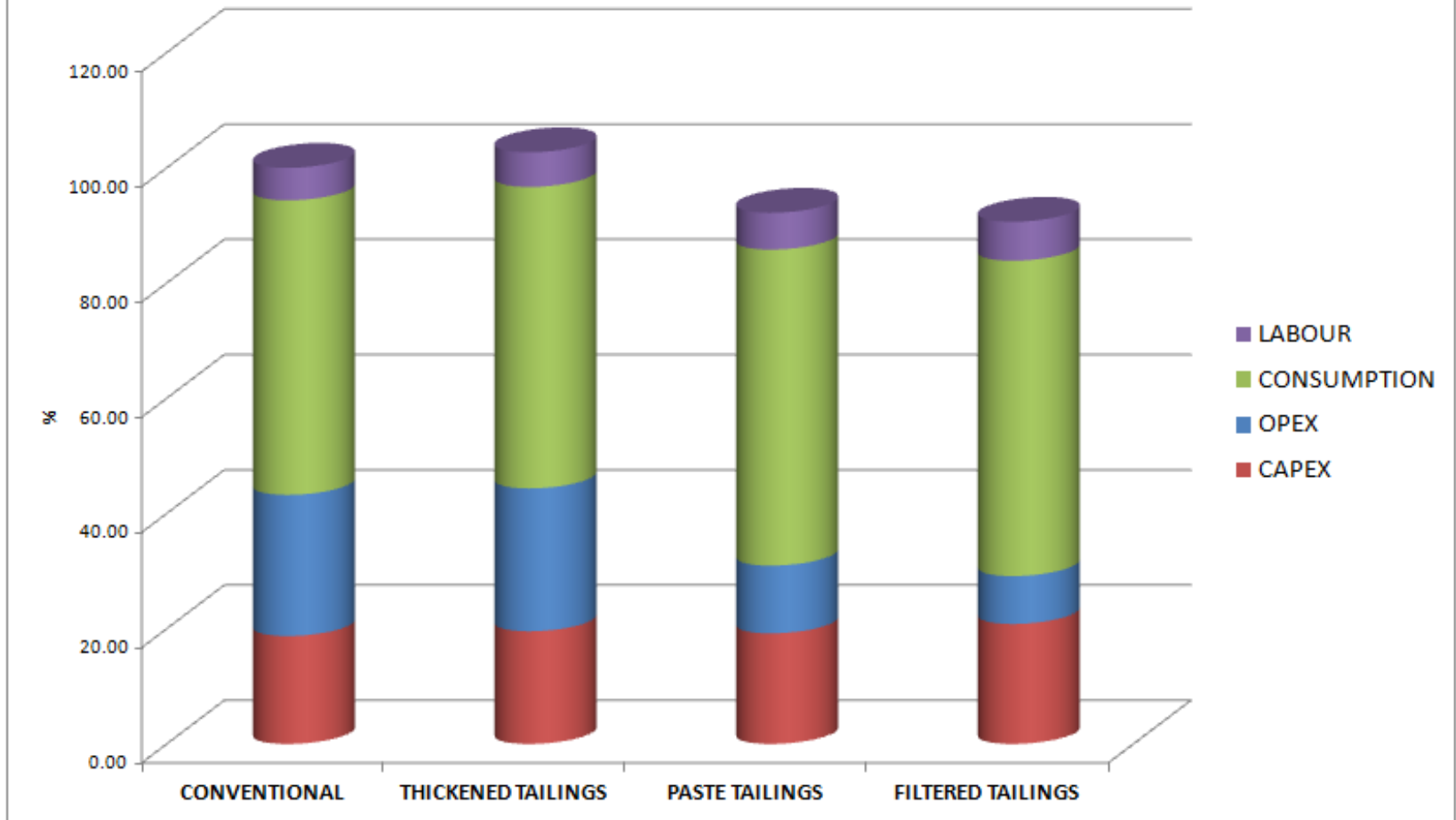
- Fresh water usage
 - ~0,15m³/t ore
 - Raw water need
 - Avg. 310 m³/h (+15%)
 - Small ETP needed
- Risk mgmt
 - Smallest operational risk
 - Dust control
- Disadvantage
 - Extra thickener + filter + conveyor
- Benefits
 - Savings on fresh water & effluent volumes
 - Smallest –
 - tailings dam
 - environmental risk
 - socio political issues



Outotec HSC Sim

Operational: Seepage, rainfall and evaporation do not influence on water balance and fresh water storage can be minimised

Estimated Full costs of 15 years lifetime of a 20Mt/a Cu Concentrator with concentrator, different tailings mgmt and water management, k€



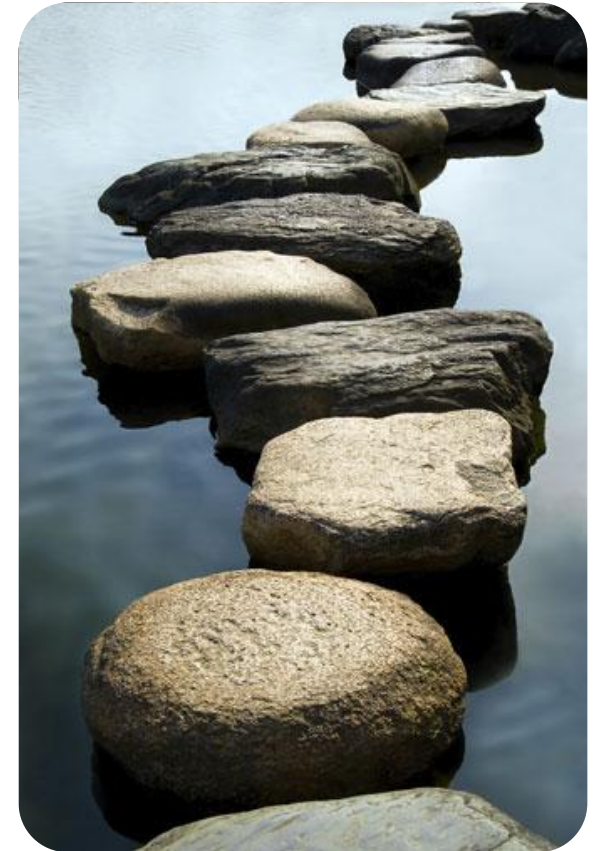
Note: with DOWNSTREAM dam

Water price 0,001 €/m3

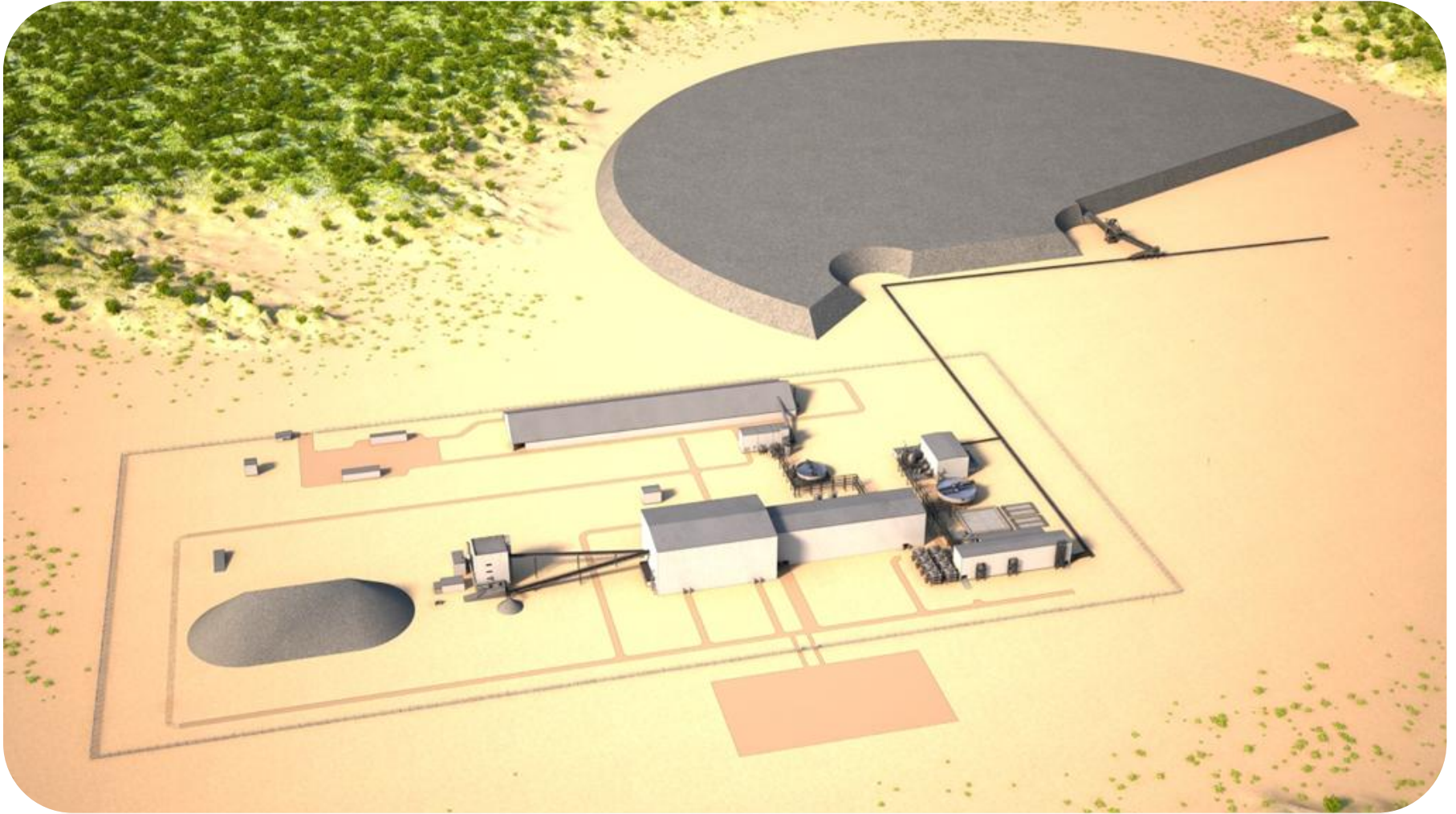
Electric price 100 €/MWh

Conclusion

- **Water mgmt**
For minimal operational risks, future is in more closed and smaller water volumes
- **Conventional & thickened**
Local weather and site conditions have a huge impact on the operational risk, Capex and Opex
- **Paste**
If any kind of disposal place for the tailings exists (old mine...), then it's a good alternative – thus it doesn't solve the water mgmt issues.
- **Filtered**
For minimal operational risks, including tailings and water mgmt is far the best



Outotec's sustainable concentrator



*If you always do what you've always done,
You will always get what you've always got
-A. Einstein-*

A close-up, slightly angled shot of the Outotec logo. The logo is rendered in a vibrant red color and is set against a brushed metal background. The letters are stylized, with the 'O's being large and rounded, and the 't's having a unique, blocky design. The lighting creates a soft glow around the edges of the logo, emphasizing its three-dimensional appearance.

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