

### A new Approach to Potash Production

## The "Belle Plaine" method vs. SMERP

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Gensource Potash Corporation (TSX.V: GSP)



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## Introduction

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- History of Saskatchewan Solution Mining
- The "Belle Plaine" method
- Solution Mining for the 21<sup>st</sup> Century Selective Mining and Enhance Recovery



## HISTORY

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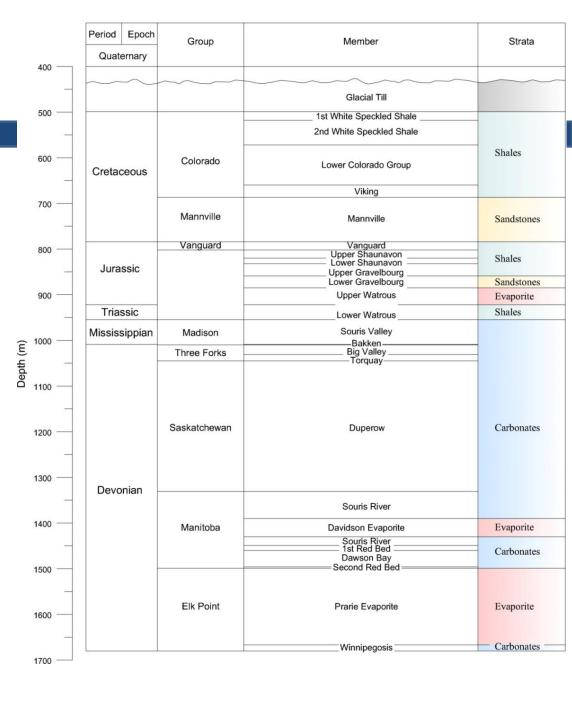
- Potash mining in SK started in the 1950's using conventional techniques (shafts, mechanical ore extraction utilizing men and equipment underground)
- Belle Plaine mine, owned by Pittsburgh Paint and Glass (PPG) was the first successful solution mine. Startup 1964
  - Initial methods from Gulf Coast salt fracking failed.
  - "Dual Well Method" developed by Edmonds et. al. and patented in 1961.
- No other solution mine has been implemented.



# The "Belle Plaine Method" – the Edmonds et. al method.

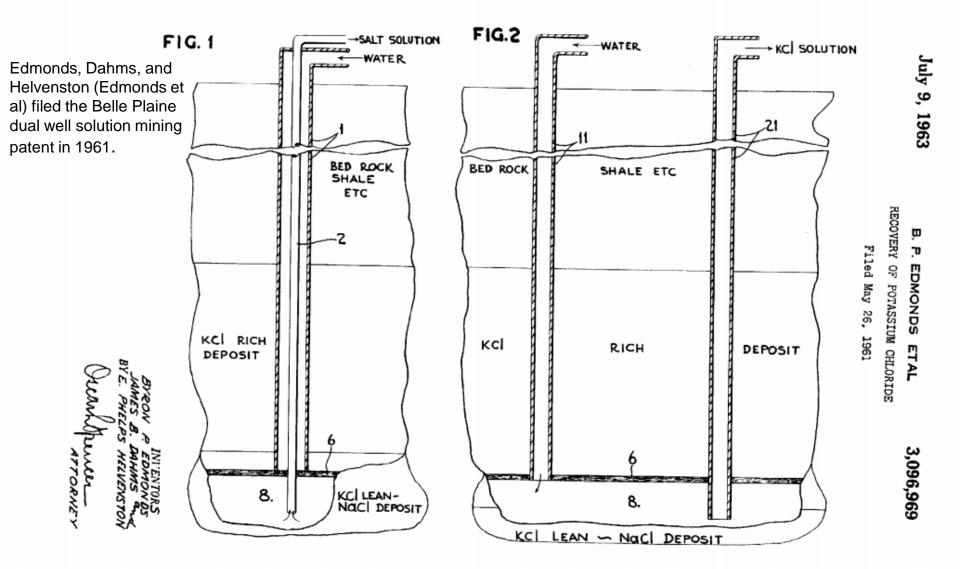


### Generalized Stratigraphic Column of the Potash One South Area

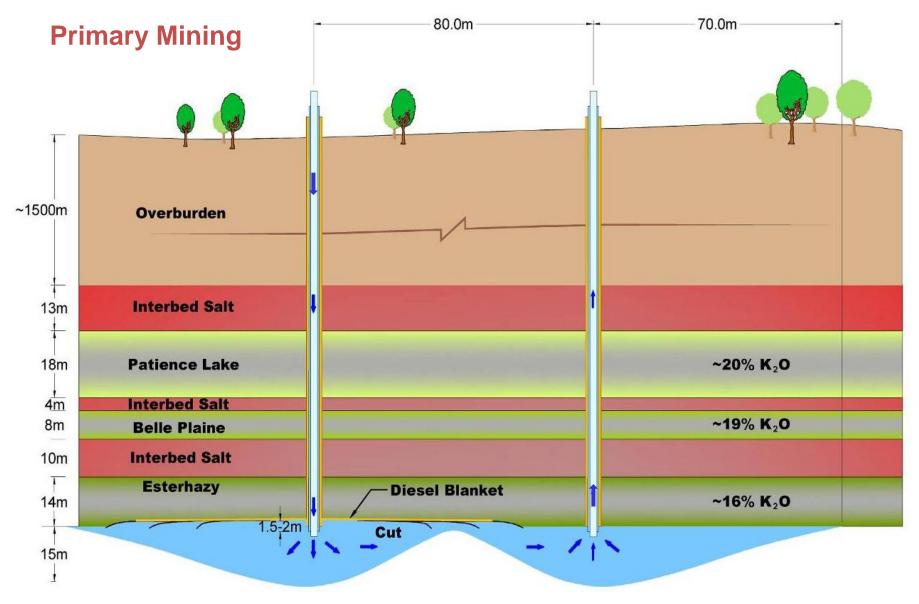




### Dual Well Solution Mining Method as Implemented at Belle Plaine, SK

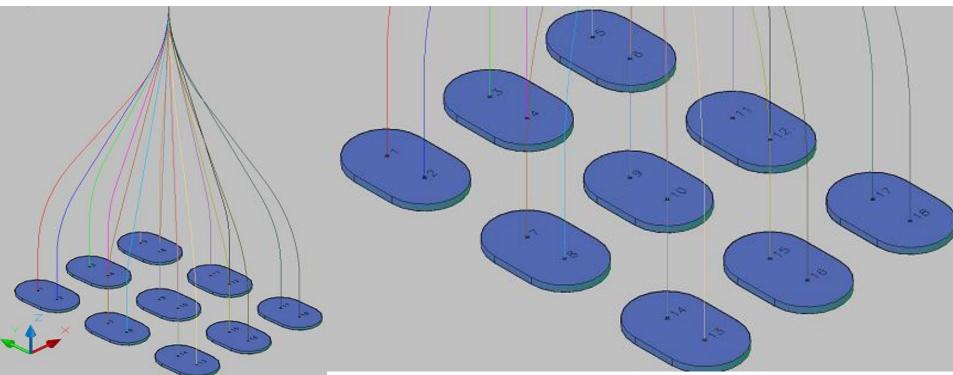


## Solution Mining – The Belle Plaine Method



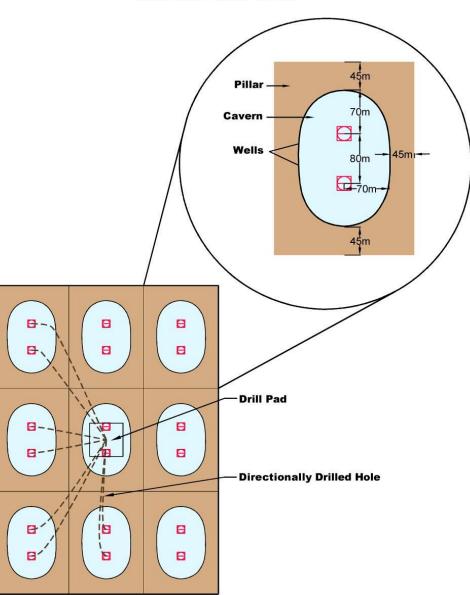


Typical Solution Mining Cavern Arrangement



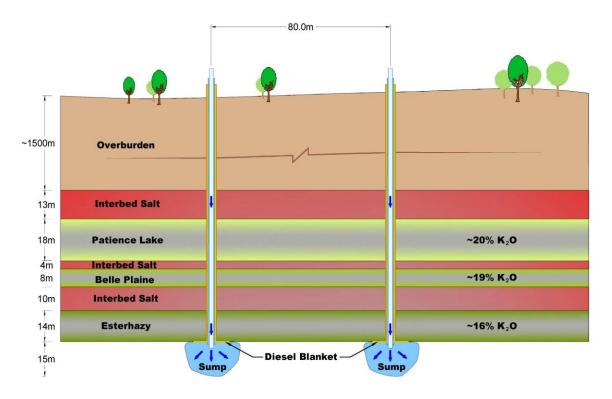
Using the Edmonds et al method, each Cavern requires two wells. Each well is about 1600m deep and is drilled similar to an oil or gas well. In this representation, 18 wells (9 Caverns) are shown being drilled from a single surface location. This is called pad drilling or a cavern cluster. Each solution mining cavern is designed to operate as an independent mining area with each cavern producing about 50K primary tonnes and 12K Secondary tonnes of K60 product per year. Each cavern will produce for between 14 – 18 years.

Each Cavern will Produce about 160 Tonnes of KCl per day. Assuming 400 \$/Tonne K60 Product and an operating Cost of 220 \$/Tonne, each cavern generates a before tax profit of about 10 million dollars per year. Typical Solution Mining Cavern Arrangement Plan View with Dimensions



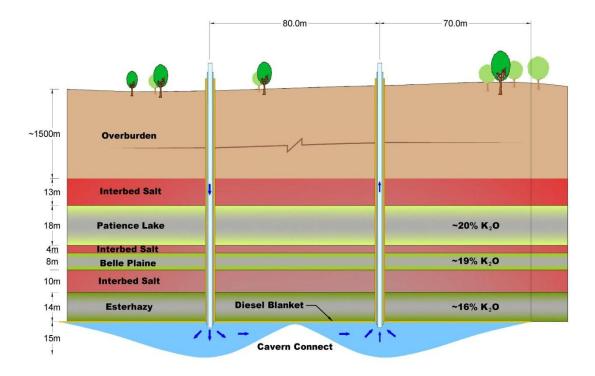
### **Cavern Plan View**

### Sequence - 1



Solution mining is initiated by injecting ambient fresh water to dissolve a sump area at the NaCl salt at the base of the solution mining caverns. This sump allows cavern volume for insoluble material to settle within the cavern without affecting the solution mining process. Note that this step utilizes an oil or diesel blanket to control vertical cavern growth. This step typically requires 30 – 60 days to complete.

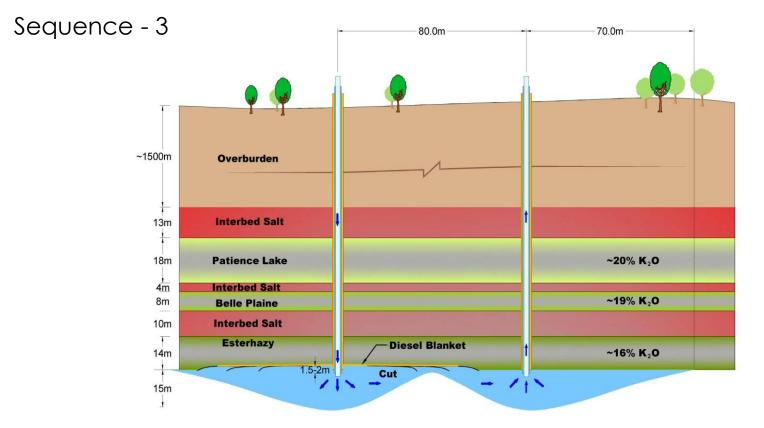
### Sequence - 2



### **Cavern Connection and Roof Development**

As the sump development is complete, fresh ambient water injection is continued and the individual caverns are solution mined using a special technique that will cause the caverns to connect or merge. Upon successful connection of the caverns, the combined cavern is solution mined in a manner that creates roof area for the subsequent solution mining. These combined steps take between 8 and 12 months to complete.

### **Primary Mining**



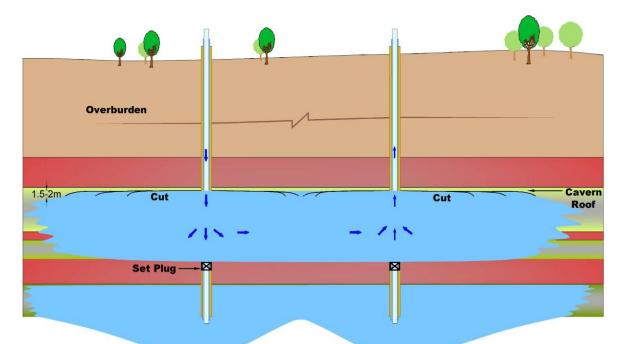
Upon completion of the cavern roof development, the primary mining of potash is initiated by creating a 1.5 - 2.0 meter casing cut or perforation into the potash mineralized zone. Heated fresh water is injected to dissolve both KCI (sylvite) and NaCI (halite) into solution. As the KCL and NaCI are dissolved into solution creating a void at the top of the cavern, the diesel or oil blanket flows upward into the cut area and flows outward laterally controlling the vertical growth of the cut as additional salt is dissolved. The primary mining stage can last for 5 - 8 years.

# Sequence - 4

**Inverted Fracture Technique** 

The inverted fracture technique allows the segregation of the inter bedded salt between the Belle Plaine and the Esterhazy potash zones from the solution mining process. It consists of setting a bridge plug in the casings of each well about a meter below the base of the Belle Plaine zone, cutting or perforating the casings at the base of the Belle Plaine zone and hydraulically fracturing along a clay seam between the two wells. This technique works effectively due to the slight sag of the inter bedded salt caused by the Esterhazy zone cavern and the presence of a thin clay seam at the base of the Belle Plaine zone.

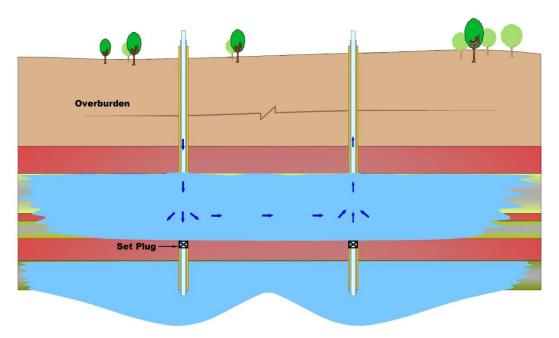
### Sequence - 5



As adequate cavern volume is created to accommodate insoluble materials and NaCl which will precipitate as KCl is dissolved into a saturated NaCl brine solution, the cavern can be converted to continuous secondary (selective) mining. A heated saturated NaCl brine is injected instead of fresh water. Only the KCl is dissolved into solution and some NaCl precipitates from solution. The cavern production rate will decrease between 40 - 60% as this stage is initiated due to the slower dissolution rate of KCl into NaCl brine but the technique allows significant flexibility in secondary mining timing and cooling pond potash recovery. Secondary mining and cooling pond potash recovery require about 25% of the energy of primary mining.

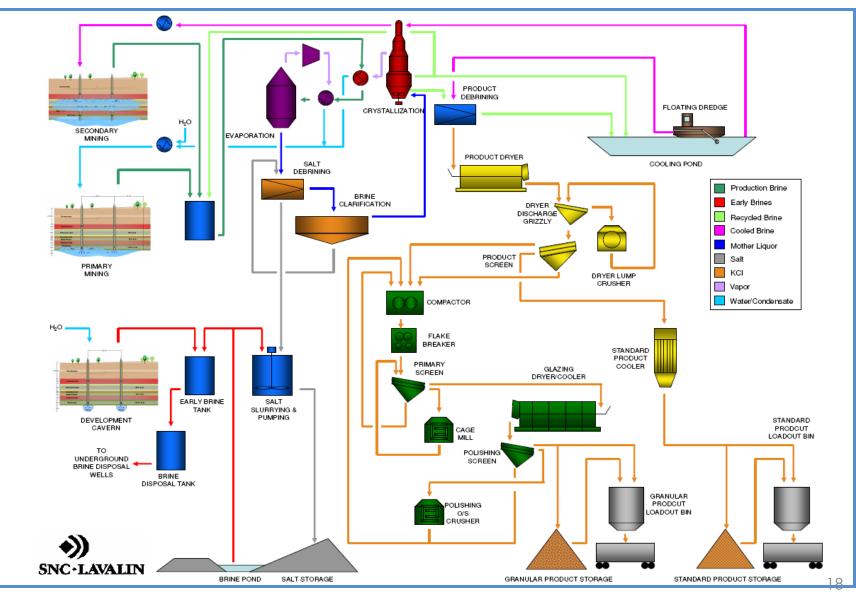
#### **Secondary Batch Mining**

### Sequence - 6



As the potash mining progresses to the top of the Patience Lake potash zone and continuous cavern operation cannot be maintained, secondary batch mining can be initiated. The technique is the same as secondary continuous mining except flow into or out of the cavern is stopped and the fluid within the cavern is allowed adequate time so reach full saturation in KCI and then upon reaching KCI saturation, the fluid in the cavern is displaced and the process repeated. At the end of the cavern life, it can take over a year in time for the cavern brine to reach full saturation in KCI.

## **GENERAL PROCESS FLOWSHEET**





# Solution Mining for the 21<sup>st</sup> Century – Selective Mining and Enhanced Recovery



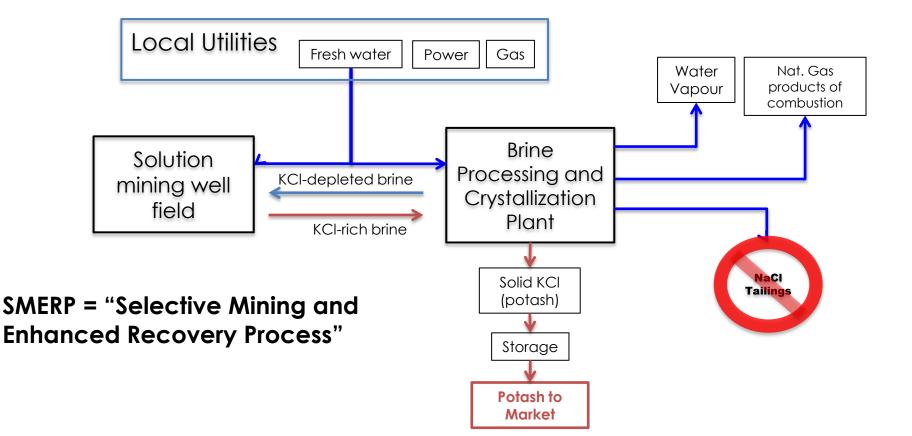
## Why Change?

"Potash 2.0" developments must deal with the issues identified during the past 50+ years of operation in SK (and exacerbated by the recent potash "rush")

Issue	Discussion
Significant salt tailings stored on surface for indefinite periods of time	Resolution of the problem for existing operations is difficult. Using mining methods that leave all or most of the salt underground provides advantages to new operations.
Large fresh water consumption	Existing mining methods consume very large volumes of fresh water, solution mining more so than conventional mining. Methods to increase re-circulation and prevent creation of excess brine will significantly reduce fresh water use.
Energy consumption, particularly for evaporation-crystallization solution mining operations is very large	Thermal processes consume large amounts of energy – new approaches driving for energy reduction result in not only reduced operating costs but lower carbon footprint as well.



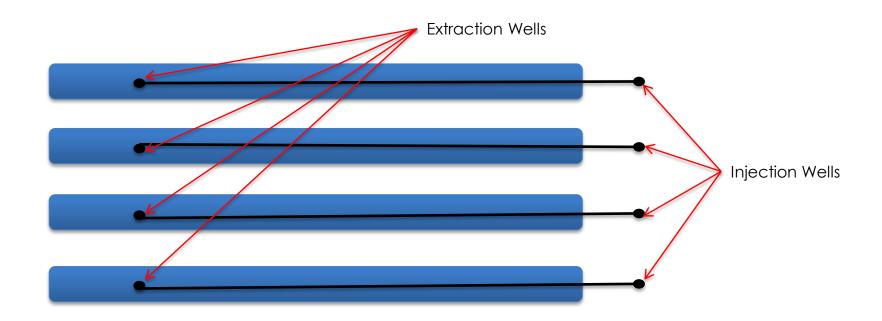




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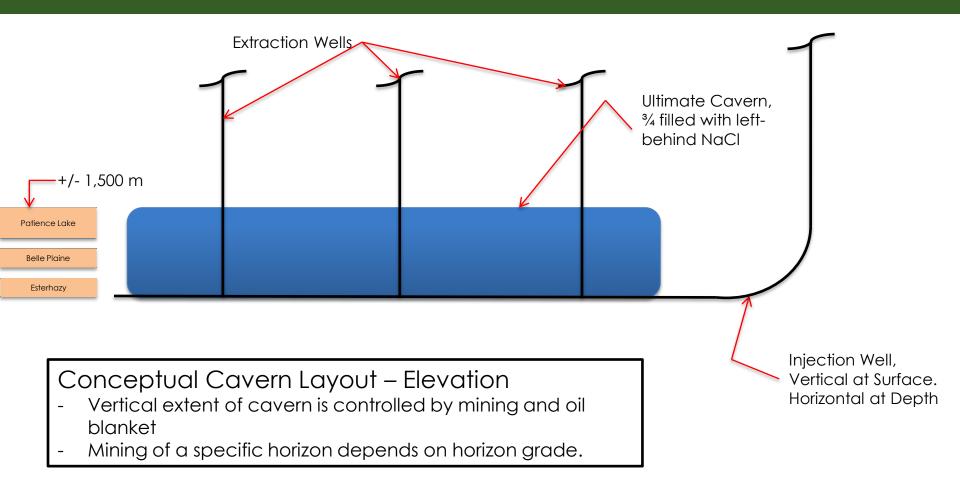
## SMERP – Solution Mining



Conceptual Cavern Layout – Plan view. Horizontal Caverns, mined Using horizontal drilling techniques now perfected in Western Canada.

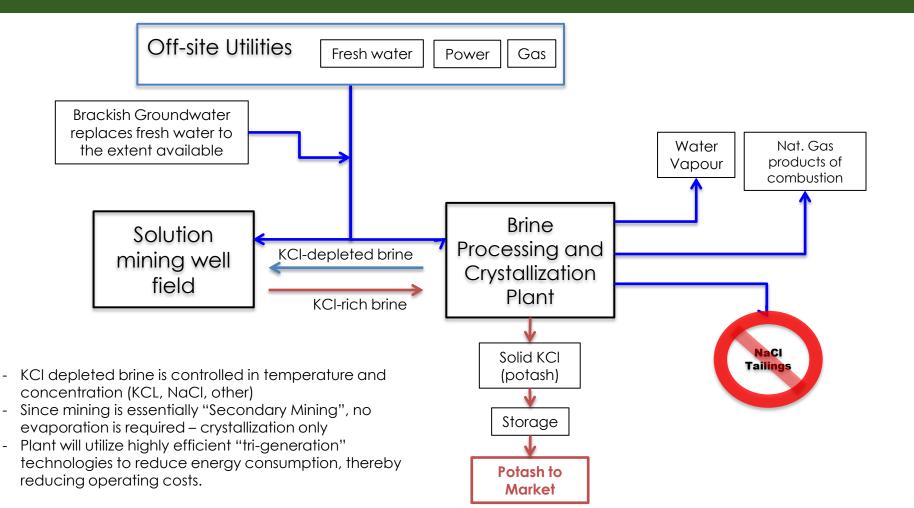


## SMERP – Solution Mining



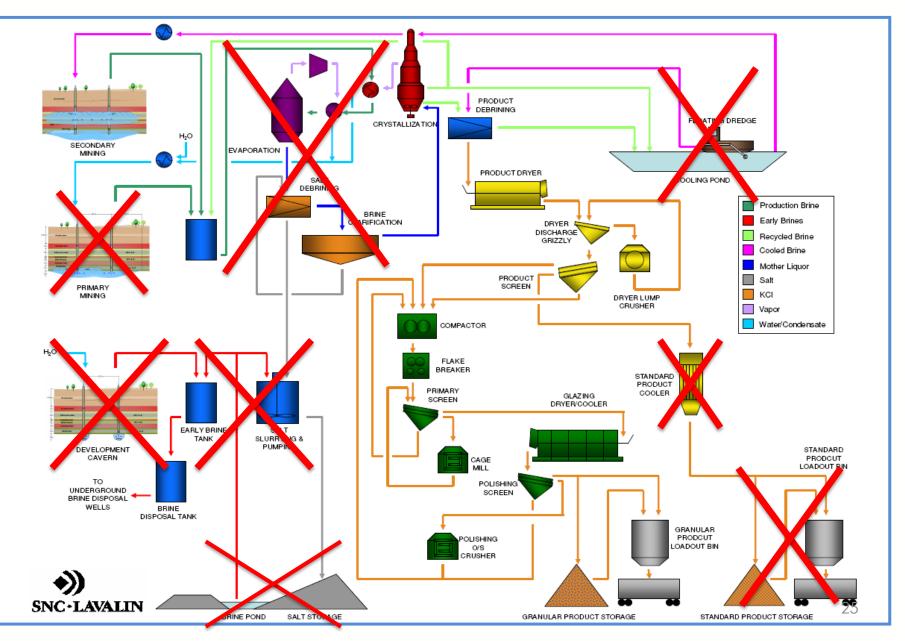


## SMERP - Processing



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### DIFFERENCES BETWEEN BELLE PLAINE PROCESSING AND SMERP





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