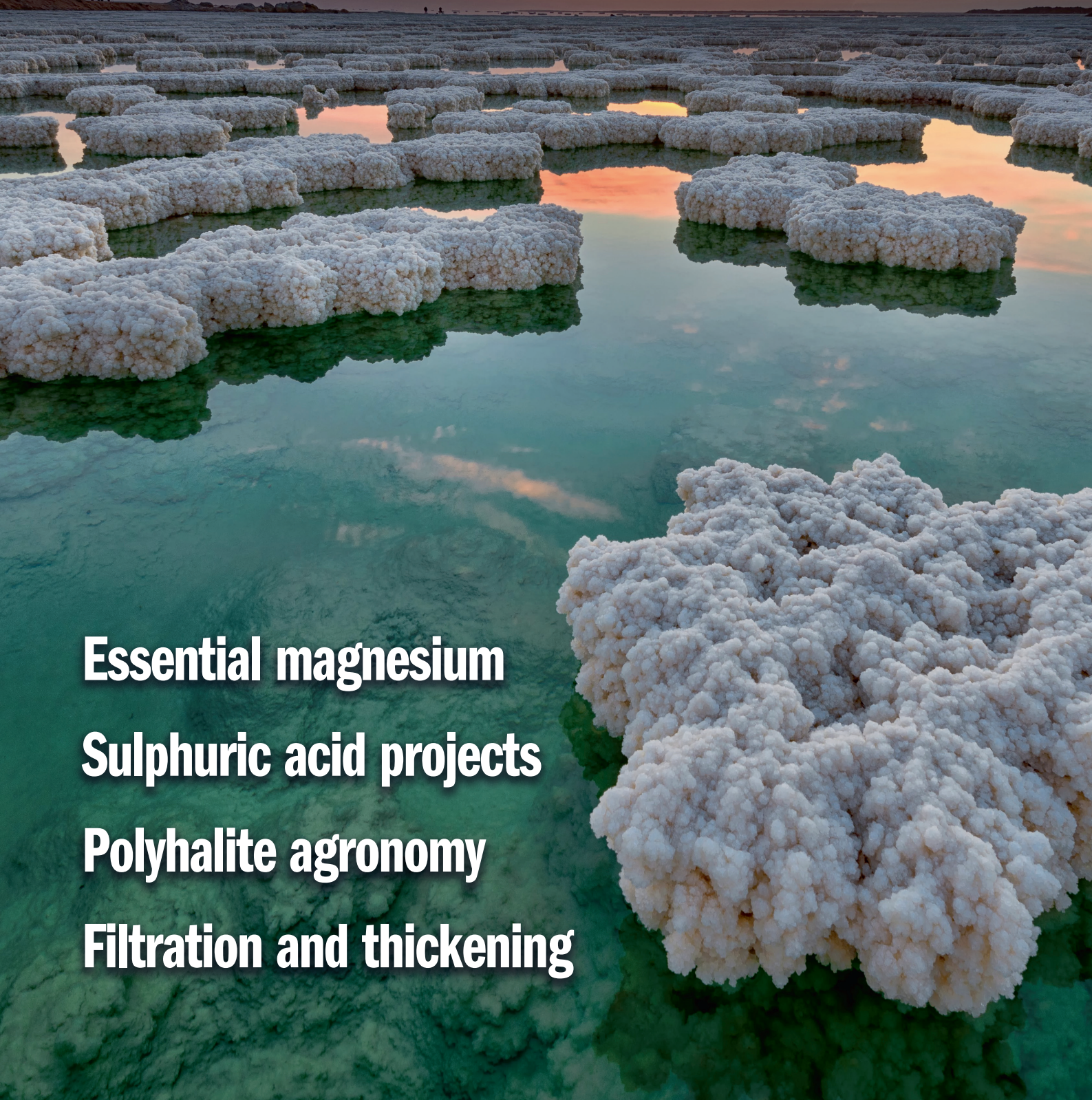


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POTASH: ESTERHAZY K3 EXPANSION PROJECT, CANADA



North and South Headframes, K3 expansion project, Esterhazy, Saskatchewan.

PHOTO: MOSAIC

Mosaic operates one of the world’s largest potash mining sites at Esterhazy, Saskatchewan, Canada. The site, which has been in operation since 1961, consists of the K1 and K2 potash mines, their respective K1 and K2 mills, and the under development K3 mine shafts. The Esterhazy complex produces a range of muriate of potash (MOP) products, including crystal, ag white, granular, and standard. The end-users for these products are primarily agricultural, supplemented by some industrial customers.

Ambitious expansion plans

Mosaic’s large-scale expansion plans for Esterhazy have involved increasing plant capacity at the K1 and K2 sites and

building the new underground K3 operations. Upon completion, the ambitious K3 development will create one of the largest underground potash mines in the world (*Fertilizer International* 490, p43).

The objective of the K3 expansion is to install massive hoisting capacity at Esterhazy’s operations – which in turn will enable production of finished potash products on a much greater scale. K3, which is scheduled to be fully operational in 2022, will eventually replace the older K1 and K2 mines (Figure 3).

Hatch has been Mosaic’s long-term engineering partner at Esterhazy, dating back to the original project to expand the capacity of the K1 and K2 mills. Mosaic engaged Hatch as their full engineering, procurement, and construction manage-

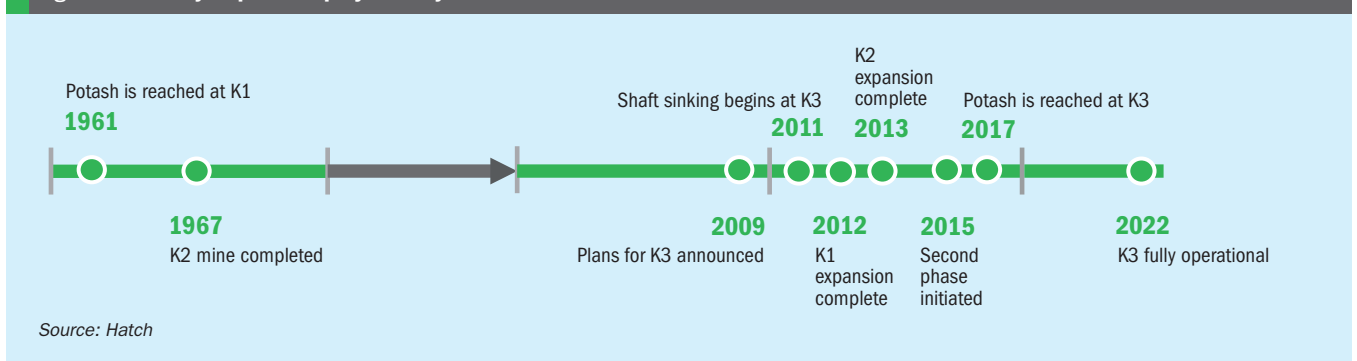
ment (EPCM) services partner following Hatch’s successful completion of the scoping, prefeasibility, and feasibility studies for this project.

By 2013, the K1 and K2 expansion projects had been completed below budget, with minimal negative impact to operations and an excellent safety record. Successful advances were also made in process automation and new production controls.

Massive state-of-the art operations

The current phase of the Esterhazy expansion is the construction of K3. This highly ambitious engineering project involved sinking twin shafts to a depth of just over 3,280 feet, and slip-forming two headframes with a design height of over 380 feet.

Fig. 3: Esterhazy expansion project: key milestones



Source: Hatch

Hatch has participated in the K3 project from its initiation in 2008, starting with scoping-level studies all the way through to project development. Indeed, Hatch will continue to partner with Mosaic until K3 is fully commissioned and operational in 2022.

The Mosaic Company approved the first stage of development at K3 in 2009. This gave the go-ahead for the detailed design and construction management of two production shafts, headframes, and hoisting systems.

The North K3 headframe, the tallest structure in the province, houses and operates the massive hoists and skips that will transport potash to the surface from more than half a mile underground.

Shaft sinking

Saskatchewan’s geology is complex and also features high water pressures at depth. Hatch and Mosaic addressed these challenging conditions by using unique shaft-linings techniques when sinking the two 20-foot diameter shafts through water-bearing geological formations.

To accomplish this, both shafts were frozen to hold back groundwater while the permanent liner was installed. “To control water inflow from the Blairmore formation, we used unique technology to freeze the ground surrounding the shafts to a depth of 1,600 feet,” explains Scott Williamson, Hatch’s shaft manager. “The shaft is lined with concrete and steel in various configurations based on the geology encountered.” The permanent shaft liner consisted of support concrete, as well as a composite steel liner to prevent water ingress, where required.

K3 has two shafts. The first is used for both production and service, while the second is dedicated to production. The two pairs of production skips each have a 60-ton payload.

Following shaft sinking, the next hurdle was the slip-forming and mechanical fit-out of the North headframe. This structure towers more than 380 feet above the prairies and houses two massive hoists – the Koepe and Blair. The Koepe hoist moves potash to the surface from underground, while the Blair hoist carries a cage for people and equipment. Hatch’s globally-responsive team of experts from Canada, Australia, and South Africa – working closely with Mosaic – designed the overall hoisting systems. These use leading-edge

technology, state-of-the-art automation, and unique hoists.

Construction in two stages

Construction at K3 – comprising foundations, an electrical substation, ground freezing, shaft sinking and hoists – was scheduled in two stages. The first construction stage included:

- Site preparations
- Sinking and lining of the two shafts
- Hoist equipment and systems in the North shaft
- Egress hoist and headframe, bottom steel, surface facilities
- Preliminary mine development.

This phase of the project was completed in 2018.

The ongoing second construction stage involves:

- Replacing the temporary sinking headframe in the South with a production headframe and hoisting system
- Completing the underground development
- Debottlenecking the K2 mill to achieve the final desired capacity of the Esterhazy complex.

Shaft construction was performed using an unusual working platform – a five-level, shaft-sinking Galloway (see photo). An excavator suspended from the Galloway removes blasted muck to large buckets, which were then hoisted to the surface. Also, to reduce underground construction time, the steelwork of the shaft load-in station was modularised. To reduce shaft hoisting times and assembly times underground, innovative work practices were also used to lower the large quantity of heavy mobile equipment and bulk material handling systems.

Meeting major milestones

Years of careful planning were finally realised in February 2017. This was the date when the team celebrated a crucial K3 project milestone – the shaft finally reaching potash at a depth of 3,350 feet (Figure 1). Other major project milestones have been achieved in the four years since.

In May 2017, the team broke through the connection drift between the North and South shafts, located some 450 feet apart. This achievement was followed shortly after by the completion of the North shaft potash-level station.



PHOTO: HATCH/MOSAIC

Galloway shaft sinking platform and potash layer, Esterhazy.

The completion of the South shaft potash station, including the equipment assembly bay and electrical substation excavation, was subsequently completed in July that year. Then, in October 2017, another significant project objective was attained – the lights were turned on underground and a new, fully-assembled drum miner chassis, weighing 60 tons, was lowered into the mine.

The hoisting systems in the North shaft were commissioned in May 2018. This enabled K3 to enter operations and the ramp-up of production to begin. The next stage during 2019 was to finalise the design of the South headframe and associated equipment, before starting construction to replace the temporary headframe.

The South headframe

In August 2020, contractor Hamon Custodis Cottrell Canada, Inc commenced a continuous slip-form concrete pour to construct K3’s 313-foot-tall South headframe. The new headframe replaced the smaller temporary structure previously used for shaft sinking and the installation of shaft bottom steel in the mine.

The continuous pour would take a massive 784 concrete trucks and 24 back-to-back days to complete. Incredibly, the structure grew upwards at a rate of six and a half inches per hour. Concrete trucks arrived every 45 minutes – delivering a

total of 4,350 cubic meters of concrete. The headframe also incorporated three million pounds of rebar (reinforcing steel).

Once the South headframe was completed, outfitting began to prepare it for operation, with a focus on the hoist infrastructure that would be required to raise millions of tonnes of potash ore from K3 to the surface. The South shaft is solely dedicated to hoisting potash ore, unlike its sister North shaft which moves both people and materials. Indeed, the South headframe will double hoisting capacity at K3 – from 36,000 tonnes to 72,000 tonnes – once it becomes fully operational in 2022.

Work continued on the South headframe during the latter part of 2020 to add a roof penthouse, internal stairways, wall covers and a permanent 65-tonne overhead bridge crane for servicing the Koepe hoist. Mosaic reported further progress on the South shaft headframe in April this year. This included outfitting with piping, electrical trays, cable, lighting and other components.

A priority during the first half of 2021 will be the massive 2,000 tonne steel floors required to support the Koepe hoist and the 60-tonne skips used to raise ore to the surface. These steel floor will be assembled at ground level in modules and then raised to their final position using a hydraulic jacking system. Concurrently, the Koepe hoist, elevator and all the electrical/mechanical infrastructure will also be installed.

The next big milestone will be rope-up and installation of the large 60-ton skips. This is scheduled for autumn of 2021, with commissioning to follow.

Ramping up production

K3 continues to break records – setting a new daily tonnage record in February this year. Mosaic is now consistently hoisting ore through the North shaft and expects the average daily tonnage to continue increasing as they move into the second half of the year.

Underground engineering to support the production ramp-up is continuing – including work on the south surge, coarse ore bins and the mainline conveyor systems. The sixth four-rotor mining machine commenced cutting underground at K3 in January, while the first two-rotor mining machine was also available to start development work in February. As well as a further new machine added in April, Mosaic expects to deploy three more mining machines to the K3 fleet when the South headframe becomes operational next year.

All these new mining machines can run autonomously. In fact, Esterhazy's engineering team is working towards automating the entire ore flow process – tracking potash as it moves underground from mining machines to conveyors to bins, before being hoisted upwards to the surface and then moved by overland conveyor to the K1 and K2 mills. These operations will be monitored from a state-of-the-art Integrated Operations Center (IOC). Mine automation at K3 is a part of Mosaic's wider plans to revolutionise its business by adopting digital technology. ■