



# **Recovery of uranium as side product in the Terrafame metal mine – regulatory perspectives**

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# Terrafame mine

- Terrafame Ltd operates a Ni-Zn-Cu-Co open pit mine in Sotkamo, Finland
- The mine is located on a relatively remote location in central Finland near Kajaani
- It is situated approximately 20 km from nearest cities
- The area of the mine site is 60 km<sup>2</sup>
- When in maximum capacity operation, annual excavation volume is approx 40 Mtonnes, making it the largest mine in Finland

# Terrafame mine history

- The mine was opened by Talvivaara Ltd in 2008
- Talvivaara Ltd had plans for Uranium production and a Uranium facility was constructed and licensed
- Uranium extraction was never started due to Talvivaara's environmental and economical problems and the Uranium production license was revoked in 2013
- After Talvivaara's bankruptcy, mostly state-owned Terrafame Ltd was formed to operate of the mine
- In October 2017 Terrafame Ltd applied for a license to begin uranium production. STUK has finished its safety review in June 2019, and the license application is now being processed by the Ministry of Economic Affairs and Employment

# Terrafame mine

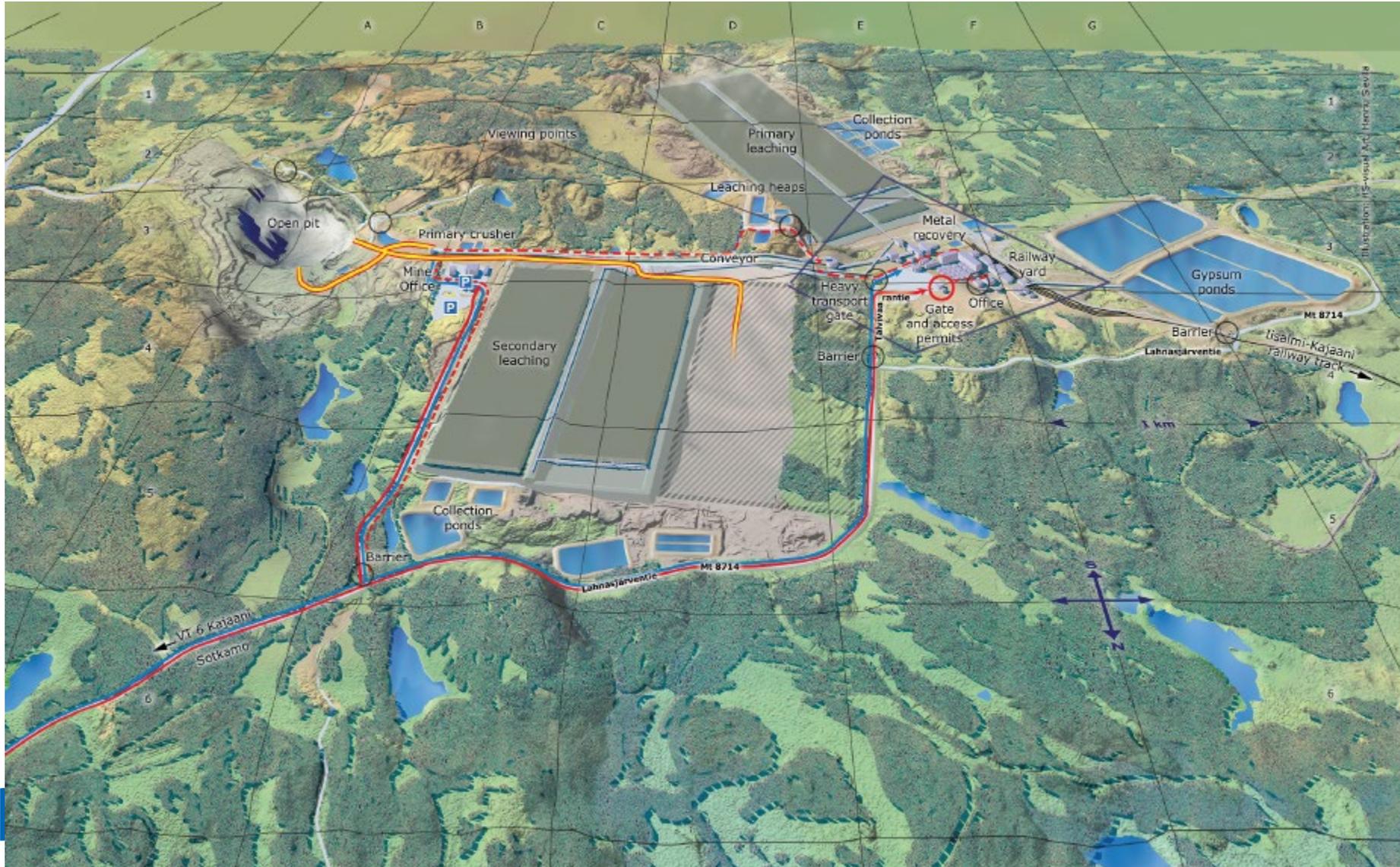


Image: Terrafame

# Uranium at the Terrafame mine

- The ore contains minor amounts of Uranium, on average 15-20 mg/kg
- Uranium content of excavated ore is roughly 270-360 t/a
- The milling of the ore is performed by sulphuric acid-accelerated bioheap leaching, which in addition to the main minerals, also dissolves approximately 50 % of the U, approximately 150 tU/a goes through the metal factory
- Daughter isotopes of Uranium do not dissolve significantly in the bioheap leaching process
- The dissolved U is currently being partly precipitated in the process solution neutralization phase into gypsum ponds at the site (50 tU/a), and the rest precipitates into secondary leaching piles, which have been licensed as waste rock piles
- Terrafame Ltd applied in the end of 2017 for a license to start producing Uranium as yellow cake
- Expected annual production would be at most 250 tU

# Regulatory perspective on Uranium production safety

- Is it safe
  - For the workers?
  - For the public?
  - For the environment?
- Criteria for Uranium production are given in Nuclear Energy legislation
  - Radiation protection of the workers like for any other use of radiation
  - 0.1 mSv/a for the public from the normal operation or from operational occurrences; 1 mSv/a from accidents
  - 0.1 mSv/a for the public from disposal of Uranium production waste from the expected evolution, 1 mSv/a from disturbances
  - No harmful radiation effects for the environment

# STUK's approach to reviewing the application

- STUK's mandate on the review is limited to radiation and nuclear safety, of which STUK issues a Statement for the Ministry of Economic Affairs and Employment
- The possible license is given by the Government based on broader consideration including the overall good of the society
- The plant is a major industrial chemical facility which uses large amounts of hazardous chemicals and is thus regulated by the Finnish Safety and Chemicals Agency.
  - Extraction chemicals used at the facility are very harmful for people and the environment
  - Chemical toxicity of Uranium has been considered in the environmental permit of the mine and limits have been set for annual releases both from the mine and from the Uranium Extraction facility

# Documentation used in the safety review

- Terrafame submitted for STUK
  - Safety assessment documentation, including
    - Description of the Uranium extraction facility processes
    - Waste management
    - Radiation protection arrangements
    - Occupational safety
    - Assessment of consequences of accidents at the uranium extraction facility
    - Environmental monitoring and EIA
    - Description of the organisation
  - Security arrangement documentation
  - Nuclear materials safeguards documents

# STUK's safety review limitations

- Finnish nuclear legislation separates Uranium mining, and Uranium production. Both can happen at the same site, or they can be separated
- STUK is already supervising the mine under radiation legislation due to environmental accidents under the previous operator in 2012 and 2013, which resulted in major leaks into the environment. Small amounts of U were released among other heavy metals.
- Terrafame's ore is of so low grade that from nuclear safety perspective there is no need to regulate the activities. Gypsum waste generated at the mine is currently near the limits set in Basic Safety Standards Directive for natural Uranium containing materials
- The Uranium contents of process solutions rise up to significant levels only in the late phases of separation at the Uranium Extraction facility
- STUK decided that based on the risks of the activities, using graded approach, only the safety of the Uranium Extraction facility was assessed
- The safety of the mining process is regulated under environmental legislation, and from safety perspective that is enough

# STUK's conclusions

- The estimated annual dose for members of the public and for the workers stay well below set limits
- The use of the Uranium extraction facility would not make significant changes in the safety of the mining site
- In the long term, having less Uranium in the waste piles at the mining site would be preferential for the safety of the public and environment, but the effect might not be very significant because the levels of Uranium in the waste piles are low regardless
- Based on the documentation, STUK came into the conclusion that from a safety perspective, the Uranium extraction facility can be given a license by the Government

# STUK's conclusions

- Terrafame's waste management strategy for the Uranium extraction facility is based on recycling of waste forms on the primary leaching pile, where Uranium would re-enter the process solution and re-enter the Uranium extraction facility to be processed into yellow cake.
- A new environmental permit would be needed for this recycling.
- STUK proposed that conditions are set in the license to review the waste management strategy and its implementation based on operating experience after 3 years of operation to ensure the proposed waste management strategy works.
- If needed, a surface disposal facility can be constructed for the Uranium-containing waste forms that cannot be recycled and released from control

