Experience with design of RAW retrieval technology

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Introduction

- It is not rocket-science 
  - Basics in ordinary pumping technology of sludge and liquid streams
  - Well-proven and ordinary technology is used (regular pumps and hoses for food or chemical industry)

- It is radioactive 
  - Need to follow ALARA principles all the time
  - Things must be done remotely as much as possible
  - Common problems must to be solved by unusual solutions 

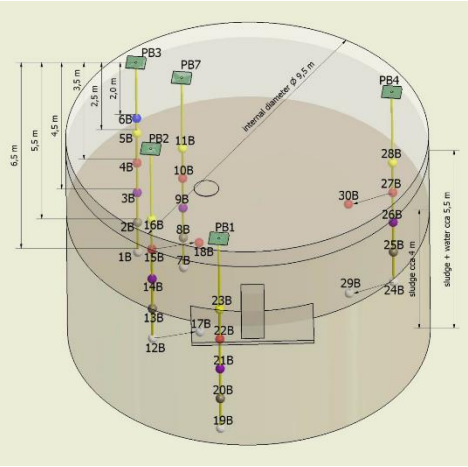
Challenges with RAW retrieval

- RAW in storage tanks can be disposed for decades
  - The waste form can be often hardened, crystallized or degraded
  - Infrastructure of nuclear facility can be in bad condition
  - No history records of waste inlets

- Inhomogeneities of RAW
  - Typical stored RAW is not homogenous – inlets can be occasional, with different parameters, several layers can be created, etc.
  - It is generally impossible to homogenize RAW in storage tank

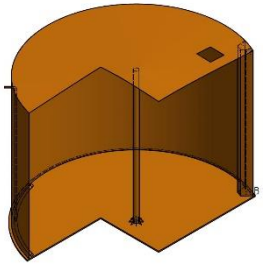
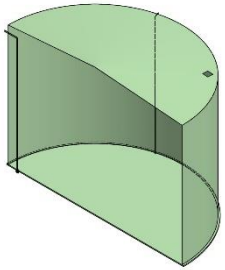
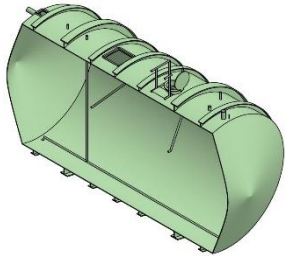
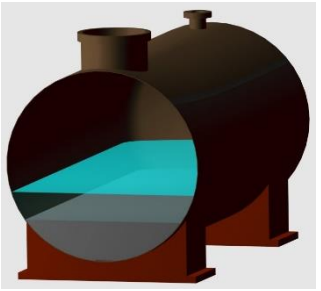
Challenges with RAW retrieval

- Unknown parameters of RAW
  - Radiological, chemical, physical properties
  - Sampling and characterization must be done prior to retrieval. BUT, it costs money and time...
  - Conducted sampling does not guarantee that the properties of RAW are the same in the whole volume
- Radioactivity of the medium
  - Not only harmful to people but also to electronic devices



Challenges with RAW retrieval

- Storage tanks with RAW
  - Different types, dimensions, shapes

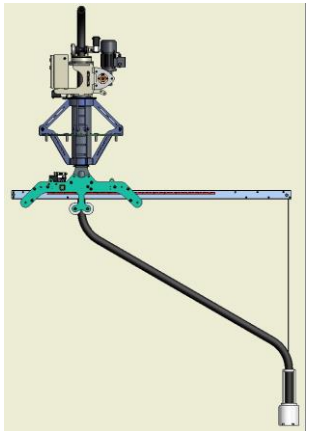





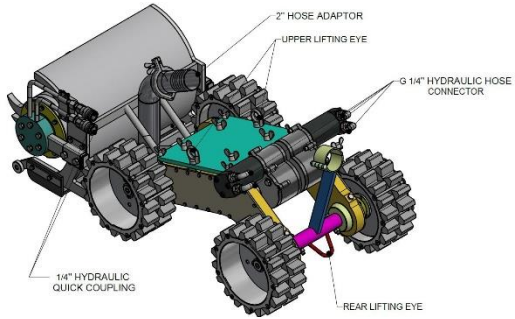
  - Contain various internal piping, columns or sinks

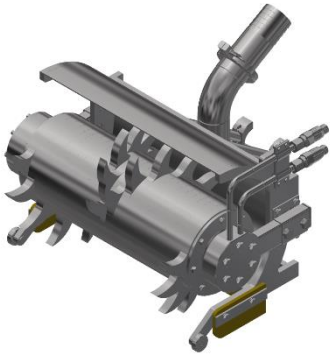


Our experience and approach

- Over-dimensioned technology based on:
  - Various **suction heads** and **manipulation systems** tailored specifically for tanks to be cleaned
  - Custom-made tailored **Remotely Operated Vehicle**
  - Local homogenization of RAW before pumping – active **shredder mill**
  - **Robust pumps** capable pump small solid particles
  - Various engineering methods for clogging prevention

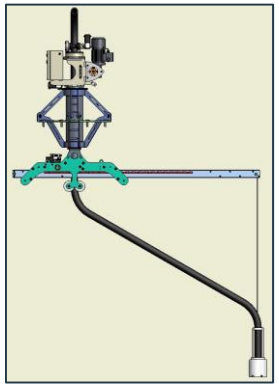






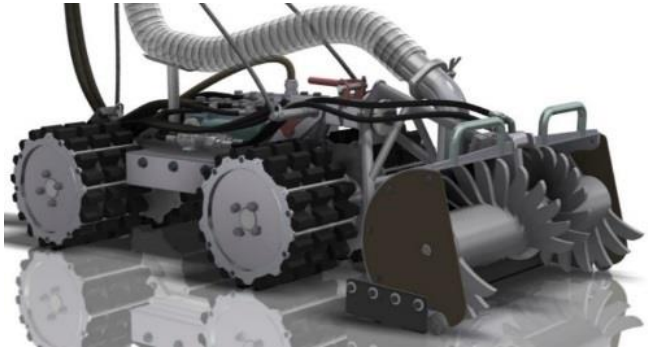
Suction manipulation systems

- Remotely operated manipulating arm
  - Installed in the tank manhole
  - Enables all necessary movements of the head (horizontal, vertical, rotation)
  - Accessibility of the suction head depends on the manhole placement
- Pantograph-based manipulation system
  - Three or more ropes connected to the suction head from different points in the tank ceiling
- Supporting structure equiped with one or more movable hoists
  - Placed over the manhole when possible



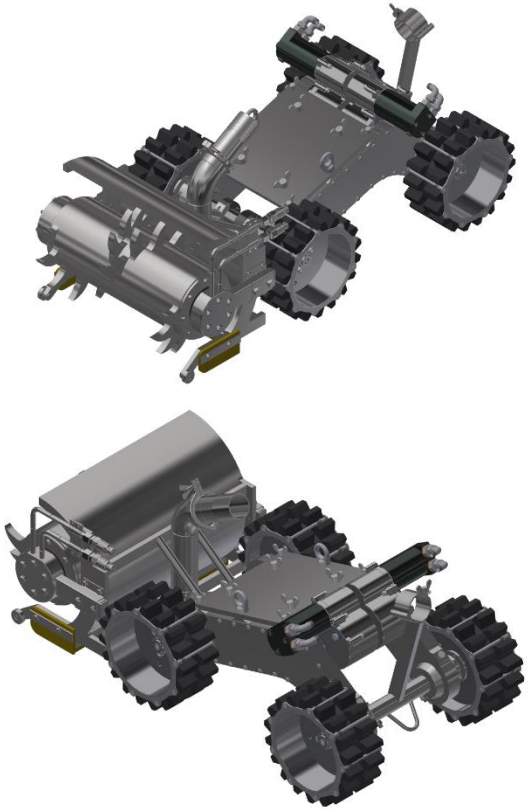
Remotely Operated Vehicle

- Propulsion: electric, pneumatic or hydraulic
- Can reach the whole tank bottom
- Decontaminable
- Can be adjusted for different tank types
- Can be equiped with additional weights to improve traction
- Repairable on the site



Remotely Operated Vehicle – the latest design

- Custom-made device designated to be operated in remote areas with radioactive materials
  - Hydraulic engine
  - Four-wheel drive
  - Radiation and chemical resistant
  - Waterproof
- Can be equiped with different heads or manipulators
  - Usually for sludge and resins retrieval – shredder mill
  - Other can be designed to pumping, shredding, cleaning, inspecting or manipulating

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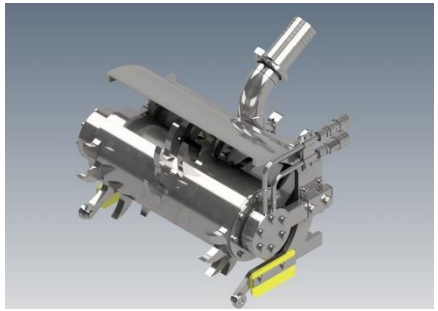
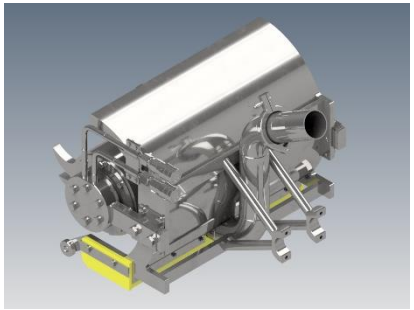
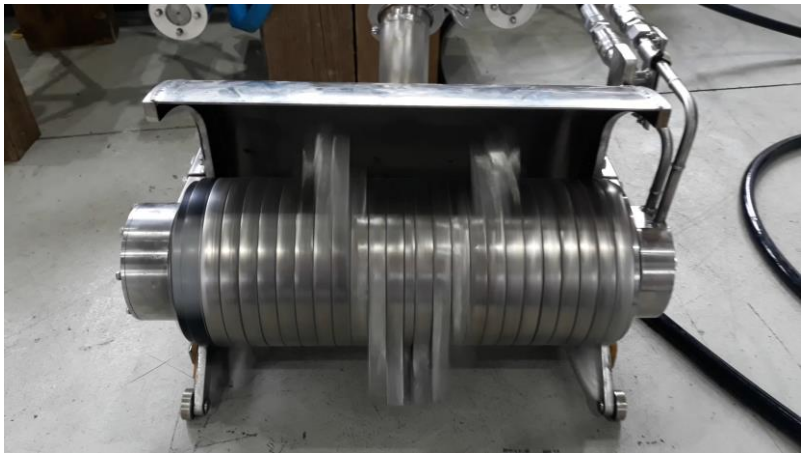
Shredder mill

- Disrupting the solid fractions of RAW and homogenizing the pumped RAW mixture directly to the ROV suction
- Can be used independently – hanged on the rope or rod and inserted to the waste
- Mill speed: 300 rpm (reversible)







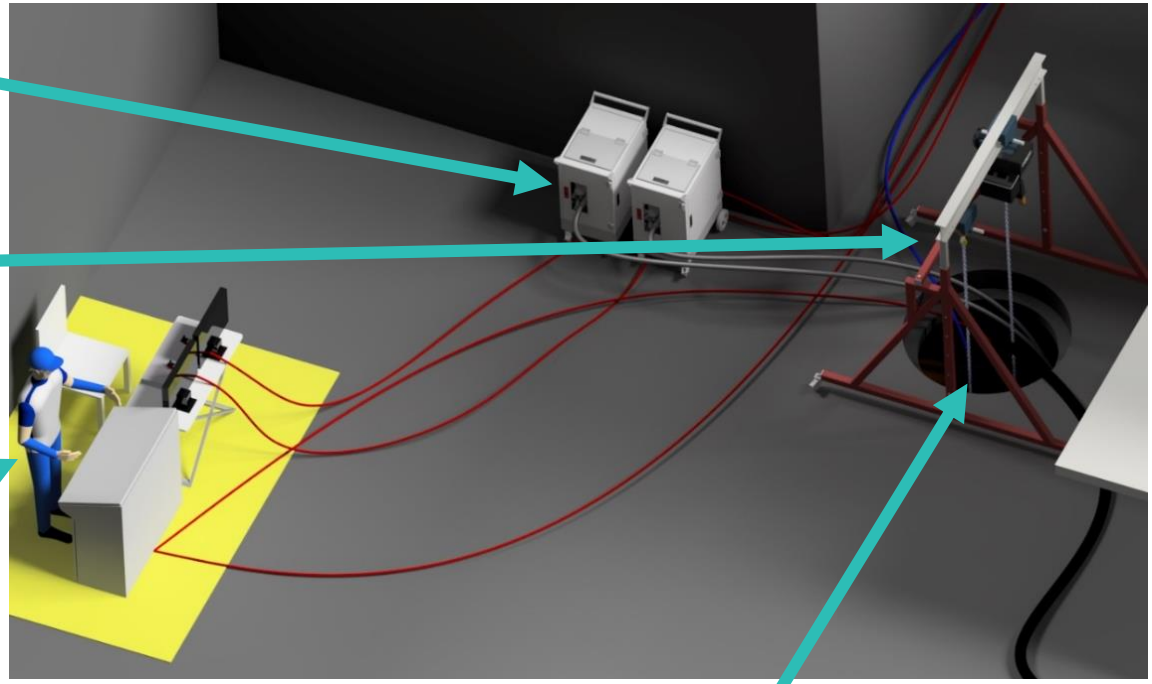
Workplace design

Two hydraulic agreggates for ROV and shredder mill

Manipulation system

- Secures ROV or other suction device and pump

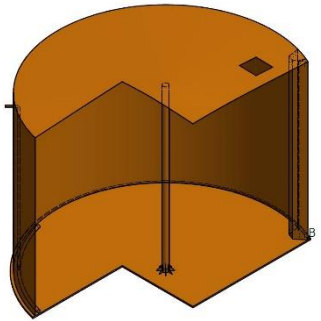
Control workplace

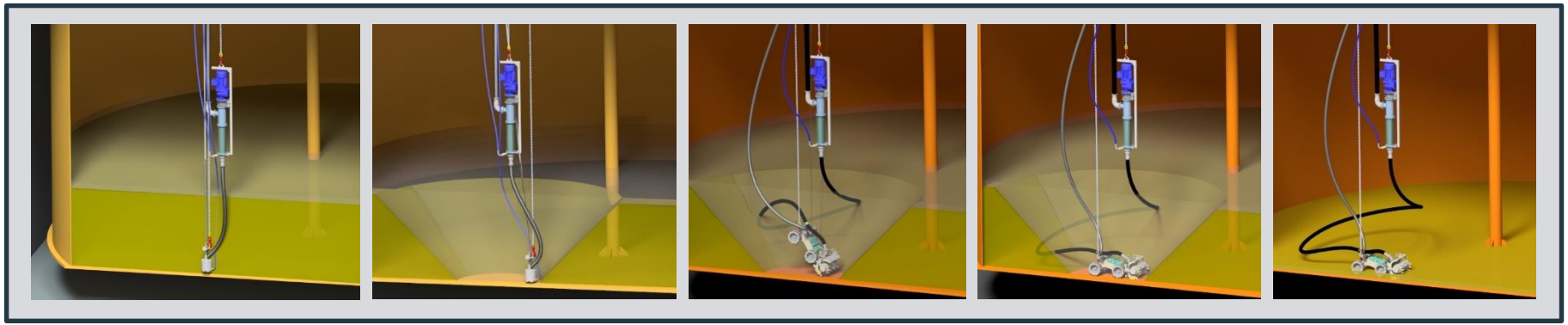


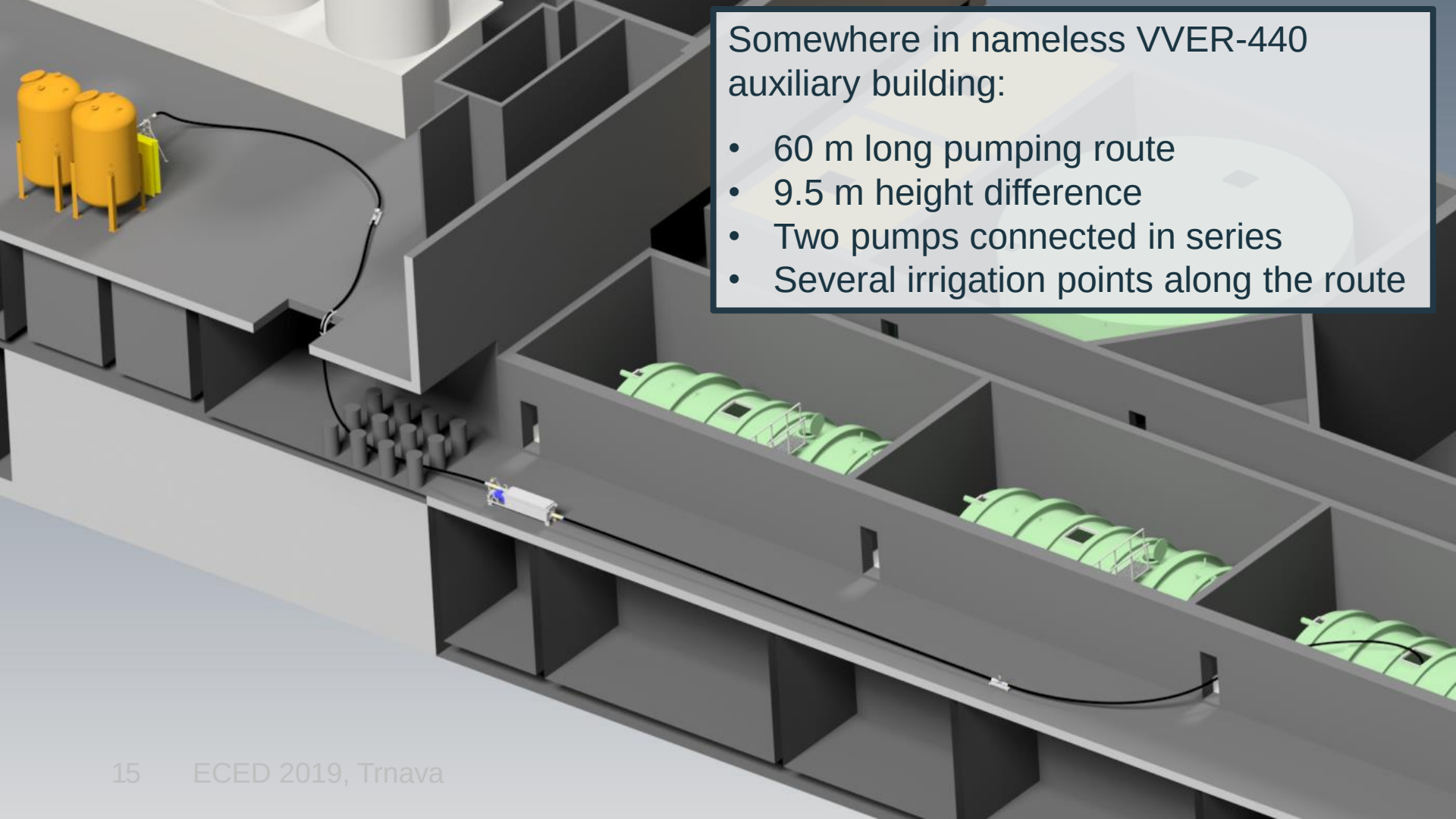
Tank manhole

Complex RAW retrieval and pumping

- Pumping of the large volume
- Wide-spread pumping
- ROV deployment





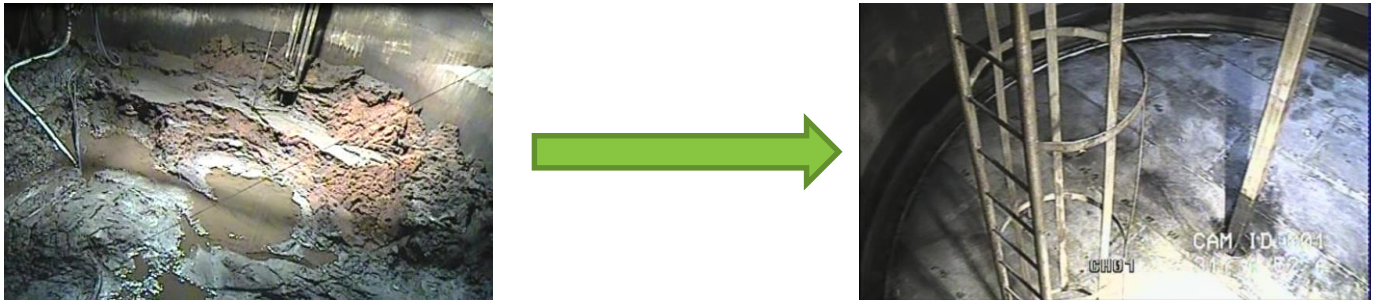


Somewhere in nameless VVER-440 auxiliary building:

- 60 m long pumping route
- 9.5 m height difference
- Two pumps connected in series
- Several irrigation points along the route

Some numbers as conclusion

- Using ROV, it takes approximately **2 months to pump out 100 m³** of sludge from one tank.
  - From installation to clean floor



- Wood Nuclear Slovakia has retrieved **more than 1800 m³** of sludge and spent ion exchange resins from NPPs – Bohunice A1, V1 and V2, Mochovce, Dukovany and Temelin over the past 15 years.

Conclusion

- Wood Nuclear Slovakia developed several types and generations of Remotely Operated Vehicles, manipulation systems and pumping routes.
- Since than, several mistakes have been done... And much more experience and knowledge have been acquired.
- New generation of hydraulically-driven ROV with different specialized heads was developed and it is prepared to be deployed.
- New pumping design, able to pump RAW further than 60 m, was designed.

Thank You for your attention.

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