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Requirements for mine flooding / water treatment at low water discharge

Case Study of mine Schlema-Alberoda, Wismut GmbH

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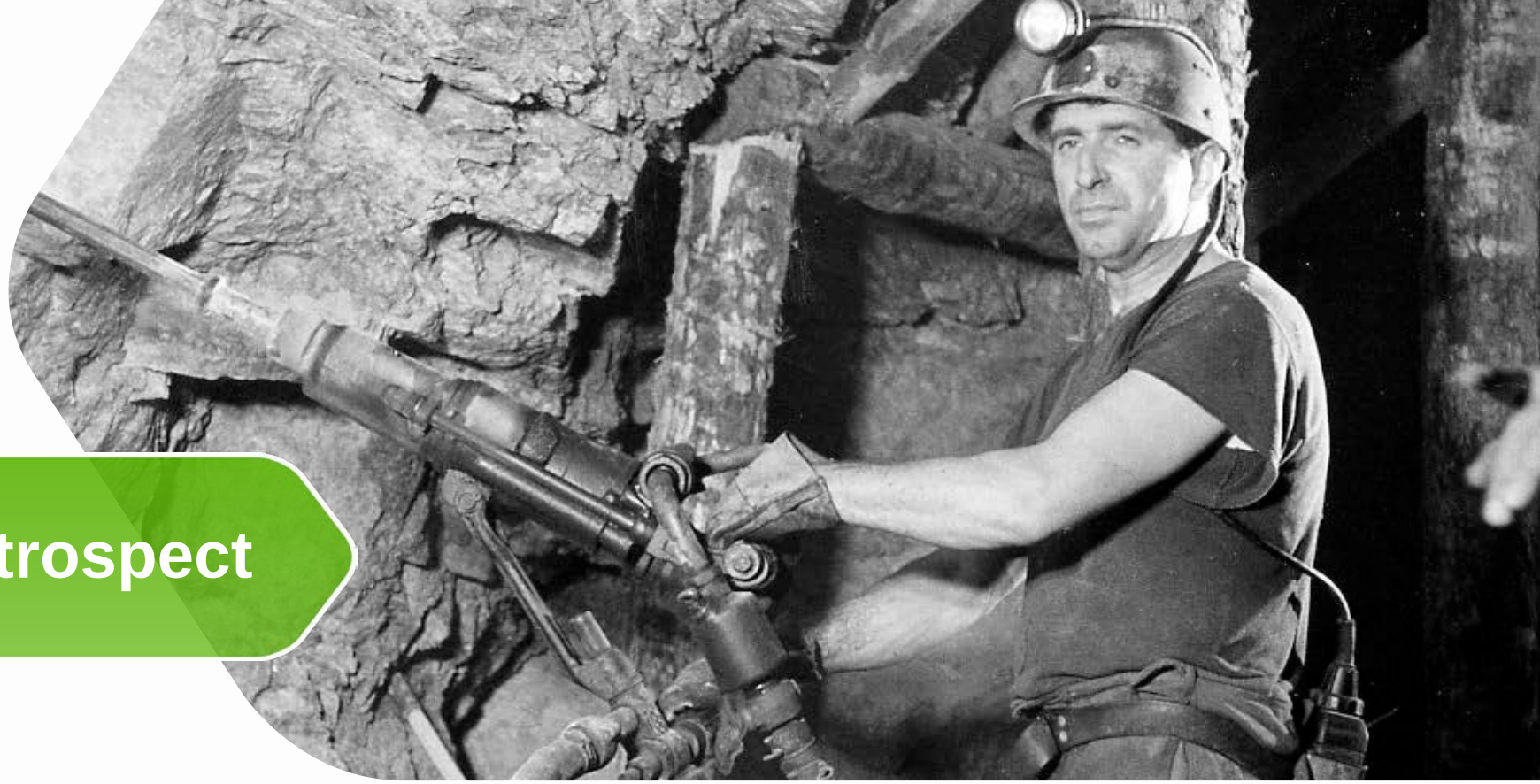
Supported by:

Federal Ministry of Economics and Energy

on the basis of a decision by the German Bundestag



Retrospect

- 1946 Start of uranium mining under supervision of Soviet military
- 1954 Establishment of the binational Soviet-German Stock company (SDAG) Wismut
- **231,000 t** cumulative **uranium** production making Wismut the world's fourth-largest uranium producer
- 1991 Remediation company Wismut GmbH

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Remediation sites of Wismut GmbH in Germany

- All sites are located in the Elbe catchment area
- The site Schlema-Alberoda has an impact on the Zwickauer Mulde water and sediment quality

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Remediation activities at the Schlema site

Coverage of waste rock piles

Dismantling of operating areas

Controlled mine flooding

Water treatment

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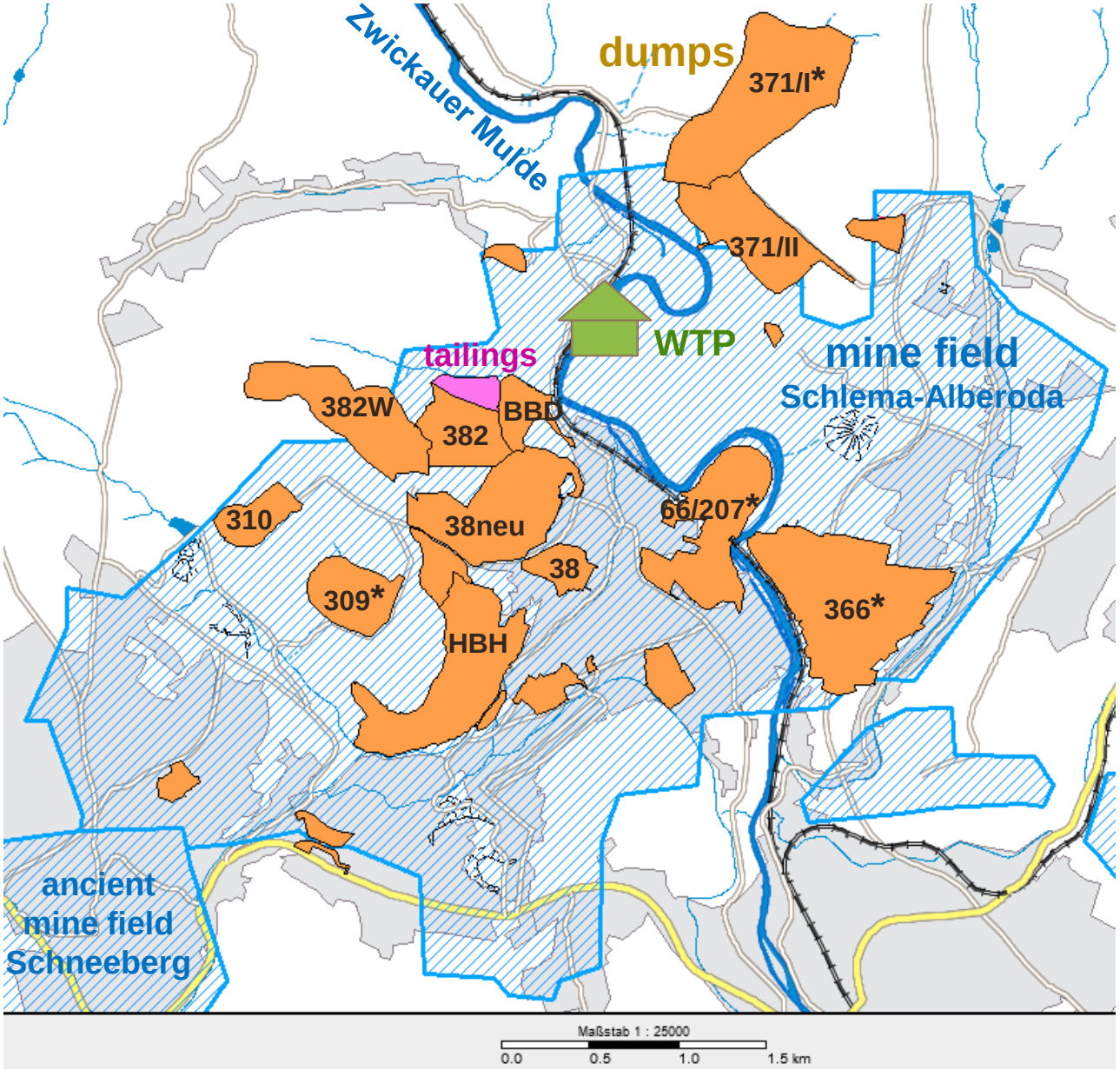
Remediation area of Schlema-Alberoda



- Mine up to 1,800 m depth → mine water
- A lot of large-scale complex dumps (48 million m^3) → seepage water
  *partially treated
- One tailing pond (0.3 million m^3)
- Water treatment plant, capacity up to 1,200 m^3/h

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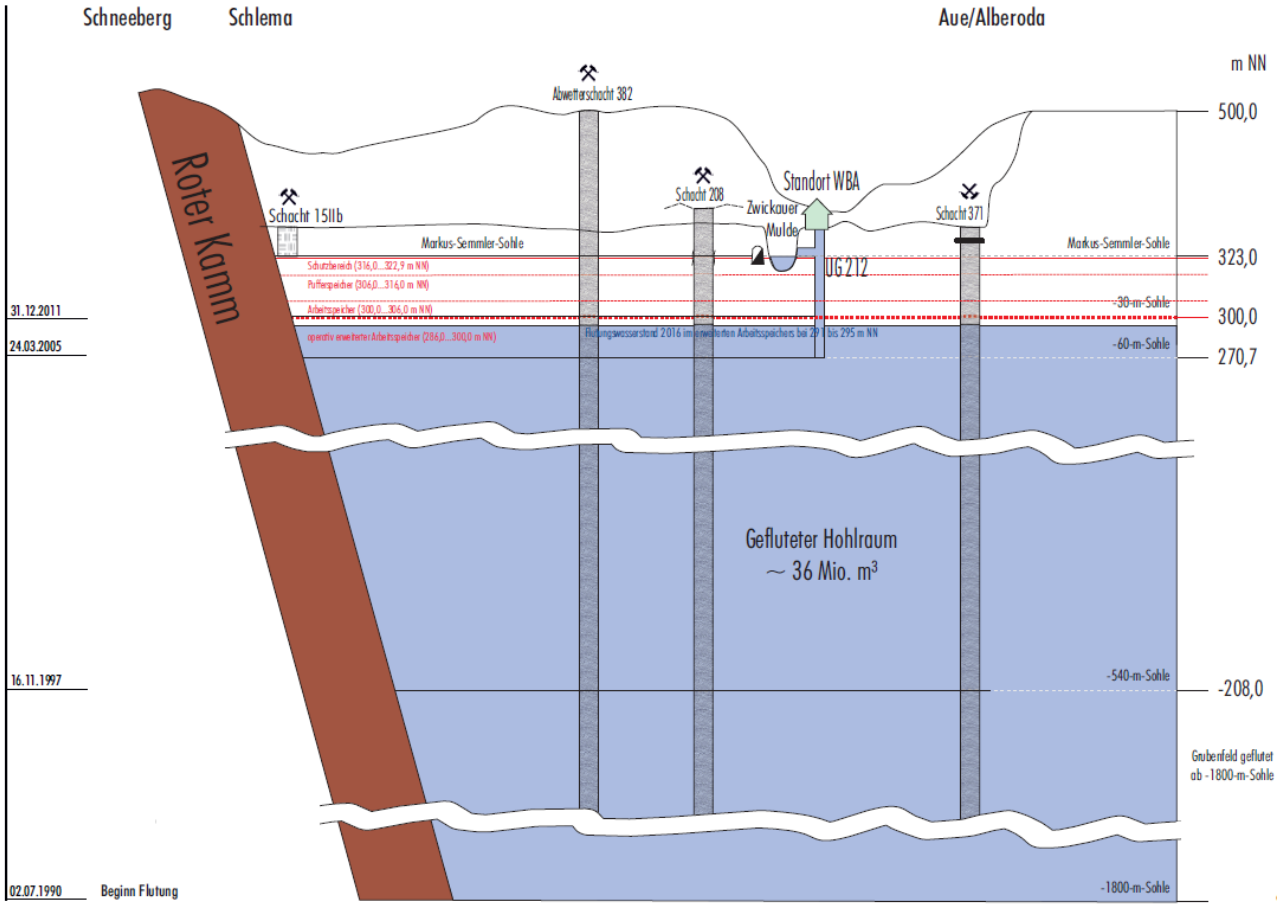
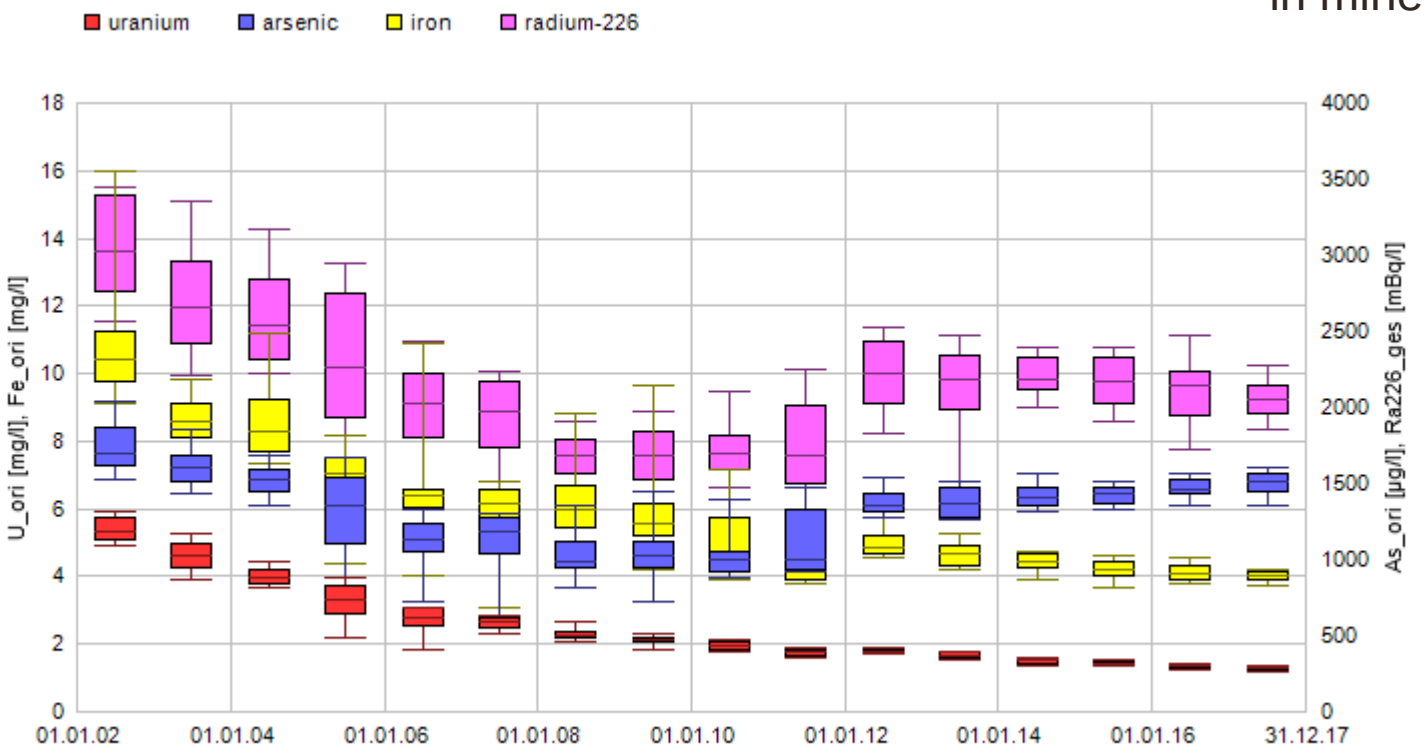
Flooding of mine Schlema-Alberoda

- Flooded volume 36 million m³
- Non-floodable voids 2 million m³
- Mine internal working and buffer storage system for WTP (0.5 million m³)



Flooding of mine Schlema-Alberoda



Mean concentrations in mine water 2017:

Ra-226
2,100 Bq/l

Arsenic
1.5 mg/l

Iron
4.0 mg/l

Uranium
1.3 mg/l

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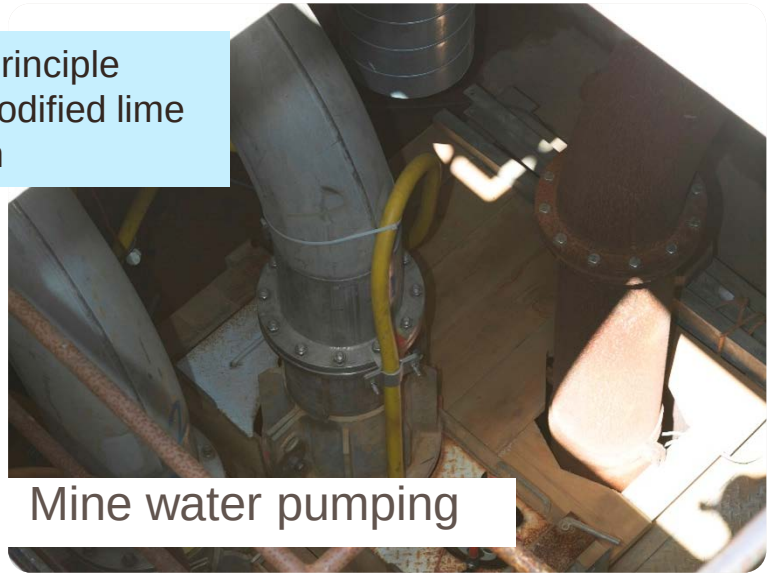
data: Wismut GmbH

Water treatment plant Schlema-Alberoda

Treatment principle based on modified lime precipitation



Mine water pumping

Precipitation basins

Solid / liquid separation

Sludge dewatering

Immobilisation with cement

Lamella separator

Discharge in receiving water

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Requirements for WTP Schlema-Alberoda

- **Flow rate-independent limits**
  - Uranium, Ra-226 → from radiation protection permit
  - additional pH value, filterable solids, Iron, Manganese, Sulfate, Chloride → from water legislation permit

pH	**filterable solids** [mg/l]	**Fe** [mg/l]	**Mn** [mg/l]	**SO_4** [mg/l]	**Cl** [mg/l]	**U** [mg/l]	**^{226}Ra** [mBq/l]
6.5…8.5	20	2	3	2,500	1,000	0.5	400

- **and Arsenic?**

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Requirements for WTP Schlema-Alberoda

- **Flow rate-dependent limits**
  - only for **Arsenic** → from water legislation permit

Gauge Niederschlema / Zwickauer Mulde [m^3/s]	Discharge of WTP Schlema-Alberoda [m^3/h]	Arsenic concen-tration of WTP [mg/l]	Arsenic load of WTP [g/h]
> 10	1,200	0,3	-
7 … 10	1,200 / 750	0,2 / 0,3	-
4 … 7	1,200 / 750 / 500	0,1 / 0,2 / 0,3	-
3 … 4	1,200	-	84
< 3	800…1,200	-	56

Are there natural discharge relations ?

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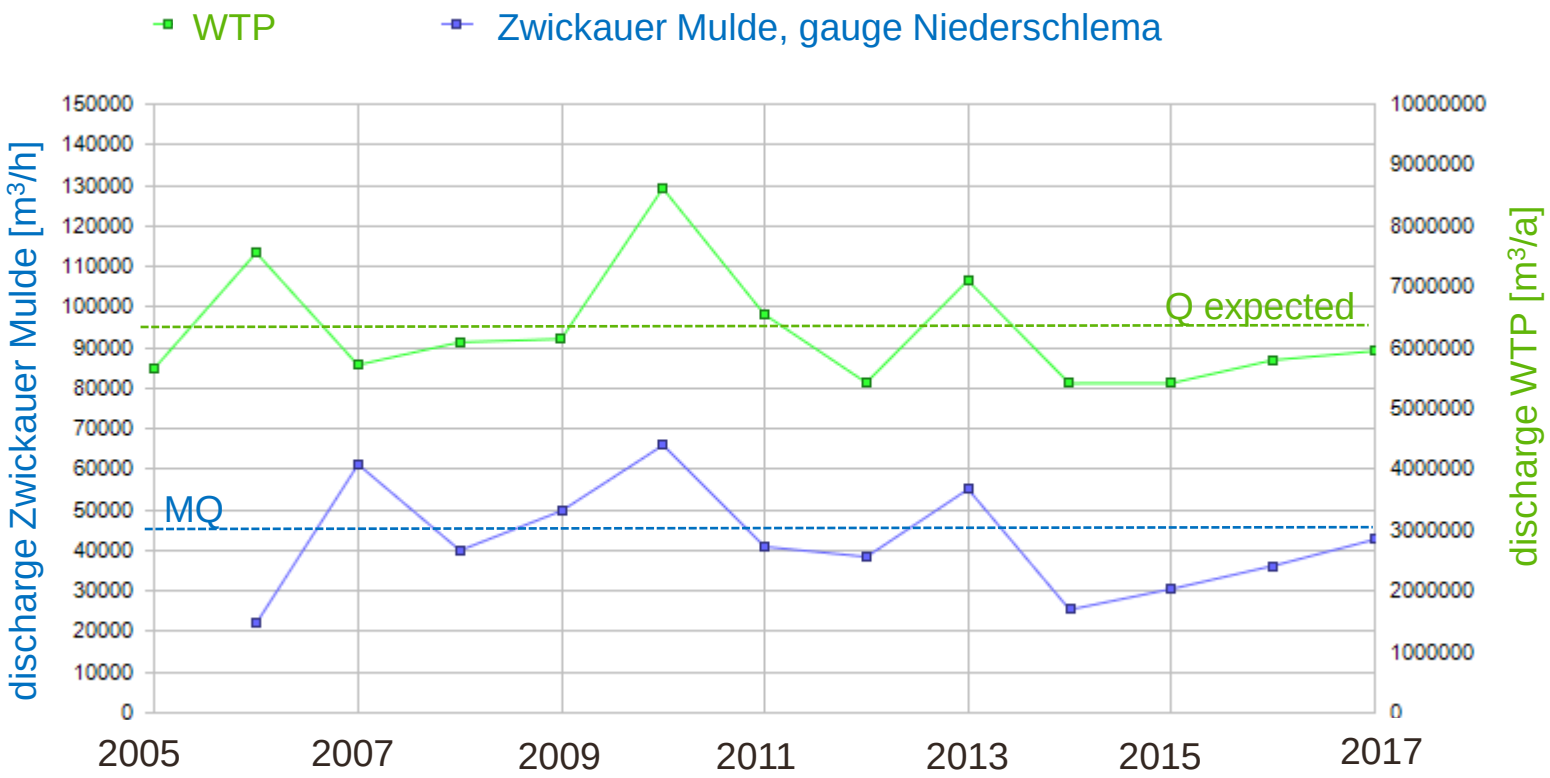
Relation between river and mine water discharges



River
Zwickauer Mulde
$MQ_{Niederschlema}$ = 12.6 m³/s

Mine
WTP Schlema-Alberoda
$Q_{expected}$ 6.5 million m³/a = 0.21 m³/s

- Both since 2014 below long-term mean discharge
- Mean relation **river : mine** discharge about **60 : 1**

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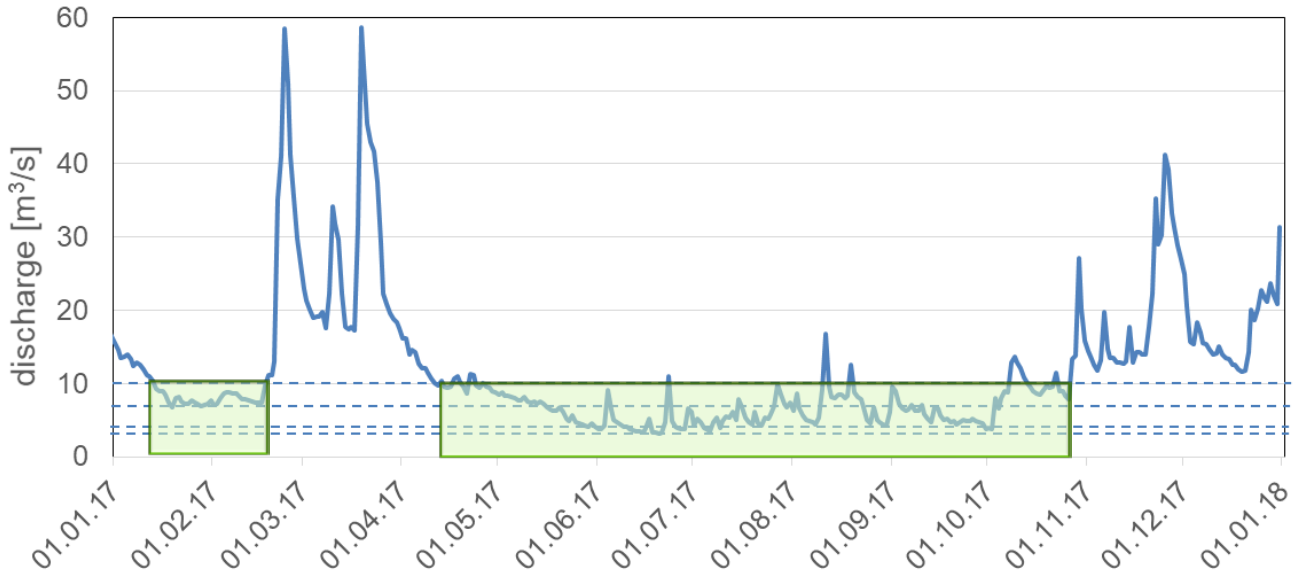
Case study 2017

- When are detailed requirements indicated?

Gauge Niederschlema / Zwickauer Mulde [m³/s]	
> 10	> 10 m³/s: about 150 days (40 %) → WTP: 0,3 mg/l for arsenic
7 … 10	< 10 m³/s: about 220 days (60 %) → WTP: detailed requirements for arsenic
4 … 7	
3 … 4	< 4 m³/s: about 18 days → WTP: arsenic load limits
< 3	

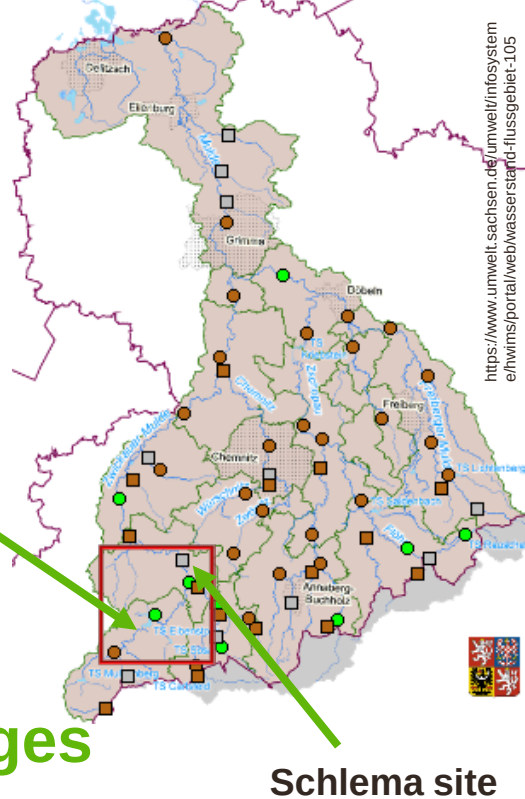
- Most critical time: the **summer period**,
- Additional the **river : mine** discharge decreases



data: LfULG, 2017

Management of river catchment

- **Compensation of flow rate in Zwickauer Mulde by reservoir Eibenstock**
  - to preserve a minimal water level particularly in case of low water discharges



Management of arsenic load emission from WTP in case of low river discharges

- **Primarily by adaption of discharge volume from WTP**
  - limitation of mine inflow volume using the internal working and buffer storage system
- **Secondary by optimization of water treatment process**
  - commissioning of both plant units
  - adjustment of internal water flows between both plant units
  - change of the addition of chemicals ($FeCl_3$- dosage)

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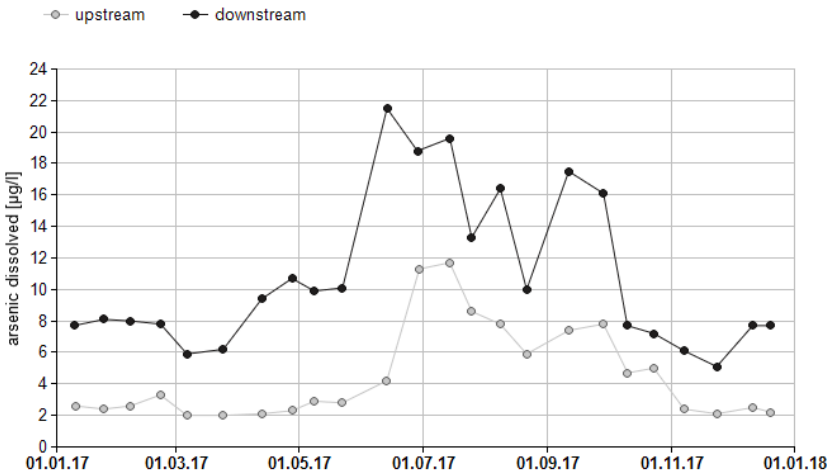
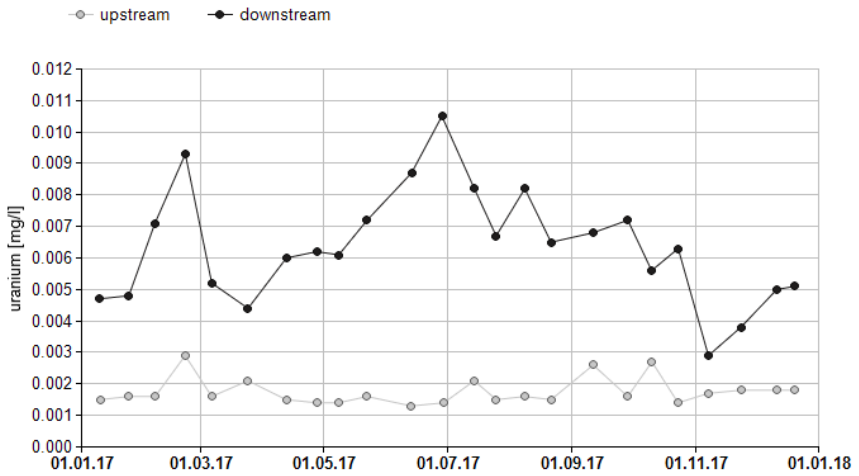
Situation in the river Zwickauer Mulde

- Increase of arsenic and uranium concentrations during passage of remediation area Schlema-Alberoda (including ancient Schneeberg mine)
- Concentrations indirect proportional to the flow rate → seasonal effects





- Increase of arsenic and uranium loads
- Avoidance of excessive concentrations during periods of low water levels

	As load [t/a]	U load [t/a]
upstream	0.87	0.45
downstream	3.0	2.0

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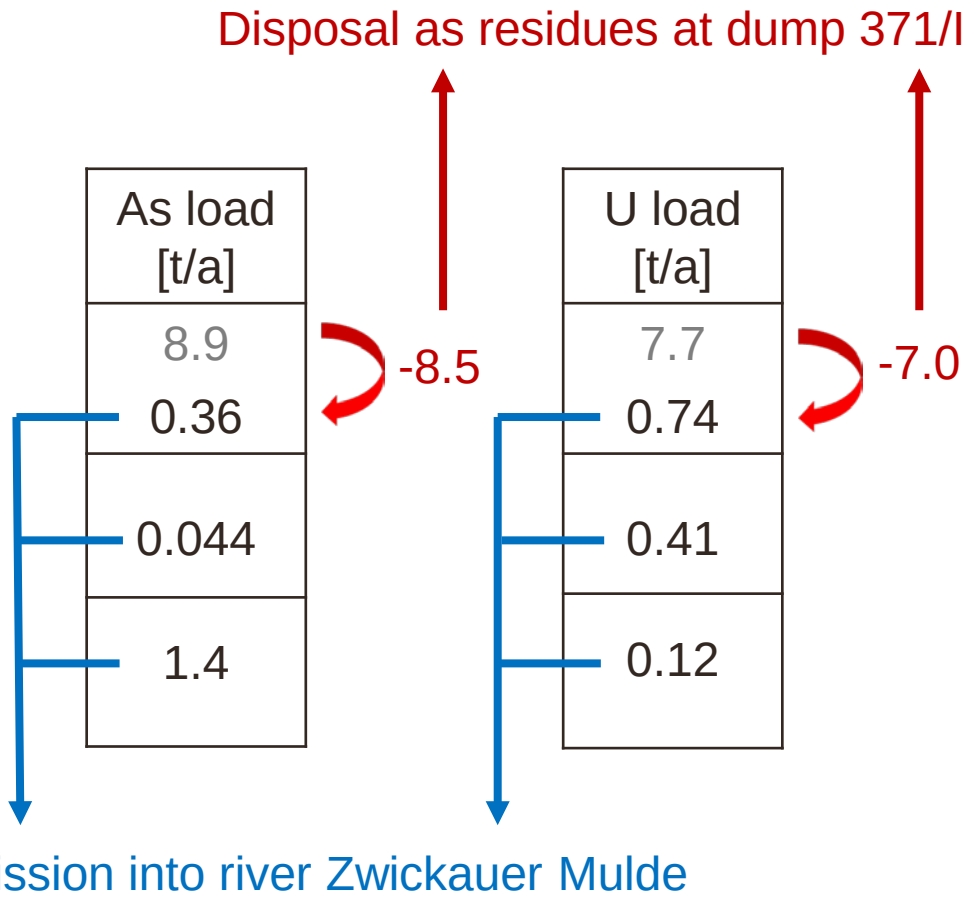
data: Wismut GmbH, 2014-2017

Performance of water treatment = performance for river water quality

- Mine water Schlema-Alberoda
  - before water treatment
  - after water treatment
- Seepage water of dumps (with connection to the receiving water)
- Mine water Schneeberg (ancient mining, no treatment)



data: Wismut GmbH, 2014-2017

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Summary

- The Wismut GmbH takes care for remediation of the Schlema site by coverage of waste rock piles, by dismantling of facilities and site clean-up, by mine flooding and water treatment, and by safe disposals of water treatment residues,
  - whereby water treatment remains as a long-term task
- The WTP Schlema-Alberoda treats millions of m^3 per year of mine and seepage water,
  - whereby it keeps tons of pollutants away from watercourse system
- The residual emissions from the WTP inevitably lead to an increase of the element concentrations in the receiving water,
  - whereby flow rate-dependent arsenic limits avoid excessive concentrations during periods of low water levels

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