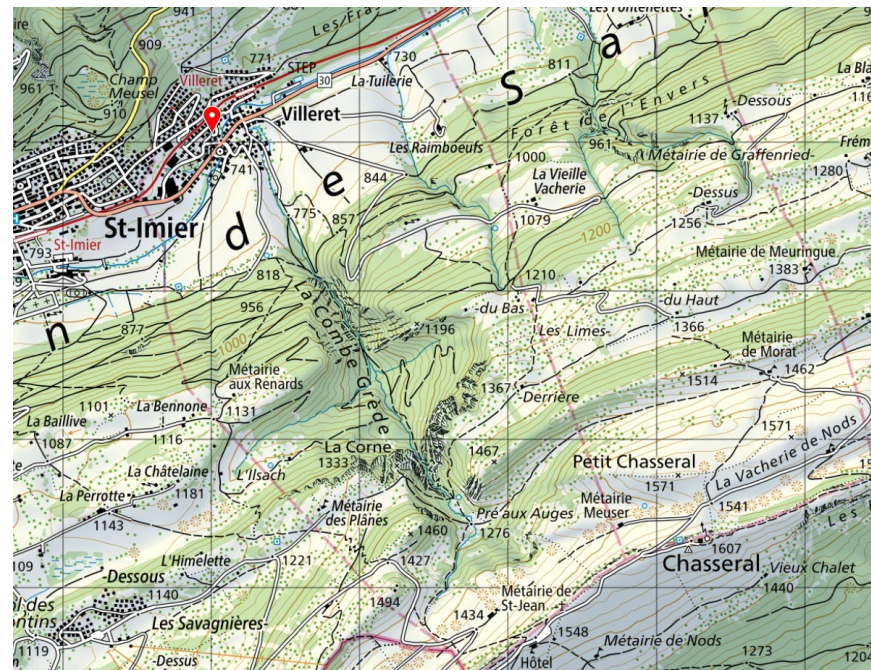
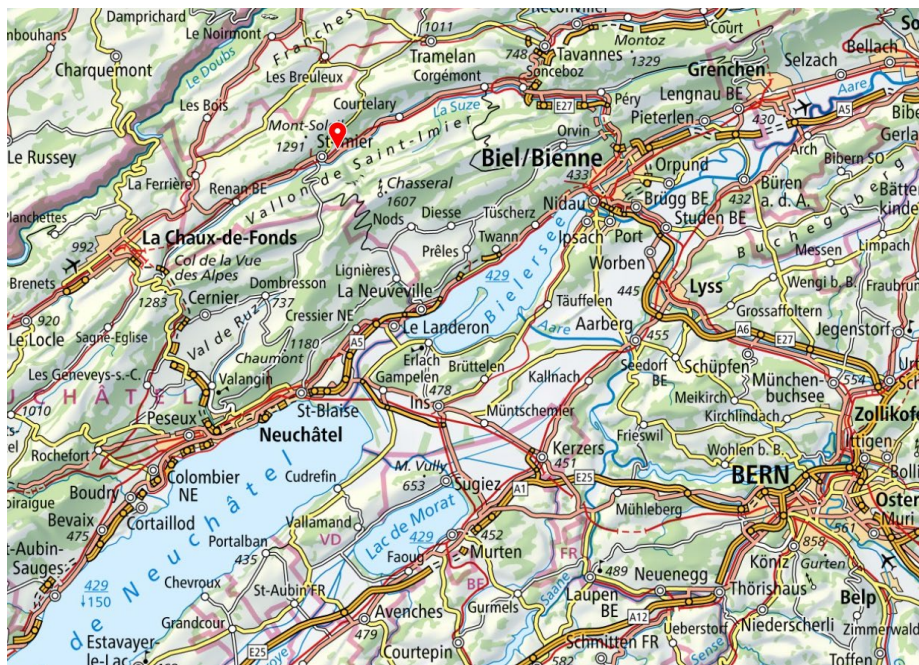




Physical Modeling of Sediment Trap for Le Bez River, Switzerland

PL-LCH









Le Bez torrent flood events

- Floods in 2007, 2018, 2019, 2021
- Clogging of the culverts at the upstream end of the village inundating the area and causing significant damage.
- Reduced bedload and driftwood capacities through the historic built area
- Clear water discharge capacity available
- June 2021 flood

(2018)

Inondation à Villeret

Une inondation a touché le cœur de Villeret lundi en fin d'après-midi. Elle a provoqué la fermeture de la route cantonale



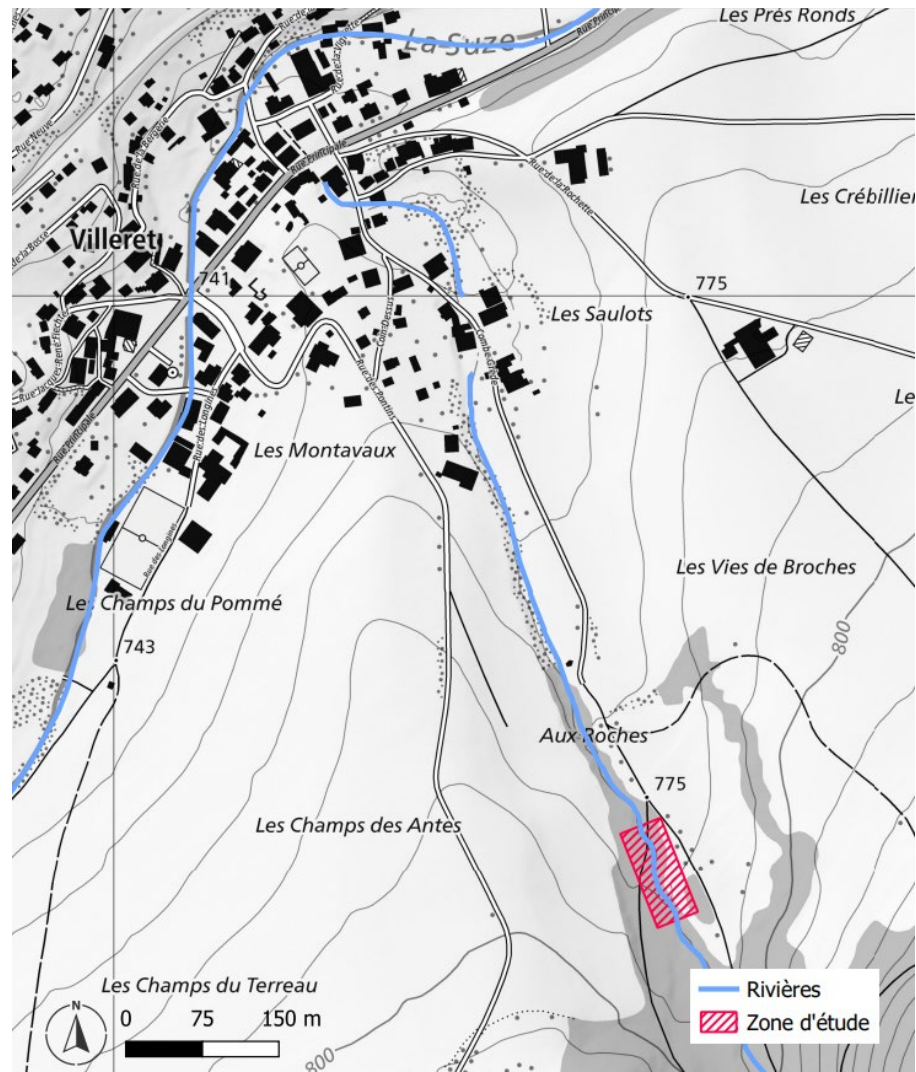


Culverts after the flood of 2018

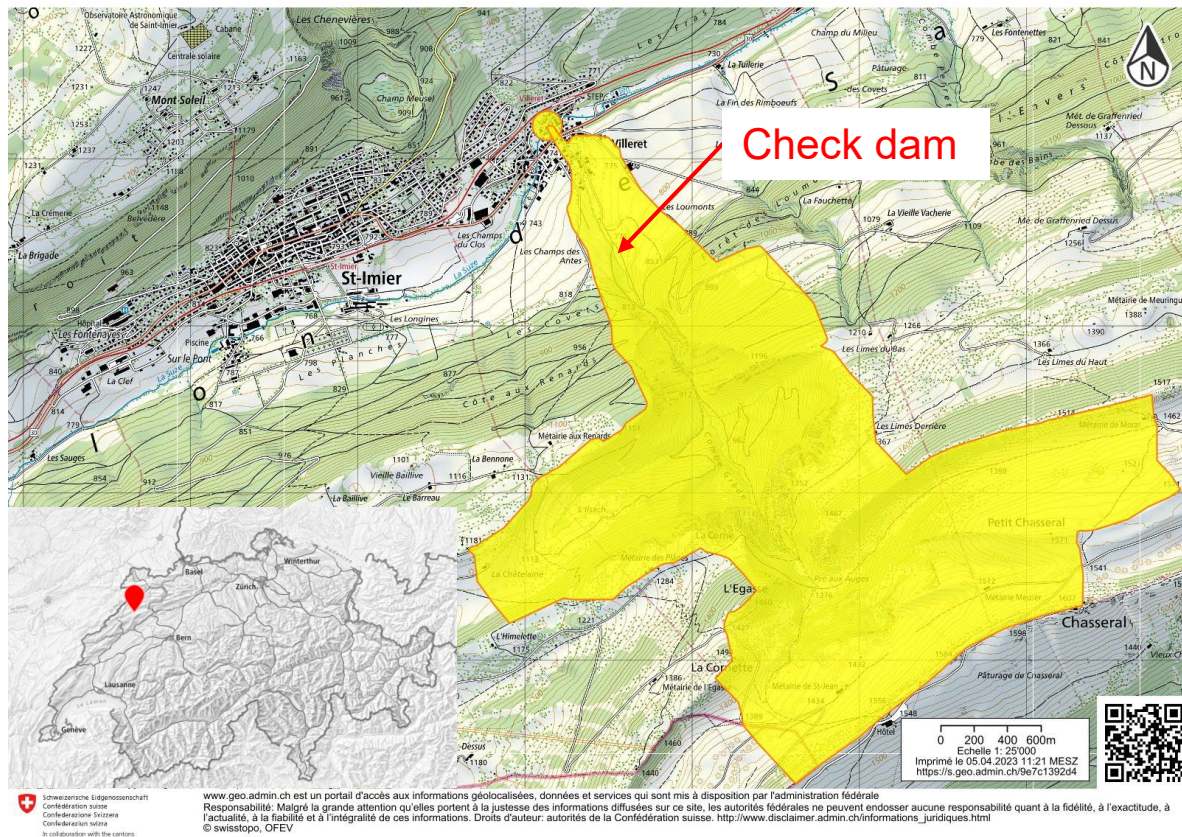
Mesure de protection

Le système doit fonctionner de manière adéquate pour des crues ayant une période de retour entre 5 et 300 ans:

- jusqu'à crue Q5 le transit sédimentaire est assuré;
- pour les crues de plus grande intensité, le système retient une grande majorité (>80%) des bois flottants et des sédiments.



- **Surface**
6.4 km²
- **Elevation max.**
1590 m a.s.l.
- **Elevation min.**
740 m a.s.l.
- **Peak discharge**
 $Q_5 = 2.3 \text{ m}^3/\text{s}$
 $Q_{100} = 8.3 \text{ m}^3/\text{s}$
 $Q_{300} = 18 \text{ m}^3/\text{s}$
- **Reduced discharge capacity through the village**

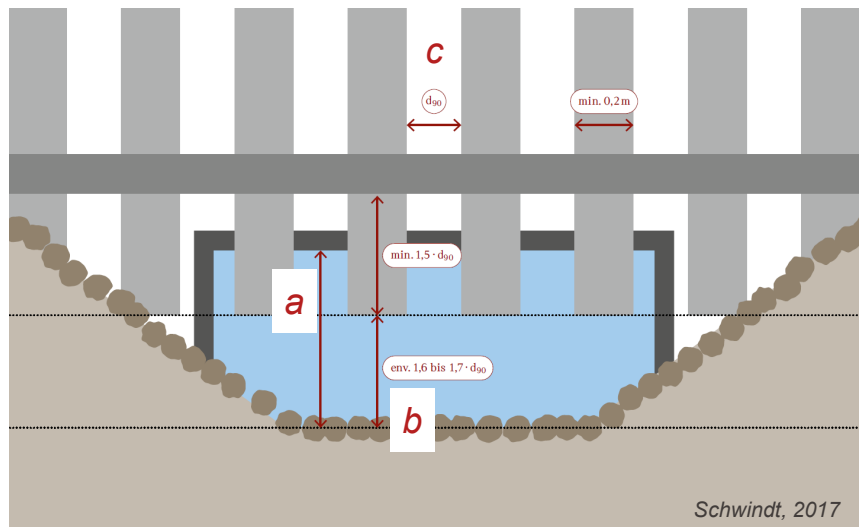


Check dam:

- Hydraulic control: the bedload transport capacity of the channel is reduced by the backwater due to the open check dam
- Mechanical control: the size of the transported objects in the form of sediment or driftwood exceeds the clearance of the opening(s) of the rack

Main parameters:

- a = vertical opening in the check dam
- b = vertical clearance of the rack
- c = spacing of the rack



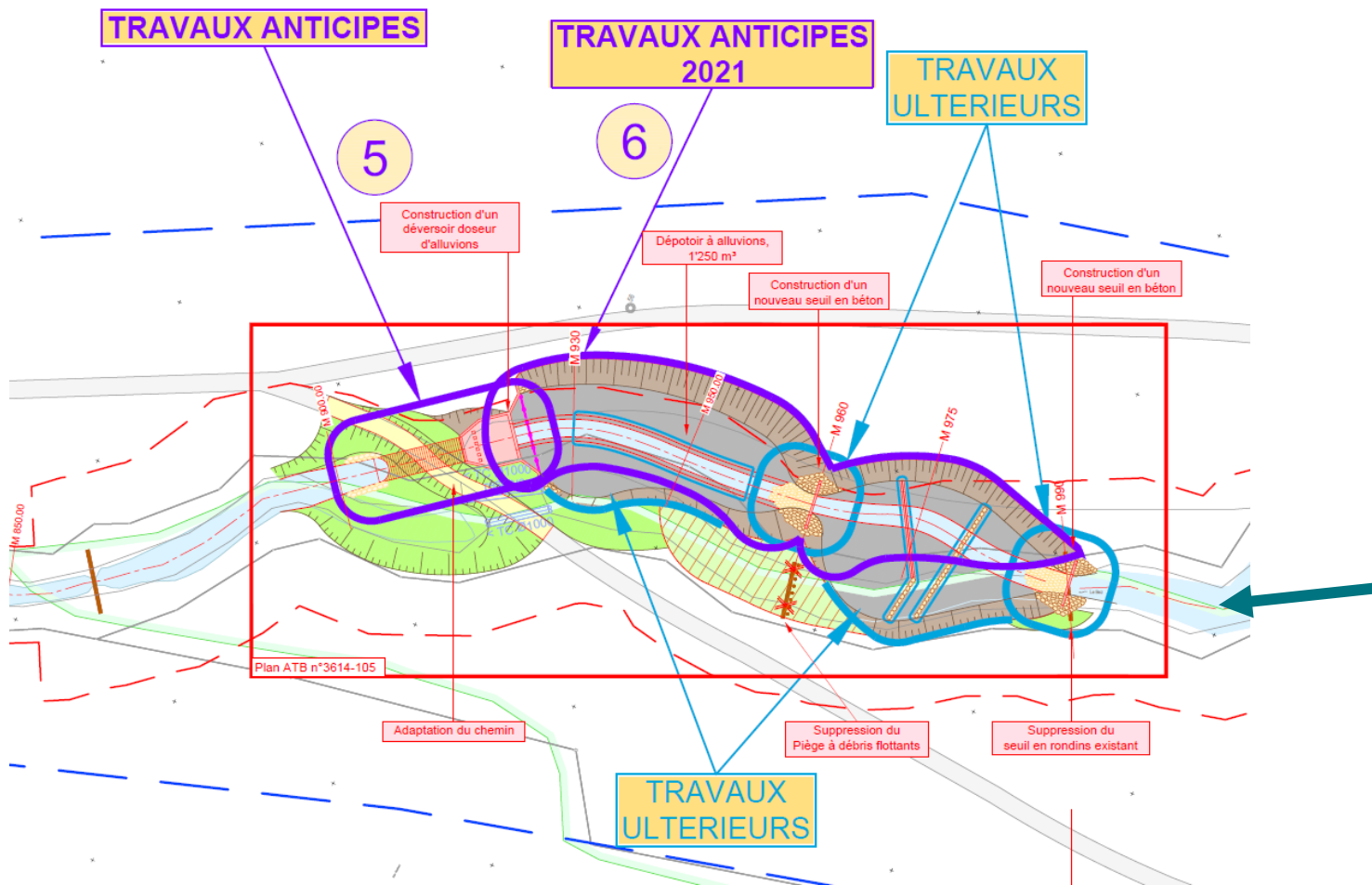
Schwindt, 2017

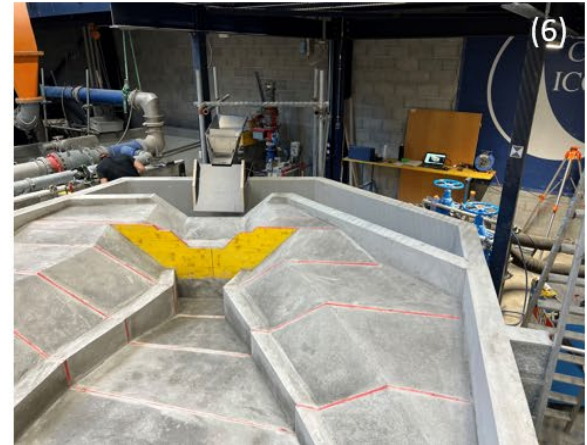
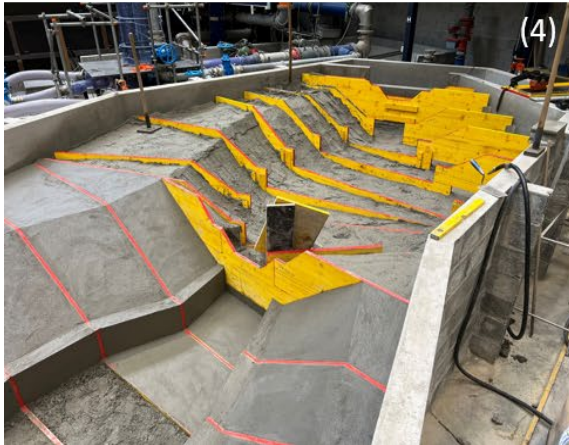


Objectives of the project

- General flood protection
 - For flood events with a return period greater than 5 years
 - Ensure proper hydraulic/mechanic control of the check dam
- Driftwood retention
 - The rack in the upstream basin should prevent driftwood to pass for all flood event, but allow bedload to transit
- Sediments
 - Allow the sediments to go through the basins and check dam for small event (5-year flood) to prevent hydro-morphological depletion of the downstream reach
 - Substantial sediment retention for major flood event

Canal guide ultérieurement,
sauf vers l'ouvrage

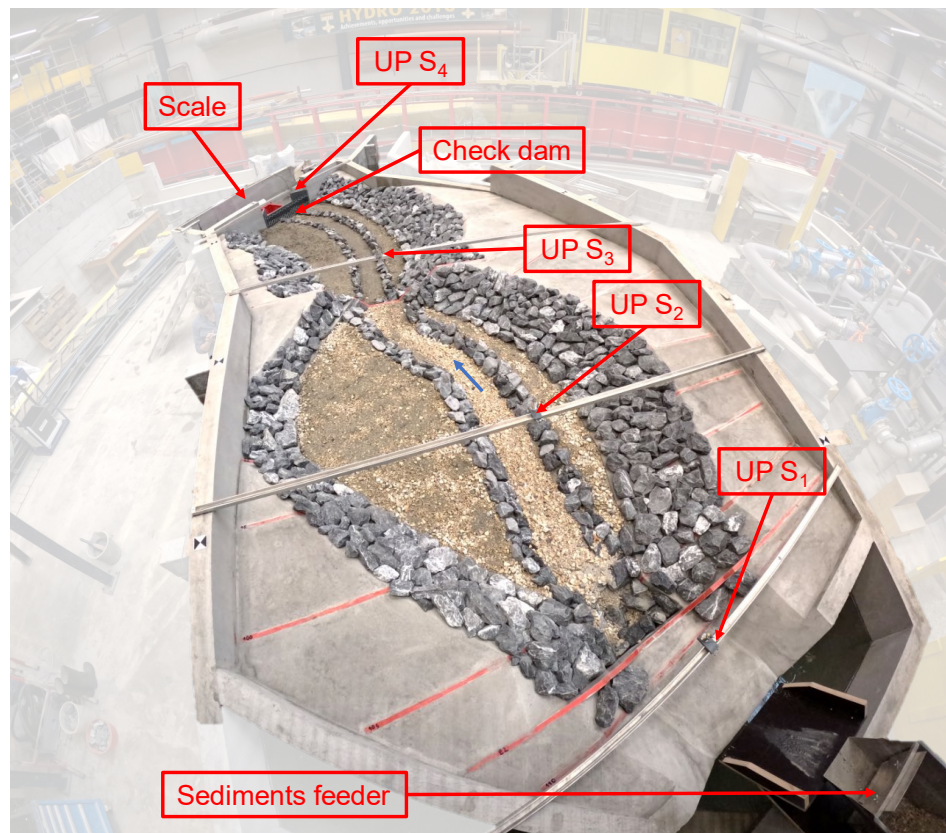




Physical model

$$Fr_p = \frac{u_p}{\sqrt{gL_p}} = \frac{u_m}{\sqrt{gL_m}} = Fr_m$$

PHYSICAL PARAMETER	SCALE RATIO	SCALING FACTOR
Length	$\frac{L_p}{L_m} = \lambda$	10
Velocity Time	$\frac{u_p}{u_m} = \frac{t_p}{t_m} = \lambda^{\frac{1}{2}}$	3.16
Discharge	$\frac{Q_p}{Q_m} = \lambda^{\frac{5}{2}}$	316



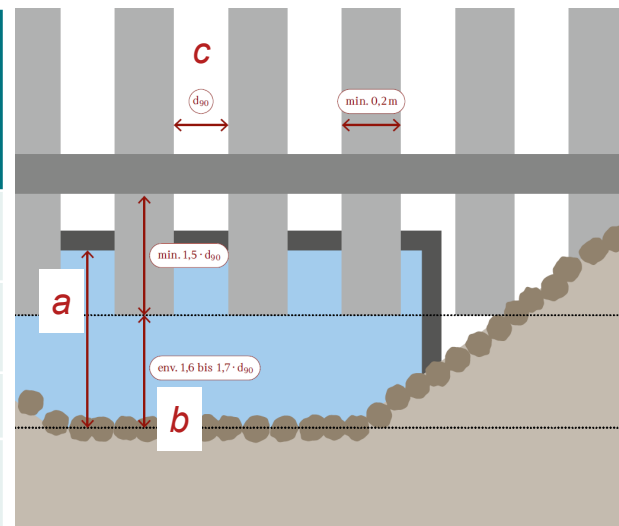
Downstream view of the physical model representing the sediment trap composed by two basins and two weirs upstream of each of them. The instrumentation included four ultrasonic probes (UP = Ultrasonic Probe), the sediment feeder, and the mass weighing scale.

List of test

Check dam optimisation

TEST	HYDROGRAPH & BEDLOAD SCENARIOS	PEAK WATER DISCHARGE [m ³ /s]	PEAK BEDLOAD DISCHARGE [kg/s]	VERTICAL CLEARANCE OF THE RACK
A11	Q ₅ (constant discharge)	2.3	40	1.1d ₉₀
A21	Q ₅ (constant discharge)	2.3	40	2.5d ₉₀
A22	Q ₁₀₀	8.2	141	2.5d ₉₀
A31	Q ₅ (constant discharge)	2.3	40	1.8d ₉₀

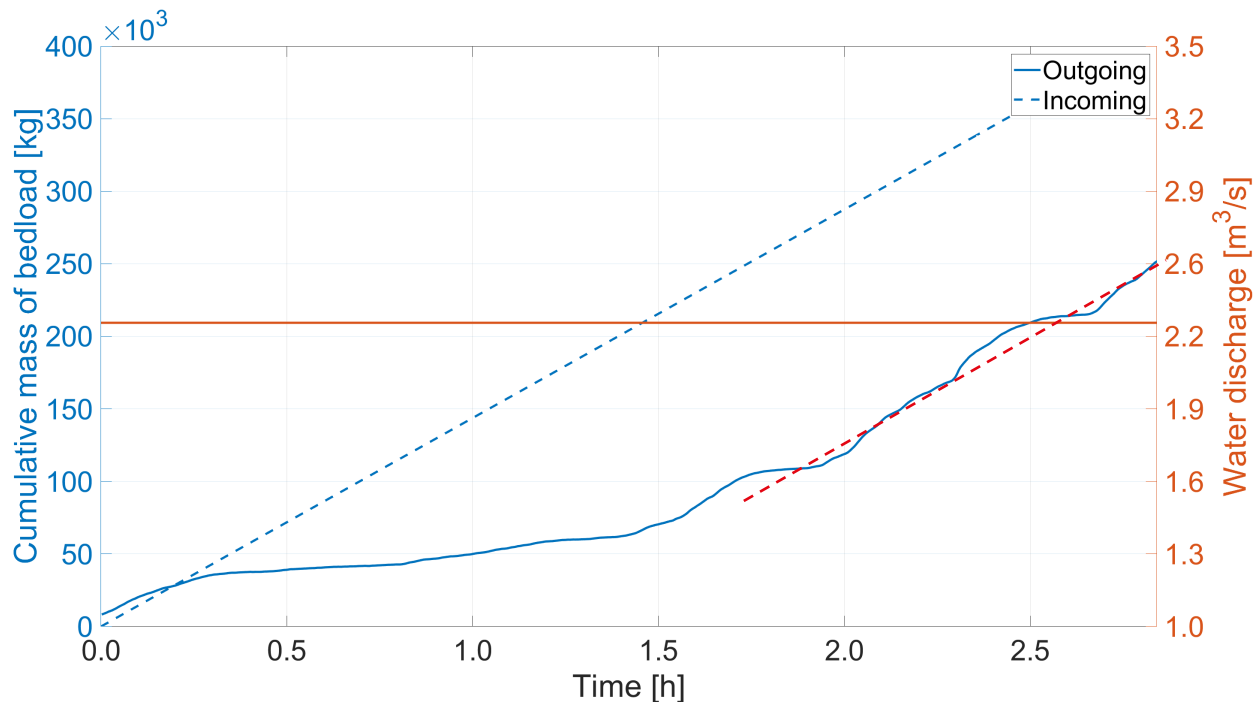
List of the tests performed. Q_x stands for a flood with a return period of x years.



Schwindt, 2017

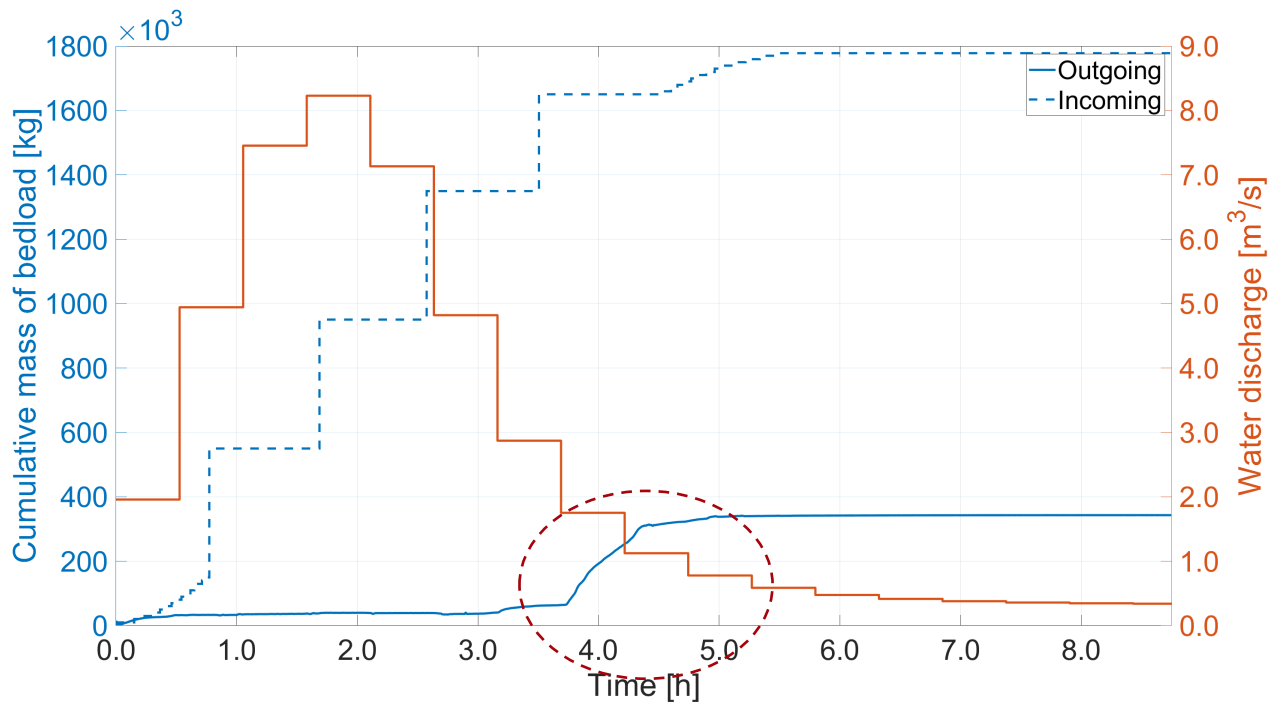
Test Q₅ (A21 – Vertical clearance 2.5 d₉₀)

After some 2 hours, balance between incoming and outgoing bedload



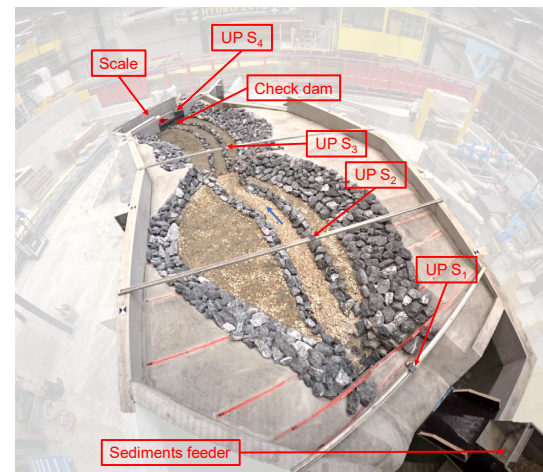
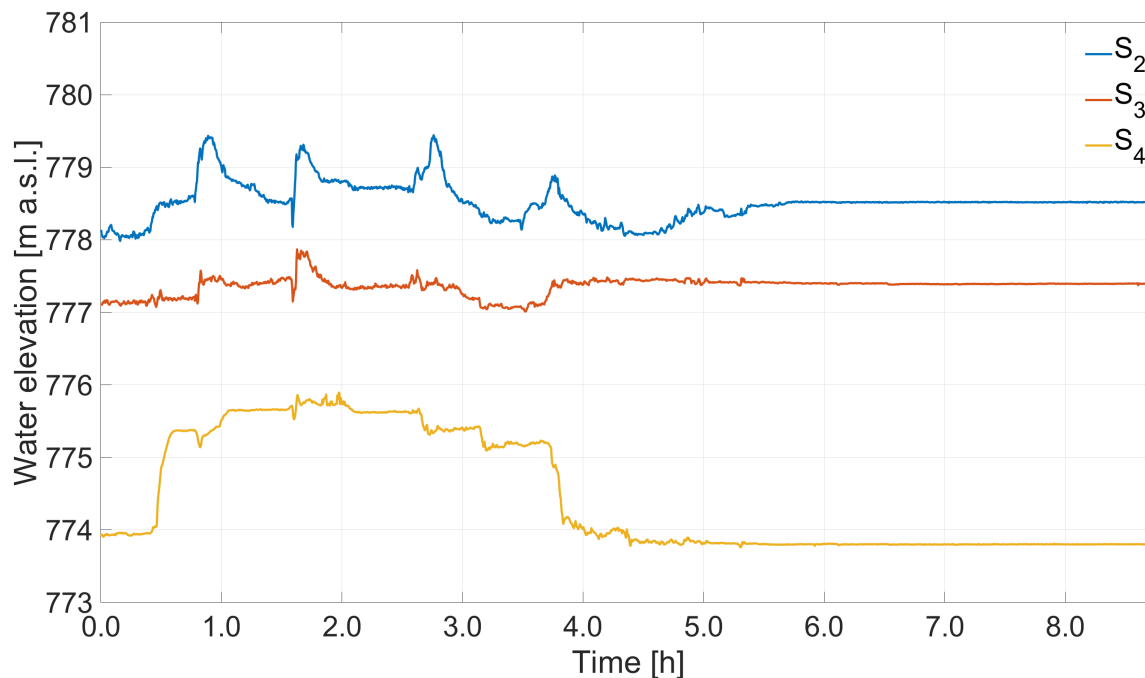
Test Q₁₀₀ (A22 – Vertical clearance 2.5d₉₀)

- Up to some 3.5 hours, almost no bed load transit -> retention
- Limited (some 19%) spontaneous flushing of the lower basin observed at flood hydrograph end



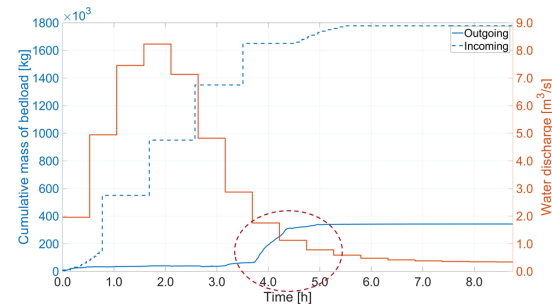
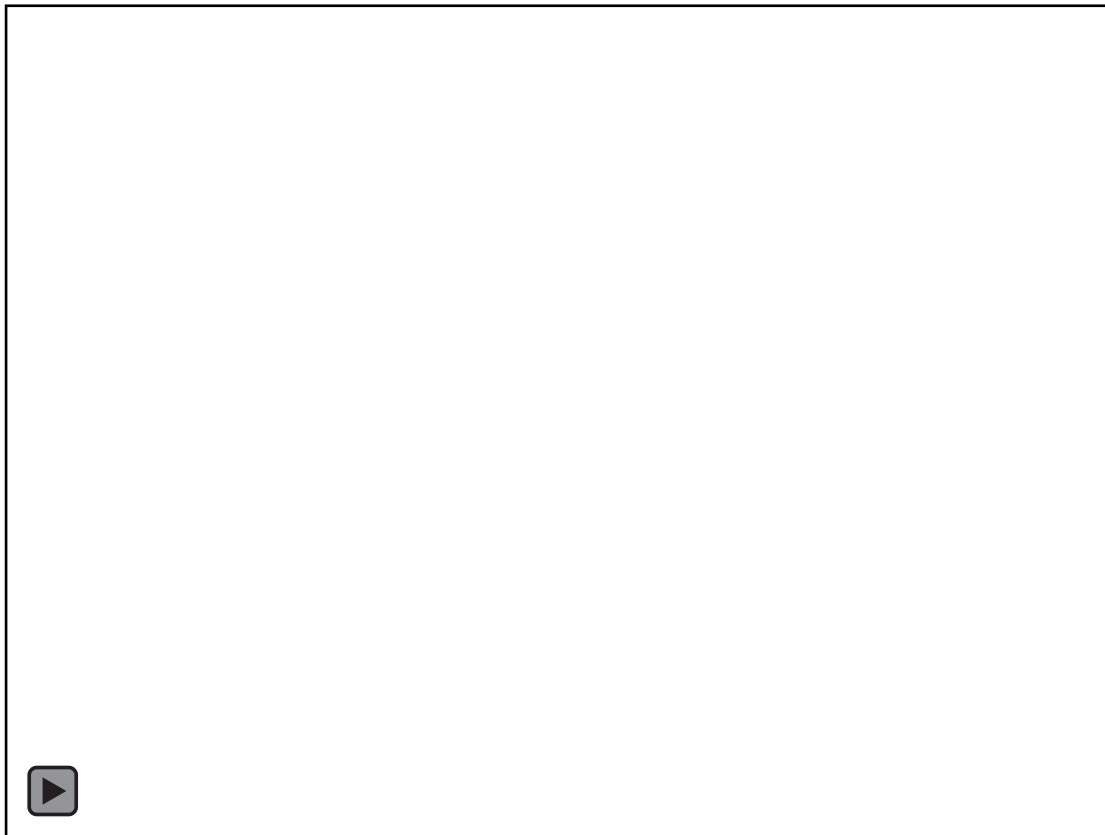
Test Q₁₀₀ (A22 – Vertical clearance 2.5d₉₀)

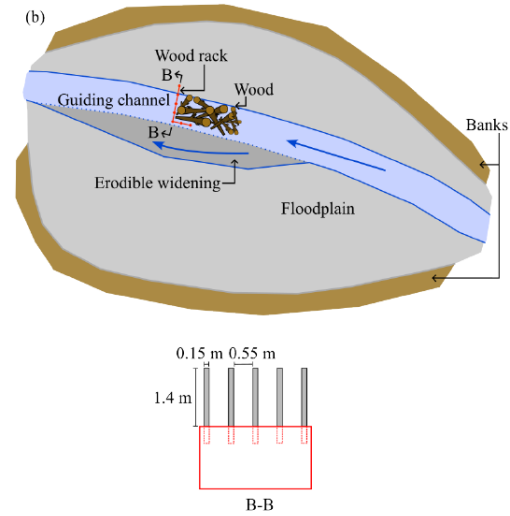
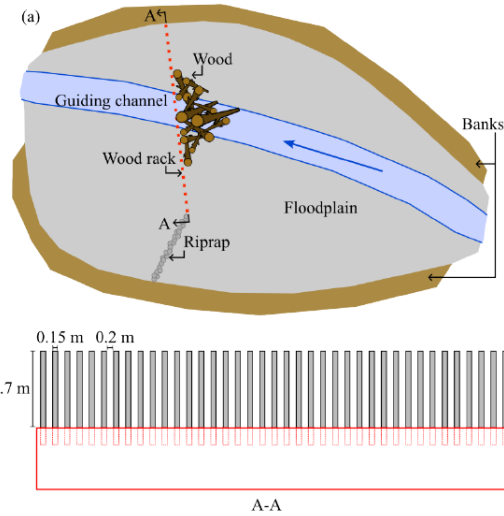
Probe S₄ from free surface to pressurized flow
-> hydraulic control works



Test Q₁₀₀ (A22 – Vertical clearance 2.5d₉₀)

Spontaneous flushing observed





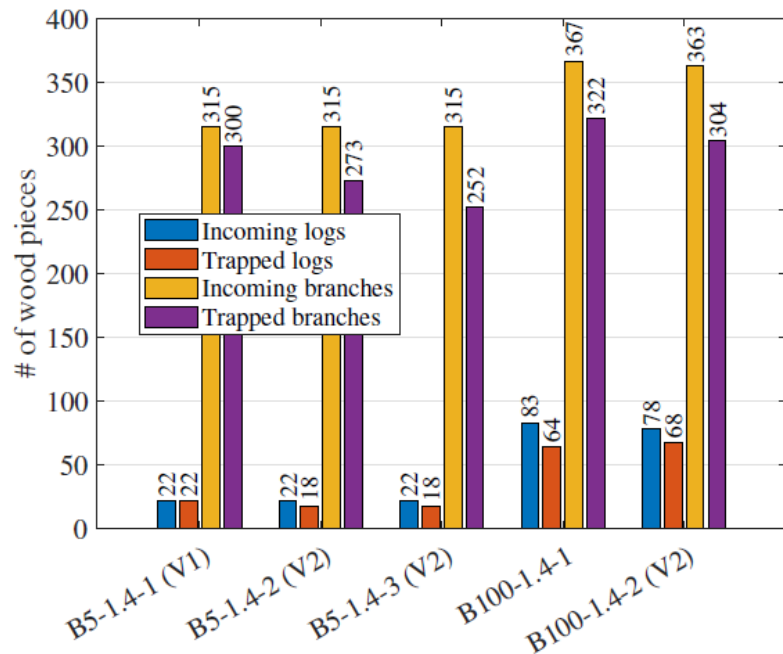


Figure 11. Incoming wood versus trapped wood. Trapped driftwood includes wood in the rack, at the check dam and in both basins (test B100-1.4-2 was carried out with a slightly smaller quantity of wood than planned due to a handling error).

Conclusion of physical modeling

- Optimal vertical spacing of the check dam rack $1.8d_{90}$
- Spontaneous flushing during the falling limb of the hydrograph
- Difficult to manage driftwood while maintaining bedload transport
- L-shaped rack is more efficient than a linear one







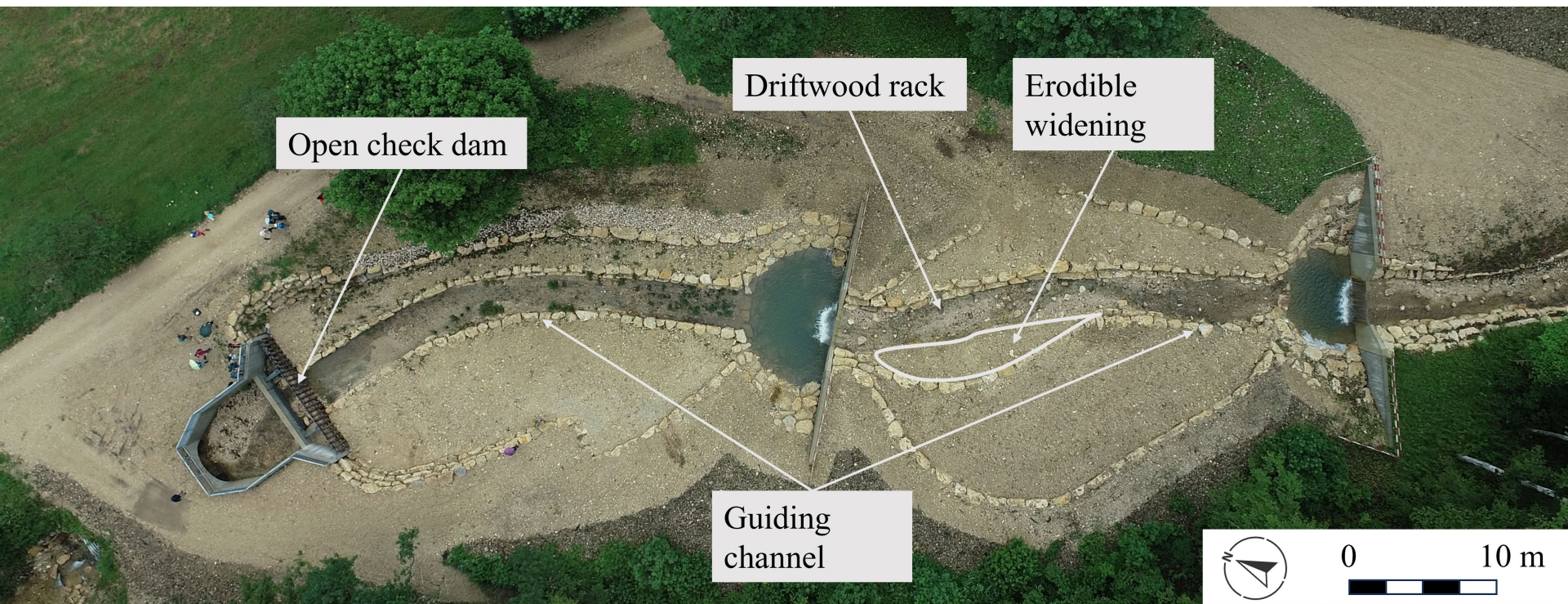
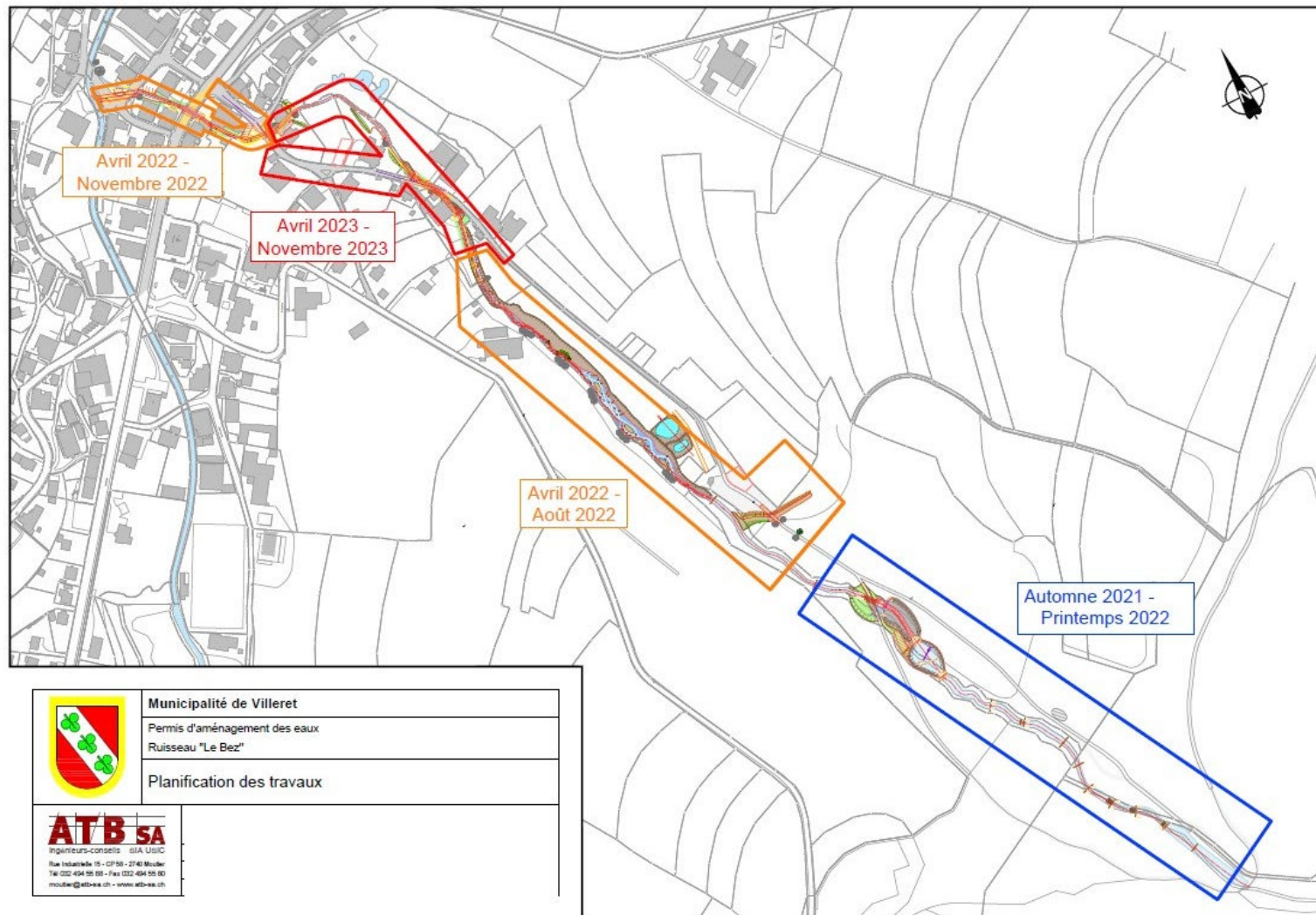






Figure 13. Picture of the sediment accumulating in the dissipation pool after the first sill in the upstream basin, taken after the winter 2023-2024. Courtesy of ATB SA.





Coût du projet??

Vidéo...