

KUNDA RIVER ANCHOR ICE FORMATION

AGENDA:

1. Introduction visitors (EP)
2. Introduction hosts (TP)
3. Anchor ice presentation (EP)
4. Anchor ice discussion (ALL)
5. SEBA & ELKESENSOR (PT, MJ)

Philipp Theuring, SEBA
Ergi Prommik, SKEEM
Heiko Källo, TTK
Marko Jäetma, ELKESENSOR

2017-02-08, Tallinn, Keskkonnaagentuur

INTRODUCTION

During last 5-10 years we have had extreme situations in Kunda river near Lontova where bottom ice (anchor ice) have created flooding issues.

Prologue

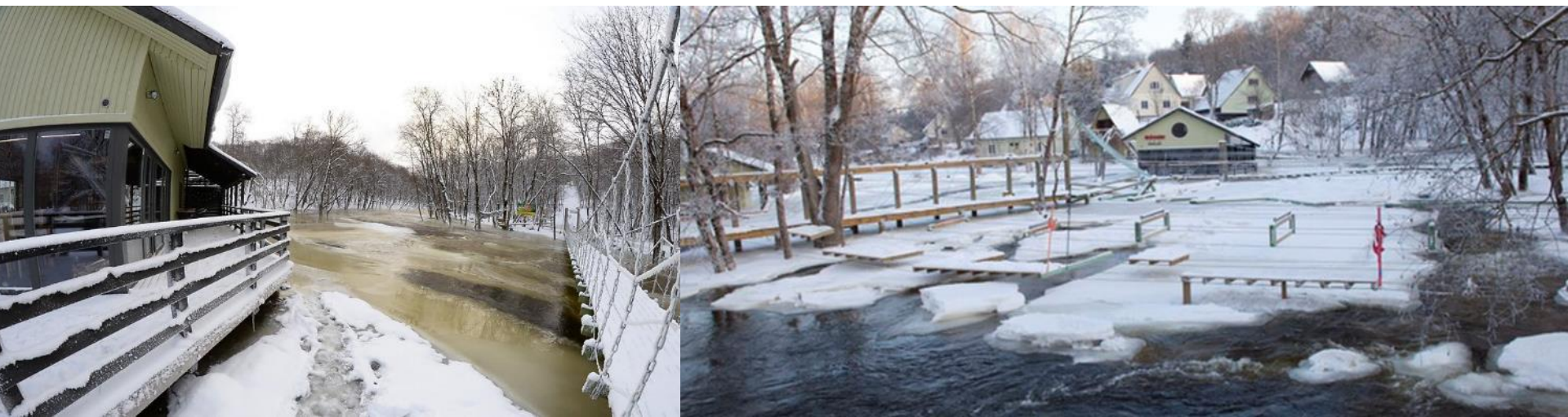
Investigations started after having daily lunch in cafe and discussed possible reasons with Mr Revo Koha (owner of the Blücheri cafe).

Goals

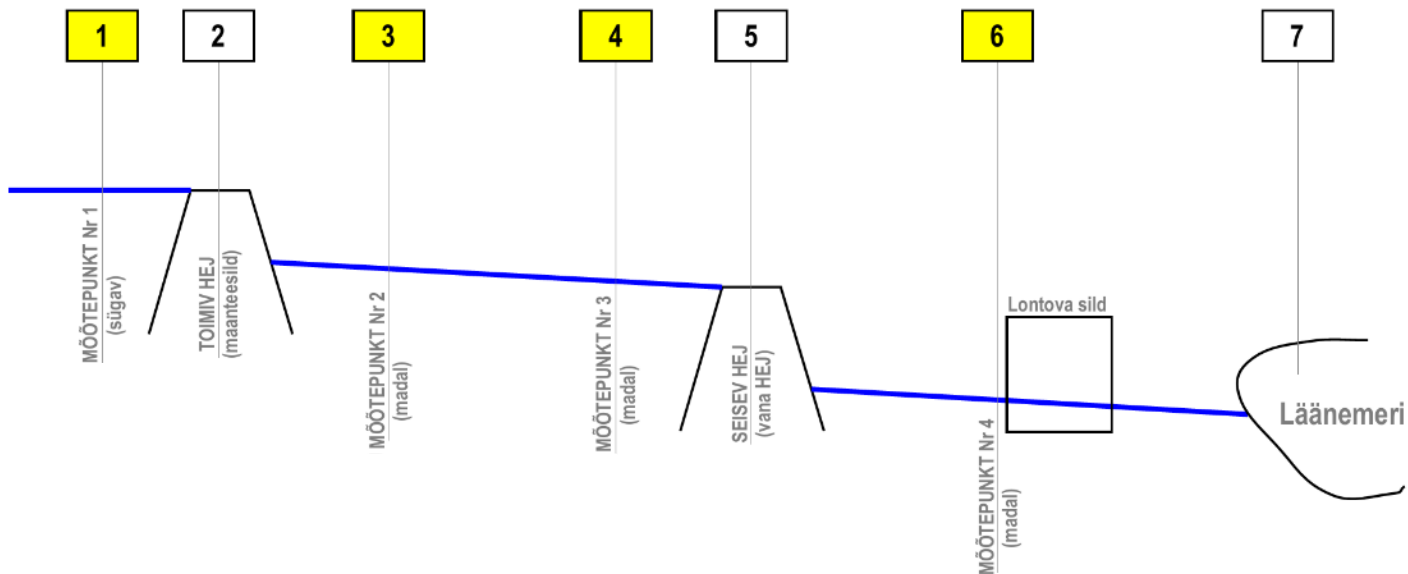
1. Understand the problem
2. Solve the problem for local people, specially for Blücheri riverside cafe.

Special thanks

Mr Håkan Jarnvall (commissioning engineer, PURAC, Sweden) – for helping us to implement the first investigation program.



INVESTIGATION SKETCH



Pos	Name	Note
1	Measuring point No 1	Water level (1 min) and temperature (1 hr)
2	Jaama st bridge	Working HPS
3	Measuring point No 2	Water level (1 min) and temperature (1 hr)
4	Measuring point No 3	Water level (1 min) and temperature (1 hr)
5	Kunda old HPS	Stopped HPS
6	Measuring point No 4	Water level (1 min) and temperature (1 hr)
7	Baltic Sea	Receiving water

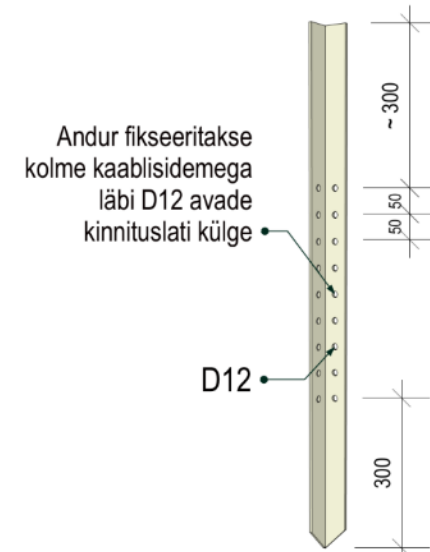
MEASURING INSTRUMENT

OTT Orpheus Mini Water Level Logger

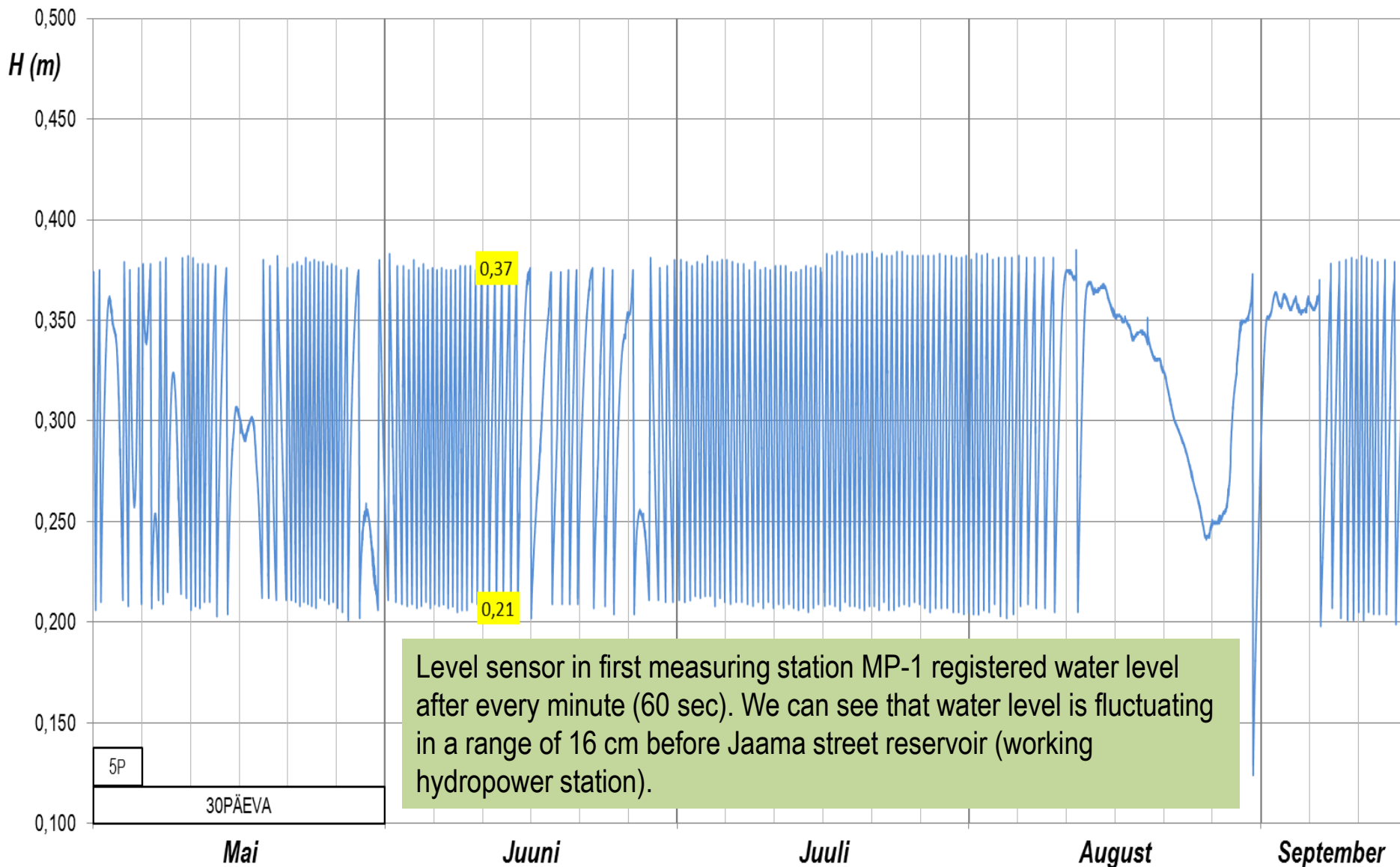
Range	0 ... 4 m
Accuracy	± 0.05 % FS
Power source	3 x 1.5 V LR6 Alkaline / Lithium
Data protocol	IrDA
Storage	4 MB
Storage capacity	approx.. 500,000
Registration interval	1 s...24 h
Saving interval	1 s...24 h
Material	ABS, POM, 904 L (DIN 1.4539)
Operation range	-20 °C ... +70 °C
Humidity	100 %
IP class (sensor)	IP68
IP class (logger)	IP67 (2 m water, max 24 h)



Anduri kinnituslatt 50x50x5



MEASURING LOCATION No 1

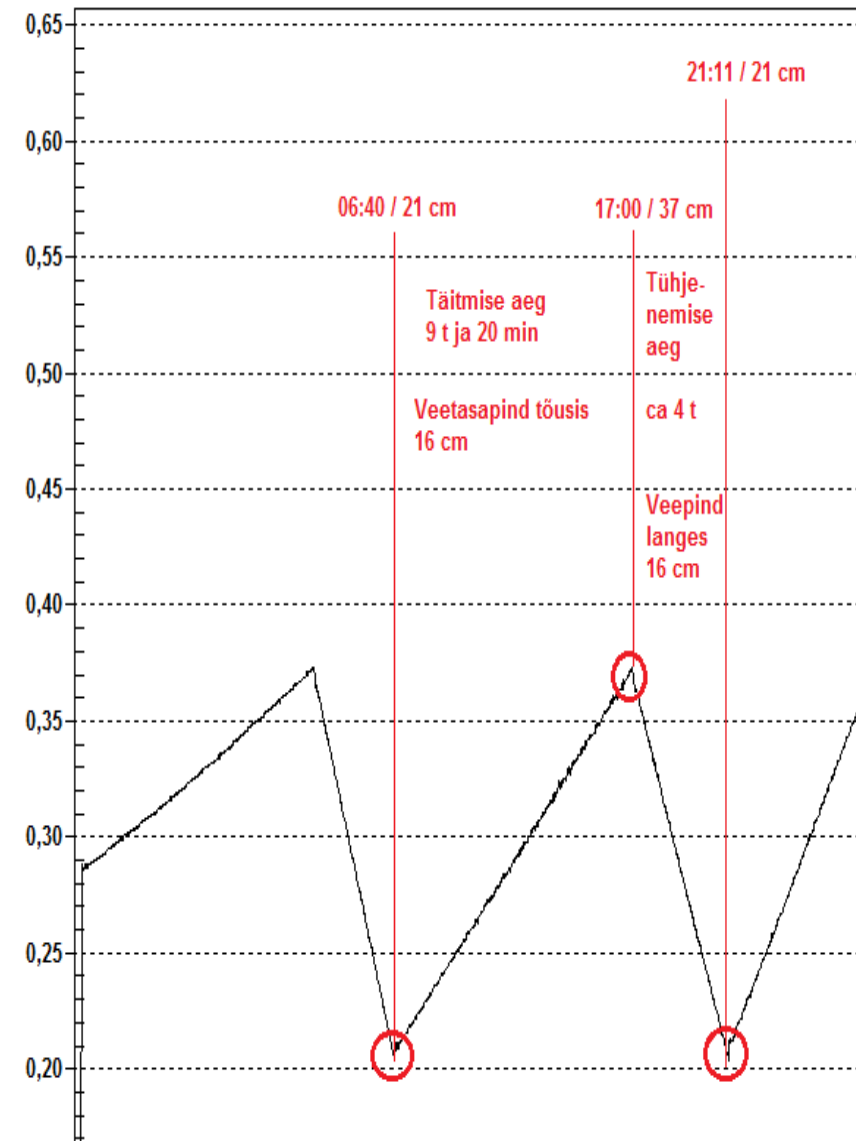


LOCATION No 1: explanations

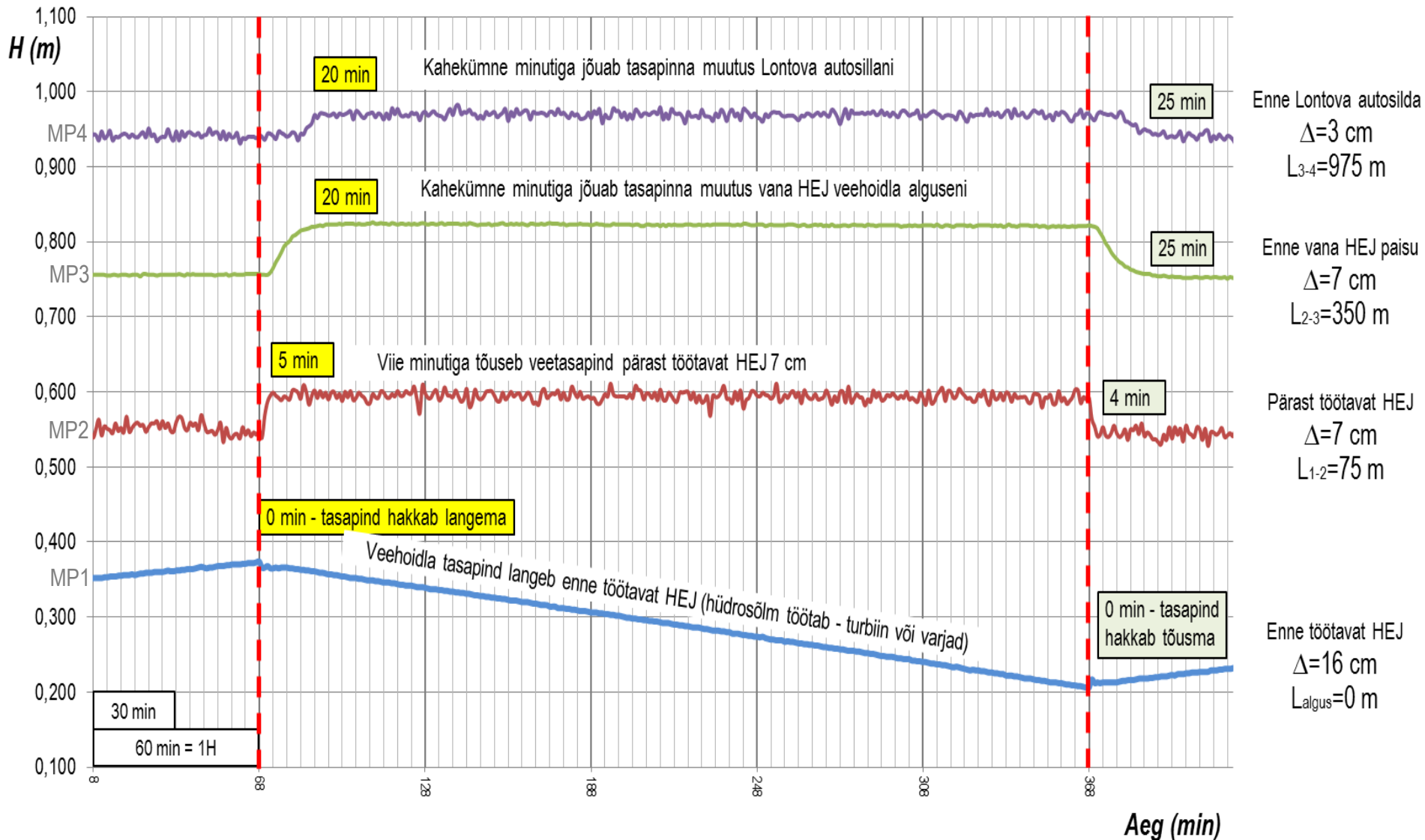
- Location No 1 = Jaama street reservoir (currently working hydropower station reservoir). Technologically there are three propeller type turbines with flows 1, 2 and 4 m³/s. Flowrate downstream can be one of seven combinations G1..G7.

Pos	Turbine	Q m3/s	Flowstep	Change %
G1	Q1	0,9		
G2	Q2	1,9	1,0	52%
G3	Q1+Q2	2,8	0,9	32%
G4	Q3	3,8	1,0	26%
G5	Q1+Q3	4,7	0,9	19%
G6	Q2+Q3	5,7	1,0	17%
G7	Q1+Q2+Q3	6,6	0,9	14%

- Water level is fluctuating in a range of 16 cm before the working HPS (in the reservoir). Allowed range ± 5 cm.
- Reservoir filling time is not align with discharge:
 - filling – 9 hr
 - discharge – 4 hr

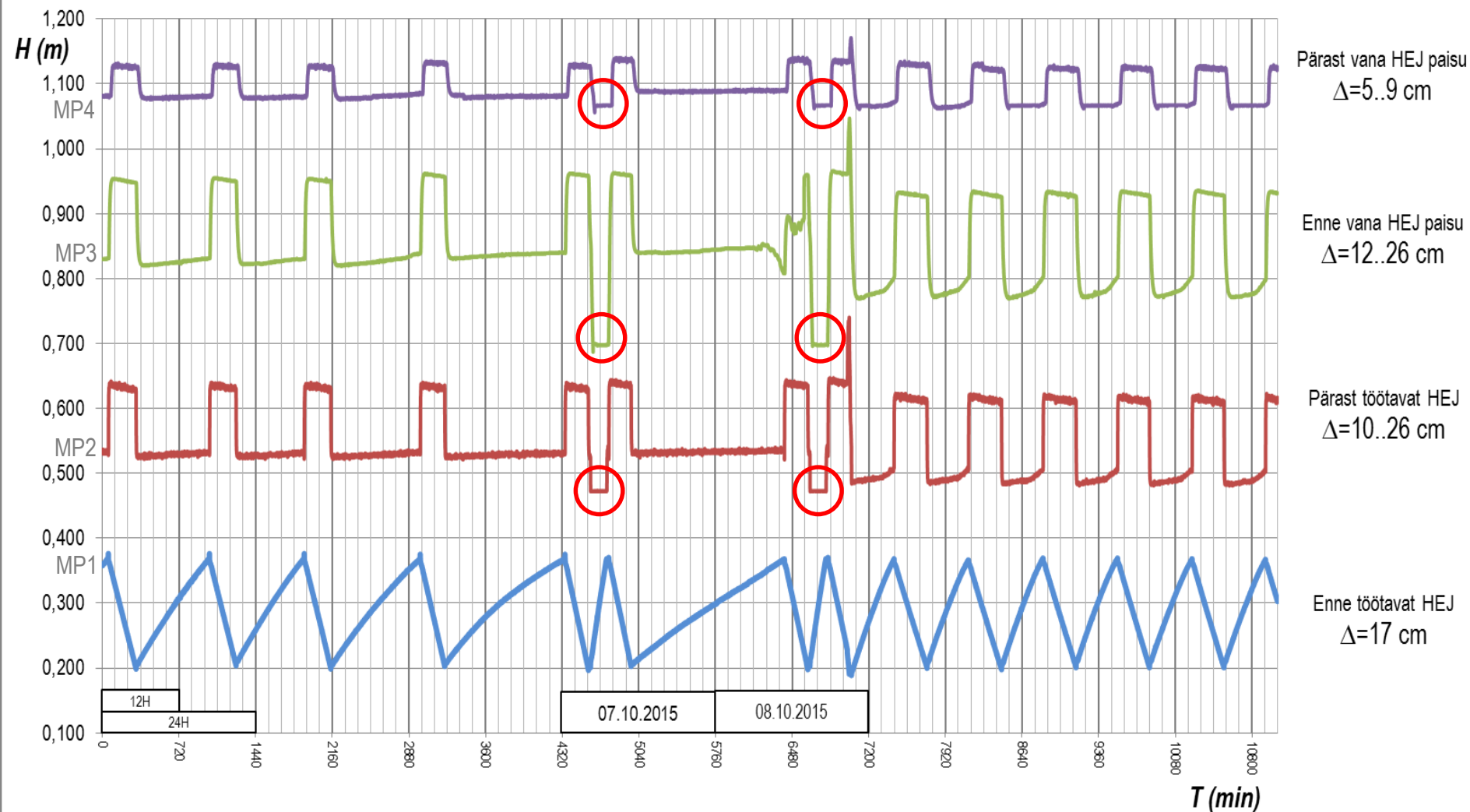


DOWNSTREAM IMPACT



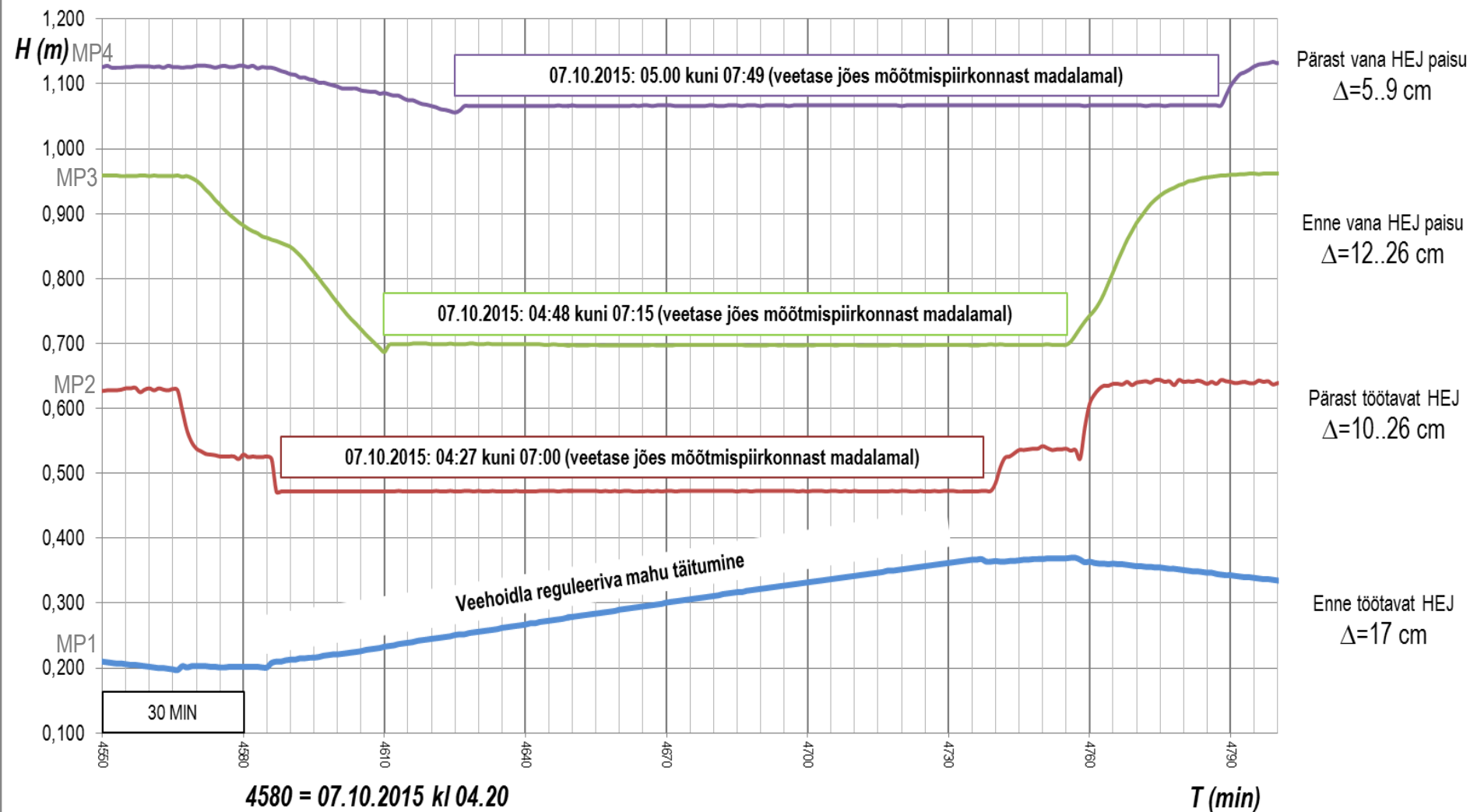
ERROR GAPS

07.10 ja 08.10.2015 were registered water levels below measurement range.



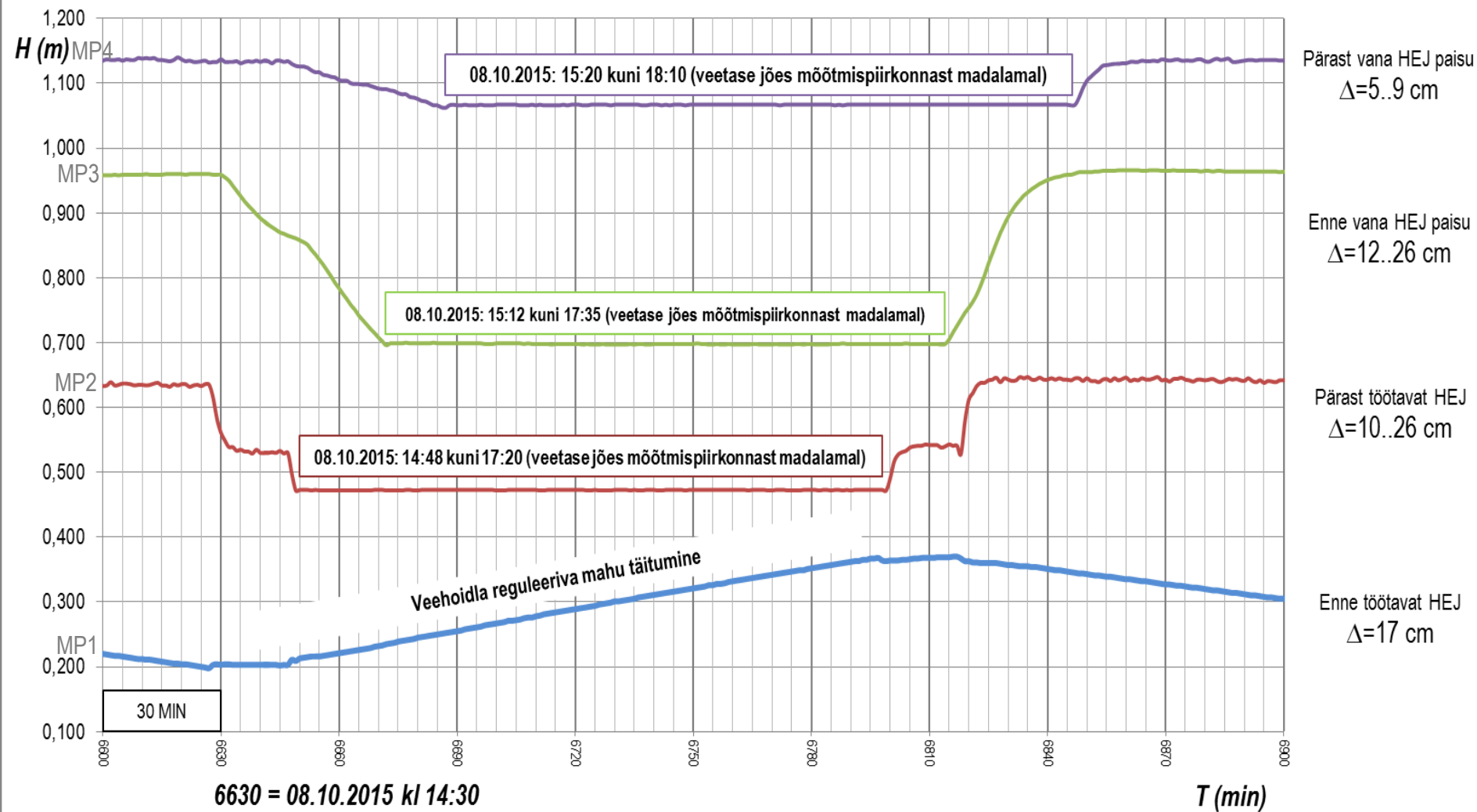
ERROR GAP: 07.10.2015

07.10.2015 out of range 04.27 until 07.49 (ca 3,5 h).



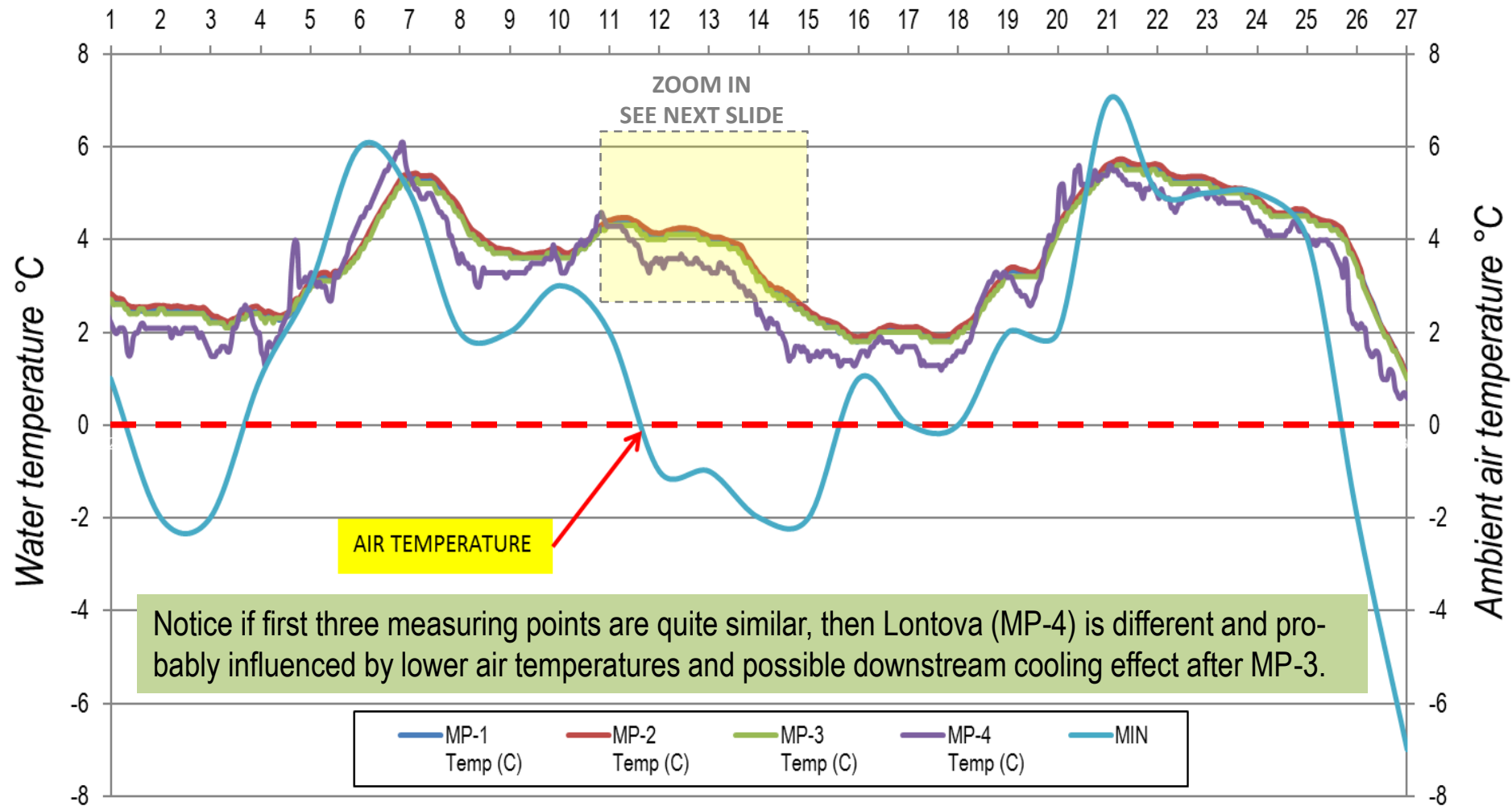
ERROR GAP: 08.10.2015

08.10.2015 out of range 14:48 until 18:10 (ca 3,0 h).



RIVER WATER TEMPERATURE

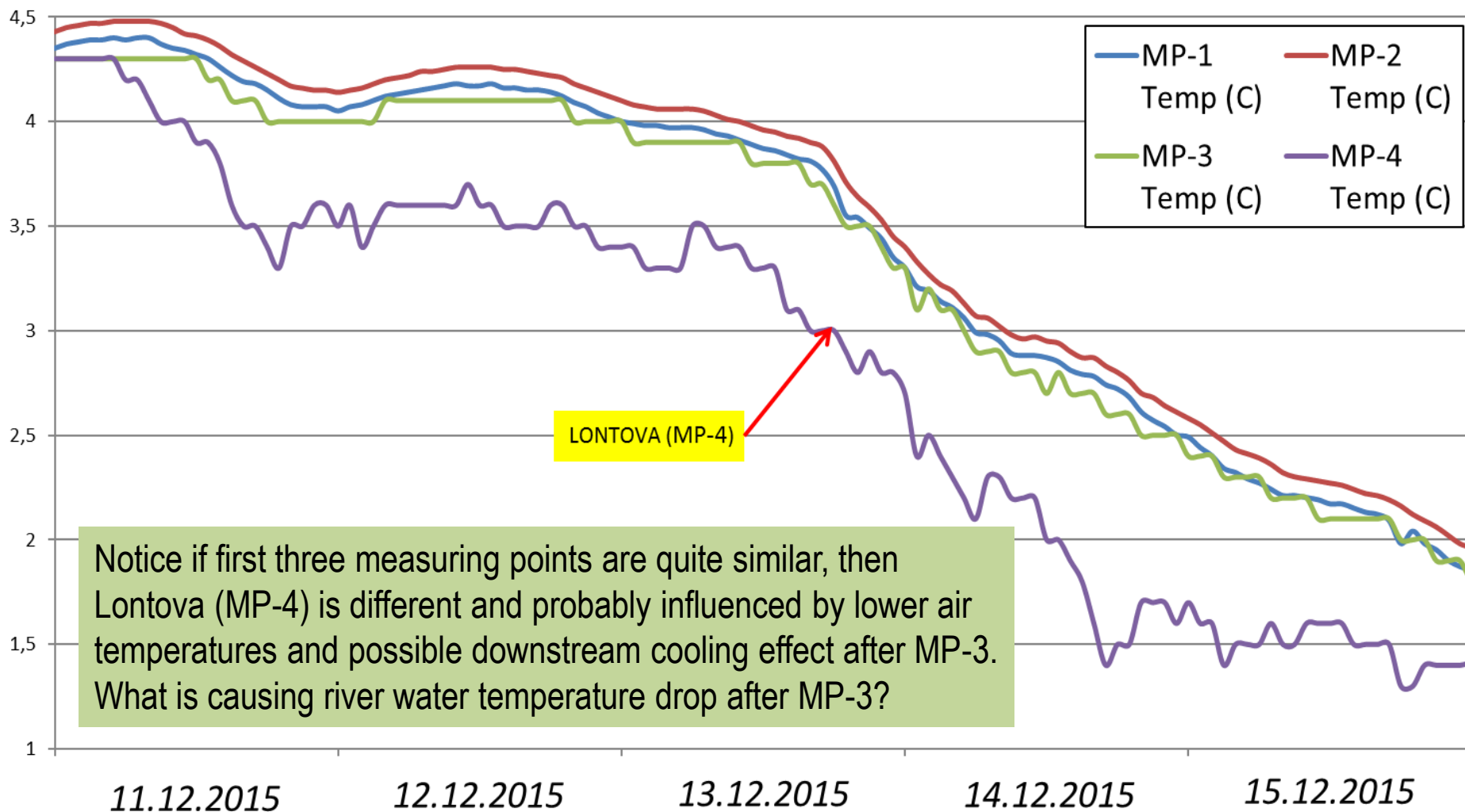
Measuring water temperature once per hour. Ambient air MIN temperature from Wunderground (daily min).



01. - 27. December 2015

RIVER WATER TEMPERATURE

Period: 11.12.2015 - 15.12.2015
Measuring water temperature once per hour.



GRAB MEASUREMENTS

16.01.2016 grab temperature measurements 15.00 – 17.00.
Ambient air temperature during measurements -17C.

Instrument: hand-held submersible unit with digital display, accuracy $\pm 0,1^\circ\text{C}$ which is enough to get indication for river water temperature, but unfortunately not enough to make any further analysis.

Mõõtepunkt	A	B	C	D	E	F	G
Asukoht	Lontova	Kunda vana HEJ (pärast paisu)	EC pumpla	Jaama tn HEJ (pärast paisu)	Kunda mõis (enne paisu)	Kohala (pärast silda)	Sämi mõõtejaam
Jõevee temperatuur ($^\circ\text{C}$)	+0,2	+0,2	+0,3	+0,3	+0,2	+0,2	+0,2
Kaugus A-st ülesvoolu (km)	0,00	0,90	1,25	1,40	4,20	16,70	24,00

NEXT STEPS

1. Required is better system for anchor ice formation studies
 - better accuracy (sensor resolution) for investigation range
 - better investigation program to evaluate the anchor ice problem

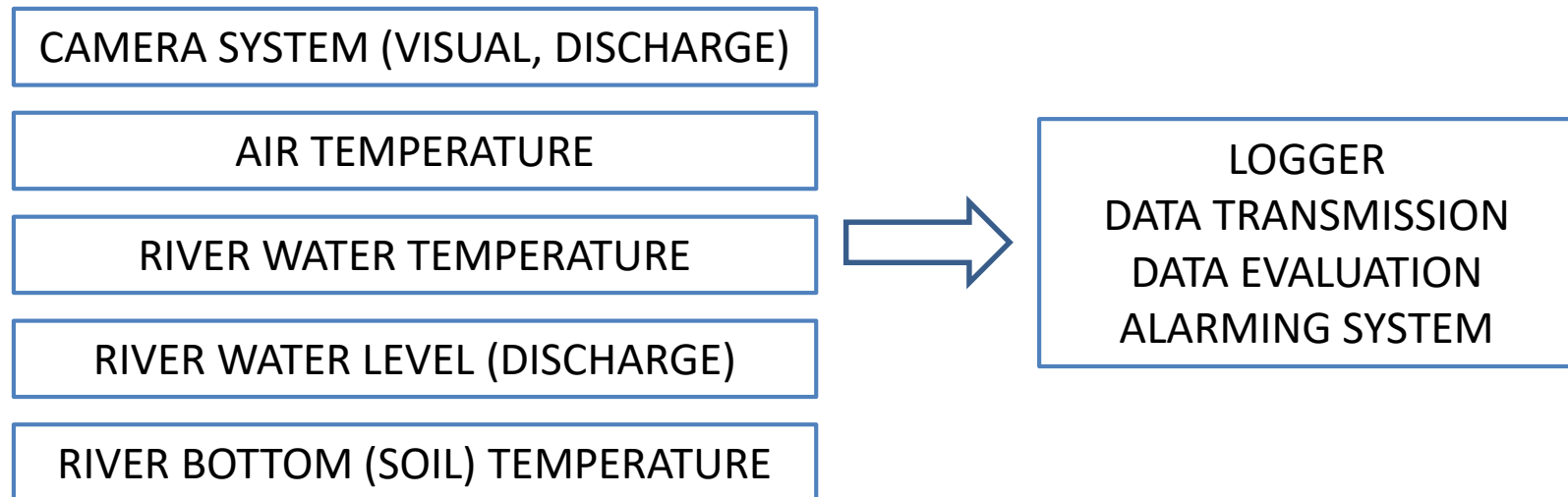
THEORETICAL KNOWLEDGE RELATED TO KUNDA ANCHOR ICE:

1. Low air temperature
2. Low river water temperature
3. Low water flow in the river (close to MIN flow in the river)
4. Low infeed from groundwater to the river (downstream, sandstone canyon)
5. River water velocity $>1,5$ m/s
6. Torrential river bed (rapid flow)
7. Low river bed temperature (ground temperature)

HYPOTHESIS FOR FURTHER STUDIES:

1. Non-natural water level and flow fluctuations are creating better conditions for anchor ice formation in downstream rapids (see title picture ice waves).
2. Rapids and not properly used dams are extra coolers for river water.
3. Error gaps are caused by poor technological system.

INVESTIGATION PROPOSAL



Brainstorming discussions with specialists from Keskkonnaagentuur on 08.02.2017 from 09.00..11.00 in Tallinn Estonia.

Topics discussed:

1. Measurement program initial task and discussion of monitoring possibilities.
2. What and when to measure (water level, soil and air temperature etc.)

Decision: visit site and make a general plan where and how to investigate.

SITE VISIT PHOTOS 20170208

Site visit and investigations took place on 08.02.2017 afternoon and following locations were reviewed: Lontova rapids and dams with reservoirs up to Jaama street.

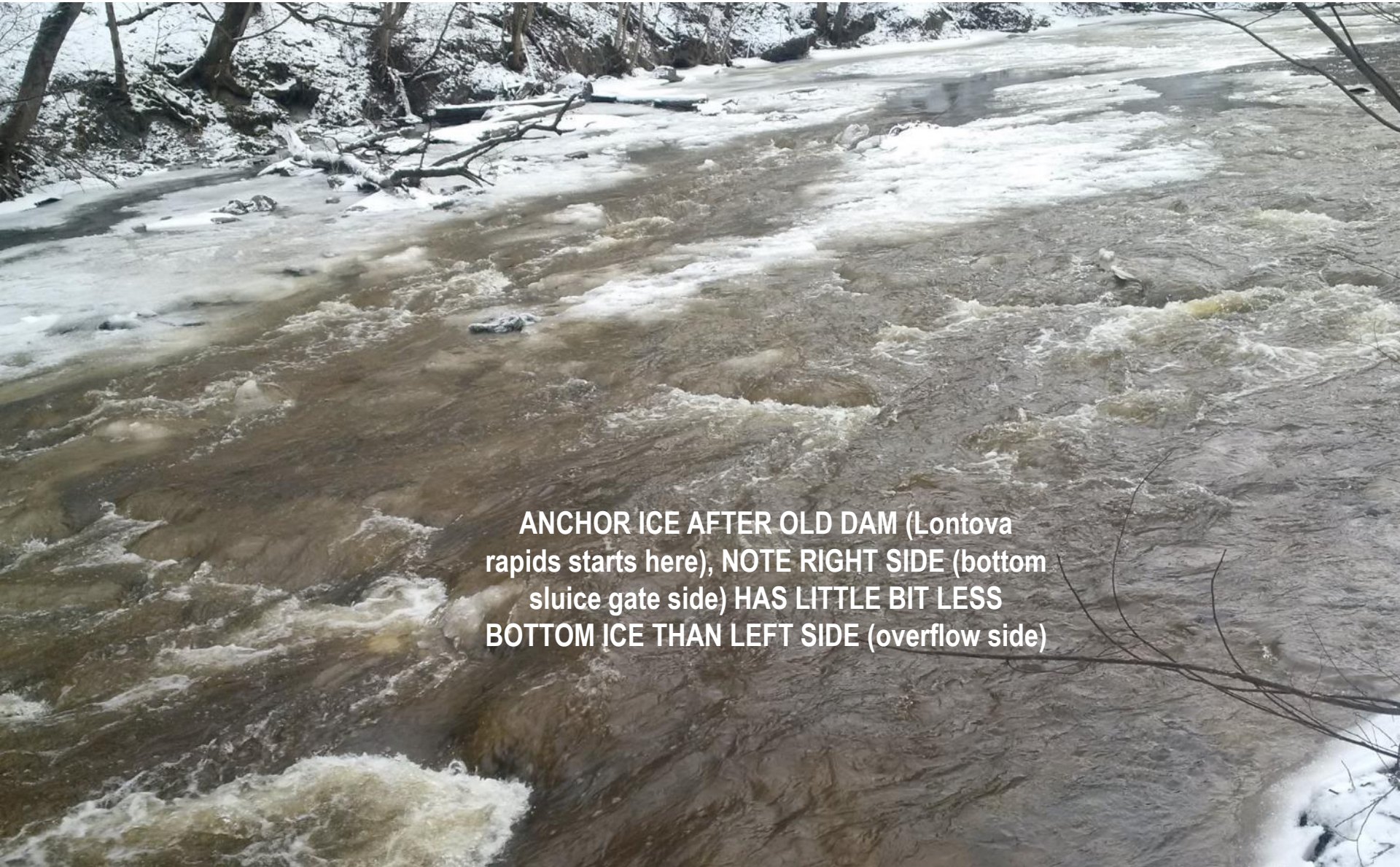
Participants: Philipp Theuring, Heiko Källo and Ergi Prommik.



PARTLY WATER OVERFLOWS OVER DAM
AND DAM IS COVERED WITH ANCHOR ICE

BOTTOM SLUICE GATE IS
OPEN AND SOME FLOW IS
COMING THREW THERE, NOTE
NO ICE AFTER BOTTOM GATE

SITE VISIT PHOTOS 20170802



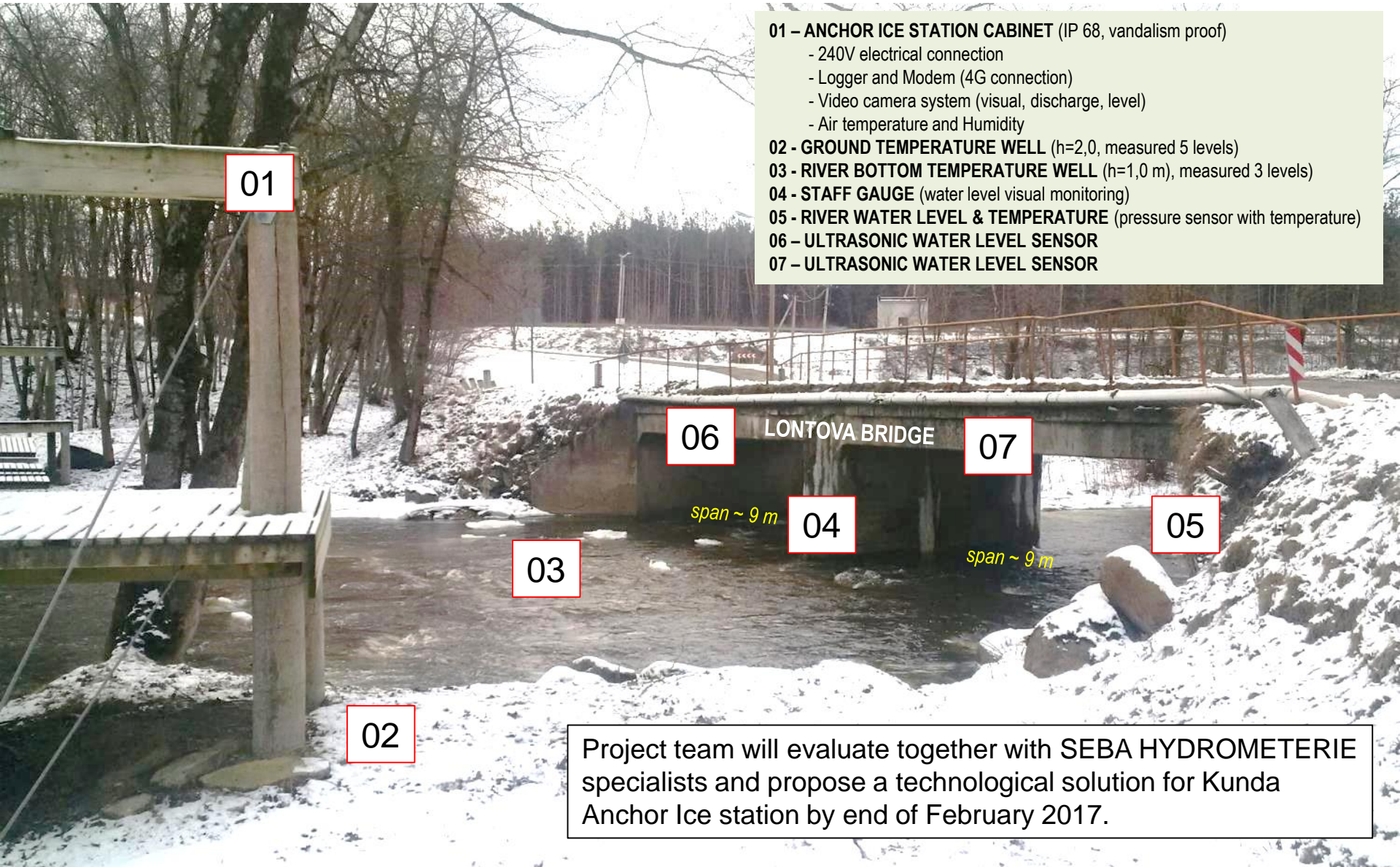
ANCHOR ICE AFTER OLD DAM (Lontova
rapids starts here), NOTE RIGHT SIDE (bottom
sluice gate side) HAS LITTLE BIT LESS
BOTTOM ICE THAN LEFT SIDE (overflow side)

SITE VISIT PHOTOS 20170802



ANCHOR ICE IN LONTOVA RAPIDS
NEAR BLÜCHERI CAFE

KUNDA ANCHOR ICE STATION



01 – ANCHOR ICE STATION CABINET (IP 68, vandalism proof)

- 240V electrical connection
- Logger and Modem (4G connection)
- Video camera system (visual, discharge, level)
- Air temperature and Humidity

02 - GROUND TEMPERATURE WELL (h=2,0, measured 5 levels)

03 - RIVER BOTTOM TEMPERATURE WELL (h=1,0 m), measured 3 levels)

04 - STAFF GAUGE (water level visual monitoring)

05 - RIVER WATER LEVEL & TEMPERATURE (pressure sensor with temperature)

06 – ULTRASONIC WATER LEVEL SENSOR

07 – ULTRASONIC WATER LEVEL SENSOR

06

LONTOVA BRIDGE

07

span ~ 9 m

04

05

span ~ 9 m

03

02

Project team will evaluate together with SEBA HYDROMETERIE specialists and propose a technological solution for Kunda Anchor Ice station by end of February 2017.