

Monthly report

Railway Field Laboratory

February 2023

Client: Swiss confederation; Federal Offices for the Environment (FOEN) and Transport (FOT), CH-3003 Bern
The FOEN and the FOT are offices of the Federal Department of the Environment, Transport, Energy and Communications (DETEC).

Consultant: Müller-BBM Rail Technologies GmbH
Helmut-A.-Müller-Straße 1 - 5
82152 Planegg
www.MuellerBBM-Rail.com

Author: Natan Isert, Stefan Lutzenberger

Supervision BAFU / BAV: Franz Kuster, Fredy Fischer
Robert Attinger, Christoph Dürig

Remarks: This report was published on behalf the Swiss Federal Office for the Environment (FOEN) and Transport (FOT). The consultant is responsible for the content and all data displayed.

Version: V2
Data basis: Database V3

Date: 26.2.2024

1. Status railway field laboratory

Construction work on the tracks:

- manual tamping after the track lowering on 01.02.2023 and 13.02.2023. The measurement cross-sections were not directly affected by this.

Downtimes of the measurement systems:

- none

Downtimes of the sensors:

- downtimes of the weather data from 27.1.2023 to 17.2.2023

Maintenance and sensor exchange:

- none

Modifications to the data, database, or analysis:

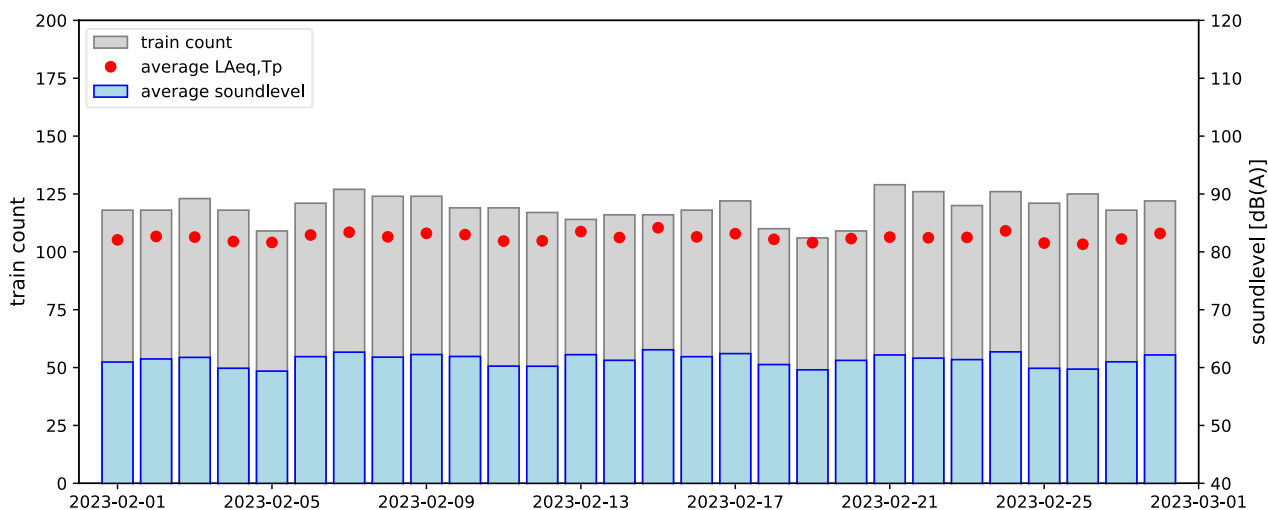
- none

Monthly data volume collected:

- 449 GB

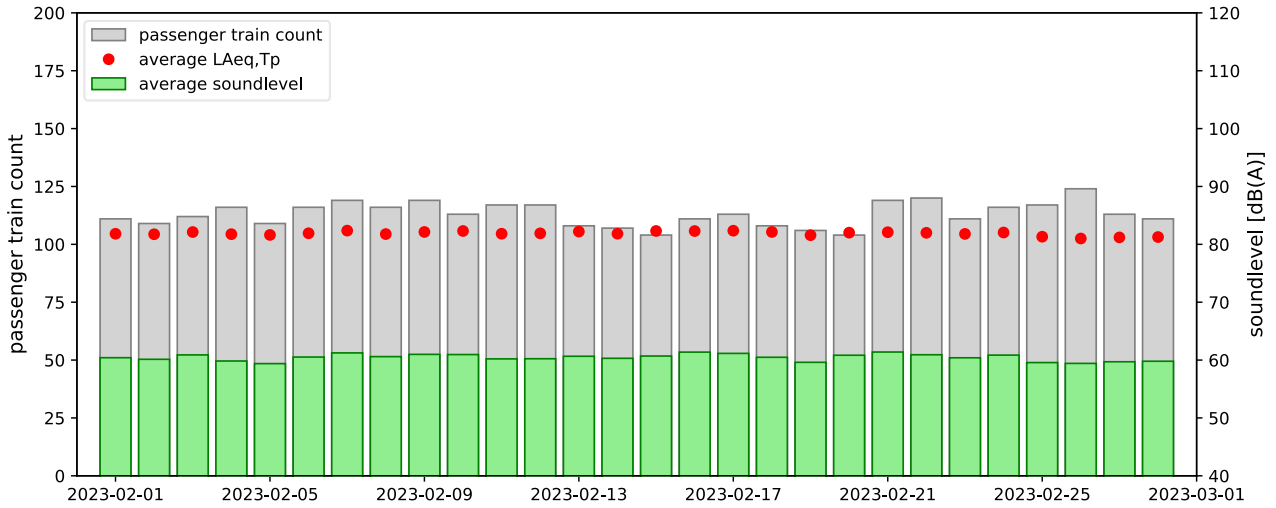
2. Measurement data

Daytime averages (24h) for all train passages at reference section (REF)



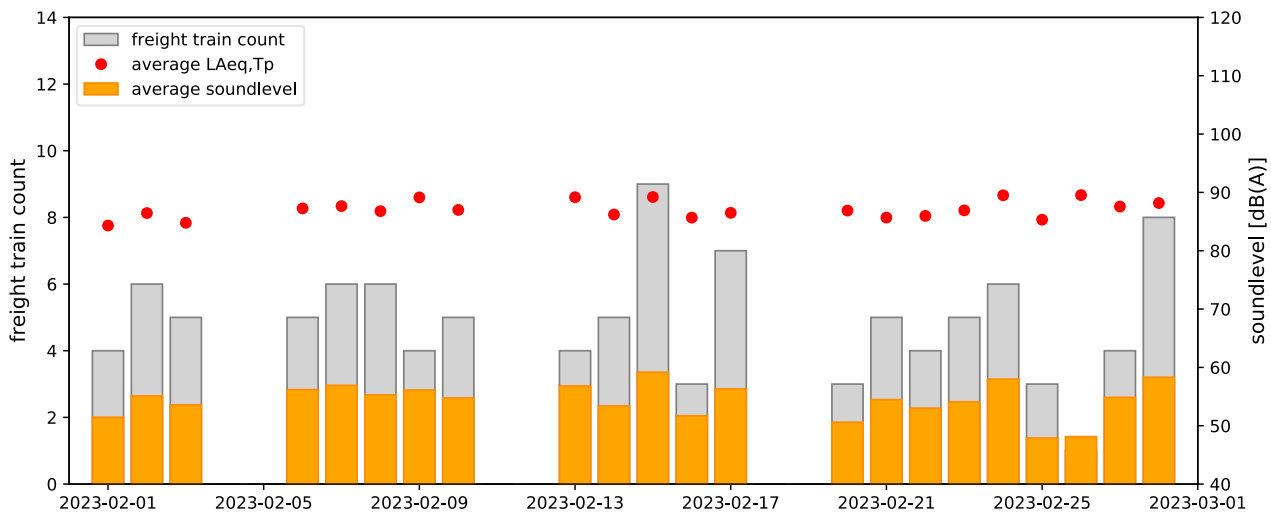
date	location	train count	passenger train count	freight train count	service train count	average LAeqTp	average soundlevel
01.02.2023	REF	118	111	4	3	82,1	61
02.02.2023	REF	118	109	6	3	82,7	61,5
03.02.2023	REF	123	112	5	6	82,5	61,8
04.02.2023	REF	118	116	0	2	81,8	59,9
05.02.2023	REF	109	109	0	0	81,6	59,4
06.02.2023	REF	121	116	5	0	82,9	61,9
07.02.2023	REF	127	119	6	2	83,4	62,7
08.02.2023	REF	124	116	6	2	82,6	61,8
09.02.2023	REF	124	119	4	1	83,2	62,3
10.02.2023	REF	119	113	5	1	83	61,9
11.02.2023	REF	119	117	0	2	81,9	60,3
12.02.2023	REF	117	117	0	0	81,9	60,2
13.02.2023	REF	114	108	4	2	83,5	62,2
14.02.2023	REF	116	107	5	4	82,5	61,3
15.02.2023	REF	116	104	9	3	84,2	63,1
16.02.2023	REF	118	111	3	4	82,6	61,9
17.02.2023	REF	122	113	7	2	83,1	62,4
18.02.2023	REF	110	108	0	2	82,2	60,5
19.02.2023	REF	106	106	0	0	81,6	59,6
20.02.2023	REF	109	104	3	2	82,3	61,2
21.02.2023	REF	129	119	5	5	82,5	62,2
22.02.2023	REF	126	120	4	2	82,4	61,6
23.02.2023	REF	120	111	5	4	82,5	61,4
24.02.2023	REF	126	116	6	4	83,6	62,7
25.02.2023	REF	121	117	3	1	81,5	59,9
26.02.2023	REF	125	124	1	0	81,3	59,7
27.02.2023	REF	118	113	4	1	82,2	61
28.02.2023	REF	122	111	8	3	83,2	62,2
month	REF	3335	3166	108	61	82,6	61,5

Daytime averages (24h) for all passenger train passages at reference section (REF)



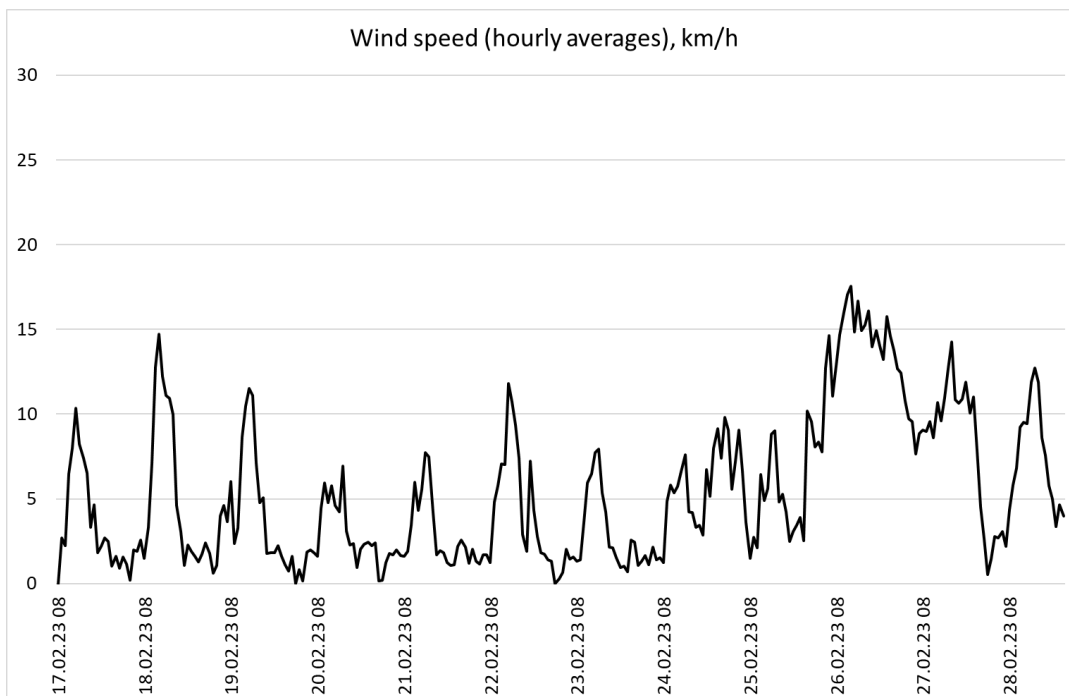
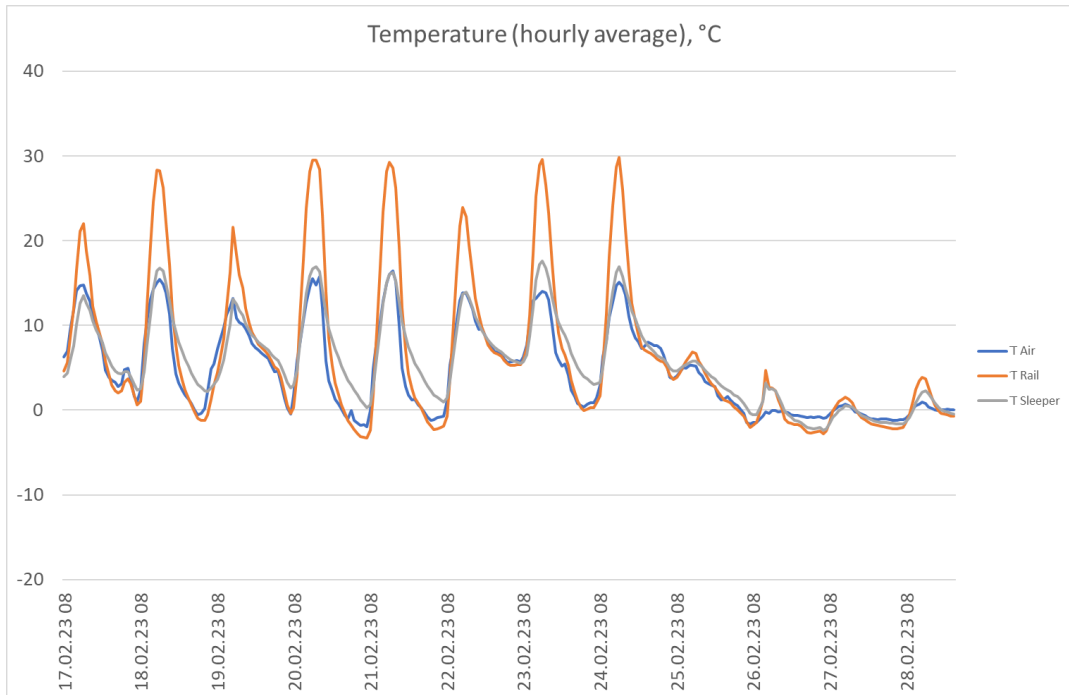
date	location	passenger train count	average speed	average length	average axlecount	average LAeqTp	average soundlevel
01.02.2023	REF	111	110,3	156,8	22,8	81,8	60,4
02.02.2023	REF	109	112,2	156,8	22,8	81,7	60,1
03.02.2023	REF	112	111,8	167	24,4	82,1	60,9
04.02.2023	REF	116	112,6	133,6	19,5	81,8	59,8
05.02.2023	REF	109	111,5	131,7	19,2	81,6	59,4
06.02.2023	REF	116	112,4	156,2	22,8	81,9	60,5
07.02.2023	REF	119	112,2	158,6	23,2	82,4	61,2
08.02.2023	REF	116	111,4	159,9	23,4	81,8	60,6
09.02.2023	REF	119	109,4	155,2	22,7	82,1	61
10.02.2023	REF	113	112,6	160,2	23,4	82,3	61
11.02.2023	REF	117	112,1	142,4	20,5	81,8	60,2
12.02.2023	REF	117	111,6	141,5	20,5	81,9	60,2
13.02.2023	REF	108	111	158,3	23,2	82,2	60,7
14.02.2023	REF	107	109,6	157,2	23	81,8	60,3
15.02.2023	REF	104	111,4	162,6	23,8	82,3	60,7
16.02.2023	REF	111	112	177,3	25,9	82,3	61,4
17.02.2023	REF	113	112,2	166,6	24,3	82,4	61,2
18.02.2023	REF	108	113,5	156,4	22,7	82,1	60,5
19.02.2023	REF	106	110,6	141,5	20,6	81,6	59,6
20.02.2023	REF	104	110,7	176,4	25,6	82	60,8
21.02.2023	REF	119	111,5	175	25,5	82,1	61,4
22.02.2023	REF	120	111,7	158,8	23,2	82	60,9
23.02.2023	REF	111	112,4	161,1	23,5	81,8	60,4
24.02.2023	REF	116	112,3	161,4	23,5	82	60,9
25.02.2023	REF	117	111,3	135,4	19,7	81,3	59,6
26.02.2023	REF	124	111,7	134,9	19,8	81	59,4
27.02.2023	REF	113	113,6	156,5	22,8	81,2	59,7
28.02.2023	REF	111	110,4	153,7	22,4	81,3	59,8
month	REF	3166	111,7	155,3	22,7	81,9	60,5

Daytime averages (24h) for all freight train passages at reference section (REF)



date	location	freight train count	average speed	average length	average axle count	average LAeqTp	average soundlevel
01.02.2023	REF	4	78,3	218,7	46	84,3	51,5
02.02.2023	REF	6	79	219,8	55,7	86,5	55,1
03.02.2023	REF	5	80,7	268,9	63,2	84,8	53,6
04.02.2023	REF	0					0
05.02.2023	REF	0					0
06.02.2023	REF	5	80,1	295	65,6	87,3	56,2
07.02.2023	REF	6	83,1	266,1	63,3	87,7	56,9
08.02.2023	REF	6	86,9	225,9	55	86,8	55,3
09.02.2023	REF	4	87,1	248	53,5	89,1	56,1
10.02.2023	REF	5	94,5	264,1	62	87	54,8
11.02.2023	REF	0					0
12.02.2023	REF	0					0
13.02.2023	REF	4	78	266,3	64,8	89,2	56,8
14.02.2023	REF	5	88,6	209,4	46,8	86,2	53,4
15.02.2023	REF	9	93,1	231,1	56,7	89,2	59,2
16.02.2023	REF	3	93,2	284,6	69,3	85,7	51,7
17.02.2023	REF	7	76,4	242,7	59,7	86,5	56,3
18.02.2023	REF	0					0
19.02.2023	REF	0					0
20.02.2023	REF	3	83,3	151,1	26,7	86,9	50,6
21.02.2023	REF	5	73,2	263,9	60,5	85,7	54,5
22.02.2023	REF	4	76,7	205,4	53	86	53
23.02.2023	REF	5	87,2	218,3	50,8	86,9	54,1
24.02.2023	REF	6	88,2	248,5	59	89,5	58
25.02.2023	REF	3	84	119,8	34,7	85,3	47,9
26.02.2023	REF	1	77,6	138	36	89,5	48,1
27.02.2023	REF	4	86	265,8	53,5	87,6	54,9
28.02.2023	REF	8	86,4	243,3	53,8	88,2	58,3
month	REF	108	84,3	237,8	55,6	87,4	54,2

3. Weather data



Appendix: measurement quantities

Transit Exposure Level *TEL*

A-weighted sound pressure level of a single train pass-by as energetic average over the entire exposure duration T and averaged over the pass-by duration T_p .

$$TEL = 10 \log \left(\frac{1}{T_p} \int_0^T \frac{p_A^2(t)}{p_0^2} dt \right) \quad (1)$$

Where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p_0 = 20 \mu Pa$ (reference pressure), [Pa]

$T_p = T_2 - T_1$ = pass-by duration of the train, time interval during which a train is within the measurement cross-section and which starts with the entry time T_1 into the measurement cross-section and ends with the exit time T_2 , [s]

T = time interval which starts when the smoothed sound pressure level (sound pressure level smoothed as a function of time with the frequency weighting A and a time weighting F („fast“ or averaging over a duration period of time, e.g. 100 ms) is for the last time 10 dB below that prevailing at the time of entering the measurement cross-section and which ends when the smoothed sound pressure level is for the first time 10 dB below the one at the time of leaving the measurement cross-section. [s]

A-weighted equivalent sound pressure level of the train pass-by $L_{Aeq,Tp}$

The A-weighted equivalent sound pressure level equals the (energetic) average of the sound pressure level over the train pass-by time T_p according to the following equation:

$$L_{Aeq,Tp} = 10 \log \left(\frac{1}{T_p} \int_{T_1}^{T_2} \frac{p_A^2(t)}{p_0^2} dt \right) \quad (2)$$

where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p_0 = 20 \mu Pa$ (reference sound pressure), [Pa]

$T_p = T_2 - T_1$ = pass-by duration of the train, [s]

Sound Exposure Level *SEL*

The sound exposure level *SEL* references the acoustic energy of the entire pass-by event to one second. The *SEL* is used in calculating average sound level contributions from trains over longer periods of time (i.e. days/months/year). The *SEL* is related to the transit exposure level *TEL* through:

$$SEL = TEL - 10 \log (T_0 / T_p) \quad (3)$$

where

$$T_0 = 1 \text{ [s]}$$

T_p = pass-by duration of the train, [s]

Average sound level (period)

Average (energetic) A-weighted sound pressure level measured over a given period of time.

For the average sound level contributions from train pass-byes this equals the sum (energetic) of all sound exposure levels during the period for a given measurement position:

$$average \ soundlevel = 10 \cdot \log_{10} \left(\sum 10^{\frac{SEL}{10}} \right) - A1 \quad (4)$$

where

$$A1 = 10 \cdot \log_{10}(n \cdot 24 \cdot 3600) \text{ for a 24-hour period}$$

SEL (see equation 3) taken from measurement data

n = number of days being averaged over

Average $L_{Aeq,Tp}$

Average (energetic) sound level of all the A-weighted sound pressure levels from the individual equivalent sound level of all train pass-byes in a given period of time (day/month/year).

Calculated per train category and per period day/night, month, year, etc. and per measurement location:

$$average \ L_{Aeq,Tp} = 10 \cdot \log_{10} \left(\sum T_p \cdot 10^{\frac{L_{Aeq,Tp}}{10}} \right) + 10 \cdot \log_{10} \left(\frac{1}{\sum T_p} \right) \quad (5)$$

where

T_p = pass-by duration of the train [s]

$L_{Aeq,Tp}$ (see equation 2) is calculated directly from the measurement data