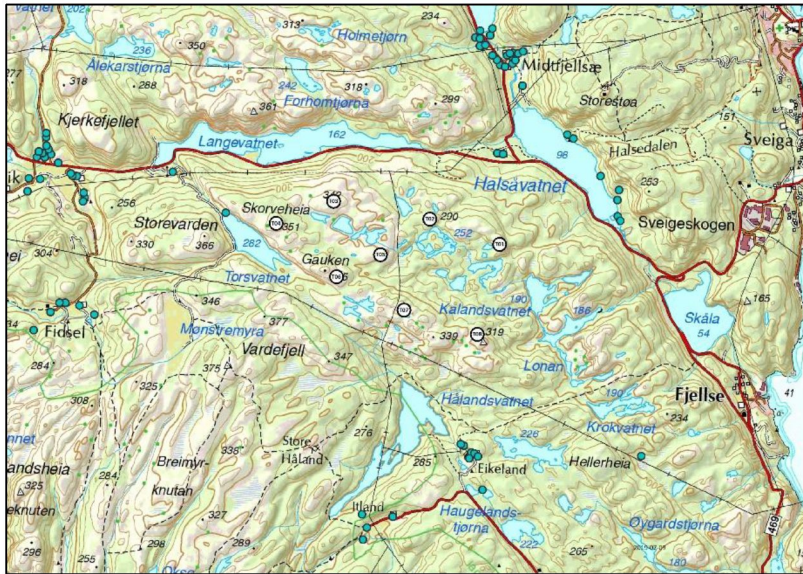


Calculation of noise immission from wind turbines

Wind farm Skorveheia



Client information

Project: Wind farm Skorveheia

Client: Norsk Vind Energi AS

Client reference: John Amund Lund

Project information

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Wind Farm	WTG type	Number of WTG	Hub height [m]	Total height [m]	Noise emission [dBA]
Skorveheia	NN	8	125	200	91,5-104,9

Calculation parameters		Calculation cases	
Calculation program	SoundPLAN 8.1	A01: Noise from wind farm Skorveheia for "Worst case" with downwind from all wind directions for 8 m/s at 10 m height with noise reducing measures, "tilltak", to comply with the noise limit. WTG in operation 365 days a year (8760 hours). A02: Noise from wind farm Skorveheia for 3-30 m/s at hub height for measured wind speed and wind direction distribution in 30° sectors according to Table 2-3. Noise emission for each wind speed at hub height according to Table 1, 91,8-104,9 dBA. This represents a yearly average of L_{den} based on wind speeds on site, "lokale vindforhold".	
Calculation standard	Nord2000		
Search radius	30 000 m		
Calculation height	1,5 m and 4,0 m		
Air absorption	ISO 9613-1		
Air pressure	1013,25 mbar		
Relative humidity	70%		
Temperature	15 °C		
Temperature gradient	+0,05 °C/m		
Roughness length	0,3 m		
Wind speed at 10 m height	8 m/s		
Standard deviation wind speed	0,5 m/s		
Wind direction	Downwind and wind statistics		
Turbulence strength parameter wind	0,12 m ⁴ /3/s ²		
Turbulence strength parameter temperature	0,008 K/s ²		
Effective flow resistivity forest	Impedance class D		
Effective flow resistivity other	Impedance class E		
Effective flow resistivity mountain	Impedance class F		
Effective flow resistivity water	Impedance class H		
Coordinate system	UTM WGS84 Zone: 32		
Height data	5 m height contours		

Information on calculation parameters

As the weather conditions varies during a normal year, weather parameters according to standard noise calculation methods are used, which are also identical to the values given in the ISA-Standard (International Standard Atmosphere) for air pressure and temperature. The applied relative humidity 70 % and temperature 15 °C is also recommended in the new Finish guidelines for calculation of wind turbine noise with Nord2000 as well as in the Danish regulations on industrial noise. In the Nordic calculation method for external industrial noise report *General Prediction Method, DAL-32*, the relative humidity 70 % and temperature 15 °C is used for planning purposes. DAL-32 is an approved method for calculation of wind turbine noise according to chapter 9.8.1 in the Norwegian guidelines on wind turbine noise M-128/2014, *Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442/2016)* (revised August 2018).

It shall be noted that the calculations are performed for a positive temperature gradient which is comparable to moderate inversion. The used value +0,05 °C/m is also the highest approved value according to the measurement method for noise immission from wind turbines *Elforsk 98:24* as recommended for measurements in M-128/2014. The noise level at a positive temperature gradient is usually higher compared to a negative temperature gradient.

The effective flow resistivity in Nord2000 represent the ground impedance or hardness of the ground. In the guidelines for Nord2000 seven impedance classes are defined, impedance class A-H, where A represents the softest ground for example snow and H represents the hardest ground for example water. In the performed calculations areas with different impedance classes has been specified based on maps and satellite images as well as information from the client. The different areas are shown in page 8 in a ground absorption map.

The calculations are performed with the assumption that the noise sensitive areas (NSA) are located 1,5 m and 4,0 m above ground. The height of 4,0 m should be considered decisive according to M-128/2014. Although it shall be noted that sound immission measurements according to the measurement standard *Elforsk 98:24*, recommended in chapter 9.8.5 in M-128/2014, should be performed at 1,2-1,5 m above ground. According to the European directive on environmental noise it is also possible to use calculations on 1,5 m above ground for recreational areas and areas with one-story housing as an additional indicator. The result on 1,5 m above ground should also be considered more representative to the exposure of noise outside of a dwelling.

Method description

The calculations are performed with the Nordic environmental noise prediction method Nord2000 which is an approved method for calculation of wind turbine noise according to chapter 9.8.1. in the guidelines M-128/2014. Nord2000 takes into account different aspects of noise spreading for example ground impedance, topography and wind direction. The calculations are performed both as "Worst case støyberegninger" ([Case A01](#)) and "Støyutredning basert på lokale vindforhold" ([Case A02](#)) in accordance with chapter 9.8.2-9.8.3 in M-128/2014.

The "Worst case støyberegninger" assumes specific weather conditions with a conservative transmission loss, high noise emission and the wind turbines in operation 8760 hours a year (365 days). This is equal to the noise immission during a day with downwind conditions and wind speed 8 m/s at 10 m height. The Calculations according to "Støyutredning basert på lokale vindforhold" are based on long term wind measurements and also considering the wind speed dependence of the noise emission, both high and low noise emission depending on the wind speed. Such calculations represent a more accurate value of a yearly average L_{den} . The level of L_{den} based on "lokale vindforhold" is, according to Akustikkonsultens experience, always lower than L_{den} for "worst case". This is also mentioned in chapter 9.8.3 in M-128/2014 where for example calculations considering different wind directions (Vindretning) is said to affect the calculation result with $\pm 1-2$ dB while different wind speed and noise emission (Vindhastighet og kildestøy) could affect the calculation result with up to 8 dB, both cases in comparison to "worst case" calculations.

Unfortunately, M-128/2014 do not present any detailed instructions on how to perform calculations assuming "lokale vindforhold". Akustikkonsulten suggests the method below to perform "Støyutredning basert på lokale vindforhold" based on long term wind measurements.

1. Sort the wind speed data so it corresponds to the wind speed dependency of the noise emission. For example, the cut-in wind speed, when the blades start to rotate and emit noise, is normally around 3 m/s at hub height for modern wind turbines. Based on wind and noise data for the current project the wind turbines has been assumed to not emit noise for wind speeds below 3 m/s, approx. 9,5 % of the year, and the highest noise emission 104,9 dBA (for the highest noise setting Mode 0) occurs for the wind speed 11 m/s at hub height and above, approx. 22,7 % of the year. For wind speeds between 3-10 m/s the noise emission is assumed to vary between 91,8-104,1 dBA for noise setting Mode 0. The wind speed dependent noise emission is given in Table 1-Table 3 for the used noise settings.
2. Divide the wind direction data in 30° sectors and calculate the percentual distribution for the wind speeds between 3 m/s to ≥ 11 m/s separately, similar to a wind rose, according to Table 4. The percentage for each wind direction is used for the calculations in step 4, where NSA in a dominant wind direction gets more noise during a year.
3. Calculate the noise immission for each wind direction in 30° sectors for wind speeds between 3 m/s to ≥ 11 m/s, a total of 96 calculations. The 12 results, for each wind speed, are then weighted using the wind direction distribution calculated in step 2.
4. The last step is to calculate the yearly average based on the result in step 2-3. The yearly average is weighted using the wind speed distribution between 0-30 m/s according to Table 2. The result is given in calculation [Case A02](#).

The calculations in [Case A02](#) are performed according to the method described above.

Calculation uncertainty

The use of the prediction model Nord2000 on wind turbine noise has been evaluated and validated by a Danish research project *PSO-07 F & U project no 7389. Noise and energy optimization of wind farms. Validation of the Nord2000 propagation model for use on wind turbine noise.*, Delta, rapport AV 1236/09 Hörsholm, Danmark 2009. In general, the conclusion is that the calculation results of Nord2000 show good agreement with sound measurements, for simple plain terrain with simple meteorological parameters as well as for complex hilly terrain with complex meteorological conditions. In comparison with ISO 9613-2, Nord2000 is an improvement, especially for the more complex situations.

Based on the above study it is believed that, with a confidence interval of 90 %, the calculated value is within the interval of (-5, +3 dB) from a measured value for complex norwegian terrain for distances up to 4 km from the wind farm. This confidence interval includes the uncertainty on the noise emission. It shall be noted that the uncertainty increases with the distance from the wind farm. This uncertainty is also expected to include a variation of the meteorological parameter's temperature, air pressure and humidity relative to the assumed values.

Noise reducing measures

To comply with the noise limit $L_{den}=45$ dBA the noise immission from the wind farm is optimized with noise reducing measures, "Avbøtende tiltak", in accordance to chapter 7.8.6 in M-128/2014. The "worst case" **Case A01** is dimensioning for the noise reducing measures, but the same noise reducing measures are also used for the calculations with "lokale vindforhold" **Case A02**.

For the assessment of noise reducing measures different noise settings (Modes) on the evaluated WTG is used. The WTG also offers blades with serrated trailing edges (STE) to reduce the noise emission. The noise emission without STE is 107,7 dBA for the highest noise setting and 104,9 dBA with STE, i.e. STE reduce the noise emission with 2,8 dBA. All WTG in the wind farm are assumed to have STE, which is most common in the wind turbine industry today as it is also often more favourable for the energy production. For the version with STE there are X additional noise settings available, with noise emission down to 98,0 dBA. The optimization is performed to comply with the noise limit for both 1,5 m and 4,0 m calculation height. The WTG giving the highest noise level in each NSA is curtailed with different noise settings until all NSA comply with the noise limit. The curtailment is only performed for time period Night (23-07), which have a penalty of 10 dBA and thus is more favourable for curtailment of L_{den} . During time period Day (07-19) and time period Evening (19-23) all WTG are operating with the highest noise setting, Mode 0 with noise emission 104,9 dBA.

Wind shadow

The former guide lines for wind turbine noise in Norway, *Veileder til Miljøverndepartementets retningslinje for behandling av støy i arealplanlegging (støyretningslinjen) (TA-2115/2005)*, had special recommendations for dwellings situated in wind shielded areas (wind shadow). But in the latest revision of the guidelines M-128/2014, dated August 2018, no special noise limits are given for these situations. The following recommendation is mentioned about wind shadow:

"Hvis en vindturbin er plassert høyt i terrenget og støymottaker ligger i le i dalformasjoner, kan maskeringen fra vindsuset reduseres vesentlig fordi mottaker er skjermet for vinden. Mottakeren ligger da i vindskygge, og vil høre støy fra vindturbinene bedre. Det finnes ikke spesielle støykrav ved vindskygge, men spesielt i detaljprosjekteringsfasen bør utreder være oppmerksom på støyfølsom bebyggelse som ligger i vindskygge. I slike tilfeller kan støy fra vindturbiner ofte høres best ved vindstyrker i 10 –12 m/s. Dette bør da legges til grunn for støyberegninger. "

All noise calculations and reports produced by Akustikkonsulten undergoes a quality assurance check in accordance with Akustikkonsultens quality system. It could be noted that Akustikkonsulten is one of few noise consultants in the Nordic region that are accredited (by SWEDAC and in compliance with ILAC, International Laboratory Accreditation Cooperation) according to ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories as well as for the measurement standard for noise emission from wind turbines IEC 61400-11. Akustikkonsultens consultants have more than 10 years of experience from noise calculations of wind turbine noise and have performed calculations for more than 500 wind farms over the years.

The performed "worst case" calculations are to be considered as conservative compared to the calculations based on "lokale vindforhold". In addition, the highest noise emission for wind speeds between 3 m/s-20 m/s is assumed in the "worst case" calculations, as recommended in M-128/2014 when there could be a risk for wind shadow. This noise emission also corresponds to the warranted noise emission according to the wind turbine manufacturer.

Noise data

Table 1

WTG type	Noise setting	Wind speed at hub height [m/s]	Noise emission [dBA]
	Mode 0 STE ³⁾	4 ¹⁾	91,8
	Mode 0 STE ³⁾	5	94,1
	Mode 0 STE ³⁾	6	96,9
	Mode 0 STE ³⁾	7	100,0
	Mode 0 STE ³⁾	8	102,7
	Mode 0 STE ³⁾	9	104,0
	Mode 0 STE ³⁾	10	104,1
	Mode 0 STE ³⁾	≥11 ²⁾	104,9

Reference noise data: Frequency spectrum 1/3-octave bands between 20 Hz and 10 000 Hz has been taken from the WTG manufacturer document xx dated 2019-05-20 supplied by the client. The noise emission is given for wind speeds between 3 m/s up to 20 m/s.

The highest noise emission for any wind speeds, between 3-20 m/s, is used in the calculation corresponding to the wind speed 11 m/s at hub height.

¹⁾Used for wind speed 3-4 m/s

²⁾Used for wind speed ≥11 m/s

³⁾STE - Blades with serrated trailing edges

Disclaimer: The calculations are valid for the used noise emission and frequency spectrum. Akustikkonsulten gives no guaranty on the actual noise emission level nor frequency spectrum.

Noise data

Table 2

WTG type	Noise setting	Wind speed at hub height [m/s]	Noise emission [dBA]
	SRMO STE ³⁾	4 ¹⁾	91,8
	SRMO STE ³⁾	5	94,1
	SRMO STE ³⁾	6	96,9
	SRMO STE ³⁾	7	100,0
	SRMO STE ³⁾	8	102,6
	SRMO STE ³⁾	9	103,7
	SRMO STE ³⁾	10	103,9
	SRMO STE ³⁾	≥11 ²⁾	104,0

Reference noise data: Frequency spectrum 1/3-octave bands between 20 Hz and 10 000 Hz has been taken from the WTG manufacturer document xx dated 2019-05-20 supplied by the client. The noise emission is given for wind speeds between 3 m/s up to 20 m/s.

The highest noise emission for any wind speeds, between 3-20 m/s, is used in the calculation corresponding to the wind speed 11 m/s at hub height.

¹⁾Used for wind speed 3-4 m/s

²⁾Used for wind speed ≥11 m/s

³⁾STE - Blades with serrated trailing edges

Disclaimer: The calculations are valid for the used noise emission and frequency spectrum. Akustikkonsulten gives no guaranty on the actual noise emission level nor frequency spectrum.

Noise data

Table 3

WTG type	Noise setting	Wind speed at hub height [m/s]	Noise emission [dBA]
	SRM3 STE ³⁾	4 ¹⁾	91,5
	SRM3 STE ³⁾	5	93,9
	SRM3 STE ³⁾	6	96,9
	SRM3 STE ³⁾	7	99,7
	SRM3 STE ³⁾	8	101,0
	SRM3 STE ³⁾	9	101,0
	SRM3 STE ³⁾	10	101,0
	SRM3 STE ³⁾	≥11 ²⁾	101,0

Reference noise data: Frequency spectrum 1/3-octave bands between 20 Hz and 10 000 Hz has been taken from the WTG manufacturer document xx dated 2019-05-20 supplied by the client. The noise emission is given for wind speeds between 3 m/s up to 20 m/s.

The highest noise emission for any wind speeds, between 3-20 m/s, is used in the calculation corresponding to the wind speed 11 m/s at hub height.

¹⁾Used for wind speed 3-4 m/s

²⁾Used for wind speed ≥11 m/s

³⁾STE - Blades with serrated trailing edges

Disclaimer: The calculations are valid for the used noise emission and frequency spectrum. Akustikkonsulten gives no guaranty on the actual noise emission level nor frequency spectrum.

Wind data

Table 4

Wind speed at hh [m/s]	Total [%]	0° [%]	30° [%]	60° [%]	90° [%]	120° [%]
0-2	9,5	0,7	0,8	0,8	0,8	0,7
3-4	15,0	1,0	1,1	1,1	1,1	1,2
5	9,4	0,7	0,7	0,8	0,8	0,7
6	9,8	0,7	0,6	0,8	0,9	0,8
7	9,7	0,7	0,6	0,9	1,0	0,8
8	9,0	0,6	0,5	0,9	1,0	0,7
9	8,1	0,4	0,3	0,9	1,0	0,7
10	7,0	0,3	0,2	0,8	1,0	0,6
11-30	22,7	0,7	0,4	2,4	5,2	1,6
All wind speeds	100,0	5,8	5,1	9,4	12,8	7,8
Wind speed at hh [m/s]	150° [%]	180° [%]	210° [%]	240° [%]	270° [%]	300° [%]
0-2	0,7	0,7	0,8	0,9	1,0	0,9
3-4	1,1	1,2	1,3	1,6	1,6	1,5
5	0,7	0,6	0,7	0,8	1,0	1,0
6	0,7	0,6	0,7	0,8	1,1	1,1
7	0,7	0,5	0,6	0,8	1,0	1,1
8	0,5	0,5	0,5	0,7	0,9	1,1
9	0,5	0,4	0,5	0,6	0,8	1,0
10	0,3	0,3	0,4	0,5	0,7	0,9
11-30	0,6	0,6	1,0	1,8	2,3	3,1
All wind speeds	5,8	5,4	6,4	8,6	10,3	11,7
Wind speed at hh [m/s]	330° [%]					
0-2	0,9					
3-4	1,3					
5	0,8					
6	1,0					
7	1,0					
8	1,0					
9	1,0					
10	0,9					
11-30	3,2					
All wind speeds	10,9					

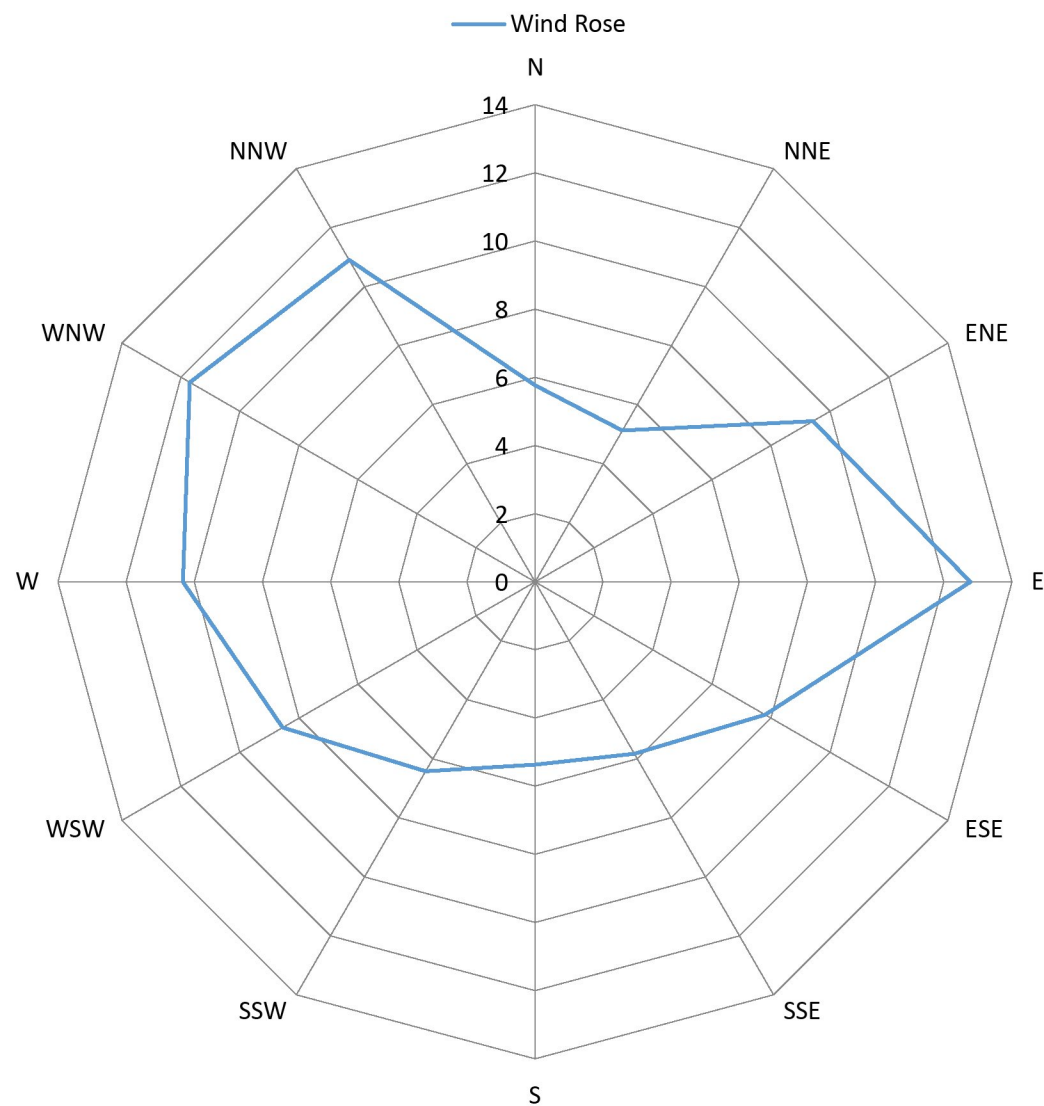
Wind distribution used in calculation

Case A02: Both wind speed and wind direction distribution is used for wind speed 0-30 m/s, red values. This case represents an accurate yearly average of L_{den} .

Reference wind data: The wind speed distribution is compiled and supplied by Meventus AS. The data corresponds to long term corrected values for 125 m height.

Disclaimer: The calculations are valid for the used wind speed distribution. Akustikkonsulten gives no guaranty that the real wind distribution is the same.

Wind data



Wind Farm Skorveheia							
WTG	X [m]	Y [m]	Hub height [m]	Hub height level [mas]	Ground level [mas]	Noise emission [dBA]	Noise setting
T01	359651	6462387	125	420	295	104,9/101,0 ¹⁾	Mode 0/SRM3
T02	359078	6462595	125	411	286	104,9/104,0 ²⁾	Mode 0/SRM0
T03	358285	6462741	125	463	338	104,9	Mode 0
T04	357812	6462559	125	476	351	104,9	Mode 0
T05	358671	6462303	125	438	313	104,9	Mode 0
T06	358308	6462121	125	474	349	104,9	Mode 0
T07	358864	6461847	125	467	342	104,9	Mode 0
T08	359467	6461650	125	421	296	104,9/104,0 ²⁾	Mode 0/SRM0

¹⁾Noise setting Mode 0, 104,9 dBA, is used for time period Day (07-19) and Evening (19-23) and curtailment to noise setting SRM3, 101,0 dBA, is used for timeperiod Night

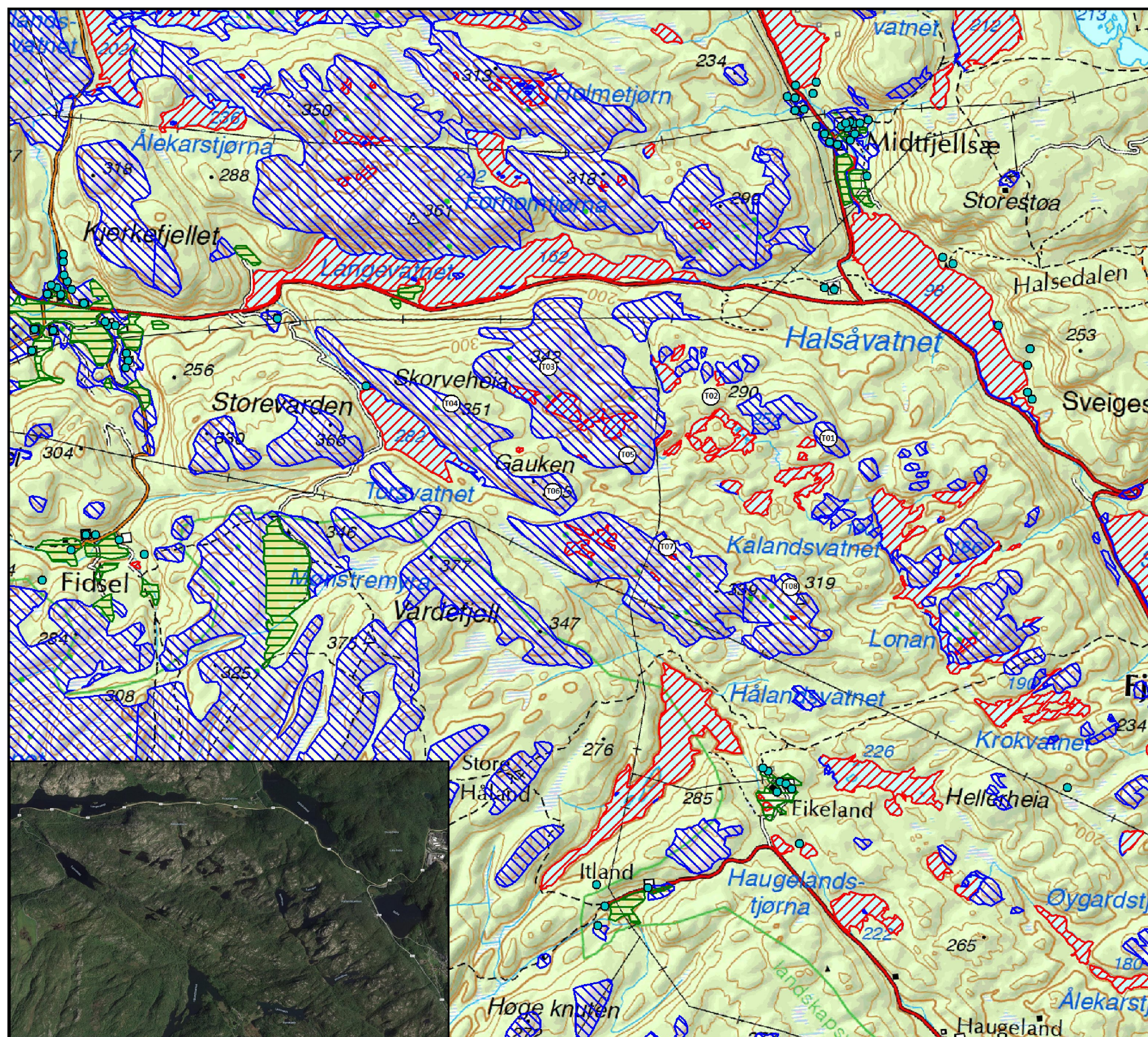
²⁾Noise setting Mode 0, 104,9 dBA, is used for time period Day (07-19) and Evening (19-23) and curtailment to noise setting SRM0, 104,0 dBA, is used for timeperiod Night

Wind Farm Skorveheia							
WTG	X [m]	Y [m]	Hub height [m]	Hub height level [mas]	Ground level [mas]	Noise emission [dBA]	Noise setting
T01	359651	6462387	125	420	295	91,3-104,9/91,3-101,0 ¹⁾	Mode 0/SRM3
T02	359078	6462595	125	411	286	91,3-104,9/91,3-104,0 ²⁾	Mode 0/SRM0
T03	358285	6462741	125	463	338	91,3-104,9	Mode 0
T04	357812	6462559	125	476	351	91,3-104,9	Mode 0
T05	358671	6462303	125	438	313	91,3-104,9	Mode 0
T06	358308	6462121	125	474	349	91,3-104,9	Mode 0
T07	358864	6461847	125	467	342	91,3-104,9	Mode 0
T08	359467	6461650	125	421	296	91,3-104,9/91,3-104,0 ²⁾	Mode 0/SRM0

¹⁾Noise setting Mode 0, 104,9 dBA, is used for time period Day (07-19) and Evening (19-23) and curtailment to noise setting SRM3, 101,0 dBA, is used for timeperiod Night

²⁾Noise setting Mode 0, 104,9 dBA, is used for time period Day (07-19) and Evening (19-23) and curtailment to noise setting SRM0, 104,0 dBA, is used for timeperiod Night

Ground absorption map



- NSA
- WTG

- Impedance class H 1)
- Impedance class F 2)
- Impedance class E 3)

- 1) Impedance class H -
Very hard and dense surface (dense asphalt, concrete, water)
- 2) Impedance class F -
Compacted dense ground (gravel road, parking lot, ISO 10844 asphalt)
- 3) Impedance class E -
Compact field and gravel (compacted lawns, park area)
- 4) All other areas Impedance class D -
Normal uncompacted ground (forest floors, pasture fields)



0 400 800 1200 m

Wind farm Skorveheia
Nord2000 impedance classes in
calculations

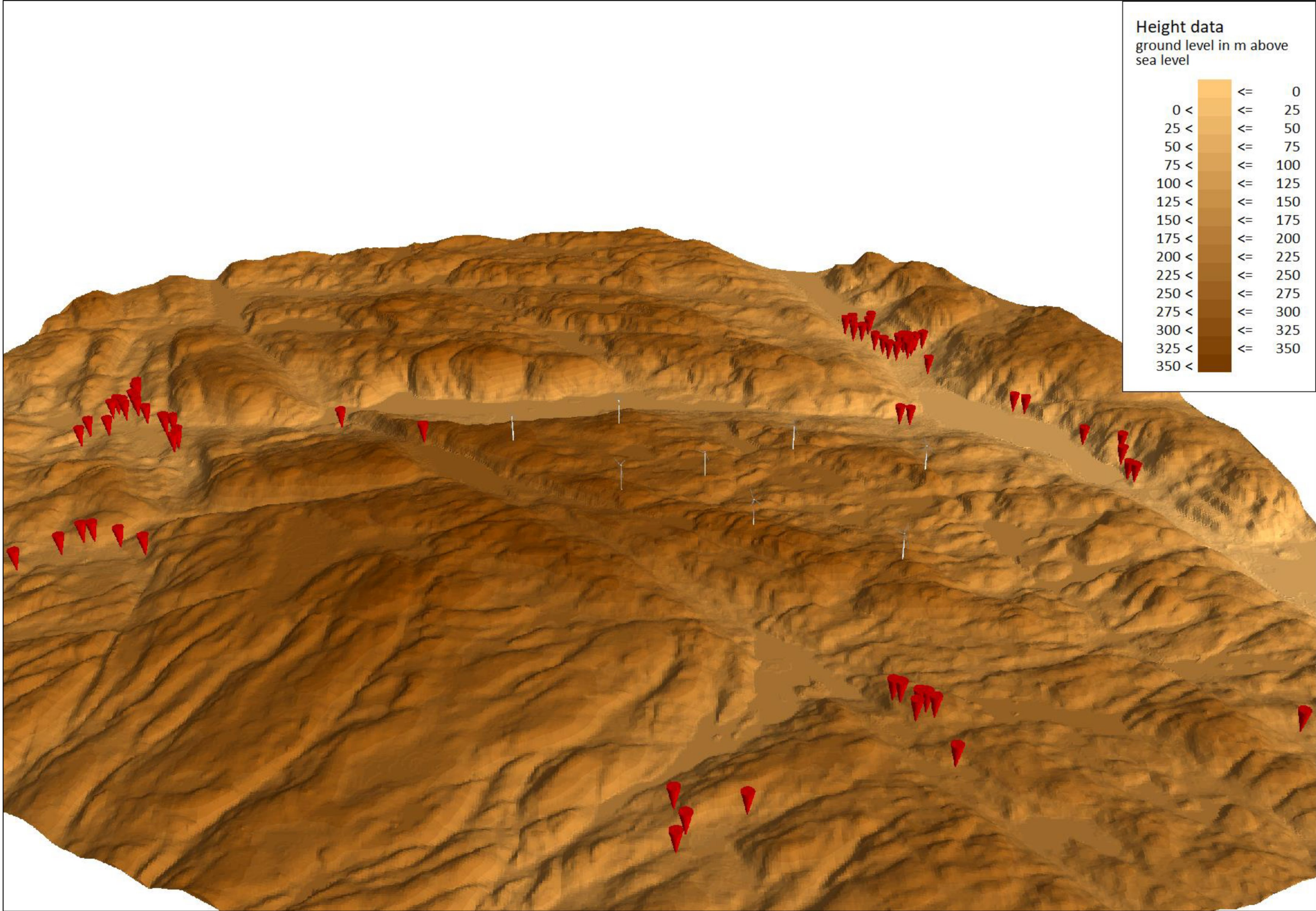


Beräknad med SoundPLAN 8.1 uppdatering 2019-07-09

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Handläggare	Paul Appelqvist	Kvalitetsgranskare	Jens Fredriksson
Projekt nr.	10-19124	Riktning	
Datum	2019-07-12		

Ground model



Distance NSA-WTG

			Horizontal distance NSA-WTG [m]							
NSA	X [m]	Y [m]	T01	T02	T03	T04	T05	T06	T07	T08
1	359418	6460680	1723	1945	2352	2472	1787	1819	1292	972
2	356963	6462982	2753	2150	1344	949	1838	1597	2214	2836
3	358520	6460171	2488	2487	2581	2491	2137	1961	1711	1756
4	358772	6460154	2400	2460	2632	2590	2151	2021	1695	1650
5	358560	6460063	2567	2584	2692	2606	2243	2073	1810	1828
6	358526	6459965	2671	2687	2786	2690	2342	2167	1912	1930
7	360208	6463287	1058	1325	1999	2504	1825	2229	1970	1797
8	359839	6463690	1316	1333	1821	2321	1813	2192	2085	2074
9	360259	6463257	1061	1354	2040	2545	1853	2258	1983	1792
10	359656	6463859	1472	1390	1769	2256	1842	2199	2162	2217
11	356316	6461811	3384	2871	2178	1673	2406	2016	2548	3155
12	360483	6462948	1003	1449	2208	2699	1923	2327	1958	1648
13	359696	6463847	1461	1396	1793	2282	1853	2215	2166	2209
14	359631	6463902	1515	1419	1778	2261	1865	2219	2193	2258
15	360623	6462618	999	1545	2341	2812	1977	2368	1921	1508
16	360645	6462581	1013	1567	2365	2833	1993	2382	1926	1501
17	359592	6463940	1554	1440	1774	2253	1878	2227	2216	2293
18	359488	6464016	1637	1479	1753	2221	1898	2232	2257	2366
19	359757	6463870	1487	1445	1855	2346	1907	2271	2211	2239
20	359533	6464024	1641	1500	1790	2260	1925	2263	2277	2375
21	359743	6463930	1546	1491	1881	2368	1948	2309	2261	2297
22	356193	6461884	3494	2971	2261	1754	2513	2128	2671	3282
23	359451	6464085	1710	1536	1779	2239	1945	2272	2314	2435
24	360635	6462833	1080	1575	2352	2836	2034	2433	2027	1662
25	359714	6463938	1552	1486	1864	2349	1939	2297	2257	2301
26	359780	6463900	1518	1482	1892	2381	1944	2309	2248	2272
27	359489	6464078	1699	1539	1799	2263	1954	2286	2317	2428
28	359777	6463952	1570	1526	1922	2409	1986	2347	2294	2323
29	359756	6463959	1576	1523	1910	2396	1980	2340	2293	2327

Distance NSA-WTG

			Horizontal distance NSA-WTG [m]							
NSA	X [m]	Y [m]	T01	T02	T03	T04	T05	T06	T07	T08
30	359805	6463954	1575	1541	1945	2433	2003	2367	2308	2329
31	359575	6464103	1718	1588	1876	2344	2014	2352	2365	2455
32	359845	6463970	1595	1574	1986	2475	2039	2404	2339	2351
33	356236	6462772	3437	2848	2049	1590	2480	2172	2786	3420
34	359592	6464159	1773	1646	1928	2393	2072	2409	2424	2512
35	356076	6461910	3607	3079	2360	1853	2625	2242	2789	3401
36	356030	6461910	3652	3124	2403	1897	2670	2288	2835	3447
37	356173	6462948	3523	2926	2122	1685	2580	2290	2908	3541
38	356135	6462950	3561	2964	2160	1722	2617	2326	2943	3577
39	355956	6461833	3736	3214	2500	1993	2755	2370	2908	3516
40	356123	6462969	3576	2979	2174	1738	2634	2344	2962	3595
41	360817	6460651	2091	2608	3283	3560	2708	2908	2290	1679
42	356019	6463057	3693	3094	2288	1861	2757	2473	3092	3724
43	355959	6463127	3765	3164	2358	1938	2834	2555	3174	3806
44	355871	6462923	3818	3224	2421	1975	2868	2566	3181	3815
45	355939	6463168	3793	3191	2385	1970	2866	2590	3209	3841
46	355907	6463101	3811	3211	2405	1981	2877	2593	3212	3844
47	355922	6463198	3816	3213	2407	1995	2891	2618	3237	3868
48	355889	6463136	3836	3235	2428	2008	2904	2623	3242	3874
49	355767	6462822	3908	3319	2519	2062	2950	2636	3247	3881
50	355920	6463266	3833	3228	2423	2020	2915	2648	3268	3898
51	355778	6462930	3911	3317	2514	2068	2960	2656	3271	3905
52	355843	6463106	3875	3275	2469	2044	2940	2655	3273	3906
53	355859	6463149	3868	3266	2460	2040	2937	2656	3275	3907
54	355920	6463302	3842	3236	2431	2033	2927	2664	3284	3913
55	359633	6463137	750	775	1405	1910	1273	1669	1501	1496
56	359681	6463128	742	805	1448	1954	1304	1703	1520	1494
57	357397	6462648	2269	1682	893	424	1320	1052	1671	2298
58	359444	6460672	1728	1958	2372	2495	1805	1841	1310	979

			Horizontal distance NSA-WTG [m]							
NSA	X [m]	Y [m]	T01	T02	T03	T04	T05	T06	T07	T08
59	359472	6460646	1750	1988	2407	2532	1840	1878	1346	1004
60	359511	6460373	2019	2264	2667	2769	2105	2122	1610	1278
61	359357	6460734	1679	1881	2275	2391	1712	1738	1217	922
62	359331	6460749	1669	1863	2250	2363	1688	1711	1193	911
63	360621	6462750	1036	1551	2336	2816	2001	2397	1976	1595
64	356228	6462812	3449	2858	2058	1604	2495	2192	2807	3441
65	356223	6462740	3446	2859	2062	1599	2487	2175	2788	3422
66	359402	6460632	1773	1990	2387	2498	1824	1848	1329	1020
67	359736	6463955	1570	1511	1892	2377	1966	2324	2281	2321
68	359491	6464141	1761	1600	1847	2306	2012	2341	2378	2491
69	355816	6461683	3899	3387	2686	2180	2922	2530	3052	3651

Information on distance

The distance corresponds to the horizontal distance in m between the NSA and the WTG.

The WTG with the shortest distance to each NSA are marked with blue color in the table.

Point calculations

NSA	X [m]	Y [m]	Z _{ground} [mas]	Calculation height [m]	L _{den} [dBA]	
					A01	A02
1	359418	6460680	253	1,5 m	40	35
1	359418	6460680	253	4,0 m	42	38
2	356963	6462982	182	1,5 m	39	32
2	356963	6462982	182	4,0 m	39	32
3	358520	6460171	220	1,5 m	40	36
3	358520	6460171	220	4,0 m	41	37
4	358772	6460154	212	1,5 m	19	11
4	358772	6460154	212	4,0 m	20	12
5	358560	6460063	200	1,5 m	25	16
5	358560	6460063	200	4,0 m	28	20
6	358526	6459965	205	1,5 m	38	34
6	358526	6459965	205	4,0 m	39	34
7	360208	6463287	102	1,5 m	42	39
7	360208	6463287	102	4,0 m	43	40
8	359839	6463690	105	1,5 m	42	38
8	359839	6463690	105	4,0 m	42	39
9	360259	6463257	103	1,5 m	42	39
9	360259	6463257	103	4,0 m	42	40
10	359656	6463859	109	1,5 m	40	34
10	359656	6463859	109	4,0 m	40	35
11	356316	6461811	208	1,5 m	22	16
11	356316	6461811	208	4,0 m	22	16
12	360483	6462948	101	1,5 m	43	39
12	360483	6462948	101	4,0 m	43	39
13	359696	6463847	104	1,5 m	41	35
13	359696	6463847	104	4,0 m	41	36
14	359631	6463902	114	1,5 m	41	34
14	359631	6463902	114	4,0 m	40	34
15	360623	6462618	102	1,5 m	41	36

Point calculations

NSA	X [m]	Y [m]	Z _{ground} [mas]	Calculation height [m]	L _{den} [dBA]	
					A01	A02
15	360623	6462618	102	4,0 m	41	37
16	360645	6462581	110	1,5 m	41	36
16	360645	6462581	110	4,0 m	41	37
17	359592	6463940	119	1,5 m	40	32
17	359592	6463940	119	4,0 m	40	33
18	359488	6464016	137	1,5 m	41	34
18	359488	6464016	137	4,0 m	40	34
19	359757	6463870	104	1,5 m	42	37
19	359757	6463870	104	4,0 m	42	37
20	359533	6464024	131	1,5 m	41	34
20	359533	6464024	131	4,0 m	40	34
21	359743	6463930	109	1,5 m	42	37
21	359743	6463930	109	4,0 m	42	37
22	356193	6461884	199	1,5 m	31	22
22	356193	6461884	199	4,0 m	30	22
23	359451	6464085	143	1,5 m	40	34
23	359451	6464085	143	4,0 m	40	34
24	360635	6462833	131	1,5 m	42	38
24	360635	6462833	131	4,0 m	42	39
25	359714	6463938	112	1,5 m	41	36
25	359714	6463938	112	4,0 m	41	37
26	359780	6463900	105	1,5 m	42	37
26	359780	6463900	105	4,0 m	42	37
27	359489	6464078	135	1,5 m	40	34
27	359489	6464078	135	4,0 m	40	34
28	359777	6463952	109	1,5 m	41	37
28	359777	6463952	109	4,0 m	41	37
29	359756	6463959	110	1,5 m	42	37
29	359756	6463959	110	4,0 m	42	37

Point calculations

NSA	X [m]	Y [m]	Z _{ground} [mas]	Calculation height [m]	L _{den} [dBA]	
					A01	A02
30	359805	6463954	108	1,5 m	41	37
30	359805	6463954	108	4,0 m	41	37
31	359575	6464103	131	1,5 m	40	35
31	359575	6464103	131	4,0 m	40	35
32	359845	6463970	113	1,5 m	41	37
32	359845	6463970	113	4,0 m	41	38
33	356236	6462772	181	1,5 m	34	25
33	356236	6462772	181	4,0 m	34	25
34	359592	6464159	132	1,5 m	39	35
34	359592	6464159	132	4,0 m	40	35
35	356076	6461910	212	1,5 m	36	30
35	356076	6461910	212	4,0 m	37	31
36	356030	6461910	206	1,5 m	34	27
36	356030	6461910	206	4,0 m	34	28
37	356173	6462948	166	1,5 m	38	33
37	356173	6462948	166	4,0 m	38	33
38	356135	6462950	160	1,5 m	37	32
38	356135	6462950	160	4,0 m	37	33
39	355956	6461833	195	1,5 m	35	30
39	355956	6461833	195	4,0 m	35	30
40	356123	6462969	162	1,5 m	38	33
40	356123	6462969	162	4,0 m	38	34
41	360817	6460651	178	1,5 m	31	22
41	360817	6460651	178	4,0 m	32	24
42	356019	6463057	159	1,5 m	37	34
42	356019	6463057	159	4,0 m	37	34
43	355959	6463127	162	1,5 m	37	31
43	355959	6463127	162	4,0 m	36	32
44	355871	6462923	166	1,5 m	35	30

Point calculations

NSA	X [m]	Y [m]	Z _{ground} [mas]	Calculation height [m]	L _{den} [dBA]	
					A01	A02
44	355871	6462923	166	4,0 m	35	30
45	355939	6463168	165	1,5 m	37	30
45	355939	6463168	165	4,0 m	36	31
46	355907	6463101	157	1,5 m	36	32
46	355907	6463101	157	4,0 m	36	33
47	355922	6463198	165	1,5 m	35	27
47	355922	6463198	165	4,0 m	36	30
48	355889	6463136	160	1,5 m	37	33
48	355889	6463136	160	4,0 m	38	33
49	355767	6462822	167	1,5 m	35	29
49	355767	6462822	167	4,0 m	35	30
50	355920	6463266	172	1,5 m	31	22
50	355920	6463266	172	4,0 m	31	23
51	355778	6462930	158	1,5 m	36	31
51	355778	6462930	158	4,0 m	36	31
52	355843	6463106	160	1,5 m	37	33
52	355843	6463106	160	4,0 m	37	33
53	355859	6463149	161	1,5 m	38	33
53	355859	6463149	161	4,0 m	38	33
54	355920	6463302	173	1,5 m	25	17
54	355920	6463302	173	4,0 m	25	17
55	359633	6463137	114	1,5 m	45	41
55	359633	6463137	114	4,0 m	45	41
56	359681	6463128	112	1,5 m	45	40
56	359681	6463128	112	4,0 m	45	41
57	357397	6462648	288	1,5 m	48	44
57	357397	6462648	288	4,0 m	48	45
58	359444	6460672	253	1,5 m	38	32
58	359444	6460672	253	4,0 m	40	35

Point calculations

NSA	X [m]	Y [m]	Z _{ground} [mas]	Calculation height [m]	L _{den} [dBA]	
					A01	A02
59	359472	6460646	248	1,5 m	36	29
59	359472	6460646	248	4,0 m	38	32
60	359511	6460373	241	1,5 m	31	24
60	359511	6460373	241	4,0 m	36	29
61	359357	6460734	250	1,5 m	43	39
61	359357	6460734	250	4,0 m	43	40
62	359331	6460749	248	1,5 m	45	42
62	359331	6460749	248	4,0 m	45	42
63	360621	6462750	106	1,5 m	42	38
63	360621	6462750	106	4,0 m	42	38
64	356228	6462812	175	1,5 m	37	29
64	356228	6462812	175	4,0 m	36	29
65	356223	6462740	180	1,5 m	33	24
65	356223	6462740	180	4,0 m	33	24
66	359402	6460632	243	1,5 m	42	36
66	359402	6460632	243	4,0 m	42	38
67	359736	6463955	111	1,5 m	42	37
67	359736	6463955	111	4,0 m	42	37
68	359491	6464141	131	1,5 m	39	34
68	359491	6464141	131	4,0 m	40	34
69	355816	6461683	214	1,5 m	35	30
69	355816	6461683	214	4,0 m	35	30

Information on results

The calculations are performed with the assumption that the noise sensitive area (NSA) are located 1,5 m and 4,0 m above ground. The height of 4,0 m should be considered decisive according to the Norwegian guidelines on noise. According to the European directive on environmental noise it is also possible to use calculations on 1,5 m above ground for recreational areas and areas with one-storey housing as an additional indicator. For indexing of NSA see the noise maps.

Note that if the point calculation and noise map show contradictory results, it is primary the point calculation that should be used. The noise map should be considered as a complement to the point calculation.

The calculation result is rounded to the nearest integer value according to the guidelines *Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442/2016)*:

"Når det skal rundes av til nærmeste hele tall ser vi på første siffer rett etter kommaet.

-er sifferet 0, 1, 2, 3 eller 4 tar vi vekk alle desimalsifrene og beholder det hele tallet slik som det var

-er sifferet 5, 6, 7, 8 eller 9 tar vi vekk alle desimalsifrene og øker det hele tallet med 1

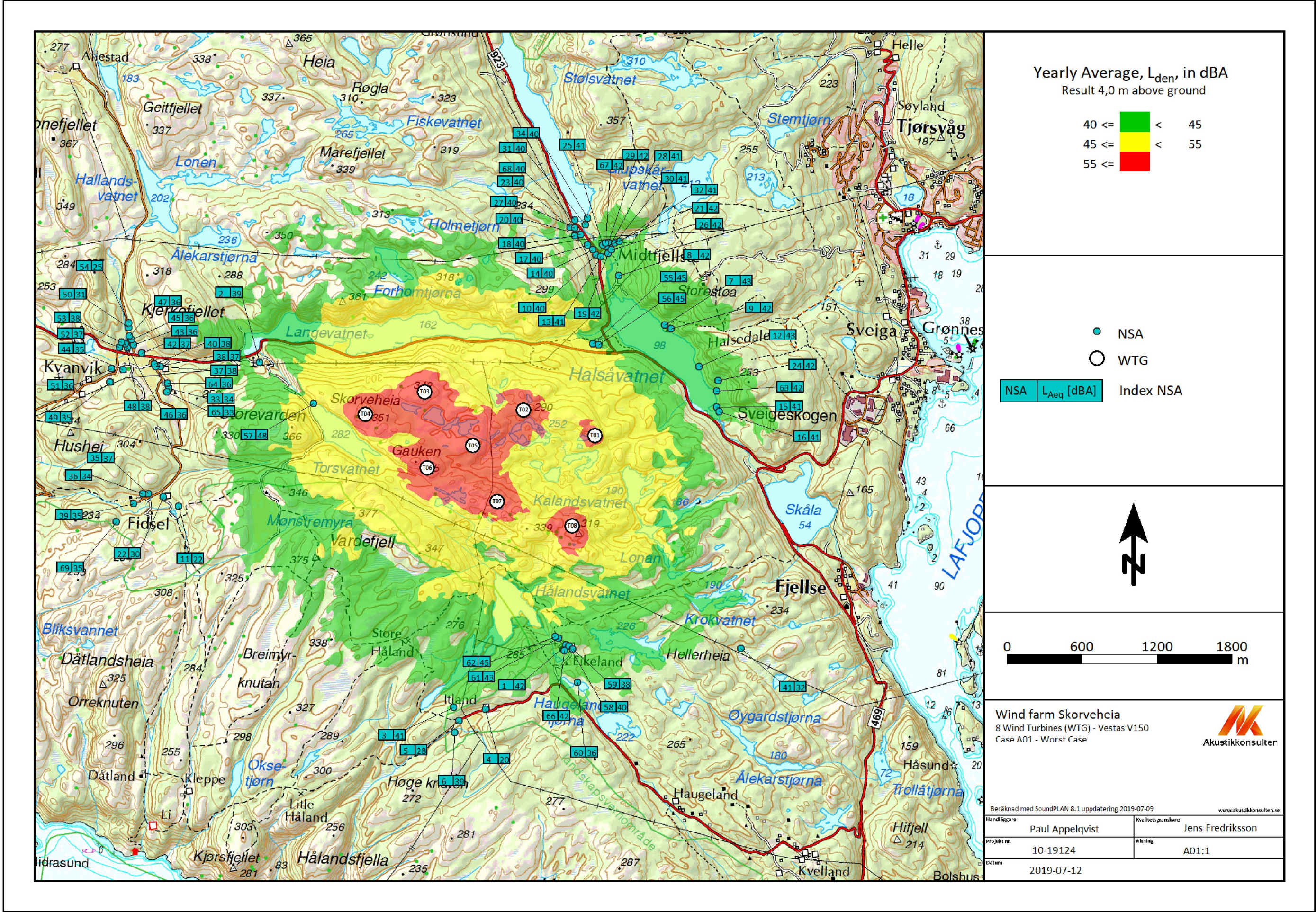
Eksempel; 54,499 = 54

54,511 = 55"

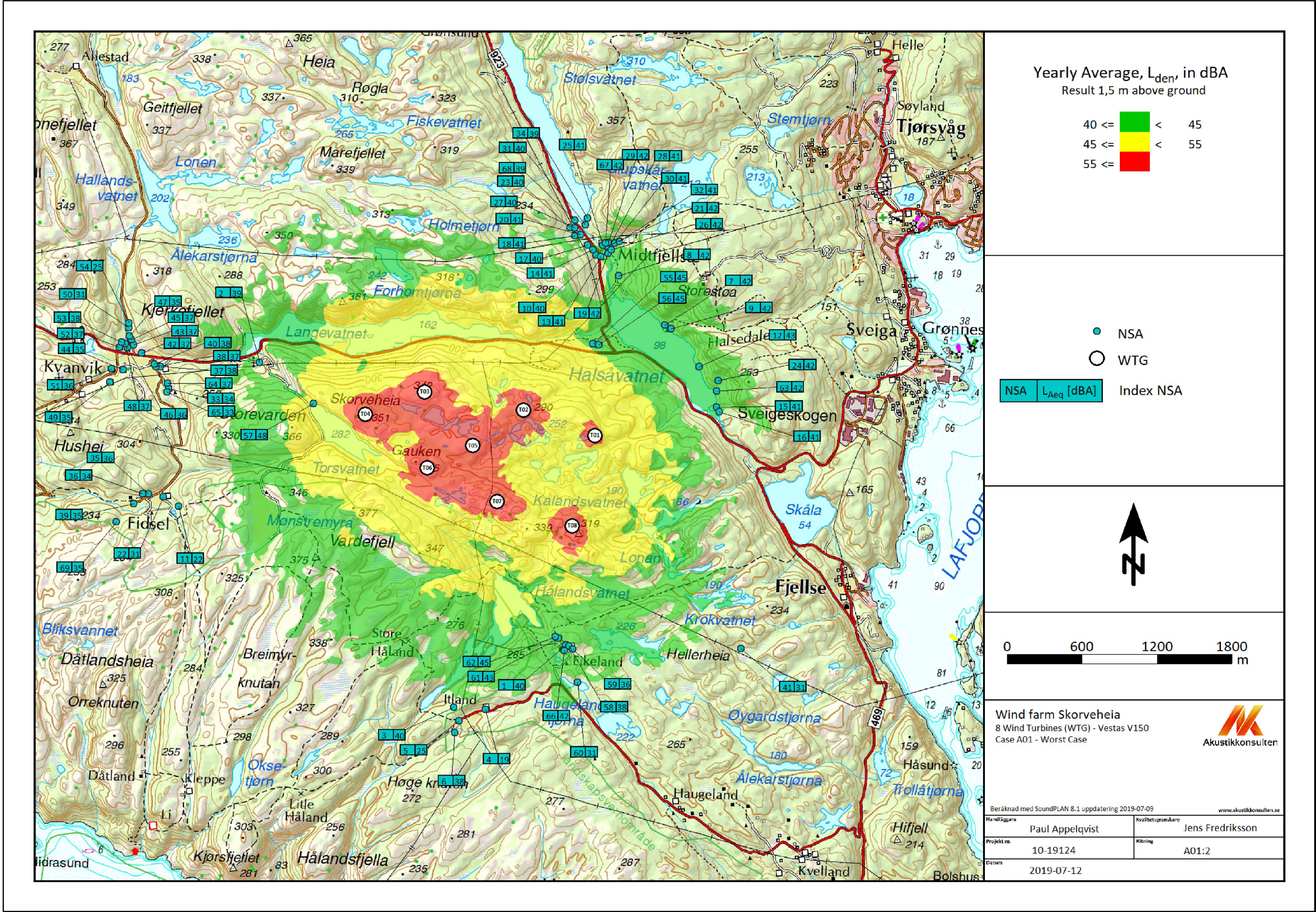
L_{den} has been calculated with a penalty of 5 dB for L_e (evening 19-23) and 10 dB for L_n (night 23-07) which is resulting in an addition of 6,4 dBA to the calculated equivalent sound level.

The noise limit has been assumed to be $L_{den}=45$ dBA according to T-1442 and if the calculated value is above the limit 45 dBA it is marked with red.

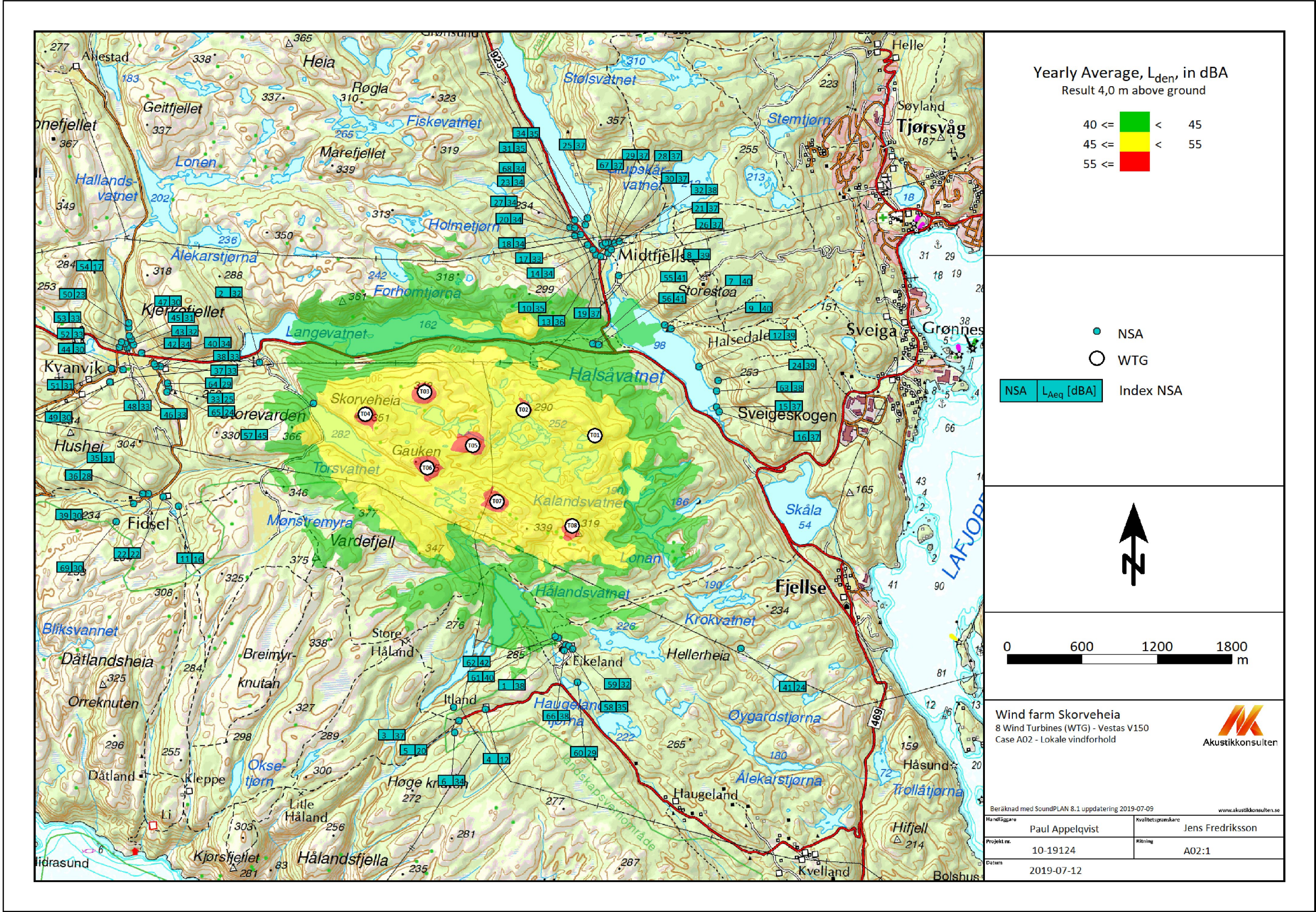
Noise map - Case A01:1 4,0 m



Noise map - Case A01:2 1,5 m



Noise map - Case A02:1 4,0 m



Noise map - Case A02:2 1,5 m

