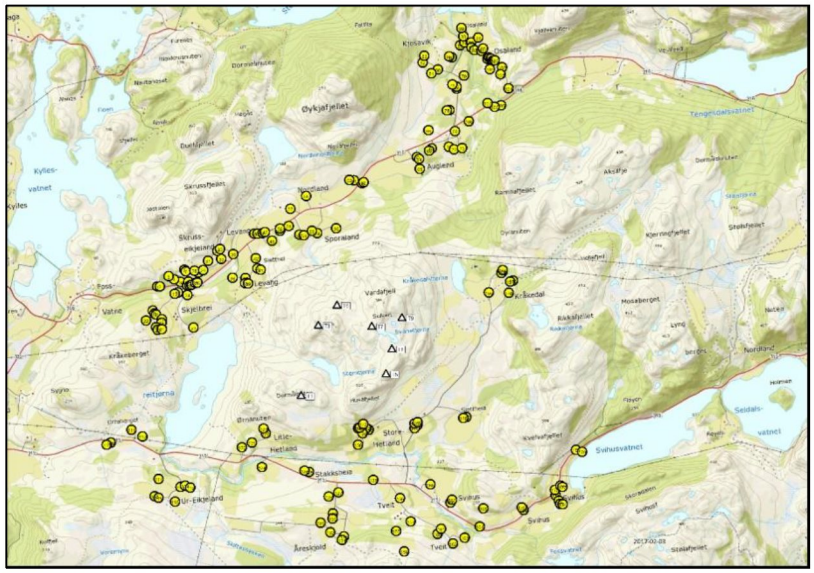
Calculation of noise immission from wind turbines

Wind farm Vardafjellet



Client information

Project:	Wind farm Vardafjellet
Client:	Nordisk Vindkraft Norge AS
Client reference:	Gudmund S. Sydness

Project information

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Company information

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Table of contents

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Calculation conditions

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Wind Farm	WTG type	Number of WTG	Hub height [m]	Total height [m]	Noise emission [dBA]
Vardafjellet	Vestas V126-3,45 MW High Torque (HTq)	7	87	150	91,3-104,4

Calculation parameters	
Calculation program	SoundPLAN 7.4
Calculation standard	Nord2000
Search radius	20 000 m
Calculation height	1,5 m and 4,0 m
Air absorbtion	ISO 9613-1
Air pressure	1013,25 mbar
Relative humidity	0,7
Temperature	15 °C
Temperature gradient	+0,05 °C/m
Roughness length	0,3 m
Anemomenter height	10 m
Wind speed	8 m/s
Standard deviation wind speed	0,5 m/s
Wind direction	Downwind and wind statistics
Turbulence strength parameter wind	0,12 m4/3/s2
Turbulence strength parameter temperature	0,008 K/s2
Effective flow resistivity forrest	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

Calculation cases	
A01:	"Worst case" with downwind from all wind directions for 8 m/s at 10 m height with noise emission 104,4 dBA. WTG in operation 365 days a year (8760 hours).
A02:	For 2,5-30,5 m/s at hub height measured wind speed and wind direction distribution in 30° sectors is used according to Table 2. Noise emission for each wind speed at hub height according to Table 1, 91,5-104,4 dBA. This represents a yearly average of L_{den} based on wind speeds on situ, "reell vind".

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Calculation conditions

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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 *DAL-32*, which is usually used in Sweden for industrial noise calculations, the relative humidity 70% and temperature 15°C is used for planning purposes.

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 *Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442/2016)*. The noise level at a positive temperature gradient in 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 points (NSP) are 1,5 m and 4,0 m above ground. The height of 4,0 m should be considered decisive according to the Norweigan guidelines on noise. Although it shall be noted that sound immission measurements according to the measurement standard *Elforsk 98:24*, recommended in chapter 9.8.6 in *Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442/2016)*, 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 to be more representative to the exposure of noise outside of a dwelling.

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Calculation uncertainty

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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*. The conclusion from the report 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 result from these studies it is believed that the uncertainty for the performed calculations, with complex hilly terrain, is within the interval of (-5, +3 dB) corresponding to a 90% confidence interval were the uncertainty increases with the distance from the wind farm.

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Method description

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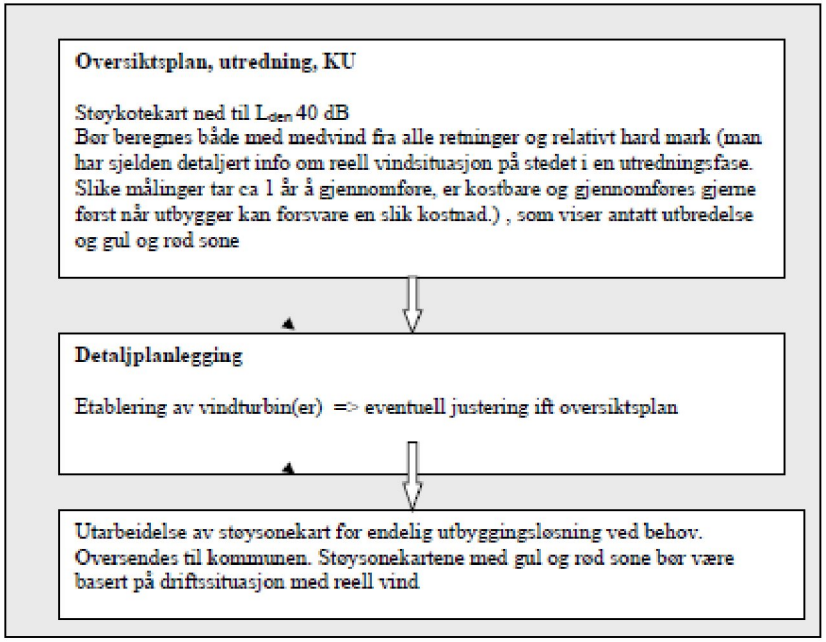
Method description

The calculations are performed with the Nordic environmental noise prediction method Nord2000 as proposed in *Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442/2016)* for detailed calculations of noise from wind turbines, method 2 in chapter 7.8.8. Nord2000 takes into account different aspects of noise spreading for example ground impedance, topography and wind direction. According to T-1442 two types of calculations should be performed in the planning process for a wind farm in Norway, according to Figure 65 in the guidelines as below:



Figur 65. Utarbeidelse av støykart for vindturbiner

The calculations in "Oversiktsplan" should be performed for "medvind fra alle retninger" or downwind conditions and should also consider the noise emission at 8 m/s on 10 m height and 365 days operation for all wind turbines. This represents a "worst case" for specific weather conditions and high noise emission. The result in calculation **Case A01** are performed according to these assumptions and is equal to the noise contribution during a day with downwind conditions and wind speed 8 m/s at 10 m height.

For "endelig utbyggingsløsning" calculations, if needed, should be performed for "reell vind" based on long term wind measurements on site. Unfortunately, the guidelines do not present any detailed instructions for such calculations of a yearly average. According to Akustikkonsultens understanding, both according to the measurement instructions on page 294 in the guidelines according to below:

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Method description

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"Resultater fra immisjonsmålinger kan ikke brukes til å kontrollere om konsesjonsvilkårene er oppfylt. Derimot kan immisjonsmålinger brukes til å dokumentere «øyeblikksverdier», i slike tilfeller gjennomsnittverdier over en relativt sett kort tidsperiode i forhold til beregnet årsmiddelverdi."

were **Case A01** represents such "øyeblikksverdier", and the definition of L_{den} on page 314 in the guidelines:

"I forbindelse med støysonekart etter EU-direktivets bestemmelser skal L_{den} beregnes for en mottakerhøyde på 4 meter og som årsmiddelverdi både med hensyn til støyemisjon/aktivitet og mht værforhold som kan påvirke støyutbredelsen. "

Calculations of a yearly averaged L_{den} based on "reell vind" should consider both the "worst case" scenario according to **Case A01** as well as periods of low or no noise from the wind turbines, that is "med hensyn till støyemisjon/aktivitet" as well as "værforhold som kan påvirke støyutbredelsen". This is similar to how, for example, noise mapping from roads are performed which consider different road traffic during the year, with both high and low noise emission, as well as a variation of the weather parameters. As mentioned no detailed instructions are given in the guidelines on how to calculate the yearly average of L_{den} based on these criterias.

Akustikkonsulten suggests the method below to calculate a yearly average considering the variation on noise emission and wind directions based on wind measurements, "reell vind". The calculations are performed as follows:

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 1,5 m/s, approx. 5,6 % of the year, and the highest noise emission occurs for wind speeds above 8 m/s, approx. 44,6 % of the year. For wind speeds between 2,5-8,5 m/s the noise emission is assumed to vary between 91,5-102,2 dBA. The wind speed dependent noise emission is given in Table 1. An conservative apporach has been chosen, for example all wind data above 8,5 m/s has been assumed to have the highest noise emission 104,4 dBA.
2. Devide the wind direction data in 30° sectors and calculate the procentual distribution for the wind speeds between 2,5 m/s to ≥8,5 m/s separately, similar to a wind rose, according to Table 2. The percentage for each wind direction is used for the calculations in step 4, were NSP:s 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 2,5 m/s to ≥8,5 m/s, a total of 72 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 0,5-30,5 m/s according to Table 2. The result is given in calculation **Case A02**.

The yearly average, in **Case A02**, calculated according to this method is lower than the "worst case" calculation as shown in **Case A01**. This is also the main definition of a yearly averaged L_{den} according to the European environmental noise directive on which the Norwegian guidelines are based, as opposed to guidelines based on L_{Aeq24h} that are used for example in Sweden, Denmark and Finland for wind turbine noise.

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Wind shadow

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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)*, gave special recommendations for dwellings situated in wind screend locations (wind shadow). But in the latest guide lines *(T-1442/2016)* no special noise limits are stated, but states the following:

"For mottakerpunkter som ligger skjermet for vinden kan vegetasjonsstøyen bli liten selv om vindturbinene går. Vi sier da at mottakeren ligger i vindskygge og her er det spesielt viktig at støyberegningene kvalitetssikres. Det finnes ikke spesielle støykrav ved vindskygge, men man bør i Veileder til retningslinje for behandling av støy i arealplanlegging (T-1442) 203 detaljprosjekteringsfasen være særlig våken for slike tilfeller hvor man savner naturlige maskeringseffekter fra terreng og/eller vegetasjon."

All noise calculations and reports produced by Akustikkonsulten undergoes a quality ensurance check in accordance with Akustikkonsultens quality system. The calculations for **Case A01** has also been verified against the method in T1442 chapter 9.3 Beregning, this method can only calculate the "worst case" downwind case. The result for values above Lden=40 dBA are in average 0,7 dBA higher calculated with Nord2000, which shows that an conservative approach has been used for the settings in Nord2000.

Akustikkonsultens consultants have more than 10 years of experience from noise calculations of wind turbine noise and have produced calculations for more then 500 wind farms over the years. We have also conducted a large number of noise measurements of wind turbine noise and our experience is that calculations performed with the Nord2000 model correlates well with measured levels at dwellings. In most cases with in ±1 dB.

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Noise data

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Table 1

WTG type	Noise setting	Wind speed at hub height [m/s][2)]	Noise emission [dBA]
Vestas V126-3,45 MW High Torque (HTq)	Mode 0[1)]	3	91,3
	Mode 0[1)]	4 (2,5-3,5)	91,5
	Mode 0[1)]	5 (4,5)	93,1
	Mode 0[1)]	6 (5,5)	96,0
	Mode 0[1)]	7 (6,5)	99,2
	Mode 0[1)]	8 (7,5)	102,2
	Mode 0[1)]	9	104,2
	Mode 0[1)]	≥10 (≥8,5)	104,4

Reference noise data: Frequency spectrum at hub height in 1/3-octave bands between 25 Hz och 10 kHz has been taken from the WTG manufacturer document *DMS 0055-1399_V01* dated 2016-05-26 supplied by the client. As the document is classified the frequency data can not be shown. According to the client the noise emission corresponds to the warranted noise emission of the WTG type.

For **Case A01** the noise emission 104,4 dBA is used which corresponds to the value for 11 m/s at hub height or 8 m/s on 10 m height, assuming reference conditions with a roughness length of 0,05 m.

For **Case A02** the noise emission corresponding to the wind speed/s within the parenthesis is used. For example, 104,4 dBA is used for all measured wind speeds above 8,5 m/s and 102,2 dBA for the wind speed 7,5 m/s.

[1)]Blades with serrated trailing edge.
[2)]The value within the parenthesis is the measured wind speed ranges according to Table 2. The other wind speed is according to the turbine manufacturer document.

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.

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Wind data

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Table 2

Wind speed at hh [m/s]	Totalt 8766 hours [%]	0° [%]	30° [%]	60° [%]	90° [%]	120° [%]
0,5-1,5	5,6	0,3	0,2	0,1	0,4	0,9
2,5-3,5	13,4	1,6	1,1	0,4	0,8	1,2
4,5	9,4	1,3	0,8	0,3	0,5	0,8
5,5	9,4	1,1	0,5	0,2	0,6	1,0
6,5	9,0	0,9	0,3	0,1	0,5	1,1
7,5	8,5	0,6	0,2	0,1	0,5	1,1
8,5-30,5	44,6	1,5	0,3	0,2	1,9	9,5
All wind speeds	**100,0**	**7,3**	**3,4**	**1,3**	**5,2**	**15,6**
Wind speed at hh [m/s]	**150° [%]**	**180° [%]**	**210° [%]**	**240° [%]**	**270° [%]**	**300° [%]**
0,5-1,5	0,5	0,5	0,4	0,4	0,5	0,6
2,5-3,5	1,0	1,0	0,8	0,9	1,2	1,4
4,5	0,7	0,7	0,5	0,5	0,7	0,9
5,5	0,8	0,8	0,5	0,5	0,7	0,9
6,5	1,0	1,0	0,5	0,5	0,6	0,8
7,5	1,2	1,1	0,6	0,5	0,6	0,8
8,5-30,5	9,6	5,8	2,6	2,0	2,5	3,0
All wind speeds	**14,8**	**10,9**	**5,9**	**5,3**	**6,7**	**8,4**
Wind speed at hh [m/s]	**330° [%]**					
0,5-1,5	0,8					
2,5-3,5	2,2					
4,5	1,7					
5,5	1,8					
6,5	1,6					
7,5	1,5					
8,5-30,5	5,6					
All wind speeds	**15,2**					

Wind distribution used in calcualtion
A02: Both wind speed and wind direction distribution is used for wind speed 0,5-30,5 m/s, green values. This case represents an accurate yearly average of L_{den}.

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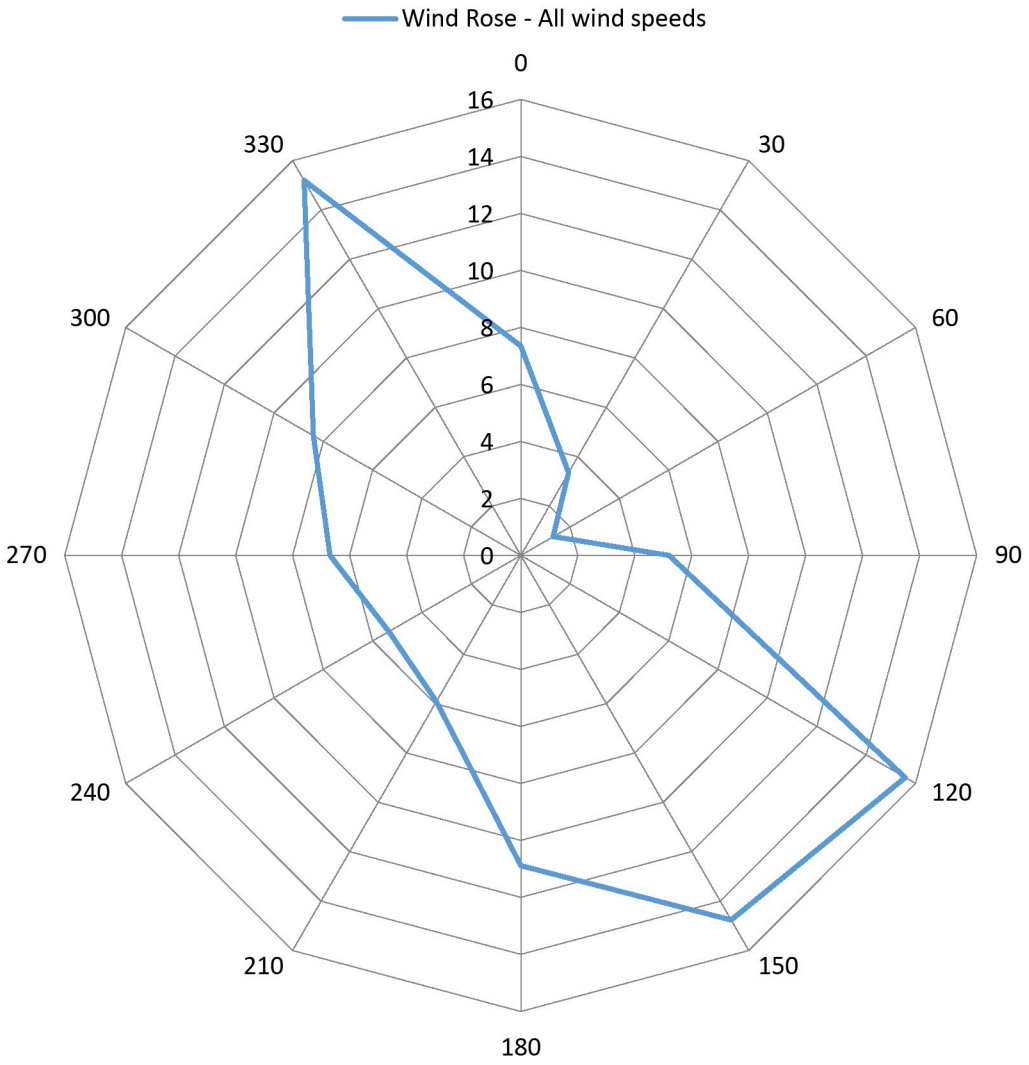
Wind data



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WTG data

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Wind Farm Vardafjellet							
WTG	**X [m]**	**Y [m]**	**Hub height [m]**	**Hub height level [mas]**	**Ground level [mas]**	**Noise emission [dBA]**	**Noise setting**
T1	320377	6525309	87	355	268	91,3-104,4	Mode 0
T3	320572	6526115	87	382	295	91,3-104,4	Mode 0
T5	321340	6525559	87	408	321	91,3-104,4	Mode 0
T6	320783	6526348	87	387	300	91,3-104,4	Mode 0
T7	321178	6526104	87	413	326	91,3-104,4	Mode 0
T8	321406	6525846	87	414	327	91,3-104,4	Mode 0
T9	321520	6526203	87	425	338	91,3-104,4	Mode 0

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Ground absorption map

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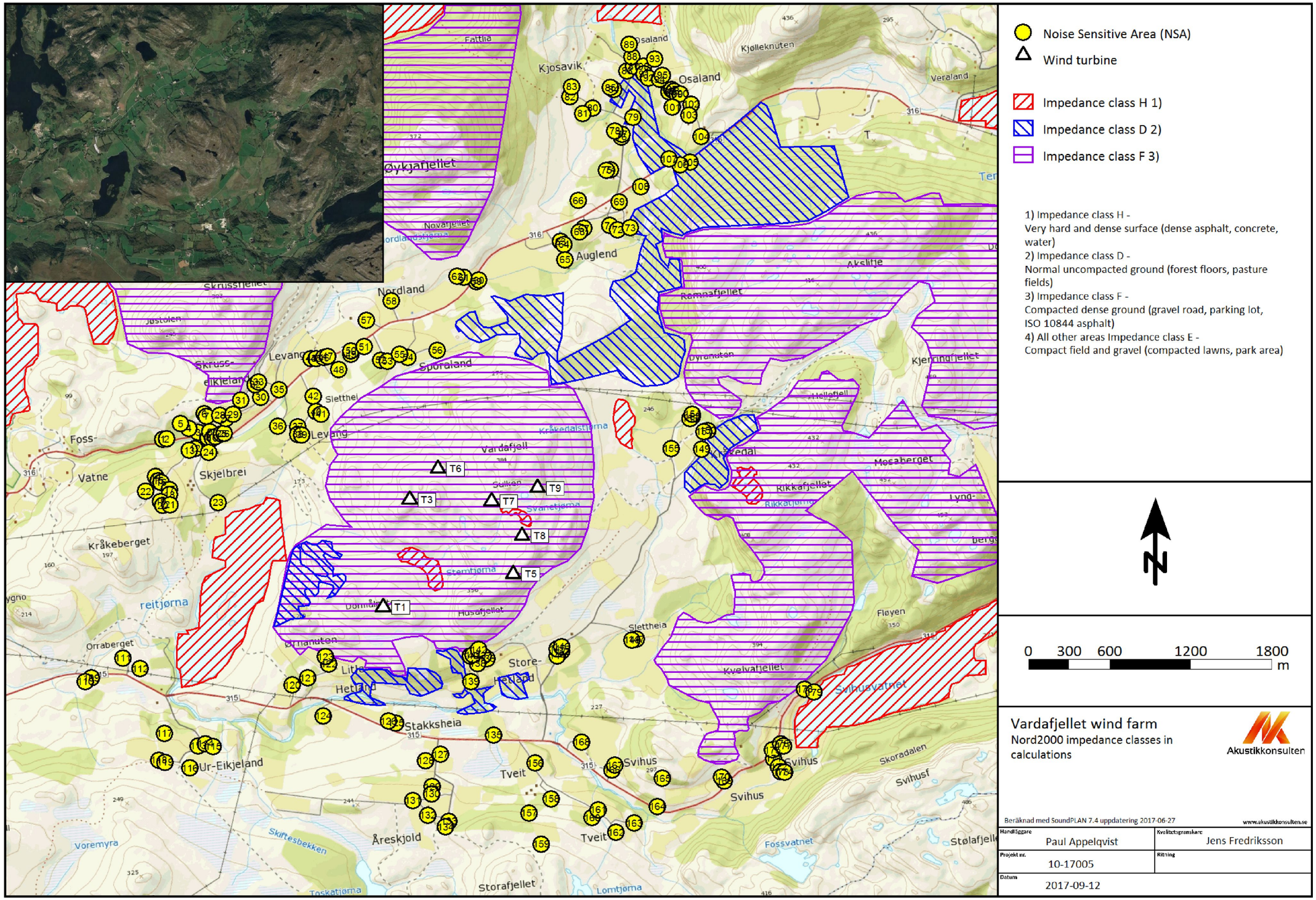

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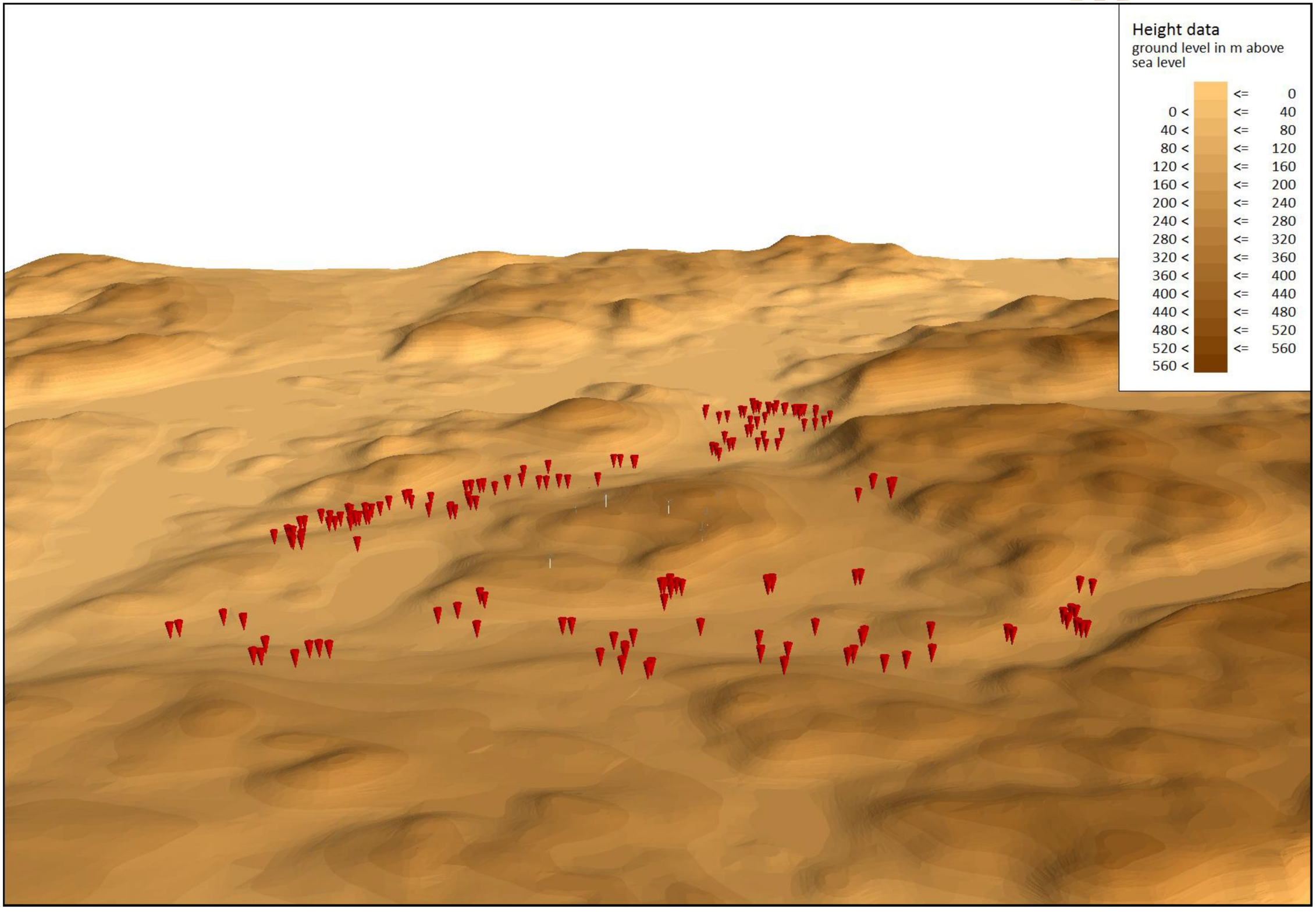
Ground model



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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
1	318747	6526569	108	1,5 m	38	35	2075	1900	2799	2067	2494	2772	2815
1	318747	6526569	108	4,0 m	38	35	2075	1900	2798	2066	2493	2772	2815
2	318775	6526571	109	1,5 m	38	35	2054	1874	2773	2039	2466	2746	2788
2	318775	6526571	109	4,0 m	38	35	2054	1873	2773	2039	2466	2746	2788
3	319010	6526620	115	1,5 m	39	36	1909	1663	2577	1814	2248	2535	2564
3	319010	6526620	115	4,0 m	39	36	1909	1663	2576	1814	2248	2535	2563
4	318939	6526652	115	1,5 m	39	36	1982	1739	2654	1888	2324	2612	2638
4	318939	6526652	115	4,0 m	39	36	1982	1739	2654	1888	2324	2612	2638
5	318877	6526686	115	1,5 m	39	36	2050	1808	2724	1955	2392	2681	2705
5	318877	6526686	115	4,0 m	39	36	2050	1808	2724	1954	2392	2681	2705
6	319053	6526760	125	1,5 m	40	37	1978	1670	2598	1797	2242	2541	2547
6	319053	6526760	125	4,0 m	40	37	1977	1670	2598	1797	2242	2540	2547
7	319070	6526741	124	1,5 m	40	37	1952	1647	2575	1777	2221	2518	2527
7	319070	6526741	124	4,0 m	40	37	1952	1647	2574	1776	2220	2518	2526
8	319085	6526582	122	1,5 m	39	36	1828	1580	2492	1734	2166	2452	2483
8	319085	6526582	122	4,0 m	39	37	1828	1580	2492	1734	2166	2452	2483
9	319097	6526625	121	1,5 m	39	37	1850	1582	2500	1729	2165	2454	2478
9	319097	6526625	121	4,0 m	40	37	1850	1582	2499	1729	2164	2454	2478
10	319115	6526579	125	1,5 m	39	37	1805	1550	2464	1704	2136	2423	2453
10	319115	6526579	125	4,0 m	40	37	1805	1550	2464	1704	2136	2422	2453
11	319136	6526589	124	1,5 m	39	37	1797	1534	2449	1685	2118	2406	2434
11	319136	6526589	124	4,0 m	40	37	1797	1533	2449	1685	2118	2406	2434
12	318983	6526500	126	1,5 m	39	36	1848	1655	2553	1825	2249	2526	2572
12	318983	6526500	126	4,0 m	40	37	1847	1654	2553	1825	2248	2526	2572
13	318945	6526486	126	1,5 m	39	36	1868	1688	2583	1861	2283	2559	2608
13	318945	6526486	126	4,0 m	39	36	1867	1688	2583	1861	2283	2559	2608
14	318695	6526290	148	1,5 m	38	35	1958	1899	2756	2102	2504	2760	2840
14	318695	6526290	148	4,0 m	38	36	1958	1899	2756	2102	2504	2760	2840
15	318715	6526258	151	1,5 m	39	36	1925	1877	2728	2083	2482	2735	2819

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
15	318715	6526258	151	4,0 m	39	36	1924	1876	2728	2083	2481	2735	2819
16	318734	6526247	151	1,5 m	39	36	1903	1857	2707	2065	2462	2715	2800
16	318734	6526247	151	4,0 m	39	36	1902	1857	2707	2065	2462	2714	2800
17	318798	6526194	151	1,5 m	39	36	1821	1791	2633	2005	2396	2644	2736
17	318798	6526194	151	4,0 m	40	37	1821	1790	2632	2004	2396	2644	2736
18	318795	6526154	151	1,5 m	40	36	1805	1792	2626	2011	2398	2642	2740
18	318795	6526154	151	4,0 m	40	37	1805	1792	2626	2011	2397	2642	2739
19	318733	6526101	154	1,5 m	39	36	1836	1853	2675	2078	2458	2698	2802
19	318733	6526101	154	4,0 m	39	37	1835	1853	2674	2077	2458	2697	2802
20	318749	6526073	153	1,5 m	39	37	1809	1838	2654	2066	2443	2679	2788
20	318749	6526073	153	4,0 m	40	37	1809	1837	2653	2065	2443	2679	2787
21	318800	6526079	150	1,5 m	39	37	1767	1787	2605	2015	2392	2630	2737
21	318800	6526079	150	4,0 m	40	37	1766	1787	2605	2015	2392	2629	2737
22	318619	6526178	156	1,5 m	39	36	1971	1967	2802	2183	2573	2818	2914
22	318619	6526178	156	4,0 m	39	36	1971	1967	2801	2183	2573	2818	2914
23	319156	6526096	118	1,5 m	42	39	1472	1440	2267	1668	2043	2283	2387
23	319156	6526096	118	4,0 m	42	39	1471	1440	2267	1668	2043	2283	2386
24	319087	6526471	134	1,5 m	40	37	1750	1547	2446	1719	2141	2418	2465
24	319087	6526471	134	4,0 m	40	37	1750	1546	2445	1719	2141	2418	2465
25	319181	6526611	125	1,5 m	40	37	1783	1499	2418	1644	2080	2370	2394
25	319181	6526611	125	4,0 m	40	38	1782	1498	2418	1644	2080	2370	2393
26	319200	6526612	125	1,5 m	40	37	1771	1481	2402	1626	2062	2353	2375
26	319200	6526612	125	4,0 m	40	38	1770	1481	2401	1625	2062	2353	2375
27	319213	6526726	131	1,5 m	41	38	1847	1511	2442	1635	2080	2380	2384
27	319213	6526726	131	4,0 m	41	38	1847	1510	2441	1634	2080	2379	2384
28	319168	6526749	131	1,5 m	40	37	1893	1561	2492	1683	2129	2430	2433
28	319168	6526749	131	4,0 m	40	38	1893	1560	2492	1683	2129	2429	2432
29	319268	6526756	135	1,5 m	41	38	1836	1474	2408	1589	2037	2340	2337
29	319268	6526756	135	4,0 m	41	38	1836	1473	2408	1589	2037	2340	2337

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
30	319474	6526884	133	1,5 m	41	38	1829	1363	2305	1437	1895	2211	2176
30	319474	6526884	133	4,0 m	42	39	1829	1363	2305	1436	1894	2211	2176
31	319323	6526863	139	1,5 m	40	38	1890	1476	2417	1568	2023	2334	2312
31	319323	6526863	139	4,0 m	41	38	1890	1475	2416	1567	2022	2334	2312
32	319430	6526978	140	1,5 m	41	38	1931	1452	2394	1513	1973	2294	2248
32	319430	6526978	140	4,0 m	41	38	1931	1451	2394	1512	1973	2293	2247
33	319457	6527000	139	1,5 m	41	38	1937	1444	2386	1498	1959	2281	2230
33	319457	6527000	139	4,0 m	41	38	1937	1444	2386	1498	1959	2281	2230
35	319606	6526941	130	1,5 m	42	38	1819	1295	2234	1343	1803	2126	2073
35	319606	6526941	130	4,0 m	42	39	1818	1295	2234	1342	1803	2125	2072
36	319600	6526668	145	1,5 m	43	40	1579	1143	2080	1249	1697	2002	1996
36	319600	6526668	145	4,0 m	43	40	1579	1142	2079	1248	1696	2002	1995
37	319748	6526664	150	1,5 m	44	40	1508	1017	1955	1108	1558	1867	1852
37	319748	6526664	150	4,0 m	44	41	1507	1016	1954	1107	1557	1867	1851
38	319745	6526607	150	1,5 m	44	40	1458	990	1926	1095	1541	1846	1841
38	319745	6526607	150	4,0 m	44	41	1458	989	1925	1095	1541	1845	1841
39	319777	6526603	150	1,5 m	44	41	1441	961	1897	1064	1510	1815	1810
39	319777	6526603	150	4,0 m	44	41	1440	960	1897	1064	1510	1815	1809
40	319881	6526776	153	1,5 m	44	41	1562	983	1917	1025	1483	1805	1758
40	319881	6526776	153	4,0 m	45	42	1561	983	1916	1025	1483	1805	1757
41	319918	6526759	154	1,5 m	44	42	1534	945	1878	985	1443	1765	1718
41	319918	6526759	154	4,0 m	45	42	1534	945	1877	985	1443	1764	1717
42	319863	6526893	146	1,5 m	44	41	1678	1078	2007	1096	1556	1884	1817
42	319863	6526893	146	4,0 m	44	41	1678	1078	2007	1095	1556	1883	1816
43	319845	6527175	136	1,5 m	42	39	1953	1309	2218	1275	1732	2069	1958
43	319845	6527175	136	4,0 m	43	40	1952	1308	2218	1275	1732	2068	1958
44	319845	6527175	136	1,5 m	42	39	1953	1309	2218	1275	1732	2069	1958
44	319845	6527175	136	4,0 m	43	40	1952	1308	2218	1275	1732	2068	1958
45	319882	6527175	138	1,5 m	43	40	1943	1288	2193	1248	1703	2041	1926

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
45	319882	6527175	138	4,0 m	43	40	1942	1287	2193	1247	1703	2040	1926
46	319941	6527181	141	1,5 m	43	40	1934	1262	2158	1209	1662	2001	1879
46	319941	6527181	141	4,0 m	43	40	1934	1261	2158	1209	1662	2000	1879
47	319967	6527192	142	1,5 m	43	40	1939	1258	2150	1199	1650	1989	1863
47	319967	6527192	142	4,0 m	43	41	1938	1258	2149	1198	1650	1988	1863
48	320048	6527092	148	1,5 m	44	41	1825	1133	2021	1073	1524	1862	1742
48	320048	6527092	148	4,0 m	44	41	1824	1132	2021	1072	1523	1862	1742
49	320138	6527206	149	1,5 m	44	41	1923	1197	2055	1099	1538	1878	1730
49	320138	6527206	149	4,0 m	44	41	1923	1196	2055	1099	1537	1878	1730
50	320138	6527234	148	1,5 m	44	41	1951	1223	2078	1121	1558	1899	1747
50	320138	6527234	148	4,0 m	44	41	1950	1222	2077	1121	1558	1898	1746
51	320238	6527263	149	1,5 m	44	41	1970	1218	2046	1091	1515	1855	1686
51	320238	6527263	149	4,0 m	45	42	1969	1217	2045	1091	1515	1855	1686
52	320359	6527162	161	1,5 m	45	42	1863	1091	1895	945	1361	1700	1529
52	320359	6527162	161	4,0 m	45	42	1863	1090	1895	944	1361	1700	1529
53	320410	6527154	161	1,5 m	46	43	1855	1074	1863	916	1325	1663	1486
53	320410	6527154	161	4,0 m	46	43	1855	1074	1862	916	1324	1663	1485
54	320562	6527183	155	1,5 m	45	42	1894	1092	1818	894	1269	1602	1397
54	320562	6527183	155	4,0 m	45	43	1893	1091	1818	893	1268	1602	1397
55	320501	6527207	155	1,5 m	45	42	1912	1117	1866	933	1319	1655	1456
55	320501	6527207	155	4,0 m	46	43	1912	1117	1866	932	1319	1654	1455
56	320778	6527236	149	1,5 m	45	41	1979	1163	1787	919	1229	1548	1302
56	320778	6527236	149	4,0 m	44	41	1979	1163	1787	918	1228	1547	1301
57	320256	6527461	145	1,5 m	43	40	2165	1403	2205	1255	1662	2001	1805
57	320256	6527461	145	4,0 m	43	41	2165	1402	2204	1254	1662	2000	1805
58	320437	6527607	135	1,5 m	43	40	2309	1518	2255	1330	1698	2029	1797
58	320437	6527607	135	4,0 m	43	40	2309	1518	2254	1329	1698	2029	1797
59	321071	6527753	110	1,5 m	40	36	2552	1734	2230	1460	1680	1960	1644
59	321071	6527753	110	4,0 m	40	37	2552	1733	2230	1460	1679	1959	1644

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
60	321086	6527763	109	1,5 m	40	36	2566	1747	2238	1473	1689	1967	1650
60	321086	6527763	109	4,0 m	40	37	2566	1747	2238	1473	1688	1967	1649
61	320976	6527784	110	1,5 m	40	36	2558	1738	2274	1475	1719	2008	1701
61	320976	6527784	110	4,0 m	40	37	2558	1738	2274	1474	1718	2008	1701
62	320927	6527791	110	1,5 m	40	36	2554	1734	2289	1476	1732	2026	1724
62	320927	6527791	110	4,0 m	40	37	2554	1734	2289	1476	1732	2025	1724
63	321691	6528053	105	1,5 m	37	34	3053	2255	2537	1952	2039	2247	1885
63	321691	6528053	105	4,0 m	38	34	3052	2254	2536	1952	2038	2246	1885
64	321716	6528030	105	1,5 m	37	34	3043	2248	2518	1944	2023	2227	1865
64	321716	6528030	105	4,0 m	38	34	3043	2247	2517	1943	2023	2227	1865
65	321726	6527917	101	1,5 m	37	33	2947	2158	2409	1853	1919	2119	1756
65	321726	6527917	101	4,0 m	38	34	2947	2158	2408	1852	1919	2118	1756
66	321823	6528360	97	1,5 m	36	33	3386	2586	2859	2283	2367	2568	2203
66	321823	6528360	97	4,0 m	36	33	3386	2585	2859	2283	2367	2568	2202
67	321862	6528152	108	1,5 m	37	33	3217	2427	2662	2120	2180	2370	2004
67	321862	6528152	108	4,0 m	37	33	3217	2426	2662	2120	2180	2370	2003
68	321831	6528126	109	1,5 m	37	33	3180	2388	2630	2082	2146	2339	1973
68	321831	6528126	109	4,0 m	37	34	3179	2388	2630	2082	2146	2339	1973
69	322125	6528351	95	1,5 m	35	31	3518	2737	2917	2429	2459	2625	2256
69	322125	6528351	95	4,0 m	35	32	3518	2737	2917	2428	2459	2625	2255
71	322056	6528172	96	1,5 m	36	32	3329	2552	2727	2243	2269	2436	2067
71	322056	6528172	96	4,0 m	36	33	3329	2552	2727	2243	2268	2435	2066
72	322112	6528142	93	1,5 m	36	32	3332	2562	2714	2252	2264	2423	2054
72	322112	6528142	93	4,0 m	36	33	3332	2562	2714	2251	2264	2423	2054
73	322206	6528156	92	1,5 m	35	32	3394	2630	2756	2319	2317	2466	2096
73	322206	6528156	92	4,0 m	36	32	3394	2630	2755	2319	2317	2465	2096
74	322061	6528593	80	1,5 m	35	32	3701	2907	3135	2601	2662	2844	2474
74	322061	6528593	80	4,0 m	35	32	3701	2906	3135	2601	2661	2843	2474
75	322031	6528588	80	1,5 m	35	32	3683	2887	3124	2582	2647	2832	2463

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
75	322031	6528588	80	4,0 m	35	32	3683	2887	3124	2582	2647	2832	2463
76	322142	6528837	68	1,5 m	33	31	3955	3158	3392	2854	2918	3099	2730
76	322142	6528837	68	4,0 m	34	31	3955	3158	3391	2853	2918	3099	2729
77	322144	6528859	67	1,5 m	33	31	3976	3178	3413	2874	2940	3121	2752
77	322144	6528859	67	4,0 m	33	31	3976	3178	3413	2874	2939	3121	2751
78	322094	6528883	66	1,5 m	33	31	3975	3175	3425	2872	2946	3133	2764
78	322094	6528883	66	4,0 m	33	31	3975	3174	3425	2872	2946	3133	2764
79	322227	6528986	63	1,5 m	33	29	4126	3329	3556	3025	3087	3264	2894
79	322227	6528986	63	4,0 m	33	30	4126	3329	3556	3024	3086	3264	2894
80	321930	6529055	67	1,5 m	33	30	4065	3254	3562	2957	3065	3270	2903
80	321930	6529055	67	4,0 m	33	30	4065	3253	3561	2957	3064	3270	2903
81	321857	6529013	69	1,5 m	33	30	3999	3185	3509	2891	3007	3217	2852
81	321857	6529013	69	4,0 m	33	30	3999	3185	3508	2890	3006	3217	2852
82	321759	6529138	75	1,5 m	33	30	4080	3262	3619	2972	3107	3328	2965
82	321759	6529138	75	4,0 m	33	30	4080	3262	3618	2972	3107	3328	2965
83	321775	6529214	74	1,5 m	33	30	4157	3338	3696	3049	3185	3405	3042
83	321775	6529214	74	4,0 m	33	30	4157	3338	3695	3049	3184	3405	3042
84	322086	6529194	60	1,5 m	32	29	4254	3446	3727	3147	3240	3435	3066
84	322086	6529194	60	4,0 m	32	30	4254	3446	3727	3147	3239	3434	3065
85	322060	6529208	60	1,5 m	32	29	4257	3447	3735	3149	3246	3443	3075
85	322060	6529208	60	4,0 m	32	30	4257	3447	3735	3149	3246	3443	3074
86	322183	6529334	47	1,5 m	31	28	4422	3615	3885	3315	3402	3592	3222
86	322183	6529334	47	4,0 m	31	29	4422	3615	3884	3315	3402	3592	3222
87	322232	6529368	44	1,5 m	31	28	4473	3668	3929	3367	3450	3636	3266
87	322232	6529368	44	4,0 m	32	29	4473	3667	3929	3367	3449	3636	3266
88	322219	6529439	37	1,5 m	31	28	4533	3726	3995	3426	3514	3703	3333
88	322219	6529439	37	4,0 m	31	28	4533	3725	3995	3426	3513	3703	3333
89	322199	6529532	32	1,5 m	31	28	4610	3801	4082	3503	3597	3789	3420
89	322199	6529532	32	4,0 m	31	28	4610	3800	4082	3502	3597	3789	3420

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
90	322307	6529368	44	1,5 m	31	28	4505	3702	3946	3400	3473	3654	3283
90	322307	6529368	44	4,0 m	31	28	4505	3702	3946	3400	3473	3654	3283
91	322311	6529311	49	1,5 m	31	28	4455	3654	3892	3351	3420	3600	3229
91	322311	6529311	49	4,0 m	32	29	4455	3653	3892	3350	3420	3599	3229
92	322343	6529280	52	1,5 m	32	29	4441	3642	3870	3338	3402	3578	3207
92	322343	6529280	52	4,0 m	32	29	4441	3641	3870	3338	3402	3578	3207
93	322387	6529424	39	1,5 m	31	28	4590	3790	4021	3486	3553	3729	3358
93	322387	6529424	39	4,0 m	31	28	4590	3789	4021	3486	3553	3729	3357
94	322425	6529269	54	1,5 m	31	28	4468	3673	3881	3367	3420	3589	3218
94	322425	6529269	54	4,0 m	31	28	4468	3672	3881	3367	3420	3589	3218
95	322443	6529299	51	1,5 m	31	28	4503	3708	3915	3402	3455	3623	3252
95	322443	6529299	51	4,0 m	31	28	4503	3707	3915	3402	3455	3623	3252
96	322495	6529178	67	1,5 m	32	29	4420	3630	3814	3323	3362	3522	3151
96	322495	6529178	67	4,0 m	32	29	4420	3630	3814	3323	3362	3522	3151
97	322514	6529193	68	1,5 m	32	29	4442	3653	3834	3345	3383	3542	3171
97	322514	6529193	68	4,0 m	33	29	4442	3653	3834	3345	3383	3542	3171
98	322532	6529182	70	1,5 m	32	29	4441	3653	3829	3345	3380	3538	3166
98	322532	6529182	70	4,0 m	33	29	4441	3653	3829	3345	3380	3537	3166
99	322557	6529158	73	1,5 m	32	29	4432	3646	3814	3338	3368	3523	3151
99	322557	6529158	73	4,0 m	33	30	4432	3646	3814	3338	3368	3522	3151
100	322576	6529162	75	1,5 m	33	29	4445	3660	3823	3351	3379	3533	3161
100	322576	6529162	75	4,0 m	33	29	4445	3660	3823	3351	3379	3532	3161
101	322519	6529061	67	1,5 m	33	30	4330	3545	3711	3237	3265	3420	3048
101	322519	6529061	67	4,0 m	33	30	4330	3545	3710	3236	3265	3419	3048
102	322658	6529082	87	1,5 m	32	29	4417	3639	3775	3329	3341	3485	3114
102	322658	6529082	87	4,0 m	32	30	4417	3639	3775	3328	3341	3485	3114
103	322641	6529001	85	1,5 m	33	30	4339	3563	3694	3253	3262	3404	3033
103	322641	6529001	85	4,0 m	33	30	4339	3563	3693	3253	3262	3404	3033
104	322731	6528839	106	1,5 m	33	30	4250	3487	3575	3175	3160	3288	2918

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
104	322731	6528839	106	4,0 m	33	30	4250	3487	3575	3174	3160	3287	2918
105	322649	6528647	122	1,5 m	33	30	4044	3285	3366	2973	2952	3078	2709
105	322649	6528647	122	4,0 m	34	31	4044	3285	3366	2972	2952	3078	2709
106	322575	6528629	108	1,5 m	33	30	3989	3226	3323	2914	2902	3034	2664
106	322575	6528629	108	4,0 m	34	31	3989	3226	3322	2914	2901	3034	2664
107	322495	6528672	91	1,5 m	33	30	3983	3212	3335	2902	2904	3046	2675
107	322495	6528672	91	4,0 m	34	31	3983	3212	3335	2901	2903	3045	2675
108	322283	6528464	82	1,5 m	34	31	3696	2921	3071	2611	2627	2781	2411
108	322283	6528464	82	4,0 m	34	31	3696	2921	3071	2611	2626	2780	2410
109	318221	6524778	103	1,5 m	35	33	2234	2719	3230	3018	3255	3373	3608
109	318221	6524778	103	4,0 m	35	33	2234	2719	3229	3018	3255	3373	3608
110	318173	6524753	104	1,5 m	35	32	2287	2772	3282	3072	3309	3427	3662
110	318173	6524753	104	4,0 m	35	33	2286	2772	3282	3071	3309	3426	3662
111	318453	6524927	103	1,5 m	37	34	1977	2445	2971	2744	2984	3108	3338
111	318453	6524927	103	4,0 m	37	34	1977	2445	2971	2743	2984	3108	3337
112	318579	6524848	105	1,5 m	37	34	1873	2378	2867	2681	2903	3014	3254
112	318579	6524848	105	4,0 m	37	34	1872	2377	2867	2680	2903	3013	3254
113	319011	6524268	160	1,5 m	37	35	1728	2428	2674	2742	2851	2879	3180
113	319011	6524268	160	4,0 m	38	36	1728	2428	2674	2742	2851	2879	3180
114	319063	6524285	157	1,5 m	37	35	1677	2382	2621	2696	2801	2827	3129
114	319063	6524285	157	4,0 m	38	36	1677	2382	2621	2695	2801	2827	3129
115	319120	6524264	159	1,5 m	38	35	1646	2363	2582	2676	2772	2792	3097
115	319120	6524264	159	4,0 m	38	36	1646	2363	2582	2676	2772	2791	3097
116	318950	6524103	179	1,5 m	37	35	1877	2592	2808	2906	3004	3021	3328
116	318950	6524103	179	4,0 m	38	35	1876	2592	2808	2905	3003	3021	3328
117	318761	6524362	157	1,5 m	37	34	1883	2530	2854	2843	2990	3044	3328
117	318761	6524362	157	4,0 m	37	35	1883	2530	2854	2843	2990	3043	3328
118	318718	6524163	177	1,5 m	36	33	2024	2700	2979	3014	3142	3180	3475
118	318718	6524163	177	4,0 m	37	34	2024	2700	2979	3013	3142	3180	3475

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
119	318762	6524145	178	1,5 m	37	34	1999	2683	2949	2997	3119	3153	3450
119	318762	6524145	178	4,0 m	37	35	1998	2683	2949	2997	3119	3152	3450
120	319707	6524725	151	1,5 m	42	38	912	1653	1851	1961	2033	2052	2355
120	319707	6524725	151	4,0 m	42	39	911	1653	1851	1961	2033	2052	2355
121	319820	6524779	158	1,5 m	43	39	793	1549	1726	1855	1914	1928	2234
121	319820	6524779	158	4,0 m	43	40	793	1549	1726	1855	1914	1928	2233
122	319977	6524884	178	1,5 m	45	42	609	1382	1538	1684	1728	1738	2045
122	319977	6524884	178	4,0 m	45	43	609	1382	1538	1684	1727	1738	2045
123	319951	6524939	185	1,5 m	45	42	589	1344	1537	1649	1707	1730	2029
123	319951	6524939	185	4,0 m	46	42	588	1344	1537	1648	1707	1729	2029
124	319933	6524495	155	1,5 m	43	40	948	1756	1782	2052	2051	2015	2347
124	319933	6524495	155	4,0 m	43	40	948	1756	1781	2051	2050	2015	2347
125	320470	6524440	176	1,5 m	43	40	892	1691	1436	1945	1824	1706	2067
125	320470	6524440	176	4,0 m	43	41	891	1690	1436	1945	1823	1705	2067
126	320419	6524455	173	1,5 m	43	40	874	1680	1456	1939	1831	1722	2081
126	320419	6524455	173	4,0 m	43	40	873	1680	1456	1939	1830	1722	2081
127	320803	6524206	192	1,5 m	42	39	1193	1932	1471	2151	1947	1761	2135
127	320803	6524206	192	4,0 m	42	40	1193	1932	1471	2151	1947	1761	2134
128	320692	6524158	196	1,5 m	42	39	1204	1969	1558	2200	2017	1845	2218
128	320692	6524158	196	4,0 m	42	40	1203	1969	1557	2200	2017	1845	2218
129	320740	6523964	223	1,5 m	40	38	1399	2163	1714	2390	2192	2005	2380
129	320740	6523964	223	4,0 m	41	38	1399	2163	1714	2390	2192	2005	2379
130	320737	6523908	226	1,5 m	40	37	1452	2219	1767	2446	2247	2059	2433
130	320737	6523908	226	4,0 m	41	38	1452	2218	1767	2445	2247	2058	2433
131	320599	6523860	230	1,5 m	40	37	1471	2260	1862	2500	2325	2151	2525
131	320599	6523860	230	4,0 m	40	38	1471	2260	1862	2499	2324	2151	2525
132	320709	6523750	228	1,5 m	39	35	1599	2374	1924	2604	2407	2217	2591
132	320709	6523750	228	4,0 m	39	35	1599	2374	1924	2604	2407	2216	2591
133	320863	6523703	232	1,5 m	40	36	1682	2434	1924	2651	2428	2218	2592

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
133	320863	6523703	232	4,0 m	40	37	1682	2434	1924	2651	2428	2218	2592
134	320841	6523661	231	1,5 m	39	36	1716	2473	1970	2692	2473	2264	2638
134	320841	6523661	231	4,0 m	39	37	1716	2473	1970	2692	2473	2264	2638
135	321197	6524351	181	1,5 m	43	40	1273	1882	1237	2050	1768	1527	1896
135	321197	6524351	181	4,0 m	43	41	1272	1882	1237	2049	1768	1527	1895
136	321147	6524925	205	1,5 m	47	43	873	1333	693	1480	1197	979	1349
136	321147	6524925	205	4,0 m	47	44	873	1333	692	1480	1197	979	1349
137	321117	6524944	207	1,5 m	47	43	838	1303	684	1454	1179	969	1340
137	321117	6524944	207	4,0 m	47	43	838	1303	683	1454	1179	969	1339
138	321078	6524886	199	1,5 m	46	42	833	1341	751	1503	1240	1037	1407
138	321078	6524886	199	4,0 m	46	43	833	1341	751	1503	1240	1036	1407
139	321027	6524753	181	1,5 m	45	41	873	1450	894	1627	1379	1180	1551
139	321027	6524753	181	4,0 m	45	41	872	1449	893	1626	1378	1179	1550
140	321026	6524944	210	1,5 m	46	42	758	1267	718	1436	1187	999	1369
140	321026	6524944	210	4,0 m	46	42	758	1267	717	1435	1187	999	1369
141	321044	6524950	210	1,5 m	46	42	771	1268	705	1433	1179	987	1357
141	321044	6524950	210	4,0 m	46	43	770	1268	704	1433	1179	987	1357
142	321084	6524991	217	1,5 m	46	42	787	1246	651	1400	1134	934	1305
142	321084	6524991	217	4,0 m	46	42	787	1246	650	1400	1133	934	1304
143	321700	6524979	184	1,5 m	46	42	1374	1613	718	1660	1261	944	1260
143	321700	6524979	184	4,0 m	46	43	1374	1613	717	1660	1260	943	1260
144	321668	6524944	182	1,5 m	46	42	1353	1616	732	1672	1280	967	1290
144	321668	6524944	182	4,0 m	46	43	1352	1616	731	1672	1280	967	1290
145	321668	6524998	187	1,5 m	46	43	1338	1577	686	1626	1230	916	1237
145	321668	6524998	187	4,0 m	46	43	1338	1577	685	1626	1230	915	1236
146	321701	6525013	187	1,5 m	47	43	1367	1590	690	1632	1230	912	1227
146	321701	6525013	187	4,0 m	47	43	1367	1589	689	1632	1230	911	1226
147	322253	6525070	179	1,5 m	44	40	1899	1990	1060	1959	1510	1172	1371
147	322253	6525070	179	4,0 m	44	41	1899	1989	1060	1959	1509	1172	1371

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
148	322221	6525062	178	1,5 m	45	41	1869	1967	1037	1940	1493	1155	1361
148	322221	6525062	178	4,0 m	45	42	1868	1967	1036	1940	1492	1154	1361
149	322735	6526495	245	1,5 m	43	40	2642	2200	1688	1963	1614	1488	1262
149	322735	6526495	245	4,0 m	43	40	2642	2200	1687	1962	1614	1488	1261
150	322782	6526635	255	1,5 m	42	39	2748	2274	1806	2024	1697	1594	1344
150	322782	6526635	255	4,0 m	42	40	2748	2274	1805	2024	1697	1594	1344
151	322752	6526626	251	1,5 m	43	39	2718	2243	1777	1993	1666	1564	1314
151	322752	6526626	251	4,0 m	43	40	2718	2243	1776	1993	1666	1564	1313
152	322664	6526739	243	1,5 m	41	38	2700	2187	1781	1927	1625	1552	1276
152	322664	6526739	243	4,0 m	41	39	2699	2187	1781	1926	1624	1552	1275
153	322651	6526725	242	1,5 m	41	38	2681	2171	1762	1911	1607	1534	1258
153	322651	6526725	242	4,0 m	41	39	2681	2171	1762	1911	1607	1533	1258
154	322667	6526758	243	1,5 m	42	39	2712	2196	1796	1933	1635	1565	1287
154	322667	6526758	243	4,0 m	42	39	2712	2196	1796	1933	1635	1565	1286
155	322510	6526499	226	1,5 m	43	41	2446	1982	1512	1741	1402	1296	1052
155	322510	6526499	226	4,0 m	43	41	2446	1982	1511	1741	1401	1296	1051
156	321501	6524140	185	1,5 m	41	38	1630	2191	1445	2330	2003	1724	2077
156	321501	6524140	185	4,0 m	42	39	1630	2191	1445	2330	2003	1723	2077
157	321457	6523765	257	1,5 m	39	37	1887	2514	1804	2673	2361	2087	2444
157	321457	6523765	257	4,0 m	40	37	1887	2514	1804	2672	2360	2087	2444
158	321622	6523873	223	1,5 m	40	37	1905	2481	1719	2618	2283	1994	2341
158	321622	6523873	223	4,0 m	41	38	1905	2481	1719	2618	2282	1994	2341
159	321549	6523531	287	1,5 m	38	35	2131	2764	2042	2921	2603	2323	2676
159	321549	6523531	287	4,0 m	38	36	2130	2764	2042	2921	2602	2323	2675
160	321925	6523730	238	1,5 m	39	36	2214	2746	1928	2860	2495	2186	2513
160	321925	6523730	238	4,0 m	39	36	2214	2746	1927	2860	2495	2186	2513
161	321968	6523790	228	1,5 m	39	36	2203	2716	1886	2824	2452	2139	2462
161	321968	6523790	228	4,0 m	39	37	2203	2716	1885	2823	2452	2139	2462
162	322102	6523620	239	1,5 m	38	35	2417	2930	2090	3034	2656	2339	2654

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
162	322102	6523620	239	4,0 m	38	36	2417	2930	2090	3034	2656	2339	2654
163	322236	6523689	224	1,5 m	38	35	2469	2946	2082	3034	2643	2319	2621
163	322236	6523689	224	4,0 m	39	36	2469	2946	2081	3034	2643	2319	2621
164	322406	6523815	205	1,5 m	37	33	2524	2947	2054	3014	2606	2273	2556
164	322406	6523815	205	4,0 m	37	33	2524	2947	2054	3014	2606	2273	2556
165	322445	6524026	251	1,5 m	38	33	2436	2809	1896	2859	2439	2102	2371
165	322445	6524026	251	4,0 m	38	35	2436	2809	1896	2859	2439	2102	2371
166	322073	6524090	194	1,5 m	40	37	2095	2528	1655	2608	2215	1891	2196
166	322073	6524090	194	4,0 m	40	37	2095	2527	1655	2607	2214	1891	2196
167	322093	6524123	198	1,5 m	40	37	2092	2513	1635	2589	2193	1867	2169
167	322093	6524123	198	4,0 m	40	37	2092	2513	1634	2589	2192	1867	2169
168	321845	6524298	179	1,5 m	42	39	1791	2228	1377	2318	1939	1626	1948
168	321845	6524298	179	4,0 m	42	39	1791	2227	1377	2318	1939	1626	1948
169	322905	6524006	212	1,5 m	35	28	2848	3149	2213	3165	2725	2382	2605
169	322905	6524006	212	4,0 m	35	28	2847	3149	2213	3165	2724	2382	2605
170	322884	6524036	216	1,5 m	35	28	2815	3114	2177	3129	2688	2345	2569
170	322884	6524036	216	4,0 m	35	28	2815	3114	2177	3128	2688	2345	2568
171	323267	6524174	217	1,5 m	35	28	3108	3325	2381	3305	2851	2509	2685
171	323267	6524174	217	4,0 m	35	28	3108	3325	2380	3305	2851	2509	2685
172	323303	6524112	209	1,5 m	34	28	3165	3391	2447	3374	2920	2578	2756
172	323303	6524112	209	4,0 m	35	28	3165	3391	2446	3373	2919	2578	2756
173	323320	6524074	207	1,5 m	35	28	3195	3427	2483	3412	2958	2616	2796
173	323320	6524074	207	4,0 m	35	29	3195	3427	2483	3412	2958	2616	2796
174	323348	6524073	208	1,5 m	34	28	3221	3450	2506	3433	2979	2638	2815
174	323348	6524073	208	4,0 m	34	29	3221	3450	2506	3433	2979	2637	2815
175	323261	6524238	225	1,5 m	35	28	3079	3283	2338	3259	2803	2462	2632
175	323261	6524238	225	4,0 m	35	28	3079	3283	2338	3258	2803	2462	2632
176	323322	6524286	225	1,5 m	35	28	3120	3306	2363	3275	2817	2478	2638
176	323322	6524286	225	4,0 m	35	28	3120	3306	2362	3275	2817	2478	2638

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Point calculations

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					L_{den} [dBA]		*Distance WTG hub height - NSP calculation height* [m]						
NSP	**X [m]**	**Y [m]**	**Z,ground [mas]**	**Calculation height [m]**	**A01**	**A02**	**T1**	**T3**	**T5**	**T6**	**T7**	**T8**	**T9**
177	323343	6524270	222	1,5 m	34	28	3145	3333	2389	3301	2844	2504	2664
177	323343	6524270	222	4,0 m	34	28	3145	3333	2389	3301	2843	2504	2664
178	323497	6524694	233	1,5 m	25	17	3182	3255	2330	3182	2720	2394	2494
178	323497	6524694	233	4,0 m	25	17	3182	3255	2330	3182	2720	2394	2494
179	323567	6524673	221	1,5 m	26	18	3255	3328	2404	3253	2791	2466	2563
179	323567	6524673	221	4,0 m	26	18	3255	3328	2404	3253	2791	2466	2563

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Point calculations

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Information on results

The calculations are performed with the assumption that the noise sensitive points (NSP) are located 1,5 m and 4,0 m above ground. The height of 4,0 m should be considered decisive according to the norweigan 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 NSP:s see the noise maps.

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

The calculations for **Case A01** has also been verified against the method in T1442 chapter 9.3 Beregning, this method can only calculate the "worst case" downwind case. The result for values above L_{den}=40 dBA are in average 0,7 dBA higher calculated with Nord2000, which shows that an conservative approach has been used for the settings in Nord2000. Below are a point list of some conservative assumptions that has been assumed in the calculations:

1. For **Case A02** the noise emission for the upper wind speed is used due to the measured wind speed beeing offset by 0,5 m/s. Example, the noise emission for 6 m/s is used for the measured wind speed 5,5 m/s. For these two cases the highest noise emission 104,4 dBA is also used for all wind speeds above 8,5 m/s at hub height.
2. If there is a doubt of the ground impedance, i.e. hardness of the ground, the higher impedance class has been used. Example, impedance class F is used for the whole area below the wind farm area although some areas are probably softer according to the satellite images.
3. For **Case A01** downwind from all wind directions at the same time has been assumed, i.e. downwind from all WTG to each NSP is assumed. That probably overestimates the noise level in NSP:s surrounded by WTG for example the cluster of NSP:s (142...) located at Store-Hetland.
4. For **Case A02** the stand still time of the wind farm is only assumed for wind speeds of 1,5 m/s and below corresponding to approximately 21 days, which probably underestimates the real stand still time during a year.

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Noise map - Case A01:1 4,0 m

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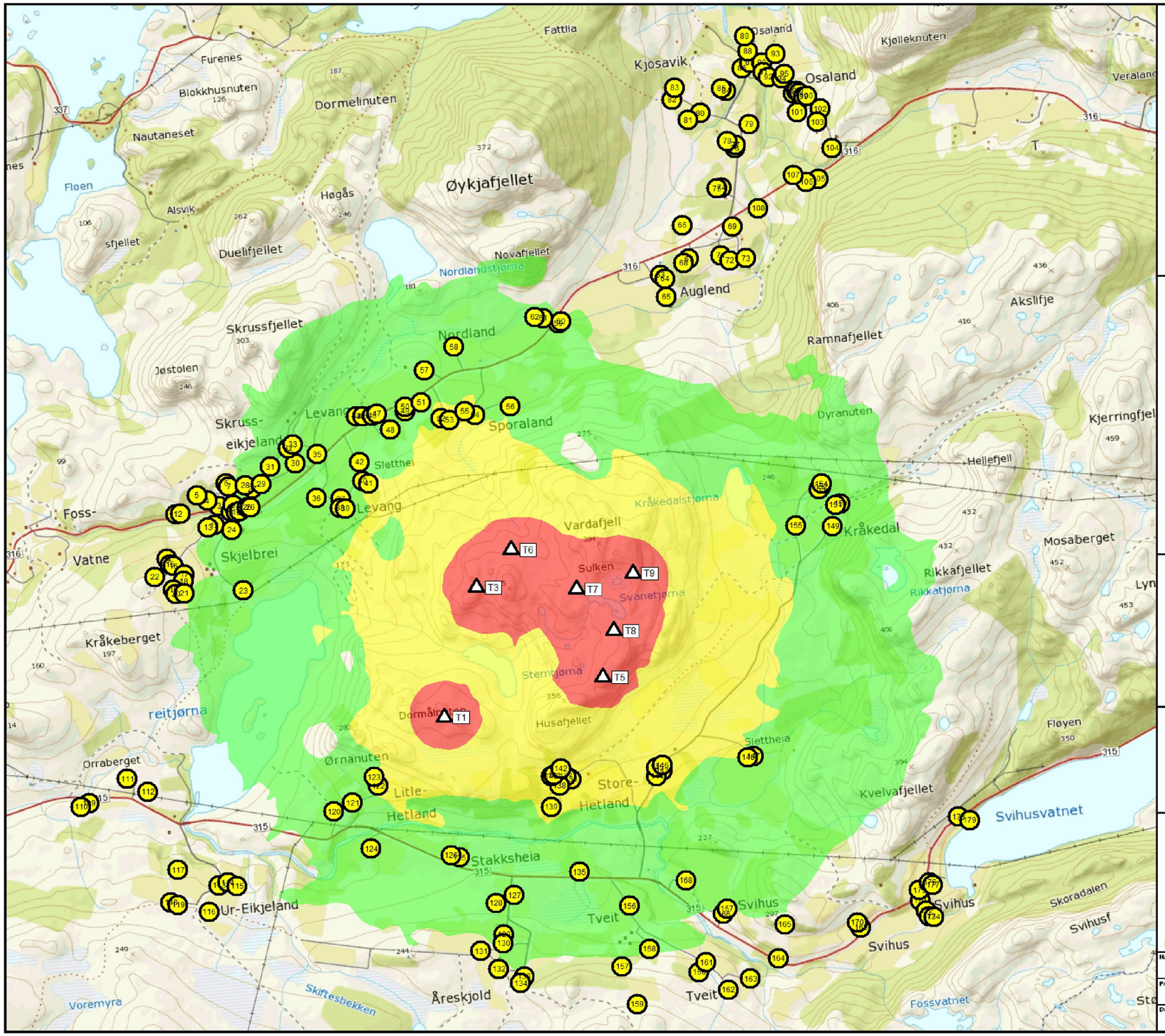


Yearly Average, L_{den}, in dBA
Result 4,0 m above ground

40 <= < 45
45 <= < 55
55 <=

Noise sensitive point (NSP)
Wind turbine

N

0 300 600 1200 1800 m

Vardafjellet wind farm
7 Wind Turbines (WTG) - Vestas V126-3,45 MW HT
Case A01

Akustikkonsulten

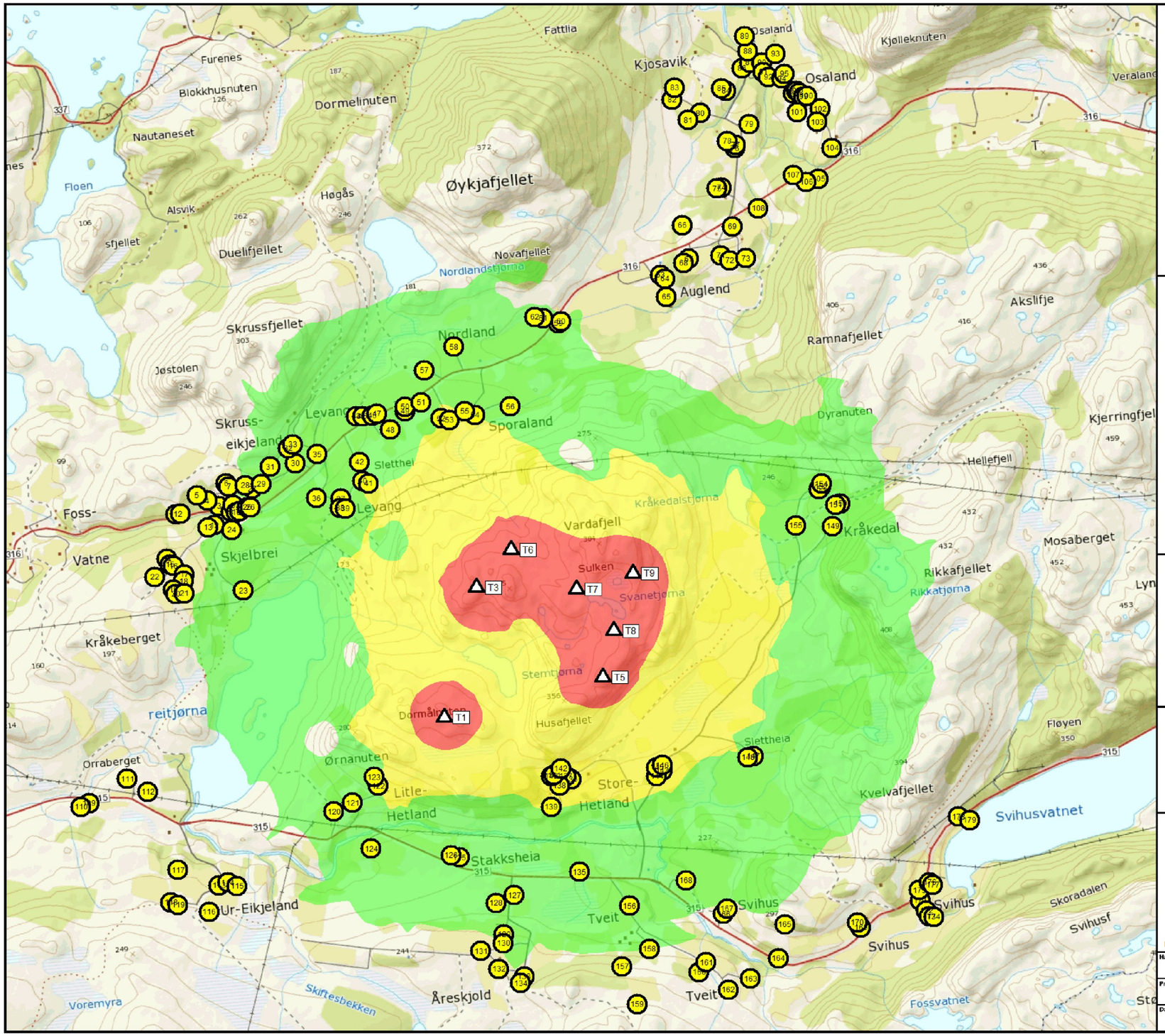
Beräknad med SoundPLAN 7.4 uppdatering 2017-06-27
www.akustikkonsulten.se

Handläggare	Kvalitetsgranskare
Paul Appelqvist	Jens Fredriksson
Projekt nr. 10-17005	Ritning A01:1
Datum 2017-09-12	

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Noise map - Case A01:2 1,5 m

Akustikkonsulten



Yearly Average, L_{den}, in dBA
Result 1,5 m above ground

40 <= < 45
45 <= < 55
55 <=

Noise sensitive point (NSP)
Wind turbine

N

0 300 600 1200 1800 m

Vardafjellet wind farm
7 Wind Turbines (WTG) - Vestas V126-3,45 MW HT
Case A01

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Handläggare	Kvalitetsgranskare
Paul Appelqvist	Jens Fredriksson
Projekt nr. 10-17005	Ritning A01:2
Datum 2017-09-12	

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
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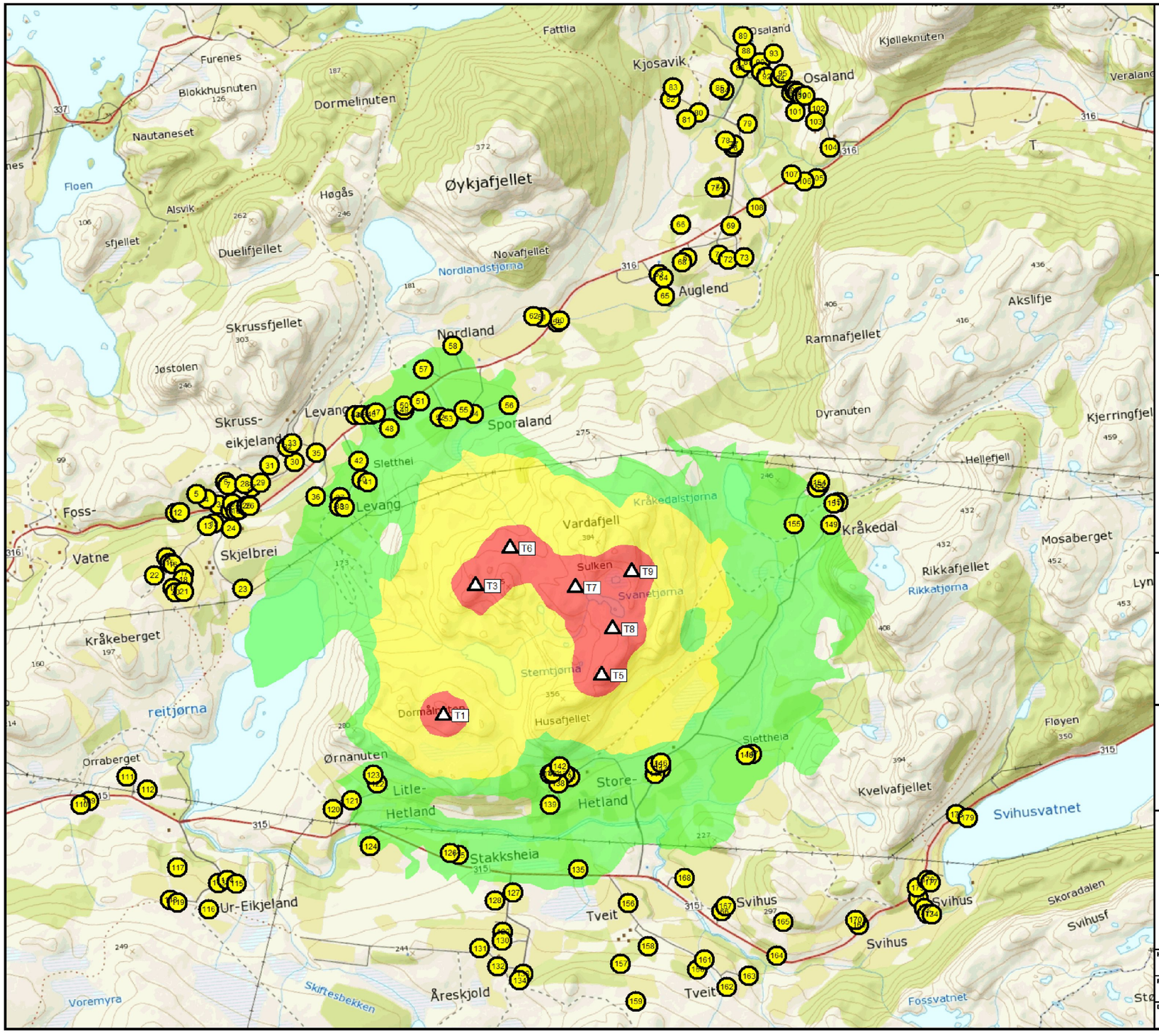
Noise map - Case A02:1 4,0 m

Akustikkonsulten



Yearly Average, L_{den}, in dBA
Result 4,0 m above ground

40 <= < 45
45 <= < 55
55 <=

Noise sensitive point (NSP)
Wind turbine

N

0 300 600 1200 1800 m

Vardafjellet wind farm
7 Wind Turbines (WTG) - Vestas V126-3,45 MW HT
Case A02

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Handläggare	Kvalitetsgranskare
Paul Appelqvist	Jens Fredriksson
Projekt nr. 10-17005	Ritning A02:1
Datum 2017-09-12	

Prepared By: Paul Appelqvist, paul@akustikkonsulten.se
Checked By: Jens Fredriksson, jens@akustikkonsulten.se

Noise map - Case A02:2 1,5 m

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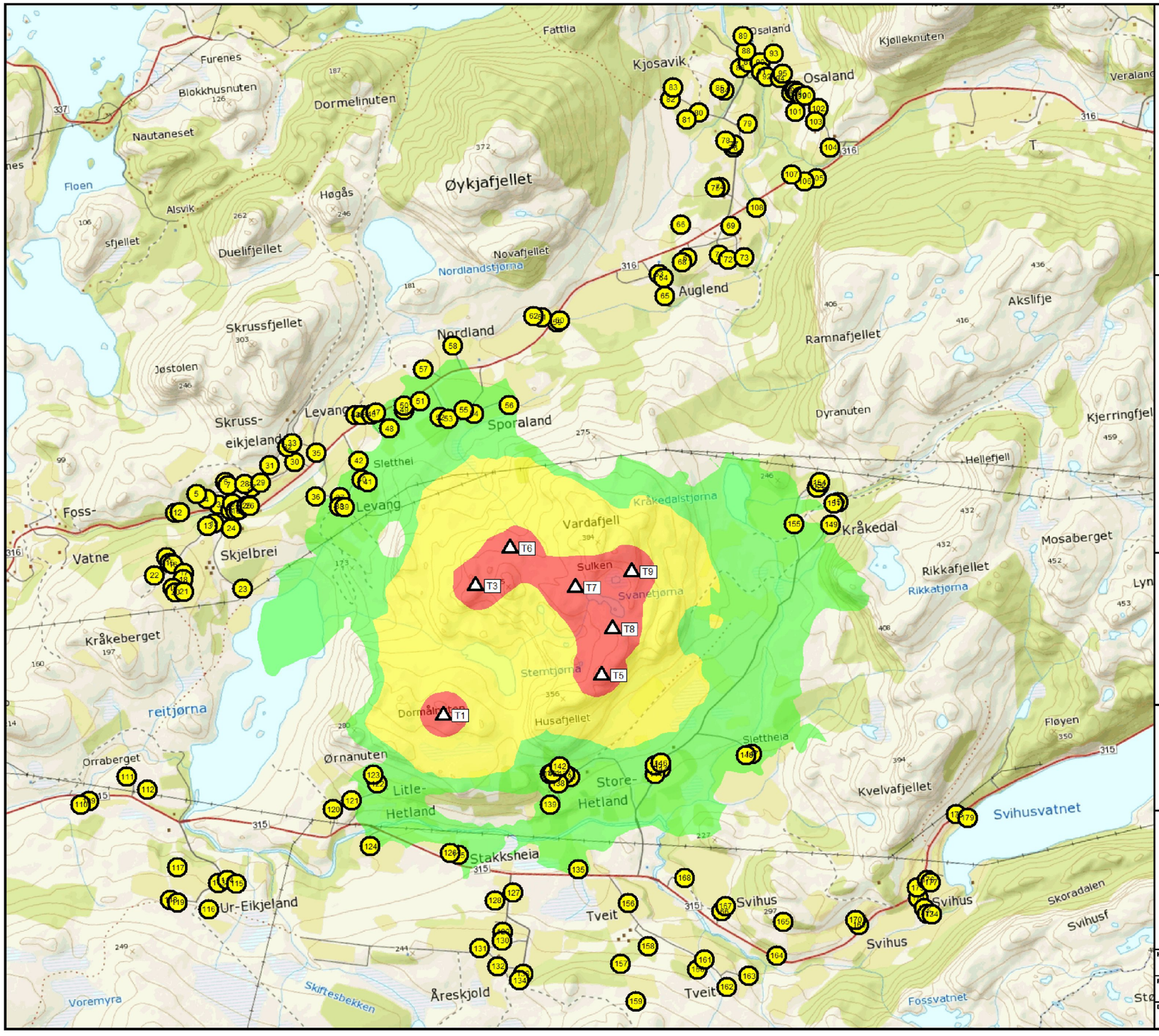

Yearly Average, L_{den}, in dBA
Result 1,5 m above ground

40 <= < 45
45 <= < 55
55 <=

Noise sensitive point (NSP)
Wind turbine

N

0 300 600 1200 1800 m

Vardafjellet wind farm
7 Wind Turbines (WTG) - Vestas V126-3,45 MW HT
Case A02

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Handläggare	Kvalitetsgranskare
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Projekt nr. 10-17005	Ritning A02:2
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