07.05 Strategic Noise Maps (Edition 2008)

Overview

Legal Provisions and Competent Authorities

The "Directive of the European Parliament and of the Council relating to the assessment and management of environmental noise" came into force on 18th February 2002, when it was published in the Official Journal of the European Community. This opened for the European Community the path towards legal provisions which were also to apply to noise immission in the environment.

The German Federal Environmental Office describes the objectives of the Directive as follows:

"Ensuring a high degree of health and environmental protection is part of the Community policies, one of the objectives being noise protection." To achieve this, "adverse effects of and annoyance caused by environmental noise must be prevented, avoided and reduced." This requires the following action:

- determining the load caused by environmental noise by means of noise maps and according to assessment methods to be used by all of the Member States;
- ensuring that the public is informed about environmental noise and its effects;
- adoption of action plans through the Member States based on the results of noise maps and aiming at preventing and reducing environmental noise where necessary and particularly in cases where exposure levels might have effects that are detrimental to health and further aiming at maintaining environmental noise quality where it is good.

Furthermore, the Directive should form the basis for further development and enhancement of measures to reduce the noise emission of the most relevant noise sources and it should also inform the European Commission about the exposure caused by environmental noise in the Member States.

The "Senatsverwaltung für Gesundheit, Umwelt und Verbraucherschutz" (Senate Administration for Public Health, Social Services and Consumer Protection) ordered and implemented the noise mapping project for the Land of Berlin as provided in the requirements of the Noise Mapping Decree (34th BImSchV = Bundes-Immissionschutzverordnung or Federal Immission Protection Decree) in connection with Paras. 47 a–f of BImSchG (Bundes-Immissionschutzgesetz or Federal Immission Control Act) and Directive 2002/49/EC (Environmental Noise Directive), with the current LAI instructions on noise mapping taken into consideration.

The plan aimed at creating strategic noise maps and the related statistical evaluations (exposure for humans, dwellings, schools and hospitals in specific immission level classes). Results were prepared with regard to the following items for further utilization through the customer:

- basis for reporting to the EU and for informing the public;
- basis for drawing up action plans for noise reduction measures (noise reduction plans for Berlin);
- basis for managing the output data (data model care);
- basis for re-calculation and evaluation of spatially defined areas.

Paras. 47 a–f of the Federal Immission Control Act (BImSchG) lay down the rules for implementing the EU Environmental Noise Directive according to German law. The Noise Mapping Decree (34th BImSchV) defines the requirements for noise maps according to Para. 47 c of BImSchG.

Noise maps must always be calculated. Calculations must comply with the preliminary EU-conforming calculation rules, which deviate from the Technical Codes that are binding according to national law in some aspects (see below, "Calculation Methods").

Noise maps are to be reviewed and, if necessary, revised every five years after they have been drawn up.

The maps 07.05.12 - 07.05.15 (total noise of all traffic sources) are not a component of the "Directive of the European Parliament and of the Council relating to the assessment and management of environmental noise". These maps represent the attempt, to present a summing up contemplation of the single traffic noise-sources. Due to lacking knowledge about the dose-effect relationships, only an energy summation was proceeded. Therefore the contemplation of the total noise cannot meet the requirements to respect the burden-effects of the individual noise sources (cf. cumulative values of the noise exposure).

General description of main noise sources, based on their position, size and road traffic / mapping scope

The borders of the area under examination are the borders of the Land of Berlin. The following noise sources were examined:

- Road traffic (motor vehicles including busses)
- Streetcar traffic and above-ground subway traffic
- Industrial and commercial areas with plants complying with Annex I of Directive 96/61/EC of the Council of 24th September 1996 concerning integrated pollution prevention and control (IPPC plants including power plant locations and Westhafen)
- Air traffic (Tegel Airport)
- Railway traffic according to the Allgemeines Eisenbahngesetz (AEG, General Railroad Law).

Included in the examination were further relevant main noise sources in the Brandenburg area adjoining the borders, which exceed the specified immission levels (excluding Schönefeld Airport).

Table 1 gives an overview of the noise sources included in the examination:

Noise source	Network	Route length
Road traffic	Federal Autobahn	84.4 km
	Federal Highway	191.3 km
	Municipal Highway	1,085.6 km
Streetcar traffic and above-ground subway traffic	Streetcar	188.4 km
	Subway	26.3 km
IPPC plants	1 Industrial plant	
	18 power plant locations	
Air traffic	Tegel Airport	
Railway traffic	Long-distance / freight traffic and suburban fast train	1,066.0 km

Table 1: Main noise sources for noise mapping in the conurbation area of Berlin

Constraints considering the cumulative values of the noise exposure

Until now the described regulations do not intend any calculation of total-noise levels, the individual main-noise-sources are calculated and assessed separately from each other. However, the German Council of Environmental Advisors declared in 2004, S. 490, that " a cut of the noise-burden of the population can only be successful if the combination of several noise-sources will be taken into account".

Since the dose-effect--relationships are extremely difficult from the medical and psychological point of view when simultaneous effects of several sound sources are interacting, here a simplified approach was carried out:

- All immission-value for the different main-noise-sources were assessed with the same level of annoyance; i.e. no use of sound-type-specific annoyance-factors through a bonus-malus-system

- The individual noise levels are added only energetically.

(for more detailed information to the topic " total-noise-exposure " see the study of the TÜV (German Technical Inspection Service Immission Protection and Energy Systems)).

It is to take into account that there are some specific particularities of the logarithmic decibel scale. For instance, the volumes of two 50 dB(A) sound events sum up to 53 dB(A); however the ear feels this increasing of 3 dB(A) like a duplication of the disagreeableness. Two part-levels, one of 50 dB(A) and one of 60 dB(A) sum up to 60,4 dB(A).

Statistical Bases and Calculation Model

Statistical Bases

Acoustic calculations were based on the input data submitted to the Land of Berlin for the reference year of 2006 (railroad track and traffic data excluded). Data relating to railway traffic was prepared and submitted by the Bahn-Umwelt-Zentrum of the Deutsche Bahn AG.

Mapping Zone

The mapping zone covers the area of the Land of Berlin amounting to 892 km². The examination referred to a noise load exposure for 3,332,249 inhabitants.

Terrain Model

The terrain model was based on a digital terrain model (Digitales Geländemodell DGM5) in the inner city area and, partially, in the north and south-east of the city, while DGM25 was used both for the remaining area and the neighboring area of Brandenburg. The digital terrain models (DGM5, DGM25) describe the terrain in regular grids with a dot pitch of 5 m and 25 m respectively. The terrain model was optimized to remove altitude points which do not contribute to the determination of acoustically relevant terrain structures. The result is a terrain model which consists of heterogeneous altitude points comprised to form a triangular grid (see Figure 1).

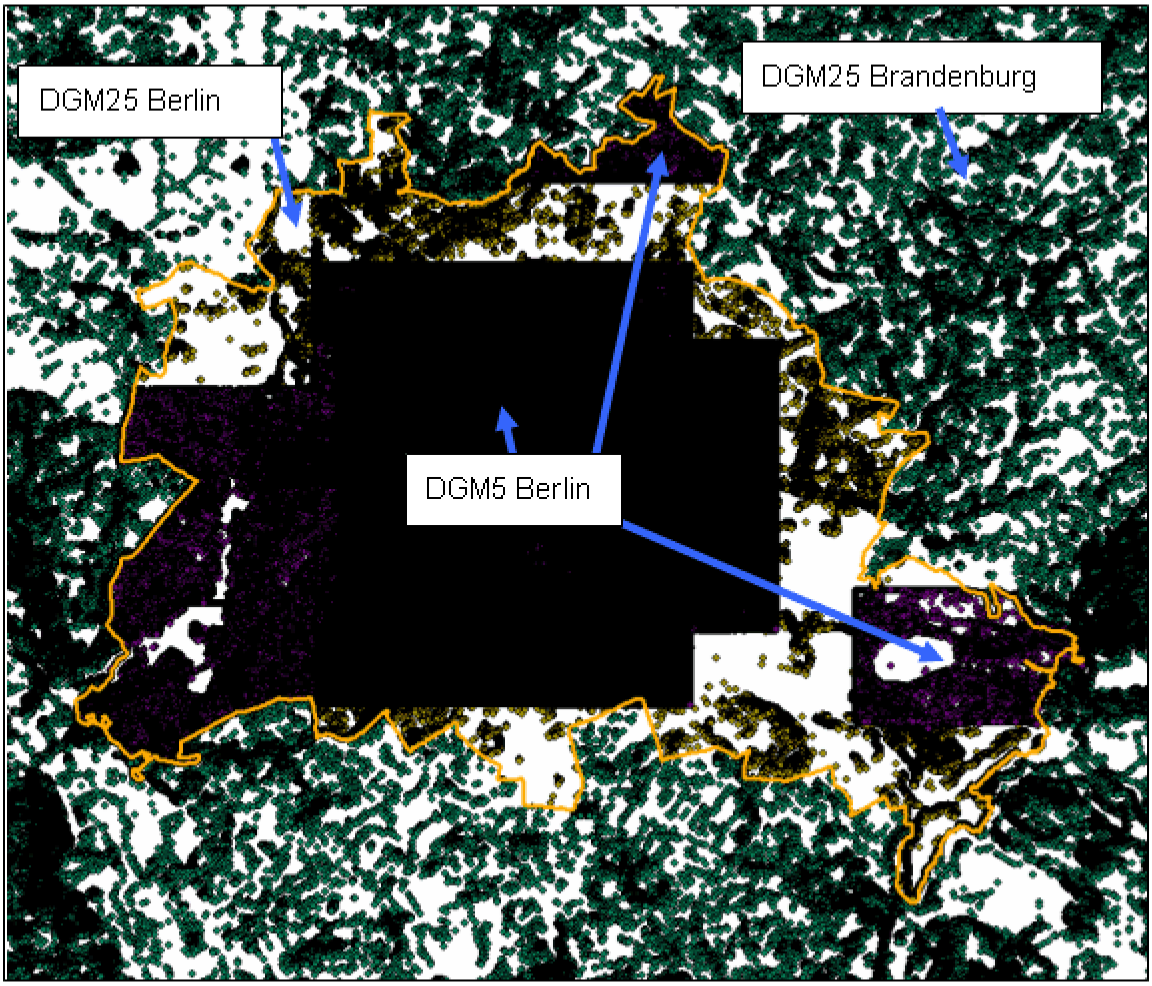

Fig. 1: Terrain model based on the optimized DGM25 Berlin (yellow, "non-crowded distribution"), DGM5 Berlin (black-violet, "dense") and DGM25 Brandenburg (green)

DGM5 fails to describe the terrain along railway embankments and cuttings satisfactorily. When such structures were located 1 m above or below the surrounding terrain, the corresponding upper and lower edges were determined with an accuracy of <0.5 m and based on stereo aerial photographs. These edges were then applied to the terrain model as altitude lines (see "Noise Insulation Facilities"). The railroad track network contains altitude data at all track points (see below, "Geometry – Railroad Traffic"). These altitude points were also applied to the terrain model.

Noise Insulation Facilities

Noise Protection – Road

The location description of noise insulation facilities at roads was taken from the existing road traffic noise map (data from 1998/2003), i.e. Road Traffic Noise Map 07.02 (edition 2005). Since part of the data was not available in georeferenced format, additional evaluations of aerial photographs and photographs on site were incorporated in the digital system as best as possible. The position and altitudes of the noise insulation facilities at the Federal Autobahn A113 (new) were directly taken from the documents for approval of the A113 (new) plan and incorporated in the digital system.

Noise Protection – Railroad

The Bahn-Umwelt-Zentrum of the Deutsche Bahn AG was not able to deliver a location description of noise insulation facilities at railroad tracks. For that reason, noise insulation facilities made of concrete, steel, glass, and the like were determined by means of an external 3D evaluation of stereo aerial photographs and according to the procedure described below. It was assumed that all of the sound insulation facilities were high-capacity sound absorbing noise barriers.

1. Import of current aerial photographs (photographic flight over Berlin in 2006; scanned black-and-white aerial photographs (8 bits); resolution approx. 15 cm) and orientations in the image evaluation system ImageStation SSK from Intergraph.
2. Interactive evaluation of aerial photograph models and entry of the noise insulation facilities in special files:
   - Where noise barriers (>1.0 m) made of concrete, steel, glass, and the like were concerned, the center axes were entered as a polygon on top of the barrier.
   - Where embankments (>1.0 m) acting as noise barriers (embankment next to the tracks) were concerned, the extension of the embankment was entered as a surrounding polygon.
   - Where tracks are running on top of an embankment (>1.0 m above the surrounding terrain), the embankment was entered with its upper and lower edges.
   - Evaluation accuracy: < 0.5 m.
3. Export or import and storage of the differently attributed files to the GIS system used.

Special Structures

Tunnels – Roads

In the calculation model, tunnel structures were represented by interruptions in the route sections.

Tunnels – Railway Stations

In the calculation model, tunnel structures were represented by interruptions in the line sections. The course of tunnel structures was represented in the layout plan. The level of emissions caused by trains passing through stations was calculated analogously to that caused by trains in the open terrain. Attenuation by platform edges and station buildings was not taken into account.

Road Bridges

Bridges across roads and waters were taken into account in 241 areas where the high position of a road has a relevant acoustic effect on the neighboring built-up area. A reflecting bridge platform was modeled across the width of the road in each of these cases.

When using the noise map, the following must be observed: bridge structures are not included in the surface of the terrain; rather, they are rising above the terrain. **Noise maps are calculated at a height of 4 m above the terrain and can, therefore, be related to the area below a "noisy" road bridge which acts as a sound barrier with accordingly low local immission levels**.

Built-up Area

550,344 floor plans of building objects with specification of the number of floors and the following building use were taken from the automated real property map of the City of Berlin (see Table 2):

Use	Number of buildings
Residential	276,511
School	2,483
Hospital	762
Miscellaneous	270,588

Table 2: Number of buildings and building use, taken as input parameters for the strategic noise maps of Berlin

Explicit building heights were not available and were, therefore, defined through the following empirically determined function: [building height = 3.2 m + number of storeys x 2.8 m]. At a distance of 3 km from the urban area, 231,445 buildings with explicit height data from the Land of Brandenburg were applied to the model. These buildings act as obstructions and reflectors of road and railway noise sources in the marginal region of the area under examination.

Building facades were included in the calculations as reflecting with an absorption loss of 1 dB(A).

Building Inhabitants

The number of inhabitants with principal and secondary domicile is available in 14,253 partial areas of the urban area with a total of 3,331,249 inhabitants in 2005 (population density map 06.05 (edition 2006)). These inhabitants were distributed proportionally over the floor areas of the residential buildings located in the particular partial areas. Buildings with mixed use were taken into account with 75%.

Dwellings

The number of dwellings was determined in relation to districts, based on the district areas and the number of inhabitants and households (dwellings) per district, which were taken from the statistical reports “Ergebnisse des Microzensus 2005” (2005 microcensus results) and “Wohngebäude und Wohnungen in Berlin 2005” (residential buildings and dwellings in Berlin in 2005) for Berlin (cf. Statistisches Landesamt Berlin 2005). This results in a mean value of 0.554 dwellings per inhabitant for the entire urban area, with only low variations. This factor and the known number of inhabitants involved were used to determine the number of dwellings involved.

Geometry – Road Traffic

The geometry of the roads under examination as well as the necessary information about the surface and the condition of the carriageway, the allowed maximum speed, the position in the terrain, and the number of lanes were taken from the existing traffic noise map for principal roads (see Road Traffic Noise Map 07.02 (edition 2005)). The data regarding the surface and the condition of the carriageways was reviewed and updated based on information from the districts and on photographs taken on site.

Furthermore, the already implemented speed-30 sections of the principal road network were determined from the existing speed-30 concepts and incorporated in the road network database. Road sections where corrections caused by multiple reflections had to be taken into account were determined based on the density of the built-up area extending in parallel to the road (see below, “Calculation Methods – Road Traffic”).

Sections of the principal road network, which have not yet been contained in the traffic noise map but are a part of the traffic survey network, were photographed on site (surface and condition of the carriageway, speed limit, position in the terrain, lanes, information about built-up areas, noise barrier) and incorporated in the road network database. Sections where corrections caused by multiple reflections had to be taken into account were also determined.

The traffic intensities of the 2005 traffic count were assigned to the sections. The data contains information about the average daily traffic volume (DTV), about heavy traffic and about bus traffic. Calculations according to the VBUS (“Vorläufige Berechnungsmethode für den Umgebungslärm an Straßen” or “preliminary calculation method for environmental noise at roads”) takes heavy traffic with 3.5 tons and more into account.

Additional sections outside of Berlin were digitized based on topographical maps. The figures of the traffic intensity map of the Land of Brandenburg (2002) were assigned to these sections.

A total of 1,770 km of the road network was included in the calculation. 1,362 km of these roads are located in the territory of the City of Berlin.

Geometry – Streetcar Traffic, Above-Ground Subway Traffic

The geometry of the streetcar and the above-ground subway networks as well as the necessary information about the type of rails, the speed limit and the position in the terrain were taken from the existing traffic noise maps for principal roads and railway traffic. The Berliner Verkehrsbetriebe (BVG) provided traffic data on streetcars and above-ground subways of 2006. This data as well as updates relating to the types of streetcar rails were included in the geometry. Altogether, 188 km of the streetcar and 26 km of the above-ground subway networks were included in the calculation.

Geometry – Industrial and Commercial Plants

Plants have an effect on environmental noise if they cause relevant sound immissions at the nearest place of use to be protected, which exceed L_{DEN} = 55 dB(A) and/or L_{Night} = 50 dB(A). The researches has resulted, that only one industrial plant comes within the limits of these values.

The Berlin noise map for commercial locations with an effect on environmental noise comprises 18 power plant locations and one industrial plant (cf. IPPC Directive).

According to an expert opinion of 2005, the Westhafen also causes rating levels at the nearest residential built-up area of less than 55 dB(A) during the day and less than 44 dB(A) during the night. According to the Environmental Noise Directive, the Westhafen is, therefore, considered to be acoustically irrelevant and was consequently not included in the examination.

The geometry for the 18 power plants inside the urban area of Berlin was determined from data about the land parcels allocated in the real estate cadaster and by comparison with the digital orthophotos and the power plant providers. The emission caused by the power plants and the IPPC plant was modeled by means of area-related sound power levels.

Geometry – Tegel Airport Traffic

The following input data was available for calculating aircraft noise:

- data acquisition system DES 06/2005, actual state of 2004;
- geometric description of the takeoff and landing runways as well as the approach and departure sections (position, altitudes, flight corridors) and route assignment with activity counts of individual aircraft types;
- distribution of flight movements of individual aircraft types for day, evening and night periods, on takeoff and landing runways in 2005.

The data acquisition system is not available for 2005. According to the Deutsche Flugsicherung DFS (German Air-Traffic Control), the route descriptions of 2005 did not differ from those of 2004, so that they can be applied to the year 2005. The submitted distribution of flight movements refers to the takeoff and landing runways; there are no details about the individual air routes. For that reason, the distribution of flight movements in 2005 over the individual air routes was applied proportionally to that found for 2004 in the data acquisition system.

Geometry – Railway Traffic

The railway and suburban fast train track sections were prepared by the Bahn-Umwelt-Zentrum Berlin (BUZ) of the Deutsche Bahn AG. The 2006 traffic data (after commissioning of the main station) were assigned to these track sections.

The route network was included in the calculation with a total of 1,365 km, 1,066 km of which are located in the territory of the City of Berlin.

There is no detailed information about areas with small curve radius where the trains do not cause any squealing noise or where such noise can be excluded through technical measures. For that reason, correction values for curve squealing noise according to VBUSch were used systematically on a worst-case basis, without taking the actual occurrence of such noise into account.

Calculation Model

The input data is prepared and combined in a 3D calculation model of the IMMI 6.1 software.

Obstructions

Obstructions, such as terrain edges, buildings and noise insulation facilities, were taken into account with the parameters described in the input data (position, altitude, reflection property, and the like). The basic model formed from the terrain and obstructions remained as it was for the calculation of all noise types.

Determination of Reception Points

At residential buildings, hospitals and schools, the position of reception points was determined according to the "Vorläufige Berechnungsmethode zur Ermittlung der Belastetenzahlen durch Umgebungslärm" (VBEB, "preliminary calculation method for determining the exposure figures caused by environmental noise"). The number of inhabitants in residential buildings was distributed across the reception points of the respective residential buildings in equal shares.

Plausibility Check

The plausibility check consists of a visual check of 3D views of the calculation model and numerous automatic plausibility queries.

Calculation Parameters

Mappings within the scope of the Environmental Noise Directive cannot be achieved in economic calculation times if the applicable calculation rules are to be followed completely and strictly. For that reason, calculation parameters were determined in a simplified manner (minimum level distance = 25 dB(A); range of reflection surfaces limited to 200 m), essentially resulting in a neglection of irrelevant immission effects at certain reception points. As tested and certified, the accuracy requirements for the noise mapping calculation results were met and complied with a total accuracy of 2 dB(A).

Calculation Method

Road Traffic

VBUS ("preliminary calculation method for environmental noise at roads") was used for acoustic calculations of the strategic noise maps (cf. 34th BImSchV, Para. 5, Section 1). The noise indices L_{DEN} (weighted 24-h mean value) and L_{Night} were calculated with a step size of 10 m x 10 m at a reception point height of 4 m above the ground.

The number of persons exposed in their dwellings, of schools and hospitals was determined according to VBEB ("Vorläufige Berechnungsmethode zur Ermittlung der Belastetenzahlen durch Umgebungslärm" or "preliminary calculation method for determining the exposure figures caused by environmental noise").

The corrections for multiple reflections were determined and considered according to the specifications made in VBUS ("preliminary calculation method for environmental noise at roads"). Separate corrections for traffic lights are not allowed.

Streetcar and Subway Traffic

VBUSch ("Vorläufige Berechnungsmethode für den Umgebungslärm an Schienenwegen" or "preliminary calculation method for environmental noise at railways") and VBEB (cf. 34th BImSchV, Para. 5, Section 1) were used for acoustic calculation of the strategic noise maps as well as the persons exposed in their dwellings, schools and hospitals. The noise indices L_{DEN} and L_{Night} were calculated with a step size of 10 m x 10 m at a reception point height of 4 m above the ground.

Commercial Plants

VBUI ("Vorläufige Berechnungsmethode für den Umgebungslärm durch Industrie und Gewerbe" or "preliminary calculation method for environmental noise caused by industrial and commercial plants") and VBEB were used for acoustic calculation of the strategic noise maps as well as the persons exposed in their dwellings, schools and hospitals. The noise indices L_{DEN} and L_{Night} were calculated with a step size of 10 m x 10 m at a reception point height of 4 m above the ground.

Air Traffic

VBUF-DES ("Vorläufige Berechnungsmethode für den Umgebungslärm an Flugplätzen – Datenerfassungssystem" or "preliminary calculation method for environmental noise at airports – data acquisition system") and VBUF-AzB ("Vorläufige Berechnungsmethode für den Umgebungslärm an Flugplätzen – Anleitung zur Berechung" or "preliminary calculation method for environmental noise at airports – calculation instructions") as well as VBEB (cf. 34th BImSchV, Para. 5, Section 1) were used for acoustic calculation of the strategic noise maps as well as the persons exposed in their dwellings, schools and hospitals.

Railway Traffic

VBUSch ("Vorläufige Berechnungsmethode für den Umgebungslärm an Schienenwegen" or "preliminary calculation method for environmental noise at railways") and VBEB (cf. 34th BImSchV, Para. 5, Section 1) were used for acoustic calculation of the strategic noise maps as well as the persons exposed in their dwellings, schools and hospitals. The noise indices L_{DEN} and L_{Night} were calculated with a step size of 10 m x 10 m at a reception point height of 4 m above the ground. According to VBUSch, the rail bonus (deduction of 5 dB because of the lower disturbing effect of railway traffic) provided in the National Calculation Provision for Rail Traffic Noise ("nationale Berechnungsvorschrift für Schienenverkehrslärm" SCHALL 03) is not assigned.

Using the Data Display

The various subject maps herewith made available to the public represent the noise situation in relation to areas in a classified form, as provided in the Environmental Noise Directive. What is more, they also provide the possibility of polling factual data: maps 07.05.1 to 07.05.10 display the individual grid values forming the basis of the classification and, for road traffic noise, additional background information about the principal road network registered. Since the grid used for representation in these maps is a 10 m x 10 m grid, the individual statements are not suited for precise evaluation of buildings. For that reason, map 07.05.11 (facade levels at residential buildings within the exposure range of main noise sources) provides a complete overview of the reception points used on the facades of residential buildings, including the immission levels calculated.

Calculation Results / Tabular Evaluations

As required in the "Directive on the Assessment and Management of Environmental Noise", strategic noise maps graphically represent the noise situation in the following isophone classes:

Fig. 2: Representation of isophone classes according to the requirements of 34th BImSchV	
	L_{Night} > 50 dB(A) up to 55 dB(A)
L_{DEN} > 55 dB(A) up to 60 dB(A)	L_{Night} > 55 dB(A) up to 60 dB(A)
L_{DEN} > 60 dB(A) up to 65 dB(A)	L_{Night} > 60 dB(A) up to 65 dB(A)
L_{DEN} > 65 dB(A) up to 70 dB(A)	L_{Night} > 65 dB(A) up to 70 dB(A)
L_{DEN} > 70 dB(A) up to 75 dB(A)	L_{Night} > 70 dB(A)
L_{DEN} > 75 dB(A)	

Fig. 2: Representation of isophone classes according to the requirements specified in the "Directive on the Assessment and Management of Environmental Noise"

They form the basis for preparing an overall urban noise reduction plan (see http://www.berlin.de/sen/umwelt/laerm/laermminderungsplanung/index.shtml).

The noise exposure is specified through the following variables:

- Tabular data about the estimated number of persons living in areas located within the isophone bands according to Fig. 2. Figures should be rounded up or down to the next hundredth place.
- Tabular data about noise-exposed areas as well as the estimated number of dwellings, schools and hospitals in these areas for the following L_{DEN} values: L_{DEN} > 55 dB(A), L_{DEN} > 65 dB(A), L_{DEN} > 75 dB(A).

Road Traffic

Table 3: Number of persons exposed to road traffic noise in their dwellings (related to noise index L_{DEN})					
Level range L_{DEN} in dB(A)	>55 to 60	>60 to 65	>65 to 70	>70 to 75	>75
Number of persons	220,200	155,000	140,200	112,600	20,800

Table 3: Number of persons exposed to road traffic noise in their dwellings (related to noise index L_{DEN})

Table 4: Number of persons exposed to road traffic noise in their dwellings (related to noise index L_N)					
Level range L_{Night} in dB(A)	>50 to 55	>55 to 60	>60 to 65	>65 to 70	>70
Number of persons	183,800	146,400	135,300	56,300	1,400

Table 4: Number of persons exposed to road traffic noise in their dwellings (related to noise index L_N)

Table 5: Areas, dwellings, school and hospital buildings exposed to road traffic noise				
		Level range L_{DEN} in dB(A)		
	Total	**>55**	**>65**	**>75**
Area in km²	891.7	277.4	97.7	21.5
Number of dwellings	1,881,800	359,300	151,500	11,500
Number of school buildings	2,483	442	95	1
Number of hospital buildings	762	140	34	0

Table 5: Areas, dwellings, school and hospital buildings exposed to road traffic noise

All individual buildings were included in the evaluation of the schools and hospitals involved. For example, if school complexes consisted of three buildings, three school buildings were evaluated.

Streetcar and Subway Traffic

Table 6: Number of persons exposed to streetcar and subway noise in their dwellings (related to noise index L_{DEN})					
Level range L_{DEN} in dB(A)	>55 to 60	>60 to 65	>65 to 70	>70 to 75	>75
Number of persons	38,000	25,700	11,600	1,400	0

Table 6: Number of persons exposed to streetcar and subway noise in their dwellings (related to noise index L_{DEN})

Table 7: Number of persons exposed to streetcar and subway noise in their dwellings (related to noise index L_N)					
Level range L_{Night} in dB(A)	>50 to 55	>55 to 60	>60 to 65	>65 to 70	>70
Number of persons	31,400	16,600	6,300	500	0

Table 7: Number of persons exposed to streetcar and subway noise in their dwellings (related to noise index L_N)

Table 8: Areas, dwellings, school and hospital buildings exposed to streetcar and subway noise				
		Level range L_{DEN} in dB(A)		
	Total	**>55**	**>65**	**>75**
Area in km²	891.7	20.4	6.0	0.1
Number of dwellings	1,881,800	42,500	7,200	0
Number of school buildings	2,483	32	5	0
Number of hospital buildings	762	11	0	0

Table 8: Areas, dwellings, school and hospital buildings exposed to streetcar and subway noise

All individual buildings were included in the evaluation of the schools and hospitals involved. For example, if school complexes consisted of three buildings, three school buildings were evaluated.

Industry and Commerce

Table 9: Number of persons exposed to industrial noise in their dwellings (related to noise index L_{DEN})					
Level range L_{DEN} in dB(A)	>55 to 60	>60 to 65	>65 to 70	>70 to 75	>75
Number of persons	200	100	100	0	0

Table 9: Number of persons exposed to industrial and commercial noise in their dwellings (related to noise index L_{DEN})

Table 10: Number of persons exposed to industrial noise in their dwellings (related to noise index L_N)					
Level range L_{Night} in dB(A)	>50 to 55	>55 to 60	>60 to 65	>65 to 70	>70
Number of persons	100	100	0	0	0

Table 10: Number of persons exposed to industrial and commercial noise in their dwellings (related to noise index L_N)

Table 11: Areas, dwellings, school and hospital buildings exposed to industrial noise				
		Level range L_{DEN} in dB(A)		
	Total	**>55**	**>65**	**>75**
Area in km²	891.7	2.8	1.2	0.0
Number of dwellings	1,881,800	200	0	0
Number of school buildings	2,483	0	0	0
Number of hospital buildings	762	0	0	0

Table 11: Areas, dwellings, school and hospital buildings exposed to industrial and commercial noise

All individual buildings were included in the evaluation of the schools and hospitals involved. For example, if school complexes consisted of three buildings, three school buildings were evaluated.

Air Traffic

Table 12: Number of persons exposed to aircraft noise in their dwellings (related to noise index L_{DEN})					
Level range L_{DEN} in dB(A)	>55 to 60	>60 to 65	>65 to 70	>70 to 75	>75
Number of persons	133,100	96,600	20,100	1,500	0

Table 12: Number of persons exposed to aircraft noise in their dwellings (related to noise index L_{DEN})

Table 13: Number of persons exposed to aircraft noise in their dwellings (related to noise index L_N)					
Level range L_{Night} in dB(A)	>50 to 55	>55 to 60	>60 to 65	>65 to 70	>70
Number of persons	61,400	12,000	600	0	0

Table 13: Number of persons exposed to aircraft noise in their dwellings (related to noise index L_N)

Table 14: Areas, dwellings, school and hospital buildings exposed to aircraft noise				
		Level range L_{DEN} in dB(A)		
	Total	**>55**	**>65**	**>75**
Area in km²	891.7	63.8	10.6	1.8
Number of dwellings	1,881,800	139,200	12,000	0
Number of school buildings	2,483	186	1	0
Number of hospital buildings	762	45	3	0

Table 14: Areas, dwellings, school and hospital buildings exposed to aircraft noise

All individual buildings were included in the evaluation of the schools and hospitals involved. For example, if school complexes consisted of three buildings, three school buildings were evaluated.

Railway Traffic

Table 15: Number of persons exposed to railway noise in their dwellings (related to noise index L_{DEN})					
Level range L_{DEN} in dB(A)	>55 to 60	>60 to 65	>65 to 70	>70 to 75	>75
Number of persons	104,600	42,200	17,200	5,100	800

Table 15: Number of persons exposed to railway and suburban fast train noise in their dwellings (related to noise index L_{DEN})

Table 16: Number of persons exposed to railway noise in their dwellings (related to noise index L_N)					
Level range L_{Night} in dB(A)	>50 to 55	>55 to 60	>60 to 65	>65 to 70	>70
Number of persons	77,900	31,800	10,300	2,600	400

Table 16: Number of persons exposed to railway and suburban fast train noise in their dwellings (related to noise index L_N)

Table 17: Areas, dwellings, school and hospital buildings exposed to railway noise				
		Level range L_{DEN} in dB(A)		
	Total	>55	>65	>75
Area in km²	891.7	159.2	42.6	10.8
Number of dwellings	1,881,800	94,100	12,800	500
Number of school buildings	2,483	106	9	0
Number of hospital buildings	762	28	0	0

Table 17: Areas, dwellings, school and hospital buildings exposed to railway and suburban fast train noise

All individual buildings were included in the evaluation of the schools and hospitals involved. For example, if school complexes consisted of three buildings, three school buildings were evaluated.

Sources of Expert Opinions and Advanced Links

Sources of Expert Opinions

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(Noise Mapping Decree – 34th BImSchV) of 6th March 2006, Federal Law Gazette 2006 Part I No. 12, issued at Bonn on 15th March 2006.

[3] **Directive 96/61/EC of the Council:**
of 24th September 1996 on the Integrated Pollution Prevention and Control (IPPC Directive).
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[4] **Directive 2002/49/EC of the European Parliament and of the Council:**
of 25th June 2002, relating to the assessment and management of environmental noise, Official Journal of the European Community L 189/12 of 17th July 2002.
Download:
http://www.umweltbundesamt.de/laermprobleme/
publikationen/200249EG.pdf

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[10] LAI, Bund/Länderarbeitsgemeinschaft für Immissionsschutz (Working Commission for Immission Protection of the Federation and the Länder):
Instructions on noise mapping as amended by the resolution of the 112th LAI meeting from 7th to 8th September 2006.

[11] Statistisches Landesamt Berlin (Ed.) 2005:
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Internet:
https://www.woelfel.de/en/products/immi.html

[13] Vorläufige Berechnungsmethode für den Umgebungslärm an Straßen (VBUS) (preliminary calculation method for environmental noise at roads):
published in Federal German Gazette No. 154 of 17th August 2006.

[14] Vorläufige Berechnungsmethode für den Umgebungslärm an Schienenwegen (VBUSch) (preliminary calculation method for environmental noise at railways):
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[15] Vorläufige Berechnungsmethode zur Ermittlung der Belastetenzahlen durch Umgebungslärm – VBEB (preliminary calculation method for determining the exposure figures caused by environmental noise):
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Links:

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Maps

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