European Environment Agency

GeoPackage Encoding Rule for Environmental Noise Directive Reporting Data

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Introduction

The Environmental Noise Directive 2002/49/EC (END) defines reporting obligations for assessing and managing environmental noise. The END contains several provisions which require Member States (MS) to communicate information to the European Commission (EC) concerning the preparation and publication of strategic noise maps and noise management action plans for:

– All roads, railways, airports, and industrial sites within agglomerations with more than 100.000 inhabitants
– major roads (more than 3 million vehicles a year)
– major railways (more than 30.000 trains a year)
– major airports (more than 50.000 movements a year, including small aircrafts and helicopters).

The main aim of the END is to identify noise pollution levels and to trigger the necessary action both at Member State and at EU level. To pursue its stated aims the END focuses on the determination of exposure to environmental noise, ensuring information on environmental noise and its effects is made available to the public, and preventing and reducing environmental noise where necessary, preserving environmental noise quality where it is good. This Directive applies to noise to which humans are exposed, particularly in built-up areas, in public parks or other quiet areas in an agglomeration, in quiet areas in open country, near schools, hospitals and other noise-sensitive buildings and areas. It does not apply to noise that is caused by the exposed person himself, noise from domestic activities, noise created by neighbours, noise at workplaces or noise inside means of transport or due to military activities in military areas.

The GeoPackage encoding of European Noise Directive data can be used to deliver data that fulfills the following requirements:

- It contains all information required for Noise Reporting
- It contains all necessary information to also derive compliant INSPIRE GML encoded data and thus comply with INSPIRE Implementing Rules

The underlying GeoPackage Encoding Standard has been developed by the Open Geospatial Consortium and is built on SQLite. The current version is 1.3.0 (12-128r17). The GeoPackage Encoding Standard defines the schema for a GeoPackage, including table definitions, integrity assertions, format limitations, and content constraints. The required and supported content of a GeoPackage is entirely defined in the standard.

Note: Some of the work described here re-uses concepts from the INSPIRE UML-to-GeoPackage encoding rule development version[1] and from the INSPIRE Action 2017.2 (Alternative Encodings) Model Transformation Rules[2]. As these works are not formally approved so far, they are not listed as normative references.

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[1] See https://github.com/IAAA-Lab/U2G/blob/master/GeoPackage/geopackage-encoding-rule.md
[2] See https://github.com/INSPIRE-MIF/2017.2/blob/master/model-transformations/TransformationRules.md

Normative References

- Environmental Noise Directive - Data model documentation version 3.0, April 2021[3]
- GeoPackage Encoding Standard version 1.3.0[4]
- INSPIRE Transport Networks Data Specification, v. 4.0[5]
- INSPIRE Area management / restriction / regulation zones & reporting units, v. 4.0[6]
- INSPIRE Human Health and Safety Data Specification, v. 4.0[7]

Conformance Classes

The European Noise Directive reporting mechanism contains three data flows containing spatial information. In addition, there are three other dataflows containing only tabular information. The data flows have been developed to completely fulfil the requirements of the European Noise Directive. For each data flow, a data model has been developed that re-uses concepts and types from the matching INSPIRE data specifications. In each model related to spatial information, there is at least one spatial type that inherits from different INSPIRE feature types. For each of these models, a streamlined view has been developed, which is essentially a simplified INSPIRE model.

The streamlined models are transformed to a GeoPackage logical schema, using different model transformation rules. Thus, this END encoding rule defines different conformance classes per model:

- DF1_5 Noise Sources
    - Major Roads (extends INSPIRE TN-RO RoadLink)
    - Major Railways (extends INSPIRE TN-RA RailwayLink)
    - Major Airports (extends INSPIRE TN-A AerodromeNode)
    - Agglomerations (extends INSPIRE AM ManagementRestrictionOrRegulationZone)
- DF4_8 Strategic noise maps
    - Noise contours for major roads (extends INSPIRE HH EnvHealthDeterminantMeasure) and noise exposure data
    - Noise contours for major railways (extends INSPIRE HH EnvHealthDeterminantMeasure) and noise exposure data
    - Noise contours for major airports (extends INSPIRE HH EnvHealthDeterminantMeasure) and noise exposure data
    - Noise contours in sgglomerations (extends INSPIRE HH EnvHealthDeterminantMeasure) and noise exposure data
- DF7_10
    - Quiet Areas (extends INSPIRE AM ManagementRestrictionOrRegulationZone)

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[3] Currently, the draft END Data Model Documentation is available as internal working document, final version will be published for public.

[4] See http://www.geopackage.org/spec/

[5] See https://inspire.ec.europa.eu/id/document/tg/tn

[6] See https://inspire.ec.europa.eu/id/document/tg/am

[7] See https://inspire.ec.europa.eu/id/document/tg/hh

  o Noise Action Plans (extends INSPIRE AM ManagementRestriction-OrRegulationZone) for noise action plan coverage areas.

A **Core** conformance class describes common rules applied to all conformance classes.

For each conformance class, the input conceptual model is represented as a UML model. The output model is represented using the hale studio schema explorer. Please note that the model transformations, especially using Default Values, can affect the given cardinality.

Specific Model Transformation Rules

To transform the streamlined or full conceptual models to logical GeoPackage schemas, several transformation rules are applied. Some have a general scope and are specified in the INSPIRE Action 2017.2 (Alternative Encodings) Model Transformation Rules, some have been refined in the INSPIRE UML-to-GeoPackage encoding rule, and others have been developed specifically in the scope of the END GeoPackage work, though they might also be applied elsewhere. The specific transformation rules are the following:

- Flatten hierarchical structures and data types with property name length limit
- Deal with INSPIRE voidable attributes
- Set default dataset properties
- Handle code list values and metadata
- Handle attributes with 1:n cardinality
- Handle associations with 1:n and n:m multiplicity
- Handle geometry types and Spatial Reference Systems

The following sections describe the specific transformation rules that are used to create END GeoPackage schemas.

Flatten hierarchical structures with property name limit (MT_ENDGPK01)

This rule is based on the General Flattening rule[8] and the GeoPackage flattening rule[9]. It modifies these rules to optimize data usability in different geographic information system software. In these applications, usability is reduced when property names are long, so this rule applies a maximum length of 31 characters for property names.

To stay within this maximum property name length, this model transformation rule is often combined with:

1. Substitution of complex types through simpler types (Simple Citation, Simple Codelist Reference, Simple Geographical Name, Simplified Localized Character String…)
2. Usage of related tables for elements where the allowed cardinality is greater 1

Voidable attributes to Companion Table (MT_ENDGPK02)

In INSPIRE conceptual models, there are often voidable properties. In END reporting, these will usually not be used and will clutter the primary feature table, resulting in tables where up to two thirds of all columns are always empty. However, to have a constant schema and to have compatibility with the INSPIRE conceptual model, this rule introduces a companion table to the actual primary feature table where these properties can be stored if required for a particular

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[8] See https://github.com/INSPIRE-MIF/2017.2/blob/master/model-transformations/GeneralFlattening.md

[9] See https://github.com/IAAA-Lab/U2G/blob/master/GeoPackage/geopackage-encoding-rule.md#flattening-of-nested-structures

data set. This enables END GeoPackages to be used as an "Alternative Encoding" for all related data sets.

While the rule "*Dataset Default values to Dataset Default Properties Table (MT-ENDGPK03)*" handles values of such properties that are constant across the whole data set, this rule (MT_ENDGPK02) handles properties that may differ from feature to feature, such as `beginLifespanVersion` and other lifecycle information.

As a general rule, the companion table is always named like the primary feature table, with a `Voidables` postfix, e.g. `MajorRoadSourceVoidables`. In the companion table, a foreign key attribute with the name `<PrimaryTablename>_id` is introduced to ensure that complete objects can be formed via a join or view.

Table 1 provides an example for both the primary table and the companion table:

Table 1: Primary table and companion table

MajorRoadSource		
id	roadId	roadNationalCode
1	AT_1	A1
2	AT_2	A2
3	AT_3	A21
4	AT_5	A22

MajorRoadSourceVoidables		
id	MajorRoadSource_id	beginLifespan-Version
1	4	null
2	3	1981-10-25
3	1	2002-11-08
4	2	null

Dataset default values to DatasetDefaultProperties Table (MT_ENDGPK03)

In INSPIRE data models, and, by extension, in the END models, there are some properties that have the same value for every object in a data set, such as the `nilReason` attributes, or the `xlink:href` and `xlink:title` attributes for codelist references. In INSPIRE conceptual models, voidable properties, that usually have a minimum cardinality of 1, can be left empty if a void reason is given. In all data sets encountered so far, these void reasons (encoded as a `nilReason` attribute on the element) have been constant over the whole data set.

Such attributes or regular properties may be encoded into a `DatasetDefaultProperties` table and are removed from the primary feature table. This results in a streamlined GeoPackage primary feature table structure. In some cases, the property may also be retained in the table, so that value for single features that are different from the default could be provided.

By default, this transformation rule is applied to `nilReason` attributes of voidable properties. In addition, each conformance class may select additional properties or attributes to factor out into the `DatasetDefaultProperties` table.

In contrast to the approach taken by the INSPIRE UML-to-GeoPackage encoding rule, where `nilReason` values are stored in the standard `gpkg_metadata` table[10], this transformation rule stores them in a data table called `DatasetDefaultProperties`. This approach was taken since the `gpkg_metadata` table is usually not directly accessible by GIS users.

The structure of the table `DatasetDefaultProperties` is as follows (Table 2):

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[10] See https://github.com/IAAA-Lab/U2G/blob/master/GeoPackage/geopackage-encoding-rule.md#voidable

Table 2: DatasetDefaultProperties

tableName	propertyName	attribute	defaultValue
MajorRoadSource	beginLifespanVersion	nilReason	http://inspire.ec.europa.eu/codelist/VoidReasonValue/Unpopulated

The parameters with which this model transformation function is called are defined as follows:

- `tableName`: Mandatory parameter, must have the name of the table from which the default value for the property has been factored out. The value of `tableName` will be stored in the column `tableName`.
- `propertyName`: Mandatory parameter, must have the name of the property for the default value is given. The value of `propertyName` will be stored in the column `propertyName`.
- `attribute`: Optional parameter that gives the name of an attribute of the property for which a default value is given. It can be used to indicate that the default given is provided for an attribute on the property, such as `codeList` or `nilReason`. If an attribute name is given, the default value applies only to that attribute, not to the property. The value of `attribute` will be stored in the column `attribute`.
- `defaultValue`: Mandatory parameter, gives the actual default value for the `property` or `attribute`. Note that his value may be mapped to a code list title via the rule "*Handle code list values and metadata (MT-ENDGPK04)*" described below. The value of `defaultValue` will be stored in the column `defaultValue`.
- `retainProperty`: Optional parameter, if set to `true`, indicates that while a default property is set, the column is retained in the output schema so that reporters can override the default value for single features. Default is `false`. This value is not persisted in the table.

Handle code list values and metadata (MT_ENDGPK04)

In INSPIRE GML, code list values are encoded as `xlinks` that point to a fully qualified URL. Since these URLs contain special characters and are quite long, they are often harder to interpret, to use as labels and to use as filters for symbology. As a result, we use a specific model transformation rule:

1. Change the type of the property to string
2. In that string, write the code list value
3. In an extra table called `CodelistProperties`, store a mapping of the table and property to the fully qualified URL of the code list.

The structure of this `CodelistProperties` table is as follows (Table 3):

Table 3: CodelistProperties

tableName	propertyName	codelist
MajorRoadSource	class	http://inspire....eu/enumeration/FunctionalRoadClassValue

This table thus stores both the uniquely identifying URL of the code list and links properties to code lists. This could later be exploited to generate a fully compliant INSPIRE GML data set, but also for validation and editing purposes (Table 4).

Table 4: Example – primary table and CodelistProperties table

MajorRoadSource	CodelistProperties		
class	**tableName**	**propertyName**	**codelist**
firstClass	MajorRoadSource	class	http://inspire.ec.europa.eu/enumeration/FunctionalRoadClassValue

Handle composition attributes with multiplicity 1:n (MT_ENDGPK05)

In INSPIRE, many attributes of a feature type can have more than one value. This is used both to represent associations and composition relationships in the conceptual model, but often presents a challenge in other encodings than GML.

As GeoPackages can contain many tables with foreign key relationships, such compositions and associations are handled by introducing related tables. This is only done when a property type is complex and when the maximum multiplicity of the property is > 1.

The relationship is established using the standard ID column of Geopackage as the primary key, and a column named `<PrimaryTablename>_id` in the related table. An example for such a table will look like this (for the data type `DirectedLink` from INSPIRE TN specification) (Table 5):

Table 5: Relationship - attributes with multiplicity 1:n

id	MajorRoadSource_id	beginLifespanVersion	validFrom
1042	7525	2020-03-27T01:00:00Z	2020-03-27T01:00:00Z

For concrete conformance classes, modelers should pay attention that the nesting depth does not exceed 3 by using simple type substitution and other rules in conjunction with this rule.

Note: The general UML-To-Geopackage specification does not have a general rule for this case, but states that "If a property has a cardinality greater than 1, a suitable mapping needs to be found on a case-by-case basis."[11]

Handle associations with a multiplicity of n:m (MT_ENDGPK06)

In INSPIRE, features can have a many-to-many relationship. Such relationships can be represented in GeoPackage using a relationship table. In a relationship table, there is a primary key, as well as two foreign keys. As in the composition case, the foreign key columns are named `<PrimaryTablename>_id` in the related table.

Compared to the general UML-to-Geopackage approach, this rule does not require the GeoPackage Related Tables extensions but may add it at a later point when clients support it fully.

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[11] See https://github.com/IAAA-Lab/U2G/blob/master/GeoPackage/geopackage-encoding-rule.md#properties

As there is no example for this in the END schemas for spatial data, we will use a generic INSPIRE example – the relation between `AdministrativeUnit` to `AdministrativeBoundary`) (Table 6):

Table 6: Relationship - multiplicity of n:m

ID	AdministrativeUnit_id	AdministrativeBoundary_id
1943	34543	4634

Such tables are named according to the types in the relationship, ordered alphabetically: `Relation_AdministrativeBoundary_AdministrativeUnit`.

Note: the current version of the END templates does not apply this rule. The rule is included to provide a complete set of general rules, and it could be useful for future versions or other data models.

Handle geometry types and Spatial Reference Systems

ISO 19107 Geometry types are mapped to GeoPackage geometry types as described in the general UML-to-GeoPackage encoding rule[12].

Spatial reference system information is stored as described in the general UML-to-GeoPackage encoding rule[13].

For END reported data, the usage of any spatial reference system allowed by the INSPIRE data specifications that have been extended is permissible. These data specifications define the following spatial reference systems (SRS) that are recognised in GeoPackage (Table 7):

Table 7 Coordinate reference systems in geoPackage

EPSG Code	Name	Notes
EPSG:3034	ETRS89-LCC	Limited support in QGIS 3.12 due to a bug in GDAL < 3.1; fixed in QGIS 3.16
EPSG:3035	ETRS89 / ETRS-LAEA	Limited support in QGIS 3.12 due to a bug in GDAL < 3.1; fixed in QGIS 3.16
EPSG:3038+	ETRS89-TM26N to ETRS89-TM39N	Limited support in QGIS 3.12 due to a bug in GDAL < 3.1; fixed in QGIS 3.16
EPSG:4258	ETRS89	
EPSG:4326	WGS 84	

The SRS known as WGS84 Web Mercator / Pseudo-Mercator (EPSG:3857) is also supported by GeoPackage and the clients but is not listed as an INSPIRE compliant SRS.

In case of the END reporting data flows, the European ETRS89 Lambert Azimuthal Equal Area coordinate reference system (ETRS89 / ETRS-LAEA, EPSG:3035) is recommended to be used for spatial data.

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[12] See https://github.com/IAAA-Lab/U2G/blob/master/GeoPackage/geopackage-encoding-rule.md#iso-19107---geometry-types

[13] See https://github.com/IAAA-Lab/U2G/blob/master/GeoPackage/geopackage-encoding-rule.md#coordinate-reference-systems

Conformance Class END DF1_5 Agglomerations

This section describes the transformation rules and its parameters applied to the Agglomerations conceptual model, which is based on the application schema INSPIRE Area Management Restriction and Regulation Zones.

Input Model

The conceptual model depicted below (Figure 1) is a streamlined version of a model that extends the INSPIRE feature type `ManagementRestrictionOrRegulationZone`.

Figure 1: Data model END DF1_5 Agglomerations
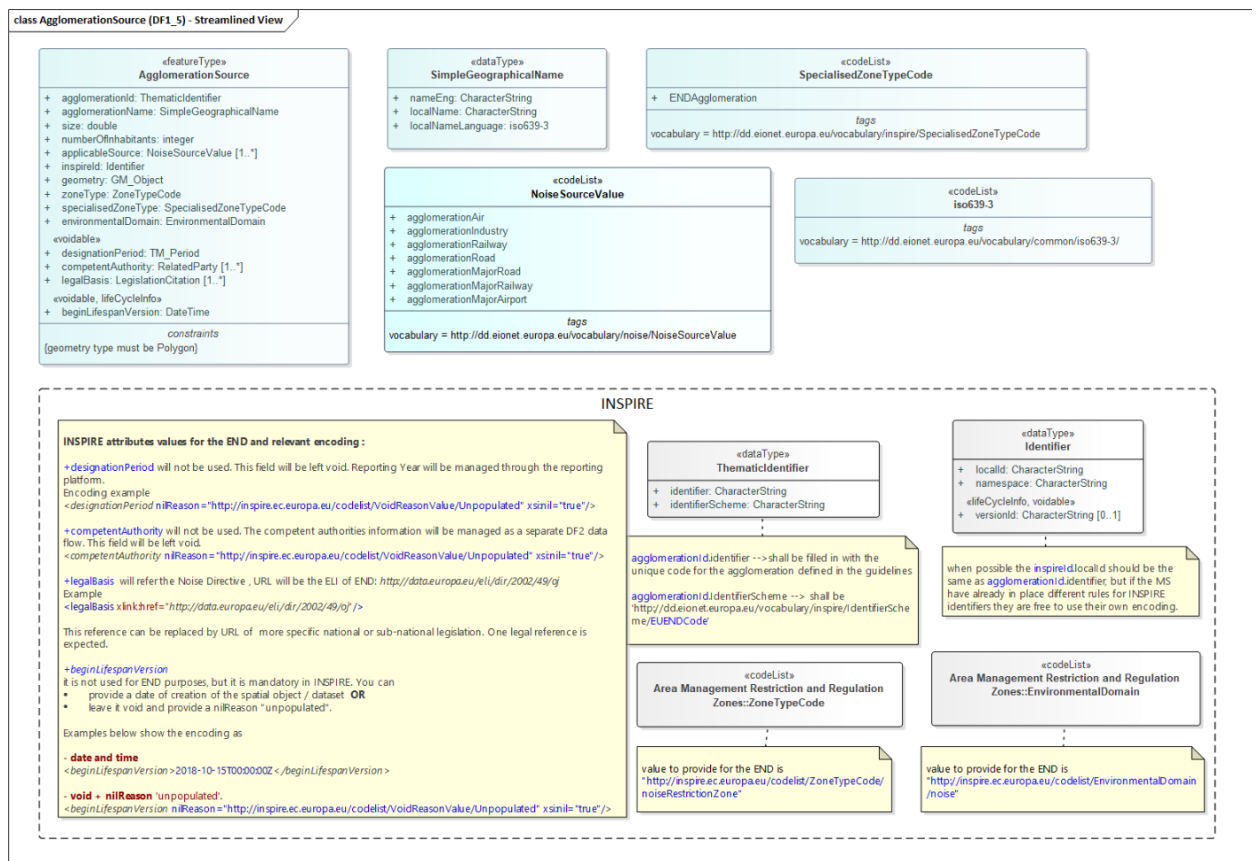
Model Transformation

The following rules are applied to the input model in this order:
1. Apply the "Flattening of hierarchical structures" rule as follows:
    a. `MT_ENDGPK01(table: AgglomerationSource, property: inspireId, separator: '_');`
    b. `MT_ENDGPK01(table: AgglomerationSource, property: agglomerationId, separator: '_');`
    c. `MT_ENDGPK01(table: AgglomerationSource, property: agglomerationName, separator: '_');`
    d. `MT_ENDGPK01(table: AgglomerationSource, property: designationPeriod, separator: '_');`
    e. `MT_ENDGPK01(table: AgglomerationSource, property: competentAuthority, separator: '_');`
    f. `MT_ENDGPK01(table: AgglomerationSource, property: legalBasis, separator: '_');`

2. Apply the "Dataset Default values" rule as follows:

a. MT_ENDGPK03(table: AgglomerationSource, property: agglomerationId_identifierScheme, defaultValue: null, http://dd.eionet.europa.eu/vocabulary/inspire/IdentifierScheme/EUENDCode);

b. MT_ENDGPK03(table: AgglomerationSource, property: zoneType, property: href, defaultValue: http://inspire.ec.europa.eu/codelist/ZoneTypeCode/noiseRestrictionZone);

c. MT_ENDGPK03(table: AgglomerationSource, property: specialisedZoneType, property: href, defaultValue: http://dd.eionet.europa.eu/vocabulary/inspire/SpecialisedZoneTypeCode/ENDAgglomeration);

d. MT_ENDGPK03(table: AgglomerationSource, property: environmentalDomain, property: href", defaultValue:http://inspire.ec.europa.eu/codelist/EnvironmentalDomain/noise);

e. MT_ENDGPK03(table: AgglomerationSource, property: designationPeriod","nilReason, defaultValue: http://inspire.ec.europa.eu/codelist/VoidReasonValue/Unpopulated);

f. MT_ENDGPK03(table: AgglomerationSource, property: competentAuthority, property: nilReason, defaultValue: http://inspire.ec.europa.eu/codelist/VoidReasonValue/Unpopulated);

g. MT_ENDGPK03(table: AgglomerationSource, property: legalBasis_link, property: href, defaultValue: http://data.europa.eu/eli/dir/2002/49/oj);

h. MT_ENDGPK03(table: AgglomerationSource, property: legalBasis_level, property: href, defaultValue: http://inspire.ec.europa.eu/codelist/LegislationLevelValue/european);

i. MT_ENDGPK03(table: AgglomerationSource, property: beginLifespanVersion, property: nilReason, defaultValue: http://inspire.ec.europa.eu/codelist/VoidReasonValue/Unpopulated);

3. Apply the "Extract Primitive Array" as follows:

a. MT002(table: AgglomerationSource, property: **applicableSource**, separator: ';)

4. Apply the "Voidable attributes to Companion Table" rule as follows:

a. MT_ENDGPK02(table: AgglomerationSource, properties: [competentAuthority_contact, competentAuthority_indivName, competentAuthority_orgName, competentAuthority_posName, competentAuthority_role, designationPeriod_beginPosition, designationPeriod_endPosition, legalBasis_level, legalBasis_link, beginLifespanVersion]);

Resulting Model

The following image (Figure 2) shows the resulting model for Agglomeration Sources. Please note that the common tables (CodelistProperties, DatasetDefaultProperties) are not repeated for each geoPackage model.

**Figure 2: Model for END DF1_5 Agglomerations geoPackage**
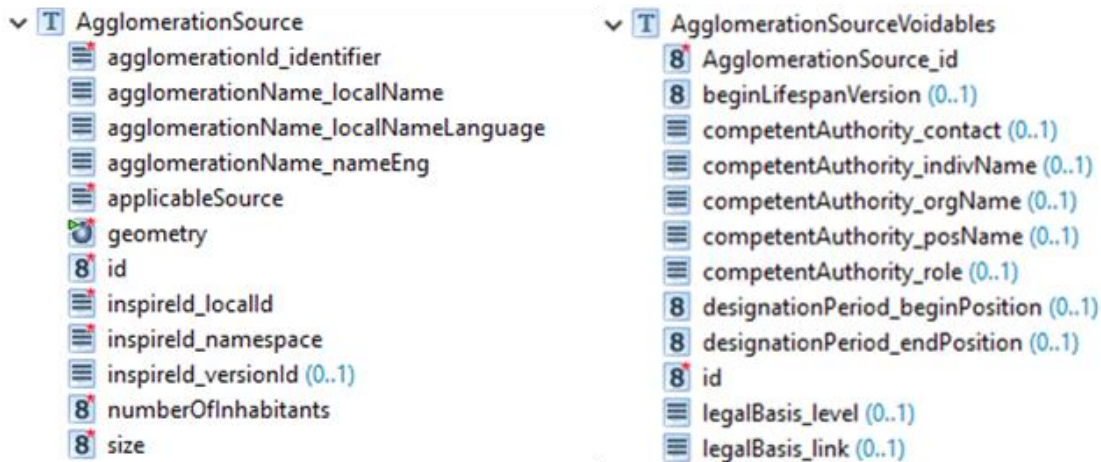
Conformance Class DF1_5 Major Airport Sources

This section describes which transformation rules with which parameters are applied to the Major Airport Source specific conceptual model.

Input Model

In this specific streamlined model (Figure 3), similarity to the corresponding INSPIRE feature type AerodromeNode is in properties geometry and airport ICAO code, additional END specific properties are added, and some substitutions have already been applied (such as for `airportName`).

Figure 3: Data model END DF1_5 Major airports
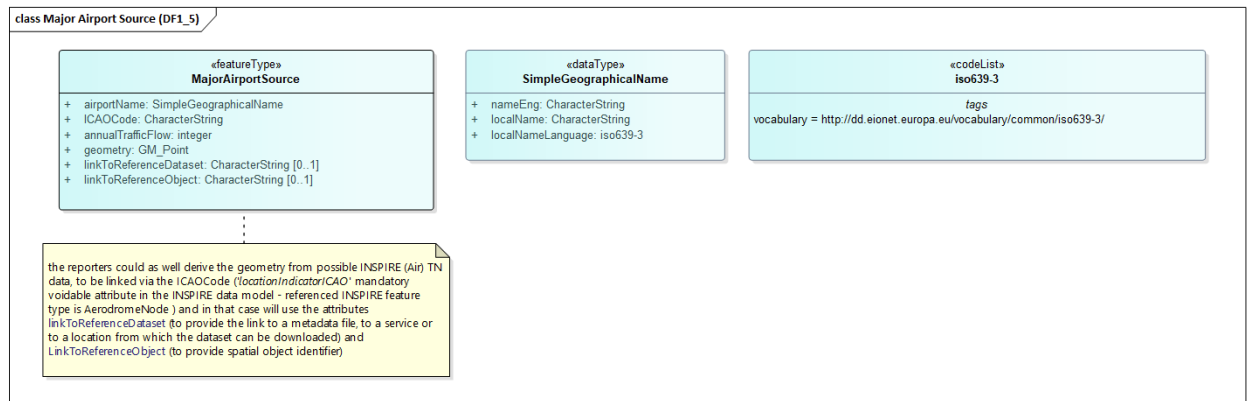
Model Transformation

The following rules are applied in this order:

1. Apply the "Flattening of hierarchical structures" rule as follows:
   ```
   MT_ENDGPK01(table: MajorAirportSource, property: airportName,
   separator: '_');
   ```

Resulting Model

The following image (Figure 4) shows the resulting model for Major Airport Sources. Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 4: Model for END DF1_5 Major airports geoPackage
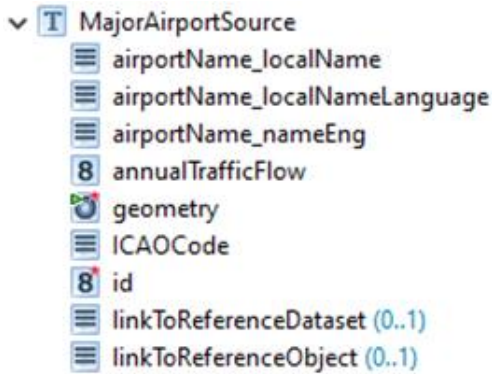
Conformance Class DF1_5 Major Railway Sources

This section describes which transformation rules with which parameters are applied to the Major Railway Sources conceptual model.

Input Model

The input model is a streamlined version of the full conceptual model, which extends the INSPIRE `RailwayLink` feature type (Figure 5).). Pptional properties have been left out, and some substitutions have already been applied (such as for railName).

Figure 5 Data model END DF1_5 Major railways
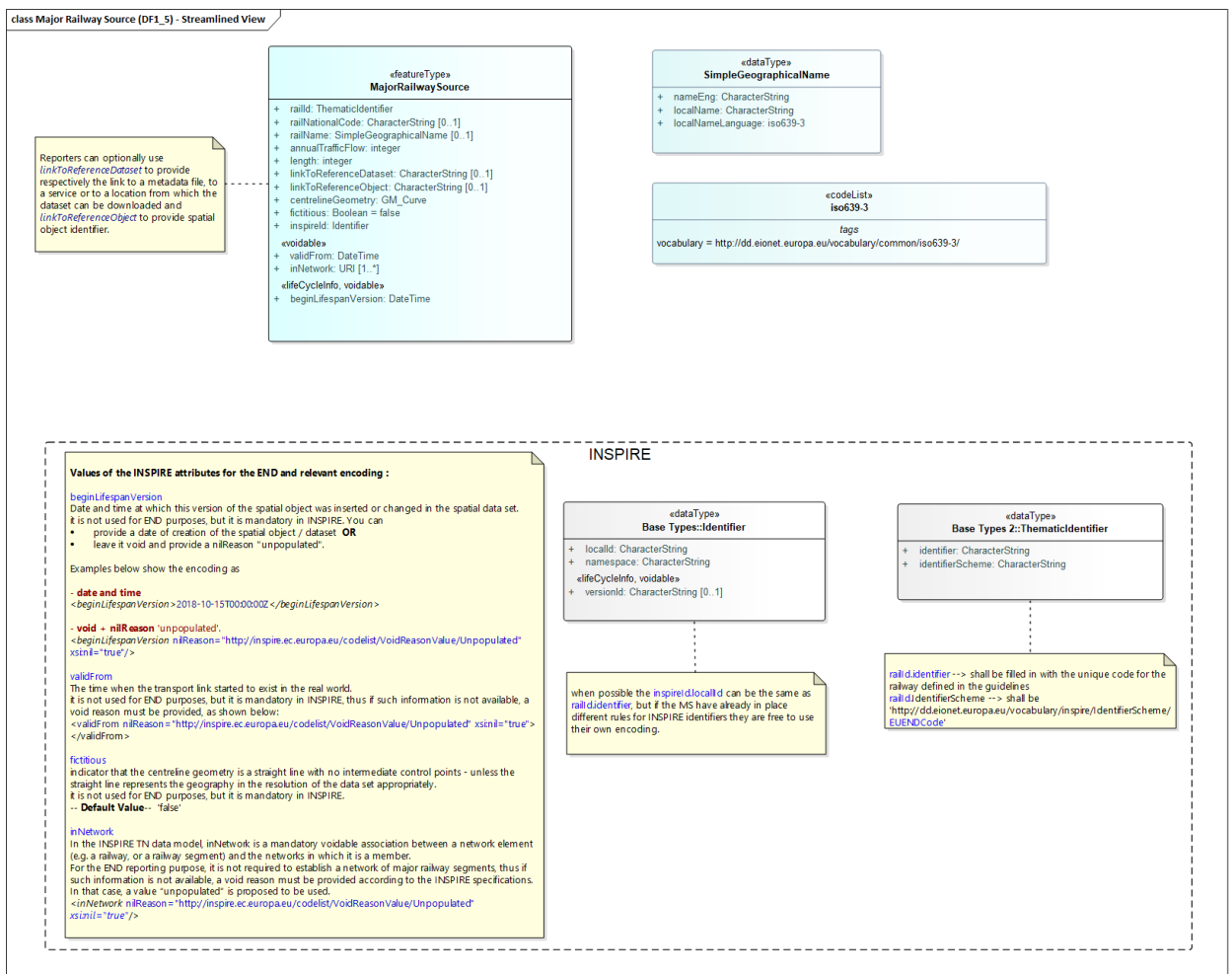
Model Transformation

The following rules are applied in this order:

2. Apply the "Flattening of hierarchical structures" rule as follows:
   a. `MT_ENDGPK01(table: MajorRailwaySource, property: inspireId, separator: '_');`
   b. `MT_ENDGPK01(table: MajorRailwaySource, property: railId, separator: '_');`
   c. `MT_ENDGPK01(table: MajorRailwaySource, property: railName, separator: '_');`

3. Apply the "Dataset Default values" rule as follows:
   a. `MT_ENDGPK03(table: MajorRailwaySource, property: inNetwork, attribute: nilReason, defaultValue: …/Unpopulated);`
   b. `MT_ENDGPK03(table: MajorRailwaySource, property: validFrom, attribute: nilReason, defaultValue: …/Unpopulated);`
   c. `MT_ENDGPK03(table: MajorRailwaySource, property: beginLifespanVersion, attribute: nilReason, defaultValue: …/Unpopulated);`
   d. `MT_ENDGPK03(table: MajorRailwaySource, property: railId_identifierScheme, attribute: href, defaultValue: http://dd.eionet.europa.eu/vocabulary/inspire/IdentifierScheme/EUENDCode);`
   e. `MT_ENDGPK03(table: MajorRailwaySource, property: fictitious, attribute: null, defaultValue: false);`

4. Apply the "Voidable attributes to Companion Table" rule as follows:
   a. `MT_ENDGPK02(table: MajorRailwaySource, properties: [validFrom, inNetwork, beginLifespanVersion]);`

Resulting Model

The following image (Figure 6) shows the resulting model for Major Railway Sources. Please note that the common tables (`CodelistProperties`, `DefaultDatasetProperties`) are not repeated for each geoPackage model.

**Figure 6: Model for END DF1_5 Major railways geoPackage**
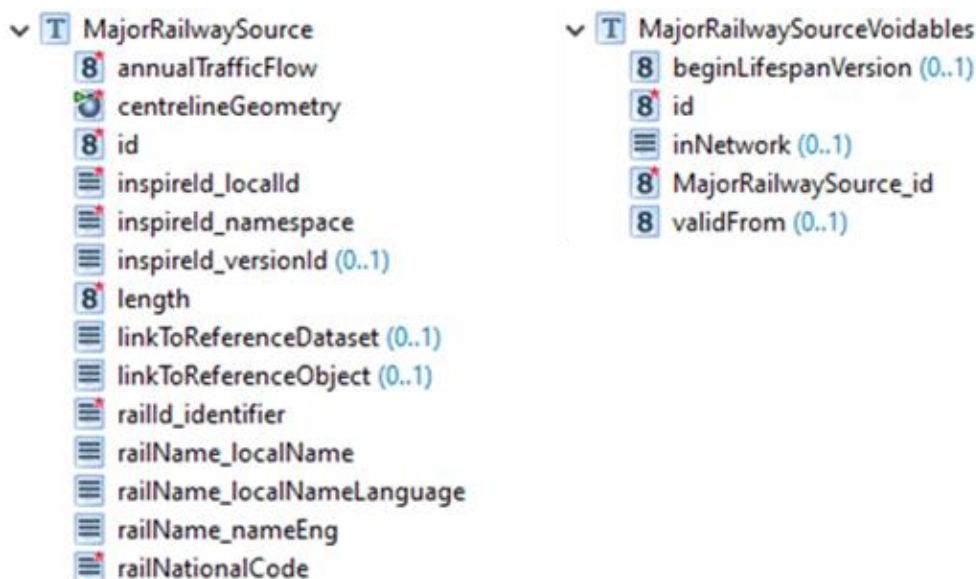
Conformance Class DF1_5 Major Road Sources

This section describes which transformation rules with which parameters are applied to the Major Road Sources streamlined conceptual model.

Input Model

The input model is a streamlined version (Figure 7) of the full conceptual model, which extends the INSPIRE `RoadLink` feature type, optional properties have been left out, and some substitutions have already been applied (such as for `roadName`).

Figure 7: Data model END DF1_5 Major roads
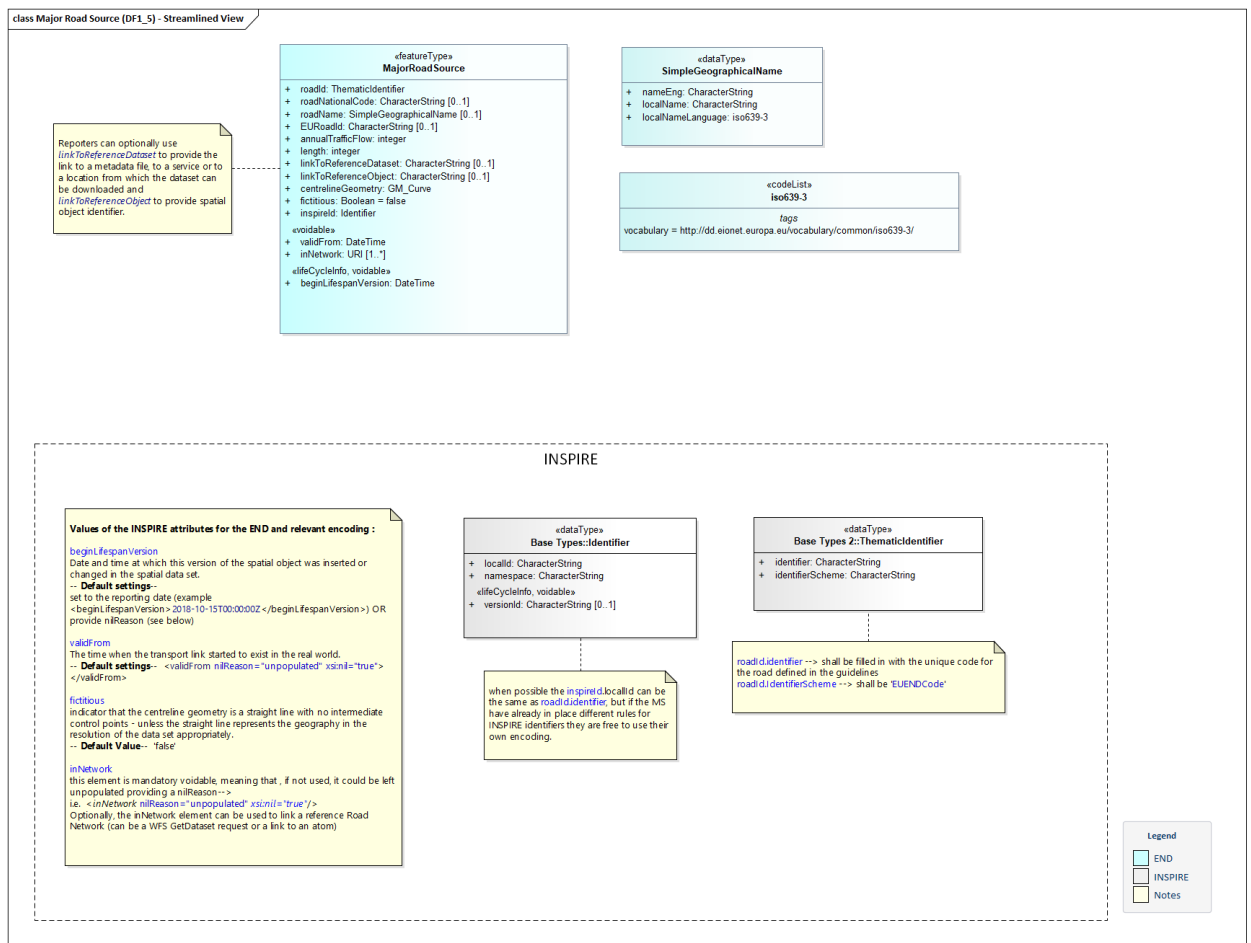
Model Transformation

The following rules are applied in this order:

1. Apply the "Flattening of hierarchical structures" rule as follows:
   a. `MT_ENDGPK01(table: MajorRoadSource, property: inspireId, separator: '_');`
   b. `MT_ENDGPK01(table: MajorRoadSource, property: roadId, separator: '_');`
   c. `MT_ENDGPK01(table: MajorRoadSource, property: roadName, separator: '_');`
2. Apply the "Dataset Default values" rule as follows:
   a. `MT_ENDGPK03(table: MajorRoadSource, property: inNetwork, attribute: nilReason, defaultValue: …/Unpopulated);`

    b. `MT_ENDGPK03(table: MajorRoadSource, property: validFrom, attribute: nilReason, defaultValue: …/Unpopulated);`

    c. `MT_ENDGPK03(table: MajorRoadSource, property: beginLifespanVersion, attribute: nilReason, defaultValue: …/Unpopulated);`

    d. `MT_ENDGPK03(table: MajorRoadSource, property: roadId_identifierScheme, attribute: href, defaultValue: http://dd.eionet.europa.eu/vocabulary/inspire/IdentifierScheme/EUENDCode);`

    e. `MT_ENDGPK03(table: MajorRoadSource, property: fictitious, attribute: null, defaultValue: false);`

3. Apply the "Voidable attributes to Companion Table" rule as follows:

    a. `MT_ENDGPK02(table: MajorRoadSource, properties: [validFrom, inNetwork, beginLifespanVersion]);`

Resulting Model

The following image (Figure 8) shows the resulting model for Major Road Sources. Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 8: Model for END DF1_5 Major roads geoPackage
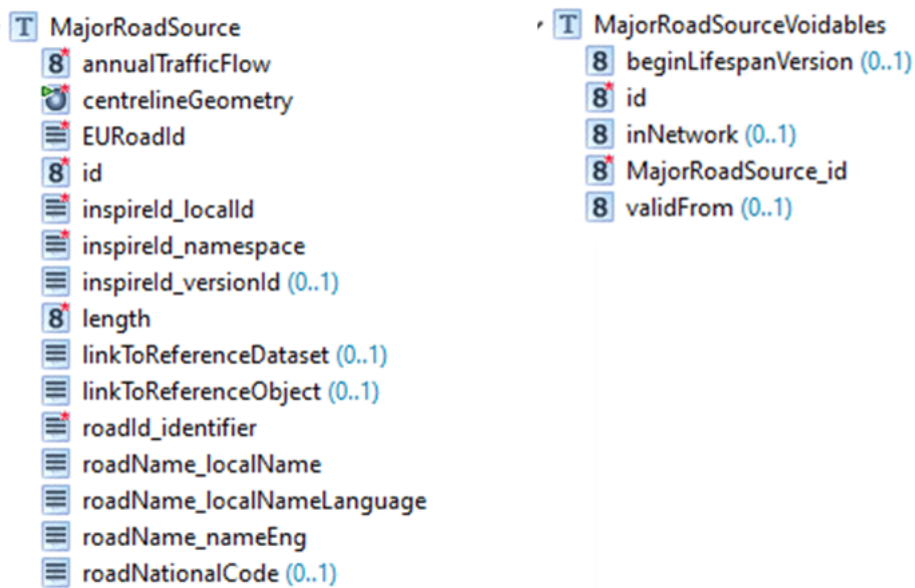
Conformance Class DF4_8 Strategic Noise Maps - Noise Contours

All models in the DF4_8 Conformance Classes use a single spatial type from the Human Health and Safety INSPIRE theme. To include categorical information such as noise level bands, this type (`EnvHealthDeterminantMeasure`) has been amended in the INSPIRE change request[14]. For the END reporting purpose, the noise contours are results of modelled data that can be provided as polygons with related noise dB range values, or as lines with indicated single noise dB values.

Input Model

Figure 9 shows the input model for DF4_8 Strategic noise maps – noise contours.

Figure 9: Data model END DF4_8 Strategic noise maps – noise contours
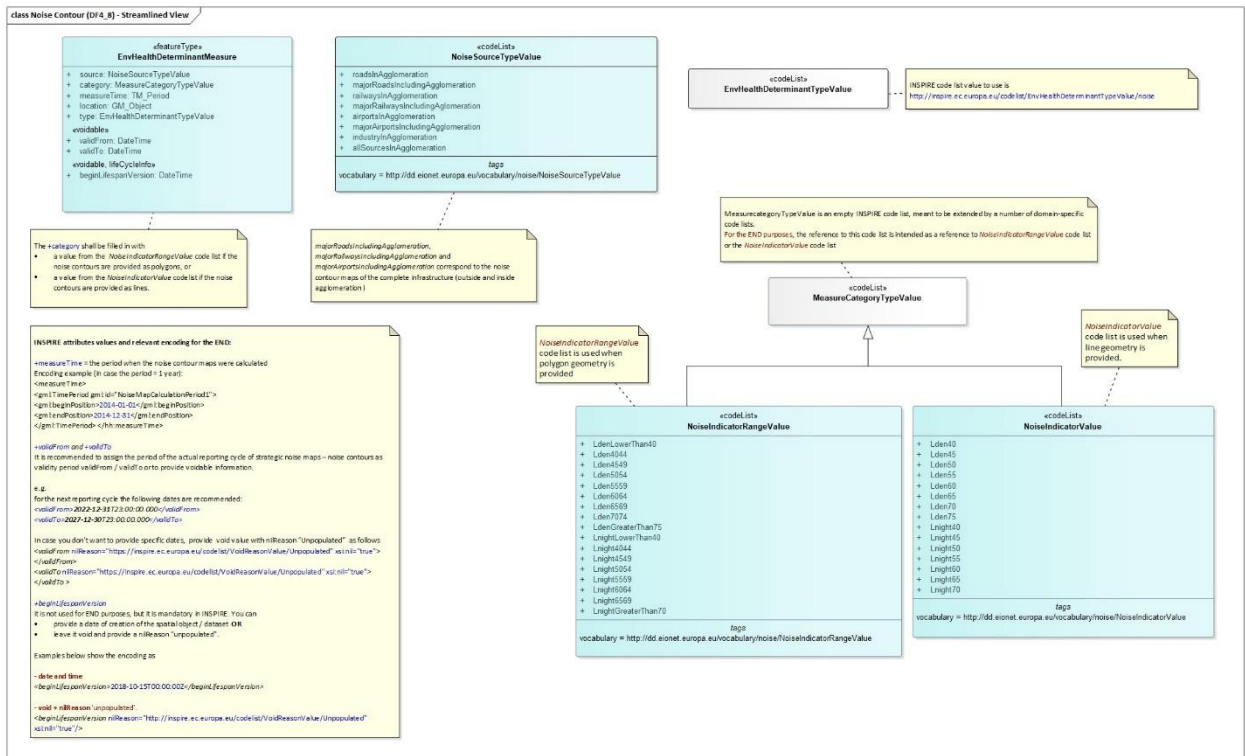
Model Transformation

The following rules are applied in this order:
1. Apply the "Flattening of hierarchical structures" rule as follows:
   a. MT_ENDGPK01(table: EnvHealthDeterminantMeasure, property: **measureTime**, separator: '_');
2. Apply the "Dataset Default values" rule as follows:
   a. MT_ENDGPK03(table: EnvHealthDeterminantMeasure, property: **type**, attribute: href, defaultValue: http://inspire.ec.europa.eu/codelist/EnvHealthDeterminantT

---

[14] See http://www.epsilon-italia.it/public/2019.07.02.Change_Proposal_HH.schema.v1.0.docx . Change proposals of the INSPIRE application schemas (UML and XSD) are governed by the common procedure and documented in the INSPIRE MIF GitHub repository. The change proposal for the INSPIRE HH is published at: https://github.com/INSPIRE-MIF/application-schemas/issues/6.

```
ype
Value/noise);
```

    b. `MT_ENDGPK03(table: EnvHealthDeterminantMeasure, property:` **`measureTime_beginPosition`**`, attribute: null,` `defaultValue: 2021-01-01T01:00:00Z);`

    c. `MT_ENDGPK03(table: EnvHealthDeterminantMeasure, property:` **`measureTime_endPosition`**`, attribute: null,` `defaultValue: 2021-12-31T23:00:00Z);`

    d. `MT_ENDGPK03(table: EnvHealthDeterminantMeasure, property:` **`validFrom`**`, attribute: null, defaultValue: 2022-12-` `31T01:00:00Z);`

    e. `MT_ENDGPK03(table: EnvHealthDeterminantMeasure, property:` **`validTo`**`, attribute: null, defaultValue: 2027-12-` `30T23:00:00Z);`

    f. `MT_ENDGPK03(table: EnvHealthDeterminantMeasure, property:` **`beginLifespanVersion`**`, attribute: nilReason, defaultValue:` `…//Unpopulated");`

3. Apply the "Voidable attributes to Companion Table" rule as follows:

    a. `MT_ENDGPK02(table: EnvHealthDeterminantMeasure,` `properties: [validFrom, validTo, beginLifespanVersion]);`

Furthermore, when used in the context of the END DF4_8 geoPackage templates, the primary table corresponding to the noise contour maps is renamed and copies are created for each applicable noise source (see code list `NoiseSourceTypeValue`, Figure 9), as well as for noise indicators L_{den} and L_{night}, resulting into several primary tables. This approach is specific to END reporting and data processing mechanisms and should not be seen as a general model transformation rule. In this case, we use a common `Voidables` table for all primary tables.

Resulting Model

The following figure (Figure 10) shows an example of a model applied to the Strategic noise maps – noise contours in agglomerations data flow.

Note that while the table created from `EnvHealthDeterminantMeasure` is called `NoiseContours_roadsInAgglomeration_Lnight`, the `Voidables` table is just called like that. Please note that the common tables (`CodelistProperties`, `Dataset-DefaultProperties`) are not repeated for each GeoPackage model.

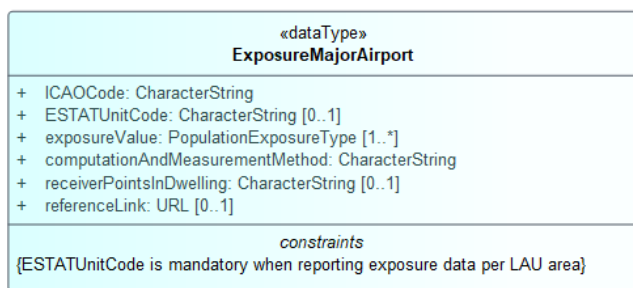**Figure 10: Model for END DF4_8 Noise contours in agglomerations geoPackage**

Figure 11: Example – Noise contours for agglomerations - primary tables and Voidables table in geoPackage (QGIS)

Voidables
- ☑ 🟪 *NoiseContours_roadsInAgglomeration_Lnight*
- ☑ 🟧 *NoiseContours_roadsInAgglomeration_Lden*
- ☑ 🟥 *NoiseContours_railwaysInAgglomeration_Lnight*
- ☑ 🟧 *NoiseContours_railwaysInAgglomeration_Lden*
- ☑ 🟪 *NoiseContours_industryInAgglomeration_Lnight*
- ☑ 🟪 *NoiseContours_industryInAgglomeration_Lden*
- ☑ 🟪 *NoiseContours_allSourcesInAgglomeration_Lnight*
- ☑ 🟩 *NoiseContours_allSourcesInAgglomeration_Lden*
- ☑ 🟨 *NoiseContours_airportsInAgglomeration_Lnight*
- ☑ 🟫 *NoiseContours_airportsInAgglomeration_Lden*

Conformance Class DF4_8 Strategic Noise Maps - Noise Exposure Agglomerations

Input Model

Error! Reference source not found. shows the input model for DF4_8 Strategic noise maps – noise exposure in agglomerations.

Figure 12: Data model END DF4_8 Strategic noise maps – noise exposure - agglomerations
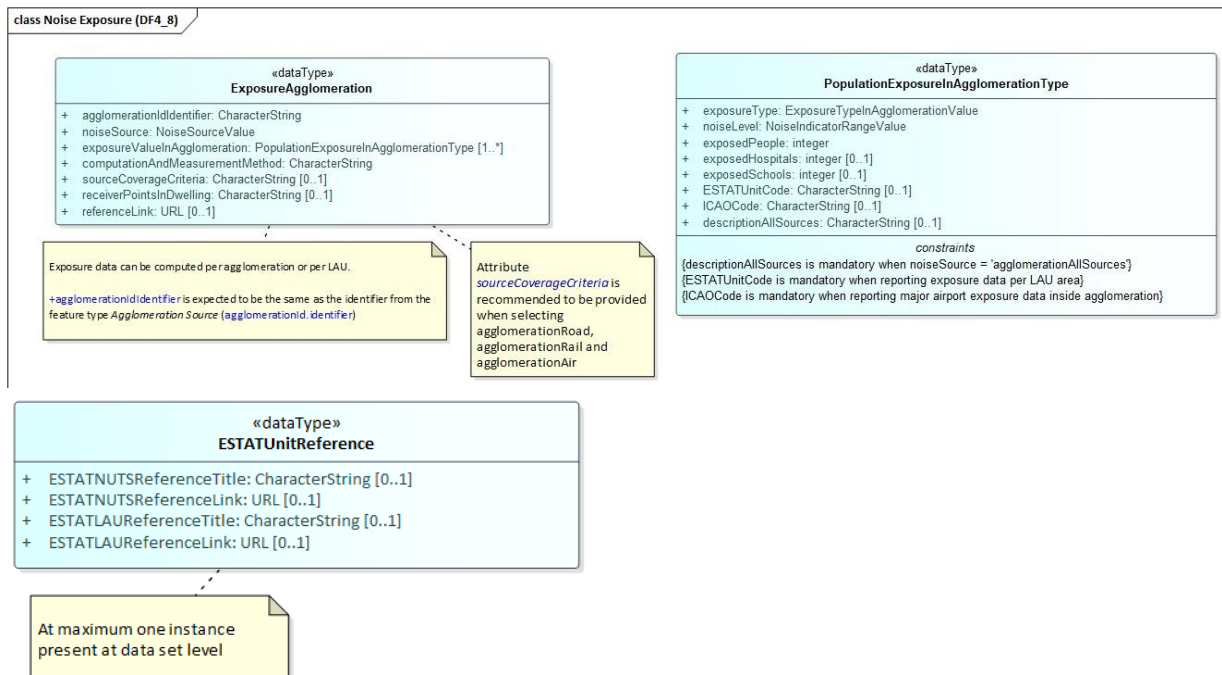
Note: there is an additional relevant type in the model called `ESTATUnitReference`*. This table is transformed to GeoPackage without any model transformations. No technical foreign key relationship is established; instead, the relationship is built on the domain key property* `ESTATUnitCode` (if provided) *in* `ExposureValueInAgglomeration`*.*

Model Transformation

The following rules are applied in this order:

1. Apply the "Handle composition attributes with multiplicity 1:n" rule as follows:
   a. MT_ENDGPK05(mainTable: ExposureAgglomeration, mainProperty: exposureValueInAgglomeration, subTableName: PopulationExposureInAgglomeration)
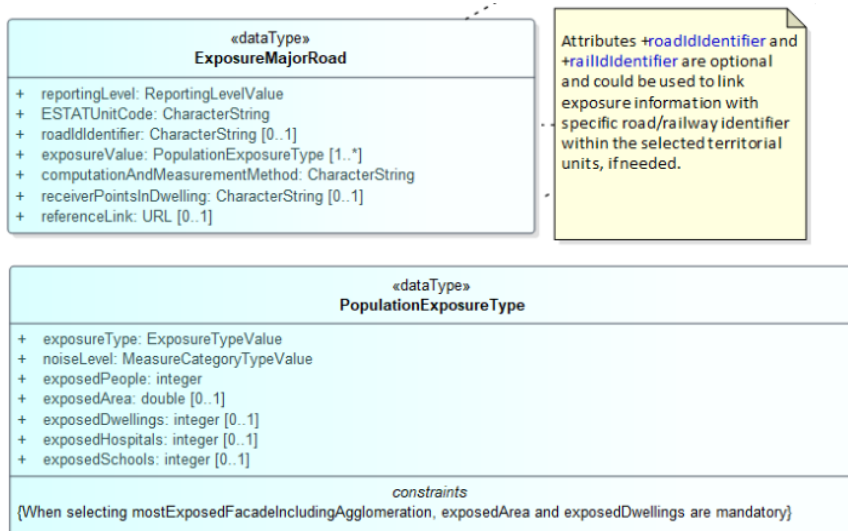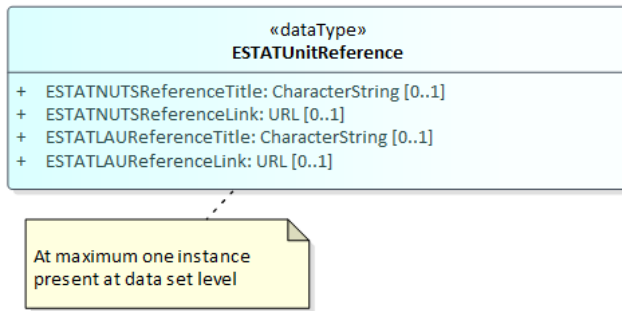
Resulting Model

The following image (**Error! Reference source not found.**) shows the resulting model for Strategic noise maps – noise exposure in agglomerations.

Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 13: Model for END DF4_8 Noise exposure in agglomerations geoPackage
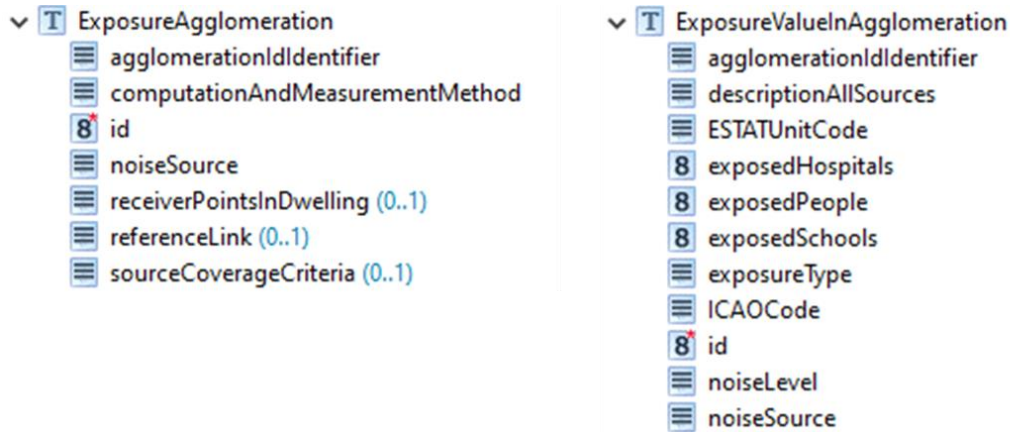
Conformance Class DF4_8 Strategic Noise Maps - Noise Exposure Major Airports

Input Model

Error! Reference source not found. shows the input model for DF4_8 Strategic noise maps – noise exposure due to major airports.

Figure 14: Data model END DF4_8 Strategic noise maps – noise exposure – major airports

«dataType»
PopulationExposureType

+ exposureType: ExposureTypeValue
+ noiseLevel: MeasureCategoryTypeValue
+ exposedPeople: integer
+ exposedArea: double [0..1]
+ exposedDwellings: integer [0..1]
+ exposedHospitals: integer [0..1]
+ exposedSchools: integer [0..1]

constraints
{When selecting mostExposedFacadeIncludingAgglomeration, exposedArea and exposedDwellings are mandatory}

«dataType»
ESTATUnitReference

+ ESTATNUTSReferenceTitle: CharacterString [0..1]
+ ESTATNUTSReferenceLink: URL [0..1]
+ ESTATLAUReferenceTitle: CharacterString [0..1]
+ ESTATLAUReferenceLink: URL [0..1]
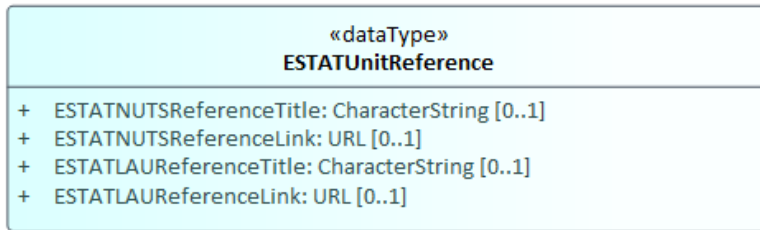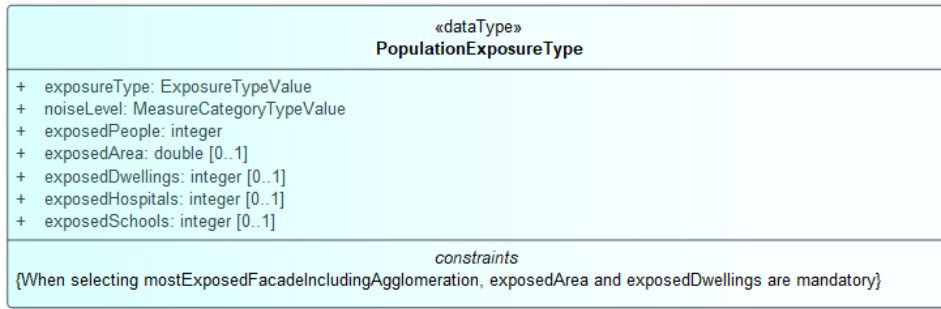
At maximum one instance
present at data set level

Note: There is an additional relevant type in the model called `ESTATUnitReference`. *This table is transformed to GeoPackage without any model transformations. No technical foreign key relationship is established; instead, the relationship is built on the domain key property* `ESTATUnitCode` *(if provided) in* `ExposureMajorAirport`.

Model Transformation

The following rules are applied in this order:

1. Apply the "Handle composition attributes with multiplicity 1:n" rule as follows:

    ```
    a. MT_ENDGPK05(mainTable: ExposureMajorAirport, mainProperty:
       exposureValue, subTableName: PopulationExposure)
    ```

Resulting Model

The following image (**Error! Reference source not found.**) shows the resulting model for Strategic noise maps – noise exposure due to major airports.

Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 15: Model for END DF4_8 Noise exposure major airports geoPackage
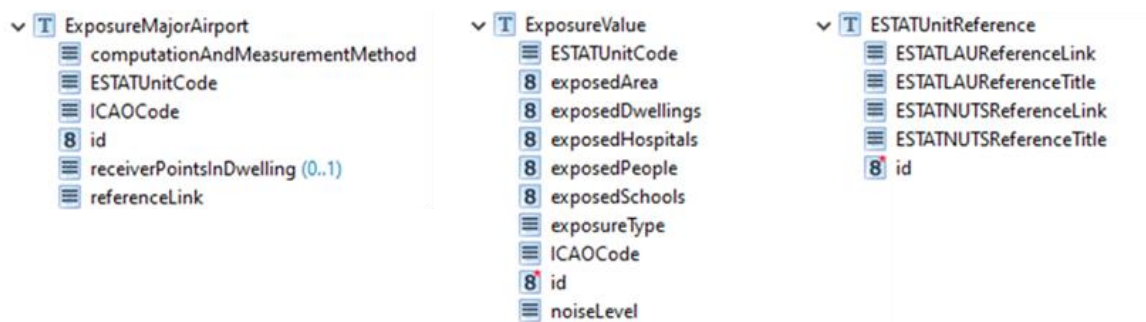
Conformance Class DF4_8 Strategic Noise Maps - Noise Exposure Major Railways

Input Model

Error! Reference source not found. shows the input model for DF4_8 Strategic noise maps – noise exposure due to major railways.

Figure 16: Data model END DF4_8 Strategic noise maps – noise exposure – major railways
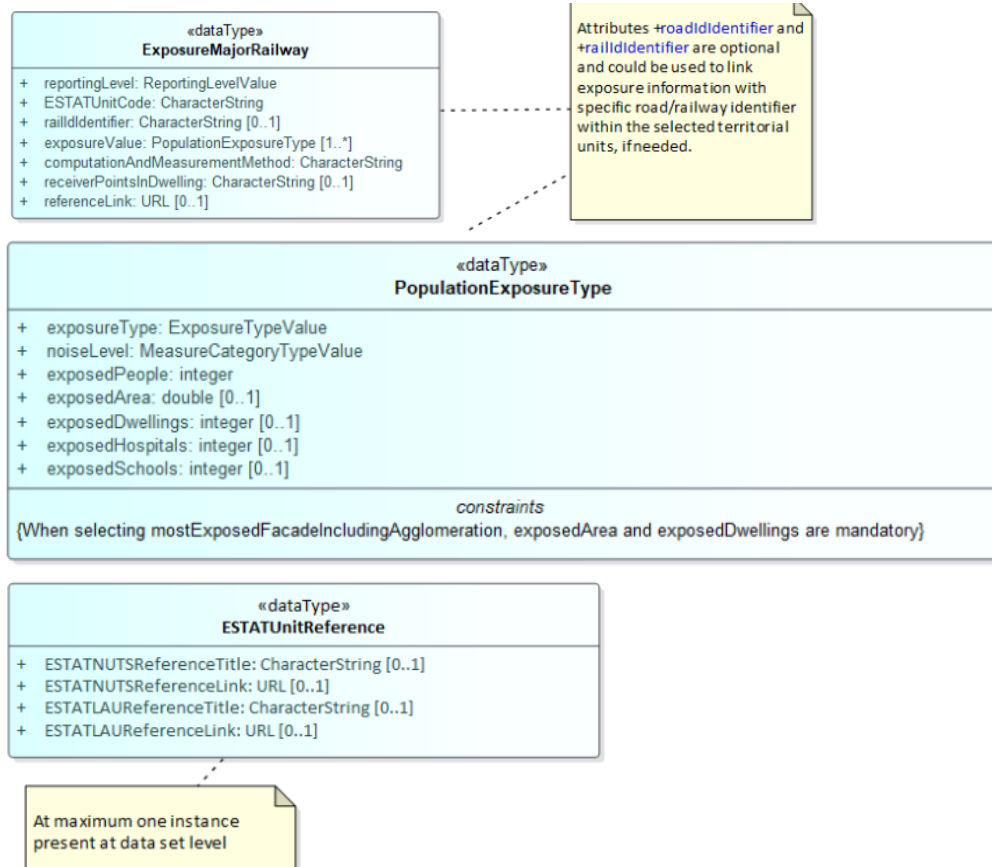
Note: there is an additional relevant type in the model called `ESTATUnitReference`*. This table is transformed to GeoPackage without any model transformations. No technical foreign key relationship is established; instead, the relationship is built on the domain key property* `ESTATUnitCode` *in* `ExposureMajorRailway`*.*

Model Transformation

The following rules are applied in this order:

1. Apply the "Handle composition attributes with multiplicity 1:n" rule as follows:
   a. `MT_ENDGPK05(mainTable: ExposureMajorRailway, mainProperty: exposureValue, subTableName: PopulationExposure)`

Resulting Model

The following image (**Error! Reference source not found.**) shows the resulting model for Strategic noise maps – noise exposure due to major railways.

Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 17: Model for END DF4_8 Noise exposure major railways geoPackage
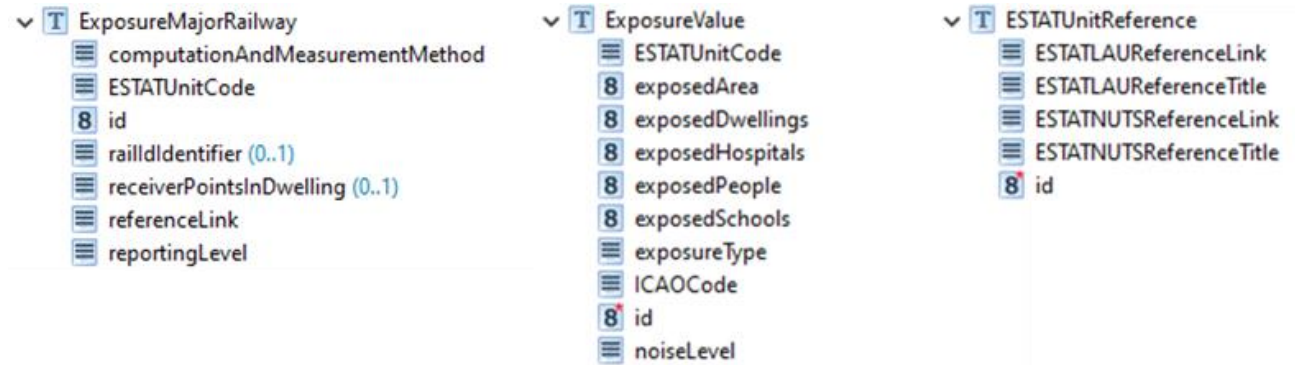
Conformance Class DF4_8 Strategic Noise Maps - Noise Exposure Major Roads

Input Model

Error! Reference source not found. shows the input model for DF4_8 Strategic noise maps – noise exposure due to major roads.

Figure 18: Data model END DF4_8 Strategic noise maps – noise exposure – major roads

«dataType»
ESTATUnitReference

+ ESTATNUTSReferenceTitle: CharacterString [0..1]
+ ESTATNUTSReferenceLink: URL [0..1]
+ ESTATLAUReferenceTitle: CharacterString [0..1]
+ ESTATLAUReferenceLink: URL [0..1]

At maximum one instance present at data set level

Note: there is an additional relevant type in the model called `ESTATUnitReference`. *This table is transformed to GeoPackage without any model transformations. No technical foreign key relationship is established; instead, the relationship is built on the domain key property* `ESTATUnitCode` *in* `ExposureMajorRoad`.

Model Transformation

The following rules are applied in this order:

1. Apply the "Handle composition attributes with multiplicity 1:n" rule as follows:
   a. `MT_ENDGPK05(mainTable: ExposureMajorRoad, mainProperty: exposureValue, subTableName: PopulationExposure)`

Resulting Model

The following image (**Error! Reference source not found.**) shows the resulting model for Strategic noise maps – noise exposure due to major roads.

Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 19: Model for END DF4_8 Noise exposure major roads geoPackage
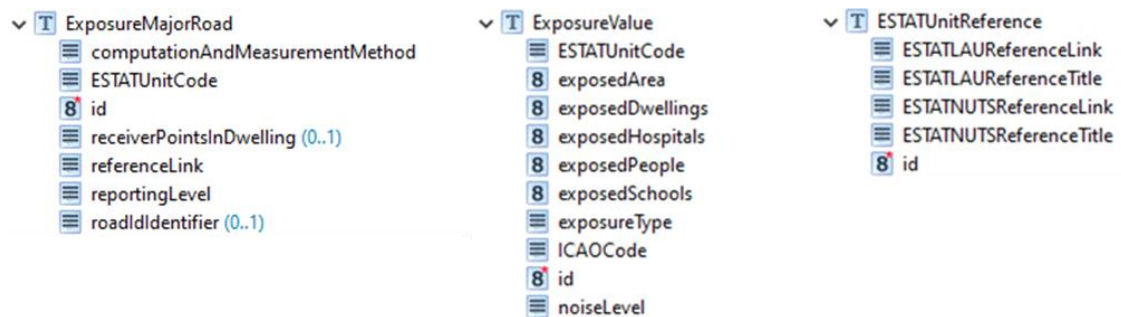
Conformance Class DF7_10 Quiet Areas

The DF7_10 data flow includes quiet areas in agglomerations or in open country.

Input Model

The `QuietArea` type extends `ManagementRestrictionOrRegulationZone` feature type from the INSPIRE Area Management, Restriction and Regulation Zones theme (see Figure 20). Quiet area documentation (`quietAreaDocumentation`) is provided according to the simplified data type `SimpleCitation`.

Figure 20: Data model END DF7_10 Quiet areas
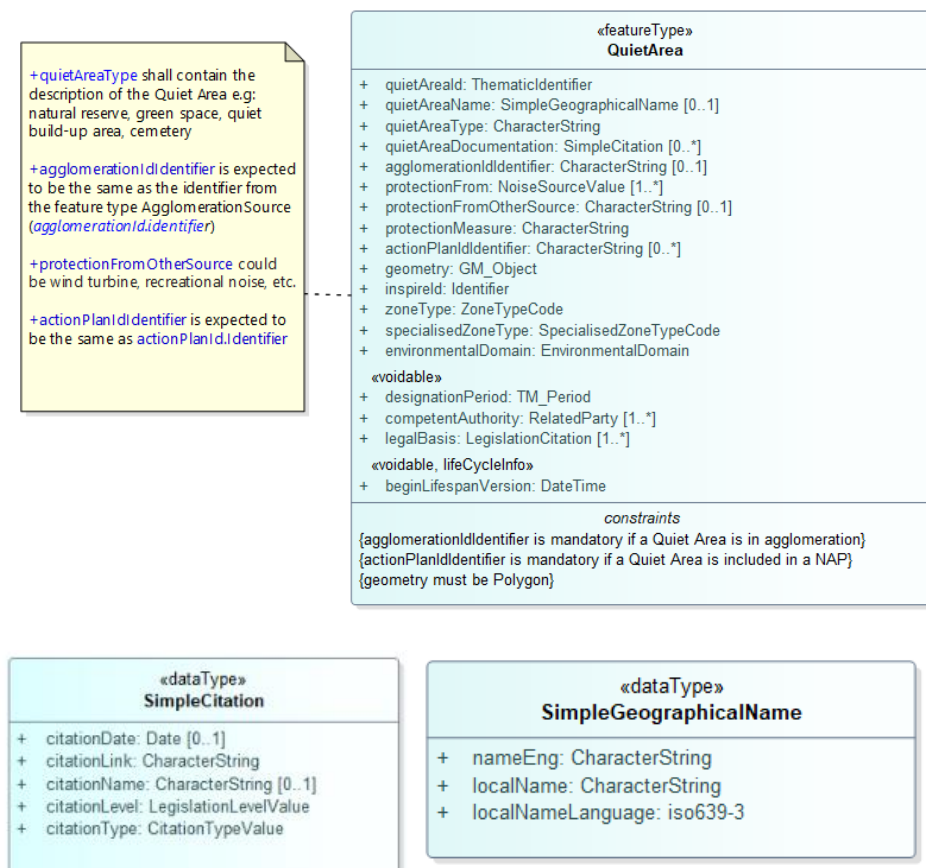
Model Transformation

The following rules are applied in this order:
1. Apply the "Flattening of hierarchical structures" rule as follows:
    a. MT_ENDGPK01(table: QuietArea, property: **quietAreaId**, separator: '_');
    b. MT_ENDGPK01(table: QuietArea, property: **quietAreaName**, separator: '_');
    c. MT_ENDGPK01(table: QuietArea, property: **inspireId**, separator: '_');
    d. MT_ENDGPK01(table: QuietArea, property: **designationPeriod**, separator: '_');
    e. MT_ENDGPK01(table: QuietArea, property: **competentAuthority**, separator: '_');

      f. `MT_ENDGPK01(table: QuietArea, property: `**`legalBasis,`**
         `separator: '_');`

      g. `MT_ENDGPK01(table: QuietAreaDocumentation, property:`
         `quietAreaId,`` separator: '_');`

2. Apply the "Extract Primitive Array" rule as follows:

      a. `MT002(table: QuietArea, property: `**`protectionFrom,`**
         `separator: ';)`

3. Apply the "Handle composition attributes with multiplicity 1:n" rule as follows:

      a. `MT_ENDGPK05(table: QuietArea, property:`
         `quietAreaDocumentation, pk: quietAreaId_identifier, fk:`
         `quietAreaId_identifier)`

4. Apply the "Dataset Default values" rule as follows:

      a. `MT_ENDGPK03(table: QuietArea, property:`
         `competentAuthority,`` attribute: nilReason, defaultValue:`
         `…/Unpopulated);`

      b. `MT_ENDGPK03(table: QuietArea, property: `**`designationPeriod,`**
         `attribute: nilReason, defaultValue: …/Unpopulated);`

      c. `MT_ENDGPK03(table: QuietArea, property: `**`legalBasis_link,`**
         `attribute: href, defaultValue:`
         `http://data.europa.eu/eli/dir/2002/49/oj);`

      d. `MT_ENDGPK03(table: QuietArea, property: `**`legalBasis_level,`**
         `attribute: href, defaultValue:`
         `https://inspire.ec.europa.eu/codelist/LegislationLevelValu`
         `e/european);`

      e. `MT_ENDGPK03(table: QuietArea, property:`
         `beginLifespanVersion,`` attribute: nilReason, defaultValue:`
         `…/Unpopulated);`

      f. `MT_ENDGPK03(table: QuietArea, property: `**`zoneType,`**
         `attribute: href, defaultValue:`
         `http://inspire.ec.europa.eu/codelist/ZoneTypeCode/noiseRes`
         `trictionZone);`

      g. `MT_ENDGPK03(table: QuietArea, property:`
         `environmentalDomain,`` attribute: href, defaultValue:`
         `http://inspire.ec.europa.eu/codelist/EnvironmentalDomain/n`
         `oise);`

      h. `MT_ENDGPK03(table: QuietArea, property:`
         `quietAreaId_identifierScheme,`` attribute: href,`
         `defaultValue:`
         `http://dd.eionet.europa.eu/vocabulary/inspire/IdentifierSc`
         `heme/EUENDCode);`

5. Apply the "Voidable attributes to Companion Table" rule as follows:

      a. `MT_ENDGPK02(table: QuietArea, properties:`
         `[competentAuthority_contact, competentAuthority_indivName,`
         `competentAuthority_orgName, competentAuthority_posName,`
         `competentAuthority_role, designationPeriod_beginPosition,`
         `designationPeriod_endPosition, legalBasis_link,`
   `legalBasis_level, beginLifespanVersion]);`

Resulting Model

The following image (**Error! Reference source not found.**) shows the resulting model for Quiet areas.

Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 21: Model for END DF7_10 Quiet areas geoPackage
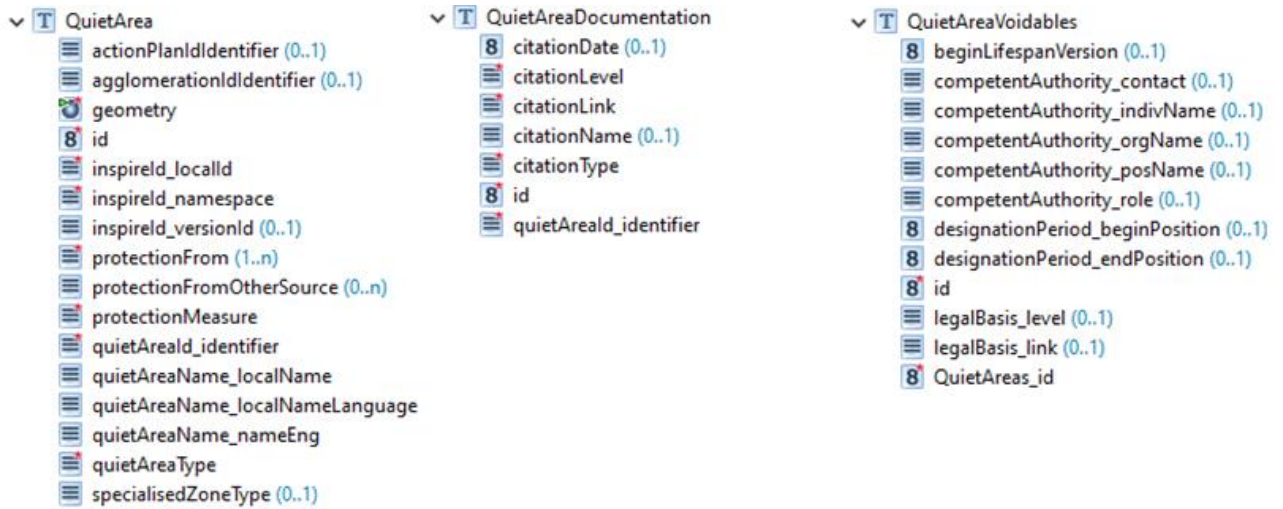
Conformance Class DF7_10 Noise Action Plans Coverage Areas

The DF7_10 data flows are special, since most non-spatial data is stored in other file formats (e.g. Microsoft Excel files supplied by the Member States), instead of in additional tables in GeoPackage. The parts described here are only those that are stored in GeoPackage. The END conceptual data model includes noise action plans for agglomerations, major airports, major railways, and major roads. All these types of noise action plans include a noise action plan coverage area spatial data. The same data model of noise action plan coverage area applies to all noise action plan types, therefore only one example is presented in this document.

Input Model

The `NoiseActionPlanCoverageArea` type extends the `ManagementRestriction-OrRegulationZone` feature type from the application schema INSPIRE Area Management Restriction and Regulation Zones (see **Error! Reference source not found.**).

Figure 22: Data model END DF7_10 Noise action plan coverage area
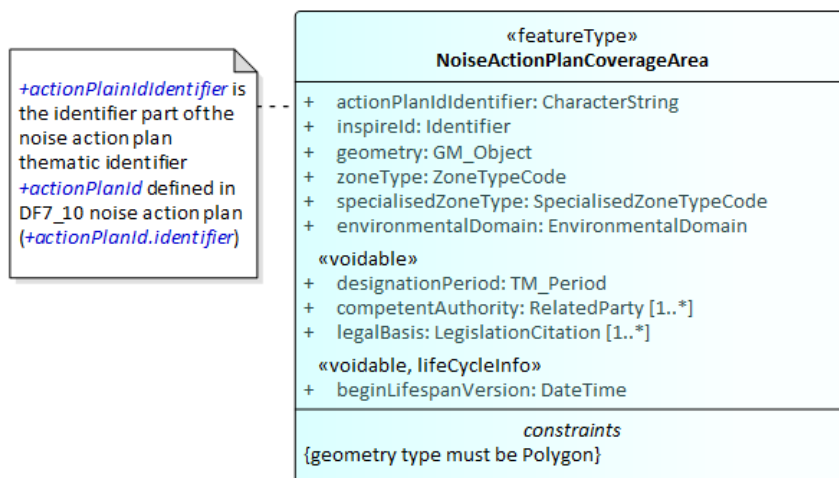
Model Transformation

The following rules are applied in this order:

1. Apply the "Flattening of hierarchical structures" rule as follows:
   a. `MT_ENDGPK01(table: NoiseActionPlanCoverageArea, property:` **`inspireId`**`, separator: '_');`
   b. `MT_ENDGPK01(table: NoiseActionPlanCoverageArea, property:` **`designationPeriod`**`, separator: '_');`
   c. `MT_ENDGPK01(table: NoiseActionPlanCoverageArea, property:` **`competentAuthority`**`, separator: '_');`
   d. `MT_ENDGPK01(table: NoiseActionPlanCoverageArea, property:` **`legalBasis`**`, separator: '_');`

2. Apply the "Dataset Default values" rule as follows:
   a. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`competentAuthority`**`, attribute: nilReason, defaultValue: …/Unpopulated);`
   b. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`designationPeriod`**`, attribute: nilReason, defaultValue: …/Unpopulated);`
   c. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`legalBasis_link`**`, attribute: href, defaultValue: http://data.europa.eu/eli/dir/2002/49/oj);`
   d. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`legalBasis_level`**`, attribute: href, defaultValue: https://inspire.ec.europa.eu/codelist/LegislationLevelValue/european);`
   e. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`beginLifespanVersion`**`, attribute: nilReason, defaultValue: …/Unpopulated);`
   f. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`zoneType`**`, attribute: href, defaultValue:` [`http://inspire.ec.europa.eu/codelist/ZoneTypeCode/noiseRestrictionZone`](http://inspire.ec.europa.eu/codelist/ZoneTypeCode/noiseRestrictionZone)`);`
   g. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`specialisedZoneType`**`, attribute: href, defaultValue: http://dd.eionet.europa.eu/vocabulary/inspire/SpecialisedZoneTypeCode/noiseActionPlanArea);`
   h. `MT_ENDGPK03(table: NoiseActionPlanCoverageArea, property:` **`environmentalDomain`**`, attribute: href, defaultValue: http://inspire.ec.europa.eu/codelist/EnvironmentalDomain/noise);`

3. Apply the "Voidable attributes to Companion Table" rule as follows:
   a. `MT_ENDGPK02(table: NoiseActionPlanCoverageArea, properties: [competentAuthority_contact, competentAuthority_indivName, competentAuthority_orgName, competentAuthority_posName, competentAuthority_role, designationPeriod_beginPosition, designationPeriod_endPosition, legalBasis_link, legalBasis_level, beginLifespanVersion]);`

Resulting Model

The following image (**Error! Reference source not found.**) shows the resulting model for Noise action plans – coverage area.

Please note that the common tables (`CodelistProperties`, `DatasetDefaultProperties`) are not repeated for each GeoPackage model.

Figure 23: Model for END DF7_10 Noise action plan coverage area geoPackage
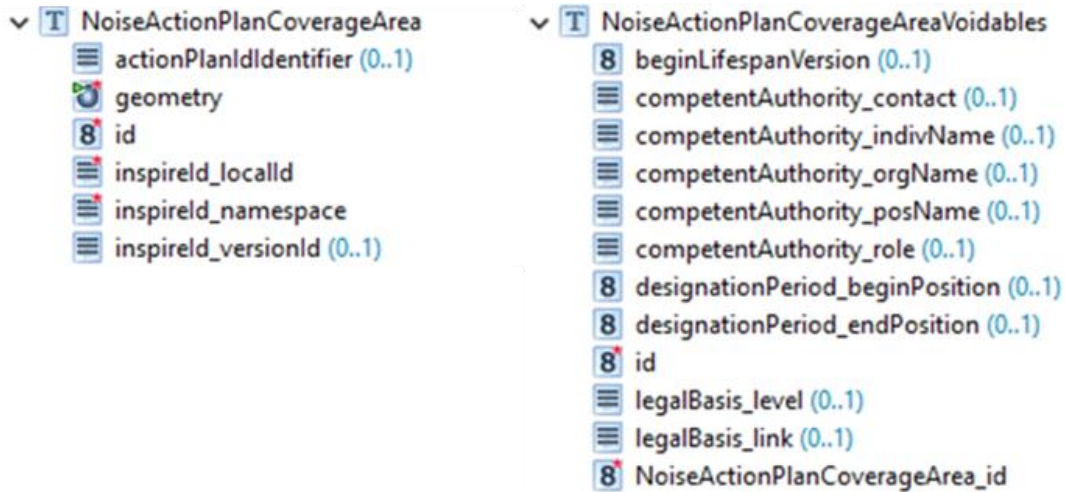
List of abbreviations

Abbreviation	Name	Reference
AM	Area Management and Regulation Zones (INSPIRE Theme)	
EC	European Commission	
EEA	European Environment Agency	www.eea.europa.eu
END	Environmental Noise Directive (Directive 2002/49/EC)	http://data.europa.eu/eli/dir/2002/49/oj
GML	Geography Markup Language	
HH	Human Health and Safety (INSPIRE Theme)	
INSPIRE	Infrastructure for spatial information in European Community (Directive 2007/2/EC)	https://inspire.ec.europa.eu/
MS	Member State(s) (European Union)	
SRS	Spatial reference systems	
TN-A	Transport Networks – Air (INSPIRE Schema)	
TN-RA	Transport Networks – Railways (INSPIRE Schema)	
TN-RO	Transport Networks – Road (INSPIRE Schema)	
UAB	Universitat Autònoma de Barcelona	
UML	Unified Modelling Language	

Annex 1 Overview of transformation rules in END GeoPackage templates

END data flow noise sources (DF1_5)

Data model and feature type / table Transformation rule	DF1-5 Agglomerations Agglomeration-Source	DF1_5 Major Airports MajorAirport-Source	DF1_5 Major Railways MajorRailway-Source	DF1_5 Major Roads MajorRoadSource
MT_ENDGPK01: Flattening of hierarchical structures	X	X	X	X
MT_ENDGPK02: Voidable attributes to Companion Table	X		X	X
MT_ENDGPK03: Dataset Default values	X		X	X
MT_ENDGPK0: Handle code list values and metadata	X	X	X	X
MT_ENDGPK05: Handle composition attributes with multiplicity 1:n				
MT_ENDGPK06: Handle associations with a multiplicity of n:m				
MT002: Extract Primitive Array	X			

END data flow strategic noise maps (DF4_8)

Data model and feature type / table Transformation rule	DF4_8 Strategic Noise Maps – Noise Contours (applicable to all noise sources) EnvHealthDeterminantMeasure (for environmental noise)	DF4_8 Strategic Noise Maps - Noise Exposure Agglomerations Exposure-Agglomeration	DF4_8 Strategic Noise Maps - Noise Exposure Major Airports ExposureMajor Airport	DF4_8 Strategic Noise Maps - Noise Exposure Major Railways ExposureMajor Railway	DF4_8 Strategic Noise Maps - Noise Exposure Major Roads ExposureMajor Road
MT_ENDGPK01: Flattening of hierarchical structures	X				
MT_ENDGPK02: Voidable attributes to Companion Table	X				
MT_ENDGPK03: Dataset Default values	X				
MT_ENDGPK0: Handle code list values and metadata	X	X	X	X	X
MT_ENDGPK05: Handle composition attributes with multiplicity 1:n		X	X	X	X
MT_ENDGPK06: Handle associations with a multiplicity of n:m					
MT002: Extract Primitive Array					

END data flow of quiet areas and coverage area part of noise action plans (DF7_10)

Data model and feature type / table Transformation rule	DF7_10 Quiet Areas QuietArea	DF7_10 Noise Action Plans Coverage Area (applicable to noise action plans for all noise sources) NoiseActionPlanCoverageArea
MT_ENDGPK01: Flattening of hierarchical structures	X	X
MT_ENDGPK02: Voidable attributes to Companion Table	X	X
MT_ENDGPK03: Dataset Default values	X	X
MT_ENDGPK0: Handle code list values and metadata	X	X
MT_ENDGPK05: Handle composition attributes with multiplicity 1:n	X	
MT_ENDGPK06: Handle associations with a multiplicity of n:m		
MT002: Extract Primitive Array	X	