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SYSTRA

TECHNICAL USER MANUAL

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1. INTRODUCTION

1.1.1 ENEVAL is an Environmental Assessment Tool, which has been developed by Systra Ltd. This software has been through a programme of continual improvement and updating. The previous version (ENEVAL version 9.0) was completed in 2011 and since then both the guidance around emissions calculations and fleet splits have changed considerably.

1.1.2 ENEVAL can take network (and junction based outputs from a range of different modelling platforms and convert the outputs into emissions information. It is primarily designed to work with road networks but can also be used with public transport networks.

1.1.3 ENEVAL outputs can also be used to undertake emissions and even congestion mapping. Although not part of the actual software these outputs are dealt with in a section towards the end of this report.

1.1.4 This user manual and technical guide describes the specification of version 10.0 of ENEVAL and describes how to use the software in operation. This version also maintains the ability for the user to output DELTA files for use in a land use model.

2. TECHNICAL SPECIFICATION

2.1 Introduction

2.1.1 This section describes the technical specification of this version of ENEVAL 10.0. It describes the formulation used in the calculation of the emissions.

2.1.2 The ENEVAL software produces regional emissions (and other network statistics). It can do this for combination of input networks or single networks.

2.1.3 The formulation is based on a variety of data sources which are detailed in section 2.2 below.

2.2 ENEVAL Specification

2.2.1 The ENEVAL process requires three types of inputs; basic data; those from the model itself and user defined inputs. This represents the data, which is input to one or both of the current versions of ENEVAL and will therefore be required as an input to the new version of ENEVAL. The extra functionality may require further input data.

2.2.2 The basic data required for ENEVAL is as follows, along with the source of the data:

- Emission Rate calculation coefficients – National Atmospheric Emissions Inventory 2013 (NAEI), TRL 2009 (It should be noted that the NAEI 2013 emissions rates are partly taken from COPERT 10 and also include emissions rates for new technology vehicles);
- Fuel Scaling parameters - NAEI 2013;
- Fleet split data – NAEI 2013;
- Degradation Factors- NAEI 2013;
- Catalytic Converter Failure rates - NAEI 2013;
- Tyre, break and abrasion emissions rates and
- Rail-based emission factors – 2012 Olympic Study.

2.2.3 The model data required by ENEVAL is as follows:

- Link-based Data: Anode, Bnode, Link Type, Jurisdiction Code, No. of Lanes, Link Length (km), Speed (kph), Flow (in vehicles by user class), including bus preloads (veh);
- (optional) Junction-based Data: Anode, Bnode, Cnode, Jurisdiction Code, Junction Time (mins), Flow (in vehicles by user class), including bus preloads (veh); and
- (optional) PT model data: Train kilometres (by rolling stock type). Could also include GHG's from electric generation, in which case we would also need tram kms etc

2.2.4 Data required for input by the user includes:

- Model Year;
- Number of Input Networks;
- Annualisation factors;

- Screening Definitions;
- Number of input vehicle types (with DMRB equivalence); and
- Selection of output units;

2.2.5 All of the above constitutes the input to the ENEVAL process. This version of ENEVAL then outputs the following regional emissions types. They are often referred to in ENEVAL and this document by their emissions type number in brackets. They are:

- Oxides of Nitrogen – NO_x **(Emissions Type 1)**;
- Nitrogen Dioxide - NO_2 **(Emissions Type 2)**;
- Particulate Matter – PM_{10} **(Emissions Type 3)**;
- Fine Particulate Matter – $PM_{2.5}$ **(Emissions Type 4);**
- Hydro-Carbons – HC **(Emissions Type 5);**
- Carbon Monoxide – CO **(Emissions Type 6);**
- Carbon Dioxide- CO_2 **(Emissions Type 7);**
- Benzene – C_6H_6 **(Emissions Type 8);**
- Methane – CH_4 **(Emissions Type 9);** and
- 1 3-Butadiene – C_4H_6 **(Emissions Type 10)**

2.2.6 The ENEVAL program calculates these emissions for 778 different fleet types for which there are distinct emissions factors. The emissions rate is given by either a single factor in (g/km) or by one of the formulae below (also in g/km).

Polynomial = (((a*(x^3))+(b*(x^2))+(c*x))+d)*(1-RF)
Polynomial = ((a*(b^x))*(x^c))*(1-RF)
Polynomial = ((a*(x^b))+(c*(x^d)))*(1-RF)
Polynomial = ((a+(b*x))^((-1)/c))*(1-RF)
Polynomial = ((Alpha*x^2)+(Beta*x)+Gamma+(Delta*(ln(x))+(Epsilon*Exp(Zita*x))+(Ita*(x^Thita)))*(1-RF)
Polynomial = ((Alpha+Gamma*x+Epsilon*x^2+Zita/x)/(1+Beta*x+Delta*x^2))*(1-RF)
Polynomial = ((Alpha*Beta^x)*(x^Gamma))*(1-RF)
Polynomial = (1/(((c*(x^2))+(b*x))+a))*(1-RF)
Polynomial = (1/(a+(b*(x^c))))*(1-RF)
Polynomial = (a+(b/(1+exp((((-1)*c)+(d*ln(x)))+(e*x)))))*(1-RF)
Polynomial = k*(a+bx+cx^2+dx^3+ex^4+fx^5+gx^6)/x
Polynomial = k*exp((a+(b/x))+(c*ln(x)))
Polynomial = k*(a+bx+cx^2+dx^3+ex^4+fx^5)
Polynomial = (((epsilon+(alpha*exp(((-1)*beta)*x)))+(gamma*exp(((-1)*delta)*x))))*(1-RF)
Polynomial = ((alpha-(beta*EXP(((-1)*gamma)*(x^delta)))))*(1-RF)

Where:

x is the speed on a particular link; and

a, b, c, d, e, f, g, k, alpha, beta, gamma, delta, epsilon, zita, ita, thita are coefficients of the formula specific to each fleet type and emissions type.

2.2.7 The above formulae gives the emission factor for a particular fleet type in grams per kilometre, where each fleet type and emission type has distinct coefficients.

2.2.8 The above formulae also hold only for certain ranges of speeds, which are different by fleet type and emission type. If the flow on a particular link is outside this range the speed is set to maximum or minimum for the purposes of the calculation.

2.3 Junction Based Emissions

2.3.1 The model also deals with junction based emissions. Junction delays are characterised by stop/start driving conditions, which have a different emission rate from either free-running, or stationary 'idling' vehicles. Since using idling engine emissions rates would underestimate the emissions, we use an assumption that stop start queuing has an average speed of the lowest speed at which a given function in section 2.2 is valid.

2.3.2 The junction delay emission rate is then given by the formula below, using the *min* kph value for which a particular emissions formula is valid. It is divided by 3600 to convert the speed in kilometres per second.

Junction Delay Emission Rate (g/s) = 5kph Emission Factor (g/km per veh) x min (kph) / 3600

2.3.3 The total junction emissions are then calculated by multiplying this by the total junction delay in seconds, which is calculated by adding the times of all relevant vehicles at the junction.

2.3.4 So, as to not double count emissions the length of the link used for the calculation of link based emissions must be reduced by the length of the queue at the junction. This is, calculated as follows:

Queue (km) = (Total Junction Time(s) x min (kph) / 3600)/ No. of Lanes

Note: For SATURN networks this allows the effects of blocking back to be calculated.

2.3.5 It is assumed for the purposes of ENEVAL that any queuing cars are spread evenly over all lanes on the road.

2.3.6 In the case when the Queue is greater than the link length we assume the queuing occurs along the full length of the link and the length of the free flowing section of the link is therefore assumed to be zero.

2.3.7 Finally, the link based emissions are calculated using the new link length (modelled link length minus queue).

2.4 Sector based outputs

2.4.1 The process can accept as an input user-defined sector system which is created through a GIS process (described in a separate document) or manually.

2.4.2 The sectors can be anything required by the user from Local Authorities or zones to user defined cordons.

2.4.3 The sector file is input as a table in the database, the format being described in the next section of this report. It should be noted that the format allows the same link to be included in different sectors with proportions, as long as the total adds up to 1.

2.4.4 If this is included as an input then the ENEVAL process will output emissions information at a sector level.

2.4.5 If the user wishes to output DELTA files for use in a land use model this input is strictly required.

2.5 Alternative / Multiple Assignment Types

2.5.1 This version of ENEVAL allows the user to input multiple or alternative assignments. This could be multiple tests or partial assignments. This feature is designed to allow the user maximum flexibility in the use of the software. This is dealt with by assigning different assignment numbers – see section 3.2.3.

2.6 Model Data

2.6.1 The model data needs to be formatted by the user themselves into the formats described in the following section.

2.6.2 Other models will have to have their own subroutines to get the data into the relevant format.

2.6.3 It should be noted that the ENEVAL process needs to convert the flows given in the network data into ENEVAL vehicle types and then into the778 fleet types used for the calculations. The ENEVAL vehicle types are:

- Electric Cra;
- Petrol Car;
- Diesel Car;
- LPG Car;
- Electric LGV;
- Petrol LGV;
- Diesel LGV;
- LPG LGV;
- Articulated HGV;
- Rigid HGV;
- Taxi;
- Motorcycle; and
- PSV.

2.6.4 These are then split into the 778 fleet types using a lookup table in the database ("Fleet_Split"). The initial model flows are split into the above vehicle types using another lookup table in the database. Both these tables are described in the next section.

2.7 Rail Based Emissions

2.7.1 The rail based emissions included within the ENEVAL program are taken from work undertaken for MVA for the Olympic Study for London 2012, where emissions factors were calculated per train (by type) from the DEFRA's values per passenger kilometre.

2.8 Outputs

2.8.1 The ENEVAL process outputs emissions and vehicle statistics for every link in the model to the model database with an identification tag. It combines them back to the input vehicle types. This means the data is stored at the same level of aggregation as the input networks.

2.8.2 From this database of outputs there are some standard reporting tables produced. However, due to the data being stored at this level of aggregation, the user can in theory define queries to extract exactly the data that they require.



3. IN OPERATION

3.1 Introduction

3.1.1 This section describes how to use the ENEVAL program, with a step by step guide to setting up a test run. It also describes the outputs from the program and also potential troubleshooting issues which may arise

3.1.2 The following are the stages that need to be followed to set up a new test with ENEVAL:

- 1) Prepare the outputs from the transport model (or other input data to the process);
- 2) Set up the input database tables (if not using the default tables);
- 3) Set up the control card for ENEVAL; and
- 4) Running the ENEVAL program.

3.2 Outputs from the Transport Model

3.2.1 Link Data, and if required Turn Data, are required from the model. This can be from any number of assignments or time time-periods. It should be noted that the ENEVAL program can run without Turn Data being specified.

3.2.2 Both Link and Turn data should be in CSV format (although they do not need CSV file extensions). The files can be stored with any file path and name that the user desires, but should contain no spaces. The files should also contain no blank lines, but can contain lines of comments identified by a '*'.

3.2.3 The Link Data CSV file should contain the information described in Table 3.1 below. The Turn Data CSV file is described in Table 3.2 below that. Both tables describe the units that the data should be in. *Note: If there is more than one assignment time period then these can either be combined by the user before running ENEVAL or input as separate CSV files.*

Table 1. Link Data CSV File Description

Column	Data	Units
1	Anode	Long Integer
2	Bnode	Long Integer
3	Assignment Type/Number	Integer
4	Link Type	Integer
5	Link Capacity	PCU per hour (Real)
6	Link Distance	Kilometres (Real)
7	Free Flow Time	Minutes (Real)
8	Congested Time	Minutes (Real)
9-	Flow (Separate Column for each User Class	Vehicles or PCUs (Real)

Table 2. Turn Data CSV File Description

Column	Data	Units
1	Anode	Long Integer
2	Bnode	Long Integer
3	Cnode	Long Integer
4	Assignment Type/Number	Integer
5	Turn Time	Minutes (Real)
6-	Flow (Separate Column for each User Class	Vehicles or PCUs (Real) **must be the same units as the Link Flows*

3.2.4 It should be noted that for every turn there should be a separate row of data thereby requiring in many cases that this file is longer than the link based file. Although this file should only be provided where turn times are known otherwise it will have no impact. Therefore this file can be provided for specific turn movements only and not all turn movements in the model

3.2.5 Examples of Link and Turn input data files can be seen in Appendices B and C of this report.

3.3 Rail Input Files

3.3.1 For rail (or any non-road) based mode the inputs should be in the form of a dbf file containing the following columns:

- Anode;
- Bnode
- A flag which refers to ID_RAIL_FLAG to indicate the type of link – the types are as follows:
  - 1 - Train;
  - 2 - Ferry;
  - 3 - Underground;
  - 4 - Tram;
  - 5 - Light Rail; and
- Vehicle kilometres.

3.3.2 It should be noted that the PT inputs must be stored in a folder structure with no spaces in the name and also it cannot be stored on the root of the C:/ Drive.

3.4 Setup the Database Tables

3.4.1 The majority of tables in the input database will fall into one of the two categories, namely:

- those containing ENEVAL parameters – which will probably not change unless the user is undertaking a specific sensitivity test; and

- those which are specific to the transport model that ENEVAL is being used with – once set up for a given modelling system these will probably not change.

Note: It is probably good practice to create a new SQL database for each model / modelling system / set of runs that ENEVAL is to be run with. In this way the user can keep tabs on their specific data tables. For those tables which fall into the first category, default tables have been created and these should be used in most cases.

3.4.2 Table 3 below describes the tables which contain the standard ENEVAL input tables. The table contains a description of the contents of the table along with the column headers.

Table 3. Standard ENEVAL inputs in the database

Table	Description	Columns
ID_Emissions	Contains a list of the emissions types calculated by the program	ID_Emiss, Description
ID_Fleet	Contains a list of the fleet types used by ENEVAL to calculate the emissions. It contains information on size, fuel type, engine size and Euro Standard.	ID_Fleet, Size, Fuel_Type, Engine, Standard
ID_Formula	Contains the various formulae types used in the process	ID_Form,Description
ID_Fuel	Contains a list of fuel types used in the model	ID_Fuel,Description
ID_RoadType	Contains a list of the Road Types used by the calculations within ENEVAL.	ID_RoadType, Description
ID_Standard	Contains a list of Euro Standards Contained in the model	ID_Standard,Desfription
ID_VehType	Contains a list of the Vehicle Types used in the calculations within ENEVAL.	ID_VehType, Description
CONV_Fleet2VehType	Contains the conversion lookup between the Vehicle Types and the Fleet Types.	ID_Fleet, ID_VehType
PRM_CatFail	Contains information detailing the proportion of vehicles in each of the fleet categories with failed catalytic converters by year.	ID_Fleet, [Year]
PRM_CatFail_Lookup	Contains a lookup for each emissions type and each fleet type, which of the other fleet types it behaves like if the cat has failed. This is entered with flags of 1's and 0's.	ID_Fleet, ID_Emiss, CAT_Lookup
PRM_EmissionsFactors	Contains the coefficients for calculating emissions, along with the maximum and minimum speed for which the	ID_Fleet, ID_Emiss, a, b, c, d, e, f, g, k, max, min

	formulation holds.	
PRM_FleetRoadType	This contains the splits by year by Vehicle Type and Road Type.	ID_RoadType, ID_VehType, [Year]
PRM_FleetSplit	This contains the fleet splits (265 categories) for a given year.	ID_Fleet, [Year]
PRM_FuelScaling	This contains the fuel efficiency scaling factors for each fleet type for a given year.	ID_Fleet, ID_Emiss, [Year]
PRM_Mileage	This table contains the average mileage by fleet type for a given year. Feeds into the degradation calculation.	ID_Mileage, [Year]
PRM_MileageFunction	Contains the coefficients for calculating the degradation scaling function from the yearly average mileages.	ID_Fleet, ID_Emiss, a, b, max
PRM_TyresAndBreaks	Contains the grams of PM10's emitted per km from tyres and breaks by Vehicle Type and Road Type.	ID_RoadType, ID_VehType, Tyres, Breaks
RAIL_ID_Flag	List of all non-road modes for which, emissions can be calculated	ID_Flag, Description
RAIL_DefaultFactors	Default Factors for all non-road modes. Emissions factors in grams per vehicle kilometre and default splits between diesel and electric vehicles.	ID_Flag, Factor_Electric, Factor_Diesel, Split_Electric, Split_Diesel

3.4.3 Table 4 below contains a description of the tables that should be set up for each particular model / modelling suite. It should be noted that there can be multiple version of each of these tables in the database for different purposes, these can then be referenced through the control card.

3.4.4 It should be noted that it is imperative that these model specific inputs are updated to reflect the transport model being used. Although it will often be the case that once created for a specific model they will not need to be updated.

Table 4. Model Specific inputs in the database

Table	Description	Columns
ID_TimePeriod	Contains a list of time periods within the model	ID_TimePeriod, Description
ID_Annualisation Factors_Yearly	Contains Yearly Annualisation Factors for each time period within the model. *These can be for one day or a full year. The database could contain*	ID_TimePeriod, PeriodFactor

	multiple annualisation factor tables for different purposes.	
ID_Annualisation Factors_12hr	Contains 12hr Annualisation Factors for each time period within the model. *These can be for one day or a full year. The database could contain multiple annualisation factor tables for different purposes.*	ID_TimePeriod, PeriodFactor
ID_LinkType	Contains a list of the Link Types within the model. It also contains the number of lanes generally attributed to that link type.	ID_LinkType, Description, No_Lanes
ID_UserClass	Contains a list of all the User Classes in the model.	ID_UC, Description
ID_LinktoZone	Contains a list of links in each zone in the model. Each link can appear more than once if the link crosses two zones. *Note: There may need to be different tables for different networks.*	Anode, Bnode, Zone, LinkProportion
CONV_LinkType2RoadType	Contains the Link Type to Road Type lookup. This will be a 1-1 relationship.	ID_LinkType, ID_RoadType
CONV_VehType2UC	Contains the UserClass to ENEVAL Vehicle Type Lookup. This could be a many to many relationship. The lookup in this case should be a flag of 1 or 0 if the User Class and Vehicle Type match.	ID_VehType, ID_UC, Lookup
RAIL_Link_Lookup	If there is specific knowledge between electric and diesel use on a particular link for non-road based modes they can be entered here. This will overwrite the default factors for this link.	Anode, Bnode, Split_Electric, Split_Diesel

3.5 Control File

3.5.1 This section describes how to create a control file for the ENEVAL program. An example of a control file can be seen in Appendix A of this report.

3.5.2 The control file for ENEVAL contains 5 distinct types of information, namely:

- Database connection information;
- Database Tables;
- Input Parameters;

- Output Parameters; and
- Files.

3.5.3 An example control file can be seen in Appendix A of this report. This example keeps all the sections described below together, but in reality all the inputs can be contained in any order desired by the user.

3.5.4 The database connection information required, the key words are in bold, with examples in italics:

- **In_Server** = *cr5706*
  This is the server that the ENEVAL input database being used for this project is stored on. SQL Server must be installed on this server before ENEVAL can be run.
- **In_Database** = *ENEVAL_v9.0*
  *This is the name of the database on the server, which is being used for this work. New databases can be set up for new projects or for different models. The name can be anything the user chooses as long as there are **no spaces** in the name.*
- **In_Username** = *sa*
  This is the username to access the SQL server.
- **In_Password** = *mva*
  This is the password to access the SQL server
- **In_Server** = *cr5706*
- *This is the server that the ENEVAL input database being used for this project is stored on. SQL Server must be installed on this server before ENEVAL can be run.*
- **Out_Database** = *ENEVAL_v9.0*
- **Out_Username** = *sa*
- **Out_Password** = *mva*
- **Out_Server** = *cr5706*

3.5.5 These are the same as above, but for the output database. It should be noted that the output database can be the same as the input database.

3.5.6 The database tables required, the **key words are in bold**, with *examples in italics*:

- **Emissions_DB** = *ID_Emissions*
- **Fleet_DB** = *ID_Fleet*
- **UserClass_DB**=*ID_Userclass*
- **VehType_DB**=*ID_VehType*
- **RoadType_DB** = *ID_RoadType*
- **LinkType_DB** = *ID_LinkType*
- **AssignmentType_DB** = *ID_Flag*
- **TimePeriod_DB** = *ID_TimePeriod*
- **Emission_Coeff_DB** = *PRM_Emissions_Coeff*
- **Fuel_Scaling_DB** = *PRM_FuelScaling*
- **MileageFunction_DB** = *PRM_MileageFunction*
- **Mileage_DB** = *PRM_Mileage*
- **VehTypeSplit_DB** = *PRM_FleetRoadType*
- **FleetSplit_DB** = *PRM_FleetSplit*
- **CatFail_DB** = *PRM_CatFail*
- **CatFail_Lookup_DB** = *PRM_CatFail_Lookup*

- **TyreBreak_DB** = *PRM_Tyres_and_Breaks*
- **UserClass2VehType_DB** = *CONV_VehType2UC*
- **VehType2Fleet_DB** = *CONV_Fleet2VehType*
- **LinkType2RoadType_DB** = *CONV_LinkType2RoadType*
- **Sector_DB** = *Model_SectorFile* (only if sector parameter is set to true)

3.5.7 The database tables do not require extra explanation, such that the example names are those contained in tables 3 and 4 above. The reason that the program requires the database tables to be specified in the control card is that it allows multiple versions of each of the tables to be created and then to be referenced from the control file.

3.5.8 If alternative databases are created, for whatever reason, the column titles described in tables 3 and 4 of this report should be contained in those tables or the program will fail.

3.5.9 It should be the situation in most cases that once this section has been set up for a particular model or a particular series of tests then it need not be changed.

3.5.10 The input paramters required, the **key words are in bold**, with *examples in italics*:

- **RunID** = *AP_2010*
  This is the ID of the run. This should contain no spaces, but other than that can contain any information required to identify this run.
- **NumberAssignmentTypes** = *1*
  The number of input assignment types could be different types of assignment of the same network (eg Partial Assignments) or it could just be used to run multiple assignments / networks through ENEVAL at the same time.
- **NumberInputNets** = *4*
  This is the number of Input Networks for a given assignment type (in most cases this will be the different time periods. These will link to the Annualisation Factors contained in the ID_AnnualisationFactors table.
- **JunctionFile** = *True*
  A Boolean operator to indicate if the program is to expect junction file data. If this is set to true input turn data CSV file(s) must be input, otherwise this can be excluded. If set to true there must be as many junction files as network files.
- **PTNets** = *False*
  A Boolean operator to indicate if PT networks will be included. If they do there should be one for each assignment type and time period.
- **FreeFlow** = *False*
  Use free flow speeds in the emissions calculations rather than the congested speeds. This will give an indications of the emissions if the network were free from delay.

3.5.11 The outputs required, the **key words are in bold**, with *examples in italics*:

- **Netstats** = *True*
  If this is set to True then the program will produce a table of Vehicle Kilometres and Hours by Link Types, Assignment Types, Time Periods and User Classes.
- **EmissionStats** = *True*
  If this is set to True then the program will produce tables of emissions by Link Types, Assignment Types, Time Periods and User Classes. This will also be split by

link and turn emissions (these are in separate tables appended with _link and _turn).

- **PTNets** = *True*
  If this is set to true the ENEVAL program expects input Public Transport networks (*.DBF files) and will calculate non-road based emissions on a link by link basis.
- **DeltaFile** = *True*
  If this is set to true a zonal delta file will be produced from ENEVAL. This contains measures by zone, in a file formatted for use in land use modelling.
- **IncTandB** = *False*
  If this Boolean operator is set to True then the output PM10 emissions will include emissions from break and tyres.
- **Sector** = *True*
  If this Boolean operator is set to True then the ENEVAL program expects a sector database as input and the outputs are then also sectored

3.5.12 The network files required, the **key words are in bold**, with *examples in italics*:

- **LinkFile(1,1) =** *C:\ Net_time1_linkdumpfull.TXT*
- **LinkFile(1,2) =** *C:\ Net_time2_linkdumpfull.TXT*
- **LinkFile(1,3) =** *C:\ Net_time3_linkdumpfull.TXT*
- **LinkFile(1,4) =** *C:\WNet_time4_linkdumpfull.TXT*

3.5.13 Link input CSV files are input in the fashion shown above. There should be a separate file for each assignment type and time period. The first index is for the assignment type and the second index is for the time period.

3.5.14 The junction files required, the **key words are in bold**, with *examples in italics*:

- **TurnFile(1,1)** = *C:\ Net_time1_turndumpfull.TXT*
- **TurnFile(1,2) =** *C:\ Net_time2_turndumpfull.TXT*
- **TurnFile(1,3) =** *C:\ Net_time3_turndumpfull.TXT*
- **TurnFile(1,4) =** *C:\Net_time4_turndumpfull.TXT*

3.5.15 Turn input CSV files are input in the fashion shown above. There should be a separate file for each assignment type and time period. The first index is for the assignment type and the second index is for the time period.

3.5.16 The output files required, the **key words are in bold**, with *examples in italics*:

- **PTLkFile(1) =** *C:\Databases\AM_VEH_KMS.DBF*
  This is the PT input DBF files. There should be one per time period. This cannot be used in conjunction with multiple highway assignment types. If it is the PT part of ENEVAL will only run on the first highway assignment type.
- **EnvrFile(1) =** *C:\ ENVR_AP_2010.DAT*
  The name and location of the output delta file if DeltaFile is set to True.
- **PrntFile =** *C:\.PRN*
  The name and location of the output print file from this run of ENEVAL.

3.6 Running the ENEVAL program

3.6.1 The ENEVAL program can be run from either a batch file or from the DOS prompt. In either case the control line is the same:

```
ENEVAL_10.EXE C:\ENEVAL_EXAMPLE.CTL
```

3.7 Outputs from ENEVAL

3.7.1 The outputs from the ENEVAL process are stored in the output SQL database. A full list of the output tables is contained in Table 3.5 below. Once the tables are created they should be renamed as otherwise they will be appended to with future runs.

Table 5. Outputs from the ENEVAL process

Table	Description	Columns
Model_LinkData	Contains the same data as in the input Link Data CSV Files, but in SQL. A Link ID has also been appended for ease of linking the output tables. *(this is made up from the Anode and Bnode)*	Link_ID, Anode, Bnode, TimePeriod, LinkType, Capacity, Distance, FreeFlowTime, CongTime
Model_TurnData	Contains the same data as in the input Turn Data CSV Files, but in SQL. A Turn ID has also been appended for ease of linking the output tables. *(this is made up from the Anode, Bnode and Cnode)*	Turn_ID, Link_ID, Cnode, TimePeriod, TurnTime
OutputLinkData	This contains the flows and the emissions (in grams).	Link_ID, ID_UC, AssignmentType, TimePeriod, Flow_veh, Flow_PCU, Emissions1-10
OutputTurnData	This contains the flows and the emissions (in grams).	Turn_ID, ID_UC, AssignmentType, TimePeriod, Flow_veh, Flow_PCU, Emissions1-10
Report_PCUKMbyZone	This report is generate if DeltaFile = True	Zone, PCU_KM
Report_VehKMbySector	Vehicle Kilometers by Sector if Netstats = True and Sector = True	Assignment Type, Sector, Veh_Hrs, Veh_KM
Report_VehKMbyAssType	Vehicle Kilometers by Assignment Type if Netstats = True	Assignment Type, Veh_Hrs, Veh_KM

Report_VehKMbyLinkType	Vehicle Kilometers by Link Type if Netstats = True	Assignment Type, Link Type, Veh_Hrs, Veh_KM
Report_VehKMbyTimePeriod	Vehicle Kilometers by Time Period if Netstats = True	Assignment Type, Time Period, Veh_Hrs, Veh_KM
Report_EmissionsbySector	Emissions statistics by Assignment Type if EmissionStats = True and Sector = True. *This is split by link and turn emissions in separate tables.*	Assignment Type, Sector, Emissions1, Emissions2, Emissions3, Emission4, Emissions5
Report_EmissionsbyAssType	Emissions statistics by Assignment Type if EmissionStats = True. *This is split by link and turn emissions in separate tables.*	Assignment Type, Emissions1-10
Report_EmissionsbyLink	Emissions statistics by Link if EmissionStats = True. *This is split by link and turn emissions in separate tables.*	Assignment Type, Link_ID, Emissions1-10
Report_EmissionsbyLinkType	Emissions statistics by Link Type if EmissionStats = True. *This is split by link and turn emissions in separate tables.*	Assignment Type, Link Type, Emissions1-10
Report_EmissionsByTimePeriod	Emissions statistics by Time Period if EmissionStats = True. *This is split by link and turn emissions in separate tables.*	Assignment Type, Time Period, Emissions1-10
Report_EmissionsbyJunction	Emission Statistics for each node if EmissionStats = True.	Assignment Type, Junction Node, Emissions1-10
RAIL_Output_Emissions	The output non-road based emissions are written to this file if PTNets = True.	TimePeriod, Anode, Bnode, ID_flag, Emissions_Electric, Emissions_Diesel

3.7.2 ENEVAL also outputs a print file in the location specified in the control file. An example of an output print file can be seen in Appendix D.

3.7.3 If the Delta option has been turned on then a DELTA output file is also produced again in the location specified in the control file. An example DELTA output file is displayed in Appendix E.



3.8 Annualisation

3.8.1 Some of the data tables are automatically annualised most of the output reports are annualised by the database table ID_AnnualisationFactors_Yearly, this should contain one entry for each modelled time period. If DELTA outputs are required then ID_AnnualisationFactors_12hr is used, again this should contain factors for each modelled time period.

3.8.2 The Annualisation factors can be changed by making copies of these tables and inserting the required values into the tables. The original tables should be renamed and the new tables inserted with the correct table names.

3.8.3 The Annualisation factors are used by the stored procedures, which take the ENEVAL outputs and apply the factors to turn them into reports.

3.8.4 It should be noted that new annualisation factors should be set up for each study and the stored procedures may require alteration as a result.



4. OUTPUTS

4.1 Introduction

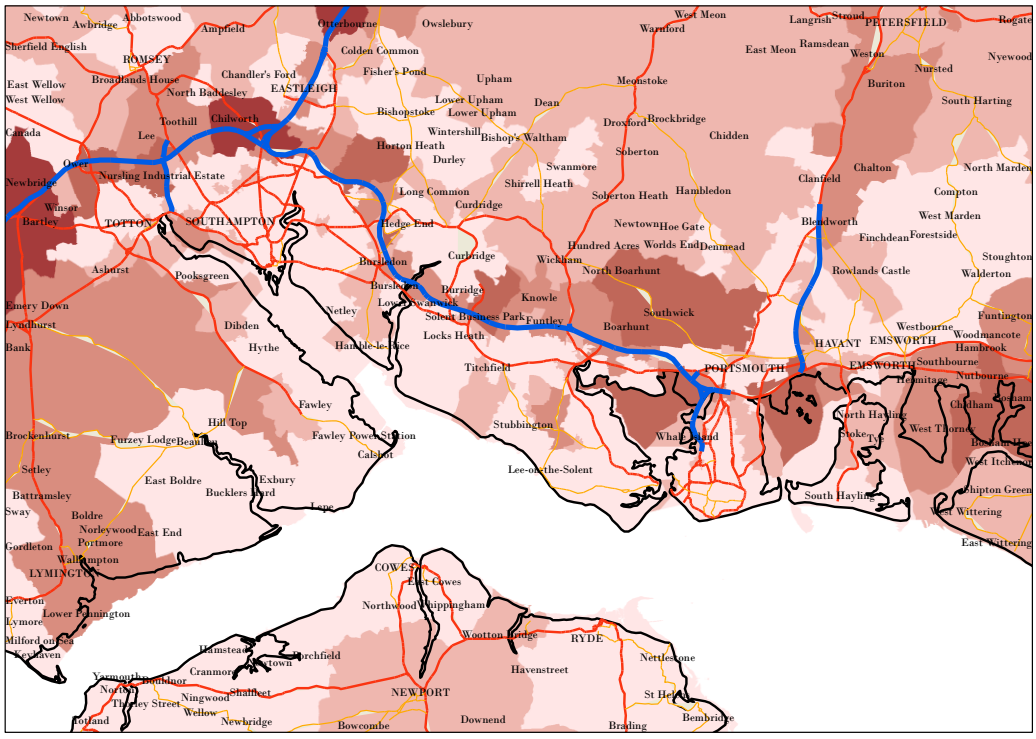
4.1.1 This section describes the possible outputs that can be obtained from the ENEVAL program. The previous section described the output tables which are created directly into the database by the ENEVAL program.

4.1.2 The output tables in the database can be exported to excel for additional analysis or can be analysed using queries directly in the database. Some standard queries have been set up, these are the Report output tables in the database.

4.2 Outputs

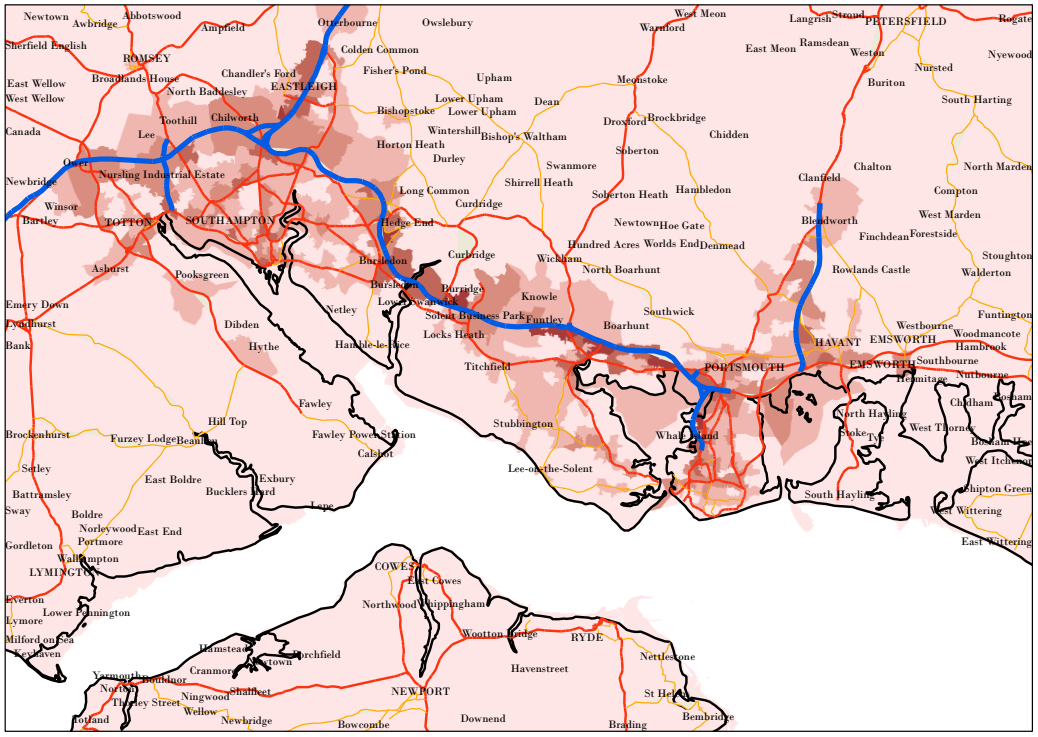
4.2.1 The following diagrams show examples of what additional analysis can be undertaken using the outputs from the ENEVAL program. These examples are all taken from the Transport for South Hampshire model for which this version of ENEVAL was initially developed.

4.2.2 The figure below shows the emissions mapped on a zonal basis. If **sector** = *True* when ENEVAL is run, the database will contain a table of emissions or vehicle hours and kilometres by sector (not necessarily zonal). These can then be taken directly into mapping software (eg ArcGIS) and mapped.



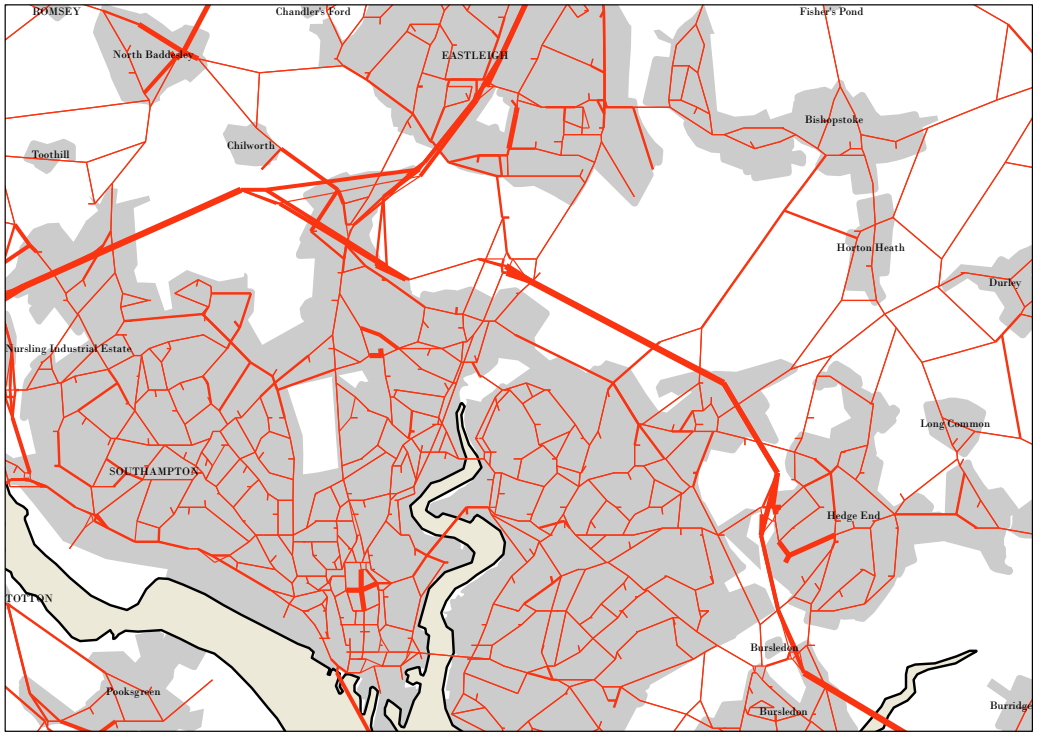
4.2.3 The figure below shows the same data as that above except that instead of total emissions it shows emissions per kilometre. In this case the emissions follow more closely the main roads.





4.2.4 The next figure below shows the emissions mapped by link. This is easy to do as the output table contains a Link_ID made up of the Anode and Bnode of each link. This can then be joined in mapping software to the network very easily. The example below shows thicker red links for those roads with higher emissions.





4.2.5 The tables below, show an example of the simple network wide summary data that can be extracted from the ENEVAL database. In this case it is Vehicle Hours, Vehicle Kilometres and Emissions for four different modelled time periods.

TimePeriod	Veh_Hrs	Veh_KM
1	68,291	3,101,264
2	41,049	2,178,822
3	65,654	2,901,490
4	12,369	725,604

TimePeriod	NOX	PM10	HC	CO	Carbon
1	1,877,961	66,225	189,536	2,410,368	701,921,812
2	1,493,520	49,110	122,720	1,650,712	496,559,687
3	1,601,902	58,629	175,515	2,241,146	642,969,430
4	490,760	16,238	37,418	538,385	161,779,653

4.2.6 Ultimately as the data is stored in databases by link and turn movement a large variety of maps, tables, graphs, queries can be undertaken by the user. There are far too many to describe here. This chapter merely gives the user a flavour for the types of analysis that can be undertaken with outputs from the ENEVAL program.

Appendix A - Example Control File

```
********************
* Example Input File
********************
*
RunID = DT_2010_withRail
*
* Database Connection Info
*
In_Server = cr5527
In_Database = ENEVAL_v9.0
In_Username = sa
In_Password = mva
Out_Server = cr5527
Out_Database = ENEVAL_v9.0
Out_Username = sa
Out_Password = mva
*
* Input Parameters
*
NumberAssignmentTypes = 1
NumberInputNets       = 1
JunctionFile          = True
PTNets                = True
ModelYear             = 2010
*
* Files
*
LinkFile(1,1)  =  C:\Working  Folder\xxx  -  Development\03  -
ENEVAL_C#_SQL\02  -  Database  Tables  Design\03  -  Model
Outputs\DT\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time
1_linkdumpfull.TXT
TurnFile(1,1)  =  C:\Working  Folder\xxx  -  Development\03  -
ENEVAL_C#_SQL\02  -  Database  Tables  Design\03  -  Model
Outputs\DT\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time
1_turndump_full.TXT
PtLkFile(1)   = C:\Databases\AM_VEH_KMS.DBF
EnvrFile(1)      =  C:\Working  Folder\xxx  -  Development\03  -
ENEVAL_C#_SQL\02  -  Database  Tables  Design\03  -  Model
Outputs\DT\Assignments\2010\Highway\Assignment\ENVR_DT_2010_WR.D
AT
PrntFile          =  C:\Working  Folder\xxx  -  Development\03  -
ENEVAL_C#_SQL\02  -  Database  Tables  Design\03  -  Model
Outputs\DT\Assignments\2010\Highway\Assignment\OUT_DT_2010_WR.PR
N
*
* Input Databases
*
Emissions_DB         = ID_Emissions
Fleet_DB             = ID_Fleet
UserClass_DB         = ID_Userclass
VehType_DB           = ID_VehType
RoadType_DB          = ID_RoadType
LinkType_DB          = ID_LinkType
```

```
AssignmentType_DB     = ID_Flag
TimePeriod_DB         = ID_TimePeriod
Emission_Coeff_DB     = PRM_Emissions_Coeff
Fuel_Scaling_DB       = PRM_FuelScaling
MileageFunction_DB    = PRM_MileageFunction
Mileage_DB            = PRM_Mileage
VehTypeSplit_DB       = PRM_FleetRoadType
FleetSplit_DB         = PRM_FleetSplit
CatFail_DB            = PRM_CatFail
CatFail_Lookup_DB     = PRM_CatFail_Lookup
TyreBreak_DB          = PRM_Tyres_and_Breaks
UserClass2VehType_DB = CONV_VehType2UC
VehType2Fleet_DB      = CONV_Fleet2VehType
LinkType2RoadType_DB = CONV_LinkType2RoadType
Sector_DB             = Model_SectorFile_DT_2010
Rail_Flag_DB          = RAIL_ID_FLAG
Rail_Factors_DB       = RAIL_Lookup_DefaultFactors
*
* Output Reports
*
Netstats = True
EmissionStats = True
DeltaFile = True
IncTandB = True
Sector = True
```

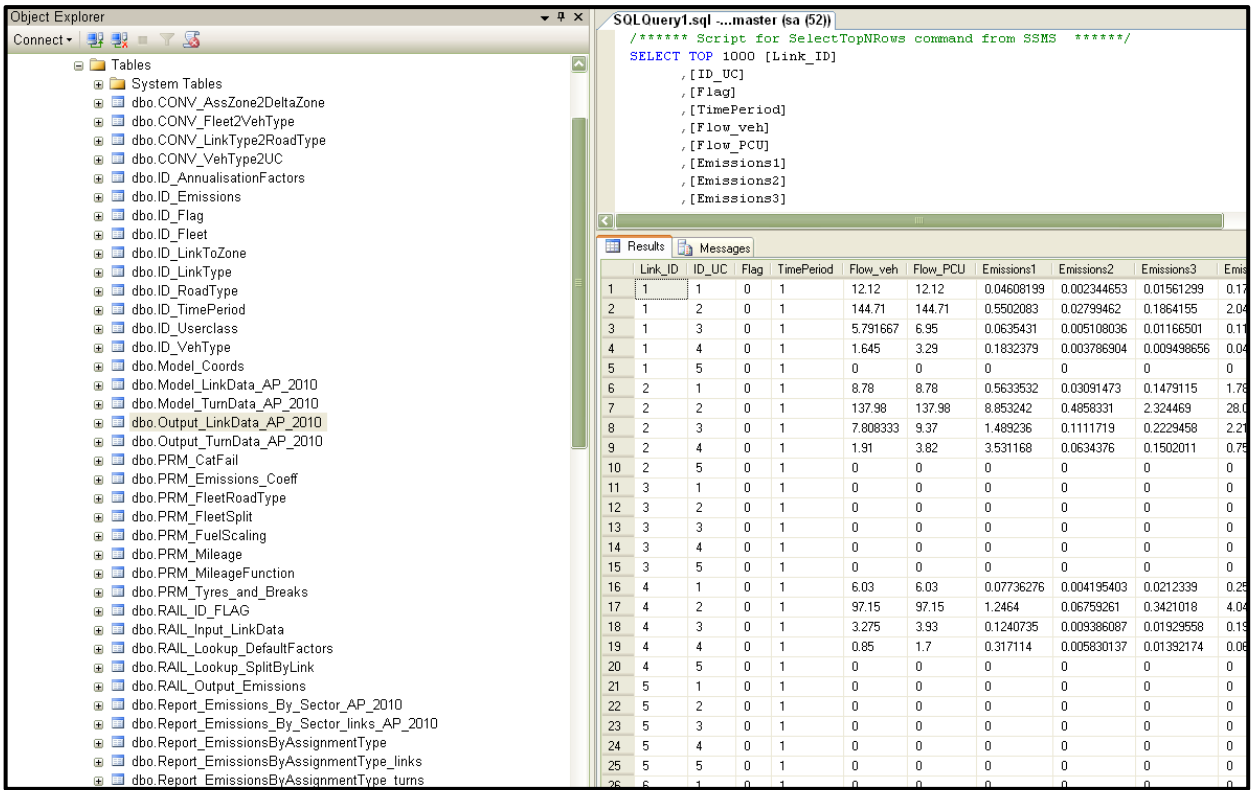
Appendix B - Example Input Link File

```
* Anode, Bnode, AssignemntType, LinkType, Capacity, Length,
FreeFlowTime, CongTime, UC1 Flow, UC2 Flow, UC3 Flow, UC4 Flow,
UC5 Flow
1124,1119,0.00,0,1200.00,0.05,0.11,0.11,7.44,78.29,20.09,1.95,0.0
1126,1121,0.00,0,1200.00,0.14,0.27,0.28,9.34,98.20,23.11,2.28,0.0
1128,1123,0.00,0,1200.00,0.06,0.12,0.13,12.47,129.71,13.31,5.14,0.
0
1119,1124,0.00,0,1355.39,0.05,0.12,0.34,6.43,22.71,2.96,0.32,0.0
11113,1124,0.00,0,1920.66,0.31,0.37,0.40,185.75,639.78,136.60,141.
14,0.0
11107,1124,0.00,0,1837.96,0.93,0.58,0.60,6.14,98.88,22.12,5.17,0.0
1132,1125,0.00,0,1200.00,0.07,0.14,0.14,1.39,13.54,1.29,0.47,0.0
1121,1126,0.00,0,2075.00,0.14,0.32,0.37,11.75,77.80,14.74,1.60,0.0
11529,1126,0.00,0,3071.02,1.63,4.06,4.10,0.00,0.00,0.00,0.00,0.0
11549,1126,0.00,0,1650.00,1.03,2.58,2.59,9.34,98.20,23.11,2.28,0.0
1130,1127,0.00,0,1200.00,0.08,0.15,0.15,6.83,68.83,6.47,3.31,0.0
1123,1128,0.00,0,2040.57,0.06,0.14,0.19,8.90,49.47,2.77,1.24,0.0
11105,1128,0.00,0,1758.60,1.07,0.66,0.69,2.33,22.75,2.20,0.49,0.0
11145,1128,0.00,0,1664.99,0.07,0.17,0.19,12.90,131.97,14.73,5.37,0
.0
1134,1129,0.00,0,1200.00,0.06,0.13,0.13,5.90,60.32,5.17,2.52,0.0
1127,1130,0.00,0,1793.95,0.08,0.17,0.26,13.01,170.89,26.26,29.31,0
.0
11555,1130,0.00,0,1847.66,0.33,0.82,0.85,31.69,193.37,32.85,33.50,
0.0
11143,1130,0.00,0,1807.76,0.35,0.88,0.90,20.31,73.62,9.66,8.72,0.0
1125,1132,0.00,0,2001.47,0.07,0.16,0.22,2.00,46.37,3.62,1.89,0.0
11151,1132,0.00,0,1703.62,0.68,1.69,1.72,5.15,42.88,5.80,2.48,0.0
11560,1132,0.00,0,1951.98,0.06,0.06,0.08,0.84,21.24,0.73,0.13,0.0
1138,1133,0.00,0,1200.00,0.05,0.11,0.11,9.70,92.81,10.35,5.04,0.0
11548,1134,0.00,0,1768.26,0.12,0.30,0.32,5.62,92.22,8.36,3.44,0.0
1129,1134,0.00,0,1948.09,0.06,0.15,0.21,12.77,207.84,26.56,27.73,0
.0
1210,1134,0.00,0,1881.53,0.46,1.14,1.16,0.28,64.35,10.85,5.57,0.0
1140,1135,0.00,0,1200.00,0.08,0.15,0.16,13.92,180.42,15.51,7.56,0.
0
11528,1136,0.00,0,2000.00,0.16,0.19,0.19,24.62,698.14,85.30,19.86,
0.0
11163,1136,0.00,0,2000.00,0.73,0.88,0.88,25.13,386.76,76.59,18.03,
0.0
11159,1137,0.00,0,1200.00,0.07,0.14,0.17,46.69,359.12,56.97,27.73,
0.0
1133,1138,0.00,0,2050.74,0.05,0.12,0.18,13.44,174.78,23.23,24.27,0
.0
```

Appendix C - Example Input Turn File

```
* Anode, Bnode, Cnode, AssignmentType, UC1 Flow, UC2 Flow, UC3 Flow, UC4 Flow, UC5 Flow
1119,1124,11113,0.00,0.05,1.02,5.33,0.39,0.05,0.0
1119,1124,11107,0.00,0.26,5.41,17.38,2.57,0.27,0.0
11113,1124,11107,0.00,0.04,180.91,600.40,128.38,140.79,0.0
11113,1124,1119,0.00,0.06,4.83,39.38,8.22,0.35,0.0
11107,1124,1119,0.00,0.02,2.61,38.91,11.87,1.60,0.0
11107,1124,11113,0.00,0.02,3.53,59.97,10.25,3.57,0.0
1121,1126,11529,0.00,0.05,0.00,0.00,0.00,0.00,0.0
1121,1126,11549,0.00,0.05,11.75,77.80,14.74,1.60,0.0
11529,1126,11549,0.00,0.02,0.00,0.00,0.00,0.00,0.0
11529,1126,1121,0.00,0.06,0.00,0.00,0.00,0.00,0.0
11549,1126,1121,0.00,0.02,9.34,98.20,23.11,2.28,0.0
11549,1126,11529,0.00,0.02,0.00,0.00,0.00,0.00,0.0
1123,1128,11105,0.00,0.05,0.02,1.19,0.03,0.00,0.0
1123,1128,11145,0.00,0.05,8.88,48.28,2.74,1.24,0.0
11105,1128,11145,0.00,0.02,2.16,19.02,1.96,0.49,0.0
11105,1128,1123,0.00,0.06,0.17,3.73,0.25,0.00,0.0
11145,1128,1123,0.00,0.02,12.30,125.98,13.06,5.14,0.0
11145,1128,11105,0.00,0.02,0.60,5.99,1.67,0.23,0.0
1127,1130,11555,0.00,0.05,0.00,0.00,0.00,0.00,0.0
1127,1130,11143,0.00,0.09,13.01,170.89,26.26,29.31,0.0
11555,1130,11143,0.00,0.02,30.30,168.76,30.60,32.60,0.0
11555,1130,1127,0.00,0.05,1.39,24.61,2.25,0.90,0.0
11143,1130,1127,0.00,0.02,5.44,44.22,4.22,2.41,0.0
11143,1130,11555,0.00,0.02,14.87,29.40,5.43,6.30,0.0
1125,1132,11151,0.00,0.05,0.96,22.43,3.25,1.80,0.0
1125,1132,11560,0.00,0.05,1.04,23.94,0.37,0.10,0.0
11151,1132,11560,0.00,0.02,3.87,31.87,4.54,2.01,0.0
11151,1132,1125,0.00,0.05,1.28,11.01,1.27,0.47,0.0
11560,1132,1125,0.00,0.02,0.11,2.53,0.02,0.00,0.0
11560,1132,11151,0.00,0.02,0.73,18.71,0.71,0.13,0.0
11548,1134,1129,0.00,0.02,5.62,54.47,5.13,2.52,0.0
11548,1134,1210,0.00,0.02,0.00,37.75,3.22,0.93,0.0
```

Appendix D – Example Database



The image above shows an example of the ENEVAL database with both input and output databases.

Appendix E – Example Output Print File

```
ENEVAL Print File 12/05/2015 09:28:29

*****************************************************************************

PARAMETERS

Database Name = ENEVAL_v9.0
Database Server = cr5706
Database User = sa

Junction Inputs / Outputs = False
Output Network Statistics = True
Output Emission Statistics = True
Output Delta File = True

Run ID = AQ_2010_NO_TURNS
Model Year = 2010
Number of Input Networks = 4
Number of Assignment Types = 1

FILES

 Print File = C:\Working Folder\xxx - Development\03 - ENEVAL_C#_SQL\02 - Database Tables
Design\03 - Model Outputs\AQ\Assignments\2010\Highway\Assignment\OUT_AQ_2010.PRN
 Assignment Type 1 Network File 1 = C:\Working Folder\xxx - Development\03 -
ENEVAL_C#_SQL\02 - Database Tables Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time1_linkdumpfull.TXT
 Assignment Type 1 Network File 2 = C:\Working Folder\xxx - Development\03 -
ENEVAL_C#_SQL\02 - Database Tables Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time2_linkdumpfull.TXT
 Assignment Type 1 Network File 3 = C:\Working Folder\xxx - Development\03 -
ENEVAL_C#_SQL\02 - Database Tables Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time3_linkdumpfull.TXT
 Assignment Type 1 Network File 4 = C:\Working Folder\xxx - Development\03 -
ENEVAL_C#_SQL\02 - Database Tables Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time4_linkdumpfull.TXT
 Assignment Type 1 Delta File = C:\Working Folder\xxx - Development\03 - ENEVAL_C#_SQL\02 -
Database Tables Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\ENVR_AQ_2010.DAT

 *****************************************************************************

 PROGRESS:

Link File C:\Working Folder\xxx - Development\03 - ENEVAL_C#_SQL\02 - Database Tables
Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time1_linkdumpfull.TXT Read
Successfully at 12/05/2011 09:28:29
Fleet Split Undertaken Successfully at 12/05/2011 09:28:29
Emissions Calculations Undertaken Successfully at 12/05/2011 09:29:19
Data Written to SQL Successfully at 12/05/2011 09:29:21
Link File C:\Working Folder\xxx - Development\03 - ENEVAL_C#_SQL\02 - Database Tables
Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time2_linkdumpfull.TXT Read
Successfully at 12/05/2011 09:29:21
Fleet Split Undertaken Successfully at 12/05/2011 09:29:22
Emissions Calculations Undertaken Successfully at 12/05/2011 09:30:11
Data Written to SQL Successfully at 12/05/2011 09:30:13
Link File C:\Working Folder\xxx - Development\03 - ENEVAL_C#_SQL\02 - Database Tables
Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time3_linkdumpfull.TXT Read
Successfully at 12/05/2011 09:30:13
Fleet Split Undertaken Successfully at 12/05/2011 09:30:13
Emissions Calculations Undertaken Successfully at 12/05/2011 09:31:03
Data Written to SQL Successfully at 12/05/2011 09:31:05
Link File C:\Working Folder\xxx - Development\03 - ENEVAL_C#_SQL\02 - Database Tables
Design\03 - Model
Outputs\AQ\Assignments\2010\Highway\Assignment\TfSH_RTM_Net_time4_linkdumpfull.TXT Read
Successfully at 12/05/2011 09:31:05
Fleet Split Undertaken Successfully at 12/05/2011 09:31:05
Emissions Calculations Undertaken Successfully at 12/05/2011 09:31:55
Data Written to SQL Successfully at 12/05/2011 09:31:56
Delta File Created Successfully at 12/05/2011 09:32:46
Output SQL Tables Created Successfully at 12/05/2011 09:34:01
```

```
Output Tables Created Successfully at 12/05/2011 09:34:01

 ENEVAL Completed Successfully 12/05/2011 09:34:01

 ********************************************************************************
```



Appendix F – Example DELTA File

```
================================================================
=================
 MVA/DSC DELTA environmental file
 >>>> Written 18/04/2011 09:29:57
 RUN TITLE - AP_2010

================================================================
=================
 ----------------------------------------------------------------
-----------------
 ENVR01: Environmental indicators by zone
 Measure       Zone       Value       -       measures       are
 VPH/KMS/SPD/CO/CO2/HC/NOX/PM10/VTM/FFTM per      hour
 ----------------------------------------------------------------
-----------------
    1     1  11530E+01
    1    19  86603.
    1    35  83465.
    1    36  62744.
    1    37  17039E+01
    1    38  34200.
    1    39  27127.
    1    40  29892.
    1    41  84407.
    1    42  63672.
    1    43  96732.
    1    44  30960.
    1    45  44198E+01
    1    46  21275E+01
    1    47  12130E+01
    1    48  85294.
    1    49  20818E+01
    1    50  13528.
    1    51  10773.
    1    52  45909.
    1    53  40181.
    1    54  23192E+01
    1    55  37836.
    1    56  19271.
    1    57  11554E+01
    1    58  46025.
    1    59  16200.
    1    60  90037.
    1    61  11605E+01
    1    62  14542E+01
    1    63  90376.
    1    64  31406.
    1    65  84283.
    1    66  19367.
0000000000000000000000000000000000000000000000000000000000000000
```

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