

## **New Zealand Transport Outlook**

### **VKT/Vehicle Numbers Model**

**November 2017**

#### **Short name**

VKT/Vehicle Numbers Model

#### **Purpose of the model**

The VKT/Vehicle Numbers Model projects New Zealand's vehicle-kilometres travelled (VKT) and number of vehicles in the fleet by region for five vehicle types for the years 2012/13-2042/43 in five-year increments.

#### **Software used**

Excel

#### **For questions and comments:**

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## **New Zealand Transport Outlook VKT/Vehicle Numbers Model**

### **1. At a high level, what does this model do?**

The VKT/Vehicle Numbers Model projects vehicle-kilometres travelled (VKT) and the number of vehicles in the fleet by region for five vehicle types for the years 2012/13-2042/43 in five-year increments. The five vehicle types are cars+SUVs, vans+utes, heavy trucks, heavy buses, and motorcycles. For cars+SUVs and vans+utes, further breakdowns are provided by primary use: household vehicles, commercial vehicles, and taxi/vehicle-share vehicles.

The model is heavily based on projections from the separately documented Transport Outlook Household Travel Model that provides projections of household (that is, non-commercial) travel, in person-kilometres, by various modes, including light-vehicle drivers, light-vehicle passengers, taxi/vehicle-share, local buses, and motorcycles.

Historical VKT estimates for 2012/13, 2013/14, and 2014/15 are designed to align as closely as possible with odometer readings from the New Zealand Motor Vehicle Register and road use from the New Zealand Transport Agency's (NZTA) Road Assessment and Management (RAMM) data. Historical vehicle numbers data are from the NZTA Motor Vehicle Register.

There are 14 regions in the model, with the Tasman, Nelson and Marlborough regions treated as a single region, labelled 'TNM'.

### **2. Where do I find the model results?**

The model consists of a single Excel workbook for each scenario to be modelled. In the workbook, the first eight sheets show the key outputs. The first sheet, labelled "Summary", shows total projected VKTs and vehicle numbers by vehicle type for all New Zealand. The second sheet, labelled "All Vehicle Types", shows VKTs for all vehicle types combined by region. It also shows vehicle numbers for all vehicle types combined for all New Zealand. It is not possible to show vehicle numbers for all types of vehicle types by region, since numbers of heavy trucks and heavy buses cannot be reliably calculated by region. The third sheet, labelled "All Light Vehicles" shows VKTs and vehicle numbers by region for all light vehicle types combined, which is the sum of "Car+SUV" and "Van+Ute".

These are followed by five sheets showing VKTs and the number of vehicles for "Car+SUV", "Van+Ute", "Heavy Truck", "Heavy Bus", and "Motorcycle". The "Car+SUV", "Van+Ute" and "Motorcycle" sheets show both VKTs and the number of vehicles by region. Heavy buses and heavy trucks, on the other hand, move between regions frequently and their region of registration often differs from where they are most commonly used. Therefore, the number of heavy trucks and heavy buses is reported only on an all New Zealand basis.

The "All Light Vehicles", "Car+SUV" and "Van+Ute" also show breakouts of VKTs and vehicle numbers by region into three categories of primary use: household vehicles, commercial vehicles, and taxi/vehicle-share vehicles.

### **3. What are the inputs to this model and where do they come from?**

As noted above, perhaps the most important inputs are from the Household Travel Model that gives projections from 2012/13 to 2042/43 in five-year increments of household (that is, non-commercial) person-kilometres (person-KM) travelled by light vehicle drivers, light vehicle passengers, taxi/vehicle-share, local bus, and motorcycle by region. This model also provides projections of household light vehicle ownership by region.

Projections of tonne-kilometres moved by heavy truck by region for 2012/13, 2022/23, 2032/33, and 2042/43 are taken from the separately documented Transport Outlook TonneKM by Region model. This model, in turn, is mostly driven by the Transport Outlook Freight Model.

Projections of GDP by region, as well as tourist days by region, for 2012/13 to 2042/43 in five-year increments are taken from the separately documented Transport Outlook Population and GDP model. That model is also the source of the assumptions on the share of household and commercial light vehicle travel diverted from private vehicles to taxi/vehicle-sharing.

Data for the historical years 2012/13, 2013/14 and 2014/15 comes from two main sources. First, data on total VKTs and the number of vehicles by vehicle type, region, and owner type (private, commercial or taxi) were taken from New Zealand Motor Vehicle Register. This data was compiled by Ministry of Transport staff directly from the New Zealand Motor Vehicle Register database for use with this model. The VKT data in the database was obtained from odometer readings that are made when each registered vehicle is inspected for a warrant of fitness. Second, NZTA RAMM data was used as a source of total VKTs on the roads of each region. This data was estimated from traffic counts compiled by NZTA and local authorities. The data was obtained from the NZTA website ([www.nzta.govt.nz/assets/userfiles/transport-data/VKT.html](http://www.nzta.govt.nz/assets/userfiles/transport-data/VKT.html)).

### **4. How does this model derive its results?**

#### **Historical VKT estimates**

Year 2012/13 VKT by vehicle type and region are estimated in the “Original 2012-13 data” and “Scaled 2012-13 Data” sheets. The starting values for vehicles other than heavy trucks are odometer data from the New Zealand Motor Vehicle Register which are assigned to regions based on the region where the vehicle is registered. Since heavy trucks typically do a great deal of travel outside their region of registration, a different approach is used for them. Heavy truck VKT in each region is estimated by multiplying total heavy truck VKT nationwide from the New Zealand Motor Vehicle Register by the fraction of heavy vehicle VKT on State highways (only) in each region according to the NZTA RAMM data. The NZTA does not publish a break-out of heavy vehicle traffic by region on roads other than State highways, so we have made the implicit assumption that the fraction of heavy truck VKT on State highways in each region is the same as the fraction of heavy truck VKT on roads other than State highways. A few records in the New Zealand Motor Vehicle Register are missing a region where the vehicle is registered. These are shown on the row of the “Original 2012-13 data” sheet labelled “Region Missing”.

We also want our estimates of VKT by vehicle type and region to be consistent with the NZTA data for total VKTs in each region. Therefore, in the “Scaled 2012-13 Data” sheet, the data on VKT by vehicle type in each region is scaled to match the NZTA RAMM data. To achieve as much consistency

as possible with both the RAMM data on VKTs by region and the New Zealand Vehicle Register data on VKTs by vehicle type nationwide, an algorithm known as ‘furnessing’ is used (see the discussion of the ‘Furness Distribution Model’ in [www.transportmodeller.com/distributionoverview.html](http://www.transportmodeller.com/distributionoverview.html)). This process repeatedly scales rows then columns to match their desired total values until both the row and column totals are sufficiently close to their desired values. The furnessing is done manually by following the instructions at the bottom of the “Scaled 2012-13 Data” sheet.

A similar process is used to obtain historical VKT data for 2013-14 in the “Original 2013-14 Data” and “Scaled 2013-14 Data” sheets, and to obtain historical VKT data for 2014-15 in the “Original 2014-15 Data” and “Scaled 2014-15 Data” sheets.

For vehicle type car+SUV, the historical VKT data by region is further broken out by vehicle usage into VKT for household car+SUV, commercial car+SUV, and taxi car+SUV (there is no vehicle sharing in the historical data). Car+SUV VKT by usage is estimated simply by multiplying the total car+SUV VKTs by region by the fraction of total car+SUV VKTs incurred by household (privately owned) car+SUV vehicles, commercial car+SUV vehicles or car+SUV taxis, as shown in the New Zealand Motor Vehicle Register odometer data. This breakout is done for household car+SUV vehicles in the “car+SUV” sheet, rows 49-63. For commercial car+SUV vehicles, the breakout is done in the “Vehicle Share Diversion Support” sheet, rows 66-80. For taxi car+SUV vehicles, the breakout is done in the “Car+SUV” sheet, rows 131-145.

An analogous breakout by vehicle usage is performed for vehicle type van+vte, mainly in the “Van+Ute” sheet. For commercial van+ute vehicles, the breakout is done in the “Vehicle Share Diversion Support” sheet, rows 86-100.

### **Historical vehicle number estimates**

Numbers of car+SUV vehicles by usage and van+ute vehicles by usage are taken from New Zealand Motor Vehicle Register data, with an adjustment that spreads the small number of vehicles that are missing region of registration data across regions in proportion to vehicles registered in the region. For car+SUV vehicles, this calculation is performed in the “Car+SUV” sheet, rows 69-84 (household vehicles), 110-124 (commercial vehicles), and 151-165 (taxi/vehicle share vehicles). For van+ute vehicles, the calculations are analogous and performed in the “Van+Ute” sheet.

For heavy trucks and heavy buses, there is no breakout of vehicle numbers by region, simply a national total, which is taken directly from the New Zealand Motor Vehicle Register. This is shown in row 28 of the ‘Heavy Truck’ and ‘Heavy Bus’ sheets, respectively.

For motorcycles, the calculations are analogous to those for car+SUV and van+ute vehicles, but there is no breakout by usage type as all motorcycles are assumed to be household usage type. These calculations are performed in rows 28-42 of the ‘Motorcycle’ sheet.

### **Car+SUV VKT projections**

Projections of car+SUV VKT by region are calculated as the sum of separate projections of household car+SUV, commercial car+SUV and taxi/vehicle-share car+SUV VKT. These calculations are made in the ‘Car+SUV’ sheet on rows 49-63, 90-104, and 131-145, respectively.

Generally, projections of household car+SUV VKT are made simply by growing estimated 2014/15 household car+SUV VKT with the growth of driver person-KM from the Household Travel Model. These VKTs are shown in the “Light Vehicle Supporting Data” sheet, rows 47-61. However, the model has a feature that allows the user to change the assumed household vehicle occupancy, if desired, and model results will then reflect the impact of this change on VKTs. VKTs will fall inversely with the assumed increase in vehicle occupancy. The household vehicle occupancy calculations can be turned on in the “Household Vehicle Occupancy” sheet, cells C2:C4. If this feature is turned on, the user may enter the assumed vehicle occupancy by region in the areas that will turn yellow further down in this sheet. For household usage, any diversion of VKTs from household vehicles to taxi/vehicle-share vehicles is performed in the Household Travel Model, and thus does not affect the calculations in the VKT/vehicle numbers model.

For commercial usage, however, any diversion of VKTs to taxi/vehicle sharing must be done in the VKT/Vehicle Numbers Model. To calculate commercial car+SUV VKTs, the projection is first performed assuming no diversion. Commercial car+SUV VKTs in each region are assumed to grow with the GDP in each region. These calculations are performed in rows 66-80 of the “Vehicle Share Diversion Support” sheet. Then, in rows 90-104 of the “Car+SUV” sheet, the fraction of VKTs diverted to taxi/vehicle share is removed. The assumed percentage diversion is shown in rows 106-119 of the “Vehicle Share Diversion Support” sheet.

VKTs for taxi/vehicle share car+SUV are perhaps the most complex calculations in the model. At a high level, it consists of the sum of three components, representing:

- the continued growth of traditional taxi services using car+SUV vehicles
- household car+SUV VKTs, which may be diverted to vehicle sharing, depending upon the scenario being modelled
- commercial Car+SUV VKTs, which may be diverted to vehicle sharing, depending upon the scenario being modelled.

The market for traditional taxi services is assumed to consist of three sub-markets: household, tourist, and commercial. The assumed share of the taxi VKTs for 2014/15 that are household, tourist, and commercial are shown in the ‘Taxi-Vehicle Share Supporting D’ sheet in cells D218:D220, respectively, and have been assigned the variable names Taxi\_Household\_Share, Taxi\_Tourist\_Share and Taxi\_Commercial\_Share, respectively. These shares are used to estimate the 2014/15 taxi VKTs by sub-market.

For the future, household taxi VKTs are assumed to grow with the projected growth of taxi person-KMs projected by the Household Travel Model. This growth is shown in rows 116-129 of the ‘Taxi-Vehicle Share Supporting D’ sheet. Tourist taxi VKTs are assumed to grow with the growth of tourism vehicle days, which are shown in row 28 of the ‘Heavy Bus Supporting Data’ sheet. Commercial taxi VKTs are assumed to grow with the growth of regional GDP in each region, which comes from the Population and GDP model.

Traditional taxi VKTs for all three components are adjusted for any assumed change in taxi/vehicle share vehicle occupancy, as shown in rows 89-102 of the ‘Household Vehicle Occupancy’ sheet. The usual default here, if cell C4 of this sheet is set to TRUE, is to set taxi vehicle occupancy equal to the assumed occupancy of household vehicles from the Household Travel Model, as shown in rows 10-

24 of the 'Household Vehicle Occupancy' sheet. However, by setting cell C4 of this sheet to FALSE, users may enter their own assumptions for taxi/vehicle share occupancy in rows 70-83 of the 'Household Vehicle Occupancy' sheet.

Total household vehicle VKTs to be diverted to vehicle sharing are shown in rows 95-109 of the 'Taxi-Vehicle Sharing Supporting D' sheet. These are based on the diverted household vehicle person-KMs shown in rows 53-67 of the 'Taxi-Vehicle Sharing Supporting D' sheet, which are derived from Household Travel Model data, divided by an assumed vehicle occupancy from rows 89-102 of the 'Household Vehicle Occupancy' sheet.

There may also be an additional adjustment if cell C2 of the 'Taxi-Vehicle Share Supporting D' sheet is set to TRUE. This multiplier depends upon the region, as shown in rows 11-25 of the 'Taxi-Vehicle Share Supporting D' sheet. It accounts for the fact that there is not an exact match between 2014/15 household vehicle VKTs (equal to driver person-KM) from the Household Travel Model and VKTs of private light vehicles from the Motor Vehicle Register data. This adjustment ensures that the projections are as consistent as possible with the historical VKT data from the Motor Vehicle Register and ensures that total VKTs do not generally change when the fraction diverted changes in both the VKT/Vehicle Numbers Model and the Household Travel Model.

To be more specific regarding the diverted household vehicle person-KMs shown in rows 53-67 of the 'Taxi-Vehicle Sharing Supporting D' sheet, these are inferred from the Household Travel Model results for driver person-KM, passenger person-KM (both *after* diversion), and the fraction of household vehicle VKTs diverted to vehicle share. Taxi/vehicle share person-KM from the Household Travel Model cannot be used for this calculation, since it includes conventional taxis as well as household vehicle VKTs diverted to vehicle share.

Household car+SUV VKTs to be diverted to vehicle sharing are obtained simply by multiplying the total household light vehicle VKTs to be diverted to vehicle sharing by the fraction of household light vehicle VKTs that are car+SUV.

Total commercial car+SUV VKTs diverted to vehicle sharing are estimated simply by multiplying the total commercial car+SUV VKTs shown rows 66-80 of the "Vehicle Share Diversion Support" sheet (see third paragraph of this section above) by the assumed percentage share of VKTs diverted to vehicle sharing shown in rows 106-119 of the 'Vehicle Share Diversion Support' sheet.

### **Car+SUV number projections**

Projections of car+SUV vehicle numbers by region are calculated as the sum of separate projections of household car+SUV, commercial car+SUV, and taxi/vehicle-share car+SUV vehicle numbers. These calculations are made in the 'car+SUV' sheet on rows 69-83, 110-124, and 151-165, respectively.

Projections of household car+SUV vehicle numbers are made simply by growing estimated 2014/15 household car+SUV vehicle numbers with the growth of total household vehicle numbers after diversion to taxi/vehicle sharing. These are shown in the 'Vehicle Share Diversion Support' sheet, rows 27-41. The Household Travel model produces projections of the number of household vehicles before any diversion to vehicle sharing, as shown in rows 6-20 of the 'Vehicle Share Diversion Support' sheet. The calculations in rows 27-41 assume that the reduction in the number of

household vehicles due to diversion to vehicle sharing will be in direct proportion to the assumed reduction in household vehicle VKTs.

Projections of commercial car+SUV vehicle numbers are made simply by growing estimated 2014/15 commercial car+SUV numbers with the growth in commercial car+SUV VKT, calculated as discussed above. Similarly, projections of taxi/vehicle share car+SUV vehicle numbers are made simply by growing estimated 2014/15 taxi/vehicle-share car+SUV numbers with the growth in taxi/vehicle share car+SUV VKT, calculated as discussed above.

### **Van+Ute VKT projections**

The van+ute VKT projections by region are shown in the 'Van+Ute' sheet and are totally analogous to the car+SUV Projections. The layout and formulas in the 'Van+Ute' sheet are essentially identical to that of the 'Car+SUV' sheet discussed above.

As with commercial car+ute VKTs, commercial van+ute VKTs in each region are assumed to grow with GDP in each region. These calculations are performed in rows 86-100 of the 'Vehicle Share Diversion Support' sheet.

Van+ute household light vehicle VKTs to be diverted to vehicle sharing are obtained simply by multiplying the total household light vehicle VKTs to be diverted to vehicle sharing by the fraction of household light vehicle VKTs that are van+ute.

Total commercial van+ute VKTs diverted to vehicle sharing are estimated simply by multiplying the total commercial van+ute VKTs shown in rows 86-100 of the "Vehicle Share Diversion Support" sheet by the assumed percentage share of VKTs diverted to vehicle sharing shown in rows 106-119 of the 'Vehicle Share Diversion Support' sheet.

### **Van+Ute number projections**

The van+ute vehicle number projections by region are shown in the 'Van+Ute' sheet and are totally analogous to the car+SUV Projections. The layout and formulas in the 'Van+Ute' sheet are essentially identical to that of the 'Car+SUV' sheet discussed above.

### **Heavy truck VKT projections**

Heavy truck VKT projections by region are shown in the 'Heavy Truck' sheet. They are obtained by growing the 2014/15 heavy truck VKT by the growth of heavy truck tonne-km in each region from the Freight Tonne-KM by Region Model. These, in turn, were calculated from the region-to-region freight flows projected by the Freight Model. There is an additional adjustment for changes in average tonnes per truckload, with heavy truck VKTs varying inversely with the growth of average tonnes per truckload. An index of heavy truck average tonnes per truckload, where 2014/15 = 1.0, is entered in row 28 of the 'Heavy Truck Supporting Data' sheet.

### **Heavy truck number projections**

Total heavy truck number projections are also shown in the 'Heavy Truck' sheet. They are obtained by growing the 2014/15 total heavy truck numbers by the growth of total heavy truck tonne-km from the Freight Tonne-KM by Region Model, discussed above. As with VKT, there is an additional

adjustment for changes in average tonnes per truckload, with heavy truck numbers varying inversely with the growth of average tonnes per truckload.

### **Heavy bus VKT projections**

Heavy bus VKT projections by region are shown in the 'Heavy Bus' sheet. Heavy buses are assumed to serve two markets: public transport and tourism.

An assumed fraction of heavy bus VKT that was public transport in 2014/15 in each region is calculated in the 'Heavy Bus Supporting Data' sheet, rows 35-50. These calculations adjust for the fact that the public transport heavy bus VKT data available from NZTA excludes school services, which are a significant component of public transport bus services. An estimate of the volume of school services in each region may be obtained by comparing the Household Travel Survey estimate of public transport bus boardings, which include school services, to the NZTA statistics on public transport bus boardings, which do not. However, the Household Travel Survey estimates are subject to significant sampling errors and, in some regions, would give absurdly high percentages of heavy bus VKTs that are public transport. Hence, the fraction of heavy bus VKTs that are for public transport was capped at 50% in all regions except Wellington, where it may actually be more than 50%. These figures are very approximate.

Public transport heavy bus VKT is estimated by growing the 2014/15 public transport heavy bus VKT by the projected growth in public transport bus person-KM from the Household Travel Model. Tourism heavy bus VKT is estimated by growing the 2014/15 tourism bus VKT by the projected growth in overseas tourism visitor days from the Population and GDP Model. This growth is shown as an index, where 2012/13 = 1.0 in row 28 of the 'Heavy Bus Supporting Data' sheet.

### **Heavy bus number projections**

Total heavy bus number projections are also shown in the 'Heavy Bus' sheet. They are obtained by an approach analogous to the heavy bus VKT projections, but at a national level. Public transport heavy bus numbers are estimated by growing the 2014/15 public transport heavy bus numbers by the projected growth in public transport bus person-KM from the Household Travel Model. Tourism heavy bus numbers are estimated by growing the 2014/15 tourism bus VKT by the projected growth in overseas tourism visitor days from the Population and GDP Model.

### **Motorcycle VKT projections**

Motorcycle VKT projections by region are shown in the 'Motorcycle' sheet. They are obtained by growing the 2014/15 motorcycle VKT by the projected growth of motorcycle person-KM from the Household Travel Model.

### **Motorcycle number projections**

Motorcycle number projections by region are shown in the 'Motorcycle' sheet. They are obtained by growing the 2014/15 motorcycle numbers by the projected growth of motorcycle person-KM from the Household Travel Model.