ENERGY-SECTOR BRIEF

Maintenance Division, Roadway Asset Management

16-09 TRAFFIC LOADS FOR SEGMENT AND CORRIDOR-LEVEL ANALYSES

Traditional pavement design requires the estimation of 18-kip equivalent single axle loads (ESALs). This energy sector brief describes a geographic information system (GIS)-based methodology to estimate truck volumes and ESALs at the individual roadway segment level for any number of oil or gas wells that are developed and operated in a geographic area. Other energy sector briefs and an implementation report (IR-16-04) provide details associated with the underlying methodology. This report and related documents are available on the TxDOT Maintenance Division (MNT) SharePoint site at https://txdot.sharepoint.com/sites/division-MNT/SitePages/Home.aspx

TRAVEL DEMAND MODELING APPROACH AND ASSUMPTIONS

Four-step travel demand modeling includes trip generation, trip distribution, mode choice, and route assignment components. Because the main goal of the modeling effort was to determine truck volumes and ESALs for pavement maintenance and design purposes, only trips requiring trucks were included in the analysis. Specific assumptions and modeling approach for the trip generation, trip distribution, and route assignment components follow:

- **Trip Generation.** This step determines the number of trips associated with wells (i.e., trip productions) and material and service providers (i.e., trip attractions). For trip productions, the number of trips corresponds to the number of trucks needed for each well development or operation activity. For trip attractions, suppliers are assumed to have sufficient capacity to address well development and operation activities.
- **Trip Distribution.** This step determines the number of trips between each trip production and each trip attraction. A mathematical model determines the number of trips between each well and supplier.
- **Route Assignment.** This step assigns truck trips between trip productions and attractions to routes based on certain rules. An all-or-nothing assignment technique is used for this purpose. With truck trips assigned to routes, the last step was to convert the assigned number of trips on each roadway segment to ESALs using the ESAL calculations for individual truck types, as described in Implementation Report IR-16-03.

Because pavement impacts vary depending on whether a truck is loaded or unloaded, the travel demand modeling effort accounted for specific characteristics of individual trips for each well development phase activity and direction of travel. The analysis period was 20 years, including the original development of a well, production over 20 years, and re-fracking events.

CASE STUDY IN KARNES COUNTY

A case study using wells completed in 2013 in Karnes County was used to evaluate the feasibility of the modeling approach. The analysis was conducted using TransCAD 7.0.

A first set of runs involved determining ESALs due to the development and operation of one random well over a 20-year analysis period. In the immediate vicinity of the well, the total number of ESALs was 10,757 for trips to the well and 15,059 for trips from the well. The total number of ESALs decreased as the roadway segments were farther away from the well. A second set of runs involved increasing the numbers of wells to 10, 100, 200, and 493 (i.e., the same number of wells completed in 2013). Figure 2 shows the spatial distribution of ESALs for the 493-well scenario.

CASE STUDY IN KARNES COUNTY (continued)

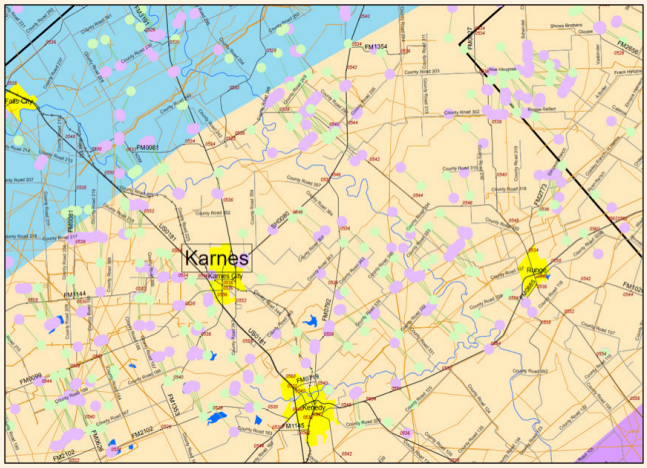

Figure 1. Wells Completed in Karnes County in 2013.

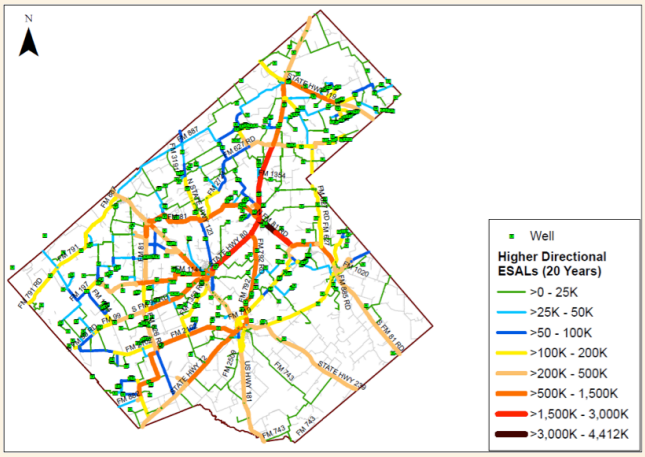

Figure 2. ESAL Distribution for Developing and Operating 493 Wells in Karnes County.

For comparison purposes, Figure 3 shows the spatial distribution of ESALs listed in the TxDOT Road-Highway Inventory Network (RHiNo) database. Of particular interest are corridors where the cumulative ESALs in Figure 2 are higher than the corresponding ESALs listed in the RHiNo database. Examples include FM 81, SH 80 south of FM 627, FM 1144, FM 1353, and FM 2102.

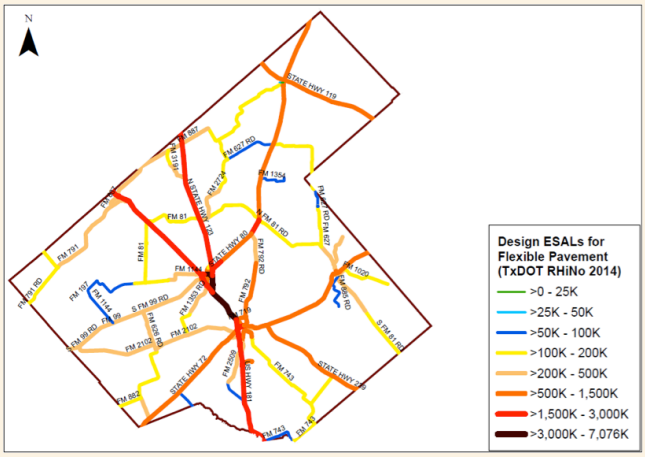

Figure 3. ESALs According to the TxDOT RHiNo Database.

APPLICABILITY OF THE METHODOLOGY

The methodology described in this report enables users to map truck traffic in connection with energy developments to the surface transportation network in the state. Examples of potential applications of the methodology include, but are not limited to, the following:

- Forecast the distribution of ESALs due to the development and operation of any number of wells. For wells that are in the development stage, analyses can be conducted to evaluate the future impact due to well development, operation, and re-fracking on the transportation network. For wells that are in production, the analysis can focus on future impact due to well production and re-fracking activities. It could also be of interest to determine how the distribution of ESALs evolves over time during the development, production, and re-fracking phases of multiple wells. The methodology enables users to forecast distributions of ESALs by aggregating ESALs associated with each well during the analysis period.
- Evaluate alternative scenarios by conducting sensitivity analyses. One potential application could be to evaluate the reduction in truck traffic impact on the transportation network resulting from various temporary water pipe implementations.
- Forecast the spatial distribution of ESALs in urban areas due to well developments that take place in rural areas. One potential application could be to determine the need and feasibility of alternative truck routes.

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