



# **Heavy-Highway Emission Inventory Update – 2018**

## **Final Report**

**Prepared for:**

**Capital Area Council of  
Governments**

**Prepared by:**

**Eastern Research Group, Inc.**

**December 13, 2013**



## Heavy-Highway Emission Inventory Update - 2018

### Final Report

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## **1.0 Introduction**

The purpose of this study was to develop site-specific emission inventory estimates for heavy-highway construction projects performed in the five county Austin-Round Rock Metropolitan Statistical Area (MSA) during 2018. These counties include Bastrop, Caldwell, Hays, Travis and Williamson.

Under previous studies,<sup>1, 2</sup> Eastern Research Group, Inc. (ERG) worked with the Capital Area Council of Governments (CAPCOG) to obtain historical highway project information through Texas Department of Transportation (TxDOT) including project location, lane-miles, contract value, start and end dates, and equipment use in the study area. This information was used to develop a profile of equipment use and emissions for diesel construction equipment greater than 25 hp used in heavy-highway construction. The study focused on construction equipment included in the heavy-highway construction profile in the Texas Commission on Environmental Quality's (TCEQ's) TexN emissions model, including<sup>3</sup>:

- Crawler Tractor/Dozers;
- Surfacing Equipment;
- Excavators;
- Pavers;
- Paving Equipment;
- Rollers;
- Scrapers;
- Tractor/Loader/Backhoes; and
- Rubber Tire Wheeled Loaders.

In the prior studies ERG categorized projects into five categories, based on general TxDOT project description, including:

- Bridgework;
- New/Rebuild;
- Repair/Resurface;
- Turn lane addition; and
- Miscellaneous.

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<sup>1</sup> "Heavy-Highway Emission Inventory Update", Eastern Research Group, Inc., for CAPCOG, April 9, 2013.

<sup>2</sup> "Heavy-Highway Emission Inventory Update - 2012", Eastern Research Group, Inc., for CAPCOG, May 31, 2013.

<sup>3</sup> Although other diesel equipment is used during heavy-highway construction, such as skid steer loaders and rough terrain forklifts, the emissions associated with these equipment types are characterized in separate profiles within the TexN model, and are therefore excluded to avoid double-counting in the emission inventory.

These project categories were developed to capture the diverse types of equipment applications used in heavy-highway projects in the study area.

Under the previous studies, project-specific equipment use information was obtained from Daily Work Reports (DWR) submitted to TxDOT, indicating the type and number of equipment units utilized on-site for a given day. ERG used the DWR data, combined with other project information including lane-miles of construction and contract dollar value to develop equipment use profiles by project type. Activity profiles differed by project type, with equipment activity expressed in terms of number of piece-days required per lane-mile (for New/Rebuild, Repair/Resurface, and Turn Lane Addition profiles), and the number of piece-days required per million dollars of contract value (for the Bridgework and Miscellaneous profiles). These profiles were then combined with the corresponding lane-mile and contract value information for the 2006, 2008 and 2012 area projects to estimate the number of pieces of equipment used per day, by equipment type.

Under the current study, ERG compiled project data for highway construction projects anticipated to be underway during 2018 in the five county CAPCOG area. Future project activity was obtained from TxDOT, the Capital Area Metropolitan Planning Organization (CAMPO), and the Central Texas Regional Mobility Authority (CTRMA). Project locations and descriptions from these sources were cross-referenced to develop an integrated project list, without double-counting. ERG combined the equipment population estimates from this project list with information from the TexN model regarding horsepower distributions, engine load factors, and average hours of use per day to estimate the total horsepower-hours associated with each construction project for the summer of 2018.

ERG then input the resulting equipment population and hours of use estimates into the TCEQ's TexN model to estimate project-specific ozone-season day emissions for each of the projects, for 2018. "Grouped" projects (general project types with aggregated contract value estimates, obtained from CAMPO) did not have an assigned location, and had their equipment population and activity profiles aggregated and input into TexN to produce region-level emissions estimates. These estimates for grouped projects were then allocated down to the county level based on the total number of lane-miles in each county.

ERG provided the resulting project-specific emissions information, along with geocoded endpoint latitude and longitude, in order to facilitate ozone modeling for the 2018 calendar year. Separate estimates were provided for both ozone summer weekday and annual scenarios. Total ozone season day emissions estimates for all project activity were also provided in NIF and XML formats for uploading into the TCEQ's TexAER

system. In addition, ERG updated the TexN MySQL database for heavy-highway equipment populations for the five county area in 2018 using the results of this assessment.

The following sections summarize the data analysis methodology, noting any differences adopted relative to the prior ERG studies, as well as the estimated emission levels.

## **2.0 Data Collection and Processing**

ERG contacted TxDOT, CAMPO and CTRMA to obtain information for projects planned for the five county region through 2018. TxDOT's Austin District office<sup>4</sup> provided ERG with an electronic file containing information on 56 projects, including:

- Description (e.g., Bridgework, rehab, etc.)
- Location (roadway with start/end points)
- Estimated project value
- Lane-miles
- County
- Project duration (anticipated start/end dates)

ERG filtered this list so as to include only those projects that were anticipated to be active in 2018, leaving 25 projects for further evaluation.

ERG also contacted CTRMA to obtain information on design-build projects anticipated for 2018. CTRMA only identified one project, the Bergstrom Expressway, that was expected to be ongoing during this time. CTRMA provided anticipated start and end dates and contract value for this project.<sup>5</sup> ERG obtained information regarding the number of planned lanes and the centerline miles from the project website.<sup>6</sup>

In addition, CAPCOG provided ERG with a detailed project list from CAMPO for both Regional and Local projects.<sup>7</sup> This list contained the same data fields as the TxDOT data, with the exception of lane-miles. This list also noted the funding source ("Sponsor") for each project. ERG filtered the list to exclude Sponsors other than TxDOT (or TxDOT partnerships such as TxDOT/Hays County), or Sponsor designations of "Various". (With the exception of CTRMA projects, only TxDOT funded projects are included in the Heavy-Highway designation in the TexN model. Other locally funded projects are included in TexN's City/County Road subsector.)

The CAMPO list designated several projects as "grouped". These projects identified a pool of funds earmarked for specific types of future roadway projects, such as preventative maintenance, without identifying specific locations. Of the six grouped project categories, ERG excluded four from consideration as they are not expected to include significant diesel equipment use (i.e., Bicycle and Pedestrian, Safety and Operations, Public Transportation O&M, and Landscaping Enhancements). The remaining two grouped projects were retained for further assessment (Roadway

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<sup>4</sup> File received from Ed Collins, TxDOT, October 31, 2013.

<sup>5</sup> Personal communication with Sean Beal, CTRMA, November 2013.

<sup>6</sup> <http://www.bergstromexpressway.com/>, last verified December 12, 2013.

<sup>7</sup> CAMPO 2035 Plan Priority Projects List, last amended June 10, 2013.



## Preventative Maintenance and Rehabilitation, and Bridge Replacement and Rehabilitation/Railroad Grade Separations)

Next ERG filtered the CAMPO list to exclude all projects with an open date before 2018, and a project let date after 2018. Remaining projects were then cross-referenced with the TxDOT and CTRMA project lists and duplicate projects were removed. ERG then contacted CAMPO to review the short list of remaining six projects. Of these projects, one (CAMPO project ID #40, 6-lane turnpike construction at the "Y" at Oak Hill) was determined to be a potential CTRMA funded project rather than TxDOT-funded.<sup>8</sup> As CTRMA did not identify this project as likely to be underway in 2018, it was dropped from the evaluation list. The remaining five projects (three cosponsor projects with TxDOT and the two grouped projects discussed above) were retained. When combined with the TxDOT and CTRMA lists, 31 projects were included in the final project list (see Table 2-1).

As noted above the projects identified from the CAMPO list did not have lane-mile data provided. Using GIS data combined with the road segment endpoints, ERG estimated centerline miles for each of the three non-grouped projects. ERG then multiplied the centerline mile information with the number of lanes specified in the project description to determine lane-miles for these projects.

Many of the projects identified in the list span multiple years. ERG apportioned the total contract value and total lane-mile estimates linearly across all years to estimate the fraction of dollars and lane-miles for the 2018 calendar year, also shown in Table 2-1.

Based on discussions with CAMPO, ERG assumed that some fraction of the two "grouped" projects were already accounted for in the TxDOT project list. In order to avoid double-counting of project activity, ERG subtracted the estimated 2018 contract value for all bridgework projects on the TxDOT list from the total 2018 contract value for the CAMPO Bridge Replacement and Rehabilitation grouped project (\$8,84M - \$4.21M) to obtain the estimated contract value of \$4.63M for bridgework unaccounted for in the TxDOT list. Similarly, ERG subtracted the 2018 contract value for TxDOT repair/resurfacing projects from the corresponding CAMPO estimate for the Roadway Preventative Maintenance and Rehabilitation grouped project (\$56.92M - \$20.12M = \$36.80M).

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<sup>8</sup> Personal communication, Cathy Stephens, CAMPO, December 6, 2013.

**Table 2-1. 2018 Heavy-Highway Project List**

ERG ID	Data Source	County	Route	ERG Project Category	Contract Value	Lane mi	2018 Value	2018 Ln-mi
18-1	TxDOT	Caldwell	SH 21	Repair/Resurface	\$760,970	1.02	\$322,293	0.43
18-2	TxDOT	Caldwell	FM 713	Bridgework	\$930,200	0.57	\$527,478	0.32
18-3	TxDOT	Caldwell	FM 671	Bridgework	\$706,100	0.2	\$400,400	0.11
18-4	TxDOT	Caldwell	FM 671	Bridgework	\$501,800	0.4	\$284,550	0.23
18-5	TxDOT	Bastrop	US 290	New/Rebuild	\$32,800,000	31.2	\$15,135,272	14.40
18-7	TxDOT	Bastrop	SH 21	Bridgework	\$1,250,000	0.2	\$708,824	0.11
18-8	TxDOT	Bastrop	SH 21	Bridgework	\$250,000	0.2	\$141,765	0.11
18-9	TxDOT	Williamson	FM 112	Repair/Resurface	\$11,100,000	22.72	\$4,869,960	9.97
18-10	TxDOT	Williamson	FM 619	Repair/Resurface	\$5,294,000	11.7	\$2,322,664	5.13
18-11	TxDOT	Williamson	IH 35	New/Rebuild	\$7,000,000	7.54	\$4,649,635	5.01
18-12	TxDOT	Williamson	SH 95	Bridgework	\$350,000	0.2	\$198,471	0.11
18-13	TxDOT	Travis	Lund Carlson Rd	Bridgework	\$450,000	0.2	\$255,176	0.11
18-14	TxDOT	Williamson	CR 258	Bridgework	\$1,620,000	0.2	\$918,635	0.11
18-15	TxDOT	Williamson	CR 126	Bridgework	\$700,000	0.2	\$396,941	0.11
18-16	TxDOT	Travis	FM 969	Turn Lanes	\$7,740,000	8.38	\$3,707,053	4.01
18-17	TxDOT	Travis	FM 969	Repair/Resurface	\$5,810,000	7.47	\$2,790,329	3.59
18-18	TxDOT	Travis	CR 416	Bridgework	\$700,000	0.2	\$373,924	0.11
18-19	TxDOT	Travis	LP 343	Repair/Resurface	\$430,100	3.36	\$284,625	2.22
18-20	TxDOT	Travis	LP 360	Repair/Resurface	\$1,343,500	16	\$889,081	10.59
18-21	TxDOT	Hays	RM 2325	Repair/Resurface	\$900,000	19.55	\$595,588	12.94
18-22	TxDOT	Hays	RM 3237	Repair/Resurface	\$1,006,300	18.35	\$665,934	12.14
18-23	TxDOT	Hays	FM 2439	Repair/Resurface	\$303,700	1.6	\$200,978	1.06
18-24	TxDOT	Hays	SH 21	Repair/Resurface	\$3,000,000	31.53	\$2,394,737	25.17
18-25	TxDOT	Caldwell	SH 21	Repair/Resurface	\$3,000,000	10.38	\$2,394,737	8.29
18-26	TxDOT	Bastrop	SH 21	Repair/Resurface	\$3,000,000	27.69	\$2,394,737	22.10
18-27	CTRNA	Travis	US 183	New/Rebuild	\$653,000,000	96	\$130,528,478	19.19
18-30	CAMPO	Hays	US 290 W	New/Rebuild	\$8,000,000	17.48	\$4,005,487	8.75
18-31	CAMPO	Williamson	RM 1431	New/Rebuild	\$3,033,333	14.96	\$433,164	2.14

<b>ERG ID</b>	<b>Data Source</b>	<b>County</b>	<b>Route</b>	<b>ERG Project Category</b>	<b>Contract Value</b>	<b>Lane mi</b>	<b>2018 Value</b>	<b>2018 Ln-mi</b>
18-32	CAMPO	Williamson	US 79	New/Rebuild	\$1,436,998	3.18	\$205,205	0.45
18-33	CAMPO	Grouped	N/A	Repair/Resurface	\$56,920,000	N/A	\$2,370,043	N/A
18-34	CAMPO	Grouped	N/A	Bridgework	\$8,840,000	N/A	\$368,081	N/A

Finally, ERG estimated the lane-miles associated with the remaining repair/resurfacing contract cost, using the average dollar per lane-mile value for the TxDOT repair/resurfacing projects, as shown below in Table 2-2.

**Table 2-2. \$/lane-mile Values for TxDOT Repair/Resurfacing Projects, 2018**

ERG Project ID #	Contract \$	Lane-Mi	\$/lane-mi	Outlier
18-1	\$760,970	1.02	\$746,049	
18-9	\$11,100,000	22.72	\$488,556	
18-10	\$5,294,000	11.7	\$452,479	
18-17	\$5,810,000	7.47	\$777,778	
18-19	\$430,100	3.36	\$128,006	Y
18-20	\$1,343,500	16	\$83,969	Y
18-21	\$900,000	19.55	\$46,036	Y
18-22	\$1,006,300	18.35	\$54,839	Y
18-23	\$303,700	1.6	\$189,813	
18-24	\$3,000,000	31.53	\$95,147	Y
18-25	\$3,000,000	10.38	\$289,017	
18-26	\$3,000,000	27.69	\$108,342	Y
		Avg - no outliers	\$490,615	

Table 2-2 indicates if the calculated \$/lane-mile value for a particular TxDOT project is designated as an outlier, based on the convention developed for the 2006-08 calendar year analysis - if the value is less than \$150,000/lane-mile, it is assumed the distance estimate includes substantial stretches of road that will not be resurfaced or rehabilitated (see May 31, 2013 CAPCOG report for details). Combining the remaining 2018 contract value for grouped repair/resurfacing projects with the average \$/lane-mile value as shown above (developed excluding outliers), ERG estimated 75.0 lane-miles of unaccounted for repair/resurfacing activity in the five county study region in 2018.

After compiling the 2018 project information and estimating the required activity parameters (contract value and lane-miles), ERG combined this data with the project profiles developed for the previous CAPCOG studies to estimate equipment requirements for each project. After assigning each project to one of the five project categories (New/Rebuild, Bridgework, Repair/Resurfacing, Turn Lanes, and Miscellaneous), ERG was able to estimate and sum the number of equipment piece-days associated with each equipment type for each project, and estimate total hours of use based on default average hours per day values from the TexN model. In this way project-specific equipment use profiles were developed for all 31 projects.

After compiling the project-specific equipment population and use estimates ERG determined that a number of projects had de minimus levels of activity, defined as requiring less than 0.1 units of equipment for all equipment category/horsepower bin

combinations (ERG ID #s 3, 4, 8, 12, 13, 15, and 18). These seven projects were estimated to require only 323 unit-hours of equipment activity total, or about 0.03% of the total unit hours for all projects identified. As such these projects would have negligible emission levels and were excluded from subsequent analysis.

### 3.0 Emissions Estimation

ERG used the data regarding project location, equipment populations, hours of use, and seasonal activity distribution to develop input files for use in the TexN model. TexN scenario files were generated for all of the remaining projects for 2018, to estimate project-specific ozone-season as well as annual emissions.

ERG first began the modeling task by entering zero for all non-heavy-highway equipment population values for each of the five counties, in order to estimate default TexN emissions for heavy-highway diesel equipment in 2018. ERG then created individual scenario files for each of the 24 target projects, entering equipment population and hours per year estimates through the TexN GUI. All TexN scenarios were set to output ozone-season daily and annual emissions, and assumed the use of TxLED fuel in all counties.

Using the project duration as well as the months with activity in 2018, monthly allocation factors were generated for each project for use in the TexN Season.dat file. If a project was underway for the full year, the default Season.dat distribution was used (for diesel construction equipment operating in the Southwest). If a project was underway for less than the full twelve month period, the default allocation factors were re-normalized to adjust for the shorter operation period. Table 3-1 presents an example allocation adjustment for a project that operated from January through August. In this way all equipment activity is allocated by TexN to active project months only.

**Table 3-1. Seasonal Allocation Adjustment Example:  
Project Operation January - August**

Month	12-month default	Jan-Aug
Jan	0.075	0.111
Feb	0.075	0.111
Mar	0.084	0.125
Apr	0.084	0.125
May	0.084	0.125
Jun	0.09	0.134
Jul	0.09	0.134
Aug	0.091	0.135
Sept	0.084	0
Oct	0.084	0
Nov	0.084	0
Dec	0.075	0
Total	1.000	1.000

Fifty-eight TexN runs were performed: 48 project-specific runs (24 ozone season day and 24 annual), and two runs per county using default inputs in order to obtain baseline emission estimates for comparison purposes. As noted above, the emission estimates associated with the two "grouped" projects (ERG ID # 33 and 34) are not associated with any particular county, since their geographic locations are not known as this time. Since the required NIF and TexN population update files require county designations, ERG allocated the TexN emission outputs for these two projects based on the 2012 lane-miles for each of the five counties.<sup>9</sup> This should be an appropriate allocation method given the strong relationship between road and bridge rehabilitation requirements and total lane-miles. The lane-mile totals and associated allocation factors for each county are presented in Table 3-2.

**Table 3-2. 2012 County Lane-miles and Grouped Project Allocation Factors**

County	Lane-Mi	Emissions Allocation
Bastrop	805	13.7%
Caldwell	587	10.0%
Hays	717	12.2%
Travis	2,096	35.8%
Williamson	1,654	28.2%

The non-grouped project-specific emissions estimates were matched with geocoded endpoint latitude and longitude, in order to facilitate ozone modeling for the 2018 calendar year. While emissions estimates for the grouped projects were allocated to the county level, no endpoint assignments were possible.

Total emissions estimates for ozone season day project activity were provided in NIF and XML formats for uploading into the TCEQ's TexAER system. ERG also developed aggregated equipment population totals in order to update the TexN model. For this purpose ERG first calculated the number of piece-hours for each equipment category/hp bin/month combination (# pieces x hours/year x monthly allocation factor), and then summed the piece-hour estimates across months to obtain total piece-hours per year for each county. (This process was necessary because many of the projects had different monthly allocations, due to differing project start and end dates.) These totals were then divided by the default hour per year values for each equipment type in order to estimate total heavy-highway diesel equipment populations for each county in 2018. Table 3-3

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<sup>9</sup> [http://www.txdot.gov/inside-txdot/division/finance/discos.html?CFC\\_\\_target=http%3A%2F%2Fwww.dot.state.tx.us%2Fapps-cg%2Fdiscos%2Fdefault.htm%3Fdist%3DAUS%26amp%3Bstat%3Dlm](http://www.txdot.gov/inside-txdot/division/finance/discos.html?CFC__target=http%3A%2F%2Fwww.dot.state.tx.us%2Fapps-cg%2Fdiscos%2Fdefault.htm%3Fdist%3DAUS%26amp%3Bstat%3Dlm), last validated December 12, 2013.

presents the resulting equipment population values, which were then used to update the MySQL population tables within TexN.

**Table 3-3. 2018 Heavy-Highway Diesel Equipment Populations by County**

Equipment Type/HP Range	Bastrop	Caldwell	Hays	Travis	Williamson
Pavers 25-40 hp	0.4003	0.0000	0.3989	0.8975	0.2992
Pavers 100-175 hp	0.5005	0.0000	0.4986	1.0970	0.3989
Pavers 175-300 hp	0.2334	0.0000	0.2992	0.5984	0.1995
Rollers 25-40 hp	2.1986	0.3989	2.7386	4.7847	2.1600
Rollers 40-50 hp	2.9482	0.5984	3.5353	6.5293	3.0405
Rollers 50-75 hp	6.4797	1.2964	7.9167	14.3551	6.3803
Rollers 75-100 hp	6.4797	1.2964	7.9167	14.3551	6.3803
Rollers 100-175 hp	13.5929	2.7419	16.9786	30.3047	13.9066
Rollers 175-300 hp	2.9482	0.5984	3.5353	6.5293	3.0405
Scraper 100-175 hp	0.1167	0.0000	0.0997	0.2992	0.0997
Scraper 175-300 hp	1.7005	0.1995	1.8937	3.5397	1.6868
Scraper 300-600 hp	2.1008	0.1995	2.3923	4.5370	2.0773
Scraper 600-750 hp	1.0501	0.0000	1.0959	2.1436	0.7978
Paving Equip 100-175 hp	0.7841	0.0000	0.7978	1.9945	0.6981
Paving Equip 175-300 hp	0.7841	0.0000	0.7978	1.9945	0.6981
Surfacing Equip 100-175 hp	1.6967	0.5984	2.2882	2.5403	1.6444
Surfacing Equip 175-300 hp	0.4159	0.1995	0.5973	0.7474	0.4816
Surfacing Equip 300-600 hp	3.1932	1.2964	4.4756	4.6312	3.2888
Surfacing Equip 600-750 hp	1.3636	0.5984	1.7907	1.7425	1.3537
Excavators 50-75 hp	0.6668	0.0000	0.6981	1.6953	0.5984
Excavators 75-100 hp	0.6668	0.0000	0.6981	1.6953	0.5984
Excavators 100-175 hp	5.2027	0.2992	5.8816	13.4619	4.9608
Excavators 175-300 hp	8.0375	0.3989	9.0214	20.7408	7.7447
Excavators 300-600 hp	1.8342	0.0997	2.1929	4.7364	1.6868
Graders 100-175 hp	15.0096	2.7419	18.0263	33.6953	14.9038
Graders 175-300 hp	0.5332	0.0997	0.7967	1.2460	0.4901
Wheeled Loader 50-75 hp	0.7000	0.0000	0.6970	1.6449	0.5899
Wheeled Loader 75-100 hp	0.7000	0.0000	0.6970	1.6449	0.5899
Wheeled Loader 100-175 hp	9.5989	1.1967	11.1584	23.6296	9.4381
Wheeled Loader 175-300 hp	6.0997	0.7978	7.1233	15.2548	6.1151
Tractor/Loader/Backhoe 50-75 hp	6.9008	0.6981	7.9715	17.8477	6.7879
Tractor/Loader/Backhoe 75-100 hp	6.9008	0.6981	7.9715	17.8477	6.7879
Tractor/Loader/Backhoe 175-300 hp	0.8833	0.0000	0.9962	2.2433	0.7893
Crawler Dozer - 50-75 hp	2.1353	0.0000	2.2937	5.7841	1.9945
Crawler Dozer - 75-100 hp	2.1353	0.0000	2.2937	5.7841	1.9945
Crawler Dozer 100-175 hp	5.1710	0.0000	5.6833	13.5627	4.7868



<b>Equipment Type/HP Range</b>	<b>Bastrop</b>	<b>Caldwell</b>	<b>Hays</b>	<b>Travis</b>	<b>Williamson</b>
Crawler Dozer 175-300 hp	1.4014	0.0000	1.4959	3.6899	1.3962
Crawler Dozer 300-600 hp	0.7841	0.0000	0.7978	2.0942	0.6981

**Note:** The ozone season day emission estimates presented in the next section were developed using project-specific SEASON.DAT files in the TexN model. As such, a single run of TexN using the updated population values shown above and a single, default SEASON.DAT file will not replicate the project-specific runs precisely.

## 4.0 Results

### 4.1 Emissions Estimates

Table 4-1 presents the emissions estimates in tons per ozone-season weekday, for each site-specific project, as well as the allocated emissions for the grouped projects. Table 4-2 presents the corresponding estimates for annual emissions.

**Table 4-1. Tons per Ozone Season Weekday, by Project**

ERG Project #	County	VOC	PM10	PM2.5	CO	NOx
18-1	Caldwell	0.00001	6.94296E-06	6.73467E-06	3.40378E-05	7.09269E-05
18-2	Caldwell	0.00002	1.70074E-05	1.64972E-05	9.00441E-05	0.000175519
18-5	Bastrop	0.00799	0.006586194	0.006388608	0.037756832	0.072516825
18-7	Bastrop	0.00004	2.80887E-05	2.72461E-05	0.000137974	0.000273261
18-9	Williamson	0.00067	0.000510137	0.000494833	0.003123271	0.005607508
18-10	Williamson	0.00034	0.000263651	0.000255742	0.001617002	0.002905183
18-11	Williamson	0.00260	0.001648946	0.001599478	0.009443975	0.017787268
18-14	Williamson	0.00004	2.96133E-05	2.87249E-05	0.000149457	0.000284465
18-16	Travis	0.00197	0.001260463	0.00122265	0.007193239	0.013266362
18-17	Travis	0.00020	0.00014866	0.0001442	0.000926774	0.001663473
18-19	Travis	0.00007	5.64746E-05	5.47804E-05	0.000352157	0.0006665
18-20	Travis	0.00031	0.00025144	0.000243896	0.001565837	0.002888433
18-21	Hays	0.00036	0.000293834	0.000285019	0.001811832	0.003356431
18-22	Hays	0.00034	0.000275935	0.000267657	0.001710637	0.003149257
18-23	Hays	0.00003	2.19678E-05	2.13088E-05	0.000125673	0.000246541
18-24	Hays	0.00155	0.001130277	0.001096369	0.007113846	0.01289865
18-25	Caldwell	0.00054	0.000391047	0.000379316	0.002434996	0.004457614
18-26	Bastrop	0.00133	0.000975364	0.000946103	0.006146587	0.011107403
18-27	Travis	0.00998	0.006355421	0.006164758	0.036469699	0.06855232
18-30	Hays	0.00453	0.002877117	0.002790803	0.016463028	0.030993512
18-31	Williamson	0.00112	0.000712789	0.000691406	0.004105389	0.007705073
18-32	Williamson	0.00025	0.000161472	0.000156628	0.000942881	0.001777573
18-33	Bastrop	0.000626	0.000456094	0.000442411	0.002874221	0.005205157
18-33	Caldwell	0.000457	0.000332968	0.000322979	0.002098302	0.003799984
18-33	Hays	0.000557	0.000406285	0.000394097	0.002560336	0.004636718
18-33	Travis	0.001629	0.00118768	0.001152049	0.007484545	0.013554364
18-33	Williamson	0.001286	0.000937324	0.000909204	0.005906848	0.010697187
18-34	Bastrop	2.05E-05	1.30771E-05	1.26848E-05	7.36645E-05	0.000135152
18-34	Caldwell	1.5E-05	9.54687E-06	9.26046E-06	5.37782E-05	9.86668E-05
18-34	Hays	1.83E-05	1.1649E-05	1.12996E-05	6.56198E-05	0.000120393
18-34	Travis	5.34E-05	3.40532E-05	3.30316E-05	0.000191824	0.00035194
18-34	Williamson	4.21E-05	2.6875E-05	2.60688E-05	0.000151389	0.000277753
<b>Total</b>		0.03898	0.02742	0.02660	0.16118	0.30123

**Table 4-2. Tons per Year, by Project**

ERG Project #	County	VOC	PM10	PM2.5	CO	NOx
18-1	Caldwell	0.00326	0.002770197	0.002687091	0.01358089	0.03058547
18-2	Caldwell	0.00421	0.003081418	0.002988975	0.01631427	0.03367153
18-5	Bastrop	1.65992	1.367849002	1.326813532	7.841493123	15.84642637
18-7	Bastrop	0.00656	0.005089139	0.004936465	0.02499822	0.05241653
18-9	Williamson	0.16781	0.127561786	0.123734932	0.780988379	1.49382457
18-10	Williamson	0.08492	0.065927226	0.063949409	0.404338696	0.773900364
18-11	Williamson	0.69930	0.444278178	0.430949833	2.544502179	5.132706091
18-14	Williamson	0.00699	0.005365353	0.005204392	0.0270787	0.05457096
18-16	Travis	0.53143	0.339608087	0.329419845	1.938084585	3.828373926
18-17	Travis	0.05494	0.04005372	0.038852108	0.249701798	0.479949675
18-19	Travis	0.02788	0.022533026	0.021857035	0.140508329	0.287258245
18-20	Travis	0.12278	0.100322786	0.097313102	0.624759247	1.245119367
18-21	Hays	0.14379	0.117238025	0.113720884	0.722909838	1.446907278
18-22	Hays	0.13472	0.110096188	0.106793302	0.682533512	1.357605292
18-23	Hays	0.01104	0.008765031	0.00850208	0.05014254	0.10627914
18-24	Hays	0.41722	0.304531832	0.295395877	1.916691116	3.721505246
18-25	Caldwell	0.14512	0.105360313	0.102199504	0.656064186	1.286057663
18-26	Bastrop	0.35846	0.262793386	0.254909585	1.656083281	3.204743164
18-27	Travis	2.68874	1.712349834	1.660979338	9.82607426	19.78149968
18-30	Hays	1.21993	0.775185147	0.751929592	4.435652228	8.943500179
18-31	Williamson	0.30158	0.192047735	0.186286303	1.106120451	2.223372121
18-32	Williamson	0.06720	0.043505506	0.042200341	0.254041482	0.512886886
18-33	Bastrop	0.16829	0.12271473	0.119033288	0.773318321	1.497431847
18-33	Caldwell	0.12286	0.089586912	0.086899304	0.564554884	1.093188199
18-33	Hays	0.14991	0.109313428	0.106034025	0.688866586	1.333901882
18-33	Travis	0.43822	0.31955231	0.309965741	2.013740785	3.899351019
18-33	Williamson	0.34585	0.252192632	0.244626853	1.589256507	3.077391601
18-34	Bastrop	0.00552	0.003523393	0.003417691	0.01984751	0.03900079
18-34	Caldwell	0.00403	0.002572225	0.002495058	0.014489517	0.028472216
18-34	Hays	0.00492	0.003138614	0.003044456	0.017680024	0.034741632
18-34	Travis	0.01438	0.009175007	0.008899756	0.051683426	0.101559059
18-34	Williamson	0.01135	0.007240971	0.007023742	0.040788875	1.497431847
<b>Total</b>		<b>10.1231</b>	<b>7.07532</b>	<b>6.86306</b>	<b>41.68689</b>	<b>83.02835</b>

Table A-1 provides the latitude/longitude coordinates for each site-specific project.

#### **4.2 Comparison with TexN Default Values**

ERG compared the ozone season day emissions estimates shown above with the default estimates generated by the TexN model for the heavy-highway sector, as shown in Table 4-3.

**Table 4-3. Emission Estimation Comparison with TexN Defaults, 2018**

COUNTY	VOC	PM10	PM2.5	CO	NOx
<b>CAPCOG Tons/Ozone Season Day</b>					
Bastrop	0.01001	0.00806	0.00782	0.04699	0.08924
Caldwell	0.00104	0.00076	0.00073	0.00471	0.00860
Hays	0.00738	0.00502	0.00487	0.02985	0.05540
Travis	0.01422	0.00929	0.00902	0.05418	0.10094
Williamson	0.00634	0.00429	0.00416	0.02544	0.04704
<b>Total</b>	0.03898	0.02742	0.02660	0.16118	0.30123
<b>TexN Tons/Ozone Season Day</b>					
Bastrop	0.00260	0.00176	0.00170	0.01033	0.01953
Caldwell	0.00105	0.00071	0.00069	0.00418	0.00787
Hays	0.00227	0.00153	0.00149	0.00902	0.01708
Travis	0.04089	0.02757	0.02674	0.16199	0.30661
Williamson	0.01121	0.00756	0.00733	0.04445	0.08411
<b>Total</b>	0.05802	0.03913	0.03796	0.22997	0.43519
<b>Percent</b>	67%	70%	70%	70%	69%

The above table indicates the estimated emission level for 2018 is somewhat lower than the TexN value, by about 30%. This is comparable to the reduction observed with the 2012 inventory estimate.

## Appendix A - Detailed Project and Equipment Data

**Table A-1. Project List with Coordinates\***

ERG ID	County	Route	Start Latitude	Start Longitude	End Latitude	End Longitude
18-1	Caldwell	SH 21	30.022	-97.711	30.024	-97.703
18-2	Caldwell	FM 713	29.851	-97.536	29.851	-97.531
18-5	Bastrop	US 290	30.301	-97.291	30.235	-97.194
18-7	Bastrop	SH 21	30.111	-97.295	30.111	-97.293
18-9	Williamson	FM 112	30.562	-97.41	30.527	-97.251
18-10	Williamson	FM 619	30.652	-97.394	30.576	-97.374
18-11	Williamson	IH 35	30.517	-97.688	30.535	-97.692
18-14	Williamson	CR 258	30.697	-97.829	30.697	-97.829
18-16	Travis	FM 969	30.276	-97.637	30.256	-97.608
18-17	Travis	FM 969	30.256	-97.608	30.248	-97.583
18-19	Travis	LP 343	30.232	-97.801	30.239	-97.789
18-20	Travis	LP 360	30.350	-97.796	30.302	-97.827
18-21	Hays	RM 2325	30.107	-98.271	30.021	-98.154
18-22	Hays	RM 3237	29.994	-98.091	30.047	-97.988
18-23	Hays	FM 2439	29.882	-97.946	29.874	-97.955
18-24	Hays	SH 21	29.877	-97.906	29.884	-97.894
18-25	Caldwell	SH 21	30.022	-97.711	30.052	-97.631
18-26	Bastrop	SH 21	30.052	-97.631	30.112	-97.415
18-27	Travis	US 183	30.325	-97.674	30.223	-97.681
18-30	Hays	US 290 W	30.193	-98.215	30.206	-98.144
18-31	Williamson	RM 1431	30.525	-97.817	30.558	-97.692
18-32	Williamson	US 79	30.518	-97.683	30.517	-97.688

\* Projects with de minimus emissions excluded