Eastern Research Group, Inc.

Update of Diesel Construction Equipment Emission Estimates for the State of Texas – Phase I and II

Final Report

Prepared for:

Texas Commission on Environmental Quality

Prepared by:

Eastern Research Group, Inc.

July 31, 2009

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Prepared for:

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ACRONYMS

AACOG	Alamo Area Council of Governments
AGC	Associated General Contractors
BPA	Beaumont/Port Arthur
CAPCOG	Capital Area Council of Governments
CO	Carbon Monoxide
DFW	Dallas/Fort Worth
DCE	Diesel Construction Equipment
EDA	Equipment Data Associates
ERG	Eastern Research Group, Inc.
ETCOG	East Texas Council of Governments
HGB	Houston/Galveston/Brazoria
HP	Horsepower
MSHA	Mine Safety and Health Administration
NIF	National Inventory Format
NOx	Oxides of Nitrogen
PM2.5	Particulate Matter < 2.5 microns in diameter
PM10	Particulate Matter < 10 microns in diameter
REMI	Regional Economic Models, Inc.
SIC	Standard Industrial Classification
SIP	State Implementation Plan
SO2	Sulfur Dioxide
TACA	Texas Aggregates and Concrete Association
TCEQ	Texas Commission on Environmental Quality
TexAER	Texas Air Emission Repository
TexN	Texas NONROAD Model
TMRA	Texas Mining and Reclamation Association
TxLED	Texas Low Emissions Diesel
UCC-1	Uniform Commercial Code-1 Forms
VOC	Volatile Organic Compounds

Executive Summary

A previous study conducted for the TCEQ in 2005 extrapolated available diesel construction equipment (DCE) data to create a statewide diesel construction emissions inventory.[1] The equipment population and use profiles developed for certain DCE categories in that study were based on data specific to the nine-county Dallas/Fort Worth (DFW) ozone nonattainment region, or were based on input from a single industry expert and had not been validated independently. The current study was conducted to refine the previous emissions inventory for DCE using surveys and other available data sources to collect data on equipment activity and use across the state. This project was conducted in two Phases. The first Phase began by identifying those elements of the previous inventory with the highest levels of uncertainty and the greatest impacts on emission estimates, and then developed strategies for improving upon these elements, collecting the necessary data to modify them to produce more accurate emissions estimates. Revised DCE population and activity estimates were then developed for specific equipment categories including rough terrain forklifts (RTFs) and trenchers, as well as certain activity subsectors, including mines and quarries, special trades contractors, scrap/recycling facilities, and utility contractors. Phase II of the study involved utilizing existing information to refine the non-road equipment inventory and use profiles, as well as the core emissions model within the Texas NONROAD (TexN) model.

Phase I of this study collected detailed survey data on selected DCE operations across the state in order to develop updated emissions estimates for these sources. Data was collected primarily through extensive phone surveys for equipment operations during the 2007 base year. The data collected included equipment-specific estimates for hours per year of operation, horsepower, and location. Operator data was also collected including industry classification, allowing for the development of industry-specific equipment population growth and geographic allocation surrogates. Appropriate surrogates were identified to forecast and back-cast equipment populations for the period between 1970 and 2050 (the range of analysis years in the TexN model). These data were used to update the TexN model currently used to calculate non-road equipment emissions for the state. Updated data included information on equipment populations by county, horsepower (hp) distributions, and hours per year of operation.

Table ES-1 details the prior and updated equipment population levels for each targeted DCE category, by DCE subsector. As seen in the table, RTFs and trenchers experienced a sizeable increase in their population estimates, while DCE within the special trades contractor

[1] Eastern Research Group, Statewide Diesel Construction Equipment Inventory – Final Report, prepared for the Texas Commission on Environmental Quality, August 31, 2005.

and scrap/recycling subsectors decreased for the most part. Scrapers and surfacing equipment, previously assumed to be present within the special trades subsector, were not found during the survey effort and were set to zero population. On the other hand, a very small number of off-highway trucks were found during the survey of scrap/recycling facilities, where none were assumed before. DCE categories that were not updated are labeled "N/A".

Table ES-2 provides the prior and updated equipment activity estimates by DCE subsector and equipment type. Although not shown on the table, crawler dozer activity within the utility subsector was also updated from the previous value of 364 hours/year to 98 hours per year, based on survey results.

Mining and quarry equipment were not included in the previous version of TexN, and are summarized separately in the Tables ES-3 and ES-4.

Table ES-1. Statewide Equipment Population Comparisons – Previous vs. Updated TexN Data (2007)

Equipment Type / Sector	Previous	Updated
Rollers – Special Trades	129	64
Scrapers – Special Trades	167	0
Surfacing Equipment – Special Trades	240	0
Trenchers	10,495	15,015
Excavators – Scrap/Recycling	439	363
Excavators – Special Trades	869	611
Graders – Special Trades	338	1,726
Off-highway Trucks – Scrap/Recycling	0	20
Rough Terrain Forklifts	7,288	16,677
Rubber Tire Loaders – Scrap/Recycling	401	207
Rubber Tire Loaders – Special Trades	1,045	351
Tractors/Loaders/Backhoes – Scrap/Recycling	1,274	6
Tractors/Loaders/Backhoes – Special Trades	6,199	4,959
Crawler Tractor/Dozers – Scrap/Recycling	84	17
Crawler Tractor/Dozers – Special Trades	907	252

Table ES-2. Activity Comparisons – Previous vs. Updated TexN Data (Hrs/Yr)

Equipment Type / Sector	Previous	Updated
Rollers – Special Trades	1,000	1,131
Scrapers – Special Trades	1,000	1,082
Surfacing Equipment – Special Trades	167	0
Trenchers	240	0
Excavators – Scrap/Recycling	2,000	1,586
Excavators – Special Trades	1,478	631
Graders – Special Trades	1,000	829
Off-highway Trucks – Scrap/Recycling	0	687

Equipment Type / Sector	Previous	Updated
Rough Terrain Forklifts	1,250	875
Rubber Tire Loaders – Scrap/Recycling	1,811	1,291
Rubber Tire Loaders – Special Trades	1,199	1,898
Tractors/Loaders/Backhoes – Scrap/Recycling	1,135	50
Tractors/Loaders/Backhoes – Special Trades	1,500	582
Crawler Tractor/Dozers – Scrap/Recycling	936	2,500
Crawler Tractor/Dozers – Special Trades	1,175	733

Table ES-3. Mining Equipment and Activity Updates[2]

Equipment Type	Statewide Population (2007)	Average Hrs/Yr
Crawler Tractors/Dozers	97	5,800
Excavators	28	5,273
Graders	32	5,218
Off-Highway Trucks	110	4,793
Scrapers	13	2,929
Wheeled Loaders	66	3,677

Table ES-4. Quarry Equipment and Activity Updates

Equipment Type	Statewide Population (2007)	Average Hrs/Yr
Tractors/Backhoes/Loaders	95	1,566
Crawler Tractors/Dozers	574	1,897
Excavators	599	1,593
Graders	565	422
Off-Highway Trucks	930	1,551
Scrapers	168	957
Wheeled Loaders	1,770	1,974

95% confidence intervals were calculated for equipment activity and horsepower values. Activity values typically fell between ~10% and 25% of the mean hour per year value for all equipment types and subsectors. Horsepower estimates frequently had tighter confidence intervals, sometimes well below 10% of the mean value. The tighter confidence intervals for the hp estimates were often a simple reflection of the uniformity of certain equipment categories such as graders and backhoes. In general, equipment/subsector categories with the tightest confidence intervals included RTFs and special trades contractor backhoes, resulting from the large survey sample, as well as crawler dozers and off-highway trucks in the mining, most likely due to the uniformity of their usage patterns within this subsector. Overall, the highest variability appeared in quarries, due to relatively low survey response rates as well as great variability in use patterns across the subsector. Regardless, the resulting emissions estimates

[2] Mining and quarry equipment were not included in the previous version of TexN.

have substantially less uncertainty than previous estimates, for which uncertainty could not even be quantified.

The Phase II tasks conducted under this study utilized currently available data in order to refine the existing inventory, rather than collecting original survey data as under Phase I. The primary tasks associated with Phase II included:

- Integrating NONROAD2008 Model within TexN
- Updating Statewide Agricultural Equipment Data utilizing results from a different TCEQ Work Order
- Updating Heavy-Highway Growth Surrogates
- Updating Construction and Mining Equipment Profile for Alamo Area Council of Governments (San Antonio) Area

The previous version of the TexN model, which utilized the NONROAD2005 model to calculate emissions, was replaced with EPA's latest version, NONROAD2008, which became available in April of 2009. This version of the model uses additional data on ethanol market share in order to estimate improved evaporative emission estimates for gasoline engines. The model also reflects the adoption of two new EPA rules, including:

- Diesel recreational marine standards in the Locomotive/Marine final rule, Federal Register Vol 73, No. 88, page 25098, May 6, 2008; and
- Small SI and SI Recreational Marine final rule, Federal Register Vol 73, No. 196, page 59034, October 8, 2008.

The new NONROAD model version incorporates Phase 3 controls for small spark ignition engines as specified by the rules listed above. It also added controls for spark ignition and diesel recreational marine engines as required by these rules.

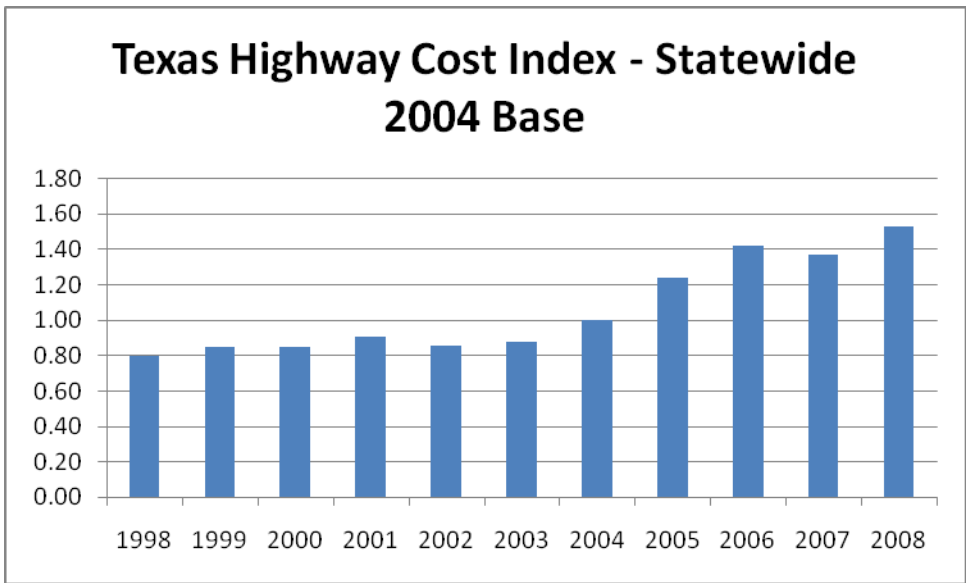
New agricultural equipment information was also incorporated into the TexN model to reflect the findings of a recent study performed for the TCEQ under a different work order. The updated agricultural equipment emissions inventory results in a substantial increase in emissions relative to the previous version which relied upon default NONROAD2005 model inputs, increasing by a factor of 3 to 4, depending upon the pollutant. Much of this increase may be attributable to the increased number of equipment pieces found in the new study.

The previous version of the TexN model utilized projected dollar value of construction estimates from Economy.com as the basis for projecting heavy-highway construction equipment

population levels into the future.[3] These estimates were obtained from the TCEQ in June of 2008, and did not reflect the extreme downturn in highway construction activity. In addition, by relying solely upon contract dollar values as the surrogate for highway construction activity, the previous method did not account for the sharp rise in materials costs that have been incurred by highway contractors over the last few years.[4] As such, relying on contract dollar values will overestimate actual equipment activity relative to the base year during times of material cost inflation.

ERG updated the TexN model to reflect these factors for the highway construction sector, utilizing the Texas Highway Cost Index report for June 2009 to establish adjustment factors to account for increasing material and other non-activity-related costs (e.g., general inflation). The Cost Index, shown in Figure ES-1 below, reflects the nominal increase in costs relative to a 2004 base year for statewide highway construction activities.[5] The figure clearly shows a sharp rise in costs per unit of delivered services beginning approximately in 2004.

Figure ES-1



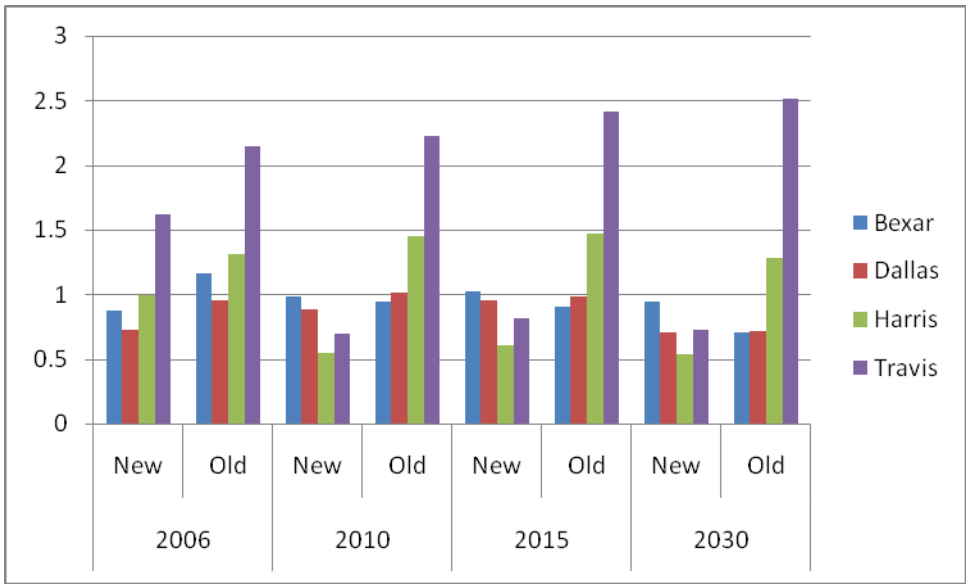
These data were combined with the updated Economy.com projections in order to forecast and back cast equipment populations.[6] Future year dollar projections reflect a

[3] TCEQ query of Economy.com database June 2009.
[4] Personal communication, Bob Lanham, Vice President Williams Brothers Construction, April 2009.
[5] ftp://ftp.dot.state.tx.us/pub/txdot-info/cst/hci_binder.pdf ; 2004 is also the current base year for highway construction equipment within TexN.
[6] Data from the Economy.com database are considered confidential and are not presented here. All manipulation and processing of the Economy.com data were performed by authorized TCEQ personnel.

substantial downturn in construction activity for the state compared to the previous Economy.com data obtained from TCEQ in 2008.

A comparison of the updated growth and previous growth factors is provided in Figure ES-2 for selected counties and analysis years.

Figure ES-2. Comparison of Updated and Previous Highway Construction Equipment – Relative Growth Factors for Selected Counties and Analysis Years



As seen in the figure, all four counties witnessed a sizeable reduction in activity for 2006 (1.32 reduction factor). This factor corresponds to the highway cost index adjustment for 2006 relative to 2004. Three of the four counties listed in the figure also see notable activity reductions in the near term 2010 case (Dallas, Harris, and Travis). This reduction is due to a combination of cost index adjustments and revised Economy.com activity projections. Bexar County however is projected to have an increase in future activity, possibly due to large new projects that were not included in the 2008 Economy.com projections. The medium and long-term cases estimate that Dallas County will approximately return to its previous projection levels, although projections for Harris and Travis Counties remain substantially below previous estimates.

Additional improvements to the DCE inventory were made to reflect updates developed by the Alamo Area Council of Governments (AACOG). AACOG has conducted a number of updates to its DCE inventory over the past several years, utilizing local surveys and surrogates in order to improve upon the prior county level DCE (TexN) estimates available from the TCEQ. The first of these updates involved population surrogate updates for the 12-county AACOG area

(2005). ERG utilized the population data for a number of DCE subsectors for this work order. The remaining subsectors have been addressed in subsequent studies performed for the TCEQ (e.g., skid steer loader, special trades, and other targeted surveys), and were not updated for this effort.

Mining and quarry survey updates were also conducted for Atascosa, Bexar, Comal, Gillespie, and Medina Counties in 2005, and landfill survey updates for Bexar, Comal, Gillespie, Guadalupe, and Kerr Counties (2008). While the surrogate updates only involved modification to equipment population and allocation for various DCE subsectors, the mining/quarry and landfill efforts were more detailed, involving extensive surveys of equipment operators in the area and elaborate QA and refinement (e.g., through the use of satellite imaging to characterize quarry equipment types and counts). As such, the mining/quarry and landfill studies also included updates to equipment horsepower distributions and activity, which have been integrated in this assessment.

AACOG provided ERG with the data sets used to develop their updates for the different DCE subsectors. Emissions and equipment populations were calculated before and after performing the TexN updates for the AACOG area. Results are presented below in Table ES-5 for the 12 county AACOG region for a 2008 ozone season day.[7] Only those SCCs affected by the update are included.

As seen in the table above, the adjustments to the default emissions and equipment population estimates are relatively minor, with about a 10 percent overall reduction in equipment population, but a much smaller net change in emissions (e.g., ~2 percent for NOx), likely due to the increase in equipment sizes at quarries.

[7] AACOG Counties include Atascosa, Bandera, Bexar, Comal, Frio, Gillespie, Guadalupe, Karnes, Kendall, Kerr, Medina, and Wilson.

Table ES-5. 12 County AACOG 2008 Ozone Season Day Emissions Before and After Update

Base Case DCE							
Equipment Type	**VOC**	**PM10**	**PM2.5**	**CO**	**NOx**	**SO2**	**Equipment Population**
Crawler Tractor/Dozers	0.21	0.18	0.18	1.12	2.34	0.07	2,475.40
Excavators	0.13	0.12	0.12	0.68	1.60	0.05	1,529.64
Graders	0.04	0.03	0.03	0.16	0.38	0.01	1,057.73
Off-highway Trucks	0.07	0.07	0.07	0.44	1.13	0.04	164.32
Pavers	0.01	0.01	0.01	0.06	0.12	0.00	1,010.02
Paving Equipment	0.01	0.00	0.00	0.03	0.05	0.00	78.41
Rollers	0.04	0.04	0.04	0.23	0.41	0.01	1,689.55
Rubber Tire Loaders	0.13	0.12	0.12	0.63	1.45	0.06	667.19
Scrapers	0.01	0.01	0.01	0.06	0.13	0.00	54.28
Surfacing Equipment	0.03	0.03	0.03	0.21	0.37	0.01	175.95
Tractors/Loaders/Backhoes	0.15	0.10	0.10	0.67	0.54	0.02	2,437.04
Total	**0.83**	**0.72**	**0.70**	**4.30**	**8.53**	**0.27**	**11,339.52**
Updated DCE							
Equipment Type	**VOC**	**PM10**	**PM2.5**	**CO**	**NOx**	**SO2**	**Equipment Population**
Crawler Tractor/Dozers	0.16	0.14	0.14	0.85	1.72	0.05	1,842.67
Excavators	0.09	0.08	0.08	0.51	1.09	0.04	1,019.33
Graders	0.06	0.05	0.05	0.24	0.52	0.02	1,014.61
Off-highway Trucks	0.08	0.09	0.09	0.56	1.33	0.05	161.35
Pavers	0.02	0.02	0.02	0.11	0.21	0.01	769.81
Paving Equipment	0.02	0.02	0.02	0.10	0.17	0.00	227.36
Rollers	0.04	0.04	0.03	0.21	0.34	0.01	1,793.27
Rubber Tire Loaders	0.12	0.13	0.12	0.75	1.64	0.06	708.65
Scrapers	0.01	0.01	0.01	0.09	0.19	0.01	59.79
Surfacing Equipment	0.03	0.02	0.02	0.17	0.29	0.01	143.85
Tractors/Loaders/Backhoes	0.22	0.16	0.15	1.04	0.83	0.02	2,669.19
	0.85	**0.76**	**0.73**	**4.63**	**8.33**	**0.28**	**10,409.9**
Delta (Updated – Base)							
Equipment Type	**VOC**	**PM10**	**PM2.5**	**CO**	**NOx**	**SO2**	**Equipment Population**
Crawler Tractor/Dozers	-0.05	-0.04	-0.04	-0.27	-0.62	-0.02	-632.73
Excavators	-0.04	-0.04	-0.04	-0.17	-0.51	-0.01	-510.31
Graders	0.02	0.02	0.02	0.08	0.14	0.01	-43.12
Off-highway Trucks	0.01	0.02	0.02	0.12	0.2	0.01	-2.97
Pavers	0.01	0.01	0.01	0.05	0.09	0.01	-240.21
Paving Equipment	0.01	0.02	0.02	0.07	0.12	0	148.95
Rollers	0	0	-0.01	-0.02	-0.07	0	103.72
Rubber Tire Loaders	-0.01	0.01	0	0.12	0.19	0	41.46
Scrapers	0	0	0	0.03	0.06	0.01	5.51
Surfacing Equipment	0	-0.01	-0.01	-0.04	-0.08	0	-32.1
Tractors/Loaders/Backhoes	0.07	0.06	0.05	0.37	0.29	0	232.15
Total	**0.02**	**0.04**	**0.03**	**0.33**	**-0.2**	**0.01**	**-929.64**

The new activity and population estimates developed under this study were used as the basis for refining the emissions estimates of volatile organic compounds (VOC), nitrogen oxide (NOx), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide (SO_2) for selected DCE categories across the state. Emissions were calculated and provided in annual tons per year and by typical ozone season day, for selected analysis regions and years, as shown in Table ES-6. Statewide runs were also performed for all 254 counties for the 2008 episode year, for both ozone season day and annual time periods. Emission estimates for each reporting period, analysis year, and region were then provided to the TCEQ in National Inventory Format (NIF3.0) for uploading into the Texas Air Emission Repository (TexAER).

Table ES-6. Region/Episode Year TexN Modeling Scenarios

Year	Beaumont/Port Arthur (BPA)	Houston-Galveston-Brazoria (HGB)	Dallas-Fort Worth (DFW)	AACOG
2000	X	X		X
2002	X	X	X	X
2005	X	X		X
2006	X	X		X
2007			X	
2008	X	X		X
2009	X	X	X	X
2010	X	X		X
2011	X	X		X
2012	X	X		X
2014	X	X		X
2017	X	X		X
2018	X	X		X
2020	X	X		X
2021	X	X		X

The updated emissions output for all non-road source categories are presented in Tables ES-7 through ES-10 below for the different non-attainment regions. Table ES-11 summarizes the statewide emission estimates for 2008.

Table ES-7. Non-road Emission Estimates, Beaumont-Port Arthur Region[8]

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2000	4.82	8.52	61.97	0.85	0.82	1.14	1.56
2002	4.62	7.47	57.17	0.74	0.72	1.08	1.08
2005	4.01	6.29	49.20	0.69	0.66	1.13	0.18
2006	3.79	5.76	47.75	0.67	0.65	1.15	0.17
2008	3.42	5.18	42.94	0.57	0.55	0.14	0.19
2009	3.18	4.89	40.54	0.56	0.54	0.14	0.20
2010	3.02	4.63	39.07	0.54	0.52	0.01	0.22
2011	2.88	4.31	37.71	0.52	0.50	0.01	0.23
2012	2.67	4.01	36.34	0.50	0.48	0.01	0.25
2014	2.35	3.44	34.38	0.44	0.42	0.01	0.29
2017	2.09	2.77	33.51	0.36	0.34	0.01	0.34
2018	2.05	2.59	33.56	0.33	0.32	0.01	0.36
2020	1.99	2.25	33.92	0.28	0.27	0.01	0.38
2021	1.98	2.12	34.21	0.26	0.25	0.01	0.39
Annual - Tons per Year							
2000	1,439	2,338	17,752	220	212	183	304
2002	1,382	2,093	16,597	193	186	174	217
2005	1,219	1,828	14,669	179	172	185	64
2006	1,155	1,676	14,256	175	168	188	67
2008	1,039	1,527	12,863	157	151	38	79
2009	973	1,434	12,212	154	148	39	86
2010	933	1,358	11,786	149	143	2	94
2011	888	1,266	11,385	144	138	2	102
2012	827	1,177	10,980	137	132	2	110
2014	733	1,010	10,415	121	116	2	128
2017	657	816	10,173	99	95	3	155
2018	643	761	10,197	92	88	3	163
2020	628	664	10,321	79	75	3	178
2021	626	629	10,414	74	71	3	182

[8] The Beaumont-Port Arthur region includes Hardin, Jefferson, and Orange Counties

Table ES-8. Non-road Emission Estimates, Dallas-Fort Worth Region[9]

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2002	73.86	100.71	928.21	8.62	8.30	9.77	11.17
2007	58.41	79.42	768.25	7.26	6.97	1.57	2.76
2009	53.94	72.46	688.89	6.99	6.71	1.54	3.28
Annual - Tons per Year							
2002	22,551	29,175	272,486	2,363	2,272	1,716	2,354
2007	17,882	23,639	229,528	2,071	1,988	430	1,127
2009	16,245	21,681	206,790	1,996	1,915	434	1,392

[9] Includes the 9-county non-attainment area, including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties.

Table ES-9. Non-road Emission Estimates, Houston-Galveston-Brazoria Region[10]

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2000	68.71	89.60	787.37	8.12	7.83	11.22	7.62
2002	66.51	84.40	750.47	7.19	6.93	10.81	5.68
2005	59.51	77.25	683.22	6.90	6.64	11.62	2.14
2006	57.06	71.94	667.70	6.78	6.52	11.89	2.32
2008	52.74	65.34	608.89	5.70	5.48	1.46	2.89
2009	49.05	61.73	577.14	5.65	5.43	1.50	3.21
2010	46.46	58.74	558.76	5.47	5.25	0.11	3.54
2011	44.34	54.87	542.35	5.30	5.08	0.11	3.89
2012	40.89	50.99	525.16	5.03	4.83	0.12	4.27
2014	35.19	42.79	500.05	4.44	4.25	0.12	5.14
2017	30.06	33.15	480.62	3.64	3.48	0.12	6.39
2018	28.95	30.53	477.31	3.37	3.22	0.12	6.76
2020	27.48	26.24	479.59	2.90	2.76	0.12	7.49
2021	27.07	24.65	482.63	2.73	2.59	0.12	7.84
Annual - Tons per Year							
2000	26,034	28,753	271,804	2,449	2,355	1,897	2,591
2002	25,220	27,149	259,405	2,179	2,092	1,829	1,927
2005	22,929	24,677	236,966	2,083	1,999	1,991	814
2006	22,022	22,987	231,587	2,041	1,958	2,035	919
2008	20,265	20,960	211,601	1,831	1,762	445	1,200
2009	19,082	19,905	201,946	1,820	1,744	460	1,355
2010	18,161	19,004	195,869	1,759	1,685	35	1,515
2011	17,226	17,806	190,326	1,704	1,631	36	1,684
2012	15,954	16,602	184,586	1,620	1,550	36	1,866
2014	13,817	14,046	176,398	1,430	1,367	37	2,271
2017	11,724	11,009	170,373	1,175	1,120	38	2,864
2018	11,245	10,182	169,490	1,090	1,038	38	3,049
2020	10,595	8,822	170,407	943	895	38	3,410
2021	10,405	8,316	171,470	889	842	39	3,586

[10] Includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties

Table ES-10. Non-road Emission Estimates, AACOG Region

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2000	29.71	57.56	357.63	4.59	4.43	5.29	18.80
2002	30.08	49.16	322.23	4.23	4.07	5.36	12.56
2005	29.74	36.31	262.12	4.01	3.85	5.77	1.01
2006	29.33	32.79	254.90	3.94	3.78	5.87	0.69
2008	28.53	29.95	229.74	3.41	3.27	0.81	0.69
2009	26.79	28.03	218.88	3.35	3.21	0.86	0.71
2010	25.45	26.61	210.34	3.20	3.06	0.05	0.73
2011	24.79	25.02	208.96	3.08	2.96	0.05	0.79
2012	23.60	23.33	203.92	2.90	2.77	0.05	0.84
2014	21.09	19.84	196.78	2.49	2.38	0.05	0.95
2017	17.98	15.24	193.09	1.90	1.81	0.05	1.11
2018	17.14	14.02	193.21	1.72	1.64	0.05	1.16
2020	16.05	12.03	194.85	1.44	1.37	0.05	1.25
2021	15.74	11.29	196.21	1.34	1.27	0.05	1.28
Annual - Tons per Year							
2000	8,896	14,112	96,039	1,159	1,117	868	3,443
2002	9,312	12,734	90,252	1,087	1,045	882	2,353
2005	9,335	10,214	77,900	1,038	996	958	318
2006	9,216	9,265	76,081	1,020	978	976	280
2008	8,995	8,471	69,595	926	887	221	301
2009	8,439	8,001	66,838	913	875	228	315
2010	8,169	7,641	65,334	880	842	14	330
2011	7,855	7,152	63,977	844	808	14	353
2012	7,468	6,672	62,492	794	759	14	379
2014	6,699	5,676	60,422	684	653	14	432
2017	5,724	4,374	59,397	525	500	14	514
2018	5,463	4,033	59,466	477	453	14	540
2020	5,121	3,478	60,019	401	380	14	586
2021	5,026	3,273	60,455	375	355	14	600

Table ES-11. Non-road Emission Estimates, Statewide Totals, 2008

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2008	352	563	3,190	55.4	53.4	13.1	14.3
Annual - Tons per Year							
2008	115,223	158,521	985,638	14,931	14,360	3,475	6,512

1.0 Introduction

This study was conducted in two phases. Phase I, completed in 2008, involved detailed surveys of a number of different diesel construction equipment categories operating in different parts of the state, in order to update their associated equipment profile and emission inventory projections.[11] Phase II of this effort involved further improvements to the inventory for diesel construction as well as other nonroad equipment, including utilization of EPA's release of its NONROAD2008 emissions model in April of 2009. The revised equipment and emissions data was integrated into the Texas NONROAD (TexN) model utility. The revised TexN data was used to update the current statewide diesel construction inventory at the county level. This project completes Phase II of the data collection and analysis effort begun under Work Order No. 582-7-84003-FY08-11. The results of both Phase I and II are provided in this report.

The purpose of the Phase I study was to refine the current emissions inventory for diesel construction equipment using surveys and other available data sources to collect data on equipment activity and use across the state. A previous study, conducted by Eastern Research Group (ERG) in 2005 under TCEQ contract 582-04-65564 Work Order 15, extrapolated diesel construction equipment (DCE) data collected for the nine-county Dallas-Fort Worth (DFW) ozone nonattainment area to create a statewide diesel construction emissions inventory.[12] The equipment population and use profiles developed for certain DCE categories were based on data specific to the DFW region, or were based on input from a single industry expert and have not been validated independently.

In order to validate the assumptions made in previous studies and to develop improvements, this project first identified those elements of the previous inventory with the highest levels of uncertainty and the greatest impacts on emission estimates. The study then developed strategies for improving upon these elements, collecting the necessary data to modify them to produce more accurate emissions estimates. For those DCE categories expected to have operating profiles that vary by region of the state, field data collection efforts focused on the Austin/San Antonio and Tyler/Longview areas (e.g., quarries in Central Texas and mining operations in East Texas). For those DCE categories expected to operate in basically the same fashion across the state, data collection efforts were conducted on a statewide basis. Revised

[11] Eastern Research Group, Update of Diesel Construction Equipment Emissions Estimates for the State of Texas, prepared for the Texas Commission on Environmental Quality, August 31, 2008.
[12] Eastern Research Group, Statewide Diesel Construction Equipment Inventory – Final Report, prepared for the Texas Commission on Environmental Quality, August 31, 2005.

DCE population and activity estimates were then used to update the current statewide diesel construction inventory at the county level for selected target years.

Data regarding typical DCE operations were collected for equipment greater than or equal to 25 horsepower, for the 2007 base year.[13] Appropriate surrogates were identified to forecast and back-cast equipment populations for the period between 1970 and 2050 (the range of analysis years in the Texas NONROAD (TexN) model). These data were used to update the data in the Texas TexN model currently used to calculate non-road equipment emissions for the state. Updated data included information on equipment populations by county, horsepower (hp) distributions, and hours per year of operation.

Phase II tasks utilized currently available data in order to refine the existing inventory, rather than collecting original survey data as under Phase I. The primary tasks associated with Phase II included:

- Integrating NONROAD2008 Model within TexN
- Updating Statewide Agricultural Equipment Data
- Updating Heavy-Highway Growth Surrogates
- Updating Construction and Mining Equipment Profile for Alamo Area Council of Governments (San Antonio) Area

The modifications made to TexN in association with the Phase II tasks are described in Section 5 of this report.

The new activity and population estimates developed under both phases of the study were used as the basis for refining the emissions estimates of volatile organic compounds (VOC), nitrogen oxide (NOx), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), and sulfur dioxide (SO_2) for selected DCE categories across the state. Emissions were calculated and provided in annual tons per year and by typical ozone season day, for selected analysis regions and years. Emission estimates for each reporting period (annual and ozone season day), analysis year, and region were then provided to the TCEQ in National Inventory Format (NIF3.0) for uploading into the Texas Air Emission Repository (TexAER).

[13] Non-road diesel equipment less than 25 hp, while numerous, contribute very little to overall criteria pollutant emissions from these sources (e.g., < 1% of NOx emissions, according the EPA's NONROAD2005 model). As such, studies for the TCEQ involving diesel engines have excluded these small engines from data collection efforts, relying on default equipment population and activity assumptions in the NONROAD model to estimate their emissions.

2.0 Data Collection Plan

The DCE inventory developed by the state consists of 24 different sectors, characterizing different types of end-users and/or unique construction activities. Examples include Residential, Commercial, and Utility construction. These subsectors utilize one or more DCE categories with distinct operation profiles, and are developed from different data sources. The subsectors represent equipment operator categories with unique activity profiles. Specifically, DCE are used for different tasks with different utilization rates depending upon the type of activity. For example, excavators in commercial building construction are operated for fewer hours per year than those used in mining and quarry operations. Only certain DCE categories may be utilized within a particular subsector, as shown in Figure 2-1.

Figure 2-1. DCE Category Distribution by Activity Subsector

Equipment Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Pavers				x	x	x	x		x				x		x				x		x	x	x	x
Tampers/Rammers																								x
Plate Compactors																								x
Rollers				x	x	x	x		x	x	x		x	x	x				x		x	x		x
Scrapers	x			x	x		x		x	x	x		x	x	x				x		x	x	x	
Paving Equipment							x		x				x	x							x			x
Surfacing Equipment						x	x		x		x			x	x				x					x
Signal Boards/Light Plants																								x
Trenchers																				x				x
Bore/Drill Rigs		x																						x
Excavators	x		x	x	x	x	x		x	x	x	x	x	x	x		x		x		x	x	x	x
Concrete/Industrial Saws																								x
Cement & Mortar Mixers																								x
Cranes								x																x
Graders	x		x	x	x	x	x		x	x	x		x	x	x				x		x	x	x	
Off-highway Trucks	x				x	x	x		x	x		x	x	x					x				x	
Crushing/Proc. Equipment																							x	x
Rough Terrain Forklifts																x								x
Rubber Tire Loaders	x		x	x	x	x	x		x	x	x	x	x	x	x		x		x		x	x	x	x
Tractors/Loaders/Backhoes	x		x	x	x	x	x		x	x	x	x	x	x	x		x		x		x	x	x	x
Crawler Tractor/Dozers	x		x	x	x	x	x		x	x	x	x	x	x	x		x		x		x	x	x	
Skid Steer Loaders																		x						x
Off-Highway Tractors																							x	x
Dumpers/Tenders																								x
Other Construction Equipment																								x

Subsector Key:

1) Agricultural Activities
2) Boring/Drilling Equipment
3) Brick and Stone Operations
4) City and County Road Construction
5) Commercial Construction
6) Concrete Operations
7) County-Owned Construction Equipment
8) Cranes
9) Heavy-Highway Construction
10) Landfill Operations
11) Landscaping Activities
12) Manufacturing Operations
13) Municipal Owned Construction Equipment
14) Transportation/Sales/Services
15) Residential Construction
16) Rough Terrain Forklifts
17) Scrap/Recycling Operations
18) Skid Steer Loaders
19) Special Trades Contractors
20) Trenchers
21) TxDOT Equipment
22) Utility Construction
23) Mining and Quarry Operations
24) Off-road Tractors, Misc. Equipment, and all Equipment < 25 hp

The Data Collection Plan developed under Phase I identified target survey stratifications based on available data, including a prioritization of which DCE and subsectors this project would focus on. Subsectors were prioritized considering their estimated impact on the DCE inventory, the availability and reliability of appropriate data sources, the anticipated improvement in the resulting inventory, and the required level of effort considering resource constraints. Field data collection efforts included those that could be performed in the Austin/San Antonio and Tyler/Longview areas. Special consideration was given to those subsector estimates deemed to have the greatest uncertainty in the DFW analysis, and the subsequent extrapolation to the state as a whole. Quality assurance and control measures were specified as appropriate for different data collection modes.

ERG performed a detailed review of the following parameters for each sector, in order to identify potentially significant sources of uncertainty in the DCE emission inventory calculations:

- Equipment population
- Horsepower distribution;
- Annual activity; and,
- Geographic allocation.

The final Phase I Data Collection Plan provided a summary of each potential area of improvement identified in the current DCE profile included in the TexN model. The plan summarized the anticipated level of effort for each option, and provided recommendations for implementing the Data Collection task. Current NOx emission estimates are provided and discussed at the state level in the plan. The Data Collection Plan for the DCE subsectors selected for this study is described below. The complete Data Collection Plan, including a discussion of these DCE categories and subsectors considered for evaluation but not included in the final recommendation, is provided in Appendix A.

2.1 Heavy-Highway Subsector

As noted in the Statewide Diesel Construction Inventory report (TCEQ, August 31, 2005), equipment profiles for heavy-highway construction activities were extrapolated to the rest of the state using 1999 survey results for the H-GAC area.[14] However, highway contractors have consistently noted that equipment use profiles vary dramatically by specific task and area of the state, depending upon work requirements and constraints. As such, the resulting equipment

[14] Survey efforts for the 2005 HARC study of the DFW area did not generate sufficient response to be statistically meaningful.

profiles for this sector were highly uncertain for areas outside of Houston, and for time periods other than the base year. Since heavy-highway construction was estimated to be the single largest source of emissions at the state level, refining this profile can provide substantial improvements to the DCE inventory as a whole, given a reasonable means of obtaining the necessary data could be identified.

ERG contacted Mr. Bob Lanham of Williams Brothers Construction, former President of the Texas Associated General Contractors (AGC) and estimator for large TxDOT highway construction projects to obtain his input.[15] Mr. Lanham indicated that very specific equipment use profiles could be developed for the broad range of TxDOT "bid codes", based on estimator inputs. (TxDOT bid codes correspond to unique activities/products involved in conducting highway contract work for the state. Examples include striping, grading, signal and signage installation, etc. Each contractor bidding on a job must provide line-item cost estimates for each bid code as part of TxDOT's contract letting process.)

Since the bid codes involved with any TxDOT project are available electronically, such profiles could be combined with the available bid code data to provide project-specific equipment activity profiles for use with the TexN model, for any county and analysis year of interest. As such, these profiles may provide a highly flexible and precise tool for development of highway sector emission estimates well into the future. To this end, Mr. Lanham offered to organize meetings with highway contractor estimators at the AGC in Austin to develop the required profiles.

2.2 Special Trades Subsector

Construction activities in this subsector correspond to work performed by special trades contractors (SIC 1700 series[16]). These contractors provide foundation, masonry, plumbing, and a host of other specialty services in support of building construction projects. These contractors (excluding SIC 1794 - Excavation Work, and 1795 – Wrecking and Demolition Work) do not generally conduct activities directly linkable to other physical quantities (e.g., number of square feet of commercial building space installed). Therefore equipment use profiles (hr/yr) for this subsector were developed previously based on expert opinion. In addition, equipment population totals were based on sales totals for the DFW area, extrapolated using economic indicator surrogate data from Regional Economic Models, Inc. (REMI).

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[15] Bob Lanham, Vice President, Williams Brothers Construction, personal communication, April 2008.
[16] Standard Industrial Classification (SIC) 1700 = Construction Special Trades Contractors. See http://www.osha.gov/pls/imis/sic_manual.display?id=12&tab=group.

It was unknown to what extent the distribution of special trades contractors is different in other areas of the state, or to what extent equipment use patterns in the DFW area are representative of other areas. The extrapolation of population totals using REMI data adds an additional source of uncertainty to emission estimates for this sector.

In order to refine the equipment population and activity profiles for this subsector a phone survey of special trades contractors was recommended for contractors across the state. The survey would utilize phone numbers obtained from USA Data for Texas companies reporting operations under the SIC 1700 series (excluding 1794 – Earthwork Operations, and 1795 – Wrecking and Demolition Work, which are included in other subsectors). Data collection focused on quantifying equipment types, hp values, model years, annual activity, and areas of operation. The Data Collection Plan established a goal of at least 200 completed phone surveys in order to obtain a confidence interval of less than 15% (+/- 7.5%). It was anticipated the equipment ownership rates among these companies would be relatively low, so data capture efficiencies would be low as well, leading to a relatively high level of effort for survey completion.

2.3 Demolition Activity Profile

Demolition and removal of pavement requires substantial hp-hours of heavy equipment use, and hence is a potentially significant source of emissions. Lacking other reliable data, the Utility subsector profile developed previously assumed that 100% of utility installation projects involved demolition and removal of surface pavement, for the entire length of the line. In addition, the Utility profile assumed all pavement to be concrete rather than asphalt, requiring substantially higher hp-hours for removal. Therefore several conservative assumptions were made regarding demolition requirements for this subsector, all of which potentially erred on over-estimating hp-hours and emissions. Under current assumptions pavement demolition was responsible for over 50% of hp-hours within the Utility subsector profile.

ERG identified two ways of refining the assumptions made regarding pavement demolition activities in this subsector. First, the fraction of asphalt versus concrete on local roadways was identified using TxDOT reports (Lane Road Miles per County by Surface Type - http://www.county.org/resources/countydata/products/2004LaneMiles.txt). A cursory review of this report clearly indicates that asphalt road pavement is far more common than concrete across the state. Since demolition of concrete is estimated to require 2/3 more hp-hours per square foot

than asphalt,[17] a sizeable reduction in hp-hours and emissions is expected for the Utility subsector was anticipated if this adjustment were performed.

The Utility subsector profile was recommended for revision to more accurately reflect the actual amount of pavement demolition required. ERG proposed to conduct phone surveys of Utility contractors, identified through the non-highway branch of the Texas AGC, in order to quantify the following:

- *The fraction of utility projects involving pavement removal;*
- *For utility projects requiring pavement removal, the typical fraction of linear feet involved, and the typical width of pavement removal (currently assumed to be 12 feet);*
- *The average depth of pavement removed;*
- *The equipment used for pavement removal;*
- *An estimate of pavement demolition and removal time per square foot, for both asphalt and concrete pavement.*

The final two questions listed above help validate and improve the current profile values obtained from professional estimators for the HARC DCE study.

2.4 Mining and Quarry Subsector

DCE use and emissions associated with mining activities was only quantified for the DFW area under previous studies. In addition, the mining activity estimates for the DFW region itself was based on a single survey profile. Therefore the uncertainty associated with the DFW area estimate was high, while estimates for the rest of the state were absent entirely.

Data from the Mine Safety and Health Administration (MSHA)[18] indicated there were 691 active mining and quarry facilities in 149 counties across Texas in the summer of 2008. The vast majority of these facilities involved sand/gravel pits (276) or crushed/dimension stone quarries (313). Eleven coal mines were also identified, all of which were lignite. While construction sand and gravel pits were likely to have limited equipment activity, larger stone quarries and coal mines were likely to have very large DCE, including offroad trucks typically 400 hp or greater. These larger quarries and surface mines were therefore likely to be significant sources of NOx emissions. Quarries are particularly prevalent in the Central Texas area, while lignite mines are predominantly located in the East Texas region.

[17] Eastern Research Group, Diesel Construction Equipment Activity and Emissions Estimates for the Dallas/Fort Worth Region – Final Report, p. 5-14, prepared for the Houston Advanced Research Center, August 31, 2005.
[18] http://www.msha.gov/drs/asp/extendedsearch/minesbystatecounty2.asp

In order to develop mining and quarry equipment profiles for the state, ERG recommended phone or mail surveys be developed and administered in across the state, with supplementary site visits for representative Central Texas quarries and East Texas lignite mines. ERG targeted approximately 50 completed surveys in order to obtain a reasonable precision and accuracy. To facilitate a survey, ERG obtained contact information for every active and intermittently active mine in Texas, by county, from the MSHA. Furthermore, at a stakeholder meeting held at the East Texas Council of Governments, ERG was able to make contacts with representatives from Luminant, a major power supplier for East Texas.[19] These representatives agreed to help ERG make the necessary contacts with the Texas Mining and Reclamation Association to encourage mine operator and contractor participation in the surveys.

The information provided by MSHA also described the type of mine, commodity, and number of employees for each mining site in Texas. Once the surveys were conducted, ERG planned to analyze the data to build appropriate profiles of diesel construction equipment used in mining and quarry operations. Furthermore, ERG planned to make at least five site visits in the Central Texas area and another five in the East Texas area, to include mining operations as well as quarry operations, to collect information on general operating practices. Separate profiles were developed for quarries and lignite mines. ERG recommended using the number of pit employees obtained from MSHA as the surrogate to expand the results of the surveys to non-responsive operations.

2.5 Specialty Equipment Profiles

Under the HARC and Statewide DCE studies, several specialty equipment types were not directly linked to the other subsector profiles, including:

- Cranes
- Rough Terrain Forklifts (RTFs)
- Trenchers
- Boring/Drilling Rigs
- Skid Steer Loaders

While a statewide skid steer loader profile was developed under a separate TCEQ work order, the other equipment categories listed above remained under consideration based on limited data sources. First, equipment population estimates for these categories were based on sales data for the nine-county DFW region, extrapolated using regional REMI output data. In addition, the annual hour estimates for trenchers, cranes, and bore/drill rigs were taken largely from

[19] Personal communication with David Duncan, Environmental Regulations Manager, Luminant, at East Texas Council of Governments NETAC Technical Committee meeting, May 15, 2008, Kilgore, Texas.

NONROAD defaults, while RTF values were based on a single estimate from Darr Forklift (an RTF specialty vendor). As such, the equipment population, activity, and geographic distribution estimates for these categories are very uncertain. Of these categories, all but boring/drilling equipment were estimated to contribute substantially to statewide NOx totals (see Appendix A), and remained under consideration for additional data collection.

While cranes are very numerous and are used in a very wide variety of applications,[20] RTFs and trenchers are much more specialized and are used in relatively uniform applications, making them easier to characterize through a targeted survey. In addition, RTFs have much smaller equipment populations, further easing data collection burden.

For these reasons it was feasible to perform a relatively small phone survey of RTF and trencher equipment within the scope of this effort. (Assuming relative uniformity in the survey results, ERG set a target of 100 completed surveys - 50 for each equipment type - for this effort). In this case equipment operator contact information for RTFs and trenchers would be obtained from Equipment Data Associates (EDA, as was done for the skid steer loader study). Equipment population, hp and model year distributions, annual hours, and geographic distribution were all to be determined from the survey. Supplemental field visits in the Austin/San Antonio and Tyler/Longview areas would also be attempted for local contractors to validate clock hour readings and model years for RTFs and trenchers.

2.6 Specialty Operator Subsectors

Certain DCE subsectors were established to reflect unique equipment profiles and operating conditions within certain business types. While equipment population estimates for these categories were based on actual EDA sales data, estimates for annual hours of use for the different equipment types were based on expert opinion from a single industry source. Accordingly, subsector profiles for these sources could be improved through surveys of some kind. These sectors include the following:

- Agricultural Operations
- Brick and Stone Production
- Concrete Production
- Scrap/Recycling Facilities
- General Manufacturing
- Landscaping Operations

[20] Under NONROAD definition, cranes consist not only of large track and wheel units with lattice booms (noticeable at the construction of multi-story structures), but also smaller truck cranes which are used in a wide variety of smaller, short-term applications such as lifting HVAC units onto building roofs.

- Special Trades Contractors
- Transportation/Sales/Service Operations

Of these subsectors, validation/refinement alternatives for Special Trades Contractors are discussed under Section 3.2. The remaining subsectors were evaluated for possible equipment profile improvements. Given the very low NOx emission estimates for the Brick/Stone and Concrete sectors, ERG concluded that refinements from detailed surveys of these businesses would likely not provide a large enough adjustment to current inventory estimates to be warranted.

While Agricultural subsector emissions are estimated to be fairly significant at the state level (ranked 10th out of the 24 DCE subsectors – see Appendix A), activity for this subsector is largely limited to rural areas. Accordingly emission contributions from this sector are expected to be much lower, in relative and absolute terms, in the urbanized ozone non-attainment regions of greatest concern. As such, ERG did not recommend validating/refining the equipment profile for this subsector.

The General Manufacturing and Transportation/Sales/Service subsectors (labeled as "Other (misc)" in Appendix A) both contribute substantial amounts to statewide as well as local NOx inventories. However, these subsectors contain literally tens of thousands of business establishments operating across the state, of which only a relatively small number are expected to utilize DCE. Those establishments actually operating DCE are anticipated to utilize their equipment in highly diverse applications which would be difficult to profile through standard phone surveys or site visits. Accordingly, ERG was not confident that a valid, representative equipment use profile for these subsectors could be developed given the available work order resources.

The Scrap/Recycling subsector was estimated to generate moderate NOx emissions at the state level (as shown in Appendix A), with somewhat higher contributions expected for urban areas. This subsector has the added expected advantage of relatively uniform equipment type and use profiles across most establishments. As such, the sector's equipment use profile was amenable to improvement through surveys of multiple facility operation practices across the state. Phone survey data collection would include the number of pieces of each equipment type as well as the make, model, model year, and hours of use for 2007 for each equipment piece. Survey contact information would be obtained from USA Data for SIC 5093.

Finally, the Landscaping subsector was also estimated to generate moderate NOx emissions from DCE use. However, equipment use profiles in this subsector were not

anticipated to be highly uniform. In addition, based on previous studies ERG determined that landscaping operators provide extremely low response rates to phone and other survey requests. Accordingly ERG concluded that the equipment profile for this subsector could not be improved in a cost-effective manner through surveys or other means under this study.

3.0 Data Collection

Data collection under Phase I was conducted for DCE operators in five different areas[21]:

- Rough Terrain Forklifts (RTFs) and Trenchers
- Mining and Quarry operations
- Special Trades contractors
- Scrap and Recycling facilities
- Utility installation contractors

For each of the above DCE subsectors, details on the operators contacted, survey findings, and interview outcomes, as appropriate, are described in this section. Descriptive statistics regarding operation profiles are also provided for the different equipment categories within each subsector.

Before commencing data collection activities, ERG contacted Benjamin Davidson, a regional sales representative with HOLT-CAT regarding DCE sales patterns across the range of end-users. Mr. Davidson confirmed that 2007 was a typical sales and operations year for most DCE users (although he noted that 2008 was not representative due to the recent economic downturn).[22] As such, it was concluded that 2007 would serve as a reasonable base year for surveying and inventory development.

In order to encourage survey response rates for all DCE subsectors under consideration, stakeholder support for the study was sought. The following trade associations and local organizations were contacted to help encourage participation in the study.

- Associated General Contractors of Texas (AGC)
- Capital Area Council of Governments (CAPCOG)
- Alamo Area Council of Governments (AACOG)
- Associated Builders and Contractors of Central and South Texas
- QUOIN
- East Texas Council of Governments (ETCOG)
- Texas Mining and Reclamation Association (TMRA)
- Texas Aggregates and Concrete Association (TACA)

ERG utilized trade associations and local governments to help distribute a letter of introduction about the project on TCEQ letterhead to the owners and operators of DCE.

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[21] Despite a promising methodology (see Section 2.1), data collection was not conducted for heavy-highway equipment use, as key AGC members were not able to participate in equipment profile development in time for completion of this study. Resources for this effort were re-assigned to tasks under Phase II (see Section 5).
[22] Personal communication with Benjamin Davidson, HOLT-CAT, February 19, 2008

All survey instruments were developed and submitted to the TCEQ Project Representative for prior approval. When necessary, the TCEQ Project Representative obtained an official letter on TCEQ letterhead explaining the purpose of the study for targeted equipment operators.

ERG is particularly sensitive to the privacy of individuals and businesses. Therefore all interviews and data collection efforts were to begin with a guarantee of privacy, anonymity, and confidentiality. To ensure a survey respondent's right to privacy respondents were informed of the research purpose, the kinds of questions that would be asked, and how TCEQ might use the results of the study. Confidentiality of responses is maintained by eliminating names from interview records, stripping all respondent-identifying characteristics from study datasets.

3.1 Mining and Quarry Operations

Sample Frame

ERG contacted the Mine Safety and Health Administration (MSHA) to obtain points of contact and phone numbers for all active surface mines within the state. MSHA provided a list containing 227 unique site listings meeting these criteria. ERG subsequently split these listings into "Coal" and "other" mining/quarry categories for data collection purposes.

Mining and Quarry Stakeholder Recruitment

In order to encourage survey response rates, stakeholder support for the study was sought. The Texas Mining and Reclamation Association (TMRA) was contacted for assistance with coal mining operations, and the Texas Aggregates and Concrete Association (TACA) was contacted for assistance with quarry and related operations. These associations agreed to notify their membership regarding the upcoming phone survey through email to help encourage participation in the study. In addition, these associations also provided specific points of contact for a number of mine operations in East Texas, and quarry operations in Central Texas. ERG obtained this information in order to obtain permission to conduct on-site visits at some of the larger operations in these regions.

Site Visit Findings

Site visits were conducted at 11 locations in East and Central Texas, as described below. These visits were conducted to allow ERG representatives to obtain first hand observations of DCE use at mining and quarry operations, with the goal of identifying "typical" and non-standard operations practices. This information, along with the phone survey results described

below, was then used to develop standard operation profiles that could be extrapolated to other sites without survey data, utilizing available surrogates. The data collection form, provided to cooperating personnel in advance of the site visits, is provided in Appendix B. The form described the purpose of the survey, the equipment and data fields of interest, and the type of observations to be made during the visit.

The following describes the findings from the different site visits.

Coal Mines

ERG requested contact information from TMRA for all 11 coal mining operation sites in the MSHA operations list for Texas. ERG was able to arrange on-site visits at six of these operations, each located in East Texas, conducted during July of 2008. The site visits were conducted to obtain first-hand observations regarding how DCE is used at these locations.

Appendix C provides a summary of the observations obtained at the six locations visited. Specific company and site names are not provided, in order to protect confidential business information.

ERG also requested and obtained equipment specific information, including make, model, year, horsepower, and hours of use during 2007. Table 3-1 summarizes the equipment profile information collected for each of the sites visited. Note that the higher hp (and more intensively used) scrapers reported for sites #2 and #5 were utilized in coal handling operations, while the smaller scraper reported for site #3 was used exclusively for road building activities. In addition, the two loaders utilized at site #5 were substantially larger (at 800 hp) than those found at other sites.

Quarry Operations

At the completion of the phone survey of quarry operations, each survey respondent was asked if they would permit an ERG representative to conduct an on-site visit of their operations. Five quarry operators in Central Texas agreed to such visits, which were conducted during August of 2008. A variety of operations were visited, ranging from very large limestone quarries and associated cement manufacturing operations, to small, custom stone cutting pits. The data collection form shown in Appendix B was provided to each participant in advance of the site visit. Appendix C summarizes the findings from these visits.

Table 3-1. Coal Mining Equipment Survey Results

Equipment Type Counts							
	Location						
Equipment Type	**1**	**2**	**3**	**4**	**5**	**6**	**Avg - all sites**
Crawler Tractor/Dozer	10	10	14	3	5	9	8.5
Excavator	3	2	6		2	2	3.0
Grader	3	3	5	1	2	3	2.8
Off-road Truck	8	11	16	3	11	9	9.7
Roller			1				1.0
Rubber Tire Loader	11	9	2	6	2	5	5.8
Scraper		1	2		4		2.3
Total	**35**	**36**	**46**	**13**	**26**	**28**	
Average HP							
	Location						
Equipment Type	**1**	**2**	**3**	**4**	**5**	**6**	**Avg - all sites**
Crawler Tractor/Dozer	529	495	480	467	478	486	493
Excavator	967	900	891		1,000	900	923
Grader	265	250	253	265	265	235	254
Off-road Truck	925	1,141	1,283	925	852	901	1,047
Roller			315				315
Rubber Tire Loader	415	388	261	407	800	544	438
Scraper		700	450		700		629
Average Hr/Yr							
	Location						
Equipment Type	**1**	**2**	**3**	**4**	**5**	**6**	**Avg - all sites**
Crawler Tractor/Dozer	6,700	6,700	3,421	6,700	6,700	6,700	5,800
Excavator	7,200	7,200	2,383		7,200	7,200	5,273
Grader	6,100	6,100	3,100	6,100	6,100	6,100	5,218
Off-road Truck	5,800	5,891	2,538	5,800	5,255	5,667	4,793
Roller			300				300
Rubber Tire Loader	3,318	3,167	1,750	3,117	6,500	5,700	3,677
Scraper		3,500	1,500		3,500		2,929

Phone Survey Findings

The contact information obtained from the MSHA was used to compile a call list for all active surface mines operating in Texas in 2007. A total of 216 unique sites/points of contact were identified. ERG representatives attempted to contact each person on the call list at least once by phone during July and August of 2008. Of these, only four facilities stated that they did not currently operate a mine or quarry operation in the state. 30 facilities agreed to participate in the survey, providing detailed information on number of units, make, model, model year, horsepower, and hours per year of operation for the 2007 base year. Appendix D provides a copy of the phone survey questionnaire administered to these entities.

Table 3-2 summarizes the types of facilities responding to the survey, along with their associated county.

Table 3-2. Quarry Survey Respondent Profile

County	Common Clays NEC	Crushed/ Broken Limestone	Dimension Stone	Oil Sand	Other Crushed/ Broken Stone	Sand/Silica	Other	Total
Austin	1							1
Bell		1						1
Cass					1			1
Cherokee					1			1
Culberson					1			1
Denton	1							1
Ector		1						1
Fayette	1							1
Harris							1	1
Hays			1					1
Hidalgo		1						1
Johnson		1						1
Kendall		1						1
Lampasas		1						1
Limestone						1		1
Lubbock					1			1
Shackelford			2					2
Starr					1			1
Travis		1						1
Uvalde		1						1
Ward		1						1
Wheeler					1			1
Williamson		1	4				1	6
Zapata				1				1
Total	**3**	**10**	**7**	**1**	**6**	**1**	**2**	**30**

Table 3-3 summarizes the equipment types and number of units reported for each of the 30 sites surveyed.

Table 3-3. Quarry Equipment Type Distribution

	Site #																													
Equipment Type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**Total**
Backhoe				1						1																1	1				4
Crawler Tractor/Dozer	2		1	4	1				1		1	1	3	1		1	1		2	1			1			1			2		24
Crushing/Proc. Eqpmnt			1	2					1						1					3					1			1		1	11
Excavator	1	1		3					2	4	1			1		4	1	1		1	2		1	1					1		25
Grader	1			1						1				1		1							1			1					7
Off-Highway Truck	2			1		1			2	6	2			3	2			4		1	2				1	5	5	2			39
Roller/compactor				1																											1
Scraper	4																						3								7
Wheeled Loader	3	5	2	2	1	3	5	2	3	2	2	1		2	2	4	2	5	3	1	3	1	2	4	3	2	5	4			74
Total	**13**	**6**	**4**	**15**	**2**	**4**	**5**	**2**	**9**	**14**	**6**	**2**	**3**	**8**	**5**	**10**	**4**	**10**	**5**	**7**	**7**	**1**	**8**	**5**	**5**	**10**	**11**	**7**	**3**	**1**	**192**

Table 3-4 summarizes the average model year, horsepower, and hours per year by equipment type for the surveyed equipment population.

Table 3-4. Surveyed Quarry Equipment Profile

Equipment Type	Avg Model Year	Avg HP	Avg Hr/Yr
Backhoe	2002	73	1,566
Crawler Tractor/Dozer	1999	241	1,897
Crushing/Processing Equipment	1993	319	1,102
Excavator	1998	246	1,593
Grader	1993	160	422
Off-Highway Truck	1993	353	1,551
Roller/compactor	2006	150	20
Scraper	1992	363	957
Wheeled Loader	1999	280	1,974

3.2 Special Trades Contractor Equipment Operation

Sample Frame

ERG obtained 6,000 business listings with phone contact information from USA Data, a leading business mailing list provider, for this subsector.[23] This call list was a proportionally drawn subset of 54,823 total listings for companies operating in Texas with a primary SIC between 1700 and 1799, excluding 1794 (excavation) and 1795 (demolition),[24] and other business categories that were highly unlikely to operate the targeted equipment types. Other excluded SIC categories included painting and paper hanging, plastering/drywall/ acoustical/insulation work, terrazzo/tile/marble/mosaic work, and glass/glazing work.

The USA Data records included the following information:

- Company Name
- Company Address (street, city, state, and zip code)
- SIC
- SIC Description
- Full Business Name
- Phone
- Contact Name
- Contact Title

[23] See http://www.usadata.com/

[24] Equipment use among excavation and demolition contractors has been evaluated under other DCE subsector profiles – commercial, highway, and utility construction activities.

The business listings were subsequently grouped into different strata, based on primary SIC and the number of observations available for each. Each of these strata was evaluated independently during the phone survey in order to determine ownership rates for the targeted equipment categories. Table 3-5 summarizes the number of listings included in the call list by strata.

Table 3-5. Special Trades Call List Distribution by Strata

SIC	Description	Total Listings
1711	Plumbing, Heating and Air-Conditioning	1,442
1731	Electrical Work	379
1741	Masonry, Stone Setting, and Other Stone Work	252
1751	Carpentry Work	18
1752	Floor Laying and Other Floor Work, NEC	108
1761	Roofing, Siding, and Sheet Metal Work	72
1771	Concrete Work	2,376
1781	Water Well Drilling	18
1791	Structural Steel Erection	361
1796	Installation or Erection of Building Equipment, NEC	54
1799	Other Contractors, Not Elsewhere Classified	920
	Total	**6,000**

Phone Surveys

ERG obtained the services of a phone survey contractor to execute this portion of the Data Collection Plan. ERG trained the staff in conducting phone surveys of DCE operators, providing background in the purpose of the study and familiarizing staff with industry terminology they would encounter. Since the working hours of the key industries vary, ERG changed the times the surveys were administered, ranging from as early as 7:00 a.m. to as late as 7:00 p.m., in order to maximize response rates. Contacts included in the sample frame were called, emailed, and/or faxed up to four times in an attempt to establish contact. After four unsuccessful attempts the number was removed from the call list.

Upon completion of the first week of phone surveys (and at regular intervals thereafter), ERG reviewed and audited the results of the surveys to check for data completeness and determine if adjustments needed to be made to the survey or survey method in order to reach the targeted response rates and ensure the survey was adequately collecting the data necessary for emissions calculations. After review, no substantive changes were made to the survey questions or protocol.

The survey collected the following information from each respondent:

a) The number of DCE operated in the state during 2007
b) County or counties of operation
c) The make and model of each unit
d) The model year of each unit
e) The typical activity (hours/year of engine-on time) for each unit
f) The horsepower (or horsepower range) for each unit

Appendix D provides the survey text and questions administered to the special trades contractors.

Once a respondent's eligibility to participate in the survey was determined (meaning they must have owned/operated/used at least one DCE in Texas greater than or equal to 25 hp during the 2007 base year), the survey was administered.

To ensure the activity, horsepower, and model year data collected in the phone surveys were reasonable, these fields had pre-defined range checks associated with them. This allowed the person conducting the survey to ask for qualifying information if the responses were not reasonable or were inconsistent. Specifically, the surveyor asked for confirmation if the reported engine-on time was greater than 2,000 hours/year.

Data collected during the survey was entered online into the Websurvey response tracking software during the phone interview. The surveyor entered a unique ID for each respondent. Automated range checks also alerted the surveyor to request confirmation on potential outliers, and to provide entries for key fields (# of DCE, hp, and hours per year).

Phone Survey Results

ERG representatives attempted to contact businesses in each of the above strata to determine DCE ownership and use patterns. Extended calling made it clear that several of the sample strata did not own or operate targeted DCE in any significant numbers. 50 or more contacts were made within the following strata, with no respondent reporting any targeted DCE:[25]

- Masonry, Stone Setting, and Other Stone Work
- Carpentry work
- Floor Laying and Other Floor Work, NEC
- Roofing, Siding, and Sheet Metal Work
- Structural Steel Erection
- Installation or Erection of Building Equipment, NEC

[25] Non-targeted equipment commonly included welders, aerial lifts, generators, and skid steer loaders (the last of which was covered in a different TCEQ survey).

Table 3-6 summarizes the survey response rates for the strata with reported DCE operation, as well as the number of companies contacted reporting no DCE operation (ineligible). As is seen, equipment incidence rates were low for special trades contractors compared with many other DCE sectors (e.g., highway contractors).

Table 3-6. Special Trades Survey Completes and Ineligibles by Strata

SIC	Description	Completes	Ineligible
1711	Plumbing, Heating and Air-Conditioning	95	320
1731	Electrical Work	21	72
1771	Concrete Work	177	530
1799	Other Contractors, Not Elsewhere Classified	10[26]	260
	Total	**303**	**1,172**

Eligible respondents reported operations in 115 counties across the state, as shown in Table 3-7.

[26] Includes one water well drilling company.

Table 3-7. Special Trades Survey Respondent Operations by County

County	Reported Activity	County	Reported Activity	County	Reported Activity
Anderson	0	Colorado	1	Gonzales	0
Andrews	0	Comal	2	Gray	0
Angelina	2	Comanche	0	Grayson	3
Aransas	0	Concho	0	Gregg	3
Archer	1	Cooke	2	Grimes	2
Armstrong	0	Coryell	1	Guadalupe	2
Atascosa	0	Cottle	0	Hale	2
Austin	1	Crane	0	Hall	0
Bailey	0	Crockett	0	Hamilton	0
Bandera	0	Crosby	0	Hansford	0
Bastrop	2	Culberson	0	Hardeman	0
Baylor	0	Dallam	1	Hardin	0
Bee	0	Dallas	13	Harris	43
Bell	2	Dawson	2	Harrison	2
Bexar	14	Deaf Smith	2	Hartley	1
Blanco	0	Delta	0	Haskell	1
Borden	0	Denton	2	Hays	1
Bosque	0	Dewitt	0	Hemphill	0
Bowie	3	Dickens	0	Henderson	1
Brazoria	11	Dimmit	0	Hidalgo	5
Brazos	1	Donley	0	Hill	1
Brewster	1	Duval	0	Hockley	1
Briscoe	0	Eastland	0	Hood	2
Brooks	0	Ector	3	Hopkins	3
Brown	0	Edwards	0	Houston	0
Burleson	0	Ellis	4	Howard	0
Burnet	1	El Paso	8	Hudspeth	0
Caldwell	0	Erath	2	Hunt	3
Calhoun	0	Falls	0	Hutchinson	0
Callahan	0	Fannin	0	Irion	0
Cameron	4	Fayette	0	Jack	0
Camp	0	Fisher	1	Jackson	0
Carson	1	Floyd	1	Jasper	2
Cass	0	Foard	0	Jeff Davis	1
Castro	1	Fort Bend	6	Jefferson	5
Chambers	1	Franklin	1	Jim Hogg	0
Cherokee	2	Freestone	1	Jim Wells	2
Childress	0	Frio	0	Johnson	3
Clay	0	Gaines	0	Jones	1
Cochran	0	Galveston	3	Karnes	0
Coke	1	Garza	1	Kaufman	1
Coleman	0	Gillespie	2	Kendall	1
Collin	5	Glasscock	0	Kenedy	0
Collingsworth	0	Goliad	0	Kent	0

County	Reported Activity
Kerr	1
Kimble	0
King	0
Kinney	0
Kleberg	0
Knox	1
Lamar	2
Lamb	0
Lampasas	1
La Salle	0
Lavaca	0
Lee	1
Leon	0
Liberty	2
Limestone	1
Lipscomb	0
Live Oak	0
Llano	1
Loving	0
Lubbock	3
Lynn	0
McCulloch	0
McLennan	7
McMullen	0
Madison	0
Marion	0
Martin	0
Mason	0
Matagorda	2
Maverick	0
Medina	0
Menard	0
Midland	2
Milam	1
Mills	0
Mitchell	0
Montague	0
Montgomery	8
Moore	2
Morris	0
Motley	0
Nacogdoches	5
Navarro	1
Newton	0
Nolan	1
Nueces	7

County	Reported Activity
Ochiltree	0
Oldham	0
Orange	3
Palo Pinto	1
Panola	0
Parker	7
Parmer	1
Pecos	0
Polk	0
Potter	4
Presidio	1
Rains	0
Randall	4
Reagan	0
Real	0
Red River	1
Reeves	0
Refugio	0
Roberts	0
Robertson	0
Rockwall	3
Runnels	0
Rusk	0
Sabine	0
San Augustine	0
San Jacinto	1
San Patricio	1
San Saba	0
Schleicher	0
Scurry	0
Shackelford	0
Shelby	1
Sherman	0
Smith	5
Somervell	0
Starr	1
Stephens	0
Sterling	0
Stonewall	1
Sutton	0
Swisher	0
Tarrant	16
Taylor	2
Terrell	0
Terry	0
Throckmorton	0

County	Reported Activity
Titus	0
Tom Green	1
Travis	17
Trinity	0
Tyler	2
Upshur	0
Upton	0
Uvalde	0
Val Verde	0
Van Zandt	2
Victoria	2
Walker	1
Waller	2
Ward	0
Washington	1
Webb	0
Wharton	0
Wheeler	0
Wichita	4
Wilbarger	1
Willacy	0
Williamson	6
Wilson	1
Winkler	0
Wise	4
Wood	2
Yoakum	0
Young	2
Zapata	0
Zavala	0

Table 3-8 lists the number of units reported for the different DCE types by category, along with the average horsepower and hours per year reported for 2007 operations.

Table 3-8. Surveyed Unit Counts, Average HP and Activity by Equipment Type

Equipment Type	Survey Counts	Average HP	Average Hr/Yr
Crawler Tractor/Dozer	38	96.6	733
Excavator	75	92.9	631
Grader	35	141.3	828
Paver	9	134.9	1,131
Roller	13	92.2	1,082
Tractor/Loader/Backhoe	377	72.7	582
Wheeled Loader	63	145.0	1,898
Total	**610**		

3.3 Rough Terrain Forklifts (RTFs) and Trenchers

Sample Frame

ERG purchased RTF and trencher buyer contact information directly from Equipment Data Associates (EDA), rather than attempting to contact owners through random calling of companies. EDA maintains a database of non-road equipment sales transactions, including RTFs and trenchers, across the U.S. back to 1990. EDA's database is constructed from UCC-1 filings, which provide data on any piece of equipment that has been financed through a note. Available data includes equipment type, year of purchase, buyer name and contact information, among others. The EDA database does not contain information on cash sales, or sales executed using extended lines of credit.27 EDA estimates that the sales records included in their database account for an estimated 70% of all RTF and 55% of trencher sales in the U.S., based on review of their data by equipment manufacturers.[28]

ERG purchased contact information from EDA for 496 companies having purchased at least one RTF in Texas and 444 companies having purchased at least one trencher in Texas since 1990. The companies were selected randomly from among the Texas companies contained in the EDA database that were listed as having purchased at least one RTF or trencher during this period. By obtaining buyer contact information directly from EDA it was possible to efficiently identify RTF and trencher operators across the entire range of end-users in Texas.

The EDA records included the following:

[27] http://www.eqtdata.com/contact.html
[28] Personal communication with Bryan Fanis, EDA, August, 2008

- Company name
- Company location (county)
- Year of purchase
- Number of units purchased
- Name and phone number of person responsible for purchasing

The sample frame records were randomly drawn from EDA's data to assure geographic and industry representativeness across the state. EDA also provided ERG with aggregated state level sales data for each year from 1990 through 2007 for later surrogate application, in order to extrapolate phone survey responses to the entire state.

Phone Surveys

Phone surveys were conducted for RTF and trencher operators in the same manner as performed for the Special Trades Contractor survey described above.

ERG representatives attempted to contact all 940 companies included in the EDA sample frame at least once. Of the 496 respondents contacted by phone for RTFs, 88 agreed to answer the survey and of these, only 49 respondents owned or operated RTFs that were eligible to be included in the survey. Strata were established for survey respondents based on SIC grouping.

Table 3-9 shows the respondent cooperation and eligibility for RTFs.

Table 3-9. Respondent Cooperation and Eligibility for RTFs

Respondents Agreeing to Take the Survey	88
Eligible Respondents	49
Ineligible Respondents	39

Respondent rates by business area (strata) for RTFs are illustrated in Table 3-10.

Table 3-10. Respondent Rates by Strata for RTFs

Strata	Completed Surveys	Ineligibles
Agricultural	4	2
Building Construction	6	3
Equipment Sales/Rental/Lease	11	7
Manufacturing	2	4
Masonry/Stone	7	1
Other	11	9
Special Trades	8	13
Total	**49**	**39**

Of the 444 respondents contacted by phone for trenchers, 91 agreed to answer the survey and of these, only 55 respondents owned or operated trenchers that were eligible to be included in the survey.

Table 3-11 shows the respondent cooperation and eligibility for trenchers.

Table 3-11. Respondent Cooperation and Eligibility for Trenchers

Respondents Agreeing to Take the Survey	91
Eligible Respondents	55
Ineligible Respondents	35
Don't Know	1

Respondent rates by business area (strata) for trenchers are illustrated in Table 3-12.

Table 3-12. Respondent Rates by Strata for Trenchers

Strata	Completed Surveys	Ineligibles
Agricultural	3	3
Building and Heavy Construction	9	6
Equipment Sales/Rental/Lease	11	5
Other	5	5
Plumbing/HVAC	6	4
Special Trades	9	9
Utility Construction	12	3
Total	**55**	**35**

ERG collected information on the number of people employed by the companies both willing and eligible to take the survey. This information is presented in Figure 3-1 for RTFs and Figure 3-2 for trenchers.

Figure 3-1. Company Distribution by Employee Size Range for RTFs

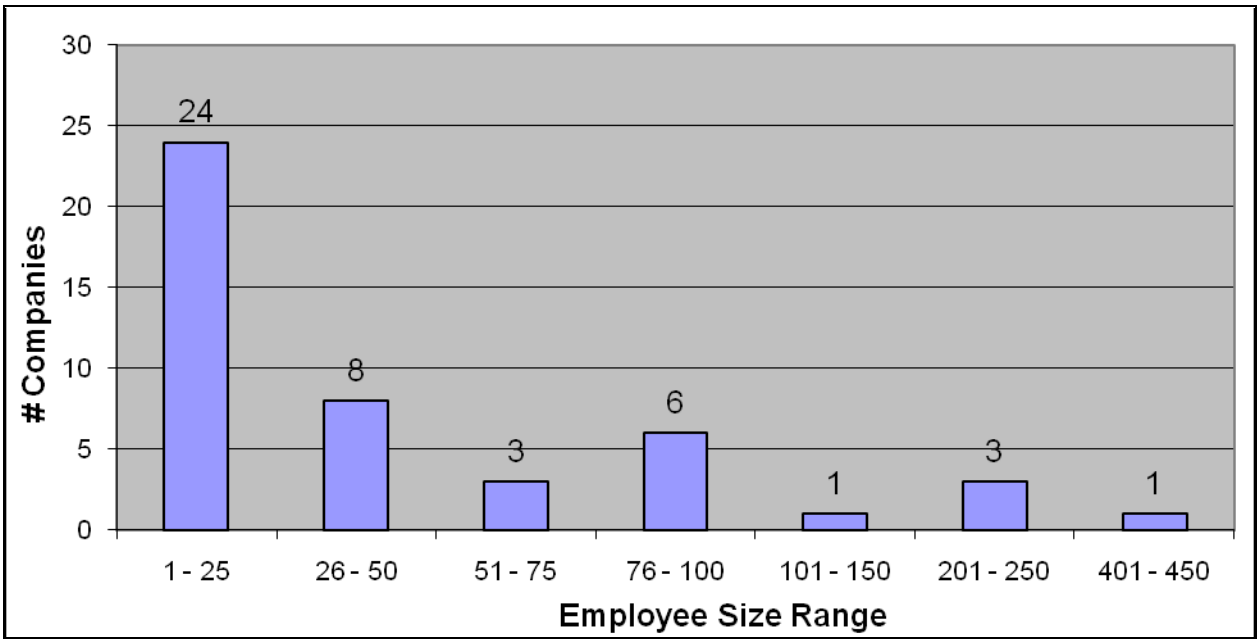
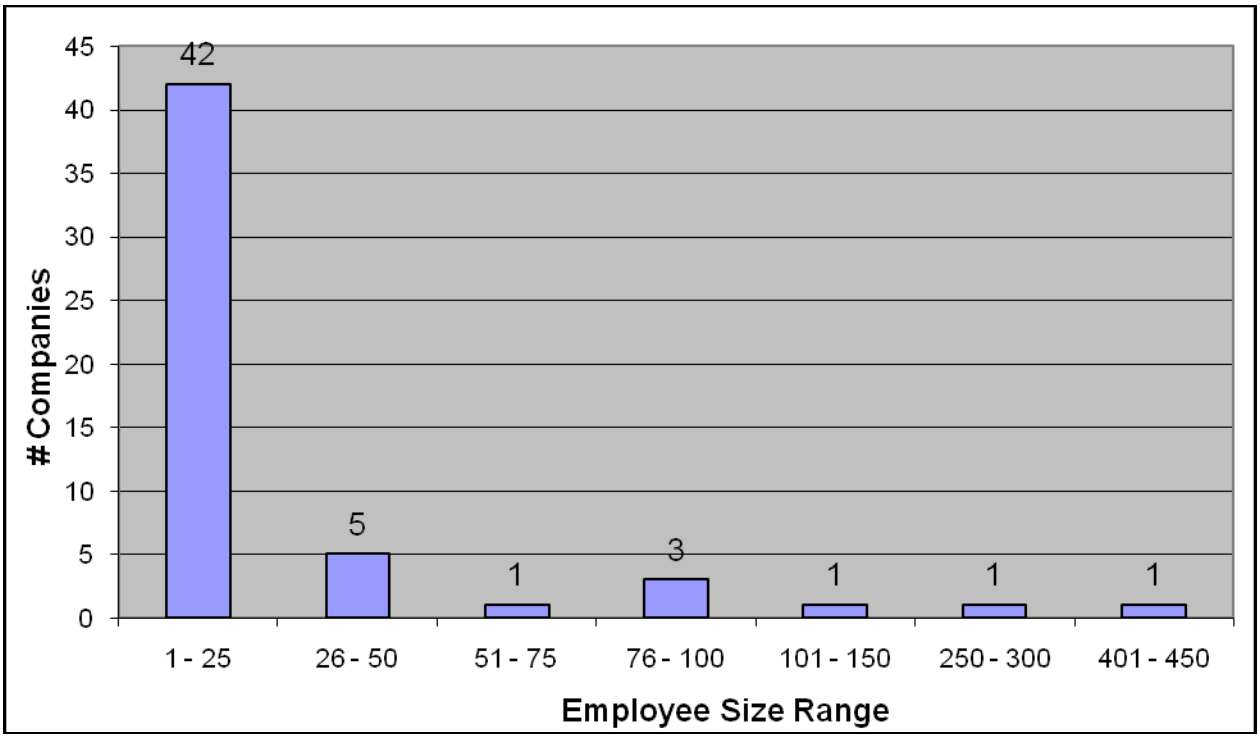


Figure 3-2. Company Distribution by Employee Size Range for Trenchers



The weighted horsepower distribution for the eligible equipment is presented in Table 3-13 for RTFs and Table 3-14 for trenchers. Equipment populations have been weighted to account for response bias in these and subsequent tables and figures. The weighting process is described in detail in Section 4.

Table 3-13. Weighted Horsepower Distribution for RTFs

Final Assigned HP Range	Total	Percentage
25 - 40	1	0.6%
41 - 50	2	1.7%
51 - 75	2	1.7%
76 - 100	88	62.2%
101 - 175	45	31.7%
N/A	3	2.2%

Table 3-14. Weighted Horsepower Distribution for Trenchers

Final Assigned HP Range	Total	Percentage
25 - 40	34	40.2%
41 - 50	12	14.0%
51 - 75	10	12.5%
76 - 100	3	4.0%
101 - 175	1	1.7%
176 - 300	4	4.9%
301 - 600	15	18.1%
601 - 750	2	2.5%
N/A	2	2.1%

The weighted activity distribution for the eligible equipment is presented in Table 3-15 for RTFs and Table 3-16 for trenchers.

Table 3-15. Weighted Activity Distribution for RTFs

RTF Activity Range (hrs/yr)	Population
0 - 99	2
100 - 249	14
250 - 499	13
500 - 749	14
750 - 999	45
1,000 – 1,499	37
1,500 – 1,999	4
2,000 – 3,000	13
Total	**142**

Table 3-16. Weighted Activity Distribution for Trenchers

Trencher Activity Range (hrs/yr)	Population
0 - 99	7
100 - 249	15
250 - 499	10
500 - 749	11
750 - 999	2
1,000 – 1,499	16
1,500 – 1,999	13
2,000 – 3,000	11
Total	**84**

As illustrated by Figures 3-3 and 3-4 for RTFs and trenchers, respectively, RTFs and trenchers are used by a variety of business areas.

Figure 3-3. Weighted Equipment Distribution by Strata for RTFs

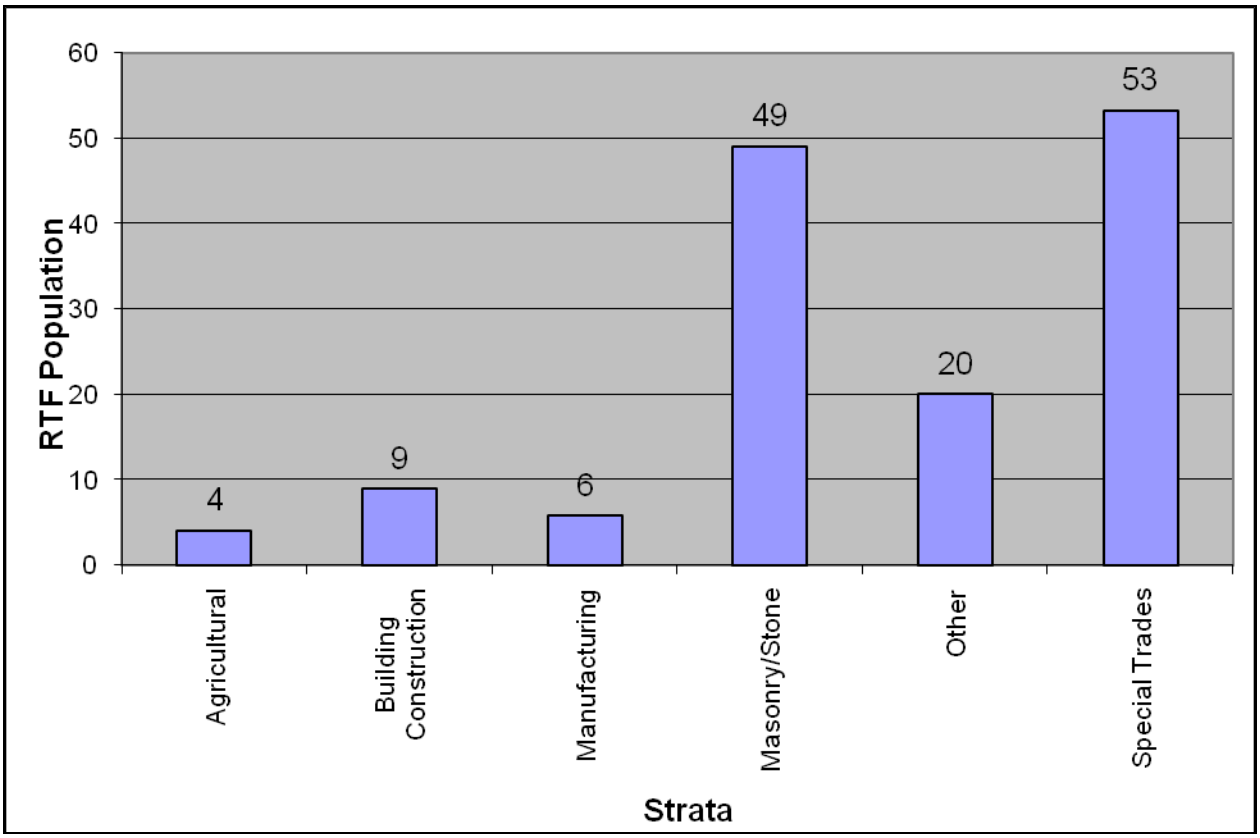
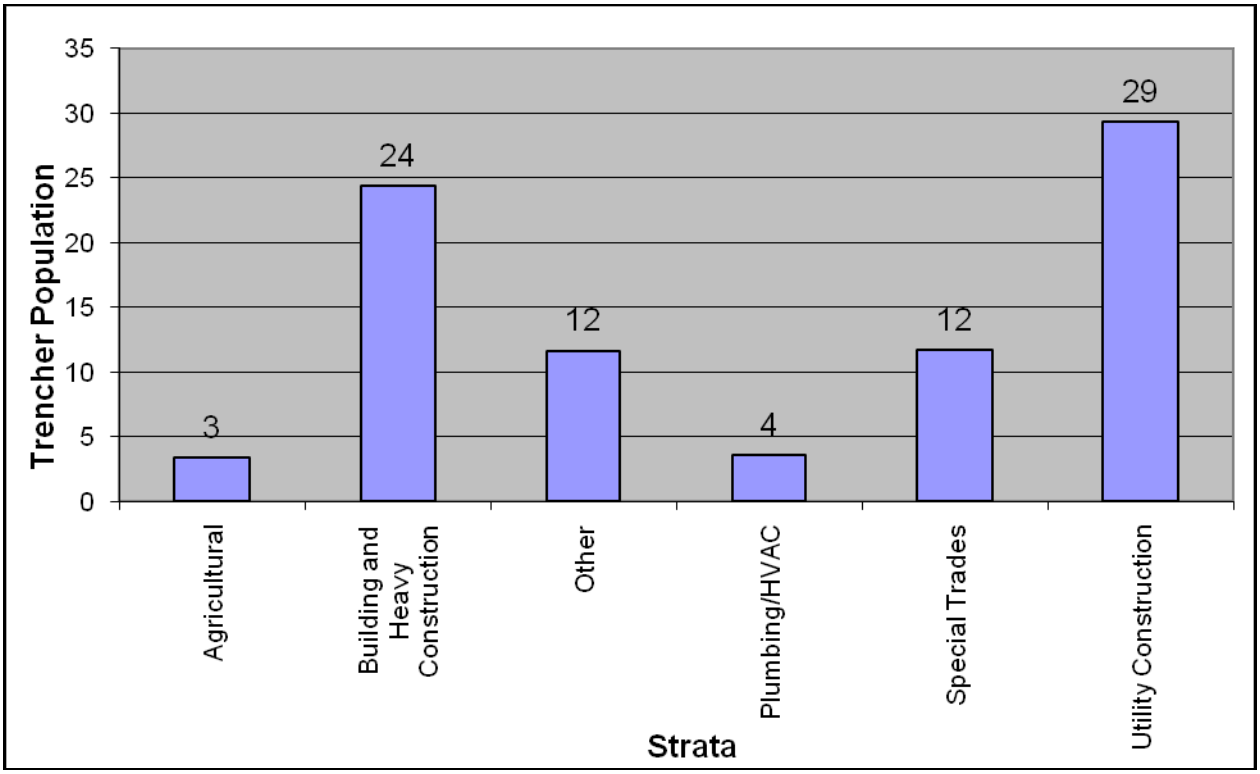


Figure 3-4. Weighted Equipment Distribution by Strata for Trenchers



The weighted average activity for RTFs and trenchers by strata is presented in Tables 3-17 and 3-18, respectively.

Table 3-17. Weighted Average Activity by Strata for RTFs

Strata	Average Activity (hrs/yr)
Agricultural	214
Building Construction	659
Manufacturing	1,971
Masonry/Stone	1,052
Other	657
Special Trades	627
All Strata	**875**

Table 3-18. Weighted Average Activity by Strata for Trenchers

Strata	Average Activity (hrs/yr)
Agricultural	253
Building and Heavy Construction	1,442
Other	688
Plumbing/HVAC	454
Special Trades	611
Utility Construction	1,115
All Strata	**914**

The weighted population by equipment make is illustrated in Table 3-19 for RTFs and Table 3-20 for trenchers.

Table 3-19. Weighted RTF Population Distribution by Equipment Make

Make	Population
Case	2
Caterpillar	10
Eaves	1
Genie	16
Heister	2
Highlander	2
JLG	1
John Deere	1
Kooi	1
Lift Systems	4
Lowe	2
Lull	7
Manitou	3
Massey Ferguson	1
Pettibone	4
Princeton	1
Selik	3
Skytrak	46
Terex	34
Toyota	2

Table 3-20. Weighted Trencher Population Distribution by Equipment Make

Make	Population
Aztec	2
Bobcat	1
Case	10
Davis	1
Ditch Witch	42
Trencor	2
Vermeer	25
Romier	1

Table 3-21 shows the observed company distribution by county for RTFs and trenchers.

Table 3-21. Company Distribution by County

County	RTF Companies	Trencher Companies
Anderson	0	1
Angelina	0	2
Bastrop	0	1
Bell	2	0
Bexar	3	1
Bowie	0	1
Brazoria	0	1
Brazos	1	1
Brewster	0	1
Calhoun	0	1
Cameron	1	0
Cass	0	1
Cherokee	1	0
Collin	0	1
Crosby	2	0
Dallas	2	0
Ector	1	0
Edwards	1	0
Ellis	0	1
El Paso	1	2
Erath	1	0
Falls	2	0
Floyd	1	0
Frio	0	2
Grayson	1	0
Gregg	0	1
Hale	1	0
Hardin	0	1
Harris	1	1
Hays	0	1
Henderson	0	1

County	RTF Companies	Trencher Companies
Hidalgo	0	2
Hill	2	3
Hockley	1	0
Hopkins	1	1
Hudspeth	0	1
Jackson	0	1
Jefferson	2	0
Johnson	0	2
Kendall	0	1
Kerr	0	1
Kinney	1	0
Kleberg	1	0
Lamb	2	0
Lampasas	1	0
Lee	0	1
Lubbock	2	0
McLennan	2	0
Matagorda	0	1
Maverick	1	0
Medina	1	1
Montgomery	1	1
Morris	0	1
Nacogdoches	0	1
Navarro	1	0
Nueces	0	2
Pala	1	0
Parker	0	1
Potter	1	4
Randall	0	3
Real	0	1
Red River	0	1
Rockwall	0	1
Rusk	1	0
San Patricio	0	2
Schleicher	0	1
Somervell	0	1
Stephens	0	1
Sutton	0	1
Tarrant	1	0
Tom Green	0	1
Travis	1	0
Uvalde	1	1
Val Verde	1	0
Victoria	0	1
Webb	0	1
Wichita	0	1
Wise	0	1

County	RTF Companies	Trencher Companies
Young	2	1
Zapata	0	1
Zavala	0	1
Total	**50**	**68**

To avoid double counting, equipment reported by equipment sales and rental companies were removed from the general analysis. The activity distribution for rental companies can be seen in Tables 3-22 and 3-23 for RTFs and trenchers, respectively.

Table 3-22. Activity Range for RTF Rentals

Activity Range (hrs/yr) for RTF Rentals	Population
0 - 99	1
250 - 499	17
500 - 749	81
750 - 999	4
1,000 – 1,499	0
1,500 – 1,999	3

Table 3-23. Activity Range for Trencher Rentals

Activity Range (hrs/yr) for Trencher Rentals	Population
100 - 249	6
250 - 499	6
500 - 749	27
750 – 1,499	0
1,500 – 1,999	8

Field Observations

ERG representatives attempted to obtain permission from survey respondents to conduct a follow up site visit in order to independently validate the reported data. Only three survey respondents (in the East Texas area) initially agreed to allow for a follow-on site visit. Of these, not a single company ultimately agreed to a confirmed appointment upon subsequent follow up.

ERG representatives conducted a second round of calling in order to recruit participants for on-site visits, expanding targeted companies beyond the East Texas area. However, these efforts also proved unsuccessful, and no site visits were performed for these equipment types.

3.4 Scrap and Recycling

Sample Frame

ERG purchased contact information for 611 business in Texas classified as Scrap and Recycling entities (SIC 5093) from USA Data. These 611 businesses represent a census for scrap and recycling businesses in Texas, so no surrogates are required for extrapolation to an unsurveyed population. The USA Data records included the following information:

- Company Name
- Company Address (street, city, state, and zip code)
- SIC
- SIC Description
- Full Business Name
- Phone
- Contact Name
- Contact Title

Phone Surveys

ERG representatives conducted a phone survey of the 611 businesses included in the call list. The survey requested essentially the same information collected under the Special Trades Contractor survey, as summarized below.

- If the company operated one or more scrap or recycling facilities in Texas;
- If the company operated diesel construction equipment greater than 25 horsepower in Texas during the 2007 calendar year;
- Number of counties of operation;
- The make and model of each unit;
- The horsepower (or horsepower range) of each unit;
- The typical activity (hours/year of engine-on time) for each unit (or an activity range) in 2007;
- The model year (or model year range) of each unit.

ERG attempted to contact all 611 businesses included in the USA Data sample frame at least once. Table 3-24 presents a call summary.

Table 3-24. Scrap and Recycling Call Summary

Companies In Frame	611
Companies Unable To Contact	488
Companies Contacted	123
Companies With Eligible Equipment	47

Equipment populations by equipment type are shown in Table 3-25.

Table 3-25. Scrap/Recycling Equipment Population by Equipment Type

Equipment Type	Population
Backhoe	1
Crawler Tractor/Dozer	3
Excavator	68
Off-Highway Truck	4
Wheeled Loader	38
Total	**186**

The distribution for the eligible equipment is presented by equipment type and horsepower range in Table 3-26.

Table 3-26. Scrap/Recycling Equipment Population Distribution by Equipment Type and Horsepower Range

Equipment Type	25 - 39	40 - 49	50 - 74	75 - 99	100 - 174	175 - 299	300 - 599
Backhoe			1				
Crawler Tractor/Dozer						1	2
Excavator					34	31	3
Off-Highway Truck						1	3
Wheeled Loader		2	3	4	19	8	2

The average horsepower by equipment type and horsepower is presented in Table 3-27.

Table 3-27. Scrap/Recycling Average Horsepower by Equipment Type and Horsepower Range

Equipment Type	25 - 39	40 - 49	50 - 74	75 - 99	100 - 174	175 - 299	300 - 599
Backhoe			62				
Crawler Tractor/Dozer						237	450
Excavator					137	238	450
Off-Highway Truck						237	450
Wheeled Loader		45	59	87	136	237	450

The activity distribution by equipment type and activity range is presented in Table 3-28.

Table 3-28. Scrap/Recycling Equipment Distribution by Activity Range and Equipment Type (Hrs/yr)

Equipment Type	0-99	100-249	250-499	500-749	750-999	1000-1499	1500-1999	2000-3000	3000+
Backhoe	1								
Crawler Tractor/Dozer								3	
Excavator	4	1	5	8	5	9	8	22	6
Off-Highway Truck				3	1				
Wheeled Loader	3	2	6	6	1	4	3	13	

The average activity (hours/year) by equipment type is presented in Table 3-29.

Table 3-29. Scrap/Recycling Average Activity by Equipment Type

Equipment Type	Average Activity (hrs/yr)
Backhoe	50
Crawler Tractor/Dozer	2,500
Excavator	1,586
Off-Highway Truck	687
Wheeled Loader	1,291

Table 3-30 shows the equipment distribution by equipment type and make.

Table 3-30. Scrap/Recycling Equipment Distribution by Equipment Type and Make

Equipment Type	Make	Population
Backhoe	John Deere	1
Crawler Tractor/Dozer	Cat	2
	Yutanni	1
Excavator	Bantam	1
	Barko	4
	Case	2
	Cat	14
	Caterpillar	3
	Fiat Atlas	1
	Hine Warner	1
	Hitachi	3
	Hyundai	2
	John Deere	5
	Kobelco	3
	Komatsu	7
	Liebherr	8
	Linkbelt	4
	Prentice	1

Equipment Type	Make	Population
	R 944 EW	1
	Samsung	3
	Sennebogen	2
	Tigercat	1
	Yutani	1
Off-Highway Truck	Freightliner	2
	Mack	2
Wheeled Loader	Alison-Chambers	1
	Case	7
	Caterpillar	14
	John Deere	8
	Liebherr	1
	Link Belt	1
	Michigan-Clark	1
	Samsung	1
	Waldon	4

Table 3-31 shows the distribution of equipment by county and equipment type.

Table 3-31. Scrap/Recycling Equipment Distribution by County and Equipment Type

County	Backhoe	Crawler Tractor/ Dozer	Excavator	Off-Highway Truck	Wheeled Loader
Angelina			2		
Bexar			1		
Brazoria			4		2
Brown			2		
Burnet					1
Caldwell			2		
Cameron			3		1
Cherokee			1		3
Dallas		1	9		9
El Paso			3		1
Ellis					
Freestone					
Galveston					
Harris			1		1
Harrison			5		3
Hector			7	1	2
Hidalgo					
Hockley			2		1
Lubbock			2		
Mason					1
Midland					
Nueces			6		
Parmer			1		

County	Backhoe	Crawler Tractor/ Dozer	Excavator	Off-Highway Truck	Wheeled Loader
Perry			1	1	
Shelby			2		2
Smith			1		4
Taylor					
Tarrant			3		1
Travis			5	1	4
Victoria		2	1	1	1
Williamson	1				
Total	**1**	**3**	**64**	**4**	**37**

3.5 Utility Construction (Demolition Profile)

Sample Frame and Survey Results

ERG contacted several trade organizations with the goal of revising the demolition portion of the utility equipment use profile (see Data Collection Plan for details). A questionnaire was developed to obtain the required information, and is provided in Appendix F. The trade organizations were given the opportunity to review and comment on the survey. Once trade organization comments were incorporated, ERG obtained contact information for 21 utility contractors from the Central and East Texas regions from several of the trade organizations. Attempts to contact these contractors to issue the survey were repeatedly made by phone, facsimile, and email. Of these, eight contractors agreed to review the survey. Of these eight, only four returned the survey. With the contractor input received through these surveys, ERG was able to make the following generalizations regarding the demolition portion of the utility DCE profile.

- 90% of all utility projects involve at least some pavement removal;
- Of these 90%, only 5% of the pavement removed is concrete with the other 95% is asphalt;
- For projects involving pavement removal, on average only about 10% of the entire lot/project site requires pavement removal;
- The average depth for concrete removal is 6 – 8 inches and for asphalt removal it is 2 – 3 inches;
- The average time for concrete removal is 10 minutes per square yard and 1 minute per square yard for asphalt removal.

3.6 Uncertainty Analysis and Confidence Intervals

An analysis was conducted to determine the error bounds associated with the average hours per year and average hp estimates developed for the different DCE subsector profiles. The error bounds take into account both the number of observations for a particular parameter, as

well as the variability of the response itself. For example, an average hp value based on three responses covering a wide range will be much more uncertain than an average based on 50 responses covering a narrow range.

The following analyses assume that the estimates of the mean for a given distribution (e.g., average activity and hp) are normally distributed. Accordingly, the confidence interval associated with any particular mean value can be calculated as a function of the sample size and the standard deviation of the distribution, as shown in Equation 1.

Equation 1. $CIp = tn\text{-}1 * \sigma / \sqrt{n}$

Where:
CI = Confidence Interval
p = Selected probability level
tn-1 = t-value of student's t-test distribution with n-1 degrees of freedom
σ = standard deviation of the distribution
n = number of observations in distribution

For this analysis error bounds are reported at the 95% level of confidence (p = 0.05). This level of confidence means that if the survey were conducted 20 times, the resulting averages would be expected to fall within the confidence intervals (confidence interval ± the parameter average) in 19 of those surveys.

The confidence intervals calculated for annual average activity and hp for the different DCE subsectors are presented in Tables 3-32 through 3-36. Uncertainty estimates are developed for equipment types with more than 5 observations.

Table 3-32. 95% Confidence Intervals – RTFs and Trenchers

Parameter	Average	Confidence Interval	Percent of Average
RTFs (N=156)			
Hours/Yr	875	±83	9.5%
HP	89	±3	3.4%
Trenchers (N=79)			
Hours/Yr	914	±175	19.1%
HP	142	±41	28.9%

The resulting error estimates are relatively small and for RTFs, but display greater uncertainty for trenchers, due to the greater variability in their associated survey responses.

Table 3-33. 95% Confidence Intervals – Special Trades Contractor Equipment

Parameter	Average	Confidence Interval	Percent of Average
Crawler Dozers (N=38)			
Hours/Yr	733	±185	25.2%
HP	91	±11	12.1%
Excavators (N=75)			
Hours/Yr	631	±152	24.1%
HP	74	±21	28.4%
Graders (N=35)			
Hours/Yr	828	±170	20.5%
HP	141	±11	7.8%
Tractors/Loaders/Backhoes (N=377)			
Hours/Yr	582	±63	10.8%
HP	69	±2	2.9%
Wheeled Loaders (N=63)			
Hours/Yr	1,898	±222	11.7%
HP	142	±14	9.9%

Within the special trades subsector tractors/loaders/backhoes and wheeled loaders displayed relatively high uniformity in activity and hp. Excavators and crawler dozers displayed much more variability in engine size and operation times, and therefore larger associated confidence intervals.

Table 3-34. 95% Confidence Intervals – Scrap/Recycling Equipment

Parameter	Average	Confidence Interval	Percent of Average
Excavators (N=68)			
Hours/Yr	1,586	±225	14.2%
HP	197	±18	9.1%
Wheeled Loaders (N=38)			
Hours/Yr	1,291	±310	24.0%
HP	158	±30	19.0%

While wheeled loaders in this subsector display more variability and uncertainty than those in special trades contracting, excavators were found to have more uniformity and correspondingly smaller confidence intervals.

Table 3-35. 95% Confidence Intervals – Mining Equipment

Parameter	Average	Confidence Interval	Percent of Average
Crawler Dozers (N=51)			
Hours/Yr	5,800	±424	7.3%
HP	493	±34	6.9%
Excavators (N=15)			
Hours/Yr	5,273	±1,453	27.6%
HP	923	±217	23.5%
Graders (N=17)			
Hours/Yr	5,218	±817	15.7%
HP	254	±15	5.9%
Off Highway Trucks (N=58)			
Hours/Yr	4,793	±448	9.3%
HP	1,047	±72	6.9%
Wheeled Loaders (N=35)			
Hours/Yr	3,677	±876	23.8%
HP	438	±101	23.1%

Despite the very high utilization and engine sizes of mining equipment, crawler dozers and off highway trucks were found to have relatively low variability and small confidence intervals when compared to much of the equipment in other DCE subsectors. Excavators and wheeled loaders displayed higher variability and uncertainty, but still comparable to heavy equipment used in other subsectors.

Table 3-36. 95% Confidence Intervals – Quarry Equipment

Parameter	Average	Confidence Interval	Percent of Average
Crawler Dozers (N=24)			
Hours/Yr	1,897	±807	42.5%
HP	241	±41	17.0%
Excavators (N=25)			
Hours/Yr	1,593	±333	20.9%
HP	246	±46	18.7%
Off Highway Trucks (N=39)			
Hours/Yr	1,551	±260	16.8%
HP	353	±39	11.0%
Wheeled Loaders (N=74)			
Hours/Yr	1,974	±264	13.4%
HP	280	±29	10.4%

Crawler dozer use at quarries displayed the largest variability and uncertainty of any equipment type with greater than five observations. Other equipment categories had activity level and engine size uncertainties roughly comparable to those in other DCE subsectors.

4.0 Data Analysis and Surrogate Application

Before analyzing the survey data for each of the DCE survey categories described in Section 3, ineligible records were removed from the data. Ineligible records included equipment units inappropriately entered into the project database. Additional range checks were conducted to ensure that horsepower, model year, and activity estimates were reasonable for each DCE type.

4.1 Development and Application of Analytical Weights – RTFs, Trenchers, Special Trades Contractors

After the survey data had been quality assured and cleaned, analytic weights were developed to adjust for potential non-response bias for certain DCE subsectors. For example, it is possible that one survey stratum within a subsector may not participate in the survey at the same rate as other strata. If equipment use patterns for the strata are different, the aggregated equipment profile may be biased. Such differential non-response could bias the results of the survey because the distribution of surveyed equipment users would not represent the equipment operator population as a whole. To illustrate, if survey strata with high equipment use levels participated in the survey at twice the rate of strata with low equipment utilization, then the estimated average hours per year based on the survey data (i.e., without adjustment) would overestimate the actual activity levels.

For this reason analytic weights were developed to correct for this type of bias for RTFs, trenchers, and special trades contractor equipment, as discussed below. (The scrap/recycling, mining, and quarry surveys were not broken out by multiple strata. As such, analytical weights were not required for these DCE subsectors.)

4.1.1 RTFs and Trenchers

A four digit SIC code was included in the EDA sample frame data set for the RTF and trencher companies listed. The companies were grouped into seven broad strata based on SIC groups, as shown below in Tables 4-1 and 4-2 for RTFs and trenchers, respectively. These groupings were selected to reflect fundamentally different equipment use patterns, based on contractor judgment.

Table 4-1. Distribution of Companies in Sample Frame by Strata for RTFs*

Strata Assignment	Total
Agricultural	35
Building Construction	72
Heavy Construction	68
Special Trades	122
Masonry/Stone	58
Manufacturing	50
Other	91
Total	**496**

*Excludes rental/leasing companies

Table 4-2. Distribution of Companies in Sample Frame by Strata for Trenchers*

Strata Assignment	Total
Agricultural	35
Building and Heavy Construction	94
Utility Construction	124
Special Trades	96
Plumbing/HVAC	42
Other	53
Total	**444**

*Excludes rental/leasing companies

Once the strata were established, the number of completed surveys and the total number of records in the EDA sample frame were then used to calculate proportions within each stratum. The resulting weights for each stratum were calculated by dividing the proportion of records in the sample frame by the proportion of completed surveys, with the results shown in Table 4-3 for RTFs and Table 4-4 for trenchers.

Table 4-3. Relative Survey and Sample Size Proportions w/ Response Weightings for RTFs

Strata	# Completed Surveys	Fraction of Completes	Records in Frame	Fraction of Records in Frame	Response Weight
Agricultural	6	0.086	35	0.071	0.823
Building Construction	9	0.129	72	0.145	1.129
Heavy Construction	4	0.057	68	0.137	2.399
Special Trades	21	0.300	122	0.246	0.820
Masonry/Stone	8	0.114	58	0.117	1.023
Manufacturing	6	0.086	50	0.101	1.176
Other	16	0.229	91	0.183	0.803
Total	**70**		**496**		

Table 4-4. Relative Survey and Sample Size Proportions w/ Response Weightings for Trenchers

Strata	# Completed Surveys	Fraction of Completes	Records in Frame	Fraction of Records in Frame	Response Weight
Agricultural	7	0.093	35	0.079	0.845
Building and Heavy Construction	15	0.200	94	0.212	1.059
Utility Construction	15	0.200	124	0.279	1.396
Special Trades	18	0.240	96	0.216	0.901
Plumbing/HVAC	10	0.133	42	0.095	0.709
Other	10	0.133	53	0.119	0.895
Total	**75**		**444**		

As a specific example, the Agricultural stratum for RTFs had 6 completed surveys constituting 8.6% of all completes (6/70). Similarly, the EDA sample frame had 35 Agricultural SICs listed, constituting 7.1% of all listings (35/496). Therefore the final response weight for this stratum is 0.071/ 0.086 = 0.823. Accordingly all survey responses for the Agricultural stratum are weighted by the 0.823 factor in order to properly adjust parameter values for this (slight) non-response value.

The response weights in Tables 4-3 and 4-4 indicate that the survey response rates were fairly representative of company type distributions as a whole, with several strata having response weights close to 1 (indicating relatively little response bias). One exception was the heavy construction stratum for RTFs, featuring substantial under-response (with a weighting factor of 2.4). The causes for under-response in this stratum are uncertain.

4.1.2 Special Trades Contractors

As discussed in Section 3.2, four strata within the special trades contractor subsector were found to have substantial numbers of targeted DCE equipment. These included[29]:

- Plumbing, heating and air conditioning (SIC 1711)
- Electrical work (SIC 1731)
- Concrete work (SIC 1771)
- Other contractors, not elsewhere classified (SIC 1799)

Once the strata were established, the number of completed surveys and the total number of records in the USA Data sample frame were then used to calculate proportions within each

[29] Since the sample frame for this subsector was selected based on SIC codes, rental and leasing companies were not included.

stratum. Unlike the RTF and trencher sample frames, the businesses in the USA Data contacts list may or may not have ever purchased targeted DCE. Accordingly, response weights must be based on expected statewide ownership rates rather than simple business listing counts.

Statewide DCE ownership rates by survey stratum were calculated as follows. First ownership rates were determined for each stratum within the survey by dividing the number of completed surveys by the total number contacted by phone (eligible plus ineligible respondents). In this instance a survey respondent had to confirm that they did not own or operate targeted DCE in order to be declared ineligible. Business listings that did not answer our calls, or provided no information were not included in the calculation.

Next, the ownership rates estimated from the survey were then applied to the statewide business listing count from USA Data in order to estimate the number of businesses expected to own targeted DCE across the state. The final response weights for each stratum were then calculated by dividing the fraction of businesses expected to own targeted DCE by the proportion of completed surveys. The data used in each of these steps and the resulting response weights are shown in Table 4-5.

The response weights in Table 4-5 indicate that the survey response rates were not representative of company type distributions as a whole, with the exception of the pluming/heating/air conditioning stratum. The electrical and other contractor strata were relatively under-represented, while the concrete work stratum was correspondingly over-represented, requiring substantial weighting adjustments.

4.2 Population Surrogates

In order to estimate statewide equipment populations based on survey data, the survey findings must be expanded upward using a reliable surrogate. Surrogates may then be used to allocate the statewide totals down to smaller geographic regions (i.e., counties).

The potential surrogates for this study varied by survey strata. Surrogates were identified for geographic allocation to the county level, as well as for forecasting and back-casting equipment populations (growth). Surrogates were selected to the extent possible to be consistent with the calculation procedures and data utilized for other DCE in the TexN model.

Table 4-5. Relative Survey and Sample Size Proportions w/ Response Weightings for Special Trades Contractors

Strata	Completed Surveys	Fraction of Completes	Ineligibles	# Contacted	Ownership Fraction	Businesses in State	Ownership in State	Fraction	Response Weight
Electrical	21	0.069	72	93	0.226	7,847	1,772	0.407	5.88
Plumbing	95	0.314	320	415	0.229	5,812	1,330	0.306	0.98
Concrete	177	0.584	530	707	0.250	3,466	868	0.200	0.34
Other	10	0.033	250	260	0.038	9,856	379	0.087	2.64
Total	**303**		**1,172**	**1,475**		**26,981**	**4,349**		

4.2.1 RTF and Trencher Equipment Population

The equipment population estimation was necessarily more complicated for RTFs and trenchers, since the survey sample frame for these equipment categories were not based on a random sample of potential operators, but upon historical sales records from EDA. Statewide annual sales data obtained from EDA from 1990 through 2007 was utilized in this effort, and is shown in Table 4-6.

Table 4-6. Statewide EDA Sales Data for RTFs and Trenchers (1990-2007)

Year	RTFs	Trenchers
1990	733	826
1991	654	802
1992	677	807
1993	636	876
1994	788	903
1995	824	945
1996	931	1,117
1997	1,046	1,087
1998	1,110	1,246
1999	966	1,274
2000	991	1,295
2001	871	952
2002	806	826
2003	857	833
2004	892	871
2005	954	857
2006	1,061	701
2007	1,264	693

The sales data were then adjusted to account for equipment purchases not included in EDA database, estimated to be 30% for RTFs and 45% for trenchers.[30] Since effectively all RTFs and trenchers are estimated to be greater than 25 hp (according to NONROAD2005 defaults), no further adjustments were applied to the equipment sales data. The resulting statewide annual sales totals are shown in Table 4-7, with equipment split between engines less than or equal to 50 hp, and engines greater than 50 hp. The hp split fractions were obtained from NONROAD2005 population file defaults, which indicate 98% of RTFs greater than 50 hp, and 45% of trenchers greater than 50 hp.

[30] Personal communication with Bryan Fanis, EDA, August, 2008

Table 4-7. Adjusted Statewide Equipment Sales for RTFs and Trenchers (1990-2007)

Year	RTF < 50 hp	Trenchers < 50 hp	RTF > 50 hp	Trenchers >50 hp
1990	31	654	1,302	526
1991	27	635	1,162	511
1992	28	639	1,203	514
1993	27	693	1,130	558
1994	33	715	1,400	575
1995	34	748	1,464	602
1996	39	884	1,654	712
1997	44	860	1,858	693
1998	46	986	1,972	794
1999	40	1,008	1,716	812
2000	41	1,025	1,760	825
2001	36	753	1,547	607
2002	34	654	1,432	526
2003	36	659	1,522	531
2004	37	689	1,585	555
2005	40	678	1,695	546
2006	44	555	1,885	447
2007	53	548	2,245	442

The adjusted sales figures were then combined with the default NONROAD2005 scrappage function to estimate the total in-use equipment population for the 2007 base year. The NONROAD default scrap function, presented in Appendix E, estimates the cumulative percent scrapped as a function of equipment age, expressed as a fraction of median life. The median life of an engine is estimated to be the age at which it has a 50% of having been scrapped. Under this convention, the engine will reach a 100% probability of scrappage at two times its median life.

Using NONROAD2005 assumptions, the median life of a diesel engine less than or equal to 50 hp is 2,500 hours (at full load), while diesel engines between 50 and 300 hp have a median life of 4,667 hours, again at full load. Therefore, in order to calculate median life in years for RTFs and trenchers at different hp ratings, the following information is required: load factor (from NONROAD defaults), median life in hours at full load, and hours per year (from survey results). Table 4-8 summarizes these data and the resulting median life estimates by equipment type and hp bin.

Table 4-8. Median Life Estimates for RTFs and Trenchers

Parameter	RTF	Trencher
Load Factor	0.59	0.59
Med life < 50 hp	2,500	2,500
Med life > 50 hp	4,667	4,667
Hr/Yr < 50 hp	341	465
Hr/Y> - > 50 hp	882	1,454
Median life yrs < 50	12.4	9.1
Median life yrs > 50	9.0	5.4

The resulting median life estimates were then combined with the NONROAD default scrap function to estimate in-use equipment population counts for both equipment types and hp groups, as presented in Table 4-9.

Table 4-9. In-Use Statewide Equipment Population for RTFs and Trenchers (2007)

Age (yrs)	RTF < 50 hp	Trencher < 50 hp	RTF > 50 hp	Trencher >50 hp
17	4	16	26	0
16	5	29	46	0
15	6	45	78	0
14	7	66	102	0
13	11	89	168	0
12	23	120	227	0
11	29	181	331	0
10	35	232	483	21
9	39	611	838	56
8	35	756	1,270	93
7	36	830	1,417	144
6	33	640	1,315	164
5	31	579	1,267	379
4	34	603	1,393	438
3	36	648	1,489	491
2	39	655	1,627	508
1	44	546	1,856	433
0	53	548	2,245	442
Total	**498**	**7,195**	**16,179**	**3,168**

The resulting 2007 statewide base year equipment population estimates for RTFs is 8,339 and 5,182 for trenchers.

4.2.2 Scrap and Recycling Equipment Population

ERG purchased contact information for 611 business in Texas classified as Scrap and Recycling entities (SIC 5093) from USA Data. These 611 businesses represent a census for

scrap and recycling businesses in Texas. However, despite repeated efforts, not all of the companies could be reached for surveying. A summary of the number of businesses contacted and those that had equipment is presented in Table 4-10.

Table 4-10. Summary of Scrap and Recycling Companies

Companies in Frame	611
Companies Unable to Contact	488
Companies Contacted	123
Companies with Targeted Equipment	47

To account for non-responses, simple assumptions were made based on the responses received from the companies that were contacted. As seen in Table 4-10, of the 123 companies contacted for the survey, only 47 (38%) of those actually owned/operated targeted DCE. Based on this information, it was assumed that 38% of the companies that were not contacted for the survey would also operate DCE, or an additional 188 companies (488 x 0.38). Equipment was assigned to these additional companies using the average number of units observed in the survey by equipment types, presented in Table 4-11. Statewide equipment population is then calculated by summing the survey results with the extrapolated estimates, also shown in Table 4-11.

Table 4-11. Equipment Population for Scrap/Recycling Subsector (2007)

Equipment Type	Survey Observations	Average/Company	Statewide Population
Excavators	68	1.45	363
Off Highway Trucks	4	0.09	20
Wheeled Loaders	38	0.81	207
Tractors/Loaders/Backhoes	1	0.02	6
Crawler Dozers	3	0.06	17

4.2.3 Special Trades Contractor Equipment Population

Table 4-5 indicates that 303 surveys were completed out of the estimated eligible population of 4,349 special trades contractors in the state (~7%). In order to estimate statewide equipment populations for this subsector, the equipment counts obtained from the survey were multiplied by an expansion factor of 14.4 (1/0.07). The resulting state level equipment population estimates are presented in Table 4-12 for each equipment type.

Table 4-12. Statewide Equipment Population for Special Trades Subsector (2007)

Equipment Type	Weighted Population (Survey)	Statewide Population
Crawler Tractor/Dozer	17.6	252
Excavator	42.6	611
Grader	12.0	172
Paver	3.1	44
Roller	4.4	64
Tractor/Loader/Backhoe	345.5	4,959
Wheeled Loader	24.5	351

4.2.4 Mining and Quarry Equipment Population

Mines

According to the MSHA's Data Retrieval System, there were 11 active surface coal mining sites in the state in of 2007.[31] Six of these locations were actually surveyed during this study to obtain in-use equipment counts. In order to estimate equipment population for the remaining five mining locations, production data was from the MSHA website for 2007 for all 11 sites. The average number of units per million tons of coal production were then estimated across the six survey locations, as shown in Table 4-13.

Table 4-13. Average Number of Units per Million Tons of Coal Production (2007)

Equipment Type	# units/M Tons
Crawler Tractor/Dozer	2.3
Excavator	0.7
Grader	0.8
Off-road Truck	2.6
Roller	0.05
Rubber Tire Loader	1.6
Scraper	0.3

These data were then used to estimate equipment populations to the five mining locations without survey data, with the exception of rollers.[32] The resulting equipment population estimates for each of the 11 mining sites are presented in Table 4-14.

[31] MSHA Data Retrieval System, http://www.msha.gov/drs/drshome.htm.
[32] Only one roller was observed at the six survey locations, and was deemed to be atypical of most mine operations.

Table 4-14. Statewide Equipment Population for Surface Mines (2007)

Location	Crawler Tractor/Dozer	Excavator	Grader	Off-road Truck	Roller	Rubber Tire Loader	Scraper
1	10.0	3.0	3.0	8.0	0.0	11.0	0.0
2	10.0	2.0	3.0	11.0	0.0	9.0	1.0
3	14.0	6.0	5.0	16.0	1.0	2.0	2.0
4	3.0	0.0	1.0	3.0	0.0	6.0	0.0
5	5.0	2.0	2.0	11.0	0.0	2.0	4.0
6	9.0	2.0	3.0	9.0	0.0	5.0	0.0
7	8.9	2.6	3.0	10.1	0.0	6.1	1.2
8	9.5	2.8	3.2	10.8	0.0	6.5	1.3
9	15.6	4.6	5.2	17.8	0.0	10.7	2.1
10	7.2	2.1	2.4	8.2	0.0	4.9	1.0
11	4.4	1.3	1.5	5.0	0.0	3.0	0.6
Total	**96.6**	**28.4**	**32.3**	**109.9**	**1**	**66.2**	**13.2**

Quarries

According to the MSHA's Data Retrieval System, there were 467 active non-coal related surface mining sites (hereafter referred to as quarries) in the state in of 2007.[33] Although production information was not available from the MSHA, annual non-office employee hours were available for 2007 for each location, and were obtained as surrogates for this subsector. The total annual hours of equipment use across the 30 surveyed sites was then divided by the total annual employee hours for these same sites to obtain an estimate of average hours of equipment operation per employee hour, as shown in Table 4-15.

Table 4-15. Average Hours of Equipment Operation per Employee Hour - Quarries

Equipment	Hrs operation/Employee Hr
Backhoe	0.011
Crawler Tractor/Dozer	0.082
Excavator	0.072
Grader	0.005
Off-Highway Truck	0.109
Scraper	0.012
Wheeled Loader	0.263

In order to obtain equipment population estimates for the 437 sites without survey data, the total annual employee hours from the MSHA data set were multiplied by the values in Table 4-15. The resulting base year equipment population estimate for all 467 locations is presented in Table 4-16.

[33] Dredges were also included in the MSHA data, but were excluded from this analysis.

Table 4-16. Statewide Equipment Population for Quarries (2007)

Equipment Type	Statewide Population
Tractors/Backhoes/Loaders	95
Crawler Tractors/Dozers	574
Excavators	599
Graders	565
Off-Highway Trucks	930
Scrapers	168
Wheeled Loaders	1,770

4.3 Geographic Allocation

Once statewide populations were developed for each subsector, selected surrogates were applied to allocate populations to the county level as described below.

4.3.1 RTF and Trencher Allocation

The statewide equipment population totals for RTFs and trenchers were first allocated across the different survey strata based on the weighted population distribution as shown in Tables 4-17 and 4-18.

Table 4-17. In-Use RTF Population by Survey Strata (2007)

Strata	Weighted Survey Observations	Fraction	In-Use Population
Agricultural	4	0.029	485
Building Construction	9	0.064	1,065
Manufacturing	6	0.042	693
Masonry/Stone	49	0.347	5,788
Other	20	0.142	2,365
Special Trades	53	0.377	6,281
Total	**141**		**16,677**

Table 4-18. In-Use Trencher Population by Survey Strata (2007)

Strata	Weighted Survey Observations	Fraction	In-Use Population
Agricultural	3	0.040	417
Building and Heavy Construction	24	0.290	3,006
Other	12	0.139	431
Plumbing/HVAC	4	0.042	3,903
Special Trades	12	0.140	1,470
Utility Construction	29	0.349	5,788
Total	**84**		**15,015**

Separate geographic surrogates were identified and applied for each of the above strata. Agricultural strata allocation was based on acreage in farms from the 2002 Texas Agricultural Census. All other allocations were based on 2007 Economy.com data on the relative economic output for businesses in each of the remaining strata.[34] Appendix F provides the strata level allocation factors for both equipment types.

The allocated equipment populations were then summed across strata to obtain the final county level base year population estimates, as shown in Table 4-19.

[34] Obtained from Anusuya Iyer, TCEQ, 4-25-08.

Table 4-19. Statewide Geographic Allocation – RTFs and Trenchers (All Survey Strata, 2007)

County	RTFs	Trenchers
Anderson	15.1	19.2
Andrews	17.3	19.8
Angelina	32.5	38.7
Aransas	6.8	8.6
Archer	4.2	4.6
Armstrong	2.1	3.2
Atascosa	14.4	10.3
Austin	81.8	29.3
Bailey	3.7	6.8
Bandera	6.7	8.7
Bastrop	363.1	34.6
Baylor	2.4	2.3
Bee	8.3	8.8
Bell	88.1	81.7
Bexar	728.1	794.8
Blanco	7.3	8.0
Borden	1.9	1.8
Bosque	20.3	14.5
Bowie	34.1	37.4
Brazoria	176.0	292.6
Brazos	86.5	71.9
Brewster	11.2	11.3
Briscoe	2.1	2.1
Brooks	2.8	2.6
Brown	990.3	13.7
Burleson	8.6	13.9
Burnet	19.1	37.0
Caldwell	7.7	10.8
Calhoun	32.1	52.4
Callahan	3.6	6.5
Cameron	103.5	91.2
Camp	7.1	6.2
Carson	4.6	5.4
Cass	5.7	6.5
Castro	3.1	4.4
Chambers	11.3	12.9
Cherokee	14.9	30.3
Childress	2.9	3.6
Clay	4.9	11.4
Cochran	2.3	10.4
Coke	2.1	2.2
Coleman	10.5	6.1
Collin	269.1	317.2
Collingsworth	2.2	1.7

County	RTFs	Trenchers
Colorado	11.5	16.1
Comal	55.9	76.0
Comanche	5.2	5.7
Concho	2.4	7.2
Cooke	24.5	27.5
Coryell	15.0	20.4
Cottle	2.9	2.5
Crane	3.2	7.2
Crockett	7.2	7.1
Crosby	2.6	2.1
Culberson	10.0	7.6
Dallam	7.2	8.1
Dallas	3029.9	1476.7
Dawson	5.9	8.3
Deaf Smith	12.6	14.9
Delta	1.1	1.4
Denton	200.9	325.5
DeWitt	10.8	10.6
Dickens	2.6	2.2
Dimmit	2.8	10.7
Donley	2.4	3.5
Duval	7.6	12.6
Eastland	22.6	24.6
Ector	84.3	187.0
Edwards	4.0	3.4
Ellis	90.0	54.5
El Paso	388.8	221.7
Erath	81.2	21.5
Falls	3.5	3.2
Fannin	9.6	7.9
Fayette	13.9	10.4
Fisher	2.4	1.8
Floyd	3.3	3.7
Foard	1.5	1.2
Fort Bend	155.8	366.1
Franklin	8.1	3.9
Freestone	24.5	81.8
Frio	4.1	6.3
Gaines	7.8	26.6
Galveston	106.5	106.2
Garza	4.9	8.0
Gillespie	15.8	19.4
Glasscock	2.5	2.7
Goliad	2.9	2.4

County	RTFs	Trenchers
Gonzales	17.3	6.2
Gray	9.7	11.5
Grayson	44.8	90.3
Gregg	100.2	89.2
Grimes	8.1	11.2
Guadalupe	86.9	49.3
Hale	14.6	14.6
Hall	2.3	2.8
Hamilton	7.7	13.2
Hansford	4.5	4.5
Hardeman	2.7	1.7
Hardin	26.3	30.4
Harris	2371.1	3733.6
Harrison	426.8	49.9
Hartley	4.1	6.6
Haskell	2.3	2.7
Hays	106.8	61.9
Hemphill	3.8	18.5
Henderson	170.6	26.1
Hidalgo	120.5	137.8
Hill	39.6	77.3
Hockley	14.0	23.2
Hood	29.0	20.7
Hopkins	16.4	27.7
Houston	5.9	7.0
Howard	13.8	22.3
Hudspeth	13.9	8.5
Hunt	28.2	24.9
Hutchinson	30.0	64.1
Irion	2.5	2.2
Jack	3.9	13.3
Jackson	12.5	34.0
Jasper	11.2	12.9
Jeff Davis	6.4	6.8
Jefferson	188.4	336.1
Jim Hogg	3.1	3.7
Jim Wells	13.7	12.6
Johnson	161.5	88.8
Jones	7.2	10.0
Karnes	4.1	7.0
Kaufman	38.3	83.1
Kendall	21.0	20.2
Kenedy	2.9	3.4
Kent	2.1	1.8
Kerr	23.8	28.1
Kimble	4.6	4.7
King	2.2	1.8

County	RTFs	Trenchers
Kinney	2.6	2.8
Kleberg	8.1	10.9
Knox	3.4	3.3
Lamar	22.7	26.3
Lamb	8.6	7.0
Lampasas	15.9	12.6
La Salle	2.9	2.2
Lavaca	10.4	8.9
Lee	11.0	49.2
Leon	17.3	30.9
Liberty	22.8	19.5
Limestone	18.8	5.1
Lipscomb	3.2	2.9
Live Oak	6.2	10.4
Llano	11.7	13.4
Loving	1.9	1.7
Lubbock	98.0	85.6
Lynn	2.3	2.0
McCulloch	3.3	4.7
McLennan	189.3	97.7
McMullen	1.9	3.5
Madison	5.4	4.5
Marion	4.1	2.5
Martin	3.3	4.4
Mason	2.2	2.7
Matagorda	9.5	13.6
Maverick	6.1	7.8
Medina	51.8	10.8
Menard	2.9	3.0
Midland	56.4	102.0
Milam	33.7	20.8
Mills	2.2	2.2
Mitchell	3.3	4.0
Montague	7.5	10.7
Montgomery	181.4	273.7
Moore	14.0	31.4
Morris	9.5	4.8
Motley	2.2	1.8
Nacogdoches	34.3	31.5
Navarro	126.4	33.4
Newton	0.9	2.2
Nolan	6.3	5.3
Nueces	178.9	260.1
Ochiltree	4.9	28.2
Oldham	3.9	3.7
Orange	38.6	28.7
Palo Pinto	96.2	8.1

County	RTFs	Trenchers
Panola	14.1	113.3
Parker	50.0	56.3
Parmer	7.4	7.0
Pecos	15.5	20.5
Polk	9.8	13.8
Potter	92.9	64.0
Presidio	6.2	6.1
Rains	3.8	3.3
Randall	132.8	31.4
Reagan	4.8	2.8
Real	2.2	3.6
Red River	6.2	7.2
Reeves	5.3	5.7
Refugio	5.5	11.8
Roberts	1.9	2.0
Robertson	5.9	3.4
Rockwall	29.5	31.7
Runnels	5.9	5.8
Rusk	14.9	25.5
Sabine	3.0	4.6
San Augustine	1.2	7.8
San Jacinto	1.9	4.9
San Patricio	24.8	41.4
San Saba	3.5	3.9
Schleicher	3.5	14.4
Scurry	11.6	29.9
Shackelford	2.5	2.9
Shelby	10.6	7.9
Sherman	2.6	2.6
Smith	170.9	81.0
Somervell	1.8	6.9
Starr	6.5	6.4
Stephens	7.8	10.7
Sterling	3.0	2.4
Stonewall	2.9	6.9
Sutton	9.0	8.4
Swisher	3.7	3.5

County	RTFs	Trenchers
Tarrant	885.7	957.9
Taylor	60.6	52.3
Terrell	5.5	4.7
Terry	5.2	4.8
Throckmorton	2.5	2.6
Titus	12.0	10.4
Tom Green	41.9	44.1
Travis	698.0	590.8
Trinity	3.9	3.0
Tyler	4.1	2.9
Upshur	11.7	8.4
Upton	3.0	6.3
Uvalde	10.1	11.2
Val Verde	22.8	17.8
Van Zandt	25.6	37.3
Victoria	42.2	47.0
Walker	16.3	14.2
Waller	14.3	19.3
Ward	5.8	5.3
Washington	16.4	15.2
Webb	50.2	68.1
Wharton	18.7	27.1
Wheeler	4.6	4.4
Wichita	373.9	42.5
Wilbarger	6.0	6.6
Willacy	2.9	8.8
Williamson	301.1	237.0
Wilson	10.4	10.6
Winkler	6.2	4.2
Wise	30.6	38.2
Wood	10.3	16.7
Yoakum	5.7	24.1
Young	7.5	8.6
Zapata	7.4	10.7
Zavala	4.3	3.6
Total	**16,677**	**15,015**

4.3.2 Scrap and Recycling Equipment Allocation

The data purchased from USA Data for scrap and recycling companies represented a census, meaning that every known scrap and recycling operation in Texas was included. Therefore, it was possible to allocate equipment to specific counties based simply on business counts by county. The equipment populations for the number of companies that responded to the survey were recorded, along with the county in which the company was located. Other companies were assigned the generic profile developed for this subsector based responses from companies that did participate in the survey. By summing the population reported by responding companies with the extrapolated population for non-respondents, by county, the geographic allocation presented in Table 4-20 was developed for targeted DCE used in scrap and recycling operations in Texas.

Table 4-20. Scrap and Recycling Equipment Allocation (2007)

County	Excavators	Off-highway Trucks	Rubber Tire Loaders	Tractors/ Loaders/ Backhoes	Crawler Tractor/ Dozers
Anderson					
Andrews					
Angelina	3.66	0.10	0.93	0.02	0.07
Aransas					
Archer					
Armstrong					
Atascosa					
Austin	1.11	0.07	0.62	0.02	0.05
Bailey	0.55	0.03	0.31	0.01	0.02
Bandera					
Bastrop					
Baylor					
Bee					
Bell	1.66	0.10	0.93	0.02	0.07
Bexar	15.93	0.88	8.34	0.22	0.66
Blanco	0.55	0.03	0.31	0.01	0.02
Borden					
Bosque	0.55	0.03	0.31	0.01	0.02
Bowie	1.66	0.10	0.93	0.02	0.07
Brazoria	5.11	0.07	2.62	0.02	0.05
Brazos	1.11	0.07	0.62	0.02	0.05
Brewster					
Briscoe					
Brooks					
Brown	2.00				
Burleson					
Burnet			1.00		

County	Excavators	Off-highway Trucks	Rubber Tire Loaders	Tractors/ Loaders/ Backhoes	Crawler Tractor/ Dozers
Caldwell	2.00				
Calhoun					
Callahan					
Cameron	9.08	0.36	4.40	0.09	0.27
Camp	0.55	0.03	0.31	0.01	0.02
Carson					
Cass	0.55	0.03	0.31	0.01	0.02
Castro					
Chambers					
Cherokee	2.66	0.10	3.93	0.02	0.07
Childress					
Clay					
Cochran					
Coke					
Coleman					
Collin	6.08	0.36	3.40	0.09	0.27
Collingsworth					
Colorado					
Comal	1.66	0.10	0.93	0.02	0.07
Comanche	0.55	0.03	0.31	0.01	0.02
Concho					
Cooke	0.55	0.03	0.31	0.01	0.02
Coryell	0.55	0.03	0.31	0.01	0.02
Cottle					
Crane	0.55	0.03	0.31	0.01	0.02
Crockett					
Crosby					
Culberson					
Dallam					
Dallas	36.09	1.59	24.14	0.40	2.20
Dawson					
Deaf Smith	0.55	0.03	0.31	0.01	0.02
Delta					
Denton	4.98	0.29	2.78	0.07	0.22
De Witt	0.55	0.03	0.31	0.01	0.02
Dickens					
Dimmit					
Donley					
Duval	1.11	0.07	0.62	0.02	0.05
Eastland					
Ector	2.76	0.16	1.54	0.04	0.12
Edwards					
El Paso	14.06	0.65	7.18	0.16	0.49
Ellis	2.76	0.16	1.54	0.04	0.12
Erath	1.66	0.10	0.93	0.02	0.07
Falls					

County	Excavators	Off-highway Trucks	Rubber Tire Loaders	Tractors/ Loaders/ Backhoes	Crawler Tractor/ Dozers
Fannin					
Fayette					
Fisher					
Floyd	1.11	0.07	0.62	0.02	0.05
Foard					
Fort Bend	3.87	0.23	2.16	0.06	0.17
Franklin					
Freestone					
Frio					
Gaines	1.11	0.07	0.62	0.02	0.05
Galveston	3.32	0.20	1.85	0.05	0.15
Garza					
Gillespie					
Glasscock					
Goliad					
Gonzales	0.55	0.03	0.31	0.01	0.02
Gray					
Grayson	3.32	0.20	1.85	0.05	0.15
Gregg	2.21	0.13	1.24	0.03	0.10
Grimes	1.11	0.07	0.62	0.02	0.05
Guadalupe	0.55	0.03	0.31	0.01	0.02
Hale					
Hall					
Hamilton					
Hansford					
Hardeman					
Hardin	0.55	0.03	0.31	0.01	0.02
Harris	82.27	4.78	46.41	1.20	3.59
Harrison	7.21	0.13	4.24	0.03	0.10
Hartley					
Haskell					
Hays	1.66	0.10	0.93	0.02	0.07
Hemphill					
Henderson	0.55	0.03	0.31	0.01	0.02
Hidalgo	6.63	0.39	3.71	0.10	0.29
Hill	0.55	0.03	0.31	0.01	0.02
Hockley	1.11	0.07	0.62	0.02	0.05
Hood	0.55	0.03	0.31	0.01	0.02
Hopkins	0.55	0.03	0.31	0.01	0.02
Houston					
Howard					
Hudspeth					
Hunt	1.11	0.07	0.62	0.02	0.05
Hutchinson	1.11	0.07	0.62	0.02	0.05
Irion					
Jack					

County	Excavators	Off-highway Trucks	Rubber Tire Loaders	Tractors/ Loaders/ Backhoes	Crawler Tractor/ Dozers
Jackson					
Jasper	0.55	0.03	0.31	0.01	0.02
Jeff Davis					
Jefferson	6.08	0.36	3.40	0.09	0.27
Jim Hogg					
Jim Wells	0.55	0.03	0.31	0.01	0.02
Johnson	2.76	0.16	1.54	0.04	0.12
Jones	0.55	0.03	0.31	0.01	0.02
Karnes					
Kaufman	2.76	0.16	1.54	0.04	0.12
Kendall					
Kenedy					
Kent					
Kerr					
Kimble					
King					
Kinney					
Kleberg	0.55	0.03	0.31	0.01	0.02
Knox					
La Salle					
Lamar	0.55	0.03	0.31	0.01	0.02
Lamb					
Lampasas					
Lavaca					
Lee					
Leon					
Liberty	1.11	0.07	0.62	0.02	0.05
Limestone					
Lipscomb					
Live Oak					
Llano					
Loving					
Lubbock	4.21	0.13	1.24	0.03	0.10
Lynn					
Madison					
Marion					
Martin					
Mason	0.55	0.03	1.31	0.01	0.02
Matagorda	0.55	0.03	0.31	0.01	0.02
Maverick	1.11	0.07	0.62	0.02	0.05
McCulloch					
McLennan	2.76	0.16	1.54	0.04	0.12
McMullen					
Medina	1.11	0.07	0.62	0.02	0.05
Menard					
Midland	1.11	0.07	0.62	0.02	0.05

County	Excavators	Off-highway Trucks	Rubber Tire Loaders	Tractors/ Loaders/ Backhoes	Crawler Tractor/ Dozers
Milam	1.11	0.07	0.62	0.02	0.05
Mills					
Mitchell					
Montague	1.11	0.07	0.62	0.02	0.05
Montgomery	2.21	0.13	1.24	0.03	0.10
Moore	0.55	0.03	0.31	0.01	0.02
Morris	1.66	0.10	0.93	0.02	0.07
Motley					
Nacogdoches					
Navarro					
Newton					
Nolan					
Nueces	9.87	0.23	2.16	0.06	0.17
Ochiltree					
Oldham					
Orange	1.66	0.10	0.93	0.02	0.07
Palo Pinto	0.55	0.03	0.31	0.01	0.02
Panola					
Parker					
Parmer	1.00				
Pecos					
Polk	0.55	0.03	0.31	0.01	0.02
Potter	3.32	0.20	1.85	0.05	0.15
Presidio					
Rains					
Randall	1.11	0.07	0.62	0.02	0.05
Reagan					
Real					
Red River	0.55	0.03	0.31	0.01	0.02
Reeves					
Refugio					
Roberts					
Robertson					
Rockwall					
Runnels					
Rusk	0.55	0.03	0.31	0.01	0.02
Sabine					
San Augustine					
San Jacinto	0.55	0.03	0.31	0.01	0.02
San Patricio	1.11	0.07	0.62	0.02	0.05
San Saba					
Schleicher					
Scurry					
Shackelford					
Shelby	2.00		2.00		
Sherman					

County	Excavators	Off-highway Trucks	Rubber Tire Loaders	Tractors/ Loaders/ Backhoes	Crawler Tractor/ Dozers
Smith	5.98	0.29	6.78	0.07	0.22
Somervell					
Starr	0.55	0.03	0.31	0.01	0.02
Stephens					
Sterling					
Stonewall					
Sutton					
Swisher					
Tarrant	19.35	1.14	10.81	0.28	0.85
Taylor	4.98	0.29	2.78	0.07	0.22
Terrell					
Terry					
Throckmorton					
Titus	0.55	0.03	0.31	0.01	0.02
Tom Green	3.87	0.23	2.16	0.06	0.17
Travis	13.29	1.49	8.63	0.12	0.37
Trinity	0.55	0.03	0.31	0.01	0.02
Tyler					
Upshur	0.55	0.03	0.31	0.01	0.02
Upton	0.55	0.03	0.31	0.01	0.02
Uvalde	1.11	0.07	0.62	0.02	0.05
Val Verde					
Van Zandt	1.11	0.07	0.62	0.02	0.05
Victoria	3.76	1.16	2.54	0.04	2.12
Walker					
Waller					
Ward					
Washington	1.11	0.07	0.62	0.02	0.05
Webb	2.76	0.16	1.54	0.04	0.12
Wharton					
Wheeler					
Wichita	1.66	0.10	0.93	0.02	0.07
Wilbarger					
Willacy					
Williamson	0.55	0.03	0.31	1.01	0.02
Wilson					
Winkler					
Wise					
Wood					
Yoakum					
Young					
Zapata					
Zavala					
Total	**363**	**20**	**207**	**6**	**17**

4.3.3 Special Trades Contractor Equipment Allocation

Allocation of statewide equipment totals for special trades contractors was based on relative county level economic outputs for businesses in the 1700 SIC series, from the 2007 Economy.com data provided by the TCEQ. (Surrogate data for specific strata within this subsector, such as plumbing and concrete work, were not available, so a single surrogate value for all special trades contractors was applied.) Table 4-21 presents the county level allocation for targeted DCE within this subsector.

4.3.4 Mining and Quarry Equipment Allocation

The location of all 11 active surface mines and all 467 active quarry sites is known from the MSHA data set. County-level equipment populations were summed across both of these subsectors, and are presented in Table 4-22.

Note that the mining equipment populations reflected in the table have been adjusted to accommodate one of the limitations of NONROAD and TexN. Namely, all equipment within the same SCC is assumed to have the same activity level (in hours per year). Since mining and quarry equipment are aggregated together within on TexN DCE subsector, and since quarry equipment has much lower annual hours per year than does mining equipment, mining equipment counts were adjusted upward to compensate for the lower hour per year levels used in TexN. To illustrate, assume a particular county had 10 crawler tractor/dozers operating in a mine, averaging 5,800 hours per year per unit. However, crawler tractor/dozers operating in quarries average only 1,897 hours per year. In order to generate the same level of emissions at the mine site, there would have to be 31 crawler tractor/dozers operating at 1,897 hours per year (the value used within TexN for this DCE subsector), i.e., 10 units x 5,800 mining hours per year / 1,897 quarry hours per year.

Table 4-21. Special Trades Contractor Equipment Allocation (2007)

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Anderson	0.0017	0.42	1.01	0.28	0.07	0.11	8.22	0.58
Andrews	0.0021	0.52	1.26	0.35	0.09	0.13	10.21	0.72
Angelina	0.0034	0.85	2.07	0.58	0.15	0.22	16.76	1.19
Aransas	0.0006	0.15	0.36	0.10	0.03	0.04	2.94	0.21
Archer	0.0002	0.06	0.14	0.04	0.01	0.01	1.16	0.08
Armstrong	0.0000	0.00	0.01	0.00	0.00	0.00	0.08	0.01
Atascosa	0.0006	0.15	0.36	0.10	0.03	0.04	2.92	0.21
Austin	0.0019	0.47	1.14	0.32	0.08	0.12	9.24	0.65
Bailey	0.0002	0.06	0.14	0.04	0.01	0.01	1.11	0.08
Bandera	0.0006	0.16	0.39	0.11	0.03	0.04	3.19	0.23
Bastrop	0.0014	0.35	0.85	0.24	0.06	0.09	6.88	0.49
Baylor	0.0001	0.02	0.05	0.01	0.00	0.00	0.39	0.03
Bee	0.0007	0.18	0.44	0.12	0.03	0.05	3.56	0.25
Bell	0.0059	1.48	3.59	1.01	0.26	0.37	29.15	2.06
Bexar	0.0689	17.38	42.10	11.82	3.04	4.39	341.64	24.18
Blanco	0.0008	0.21	0.50	0.14	0.04	0.05	4.07	0.29
Borden	0.0000	0.00	0.01	0.00	0.00	0.00	0.09	0.01
Bosque	0.0004	0.11	0.25	0.07	0.02	0.03	2.07	0.15
Bowie	0.0026	0.66	1.59	0.45	0.12	0.17	12.94	0.92
Brazoria	0.0114	2.88	6.97	1.96	0.50	0.73	56.57	4.00
Brazos	0.0061	1.54	3.74	1.05	0.27	0.39	30.34	2.15
Brewster	0.0003	0.07	0.17	0.05	0.01	0.02	1.39	0.10
Briscoe	0.0001	0.01	0.04	0.01	0.00	0.00	0.29	0.02
Brooks	0.0001	0.03	0.07	0.02	0.01	0.01	0.61	0.04
Brown	0.0012	0.30	0.74	0.21	0.05	0.08	5.97	0.42
Burleson	0.0008	0.19	0.47	0.13	0.03	0.05	3.82	0.27
Burnet	0.0018	0.45	1.09	0.31	0.08	0.11	8.83	0.63
Caldwell	0.0005	0.12	0.29	0.08	0.02	0.03	2.39	0.17
Calhoun	0.0029	0.73	1.77	0.50	0.13	0.18	14.37	1.02
Callahan	0.0001	0.02	0.06	0.02	0.00	0.01	0.46	0.03
Cameron	0.0075	1.88	4.56	1.28	0.33	0.48	36.97	2.62

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Camp	0.0006	0.15	0.35	0.10	0.03	0.04	2.88	0.20
Carson	0.0001	0.02	0.04	0.01	0.00	0.00	0.36	0.03
Cass	0.0005	0.13	0.30	0.09	0.02	0.03	2.47	0.18
Castro	0.0000	0.01	0.03	0.01	0.00	0.00	0.24	0.02
Chambers	0.0007	0.18	0.45	0.13	0.03	0.05	3.62	0.26
Cherokee	0.0010	0.25	0.60	0.17	0.04	0.06	4.86	0.34
Childress	0.0001	0.03	0.08	0.02	0.01	0.01	0.62	0.04
Clay	0.0002	0.05	0.12	0.03	0.01	0.01	0.99	0.07
Cochran	0.0001	0.02	0.04	0.01	0.00	0.00	0.33	0.02
Coke	0.0000	0.01	0.02	0.01	0.00	0.00	0.16	0.01
Coleman	0.0003	0.07	0.17	0.05	0.01	0.02	1.38	0.10
Collin	0.0225	5.67	13.74	3.86	0.99	1.43	111.53	7.89
Collingsworth	0.0000	0.00	0.01	0.00	0.00	0.00	0.08	0.01
Colorado	0.0009	0.23	0.56	0.16	0.04	0.06	4.52	0.32
Comal	0.0058	1.46	3.54	0.99	0.26	0.37	28.75	2.04
Comanche	0.0003	0.08	0.20	0.06	0.01	0.02	1.62	0.11
Concho	0.0000	0.01	0.02	0.01	0.00	0.00	0.17	0.01
Cooke	0.0030	0.76	1.84	0.52	0.13	0.19	14.95	1.06
Coryell	0.0011	0.28	0.68	0.19	0.05	0.07	5.51	0.39
Cottle	0.0000	0.01	0.03	0.01	0.00	0.00	0.24	0.02
Crane	0.0001	0.03	0.08	0.02	0.01	0.01	0.68	0.05
Crockett	0.0000	0.01	0.03	0.01	0.00	0.00	0.24	0.02
Crosby	0.0000	0.00	0.01	0.00	0.00	0.00	0.06	0.00
Culberson	0.0000	0.01	0.01	0.00	0.00	0.00	0.12	0.01
Dallam	0.0003	0.08	0.18	0.05	0.01	0.02	1.48	0.10
Dallas	0.1601	40.39	97.80	27.47	7.06	10.20	793.72	56.18
Dawson	0.0004	0.11	0.26	0.07	0.02	0.03	2.08	0.15
Deaf Smith	0.0008	0.20	0.49	0.14	0.04	0.05	4.00	0.28
Delta	0.0001	0.01	0.03	0.01	0.00	0.00	0.26	0.02
Denton	0.0160	4.05	9.80	2.75	0.71	1.02	79.57	5.63
De Witt	0.0006	0.16	0.39	0.11	0.03	0.04	3.13	0.22
Dickens	0.0001	0.02	0.04	0.01	0.00	0.00	0.31	0.02
Dimmit	0.0000	0.01	0.03	0.01	0.00	0.00	0.21	0.02

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Donley	0.0000	0.00	0.01	0.00	0.00	0.00	0.06	0.00
Duval	0.0005	0.14	0.33	0.09	0.02	0.03	2.67	0.19
Eastland	0.0022	0.55	1.33	0.37	0.10	0.14	10.80	0.76
Ector	0.0066	1.68	4.06	1.14	0.29	0.42	32.93	2.33
Edwards	0.0000	0.01	0.02	0.00	0.00	0.00	0.14	0.01
Ellis	0.0047	1.18	2.87	0.81	0.21	0.30	23.27	1.65
El Paso	0.0197	4.97	12.02	3.38	0.87	1.25	97.58	6.91
Erath	0.0014	0.35	0.85	0.24	0.06	0.09	6.89	0.49
Falls	0.0002	0.04	0.10	0.03	0.01	0.01	0.85	0.06
Fannin	0.0008	0.20	0.49	0.14	0.04	0.05	3.96	0.28
Fayette	0.0010	0.24	0.59	0.16	0.04	0.06	4.77	0.34
Fisher	0.0000	0.01	0.02	0.01	0.00	0.00	0.17	0.01
Floyd	0.0001	0.01	0.04	0.01	0.00	0.00	0.29	0.02
Foard	0.0000	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Fort Bend	0.0110	2.77	6.72	1.89	0.49	0.70	54.52	3.86
Franklin	0.0001	0.03	0.07	0.02	0.00	0.01	0.56	0.04
Freestone	0.0014	0.36	0.88	0.25	0.06	0.09	7.13	0.50
Frio	0.0002	0.05	0.13	0.04	0.01	0.01	1.04	0.07
Gaines	0.0006	0.15	0.37	0.10	0.03	0.04	2.98	0.21
Galveston	0.0092	2.31	5.60	1.57	0.40	0.58	45.42	3.22
Garza	0.0004	0.11	0.27	0.08	0.02	0.03	2.20	0.16
Gillespie	0.0016	0.39	0.95	0.27	0.07	0.10	7.71	0.55
Glasscock	0.0001	0.02	0.05	0.01	0.00	0.01	0.43	0.03
Goliad	0.0000	0.01	0.03	0.01	0.00	0.00	0.24	0.02
Gonzales	0.0002	0.05	0.11	0.03	0.01	0.01	0.89	0.06
Gray	0.0009	0.22	0.54	0.15	0.04	0.06	4.40	0.31
Grayson	0.0035	0.89	2.15	0.60	0.16	0.22	17.48	1.24
Gregg	0.0077	1.95	4.72	1.33	0.34	0.49	38.31	2.71
Grimes	0.0005	0.13	0.32	0.09	0.02	0.03	2.60	0.18
Guadalupe	0.0037	0.93	2.25	0.63	0.16	0.24	18.30	1.30
Hale	0.0010	0.26	0.64	0.18	0.05	0.07	5.20	0.37
Hall	0.0000	0.01	0.02	0.01	0.00	0.00	0.16	0.01
Hamilton	0.0008	0.20	0.48	0.14	0.03	0.05	3.92	0.28

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Hansford	0.0002	0.06	0.15	0.04	0.01	0.02	1.19	0.08
Hardeman	0.0000	0.00	0.01	0.00	0.00	0.00	0.05	0.00
Hardin	0.0015	0.37	0.90	0.25	0.06	0.09	7.29	0.52
Harris	0.2168	54.70	132.46	37.20	9.57	13.82	1074.97	76.09
Harrison	0.0029	0.74	1.79	0.50	0.13	0.19	14.53	1.03
Hartley	0.0001	0.02	0.06	0.02	0.00	0.01	0.45	0.03
Haskell	0.0000	0.01	0.01	0.00	0.00	0.00	0.10	0.01
Hays	0.0051	1.28	3.10	0.87	0.22	0.32	25.12	1.78
Hemphill	0.0002	0.05	0.13	0.04	0.01	0.01	1.02	0.07
Henderson	0.0016	0.40	0.97	0.27	0.07	0.10	7.88	0.56
Hidalgo	0.0108	2.71	6.57	1.85	0.47	0.69	53.35	3.78
Hill	0.0007	0.19	0.46	0.13	0.03	0.05	3.71	0.26
Hockley	0.0011	0.27	0.65	0.18	0.05	0.07	5.26	0.37
Hood	0.0024	0.60	1.45	0.41	0.10	0.15	11.79	0.83
Hopkins	0.0017	0.43	1.04	0.29	0.07	0.11	8.40	0.59
Houston	0.0003	0.07	0.18	0.05	0.01	0.02	1.44	0.10
Howard	0.0010	0.25	0.60	0.17	0.04	0.06	4.91	0.35
Hudspeth	0.0000	0.00	0.01	0.00	0.00	0.00	0.09	0.01
Hunt	0.0026	0.67	1.61	0.45	0.12	0.17	13.09	0.93
Hutchinson	0.0031	0.78	1.90	0.53	0.14	0.20	15.41	1.09
Irion	0.0001	0.02	0.04	0.01	0.00	0.00	0.31	0.02
Jack	0.0002	0.06	0.14	0.04	0.01	0.01	1.12	0.08
Jackson	0.0012	0.29	0.71	0.20	0.05	0.07	5.77	0.41
Jasper	0.0011	0.29	0.69	0.19	0.05	0.07	5.61	0.40
Jeff Davis	0.0001	0.03	0.06	0.02	0.00	0.01	0.51	0.04
Jefferson	0.0164	4.13	10.00	2.81	0.72	1.04	81.14	5.74
Jim Hogg	0.0001	0.01	0.03	0.01	0.00	0.00	0.27	0.02
Jim Wells	0.0014	0.34	0.83	0.23	0.06	0.09	6.71	0.48
Johnson	0.0065	1.64	3.98	1.12	0.29	0.41	32.26	2.28
Jones	0.0003	0.08	0.19	0.05	0.01	0.02	1.54	0.11
Karnes	0.0002	0.04	0.09	0.03	0.01	0.01	0.75	0.05
Kaufman	0.0040	1.00	2.42	0.68	0.17	0.25	19.65	1.39
Kendall	0.0019	0.47	1.13	0.32	0.08	0.12	9.18	0.65

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Kenedy	0.0002	0.04	0.10	0.03	0.01	0.01	0.77	0.05
Kent	0.0000	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Kerr	0.0022	0.54	1.31	0.37	0.09	0.14	10.67	0.76
Kimble	0.0002	0.04	0.10	0.03	0.01	0.01	0.79	0.06
King	0.0000	0.00	0.01	0.00	0.00	0.00	0.08	0.01
Kinney	0.0000	0.01	0.02	0.00	0.00	0.00	0.13	0.01
Kleberg	0.0005	0.12	0.29	0.08	0.02	0.03	2.34	0.17
Knox	0.0002	0.04	0.09	0.03	0.01	0.01	0.75	0.05
Lamar	0.0023	0.57	1.38	0.39	0.10	0.14	11.21	0.79
Lamb	0.0002	0.06	0.15	0.04	0.01	0.02	1.22	0.09
Lampasas	0.0015	0.37	0.89	0.25	0.06	0.09	7.24	0.51
La Salle	0.0000	0.00	0.01	0.00	0.00	0.00	0.09	0.01
Lavaca	0.0005	0.12	0.29	0.08	0.02	0.03	2.36	0.17
Lee	0.0012	0.30	0.73	0.20	0.05	0.08	5.90	0.42
Leon	0.0014	0.36	0.86	0.24	0.06	0.09	6.98	0.49
Liberty	0.0015	0.37	0.90	0.25	0.06	0.09	7.30	0.52
Limestone	0.0003	0.07	0.16	0.04	0.01	0.02	1.30	0.09
Lipscomb	0.0001	0.01	0.03	0.01	0.00	0.00	0.26	0.02
Live Oak	0.0003	0.07	0.18	0.05	0.01	0.02	1.45	0.10
Llano	0.0006	0.14	0.35	0.10	0.02	0.04	2.80	0.20
Loving	0.0000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lubbock	0.0081	2.03	4.93	1.38	0.36	0.51	39.97	2.83
Lynn	0.0000	0.00	0.01	0.00	0.00	0.00	0.09	0.01
McCulloch	0.0001	0.03	0.07	0.02	0.01	0.01	0.56	0.04
McLennan	0.0109	2.74	6.63	1.86	0.48	0.69	53.81	3.81
McMullen	0.0000	0.00	0.01	0.00	0.00	0.00	0.06	0.00
Madison	0.0003	0.08	0.19	0.05	0.01	0.02	1.58	0.11
Marion	0.0001	0.02	0.04	0.01	0.00	0.00	0.35	0.02
Martin	0.0001	0.03	0.08	0.02	0.01	0.01	0.65	0.05
Mason	0.0001	0.03	0.07	0.02	0.00	0.01	0.53	0.04
Matagorda	0.0011	0.27	0.66	0.19	0.05	0.07	5.35	0.38
Maverick	0.0004	0.09	0.22	0.06	0.02	0.02	1.79	0.13
Medina	0.0009	0.22	0.52	0.15	0.04	0.05	4.23	0.30

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Menard	0.0001	0.03	0.07	0.02	0.01	0.01	0.58	0.04
Midland	0.0051	1.29	3.13	0.88	0.23	0.33	25.41	1.80
Milam	0.0003	0.08	0.19	0.05	0.01	0.02	1.51	0.11
Mills	0.0000	0.01	0.03	0.01	0.00	0.00	0.22	0.02
Mitchell	0.0001	0.02	0.05	0.01	0.00	0.01	0.43	0.03
Montague	0.0007	0.18	0.45	0.13	0.03	0.05	3.62	0.26
Montgomery	0.0121	3.05	7.39	2.08	0.53	0.77	60.00	4.25
Moore	0.0009	0.24	0.57	0.16	0.04	0.06	4.66	0.33
Morris	0.0001	0.03	0.06	0.02	0.00	0.01	0.51	0.04
Motley	0.0000	0.01	0.01	0.00	0.00	0.00	0.11	0.01
Nacogdoches	0.0027	0.69	1.66	0.47	0.12	0.17	13.51	0.96
Navarro	0.0007	0.18	0.44	0.12	0.03	0.05	3.60	0.26
Newton	0.0000	0.01	0.02	0.01	0.00	0.00	0.15	0.01
Nolan	0.0005	0.12	0.29	0.08	0.02	0.03	2.35	0.17
Nueces	0.0124	3.13	7.57	2.13	0.55	0.79	61.47	4.35
Ochiltree	0.0003	0.08	0.19	0.05	0.01	0.02	1.58	0.11
Oldham	0.0001	0.01	0.03	0.01	0.00	0.00	0.26	0.02
Orange	0.0026	0.65	1.57	0.44	0.11	0.16	12.73	0.90
Palo Pinto	0.0005	0.13	0.33	0.09	0.02	0.03	2.65	0.19
Panola	0.0017	0.44	1.06	0.30	0.08	0.11	8.59	0.61
Parker	0.0036	0.90	2.18	0.61	0.16	0.23	17.72	1.25
Parmer	0.0002	0.05	0.13	0.04	0.01	0.01	1.03	0.07
Pecos	0.0006	0.16	0.39	0.11	0.03	0.04	3.16	0.22
Polk	0.0007	0.18	0.42	0.12	0.03	0.04	3.44	0.24
Potter	0.0057	1.44	3.48	0.98	0.25	0.36	28.22	2.00
Presidio	0.0000	0.01	0.01	0.00	0.00	0.00	0.11	0.01
Rains	0.0004	0.10	0.23	0.07	0.02	0.02	1.90	0.13
Randall	0.0029	0.73	1.76	0.49	0.13	0.18	14.25	1.01
Reagan	0.0001	0.04	0.09	0.02	0.01	0.01	0.72	0.05
Real	0.0001	0.01	0.03	0.01	0.00	0.00	0.26	0.02
Red River	0.0004	0.09	0.22	0.06	0.02	0.02	1.82	0.13
Reeves	0.0001	0.02	0.05	0.01	0.00	0.01	0.39	0.03
Refugio	0.0005	0.13	0.31	0.09	0.02	0.03	2.48	0.18

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Roberts	0.0000	0.00	0.01	0.00	0.00	0.00	0.07	0.00
Robertson	0.0002	0.05	0.12	0.03	0.01	0.01	0.97	0.07
Rockwall	0.0026	0.66	1.60	0.45	0.12	0.17	12.95	0.92
Runnels	0.0003	0.07	0.18	0.05	0.01	0.02	1.43	0.10
Rusk	0.0011	0.28	0.69	0.19	0.05	0.07	5.58	0.39
Sabine	0.0001	0.03	0.07	0.02	0.01	0.01	0.56	0.04
San Augustine	0.0000	0.01	0.03	0.01	0.00	0.00	0.23	0.02
San Jacinto	0.0001	0.04	0.09	0.02	0.01	0.01	0.70	0.05
San Patricio	0.0021	0.52	1.27	0.36	0.09	0.13	10.30	0.73
San Saba	0.0001	0.02	0.04	0.01	0.00	0.00	0.34	0.02
Schleicher	0.0001	0.02	0.05	0.01	0.00	0.00	0.39	0.03
Scurry	0.0011	0.27	0.64	0.18	0.05	0.07	5.22	0.37
Shackelford	0.0000	0.01	0.02	0.01	0.00	0.00	0.16	0.01
Shelby	0.0006	0.14	0.34	0.09	0.02	0.04	2.74	0.19
Sherman	0.0000	0.01	0.02	0.00	0.00	0.00	0.14	0.01
Smith	0.0069	1.73	4.19	1.18	0.30	0.44	33.98	2.41
Somervell	0.0001	0.02	0.06	0.02	0.00	0.01	0.48	0.03
Starr	0.0002	0.06	0.15	0.04	0.01	0.02	1.23	0.09
Stephens	0.0007	0.17	0.41	0.12	0.03	0.04	3.34	0.24
Sterling	0.0001	0.01	0.04	0.01	0.00	0.00	0.29	0.02
Stonewall	0.0001	0.03	0.07	0.02	0.00	0.01	0.55	0.04
Sutton	0.0008	0.21	0.52	0.15	0.04	0.05	4.21	0.30
Swisher	0.0001	0.02	0.05	0.01	0.00	0.01	0.42	0.03
Tarrant	0.0759	19.14	46.36	13.02	3.35	4.84	376.26	26.63
Taylor	0.0053	1.34	3.25	0.91	0.23	0.34	26.39	1.87
Terrell	0.0000	0.00	0.00	0.00	0.00	0.00	0.03	0.00
Terry	0.0003	0.08	0.19	0.05	0.01	0.02	1.57	0.11
Throckmorton	0.0000	0.01	0.03	0.01	0.00	0.00	0.21	0.01
Titus	0.0009	0.22	0.54	0.15	0.04	0.06	4.41	0.31
Tom Green	0.0032	0.81	1.95	0.55	0.14	0.20	15.86	1.12
Travis	0.0500	12.63	30.58	8.59	2.21	3.19	248.17	17.56
Trinity	0.0003	0.09	0.21	0.06	0.02	0.02	1.72	0.12
Tyler	0.0005	0.12	0.28	0.08	0.02	0.03	2.29	0.16

County	Output Fraction	Population						
		Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Backhoe	Wheeled Loader
Upshur	0.0006	0.16	0.39	0.11	0.03	0.04	3.16	0.22
Upton	0.0000	0.01	0.02	0.00	0.00	0.00	0.14	0.01
Uvalde	0.0006	0.15	0.37	0.10	0.03	0.04	2.99	0.21
Val Verde	0.0011	0.29	0.70	0.20	0.05	0.07	5.68	0.40
Van Zandt	0.0023	0.59	1.43	0.40	0.10	0.15	11.60	0.82
Victoria	0.0035	0.88	2.13	0.60	0.15	0.22	17.28	1.22
Walker	0.0015	0.37	0.90	0.25	0.06	0.09	7.28	0.52
Waller	0.0016	0.41	1.00	0.28	0.07	0.10	8.10	0.57
Ward	0.0004	0.11	0.27	0.07	0.02	0.03	2.15	0.15
Washington	0.0017	0.44	1.06	0.30	0.08	0.11	8.64	0.61
Webb	0.0037	0.94	2.28	0.64	0.16	0.24	18.52	1.31
Wharton	0.0014	0.34	0.83	0.23	0.06	0.09	6.70	0.47
Wheeler	0.0003	0.08	0.19	0.05	0.01	0.02	1.53	0.11
Wichita	0.0038	0.96	2.33	0.66	0.17	0.24	18.93	1.34
Wilbarger	0.0002	0.05	0.12	0.03	0.01	0.01	0.98	0.07
Willacy	0.0001	0.01	0.03	0.01	0.00	0.00	0.28	0.02
Williamson	0.0202	5.10	12.36	3.47	0.89	1.29	100.29	7.10
Wilson	0.0010	0.24	0.58	0.16	0.04	0.06	4.72	0.33
Winkler	0.0003	0.07	0.16	0.05	0.01	0.02	1.32	0.09
Wise	0.0014	0.34	0.83	0.23	0.06	0.09	6.72	0.48
Wood	0.0009	0.23	0.55	0.15	0.04	0.06	4.42	0.31
Yoakum	0.0004	0.11	0.27	0.08	0.02	0.03	2.17	0.15
Young	0.0006	0.16	0.39	0.11	0.03	0.04	3.14	0.22
Zapata	0.0007	0.18	0.43	0.12	0.03	0.04	3.46	0.24
Zavala	0.0001	0.02	0.06	0.02	0.00	0.01	0.48	0.03
	Total	**252**	**611**	**172**	**44**	**64**	**4,959**	**351**

Table 4-22. Mining and Quarry Equipment Allocation (2007)

County	Backhoe	Crawler Tractor/Dozer	Excavator	Grader	Off-Highway Truck	Scraper	Wheeled Loader
Atascosa	0.56	25.33	10.49	30.59	30.71	4.00	19.53
Austin	0.00	0.34	0.68	1.16	1.36	0.00	2.16
Bastrop	0.42	2.52	2.63	0.74	4.10	0.74	7.78
Bee	0.24	1.44	1.50	0.42	2.33	0.42	4.43
Bell	2.60	15.58	17.18	4.54	29.19	4.54	51.83
Bexar	5.58	33.44	34.85	9.75	54.34	9.75	103.10
Borden	0.14	0.82	0.86	0.24	1.34	0.24	2.54
Bosque	0.71	4.23	4.41	1.23	6.88	1.23	13.05
Brazoria	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brewster	0.23	1.38	1.43	0.40	2.24	0.40	4.24
Brown	0.76	4.55	4.74	1.33	7.39	1.33	14.02
Burleson	0.11	0.64	0.67	0.19	1.04	0.19	1.97
Burnet	1.99	11.97	12.47	3.49	19.44	3.49	36.89
Cass	0.00	0.16	1.13	0.00	1.68	0.00	1.82
Cherokee	1.23	3.08	2.27	0.05	0.64	0.00	1.95
Coke	0.35	2.07	2.16	0.60	3.37	0.60	6.39
Colorado	4.32	25.90	26.99	7.55	42.09	7.55	79.85
Comal	2.92	17.54	18.28	5.11	28.51	5.12	54.09
Comanche	0.06	0.35	0.37	0.10	0.57	0.10	1.09
Cooke	0.31	1.85	1.93	0.54	3.01	0.54	5.71
Coryell	0.16	0.97	1.02	0.28	1.58	0.28	3.00
Crosby	0.75	4.50	4.69	1.31	7.32	1.31	13.88
Culberson	0.08	0.97	1.10	0.14	1.39	0.14	2.00
Dallas	0.43	2.56	2.67	0.75	4.16	0.75	7.90
Deaf Smith	0.04	0.25	0.26	0.07	0.41	0.07	0.78
Denton	0.08	1.42	0.91	1.62	0.80	2.10	3.05
Duval	0.27	1.63	1.69	0.47	2.64	0.47	5.01
Eastland	0.17	1.05	1.09	0.31	1.70	0.31	3.23
Ector	0.33	2.00	2.08	0.58	4.54	0.58	8.19
El Paso	3.00	18.02	18.77	5.25	29.28	5.25	55.54
Ellis	0.49	2.95	3.08	0.86	4.80	0.86	9.10
Erath	0.24	1.45	1.51	0.42	2.35	0.42	4.46

County	Backhoe	Crawler Tractor/Dozer	Excavator	Grader	Off-Highway Truck	Scraper	Wheeled Loader
Falls	0.66	3.94	4.11	1.15	6.41	1.15	12.16
Fannin	0.35	2.12	2.21	0.62	3.44	0.62	6.53
Fayette	1.30	9.10	8.75	2.27	12.63	2.27	24.98
Fisher	0.19	1.11	1.16	0.32	1.81	0.32	3.43
Floyd	0.15	0.88	0.92	0.26	1.44	0.26	2.72
Fort Bend	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Freestone	0.00	27.27	8.68	36.75	31.34	3.75	11.40
Garza	0.08	0.50	0.53	0.15	0.82	0.15	1.55
Gillespie	0.75	4.50	4.69	1.31	7.31	1.31	13.87
Glasscock	0.23	1.40	1.46	0.41	2.28	0.41	4.32
Gonzales	0.05	0.29	0.30	0.08	0.47	0.08	0.89
Grayson	0.44	2.61	2.72	0.76	4.24	0.76	8.05
Gregg	0.05	0.30	0.31	0.09	0.48	0.09	0.91
Guadalupe	0.07	0.44	0.46	0.13	0.71	0.13	1.35
Hardeman	0.26	1.57	1.64	0.46	2.56	0.46	4.85
Harris	0.16	0.98	1.02	0.28	2.56	0.28	10.31
Harrison	0.25	44.30	21.42	62.26	51.88	6.56	8.34
Haskell	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hays	0.58	4.23	6.58	1.97	5.67	1.02	14.14
Henderson	0.25	1.48	1.54	0.43	2.40	0.43	4.55
Hidalgo	3.95	23.72	24.72	6.91	38.55	6.92	73.14
Hill	0.79	4.72	4.92	1.38	7.67	1.38	14.55
Hood	2.24	13.46	14.03	3.92	21.88	3.93	41.51
Hopkins	0.00	15.29	6.62	24.73	33.99	12.24	3.73
Houston	0.26	1.54	1.61	0.45	2.50	0.45	4.75
Hudspeth	0.29	1.75	1.82	0.51	2.84	0.51	5.39
Hunt	0.08	0.45	0.47	0.13	0.73	0.13	1.39
Hutchinson	0.15	0.92	0.96	0.27	1.50	0.27	2.85
Jack	0.71	4.28	4.46	1.25	6.96	1.25	13.20
Johnson	0.62	3.71	4.49	1.08	6.02	1.08	15.47
Jones	1.76	10.55	11.00	3.08	17.15	3.08	32.54
Kaufman	0.77	4.62	4.81	1.35	7.50	1.35	14.23
Kendall	0.13	1.78	0.78	0.22	1.22	0.22	3.31
Kerr	0.40	2.39	2.49	0.70	3.89	0.70	7.38

County	Backhoe	Crawler Tractor/Dozer	Excavator	Grader	Off-Highway Truck	Scraper	Wheeled Loader
Kimble	0.16	0.98	1.02	0.28	1.59	0.29	3.01
Lampasas	1.60	9.60	10.01	2.80	17.54	2.80	32.13
Lee	0.00	29.01	9.24	39.10	33.34	3.98	12.13
Leon	0.00	47.72	15.20	64.33	54.85	6.56	19.95
Liberty	0.35	2.08	2.17	0.61	3.38	0.61	6.42
Limestone	2.29	15.08	15.66	6.38	22.88	9.05	44.62
Lubbock	0.32	1.91	1.99	0.56	3.10	0.56	8.22
Maverick	0.25	1.47	1.54	0.43	2.39	0.43	4.54
Mcculloch	1.89	11.32	11.80	3.30	18.39	3.30	34.90
Mclennan	1.15	6.92	7.21	2.02	11.24	2.02	21.33
Mcmullen	0.02	0.14	0.14	0.04	0.22	0.04	0.42
Medina	0.92	5.55	5.78	1.62	9.02	1.62	17.10
Midland	0.16	0.98	1.02	0.28	1.59	0.28	3.01
Milam	1.02	6.11	6.37	1.78	9.93	1.78	18.83
Mitchell	0.17	1.02	1.06	0.30	1.66	0.30	3.14
Montague	0.27	1.64	1.71	0.48	2.66	0.48	5.06
Montgomery	0.32	1.91	1.99	0.56	3.11	0.56	5.90
Motley	0.25	1.50	1.56	0.44	2.43	0.44	4.61
Navarro	1.58	9.49	9.89	2.76	15.41	2.77	29.24
Newton	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nolan	0.62	3.74	3.90	1.09	6.08	1.09	11.54
Nueces	0.91	5.43	5.66	1.58	8.83	1.58	16.74
Oldham	1.02	6.14	6.40	1.79	9.98	1.79	18.93
Orange	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Palo Pinto	1.28	7.66	7.98	2.23	12.45	2.23	23.62
Panola	0.00	39.75	9.93	49.46	33.99	0.00	31.67
Parker	1.96	11.78	12.28	3.43	19.14	3.44	36.32
Parmer	0.21	1.28	1.33	0.37	2.08	0.37	3.94
Pecos	0.17	1.02	1.07	0.30	1.66	0.30	3.16
Potter	1.37	8.22	8.57	2.40	13.36	2.40	25.35
Randall	0.06	0.33	0.35	0.10	0.54	0.10	1.03
Reeves	0.44	2.66	2.78	0.78	4.33	0.78	8.21
Robertson	0.05	13.67	4.55	18.14	15.84	1.92	6.44
Rusk	0.00	30.57	6.62	37.09	33.99	3.06	16.77

County	Backhoe	Crawler Tractor/Dozer	Excavator	Grader	Off-Highway Truck	Scraper	Wheeled Loader
Sabine	0.29	1.75	1.82	0.51	2.84	0.51	5.38
San Augustine	0.06	0.35	0.37	0.10	0.57	0.10	1.09
San Patricio	0.52	3.15	3.28	0.92	5.12	0.92	9.71
San Saba	0.25	1.50	1.57	0.44	2.44	0.44	4.63
Scurry	0.02	0.14	0.15	0.04	0.23	0.04	0.44
Shackelford	0.56	3.37	8.23	0.98	7.41	0.98	18.86
Smith	0.16	0.96	1.00	0.28	1.56	0.28	2.97
Somervell	1.00	5.99	6.24	1.74	9.73	1.75	18.46
Starr	2.02	2.15	8.77	0.75	13.56	0.63	9.26
Tarrant	0.42	2.53	2.63	0.74	4.10	0.74	7.79
Taylor	0.21	1.23	1.28	0.36	2.00	0.36	3.80
Titus	0.16	0.98	1.02	37.38	1.59	0.29	3.02
Tom Green	0.37	2.23	2.32	0.65	3.62	0.65	6.87
Travis	3.11	16.14	16.81	4.70	32.32	4.71	56.78
Uvalde	2.14	12.85	13.39	3.74	20.88	3.75	39.61
Val Verde	0.11	0.68	0.70	0.20	1.10	0.20	2.08
Van Zandt	0.34	2.06	2.15	0.60	3.35	0.60	6.36
Victoria	0.65	3.90	4.06	1.14	6.33	1.14	12.01
Ward	0.26	2.90	2.43	0.46	2.57	0.46	4.87
Washington	0.11	0.67	0.70	0.20	1.09	0.20	2.08
Webb	0.68	4.08	4.25	1.19	6.63	1.19	12.57
Wheeler	0.00	0.00	0.00	0.00	0.00	0.00	2.53
Williamson	9.83	71.05	62.91	17.19	99.33	17.20	194.21
Wise	4.40	26.40	27.51	7.69	42.90	7.70	81.38
Wood	0.06	0.34	0.36	0.10	0.55	0.10	1.05
Young	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Zapata	0.06	0.36	0.38	0.11	0.59	0.11	1.30
Zavala	0.03	0.20	0.21	0.06	0.32	0.06	0.61
Total	**95.21**	**841.81**	**686.86**	**564.83**	**1,241.82**	**208.35**	**1,884.38**

4.4 Growth Surrogates

Surrogates for forecasting and back-casting equipment populations from the 2007 base year were developed for the period between 1970 and 2050, for all targeted DCE categories and subsectors, as described below.

4.4.1 RTF and Trencher Growth

The statewide sales data obtained from EDA for 1990 through 2007 served as the primary surrogate for RTF and trencher back-casting for this time period. Equipment population prior to and after this period was assumed to follow economic output for all construction sectors. This data was obtained at the county level for 1978 through 2037 by the TCEQ using the Economy.com database. Equipment populations prior to 1978 were assumed equal to 1978 levels, while those beyond 2037 were set equal to 2037 levels. Growth factors relative to the 2007 base year (where the associated factor equals 1.0) are presented in Table 4-23.

Table 4-23. Statewide Growth Factors – RTFs and Trenchers (2007 base)

Year	Growth Factor
1970	0.497
1971	0.497
1972	0.497
1973	0.497
1974	0.497
1975	0.497
1976	0.497
1977	0.497
1978	0.497
1979	0.567
1980	0.618
1981	0.675
1982	0.703
1983	0.698
1984	0.694
1985	0.684
1986	0.631
1987	0.558
1988	0.540
1989	0.543
1990	0.580
1991	0.517
1992	0.536
1993	0.503
1994	0.623
1995	0.652
1996	0.737
1997	0.828
1998	0.878
1999	0.764
2000	0.784
2001	0.689
2002	0.638
2003	0.678
2004	0.706
2005	0.755
2006	0.839
2007	1.000
2008	1.008
2009	1.029
2010	1.055
2011	1.066
2012	1.091
2013	1.113
2014	1.138

Year	Growth Factor
2015	1.187
2016	1.254
2017	1.299
2018	1.324
2019	1.326
2020	1.324
2021	1.331
2022	1.330
2023	1.326
2024	1.321
2025	1.316
2026	1.312
2027	1.309
2028	1.307
2029	1.305
2030	1.304
2031	1.314
2032	1.340
2033	1.349
2034	1.361
2035	1.371
2036	1.381
2037	1.388
2038	1.388
2039	1.388
2040	1.388
2041	1.388
2042	1.388
2043	1.388
2044	1.388
2045	1.388
2046	1.388
2047	1.388
2048	1.388
2049	1.388
2050	1.388

4.4.2 Scrap and Recycling Growth

County level economic output data for scrap and recycling businesses in Texas were obtained from TX-REMI model outputs, extrapolated from 1970 through 2050, set to a 2007 base year. These growth factors are consistent with those used for a recent study of skid steer loader activity across the state conducted for the TCEQ.[35] Appendix G presents the county level growth factors for this sector.

4.4.3 Special Trades Contractor Growth

County level Economy.com economic output data for special trades contractors (1700 SIC series) were used as the growth surrogate for this sector. As with RTFs and trenchers, growth factors for years prior to 1978 were set equal to 1978 values, and values for years after 2037 were set equal to 2037, due to lack of available data. Appendix H presents the county level growth factors, with 2007 values set to 1.00.

4.4.4 Mining and Quarry Growth

County level Economy.com economic output data for mining activity (excluding oil and gas production) were used as the growth surrogate for this sector. Growth factors for years prior to 1978 were set equal to 1978 values, and values for years after 2037 were set equal to 2037, due to lack of available data. Appendix I presents the county level growth factors, with 2007 values set to 1.00.

4.5 Horsepower Distributions

Equipment populations were distributed across hp bins consistent with TexN and NONROAD hp categories.

4.5.1 RTFs and Trenchers

The RTF and trencher surveys were designed to develop equipment population and activity estimates specific to the state of Texas. However, assuming hp distributions across the state are similar to those at the national level, the hp distribution data developed from national surveys for the NONROAD model should provide the best available source for this information. Accordingly, the hp distributions from NONROAD2005 (provided in Table 4-24) were applied to total population estimates for these two equipment categories.

[35] Eastern Research Group, Skid Steer Loader Emission Inventory for the State of Texas, prepared for TCEQ August 31, 2008.

Table 4-24. HP Distributions – RTFs and Trenchers (NONROAD2005 basis)

HP Bin	RTFs	Trenchers
25 – 49	4.1%	9.6%
50 – 74	4.6%	24.0%
75 – 99	9.1%	40.0%
100 – 174	52.3%	16.1%
175 – 299	26.7%	5.0%
300 – 599	1.4%	3.4%
600 – 749	1.8%	1.7%

4.5.2 Scrap and Recycling Equipment

HP distributions were developed from the weighted survey data for excavators and wheeled loaders, with the fractions by bin and averages within each bin provided in Table 4-25.

Table 4-25. HP Distributions – Scrap/Recycling Equipment

		25 - 49	50 - 74	75 - 99	100 - 174	175 - 299	300 - 599
Excavator	Avg HP				137	238	450
Excavator	Fraction	0	0	0	0.500	0.456	0.044
Loader	Avg HP	45	59	87	136	237	450
Loader	Fraction	0.053	0.079	0.105	0.5	0.211	0.053

There were less than five observations each for off-highway trucks, crawler dozers, and tractor/loader/backhoes. Given the limited data set, point estimates based on weighted average survey values were provided for hp for these equipment categories rather than distributions, as summarized below:

- Off-highway trucks – 396 hp;
- Crawler dozers – 379 hp;
- Tractor/loader/backhoes – 62 hp.

4.5.3 Special Trades Contractor Equipment

HP distributions for this subsector were developed based on the weighted survey data. Fractions and average values by hp bin are presented in Table 4-26.

Table 4-26. HP Distributions – Special Trades Contractor Equipment (Avg hp / Fraction)

HP Bin	Crawler Tractor/Dozer	Excavator	Grader	Paver	Roller	Tractor/ Loader/ Backhoe	Wheeled Loader
25 - 49	-	37.6 / 0.602	-	36.7 / 0.333	32.0 / 0.154	36.8 / 0.096	-
50 - 74	61.3 / 0.155	58.4 / 0.126	60.0 / 0.057	50.0 / 0.111	72.0 / 0.231	69.2 / 0.731	63.0 / 0.096
75 - 99	81.8 / 0.631	83.0 / 0.024	85.0 / 0.029	-	95.0 / 0.231	83.5 / 0.158	82.7 / 0.140
100 - 174	131.1 / 0.194	127.9 / 0.207	139.6 / 0.743	127.0 / 0.333	126.6 / 0.385	130.4 / 0.014	138.2 / 0.527
175 - 299	223 / 0.019	186.5 / 0.016	1853 / 0.171	225.0 / 0.222	-	180.0 0.001	215.9 / 0.237
300 - 599	-	473.0 / 0.024	-	-	-	-	-

4.5.4 Mining and Quarry Equipment

The survey data for mine and quarry equipment was considered too thin to develop hp distributions. For this reason average (point) estimates were developed for hp for each equipment type, as summarized in Table 4-27.

Table 4-27. Average HP Values – Mining and Quarry Equipment

Equipment Type	Mines	Quarries
Tractor/Loader/Backhoe	-	70
Crawler Tractor/Dozer	493	223
Excavator	923	275
Grader	-	178
Off-Highway Truck	1,047	361
Scraper	629	363
Wheeled Loader	438	261

5.0 Phase II Data and Emissions Updates

Phase II of this study involved incorporation of existing data sources in order to refine the DCE emission inventory data developed under Phase I. An additional improvement was also made to a non-DCE category, integrating new data on agricultural equipment populations and activity into the TexN model. This section discusses the different improvements made to the TexN model under Phase II.

5.1 Integrating NONROAD2008 within TexN

The previous TexN model utilized NONROAD2005 as the core calculation utility. However, in order to meet EPA reporting requirements, nonroad emissions inventories for the next NEI must be calculated using NONROAD2008 for the sources contained within the model. Therefore this task involved modifying TexN to integrate NONROAD2008 as the core calculation routine.

The NONROAD2008 model has several differences from the NONROAD2005 model. Full documentation of the changes in the model has not been released by EPA as of this date. Many of the changes discussed below are described in a document released by EPA, Frequently Asked Questions about NONROAD2008, available on EPA's website at http://www.epa.gov/oms/models/nonrdmdl/nonrdmdl2008/420f09021.pdf. However, other changes to the model, not yet documented, were discovered through a rigorous QA of emissions estimates obtained from TexN using NONROAD2008 compared to the emissions estimates from TexN using NONROAD2005, in conjunction with conversations with EPA nonroad modeling staff.

5.1.1 New Small SI and Recreational Marine Rules

The NONROAD2008 model accounts for the emissions reductions resulting from two rules finalized by EPA in 2008. These two rules are:

- Diesel recreational marine standards in the Locomotive/Marine final rule, Federal Register Vol 73, No. 88, page 25098, May 6, 2008; and
- Small SI and SI Recreational Marine final rule, Federal Register Vol 73, No. 196, page 59034, October 8, 2008.

The new model version incorporates new Phase 3 controls for small SI engines as specified by the rules listed above. It also added controls for SI and CI recreational marine engines as required by these rules.

Other than incorporation of the NONROAD2008 model into TexN, no further changes were required by TexN in order to model the effects of these two new rules. However, unlike other regulations modeled by TexN, currently there is not a way for a user to model the effects of each of these rules individually or toggle the effects of these rules on and off.

Fuel Inputs

NONROAD2008 also gives a user the ability to model the effects of ethanol blends on fuel tank and hose permeation losses. Two input fields have been added to the option file to allow users to specify ethanol blend market share and volume percent ethanol in the blend. These inputs are required to accurately model permeation emissions from fuel tanks and hoses with ethanol blends. Accordingly, the TexN database has been updated to accommodate ethanol blend percent volume and market share information. However, the user cannot change this information directly through the TexN graphical user interface.

Accordingly, modifications were made to TexN functionality as well as supporting data tables as described below in order to fully utilize the new fuel features of NONROAD2008.

ERG first exported oxygenate market share information from the "countymonthyear" table in EPA's National Mobile Inventory Model (NMIM). This table contains market share information for ethanol, MTBE, ETBE, and TAME by county, year, and month. ERG averaged the market share data for each county and year across months in order to make it compatible with TexN. The months May through October constitute summer months, while November through April were assigned as winter months, consistent with TexN modeling procedures.

Next, percent volume information was compiled using a combination of NIPER data and Southwest Research Institute (SwRI) sampling data collected over various years for TCEQ. The source of each year's fuel data is identified by season in Table 5-1.

Table 5-1. TexN Fuel Property Data Sources

Year	Summer	Winter
1994 and earlier	1994 NIPER	1994 NIPER
1995	1995 NIPER	1995 NIPER
1996	1996 NIPER	1995 NIPER
1997	1997 NIPER	1998 NIPER
1998	1998 NIPER	1998 NIPER
1999	1999 NIPER	1999 NIPER
2000	2000 NIPER	1999 NIPER
2001	2000 NIPER	2002 NIPER
2002	2002 NIPER	2002 NIPER

Year	Summer	Winter
2003	2003 SwRI	2002 NIPER
2004	2004 SwRI	2002 NIPER
2005	2005 SwRI	2002 NIPER
2006	2005 SwRI	2006 SwRI
2007	2007 SwRI	2002 NIPER
2008	2008 SwRI	2002 NIPER

Once this information was compiled, the oxygenate weight percent that is used as an input into TexN, was updated according to the following formula, which is consistent with how NMIM calculates oxygenate weight percent.

```
oxywtpct =    (etohvolume*0.3448*etohmktshare) + (mtbevolume*0.1786*mtbemktshare) +
              (tamevolume*0.1636*tamemktshare) + (etbevolume*0.1533*etbemktshare)
```

Once compiled, ERG updated the Oxygen Weight Percentage field in the fuel table within the TexN database. ERG also added two fields in the TexN fuel table for "ETOH volume" and "ETOH market share" (by year, county, and season) as well as to the MySQL Stored Procedure that reads the fuel data when generating the OPT file. ERG then added the two new ETOH fields to the nonroad OPT file, as required by the NONROAD2008 model. Next, ERG updated the NONROAD008 source code, replicating the changes made to the NONROAD2005 model to allow nonroad to be installed in a folder other than c:\nonroad. Finally, ERG updated the TexN installation program to include all of these changes.

Changes in Technology Types and Implications for Ammonia Emissions Estimates

Technology type names within NONROAD2008 have been revised and expanded for certain equipment types to provide more specificity, especially for recreational engines (snowmobiles, ATVs, and offroad motorcycles) and diesel recreational marine engines. New technology types were added for recreational marine engines and small SI engines for the levels of control required by the new rules. New technology type sales fractions have also been updated or corrected for Phase 2 engines. Technology types for snowblowers have been corrected to include 4-stroke engines.

Changes in technology types have a direct impact on ammonia emissions estimates since the appropriate emission factors are chosen based on a combination of fuel and technology type. Documentation about specific changes to technology types have not been released by EPA. Therefore, ERG contacted EPA to help identify which technology types utilize three-way

catalysts, as this is the determining factor in choosing the correct ammonia emission factor. Table 5-2 details the outcome of these conversations with EPA.[36]

Table 5-2. Technology Types with 3-Way Catalysts

Tech Type	Description	3-Way Catalyst? (Response from EPA)
G2H3	Gasoline 2-stroke handheld Class 3	
G2H3 1	Gasoline 2-stroke handheld Class 3 meeting Phase 1 Standards	
G2H3C1	Gasoline 2-stroke handheld Class 3 meeting Phase 1 Standards with a catalyst	
G2H32	Gasoline 2-stroke handheld Class 3 meeting Phase 2 Standards	
G2H3C2	Gasoline 2-stroke handheld Class 3 meeting Phase 2 Standards with a catalyst	Because small engines are not very sophisticated, the catalysts are not the typical 3-way catalysts.
G2H4	Gasoline 2-stroke handheld Class 4	
G2H41	Gasoline 2-stroke handheld Class 4 meeting Phase 1 Standards	
G2H4C1	Gasoline 2-stroke handheld Class 4 meeting Phase 1 Standards with a catalyst	
G4H41	Gasoline 4-stroke handheld Class 4 meeting Phase 1 Standards	
G2H42	Gasoline 2-stroke handheld Class 4 meeting Phase 2 Standards	
G2H4C2	Gasoline 2-stroke handheld Class 4 meeting Phase 2 Standards with a catalyst	Because small engines are not very sophisticated, the catalysts are not the typical 3-way catalysts.
G4H42	Gasoline 4-stroke handheld Class 4 meeting Phase 2 Standards	
G2H5	Gasoline 2-stroke handheld Class 5	
G2H5 1	Gasoline 2-stroke handheld Class 5 meeting Phase 1 Standards	
G2H5C1	Gasoline 2-stroke handheld Class 5 meeting Phase 1 Standards with a catalyst	
G2H52	Gasoline 2-stroke handheld Class 5 meeting Phase 2 Standards	
G2H5C2	Gasoline 2-stroke handheld Class 5 meeting Phase 2 Standards with a catalyst	Because small engines are not very sophisticated, the catalysts are not the typical 3-way catalysts.

[36] Personal communications with Philip Carlson with EPA, June 2009.

Tech Type	Description	3-Way Catalyst? (Response from EPA)
G2N1	Gasoline 2-stroke nonhandheld Class 1	
G4N1 S	Gasoline 4-stroke nonhandheld Class 1 side-valve carburetor	
G4N1O	Gasoline 4-stroke nonhandheld Class 1 overhead-valve carburetor	
G2N1	Gasoline 2-stroke nonhandheld Class 1	
G4N1 S1	Gasoline 4-stroke nonhandheld Class 1 side-valve carburetor meeting Phase 1 Standards	
G4N1O1	Gasoline 4-stroke nonhandheld Class 1 overhead-valve carburetor meeting Phase 1 Standards	
G4N1 SC1	Gasoline 4-stroke nonhandheld Class 1 side-valve carburetor meeting Phase 1 Standards with a catalyst	
G4N1 S2	Gasoline 4-stroke nonhandheld Class 1 side-valve carburetor meeting Phase 2 Standards	
G4N1O2	Gasoline 4-stroke nonhandheld Class 1 overhead-valve carburetor meeting Phase 2 Standards	
G2N2	Gasoline 2-stroke nonhandheld Class 2	
G4N2S	Gasoline 4-stroke nonhandheld Class 2 side-valve carburetor	
G4N2O	Gasoline 4-stroke nonhandheld Class 2 overhead-valve carburetor	
G4N2S1	Gasoline 4-stroke nonhandheld Class 2 side-valve carburetor meeting Phase 1 Standards	
G4N2O1	Gasoline 4-stroke nonhandheld Class 2 overhead-valve carburetor meeting Phase 1 Standards	
G4N2S2	Gasoline 4-stroke nonhandheld Class 2 side-valve carburetor meeting Phase 2 Standards	
G4N2O2	Gasoline 4-stroke nonhandheld Class 2 overhead-valve carburetor meeting Phase 2 Standards	
G2GT25	Gasoline 2-stroke greater than 25 horsepower	
G4GT25	Gasoline 4-stroke greater than 25 horsepower	
G4GT251	Gasoline 4-stroke greater than 25 horsepower meeting Tier 1 Standards	Yes
G4GT252	Gasoline 4-stroke greater than 25 horsepower meeting Tier 2 Standards	Yes
R12S	Gasoline Recreational 2-stroke	

Tech Type	Description	3-Way Catalyst? (Response from EPA)
* R12SP	Gasoline Recreational 2-stroke ("P" = Pump Fueled, unused as a separate tech type)	
R12S1	Gasoline Recreational 2-stroke meeting Tier 1 Standards	
R12S1P	Gasoline Recreational 2-stroke meeting Tier 1 Standards ("P" = Pump Fueled, unused as a separate tech type)	
R12S2	Gasoline Recreational 2-stroke meeting Tier 2 Standards	
* R12S2P	Gasoline Recreational 2-stroke meeting Tier 2 Standards ("P" = Pump Fueled, unused as a separate tech type)	
R14S	Gasoline Recreational 4-stroke	
* R14SP	Gasoline Recreational 4-stroke ("P" = Pump Fueled, unused as a separate tech type)	
R14S1	Gasoline Recreational 4-stroke meeting Tier 1 Standards	
LGT25	LPG greater than 25 horsepower	
LGT251	LPG greater than 25 horsepower meeting Tier 1 Standards	Yes
LGT252	LPG greater than 25 horsepower meeting Tier 2 Standards	Yes
NGT25	CNG greater than 25 horsepower	
NGT251	CNG greater than 25 horsepower meeting Tier 1 Standards	Yes
NGT252	CNG greater than 25 horsepower meeting Tier 2 Standards	Yes
Base	Early (pre-1988) uncontrolled diesel engines	
T0	Late model (1988+) uncontrolled diesel engines	
T1	Diesel engine meeting Tier 1 Standards	
T2	Diesel engine meeting Tier 2 Standards	
T3	Diesel land-based engine meeting Tier 3 Standards	
T3B	Diesel land-based engine meeting Tier 3 Standards for 75-100 hp engines	
T4A	Diesel land-based engine meeting transitional Tier 4 Standards for engines under 50 hp	
T4B	Diesel land-based engine meeting transitional Tier 4 Standards for engines under 25 hp	
T4	Diesel land-based engine meeting full Tier 4 PM Standards	No 3-way. But new technologies could affect NH3

Tech Type	Description	3-Way Catalyst? (Response from EPA)
* T4N1	Unused	
T4N	Diesel land-based engine meeting full Tier 4 PM & NOx Standards	No 3-way. But new technologies could affect NH3
T2M	Diesel recreational marine engine meeting "Tier 2" Standards for over 50 hp engines	
MO2C	2-stroke gasoline Outboard Carbureted	
MO2I	2-stroke gasoline Outboard with Indirect injection	
MO2D	2-stroke gasoline Outboard with Direct injection	
MO4C	4-stroke gasoline Outboard Carbureted	
MO4I	4-stroke gasoline Outboard with Indirect injection	
MO4D	4-stroke gasoline Outboard with Direct injection	
MP2C	2-stroke gasoline Personal Watercraft Carbureted	
MP2I	2-stroke gasoline Personal Watercraft with Indirect injection	
MP2D	2-stroke gasoline Personal Watercraft with Direct injection	
MP4C	4-stroke gasoline Personal Watercraft Carbureted	
MP4I	4-stroke gasoline Personal Watercraft with Indirect injection	
MP4D	4-stroke gasoline Personal Watercraft with Direct injection	
MS4C	4-stroke gasoline Sterndrive/Inboard Carbureted	
MS4D	4-stroke gasoline Sterndrive/Inboard with Direct Injection	
G4N1O3	Phase 3, nonhandheld, Class I, overhead valve	Because small engines are not very sophisticated, the catalysts are not the typical 3-way catalysts.
G4N1S3	Phase 3, nonhandheld, Class I, side valve	Because small engines are not very sophisticated, the catalysts are not the typical 3-way catalysts.

Tech Type	Description	3-Way Catalyst? (Response from EPA)
G4N23a	Phase 3, nonhandheld, Class II	Because small engines are not very sophisticated, the catalysts are not the typical 3-way catalysts. (FYI - we projected only 50% of Class II would use catalysts)
G4N23b	--	
MOC1	New stds for outboards	
MPC1	New stds for personal watercraft	
MSC1	New stds for SD/I engines	Yes
T3M		
T4M		

Based on this information, TexN was updated according to the information presented in Table 5-3.

Table 5-3. Engine and Technology Types with Ammonia Emission Factors

Engine Type	SCC	Technology Type(s)	Ammonia Emission Factor
Diesel	2270XXXXXX	All Tech Types	0.00162 g/hp-hr
Gasoline with 3-way catalysts	2260XXXXXX 2265XXXXXX	G2H3C2 G2H4C2 G2H5C2 G4GT251 G4GT252 G4N1O3 G4N1S3 G4N23a MSC1	0.069 g/hp-hr
NG/LPG with 3-way catalysts	2267XXXXXX 2268XXXXXX	LGT251 LGT252 NGT251 NGT252	0.103 g/hp-hr
SI engines without 3-way catalysts	2260XXXXXX 2265XXXXXX 2267XXXXXX 2268XXXXXX	All other Tech Types	0.15 g/gal

Note that all emission factors are in g/hp-hr except for SI engines w/out 3-way catalysts, which is in g/gal. Emissions for SCC/Tech Type combinations with emission factors in g/hp-hr are calculated by multiplying the factor by the Average HP value, the Load Factor, and the Activity value in the exhaust emissions file. (Note: Ammonia is an exhaust emission, so the

evaporative emissions file is not needed for this calculation). The result is then multiplied by 1.1023e-6 to convert grams to tons.

For SCC/Tech Type combinations expressed in g/gal, emissions are calculated by multiplying the emission factor by the Fuel Consumption value in the exhaust file, then multiplying by 1.1023e-6 to convert grams to tons.

Changes in Emission Factors and Other NONROAD Model Inputs

NONROAD2008 also incorporates new emissions factors for small SI engines based on EPA and industry test data, along with minor revisions to tank sizes. EPA has added new fuel tank diffusion losses to the diurnal emission estimates for small SI engines. Exhaust emission factors and deterioration rates have been updated or corrected for Phase 2 engines. Hot soak and running loss inputs for handheld equipment have been added in the NONROAD2008 version of the model. Running loss emission factors for Class 1 snowblowers have been corrected to account for cold weather applications.

Brake-specific fuel consumption factors have been revised for recreational marine SI engines. PM emission factors for 2-stroke technology engines have also been revised for recreational marine SI engines. Fuel tank and hose permeation emission factors and temperature effects for recreational marine SI engines have also been incorporated into the NONROAD2008 model. Hot soak and running loss emission estimates have also been added for recreational marine engines. Modeling inputs for high performance (greater than 600 hp) sterndrive and inboard (SD/I) engines.

Through a rigorous QA process, ERG identified changes in NOx emissions that could not be explained by changes described in the limited NONROAD2008 documentation. After contacting EPA about the changes in NOx emissions between versions, it was discovered that EPA had erroneously made changes to NOx emission factors for land-based diesels. Consequently, EPA gave two options:

- Run the model as-is, with the erroneous NOx emissions for land-based diesels, or
- Use the NOx emission factors from NONROAD2005 for land-based diesels.

After consulting with TCEQ regarding these options, ERG corrected the exhaust NOx emission factor file within TexN to incorporate NOx emission factors from NONROAD2005 for land-based diesel engines.

In addition to inconsistent NOx emission estimates, there were also changes in PM emissions estimates that were not explained by the available documentation. After contacting EPA about these differences, EPA explained that changes had been made to the Base PM Sulfur packet in the option file of the NONROAD2008 model.

Updates to Average Horsepower and Useful Life

It was discovered during the QA process, although not documented by EPA, that there were some changes made to the average horsepower values for some SCCs in the NONROAD2008 model. Therefore, since average horsepower is critical to calculating emissions, and in order to make TexN consistent with NONROAD2008, ERG wrote database scripts to update the average horsepower and useful life for all non-diesel construction equipment. (Diesel construction equipment was excluded from this update due to the fact that average horsepower and useful life were meticulously calculated for TCEQ to update data for diesel construction equipment.)

5.2 Updates to Statewide Agricultural Equipment Data

Under a work order for TCEQ, E.H. Pechan & Associates, Inc. collected data to update population, activity, and temporal allocation for agricultural equipment across the state (2008 base year). TCEQ provided the agricultural equipment populations developed by SCC and horsepower for years 1970 through 2050. These populations were normalized using the default growth rate to the study base year of 2007. That is, all growth factors were divided by the 2007 growth factor, yielding a value of 1.0 for 2007.

ERG used the data provided to write MySQL database scripts to update the population tables in TexN for agricultural equipment. New activity data was also provided for agricultural equipment, along with updated temporal allocation. ERG wrote MySQL scripts to update the activity in TexN using these data and incorporated the new temporal allocation profiles into the *Season.dat* file.

ERG conducted statewide runs of the TexN model before and after updating the database with the new agricultural equipment data. A summary of the emissions results for a typical ozone season day in 2008 are presented in Tables 5-4 and 5-5 below.

Table 5-4. Statewide Agricultural Equipment Emissions, 2008 OSD Prior Default Data

	CO	NOx	PM10	SO2	VOC
2-Wheel Tractor	1.2792	0.0055	0.0004	0.0001	0.0182
Agricultural Mowers	0.9763	0.0090	0.0010	0.0001	0.0199
Agricultural Tractor	32.3041	49.9095	5.3645	0.9862	5.7811
Balers	0.9553	0.0649	0.0041	0.0006	0.0701
Combines	2.2781	5.1931	0.5927	0.0885	0.5167
Irrigation Sets	2.3065	0.7537	0.0617	0.0144	0.1503
Other Agricultural Equipment	4.0161	1.1283	0.1231	0.0195	0.2524
Sprayers	8.2422	0.4626	0.0547	0.0078	0.4360
Swathers	1.7350	0.4403	0.0546	0.0071	0.1378
Tillers > 6hp	19.5582	0.0816	0.0033	0.0007	0.6754
Total	**73.6511**	**58.0485**	**6.2601**	**1.1251**	**8.0579**

Table 5-5. Statewide Agricultural Equipment Emissions, 2008 OSD Updated Data

	CO	NOx	PM10	SO2	VOC
2-Wheel Tractor	4.6061	0.8814	0.1540	0.0251	0.2405
Agricultural Mowers	19.6038	9.8901	1.6290	0.2187	1.8637
Agricultural Tractor	140.2537	188.4401	16.0605	5.2239	17.5471
Balers	7.8042	8.2033	1.4292	0.1842	1.5680
Combines	10.0875	16.0300	1.5403	0.3292	1.7001
Irrigation Sets	142.8615	29.9489	2.0608	0.5739	5.1628
Other Agricultural Equipment	20.4891	7.9802	0.5132	0.1457	1.2713
Sprayers	12.9526	14.0105	1.8768	0.2858	2.3200
Swathers	2.4812	2.8662	0.4423	0.0632	0.4061
Tillers > 6hp	2.8672	3.7552	0.3932	0.0746	0.4168
Total	**364.0067**	**282.0058**	**26.0994**	**7.1243**	**32.4965**

As is seen in the tables, the updated agricultural equipment emissions inventory results in a substantial increase in emissions relative to the previous version which relied upon NONROAD2005 model inputs, increasing by a factor of 4 or more, depending upon the pollutant. Much of this increase may be attributable to the increased number of equipment pieces found in the new study. Table 5-6 presents the counts for the previous default equipment populations by equipment category, as well as the updated counts, for 2008.

Table 5-6. Statewide Agricultural Equipment Populations, 2008 Previous versus Updated Data

	Default	Update	Difference	%*
2-Wheel Tractor	309	11,820	11,511	3,724%
Agricultural Mowers	499	21,599	21,100	4,230%
Agricultural Tractor	83,952	142,542	58,590	70%
Balers	1,379	13,239	11,859	860%
Combines	16,908	9,268	-7,640	-45%
Irrigation Sets	1,759	19,186	17,427	991%
Other Agricultural Equipment	2,928	8,888	5,960	204%
Sprayers	13,919	18,078	4,160	30%
Swathers	4,187	4,418	231	6%
Tillers > 6hp	42,274	5,966	-36,308	-86%
Total	**168,115**	**255,006**	**86,891**	**52%**

* Difference divided by default value

5.3 Update to Heavy-Highway Growth Surrogates

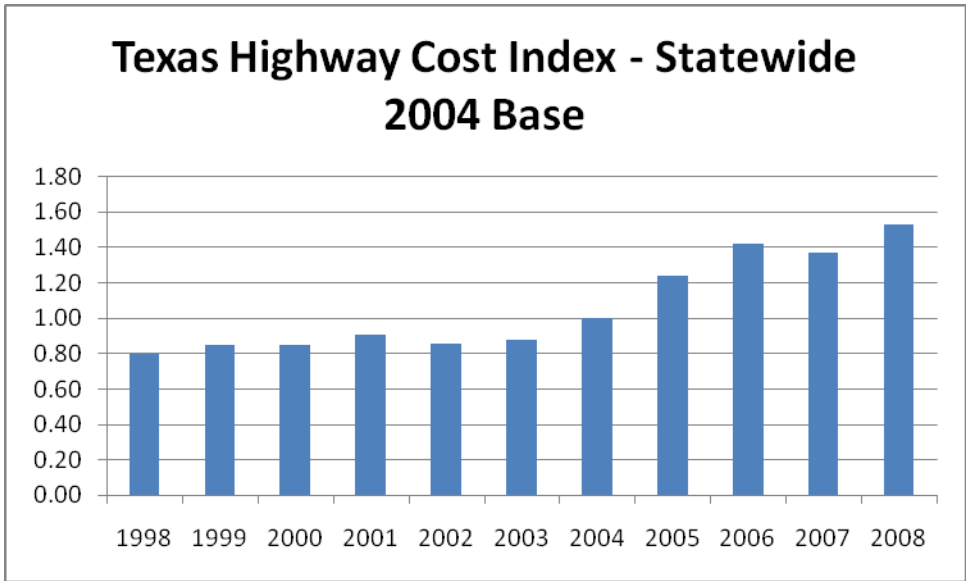
The previous version of the TexN model (1.3) utilized historical contract dollars for the 1998 – 2006 time period as the basis for projecting heavy-highway construction equipment population levels from base year estimates. Population levels outside of this time period were projected using dollar value of construction estimates from Economy.com.[37] These estimates were obtained from the TCEQ in June of 2008, and did not reflect the extreme downturn in highway construction activity that has been ongoing for the last two years. In addition, by relying solely upon contract dollar values as the surrogate for highway construction activity, the previous method did not account for the sharp rise in materials costs that have been incurred by highway contractors over the last few years.[38] As such, relying on contract dollar values will overestimate actual equipment activity relative to the base year during times of material cost inflation.

ERG updated the TexN model to reflect these factors for the highway construction sector, from 1970-2050. As a first step ERG obtained updated county highway expenditures for the years 2007 and 2008 from the Texas County Highway Construction and Maintenance Annual Expenditures reports.[39] These data supplement the previous historical activity obtained for the 1998 – 2006 time period. Next, ERG utilized the Texas Highway Cost Index report for June 2009 to establish adjustment factors to account for increasing material and other non-activity-

[37] TCEQ query of Economy.com database June 2009.
[38] Personal communication, Bob Lanham, Vice President Williams Brothers Construction, April 2009.
[39] http://www.window.state.tx.us/taxbud/expbyco/

related costs (e.g., general inflation). The Cost Index, shown in Figure 5-1 below, reflects the nominal increase in costs relative to a 2004 base year for statewide highway construction activities.[40] The figure clearly shows a sharp rise in costs per unit of delivered services beginning approximately in 2004.

Figure 5-1



These factors were then used to adjust the county-level expenditure data (1998 – 2008) to the 2004 base year level, dividing the actual dollar value from the Annual Expenditure Reports by the factor from the appropriate year.

These data were then combined with the updated Economy.com projections in order to forecast and back cast equipment populations. Growth factors were derived at the county level for the 1978 – 1997 and 2009 - 2039 periods using economic output (in real dollars) for NAICS code 2373, Highway Street and Bridge Construction.[41] Future year dollar projections reflect a substantial downturn in construction activity for the state compared to the previous Economy.com data obtained from TCEQ in 2008. Dollar amounts outside this period were assumed constant from 1970 – 1978 and from 2039 - 2050.

Growth factors for the entire modeling period were calculated as follows.

[40] ftp://ftp.dot.state.tx.us/pub/txdot-info/cst/hci_binder.pdf ; 2004 is also the current base year for highway construction equipment within TexN.
[41] Data from the Economy.com database are considered confidential and are not presented here. All manipulation and processing of the Economy.com data were performed by authorized TCEQ personnel.

Step 1 – Adjust county level annual highway expenditures for 1998 – 2008 by Highway Cost Index Factors. Historical dollar values from the Comptroller Expenditure reports are provided in Table J-1. These values are divided by the cost index values normalized for the 2004 base year, shown in Figure 5-1 and listed below in Table 5-7.

Table 5-7. Statewide Highway Cost Index Factors (2004 Base)

Year	Cost Index
1998	0.793
1999	0.843
2000	0.848
2001	0.900
2002	0.855
2003	0.878
2004	1.000
2005	1.238
2006	1.419
2007	1.365
2008	1.528

Step 2 – Calculate growth factors from adjusted dollar values for the historical data. For each county, divide the adjusted dollar value for each year by the corresponding dollar value in year 2004. All values for 2004 therefore equal 1.

Step 3 – Forecast growth factors for 2009 – 2039 using Economy.com data. First, for each county divide the adjusted dollar value for 2008 by the adjusted value for 2004. This provides the ratio of "real" activity in 2008 relative to the 2004 base year. Next, multiply this value by the ratio of the Economy.com factors (target year divided by 2008 value). An example calculation for Steps 1 through 3 is provided below.

Example - Anderson County, 2009:

- 2004 Nominal Expenditure - $6,780,698
- 2008 Nominal Expenditure - $17,141,400
- 2004 Adjusted Expenditure - $6,780,698 (adjustment factor = 1.0 for base year)
- 2008 Adjusted Expenditure - $11,216,411 (adjustment factor = 1.528 for 2008)
- 2008 Adjusted Expenditure / 2004 Adjusted Expenditure = 1.654
- Economy.com 2009 factor / Economy.com 2008 factor = 2.33 / 2.51 = 0.927
- 2009 growth factor = 1.654 * 0.927 = 1.533

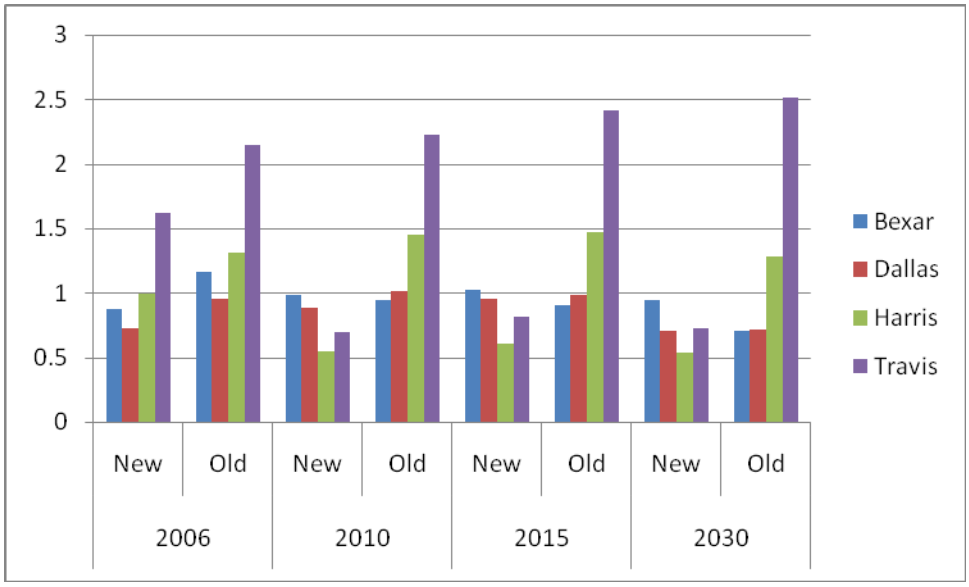
Therefore the equipment population and activity in Anderson County in 2009 is projected to be 1.533 higher than that in 2004.

Step 4 – Back cast growth factors for 1978 – 1997 using Economy.com data. This process is identical to that described in Step 3, except the various values for the 2008 calendar year shown above are replaced by the corresponding values for 1998.

Step 5 – Project growth factors for remaining time periods. Economy.com data is limited to the period between 1978 and 2039. Growth factors for 1970 – 1977 are assumed equal to the 1978 value, while the 2040 – 2050 values are assumed equal to the 2039 value (i.e., no growth is assumed during these outlying periods).

The resulting growth factor table is very large, covering 254 counties and 80 years, and has been provided to TCEQ in electronic format. However, a comparison of the updated growth and previous growth factors is provided in Figure 5-2 for selected counties and analysis years. Table J-2 provides a by-county comparison of these factors for the entire state, for the 2008 and 2018 calendar years.

Figure 5-2. Comparison of Updated and Previous Highway Construction Equipment – Relative Growth Factors for Selected Counties and Analysis Years



As seen in the figure, all four counties witnessed a sizeable reduction in activity for 2006 (1.32 reduction factor). This factor corresponds to the highway cost index adjustment for 2006 relative to 2004.

Three of the four counties listed in the figure also see notable activity reductions in the near term 2010 case (Dallas, Harris, and Travis). This reduction is due to a combination of cost index adjustments and revised Economy.com activity projections. Bexar County however is

projected to have an increase in future activity, possibly due to large new projects that were not included in the 2008 Economy.com projections. The medium and long-term cases estimate that Dallas County will approximately return to its previous projection levels, although projections for Harris and Travis Counties remain substantially below previous estimates.

The growth factors obtained for all counties and years will be applied to the base year equipment populations for each county and year in the TexN model for the model's next update cycle. This calculation provides forecast and back-cast equipment population totals for every calendar year, from 1970 through 2050. The TexN model stores the population data for every possible scenario year, bypassing the need to modify growth factors into the future. The model looks up the correct population based on the scenario year directly input by the user, thereby avoiding problems with SCCs that experience rapid fluctuations in their population levels such as in the highway sector.[42]

5.4 Update to DCE Profile for Alamo Area Council of Governments (San Antonio) Area

The Alamo Area Council of Governments (AACOG) has conducted a number of updates to its DCE inventory over the past several years, utilizing local surveys and surrogates in order to improve upon the statewide, county level DCE (TexN) estimates available from the TCEQ. AACOG member counties include:

- Atascosa
- Bandera
- Bexar
- Comal
- Frio
- Gillespie
- Guadalupe
- Karnes
- Kendall
- Kerr
- Medina
- Wilson

AACOG follows the inventory development convention utilized by the TCEQ and consistent with TexN, employing the 24 DCE subsectors, each with their own surrogates and data sources. AACOG has developed updated DCE population, horsepower, and/or activity estimates for a number of DCE subsectors. The first of these updates involved population surrogate updates for the 12-county AACOG area (2005), for the DCE subsectors shown in Table 5-8.[43]

[42] The NONROAD model's scrappage algorithm is not capable of accurately modeling equipment populations with highly negative growth from year to year. This situation is common with certain types of transient activities, such as heavy-highway projects and boring/drilling activities.
[43] From AACOG Chapter 2, Table 2-27, 2005 Non-road Emissions Inventory

ERG utilized the population data for the 13 DCE subsectors noted in bold italics in the table above for this work order. The remaining subsectors have been addressed in subsequent studies performed for the TCEQ (e.g., skid steer loader, special trades, and other targeted surveys), and were not updated for this effort.

Mining and quarry survey updates were also conducted for Atascosa, Bexar, Comal, Gillespie, and Medina Counties in 2005, and landfill survey updates for Bexar, Comal, Gillespie, Guadalupe, and Kerr Counties (2008). While the surrogate updates only involved modification to equipment population and allocation for various DCE subsectors, the mining/quarry and landfill efforts were more detailed, involving extensive surveys of equipment operators in the area and elaborate QA and refinement (e.g., through the use of satellite imaging to characterize quarry equipment types and counts). As such, the mining/quarry and landfill studies also included updates to equipment horsepower distributions and activity, which have been integrated in this assessment.

AACOG provided ERG with the data sets used to develop their updates for the different DCE subsectors. The following steps were followed during the processing of the AACOG data, in order to make it consistent with the TexN data formats.

Table 5-8. AACOG Diesel Construction Equipment – Surrogate Factors by Sector, 2005

Sector	Allocation Method	Data Source	Year	Surrogate Factor
Heavy Highway	TxDOT Lettings	TxDOT	2005	0.65
Utility	MSA Population	Tx Water Development Board	2005	0.35
Municipal	MSA Population	Tx Water Development Board	2005	0.35
Commercial Construction	Construction Employees Population	County Business Patterns	2004	0.23
Residential	Family Dwelling Building Permits	Census Building permits	2005	0.30
City/County Roads	MSA Population	Tx Water Development Board	2005	0.35
TxDOT	MSA Population	Tx Water Development Board	2005	0.35
Scrap Recycling	Scrap and waste Materials	County Business Patterns	2004	0.19
Landscaping	Landscaping, Lawn and Garden Services	County Business Patterns	2004	0.39
Brick and Stone	Related construction materials	County Business Patterns	2004	0.12
Trenchers	Construction Employees Population	County Business Patterns	2004	0.23
Concrete	Block, brick, other, and ready-mix	County Business Patterns	2004	0.46
Skid Steer Loaders	Construction Employees Population	County Business Patterns	2004	0.23
Special Trade	Concrete, Erection, & finishing (exclud. Demol. & excav.)	County Business Patterns	2004	0.22
Cranes	Construction Employees Population	County Business Patterns	2004	0.23
RT Forklifts	Construction Employees Population	County Business Patterns	2004	0.23
Manufacturing	Manufacturing Employees	County Business Patterns	2004	0.15
Bore/Drill Rigs	Construction Employees Population	County Business Patterns	2004	0.23
Other	Construction Employees Population	County Business Patterns	2004	0.23
Agriculture	Agriculture, forestry, fishing	County Business Patterns	2004	0.17

Step 1 - Allocate equipment population to counties for base year. Data for the surrogate updates were provided for the total 12 county AACOG region, as shown in Table 5-9. These totals were allocated to the county level using the distribution obtained from AACOG, shown in Table 5-10. In addition to specialty equipment as noted above, note that equipment less than 25 horsepower were also dropped from the data set to be consistent with TexN, which assumes default values for small engines.

Similar data were also provided for the landfill, mining and quarry surveys. These data were aggregated into unique county/SCC/hp bin combinations, as summarized below in Tables 5-11 and 5-12, respectively. In two cases where individual quarries straddled county boundaries, population was allocated 50/50 to each county.

In order to do the aggregation, average hp for a given county/SCC/hp bin combination was calculated based on the hp values for individual pieces of equipment, weighted by the relative hp-hrs for the county/SCC/hp bin combination. Average activity (in hours per year) is the same for each SCC across all hp bins within TexN (and NONROAD). As such, average hours per year for each county/SCC combination were determined using a weighted average of the hour per year estimates for each individual piece of equipment surveyed, again by hp-hours. Weighted average hours per year are also shown in the tables above, and are the values used in the TexN updates.

Step 2 – Apply growth factors to base year data for forecasting and back-casting. ERG applied the growth surrogates developed for the different DCE subsectors under previous work orders in order to estimate county/SCC specific population estimates for 1970 – 2050. Query updates were developed and applied to the TexN database in order to upload the year-specific population counts for the appropriate DCE subsectors and counties. These updates also reflected the average hp values for each SCC/county, calculated as described above. The database script used to update the population values within TexN is as follows, for one example record:

update l_population_years set l_population_years.popval=0 where l_population_years.popyear=2008 and l_population_years.popid = (select l_population_main.popid from l_population_main where 1=1 and l_population_main.fips=13 and l_population_main.scc=2270002003 and l_population_main.dcesubsectorid=23 and l_population_main.minhp=25);

Table 5-9. AACOG 12 County DCE Population by Subsector

Equipment Description	HPmn	HPmx	HPavg	1	2	3	4	5	6	7	8	9	10	11	12	13
Dsl – Pavers	25	40	32.8	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.00
Dsl – Pavers	40	50	45.34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.2	0.0	0.00
Dsl – Pavers	50	75	62.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.00
Dsl – Pavers	75	100	86.65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.15
Dsl – Pavers	100	175	134.6	7.8	0.0	0.0	105.9	308.1	0.0	0.0	0.0	0.0	0.0	12.1	2.4	3.85
Dsl – Pavers	175	300	221.1	3.9	77.8	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15
Dsl – Pavers	300	600	386.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.2	0.0	0.00
Dsl – Rollers	25	40	32.52	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	65.3	3.1	1.14
Dsl – Rollers	40	50	45.81	9.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	63.5	0.00
Dsl – Rollers	50	75	60.74	20.6	0.0	0.0	105.9	0.0	0.5	0.0	0.0	0.0	0.0	197.0	35.9	0.30
Dsl – Rollers	75	100	84.76	20.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	42.4	107.8	2.55
Dsl – Rollers	100	175	132.2	43.5	151.0	104.5	105.9	308.1	1.3	0.0	0.7	0.0	0.0	34.3	17.4	0.00
Dsl – Rollers	175	300	217	9.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.1	0.0	0.00
Dsl – Rollers	300	600	420.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.00
Dsl – Scrapers	50	75	66	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Scrapers	100	175	160.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	12.56
Dsl – Scrapers	175	300	246.9	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	2.0	0.3	1.66
Dsl – Scrapers	300	600	422.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3	0.0	0.00
Dsl – Scrapers	600	750	687.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Scrapers	750	1000	760	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Paving Equipment	25	40	33.82	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.2	2.4	0.00
Dsl – Paving Equipment	40	50	41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Paving Equipment	50	75	61.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.00
Dsl – Paving Equipment	75	100	83.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	1.4	0.00
Dsl – Paving Equipment	100	175	131.3	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.1	30.7	0.07
Dsl – Paving Equipment	175	300	230.2	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.3	62.1	0.00
Dsl – Paving Equipment	300	600	460	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.1	17.4	0.00
Dsl – Surfacing Equipment	25	40	31.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Surfacing Equipment	40	50	44.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Surfacing Equipment	50	75	54.93	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Surfacing Equipment	75	100	80.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Surfacing Equipment	100	175	126.5	22.6	0.0	44.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00

Equipment Description	HPmn	HPmx	HPavg	1	2	3	4	5	6	7	8	9	10	11	12	13
Dsl – Surfacing Equipment	175	300	233	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Surfacing Equipment	300	600	492.6	21.8	0.0	17.4	0.0	0.0	1.9	0.0	0.7	0.0	0.0	2.0	0.0	11.24
Dsl – Surfacing Equipment	600	750	713.5	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.22
Dsl – Surfacing Equipment	750	1000	897	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Surfacing Equipment	1000	1200	1050	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Surfacing Equipment	1200	2000	1544	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Excavators	25	40	33.05	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.1	0.0	0.1	0.0	0.0	0.41
Dsl – Excavators	40	50	45.77	0.0	77.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Excavators	50	75	61.3	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.2	0.0	0.0	0.0	1.62
Dsl – Excavators	75	100	91.67	0.0	0.0	0.0	0.0	0.0	2.6	0.3	0.1	0.0	0.5	7.2	2.1	4.35
Dsl – Excavators	100	175	137.6	0.0	0.0	0.0	0.0	0.0	2.1	0.5	2.6	0.2	2.0	21.5	10.1	15.49
Dsl – Excavators	175	300	233.3	0.0	77.8	69.8	0.0	308.1	0.5	1.3	3.3	0.1	1.6	38.5	38.7	9.51
Dsl – Excavators	300	600	410.6	0.0	0.0	54.5	0.0	0.0	0.6	2.4	4.9	0.6	2.1	0.0	0.0	10.53
Dsl – Excavators	600	750	719.4	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.4	0.2	0.3	0.0	0.0	1.07
Dsl – Excavators	750	1000	884	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Excavators	1000	1200	1200	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Excavators	1200	2000	1768	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Excavators	2000	3000	2350	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Graders	25	40	35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Graders	40	50	48.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Graders	50	75	59.54	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.4	0.0	2.4	1.39
Dsl – Graders	75	100	84.21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	37.3	0.00
Dsl – Graders	100	175	140.8	41.2	0.0	14.7	52.9	0.0	4.1	0.6	1.3	0.0	3.7	187.7	154.2	17.41
Dsl – Graders	175	300	231.2	1.5	0.0	0.0	0.0	308.1	0.0	0.0	0.0	0.0	0.0	16.2	1.4	1.13
Dsl – Graders	300	600	341.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.15
Dsl – Graders	600	750	750	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Off-highway Trucks	100	175	160.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Off-highway Trucks	175	300	244.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.9	0.0	0.0	3.09
Dsl – Off-highway Trucks	300	600	419.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	3.6	2.0	0.0	6.07
Dsl – Off-highway Trucks	600	750	688.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.05
Dsl – Off-highway Trucks	750	1000	868	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.00
Dsl – Off-highway Trucks	1000	1200	1153	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Off-highway Trucks	1200	2000	1787	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Off-highway Trucks	2000	3000	2424	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00

Equipment Description	HPmn	HPmx	HPavg	1	2	3	4	5	6	7	8	9	10	11	12	13
Dsl – Rubber Tire Loaders	25	40	34.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.00
Dsl – Rubber Tire Loaders	40	50	45.44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	2.0	0.0	1.11
Dsl – Rubber Tire Loaders	50	75	61.7	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.16
Dsl – Rubber Tire Loaders	75	100	85.48	3.1	0.0	0.0	0.0	0.0	0.0	0.3	7.1	0.3	1.4	4.0	0.0	5.03
Dsl – Rubber Tire Loaders	100	175	136.3	47.5	0.0	135.0	0.0	0.0	0.0	0.6	1.8	0.9	3.9	103.9	0.0	18.06
Dsl – Rubber Tire Loaders	175	300	230	28.0	0.0	0.0	52.9	0.0	0.0	2.0	1.9	1.1	2.0	10.1	0.0	12.51
Dsl – Rubber Tire Loaders	300	600	419.4	15.5	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.6	1.8	2.0	0.0	7.62
Dsl – Rubber Tire Loaders	600	750	692.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.0	0.0	0.82
Dsl – Rubber Tire Loaders	750	1000	866.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Rubber Tire Loaders	1000	1200	1082	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Rubber Tire Loaders	1200	2000	1867	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Rubber Tire Loaders	2000	3000	2243	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Tractors/Loaders/Backhoes	25	40	32.49	0.0	0.0	0.0	0.0	6.8	13.2	0.0	0.0	0.1	2.7	18.3	1.0	1.73
Dsl – Tractors/Loaders/Backhoes	40	50	46.23	0.0	0.0	0.0	0.0	3.6	108.4	0.2	0.1	1.7	10.8	0.0	12.6	7.03
Dsl – Tractors/Loaders/Backhoes	50	75	62.46	30.7	0.0	0.0	0.0	67.5	228.9	0.9	4.7	3.4	37.1	550.8	79.5	49.99
Dsl – Tractors/Loaders/Backhoes	75	100	87.17	30.7	0.0	0.0	0.0	238.7	0.0	1.1	0.0	1.7	31.1	149.1	139.5	70.74
Dsl – Tractors/Loaders/Backhoes	100	175	120.7	0.0	0.0	0.0	0.0	158.8	0.0	0.0	0.0	0.0	0.2	9.2	156.6	0.41
Dsl – Tractors/Loaders/Backhoes	175	300	200	3.9	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	7.2	0.0	0.00
Dsl – Crawler Tractor/Dozers	25	40	25.75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Crawler Tractor/Dozers	40	50	42.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Crawler Tractor/Dozers	50	75	57.98	19.1	0.0	13.5	0.0	0.0	7.0	0.3	1.1	2.6	10.9	4.0	9.4	9.46
Dsl – Crawler Tractor/Dozers	75	100	87.86	19.1	0.0	13.5	0.0	0.0	8.6	0.5	1.2	1.2	8.0	0.0	11.9	5.82
Dsl – Crawler Tractor/Dozers	100	175	136.1	45.2	75.5	114.1	0.0	0.0	11.6	0.7	3.4	2.7	12.3	185.8	30.7	15.90
Dsl – Crawler Tractor/Dozers	175	300	235.5	12.5	0.0	0.0	105.9	308.1	2.6	0.5	1.2	1.3	6.3	4.0	1.7	9.19
Dsl – Crawler Tractor/Dozers	300	600	425.3	7.0	75.5	0.0	0.0	308.1	0.5	0.3	0.7	1.7	2.4	0.0	0.0	6.03
Dsl – Crawler Tractor/Dozers	600	750	707	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.61
Dsl – Crawler Tractor/Dozers	750	1000	923	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Crawler Tractor/Dozers	1000	1200	1065	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00
Dsl – Crawler Tractor/Dozers	1200	2000	1473	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00

Key:
1 – Heavy Highway
2 – Utility
3 – Residential
4 – City/County Roads 5 – Commercial Construction
6 – Landscaping
7 – Brick and Stone
8 – Concrete
9 – Manufacturing
10 – Agricultural
11 – Municipal/County Equipment
12 – TxDOT
13 – Other

Table 5-10. AACOG Allocation Surrogates by County and DCE Subsector

Sector	Atascosa	Bandera	Bexar	Comal	Frio	Gillespie	Guadalupe	Karnes	Kendall	Kerr	Medina	Wilson	Total
Heavy Highway	0.015	0.003	0.743	0.023	0.026	0.009	0.088	0.002	0.004	0.070	0.006	0.011	1.000
Utility	0.021	0.011	0.762	0.047	0.009	0.011	0.051	0.008	0.015	0.023	0.022	0.019	1.000
Municipal	0.021	0.011	0.762	0.047	0.009	0.011	0.051	0.008	0.015	0.023	0.022	0.019	1.000
Commercial	0.010	0.007	0.747	0.089	0.003	0.015	0.050	0.002	0.019	0.038	0.012	0.010	1.000
Residential	0.004	0.000	0.700	0.148	0.000	0.000	0.104	0.000	0.038	0.000	0.003	0.002	1.000
City/County Roads	0.021	0.011	0.762	0.047	0.009	0.011	0.051	0.008	0.015	0.023	0.022	0.019	1.000
TxDOT	0.021	0.011	0.762	0.047	0.009	0.011	0.051	0.008	0.015	0.023	0.022	0.019	1.000
Landscaping	0.002	0.002	0.892	0.025	0.000	0.008	0.028	0.002	0.014	0.020	0.004	0.002	1.000
Brick and Stone	0.058	0.000	0.738	0.058	0.000	0.000	0.000	0.000	0.058	0.086	0.000	0.000	1.000
Trenches	0.010	0.007	0.747	0.089	0.003	0.015	0.050	0.002	0.019	0.038	0.012	0.010	1.000
Concrete	0.005	0.031	0.711	0.061	0.031	0.005	0.092	0.005	0.010	0.031	0.010	0.010	1.000
Manufacturing	0.003	0.001	0.718	0.069	0.001	0.010	0.139	0.004	0.019	0.018	0.011	0.006	1.000
Other	0.010	0.007	0.747	0.089	0.003	0.015	0.050	0.002	0.019	0.038	0.012	0.010	1.000
Agriculture	0.049	0.049	0.340	0.062	0.072	0.049	0.049	0.049	0.088	0.049	0.144	0.000	1.000

Table 5-11. AACOG Landfill Survey Findings

Equip Type	County	No. of Units	Wtd HP	Hours per Year	Wtd Hr/Yr
Roller	Bexar	2	220	3650	3544
Roller	Bexar	2	500	3495	
Scraper	Bexar	2	250	2765	2347
Scraper	Bexar	2	555	2100	
Excavators	Bexar	1	225	2088	2088
Motor Grader	Bexar	1	165	1044	1178
Motor Grader	Bexar	1	250	1252	
Rubber Tire Loaders	Bexar	1	125	1721	1755
Rubber Tire Loaders	Bexar	1	210	1774	
Cr Tractor-Dozer	Bexar	1	80	2347	3780
Cr Tractor-Dozer	Bexar	1	165	4172	
Cr Tractor-Dozer	Bexar	2	250	3495	
Cr Tractor-Dozer	Bexar	1	305	4172	
Roller	Comal	2	345	3268	3268
Scraper	Comal	1	341	2100	2100
Motor Grader	Comal	1	222	939	939
Rubber Tire Loaders	Comal	1	166	1435	1435
Cr Tractor-Dozer	Comal	1	123	3260	3321
Cr Tractor-Dozer	Comal	1	261	3349	
Roller	Gillespie	1	130	1513	1513
Scraper	Gillespie	1	187	887	887
Rubber Tire Loaders	Gillespie	1	205	522	522
Cr Tractor-Dozer	Gillespie	1	250	1774	1774
Roller	Guadalupe	2	345	3268	3268
Scraper	Guadalupe	1	341	2100	2100
Motor Grader	Guadalupe	1	222	939	939
Rubber Tire Loaders	Guadalupe	1	166	1435	1435
Cr Tractor-Dozer	Guadalupe	1	123	3260	3321
Cr Tractor-Dozer	Guadalupe	1	261	3349	
Roller	Kerr	1	500	3807	3807
Scraper	Kerr	1	250	1982	1982
Motor Grader	Kerr	1	250	522	522
Rubber Tire Loaders	Kerr	1	125	1721	1721
Cr Tractor-Dozer	Kerr	1	250	3807	3807

Table 5-12. AACOG Mining and Quarry Survey Findings

Equip Type	County	No. of Units	Wtd HP	Hours per Year	Wtd Hrs/Yr
Scrapers	Atascosa	1.1	482	2099	2099
Excavators	Atascosa	0.5	500	1092	7206
Excavators	Atascosa	2.0	1200	7300	
Graders	Atascosa	3.2	279	4347	4347
Off-highway Trucks	Atascosa	2.0	164	1641	3564
Off-highway Trucks	Atascosa	1.0	210	1641	
Off-highway Trucks	Atascosa	3.6	364	1930	
Off-highway Trucks	Atascosa	10.0	1050	3713	
Loaders	Atascosa	0.5	160	3130	1376
Loaders	Atascosa	1.7	395	1665	
Rubber Tire Loaders	Atascosa	2.0	808	730	730
Backhoes	Atascosa	1.1	80	1172	1172
Crawler Tractor/Dozers	Atascosa	1.5	282	6106	6477
Crawler Tractor/Dozers	Atascosa	5.0	490	6536	
Scrapers	Bexar	8.1	426	2687	2687
Excavators	Bexar	16.8	500	1092	1092
Graders	Bexar	7.1	200	1143	1143
Off-highway Trucks	Bexar	56.8	411	2334	2334
Rubber Tire Loaders	Bexar	0.5	160	3130	2043
Rubber Tire Loaders	Bexar	3.0	225	761	
Rubber Tire Loaders	Bexar	80.9	403	2049	
Backhoes	Bexar	50.1	80	1168	1168
Crawler Tractor/Dozers	Bexar	17.8	250	1583	1583
Scrapers	Comal	2.4	400	2208	2208
Excavators	Comal	13.7	500	1092	1092
Graders	Comal	4.6	200	1135	1135
Off-highway Trucks	Comal	48.4	411	2113	2113
Rubber Tire Loaders	Comal	49.0	396	1598	1598
Backhoes	Comal	33.0	80	1168	1168
Crawler Tractor/Dozers	Comal	13.6	250	1440	1440
Excavators	Gillespie	1.0	500	1092	1092
Off-highway Trucks	Gillespie	4.0	430	1525	1525
Rubber Tire Loaders	Gillespie	4.0	430	850	850
Backhoes	Gillespie	6.0	80	1226	1226
Crawler Tractor/Dozers	Gillespie	1.0	250	899	899
Scrapers	Medina	0.4	400	2208	2208
Excavators	Medina	2.3	500	1092	1092
Graders	Medina	0.6	200	1135	1135
Off-highway Trucks	Medina	7.7	411	2138	2138
Rubber Tire Loaders	Medina	8.2	395	1665	1665
Backhoes	Medina	4.5	80	1172	1172
Crawler Tractor/Dozers	Medina	2.2	250	1467	1467

In this case the update is made for the 2008 calendar year, Atascosa County (FIPS = 13), rollers (SCC 2270002003), mining/quarry subsector (DCE subsector ID = 23), and for the 25 to 50 hp bin (min hp = 25). Similar scripts were executed for all counties, SCCs, hp bins, DCE subsectors, and years of interest.

Activity estimates within the TexN database are not specific to a given county. However, activity can be varied at the county level through specifying updated values for a given scenario, using the TexN GUI. The GUI was used to generate the county-specific activity scenarios for the AACOG region, as discussed below.

Emissions and equipment populations were calculated before and after performing the TexN updates for the AACOG area. Results are presented below in Table 5-13 for the 12 county AACOG region for a 2008 ozone season day. Only those SCCs affected by the update are included.

As seen in the table above, the adjustments to the default emissions and equipment population estimates are relatively minor, with about a 10 percent overall reduction in equipment population, but a much smaller net change in emissions (e.g., ~2 percent for NOx), likely due to the increase in equipment sizes at quarries.

Table 5-13. 12 County AACOG 2008 Ozone Season Day Emissions Before and After Update

Base Case DCE							
Equipment Type	**VOC**	**PM10**	**PM2.5**	**CO**	**NOx**	**SO2**	**Equipment Population**
Crawler Tractor/Dozers	0.21	0.18	0.18	1.12	2.34	0.07	2475.40
Excavators	0.13	0.12	0.12	0.68	1.60	0.05	1529.64
Graders	0.04	0.03	0.03	0.16	0.38	0.01	1057.73
Off-highway Trucks	0.07	0.07	0.07	0.44	1.13	0.04	164.32
Pavers	0.01	0.01	0.01	0.06	0.12	0.00	1010.02
Paving Equipment	0.01	0.00	0.00	0.03	0.05	0.00	78.41
Rollers	0.04	0.04	0.04	0.23	0.41	0.01	1689.55
Rubber Tire Loaders	0.13	0.12	0.12	0.63	1.45	0.06	667.19
Scrapers	0.01	0.01	0.01	0.06	0.13	0.00	54.28
Surfacing Equipment	0.03	0.03	0.03	0.21	0.37	0.01	175.95
Tractors/Loaders/Backhoes	0.15	0.10	0.10	0.67	0.54	0.02	2437.04
Total	**0.83**	**0.72**	**0.70**	**4.30**	**8.53**	**0.27**	**11339.52**
Updated DCE							
Equipment Type	**VOC**	**PM10**	**PM2.5**	**CO**	**NOx**	**SO2**	**Equipment Population**
Crawler Tractor/Dozers	0.16	0.14	0.14	0.85	1.72	0.05	1842.67
Excavators	0.09	0.08	0.08	0.51	1.09	0.04	1019.33
Graders	0.06	0.05	0.05	0.24	0.52	0.02	1014.61
Off-highway Trucks	0.08	0.09	0.09	0.56	1.33	0.05	161.35
Pavers	0.02	0.02	0.02	0.11	0.21	0.01	769.81
Paving Equipment	0.02	0.02	0.02	0.10	0.17	0.00	227.36
Rollers	0.04	0.04	0.03	0.21	0.34	0.01	1793.27
Rubber Tire Loaders	0.12	0.13	0.12	0.75	1.64	0.06	708.65
Scrapers	0.01	0.01	0.01	0.09	0.19	0.01	59.79
Surfacing Equipment	0.03	0.02	0.02	0.17	0.29	0.01	143.85
Tractors/Loaders/Backhoes	0.22	0.16	0.15	1.04	0.83	0.02	2669.19
	0.85	**0.76**	**0.73**	**4.63**	**8.33**	**0.28**	**10409.9**
Delta (Updated – Base)							
Equipment Type	**VOC**	**PM10**	**PM2.5**	**CO**	**NOx**	**SO2**	**Equipment Population**
Crawler Tractor/Dozers	-0.05	-0.04	-0.04	-0.27	-0.62	-0.02	-632.73
Excavators	-0.04	-0.04	-0.04	-0.17	-0.51	-0.01	-510.31
Graders	0.02	0.02	0.02	0.08	0.14	0.01	-43.12
Off-highway Trucks	0.01	0.02	0.02	0.12	0.2	0.01	-2.97
Pavers	0.01	0.01	0.01	0.05	0.09	0.01	-240.21
Paving Equipment	0.01	0.02	0.02	0.07	0.12	0	148.95
Rollers	0	0	-0.01	-0.02	-0.07	0	103.72
Rubber Tire Loaders	-0.01	0.01	0	0.12	0.19	0	41.46
Scrapers	0	0	0	0.03	0.06	0.01	5.51
Surfacing Equipment	0	-0.01	-0.01	-0.04	-0.08	0	-32.1
Tractors/Loaders/Backhoes	0.07	0.06	0.05	0.37	0.29	0	232.15
Total	**0.02**	**0.04**	**0.03**	**0.33**	**-0.2**	**0.01**	**-929.64**

6.0 Emissions Inventory Development and Results

The results from the Phase I DCE operator survey and the Phase II data updates were utilized to estimate emissions estimates for selected target years as described below.

6.1 TexN Updates

ERG updated the most recent version of the TexN model, including the NONROAD2008 core model update, to include the following information from the DCE surveys and other data updates, as available:

- County level equipment population and average hp, by hp bin (> 25), back-cast and forecast for all years (1970 – 2050);
- Average hrs/yr.

Details regarding these updates are also provided in an addendum to the TexN User's Guide.

Table 6-1 details the prior and updated equipment population levels for each targeted DCE category, by DCE subsector. As seen in the table, RTFs and trenchers experienced a sizeable increase in their population estimates, while DCE within the special trades contractor and scrap/recycling subsectors decreased for the most part. Scrapers and surfacing equipment, previously assumed to be present within the special trades subsector, were not found during the survey effort and were set to zero population. On the other hand, a very small number of off-highway trucks were found during the survey of scrap/recycling facilities, where none were assumed before. Mining and quarry equipment were not included in the previous version of TexN, and are therefore not shown on the table. DCE categories that were not updated are labeled "N/A".

Table 6-2 provides the prior and updated equipment activity estimates by DCE subsector and equipment type.[44] Although not shown on the table, crawler dozer activity within the utility subsector was also updated from the previous value of 364 hours/year to 98 hours per year, based on survey results.

[44] Activity values are provided for statewide averages. Activity value updates specific to AACOG counties are provided in Section 5.

Table 6-1. Statewide Equipment Population Comparisons – Previous vs. Updated TexN Data (2007)

Equipment Type / Sector	Previous	Updated
Rollers – Special Trades	129	64
Scrapers – Special Trades	167	0
Surfacing Equipment – Special Trades	240	0
Trenchers	10,495	15,015
Excavators – Scrap/Recycling	439	363
Excavators – Special Trades	869	611
Graders – Special Trades	338	1,726
Off-highway Trucks – Scrap/Recycling	0	20
Rough Terrain Forklifts	7,288	16,677
Rubber Tire Loaders – Scrap/Recycling	401	207
Rubber Tire Loaders – Special Trades	1,045	351
Tractors/Loaders/Backhoes – Scrap/Recycling	1,274	6
Tractors/Loaders/Backhoes – Special Trades	6,199	4,959
Crawler Tractor/Dozers – Scrap/Recycling	84	17
Crawler Tractor/Dozers – Special Trades	907	252

Table 6-2. Activity Comparisons – Previous vs. Updated TexN Data (Hrs/Yr)

Equipment Type / Sector	Previous	Updated
Rollers – Special Trades	1,000	1,131
Scrapers – Special Trades	1,000	0
Surfacing Equipment – Special Trades	167	0
Trenchers	240	914
Excavators – Scrap/Recycling	2,000	1,586
Excavators – Special Trades	1,478	631
Graders – Special Trades	1,000	829
Off-highway Trucks – Scrap/Recycling	0	687
Rough Terrain Forklifts	1,250	875
Rubber Tire Loaders – Scrap/Recycling	1,811	1,291
Rubber Tire Loaders – Special Trades	1,199	1,898
Tractors/Loaders/Backhoes – Scrap/Recycling	1,135	50
Tractors/Loaders/Backhoes – Special Trades	1,500	582
Crawler Tractor/Dozers – Scrap/Recycling	936	2,500
Crawler Tractor/Dozers – Special Trades	1,175	733

6.2 Emissions Estimation

Once the TexN data tables were updated for each DCE subsector and targeted equipment type, the model was then run for the following region/episode year combinations, for both annual and ozone season day time periods, as specified by the TCEQ Project Representative.

Table 6-3. Region/Episode Year TexN Modeling Scenarios

Year	Beaumont/Port Arthur (BPA)	Houston-Galveston-Brazoria (HGB)	Dallas-Fort Worth (DFW)	AACOG
2000	X	X		X
2002	X	X	X	X
2005	X	X		X
2006	X	X		X
2007			X	
2008	X	X		X
2009	X	X	X	X
2010	X	X		X
2011	X	X		X
2012	X	X		X
2014	X	X		X
2017	X	X		X
2018	X	X		X
2020	X	X		X
2021	X	X		X

Statewide runs were also performed for all 254 counties for the 2008 episode year, for both ozone season day and annual time periods, for all SCCs.

The updated non-road emissions output by the TexN model for the different non-attainment regions are presented in Tables 6-4 through 6-7 below. Table 6-8 summarizes the statewide emission estimates for 2008. Note that these estimates assume the use of TxLED in all designated counties for all scenarios from 2006 onward. In addition, these estimates include all equipment categories, fuel types, and DCE less than 25 hp as well, for completeness.[45]

Corresponding TexN Scenario files and NIF3.0 files have been provided to the TCEQ in electronic format.

[45] Equipment profiles for engines < 25 hp are based on NONROAD2005 defaults.

Table 6-4. Non-road Emission Estimates, Beaumont-Port Arthur Region[46]

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2000	4.82	8.52	61.97	0.85	0.82	1.14	1.56
2002	4.62	7.47	57.17	0.74	0.72	1.08	1.08
2005	4.01	6.29	49.20	0.69	0.66	1.13	0.18
2006	3.79	5.76	47.75	0.67	0.65	1.15	0.17
2008	3.42	5.18	42.94	0.57	0.55	0.14	0.19
2009	3.18	4.89	40.54	0.56	0.54	0.14	0.20
2010	3.02	4.63	39.07	0.54	0.52	0.01	0.22
2011	2.88	4.31	37.71	0.52	0.50	0.01	0.23
2012	2.67	4.01	36.34	0.50	0.48	0.01	0.25
2014	2.35	3.44	34.38	0.44	0.42	0.01	0.29
2017	2.09	2.77	33.51	0.36	0.34	0.01	0.34
2018	2.05	2.59	33.56	0.33	0.32	0.01	0.36
2020	1.99	2.25	33.92	0.28	0.27	0.01	0.38
2021	1.98	2.12	34.21	0.26	0.25	0.01	0.39
Annual - Tons per Year							
2000	1,439	2,338	17,752	220	212	183	304
2002	1,382	2,093	16,597	193	186	174	217
2005	1,219	1,828	14,669	179	172	185	64
2006	1,155	1,676	14,256	175	168	188	67
2008	1,039	1,527	12,863	157	151	38	79
2009	973	1,434	12,212	154	148	39	86
2010	933	1,358	11,786	149	143	2	94
2011	888	1,266	11,385	144	138	2	102
2012	827	1,177	10,980	137	132	2	110
2014	733	1,010	10,415	121	116	2	128
2017	657	816	10,173	99	95	3	155
2018	643	761	10,197	92	88	3	163
2020	628	664	10,321	79	75	3	178
2021	626	629	10,414	74	71	3	182

[46] Includes Hardin, Jefferson, and Orange Counties

Table 6-5. Non-road Emission Estimates, Dallas-Fort Worth Region[47]

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2002	73.86	100.71	928.21	8.62	8.30	9.77	11.17
2007	58.41	79.42	768.25	7.26	6.97	1.57	2.76
2009	53.94	72.46	688.89	6.99	6.71	1.54	3.28
Annual - Tons per Year							
2002	22,551	29,175	272,486	2,363	2,272	1,716	2,354
2007	17,882	23,639	229,528	2,071	1,988	430	1,127
2009	16,245	21,681	206,790	1,996	1,915	434	1,392

[47] Includes the 9-county non-attainment area, including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties

Table 6-6. Non-road Emission Estimates, Houston-Galveston-Brazoria Region[48]

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2000	68.71	89.60	787.37	8.12	7.83	11.22	7.62
2002	66.51	84.40	750.47	7.19	6.93	10.81	5.68
2005	59.51	77.25	683.22	6.90	6.64	11.62	2.14
2006	57.06	71.94	667.70	6.78	6.52	11.89	2.32
2008	52.74	65.34	608.89	5.70	5.48	1.46	2.89
2009	49.05	61.73	577.14	5.65	5.43	1.50	3.21
2010	46.46	58.74	558.76	5.47	5.25	0.11	3.54
2011	44.34	54.87	542.35	5.30	5.08	0.11	3.89
2012	40.89	50.99	525.16	5.03	4.83	0.12	4.27
2014	35.19	42.79	500.05	4.44	4.25	0.12	5.14
2017	30.06	33.15	480.62	3.64	3.48	0.12	6.39
2018	28.95	30.53	477.31	3.37	3.22	0.12	6.76
2020	27.48	26.24	479.59	2.90	2.76	0.12	7.49
2021	27.07	24.65	482.63	2.73	2.59	0.12	7.84
Annual - Tons per Year							
2000	26,034	28,753	271,804	2,449	2,355	1,897	2,591
2002	25,220	27,149	259,405	2,179	2,092	1,829	1,927
2005	22,929	24,677	236,966	2,083	1,999	1,991	814
2006	22,022	22,987	231,587	2,041	1,958	2,035	919
2008	20,265	20,960	211,601	1,831	1,762	445	1,200
2009	19,082	19,905	201,946	1,820	1,744	460	1,355
2010	18,161	19,004	195,869	1,759	1,685	35	1,515
2011	17,226	17,806	190,326	1,704	1,631	36	1,684
2012	15,954	16,602	184,586	1,620	1,550	36	1,866
2014	13,817	14,046	176,398	1,430	1,367	37	2,271
2017	11,724	11,009	170,373	1,175	1,120	38	2,864
2018	11,245	10,182	169,490	1,090	1,038	38	3,049
2020	10,595	8,822	170,407	943	895	38	3,410
2021	10,405	8,316	171,470	889	842	39	3,586

[48] Includes Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties

Table 6-7. Non-road Emission Estimates, AACOG Region

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2000	29.71	57.56	357.63	4.59	4.43	5.29	18.80
2002	30.08	49.16	322.23	4.23	4.07	5.36	12.56
2005	29.74	36.31	262.12	4.01	3.85	5.77	1.01
2006	29.33	32.79	254.90	3.94	3.78	5.87	0.69
2008	28.53	29.95	229.74	3.41	3.27	0.81	0.69
2009	26.79	28.03	218.88	3.35	3.21	0.86	0.71
2010	25.45	26.61	210.34	3.20	3.06	0.05	0.73
2011	24.79	25.02	208.96	3.08	2.96	0.05	0.79
2012	23.60	23.33	203.92	2.90	2.77	0.05	0.84
2014	21.09	19.84	196.78	2.49	2.38	0.05	0.95
2017	17.98	15.24	193.09	1.90	1.81	0.05	1.11
2018	17.14	14.02	193.21	1.72	1.64	0.05	1.16
2020	16.05	12.03	194.85	1.44	1.37	0.05	1.25
2021	15.74	11.29	196.21	1.34	1.27	0.05	1.28
Annual - Tons per Year							
2000	8,896	14,112	96,039	1,159	1,117	868	3,443
2002	9,312	12,734	90,252	1,087	1,045	882	2,353
2005	9,335	10,214	77,900	1,038	996	958	318
2006	9,216	9,265	76,081	1,020	978	976	280
2008	8,995	8,471	69,595	926	887	221	301
2009	8,439	8,001	66,838	913	875	228	315
2010	8,169	7,641	65,334	880	842	14	330
2011	7,855	7,152	63,977	844	808	14	353
2012	7,468	6,672	62,492	794	759	14	379
2014	6,699	5,676	60,422	684	653	14	432
2017	5,724	4,374	59,397	525	500	14	514
2018	5,463	4,033	59,466	477	453	14	540
2020	5,121	3,478	60,019	401	380	14	586
2021	5,026	3,273	60,455	375	355	14	600

Table 6-8. Non-road Emission Estimates, Statewide Totals, 2008

Year	VOC	NOx	CO	PM_{10}	$PM_{2.5}$	SO_2	Ammonia
Ozone Season Day - Tons per Day							
2008	343	449	3,129	46.2	44.5	9.1	21.6
Annual - Tons per Year							
2008	115,223	158,521	985,638	14,931	14,360	3,475	6,512

From the above tables it is clear that although equipment populations are expected to increase continually over time, VOC, NOx, CO, and PM emissions begin declining approximately after the 2005 calendar year due to the introduction of Tier 3 and later engines.

6.3 Selected Comparisons

Sensitivity analyses were also performed for selected counties for 2005 ozone season day conditions to illustrate the impact of the individual Phase I DCE subsector updates. The impacts of the RTF and trencher updates in Harris County are presented in Table 6-9. In this case RTF estimates decreased relative to the prior inputs (indicated by the negative sign), while trencher emission estimates increased substantially.

Table 6-9. RTF and Trencher Update Impacts, Harris County OSD 2005 (TPD)

Equipment Type	VOC	PM_{10}	$PM_{2.5}$	CO	NOx	Ammonia	SO_2
RTFs	-0.009	-0.012	-0.012	-0.068	-0.247	-0.0001	-0.009
Trenchers	0.269	0.243	0.236	1.522	2.308	0.0006	0.056

Table 6-10 presents the impact of the utility subsector update in Harris County, due entirely to the reduction in crawler dozer hours of operation.

Table 6-10. Utility Subsector Update Impacts, Harris County OSD 2005 (TPD)

VOC	PM_{10}	$PM_{2.5}$	CO	NOx	Ammonia	SO_2
-0.047	-0.042	-0.041	-0.255	-0.508	-0.00013	-0.009

Mining and quarry operations are minimal in Harris County, so the impacts for this subsector were evaluated for Panola and Williamson Counties (each having significant mining and quarry activity levels). Table 6-11 presents the 2005 OSD emission estimate increases for the mining and quarry subsector updates.

Table 6-11. Mining and Quarry Subsector Update Impacts, Panola and Williamson County, OSD 2005 (TPD)

County	VOC	PM_{10}	$PM_{2.5}$	CO	NOx	Ammonia	SO_2
Panola	0.045	0.035	0.034	0.267	0.696	0.0002	0.017
Williamson	0.150	0.111	0.108	0.635	2.058	0.0007	0.054

Table 6-12 provides the emission impacts for the scrap/recycling subsector update for Harris County, indicating a decrease in population and activity values.

Table 6-12. Scrap/Recycling Subsector Update Impacts, Harris County OSD 2005 (TPD)

VOC	PM_{10}	$PM_{2.5}$	CO	NOx	Ammonia	SO_2
-0.033	-0.027	-0.026	-0.177	-0.433	-0.00015	-0.013

Table 6-13 summarizes the emission impacts for the special trades contractor subsector update for Harris County, again illustrating substantially decreased equipment population and activity level estimates.

Table 6-13. Special Trades Contractor Subsector Update Impacts, Harris County OSD 2005 (TPD)

VOC	PM_{10}	$PM_{2.5}$	CO	NOx	Ammonia	SO_2
-0.349	-0.276	-0.268	-1.767	-2.758	-0.0009	-0.069

6.4 NIF File Development

Once the emissions were calculated for each designated modeling scenario, NIF3.0 files were exported from TexN. TexN produces a separate text file for each NIF record (transmittal (TR), emissions (EM, emissions period (PE), emissions process (EP), and control efficiency (CE)). These records were then concatenated into a single file to accommodate loading of the new emissions data into TexAER. Associated scenario file exports from TexN were also provided to the TCEQ in electronic format.

NIF files were provided for both ozone season day and annual time periods, for all NONROAD SCCs, for each geographic area and year indicated in Table 6-3.

7.0 Conclusion

A previous study had been conducted for the TCEQ which extrapolated available DCE data to create a statewide diesel construction emissions inventory.[49] The equipment population and use profiles developed for certain DCE categories in that study were based on data specific to the nine-county DFW ozone nonattainment region, or were based on input from a single industry expert and had not been validated independently. The current study was conducted to refine the previous emissions inventory for DCE using surveys and other available data sources to collect data on equipment activity and use across the state. This project was conducted in two Phases. The first Phase began by identifying those elements of the previous inventory with the highest levels of uncertainty and the greatest impacts on emission estimates, and then developed strategies for improving upon these elements, collecting the necessary data to modify them to produce more accurate emissions estimates. Revised DCE population and activity estimates were then developed for specific equipment categories including RTFs and trenchers, as well as certain activity subsectors, including mines and quarries, special trades contractors, scrap/recycling facilities, and utility contractors. Phase II of the study involved utilizing existing information to refine the non-road equipment inventory and use profiles, as well as the core emissions model within the TexN model.

Phase I of this study collected detailed survey data on selected DCE operations across the state in order to develop updated emissions estimates for these sources. Data was collected primarily through extensive phone surveys for equipment operations during the 2007 base year. The data collected included equipment-specific estimates for hours per year of operation, horsepower, and location. Operator data was also collected including industry classification, allowing ERG to develop industry-specific equipment population growth and geographic allocation surrogates. Data collection focused on equipment greater than or equal to 25 horsepower.[50] Appropriate surrogates were identified to forecast and back-cast equipment populations for the period between 1970 and 2050 (the range of analysis years in the TexN model). These data were used to update the data in the TexN model.

Based on the survey findings, key updates were performed for equipment population, county allocation, growth, activity, and hp distributions. As discussed in Section 3.5, the number

[49] Eastern Research Group, Statewide Diesel Construction Equipment Inventory – Final Report, prepared for the Texas Commission on Environmental Quality, August 31, 2005.

[50] Non-road diesel equipment less than 25 hp, while numerous, contribute very little to overall criteria pollutant emissions from these sources (e.g., < 1% of NOx emissions, according the EPA's NONROAD2005 model). As such, studies for the TCEQ involving diesel engines have excluded these small engines from data collection efforts, relying on default equipment population and activity assumptions in the NONROAD model to estimate their emissions.

of completed surveys directly impacts estimated errors for the average activity and hp estimates, as do the inherent variability of the parameter of interest. The 95% confidence interval for equipment activity typically fell between ~10% and 25% of the mean hour per year value for all equipment types and subsectors. HP estimates frequently had tighter confidence intervals, sometimes well below 10% of the mean value. The tighter confidence intervals for the hp estimates were often a simple reflection of the uniformity of certain equipment categories such as graders and backhoes. In general, equipment/subsector categories with the tightest confidence intervals included RTFs and special trades contractor backhoes, resulting from the large survey sample, as well as crawler dozers and off-highway trucks in the mining, most likely due to the uniformity of their usage patterns within this subsector. Overall, the highest variability appeared in quarries, due to relatively low survey response rates as well as great variability in use patterns across the subsector. Regardless, the resulting emissions estimates are expected to have substantially less uncertainty than previous estimates, for which uncertainty could not even be quantified.

The impacts of the major updates conducted under Phases I and II of this study are summarized below.

- Depending upon the region of the state, the new mining and quarry emission estimates can increase NOx (and to a lesser extent other pollutants) by sizable amounts (e.g., by greater than 2 tons per day of NOx in areas with substantial mining/quarry activity);

- Equipment counts and associated emissions fell broadly for the Special Trades sector compared to previous data. General reductions were also found for the Scrap/Recycling sector, although impacts varied by specific region;

- Trencher emissions increased across the state, due to increased population and activity estimates. RTF emissions were not impacted to the same degree, with increased population counts being countered by reduced per unit activity estimates;

- Future highway sector activity projections were reduced by a sizeable amount for most areas of the state in the near to medium term;

- Agricultural equipment emissions increased notably due to higher population as well as activity estimates;

- While moderate changes in equipment counts were provided for the AACOG region, emissions impacts were not substantial, due to mitigating trends in engine hp and activity estimates.

Further improvements could be made to these estimates if detailed in-use engine operation data were available for a statistically representative sample of DCE. Specifically, if load factor could be determined from portable activity monitoring system (PAMS) data for a sufficiently large number of units, the load factor estimates utilized within TexN could be updated.[51] Engine load factors have a disproportionate impact on emissions, particularly NOx, with emission rates increasing non-linearly with increasing engine load. Engine load factors also influence scrap rates and model year distributions within the NONROAD model. Accordingly such data could provide further improvements to the emission inventory results. An alternative data collection option could utilize second-by-second data streams (similar to on-board diagnostic data in on-road vehicles). Certain late-model equipment categories may record data sufficient to infer engine load from various parameters.

In addition, to the extent that load factor and other PAMS data can be associated with different operator types (e.g., agricultural applications), the data collected under this study can be used to further refine emissions estimates, as well as to refine control effectiveness assessments.[52]

[51] DCE load factors are currently set to the default NONROAD2005 model.
[52] Many diesel retrofit options have control efficiencies that are dependent on exhaust gas temperature profiles, such as diesel oxidation catalysts.

APPENDIX A

DATA COLLECTION PLAN

MEMORANDUM

TO: Anusuya Iyer (TCEQ)

FROM: Rick Baker, Diane Preusse (ERG)

DATE: May 27, 2008

SUBJECT: Work Order # 582-7-84003-FY08-11, Deliverable 2- Data Collection Plan – Revision 1

This memo provides revised documentation for the Data Collection Plan for the work order "Quality Assurance and/or Modification of Methodology for Extrapolating the Dallas-Fort Worth Diesel Construction Data to Other Areas of the State". The revision incorporates data collection strategies for the Tyler/Longview area, as per the requirements of the amended Work Plan, dated May 14, 2008.

The plan identifies target stratifications based on available data, including a prioritization of which DCE and subsectors this project will focus on. Subsectors are prioritized considering their estimated impact on the diesel construction equipment (DCE) inventory, the availability and reliability of appropriate data sources, the anticipated improvement in the resulting inventory, and the required level of effort considering resource constraints. Field data collection efforts include those that can be performed in the Austin/San Antonio and Tyler/Longview areas. Special consideration is given to those subsector estimates deemed to have the greatest uncertainty in the DFW analysis. Quality assurance and control measures are specified as appropriate for different data collection modes. Details of the draft Data Collection Plan have been subjected to external peer review.

Overview

The DCE inventory developed by the state consists of 24 different sectors, characterizing different types of end-users and/or unique construction activities. Examples include Residential, Commercial, and Utility construction. These sectors utilize one or more pieces of DCE with distinct operation profiles, and are developed from different data sources.

ERG performed a detailed review of the following parameters for each sector, in order to identify potentially significant sources of uncertainty in the DCE emission inventory calculations:

- Equipment population and horsepower distribution;
- Annual activity;
- Geographic allocation; and,
- Load factors.

The following provides a summary of each potential area of improvement identified in the current DCE profile included in the TexN model. The concluding section summarizes the anticipated level of effort for each option, and provides recommendations for implementing the Data Collection task under this work order. Current NOx emission estimates are provided in Figure A-1 at the state level for reference.

Validation/Refinement Options

1. Heavy-Highway Sector

As noted in the Statewide Diesel Construction Inventory report (TCEQ, August 31, 2005), equipment profiles for heavy-highway construction activities were extrapolated to the rest of the state from 1999 survey results for the H-GAC area.[53] However, highway contractors have consistently noted that equipment use profiles vary dramatically from contract to contract, and by area of the state, depending upon work requirements and constraints. As such, the resulting equipment profiles for this sector are highly uncertain for areas outside of Houston. Since heavy-highway construction was estimated to be the single largest source of emissions at the state level, refining this profile could provide substantial improvements to the DCE inventory as a whole, if a reasonable means of obtaining the necessary data can be identified.

ERG contacted Mr. Bob Lanham of Williams Brothers Construction, former President of the Texas AGC and estimator for large TxDOT highway construction projects to obtain his input. Mr. Lanham indicated that very specific equipment use profiles could be developed for the broad range of TxDOT "bid codes", based on estimator inputs. (TxDOT bid codes correspond to unique activities/products involved in conducting highway contract work for the state. Examples include striping, grading, signal and signage installation, etc. Each contractor bidding on a job must provide line-item cost estimates for each bid code as part of TxDOT's contract letting process.)

Since the bid codes involved with any TxDOT project are available electronically, such profiles could be combined with the available bid code data to provide project-specific equipment activity profiles for use with the TexN model, for any county and scenario year of interest. As such, these profiles would provide a highly flexible and precise tool for development of highway sector emission estimates well into the future. To this end, Mr. Lanham has offered to organize meetings with highway contractor estimators at the AGC in Austin to develop the required profiles.

Emission Level/Impact:	Very high
Uncertainty:	Very high
Data Availability:	Medium (bid codes available electronically; profiles not currently available but can be developed under this work order)
Recommendation:	Include in options analysis

[53] Survey efforts for the 2005 HARC study of the DFW area did not generate sufficient response to be statistically meaningful.

2. Special Trades Sector

Construction activities in this sector correspond to work performed by special trades contractors (SIC 1700 series). These contractors provide foundation, masonry, plumbing, and a host of other specialty services in support of building construction projects. These contractors do not generally conduct earthwork activities and are not directly linkable to other physical quantities (e.g., number of square feet of commercial building space installed). Therefore equipment use profiles (hr/yr) for this sector were developed previously based on expert opinion. In addition, equipment population totals were based on sales totals for the DFW area, extrapolated using REMI economic indicator surrogates.

It is unknown to what the extent the distribution of special trades contractors is different in other areas of the state, or to what extent equipment use patterns in the DFW area are representative of other areas. The extrapolation of population totals using REMI data adds an additional source of uncertainty to emission estimates for this sector.

In order to refine the equipment population and activity profiles for this sector a phone survey of special trades contractors could be conducted for contractors across the state. The survey would utilize phone numbers obtained from USA Data for Texas companies reporting operations under the SIC 1700 series (excluding 1794 – Earthwork Operations, which are included elsewhere). Data collection would focus on quantifying equipment types, hp values, model years, annual activity, and areas of operation. We would target at least 200 completed surveys in order to obtain a confidence interval of less than 15% (+/- 7.5%). We anticipate the equipment ownership rates among these companies to be relatively low, so data capture efficiencies may be low as well, leading to relatively high costs for survey completion.

Emission Level/Impact:	High
Uncertainty:	High
Data Availability:	Medium/Low (Extensive phone surveys needed to obtain required data)
Recommendation:	Include in options analysis

3. Demolition Activity Profile

Demolition of structures and pavement require substantial hp-hrs of heavy equipment use. Pavement demolition can be a particularly large source of hp-hr requirements, and hence emissions. Lacking other reliable data, the Utility sector profile developed previously assumed that 100% of utility line projects involved demolition and removal of surface pavement, for the entire length of the line. Similarly, the Commercial sector profile assumed that, for projects involving demolition (estimated at 16% based on available permit data), pavement covered 100% of the lot, all of which required demolition and removal. Finally, both profiles assumed all pavement to be concrete rather than asphalt, requiring substantially higher hp-hrs for removal. Therefore several conservative assumptions were made regarding demolition requirements for these sectors, all of which potentially erred on over-estimating

hp-hrs and emissions. Under current assumptions pavement demolition is responsible for 28.5% of equipment hp-hrs within the Commercial sector profile, and over 50% of hp-hrs within the Utility sector profile.

ERG has identified two ways of refining the assumptions made regarding pavement demolition activities in these sectors. First, the fraction of asphalt versus concrete on local roadways can be identified using TxDOT reports (Lane Road Miles per County by Surface Type - http://www.county.org/resources/countydata/products/2004LaneMiles.txt). A cursory review of this report clearly indicates that asphalt road pavement is far more common than concrete outside of the Houston area. Since demolition of concrete is estimated to require 2/3 more hp-hrs per square foot than asphalt, we anticipate a sizeable reduction in hp-hrs and emissions for the Utility sector if this adjustment is performed. (No data source has been identified to provide comparable fractions of asphalt vs. concrete pavement for Commercial sector projects, however).

The Utility and Commercial profiles may also be revised to more accurately reflect the actual amount of pavement demolition required. ERG proposes to conduct phone surveys of Utility and Commercial sector contractors, identified through the non-highway branch of the Texas AGC, in order to quantify the following:

- The fraction of projects involving pavement removal;
- For Commercial projects requiring pavement removal, the typical fraction of lots impacted and the proportion of concrete vs. asphalt;
- For Utility projects requiring pavement removal, the typical fraction of linear feet involved, and the typical width of pavement removal (currently assumed to be 12 feet);
- The average depth of pavement removed;
- The equipment used for pavement removal;
- An estimate of pavement demolition and removal time per square foot, for both asphalt and concrete pavement.

The final two questions listed above will help validate and/or improve the current profile values obtained from CCMC estimating for the HARC DCE study. The total number of surveys completed will depend upon the number of Utility and Commercial Sector companies identified through the AGC (not yet obtained).

Emission Level/Impact:	Medium
Uncertainty:	High
Data Availability:	High/Medium (Asphalt/concrete fractions available by county for Utility profiles. Phone surveys needed to obtain required data on frequency of pavement removal and equipment requirements, but number of prime contractors expected to be relatively small.)
Recommendation:	Include in options analysis

4. Mining Sector

DCE use and emissions associated with mining activities was only quantified for the DFW area, and was based on a single survey profile. Therefore the uncertainty associated with the Dallas area estimate is high, while estimates for the rest of the state are absent entirely.

Data from the Mine Safety and Health Administration (MSHA) (http://www.msha.gov/drs/asp/extendedsearch/minesbystatecounty2.asp) indicate there are 691 active facilities in 149 counties across Texas. The vast majority of these facilities involve sand/gravel pits (276) or crushed/dimension stone quarries (313). 18 coal mines are also identified, primarily lignite. While construction sand and gravel pits are likely to have limited equipment activity, larger stone quarries and coal mines are likely to have very large DCE, including offroad trucks typically 400 hp or greater. These larger quarries and surface mines are therefore likely to be significant sources of NOx emissions. Quarries are particularly prevalent in the Central Texas area.

In order to develop mining and quarry equipment profiles for the state, ERG can first integrate the findings from the recent AACOG study on this source category in the San Antonio region. In addition, similar phone or mail surveys can be developed to be administered in other areas of the state. ERG will target 50 completed surveys in order to obtain a reasonable precision and accuracy. In the event of poor survey response, on-site observations will be attempted. To facilitate a survey, ERG obtained contact information for every active and intermittently active mine in Texas, by county, from the MSHA. Furthermore, at a recent stakeholder meeting held at the East Texas Council of Governments, ERG was able to make contacts with representatives from Luminant, a major power supplier for East Texas.[54] These representatives have agreed to help ERG make the necessary contacts with the Texas Mining and Reclamation Association to encourage mine operator and contractor participation in the surveys.

The information provided by MSHA also describes the type of mine, commodity, and number of employees for each mining site in Texas. Once the surveys have been conducted, ERG will analyze the data to build appropriate profiles of diesel construction equipment used in mining and quarry operations. Furthermore, ERG will attempt to make at least five site visits in the Central Texas area and another five in the East Texas area, to include mining operations as well as quarry operations, to collect information on general operating practices.[55] Separate profiles will be developed for quarry, lignite mine, and possibly sand/gravel pits. ERG may use the number of non-office employees obtained from MSHA as the surrogate to expand the results of the surveys to non-responsive operations.

[54] Discussion with David Duncan, Environmental Regulations Manager, Luminant, at East Texas Council of Governments NETAC Technical Committee meeting, May 15, 2008, Kilgore, Texas.
[55] There are only limited quarry operations in East Texas – site visits in this area may be limited to lignite mines, and possibly one salt mine in Van Zandt County.

Emission Level/Impact:	Medium
Uncertainty:	Very High
Data Availability:	High/Medium (Sound data already available for San Antonio region. Site surveys required for lignite mines, stone quarries and sand/gravel pits required for rest of the state, to be coordinated through the MSHA.)
Recommendation:	Include in options analysis

5. Specialty Equipment Profiles

Under the HARC and Statewide DCE studies, several specialty equipment types were not directly linked to the other sector profiles, including:

- Cranes
- Rough Terrain Forklifts (RTFs)
- Trenchers
- Boring/Drilling Rigs
- Skid Steer Loaders

While a statewide skid steer loader profile is currently being developed under a separate work order, the other equipment categories listed above remain based on limited data sources. First, equipment population estimates for these categories are based on sales data for the 9-county DFW region, extrapolated using regional REMI output data. In addition, the annual hour estimates for trenchers, cranes, and bore/drill rigs were taken from NONROAD defaults for the most part, while RTF values were based on a single estimate from Darr Forklift (an RTF specialty vendor). As such, we believe the equipment population, activity, and geographic distribution estimates for these categories to be very uncertain. Of these categories, all but boring/drilling equipment are estimated to contribute substantially to statewide NOx totals.

After meeting with stakeholders at a meeting of the East Texas Council of Governments, it is now anticipated that boring and drilling equipment may actually have significant contributions to NOx emissions in the East Texas area. Emissions from exploratory boring and drilling for gas and oil reserves were estimated in a previous study for TCEQ[56], using some general assumptions about well depth, horsepower ratings, and drilling operations. However, those estimates can be refined based on actual drilling time, horsepower estimates, equipment model year, and possibly other factors. All exploratory oil and gas drilling in Texas requires a permit from the Texas Railroad Commission (TRC). Permit[57] and operator[58] data may be obtained from TRC, providing the necessary contact information to build a survey frame for boring and drilling operations. A survey of this sector would collect hours of use per year, equipment horsepower, model year, and geographic information from the drill operators. Survey participation for boring and drilling surveys

[56] Emissions From Oil and Gas Production Facilities. TCEQ Contract 582-7-84003, Work Order No. 1. August, 2007.
[57] http://webapps.rrc.state.tx.us/DP/initializePublicQueryAction.do
[58] http://www.rrc.state.tx.us/divisions/og/ogdirectory/index.html

may be further encouraged by contacting the electric generating facilities and asking for their support. Final survey results for oil and gas exploration would be adjusted to account for the fraction of boring and drilling activity occurring in highway and other construction sectors using available surrogates.

While cranes are very numerous and are used in a very wide variety of applications,[59] RTFs, trenchers, and bore/drill rigs much more specialized and are used in relatively uniform applications, making them easier to characterize through a targeted survey. In addition, RTFs and bore/drill rigs have much smaller equipment populations, further easing data collection burdens.

For these reasons it may be feasible to perform a relatively small phone survey of RTF, boring and drilling, and trencher equipment within the scope of this effort. (Assuming relative uniformity in the survey results, ERG would set a target of 150 completed surveys - 50 for each equipment type - for this effort). In this case equipment operator contact information for RTFs and trenchers can be obtained from EDA (as was done for the skid steer loader survey) and contact information for drilling operators can be obtained from the Texas Railroad Commission to target the surveys. Equipment population, hp and model year distributions, annual hours, and geographic distribution can all be determined from such a survey. Supplemental field visits in the Austin/San Antonio and Tyler/Longview areas could be arranged to local contractors to validate clock hour readings and model years for RTFs and trenchers.[60]

Emission Level/Impact:	Medium
Uncertainty:	High
Data Availability:	Medium/Low (Extensive phone surveys needed to obtain required data. Data purchase required to generate contact list.)
Recommendation:	Exclude cranes (due to high variability in application types). Include bore/drill rigs (due to high impact in East Texas), RTFs and Trenchers in options analysis.

6. <u>Commercial Sector – Lot Development</u>

Commercial building construction involves development of the actual structure as well as preparation of the remainder of the lot for associated parking and/or landscaping. In general, the larger the size of the lot (net of building footprint), the more equipment activity and emissions. The previous HARC DCE study evaluated over 100 commercial developments in the DFW area to establish average ratios between building footprint and total lot size, by footprint bin (> 10,000 sqft, 10,000 – 40,000 sqft, and > 40,000 sqft), obtained from the Dallas Central Appraisal District website. These ratios allowed ERG to estimate the amount

[59] Under NONROAD definition, cranes consist not only of large track and wheel units with lattice booms (noticeable at the construction of multi-story structures), but also smaller truck cranes which are used in a wide variety of smaller, short-term applications such as lifting HVAC units onto flat building roofs.
[60] Boring and drilling equipment use is highly transitory by nature. As such, on-site validation of equipment-specific data will not be performed for this equipment type.

of earthwork associated with commercial building development in the region, utilizing building footprint installation data obtained from McGraw-Hill.

The ratios for building footprint to total lot size were assumed to hold constant across all areas of the state however. To the extent that commercial developments in other areas utilize more or less land per square foot of building space, earthwork requirements and associated emissions will be over or underestimated. ERG hoped to use data from other appraisal districts across the state in order to develop region-specific ratios which could be used to refine the commercial sector equipment profiles by county. After contacting appraisal districts in the Austin, San Antonio, and Houston areas, however, we determined that none of the databases maintained by these other regions had the requisite data to allow for the recalculation of these ratios.[61] No other alternative data sources have been identified for this information, other than conducting random site surveys.

The amount of lot development will also be impacted by any impermeable surface restrictions required by local ordinances. Such ordinances would necessarily limit the amount of paving activities allowable for a given commercial development, and lower equipment activity and emissions accordingly. However, since such requirements are administered on a city rather than county basis, it would require extensive GIS application development in order to estimate average paving amounts at the county level, as required by TexN. In addition, paving activities are estimated to contribute only 17% of the total hp-hrs in the Commercial sector equipment profile. For these reasons ERG does not recommend attempting to refine the Commercial sector profiles to account for local surfacing restrictions.

Emission Level/Impact:	Medium/Low
Uncertainty:	Medium/Low
Data Availability:	Low (Extensive site surveys needed to obtain required data – would require over 100 to obtain necessary validity, and would only be valid for one area.)
Recommendation:	Do not include in options analysis.

7. Surrogate Selection

Surrogates are used for a number of purposes in previous DCE studies, including extrapolation of equipment population from one area to the state as a whole, and allocating equipment to the county level. (Additional surrogates are used to forecast and back-cast equipment activity levels beyond the base year data. DCE growth surrogates are currently being evaluated and updated under a different work order.)

Surrogates that represent physical quantities directly tied to equipment population and activity levels are preferred over surrogates having only a rough correlation with these parameters. The current DCE inventory utilizes the following surrogates for estimating equipment populations and establishing county-level allocations:

[61] For example, total building square footage would be available, but not the number of floors, so building footprint could not be established.

Sector	Population/Geographic Distribution
Heavy Highway	TxDOT lane-mile data for base year project lettings
City/County Roads	Reed Construction roadway project list
Single-Family Housing	U.S. Census historical building permits
Commercial	McGraw-Hill Construction sqft of footprint, by size bin*
Utility	Reed Construction utility project list, including linear feet of installation
Municipal/County Equipment Fleets	Census population
TxDOT Equipment Fleet	Equipment inventory and clock hour readings
Landfills	Per capita disposal rate and Census population
Other Industry & Specialty Equipment Sectors	EDA historical sales data for DFW region combined with Tx-REMI model outputs for statewide population and geographic allocation

* Structures grouped by size of footprint (< 10,000 SF, 10,000 – 40,000 SF, > 40,000 SF)

ERG reviewed the surrogate data sources currently used to determine if these data might be improved. In most cases these surrogates are tied to physical quantities that are expected to be closely correlated with actual equipment usage (e.g., lane-miles for the Highway sector, linear feet of installation for the Utility sector, building permits and square feet of installation for the Residential and Commercial sectors, and waste disposal rates for the Landfill sector).[62] We do not believe the surrogates for these sectors can be substantively improved given the known data sets available.

ERG has attempted detailed surveys of Municipal and County Fleets before, with limited success. While census population only shows a moderate correlation with the completed surveys available for these fleets, the level of effort required to survey additional municipalities and counties to obtain a broad representation for these sectors is daunting. (For example, ERG's last attempt to survey equipment ownership and usage among cities and counties achieved less than a 10% response rate.) Therefore we have concluded that the current surrogates used for these sectors cannot be improved upon for a reasonable level of effort.

(Finally, the use of EDA sales data and REMI model outputs as surrogates for other industry and specialty equipment sectors may be improved upon, as discussed under options 2 and 5 above.)

Emission Level/Impact: High
Uncertainty: Low
Data Availability: Low (Sector and fleet-specific surveys would be needed in most cases to improve upon existing surrogates.)
Recommendation: Do not include in options analysis.

[62] The TxDOT equipment sector does not utilize a surrogate per se, since actual equipment counts and annual hour readings were provided directly.

8. Commercial Sector – Equipment Profiles

DCE use in the Commercial Construction sector was characterized based on professional estimator profiles for a number of commercial building projects. These profiles specified the type of equipment to be used, associated horsepower, and hours of use for specific tasks (e.g., rough grading, trenching and backfilling for utility installation, paving, etc.) As such the composite equipment use profile represents a cross-section of representative, real-world commercial projects. However, there were only a limited number of projects available for the composite profiles, with each project task being based on an average of 4 to 6 data points. Therefore the emission estimates for these tasks are relatively uncertain.

To reduce the uncertainty associated with these profiles it may be possible to obtain additional profiles from other professional estimators, or obtain peer review of the existing profiles, in order to validate or adjust our assumptions for local conditions and practices. The goal of this effort would be to obtain enough actual estimator project data to conduct a quantitative analysis of equipment profile variability for different project tasks. Lacking this, expert interviews providing an estimate of equipment profile variability may be used to adjust emission estimates for this sector. In either case, special attention will be paid to equipment use requirements for cut-and-fill operations.

While estimator cooperation has been difficult to obtain in past studies, multiple trade associations have agreed to assist in this matter (e.g., Central and South Texas ABC, Central Texas AGC).

Emission Level/Impact:	High/Medium
Uncertainty:	High/Medium
Data Availability:	Low (Estimator cooperation is required in order to adjust current profiles.)
Recommendation:	Include in options analysis

9. Specialty Operator Sectors

Certain DCE sectors were established to reflect unique equipment profiles and operating conditions within certain business types. While equipment population estimates for these categories were based on actual EDA sales data, estimates for annual hours of use for the different equipment types were based on expert opinion from a single industry source. Accordingly, sector profiles for these sources might be improved through surveys of some kind. These sectors include the following:

- Agricultural Operations
- Brick and Stone Production
- Concrete Production
- Scrap/Recycling Facilities
- General Manufacturing
- Landscaping Operations
- Special Trades Construction

- Transportation/Sales/Service Operations

Of these sectors, validation/refinement alternatives for Special Trades are discussed under option 2 above. The remaining sectors were evaluated for possible equipment profile improvements. Given the very low NOx emission estimates for the Brick/Stone and Concrete sectors, ERG concluded that refinements from detailed surveys of these businesses would not provide a large enough adjustment to current inventory estimates to be warranted.

While Agricultural sector emissions are estimated to be fairly significant at the state level (ranked 10th out of the 24 DCE subsectors – see Figure A-1), activity for this sector is limited to rural areas. Accordingly emission contributions from this sector are much lower, in relative and absolute terms, in the urbanized ozone non-attainment regions of greatest concern. As such, ERG does not recommend utilizing work order resources to validate/refine the equipment profile for this sector.

The General Manufacturing and Transportation/Sales/Service sectors (labeled as "Other (misc)" in Figure A-1) both contribute substantial amounts to statewide as well as local NOx inventories. However, these sectors contain literally tens of thousands of business establishments operating across the state, of which only a relatively small number utilize DCE. Those establishments actually owning DCE utilize their equipment in highly diverse applications which are difficult to profile through standard phone surveys or site visits. Accordingly, ERG is not confident of our ability to develop a valid, representative equipment use profile for these sectors given the limited work order resources.

The Scrap/Recycling sector is estimated to generate moderate NOx emissions at the state level, with somewhat higher contributions expected for urban areas. This sector has the added advantage of relatively uniform equipment type and use profiles across most establishments. As such, the sector's equipment use profile may be amenable to improvement though on-site surveys of multiple facility's operation practices in the Austin/San Antonio and Tyler/Longview areas. On-site data collection will profile equipment use for a typical day of operation at a facility. Data collected will include the number of pieces of each equipment type on-site as well as the make, model, model year, and the hour-meter for each equipment piece. On-site data collection will also include recording observed engine on-time for each piece of equipment. 18 scrap/recyclable material establishments are listed in the Austin-Round Rock MSA, of which ERG would target 6 to 8 facilities for on-site surveys.

Finally, the Landscaping sector is also estimated to generate moderate NOx emissions from DCE use. However, equipment use profiles in this sector are not anticipated to be highly uniform. In addition, based on previous studies ERG has determined that landscaping operators provide extremely low response rates to phone and other survey requests. Accordingly we do not believe the equipment profile for this sector can be improved in a cost-effective manner through surveys or other means.

Emission Level/Impact:	Medium/Low
Uncertainty:	Medium
Data Availability:	Low (Sector and fleet-specific surveys would be needed in most cases to improve upon existing surrogates.)
Recommendation:	Only include Scrap/Recycling Facilities in options analysis.

10. Load Factor Refinement

Emission estimates are highly sensitive to engine load factors. The current version of EPA's NONROAD model uses load factors obtained from actual engine testing over several transient cycles. The transient cycle development and engine tests were conducted by Southwest Research Institute under contract to EPA (with some of the cycle development work also co-sponsored by the Engine Manufacturers Association). Seven transient cycles were developed: agricultural tractor, backhoe loader, crawler dozer, rubber-tire loader, skid-steer loader, arc welder, and excavator. For the rubber-tire loader, skid-steer loader, and arc welder cycles, both "typical transient" and "high transient" versions of the cycles were developed; however, the load factors in the model were developed based on the typical transient cycle.

The load factors for the seven transient cycles were further binned into three categories, "High," "Low," and "steady-state" (represented by an average of the seven cycles). EPA considers this approach simpler and more defensible, given the limited number of cycles designed to represent in-use operation for specific equipment types and uncertainty in extrapolating the test data to broader equipment populations. This approach is also consistent with that used to develop the new transient adjustment factors in the model. The high load factor bin includes the following cycles: agricultural tractor (LF=0.78), crawler dozer (LF=0.58), rubber-tire loader (LF=0.48), and excavator (LF=0.53). The low load factor bin includes the remaining cycles: backhoe/loader (LF=0.21), skid-steer loader (LF=0.23), and arc welder (LF=0.19). The "high" load factor cycles were averaged to obtain a composite High LF (0.59). Similarly, the "low" load factor cycles were averaged to obtain a composite Low LF (0.21). The load factors for all seven cycles were averaged to obtain a composite 7-cycle average "steady-state" LF (0.43).

Each diesel nonroad equipment type was assigned one of these three composite load factors (Hi LF, Lo LF, or 7-cycle average). To apply these load factors, EPA matched nonroad applications with the test cycle that most closely represents the nonroad activity for the application.

Given this background information on the generic application of average load factors to diesel construction equipment and the relatively high impacts small changes in load factors can have on emissions, emissions estimates for diesel construction equipment in Texas could be refined if sufficient data could be collected on engine load factors. Unfortunately, direct measurement of engine loads is notoriously difficult, involving either the use of strain gauges or decoding of the ECU's electronic data stream. Indirect measurement of load may be achieved through second-by-second measurement of fuel consumption rates. In these cases,

the required data collection effort is highly resource intensive and not feasible within the constraints of this work order. (Reliance on lower cost methods such as instrumentation for engine RPM and/or exhaust gas temperature, or visual observation of equipment activity, does not provide a reliable, valid means of estimating load factors.)

Given this, considerations were given to other possible sources for refining load factors. Specifically, the *Caterpillar Performance Handbook, Edition 31* was investigated for its potential use in developing new load factors. While the handbook has detailed instructions on several topics such as calculating load capacity, cycle times, and production estimating methodologies, it does not offer information that could be used effectively for refined load factor development.

No other alternatives for load factor modification were identified at this time.

Emission Level/Impact: Very High
Uncertainty: High
Data Availability: Very Low (In-use equipment instrumentation highly resource intensive.)
Recommendation: Do not include in options analysis.

Option Recommendations

ERG developed cost estimates for each of the validation/refinement options recommended for further analysis, as shown in the following table.

Budget Estimates for DCE Validation/Refinement Options

DCE Sector	Description	Budget Estimate
Highway	Bid-code profile development	$29,508
Special Trades	Phone surveys; site visits	$25,426
Demolition Profile	Phone surveys; site visits	$6,876
Mining/Quarry Profile	Site visits	$14,448
RTF/Trenchers	Phone surveys; site visits	$11,176
Boring & Drilling Equipment	Phone surveys; expert interviews	$7,824
Scrap/Recycling	Site visits	$6,156
Commercial	Estimator review/modification	$14,142
	Total	**$115,556**

Based on the above assessment and budget estimates, ERG recommends the following options be adopted for the amended work order.

1. Heavy-Highway Profile Development
2. Special Trades Equipment Survey
3. Demolition Profile Improvement
4. Mining and Quarry Profile Development
5. RTF/Trencher Equipment Survey

6. Boring and Drilling Operator Survey

ERG believes selection of these options will provide the most cost-effective package of improvements to the existing DCE inventory, considering available resources. Further validation/refinement options may be undertaken when additional resources become available.

The following provides general information on ERG's anticipated survey methods. Once the options list for this work order has been finalized ERG will provide TCEQ with specific surveys and related details regarding data collection procedures.

General Survey Procedure

Any survey instruments will be developed and submitted to the TCEQ Project Representative for prior approval. If necessary, the TCEQ Project Representative may obtain an official letter on TCEQ letterhead explaining the purpose of the study for targeted equipment operators.

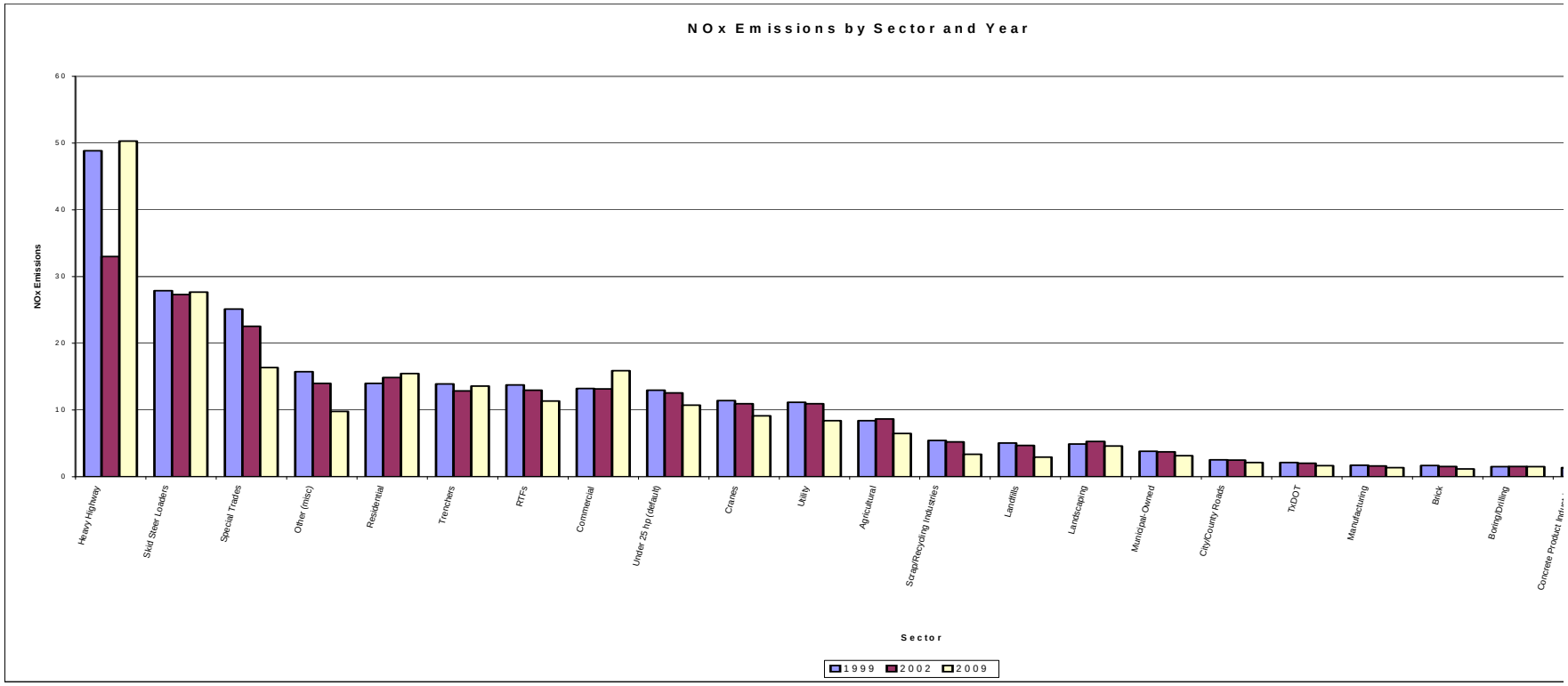
Participant Recruitment: In order to encourage survey response rates, stakeholder support for surveys will be sought. ERG has extensive experience working with industry trade associations and local agencies to encourage stakeholder participation. The following trade associations and local agencies will be contacted to help encourage participation in this diesel construction equipment study.

a) Associated General Contractors – Texas Chapter (AGC – Highway and Non-Highway branches)
b) Central and South Texas Associated Builders and Contractors
c) Austin Contractors and Engineers Association

ERG will attempt to attend one or more stakeholder meetings to promote cooperation with the surveys, to identify reviewers for the surveys and data collection plan, and to identify potential participant lists.

Confidentiality: ERG is particularly sensitive to the privacy of individuals and businesses. Therefore all interviews and data collection efforts will begin with a guarantee of privacy, anonymity, and confidentiality. To ensure a survey respondent's right to privacy respondents will be informed of the research purpose, the kinds of questions that will be asked, and how TCEQ may use the results of the study. Confidentiality will be maintained by eliminating names from interview records, stripping all respondent-identifying characteristics from study datasets. In addition, all project staff will be given explicit training regarding confidentiality protocols and commitments.

Figure A-1. Statewide DCE Inventory by Sector for Key Analysis Years



Appendix B

Mining and Quarry Data Collection Form

MINING/QUARRY SITE VISIT DATA COLLECTION FORM

Eastern Research Group (ERG) is conducting a survey on behalf of the Texas Commission on Environmental Quality. We are surveying mine and quarry owners and operators about diesel construction equipment used in their operations. The information collected in the survey will provide more accurate data on diesel construction equipment operated in Texas so that state air quality estimates can be updated.

This survey is being conducted with the full knowledge of the Texas Mining and Reclamation Association and the Texas Aggregates and Concrete Association, as well as the Associated General Contractors of Texas, QUOIN, and the Associated Builders and Contractors of Central and South Texas. Responses to this survey will be kept confidential and will not be disclosed in identifiable form. This means that we may not disclose any information that may identify you, such as your address, contact information or worksite locations, unless required by law. The information your establishment provides will be used for statistical purposes only.

You may address questions regarding the survey to the following:

- Rick Baker, ERG Project Manger (512) 407-1823
- Anusuya Iyer, TCEQ Project Manager (512) 239-1435

Please fill out the table for each piece of diesel construction equipment operated at this mine/quarry location. Alternatively, if you currently track this information in another format, you may submit this information using an existing equipment inventory in place of this table. If you have any questions or concerns, please contact Rick Baker, the ERG Project Manager.

The types of equipment we are collecting information on include the following:

- Pavers
- Tampers/Rammers
- Plate Compactors
- Rollers
- Scrapers
- Paving Equipment
- Surfacing Equipment
- Signal Boards/Light Plants
- Trenchers
- Bore/Drill Rigs
- Excavators
- Concrete/Industrial Saws
- Cement & Mortar Mixers
- Cranes
- Graders
- Off-highway Trucks

- Crushing & Processing Equipment
- Rough Terrain Forklifts
- Rubber Tire Loaders
- Tractors/Backhoes
- Crawler Tractors & Dozers
- Skid Steer Loaders
- Off-Highway Tractors
- Dumpers/Tenders
- Other Construction Equipment (please describe)

1. Name of Company:	
2. Company ID:	
3. Number of Employees (non-clerical FTEs)	
4. Site Location:	
5. Site Personnel Contact Name:	
6. Site Personnel Title:	
7. Site Personnel Phone #:	
8. Date of site visit:	

Equipment Type	Fuel Type	Make	Model	Horsepower	Model Year	Clock Hours	Serial Number*	Typical Hours Per Year of Engine On Time (in 2007)	Repowered (Y/N)	Year of Repower (if applicable)

* If this unit has been repowered, then do not collect the serial number.
(Make additional copies as necessary.)

Record your observations about the equipment you see in use at this site (include what the equipment is, what task they are doing, how many cycles are completed in a given time).

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix C

Mining and Quarry Site Visit Summaries

Coal Mine Site Visit Report

In general, most equipment is utilized in similar ways across different mines: draglines[63] remove the rock and dirt covering the coal seam, crawler dozers push dirt, the loaders load coal into the haulers, the backhoes load end dumps, and graders primarily maintain the road. However, there are slight variations in cycle times and jobs for the equipment from site to site, as discussed below.

Site #1

This site is a smaller operation that only has one dragline. The smaller the operation, the broader the job range is for the equipment. The site had one D9 crawler dozer working with the dragline preparing the coal seam for removal, one performing miscellaneous activities, and one D10 dozer working with the left over material (spoil).

This mine usually ran one wheeled loader in the pit, with the other being maintained or performing miscellaneous activities. 14 loader buckets were required to load a hauler (off-road truck). These units may also haul clay as well. Four buckets of clay were loaded per hauler. Usually there were two haulers working at a time. The hauler cycle time was 40 minutes, and there were about 5 to 10 minutes between haul trucks.

Site #2

This site operated three draglines and three pits. Each dragline was assigned a D9 dozer for coal seam preparation.

There was typically one loader assigned to each pit, with two haulers for each loader. One loader and two haulers are usually under preventative maintenance at any given time. The cycle time for the haulers was 38 minutes.

Excavators worked in the pre-strip process to help the dragline by preparing the walkway. Eight to nine loader buckets were required to fill an off-road truck, with five minutes required for loading. The total cycle time was approximately 10-12 minutes.

Site #3

This mine had two draglines working two separate pits, as well as an auxiliary pit. Like the other pits observed, each dragline was assigned a D9 dozer. Additional D9's were performing other miscellaneous activities, while most of the D10's were working the spoil. There is usually one dozer under preventative maintenance at any given time. The haulers at this site had a cycle time of 45 minutes.

The auxiliary pit was operated differently. Where the major coal seam was shallow, the dirt was removed by the dozers and not the dragline. There were two D10s operating in the pit at the time

[63] Draglines are electrically powered and not included in the DCE profiles.

of the visit, and there was also an excavator loading off-road trucks continuously. There were three trucks assigned to each excavator, and each load required approximately four minutes per truck.

Site #4

This mine operates two draglines, a cross-pit spreader (electric earth moving equipment, like a dragline), as well as an auxiliary pit. The auxiliary pit was operated in a very similar fashion to that at site #3, with two D10 dozers, an excavator, and off-road trucks. Each dragline and the cross pit spreader were assigned a D9 to prepare the coal seam. This site had one D10 assigned to a stockpile, and the others to working the spoil. The average haul time was 45 minutes, and in a 12-hr shift a hauler would take 12 to 13 loads.

The data collector was able to witness how rain affects the operation at this mine. When it rains, most of the dozers help with the drainage by building berms. The haulers may be placed on hold to ensure the safety of personnel and equipment. Other than that, things continue as normal.

Site #5

This site was substantially smaller than the other sites visited and did not operate a dragline, consisting of a single auxiliary pit. However, the auxiliary pit was deeper and longer than the other auxiliary pits visited.

There are three sections to the pit. While the excavators remove the dirt from the coal in one particular area, the loaders load the coal onto the haul trucks at another area. The haulers here have a 30 minute cycle time.

This site utilizes scrapers in a different way than seen at other locations. The scrapers here are used to remove dirt from the coal, while scrapers used at other sites were said to be used exclusively for road development and maintenance.[64] The scrapers have a 3 to 3.5 minute cycle time depending on their haul distance.

Site #6

This mine is a very large operation, with three to four pits being mined at a time. Each pit is about a mile to a mile and a half long. Most of the available equipment was in use at the time of the visit.

This mine utilized mobile crushing machines that serve the purpose of a dragline in the coal removal process, and are also used to load the haul trucks. Approximately minutes were required to load a haul truck, with about a 10 minute interval between trucks.

---

[64] Scrapers were not witnessed conducted road cutting or maintenance activities during any of the site visits, but there operations were described by site operations personnel.

D6 dozers start the spoil grading, then much larder D11 dozers perform most of the of the spoil grading work, conducting basic cut and fill functions. D9 and D10 dozers help prepare the coal seams, and perform the truck/shovel work.

Wheeled loaders operate in a "coal barn" loading the coal into haul trucks. Four bucket loads were needed load a haul truck. When the loaders are not loading, they either straighten up the coal pile or are turned off.

Excavators work in the pre-strip/ reclamation portion of the mining process, helping cut the clay and load dump trucks. Four minutes was required to load a truck, with essentially no down time between trucks.

An additional excavator digs entry ways, helps digging holes, and serves as a utility vehicle. Two other excavators assist with digging ditches, trenches, sumps, putting in pipes, etc.

Scrapers are used to build the roads and retention ponds.

Graders work in the pre-strip process. One grader was used exclusively for construction and maintenance of the roads. One grader assists with the load-haul process, while a smaller grader serves as a utility vehicle.

A roller/compactor is used intermittently for road construction.

General Comments

With the exception of the above described differences, equipment use profiles were quite similar across all mines visited. Also, in the reclamation process at these particular sites, about 90% of the land is planted with trees, with about 70% of those being pines. Most of the land around the pits has been mined in years past and has since been reclaimed, so there is significant vegetation and wildlife around the mines.

QUARRY SITE VISIT REPORTS

Site #7

The site operator owns this quarry and the adjoining cement plant though the two entities are operated fairly independently. The primary operation moves the rough material from the quarry to the first crusher and works one shift 6 days per week. The secondary operation includes the finishing plant and works two shifts 6 days per week. The site has 20 pieces of non-road diesel construction equipment including a number of redundant units so that work does not slow down during mechanical failures or routine maintenance. During this visit, 16 units were operating. Generally equipment of the same type was performing the same task.

Equipment-specific profile information including hours per year were provided under the phone survey task, and could not be independently verified during the visit. This information is reported separately.

Primary Operation (Quarry)

Front End Loaders

Typically three Caterpillar 992's operate in the quarry loading blasted material into the haul trucks. They divide the quarry face that is being removed into three sections and each loader is served by two haul trucks. It takes five buckets to fill a haul truck and this is usually accomplished in two to three minutes. At the time of this site visit, there were only two loaders operating in the quarry because the third was temporarily pulled away to dig out a small amount of unblasted material.

Haul Trucks

Six haul trucks serve the loaders in the quarry. Five of these trucks are Caterpillar 777 series and the sixth is a Caterpillar 773. The haul trucks transport the rough blasted material from the quarry loaders and deposit it into the primary crusher.[65] At the time of this site visit the haul distance was about two miles round trip. Each truck's cycle time was about 10 minutes.

Excavator

At the time of the visit, neither of the site's two excavators was in operation. According to the site foreman, personnel generally use a single excavator with a jackhammer bit to break up oversize material that is too big to be loaded into the haul trucks. The excavator is driven under its own power among the piles of oversize material around the quarry.

Secondary Operation (Finishing Plant)

Front End Loaders

Two Caterpillar 998 loaders were being used to load finished material from piles into on-road trucks. The trucks ran continuously. It took between two and three buckets to load each truck.

[65] Rock crushers are permitted area sources, and excluded from this analysis.

A Caterpillar 992C and a Caterpillar 998F were used to push intermediate material piles into the plant's loading conveyor. These units ran continuously, organizing piles and keeping a steady intake of material into the plant.

Haul Trucks
Typically (and at the time of the site visit) two 773 series trucks haul finished material from the plant to piles around the site. These units load from either bins or belts, but both methods took between five and six minutes to fill the trucks. Their overall cycle time depended on where the pile was located, but at the time of the visit, the cycle time was under nine minutes.

Backhoe
A John Deere 310E backhoe is used to clean out material from under the plant. It was working continuously making sure that piles did not fill up high enough to obstruct or clog the belts and the other material handling systems under the plant.

Site #8

This facility operates a relatively small quarry in Central Texas. The primary operation moves the rough material from the quarry to the first crusher and the secondary operation includes the finishing crusher and the cleaning plant. The site operates approximately 50 hours per week. The site has 10 pieces of diesel construction equipment. Seven units were in operation at the time of the visit. Maintenance records were kept on a white board in the office and were erased and updated each time maintenance was performed on the equipment so it was difficult to confirm yearly usage estimates.

Equipment-specific profile information including hours per year were provided under the phone survey task, and could not be independently verified during the visit. This information is reported separately.

Primary Operation (Quarry)

Front End Loaders
Generally only one of the two Komatsu WA500 loaders operates in the quarry at any time. This unit loads coarse material that has been blasted off the rock face into the haul trucks. There were two types of haul trucks in use; one held three buckets of material and two held four buckets. Loading took about three minutes for both types of truck. With three haul trucks running and only one loader, the loader ran continuously with some queuing of the trucks.

Haul Trucks
The three haul trucks moved the coarse material from the blasting area to the primary crusher. There were two Euclid 650's and one Volvo A-35 operating at the time of the visit. There was another Euclid truck on site that was down for maintenance. The cycle time for the trucks was about 10 minutes with one or two minutes at idle waiting for the previous truck to finish loading.

Excavator
The excavator runs continuously with a jackhammer bit breaking up oversized material from blasting.

Drill
The drill is used to make holes for packing with blasting material. It was not in operation at the time of the visit and the manager said it is rarely used by comparison to the other units.

Secondary Operation (Finishing and Cleaning Plant)

Front End Loaders
Two of the Komatsu WA500 loaders were operating in the finishing area. The manager mentioned that usually one loader (of the total of four) was not used during the day and was retained as a backup. One loader was responsible for moving material from the output of the primary crusher to the secondary crusher. The distance between these two was about 50 yards, so the cycle time for this loader was under one minute. This unit spends much of the day performing this task, but was also responsible for maintaining the output piles from the secondary crusher, making sure the piles did not get high enough to impede the conveyors. The other loader is used to load on-road trucks and to maintain the storage piles. At the time of the site visit, there were no on-road trucks present so this loader was working among the storage piles.

Skid-Steer Loader
The skid steer loader worked continuously around the primary and secondary crushers cleaning under the conveyors to prevent material overflow from contacting any moving parts.

Site #9

This site is a sand and gravel/ready mix operation. The operation consists of excavators in constant use, digging material up depositing it on a conveyer belt or onto a large pile, where it is then scooped up by a loader and either placed into a truck or a hopper on a conveyer belt. The excavators and loaders were in constant use for the 2.5 hours of observation.

A skid loader was reportedly used intermittently for tight spaces in which the larger loaders could not operate, although it was not in use during the site visit.

A dozer and grader are used to maintain the roads, while the excavators and loaders are used to transport material. None of these units were in use during the site visit.

One of the Loaders was used exclusively in the Ready-Mix aspect of the operation.

The site operators provided the following equipment-specific information at the time of the site visit.

Type	Brand	Model	Year	Hp	Engine Readings/Notes
Excavator	Linkbelt	5800	1998	318	400 hr/yr, estimated. No reading/machine not operable. Considered a spare-foreman estimates 5 hrs/week. Machine parked.
Excavator (Long stick)	Caterpillar	325B	2000	204	400 yr. est. (12694.3 hour meter) Superintendent did not know if machine was original equipment Machine was in constant use during visit. Foreman estimated 8 hours a day, 5 days a week (differs greatly from superintendant estimate)
Excavator (Short stick)	Caterpillar	325B	2000	204	1800 hr/yr. est.(14224.5 hour meter) Super did not know if machine was original. He estimated 10 hours a day, 5 days a week. Machine in constant use during visit.
Loader	Caterpillar	950G	2004	217	2100 hr/yr est. (9741.7 hour meter)** Super said they obtained this equipment new-original hours. In constant use during visit.
Loader* (Ready-Mix)	Caterpillar	950G	2004	217	2100 hr/yr estimate. (11663.6)** Leased new, original hours. In constant use during visit.
Grader	Caterpillar	140G	1995	150	400 hr/yr est: (2083.8 hour meter) Super said purchased used. Parked during visit.
Loader	Case	721D	2004	181	400 hr/yr est. (6402.8 hour meter) Super said equipment was purchased used. Constant use during visit.
Skid Loader	John Deere	320	2008	66	400 hr/yr est. (168.2 hour meter)** Purchased new. Parked during visit.
Dozer	Caterpillar	D8	2007	310	1400 hr/yr est. (2567.7 hour meter)** original equip/purchased new. Parked during visit.
Loader	John Deere	844J	2006	380	2100 hr/yr est. (3906.0 hour meter) **Leased new. In constant use during visit.
Excavator	John Deere	600C	2005	396	2100 hr/yr est. (8543.0 hour meter)** Original equipment. In constant use during visit.

*Only used for Ready-Mix Concrete operation.
**Original hours-leased or new equipment.

Site #10

This facility operated a small dimension limestone operation in Central Texas. Equipment use is very straightforward and consistent according to the operations manager. Essentially a rock saw (~20 hp and therefore not targeted under this survey) is used 4-5 days a week, 8-10 hours a day depending on their orders. The saw is used to cut a large swath of stone into a grid pattern. A Caterpillar 977L loader and two skid steer loaders with fork attachments handle and transport to material for further processing and shipping via on-road truck.

The equipment-specific information collected during the visit is presented below.

TYPE	BRAND	MODEL	YEAR	HOUR METER	ESTIMATE
Skid Steer	Case	95XT	2008	567.5*	2,080
Skid Steer	Case	95XT	2005	4093.0	2,080
Loader	Caterpillar	977L	1988	Not working	1,040

* May through August of 2008

The rock saw was not in use during the visit, although the skid steers were in constant use. One unit was purchased new in May of 2008.

The site manager estimated the loader is used two to three times a week, and eight hours a day when in use, to haul the stone cut by the rock saw.

Site #11

This facility operated a somewhat larger dimension stone quarry in Central Texas. The operation consists of cutting large blocks of stone into smaller blocks of uniform sizes and hauling the material for use as pavestones and in masonry. The company uses a rock saw (< 25 hp) to cut large pieces of rock. A Caterpillar 977 loader moves the larger pieces, while two skid steers are used with pallet forks and small buckets to load and move smaller rocks and paving stones. A Volvo loader is used for the small bricks to be loaded into an on-road dump truck.

The rock saw was not in operation during the visit. The site manager estimated that the saw ran five to eight hours a day, five days a week. The only equipment in operation during the visit were case skid steer 1845c and an electric cutting machine used for cutting stone blocks into smaller more uniform sizes.

The Caterpillar loader was out of service during the visit, although the site manager stated that this unit is used about 1,300 hours per year on average.

The following summarizes the equipment specific information collected during the visit. Note that none of the equipment was purchased new, so hour meter readings cannot be used as an independent validation of estimated hours per year at this facility.

Type	Make	Model / Yr	Hour Meter	Hr/yr Estimate
Skid Steer	Bobcat	843 / 1995	5887.8	1,040
Skid Steer	Case	1845C / 1992	4775.9	2,080
Skid Steer	Case	95XT / 1999	8231.2	2,080
Crawler Loader	Caterpillar	1987/ 977L	1,775.3	1,300
Wheeled Loader	Volvo	1985/ L160	19,0589	520

Appendix D

Survey Questionnaire for Special Trades Contractors

TELEPHONE QUESTIONNAIRE

ALL TEXT IN CAPS ARE PROGRAMMING OR INTERVIEWER NOTES AND ARE NOT READ TO THE RESPONDENT

INTRO 1

Hi, my name is [NAME] and I'm calling on behalf of Eastern Research Group. May I speak with [NAME OF CONTACT]?

INTRO 2

Hi my name is [NAME] and I'm calling on behalf of Eastern Research Group. Eastern Research Group is conducting a survey on behalf of the Texas Commission on Environmental Quality. We are conducting a survey with business owners in various industries about diesel construction equipment used in their operations. The information collected in the survey will provide more accurate data on diesel construction equipment operated in Texas so that state air quality estimates can be updated.

This survey is being conducted with the full knowledge and support of the Associated General Contractors of Texas, QUOIN, Associated Builders and Contractors of Central Texas, and the Associated Builders and Contractors of South Texas. Responses to this survey will be kept confidential and will not be disclosed in identifiable form. This means that we may not disclose any information that may identify you, such as your address, contact information or worksite locations, unless required by law. The information your establishment provides will be used for statistical purposes only.

You may address questions regarding the survey to the following:

- Rick Baker, ERG Project Manger (512) 407-1823
- Anusuya Iyer, TCEQ Project Manager (512) 239-1435

Your business has been randomly selected participate in this study. We would like to talk to the person in your company who is most knowledgeable about the off-road equipment you own or lease. Are you that person?

[IF YES, PROCEED; IF NO, ASK: CAN YOU REFER ME TO THE PERSON MOST KNOWLEDGEABLE ABOUT YOUR OFF-ROAD EQUIPMENT? WHEN CONTACT MADE WITH MOST KNOWLEDGEABLE PERSON START WITH INTRO 3]

INTRO 3—use if referred by owner/operator as "most knowledgeable person."

Hi my name is [NAME] and I'm calling on behalf of Eastern Research Group. Eastern Research Group is conducting a survey on behalf of the Texas Commission on Environmental Quality. We are conducting a survey with business owners in various industries about diesel construction equipment used in their operations. The information collected in the survey will provide more accurate data on diesel construction equipment operated in Texas so that state air quality estimates can be updated.

This survey is being conducted with the full knowledge and support of the Associated General Contractors of Texas, QUOIN, Associated Builders and Contractors of Central Texas, and the Associated Builders and Contractors of South Texas.

<Name of Referral> is participating in this study and s/he referred us to you because are the person most knowledgeable about the off-road equipment owned or leased by your company. Some examples of diesel construction equipment include: graders, rollers, excavators, backhoes, and dozers to name a few.

START SURVEY.

SCREENING INTERVIEW

First, I have a few general questions for you.

S1. How would you describe your primary business activity? **[READ A FEW, THEN GIVE THE RESPONDENT A CHANCE TO PROVIDE THE ANSWER...INSTEAD OF READING THE LONG LIST BELOW. ONLY READ THE LIST IF THE RESPONDENT DOES NOT KNOW HOW TO RESPOND.]**

Plumbing, Heating, and Air-conditioning	1
Painting and Paper Hanging	2
Electrical Work	3
Masonry, Stonework, Tile Setting, and Plastering	4

Carpentry and Floor Work	5	
Roofing, Siding, and Sheet Metal Work	6	
Concrete Work	7	
Water Well Drilling	8	
Structural Steel Erection	9	
Glass and Glazing Work	10	
Excavation Work	11	TERMINATE
Wrecking and Demolition Work	12	TERMINATE
Other (Please Specify)	13	
DK	9998	ASK FOR MORE KNOWLEGEABLE PERSON AND REPEAT INTRO 2

PROGRAMMER NOTE: IF THE RESPONDENT DESCRIBES THEIR AREA OF BUSINESS AS GENERAL CONTRACTORS FOR RESIDENTIAL, COMMERCIAL, INDUSTRIAL, OR HIGHWAY CONSTRUCTION…TERMINATE SURVEY.

S2. Did your company operate any diesel construction equipment greater than 25 horsepower in Texas during the 2007 calendar year?

YES	1	
NO	2	TERMINATE

S3. In what county or counties were these units primarily operated?

Provide list of counties…as in skid survey

EQUIPMENT AND USAGE

Now, for this last series of questions, I'm going to ask you about each type of diesel construction equipment you own or operate.

1. I will read *(continue reading)* a list of equipment eligible for this survey. Please tell me if you own or operate any of the following diesel equipment. For each equipment type you own or operate, I will collect additional information on that equipment.

EQUIPMENT TYPE	OWN or OPERATE? (YES OR NO) IF YES… CYCLE THROUGH QUESTIONS A – J Then read the first sentence of the question and resume reading the list	QUANTITY
Pavers		
Rollers		
Scrapers		
Paving Equipment *(Various equipment types used to smooth and distribute paving material including vibrators and finishers to support the work of the pavers)*		
Surfacing Equipment *(Other various equipment used to supplement paving activity including paving material mixers, surface profilers (road reclaiming chippers), and seal coating equipment not used to distribute paving material as with paving equipment.)*		
Excavators		
Graders		
Off-highway Trucks *(Trucks used offroad that are NOT registered for onroad use.)*		
Rubber Tire Loaders		
Tractor-Loader-Backhoes		
Crawler Tractors and Dozers		

A. How many hours of engine on-time does this (equipment type) have in a typical year?

OPEN RESPONSE

DK 9998

RF	9999

IF HOURS PER YEAR IS UNKNOWN (OR REFUSAL), ASK FOR RANGE:

0 – 99	1
100 – 249	2
250 – 499	3
500 – 749	4
750 – 999	5
1000 – 1499	6
1500 – 1999	7
2000 – 3000	8
3000 +	9
DK	9998
RF	9999

B. What is the make of this [EQUIPMENT TYPE]?

OPEN RESPONSE

DK	9998
RF	9999

C. And what is the model name or number?

OPEN RESPONSE

DK	9998

RF	9999

D. What is the model year of this equipment?

OPEN RESPONSE

DK	9998
RF	9999

IF THE MODEL YEAR IS UNKNOWN (OR REFUSAL), ASK FOR A RANGE:

Pre-1988	1
1988 – 1997	2
1998 – 2003	3
2004 - 2007	

E. What is the horsepower of this unit?

OPEN RESPONSE

DK	9998
RF	9999

IF THE HORSEPOWER IS UNKNOWN (OR REFUSAL), ASK FOR A RANGE:

Less than 25 horsepower	1	MOVE TO NEXT EQUIPMENT TYPE OR TERMINATE IF LAST EQUIPMENT

26 – 40	2	
41 – 50	3	
51 – 75	4	
76 – 100	5	
101 – 175	6	
176 – 300	7	
301 – 600	8	
601 – 750	9	
751 – 1000	10	
1001 – 1200	11	
1201 – 2000	12	
2001 – 3000	13	
Greater than 3000	14	CONFIRM

E. What fuel type does this equipment use?

Diesel	1
Gasoline	2
Natural Gas	3
Propane	4
Electric	5
Other (SPECIFY)	9997
DK	9998

RF 9999

G. How many of your (equipment type) are also of this make, model, and model year?

OPEN RESPONSE [RANGE 1-999]

DK 9998

RF 9999

2. Finally, approximately how many employees are there in your company?

OPEN RESPONSE

DK 9998

RF 9999

PROGRAMMER NOTE: WHEN INVENTORY FOR EACH EQUIPMENT TYPE AND MAKE/MODEL/MODEL YEAR IS COMPLETED, GO TO TERMINATION 1.

T1. A small number of companies responding to this survey may be randomly selected for a site visit from an ERG representative. The representative will physically inspect and collect readily available information, much like that collected in this survey, from each piece of diesel construction equipment on site. Only a small percentage of companies will be asked to participate in on-site field data collection. This information will only be used to validate overall survey responses. If selected, would you be willing to allow a site visit from one of our representatives?

Yes 1

No 2

T2. If yes, who would be the best person to contact to arrange an on-site visit? These visits would be scheduled at your convenience, when the machinery is least likely to be in use in the field.

T2A. Contact Name

T2B. Contact Title

T2C. Contact Phone

T2D. Best time to contact

T2E. Other important information

This concludes our survey. Thank you very much for your time and cooperation.

Appendix E

NONROAD2005 Default Scrap Function

Fraction of Median Life	Cumulative % Scrapped
0	0
0.0294	0.5
0.0588	1
0.08705	1.5
0.1153	2
0.14235	2.5
0.1694	3
0.19535	3.5
0.2213	4
0.24615	4.5
0.271	5
0.29475	5.5
0.3185	6
0.3412	6.5
0.3639	7
0.3856	7.5
0.4073	8
0.42795	8.5
0.4486	9
0.4683	9.5
0.488	10
0.5067	10.5
0.5254	11
0.5432	11.5
0.561	12
0.5779	12.5
0.5948	13
0.6108	13.5
0.6268	14
0.6419	14.5
0.657	15
0.6713	15.5
0.6856	16
0.69905	16.5
0.7125	17

Fraction of Median Life	Cumulative % Scrapped
0.7252	17.5
0.7379	18
0.7498	18.5
0.7617	19
0.77285	19.5
0.784	20
0.79445	20.5
0.8049	21
0.81465	21.5
0.8244	22
0.83345	22.5
0.8425	23
0.85095	23.5
0.8594	24
0.8672	24.5
0.875	25
0.8822	25.5
0.8894	26
0.89605	26.5
0.9027	27
0.90875	27.5
0.9148	28
0.92035	28.5
0.9259	29
0.93095	29.5
0.936	30
0.94055	30.5
0.9451	31
0.9492	31.5
0.9533	32
0.957	32.5
0.9607	33
0.96395	33.5
0.9672	34
0.9701	34.5

Fraction of Median Life	Cumulative % Scrapped
0.973	35
0.9755	35.5
0.978	36
0.9802	36.5
0.9824	37
0.9843	37.5
0.9862	38
0.9878	38.5
0.9894	39
0.9907	39.5
0.992	40
0.9931	40.5
0.9942	41
0.99505	41.5
0.9959	42
0.9966	42.5
0.9973	43
0.9978	43.5
0.9983	44
0.99865	44.5
0.999	45
0.99925	45.5
0.9995	46
0.99965	46.5
0.9998	47
0.99985	47.5
0.9999	48
0.99995	49
1	50
1.00005	51
1.0001	52
1.00015	52.5
1.0002	53
1.00035	53.5
1.0005	54

Fraction of Median Life	Cumulative % Scrapped
1.00075	54.5
1.001	55
1.00135	55.5
1.0017	56
1.0022	56.5
1.0027	57
1.0034	57.5
1.0041	58
1.00495	58.5
1.0058	59
1.0069	59.5
1.008	60
1.0093	60.5
1.0106	61
1.0122	61.5
1.0138	62
1.0157	62.5
1.0176	63
1.0198	63.5
1.022	64
1.0245	64.5
1.027	65
1.0299	65.5
1.0328	66
1.03605	66.5
1.0393	67
1.043	67.5
1.0467	68
1.0508	68.5
1.0549	69
1.05945	69.5
1.064	70
1.06905	70.5
1.0741	71
1.07965	71.5

Fraction of Median Life	Cumulative % Scrapped
1.0852	72
1.09125	72.5
1.0973	73
1.10395	73.5
1.1106	74
1.1178	74.5
1.125	75
1.1328	75.5
1.1406	76
1.14905	76.5
1.1575	77
1.16655	77.5
1.1756	78
1.18535	78.5
1.1951	79
1.20555	79.5
1.216	80
1.22715	80.5
1.2383	81
1.2502	81.5
1.2621	82
1.2748	82.5
1.2875	83
1.30095	83.5
1.3144	84
1.3287	84.5
1.343	85
1.3581	85.5
1.3732	86
1.3892	86.5

Fraction of Median Life	Cumulative % Scrapped
1.4052	87
1.4221	87.5
1.439	88
1.4568	88.5
1.4746	89
1.4933	89.5
1.512	90
1.5317	90.5
1.5514	91
1.57205	91.5
1.5927	92
1.6144	92.5
1.6361	93
1.6588	93.5
1.6815	94
1.70525	94.5
1.729	95
1.75385	95.5
1.7787	96
1.80465	96.5
1.8306	97
1.85765	97.5
1.8847	98
1.91295	98.5
1.9412	99
1.9706	99.5
2	100

Appendix F

Geographic Allocation Factors by Survey Subsector and Strata

RTFs – Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Anderson	365,182	0.0028	1.4
Andrews	803,998	0.0062	3.0
Angelina	116,769	0.0009	0.4
Aransas	50,032	0.0004	0.2
Archer	535,965	0.0041	2.0
Armstrong	506,308	0.0039	1.9
Atascosa	669,890	0.0052	2.5
Austin	367,497	0.0028	1.4
Bailey	394,475	0.0030	1.5
Bandera	366,827	0.0028	1.4
Bastrop	422,852	0.0033	1.6
Baylor	327,716	0.0025	1.2
Bee	509,544	0.0039	1.9
Bell	450,923	0.0035	1.7
Bexar	441,206	0.0034	1.7
Blanco	389,282	0.0030	1.5
Borden	480,015	0.0037	1.8
Bosque	562,851	0.0043	2.1
Bowie	307,531	0.0024	1.2
Brazoria	613,891	0.0047	2.3
Brazos	308,814	0.0024	1.2
Brewster	1,675,564	0.0129	6.3
Briscoe	425,565	0.0033	1.6
Brooks	439,771	0.0034	1.6
Brown	481,936	0.0037	1.8
Burleson	388,982	0.0030	1.5
Burnet	565,413	0.0044	2.1
Caldwell	304,844	0.0024	1.1
Calhoun	247,827	0.0019	0.9
Callahan	515,396	0.0040	1.9
Cameron	350,437	0.0027	1.3
Camp	69,343	0.0005	0.3
Carson	451,669	0.0035	1.7
Cass	193,244	0.0015	0.7
Castro	563,538	0.0044	2.1
Chambers	274,853	0.0021	1.0
Cherokee	286,306	0.0022	1.1
Childress	368,782	0.0028	1.4
Clay	654,342	0.0051	2.5
Cochran	439,252	0.0034	1.6
Coke	485,397	0.0037	1.8
Coleman	642,263	0.0050	2.4
Collin	309,630	0.0024	1.2
Collingsworth	506,942	0.0039	1.9

RTFs – Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Colorado	538,635	0.0042	2.0
Comal	203,291	0.0016	0.8
Comanche	543,386	0.0042	2.0
Concho	544,312	0.0042	2.0
Cooke	458,775	0.0035	1.7
Coryell	493,087	0.0038	1.8
Cottle	574,177	0.0044	2.2
Crane	561,912	0.0043	2.1
Crockett	1,735,476	0.0134	6.5
Crosby	489,613	0.0038	1.8
Culberson	1,694,512	0.0131	6.4
Dallam	884,166	0.0068	3.3
Dallas	89,112	0.0007	0.3
Dawson	572,422	0.0044	2.1
Deaf Smith	964,347	0.0074	3.6
Delta	141,992	0.0011	0.5
Denton	349,093	0.0027	1.3
Dewitt	576,896	0.0045	2.2
Dickens	567,096	0.0044	2.1
Dimmit	570,684	0.0044	2.1
Donley	584,340	0.0045	2.2
Duval	850,360	0.0066	3.2
Eastland	498,047	0.0038	1.9
Ector	503,781	0.0039	1.9
Edwards	973,512	0.0075	3.6
Ellis	464,039	0.0036	1.7
El Paso	113,948	0.0009	0.4
Erath	580,627	0.0045	2.2
Falls	408,692	0.0032	1.5
Fannin	483,446	0.0037	1.8
Fayette	552,414	0.0043	2.1
Fisher	479,270	0.0037	1.8
Floyd	573,794	0.0044	2.2
Foard	286,492	0.0022	1.1
Fort Bend	415,251	0.0032	1.6
Franklin	132,241	0.0010	0.5
Freestone	429,339	0.0033	1.6
Frio	603,119	0.0047	2.3
Gaines	758,896	0.0059	2.8
Galveston	127,280	0.0010	0.5
Garza	499,552	0.0039	1.9
Gillespie	645,422	0.0050	2.4
Glasscock	492,939	0.0038	1.8
Goliad	506,019	0.0039	1.9

RTFs – Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Gonzales	695,774	0.0054	2.6
Gray	452,820	0.0035	1.7
Grayson	441,246	0.0034	1.7
Gregg	46,660	0.0004	0.2
Grimes	414,887	0.0032	1.6
Guadalupe	384,824	0.0030	1.4
Hale	605,020	0.0047	2.3
Hall	431,782	0.0033	1.6
Hamilton	449,671	0.0035	1.7
Hansford	593,063	0.0046	2.2
Hardeman	345,897	0.0027	1.3
Hardin	68,512	0.0005	0.3
Harris	304,868	0.0024	1.1
Harrison	229,272	0.0018	0.9
Hartley	789,289	0.0061	3.0
Haskell	491,957	0.0038	1.8
Hays	278,352	0.0022	1.0
Hemphill	546,373	0.0042	2.0
Henderson	340,869	0.0026	1.3
Hidalgo	593,158	0.0046	2.2
Hill	504,322	0.0039	1.9
Hockley	491,498	0.0038	1.8
Hood	202,131	0.0016	0.8
Hopkins	431,411	0.0033	1.6
Houston	464,706	0.0036	1.7
Howard	518,369	0.0040	1.9
Hudspeth	2,121,727	0.0164	8.0
Hunt	400,272	0.0031	1.5
Hutchinson	552,995	0.0043	2.1
Irion	536,292	0.0041	2.0
Jack	596,172	0.0046	2.2
Jackson	470,500	0.0036	1.8
Jasper	96,286	0.0007	0.4
Jeff Davis	1,488,732	0.0115	5.6
Jefferson	388,239	0.0030	1.5
Jim Hogg	603,511	0.0047	2.3
Jim Wells	497,880	0.0038	1.9
Johnson	362,004	0.0028	1.4
Jones	517,244	0.0040	1.9
Karnes	474,806	0.0037	1.8
Kaufman	419,553	0.0032	1.6
Kendall	326,956	0.0025	1.2
Kenedy	474,073	0.0037	1.8
Kent	560,695	0.0043	2.1
Kerr	564,352	0.0044	2.1

RTFs – Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Kimble	615,501	0.0048	2.3
King	546,693	0.0042	2.0
Kinney	613,634	0.0047	2.3
Kleberg	474,073	0.0037	1.8
Knox	564,263	0.0044	2.1
Lamar	470,216	0.0036	1.8
Lamb	628,505	0.0049	2.4
Lampasas	412,491	0.0032	1.5
La Salle	558,559	0.0043	2.1
Lavaca	601,698	0.0046	2.3
Lee	366,367	0.0028	1.4
Leon	562,615	0.0043	2.1
Liberty	304,574	0.0024	1.1
Limestone	529,924	0.0041	2.0
Lipscomb	578,025	0.0045	2.2
Live Oak	525,291	0.0041	2.0
Llano	533,234	0.0041	2.0
Loving	515,192	0.0040	1.9
Lubbock	557,182	0.0043	2.1
Lynn	530,475	0.0041	2.0
Mcculloch	555,597	0.0043	2.1
Mclennan	619,142	0.0048	2.3
Mcmullen	476,245	0.0037	1.8
Madison	546,293	0.0042	2.0
Marion	538,473	0.0042	2.0
Martin	596,900	0.0046	2.2
Mason	244,524	0.0019	0.9
Matagorda	59,602	0.0005	0.2
Maverick	526,007	0.0041	2.0
Medina	804,941	0.0062	3.0
Menard	548,838	0.0042	2.1
Midland	361,558	0.0028	1.4
Milam	576,809	0.0045	2.2
Mills	427,342	0.0033	1.6
Mitchell	487,922	0.0038	1.8
Montague	503,562	0.0039	1.9
Montgomery	197,892	0.0015	0.7
Moore	549,548	0.0042	2.1
Morris	99,674	0.0008	0.4
Motley	486,994	0.0038	1.8
Nacogdoches	273,880	0.0021	1.0
Navarro	537,104	0.0041	2.0
Newton	69,381	0.0005	0.3
Nolan	481,183	0.0037	1.8
Nueces	523,859	0.0040	2.0

RTFs – Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Ochiltree	559,479	0.0043	2.1
Oldham	936,390	0.0072	3.5
Orange	73,474	0.0006	0.3
Palo Pinto	484,964	0.0037	1.8
Panola	222,910	0.0017	0.8
Parker	486,658	0.0038	1.8
Parmer	576,461	0.0045	2.2
Pecos	2,916,070	0.0225	10.9
Polk	129,956	0.0010	0.5
Potter	521,824	0.0040	2.0
Presidio	1,503,639	0.0116	5.6
Rains	93,601	0.0007	0.4
Randall	512,309	0.0040	1.9
Reagan	538,285	0.0042	2.0
Real	399,963	0.0031	1.5
Red River	422,645	0.0033	1.6
Reeves	1,009,877	0.0078	3.8
Refugio	505,954	0.0039	1.9
Roberts	494,588	0.0038	1.9
Robertson	515,311	0.0040	1.9
Rockwall	46,419	0.0004	0.2
Runnels	584,878	0.0045	2.2
Rusk	272,436	0.0021	1.0
Sabine	30,808	0.0002	0.1
San Augustine	58,723	0.0005	0.2
San Jacinto	93,497	0.0007	0.4
San Patricio	345,395	0.0027	1.3
San Saba	709,336	0.0055	2.7
Schleicher	778,272	0.0060	2.9
Scurry	564,813	0.0044	2.1
Shackelford	557,102	0.0043	2.1
Shelby	192,036	0.0015	0.7
Sherman	546,237	0.0042	2.0
Smith	286,894	0.0022	1.1
Somervell	84,262	0.0007	0.3
Starr	570,430	0.0044	2.1
Stephens	427,859	0.0033	1.6
Sterling	633,007	0.0049	2.4
Stonewall	524,308	0.0041	2.0
Sutton	879,789	0.0068	3.3

RTFs – Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Swisher	566,429	0.0044	2.1
Tarrant	173,493	0.0013	0.7
Taylor	533,937	0.0041	2.0
Terrell	1,413,092	0.0109	5.3
Terry	444,996	0.0034	1.7
Throckmorton	561,306	0.0043	2.1
Titus	178,303	0.0014	0.7
Tom Green	844,695	0.0065	3.2
Travis	298,426	0.0023	1.1
Trinity	104,724	0.0008	0.4
Tyler	79,600	0.0006	0.3
Upshur	196,450	0.0015	0.7
Upton	723,446	0.0056	2.7
Uvalde	968,866	0.0075	3.6
Val Verde	1,661,161	0.0128	6.2
Van Zandt	422,084	0.0033	1.6
Victoria	513,828	0.0040	1.9
Walker	206,311	0.0016	0.8
Waller	277,000	0.0021	1.0
Ward	465,639	0.0036	1.7
Washington	354,813	0.0027	1.3
Webb	2,042,680	0.0158	7.7
Wharton	637,982	0.0049	2.4
Wheeler	533,569	0.0041	2.0
Wichita	301,574	0.0023	1.1
Wilbarger	872,488	0.0067	3.3
Willacy	369,893	0.0029	1.4
Williamson	583,099	0.0045	2.2
Wilson	446,157	0.0034	1.7
Winkler	491,718	0.0038	1.8
Wise	493,044	0.0038	1.8
Wood	228,146	0.0018	0.9
Yoakum	454,981	0.0035	1.7
Young	509,721	0.0039	1.9
Zapata	397,594	0.0031	1.5
Zavala	707,383	0.0055	2.7
Total	**129,448,957**		**485**

RTFs - Building Contractors Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.00043	0.5
Andrews	0.00021	0.2
Angelina	0.00412	4.4
Aransas	0.00092	1.0
Archer	0.00005	0.1
Armstrong	0.00004	0.0
Atascosa	0.00106	1.1
Austin	0.00110	1.2
Bailey	0.00016	0.2
Bandera	0.00031	0.3
Bastrop	0.00059	0.6
Baylor	0.00002	0.0
Bee	0.00025	0.3
Bell	0.00817	8.7
Bexar	0.06786	72.2
Blanco	0.00017	0.2
Borden	0.00001	0.0
Bosque	0.00039	0.4
Bowie	0.00219	2.3
Brazoria	0.04022	42.8
Brazos	0.00322	3.4
Brewster	0.00077	0.8
Briscoe	0.00000	0.0
Brooks	0.00003	0.0
Brown	0.00240	2.6
Burleson	0.00027	0.3
Burnet	0.00230	2.5
Caldwell	0.00036	0.4
Calhoun	0.00148	1.6
Callahan	0.00023	0.2
Cameron	0.00448	4.8
Camp	0.00043	0.5
Carson	0.00010	0.1
Cass	0.00021	0.2
Castro	0.00009	0.1
Chambers	0.00085	0.9
Cherokee	0.00046	0.5
Childress	0.00007	0.1
Clay	0.00009	0.1
Cochran	0.00009	0.1
Coke	0.00001	0.0
Coleman	0.00041	0.4
Collin	0.02666	28.4

RTFs - Building Contractors Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Collingsworth	0.00000	0.0
Colorado	0.00188	2.0
Comal	0.00380	4.0
Comanche	0.00009	0.1
Concho	0.00007	0.1
Cooke	0.00047	0.5
Coryell	0.00110	1.2
Cottle	0.00007	0.1
Crane	0.00004	0.0
Crockett	0.00003	0.0
Crosby	0.00002	0.0
Culberson	0.00004	0.0
Dallam	0.00069	0.7
Dallas	0.10673	113.6
Dawson	0.00014	0.1
Deaf Smith	0.00042	0.4
Delta	0.00002	0.0
Denton	0.01182	12.6
DeWitt	0.00020	0.2
Dickens	0.00000	0.0
Dimmit	0.00013	0.1
Donley	0.00001	0.0
Duval	0.00023	0.2
Eastland	0.00047	0.5
Ector	0.00583	6.2
Edwards	0.00003	0.0
Ellis	0.00290	3.1
El Paso	0.02343	24.9
Erath	0.00137	1.5
Falls	0.00011	0.1
Fannin	0.00028	0.3
Fayette	0.00111	1.2
Fisher	0.00000	0.0
Floyd	0.00010	0.1
Foard	0.00001	0.0
Fort Bend	0.01498	15.9
Franklin	0.00005	0.1
Freestone	0.00059	0.6
Frio	0.00008	0.1
Gaines	0.00045	0.5
Galveston	0.01324	14.1
Garza	0.00004	0.0
Gillespie	0.00163	1.7

RTFs - Building Contractors Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Glasscock	0.00004	0.0
Goliad	0.00005	0.1
Gonzales	0.00016	0.2
Gray	0.00019	0.2
Grayson	0.00277	3.0
Gregg	0.00301	3.2
Grimes	0.00053	0.6
Guadalupe	0.00676	7.2
Hale	0.00053	0.6
Hall	0.00008	0.1
Hamilton	0.00015	0.2
Hansford	0.00013	0.1
Hardeman	0.00002	0.0
Hardin	0.00918	9.8
Harris	0.26750	284.8
Harrison	0.00129	1.4
Hartley	0.00054	0.6
Haskell	0.00007	0.1
Hays	0.00383	4.1
Hemphill	0.00014	0.1
Henderson	0.00130	1.4
Hidalgo	0.00909	9.7
Hill	0.00014	0.2
Hockley	0.00049	0.5
Hood	0.00099	1.1
Hopkins	0.00212	2.3
Houston	0.00045	0.5
Howard	0.00023	0.2
Hudspeth	0.00002	0.0
Hunt	0.00067	0.7
Hutchinson	0.00227	2.4
Irion	0.00001	0.0
Jack	0.00012	0.1
Jackson	0.00027	0.3
Jasper	0.00156	1.7
Jeff Davis	0.00007	0.1
Jefferson	0.03417	36.4
Jim Hogg	0.00004	0.0
Jim Wells	0.00028	0.3
Johnson	0.00272	2.9
Jones	0.00005	0.1
Karnes	0.00007	0.1
Kaufman	0.00209	2.2
Kendall	0.00163	1.7

RTFs - Building Contractors Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kenedy	0.00006	0.1
Kent	0.00000	0.0
Kerr	0.00418	4.5
Kimble	0.00020	0.2
King	0.00000	0.0
Kinney	0.00011	0.1
Kleberg	0.00114	1.2
Knox	0.00003	0.0
Lamar	0.00199	2.1
Lamb	0.00015	0.2
Lampasas	0.00076	0.8
La Salle	0.00001	0.0
Lavaca	0.00040	0.4
Lee	0.00046	0.5
Leon	0.00453	4.8
Liberty	0.00123	1.3
Limestone	0.00032	0.3
Lipscomb	0.00001	0.0
Live Oak	0.00051	0.5
Llano	0.00150	1.6
Loving	0.00000	0.0
Lubbock	0.00522	5.6
Lynn	0.00001	0.0
McCulloch	0.00002	0.0
McLennan	0.00562	6.0
McMullen	0.00002	0.0
Madison	0.00035	0.4
Marion	0.00006	0.1
Martin	0.00002	0.0
Mason	0.00009	0.1
Matagorda	0.00073	0.8
Maverick	0.00032	0.3
Medina	0.00080	0.9
Menard	0.00001	0.0
Midland	0.00447	4.8
Milam	0.00617	6.6
Mills	0.00004	0.0
Mitchell	0.00054	0.6
Montague	0.00025	0.3
Montgomery	0.02139	22.8
Moore	0.00010	0.1
Morris	0.00016	0.2
Motley	0.00001	0.0
Nacogdoches	0.00137	1.5

RTFs - Building Contractors Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Navarro	0.00088	0.9
Newton	0.00010	0.1
Nolan	0.00016	0.2
Nueces	0.04135	44.0
Ochiltree	0.00010	0.1
Oldham	0.00003	0.0
Orange	0.00388	4.1
Palo Pinto	0.00031	0.3
Panola	0.00022	0.2
Parker	0.00239	2.5
Parmer	0.00018	0.2
Pecos	0.00019	0.2
Polk	0.00037	0.4
Potter	0.00448	4.8
Presidio	0.00021	0.2
Rains	0.00007	0.1
Randall	0.00238	2.5
Reagan	0.00001	0.0
Real	0.00020	0.2
Red River	0.00050	0.5
Reeves	0.00003	0.0
Refugio	0.00016	0.2
Roberts	0.00000	0.0
Robertson	0.00004	0.0
Rockwall	0.00177	1.9
Runnels	0.00021	0.2
Rusk	0.00263	2.8
Sabine	0.00055	0.6
San Augustine	0.00013	0.1
San Jacinto	0.00013	0.1
San Patricio	0.00164	1.7
San Saba	0.00002	0.0
Schleicher	0.00005	0.1
Scurry	0.00024	0.3
Shackelford	0.00001	0.0
Shelby	0.00044	0.5
Sherman	0.00004	0.0
Smith	0.00526	5.6
Somervell	0.00025	0.3
Starr	0.00032	0.3
Stephens	0.00015	0.2
Sterling	0.00000	0.0

RTFs - Building Contractors Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Stonewall	0.00009	0.1
Sutton	0.00013	0.1
Swisher	0.00004	0.0
Tarrant	0.05487	58.4
Taylor	0.00348	3.7
Terrell	0.00003	0.0
Terry	0.00005	0.1
Throckmorton	0.00001	0.0
Titus	0.00061	0.6
Tom Green	0.00161	1.7
Travis	0.04345	46.3
Trinity	0.00008	0.1
Tyler	0.00002	0.0
Upshur	0.00051	0.5
Upton	0.00004	0.0
Uvalde	0.00045	0.5
Val Verde	0.00051	0.5
Van Zandt	0.00092	1.0
Victoria	0.00504	5.4
Walker	0.00063	0.7
Waller	0.00037	0.4
Ward	0.00008	0.1
Washington	0.00124	1.3
Webb	0.00549	5.8
Wharton	0.00090	1.0
Wheeler	0.00023	0.2
Wichita	0.00209	2.2
Wilbarger	0.00018	0.2
Willacy	0.00010	0.1
Williamson	0.01002	10.7
Wilson	0.00063	0.7
Winkler	0.00006	0.1
Wise	0.00101	1.1
Wood	0.00109	1.2
Yoakum	0.00014	0.1
Young	0.00027	0.3
Zapata	0.00020	0.2
Zavala	0.00011	0.1
	Total	**1,065**

RTFs – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0004	0.3
Andrews	0.0005	0.3
Angelina	0.0053	3.6
Aransas	0.0001	0.0
Archer	0.0002	0.1
Armstrong	0.0000	0.0
Atascosa	0.0003	0.2
Austin	0.0022	1.5
Bailey	0.0001	0.1
Bandera	0.0001	0.0
Bastrop	0.0011	0.7
Baylor	0.0001	0.1
Bee	0.0002	0.1
Bell	0.0052	3.6
Bexar	0.0281	19.5
Blanco	0.0001	0.0
Borden	0.0000	0.0
Bosque	0.0005	0.3
Bowie	0.0024	1.6
Brazoria	0.0218	15.1
Brazos	0.0047	3.3
Brewster	0.0001	0.1
Briscoe	0.0000	0.0
Brooks	0.0000	0.0
Brown	0.0033	2.3
Burleson	0.0002	0.2
Burnet	0.0009	0.6
Caldwell	0.0003	0.2
Calhoun	0.0058	4.0
Callahan	0.0001	0.1
Cameron	0.0059	4.1
Camp	0.0002	0.1
Carson	0.0023	1.6
Cass	0.0012	0.8
Castro	0.0001	0.0
Chambers	0.0022	1.5
Cherokee	0.0030	2.1
Childress	0.0001	0.1
Clay	0.0004	0.2
Cochran	0.0000	0.0
Coke	0.0000	0.0
Coleman	0.0001	0.1
Collin	0.0332	23.0
Collingsworth	0.0000	0.0

RTFs – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0010	0.7
Comal	0.0025	1.7
Comanche	0.0001	0.1
Concho	0.0000	0.0
Cooke	0.0027	1.9
Coryell	0.0004	0.3
Cottle	0.0000	0.0
Crane	0.0001	0.1
Crockett	0.0000	0.0
Crosby	0.0000	0.0
Culberson	0.0001	0.1
Dallam	0.0002	0.1
Dallas	0.1658	114.9
Dawson	0.0001	0.1
Deaf Smith	0.0007	0.5
Delta	0.0000	0.0
Denton	0.0112	7.8
DeWitt	0.0011	0.7
Dickens	0.0000	0.0
Dimmit	0.0000	0.0
Donley	0.0000	0.0
Duval	0.0001	0.1
Eastland	0.0008	0.5
Ector	0.0038	2.7
Edwards	0.0000	0.0
Ellis	0.0087	6.0
El Paso	0.0163	11.3
Erath	0.0013	0.9
Falls	0.0001	0.1
Fannin	0.0005	0.3
Fayette	0.0010	0.7
Fisher	0.0001	0.0
Floyd	0.0001	0.1
Foard	0.0001	0.0
Fort Bend	0.0173	12.0
Franklin	0.0001	0.1
Freestone	0.0005	0.3
Frio	0.0000	0.0
Gaines	0.0001	0.1
Galveston	0.0101	7.0
Garza	0.0001	0.0
Gillespie	0.0006	0.4
Glasscock	0.0000	0.0
Goliad	0.0001	0.0

RTFs – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0008	0.6
Gray	0.0013	0.9
Grayson	0.0070	4.8
Gregg	0.0131	9.1
Grimes	0.0011	0.8
Guadalupe	0.0062	4.3
Hale	0.0021	1.5
Hall	0.0001	0.0
Hamilton	0.0002	0.1
Hansford	0.0001	0.0
Hardeman	0.0002	0.2
Hardin	0.0007	0.5
Harris	0.2026	140.4
Harrison	0.0038	2.6
Hartley	0.0000	0.0
Haskell	0.0000	0.0
Hays	0.0032	2.2
Hemphill	0.0000	0.0
Henderson	0.0016	1.1
Hidalgo	0.0053	3.6
Hill	0.0006	0.4
Hockley	0.0003	0.2
Hood	0.0004	0.3
Hopkins	0.0010	0.7
Houston	0.0005	0.3
Howard	0.0009	0.6
Hudspeth	0.0001	0.0
Hunt	0.0052	3.6
Hutchinson	0.0017	1.2
Irion	0.0000	0.0
Jack	0.0001	0.0
Jackson	0.0009	0.6
Jasper	0.0016	1.1
Jeff Davis	0.0000	0.0
Jefferson	0.0212	14.7
Jim Hogg	0.0000	0.0
Jim Wells	0.0004	0.3
Johnson	0.0053	3.6
Jones	0.0009	0.6
Karnes	0.0002	0.1
Kaufman	0.0030	2.0
Kendall	0.0007	0.5
Kenedy	0.0000	0.0
Kent	0.0000	0.0
Kerr	0.0008	0.6

RTFs – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0003	0.2
King	0.0000	0.0
Kinney	0.0000	0.0
Kleberg	0.0002	0.1
Knox	0.0000	0.0
Lamar	0.0039	2.7
Lamb	0.0008	0.6
Lampasas	0.0005	0.4
La Salle	0.0001	0.1
Lavaca	0.0015	1.0
Lee	0.0003	0.2
Leon	0.0003	0.2
Liberty	0.0019	1.3
Limestone	0.0009	0.6
Lipscomb	0.0001	0.1
Live Oak	0.0003	0.2
Llano	0.0001	0.1
Loving	0.0000	0.0
Lubbock	0.0045	3.1
Lynn	0.0001	0.1
McCulloch	0.0003	0.2
McLennan	0.0142	9.8
McMullen	0.0000	0.0
Madison	0.0001	0.1
Marion	0.0003	0.2
Martin	0.0000	0.0
Mason	0.0001	0.0
Matagorda	0.0006	0.4
Maverick	0.0003	0.2
Medina	0.0005	0.4
Menard	0.0000	0.0
Midland	0.0024	1.7
Milam	0.0018	1.3
Mills	0.0001	0.0
Mitchell	0.0000	0.0
Montague	0.0003	0.2
Montgomery	0.0089	6.2
Moore	0.0033	2.3
Morris	0.0023	1.6
Motley	0.0000	0.0
Nacogdoches	0.0024	1.7
Navarro	0.0026	1.8
Newton	0.0001	0.1
Nolan	0.0009	0.6
Nueces	0.0120	8.3

RTFs – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0000	0.0
Oldham	0.0000	0.0
Orange	0.0079	5.5
Palo Pinto	0.0019	1.3
Panola	0.0007	0.5
Parker	0.0020	1.4
Parmer	0.0016	1.1
Pecos	0.0001	0.0
Polk	0.0008	0.6
Potter	0.0052	3.6
Presidio	0.0000	0.0
Rains	0.0001	0.1
Randall	0.0017	1.2
Reagan	0.0003	0.2
Real	0.0000	0.0
Red River	0.0005	0.4
Reeves	0.0002	0.1
Refugio	0.0000	0.0
Roberts	0.0000	0.0
Robertson	0.0005	0.4
Rockwall	0.0014	0.9
Runnels	0.0005	0.4
Rusk	0.0012	0.8
Sabine	0.0004	0.3
San Augustine	0.0001	0.1
San Jacinto	0.0000	0.0
San Patricio	0.0023	1.6
San Saba	0.0000	0.0
Schleicher	0.0000	0.0
Scurry	0.0002	0.1
Shackelford	0.0000	0.0
Shelby	0.0019	1.3
Sherman	0.0000	0.0
Smith	0.0078	5.4
Somervell	0.0002	0.1
Starr	0.0001	0.1
Stephens	0.0004	0.3
Sterling	0.0000	0.0
Stonewall	0.0000	0.0
Sutton	0.0000	0.0

RTFs – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.0002	0.1
Tarrant	0.0782	54.2
Taylor	0.0020	1.4
Terrell	0.0000	0.0
Terry	0.0002	0.1
Throckmorton	0.0000	0.0
Titus	0.0061	4.2
Tom Green	0.0036	2.5
Travis	0.0887	61.5
Trinity	0.0002	0.1
Tyler	0.0001	0.1
Upshur	0.0003	0.2
Upton	0.0000	0.0
Uvalde	0.0004	0.3
Val Verde	0.0022	1.5
Van Zandt	0.0005	0.3
Victoria	0.0038	2.6
Walker	0.0008	0.5
Waller	0.0021	1.4
Ward	0.0002	0.1
Washington	0.0021	1.5
Webb	0.0012	0.9
Wharton	0.0015	1.0
Wheeler	0.0000	0.0
Wichita	0.0059	4.1
Wilbarger	0.0011	0.7
Willacy	0.0001	0.0
Williamson	0.0084	5.8
Wilson	0.0003	0.2
Winkler	0.0004	0.3
Wise	0.0016	1.1
Wood	0.0007	0.5
Yoakum	0.0001	0.1
Young	0.0010	0.7
Zapata	0.0000	0.0
Zavala	0.0002	0.2
	Total	**693**

RTFs - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0017	10.4
Andrews	0.0021	12.9
Angelina	0.0034	21.2
Aransas	0.0006	3.7
Archer	0.0002	1.5
Armstrong	0.0000	0.1
Atascosa	0.0006	3.7
Austin	0.0019	11.7
Bailey	0.0002	1.4
Bandera	0.0006	4.0
Bastrop	0.0014	8.7
Baylor	0.0001	0.5
Bee	0.0007	4.5
Bell	0.0059	36.9
Bexar	0.0689	432.8
Blanco	0.0008	5.2
Borden	0.0000	0.1
Bosque	0.0004	2.6
Bowie	0.0026	16.4
Brazoria	0.0114	71.7
Brazos	0.0061	38.4
Brewster	0.0003	1.8
Briscoe	0.0001	0.4
Brooks	0.0001	0.8
Brown	0.0012	7.6
Burleson	0.0008	4.8
Burnet	0.0018	11.2
Caldwell	0.0005	3.0
Calhoun	0.0029	18.2
Callahan	0.0001	0.6
Cameron	0.0075	46.8
Camp	0.0006	3.6
Carson	0.0001	0.5
Cass	0.0005	3.1
Castro	0.0000	0.3
Chambers	0.0007	4.6
Cherokee	0.0010	6.2
Childress	0.0001	0.8
Clay	0.0002	1.3
Cochran	0.0001	0.4
Coke	0.0000	0.2
Coleman	0.0003	1.8
Collin	0.0225	141.3
Collingsworth	0.0000	0.1

RTFs - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0009	5.7
Comal	0.0058	36.4
Comanche	0.0003	2.1
Concho	0.0000	0.2
Cooke	0.0030	18.9
Coryell	0.0011	7.0
Cottle	0.0000	0.3
Crane	0.0001	0.9
Crockett	0.0000	0.3
Crosby	0.0000	0.1
Culberson	0.0000	0.1
Dallam	0.0003	1.9
Dallas	0.1601	1005.4
Dawson	0.0004	2.6
Deaf Smith	0.0008	5.1
Delta	0.0001	0.3
Denton	0.0160	100.8
DeWitt	0.0006	4.0
Dickens	0.0001	0.4
Dimmit	0.0000	0.3
Donley	0.0000	0.1
Duval	0.0005	3.4
Eastland	0.0022	13.7
Ector	0.0066	41.7
Edwards	0.0000	0.2
Ellis	0.0047	29.5
El Paso	0.0197	123.6
Erath	0.0014	8.7
Falls	0.0002	1.1
Fannin	0.0008	5.0
Fayette	0.0010	6.0
Fisher	0.0000	0.2
Floyd	0.0001	0.4
Foard	0.0000	0.0
Fort Bend	0.0110	69.1
Franklin	0.0001	0.7
Freestone	0.0014	9.0
Frio	0.0002	1.3
Gaines	0.0006	3.8
Galveston	0.0092	57.5
Garza	0.0004	2.8
Gillespie	0.0016	9.8
Glasscock	0.0001	0.5
Goliad	0.0000	0.3

RTFs - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0002	1.1
Gray	0.0009	5.6
Grayson	0.0035	22.1
Gregg	0.0077	48.5
Grimes	0.0005	3.3
Guadalupe	0.0037	23.2
Hale	0.0010	6.6
Hall	0.0000	0.2
Hamilton	0.0008	5.0
Hansford	0.0002	1.5
Hardeman	0.0000	0.1
Hardin	0.0015	9.2
Harris	0.2168	1361.7
Harrison	0.0029	18.4
Hartley	0.0001	0.6
Haskell	0.0000	0.1
Hays	0.0051	31.8
Hemphill	0.0002	1.3
Henderson	0.0016	10.0
Hidalgo	0.0108	67.6
Hill	0.0007	4.7
Hockley	0.0011	6.7
Hood	0.0024	14.9
Hopkins	0.0017	10.6
Houston	0.0003	1.8
Howard	0.0010	6.2
Hudspeth	0.0000	0.1
Hunt	0.0026	16.6
Hutchinson	0.0031	19.5
Irion	0.0001	0.4
Jack	0.0002	1.4
Jackson	0.0012	7.3
Jasper	0.0011	7.1
Jeff Davis	0.0001	0.7
Jefferson	0.0164	102.8
Jim Hogg	0.0001	0.3
Jim Wells	0.0014	8.5
Johnson	0.0065	40.9
Jones	0.0003	1.9
Karnes	0.0002	0.9
Kaufman	0.0040	24.9
Kendall	0.0019	11.6
Kenedy	0.0002	1.0
Kent	0.0000	0.0
Kerr	0.0022	13.5

RTFs - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0002	1.0
King	0.0000	0.1
Kinney	0.0000	0.2
Kleberg	0.0005	3.0
Knox	0.0002	1.0
Lamar	0.0023	14.2
Lamb	0.0002	1.5
Lampasas	0.0015	9.2
La Salle	0.0000	0.1
Lavaca	0.0005	3.0
Lee	0.0012	7.5
Leon	0.0014	8.8
Liberty	0.0015	9.3
Limestone	0.0003	1.6
Lipscomb	0.0001	0.3
Live Oak	0.0003	1.8
Llano	0.0006	3.5
Loving	0.0000	0.0
Lubbock	0.0081	50.6
Lynn	0.0000	0.1
McCulloch	0.0001	0.7
McLennan	0.0109	68.2
McMullen	0.0000	0.1
Madison	0.0003	2.0
Marion	0.0001	0.4
Martin	0.0001	0.8
Mason	0.0001	0.7
Matagorda	0.0011	6.8
Maverick	0.0004	2.3
Medina	0.0009	5.4
Menard	0.0001	0.7
Midland	0.0051	32.2
Milam	0.0003	1.9
Mills	0.0000	0.3
Mitchell	0.0001	0.5
Montague	0.0007	4.6
Montgomery	0.0121	76.0
Moore	0.0009	5.9
Morris	0.0001	0.6
Motley	0.0000	0.1
Nacogdoches	0.0027	17.1
Navarro	0.0007	4.6
Newton	0.0000	0.2
Nolan	0.0005	3.0
Nueces	0.0124	77.9

RTFs - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0003	2.0
Oldham	0.0001	0.3
Orange	0.0026	16.1
Palo Pinto	0.0005	3.4
Panola	0.0017	10.9
Parker	0.0036	22.4
Parmer	0.0002	1.3
Pecos	0.0006	4.0
Polk	0.0007	4.4
Potter	0.0057	35.7
Presidio	0.0000	0.1
Rains	0.0004	2.4
Randall	0.0029	18.0
Reagan	0.0001	0.9
Real	0.0001	0.3
Red River	0.0004	2.3
Reeves	0.0001	0.5
Refugio	0.0005	3.1
Roberts	0.0000	0.1
Robertson	0.0002	1.2
Rockwall	0.0026	16.4
Runnels	0.0003	1.8
Rusk	0.0011	7.1
Sabine	0.0001	0.7
San Augustine	0.0000	0.3
San Jacinto	0.0001	0.9
San Patricio	0.0021	13.1
San Saba	0.0001	0.4
Schleicher	0.0001	0.5
Scurry	0.0011	6.6
Shackelford	0.0000	0.2
Shelby	0.0006	3.5
Sherman	0.0000	0.2
Smith	0.0069	43.0
Somervell	0.0001	0.6
Starr	0.0002	1.6
Stephens	0.0007	4.2
Sterling	0.0001	0.4
Stonewall	0.0001	0.7

RTFs - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Sutton	0.0008	5.3
Swisher	0.0001	0.5
Tarrant	0.0759	476.6
Taylor	0.0053	33.4
Terrell	0.0000	0.0
Terry	0.0003	2.0
Throckmorton	0.0000	0.3
Titus	0.0009	5.6
Tom Green	0.0032	20.1
Travis	0.0500	314.4
Trinity	0.0003	2.2
Tyler	0.0005	2.9
Upshur	0.0006	4.0
Upton	0.0000	0.2
Uvalde	0.0006	3.8
Val Verde	0.0011	7.2
Van Zandt	0.0023	14.7
Victoria	0.0035	21.9
Walker	0.0015	9.2
Waller	0.0016	10.3
Ward	0.0004	2.7
Washington	0.0017	10.9
Webb	0.0037	23.5
Wharton	0.0014	8.5
Wheeler	0.0003	1.9
Wichita	0.0038	24.0
Wilbarger	0.0002	1.2
Willacy	0.0001	0.4
Williamson	0.0202	127.0
Wilson	0.0010	6.0
Winkler	0.0003	1.7
Wise	0.0014	8.5
Wood	0.0009	5.6
Yoakum	0.0004	2.8
Young	0.0006	4.0
Zapata	0.0007	4.4
Zavala	0.0001	0.6
	Total	**6,281**

RTFs - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0007	1.6
Andrews	0.0002	0.5
Angelina	0.0010	2.4
Aransas	0.0007	1.5
Archer	0.0002	0.6
Armstrong	0.0000	0.1
Atascosa	0.0008	1.8
Austin	0.0007	1.6
Bailey	0.0001	0.2
Bandera	0.0004	0.9
Bastrop	0.0012	3.0
Baylor	0.0000	0.1
Bee	0.0003	0.8
Bell	0.0111	26.3
Bexar	0.0695	164.4
Blanco	0.0001	0.2
Borden	0.0000	0.0
Bosque	0.0001	0.3
Bowie	0.0044	10.4
Brazoria	0.0092	21.8
Brazos	0.0082	19.3
Brewster	0.0002	0.4
Briscoe	0.0000	0.0
Brooks	0.0001	0.2
Brown	0.0005	1.3
Burleson	0.0003	0.6
Burnet	0.0004	1.0
Caldwell	0.0006	1.5
Calhoun	0.0005	1.2
Callahan	0.0002	0.5
Cameron	0.0127	30.1
Camp	0.0001	0.3
Carson	0.0003	0.7
Cass	0.0003	0.7
Castro	0.0001	0.3
Chambers	0.0013	3.1
Cherokee	0.0003	0.7
Childress	0.0001	0.1
Clay	0.0002	0.4
Cochran	0.0000	0.1
Coke	0.0000	0.0
Coleman	0.0001	0.1
Collin	0.0244	57.7
Collingsworth	0.0000	0.1

RTFs - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0003	0.8
Comal	0.0031	7.4
Comanche	0.0001	0.4
Concho	0.0000	0.0
Cooke	0.0006	1.5
Coryell	0.0019	4.6
Cottle	0.0000	0.1
Crane	0.0000	0.1
Crockett	0.0001	0.3
Crosby	0.0002	0.6
Culberson	0.0000	0.0
Dallam	0.0001	0.3
Dallas	0.1588	375.7
Dawson	0.0002	0.5
Deaf Smith	0.0003	0.8
Delta	0.0001	0.2
Denton	0.0144	34.1
DeWitt	0.0003	0.7
Dickens	0.0000	0.0
Dimmit	0.0001	0.2
Donley	0.0000	0.1
Duval	0.0003	0.7
Eastland	0.0003	0.6
Ector	0.0079	18.8
Edwards	0.0000	0.0
Ellis	0.0038	8.9
El Paso	0.0221	52.2
Erath	0.0008	1.8
Falls	0.0001	0.2
Fannin	0.0002	0.6
Fayette	0.0003	0.7
Fisher	0.0000	0.1
Floyd	0.0001	0.2
Foard	0.0000	0.0
Fort Bend	0.0135	31.9
Franklin	0.0002	0.5
Freestone	0.0002	0.6
Frio	0.0001	0.3
Gaines	0.0002	0.4
Galveston	0.0100	23.6
Garza	0.0001	0.1
Gillespie	0.0003	0.8
Glasscock	0.0000	0.0
Goliad	0.0001	0.3

RTFs - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0002	0.5
Gray	0.0005	1.2
Grayson	0.0039	9.2
Gregg	0.0067	15.8
Grimes	0.0001	0.3
Guadalupe	0.0024	5.6
Hale	0.0006	1.5
Hall	0.0000	0.0
Hamilton	0.0001	0.2
Hansford	0.0001	0.2
Hardeman	0.0001	0.1
Hardin	0.0010	2.4
Harris	0.2062	487.7
Harrison	0.0009	2.1
Hartley	0.0000	0.0
Haskell	0.0001	0.2
Hays	0.0032	7.7
Hemphill	0.0001	0.2
Henderson	0.0006	1.4
Hidalgo	0.0138	32.6
Hill	0.0003	0.7
Hockley	0.0015	3.6
Hood	0.0006	1.4
Hopkins	0.0004	0.8
Houston	0.0002	0.5
Howard	0.0005	1.2
Hudspeth	0.0000	0.0
Hunt	0.0021	5.0
Hutchinson	0.0003	0.7
Irion	0.0000	0.1
Jack	0.0000	0.1
Jackson	0.0001	0.3
Jasper	0.0003	0.8
Jeff Davis	0.0000	0.1
Jefferson	0.0131	30.9
Jim Hogg	0.0001	0.3
Jim Wells	0.0005	1.3
Johnson	0.0028	6.7
Jones	0.0004	0.9
Karnes	0.0001	0.3
Kaufman	0.0017	4.1
Kendall	0.0013	3.0
Kenedy	0.0000	0.1
Kent	0.0000	0.0
Kerr	0.0012	2.8

RTFs - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0001	0.1
King	0.0000	0.0
Kinney	0.0000	0.1
Kleberg	0.0005	1.2
Knox	0.0001	0.1
Lamar	0.0007	1.5
Lamb	0.0001	0.3
Lampasas	0.0008	1.8
La Salle	0.0000	0.1
Lavaca	0.0003	0.6
Lee	0.0002	0.4
Leon	0.0002	0.5
Liberty	0.0014	3.3
Limestone	0.0002	0.5
Lipscomb	0.0000	0.1
Live Oak	0.0001	0.3
Llano	0.0002	0.5
Loving	0.0000	0.0
Lubbock	0.0148	35.1
Lynn	0.0000	0.1
McCulloch	0.0001	0.2
McLennan	0.0130	30.6
McMullen	0.0000	0.0
Madison	0.0001	0.3
Marion	0.0001	0.1
Martin	0.0001	0.1
Mason	0.0001	0.1
Matagorda	0.0005	1.2
Maverick	0.0003	0.6
Medina	0.0006	1.4
Menard	0.0000	0.1
Midland	0.0067	15.8
Milam	0.0004	0.9
Mills	0.0000	0.1
Mitchell	0.0001	0.2
Montague	0.0002	0.4
Montgomery	0.0159	37.7
Moore	0.0004	0.9
Morris	0.0002	0.4
Motley	0.0000	0.1
Nacogdoches	0.0007	1.6
Navarro	0.0006	1.3
Newton	0.0000	0.1
Nolan	0.0002	0.4
Nueces	0.0171	40.4

RTFs - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0002	0.5
Oldham	0.0000	0.1
Orange	0.0023	5.5
Palo Pinto	0.0004	1.0
Panola	0.0002	0.5
Parker	0.0021	5.1
Parmer	0.0001	0.4
Pecos	0.0001	0.3
Polk	0.0006	1.3
Potter	0.0098	23.1
Presidio	0.0000	0.1
Rains	0.0001	0.1
Randall	0.0029	6.9
Reagan	0.0001	0.1
Real	0.0000	0.0
Red River	0.0001	0.2
Reeves	0.0001	0.3
Refugio	0.0001	0.2
Roberts	0.0000	0.0
Robertson	0.0002	0.4
Rockwall	0.0027	6.4
Runnels	0.0001	0.2
Rusk	0.0012	2.8
Sabine	0.0001	0.1
San Augustine	0.0001	0.1
San Jacinto	0.0002	0.4
San Patricio	0.0012	2.9
San Saba	0.0001	0.2
Schleicher	0.0000	0.1
Scurry	0.0003	0.8
Shackelford	0.0000	0.1
Shelby	0.0003	0.6
Sherman	0.0001	0.2
Smith	0.0124	29.2
Somervell	0.0002	0.5
Starr	0.0008	1.8
Stephens	0.0001	0.2
Sterling	0.0000	0.1
Stonewall	0.0001	0.1
Sutton	0.0001	0.2

RTFs - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.0001	0.2
Tarrant	0.0857	202.7
Taylor	0.0082	19.5
Terrell	0.0000	0.0
Terry	0.0001	0.3
Throckmorton	0.0000	0.1
Titus	0.0003	0.8
Tom Green	0.0056	13.3
Travis	0.0800	189.2
Trinity	0.0003	0.6
Tyler	0.0001	0.2
Upshur	0.0003	0.8
Upton	0.0000	0.0
Uvalde	0.0003	0.8
Val Verde	0.0004	1.0
Van Zandt	0.0003	0.8
Victoria	0.0042	9.9
Walker	0.0008	1.8
Waller	0.0004	1.0
Ward	0.0001	0.2
Washington	0.0005	1.2
Webb	0.0050	11.8
Wharton	0.0007	1.5
Wheeler	0.0001	0.1
Wichita	0.0086	20.4
Wilbarger	0.0002	0.5
Willacy	0.0003	0.7
Williamson	0.0164	38.8
Wilson	0.0003	0.8
Winkler	0.0001	0.2
Wise	0.0010	2.4
Wood	0.0006	1.4
Yoakum	0.0001	0.2
Young	0.0002	0.5
Zapata	0.0005	1.2
Zavala	0.0001	0.2
	Total	**2,365**

RTFs - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0002	0.9
Andrews	0.0001	0.4
Angelina	0.0001	0.4
Aransas	0.0001	0.4
Archer	0.0000	0.0
Armstrong	0.0000	0.0
Atascosa	0.0009	5.0
Austin	0.0111	64.4
Bailey	0.0001	0.4
Bandera	0.0000	0.0
Bastrop	0.0602	348.4
Baylor	0.0001	0.5
Bee	0.0001	0.7
Bell	0.0019	11.0
Bexar	0.0065	37.6
Blanco	0.0000	0.3
Borden	0.0000	0.0
Bosque	0.0025	14.5
Bowie	0.0004	2.2
Brazoria	0.0038	22.3
Brazos	0.0036	20.9
Brewster	0.0003	1.8
Briscoe	0.0000	0.1
Brooks	0.0000	0.1
Brown	0.1684	974.9
Burleson	0.0002	1.3
Burnet	0.0003	1.7
Caldwell	0.0002	1.4
Calhoun	0.0011	6.2
Callahan	0.0000	0.3
Cameron	0.0028	16.5
Camp	0.0004	2.3
Carson	0.0000	0.0
Cass	0.0000	0.2
Castro	0.0000	0.2
Chambers	0.0000	0.1
Cherokee	0.0008	4.4
Childress	0.0001	0.4
Clay	0.0001	0.5
Cochran	0.0000	0.0
Coke	0.0000	0.0
Coleman	0.0010	5.7
Collin	0.0030	17.5
Collingsworth	0.0000	0.1

RTFs - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0000	0.3
Comal	0.0010	5.6
Comanche	0.0001	0.6
Concho	0.0000	0.1
Cooke	0.0000	0.0
Coryell	0.0000	0.1
Cottle	0.0000	0.2
Crane	0.0000	0.0
Crockett	0.0000	0.0
Crosby	0.0000	0.0
Culberson	0.0006	3.3
Dallam	0.0002	0.9
Dallas	0.2453	1420.0
Dawson	0.0001	0.4
Deaf Smith	0.0004	2.2
Delta	0.0000	0.0
Denton	0.0077	44.4
DeWitt	0.0005	3.0
Dickens	0.0000	0.0
Dimmit	0.0000	0.1
Donley	0.0000	0.0
Duval	0.0000	0.0
Eastland	0.0009	5.4
Ector	0.0023	13.1
Edwards	0.0000	0.1
Ellis	0.0070	40.7
El Paso	0.0305	176.3
Erath	0.0114	66.2
Falls	0.0001	0.5
Fannin	0.0003	1.6
Fayette	0.0006	3.2
Fisher	0.0001	0.3
Floyd	0.0001	0.4
Foard	0.0001	0.3
Fort Bend	0.0044	25.3
Franklin	0.0011	6.2
Freestone	0.0021	12.3
Frio	0.0000	0.1
Gaines	0.0000	0.3
Galveston	0.0007	3.8
Garza	0.0000	0.0
Gillespie	0.0001	0.7
Glasscock	0.0000	0.0
Goliad	0.0001	0.3

RTFs - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0021	12.4
Gray	0.0000	0.2
Grayson	0.0007	4.1
Gregg	0.0041	23.5
Grimes	0.0003	1.5
Guadalupe	0.0078	45.2
Hale	0.0004	2.2
Hall	0.0001	0.3
Hamilton	0.0001	0.6
Hansford	0.0001	0.3
Hardeman	0.0002	1.0
Hardin	0.0007	4.1
Harris	0.0165	95.5
Harrison	0.0693	401.4
Hartley	0.0000	0.0
Haskell	0.0000	0.1
Hays	0.0104	60.0
Hemphill	0.0000	0.1
Henderson	0.0269	155.5
Hidalgo	0.0008	4.8
Hill	0.0055	31.8
Hockley	0.0002	1.2
Hood	0.0018	10.5
Hopkins	0.0001	0.3
Houston	0.0002	1.1
Howard	0.0006	3.6
Hudspeth	0.0010	5.8
Hunt	0.0001	0.7
Hutchinson	0.0007	4.0
Irion	0.0000	0.0
Jack	0.0000	0.0
Jackson	0.0004	2.2
Jasper	0.0000	0.2
Jeff Davis	0.0000	0.0
Jefferson	0.0004	2.2
Jim Hogg	0.0000	0.2
Jim Wells	0.0003	1.5
Johnson	0.0183	106.0
Jones	0.0003	1.7
Karnes	0.0002	0.9
Kaufman	0.0006	3.5
Kendall	0.0005	3.0
Kenedy	0.0000	0.0
Kent	0.0000	0.0
Kerr	0.0001	0.4

RTFs - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0001	0.7
King	0.0000	0.0
Kinney	0.0000	0.0
Kleberg	0.0001	0.9
Knox	0.0000	0.2
Lamar	0.0001	0.3
Lamb	0.0006	3.6
Lampasas	0.0004	2.2
La Salle	0.0001	0.5
Lavaca	0.0005	3.1
Lee	0.0002	1.1
Leon	0.0001	0.8
Liberty	0.0011	6.4
Limestone	0.0023	13.6
Lipscomb	0.0001	0.6
Live Oak	0.0002	1.4
Llano	0.0007	4.0
Loving	0.0000	0.0
Lubbock	0.0003	1.5
Lynn	0.0000	0.0
McCulloch	0.0000	0.1
McLennan	0.0125	72.4
McMullen	0.0000	0.0
Madison	0.0001	0.6
Marion	0.0002	1.2
Martin	0.0000	0.1
Mason	0.0001	0.3
Matagorda	0.0000	0.1
Maverick	0.0001	0.7
Medina	0.0070	40.8
Menard	0.0000	0.0
Midland	0.0001	0.6
Milam	0.0036	20.8
Mills	0.0000	0.1
Mitchell	0.0000	0.2
Montague	0.0000	0.1
Montgomery	0.0066	38.0
Moore	0.0005	2.7
Morris	0.0011	6.3
Motley	0.0000	0.1
Nacogdoches	0.0020	11.4
Navarro	0.0200	115.8
Newton	0.0000	0.2
Nolan	0.0001	0.3
Nueces	0.0011	6.4

RTFs - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0000	0.2
Oldham	0.0000	0.0
Orange	0.0012	7.0
Palo Pinto	0.0153	88.3
Panola	0.0002	1.1
Parker	0.0029	16.7
Parmer	0.0004	2.3
Pecos	0.0000	0.0
Polk	0.0005	2.7
Potter	0.0041	23.7
Presidio	0.0000	0.1
Rains	0.0001	0.8
Randall	0.0177	102.2
Reagan	0.0003	1.6
Real	0.0000	0.1
Red River	0.0002	1.3
Reeves	0.0001	0.6
Refugio	0.0000	0.0
Roberts	0.0000	0.0
Robertson	0.0003	1.9
Rockwall	0.0006	3.7
Runnels	0.0002	1.1
Rusk	0.0001	0.4
Sabine	0.0002	1.2
San Augustine	0.0001	0.3
San Jacinto	0.0000	0.1
San Patricio	0.0007	4.2
San Saba	0.0000	0.2
Schleicher	0.0000	0.0
Scurry	0.0003	1.7
Shackelford	0.0000	0.1
Shelby	0.0007	4.0
Sherman	0.0000	0.1
Smith	0.0149	86.5
Somervell	0.0000	0.0
Starr	0.0001	0.6
Stephens	0.0002	1.3
Sterling	0.0000	0.1
Stonewall	0.0000	0.0
Sutton	0.0000	0.1

RTFs - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.0001	0.7
Tarrant	0.0161	93.1
Taylor	0.0001	0.6
Terrell	0.0000	0.1
Terry	0.0002	1.1
Throckmorton	0.0000	0.0
Titus	0.0000	0.1
Tom Green	0.0002	1.2
Travis	0.0148	85.6
Trinity	0.0001	0.5
Tyler	0.0001	0.6
Upshur	0.0009	5.3
Upton	0.0000	0.0
Uvalde	0.0002	1.1
Val Verde	0.0011	6.3
Van Zandt	0.0012	7.2
Victoria	0.0001	0.5
Walker	0.0006	3.3
Waller	0.0000	0.1
Ward	0.0002	0.9
Washington	0.0000	0.2
Webb	0.0001	0.6
Wharton	0.0007	4.3
Wheeler	0.0000	0.3
Wichita	0.0556	322.0
Wilbarger	0.0000	0.0
Willacy	0.0000	0.3
Williamson	0.0201	116.6
Wilson	0.0002	1.1
Winkler	0.0004	2.2
Wise	0.0027	15.6
Wood	0.0001	0.8
Yoakum	0.0001	0.8
Young	0.0000	0.1
Zapata	0.0000	0.1
Zavala	0.0001	0.6
	Total	**5,788**

Trenchers - Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Anderson	365,182	0.0028	1.4
Andrews	803,998	0.0062	3.0
Angelina	116,769	0.0009	0.4
Aransas	50,032	0.0004	0.2
Archer	535,965	0.0041	2.0
Armstrong	506,308	0.0039	1.9
Atascosa	669,890	0.0052	2.5
Austin	367,497	0.0028	1.4
Bailey	394,475	0.0030	1.5
Bandera	366,827	0.0028	1.4
Bastrop	422,852	0.0033	1.6
Baylor	327,716	0.0025	1.2
Bee	509,544	0.0039	1.9
Bell	450,923	0.0035	1.7
Bexar	441,206	0.0034	1.7
Blanco	389,282	0.0030	1.5
Borden	480,015	0.0037	1.8
Bosque	562,851	0.0043	2.1
Bowie	307,531	0.0024	1.2
Brazoria	613,891	0.0047	2.3
Brazos	308,814	0.0024	1.2
Brewster	1,675,564	0.0129	6.3
Briscoe	425,565	0.0033	1.6
Brooks	439,771	0.0034	1.6
Brown	481,936	0.0037	1.8
Burleson	388,982	0.0030	1.5
Burnet	565,413	0.0044	2.1
Caldwell	304,844	0.0024	1.1
Calhoun	247,827	0.0019	0.9
Callahan	515,396	0.0040	1.9
Cameron	350,437	0.0027	1.3
Camp	69,343	0.0005	0.3
Carson	451,669	0.0035	1.7
Cass	193,244	0.0015	0.7
Castro	563,538	0.0044	2.1
Chambers	274,853	0.0021	1.0
Cherokee	286,306	0.0022	1.1
Childress	368,782	0.0028	1.4
Clay	654,342	0.0051	2.5
Cochran	439,252	0.0034	1.6
Coke	485,397	0.0037	1.8
Coleman	642,263	0.0050	2.4
Collin	309,630	0.0024	1.2
Collingsworth	506,942	0.0039	1.9

Trenchers - Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Colorado	538,635	0.0042	2.0
Comal	203,291	0.0016	0.8
Comanche	543,386	0.0042	2.0
Concho	544,312	0.0042	2.0
Cooke	458,775	0.0035	1.7
Coryell	493,087	0.0038	1.8
Cottle	574,177	0.0044	2.2
Crane	561,912	0.0043	2.1
Crockett	1,735,476	0.0134	6.5
Crosby	489,613	0.0038	1.8
Culberson	1,694,512	0.0131	6.4
Dallam	884,166	0.0068	3.3
Dallas	89,112	0.0007	0.3
Dawson	572,422	0.0044	2.1
Deaf Smith	964,347	0.0074	3.6
Delta	141,992	0.0011	0.5
Denton	349,093	0.0027	1.3
Dewitt	576,896	0.0045	2.2
Dickens	567,096	0.0044	2.1
Dimmit	570,684	0.0044	2.1
Donley	584,340	0.0045	2.2
Duval	850,360	0.0066	3.2
Eastland	498,047	0.0038	1.9
Ector	503,781	0.0039	1.9
Edwards	973,512	0.0075	3.6
Ellis	464,039	0.0036	1.7
El Paso	113,948	0.0009	0.4
Erath	580,627	0.0045	2.2
Falls	408,692	0.0032	1.5
Fannin	483,446	0.0037	1.8
Fayette	552,414	0.0043	2.1
Fisher	479,270	0.0037	1.8
Floyd	573,794	0.0044	2.2
Foard	286,492	0.0022	1.1
Fort Bend	415,251	0.0032	1.6
Franklin	132,241	0.0010	0.5
Freestone	429,339	0.0033	1.6
Frio	603,119	0.0047	2.3
Gaines	758,896	0.0059	2.8
Galveston	127,280	0.0010	0.5
Garza	499,552	0.0039	1.9
Gillespie	645,422	0.0050	2.4
Glasscock	492,939	0.0038	1.8
Goliad	506,019	0.0039	1.9

Trenchers - Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Gonzales	695,774	0.0054	2.6
Gray	452,820	0.0035	1.7
Grayson	441,246	0.0034	1.7
Gregg	46,660	0.0004	0.2
Grimes	414,887	0.0032	1.6
Guadalupe	384,824	0.0030	1.4
Hale	605,020	0.0047	2.3
Hall	431,782	0.0033	1.6
Hamilton	449,671	0.0035	1.7
Hansford	593,063	0.0046	2.2
Hardeman	345,897	0.0027	1.3
Hardin	68,512	0.0005	0.3
Harris	304,868	0.0024	1.1
Harrison	229,272	0.0018	0.9
Hartley	789,289	0.0061	3.0
Haskell	491,957	0.0038	1.8
Hays	278,352	0.0022	1.0
Hemphill	546,373	0.0042	2.0
Henderson	340,869	0.0026	1.3
Hidalgo	593,158	0.0046	2.2
Hill	504,322	0.0039	1.9
Hockley	491,498	0.0038	1.8
Hood	202,131	0.0016	0.8
Hopkins	431,411	0.0033	1.6
Houston	464,706	0.0036	1.7
Howard	518,369	0.0040	1.9
Hudspeth	2,121,727	0.0164	8.0
Hunt	400,272	0.0031	1.5
Hutchinson	552,995	0.0043	2.1
Irion	536,292	0.0041	2.0
Jack	596,172	0.0046	2.2
Jackson	470,500	0.0036	1.8
Jasper	96,286	0.0007	0.4
Jeff Davis	1,488,732	0.0115	5.6
Jefferson	388,239	0.0030	1.5
Jim Hogg	603,511	0.0047	2.3
Jim Wells	497,880	0.0038	1.9
Johnson	362,004	0.0028	1.4
Jones	517,244	0.0040	1.9
Karnes	474,806	0.0037	1.8
Kaufman	419,553	0.0032	1.6
Kendall	326,956	0.0025	1.2
Kenedy	474,073	0.0037	1.8
Kent	560,695	0.0043	2.1
Kerr	564,352	0.0044	2.1

Trenchers - Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Kimble	615,501	0.0048	2.3
King	546,693	0.0042	2.0
Kinney	613,634	0.0047	2.3
Kleberg	474,073	0.0037	1.8
Knox	564,263	0.0044	2.1
Lamar	470,216	0.0036	1.8
Lamb	628,505	0.0049	2.4
Lampasas	412,491	0.0032	1.5
La Salle	558,559	0.0043	2.1
Lavaca	601,698	0.0046	2.3
Lee	366,367	0.0028	1.4
Leon	562,615	0.0043	2.1
Liberty	304,574	0.0024	1.1
Limestone	529,924	0.0041	2.0
Lipscomb	578,025	0.0045	2.2
Live Oak	525,291	0.0041	2.0
Llano	533,234	0.0041	2.0
Loving	515,192	0.0040	1.9
Lubbock	557,182	0.0043	2.1
Lynn	530,475	0.0041	2.0
Mcculloch	555,597	0.0043	2.1
Mclennan	619,142	0.0048	2.3
Mcmullen	476,245	0.0037	1.8
Madison	546,293	0.0042	2.0
Marion	538,473	0.0042	2.0
Martin	596,900	0.0046	2.2
Mason	244,524	0.0019	0.9
Matagorda	59,602	0.0005	0.2
Maverick	526,007	0.0041	2.0
Medina	804,941	0.0062	3.0
Menard	548,838	0.0042	2.1
Midland	361,558	0.0028	1.4
Milam	576,809	0.0045	2.2
Mills	427,342	0.0033	1.6
Mitchell	487,922	0.0038	1.8
Montague	503,562	0.0039	1.9
Montgomery	197,892	0.0015	0.7
Moore	549,548	0.0042	2.1
Morris	99,674	0.0008	0.4
Motley	486,994	0.0038	1.8
Nacogdoches	273,880	0.0021	1.0
Navarro	537,104	0.0041	2.0
Newton	69,381	0.0005	0.3
Nolan	481,183	0.0037	1.8
Nueces	523,859	0.0040	2.0

Trenchers - Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Ochiltree	559,479	0.0043	2.1
Oldham	936,390	0.0072	3.5
Orange	73,474	0.0006	0.3
Palo Pinto	484,964	0.0037	1.8
Panola	222,910	0.0017	0.8
Parker	486,658	0.0038	1.8
Parmer	576,461	0.0045	2.2
Pecos	2,916,070	0.0225	10.9
Polk	129,956	0.0010	0.5
Potter	521,824	0.0040	2.0
Presidio	1,503,639	0.0116	5.6
Rains	93,601	0.0007	0.4
Randall	512,309	0.0040	1.9
Reagan	538,285	0.0042	2.0
Real	399,963	0.0031	1.5
Red River	422,645	0.0033	1.6
Reeves	1,009,877	0.0078	3.8
Refugio	505,954	0.0039	1.9
Roberts	494,588	0.0038	1.9
Robertson	515,311	0.0040	1.9
Rockwall	46,419	0.0004	0.2
Runnels	584,878	0.0045	2.2
Rusk	272,436	0.0021	1.0
Sabine	30,808	0.0002	0.1
San Augustine	58,723	0.0005	0.2
San Jacinto	93,497	0.0007	0.4
San Patricio	345,395	0.0027	1.3
San Saba	709,336	0.0055	2.7
Schleicher	778,272	0.0060	2.9
Scurry	564,813	0.0044	2.1
Shackelford	557,102	0.0043	2.1
Shelby	192,036	0.0015	0.7
Sherman	546,237	0.0042	2.0
Smith	286,894	0.0022	1.1
Somervell	84,262	0.0007	0.3
Starr	570,430	0.0044	2.1
Stephens	427,859	0.0033	1.6
Sterling	633,007	0.0049	2.4
Stonewall	524,308	0.0041	2.0
Sutton	879,789	0.0068	3.3

Trenchers - Agricultural Stratum			
2002 Land in farms basis			
County	**Acres**	**Fraction**	**Pop**
Swisher	566,429	0.0044	2.1
Tarrant	173,493	0.0013	0.7
Taylor	533,937	0.0041	2.0
Terrell	1,413,092	0.0109	5.3
Terry	444,996	0.0034	1.7
Throckmorton	561,306	0.0043	2.1
Titus	178,303	0.0014	0.7
Tom Green	844,695	0.0065	3.2
Travis	298,426	0.0023	1.1
Trinity	104,724	0.0008	0.4
Tyler	79,600	0.0006	0.3
Upshur	196,450	0.0015	0.7
Upton	723,446	0.0056	2.7
Uvalde	968,866	0.0075	3.6
Val Verde	1,661,161	0.0128	6.2
Van Zandt	422,084	0.0033	1.6
Victoria	513,828	0.0040	1.9
Walker	206,311	0.0016	0.8
Waller	277,000	0.0021	1.0
Ward	465,639	0.0036	1.7
Washington	354,813	0.0027	1.3
Webb	2,042,680	0.0158	7.7
Wharton	637,982	0.0049	2.4
Wheeler	533,569	0.0041	2.0
Wichita	301,574	0.0023	1.1
Wilbarger	872,488	0.0067	3.3
Willacy	369,893	0.0029	1.4
Williamson	583,099	0.0045	2.2
Wilson	446,157	0.0034	1.7
Winkler	491,718	0.0038	1.8
Wise	493,044	0.0038	1.8
Wood	228,146	0.0018	0.9
Yoakum	454,981	0.0035	1.7
Young	509,721	0.0039	1.9
Zapata	397,594	0.0031	1.5
Zavala	707,383	0.0055	2.7
Total	**129,448,957**		**485**

Trenchers - Building Contractor Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.00043	0.5
Andrews	0.00021	0.2
Angelina	0.00412	4.4
Aransas	0.00092	1.0
Archer	0.00005	0.1
Armstrong	0.00004	0.0
Atascosa	0.00106	1.1
Austin	0.00110	1.2
Bailey	0.00016	0.2
Bandera	0.00031	0.3
Bastrop	0.00059	0.6
Baylor	0.00002	0.0
Bee	0.00025	0.3
Bell	0.00817	8.7
Bexar	0.06786	72.2
Blanco	0.00017	0.2
Borden	0.00001	0.0
Bosque	0.00039	0.4
Bowie	0.00219	2.3
Brazoria	0.04022	42.8
Brazos	0.00322	3.4
Brewster	0.00077	0.8
Briscoe	0.00000	0.0
Brooks	0.00003	0.0
Brown	0.00240	2.6
Burleson	0.00027	0.3
Burnet	0.00230	2.5
Caldwell	0.00036	0.4
Calhoun	0.00148	1.6
Callahan	0.00023	0.2
Cameron	0.00448	4.8
Camp	0.00043	0.5
Carson	0.00010	0.1
Cass	0.00021	0.2
Castro	0.00009	0.1
Chambers	0.00085	0.9
Cherokee	0.00046	0.5
Childress	0.00007	0.1
Clay	0.00009	0.1
Cochran	0.00009	0.1
Coke	0.00001	0.0
Coleman	0.00041	0.4
Collin	0.02666	28.4
Collingsworth	0.00000	0.0

Trenchers - Building Contractor Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.00188	2.0
Comal	0.00380	4.0
Comanche	0.00009	0.1
Concho	0.00007	0.1
Cooke	0.00047	0.5
Coryell	0.00110	1.2
Cottle	0.00007	0.1
Crane	0.00004	0.0
Crockett	0.00003	0.0
Crosby	0.00002	0.0
Culberson	0.00004	0.0
Dallam	0.00069	0.7
Dallas	0.10673	113.6
Dawson	0.00014	0.1
Deaf Smith	0.00042	0.4
Delta	0.00002	0.0
Denton	0.01182	12.6
DeWitt	0.00020	0.2
Dickens	0.00000	0.0
Dimmit	0.00013	0.1
Donley	0.00001	0.0
Duval	0.00023	0.2
Eastland	0.00047	0.5
Ector	0.00583	6.2
Edwards	0.00003	0.0
Ellis	0.00290	3.1
El Paso	0.02343	24.9
Erath	0.00137	1.5
Falls	0.00011	0.1
Fannin	0.00028	0.3
Fayette	0.00111	1.2
Fisher	0.00000	0.0
Floyd	0.00010	0.1
Foard	0.00001	0.0
Fort Bend	0.01498	15.9
Franklin	0.00005	0.1
Freestone	0.00059	0.6
Frio	0.00008	0.1
Gaines	0.00045	0.5
Galveston	0.01324	14.1
Garza	0.00004	0.0
Gillespie	0.00163	1.7
Glasscock	0.00004	0.0
Goliad	0.00005	0.1

Trenchers - Building Contractor Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.00016	0.2
Gray	0.00019	0.2
Grayson	0.00277	3.0
Gregg	0.00301	3.2
Grimes	0.00053	0.6
Guadalupe	0.00676	7.2
Hale	0.00053	0.6
Hall	0.00008	0.1
Hamilton	0.00015	0.2
Hansford	0.00013	0.1
Hardeman	0.00002	0.0
Hardin	0.00918	9.8
Harris	0.26750	284.8
Harrison	0.00129	1.4
Hartley	0.00054	0.6
Haskell	0.00007	0.1
Hays	0.00383	4.1
Hemphill	0.00014	0.1
Henderson	0.00130	1.4
Hidalgo	0.00909	9.7
Hill	0.00014	0.2
Hockley	0.00049	0.5
Hood	0.00099	1.1
Hopkins	0.00212	2.3
Houston	0.00045	0.5
Howard	0.00023	0.2
Hudspeth	0.00002	0.0
Hunt	0.00067	0.7
Hutchinson	0.00227	2.4
Irion	0.00001	0.0
Jack	0.00012	0.1
Jackson	0.00027	0.3
Jasper	0.00156	1.7
Jeff Davis	0.00007	0.1
Jefferson	0.03417	36.4
Jim Hogg	0.00004	0.0
Jim Wells	0.00028	0.3
Johnson	0.00272	2.9
Jones	0.00005	0.1
Karnes	0.00007	0.1
Kaufman	0.00209	2.2
Kendall	0.00163	1.7
Kenedy	0.00006	0.1
Kent	0.00000	0.0
Kerr	0.00418	4.5

Trenchers - Building Contractor Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.00020	0.2
King	0.00000	0.0
Kinney	0.00011	0.1
Kleberg	0.00114	1.2
Knox	0.00003	0.0
Lamar	0.00199	2.1
Lamb	0.00015	0.2
Lampasas	0.00076	0.8
La Salle	0.00001	0.0
Lavaca	0.00040	0.4
Lee	0.00046	0.5
Leon	0.00453	4.8
Liberty	0.00123	1.3
Limestone	0.00032	0.3
Lipscomb	0.00001	0.0
Live Oak	0.00051	0.5
Llano	0.00150	1.6
Loving	0.00000	0.0
Lubbock	0.00522	5.6
Lynn	0.00001	0.0
McCulloch	0.00002	0.0
McLennan	0.00562	6.0
McMullen	0.00002	0.0
Madison	0.00035	0.4
Marion	0.00006	0.1
Martin	0.00002	0.0
Mason	0.00009	0.1
Matagorda	0.00073	0.8
Maverick	0.00032	0.3
Medina	0.00080	0.9
Menard	0.00001	0.0
Midland	0.00447	4.8
Milam	0.00617	6.6
Mills	0.00004	0.0
Mitchell	0.00054	0.6
Montague	0.00025	0.3
Montgomery	0.02139	22.8
Moore	0.00010	0.1
Morris	0.00016	0.2
Motley	0.00001	0.0
Nacogdoches	0.00137	1.5
Navarro	0.00088	0.9
Newton	0.00010	0.1
Nolan	0.00016	0.2
Nueces	0.04135	44.0

Trenchers - Building Contractor Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.00010	0.1
Oldham	0.00003	0.0
Orange	0.00388	4.1
Palo Pinto	0.00031	0.3
Panola	0.00022	0.2
Parker	0.00239	2.5
Parmer	0.00018	0.2
Pecos	0.00019	0.2
Polk	0.00037	0.4
Potter	0.00448	4.8
Presidio	0.00021	0.2
Rains	0.00007	0.1
Randall	0.00238	2.5
Reagan	0.00001	0.0
Real	0.00020	0.2
Red River	0.00050	0.5
Reeves	0.00003	0.0
Refugio	0.00016	0.2
Roberts	0.00000	0.0
Robertson	0.00004	0.0
Rockwall	0.00177	1.9
Runnels	0.00021	0.2
Rusk	0.00263	2.8
Sabine	0.00055	0.6
San Augustine	0.00013	0.1
San Jacinto	0.00013	0.1
San Patricio	0.00164	1.7
San Saba	0.00002	0.0
Schleicher	0.00005	0.1
Scurry	0.00024	0.3
Shackelford	0.00001	0.0
Shelby	0.00044	0.5
Sherman	0.00004	0.0
Smith	0.00526	5.6
Somervell	0.00025	0.3
Starr	0.00032	0.3
Stephens	0.00015	0.2
Sterling	0.00000	0.0
Stonewall	0.00009	0.1
Sutton	0.00013	0.1

Trenchers - Building Contractor Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.00004	0.0
Tarrant	0.05487	58.4
Taylor	0.00348	3.7
Terrell	0.00003	0.0
Terry	0.00005	0.1
Throckmorton	0.00001	0.0
Titus	0.00061	0.6
Tom Green	0.00161	1.7
Travis	0.04345	46.3
Trinity	0.00008	0.1
Tyler	0.00002	0.0
Upshur	0.00051	0.5
Upton	0.00004	0.0
Uvalde	0.00045	0.5
Val Verde	0.00051	0.5
Van Zandt	0.00092	1.0
Victoria	0.00504	5.4
Walker	0.00063	0.7
Waller	0.00037	0.4
Ward	0.00008	0.1
Washington	0.00124	1.3
Webb	0.00549	5.8
Wharton	0.00090	1.0
Wheeler	0.00023	0.2
Wichita	0.00209	2.2
Wilbarger	0.00018	0.2
Willacy	0.00010	0.1
Williamson	0.01002	10.7
Wilson	0.00063	0.7
Winkler	0.00006	0.1
Wise	0.00101	1.1
Wood	0.00109	1.2
Yoakum	0.00014	0.1
Young	0.00027	0.3
Zapata	0.00020	0.2
Zavala	0.00011	0.1
	Total	**1,065**

Trenchers – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0004	0.3
Andrews	0.0005	0.3
Angelina	0.0053	3.6
Aransas	0.0001	0.0
Archer	0.0002	0.1
Armstrong	0.0000	0.0
Atascosa	0.0003	0.2
Austin	0.0022	1.5
Bailey	0.0001	0.1
Bandera	0.0001	0.0
Bastrop	0.0011	0.7
Baylor	0.0001	0.1
Bee	0.0002	0.1
Bell	0.0052	3.6
Bexar	0.0281	19.5
Blanco	0.0001	0.0
Borden	0.0000	0.0
Bosque	0.0005	0.3
Bowie	0.0024	1.6
Brazoria	0.0218	15.1
Brazos	0.0047	3.3
Brewster	0.0001	0.1
Briscoe	0.0000	0.0
Brooks	0.0000	0.0
Brown	0.0033	2.3
Burleson	0.0002	0.2
Burnet	0.0009	0.6
Caldwell	0.0003	0.2
Calhoun	0.0058	4.0
Callahan	0.0001	0.1
Cameron	0.0059	4.1
Camp	0.0002	0.1
Carson	0.0023	1.6
Cass	0.0012	0.8
Castro	0.0001	0.0
Chambers	0.0022	1.5
Cherokee	0.0030	2.1
Childress	0.0001	0.1
Clay	0.0004	0.2
Cochran	0.0000	0.0
Coke	0.0000	0.0
Coleman	0.0001	0.1
Collin	0.0332	23.0
Collingsworth	0.0000	0.0

Trenchers – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0010	0.7
Comal	0.0025	1.7
Comanche	0.0001	0.1
Concho	0.0000	0.0
Cooke	0.0027	1.9
Coryell	0.0004	0.3
Cottle	0.0000	0.0
Crane	0.0001	0.1
Crockett	0.0000	0.0
Crosby	0.0000	0.0
Culberson	0.0001	0.1
Dallam	0.0002	0.1
Dallas	0.1658	114.9
Dawson	0.0001	0.1
Deaf Smith	0.0007	0.5
Delta	0.0000	0.0
Denton	0.0112	7.8
DeWitt	0.0011	0.7
Dickens	0.0000	0.0
Dimmit	0.0000	0.0
Donley	0.0000	0.0
Duval	0.0001	0.1
Eastland	0.0008	0.5
Ector	0.0038	2.7
Edwards	0.0000	0.0
Ellis	0.0087	6.0
El Paso	0.0163	11.3
Erath	0.0013	0.9
Falls	0.0001	0.1
Fannin	0.0005	0.3
Fayette	0.0010	0.7
Fisher	0.0001	0.0
Floyd	0.0001	0.1
Foard	0.0001	0.0
Fort Bend	0.0173	12.0
Franklin	0.0001	0.1
Freestone	0.0005	0.3
Frio	0.0000	0.0
Gaines	0.0001	0.1
Galveston	0.0101	7.0
Garza	0.0001	0.0
Gillespie	0.0006	0.4
Glasscock	0.0000	0.0
Goliad	0.0001	0.0

Trenchers – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0008	0.6
Gray	0.0013	0.9
Grayson	0.0070	4.8
Gregg	0.0131	9.1
Grimes	0.0011	0.8
Guadalupe	0.0062	4.3
Hale	0.0021	1.5
Hall	0.0001	0.0
Hamilton	0.0002	0.1
Hansford	0.0001	0.0
Hardeman	0.0002	0.2
Hardin	0.0007	0.5
Harris	0.2026	140.4
Harrison	0.0038	2.6
Hartley	0.0000	0.0
Haskell	0.0000	0.0
Hays	0.0032	2.2
Hemphill	0.0000	0.0
Henderson	0.0016	1.1
Hidalgo	0.0053	3.6
Hill	0.0006	0.4
Hockley	0.0003	0.2
Hood	0.0004	0.3
Hopkins	0.0010	0.7
Houston	0.0005	0.3
Howard	0.0009	0.6
Hudspeth	0.0001	0.0
Hunt	0.0052	3.6
Hutchinson	0.0017	1.2
Irion	0.0000	0.0
Jack	0.0001	0.0
Jackson	0.0009	0.6
Jasper	0.0016	1.1
Jeff Davis	0.0000	0.0
Jefferson	0.0212	14.7
Jim Hogg	0.0000	0.0
Jim Wells	0.0004	0.3
Johnson	0.0053	3.6
Jones	0.0009	0.6
Karnes	0.0002	0.1
Kaufman	0.0030	2.0
Kendall	0.0007	0.5
Kenedy	0.0000	0.0
Kent	0.0000	0.0
Kerr	0.0008	0.6

Trenchers – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0003	0.2
King	0.0000	0.0
Kinney	0.0000	0.0
Kleberg	0.0002	0.1
Knox	0.0000	0.0
Lamar	0.0039	2.7
Lamb	0.0008	0.6
Lampasas	0.0005	0.4
La Salle	0.0001	0.1
Lavaca	0.0015	1.0
Lee	0.0003	0.2
Leon	0.0003	0.2
Liberty	0.0019	1.3
Limestone	0.0009	0.6
Lipscomb	0.0001	0.1
Live Oak	0.0003	0.2
Llano	0.0001	0.1
Loving	0.0000	0.0
Lubbock	0.0045	3.1
Lynn	0.0001	0.1
McCulloch	0.0003	0.2
McLennan	0.0142	9.8
McMullen	0.0000	0.0
Madison	0.0001	0.1
Marion	0.0003	0.2
Martin	0.0000	0.0
Mason	0.0001	0.0
Matagorda	0.0006	0.4
Maverick	0.0003	0.2
Medina	0.0005	0.4
Menard	0.0000	0.0
Midland	0.0024	1.7
Milam	0.0018	1.3
Mills	0.0001	0.0
Mitchell	0.0000	0.0
Montague	0.0003	0.2
Montgomery	0.0089	6.2
Moore	0.0033	2.3
Morris	0.0023	1.6
Motley	0.0000	0.0
Nacogdoches	0.0024	1.7
Navarro	0.0026	1.8
Newton	0.0001	0.1
Nolan	0.0009	0.6
Nueces	0.0120	8.3

Trenchers – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0000	0.0
Oldham	0.0000	0.0
Orange	0.0079	5.5
Palo Pinto	0.0019	1.3
Panola	0.0007	0.5
Parker	0.0020	1.4
Parmer	0.0016	1.1
Pecos	0.0001	0.0
Polk	0.0008	0.6
Potter	0.0052	3.6
Presidio	0.0000	0.0
Rains	0.0001	0.1
Randall	0.0017	1.2
Reagan	0.0003	0.2
Real	0.0000	0.0
Red River	0.0005	0.4
Reeves	0.0002	0.1
Refugio	0.0000	0.0
Roberts	0.0000	0.0
Robertson	0.0005	0.4
Rockwall	0.0014	0.9
Runnels	0.0005	0.4
Rusk	0.0012	0.8
Sabine	0.0004	0.3
San Augustine	0.0001	0.1
San Jacinto	0.0000	0.0
San Patricio	0.0023	1.6
San Saba	0.0000	0.0
Schleicher	0.0000	0.0
Scurry	0.0002	0.1
Shackelford	0.0000	0.0
Shelby	0.0019	1.3
Sherman	0.0000	0.0
Smith	0.0078	5.4
Somervell	0.0002	0.1
Starr	0.0001	0.1
Stephens	0.0004	0.3
Sterling	0.0000	0.0
Stonewall	0.0000	0.0
Sutton	0.0000	0.0

Trenchers – Manufacturing Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.0002	0.1
Tarrant	0.0782	54.2
Taylor	0.0020	1.4
Terrell	0.0000	0.0
Terry	0.0002	0.1
Throckmorton	0.0000	0.0
Titus	0.0061	4.2
Tom Green	0.0036	2.5
Travis	0.0887	61.5
Trinity	0.0002	0.1
Tyler	0.0001	0.1
Upshur	0.0003	0.2
Upton	0.0000	0.0
Uvalde	0.0004	0.3
Val Verde	0.0022	1.5
Van Zandt	0.0005	0.3
Victoria	0.0038	2.6
Walker	0.0008	0.5
Waller	0.0021	1.4
Ward	0.0002	0.1
Washington	0.0021	1.5
Webb	0.0012	0.9
Wharton	0.0015	1.0
Wheeler	0.0000	0.0
Wichita	0.0059	4.1
Wilbarger	0.0011	0.7
Willacy	0.0001	0.0
Williamson	0.0084	5.8
Wilson	0.0003	0.2
Winkler	0.0004	0.3
Wise	0.0016	1.1
Wood	0.0007	0.5
Yoakum	0.0001	0.1
Young	0.0010	0.7
Zapata	0.0000	0.0
Zavala	0.0002	0.2
	Total	**693**

Trenchers - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0017	10.4
Andrews	0.0021	12.9
Angelina	0.0034	21.2
Aransas	0.0006	3.7
Archer	0.0002	1.5
Armstrong	0.0000	0.1
Atascosa	0.0006	3.7
Austin	0.0019	11.7
Bailey	0.0002	1.4
Bandera	0.0006	4.0
Bastrop	0.0014	8.7
Baylor	0.0001	0.5
Bee	0.0007	4.5
Bell	0.0059	36.9
Bexar	0.0689	432.8
Blanco	0.0008	5.2
Borden	0.0000	0.1
Bosque	0.0004	2.6
Bowie	0.0026	16.4
Brazoria	0.0114	71.7
Brazos	0.0061	38.4
Brewster	0.0003	1.8
Briscoe	0.0001	0.4
Brooks	0.0001	0.8
Brown	0.0012	7.6
Burleson	0.0008	4.8
Burnet	0.0018	11.2
Caldwell	0.0005	3.0
Calhoun	0.0029	18.2
Callahan	0.0001	0.6
Cameron	0.0075	46.8
Camp	0.0006	3.6
Carson	0.0001	0.5
Cass	0.0005	3.1
Castro	0.0000	0.3
Chambers	0.0007	4.6
Cherokee	0.0010	6.2
Childress	0.0001	0.8
Clay	0.0002	1.3
Cochran	0.0001	0.4
Coke	0.0000	0.2
Coleman	0.0003	1.8
Collin	0.0225	141.3
Collingsworth	0.0000	0.1

Trenchers - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0009	5.7
Comal	0.0058	36.4
Comanche	0.0003	2.1
Concho	0.0000	0.2
Cooke	0.0030	18.9
Coryell	0.0011	7.0
Cottle	0.0000	0.3
Crane	0.0001	0.9
Crockett	0.0000	0.3
Crosby	0.0000	0.1
Culberson	0.0000	0.1
Dallam	0.0003	1.9
Dallas	0.1601	1005.4
Dawson	0.0004	2.6
Deaf Smith	0.0008	5.1
Delta	0.0001	0.3
Denton	0.0160	100.8
DeWitt	0.0006	4.0
Dickens	0.0001	0.4
Dimmit	0.0000	0.3
Donley	0.0000	0.1
Duval	0.0005	3.4
Eastland	0.0022	13.7
Ector	0.0066	41.7
Edwards	0.0000	0.2
Ellis	0.0047	29.5
El Paso	0.0197	123.6
Erath	0.0014	8.7
Falls	0.0002	1.1
Fannin	0.0008	5.0
Fayette	0.0010	6.0
Fisher	0.0000	0.2
Floyd	0.0001	0.4
Foard	0.0000	0.0
Fort Bend	0.0110	69.1
Franklin	0.0001	0.7
Freestone	0.0014	9.0
Frio	0.0002	1.3
Gaines	0.0006	3.8
Galveston	0.0092	57.5
Garza	0.0004	2.8
Gillespie	0.0016	9.8
Glasscock	0.0001	0.5
Goliad	0.0000	0.3

Trenchers - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0002	1.1
Gray	0.0009	5.6
Grayson	0.0035	22.1
Gregg	0.0077	48.5
Grimes	0.0005	3.3
Guadalupe	0.0037	23.2
Hale	0.0010	6.6
Hall	0.0000	0.2
Hamilton	0.0008	5.0
Hansford	0.0002	1.5
Hardeman	0.0000	0.1
Hardin	0.0015	9.2
Harris	0.2168	1361.7
Harrison	0.0029	18.4
Hartley	0.0001	0.6
Haskell	0.0000	0.1
Hays	0.0051	31.8
Hemphill	0.0002	1.3
Henderson	0.0016	10.0
Hidalgo	0.0108	67.6
Hill	0.0007	4.7
Hockley	0.0011	6.7
Hood	0.0024	14.9
Hopkins	0.0017	10.6
Houston	0.0003	1.8
Howard	0.0010	6.2
Hudspeth	0.0000	0.1
Hunt	0.0026	16.6
Hutchinson	0.0031	19.5
Irion	0.0001	0.4
Jack	0.0002	1.4
Jackson	0.0012	7.3
Jasper	0.0011	7.1
Jeff Davis	0.0001	0.7
Jefferson	0.0164	102.8
Jim Hogg	0.0001	0.3
Jim Wells	0.0014	8.5
Johnson	0.0065	40.9
Jones	0.0003	1.9
Karnes	0.0002	0.9
Kaufman	0.0040	24.9
Kendall	0.0019	11.6
Kenedy	0.0002	1.0
Kent	0.0000	0.0
Kerr	0.0022	13.5

Trenchers - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0002	1.0
King	0.0000	0.1
Kinney	0.0000	0.2
Kleberg	0.0005	3.0
Knox	0.0002	1.0
Lamar	0.0023	14.2
Lamb	0.0002	1.5
Lampasas	0.0015	9.2
La Salle	0.0000	0.1
Lavaca	0.0005	3.0
Lee	0.0012	7.5
Leon	0.0014	8.8
Liberty	0.0015	9.3
Limestone	0.0003	1.6
Lipscomb	0.0001	0.3
Live Oak	0.0003	1.8
Llano	0.0006	3.5
Loving	0.0000	0.0
Lubbock	0.0081	50.6
Lynn	0.0000	0.1
McCulloch	0.0001	0.7
McLennan	0.0109	68.2
McMullen	0.0000	0.1
Madison	0.0003	2.0
Marion	0.0001	0.4
Martin	0.0001	0.8
Mason	0.0001	0.7
Matagorda	0.0011	6.8
Maverick	0.0004	2.3
Medina	0.0009	5.4
Menard	0.0001	0.7
Midland	0.0051	32.2
Milam	0.0003	1.9
Mills	0.0000	0.3
Mitchell	0.0001	0.5
Montague	0.0007	4.6
Montgomery	0.0121	76.0
Moore	0.0009	5.9
Morris	0.0001	0.6
Motley	0.0000	0.1
Nacogdoches	0.0027	17.1
Navarro	0.0007	4.6
Newton	0.0000	0.2
Nolan	0.0005	3.0
Nueces	0.0124	77.9

Trenchers - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0003	2.0
Oldham	0.0001	0.3
Orange	0.0026	16.1
Palo Pinto	0.0005	3.4
Panola	0.0017	10.9
Parker	0.0036	22.4
Parmer	0.0002	1.3
Pecos	0.0006	4.0
Polk	0.0007	4.4
Potter	0.0057	35.7
Presidio	0.0000	0.1
Rains	0.0004	2.4
Randall	0.0029	18.0
Reagan	0.0001	0.9
Real	0.0001	0.3
Red River	0.0004	2.3
Reeves	0.0001	0.5
Refugio	0.0005	3.1
Roberts	0.0000	0.1
Robertson	0.0002	1.2
Rockwall	0.0026	16.4
Runnels	0.0003	1.8
Rusk	0.0011	7.1
Sabine	0.0001	0.7
San Augustine	0.0000	0.3
San Jacinto	0.0001	0.9
San Patricio	0.0021	13.1
San Saba	0.0001	0.4
Schleicher	0.0001	0.5
Scurry	0.0011	6.6
Shackelford	0.0000	0.2
Shelby	0.0006	3.5
Sherman	0.0000	0.2
Smith	0.0069	43.0
Somervell	0.0001	0.6
Starr	0.0002	1.6
Stephens	0.0007	4.2
Sterling	0.0001	0.4
Stonewall	0.0001	0.7
Sutton	0.0008	5.3

Trenchers - Special Trades Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.0001	0.5
Tarrant	0.0759	476.6
Taylor	0.0053	33.4
Terrell	0.0000	0.0
Terry	0.0003	2.0
Throckmorton	0.0000	0.3
Titus	0.0009	5.6
Tom Green	0.0032	20.1
Travis	0.0500	314.4
Trinity	0.0003	2.2
Tyler	0.0005	2.9
Upshur	0.0006	4.0
Upton	0.0000	0.2
Uvalde	0.0006	3.8
Val Verde	0.0011	7.2
Van Zandt	0.0023	14.7
Victoria	0.0035	21.9
Walker	0.0015	9.2
Waller	0.0016	10.3
Ward	0.0004	2.7
Washington	0.0017	10.9
Webb	0.0037	23.5
Wharton	0.0014	8.5
Wheeler	0.0003	1.9
Wichita	0.0038	24.0
Wilbarger	0.0002	1.2
Willacy	0.0001	0.4
Williamson	0.0202	127.0
Wilson	0.0010	6.0
Winkler	0.0003	1.7
Wise	0.0014	8.5
Wood	0.0009	5.6
Yoakum	0.0004	2.8
Young	0.0006	4.0
Zapata	0.0007	4.4
Zavala	0.0001	0.6
	Total	**6,281**

Trenchers - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0007	1.6
Andrews	0.0002	0.5
Angelina	0.0010	2.4
Aransas	0.0007	1.5
Archer	0.0002	0.6
Armstrong	0.0000	0.1
Atascosa	0.0008	1.8
Austin	0.0007	1.6
Bailey	0.0001	0.2
Bandera	0.0004	0.9
Bastrop	0.0012	3.0
Baylor	0.0000	0.1
Bee	0.0003	0.8
Bell	0.0111	26.3
Bexar	0.0695	164.4
Blanco	0.0001	0.2
Borden	0.0000	0.0
Bosque	0.0001	0.3
Bowie	0.0044	10.4
Brazoria	0.0092	21.8
Brazos	0.0082	19.3
Brewster	0.0002	0.4
Briscoe	0.0000	0.0
Brooks	0.0001	0.2
Brown	0.0005	1.3
Burleson	0.0003	0.6
Burnet	0.0004	1.0
Caldwell	0.0006	1.5
Calhoun	0.0005	1.2
Callahan	0.0002	0.5
Cameron	0.0127	30.1
Camp	0.0001	0.3
Carson	0.0003	0.7
Cass	0.0003	0.7
Castro	0.0001	0.3
Chambers	0.0013	3.1
Cherokee	0.0003	0.7
Childress	0.0001	0.1
Clay	0.0002	0.4
Cochran	0.0000	0.1
Coke	0.0000	0.0
Coleman	0.0001	0.1
Collin	0.0244	57.7
Collingsworth	0.0000	0.1

Trenchers - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0003	0.8
Comal	0.0031	7.4
Comanche	0.0001	0.4
Concho	0.0000	0.0
Cooke	0.0006	1.5
Coryell	0.0019	4.6
Cottle	0.0000	0.1
Crane	0.0000	0.1
Crockett	0.0001	0.3
Crosby	0.0002	0.6
Culberson	0.0000	0.0
Dallam	0.0001	0.3
Dallas	0.1588	375.7
Dawson	0.0002	0.5
Deaf Smith	0.0003	0.8
Delta	0.0001	0.2
Denton	0.0144	34.1
DeWitt	0.0003	0.7
Dickens	0.0000	0.0
Dimmit	0.0001	0.2
Donley	0.0000	0.1
Duval	0.0003	0.7
Eastland	0.0003	0.6
Ector	0.0079	18.8
Edwards	0.0000	0.0
Ellis	0.0038	8.9
El Paso	0.0221	52.2
Erath	0.0008	1.8
Falls	0.0001	0.2
Fannin	0.0002	0.6
Fayette	0.0003	0.7
Fisher	0.0000	0.1
Floyd	0.0001	0.2
Foard	0.0000	0.0
Fort Bend	0.0135	31.9
Franklin	0.0002	0.5
Freestone	0.0002	0.6
Frio	0.0001	0.3
Gaines	0.0002	0.4
Galveston	0.0100	23.6
Garza	0.0001	0.1
Gillespie	0.0003	0.8
Glasscock	0.0000	0.0
Goliad	0.0001	0.3

Trenchers - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0002	0.5
Gray	0.0005	1.2
Grayson	0.0039	9.2
Gregg	0.0067	15.8
Grimes	0.0001	0.3
Guadalupe	0.0024	5.6
Hale	0.0006	1.5
Hall	0.0000	0.0
Hamilton	0.0001	0.2
Hansford	0.0001	0.2
Hardeman	0.0001	0.1
Hardin	0.0010	2.4
Harris	0.2062	487.7
Harrison	0.0009	2.1
Hartley	0.0000	0.0
Haskell	0.0001	0.2
Hays	0.0032	7.7
Hemphill	0.0001	0.2
Henderson	0.0006	1.4
Hidalgo	0.0138	32.6
Hill	0.0003	0.7
Hockley	0.0015	3.6
Hood	0.0006	1.4
Hopkins	0.0004	0.8
Houston	0.0002	0.5
Howard	0.0005	1.2
Hudspeth	0.0000	0.0
Hunt	0.0021	5.0
Hutchinson	0.0003	0.7
Irion	0.0000	0.1
Jack	0.0000	0.1
Jackson	0.0001	0.3
Jasper	0.0003	0.8
Jeff Davis	0.0000	0.1
Jefferson	0.0131	30.9
Jim Hogg	0.0001	0.3
Jim Wells	0.0005	1.3
Johnson	0.0028	6.7
Jones	0.0004	0.9
Karnes	0.0001	0.3
Kaufman	0.0017	4.1
Kendall	0.0013	3.0
Kenedy	0.0000	0.1
Kent	0.0000	0.0
Kerr	0.0012	2.8

Trenchers - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0001	0.1
King	0.0000	0.0
Kinney	0.0000	0.1
Kleberg	0.0005	1.2
Knox	0.0001	0.1
Lamar	0.0007	1.5
Lamb	0.0001	0.3
Lampasas	0.0008	1.8
La Salle	0.0000	0.1
Lavaca	0.0003	0.6
Lee	0.0002	0.4
Leon	0.0002	0.5
Liberty	0.0014	3.3
Limestone	0.0002	0.5
Lipscomb	0.0000	0.1
Live Oak	0.0001	0.3
Llano	0.0002	0.5
Loving	0.0000	0.0
Lubbock	0.0148	35.1
Lynn	0.0000	0.1
McCulloch	0.0001	0.2
McLennan	0.0130	30.6
McMullen	0.0000	0.0
Madison	0.0001	0.3
Marion	0.0001	0.1
Martin	0.0001	0.1
Mason	0.0001	0.1
Matagorda	0.0005	1.2
Maverick	0.0003	0.6
Medina	0.0006	1.4
Menard	0.0000	0.1
Midland	0.0067	15.8
Milam	0.0004	0.9
Mills	0.0000	0.1
Mitchell	0.0001	0.2
Montague	0.0002	0.4
Montgomery	0.0159	37.7
Moore	0.0004	0.9
Morris	0.0002	0.4
Motley	0.0000	0.1
Nacogdoches	0.0007	1.6
Navarro	0.0006	1.3
Newton	0.0000	0.1
Nolan	0.0002	0.4
Nueces	0.0171	40.4

Trenchers - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0002	0.5
Oldham	0.0000	0.1
Orange	0.0023	5.5
Palo Pinto	0.0004	1.0
Panola	0.0002	0.5
Parker	0.0021	5.1
Parmer	0.0001	0.4
Pecos	0.0001	0.3
Polk	0.0006	1.3
Potter	0.0098	23.1
Presidio	0.0000	0.1
Rains	0.0001	0.1
Randall	0.0029	6.9
Reagan	0.0001	0.1
Real	0.0000	0.0
Red River	0.0001	0.2
Reeves	0.0001	0.3
Refugio	0.0001	0.2
Roberts	0.0000	0.0
Robertson	0.0002	0.4
Rockwall	0.0027	6.4
Runnels	0.0001	0.2
Rusk	0.0012	2.8
Sabine	0.0001	0.1
San Augustine	0.0001	0.1
San Jacinto	0.0002	0.4
San Patricio	0.0012	2.9
San Saba	0.0001	0.2
Schleicher	0.0000	0.1
Scurry	0.0003	0.8
Shackelford	0.0000	0.1
Shelby	0.0003	0.6
Sherman	0.0001	0.2
Smith	0.0124	29.2
Somervell	0.0002	0.5
Starr	0.0008	1.8
Stephens	0.0001	0.2
Sterling	0.0000	0.1
Stonewall	0.0001	0.1
Sutton	0.0001	0.2

Trenchers - Other Services Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.0001	0.2
Tarrant	0.0857	202.7
Taylor	0.0082	19.5
Terrell	0.0000	0.0
Terry	0.0001	0.3
Throckmorton	0.0000	0.1
Titus	0.0003	0.8
Tom Green	0.0056	13.3
Travis	0.0800	189.2
Trinity	0.0003	0.6
Tyler	0.0001	0.2
Upshur	0.0003	0.8
Upton	0.0000	0.0
Uvalde	0.0003	0.8
Val Verde	0.0004	1.0
Van Zandt	0.0003	0.8
Victoria	0.0042	9.9
Walker	0.0008	1.8
Waller	0.0004	1.0
Ward	0.0001	0.2
Washington	0.0005	1.2
Webb	0.0050	11.8
Wharton	0.0007	1.5
Wheeler	0.0001	0.1
Wichita	0.0086	20.4
Wilbarger	0.0002	0.5
Willacy	0.0003	0.7
Williamson	0.0164	38.8
Wilson	0.0003	0.8
Winkler	0.0001	0.2
Wise	0.0010	2.4
Wood	0.0006	1.4
Yoakum	0.0001	0.2
Young	0.0002	0.5
Zapata	0.0005	1.2
Zavala	0.0001	0.2
	Total	**2,365**

Trenchers - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Anderson	0.0002	0.9
Andrews	0.0001	0.4
Angelina	0.0001	0.4
Aransas	0.0001	0.4
Archer	0.0000	0.0
Armstrong	0.0000	0.0
Atascosa	0.0009	5.0
Austin	0.0111	64.4
Bailey	0.0001	0.4
Bandera	0.0000	0.0
Bastrop	0.0602	348.4
Baylor	0.0001	0.5
Bee	0.0001	0.7
Bell	0.0019	11.0
Bexar	0.0065	37.6
Blanco	0.0000	0.3
Borden	0.0000	0.0
Bosque	0.0025	14.5
Bowie	0.0004	2.2
Brazoria	0.0038	22.3
Brazos	0.0036	20.9
Brewster	0.0003	1.8
Briscoe	0.0000	0.1
Brooks	0.0000	0.1
Brown	0.1684	974.9
Burleson	0.0002	1.3
Burnet	0.0003	1.7
Caldwell	0.0002	1.4
Calhoun	0.0011	6.2
Callahan	0.0000	0.3
Cameron	0.0028	16.5
Camp	0.0004	2.3
Carson	0.0000	0.0
Cass	0.0000	0.2
Castro	0.0000	0.2
Chambers	0.0000	0.1
Cherokee	0.0008	4.4
Childress	0.0001	0.4
Clay	0.0001	0.5
Cochran	0.0000	0.0
Coke	0.0000	0.0
Coleman	0.0010	5.7
Collin	0.0030	17.5
Collingsworth	0.0000	0.1

Trenchers - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Colorado	0.0000	0.3
Comal	0.0010	5.6
Comanche	0.0001	0.6
Concho	0.0000	0.1
Cooke	0.0000	0.0
Coryell	0.0000	0.1
Cottle	0.0000	0.2
Crane	0.0000	0.0
Crockett	0.0000	0.0
Crosby	0.0000	0.0
Culberson	0.0006	3.3
Dallam	0.0002	0.9
Dallas	0.2453	1420.0
Dawson	0.0001	0.4
Deaf Smith	0.0004	2.2
Delta	0.0000	0.0
Denton	0.0077	44.4
DeWitt	0.0005	3.0
Dickens	0.0000	0.0
Dimmit	0.0000	0.1
Donley	0.0000	0.0
Duval	0.0000	0.0
Eastland	0.0009	5.4
Ector	0.0023	13.1
Edwards	0.0000	0.1
Ellis	0.0070	40.7
El Paso	0.0305	176.3
Erath	0.0114	66.2
Falls	0.0001	0.5
Fannin	0.0003	1.6
Fayette	0.0006	3.2
Fisher	0.0001	0.3
Floyd	0.0001	0.4
Foard	0.0001	0.3
Fort Bend	0.0044	25.3
Franklin	0.0011	6.2
Freestone	0.0021	12.3
Frio	0.0000	0.1
Gaines	0.0000	0.3
Galveston	0.0007	3.8
Garza	0.0000	0.0
Gillespie	0.0001	0.7
Glasscock	0.0000	0.0
Goliad	0.0001	0.3

Trenchers - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Gonzales	0.0021	12.4
Gray	0.0000	0.2
Grayson	0.0007	4.1
Gregg	0.0041	23.5
Grimes	0.0003	1.5
Guadalupe	0.0078	45.2
Hale	0.0004	2.2
Hall	0.0001	0.3
Hamilton	0.0001	0.6
Hansford	0.0001	0.3
Hardeman	0.0002	1.0
Hardin	0.0007	4.1
Harris	0.0165	95.5
Harrison	0.0693	401.4
Hartley	0.0000	0.0
Haskell	0.0000	0.1
Hays	0.0104	60.0
Hemphill	0.0000	0.1
Henderson	0.0269	155.5
Hidalgo	0.0008	4.8
Hill	0.0055	31.8
Hockley	0.0002	1.2
Hood	0.0018	10.5
Hopkins	0.0001	0.3
Houston	0.0002	1.1
Howard	0.0006	3.6
Hudspeth	0.0010	5.8
Hunt	0.0001	0.7
Hutchinson	0.0007	4.0
Irion	0.0000	0.0
Jack	0.0000	0.0
Jackson	0.0004	2.2
Jasper	0.0000	0.2
Jeff Davis	0.0000	0.0
Jefferson	0.0004	2.2
Jim Hogg	0.0000	0.2
Jim Wells	0.0003	1.5
Johnson	0.0183	106.0
Jones	0.0003	1.7
Karnes	0.0002	0.9
Kaufman	0.0006	3.5
Kendall	0.0005	3.0
Kenedy	0.0000	0.0
Kent	0.0000	0.0
Kerr	0.0001	0.4

Trenchers - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Kimble	0.0001	0.7
King	0.0000	0.0
Kinney	0.0000	0.0
Kleberg	0.0001	0.9
Knox	0.0000	0.2
Lamar	0.0001	0.3
Lamb	0.0006	3.6
Lampasas	0.0004	2.2
La Salle	0.0001	0.5
Lavaca	0.0005	3.1
Lee	0.0002	1.1
Leon	0.0001	0.8
Liberty	0.0011	6.4
Limestone	0.0023	13.6
Lipscomb	0.0001	0.6
Live Oak	0.0002	1.4
Llano	0.0007	4.0
Loving	0.0000	0.0
Lubbock	0.0003	1.5
Lynn	0.0000	0.0
McCulloch	0.0000	0.1
McLennan	0.0125	72.4
McMullen	0.0000	0.0
Madison	0.0001	0.6
Marion	0.0002	1.2
Martin	0.0000	0.1
Mason	0.0001	0.3
Matagorda	0.0000	0.1
Maverick	0.0001	0.7
Medina	0.0070	40.8
Menard	0.0000	0.0
Midland	0.0001	0.6
Milam	0.0036	20.8
Mills	0.0000	0.1
Mitchell	0.0000	0.2
Montague	0.0000	0.1
Montgomery	0.0066	38.0
Moore	0.0005	2.7
Morris	0.0011	6.3
Motley	0.0000	0.1
Nacogdoches	0.0020	11.4
Navarro	0.0200	115.8
Newton	0.0000	0.2
Nolan	0.0001	0.3
Nueces	0.0011	6.4

Trenchers - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Ochiltree	0.0000	0.2
Oldham	0.0000	0.0
Orange	0.0012	7.0
Palo Pinto	0.0153	88.3
Panola	0.0002	1.1
Parker	0.0029	16.7
Parmer	0.0004	2.3
Pecos	0.0000	0.0
Polk	0.0005	2.7
Potter	0.0041	23.7
Presidio	0.0000	0.1
Rains	0.0001	0.8
Randall	0.0177	102.2
Reagan	0.0003	1.6
Real	0.0000	0.1
Red River	0.0002	1.3
Reeves	0.0001	0.6
Refugio	0.0000	0.0
Roberts	0.0000	0.0
Robertson	0.0003	1.9
Rockwall	0.0006	3.7
Runnels	0.0002	1.1
Rusk	0.0001	0.4
Sabine	0.0002	1.2
San Augustine	0.0001	0.3
San Jacinto	0.0000	0.1
San Patricio	0.0007	4.2
San Saba	0.0000	0.2
Schleicher	0.0000	0.0
Scurry	0.0003	1.7
Shackelford	0.0000	0.1
Shelby	0.0007	4.0
Sherman	0.0000	0.1
Smith	0.0149	86.5
Somervell	0.0000	0.0
Starr	0.0001	0.6
Stephens	0.0002	1.3
Sterling	0.0000	0.1
Stonewall	0.0000	0.0
Sutton	0.0000	0.1

Trenchers - Masonry/Stone Stratum		
Econ.com - 2007		
County	**Output Fraction**	**Pop**
Swisher	0.0001	0.7
Tarrant	0.0161	93.1
Taylor	0.0001	0.6
Terrell	0.0000	0.1
Terry	0.0002	1.1
Throckmorton	0.0000	0.0
Titus	0.0000	0.1
Tom Green	0.0002	1.2
Travis	0.0148	85.6
Trinity	0.0001	0.5
Tyler	0.0001	0.6
Upshur	0.0009	5.3
Upton	0.0000	0.0
Uvalde	0.0002	1.1
Val Verde	0.0011	6.3
Van Zandt	0.0012	7.2
Victoria	0.0001	0.5
Walker	0.0006	3.3
Waller	0.0000	0.1
Ward	0.0002	0.9
Washington	0.0000	0.2
Webb	0.0001	0.6
Wharton	0.0007	4.3
Wheeler	0.0000	0.3
Wichita	0.0556	322.0
Wilbarger	0.0000	0.0
Willacy	0.0000	0.3
Williamson	0.0201	116.6
Wilson	0.0002	1.1
Winkler	0.0004	2.2
Wise	0.0027	15.6
Wood	0.0001	0.8
Yoakum	0.0001	0.8
Young	0.0000	0.1
Zapata	0.0000	0.1
Zavala	0.0001	0.6
	Total	**5,788**

Appendix G
County Level Growth Factors for Scrap/Recycling Subsector

Provided Electronically to the TCEQ

Appendix H
County Level Growth Factors for Special Trades Contractors

Provided Electronically to the TCEQ

Appendix I
County Level Growth Factors for Mining/Quarry Activity

Provided Electronically to the TCEQ

Appendix J

Heavy-Highway Update Supporting Information

Table J-1. Texas County Highway Construction and Maintenance Annual Expenditures ($000's)

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Anderson	$5,125	$4,009	$3,088	$4,759	$5,116	$10,890	$6,781	$9,329	$16,252	$9,969	$17,141
Andrews	$1,366	$1,288	$1,432	$1,137	$1,431	$3,629	$2,188	$1,450	$2,544	$1,803	$365
Angelina	$12,791	$18,987	$20,048	$17,049	$16,927	$13,314	$9,767	$15,885	$31,024	$40,185	$33,239
Aransas	$1,072	$4,238	$870	$1,931	$9,241	$7,769	$8,116	$14,562	$8,355	$2,746	$1,398
Archer	$2,627	$3,831	$3,968	$3,122	$1,289	$3,388	$2,755	$13,750	$11,395	$3,203	$8,469
Armstrong	$1,127	$882	$369	$1,362	$6,580	$5,425	$713	$3,510	$17,715	$8,387	$5,601
Atascosa	$6,243	$6,306	$14,993	$11,630	$7,273	$3,916	$4,978	$11,147	$23,197	$16,356	$9,786
Austin	$1,451	$5,331	$5,230	$3,840	$1,975	$2,097	$7,299	$5,986	$12,000	$11,991	$5,815
Bailey	$1,070	$1,103	$417	$244	$847	$3,273	$2,747	$2,689	$4,028	$1,436	$735
Bandera	$1,578	$1,539	$1,617	$2,264	$1,125	$2,437	$790	$3,877	$8,760	$15,446	$17,379
Bastrop	$3,866	$5,985	$9,694	$10,802	$11,321	$7,267	$14,935	$14,382	$11,936	$24,848	$20,972
Baylor	$3,738	$3,006	$1,337	$2,010	$911	$1,082	$448	$1,422	$11,134	$29,198	$21,571
Bee	$1,883	$4,457	$4,294	$3,375	$6,778	$6,046	$6,493	$6,572	$17,280	$15,633	$23,109
Bell	$15,238	$17,125	$19,891	$15,267	$17,631	$30,862	$37,654	$52,371	$52,920	$94,719	$86,372
Bexar	$97,586	$94,740	$119,230	$138,860	$188,039	$161,610	$184,464	$220,742	$229,679	$238,303	$319,579
Blanco	$1,763	$1,059	$492	$2,177	$2,273	$1,005	$254	$1,322	$1,292	$1,977	$2,459
Borden	$943	$1,207	$844	$1,158	$4,036	$404	$1,849	$1,813	$1,850	$853	$517
Bosque	$1,864	$1,503	$1,074	$2,453	$1,143	$1,640	$3,160	$3,781	$7,325	$3,983	$1,953
Bowie	$21,762	$13,383	$27,351	$34,513	$22,476	$22,064	$12,151	$11,925	$9,596	$47,814	$32,886
Brazoria	$27,729	$34,034	$26,229	$14,189	$32,358	$31,203	$35,648	$55,205	$39,812	$52,450	$28,553
Brazos	$13,821	$16,656	$19,094	$18,105	$19,635	$19,983	$31,646	$30,659	$45,367	$60,236	$53,169
Brewster	$4,239	$2,166	$367	$4,124	$3,583	$1,988	$5,965	$3,693	$3,755	$6,887	$5,966
Briscoe	$1,029	$1,698	$1,412	$1,548	$550	$833	$481	$1,416	$1,986	$4,086	$4,112
Brooks	$1,342	$2,197	$4,367	$7,760	$846	$961	$1,747	$836	$1,538	$2,791	$6,732
Brown	$5,496	$6,629	$4,472	$12,196	$7,626	$10,440	$5,602	$7,530	$10,785	$7,436	$9,554
Burleson	$2,916	$4,885	$13,525	$10,472	$5,337	$2,733	$3,994	$10,551	$11,019	$7,289	$8,763
Burnet	$2,084	$3,715	$7,177	$13,495	$10,420	$5,409	$2,589	$6,739	$9,766	$16,383	$13,655
Caldwell	$3,085	$4,806	$6,409	$5,391	$2,775	$2,211	$2,951	$7,669	$5,099	$7,728	$8,827
Calhoun	$2,250	$6,603	$6,288	$1,489	$1,207	$1,038	$3,308	$4,134	$13,695	$6,131	$6,244
Callahan	$2,569	$5,850	$3,102	$8,383	$10,315	$4,169	$5,862	$2,443	$5,891	$8,991	$7,484
Cameron	$25,899	$26,936	$66,167	$54,731	$54,394	$71,285	$85,706	$94,186	$100,860	$123,861	$78,898

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Camp	$984	$4,093	$796	$3,786	$3,063	$2,760	$6,017	$2,463	$4,953	$6,806	$10,444
Carson	$1,781	$3,785	$4,426	$1,860	$14,514	$10,284	$4,523	$4,210	$5,839	$10,021	$17,383
Cass	$10,155	$9,227	$12,032	$12,103	$11,277	$12,911	$6,051	$13,711	$19,697	$24,144	$19,503
Castro	$1,033	$1,383	$1,438	$1,233	$1,175	$3,263	$4,788	$4,607	$5,967	$1,842	$918
Chambers	$5,305	$7,724	$15,921	$5,575	$2,352	$4,021	$20,132	$24,838	$45,003	$84,317	$48,910
Cherokee	$11,323	$9,898	$5,915	$2,887	$8,237	$10,317	$13,530	$9,412	$5,422	$17,482	$4,689
Childress	$3,883	$6,092	$12,369	$16,223	$8,599	$4,783	$8,627	$4,420	$5,787	$15,224	$7,574
Clay	$5,166	$4,130	$5,825	$6,941	$7,688	$4,159	$5,133	$7,788	$6,130	$6,604	$2,659
Cochran	$3,562	$3,300	$760	$2,544	$2,437	$1,515	$141	$362	$738	$829	$531
Coke	$493	$1,378	$1,135	$1,325	$2,349	$1,407	$931	$1,050	$518	$316	$497
Coleman	$2,074	$2,353	$4,753	$2,910	$1,806	$2,507	$4,429	$5,452	$2,010	$1,050	$1,167
Collin	$56,721	$51,188	$112,622	$62,878	$49,579	$79,789	$50,713	$80,676	$67,460	$91,404	$51,433
Collingsworth	$1,025	$879	$1,623	$1,430	$762	$7,679	$880	$6,305	$3,200	$360	$827
Colorado	$3,165	$8,836	$3,272	$4,336	$4,772	$7,866	$3,835	$7,564	$11,005	$7,677	$7,190
Comal	$10,089	$16,898	$17,660	$20,542	$18,842	$21,409	$22,552	$29,457	$34,750	$23,463	$16,077
Comanche	$2,032	$4,865	$4,034	$4,759	$3,023	$4,226	$2,983	$4,168	$7,065	$4,066	$10,325
Concho	$3,017	$1,611	$1,787	$3,579	$3,507	$1,437	$1,597	$3,015	$2,776	$2,625	$19,370
Cooke	$6,763	$7,660	$8,337	$5,700	$7,006	$3,045	$4,119	$13,504	$7,305	$9,370	$5,881
Coryell	$5,520	$3,882	$5,887	$3,370	$3,539	$1,732	$2,697	$5,993	$15,029	$18,282	$19,300
Cottle	$2,839	$733	$591	$1,446	$5,476	$5,615	$11,652	$943	$5,605	$4,300	$3,104
Crane	$4,215	$1,456	$1,498	$1,832	$987	$106	$1,063	$205	$122	$1,406	$1,223
Crockett	$2,051	$2,392	$5,882	$1,895	$5,490	$1,979	$1,693	$4,266	$7,742	$4,256	$4,672
Crosby	$1,435	$1,306	$4,357	$2,678	$850	$2,345	$1,361	$4,455	$6,735	$2,240	$898
Culberson	$2,414	$1,706	$1,895	$6,871	$2,188	$815	$4,811	$4,919	$10,676	$9,029	$2,433
Dallam	$1,581	$5,726	$6,017	$11,412	$4,317	$2,289	$4,715	$6,757	$15,765	$11,007	$11,823
Dallas	$163,340	$198,832	$298,550	$260,994	$259,475	$268,927	$289,913	$306,806	$296,899	$358,395	$443,178
Dawson	$3,236	$2,055	$1,330	$4,243	$7,065	$1,485	$629	$455	$4,863	$12,978	$1,129
Deaf Smith	$4,700	$1,195	$2,777	$2,489	$10,509	$8,771	$4,440	$5,448	$3,935	$1,407	$1,195
Delta	$2,559	$4,983	$854	$1,461	$2,569	$1,022	$811	$1,827	$2,264	$1,280	$9,981
Denton	$35,993	$42,802	$32,421	$49,870	$46,181	$71,520	$107,507	$119,470	$65,700	$94,356	$75,773
De Witt	$6,275	$10,060	$9,603	$5,742	$11,905	$9,989	$8,774	$5,979	$10,687	$17,456	$7,015
Dickens	$2,545	$1,220	$2,411	$2,408	$874	$1,594	$933	$1,430	$490	$315	$4,088
Dimmit	$6,217	$4,245	$570	$3,964	$10,096	$6,582	$4,254	$5,454	$9,470	$16,546	$3,841

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Donley	$5,492	$2,415	$5,331	$1,087	$5,482	$12,178	$3,040	$4,061	$4,628	$3,465	$2,883
Duval	$1,840	$2,512	$2,901	$4,551	$3,638	$5,568	$3,094	$1,810	$1,641	$9,882	$11,148
Eastland	$6,104	$9,777	$2,450	$5,269	$5,073	$11,975	$6,910	$6,520	$12,029	$8,531	$6,693
Ector	$4,318	$11,176	$14,537	$7,915	$14,036	$13,543	$15,173	$15,015	$18,198	$19,665	$20,182
Edwards	$2,227	$4,528	$2,061	$2,041	$2,677	$1,858	$1,926	$1,380	$583	$535	$3,524
Ellis	$21,343	$18,542	$22,767	$26,568	$20,377	$44,116	$66,500	$66,634	$69,920	$53,734	$62,422
El Paso	$67,001	$80,624	$67,100	$56,457	$72,830	$79,635	$97,996	$113,810	$92,020	$78,533	$85,309
Erath	$8,085	$13,058	$10,696	$6,192	$3,839	$4,358	$9,199	$6,772	$12,259	$14,495	$9,795
Falls	$3,046	$2,576	$7,626	$3,552	$14,297	$9,783	$11,257	$11,291	$14,627	$13,485	$20,458
Fannin	$13,478	$10,967	$7,311	$11,290	$9,325	$14,858	$5,165	$7,421	$3,469	$4,214	$5,846
Fayette	$2,931	$5,982	$6,834	$9,554	$10,364	$6,595	$6,024	$16,249	$9,572	$4,900	$9,622
Fisher	$1,356	$2,241	$4,310	$1,407	$1,063	$592	$2,149	$3,908	$2,483	$1,527	$852
Floyd	$2,138	$5,779	$1,050	$762	$4,779	$2,964	$2,073	$5,940	$5,242	$3,061	$8,734
Foard	$504	$1,672	$3,114	$1,385	$269	$447	$919	$628	$948	$5,679	$4,640
Fort Bend	$39,006	$34,678	$70,112	$47,185	$68,309	$73,672	$62,851	$155,180	$146,012	$166,090	$108,815
Franklin	$4,856	$2,374	$2,566	$2,406	$2,822	$4,792	$4,138	$3,370	$4,121	$2,888	$3,684
Freestone	$6,109	$9,994	$6,975	$5,245	$7,721	$7,771	$9,552	$11,159	$10,262	$12,848	$9,494
Frio	$3,796	$5,074	$1,323	$6,096	$2,350	$4,561	$1,524	$3,897	$9,758	$7,490	$13,258
Gaines	$2,560	$2,464	$3,326	$8,158	$1,461	$1,440	$1,214	$1,075	$1,593	$4,042	$4,429
Galveston	$21,419	$35,591	$54,936	$33,255	$23,451	$19,919	$60,592	$93,840	$78,554	$72,140	$83,066
Garza	$6,740	$5,433	$6,783	$440	$2,824	$3,625	$17,385	$10,290	$1,349	$1,034	$1,292
Gillespie	$1,649	$2,085	$2,326	$1,730	$4,500	$2,179	$1,382	$1,626	$6,643	$7,553	$8,146
Glasscock	$1,171	$867	$2,508	$1,875	$863	$4,859	$5,366	$5,798	$1,675	$712	$549
Goliad	$1,794	$3,167	$1,817	$3,417	$3,795	$1,578	$2,004	$2,367	$16,756	$20,650	$13,748
Gonzales	$3,736	$2,917	$5,384	$6,790	$7,685	$2,606	$5,824	$16,780	$14,394	$10,313	$12,200
Gray	$6,050	$5,226	$2,708	$5,703	$13,649	$7,046	$2,230	$3,719	$6,222	$4,109	$3,668
Grayson	$16,188	$27,053	$24,752	$22,221	$25,525	$36,597	$33,305	$18,111	$14,234	$15,508	$22,522
Gregg	$13,685	$8,370	$11,705	$9,542	$19,316	$19,206	$13,733	$15,547	$10,770	$18,595	$12,935
Grimes	$7,762	$3,415	$4,237	$1,612	$1,643	$5,425	$5,569	$5,895	$10,942	$6,117	$6,366
Guadalupe	$8,704	$9,450	$16,672	$18,883	$12,768	$7,708	$13,223	$25,426	$33,404	$18,639	$17,354
Hale	$4,363	$5,948	$4,217	$15,116	$17,739	$10,592	$2,171	$2,398	$3,343	$8,907	$8,175
Hall	$1,661	$3,496	$4,312	$1,993	$5,306	$3,746	$1,142	$1,845	$4,286	$772	$1,142
Hamilton	$4,803	$3,935	$5,706	$3,172	$2,849	$2,148	$1,193	$1,368	$1,310	$5,948	$4,660

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Hansford	$1,529	$2,915	$4,171	$4,987	$5,250	$1,948	$1,178	$1,426	$2,056	$505	$1,277
Hardeman	$1,505	$2,058	$2,997	$2,426	$9,969	$5,213	$6,030	$5,072	$5,560	$2,005	$6,634
Hardin	$5,639	$4,510	$8,175	$6,941	$6,551	$7,977	$13,487	$11,454	$15,345	$13,243	$9,315
Harris	$243,804	$288,512	$304,236	$288,218	$309,844	$437,479	$576,956	$953,577	$810,725	$600,141	$541,144
Harrison	$8,147	$8,583	$12,130	$15,453	$13,382	$10,877	$7,058	$7,255	$22,826	$21,760	$16,069
Hartley	$4,551	$7,349	$4,165	$942	$2,999	$4,318	$939	$1,184	$3,800	$3,976	$146
Haskell	$1,565	$3,372	$3,595	$2,638	$3,763	$3,026	$2,726	$11,713	$8,968	$8,701	$2,190
Hays	$7,396	$5,261	$12,688	$11,871	$20,504	$22,205	$17,056	$32,770	$36,214	$15,197	$13,242
Hemphill	$4,336	$1,517	$699	$2,393	$331	$1,971	$2,743	$10,245	$9,846	$2,399	$3,076
Henderson	$12,807	$16,985	$11,905	$13,758	$9,301	$5,814	$16,588	$26,488	$15,094	$21,745	$36,106
Hidalgo	$49,766	$46,328	$46,599	$88,961	$94,670	$91,424	$86,595	$114,552	$122,028	$113,060	$97,245
Hill	$8,550	$14,780	$36,536	$29,510	$8,087	$14,806	$17,720	$19,531	$29,802	$29,996	$34,426
Hockley	$1,910	$7,521	$6,830	$3,465	$2,260	$1,278	$902	$5,454	$5,489	$7,283	$7,704
Hood	$2,241	$4,902	$2,325	$4,795	$14,539	$9,104	$2,867	$4,750	$1,358	$4,297	$11,152
Hopkins	$4,941	$16,281	$13,544	$8,332	$15,140	$11,925	$7,845	$7,366	$17,295	$16,311	$22,368
Houston	$3,506	$6,692	$5,593	$10,929	$13,860	$7,671	$6,523	$9,567	$8,835	$13,370	$10,901
Howard	$6,211	$3,520	$3,962	$12,943	$8,070	$4,872	$2,071	$10,219	$6,963	$12,873	$11,232
Hudspeth	$3,333	$3,414	$7,530	$21,449	$45,146	$35,285	$18,156	$4,827	$3,722	$5,078	$2,498
Hunt	$14,829	$28,506	$39,222	$33,614	$23,681	$17,522	$11,890	$6,344	$17,101	$24,336	$24,111
Hutchinson	$6,281	$2,098	$2,513	$1,409	$927	$2,609	$4,161	$3,151	$2,926	$5,942	$4,571
Irion	$2,046	$1,254	$379	$566	$728	$1,310	$1,688	$952	$184	$112	$471
Jack	$2,020	$1,825	$1,399	$3,206	$6,337	$2,713	$1,621	$3,326	$2,569	$2,067	$3,598
Jackson	$5,729	$6,183	$8,936	$8,001	$6,389	$5,956	$5,009	$6,871	$5,998	$7,542	$2,671
Jasper	$10,189	$10,627	$7,929	$7,066	$13,486	$15,587	$18,780	$29,700	$18,665	$20,977	$22,239
Jeff Davis	$1,420	$2,855	$5,280	$2,789	$6,503	$1,511	$114	$15,620	$15,596	$2,824	$1,528
Jefferson	$27,830	$27,539	$29,035	$28,315	$25,759	$28,766	$30,725	$40,860	$45,722	$37,098	$33,615
Jim Hogg	$2,580	$2,844	$951	$891	$11,772	$1,088	$1,188	$284	$654	$152	$775
Jim Wells	$12,821	$13,103	$6,538	$10,188	$3,902	$4,372	$4,241	$4,342	$6,608	$10,485	$14,818
Johnson	$13,972	$11,330	$17,444	$19,637	$21,424	$13,855	$12,338	$19,180	$21,486	$50,029	$40,261
Jones	$4,014	$3,808	$6,089	$5,710	$8,543	$5,945	$6,130	$3,841	$1,658	$5,933	$5,066
Karnes	$1,584	$2,071	$1,439	$8,557	$2,095	$1,101	$4,192	$1,883	$3,025	$4,545	$2,128
Kaufman	$10,695	$11,219	$5,274	$12,322	$17,857	$8,106	$24,245	$19,396	$15,651	$25,895	$31,475
Kendall	$3,146	$2,968	$3,272	$1,393	$1,148	$1,239	$459	$1,273	$2,214	$7,056	$6,145

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Kenedy	$1,263	$1,829	$1,332	$2,562	$677	$295	$564	$435	$1,322	$344	$465
Kent	$2,269	$5,115	$2,943	$945	$387	$440	$2,967	$2,996	$2,132	$1,685	$732
Kerr	$5,132	$2,687	$6,888	$1,990	$1,877	$5,922	$5,767	$7,998	$16,243	$22,142	$16,491
Kimble	$1,425	$1,952	$1,877	$2,637	$972	$1,372	$9,100	$2,403	$3,112	$13,123	$8,009
King	$2,110	$912	$1,176	$1,086	$496	$829	$702	$417	$3,895	$5,675	$4,306
Kinney	$876	$929	$1,930	$680	$743	$1,322	$398	$4,527	$1,378	$1,532	$2,783
Kleberg	$1,130	$4,502	$4,432	$3,886	$892	$9,503	$16,418	$9,149	$2,647	$625	$3,305
Knox	$2,759	$2,529	$3,685	$3,646	$7,636	$2,695	$2,552	$10,276	$12,929	$10,384	$1,940
Lamar	$18,381	$19,671	$18,349	$14,436	$10,583	$10,101	$8,467	$7,681	$11,968	$8,864	$13,427
Lamb	$3,934	$4,684	$4,080	$7,588	$12,731	$4,617	$182	$1,069	$2,090	$5,389	$9,822
Lampasas	$6,254	$5,445	$4,039	$3,658	$2,631	$2,926	$3,548	$1,146	$3,424	$3,563	$8,616
La Salle	$6,485	$3,291	$4,011	$8,403	$19,550	$5,435	$6,411	$15,121	$8,815	$5,328	$4,264
Lavaca	$4,814	$2,663	$6,871	$7,226	$2,219	$4,227	$6,293	$10,773	$9,084	$17,521	$20,467
Lee	$5,179	$4,806	$1,024	$5,120	$7,495	$2,291	$2,469	$11,734	$5,153	$4,180	$4,674
Leon	$4,825	$6,607	$6,477	$7,723	$6,417	$12,404	$7,550	$10,489	$12,393	$7,781	$5,511
Liberty	$10,764	$13,137	$16,164	$7,477	$5,446	$11,252	$9,681	$14,567	$21,896	$25,833	$36,759
Limestone	$4,232	$6,949	$4,283	$5,753	$2,865	$2,082	$4,685	$7,118	$7,653	$8,753	$13,934
Lipscomb	$962	$737	$232	$411	$677	$718	$259	$3,289	$4,638	$198	$835
Live Oak	$3,142	$2,985	$4,552	$6,909	$15,660	$5,952	$12,300	$8,562	$6,813	$13,250	$29,781
Llano	$881	$1,231	$1,073	$4,089	$1,703	$5,483	$2,733	$1,379	$4,048	$7,149	$4,175
Loving	$108	$65	$25	#VALUE!	$8	$153	$467	$5	$4	$8	$12
Lubbock	$27,092	$40,842	$53,830	$49,806	$85,113	$54,570	$54,937	$65,740	$74,753	$66,522	$90,828
Lynn	$1,402	$1,724	$723	$3,312	$9,580	$13,971	$3,927	$4,687	$8,166	$2,592	$1,153
Madison	$4,116	$9,034	$7,171	$1,910	$4,947	$7,981	$7,915	$2,281	$3,139	$2,775	$3,575
Marion	$2,984	$1,811	$3,655	$2,115	$2,133	$3,301	$1,829	$4,012	$5,005	$12,415	$11,877
Martin	$1,052	$2,378	$2,674	$2,275	$1,281	$1,117	$4,188	$473	$3,405	$3,725	$1,964
Mason	$849	$1,216	$544	$667	$345	$809	$197	$834	$1,279	$1,616	$593
Matagorda	$4,739	$10,476	$6,929	$12,554	$9,891	$4,856	$5,898	$6,553	$12,583	$20,623	$19,746
Maverick	$6,305	$4,973	$8,433	$6,506	$9,891	$12,438	$2,503	$3,828	$6,065	$12,753	$13,528
McCulloch	$2,430	$1,891	$1,658	$4,483	$4,489	$3,074	$1,051	$1,029	$3,499	$4,374	$3,094
McLennan	$16,143	$13,162	$17,808	$21,012	$26,463	$31,533	$55,290	$68,230	$58,475	$59,594	$44,268
McMullen	$1,733	$3,435	$3,716	$3,880	$1,842	$1,403	$960	$3,214	$4,216	$4,170	$4,112
Medina	$10,183	$7,274	$4,381	$5,691	$3,050	$10,720	$5,316	$10,053	$12,749	$16,158	$10,574

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Menard	$438	$1,061	$383	$1,674	$2,563	$791	$435	$992	$1,420	$563	$1,682
Midland	$6,702	$12,908	$6,350	$16,672	$11,423	$7,375	$12,656	$8,598	$6,903	$13,873	$17,867
Milam	$5,296	$7,887	$17,779	$14,995	$15,402	$7,515	$3,527	$16,557	$14,272	$8,970	$9,709
Mills	$1,707	$1,756	$607	$730	$599	$1,109	$1,376	$1,238	$1,208	$1,260	$1,285
Mitchell	$2,683	$6,586	$3,915	$2,866	$1,096	$6,116	$5,255	$2,480	$2,184	$1,185	$1,539
Montague	$2,625	$4,361	$3,142	$3,426	$4,171	$3,381	$2,621	$3,059	$7,861	$9,199	$4,109
Montgomery	$19,547	$34,745	$35,237	$55,783	$45,114	$28,925	$32,005	$71,038	$67,664	$119,272	$189,790
Moore	$5,929	$5,303	$1,417	$3,033	$1,175	$7,618	$10,794	$4,448	$1,857	$9,032	$3,709
Morris	$4,599	$2,852	$1,363	$2,847	$2,699	$2,463	$3,929	$8,710	$7,786	$5,948	$2,065
Motley	$1,187	$2,229	$2,044	$1,062	$507	$455	$815	$4,586	$587	$702	$6,324
Nacogdoches	$8,177	$11,991	$10,896	$7,220	$13,727	$15,018	$11,566	$14,623	$13,589	$10,792	$17,081
Navarro	$11,527	$10,488	$17,654	$16,850	$17,340	$26,756	$28,907	$26,038	$24,362	$17,225	$32,387
Newton	$4,177	$3,827	$4,351	$2,402	$2,843	$5,668	$13,139	$5,698	$5,765	$7,873	$4,785
Nolan	$7,957	$7,810	$6,454	$1,748	$5,409	$8,693	$4,583	$3,632	$3,786	$15,621	$14,608
Nueces	$19,923	$20,955	$15,711	$37,053	$57,729	$59,446	$69,196	$91,481	$66,711	$37,288	$36,707
Ochiltree	$2,876	$1,540	$7,037	$4,341	$6,451	$6,352	$4,241	$1,176	$2,860	$1,535	$745
Oldham	$3,663	$5,518	$5,630	$6,091	$13,148	$23,743	$12,492	$6,033	$13,641	$28,944	$13,365
Orange	$12,448	$10,398	$31,369	$32,477	$29,837	$22,356	$45,617	$32,433	$48,352	$48,803	$45,843
Palo Pinto	$3,170	$3,116	$3,401	$2,782	$4,521	$6,135	$15,122	$22,793	$9,891	$20,010	$28,989
Panola	$7,448	$7,374	$9,128	$16,398	$22,397	$15,470	$13,834	$9,992	$10,135	$6,113	$8,126
Parker	$8,887	$9,348	$12,144	$6,565	$7,120	$10,611	$7,607	$12,805	$12,949	$18,649	$21,479
Parmer	$1,355	$1,170	$1,256	$425	$1,188	$8,368	$4,158	$4,450	$10,949	$3,879	$4,396
Pecos	$6,175	$8,157	$1,946	$6,825	$5,518	$8,540	$6,141	$2,649	$8,584	$6,846	$11,932
Polk	$11,168	$17,294	$16,999	$18,014	$10,018	$6,926	$11,504	$12,133	$19,987	$21,051	$10,511
Potter	$16,166	$22,071	$30,894	$25,918	$31,238	$20,569	$21,683	$28,142	$19,332	$28,874	$19,118
Presidio	$2,102	$2,843	$1,082	$3,638	$5,200	$876	$2,475	$750	$1,997	$6,948	$6,654
Rains	$2,255	$4,186	$3,709	$3,521	$2,331	$1,421	$938	$4,629	$4,516	$956	$2,070
Randall	$2,944	$9,172	$5,912	$16,758	$16,914	$6,409	$9,952	$6,319	$6,310	$4,653	$10,627
Reagan	$515	$606	$1,813	$478	$1,211	$6,063	$4,497	$1,263	$195	$257	$570
Real	$1,398	$5,171	$2,617	$472	$232	$2,981	$3,415	$7,249	$2,785	$8,174	$6,590
Red River	$15,098	$7,291	$4,166	$4,247	$4,282	$5,034	$10,090	$8,614	$8,763	$3,085	$7,920
Reeves	$4,131	$9,530	$6,014	$1,124	$2,802	$4,767	$10,372	$9,503	$3,117	$17,808	$5,119
Refugio	$3,593	$4,819	$12,851	$1,556	$6,891	$3,519	$3,138	$2,598	$5,187	$9,610	$5,580

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Roberts	$695	$1,559	$3,275	$4,188	$2,176	$3,480	$371	$486	$1,983	$4,712	$219
Robertson	$5,636	$8,613	$2,677	$3,128	$8,915	$3,781	$5,825	$6,528	$14,527	$10,288	$17,161
Rockwall	$8,028	$3,686	$12,213	$24,078	$21,180	$6,755	$3,389	$4,525	$4,377	$15,539	$21,243
Runnels	$3,986	$3,958	$1,898	$2,656	$3,522	$776	$2,569	$5,456	$2,474	$965	$6,231
Rusk	$4,432	$7,100	$9,070	$12,248	$23,217	$13,100	$8,601	$7,497	$8,215	$11,249	$10,876
Sabine	$3,842	$2,928	$2,678	$2,669	$3,493	$4,002	$2,551	$3,112	$4,262	$7,635	$10,685
San Augustine	$3,108	$5,163	$5,220	$4,169	$5,274	$1,250	$1,832	$2,975	$3,939	$4,007	$3,540
San Jacinto	$2,726	$5,156	$2,894	$8,149	$7,675	$7,149	$9,957	$10,986	$10,975	$25,072	$14,940
San Patricio	$18,808	$12,933	$12,748	$9,338	$4,890	$9,460	$19,368	$11,972	$27,485	$37,494	$33,380
San Saba	$1,678	$1,091	$1,419	$1,639	$5,718	$1,438	$1,223	$910	$1,560	$978	$740
Schleicher	$440	$608	$2,620	$2,121	$1,435	$203	$938	$1,797	$939	$1,552	$2,244
Scurry	$3,044	$1,751	$3,412	$8,496	$5,066	$7,584	$8,084	$11,146	$3,936	$3,652	$6,462
Shackelford	$4,504	$1,122	$580	$2,293	$5,488	$5,127	$1,688	$481	$265	$3,137	$3,787
Shelby	$5,883	$9,461	$4,882	$21,673	$22,253	$15,157	$12,678	$8,918	$17,454	$11,990	$12,478
Sherman	$1,151	$2,657	$8,882	$12,772	$8,686	$2,188	$808	$1,127	$1,353	$1,958	$1,075
Smith	$24,782	$24,050	$22,791	$22,166	$14,474	$32,381	$35,356	$36,354	$51,159	$66,896	$47,760
Somervell	$967	$1,566	$348	$2,033	$6,109	$4,400	$910	$4,265	$7,781	$3,116	$3,528
Starr	$8,600	$4,869	$11,207	$4,960	$2,471	$4,952	$5,548	$3,970	$3,457	$2,113	$6,921
Stephens	$1,724	$2,493	$1,145	$1,026	$1,541	$1,982	$2,299	$2,411	$1,485	$539	$887
Sterling	$3,229	$1,615	$7,848	$1,648	$4,408	$6,255	$3,596	$1,856	$925	$216	$960
Stonewall	$2,237	$1,477	$322	$2,815	$3,283	$1,232	$853	$3,360	$2,083	$366	$1,767
Sutton	$6,925	$4,118	$2,345	$4,287	$4,910	$2,639	$3,244	$1,937	$2,136	$1,722	$646
Swisher	$1,950	$1,372	$4,728	$3,952	$1,185	$357	$548	$1,594	$3,403	$2,396	$851
Tarrant	$104,938	$139,734	$161,582	$151,981	$141,529	$109,025	$119,001	$140,876	$120,611	$143,678	$160,384
Taylor	$9,036	$18,024	$15,110	$11,932	$17,203	$33,747	$19,635	$13,796	$21,157	$22,805	$27,987
Terrell	$1,013	$3,136	$3,420	$247	$1,116	$1,620	$209	$2,331	$2,702	$445	$67
Terry	$2,572	$1,142	$255	$681	$2,081	$755	$840	$470	$9,652	$7,071	$10,982
Throckmorton	$1,163	$1,152	$409	$2,116	$1,002	$1,292	$834	$1,533	$2,920	$3,293	$3,703
Titus	$6,402	$10,353	$13,604	$7,330	$9,385	$8,177	$7,392	$6,418	$6,911	$8,561	$8,675
Tom Green	$15,215	$10,146	$20,660	$8,822	$25,807	$30,656	$19,086	$20,748	$15,776	$21,907	$23,427
Travis	$57,888	$65,274	$81,838	$81,636	$83,590	$168,284	$247,440	$444,897	$569,018	$407,910	$296,592
Trinity	$2,723	$3,422	$12,094	$13,703	$11,807	$6,000	$9,039	$4,121	$2,597	$4,653	$2,908
Tyler	$2,446	$2,457	$3,322	$3,124	$1,049	$766	$1,879	$3,727	$6,560	$17,708	$10,947

County	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Upshur	$8,191	$7,875	$16,022	$17,213	$20,698	$15,637	$7,816	$5,852	$9,223	$14,509	$19,594
Upton	$744	$2,200	$756	$775	$363	$2,018	$5,255	$2,568	$601	$1,851	$690
Uvalde	$2,839	$4,855	$10,364	$9,050	$5,647	$6,175	$2,719	$11,027	$11,933	$10,470	$12,253
Val Verde	$6,605	$3,043	$3,916	$15,465	$4,625	$1,311	$6,328	$8,704	$6,737	$6,717	$8,056
Van Zandt	$7,284	$13,328	$16,233	$8,416	$9,619	$23,032	$5,381	$4,752	$8,487	$19,213	$21,089
Victoria	$14,245	$14,921	$17,040	$18,276	$33,916	$29,066	$33,473	$33,111	$15,232	$16,676	$14,545
Walker	$7,303	$11,562	$17,373	$9,251	$12,636	$9,063	$7,532	$14,562	$20,665	$20,018	$11,718
Waller	$5,692	$4,235	$2,804	$4,665	$7,995	$14,198	$7,533	$10,845	$16,673	$8,427	$4,050
Ward	$1,704	$1,943	$13,167	$2,513	$5,508	$1,403	$9,156	$2,211	$10,249	$1,479	$2,292
Washington	$8,457	$11,106	$10,646	$6,311	$13,261	$19,736	$3,942	$4,329	$5,991	$5,837	$9,829
Webb	$19,678	$32,912	$69,101	$45,549	$31,306	$27,081	$27,667	$67,191	$65,001	$78,258	$73,723
Wharton	$3,190	$6,949	$9,738	$6,904	$7,418	$9,300	$9,280	$12,219	$19,686	$12,930	$9,006
Wheeler	$11,597	$14,296	$16,525	$14,116	$22,303	$3,076	$2,109	$3,315	$3,524	$15,323	$9,581
Wichita	$11,704	$18,861	$39,136	$32,077	$24,745	$34,434	$19,468	$14,993	$35,154	$22,759	$24,993
Wilbarger	$2,004	$4,739	$2,164	$7,083	$9,017	$4,813	$8,098	$5,371	$12,312	$11,128	$14,738
Willacy	$3,383	$1,682	$2,263	$2,007	$11,799	$38,534	$6,279	$396	$2,549	$21,102	$8,430
Williamson	$17,422	$21,802	$27,429	$66,222	$75,855	$132,851	$254,722	$287,965	$254,902	$169,536	$70,061
Wilson	$2,483	$1,895	$6,052	$7,128	$8,114	$4,777	$3,353	$9,585	$7,240	$10,710	$8,970
Winkler	$1,215	$534	$353	$1,288	$767	$601	$1,157	$331	$861	$739	$168
Wise	$8,048	$8,964	$6,433	$6,125	$8,457	$6,057	$16,528	$27,064	$28,621	$18,399	$13,887
Wood	$5,519	$3,826	$1,600	$2,900	$2,525	$5,001	$4,400	$5,795	$12,603	$14,693	$10,114
Yoakum	$912	$2,833	$995	$249	$997	$316	$95	$329	$2,154	$3,147	$1,164
Young	$2,047	$5,782	$5,150	$4,027	$3,153	$2,279	$4,273	$7,417	$5,531	$6,592	$6,210
Zapata	$3,366	$1,314	$254	$324	$919	$1,886	$3,340	$1,884	$633	$3,106	$7,275
Zavala	$1,837	$2,402	$1,733	$3,061	$2,661	$1,801	$5,831	$5,136	$4,232	$1,239	$4,042

Table J-2. Comparison of Old and New Highway Growth Factors by County for Selected Years

County	2008 new	2008 old	2018 new	2018 old
Anderson	1.654168	2.470824	1.537031	2.420294
Andrews	0.109184	0.997372	0.085255	0.835839
Angelina	2.226828	2.989535	2.229251	3.15666
Aransas	0.112684	0.92425	0.110718	0.894661
Archer	2.01156	4.238159	2.361093	5.091945
Armstrong	5.141394	21.75422	4.485672	20.31286
Atascosa	1.286206	3.942679	1.166427	4.283758
Austin	0.521322	1.671438	0.531818	1.798472
Bailey	0.175204	1.307452	0.154809	1.28418
Bandera	14.38923	8.353278	11.89599	7.710283
Bastrop	0.918856	0.775572	0.899704	0.923986
Baylor	31.48085	22.51264	23.73602	18.34755
Bee	2.329001	2.554422	2.006035	2.457429
Bell	1.500968	1.230107	1.587083	1.35998
Bexar	1.133637	0.972336	1.06664	0.923735
Blanco	6.32738	4.67472	7.09226	5.504238
Borden	0.183098	0.894069	0.111165	0.69026
Bosque	0.404481	2.251972	0.371905	2.303218
Bowie	1.770896	1.005366	1.826878	1.131786
Brazoria	0.524111	1.381211	0.626582	1.749612
Brazos	1.099399	1.218104	1.37563	1.402947
Brewster	0.654382	0.564137	0.603209	0.554645
Briscoe	5.596985	4.652653	3.969236	3.631571
Brooks	2.522028	0.794098	1.918401	0.67225
Brown	1.1159	2.096093	1.144343	2.246766
Burleson	1.435455	2.124558	1.379162	2.212493
Burnet	3.451512	3.784122	4.038725	4.757158
Caldwell	1.957377	1.632083	1.823708	1.800122
Calhoun	1.235092	5.29459	1.411816	6.425367
Callahan	0.835308	1.29172	0.894233	1.5378
Cameron	0.602375	1.320509	0.636801	1.368438
Camp	1.13567	0.785139	1.108366	0.834186
Carson	2.514888	1.191767	2.194461	1.302956
Cass	2.10885	3.050926	2.067875	3.127812
Castro	0.125443	1.153782	0.091764	0.953141
Chambers	1.589736	2.494638	1.630448	2.776471
Cherokee	0.226798	0.363072	0.21862	0.38471
Childress	0.574501	0.631768	0.501785	0.625694

County	2008 new	2008 old	2018 new	2018 old
Clay	0.338991	1.120002	0.30764	1.023807
Cochran	2.46477	4.560324	1.533405	3.338509
Coke	0.349051	0.510589	0.288349	0.458119
Coleman	0.172404	0.412513	0.143636	0.37109
Collin	0.663637	1.345856	0.84996	1.824653
Collingsworth	0.614654	4.660416	0.477601	3.186424
Colorado	1.226864	2.561003	1.114101	2.580106
Comal	0.46645	1.420205	0.559335	1.757724
Comanche	2.265192	2.091072	1.821676	1.883505
Concho	7.937572	1.601845	6.711052	1.524762
Cooke	0.934307	1.690695	0.915416	1.797886
Coryell	4.682795	5.069991	3.900961	4.635887
Cottle	0.174303	0.42566	0.109364	0.304646
Crane	0.752912	0.10032	0.598337	0.085938
Crockett	1.805674	3.979384	1.475197	3.565821
Crosby	0.431832	4.518226	0.330727	4.085699
Culberson	0.33093	1.963668	0.227048	1.466899
Dallam	1.640698	3.345362	1.526589	3.470165
Dallas	1.000271	1.036664	0.978552	1.005189
Dawson	1.174124	6.835654	0.860367	5.643546
De Witt	0.176112	0.793482	0.178299	0.766474
Deaf Smith	8.054665	2.589409	7.279933	2.699543
Delta	0.461192	0.563185	0.570043	0.579679
Denton	0.523184	1.208407	0.446402	1.576372
Dickens	2.868042	0.684046	2.340284	0.545466
Dimmit	0.590741	1.897954	0.472577	1.774945
Donley	0.620458	1.424104	0.548774	1.377709
Duval	2.357404	0.480894	1.848638	0.425512
Eastland	0.633742	1.560358	0.527095	1.415093
Ector	0.870357	1.049222	0.868296	1.133621
Edwards	1.197191	0.34891	0.809741	0.248759
El Paso	0.614219	1.096088	0.719797	1.113538
Ellis	0.569634	1.018576	0.597947	1.293913
Erath	0.696775	1.224367	0.741134	1.321346
Falls	1.189149	1.331121	0.923458	1.117348
Fannin	0.740652	0.637194	0.846217	0.738712
Fayette	1.045239	1.44777	1.017028	1.49896
Fisher	0.259251	1.213507	0.19039	0.92731
Floyd	2.756196	2.387577	1.983619	1.957257
Foard	3.303574	0.952642	2.419409	0.824257
Fort Bend	1.132876	2.662	1.440587	3.614131

County	2008 new	2008 old	2018 new	2018 old
Franklin	0.582518	0.938913	0.581373	1.001431
Freestone	0.650407	0.928793	0.567803	0.900476
Frio	5.691195	5.49741	4.502227	4.905001
Gaines	2.387213	1.131073	2.069121	1.097547
Galveston	0.897043	1.528249	0.922825	1.612386
Garza	0.048615	0.069729	0.038501	0.061995
Gillespie	3.856633	4.545243	4.500568	5.396615
Glasscock	0.066987	0.276801	0.044624	0.210413
Goliad	4.489783	10.41605	4.41478	10.70218
Gonzales	1.370766	2.28097	1.392097	2.524421
Gray	1.076261	2.628442	0.880428	2.278903
Grayson	0.442501	0.4327	0.402115	0.450615
Gregg	0.6163	0.89319	0.715335	1.039601
Grimes	0.747993	1.865827	0.899931	2.337079
Guadalupe	0.858779	2.056698	0.87037	2.249295
Hale	2.463546	1.382753	2.093223	1.335458
Hall	0.654576	3.226922	0.493374	2.819513
Hamilton	2.555942	0.964451	2.417163	0.931204
Hansford	0.709381	1.472272	0.61767	1.403646
Hardeman	0.719976	0.855841	0.534884	0.706316
Hardin	0.451944	1.118537	0.449019	0.887735
Harris	0.61373	1.441606	0.630331	1.550868
Harrison	1.48981	2.880694	1.309947	2.821193
Hartley	0.10145	4.014557	0.091589	4.18024
Haskell	0.525583	2.78043	0.442429	2.413422
Hays	0.508034	2.089426	0.682348	2.966387
Hemphill	0.733971	3.172246	0.620665	2.984955
Henderson	1.424227	0.831279	1.424346	0.916086
Hidalgo	0.734824	1.24149	0.81989	1.354152
Hill	1.271208	1.528574	1.220532	1.652494
Hockley	5.58757	5.35094	4.33423	4.699476
Hood	2.54546	0.462796	2.781289	0.547321
Hopkins	1.865617	2.031212	1.916526	2.208737
Houston	1.093496	1.301519	0.979539	1.230372
Howard	3.54924	3.037741	3.404437	3.025749
Hudspeth	0.090028	0.189245	0.082209	0.193598
Hunt	1.326853	1.454021	1.338532	1.589824
Hutchinson	0.718764	0.66361	0.59195	0.579642
Irion	0.182709	0.102522	0.159637	0.101926
Jack	1.452205	1.515695	1.366922	1.611564
Jackson	0.348907	1.095901	0.297893	1.062754

County	2008 new	2008 old	2018 new	2018 old
Jasper	0.774872	0.941546	0.697309	0.939902
Jeff Davis	8.783972	127.6275	7.642087	126.8408
Jefferson	0.715913	1.359615	0.519398	1.204453
Jim Hogg	0.426923	0.469488	0.324773	0.401951
Jim Wells	2.286142	1.494811	2.025962	1.409749
Johnson	2.135299	1.705666	2.143927	1.823052
Jones	0.540738	0.392494	0.419304	0.320681
Karnes	0.332218	0.706143	0.300203	0.705132
Kaufman	0.849486	0.64474	0.993856	0.826299
Kendall	8.76374	4.01717	9.234979	4.374313
Kenedy	0.539929	2.033071	0.439239	1.897566
Kent	0.161454	0.56643	0.09587	0.358687
Kerr	1.871194	2.984166	1.945493	3.166456
Kimble	0.575897	0.306841	0.642613	0.350228
King	4.016666	4.31637	2.538511	2.997226
Kinney	4.578094	3.298013	3.93468	3.103219
Kleberg	0.131744	0.153996	0.11985	0.143833
Knox	0.497437	4.491612	0.310135	3.220133
La Salle	1.037741	1.29938	1.023965	1.226656
Lamar	35.28757	11.15168	29.75442	11.68473
Lamb	1.588811	0.936749	1.66763	0.865591
Lampasas	0.435179	1.255942	0.373856	1.499367
Lavaca	2.128147	1.35685	1.98453	1.395367
Lee	1.238466	1.957629	1.185282	2.099502
Leon	0.47767	1.544657	0.5506	1.849018
Liberty	2.484555	2.685331	2.429138	2.797219
Limestone	1.946057	1.490878	1.957472	1.594791
Lipscomb	2.111742	16.25257	1.916218	16.61423
Live Oak	1.584375	0.494514	1.287144	0.455468
Llano	0.999366	1.613535	1.013185	1.705222
Loving	0.016214	0.006978	0.003281	0.002112
Lubbock	1.081837	1.274372	1.091489	1.261054
Lynn	0.19208	1.878887	0.149697	1.708202
Madison	0.295588	0.37477	0.332217	0.41493
Marion	4.249283	2.569267	3.705529	2.51434
Martin	0.306887	0.727788	0.240802	0.620636
Mason	1.97291	6.05514	1.779022	6.070614
Matagorda	2.19078	2.033807	1.786873	1.878678
Maverick	3.535974	2.487791	3.744343	2.715856
McCulloch	1.925826	3.058395	1.625476	2.885573
McLennan	0.523901	1.002504	0.560855	1.03783

County	2008 new	2008 old	2018 new	2018 old
McMullen	2.803672	4.008543	2.594636	4.253973
Medina	1.30158	2.194662	1.203649	2.163668
Menard	2.529333	2.993754	1.861532	2.52053
Midland	0.923801	0.724428	1.004086	0.810159
Milam	1.801291	3.684674	1.657887	3.770819
Mills	0.611373	0.825843	0.545497	0.832743
Mitchell	0.191665	0.385172	0.202208	0.419876
Montague	1.025979	2.860104	0.994812	2.943835
Montgomery	3.880295	2.209305	4.538582	2.670049
Moore	0.224853	0.152597	0.210232	0.161304
Morris	0.343857	2.070286	0.335964	2.223337
Motley	5.078741	0.655188	3.925708	0.542659
Nacogdoches	0.966418	1.067541	0.934382	1.075195
Navarro	0.733125	0.760539	0.718826	0.821192
Newton	0.238302	0.385532	0.181251	0.336013
Nolan	2.085835	0.835706	1.689055	0.684428
Nueces	0.347112	0.762021	0.320394	0.700113
Ochiltree	0.114902	0.593517	0.106166	0.608052
Oldham	0.700079	0.97997	0.53402	0.845566
Orange	0.657592	1.013335	0.564827	0.839934
Palo Pinto	1.25435	0.899724	1.274085	0.86306
Panola	0.384328	0.65063	0.326067	0.614956
Parker	1.847513	1.602127	1.917174	1.748619
Parmer	0.691834	2.23813	0.574227	2.131496
Pecos	1.271276	1.266937	1.002544	1.115219
Polk	0.597859	1.747618	0.620678	2.017235
Potter	0.576938	0.804035	0.601561	0.832909
Presidio	1.759222	0.76795	1.665605	0.817445
Rains	1.444354	5.082442	1.64668	5.987946
Randall	0.698728	0.673939	0.769534	0.711842
Reagan	0.08295	0.035172	0.052763	0.022822
Real	1.26252	0.773	1.132236	0.788223
Red River	0.513616	0.80436	0.408916	0.717067
Reeves	0.32296	0.256983	0.227697	0.190622
Refugio	1.163525	1.378518	0.849615	1.155869
Roberts	0.386335	5.838101	0.291939	4.225645
Robertson	1.92781	2.048271	2.407489	2.588004
Rockwall	4.101988	1.434799	5.952543	2.050691
Runnels	1.587206	0.913207	1.235711	0.8048
Rusk	0.827472	0.969118	0.906632	1.09222
Sabine	2.740866	1.596781	2.420245	1.626967

County	2008 new	2008 old	2018 new	2018 old
San Augustine	1.264073	2.006163	1.131949	2.02684
San Jacinto	0.981829	1.144397	0.923464	1.128315
San Patricio	1.127738	1.727515	1.176028	1.929049
San Saba	0.396049	1.16577	0.341246	1.105911
Schleicher	1.5647	0.855182	1.233405	0.732466
Scurry	0.523021	0.425753	0.421817	0.374811
Shackelford	1.468317	0.138666	1.307843	0.134045
Shelby	0.643994	1.337463	0.697042	1.510173
Sherman	0.870831	1.557911	0.754115	1.493146
Smith	0.883892	1.641092	0.985809	1.80889
Somervell	2.537715	7.764175	2.753014	9.336222
Starr	0.81633	0.770255	0.828972	0.760876
Stephens	0.252541	0.581383	0.221718	0.556718
Sterling	0.174714	0.230832	0.114139	0.161164
Stonewall	1.356621	2.090672	0.825956	1.313579
Sutton	0.130232	0.665351	0.118155	0.659006
Swisher	1.01671	5.656397	0.832369	5.13029
Tarrant	0.881895	0.955717	0.911182	1.021561
Taylor	0.932682	1.811252	0.917325	1.531893
Terrell	0.209336	11.80699	0.132769	8.434885
Terry	8.550519	9.803052	7.197598	8.844362
Throckmorton	2.906023	3.169439	2.126346	2.568592
Titus	0.767893	0.914362	0.770165	1.021779
Tom Green	0.803178	0.79998	0.7271	0.726079
Travis	0.784328	2.266628	0.848612	2.63056
Trinity	0.210521	0.34479	0.197031	0.317235
Tyler	3.811552	3.230572	3.285271	3.307878
Upshur	1.640427	1.229184	1.774942	1.351288
Upton	0.085878	0.099236	0.060241	0.078118
Uvalde	2.949068	3.971941	2.827705	4.143707
Val Verde	0.833058	1.010421	0.816866	1.04413
Van Zandt	2.564313	1.452439	2.335234	1.498678
Victoria	0.284333	0.612551	0.311206	0.676726
Walker	1.018028	2.513111	0.910603	2.446643
Waller	0.351835	2.249063	0.310181	2.12729
Ward	0.163836	0.966297	0.119309	0.763654
Washington	1.631364	1.403558	1.491126	1.40197
Webb	1.743588	2.462674	1.606778	2.30918
Wharton	0.635034	2.057392	0.554601	2.003753
Wheeler	2.972859	1.435838	2.600775	1.27172

County	2008 new	2008 old	2018 new	2018 old
Wichita	0.840042	1.792259	0.75883	1.555385
Wilbarger	1.190952	1.426247	1.094439	1.366418
Willacy	0.878472	0.380403	0.819929	0.393699
Williamson	0.179976	0.999784	0.225802	1.396375
Wilson	1.750238	1.874801	1.795897	1.968962
Winkler	0.095152	0.638558	0.070072	0.509956
Wise	0.549764	1.626067	0.549248	1.933226
Wood	1.504001	2.733325	1.48032	2.909157
Yoakum	8.002984	19.7065	6.795373	18.10506
Young	0.950944	1.172602	0.84015	1.200483
Zapata	1.425392	0.175861	1.333169	0.184342
Zavala	0.453572	0.669709	0.36342	0.611468