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Agribusiness and Applied Economics Report 707



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# Population Estimates for City of Williston

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## Executive Summary

Rapid expansion in the petroleum sector has led to unprecedented growth in the City of Williston. Employment opportunities in the oil and gas industry and other associated sectors (e.g., residential and commercial construction) has attracted thousands of workers fueling population growth, housing shortages and inflated housing costs. Further, rapid growth has strained existing infrastructure and the delivery of public services. Communities are struggling to manage the many challenges associated with rapid growth as well as plan for future delivery of public services and gauge response to demand for housing and infrastructure. One of the most basic metrics used to gauge response and guide planning processes is population projections.

Study objectives were to estimate the current service population of Williston and Williams County and develop a five-year service population projection. The service population includes long-term normal residents, others that may work in North Dakota and live elsewhere, and those that live in North Dakota temporarily.

Models, methodologies and strategies used in the past to assess changes in the economy were not well suited to model the effects of the rapid growth in the petroleum sector. Because of the unique nature of the circumstances in western North Dakota, many of the tools traditionally used to model economic, demographic, and fiscal impacts are not properly calibrated to the current economic environment. Traditional models do not accurately reflect the effects of rapid and wide-spread expansion of regional employment that has occurred in the Williston Basin. Accordingly two models were developed to estimate current and projected service population using two different metrics; employment and housing. Service population was defined as the sum of the normal resident population (Census population) and the population that works in the Williston area but maintains a residence elsewhere.

Because expansion in the oil and gas industry and associated employment is driving growth, a model based on oil field development was created to forecast regional employment, housing and population based on various oil and gas development scenarios. Scenarios were based on the rate (rig counts) and scope (number of wells) of oil field development. The housing build-out model used a combination of Census information, informal lodging arrangements, housing completions since the 2010 Census, and anticipated housing build-out rates to examine near-term population potential.

Findings quantified the current and projected service population in Williston and Williams County. The housing model and the employment model estimated Williston's current service population to be 25,000 and 33,000, respectively. When the six surrounding townships were included in the estimate, the housing model and the employment model estimated Williston's current service population to be 37,000 and 41,000, respectively. Both models project that the permanent and service population in Williston is likely to continue to grow at a high rate in the near term. The housing model projected the 2017 service population for

Williston to increase to just less than 40,000 and the employment model projected the 2017 service population for Williston to increase to 44,000. When the six surrounding townships were included in the projected service population, the housing model and the employment model projected the 2017 Williston service populations to be 53,000 and 54,000, respectively.

Findings would suggest that housing development in Williston appear to be in line with industry expectations for future employment growth and demand for housing associated with that growth. Based on model projections, it does not appear that Williston is in danger of overbuilding in the near term. Projections for continued increase in service population also underscore the continued need for temporary housing to meet the housing needs of the service population associated with transient employment.



# Population Estimates for City of Williston

Nancy M. Hodur and Dean A. Bangsund<sup>1</sup>

## Introduction

Rapid expansion in the petroleum sector has led to unprecedented growth in the City of Williston. Employment opportunities in the oil and gas industry and other associated sectors (e.g., residential and commercial construction) has attracted thousands of workers fueling population growth, housing shortages and inflated housing costs. Further, rapid growth has strained existing infrastructure and the delivery of public services. Communities are struggling to manage the many challenges associated with rapid growth as well as plan for future delivery of public services and gauge response to demand for housing and infrastructure. One of the most basic metrics used to gauge response and guide planning processes is population projections.

## Objectives

Study objectives were to estimate the current service population of Williston and Williams County and develop a five-year service population projection. The service population includes long-term normal residents, others that may work in North Dakota and live elsewhere, and those that live in North Dakota temporarily.

## Methodology and Findings

The rapid expansion of the petroleum sector has left planners, policymakers, and community leaders struggling to develop strategies to address the challenges associated with unprecedented growth in the petroleum sector. Models, methodologies and strategies used in the past to assess changes in the economy are not well suited to model the effects of the rapid growth in the petroleum sector. Because of the unique nature of the circumstances in western North Dakota, namely the extremely rapid and significant expansion of the sector combined with severe housing shortages, many of the tools traditionally used to model economic, demographic, and fiscal impacts are not properly calibrated to the current economic environment. Traditional models do not accurately reflect the effects of rapid and wide-spread expansion of regional employment that has occurred in the Williston Basin. Further, models are not easily updated in their entirety given the paucity of current economic data and the time lag associated with data collection.

Because of these unique circumstances new approaches and methodologies must be developed. Because the petroleum sector is the driving economic influence in western North Dakota, models and methods should focus on the effects of petroleum sector. Models and processes must be dynamic and flexible to allow for new data to be incorporated into modeling efforts as it becomes available.

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## **Employment Model**

Bangsund and Hodur (2012) developed a process to model direct and secondary employment associated with future development scenarios for the petroleum sector. This study uses the petroleum sector employment model and expands the analysis to include changes in regional employment in western North Dakota. The combined effects of future changes in the petroleum sector and future employment changes in other regional industries are used to produce estimates of regional employment. Regional employment forecasts are then converted into demand for housing and ultimately future population. Employment, housing and population modeling are detailed in Figure 1.

Employment in western North Dakota was separated into two categories; 1) employment in the petroleum sector and 2) employment in all other industries and sectors (Figure 1). Petroleum sector employment estimates were based on a model developed by Bangsund and Hodur (2012). Constraints were used to adjust employment coefficients in the petroleum sector and to limit future employment change in non-petroleum base industries. Secondary employment was also subject to constraints within the model. The model produced a regional employment forecast that was used to estimate future housing demand (Figure 1). Because of workforce mobility, housing demand was estimated on a regional basis. Historic data on occupancy rates, current information on build-out rates and future mix of housing types were used to estimate regional population potential (Figure 1). The model estimates employment, housing, and population by modeling potential changes in the petroleum industry and existing industries in western North Dakota.

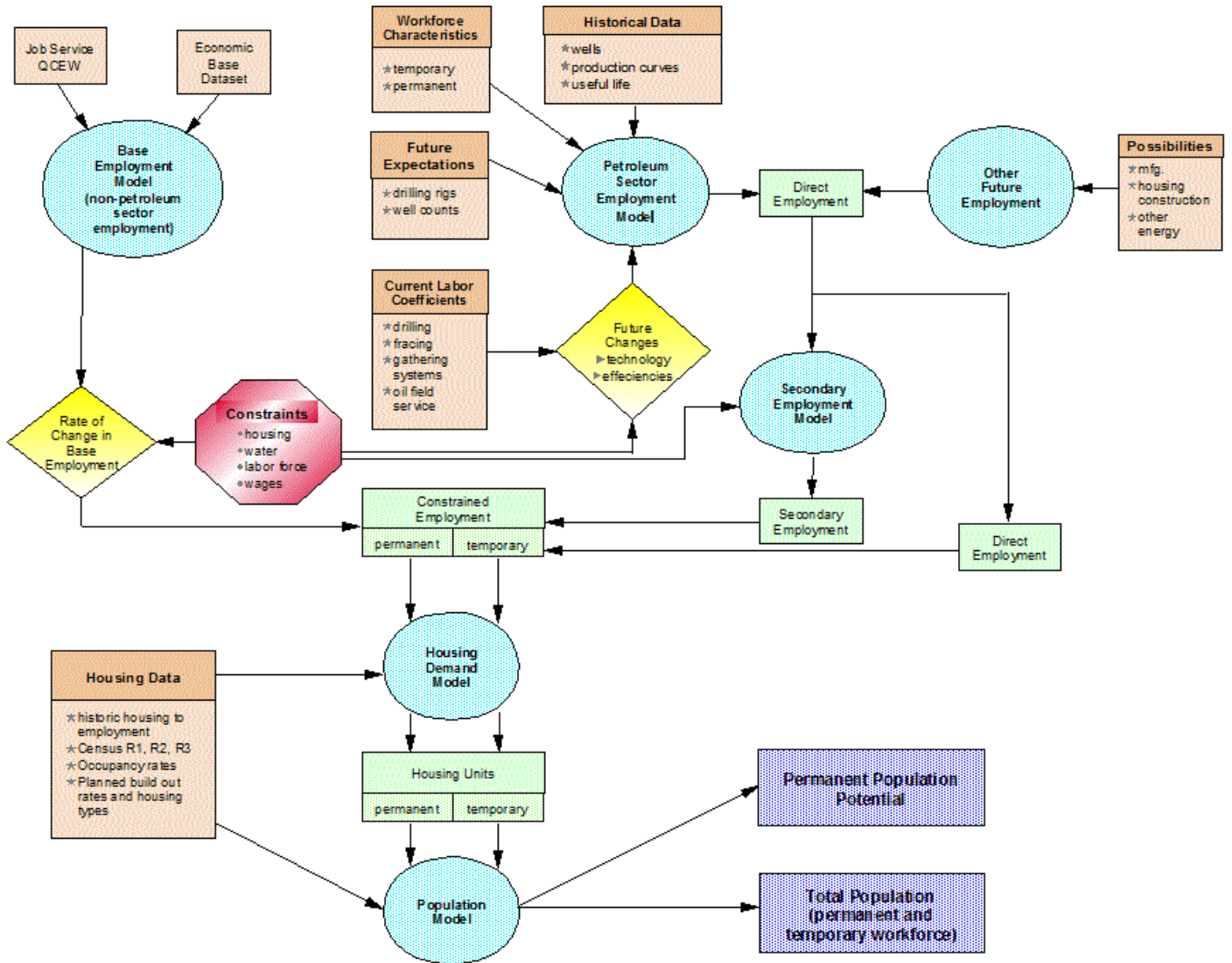


Figure 1. Employment, Housing, and Population Modeling Overview, Western North Dakota, 2012

Source: Bangsund and Hodur (2012).

## Future Scenarios

The scope of future oil field development in the Williston Basin is unknown. Accordingly, three scenarios were developed, based on stakeholders' input, economic expectations, and reservoir characteristics in the Basin. The range of development scenarios provides context to address the uncertainty associated with the rate and extent of future oil field development (KLJ 2012). Modeling for this report was based on the consensus scenario.

**Low:** The basic premise for the low scenario is that economic conditions or overall economic climate are worse than current conditions.

**Consensus:** The consensus scenario was designed around the premise that economic conditions remain relatively similar to those in early 2012.

**High:** The high scenario considers an improved economic climate relative to early 2012.

## Drilling Activities

The number of drilling rigs is an important factor in the rate of oil field development, and has direct implications on employment in the Basin. Rig counts were estimated for North Dakota for the three scenarios (Figure 2). Rig counts increase and eventually peak at 222 in 2014 in the high scenario. The consensus scenario has rig counts peaking at 205 in 2014, while rig counts have already peaked in the low scenario.

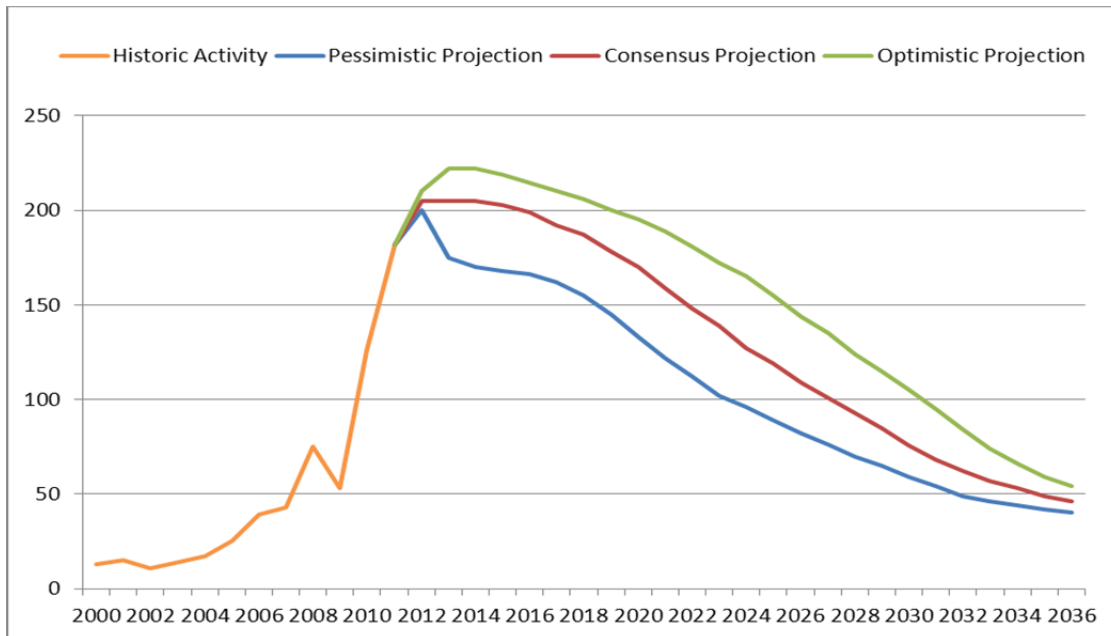


Figure 2. Rig Counts, North Dakota, 2000 - 2036

Source: Bangsund and Hodur (2013).

## Well Counts

The number of producing oil wells is a key metric to describe the extent or size of oil field development. North Dakota is projected in 2036 to have about 32,500 operating wells in the low scenario, 39,700 operating wells in the consensus scenario, and around 46,200 operating wells in the high scenario (Figure 3).

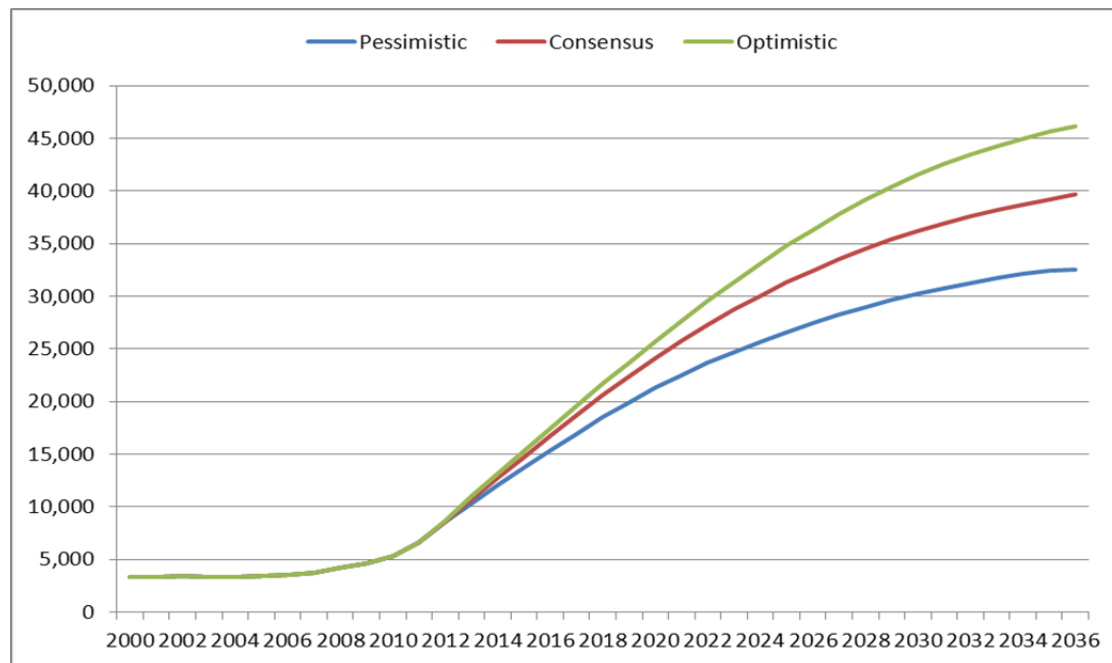


Figure 3. Estimated Number of Operating Oil Wells, North Dakota, 2000 - 2036  
Source: Bangsund and Hodur (2013)

## Employment Forecasts

Total regional employment consists of direct employment in the oil and gas industry, secondary job creation, and employment in other industries and sectors. Direct employment in the petroleum industry was first estimated for the North Dakota portion of the Williston Basin, and then a portion of that employment was allocated over the projection period to State Planning Region 1. Secondary job creation expected over the projection period in State Planning Region 1 as a result of expansion of the oil and gas industry was estimated using a variety of methods (see Bangsund and Hodur 2012a). Changes in regional employment were evaluated after removing direct employment in the oil and gas industry. Trend analysis of the employment change in remaining industries and economic sectors provided the basis for predicting future employment in non-petroleum related industries.

## Base Employment

Historical employment for the Williston trade area was obtained from Job Service North Dakota (2012). Employment data was based on the Quarterly Census of Employment and

Wages (QCEW) and represented a measure of jobs in a specified location using the North American Industrial Classification System (NAICS).

Because petroleum sector employment was modeled separately from other economic sectors, petroleum employment was removed from QCEW data for the Williston trade area from 1990 through 2010 (Figure 4). Evaluation of overall employment, less petroleum industry employment, revealed small historical changes in employment outside of the petroleum industry. Time-series regression of the data revealed an average annual increase of about 120 jobs in State Planning Region 1 over the 1990 to 2011 period after removing petroleum sector employment.

The regional economy currently is extremely sensitive to changes in petroleum sector employment as the industry comprises a considerable share of total employment in the region. Further, the pace of change in total employment in the region has overwhelmed local resources, further straining the regional economy constraining growth in commercial and service employment. Up until about 2012, growth in total employment in the region has been largely driven by changes in petroleum sector employment. Going forward, expansions or contractions in employment will have immediate effects in the region as base industries appear to be stagnant. Recent changes in near-term employment growth outside of the petroleum sector have been largely attributed to construction of roads, housing, and oil and gas related commercial activity.

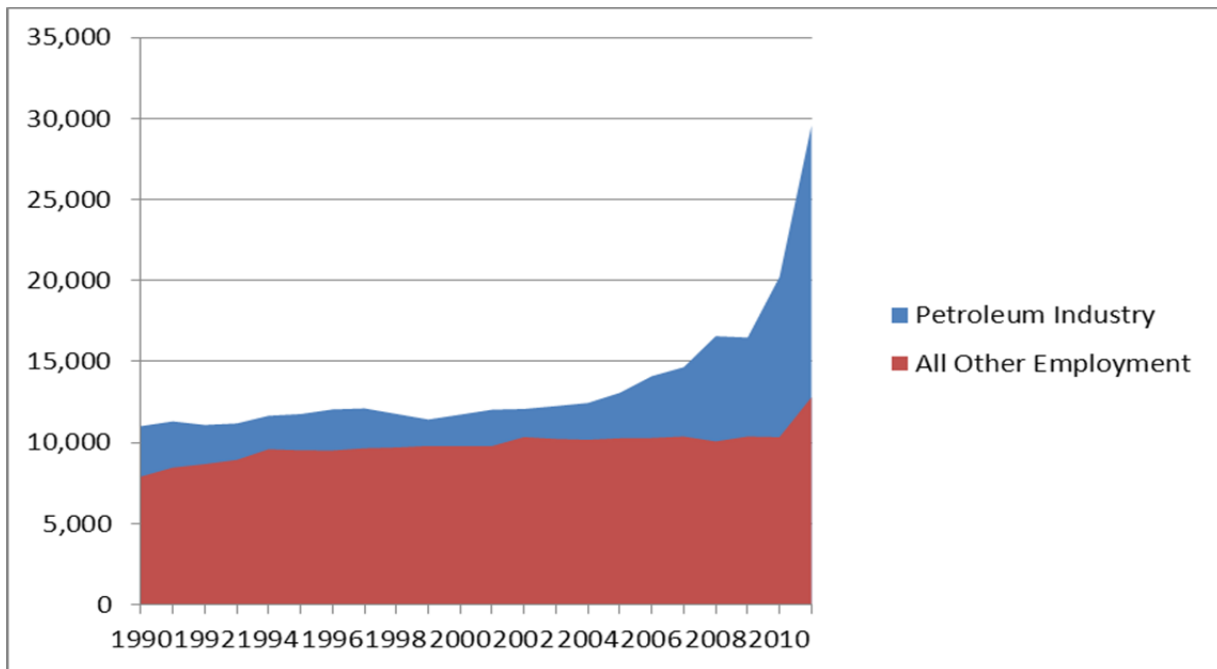


Figure 4. Employment in the Petroleum Industry and All Other Industries, State Planning Region 1, North Dakota, 1990 - 2011

## Petroleum Industry

Employment in the petroleum industry was based on rig counts, well completions, oil field service, and construction of gathering systems. Oil field service employment included jobs for well operations and maintenance, infrastructure maintenance and transportation, and jobs associated with processing activities. Labor coefficients were adjusted over time to reflect anticipated changes in production practices and technological efficiencies.

Workforce characteristics vary by type of oilfield activity. The workforce for activities related to well maintenance, production, pipeline and rail operations, and associated processing are expected to be comprised of workers who are established permanent residents of North Dakota. They would be considered normal residents and included in U.S. Census figures. Alternately, the workforce associated with oil field development activities such as drilling, hydraulic fracturing (fracing), and construction of gathering systems (e.g. pipelines) often consist of workers who do not make North Dakota their permanent residence. Employment can be characterized by alternating working and non-working periods coinciding with workers returning to their normal residence.

Other workers associated with oilfield development may only temporarily make their residence in North Dakota. The workforce related to pipeline construction provides a good example. When the pipeline is done, the worker moves on to the next job site. Even though workers that live in North Dakota before moving on to the next job site may be in the state for extended periods, they are viewed as temporary workers relative to the lifecycle of the oil field. Non-resident workers and workers that live in North Dakota temporarily while they work in North Dakota are included in the service population and would not be included in the U.S. Census population.

In the consensus scenario, petroleum employment continues to increase in the Basin for the next 8 to 10 years. Coinciding with a completion of gathering systems in the Bakken/Three Forks Formations, total petroleum sector employment in the Williston Basin is forecasted to contract (Figure 5). In the long-term, employment in the industry becomes more aligned with oil field service employment. Total employment in the long-term exhibits a general decline as expectations for labor efficiencies reduce overall labor requirements.

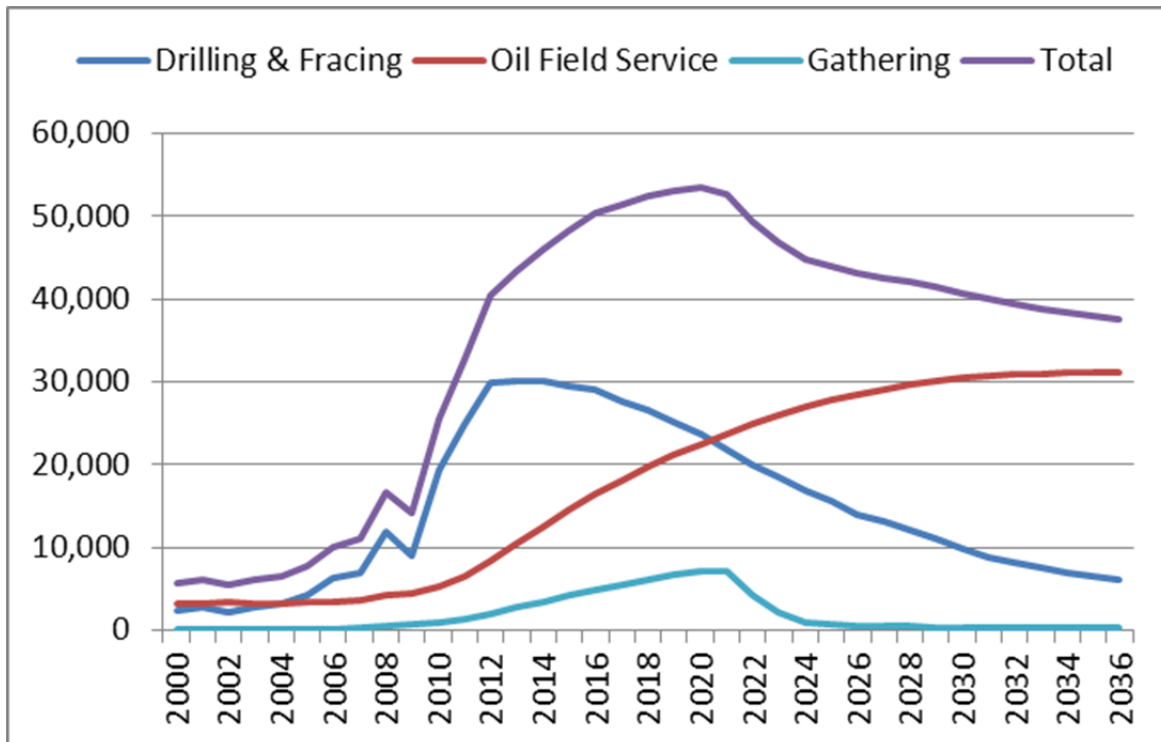


Figure 5. Petroleum Sector Direct Employment, Consensus Scenario, North Dakota Williston Basin, 2000 - 2036

Source: Bangsund and Hodur (2013).

Petroleum sector employment, for the consensus scenario, was divided between temporary (development) and permanent (operations) employment. The early stages of oil development in the Williston Basin are characterized by a surge in temporary employment, while steady growth in long-term permanent employment is demonstrated over the projection period (Figure 6). The changing composition of the overall industry’s workforce has important implications for housing demand and secondary job creation.

Figure 1 illustrates employment estimates for the petroleum sector in North Dakota for the various types of activities and Figure 2 illustrates total petroleum sector employment with delineations for temporary and permanent workforce. Figure 2 illustrates the surge in temporary employment in the early years of oil field exploration and development and the steady growth in long-term permanent employment associated with oil field maintenance and service.



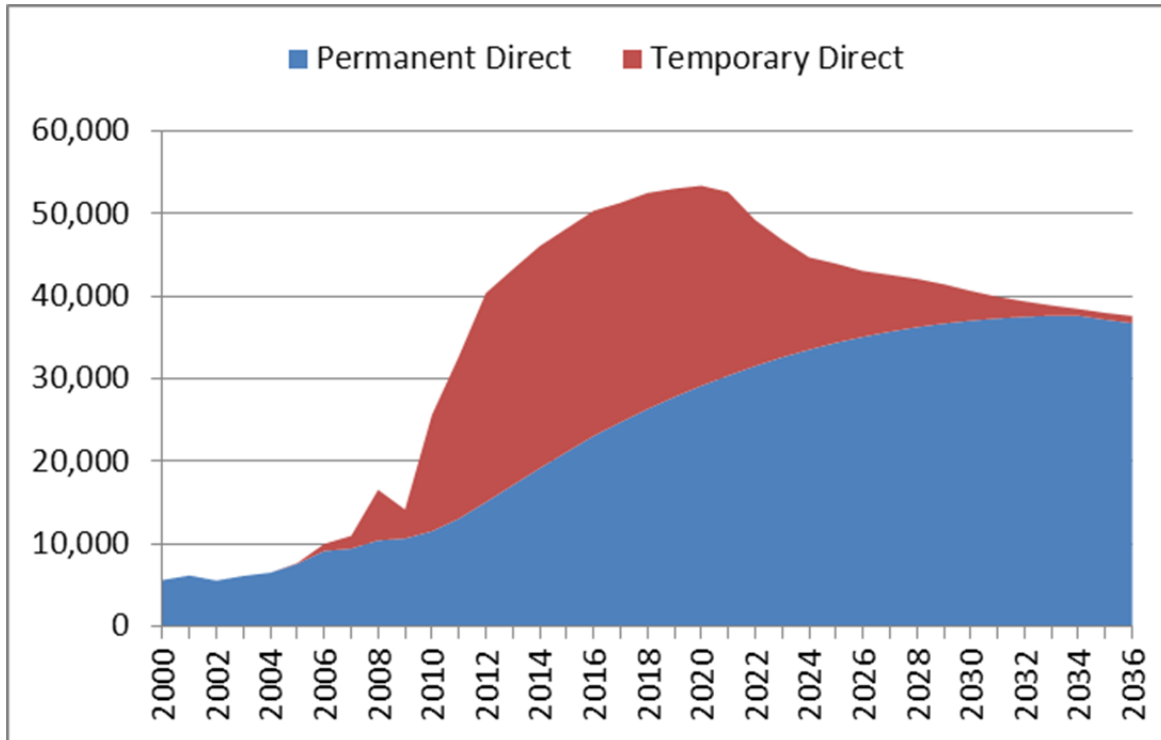


Figure 6. Total Direct Permanent and Temporary Employment in the Petroleum Industry, Consensus Scenario, North Dakota Williston Basin, 2000 - 2036  
Source: Bangsund and Hodur (2013).

Total petroleum industry employment was adjusted to reflect expectations for future employment by the industry in State Planning Region 1. The current share of petroleum industry employment for the region’s major trade centers was measured using QCEW employment in NAICS code 21 for western North Dakota (Table 1). Based on that metric, State Planning Region 1 had about 63 percent of the petroleum industry employment in 2011. To more closely align with historical percentages the share of industry employment in State Planning Region 1 was slowly decreased to 58 percent, and kept at that amount from 2018 through 2036.

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	----- percent of petroleum industry employment -----									
Bowman	2.4	3.9	4.2	3.2	2.8	2.5	1.9	1.7	1.2	1.2
Bismarck/Mandan	16.5	16.0	20.7	3.1	2.6	3.4	2.1	0.8	0.7	0.8
Dickinson	15.6	15.0	13.6	14.9	12.4	13.1	14.3	16.8	17.0	20.7
Williston	33.1	34.7	42.3	55.8	63.4	63.5	67.4	64.1	64.1	63.3
Minot	32.3	30.3	19.2	23.0	18.9	17.5	14.2	16.6	16.9	14.0

<sup>a</sup>Based on NAICS code 21 for county-level data obtained from Job Service North Dakota (2012). Some years may not total due to rounding.

## Secondary Employment

Economists primarily use Input-Output analysis to estimate changes in employment associated with changes in revenues or expenditures within an industry. Those techniques have been refined over many decades (Leistritz 1998, 1994). However, current data would suggest a methodology relying on historic productivity ratios or employment multipliers, either linked to sales volume (sales to final demand) or industry spending (in-state expenditures) would currently overestimate total employment from the petroleum sector in North Dakota (Bangsund and Hodur 2012).

A more direct approach to estimating secondary employment was adopted that used the relationship between employment in basic-sectors (industries that bring money into a region) and non-basic sectors (industries that provide support and service to basic-sector industries). Bangsund and Hodur (2012) used the ND Economic Base Data Set (Coon et al. 2012) in estimating secondary employment associated with current oil expansion in western North Dakota. The model developed by Bangsund and Hodur (2012) uses separate coefficients for creation of secondary employment for temporary and permanent workforce in the petroleum sector.

The rationale for differential treatment between temporary and permanent workforce was that characteristics of those types of workforce result in different demand for goods and services in the economy and that the petroleum sector workforce is expected to transition to a more permanent workforce over the next decade (Bangsund and Hodur 2012). Bangsund and Hodur (2012) suggest as the economy removes constraints (e.g., housing, workforce, wage rates) it would be expected that secondary employment dynamics in the region return to more historic observations.

## Total Regional Employment

Total future employment in the State Planning Region 1 was a function of the change in base employment and the change in direct and secondary employment associated with the petroleum sector. Constraints on employment (i.e., housing, wages, labor force availability) were included in base employment, petroleum sector direct employment, and secondary employment estimates.

Future employment in the planning region was forecasted to continue to increase for the next 6 to 10 years, depending upon scenario (Figure 7). Total employment in the region was forecasted to decline in each scenario upon completion of gathering systems in the Basin. After the petroleum sector contraction, overall employment in the region was expected to stabilize largely to do growth in base employment and secondary job growth associated with a growing permanent workforce (Figure 8).

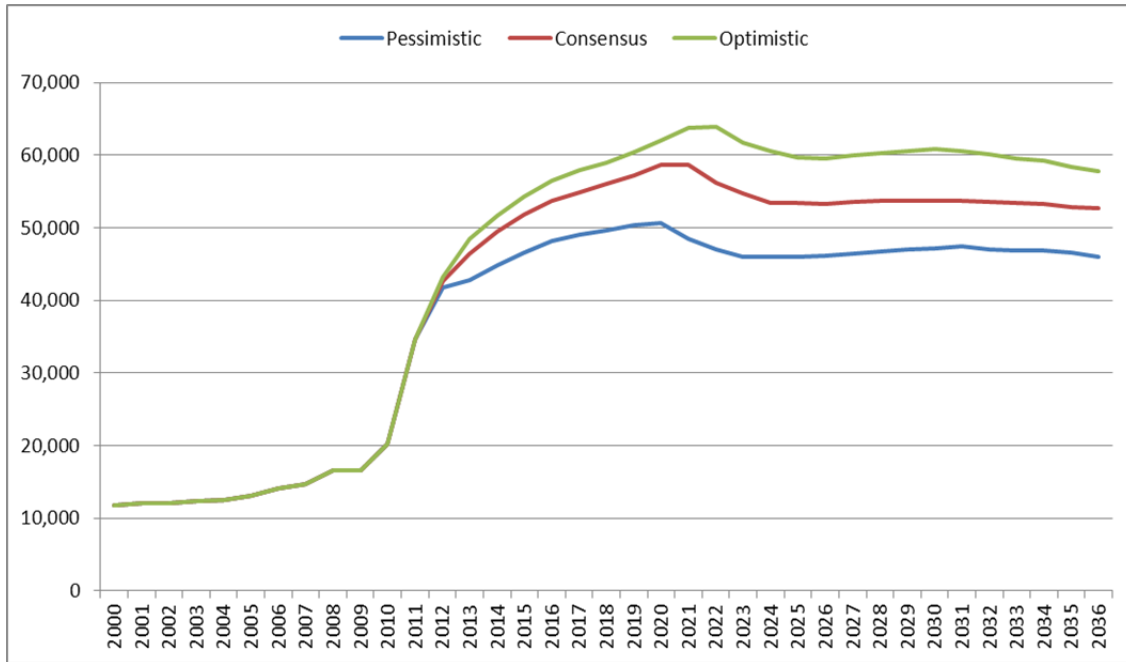


Figure 7. Total Employment in State Planning Region 1, by Scenario, North Dakota, 2000 – 2036

Source: Bangsund and Hodur (2013).

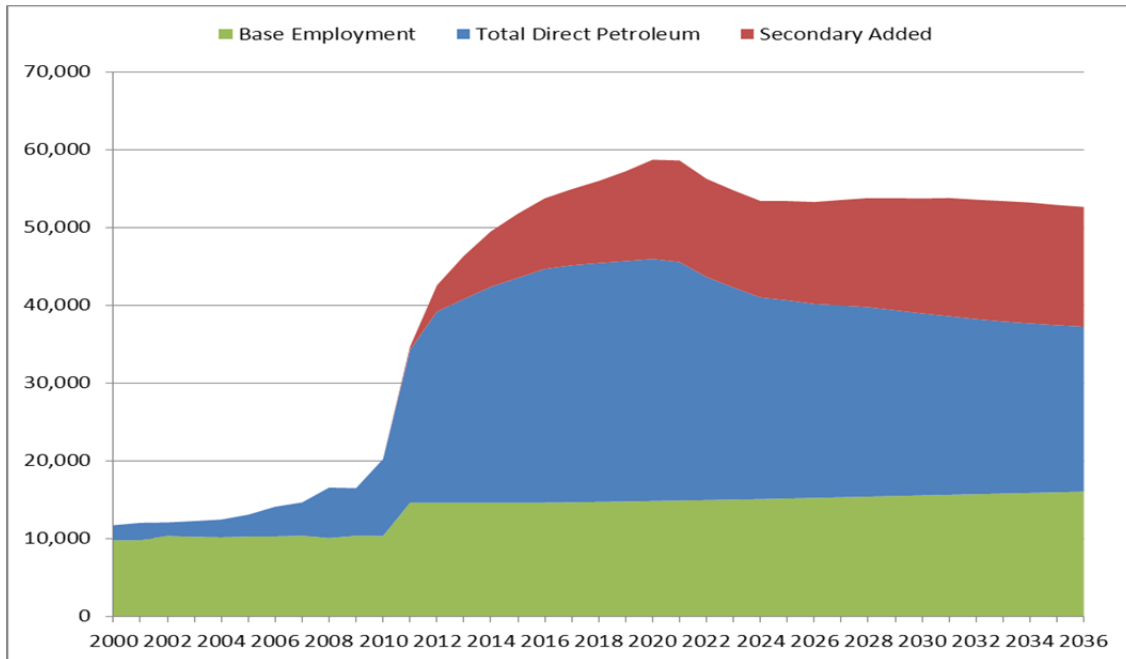


Figure 8. Total Employment in State Planning Region 1, by Major Component, Consensus Scenario, North Dakota, 2000 – 2036

Source: Bangsund and Hodur (2013).

## Housing Demand Forecasts

A housing demand model was developed based on historical relationships between regional employment and regional housing supply. The model produced estimates of housing demand for permanent employment and housing demand for total (permanent and temporary) employment. Housing demand was quantified as total housing units. A housing unit can be a house, twin home, or apartment. Housing demand was estimated for State Planning Region 1, Williston County and the city of Williston.

### Regional Demand

The rate of growth in employment in State Planning Region 1 quickly exhausted the supply of housing thereby removing any elasticity in housing supply.<sup>2</sup> With elasticity in housing supply removed from the region, future demand for housing will be more closely linked to absolute (as opposed to percentage or relative) changes in employment.

The housing model linking the ratio of regional employment to regional housing to project future housing demand based on employment projections. Examination of the direct ratio of employment to housing (see Table 2) shows how increasing regional employment and the lack of corresponding supply of housing has resulted in a situation where an increase in one job could be expected to result in an equivalent increase in housing units.

The employment-to-housing ratios within the model were adjusted over the 25-year planning period to reflect different dynamics with respect to absolute changes (as opposed to percentage changes) in employment. During a period of rapid employment growth, absolute change in employment resulted in nearly proportional changes in housing demand. During periods immediately following rapid employment growth, the proportionality between housing demand and employment was reduced. That is, more than 1 additional job would be required to add one housing unit. During periods of relatively stable employment, which occurred in the latter years of the employment projections, housing demand was modeled to more closely approach historical employment-to-housing ratios. The process of relaxing future housing demand when employment became stable is consistent with historical observations within the region and is consistent with introducing more elasticity into the regional housing market (see Table 2).

The housing model produced estimates of future housing demand for permanent employment and total (permanent and temporary) employment in the State Planning Region 1 (Figure 9). For community planning purposes, it was imperative that separate housing needs be developed for temporary and permanent employment. Also, the pattern of how housing demand may change in the future for both temporary and permanent workforce is useful as communities develop strategies to supply both types of housing.

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<sup>2</sup>Elasticity in the context of a housing market can be described as the ability to absorb change in housing demand without creating divergence between housing demand and housing supply. Essentially, in a situation where housing supply is in equilibrium with housing demand small changes in employment can be absorbed by existing supply without creating housing shortages. Housing supply therefore is not as acutely influenced by year to year variations in employment. However, elasticity is said to be exhausted when housing supply fails to keep pace with housing demand. In those conditions, additional employment will more closely require corresponding changes in housing supply since the existing housing supply has been exhausted.

**Table 2. Historical Ratios of Regional Employment and Housing, Williston Trade Area, 2000 through 2010**

Year	Regional Employment		Housing Units		Employment to Housing Ratios	
	Number	Annual Change (%)	Number	Annual Change (%)	Direct Ratio <sup>a</sup>	Ratio of Change <sup>b</sup>
2000	11,731		13,868		1.18	
2001	12,039	2.6	13,921	0.38	1.16	6.87
2002	12,086	0.4	13,948	0.19	1.15	2.01
2003	12,264	1.5	13,981	0.24	1.14	6.22
2004	12,456	1.6	14,013	0.23	1.13	6.84
2005	13,081	5.0	14,042	0.21	1.07	24.25
2006	14,106	7.8	14,073	0.22	1.00	35.49
2007	14,658	3.9	14,133	0.43	0.96	9.18
2008	16,575	13.1	14,254	0.86	0.86	15.28
2009	16,490	-0.5	14,386	0.93	0.87	-0.55
2010	20,232	22.7	14,878	3.42	0.74	6.64

<sup>a</sup> Ratio of housing units to employment.

<sup>b</sup> Ratio created by dividing the annual change in employment (jobs) by the annual change in housing supply(units).

Sources: U.S. Census Bureau (2012a, d).

Future housing demand in the consensus scenario is characterized by growing demand for both temporary and permanent housing in the near term, followed by reduced temporary housing demand and stabilizing permanent housing demand towards the end of the 25-year period (Figure 9). Demand for temporary housing peaks in about 8 years, then exhibits a contraction, and subsequently declines over the next decade. Permanent housing demand does not peak till the end of the 25-year period. Since temporary housing demand is slowly reduced over a 20-year period until total housing demand equals permanent demand, it might be suggested that local communities could cover total housing demand by quickly producing a substantial supply of permanent housing, and then largely hold that supply constant as temporary housing demand decreases and permanent demand increases; however, that strategy would risk overbuilding as the near term peak in housing demand in 6 to 10 years is substantially greater than total housing demand at the end of the projection period (Figure 9).

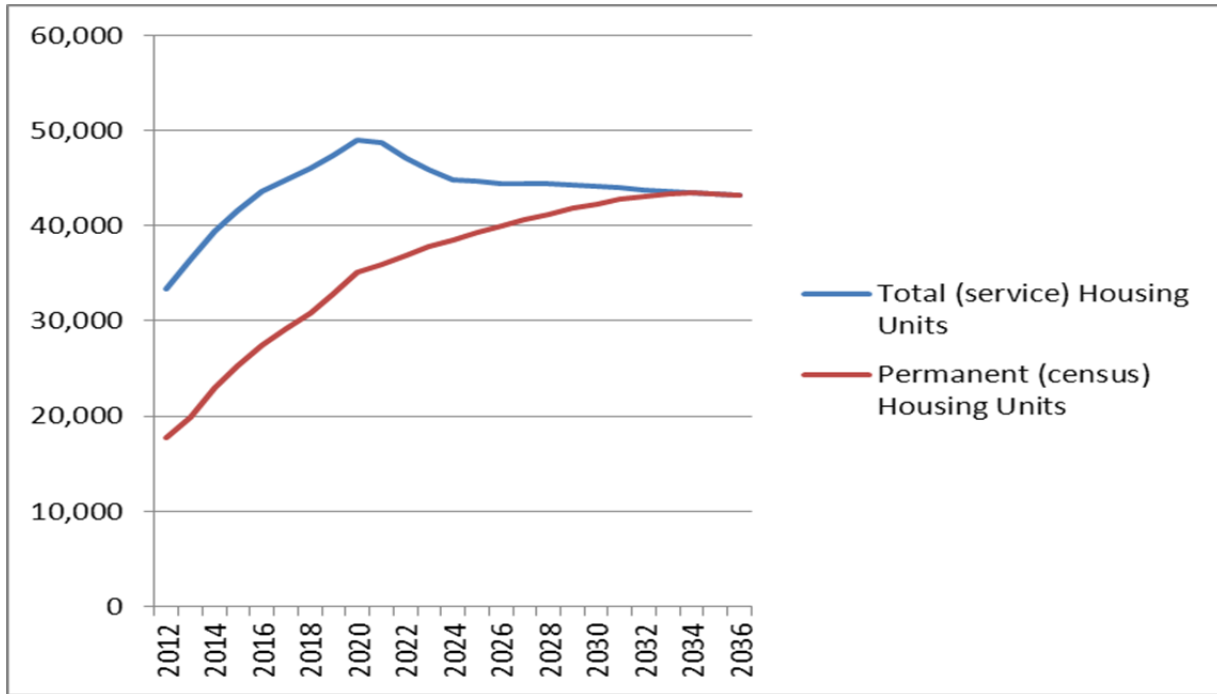


Figure 9. Housing Demand, Consensus Scenario, State Planning Region 1, North Dakota, 2012 - 2036

#### Distribution of Housing Demand Among Counties

Regional housing demand consisted of housing units for the three-county trade area. Distribution of expected future supply of housing units by county was based on the relative share of each county's share of regional supply and the rate of change in the number of housing units in each county from 2000 through 2010 (Table 3). Workforce projections were done on a regional basis. Future housing demand as a result of those workforce projections were allocated among the trade center counties based on the historic distribution of housing due to workforce mobility. Workers may not necessarily reside where they work or work where they reside. Therefore, a direct correlation between place of employment and place of residence could not be used to allocate regional housing demand.

Trends in the distribution of housing among counties in the State Region 1 revealed that McKenzie and Williams County increased their regional share of housing from 2000 to 2010 (Table 3). The relative share of regional housing demand among the region's three counties was fixed at the percentage estimated in 2010 (Rathge et al. 2012; Bangsund and Hodur 2013). Over the next 25 years Divide, McKenzie, and Williams Counties were modeled to have 8.9 percent, 20.8 percent, and 70.3 percent of regional housing demand, respectively (Table 3).

The estimated future share of housing demand for each county was multiplied by the regional forecast for housing demand to estimate per-county future housing demand from 2011 through 2036. Housing changes have been highlighted in 5-year increments for the consensus development scenario (Table 4).

**Table 3. Distribution of Housing Units, by County, State Planning Region 1, North Dakota, 2000 - 2010**

	Total Housing Units		
Year	Divide	McKenzie	Williams
2000	1,439	2,719	9,680
Share of Regional Total (2000)	10.6%	19.6%	69.8%
2001	1,474	2,740	9,707
2002	1,478	2,753	9,717
2003	1,478	2,769	9,734
2004	1,477	2,786	9,750
2005	1,475	2,797	9,770
2006	1,472	2,795	9,806
2007	1,473	2,798	9,862
2008	1,471	2,801	9,982
2009	1,469	2,801	10,116
2010	1,324	3,090	10,464
Share of Regional Total (2010)	8.90%	20.77%	70.33%
Numeric Change 2000-2010	-145	371	784
Percentage Change 2000-2010	-9.9%	13.6%	8.1%

Source: U.S. Census Bureau (2012c,d)

<b>Table 4. Estimated Distribution of Future Housing Units by County, Consensus Development Scenario, State Planning Region 1, North Dakota, 2015 - 2035</b>			
Year	Divide	McKenzie	Williams
	----- Percentage of Regional Supply -----		
2015	8.90	20.77	70.33
2020	8.90	20.77	70.33
2025	8.90	20.77	70.33
2030	8.90	20.77	70.33
2035	8.90	20.77	70.33
	----- Permanent and Temporary Housing Demand -----		
2010	1,408	3,019	10,184
2015	3,703	8,641	29,264
2020	4,357	10,169	34,436
2025	3,973	9,272	31,400
2030	3,924	9,159	31,015
2035	3,849	8,983	30,421
	----- Permanent Housing Demand Only -----		
2010	1,408	3,019	10,184
2015	2,250	5,251	17,780
2020	3,117	7,275	24,636
2025	3,494	8,154	27,614
2030	3,762	8,779	29,731
2035	3,849	8,983	30,421



**Table 5. Housing Type and Occupancy Rate, By County, State Planning Region 1, North Dakota, 2010**

	Divide	McKenzie	Williams
2010 Total Housing Units American Community Survey			
R1 Housing Units	1,280	2,467	7,217
R1 as Percentage of Total Housing	90.9	81.7	70.9
R2 Housing Units	51	56	383
R2 as Percentage of Total Housing	3.6	1.9	3.8
R3 Housing Units	52	165	1,532
R3 as Percentage of Total Housing	3.7	5.5	15.0
Mobile Home Units	25	331	1,052
Mobile Home as Percentage of Total Housing	1.8	11.0	10.3
----- Persons per Housing Unit -----			
R1 Housing	2.03	2.53	2.38
R2 Housing	1.08	1.96	1.41
R3 Housing	1.03	1.55	1.55
Mobile Home	1.36	2.21	2.35

Notes: R1 housing is single family homes. R2 housing is structures with two to four units. R3 housing structures have five or more units. Sources: U.S. Census Bureau (2012c).

## Population Potential

The final step in estimating population potential using the employment model was to apply occupancy rates (i.e., number of people living in a housing unit) by housing type, by county, to convert housing demand into population. Occupancy rates for each type of housing unit by county were based on 2010 Census data (Table 5). The model was designed to generate two population estimates to illustrate the unique conditions present in the Williston Basin.

Permanent population is an estimate of individuals who work in the region and are established residents. Spouses and children of permanent workers living in the region also would be counted as permanent residents. Permanent population is consistent with population measured by the U.S. Census Bureau.

Total (service) population includes permanent population and temporary population. Temporary population includes individuals not counted by the U.S. Census Bureau who claim residency in other states, work for short periods of time in the region, do not have permanent addresses in the region or are otherwise associated with short-term employment (relative to the life-span of the oil fields).

Adjustments to the county-level population projections developed by the employment model were performed to produce estimates for local areas within Williams County. Population estimates for the city of Williston were based on the historic distribution of the percentage of Williams County population that resides in the city of Williston, 65.7 percent. A second estimate assumed that six Williams County townships (Williston, Judson, Missouri, Pherrin, Stony Creek and Trenton) were functionally part of the city of Williston and may in the future become part of the city. The city of Williston and the 6 surrounding townships historically comprise 80.5 percent of the population of Williams County (Table 6).

County Subdivision	Population		% of Williams County
Williams County	22,398		100.0
City of Williston	14,716	14,716	65.7
Williston Township		1,307	
Judson Township		130	
Missouri Ridge Township		496	
Pherrin Township		276	
Stony Creek Township		558	
Trenton Township		541	
Subtotal, Williston and Six Surrounding Townships		18,024	80.4

The 2010 U.S. Census population for the city of Williston was 14,716 and for Williams County was 22,398 (Table 7). Using the employment model, the 2012 estimated *permanent* population in Williston and Williams County was 17,792 and 27,081, respectively. The 2012 *service* population for Williston and Williams County was estimated to be 33,547 and 51,061, respectively. Projected 2017 permanent population for Williston and Williams County was 28,658 and 43,619, respectively. Projected service population in 2017 for Williston and Williams County was 43,993 and 66,960, respectively, a 134 percent increase.

When the six surrounding townships were included in the estimate of Williston, the projections naturally increase. The 2010 Census population for Williston and the six surrounding townships was 18,030. The 2012 estimated *permanent* population for Williston and the six surrounding townships was 21,800 and the *service* population was estimated to be 41,104 (Table 7). The 2017 estimated permanent population for Williston and the six surrounding townships was 35,113 and the service population was estimated to be 53,903 (Table 7).

The increases in population for both the permanent and service population were substantial. Permanent population change from 2010 to 2012 was estimated to be approximately 21 percent, while the change in 2012 estimated service population compared to 2010 Census population was nearly 128 percent. In 2017 permanent and service population was projected to increase by 61 percent and nearly 134 percent over 2012 estimates, respectively (Table 7).

<b>Table 7. Population Estimates, Employment Model, Consensus Scenario, City of Williston, Six Surrounding Townships, and Williams County, North Dakota, 2010 - 2017</b>						
	Williams County		City of Williston <sup>1</sup>		City of Williston and 6 surrounding townships <sup>2</sup>	
Item	Permanent Population <sup>3</sup>	Service Population (permanent and temporary) <sup>4</sup>	Permanent Population <sup>3</sup>	Service Population (permanent and temporary) <sup>4</sup>	Permanent Population <sup>3</sup>	Service Population (permanent and temporary) <sup>4</sup>
2010	22,398 <sup>5</sup>	22,398	14,715 <sup>5</sup>	14,715	18,030 <sup>5</sup>	18,030
2012	27,081	51,061	17,792	33,547	21,800	41,104
Change 2010-2012	4,683	28,663	3,077	18,832	3,770	23,074
Percent Change 2010-2012	20.9%	127.9%	20.9%	127.9%	20.9%	127.9%
2017	43,619	66,960	28,658	43,993	35,113	53,903
Change 2012-2017	16,538	15,899	10,866	10,446	13,313	12,799
Percent Change 2012-2017	61.0%	31%	61.0%	31%	61.0%	31%
<sup>1</sup> City of Williston is 65.7% of the population of Williams County.						
<sup>2</sup> City of Williston and 6 surrounding townships is 80.5% of the population of Williams County.						
<sup>3</sup> Population associated with permanent workforce.						
<sup>4</sup> Population associated with permanent and temporary workforce.						
<sup>5</sup> Source: 2010 Census. No estimate for service population in 2010. Census population only.						

## Key Assumptions of Employment Model

Employment model population estimates represent population potential. The estimates for Williston and Williams County were based on housing demand and the model assumes that the demand for housing is met. The model also assumes historic population distributions remain valid. However, it is possible that the distribution of housing may change over time, (e.g., the city of Williston may have a greater or lesser proportion of county population). Housing distribution may change depending on where housing demand is met. The petroleum industry workforce is mobile and may not live in the same place as their job. The workforce will live where housing is available.

The employment model assumes that historic occupancy rates are valid. Anecdotal evidence suggests historic occupancy rates may, in some cases, underrepresent current conditions (e.g., double ups and multiple families sharing housing due to high cost of living). In other cases, historic occupancy rates may overstate current conditions as some workers are unaccompanied by spouses and dependents. It also is possible that due to acute housing shortages and expensive housing costs, unaccompanied workers may double up and share housing to help alleviate high housing costs. With no information available to suggest to what degree historic occupancy rates may have appreciably changed, historic occupancy rates were used and assumed to remain valid.

The employment model also assumes that the temporary workforce has similar characteristics as the permanent workforce, (e.g. occupancy rates, demographics). In some cases, this assumption may overestimate service population as some workers are only present in the state during work periods and are unaccompanied by their families. Alternately, some of the temporary workforce has similar characteristics as the permanent population because some workers relocate to North Dakota for extended periods, ranging from several months to several years. Reports from community leaders and industry experts support the premise that at least some portion of the temporary population has characteristics similar to the permanent population (Personal Conversations, 2012). No data on workforce characteristics were available to suggest to what degree demographic characteristics of the service population may be different or the same as the historic permanent population.

The model is sensitive to changes in key variables. For example, small changes in occupancy rates result in substantial changes in projections. The model also lacks a good baseline. The model's baseline is the 2010 census which did not capture the substantial service population already present in the region in 2010. There was no estimate of the service population for 2010. Accordingly, the percentage change in estimated 2012 service population compared to the 2010 Census is very large. The actual percentage change is likely less due to the lack of a 2010 service population estimate that included the service population already present in Williston.

## **Housing Build-Out Model**

The housing build-out model uses a combination of Census information, informal lodging arrangements, housing completions since the 2010 Census, and anticipated housing build-out rates to examine near-term population potential. This approach provides reasonable estimates of a city's service population in the next 5 years using metrics different from those in the employment model. Service population was defined as the sum of the normal resident population (Census population) and the population that works in the Williston area but maintains a residence elsewhere.

The service population is not captured by U.S. Census estimates. Estimates of the service population are necessary to provide guidance to city administrators on the provision of public services. While those individuals that make up the "service population" are not considered permanent residents of the city of Williston, they do use and demand city and public services.

Data were collected from multiple sources to inventory non-traditional housing, such as hotels, crew camps, RV camps and housing permitted via conditional use permits. The model also estimated the number of new housing units constructed since 2010 and estimated the 5-year housing build-out potential by inventorying new housing developments and estimating the number of housing units for each development. Housing data were collected for Williston and Williams County. Other incorporated cities in Williams County were not included in the assessment. Most of the data collected for the build-out model were primary data provided by the city of Williston and Williams County.

Upon completion of an inventory of the various types of housing units, occupancy rates were applied to the total number of each type of housing unit. Historic occupancy rates for traditional housing units, (single family homes, apartments, mobile homes) were applied to the total number of units built since 2010 to estimate the 2012 permanent population. The 2012 service population was estimated by applying appropriate occupancy rates for various types of non-traditional housing (e.g., hotels, RVs, crew camps) and summing with permanent population estimates. Occupancy rates for hotels were assumed to be 1.2 persons per room (Bangsund and Hodur 2012) and RV camps were assumed to have 1.5 persons per unit (Bangsund et al. 2012). Number of permitted beds was used to estimate service population for housing permitted under conditional use permits and crew camps.

Historical occupancy rates were applied to the number of housing units in approved and platted housing developments and likely residential annexations to estimate future population potential. Because no data exist to suggest whether population associated with non-traditional housing will increase or decrease, the model assumes there would be no change. Considering it is likely that economic activity will remain at current levels for the next 6-8 years (consistent with employment model assumptions), it is reasonable to assume that the use of non-traditional housing will remain at current levels. Non-traditional housing will remain an important component in meeting the demand for temporary housing for the temporary workforce. The same assumption was applied to future levels of non-traditional housing in Williams County.

## Population Potential

The 2012 service population for Williston was estimated to be 25,349 (Table 8). Population associated with housing units constructed since 2010 was estimated to be just over 7,000 with another nearly 3,600 associated with non-traditional housing; hotels, crew camps and housing permitted with conditional use permits. Population potential associated with the build-out of known housing developments resulted in an estimated increase in service population of 14,000 for an estimated 2017 service population for the City of Williston of 39,679 (Table 8).

The 2012 service population for Williston was estimated to be 25,349. When the service population in the six surrounding townships and additional housing constructed since 2010 in the six surrounding townships was included, the 2012 service population for Williston was estimated to be 37,000 (Table 8). The 2012 service population for Williams County, including the city of Williston, was estimated to be just over 47,000. Population associated with non-traditional housing, specifically hotels, crew camps and housing units permitted with conditional use permits in Williams was estimated to be over 13,000 with 54 percent (7,234) located in the six surrounding townships (Table 8).

The estimated build-out for Williston could be expected to lead to an increase in population of 13,600. An additional 2,000 population increase was estimated as a result of potential build-out in the six surrounding counties for an estimated 2017 service population of over 53,000 for Williston and the six surrounding townships (Table 8).

The estimated build-out for Williams County (not including Williston) could be expected to result in an increase in population of over 4,000 for a total estimated 2017 service population for Williams County (including Williston) of 68,176 (Table 8).

## Key Assumptions of Build-out Model

Like the employment model, the build-out model represents population potential based on the assumption that housing in approved developments and likely annexations will be constructed. Build-out time was based on data provided by Williston and Williams County. For developments that have not yet started construction, and there was no estimate of planned rate of development, the build-out time was assumed to be five years.

The build-out model, like the housing model, assumes occupancy rates for traditional housing units were the same as historic rates. As was the case with the employment model, data were not available to suggest otherwise. Baring the availability of additional data, the use of historic occupancy rates will remain the only available option.

**Table 8. Service Population Estimates, Housing Build-out Model, City of Williston, Six Surrounding Townships, and Williams County, North Dakota, 2012 and 2017**

Item	Service Population Estimate <sup>1</sup> 2012			Service Population Projection <sup>1</sup> 2017			
<b>Williston:</b>							
Census Population , 2010	14,716						
Hotels, Crew Camps, Condition Use Permits	3,592						
Estimated Housing Units Constructed 2010-2012	<u>7,041</u>						
Estimated Service Population, 2012	<u>25,349</u>	25,349		25,349			
5-year housing build-out				<u>14,330</u>			
Estimates Service Population, City of Williston, 2017				<u>39,679</u>		39,679	
<b>Surrounding Townships<sup>2</sup>:</b>							
Census Population , 2010	3,308						
Hotels, Crew Camps, Condition Use Permits	7,234						
Estimated Housing Units Constructed 2010-2012	<u>1,057</u>						
Estimated Service Population, Surrounding Townships,2012	<u>11,599</u>	<u>11,599</u>		11,599			
Estimated Service Population, Williston and Surrounding Townships, 2012		<u>36,948</u>	36,948				
5-year Housing Build-out Surrounding Townships				<u>2,035</u>			
Estimated Service Population, Surrounding Townships, 2017				<u>13,634</u>		<u>13,634</u>	
Estimated Service Population, City of Williston and Surrounding Townships, 2017						<u>53,313</u>	53,313
<b>Williams County:</b>							
2010 Census Population, Williams County (excluding Williston and Surrounding Townships)	4,374						
Hotels, Crew Camps, Conditional Use Permits	6,063						
Estimated Housing Units Constructed 2010-2012	<u>0</u>						
Estimated Service Population, Williams County (excluding Williston and Surrounding Townships)	<u>10,437</u>		<u>10,437</u>			10,437	
Total Estimated Service Population, Williams County (including Williston and Surrounding Townships), 2012			<u>47,385</u>				
5-year housing build-out						4,426	
Total Estimated Service Population, Williams County (excluding Williston and Surrounding Townships), 2017						<u>14,863</u>	<u>14,863</u>
Total Estimated Service Population, Williams County (including Williston and Surrounding Townships), 2017							<u>68,176</u>

<sup>1</sup>Population associated with permanent and temporary workforce.

<sup>2</sup>Williston, Judson, Missouri, Pherrin, Stony Creek, and Trenton Townships.

## Model Comparison

A comparison of the two models reveals that at the county level, the two estimates are remarkably similar, with only a seven percent difference in the estimate of the 2012 service population and a two percent difference in the 2017 population estimate. The employment and housing models estimated the 2012 Williams County service population to be about 51,000 and 47,000, respectively (Table 9).

Alternately, an initial comparison of the two models for Williston suggests substantial disparity in the projections. The housing model suggests a 2012 estimated service population of just over 25,000 compared to the employment model estimate of over 33,000, a 28 percent difference. The two estimates of the 2017 service population were more closely aligned. The housing model projects 2017 service population for Williston of over 39,000 while the employment model suggested a projected population of 44,000, a 10 percent difference (Table 9).

Assumptions about how Williston is defined affect model results. If the service population of the six surrounding townships is included in Williston's population estimates, the estimates were more closely aligned. When the six surrounding townships were included, the 2012 estimated service population for Williston was 37,000 compared to 41,000 for the employment model, a 10 percent difference. An estimated service population of approximately 13,000 resides in non-traditional housing units in Williams County, of which over 7,000 reside in non-traditional housing in the six surrounding townships (Table 10). Including the service population that lives just outside city limits in the six surrounding townships in the estimate of the city of Williston brings the two estimates more in line with each other. Including the six surrounding townships in the 2012 and 2017 estimated service population brings the estimates from the two models to within 10 percent and less than 1 percent (Table 10).

Item	Estimated Service Population		Estimated Service Population	
	2012		2017	
	Employment Model	Housing Model	Employment Model	Housing Model
Williston	33,547 <sup>1</sup>	25,349 <sup>2</sup>	43,993 <sup>1</sup>	39,679 <sup>2</sup>
Percent Difference	27.8%		10.3%	
Williams County (excluding Williston)	17,514	22,036	22,697	28,497
Percent Difference	22.8%		22.6%	
Total	51,061	47,385	66,690	68,176
Percent Difference	7.5%		2.2%	

<sup>1</sup>Assumes City of Williston is 65.7 percent of Williams County population.  
<sup>2</sup>City of Williston only.



**Table 10. Comparison of Estimated Service Population, Employment Model and Housing Model, City of Williston Including 6 Surrounding Townships and Williams County, North Dakota, 2012 and 2017**

Item	Estimated Service Population		Estimated Service Population	
	2012		2017	
	Employment Model	Housing Model	Employment Model	Housing Model
Williston	41,104 <sup>1</sup>	36,948 <sup>2</sup>	53,903 <sup>1</sup>	53,313 <sup>2</sup>
Percent Difference	10.6%		>1%	
Williams County (excluding Williston and 6 surrounding townships)	9,957	10,437	12,787	14,863
Percent Difference	4.7%		15.0%	
Total	51,061	47,385	66,690	68,176
Percent Difference	7.4%		2.2%	
<sup>1</sup> Assumes City of Williston is 80.5 percent of Williams County population. <sup>2</sup> City of Williston and six surrounding townships.				

## **Conclusions, Implications, and Need for Study**

Because of the unique circumstances present in western North Dakota, traditional population modeling tools were not appropriate for estimating the current or future service population in the city of Williston. Two methods were used to estimate the current and future service population of the City of Williston and Williams County. Both methods resulted in similar results which enhances confidence in the estimates.

Findings quantified the current and projected service population in Williston using two distinct models, based on different metrics; employment and housing. The housing model and the employment model estimated Williston's current service population to be 25,000 and 33,000, respectively. When the six surrounding townships were included in the estimate, the housing model and the employment model estimated Williston's current service population to be 37,000 and 41,000, respectively.

Both models project that the permanent and service population in Williston is likely to continue to grow at a high rate in the near term. The housing model projected the 2017 service population for Williston to increase to just under 40,000 and the employment model projected the 2017 service population for Williston to increase to 44,000. When the six surrounding townships were included in the projected service population, the housing model and the employment model projected the 2017 Williston service populations to be 53,000 and 54,000, respectively.

The estimates of current service population and projected increases suggest continued high demand for and strain on infrastructure and public services. Although a portion of the service population related to the temporary workforce will ultimately move on to the next job site, they will use and require housing, infrastructure and public services while working and living in North Dakota. Even if only permanent population growth is considered, the employment model projects a 60 percent permanent population increase in Williston of nearly 10,000 (not including six surrounding townships) to just over 13,000 (including six surrounding townships), in just 5 years.

Findings would suggest that housing development in Williston appear to be in line with industry expectations for future employment growth and demand for housing associated with that growth. Based on model projections, it does not appear that Williston is in danger of overbuilding in the near term. Projections for continued increase in service population also underscore the continued need for temporary housing to meet the housing needs of the service population associated with transient employment.

Models should be updated and the data base of housing development maintained to track new annexations and zoning, platting and permitting of new housing developments. If housing build-out is constantly monitored, the housing model can easily be updated to reflect the dynamic conditions present in Williston and Williams County.

Further study is needed to refine the understanding of workforce characteristics. A better understanding of workforce characteristics would enable model refinements and improved estimates of both future permanent and service (temporary and permanent) populations.

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Table A1. Housing Demand in Total Units, Consensus Scenario, by County, State Planning Region 1, 2012 through 2036				
	State Planning Region 1			
Year	Divide	McKenzie	Williams	Total
	Permanent Housing <sup>a</sup>			
2012	1,574	3,672	12,436	17,682
2013	1,770	4,130	13,986	19,885
2014	2,039	4,758	16,111	22,907
2015	2,250	5,251	17,780	25,281
2016	2,442	5,698	19,296	27,436
2017	2,597	6,061	20,526	29,185
2018	2,742	6,399	21,669	30,809
2019	2,923	6,822	23,102	32,847
2020	3,117	7,275	24,636	35,028
2021	3,201	7,470	25,298	35,969
2022	3,282	7,659	25,935	36,876
2023	3,358	7,837	26,538	37,732
2024	3,427	7,999	27,089	38,515
2025	3,494	8,154	27,614	39,262
2026	3,556	8,298	28,101	39,955
2027	3,613	8,433	28,556	40,602
2028	3,667	8,558	28,982	41,208
2029	3,717	8,674	29,373	41,763
2030	3,762	8,779	29,731	42,272
2031	3,803	8,877	30,060	42,740
2032	3,830	8,939	30,271	43,040
2033	3,853	8,993	30,453	43,298
2034	3,864	9,017	30,535	43,416
2035	3,849	8,983	30,421	43,253
2036	3,838	8,956	30,330	43,124

<sup>a</sup>Housing needs associated with permanent workforce.

Table A1. (continued)				
State Planning Region 1				
Year	Divide	McKenzie	Williams	Total
Total (Permanent and Temporary) Housing <sup>b</sup>				
2012	2,967	6,924	23,449	33,340
2013	3,247	7,577	25,659	36,482
2014	3,508	8,188	27,727	39,423
2015	3,703	8,641	29,264	41,608
2016	3,873	9,040	30,613	43,526
2017	3,987	9,305	31,510	44,802
2018	4,090	9,546	32,326	45,962
2019	4,215	9,836	33,309	47,360
2020	4,357	10,169	34,436	48,962
2021	4,339	10,126	34,289	48,754
2022	4,185	9,767	33,076	47,029
2023	4,083	9,530	32,271	45,884
2024	3,988	9,308	31,522	44,818
2025	3,973	9,272	31,400	44,645
2026	3,951	9,222	31,228	44,401
2027	3,953	9,225	31,239	44,417
2028	3,953	9,226	31,243	44,422
2029	3,939	9,193	31,133	44,265
2030	3,924	9,159	31,015	44,098
2031	3,916	9,139	30,947	44,001
2032	3,895	9,091	30,787	43,774
2033	3,878	9,051	30,651	43,580
2034	3,864	9,017	30,535	43,416
2035	3,849	8,983	30,421	43,253
2036	3,838	8,956	30,330	43,124

<sup>b</sup>Housing demand associated with permanent and temporary workforce.

Table B1. Population Estimates, Consensus Scenario, by County, State Planning Region 1, North Dakota, 2010 through 2036

State Planning Region 1				
Year	Divide	McKenzie	Williams	Total
Permanent Population <sup>a</sup>				
2010	2,071	6,360	22,398	30,829
2011	2,125	7,019	24,374	33,518
2012	2,981	8,760	27,081	38,822
2013	3,304	9,752	30,210	43,266
2014	3,750	11,119	34,518	49,388
2015	4,077	12,145	37,784	54,007
2016	4,425	13,181	41,005	58,611
2017	4,707	14,021	43,619	62,346
2018	4,969	14,801	46,046	65,816
2019	5,298	15,780	49,092	70,170
2020	5,650	16,828	52,352	74,829
2021	5,801	17,280	53,758	76,840
2022	5,948	17,716	55,113	78,776
2023	6,086	18,127	56,393	80,606
2024	6,212	18,503	57,564	82,279
2025	6,332	18,862	58,680	83,874
2026	6,444	19,195	59,716	85,356
2027	6,549	19,506	60,682	86,737
2028	6,646	19,797	61,588	88,031
2029	6,736	20,064	62,418	89,218
2030	6,818	20,308	63,178	90,304
2031	6,893	20,533	63,878	91,304
2032	6,942	20,677	64,327	91,946
2033	6,983	20,801	64,712	92,497
2034	7,002	20,858	64,888	92,748
2035	6,976	20,780	64,645	92,401
2036	6,955	20,717	64,451	92,124

<sup>a</sup> Population associated with permanent workforce. Population in 2010 represents Census estimates.



Table B1. (continued)				
State Planning Region 1				
Year	Divide	McKenzie	Williams	Total
Service (Permanent and Temporary) Population <sup>b</sup>				
2010 <sup>c</sup>	2,071	6,360	22,398	30,829
2011	2,125	7,019	24,374	33,518
2012	5,621	16,517	51,061	73,199
2013	6,062	17,891	55,424	79,377
2014	6,455	19,136	59,406	84,997
2015	6,711	19,989	62,186	88,885
2016	7,020	20,911	65,053	92,984
2017	7,226	21,524	66,960	95,709
2018	7,413	22,081	68,693	98,187
2019	7,638	22,752	70,782	101,173
2020	7,897	23,522	73,178	104,597
2021	7,863	23,422	72,866	104,151
2022	7,585	22,593	70,288	100,466
2023	7,400	22,043	68,576	98,020
2024	7,229	21,531	66,984	95,744
2025	7,201	21,448	66,725	95,373
2026	7,161	21,331	66,361	94,854
2027	7,164	21,339	66,384	94,887
2028	7,165	21,341	66,391	94,897
2029	7,139	21,266	66,157	94,562
2030	7,112	21,185	65,907	94,205
2031	7,097	21,139	65,763	93,998
2032	7,060	21,030	65,423	93,513
2033	7,029	20,937	65,134	93,100
2034	7,002	20,858	64,888	92,748
2035	6,976	20,780	64,645	92,401
2036	6,955	20,717	64,451	92,124

<sup>b</sup> Population associated with permanent and temporary workforce.  
<sup>c</sup> Service population not estimated for 2010. Figures represent 2010 Census population only (U.S. Census Bureau 2012b)



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