GILLETTE MADISON PIPELINE PROJECT (GMPP)
TECHNICAL MEMORANDUM #3
FINAL

TO:	Mike Cole, P.E., City of Gillette
FROM:	Casey Hanson, P.E., MMI
DATE:	April 30, 2010, Finalized July 19, 2010
JOB NO.:	BMcD # 54432, MMI #4776.001
RE:	Population Projections, Demands, and Source of Supply Requirements
CC:	Darin Brickman, P.E., BMcD Dan Korinek, P.E., BMcD Carl Anderson, P.E., MMI Jaime Tarver, P.E., Tarver Consulting Bryan Clerkin, P.E., WWDC
ATTACHMENTS:	Graph Summary of Average Unit Demands Figure 2-1, Level II Study Figure 4-1, GRMP

☐ **Urgent** ☒ **For Review** ☒ **Please Comment** ☐ **Please Reply** ☐ **For Your Use**

Background

Population projection is usually a subjective, but key, component to predicting and ultimately meeting water demands. Population trends in Gillette and the surrounding area have been somewhat erratic in recent history due to growth in energy development in the area. A number of engineering studies over the last 31 years have analyzed population trends and made future population predictions from their data. Due to the population fluctuations of this energy-driven community, many of these previous studies are no longer truly indicative of the current population composition and trends in the Gillette area. The two most recent engineering studies

addressing population and demand projections are considered the most accurate and most valid due to their close tracking with actual population trends over recent years.

The 2007 City of Gillette Long Term Water Supply, Level II Study by Morrison Maierle, Inc. and Burns & McDonnell (Level II), and the 2009 Gillette Regional Master Plan Level I Study by HDR Engineering, Inc. (GRMP) projected both population and land-use trends. Both of these reports utilized a population prediction method from an outside report that is tailored to energy-driven population growth centers and was adapted to Gillette in particular. The Level II study and GRMP differed significantly in their approach to potential service area; however, the resulting projections for the City of Gillette area were nearly identical. A comparison and contrast of the two studies is discussed in more detail below.

Discussion of Previous Studies

Both the Level II and GRMP studies examined a number of population growth models and scenarios. The preferred population model from both reports was based on the population growth rate and structure developed in the *Task 3C Report for the Powder River Basin Coal Review* report prepared by ENSR Corporation for the Bureau of Land Management (Task 3C). This report gave two possible growth scenarios for the Powder River Basin – a high production scenario and a low production scenario based on energy production rates in the area. Both the Level II and GRMP studies concluded that the high production scenario most closely matched the recent observed population growth rates in the Gillette and Powder River Basin areas. The Task 3C model was based on a two-tiered population growth model: 4.6% per year from 2003-2010, with a lower growth rate of 1.10% per year from 2010-2020. The Level II report extrapolated the latter rate (1.10%) out to year 2037. The GRMP does not specify how population growth beyond 2020 was calculated.

The planning areas in the Level II and GRMP studies are vastly different, which is not surprising given the difference in scope of these two studies. The scope of the Level II study was to evaluate long term water supply options for the City of Gillette. The scope of the GRMP was to look at the potential of a regional system which includes the needs of the City of Gillette. The planning use boundary for the Level II study is detailed in Figure 2-1 of that study which is attached to this tech memo. This boundary was used in the Level II report only to show the boundaries of the population and service area, and not for any population or demand projections. The findings of the Level II study were that the population growth was not land- or area-constrained but rather driven by the energy industry and, therefore, by definition the growth economically constrained. In other words, jobs will control the growth in Gillette, not the available land for housing and infrastructure.

The GRMP approach to setting the study area definitions was based significantly more on land and features. This approach attempts to determine where growth will occur in addition to the extent that it will occur. The GRMP identified two potential boundaries: a “possible” boundary and a “probable” boundary. The probable area is the area which most likely will develop, whereas the possible areas contain land where development is physically possible, but not as likely as the probable areas. Figure 4-1 of that report graphically shows these two areas and their proximity to the project area. Figure 4-1 is attached to this tech memo.

The Level II (2007) and GRMP (2008) were prepared approximately one (1) year apart. As a result, population values for a 30 year planning period are also one (1) year apart. The terminal year of the 30-year planning horizon in the Level II study was 2037, while the terminal year in the GRMP planning horizon was 2038. Level II population estimates could be inflated 1.10% to normalize the projections in year 2038.

Previous Study Population Projections

The population projection from the Level II study was 50,018 in 2037. Indexing this forward to 2038 for a common comparison with the GRMP gives a 2038 population projection of 50,568. The population projection for the "Proposed Gillette PDB (Planning District Boundary)" from the GRMP encompassed a very similar area to the planning district boundary used in the Level II study. The 2038 Proposed Gillette PDB projected population from the GRMP is 51,003. Thus, the Level II and GRMP 2038 population projections for the Gillette area only differ by 317 people, or 0.6%. The GRMP study also looked at a wider service area outside of the Gillette PDB.

The GRMP reported a total potable water serviceable area population for this project at 57,698 people, with 1,382 people in Crook County and 56,316 people in Campbell County. This potable water service area includes regional customers inside the probable boundary, but excludes potential regional customers outside the probable boundary but inside the possible boundary. The GRMP identified Green Valley Estates Improvement District, Glory Hole Homeowners Association, Rag Coal West, Inc./Rawhide School, and Ridgeway Community Well Association as potential users that fall into the possible but not probable service area. As the GRMP service area name implies, these potential regional customers can be served by the regional system, but will not likely be too due to cost, remote location, and other possible factors. All of these potential regional customers are relatively small. They are all currently less than 25 taps each totaling a projected peak flow of 114,000 gallons per day. The sum of their demands is 79 gpm which is well within the margin of error inherent in estimating a system of this size. Based on their small size and the improbability of their inclusion in the system, their demands are not included further in this analysis. However, in the event these flows were required to be added to this system, they most likely could be served with no changes to the proposed sizing and configuration of the GMPP system.

The Campbell County population of 56,316 was used to develop demands for the GRMP with the Crook County population excluded because "*WWDC had decided during the preparation of the analysis that Crook County would be served separately from the Gillette regional water system, so should not be included in the demands used for sizing this system*" (GRMP, Pg. 36) Subtracting the Gillette PDB population from the total Campbell County serviceable population gives a total of 5,313 servable people outside the Gillette PDB using GRMP estimates. In both studies the Gillette PDB includes the Crestview, Antelope Valley, and Sleepy Hollow subdivisions.

Previously Developed Unit Demands

Both the Level II and GRMP studies used the same unit demands that were developed during the Level II. These are summarized in Table 1 below.

Table 1 **Unit Demands (gpcd)**	
Minimum Day	92
Average Day	190
Peak Day	613

The GRMP also identified a Peak Hour Peaking factor of 1.5 times the Peak Day. While the Level II study was being finished, Gillette was undertaking an ambitious conservation program that has now been in effect for nearly three (3) years. The GRMP concluded that the data from this program was not conclusive enough to make a change to the unit demand work performed in the Level II study.

Current Development Population Comparison

For comparison purposes, the "Developing Gillette The 2009 Annual Development Summary" (Developing Gillette) was checked against the Level II and GRMP project population projections. The Developing Gillette summary reported the 2009 Gillette population as 33,159. The Level II population projection for 2009 was 35,589, which included populations from Crestview, Antelope Valley, and Sleepy Hollow. These populations total 3,971 people. The adjusted population prediction from the Level II study with these areas removed for 2009 is 31,618. The Level II population projection deviated from the Developing Gillette population by slightly less than 5%. It should be noted that the Developing Gillette population is based on multiplying 2.7 average persons per household (or average household size) by the number of building units added over a given period of time. While this method provides a good check and makes an interesting comparison to other more census based data, it does have some inherent inaccuracy and should not be considered as a census-level population counting effort.

Population Planning Horizon Update

A 2038 population projection only provides a 28-year planning horizon from the writing of this memo in 2010. With the design of this project beginning in late 2009, this tech memo proposes to update the population projections for the project to 2010. The intention of this update is to finalize the population, and resulting demand projections for the project. Continuing the population projection approach discussed above, 2038 values can be adjusted to 2040 by applying a growth rate of 1.10% per year compounded for two (2) years. A 2038 population of 56,316 indexed forward at the above rate yields a 2040 population projection of 57,562.

Regional System Potential Participant Connections Study Comparison

During the preparation of this tech memo, a draft of the Regional System Potential Participant Connections Study (RSPCS) currently being performed by HDR Engineering, Inc. was made available for review.

The total regional service population from the RSPCS indexed to 2040 is 11,290. The total regional service population from the Level II effort projected to 2040 is 12,012. The total calculated demand from the RSPCS is 4,806 gpm. The total calculated demand using GRMP and Level II numbers is 5,113 gpm. The difference is 307 gpm, which is less than 2% of the entire new GMPP supply. It is recommended to use the adjusted Level II numbers as they are slightly more conservative.

Unit Demand Update

Updated City of Gillette water use and pumping data were requested to help verify the earlier data used in the Level II study. Data from years 2007, 2008, and 2009 were added to the 2002-2006 data set used to prepare the Level II study. Table 2 below summarizes the updated unit demands. The average daily consumption dropped from 190 gpcd to 179 gpcd. This could be a result of the conservation program or other external factors, such as weather. The minimum day flow changed from 92 gpcd to 93 gpcd. The peak day did not change as this was based on an actual 15.825 MGD peak pumping event occurring in June of 2005 that has not been exceeded on a per capita basis.

Table 2
Updated Unit Demands (gpcd)

Minimum Day	93
Average Day	179
Peak Day	613

See attached graphical summary of average unit demands on a monthly basis for the years 2002 through 2009.

Since the Level II study was complete, Bell Knob Golf Course, a major irrigation user of the City of Gillette (COG) water system has discontinued their use of the COG system. They have installed a new well system for their irrigation uses. Retiring such a large customer would have the effect of lowering peak demands on the system. However, in the same time period, the new Campbell County Recreation Center (Rec Center) and a major addition to the Cam-Plex are assumed to have placed significant demands on the COG system. For the purposes of this analysis, it was assumed that the Bell Knob retirement and the Rec Center and Cam-Plex additions are approximately equal resulting in no net change to the unit demands.

Calculated Demands

Calculating demands is a relatively straightforward process of multiplying the ultimate population by the unit demands. Table 3 below summarizes the daily design demands for the project. The ultimate 2040 design population of 57,562 is used to represent the projected service population of this project. The updated unit demands in Table 2 were used to calculate the ultimate demands in Table 3.

Table 3
2040 Total Demand

	Demand (MGD)	Demand (gpm)
Minimum Day	5.35	3,717
Average Day	10.30	7,155
Peak Day	35.29	24,500

Table 4 shows the average day and peak day demands by 10 year epoch.

Table 4
Demand by 10 Year Epoch

Year	Average Day Demand (gpm)	Peak Day Demand (gpm)
2010	4,981	17,058
2020	5,749	19,688
2030	6,414	21,964
2040	7,155	24,504

Current Wellfield System Capacity

Although many of the existing system components operate near their capacity when the entire system is running (no elements out of service), when the system is analyzed on a firm capacity basis, the supply available from the wells becomes the limiting factor. In the supply analysis, it is important to consider the current system capacity under two scenarios: average flow and peak flow. The Wyoming State Engineer's Office (SEO) has imposed a volumetric withdrawal cap of 1,500 Acre•Feet/Year collectively on the City of Gillette Fort Union wells. This cap affects average and peak withdrawals in different ways. For that reasons, both scenarios are discussed in more depth below. Due to very high Fluoride levels, the existing Fox Hills wells were not considered for either average day or peak day source calculations. It was assumed that Fox Hills wells would only be used for an emergency backup source when all other sources have been utilized to their maximum capacity.

Table 5 below summarizes the annual average daily flows by source. The average daily flow from the Fort Union wells is obtained by converting the 1,500 Acre•Feet/Year SEO volumetric cap to an average daily flow value. The average daily flow from the Madison well field was based on firm capacity which was calculated by adding the flows from all the well pumps and subtracting the largest producing well as out-of-service. The combination of the existing Fort Union and Madison well field capacities exceed the average 2040 daily requirement.

Table 5
Annual Average Daily Flow By Source (Firm Capacity)

Source	Average Daily Flow (MGD)	Average Daily Flow (gpm)
Fort Union Wells[1]	1.34	930
Existing Madison Wellfield[2]	9.45	6,565
Total	10.79	7,495

[1] Source is limited by annual SEO cap, not system capacity.
[2] Source is limited by firm capacity of wellfield.

Table 6 below summarized the peak daily flows by source. The peak daily flow from the Fort Union and Madison wells were based on firm capacity which was calculated by adding the flows from all the well pumps and subtracting the largest producing well as out-of-service for each respective field. The individual well flow rates used in this analysis were based on 2007-2009 pumping data provided by the City of Gillette. Where this pumping data was not available, well flows from the recent City of Gillette Fort Union Well Replacement Project and the Level II study were used.

Table 6
Peak Flow By Source (Firm Capacity)

Source	Peak Daily Flow (MGD)	Peak DailyFlow (gpm)
Fort Union Wells	2.74	1,906
Existing Madison Wellfield	9.45	6,565
Total	12.19	8,471

The combination of the existing Fort Union and Madison well field capacities do not meet the 2040 peak daily flow demands.

Required New System Capacity

The required new system capacity can be calculated by subtracting the total peak flows available with the current system (Table 6) from the total demands (Table 3). The resulting deficit must be met by the firm capacity of the new Madison system. Table 7 below gives the required firm capacities for the new system.

Table 7
Required Firm Capacity

Source	Peak Day Flow (MGD)	Peak Day Flow (gpm)
New Source Requirement	23.10	16,000

Table 8 below shows the number of new wells needed by each epoch by dividing the total new demand needed by 1,400 gpm per well and adding one well for firm capacity. The peak

demand from new system and number of wells needed in year 2010 includes all regional demand assuming no contribution from regional systems. Until the GMPP is constructed and in operation this is an unrealistic assumption, but it was included herein for comparison purposes.

Table 8
Number of Wells by 10-Year Epoch

Year	Peak Demand from New System (gpm)	Number of Wells Needed
2010	8,587	7
2020	11,217	9
2030	13,493	11
2040	16,033	13

Recommendation

It is recommended that the required firm capacity in Table 7 be used for planning and design purposes for the source of the GMPP. It is also recommended that the total demands shown in Table 3 be utilized for the design and planning of other elements of the project.

The firm capacity of the existing sources was the limiting factor in this analysis. The design of the pump station and pipeline facilities will need to be evaluated in conjunction with the existing facilities to determine design flow requirements. It is anticipated that the design flows for those facilities will be less than the 23.10 MGD (16,000 gpm) required of the new source since those facilities are not the limiting factors of the system on a firm capacity basis. The flow requirements for pump stations, pipelines, and any other ancillary facilities will be discussed more in-depth with those respective design facilities.