EAST LARAMIE WASTE WATER FEASIBILITY STUDY

APRIL 1, 2013

Prepared For: City of Laramie
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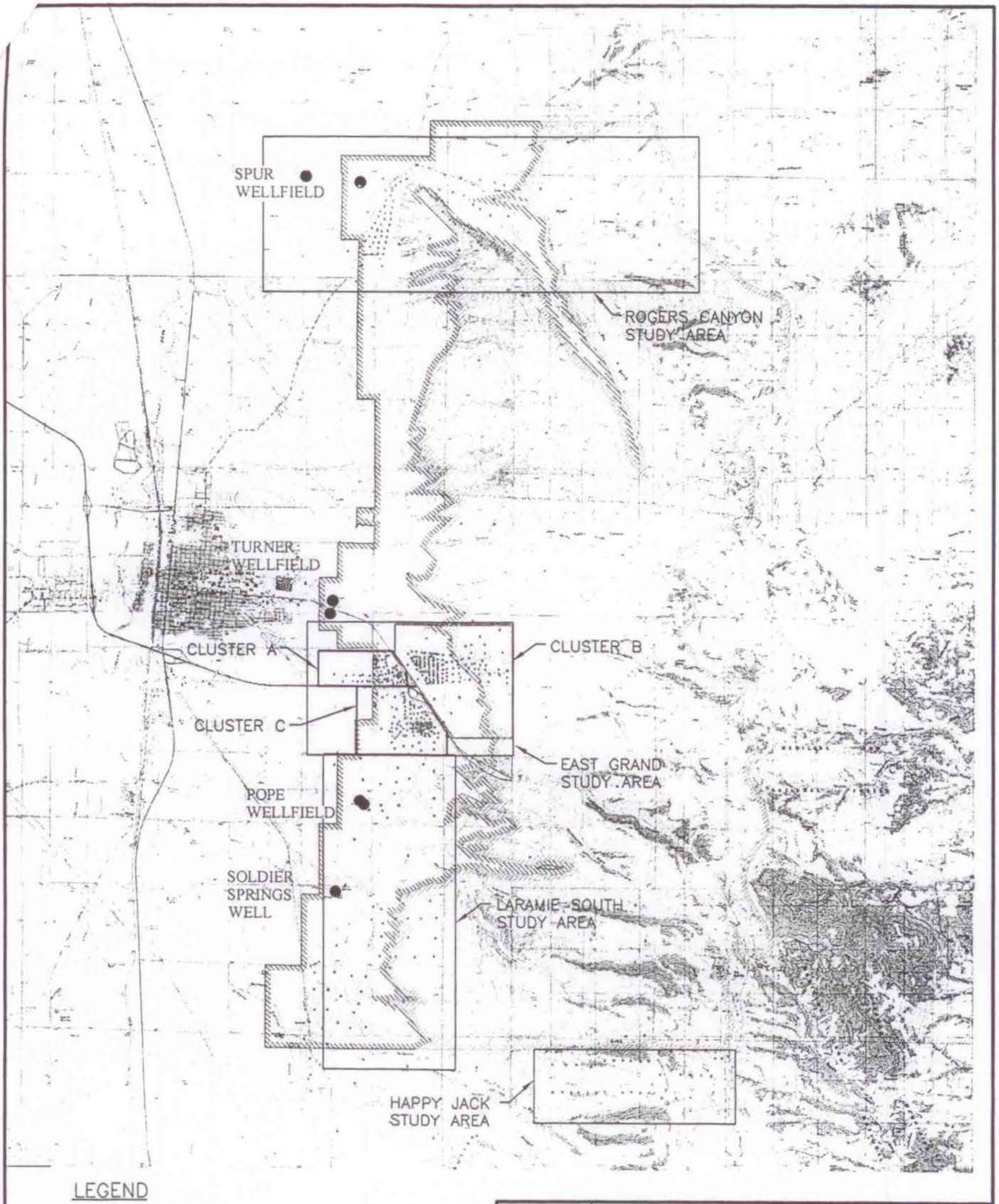
EXECUTIVE SUMMARY

Private septic systems east of Laramie do not pose a significant risk of nitrate contamination to the City of Laramie public drinking water supply wells at this time. However, there are residential areas east of Laramie that have groundwater nitrate concentrations above those typically considered as naturally occurring. In some instances the local groundwater nitrate concentrations are close to or exceed the Environmental Protection Agency maximum regulatory drinking water standard of 10 mg/l.

One recommendation of this study is to perform the planning and design activities needed in advance of a construction project that would mitigate groundwater nitrate contamination.

This study presents conceptual level designs and cost estimates for two projects that can mitigate the risk of septic system induced nitrate contamination to both City wells and private wells. One project is a decentralized wastewater treatment system. This project would collect septic tank effluent from about 350 homes, treat the liquid at a central location, and discharge the treated effluent to the ground surface. The cost of this project is about $13 million dollars. An option to decentralized treatment would be to install a sewage collection system in the areas east of Laramie and deliver sewage to the City system. This second project would also require upgrading components of the existing City collection system. This second project would have a capital cost of about $26 million.

Other study recommendations include one related to the installation of additional monitoring wells and one related to additional groundwater testing.



DESIGNED BY: MTS/KST	FIGURE 1 STUDY AREAS
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2.0 CHARACTERIZATION AND RISK

2.1 Introduction

This report chapter will:

- Provide background information on nitrate health effects, regulation, chemistry and its relationship to septic systems.
- Provide an evaluation of groundwater contamination risk to both private and public wells.
- Provide discussion and recommendations related to groundwater sampling.

2.2 Background

2.2.1 Nitrate Health Effects

The presence of high concentrations of nitrate (NO3) in drinking water has been shown to cause a condition caused methemoglobinemia. Methemoglobinemia is a blood disorder in which the blood fails to provide enough oxygen to the body. Infants less than 6 months old are particularly susceptible to this condition. In infants methemoglobinemia is known as "blue baby syndrome" since it causes a bluish color to appear around an infant's mouth, hands and feet. Adults can tolerate higher levels of nitrate than infants without developing methemoglobinemia. But certain groups of adults: pregnant women, nursing mothers, and persons with iodine deficient diets are at risk of methemoglobinemia as well.

2.2.2 Drinking Water Nitrate Regulation

Nitrate is regulated under the Safe Drinking Water Act (SDWA). Nitrate levels in public water systems must remain below a Maximum Contaminant Level (MCL) of 10 mg/L as nitrogen (10 mg/L as N). Nitrate is considered an acute contaminant which is immediately dangerous to human health at levels above the MCL. Any measurement of nitrate at or above 10 mg/L in drinking water is considered a violation of the MCL. Public water systems which violate the nitrate MCL must notify the public of the violation. The EPA can fine a utility for exceeding the nitrate MCL and take legal action to force its compliance with the regulation.

Private wells are not regulated under the SDWA. However, the health risk to infants and adults from nitrate is no different from private wells than from public wells. Boiling will not remove nitrate from water, nor will charcoal filters attached to the user's taps. Private wells containing unsafe levels of nitrate must be treated, typically using reverse osmosis membranes. Alternatively, a new source of potable water must be obtained to replace the nitrate contaminated source.

2.2.3 Relationship of Nitrate to Septic Systems

Conventional septic systems are a common source of nitrate. Nitrogen in the form of ammonia exits from a septic tank into the leachfield, typically at concentrations around 45 mg/L-N. In the leachfield a process called nitrification biologically transform the ammonia into nitrate. Nitrate is a relatively stable compound and will easily move with water percolating from the leachfield. Nitrate can be transformed in the soil column prior to reaching an aquifer into harmless nitrogen by another biological process called denitrification. This process requires soils with high moisture content, low oxygen content and high amounts of organic carbon to occur. These conditions do not exist in the Laramie area and little decomposition of nitrate by denitrification is expected to occur. Hence the primary method for reducing the nitrate concentrations from septic systems is though dilution by recharge from rain and snow melt. Since precipitation and recharge rates are low in the Laramie area, relatively large lots sizes are required to provide enough recharge to dilute nitrate concentrations to a safe level prior to contaminating a nearby well.

The CAPP recommends a minimum lot size of 10 acres per dwelling with septic systems to provide sufficient dilution of nitrate to protect water sources. Many existing inhabited lots in the Casper Aquifer Protection Area (CAPA) do not meet this recommendation.

2.2.4 Other Sources of Nitrate

Septic systems are not the only potential sources of nitrate. Agricultural activities involving fertilizers, concentrated feedlot operations and livestock, including horses, are potential sources of nitrate. Application of fertilizers for lawn care can serve a source of nitrate as well. However, there are no large scale agricultural activities or feed lot operations in the CAPA. It is possible that horses contribute to the nitrate loads, but in the areas discussed by this study, their contribution is likely to be small compared to septic systems.

2.2.5 Occurrence of Nitrate in Groundwater

Naturally, nitrate occurs at low concentrations in groundwater, typically at levels less than 2 mg/L. In general, concentrations of nitrate exceeding this level are due to anthropogenic (man-made) sources.

In order to evaluate the risks of nitrate contamination from septic systems a classification system has been developed by the Feasibility Study. The nitrate classification levels and the rationale for their selection are presented in Table 1.

Table 1. Classification of Nitrate Levels in Groundwater

Nitrate Impact Classification	Criteria (Nitrate as N)	Rationale
No Impact	< 2 mg/L	Unable to distinguish between natural and anthropogenic source (Background level)
Impacted	2 to < 5 mg/L	Natural nitrate concentration unlikely at this level, anthropogenic contamination present
Significant Impact	5 to < 10 mg/L	Level triggers increased monitoring by utilities under SDWA due to increased heath risk
Violation of MCL	10 mg/L and greater	Exceeds SDWA MCL, considered unsafe for human consumption

Source: (http://www.deq.idaho.gov/media/473140-ranking_2008.pdf

2.3 Nitrate Risk to Public Wells

The Feasibility Study's assessment is that City of Laramie public drinking water supply wells may be affected by nitrate contamination, but are currently not at significant risk of exceeding the MCL for nitrate.

Nitrate risk to the City of Laramie public drinking water supply wells, albeit very low at present, results primarily from private septic systems in the developed residential areas east and southeast of the City. The risk arises because the septic systems contribute a significant amount of nitrate to the groundwater system and, under existing conditions of aquifer recharge and groundwater flow, those nitrate contributions can cause nitrate concentrations in the groundwater in certain areas to exceed the MCL. One such scenario is described in Appendix K of the CAPA, where modeling of nitrate discharge from septic systems in the Laramie Plains Subdivision predicted nitrate concentrations of 14 to 29.7 mg/L at the downgradient boundary of the subdivision. The CAPA's text includes a qualifier which states that the simplistic model used in the study is designed for porous media and is not considered appropriate for application to aquifers in fractured or faulted environments. That is because fractures or faults can channel groundwater flow and produce very different contaminant distributions, in both time and space, than would occur in unfractured, unfaulted porous media. Given that the Sherman Hills Fault passes through the northern end of the subdivision, channelization of groundwater flow could occur. The Sherman Hills Fault could also affect nitrate concentrations entering the Laramie Plains Subdivision, as it passes through the northern end of the Sherman Hills Subdivision upgradient of the Laramie Plains Subdivision. However, even with these qualifiers, the scenario described in the CAPA Appendix K is still useful to illustrate the potential effect of nitrate loading from a single subdivision.

Whether groundwater with high concentrations of nitrate reaches the City wells depends on the locations of the City wells relative to the nitrate sources and the directions of groundwater flow. Groundwater flow east of Laramie is illustrated in a general way on Figure 2. Groundwater in the Casper aquifer flows generally west from recharge areas on the Casper aquifer outcrop east of the City. Although flow in most of the area occurs as intergranular flow in the sandstone members of the Casper, faults in the area serve as high-permeability conduits through which groundwater can flow much more rapidly than it would through unfractured parts of the aquifer. In upgradient areas, the high permeability can cause groundwater flow to locally converge toward the faults, particularly some of the larger faults with generally east-west orientations. In areas farther downgradient and near the contact between the Casper Formation and the overlying Satanka Shale, the high permeability can result in vertically upward groundwater flow. This phenomenon produced the springs at City, Pope and Soldier Springs.

The City wellfields have targeted the larger fault zones because the higher permeability allows for very productive wells. With the benefit of high production rates comes the potential for increased risk of contamination from a variety of sources, including upgradient residential septic systems. Fortunately, assessment of groundwater flow patterns and fault locations in the existing areas of relatively high density development east of the City does not raise immediate and substantial concern regarding nitrate contamination of the City's public drinking water supply wells at this time. This does not mean that conditions will not change in the future.

The Turner Wellfield is located along the Quarry Fault; few septic systems are present in the areas adjacent to that fault. The largest number and highest density of septic systems are in areas

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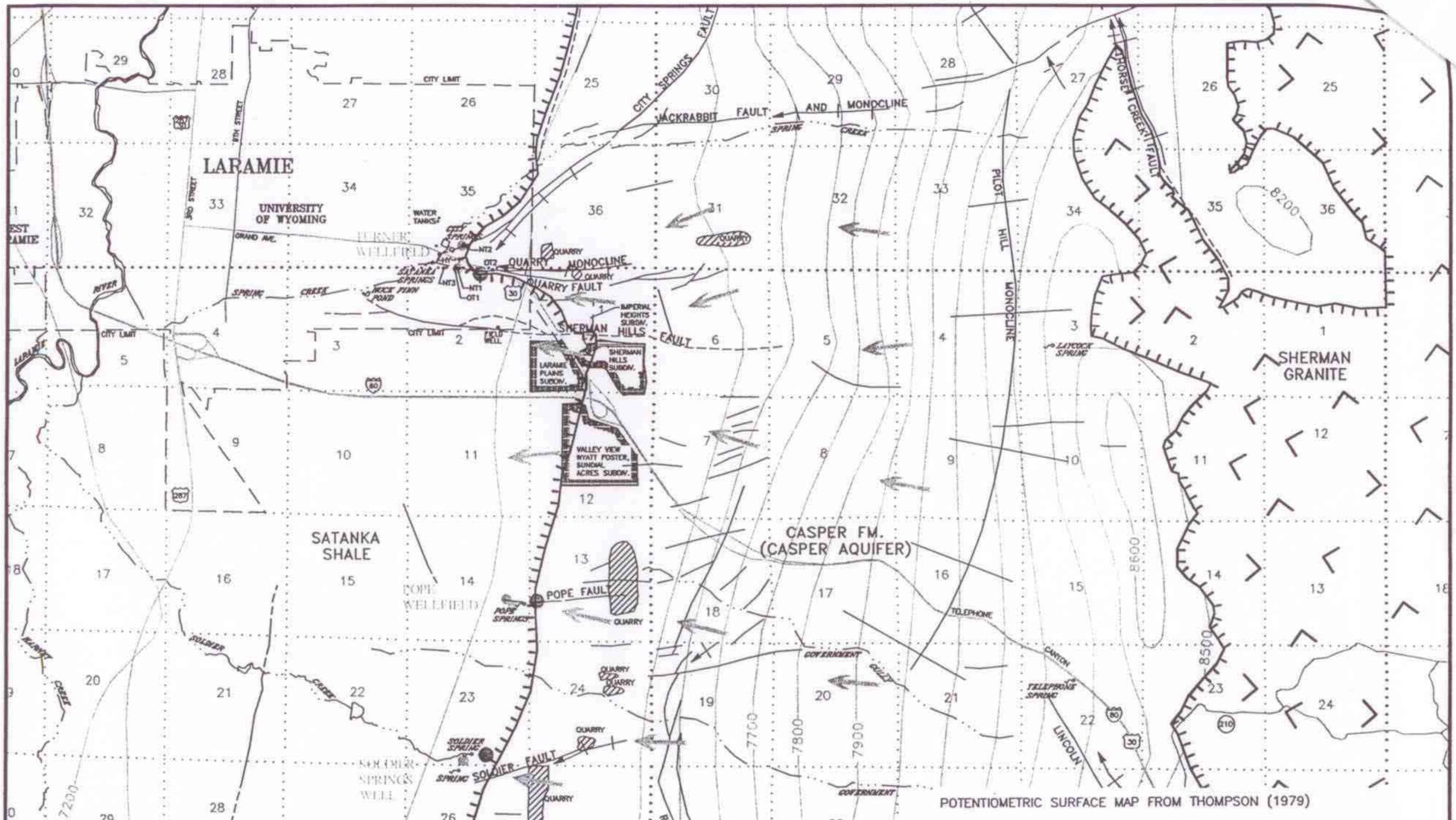

POTENTIOMETRIC SURFACE MAP FROM THOMPSON (1979)

FAULT AND FOLD MAP FROM LUNDY (1978)

LEGEND

7200	POTENTIOMETRIC SURFACE CONTOUR OF THE CASPER AQUIFER
	GENERAL DIRECTION OF GROUND-WATER FLOW
	SATANKA – CASPER CONTACT AND SHERMAN GRANITE – CASPER CONTACT
	CITY WELLS
	PROPOSED MONITORING WELL LOCATION
	FAULT
	INFERRED FAULT
	CONCEALED FAULT
	ANTICLINE
	SYNCLINE
	MONOCLINE

SCALE: 0 – 6000'

DESIGNED BY: MTS/KST	**FIGURE 2** POTENTIOMETRIC SURFACE AND FAULT/FOLD MAP OF THE CASPER AQUIFER
DRAWN BY: SDH	
CHECKED BY: MTS/KST	EAST LARAMIE WASTEWATER FEASIBILITY STUDY LARAMIE, WY
DATE: 10/12	WWC ENGINEERING

south and immediately north of the Sherman Hills Fault, which trends parallel to but about 0.4 mile south of the Quarry Fault. Groundwater flow patterns near the Sherman Hills Fault restrict northward movement of groundwater from the areas of highest septic system density and instead carry the groundwater generally west toward Spring Creek downstream of the Turner Wellfield, rather than toward the wellfield. Therefore, although the upgradient septic systems do present risk to the Turner Wellfield, the risk at this time is not considered immediate and substantial.

The Pope Springs and Soldier Springs Wellfields are located along the Pope and Soldier Faults, respectively, and the Spur Wellfield is located along the Spur Anticline. Subdivisions with residential septic systems are present upgradient of all three wellfields, but the upgradient areas have few septic systems along or near the trend of the faults or the anticline, and the septic system density in all three areas is low. Consequently, the wellfields are not at significant risk of substantial nitrate contamination from septic systems in those areas.

Long-term monitoring data from the wellfields from as early as 1973 through May 2012 (Table 2 and Figure 3) indicate that the concentrations of nitrate as nitrogen (NO_3 as N) and nitrate plus nitrite as nitrogen (NO_3+NO_2 as N) average from 1.37 to 1.91 mg/L. The standard deviations, which are a measure of the spread of the data, are small to moderate. Of the 48 samples, eight samples (five from the Turner Wellfield, one from the Soldier Wellfield and two from the Spur Wellfield) had reported NO_3 as N or NO_3+NO_2 as N concentrations of 2.0 mg/L or more. The concentrations at the Turner and Soldier wellfields exhibit trends of slight increases over time, based on statistically significant correlations (at the 95% confidence level) between sample date and nitrogen concentrations. The slopes of the linear regression lines indicate concentration increases of 0.03 and 0.009 mg/L per year for the Turner and Pope wellfields, respectively. If concentrations increased at those rates, more than a century would pass before the concentrations reached the 5 mg/L level at which increased monitoring is required (see Table 1). The concentrations at the Pope and Spur wellfields do not exhibit increasing trends.

Table 2. Monitoring Data for Municipal Wellfields

Turner Wellfield		Pope Wellfield		Soldier Wellfield		Spur Wellfield	
Sample Date	Nitrogen[1] (mg/L)	Sample Date	Nitrogen (mg/L)	Sample Date	Nitrogen (mg/L)	Sample Date	Nitrogen (mg/L)
8/1/1973	1.40	Apr-43	1.13	Apr-43	1.20	10/2/1997	3.0
8/4/1976	0.90	7/31/1973	1.65	7/31/1973	1.74	10/16/1997	1.33
12/7/1981	0.63	12/7/1981	0.79	8/22/1995	1.65	10/30/1997	1.58
12/7/1981	0.20	6/1/1993	0.77	7/10/1996	1.86	10/2/1997	3.1
6/1/1993	3.30	7/10/1996	1.88	8/6/1996	1.82	10/16/1997	1.39
9/20/1993	1.39	9/3/1996	1.64	10/11/1996	1.80	10/30/1997	1.49
11/30/1993	1.85	5/28/1997	1.75	10/11/1996	1.79	5/15/12	1.5
7/18/1995	2.04			7/23/1997	1.98		
9/1/1995	1.6			5/26/2004	1.8		
8/6/1996	1.6			6/4/2004	1.8		
5/28/1997	1.49			5/9/2006	1.6		
7/9/1998	1.66			5/15/2012	2		
5/21/2002	2						
5/25/2004	1.5						
5/24/2005	1.6						
5/9/2006	1.8						
10/23/2006	2.1						
5/8/2007	1.6						
5/27/2009	1.4						
5/25/2010	2.3						
5/15/2012	1.9						
Mean	1.63		1.37		1.75		1.91
Standard Deviation	0.62		0.47		0.20		0.78
95% Confidence Interval for the Mean[2]	1.33 to 1.93		0.98 to 1.77		1.62 to 1.88		1.25 to 2.57
Correlation Coefficient[3]	0.49		0.31		0.76		-0.24

[1] Values in black are nitrate as nitrogen (NO_3-N). Values in red are nitrate plus nitrite as nitrogen (NO_3+NO_2-N).
[2] 95 % confidence limits for the mean concentration.
[3] Correlation coefficient for linear regression of date versus concentration.
Data sources:
1943: Morgan, A.M., Geology and groundwater in the Laramie area, Albany County, Wyoming. U.S. Geological Survey Open-File Report.
1976: Lundy, D.A., 1978, Hydrology and geochemistry of the Casper aquifer in the vicinity of Laramie, Wyoming. Univ. of Wyoming M.S. thesis.
1973, 1981 to present: City of Laramie

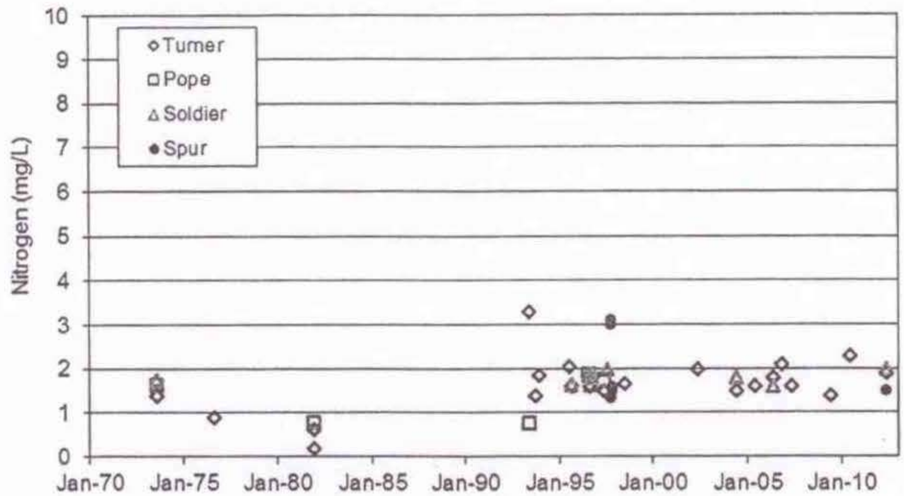

Figure 3. Nitrate or Nitrate+Nitrite as Nitrogen Concentrations at Municipal Wellfields

Confidence intervals were calculated for the mean concentration at each wellfield. Confidence intervals are indicators of the uncertainty in the mean value and provide a range of values within which the true mean is likely to fall. Wide confidence intervals often result from sample sets that are highly variable or too small and therefore do not provide a good representation of conditions. For the nitrate data sets from the City wellfields, the upper end of the confidence intervals (also called upper confidence limits, or UCLs) are of interest because they represent the values below which the true means are likely to fall.

The mean concentrations for all four City wellfields and the 95% UCLs for the mean concentrations for all except the Spur Wellfield are slightly less than 2.0 mg/L. The 95% UCL of 2.57 mg/L for the Spur Wellfields suggests potential impacts there. However, the small number of samples from the Spur wells and the standard deviation of about 41% of the mean nitrate concentration results in a very wide confidence interval and should be taken into account when interpreting the meaning of the UCL for the Spur Wellfield. Also, the two higher-concentration results were for the first sample collected from each of the two Spur wells, and the nitrate concentrations in all subsequent samples have been between 1.3 and 1.6 mg/L.

2.4 Nitrate Risk to Private Wells

In the summer and fall of 2009 the City of Laramie completed the first round of nitrate sampling from private wells located in the CAPA. Results from this sampling were published in *Report on the Summer/Fall 2009 Nitrate-Nitrogen Monitoring in the Casper Aquifer Protection Area* by the City of Laramie in February 2010. A second round of nitrate sampling was conducted in the spring of 2010, the results of which were published in over 115 private wells were sampled for nitrate in four geographic areas:

- East Grand
- Happy Jack
- Laramie South

- Roger Canyon

The Happy Jack, Laramie South and Rogers Canyon areas are similar in that they contain a low density of septic systems and residences remote from the City Limits. On the other hand, the East Grand area consists of several sub-divisions grouped into three clusters (refer to Figure 1) located near the City Limits:

- Cluster A: Bounded on the south by I-80, on the west by Vista Drive and on the northeast by Grand Avenue
- Cluster B: East of Sherman Hills Road, running north and south of Pilot Peak Road
- Cluster C: South and west of I-80, ending south of Sunset Drive.

Figures 4 and 5 present the results of the sampling for wells in the East Grand area and the Happy Jack, Laramie South and Rogers Canyon areas, respectively. Each figure presents the percentage of wells whose nitrate levels fall into the categories described in Table 1. It should be noted that, due to rounding, the percentage in each figure may not add up to 100%.

Laramie Plains

Sherman

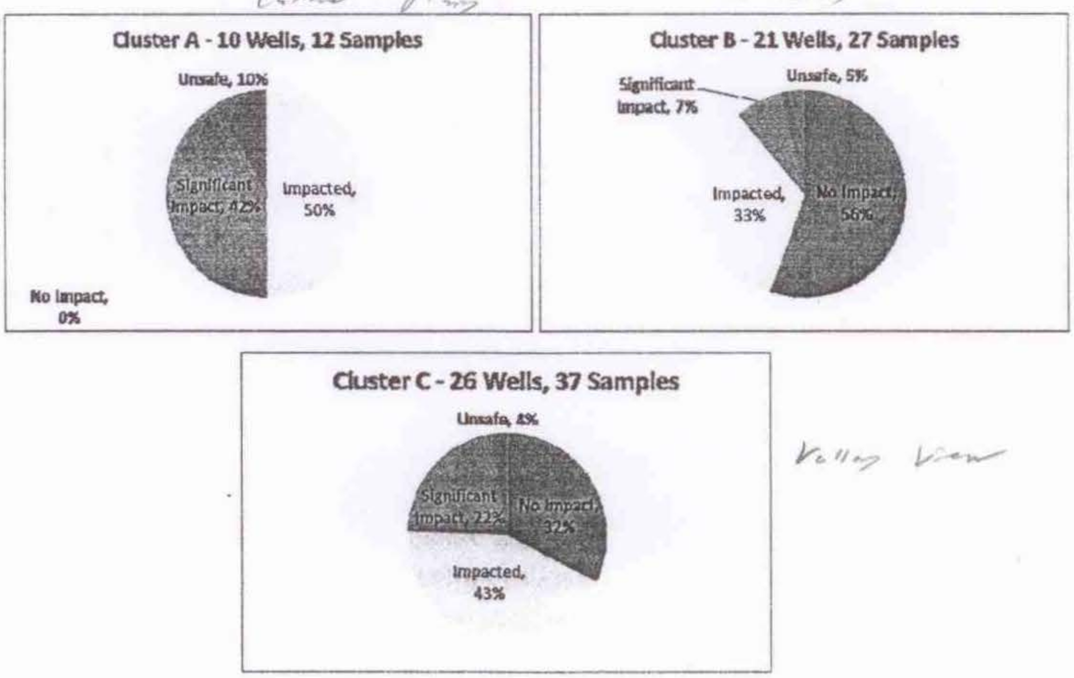

Figure 4. Impact of Nitrate on Private Well Water for Clusters A, B and C of the East Grand Area

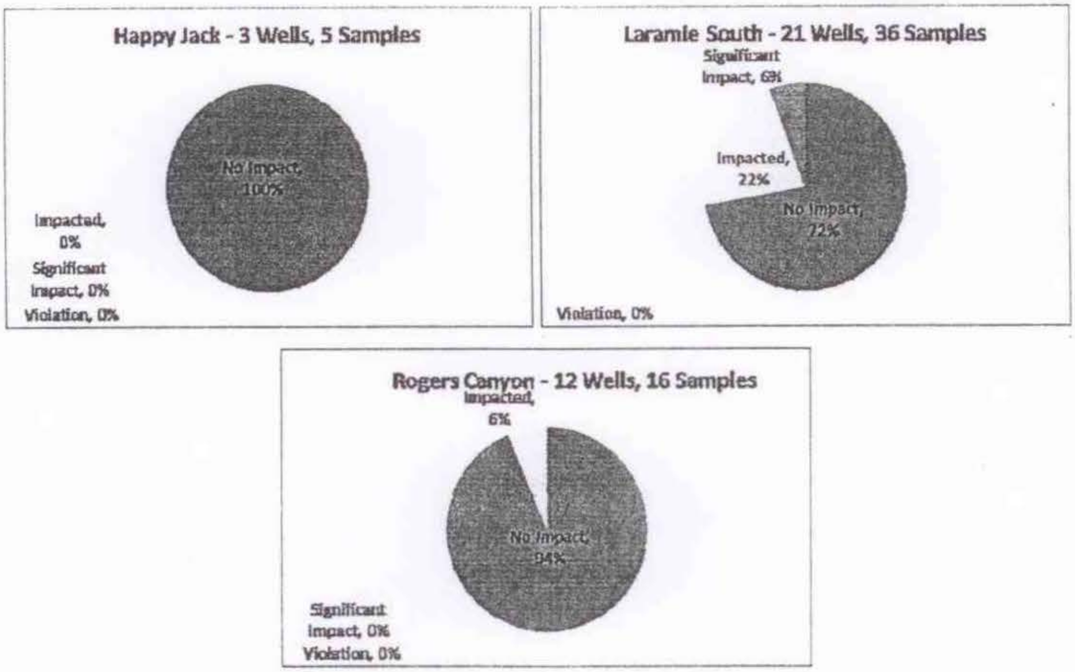

Figure 5. Impact of Nitrate on Private Well Water for Happy Jack, Laramie South and Rogers Canyon Areas

All wells sampled in Cluster A are impacted by nitrate. All Cluster A wells detected nitrate above a 2 mg/L background level and 50% of the wells contained nitrate concentrations greater than 5 mg/L. Cluster C wells are also strongly impacted by nitrate, with approximately 70% of the wells detecting nitrate above a 2 mg/L background level. Cluster B wells appear to be less impacted by nitrate, than Clusters A and C. Still, about one third of the sampled wells containing nitrate exceeded a 2 mg/L background level.

Wells sampled from the more remote and lower septic system density Happy Jack, Laramie South and Roger Canyon areas were much less impacted by nitrate than in the East Grand area. Wells in the Roger Canyon and Happy Jack areas show practically no impact from nitrate, while approximately 70 % of the wells in the Laramie South area detect nitrate below a 2 mg/L background level.

Table 3 compares nitrate levels in wells sampled in the East Grand area to the combined nitrate observations for the Happy Jack, Laramie South and Roger Canyon areas. As can be seen in the table, nitrate is consistently present at higher levels in the East Grand area than in the other areas. Five percent of the wells sampled in the East Grand area exceed the drinking water MCL. No wells sampled outside of the East Grand area exceed the drinking water MCL.

Table 3. Comparison of East Grand Private Well Nitrate Levels to Other Areas

Nitrate Impact Classification	Criteria (Nitrate as N)	East Grand	All Others
No Impact	< 2 mg/L	36%	81%
Impacted	2 to < 5 mg/L	41%	16%
Significant Impact	5 to < 10 mg/L	20%	4%
Violation of MCL	10 mg/L and greater	4%	0%

2.5 Groundwater Monitoring

Given the reality that nitrate impacts exist in the Casper Aquifer, and the value of groundwater supplies to both City and County residents, an expansion of groundwater monitoring is recommended. The following sections provide an initial discussion on this subject.

2.5.1 Monitoring Well Locations

- The City should locate and install a monitoring well network designed to be an early warning system for contamination arising from septic systems east of Laramie.
- For monitoring related to the Turner Wellfield, at least one well should be sited along or immediately south of the Quarry Fault and between ¼ and ½ mile east of the Turner wells. The well(s) should be installed and screened to depths of approximately 250 to 350 feet, similar to the Turner wells. Given the density of existing development near the City, this monitoring location would be the highest priority.
- For monitoring related to the Pope Wellfield, a monitoring well could be sited along the Pope Fault approximately 1/8 mile east of the wellfield. This well should be installed and screened to a total depth of approximately 150 feet.
- For monitoring related to the Soldier Wellfield, monitoring wells installed earlier, if still in existence, could likely be used. If the wells have been unused for a long period, some rehabilitation may be required. If the monitoring wells are no longer present, a well could be installed approximately 1/8 mile east of the site and to a depth of approximately 100 feet.
- For monitoring related to the Spur Wellfield, a monitoring well should be installed between the City wells and the existing residential development and to a depth of approximately 300 feet, similar to the existing City wells.

It may be possible for portions of this network to be co-designed with a network designed to provide early warning from Interstate Highway I-80 issues.

2.5.2 Monitoring Parameter

When drinking water wells and septic systems are in close physical proximity there is a risk of contamination of the well due to seepage from the septic system. Seepage is a potential risk to human health due to the possible contamination of the wells by pathogenic microorganisms present in septic systems as well as by nitrate which is formed by naturally occurring oxidation of ammonia in the effluent of septic systems.

The *Casper Aquifer Protection Area Monitoring Plan (FY2009-2010)* included a sampling plan designed to determine if there was evidence of contamination of drinking water wells by septic systems. The plan included testing wells for the following parameters:

- Alkalinity
- Chloride
- Nitrate
- pH
- Dissolved oxygen
- Temperature
- Conductivity
- Fecal Coliform (follow-up if contamination is suspected)

This sampling plan is sound and has the advantage of monitoring common and easily measured water quality parameters. However in areas where contamination wells by nitrate was observed, the City should consider targeted monitoring of these wells for other contaminants that could more strongly identify the source of contamination as septic systems. Table 4 provides a list of additional parameters the City could monitor and discusses their advantages and limitations.

Table 4. Additional Parameters Which Could be Monitored by a Targeted Sampling Program.

Parameter	Advantages and Limitations
Acetaminophen	Acetaminophen is a pain reliever commonly used by humans and found in wastewater. However it presence would not be unambiguous proof of contamination by septic systems since it is used as pain reliever for animals including horses.
Caffeine	Detection of caffeine in well water would be a strong indication of contamination from septic systems. However, since caffeine is somewhat biodegradable its absence is not proof that contamination does not exist.
Carbamazepine	Carbamazepine is an anticonvulsant drug used only by humans. It is persistent in the environment and is an accepted marker of wastewater contamination. Its detection unambiguously indicates contamination by septic systems. However the user of the septic system needs to be taking the drug for this to be useful parameter to monitor.
Coprostanol	Coprostanol is a form of cholesterol present in fecal material of higher animals. A particular form, 5□-corostanol is unique to humans. Its detection would unambiguously indicate contamination by septic systems. However its absence is not proof that contamination does not exist.
E coli	*E. coli* is a type of bacteria found in the intestines of mammals. The presence of *E. coli* is a widely accepted indication of fecal contamination. However, its presence can be caused by animals as well as humans.
Total Inorganic Nitrogen	This is the sum of ammonia, nitrite and nitrate. This parameter provides a more complete picture of contamination caused by nitrogen sources like septic systems. The presence of ammonia or nitrite in a well could indicate near direct connection between a septic system and a well.

2.6 Conclusions

Private drinking water wells in the East Grand area, particularly wells located in Clusters A and C, are at risk of contamination from nitrate originating from septic systems. Based on the initial round of nitrate sampling, approximately 65% of the East Grand area wells that were sampled show nitrate contamination, with 4% of the wells exceeding the drinking water MCL. Of the wells sampled in the other areas, approximately 20% show nitrate contamination.

Although the mean nitrate concentrations at all the wellfields still remain below the 2.0 mg/L threshold at which anthropogenic contamination is likely, the apparent increasing trends at the Turner and Soldier wellfields and the sporadic occurrences of concentrations of 2.0 mg/L or greater suggest possible impacts at all except the Pope Wellfield.

3.0 MITIGATION

This chapter presents project options that reduce the contamination risk that septic systems pose to the Casper Aquifer and City of Laramie wells. The options are discussed in terms of technical challenges, project capital costs, operating costs and effectiveness.

3.1 Improve Existing Septic Systems.

Typical septic tank and leach field systems are not effective at removing the nitrogen loading from the waste stream. In a USGS study (USGS 1) of leach field performance, the median dissolved nitrogen concentration was found to be 44 mg/l, from over 300 tests of 4 separate leach fields. Other information resources (Washington State Department of Health, 2005, EPA 1, 2, and USGS 1) support the idea that septic systems, while effective at removing some constituents, do not do a good job of removing nitrogen.

As requested by our contract scope of work, WWC was hired to evaluate minor or modest improvements to existing septic systems that could possibly be made as a means of reducing nitrate contamination risk. Thus the section heading of this report – Improve Existing Septic Systems.

WWC evaluated four mitigation options under this category, including:

- the use of septic system additives
- frequent septic tank pumping
- aeration system retrofits
- drain field replacements

WWC could not locate or assemble evidence to support the idea that these types of improvements would enhance nitrogen removal, thus reducing risk. Therefore, we have not prepared any conceptual designs or recommendations that pertain to modifying existing septic systems. And, while it may help with general septic system performance, regular inspection and maintenance will not provide a reliable and quantifiable nitrate impact risk reduction.

3.2 Holding Tanks

A simple solution, and one that could be implemented relatively easily, would be to convert the existing septic tanks to holding tanks, eliminating waste stream discharges to leach fields. Holding tanks would be equipped with level sensors alerting the homeowner (or sewer district) when pumping is needed. A sewer pump truck would evacuate the holding tanks periodically and delivering wastes to the City of Laramie wastewater treatment plant. This option would eliminate nitrates and other pollutants from entering the ground. The most significant drawback to this idea is the long term cost to pump and dispose the wastes. In addition, WDEQ technically does not permit holding tanks as a solution.

The construction cost estimates for converting 350 septic systems to holding tanks (in Study areas A, B and C only) is a modest $2,000,000 but when considering the costs associated with regular holding tank pumping for 30 years the cost estimate significantly increases to near $300,000,000.

3.3 Decentralized Waste Water Treatment System

A decentralized wastewater treatment system could be used to treat domestic wastewater. Decentralized means that some of the treatment (primary treatment) will occur at the homes and some will occur at a central location. The system evaluated for use under this study is an Orenco brand Advantex system. The system makes use of septic tanks at homes to pre-treat domestic wastewater, by settling solids. The septic tank effluent is then pumped to a central location for secondary treatment. Effluent pumping is arguably a more cost effective way than gravity sewers to collect wastewater at a central location. Secondary treatment, in the case of the Advantex system evaluated for this study, is achieved via a recirculating media filter. A recirculating media filter is conceptually similar to a recirculating sand filter. In the case of Advantex, the media is a synthetic fabric, upon which biological growth is maintained. It is the biological activity in the mat that treats wastewater. The system includes modular, pre-manufactured recirculating fabric media pods. Disposal of the treated liquid could possibly be to the surface or underground; onsite or at a remote location. This option would eliminate the leaching of septic system effluent at individual residences, thus reducing risk to City wells.

A project such as this is envisioned to require the formation of a local sewer district or other legal body, capable of obtaining financial assistance from various sources.

Figure 6 presents an overview schematic showing the wastewater collection system piping and a centralized treatment location. The location of the pipelines and the treatment system are conceptual and subject to modification should a project like this be implemented.

While there are alternative methods for treating water at the central location, WWC Engineering has recent and successful experience using the Advantex recirculating filter system. Appendix A presents some detailed drawings from a vendor of this system. As mentioned previously, treated effluent could possibly be disposed in the several manners, each having different permitting requirements.

- By underground disposal.

  This would require a UIC permit from WDEQ. Based on initial discussion with WDEQ staff, this disposal option seems less likely that a disposal permit through the WYPDES program.

- By surface discharge.

  Surface discharge would require a WYPDES permit. Effluent levels would be required to meet certain water quality standards, depending on the classification of the receiving water body. In the case of this project, disposal might even be to a dry drainage. BOD, TDS, TSS, Ammonia and pH would likely have to be tested and comply with certain limitations.

- To the City of Laramie WW collection system

PIPELINE SCHEDULE

	AREA A	AREA B	AREA C
TRUNKLINE (4")	16,000 FT	34,000 FT	29,000 FT
SERVICE LINE (2")	11,000 FT	24,000FT	16,000FT
2" TO 4" REDUCER	90	130	120
2" BALL VALVE	90	130	120

DESIGNED BY TJS	FIGURE 6 CONCEPTUAL DESIGN DECENTRALIZED WASTEWATER TREATMENT SYSTEM
DRAWN BY TJS/SDH	
CHECKED BY: MTS	EAST LARAMIE WASTEWATER FEASIBILITY STUDY LARAMIE, WY
DATE 10/12	WWC ENGINEERING

The City would have to determine if this is allowable.

A planning level total project cost estimate for this option is $13,000,000. (See Appendix A)

3.4 Sewage Collection and Treatment by City

A new sewage collection system could be developed to convey flows from the East Laramie area currently served by septic systems to the existing City's collection system. The existing Laramie WWTP would handle all of the treatment of the flow from the service expansion area.

Wastewater flow estimates have been established for the East Laramie area. The new sewer collection system expansion, existing collection system, and Laramie WWTP would need to have capacity to support this approach of handling sewage from the East Laramie homes. This section considers each of these capacity considerations including the East Laramie sewer collection extension and related existing infrastructure improvements.

Wastewater Flow Estimates

Average and peak wastewater flow estimates were established for the East Laramie area. A yearly average day sewer flow of 0.09 mgd and a peak hour sewer flow of 0.20 mgd sewer were calculated. Table 5 presents the calculations and related assumptions used in the calculations of the wastewater flow estimates for East Laramie.

Table 5. Wastewater Flow Estimate Calculations for East Laramie

Item	Value	Unit
# of Homes	350	
Daily Water Demand	101	gpcd
Single Family Home	2.44	people per home
Daily Water Demand per Home	246.44	gpd
Daily Sewer Flow Contribution	100%	
Daily Sewer Flow per Home	246.44	gpd
Average Sewer Flow	**86,254**	**gpd**
	0.086	**mgd**
Peaking Factor	2.3	
Peak Sewer Flow	**198,384**	**gpd**
	0.198	**mgd**

The assumptions used to develop the wastewater flow estimates as follows:

1. 350 Single Family homes are assumed for the existing East Laramie area, which are in clusters A, B, and C shown on Figure 1.
2. Residential sewer flows were calculated from daily average water demands (Source: City of Laramie Draft Standard for Subdivisions).
3. Peaking factor between average and peak flows is 2.3. (Source: City of Laramie Draft Standard for Subdivisions).
4. Due to the uncertainty of future development in this area, no buildout flow estimates were established.

Proposed East Laramie Wastewater Collection System

A new collection system will need to be constructed to provide service to the homes in East Laramie currently with septic systems. The system will consist of mainly gravity mains, however, one lift station and forcemain will be required to serve one area to the south. Potentially this area could be left out of the expansion, if desired, or developed later as a phased portion of the system.

With sizing for existing estimated flows from the area, the proposed collection system would consist of 8-inch and 10-inch gravity sewer pipe. The forcemain system could be sized as 4-inch. The proposed East Laramie collection system generally serves three subdivisions outside of the City Limits. Refer to Figure 7 for the preliminary layout of the new East Laramie collection system.

A conceptual planning level cost estimate for the proposed East Laramie wastewater collection system is $18,850,000. Refer to Appendix B for the detailed cost items and assumptions.

Existing Collection System Impacts

With the increased flow into the existing collection system from the East Laramie collection system expansion, there is the potential for capacity issues if the sewers downstream are

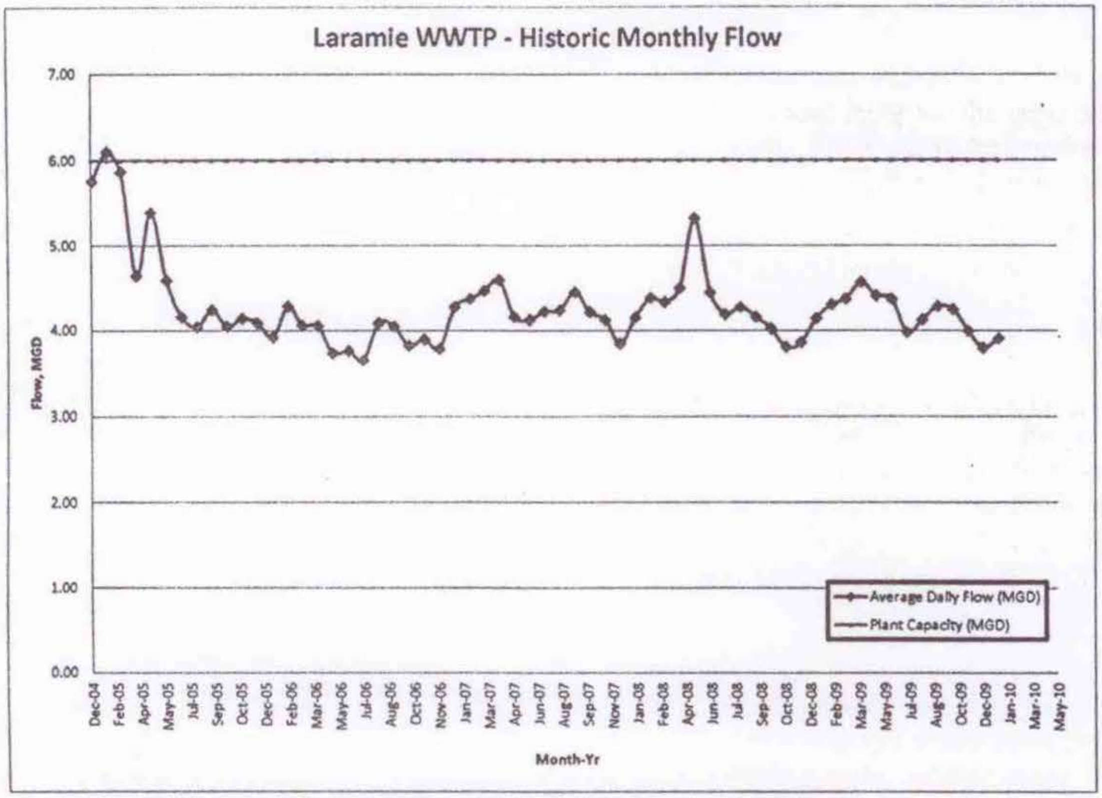

Figure 9. Historical Recorded Flow Data for the Laramie WWTP

The average anticipated flows from East Laramie will be 0.09 MGD, with a peak instantaneous flow anticipated to be 0.20 MGD. Based on the relatively stable average flows, at around 74% of the WWTP rated hydraulic capacity, the Laramie WWTP should be able to accommodate the East Laramie flows. A hydraulic analysis of the WWTP has not been conducted to determine that the plant can handle peak instantaneous or peak hourly flows and that this statement assumes that there are no known competing projects that would require capacity at the WWTP.

Through additional planning, if it is determined that the WWTP will need to be updated, a conceptual planning level cost metric to use would be \$8.00 - \$10.00 per gallon for construction costs. In other words, if there are adequate drivers to warrant an increase in capacity at the WWTP of around 0.2 MGD to accommodate the East Laramie flows a conceptual planning level cost for construction would be between \$1.6 - \$2.0 Million.

Table 7 - Project Financing Scenarios

Scenario	Number of Beneficiaries	Project	Capital Cost	Financed Ammount	Annual Payment	Annual O&M	Beneficiary cost/month
Funding by East of Laramie Residents only	350	Decentralized Treatment System	12,700,000	3,175,000	-661,458	-20,000	($162.25)
	350	Connection to City of Laramie WW System	24,750,000	6,187,500	-1,289,063	-20,000	($311.68)
Funding By County and City	8350	Decentralized Treatment System	12,700,000	3,175,000	-661,458	-20,000	($6.80)
	8350	Connection to City of Laramie WW System	24,750,000	6,187,500	-1,289,063	-20,000	($13.06)

Financing Assumptions and Notes

1 Grants or SPT at Construction = 75% of Project capital cost
2 CWSRF for 2.5% , 20 year loan on financed ammount

5.0 RECOMENDATIONS

1. The City should install at least three groundwater monitoring wells to provide groundwater quality data about the Caper Aquifer. Specific details on the location of these wells is provided in the body of the report. Consideration should be given to the possible location of similar wells that have been recommended by other projects (e.g. pending I-80 detention basin project).

2. Groundwater sampling tests should be performed to provide more information on the sources of groundwater nitrate impacts in the Casper Aquifer. The body of this report includes suggestions for tests that will (only if positive test result) provide conclusive evidence that groundwater impacts are the results of septic system effluent.

3. The City and County should jointly perform the more in depth planning and design work needed to implement one of the two solutions presented for mitigating the Casper Aquifer groundwater nitrate impacts.

   The first task should be to decide, through carefully performed public engagement, who the beneficiaries of risk mitigation will be. That decision will help determine what entity should take leadership in project financing and implementation. This task should be completed by the end of 2014. A schedule for subsequent planning and design tasks should be prepared at that time.