Washoe County Community Services Department

Spanish Springs Sanitary Sewer Collection System

Facility Plan

July 2016

Prepared by:

FARR WEST
ENGINEERING

CONTENTS

WASHOE COUNTY COMMUNITY SERVICES DEPARTMENT

SPANISH SPRINGS SANITARY SEWER COLLECTION SYSTEM FACILITY PLAN SUMMARY MEMORANDUM

EXECUTIVE SUMMARY

Tables – Executive Summary

Figures – Executive Summary

TM NO. 1 EXISTING AND FUTURE SEWER FLOWS AND MODEL DEVELOPMENT

Tables – TM No. 1

Figures – TM No. 1

Appendices – TM No. 1

TM NO.2 ALTERNATIVES EVALUATION AND PREFERRED PROJECT

Tables – TM No. 2

Figures – TM No. 2

Appendices – TM No. 2

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EXECUTIVE SUMMARY

WASHOE COUNTY COMMUNITY SERVICES DEPARTMENT

SPANISH SPRINGS SANITARY SEWER COLLECTION SYSTEM FACILITY PLAN

Prepared For: Alan Jones, P.E., Senior Licensed Engineer

Prepared By: Lucas Tipton, P.E.

Review By: Brent Farr, P.E.

Date: July 19, 2016

Subject: **Executive Summary**

ES.1 PURPOSE

The Summary Memorandum is the final component of the Washoe County Community Services Department's (County) Spanish Springs Sanitary Sewer Collection System (System) Facility Plan. The Summary Memorandum is made up of two technical memorandums (TMs). These TMs assess existing system capacity, estimate additional wastewater flow created by future development, develop and evaluate infrastructure improvement alternatives, and recommend a preferred project alternative. The TMs include:

- TM No. 1 - Existing and Future Sewer Flows and Model Development
- TM No. 2 - Alternatives Evaluation & Preferred Project

The purpose of TM No. 1 is to evaluate existing and future sewer flows and discuss the development of the collection system hydraulic model. The document incorporates regional land use studies, a previous planning study regarding the conversion of parcels with on-site septic systems to the County maintained System, and hydraulic modeling analysis to provide a basis of understanding upon which improvement project alternatives will be developed. The dual planning horizon for this document is 20 years, or the year 2035, and at the eventual build-out of all unimproved land within Washoe County's current Truckee Meadows Service Area (TMSA) boundary in the Spanish Springs Valley.

The purpose of TM No. 2 is to develop infrastructure improvement alternatives which provide excess capacity in the System in response to increased sewer flows as a result of future development in the Spanish Springs Valley and to recommend a preferred project. The document provides an evaluation of infrastructure improvement alternatives which includes both non-economic and economic components. The non-economic analysis compares the various project alternatives against a diverse set of criteria and subcriteria, and the economic analysis includes planning level cost estimates for each improvement alternative. The most preferred alternative is detailed further as a recommended preferred project.

ES.2 TM NO. 1 - EXISTING AND FUTURE SEWER FLOWS AND MODEL DEVELOPMENT

TM No. 1 combined the sewer flows from existing sewer customers, as of 2015, with flows added by future development and septic to sewer projects. These values are listed in Table ES-1. The Buildout flow scenario represents the development of all 2,500 acres of currently unimproved land in the Spanish Springs Valley. The Buildout + Septic flow scenario represents the Buildout scenario plus sewer flows after all nine phases of the septic to sewer conversion projects are completed. The Buildout + Septic condition represents the maximum potential flow for the System. A third flow scenario using interim growth projections was created to estimate a 20 year flow condition in the year 2035.

In this facility plan, all System capacity evaluations shall be determined on an Equivalent Residential Unit (ERU) basis with an average daily flow of 270 gallons per day (gpd) per ERU. This document normalizes all non-residential connections to the ERU basis for consistency. Buildout and interim growth projection data was provided by the Truckee Meadows Regional Planning Agency (TMRPA).

Table ES-1 –Sewer Flows and ERU Count

Scenario	Average Flow (gpd)	Incremental ERU Count	Total ERU Count
Existing	684,200	4,175	4,175
Buildout	1,568,800	3,303	7,478
Buildout + Septic	2,038,350	1,782	9,260
2035	1,300,200	2,390	6,565*

* Because the 2035 flow scenario will occur prior to Buildout, the Total ERU Count for this flow scenario is calculated by adding the Existing ERU Total to the 2035 Incremental ERU Count only.

Existing System capacity was assessed against a pipe surcharge criterion, a manhole surcharge criterion, and a lift station operational guidance document. TM No. 1 found that the System currently meets the criteria for existing flows with an additional 517 ERUs of capacity remaining. Existing system capacity is anticipated to be exceeded in the year 2025 per current planning estimates.

TM No. 1 also provides a discussion of the City of Sparks (Sparks) *Interlocal Agreement to Provide Sanitary Sewer Service in Spanish Springs Valley* (Agreement) at the existing, Buildout, and Buildout + Septic flow conditions. The Agreement stipulates that Sparks shall reserve 8,495

ERUs of capacity in their sewer interceptors and at Truckee Meadows Water Reclamation Facility for the County's customers in Spanish Springs Valley. The only flow scenario in which the reserved capacity will be exceeded is the Buildout + Septic flow condition by approximately 765 ERU's.

The System was constructed between 1995 and 2008 and does not currently experience any infiltration or inflow from high groundwater or from storm events. Study of flow monitoring data indicates a System average daily flow peaking factor of 2 for peak hour dry weather flows. Table ES-2 provides a summary of System infrastructure for all interceptors 10 inches or greater in diameter.

Table ES-2 – System Assets

Item	Unit	Quantity
10 Inch Pipe	Linear Feet	25,532
12 Inch Pipe	Linear Feet	7,420
15 Inch Pipe	Linear Feet	11,861
18 Inch Pipe	Linear Feet	5,610
Manholes	Each	167
Pebble Creek Lift Station	Each	1

A hydraulic model of the System including all flow scenarios was built using InfoSWMM® by Innovyze®. A digital copy of the model is included with this memorandum for use by the County.

ES.3 TM NO. 2 – ALTERNATIVES EVALUATION AND PREFERRED PROJECT

Using the flow estimates generated in TM No. 1, this memorandum assessed System capacity at the Buildout and the Buildout + Septic flow scenarios. The pipe capacity criterion was exceeded in the southern region of the System during both future flow conditions. Three infrastructure improvement alternatives were developed which increased System capacity to an acceptable standard as determined by the County. These improvement alternatives were evaluated using a non-economic and economic analysis. The non-economic evaluation included a matrix comparison of the following seven criteria:

1. Right of Way Requirements
2. Constructability
3. Capacity Criteria
4. Design Criteria
5. Permitting
6. Operations and Maintenance
7. Timing of Improvements

Table ES-3 provides a summary of the evaluation results as well as the planning level cost estimates for each alternative. A figure detailing improvement alternative project 1 is attached to this summary, while figures for the other two projects are shown on Figures 3 and 4 in TM No. 2.

Table ES-3 – Alternative Project Evaluation Results

Alternative	Rank	Score	Construction Cost Estimate ($)
Project 1	1	86.3	568,440
Project 2	2	82.2	828,186
Project 3	3	81.4	858,046

This Facility Plan has concluded that a single improvement project will be required to collect, pump and convey wastewater flows for the Buildout flow condition (7,478 ERUs) in the Spanish Springs service area. Project 1 has been recommended as the most preferred project.

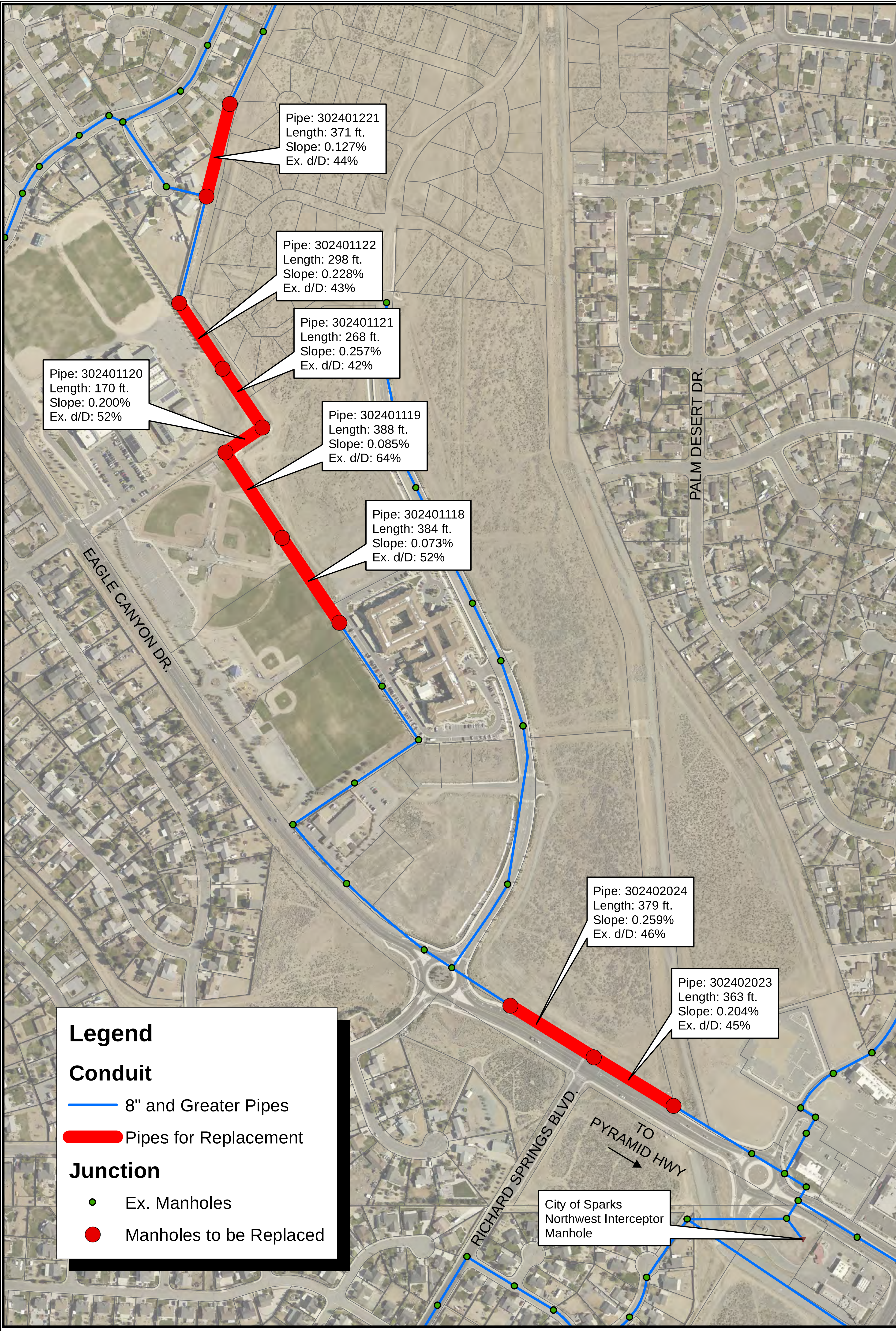

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Figure 2 - Project 1: Meets Buildout Flow Condition

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TECHNICAL MEMORANDUM #1

WASHOE COUNTY COMMUNITY SERVICES DEPARTMENT

SPANISH SPRINGS SANITARY SEWER COLLECTION SYSTEM FACILITY PLAN

Prepared For: Alan Jones, P.E., Senior Licensed Engineer

Prepared By: Lucas Tipton, P.E.

Review By: David Hunt, P.E.

Date: July 19, 2016

Subject: **Technical Memorandum No. 1 – Existing and Future Sewer Flows and Model Development**

1.0 PURPOSE

The Washoe County Community Services Department (County) operates and maintains the Spanish Springs wastewater collection system (System) that services the Spanish Springs Valley in northern Nevada, an area of approximately 7,400 acres. A hydraulic model of the System was built in InfoSWMM® by Innovyze® and was used to assess the System at an existing condition as well as at four future stages of potential development. The first stage is after 2,500 acres of vacant land is developed and shall be referred to as the Buildout flow condition. The second stage is after all nine phases of the septic to sewer conversion projects are completed and connected to the existing collection system; this shall be referred to as the Buildout + Septic flow condition. The Buildout + Septic condition represents the maximum potential flow for the System. The third condition used projected growth estimates to develop a 20 year flow scenario in the year 2035, and shall be referred to as the 2035 flow scenario. And lastly a flow scenario was developed at the year when remaining existing system capacity is expected to be exceeded.

The purpose of this memorandum is to evaluate existing and future sewer flows and discuss the development of the collection system hydraulic model for the System. This document will provide a basis of understanding upon which improvement project alternatives and eventually a capital improvement plan will be developed. This memorandum includes:

- An evaluation of existing sanitary flows;
- A statement of the planning criteria used to estimate future sewer flows;
- An estimate of interim and buildout sewer flows;
- A description of processes used to incorporate Truckee Meadows Regional Planning Agency (TMRPA) land use studies into future sewer flow projections;
- An estimate of the flow contribution from parcels with on-site septic systems, and
- A discussion on the development of the hydraulic model.

2.0 EXISTING AND FUTURE SEWER FLOWS

2.1 EXISTING LAND USE AND ZONING

In total, there are approximately 5,300 parcels which have been previously developed in the Spanish Springs Valley. This collection is primarily made up of low to medium density suburban uses that include structures currently connected to the System as well as parcels with on-site septic systems. Figure 1 provides a summary of developed, vacant and unbuildable land and Figure 2 provides a graphical depiction of the exiting land use zoning in the Spanish Springs Valley.

Areas identified as “unbuildable” on the figures are whole parcels which have been previously classified as such by TMRPA or Washoe County. These parcels either have development constraints or contain assets such as roads, common areas or storm detention facilities which do not allow for future improvement. Areas labeled “DCA” are the actual limits of development constraints such as wetlands or areas containing slopes greater than 30%.

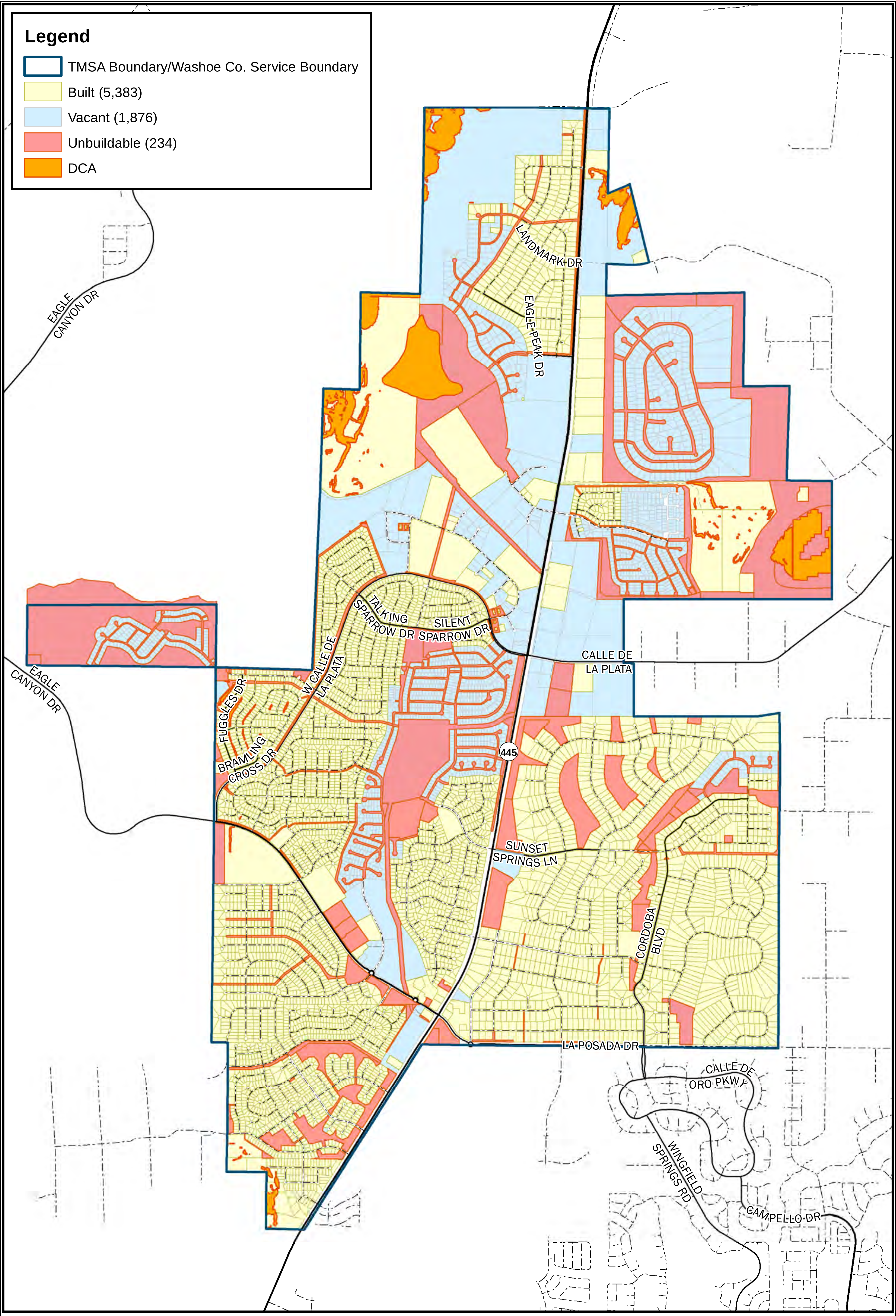

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Figure 1 - Built, Vacant and Undevelopable Parcels

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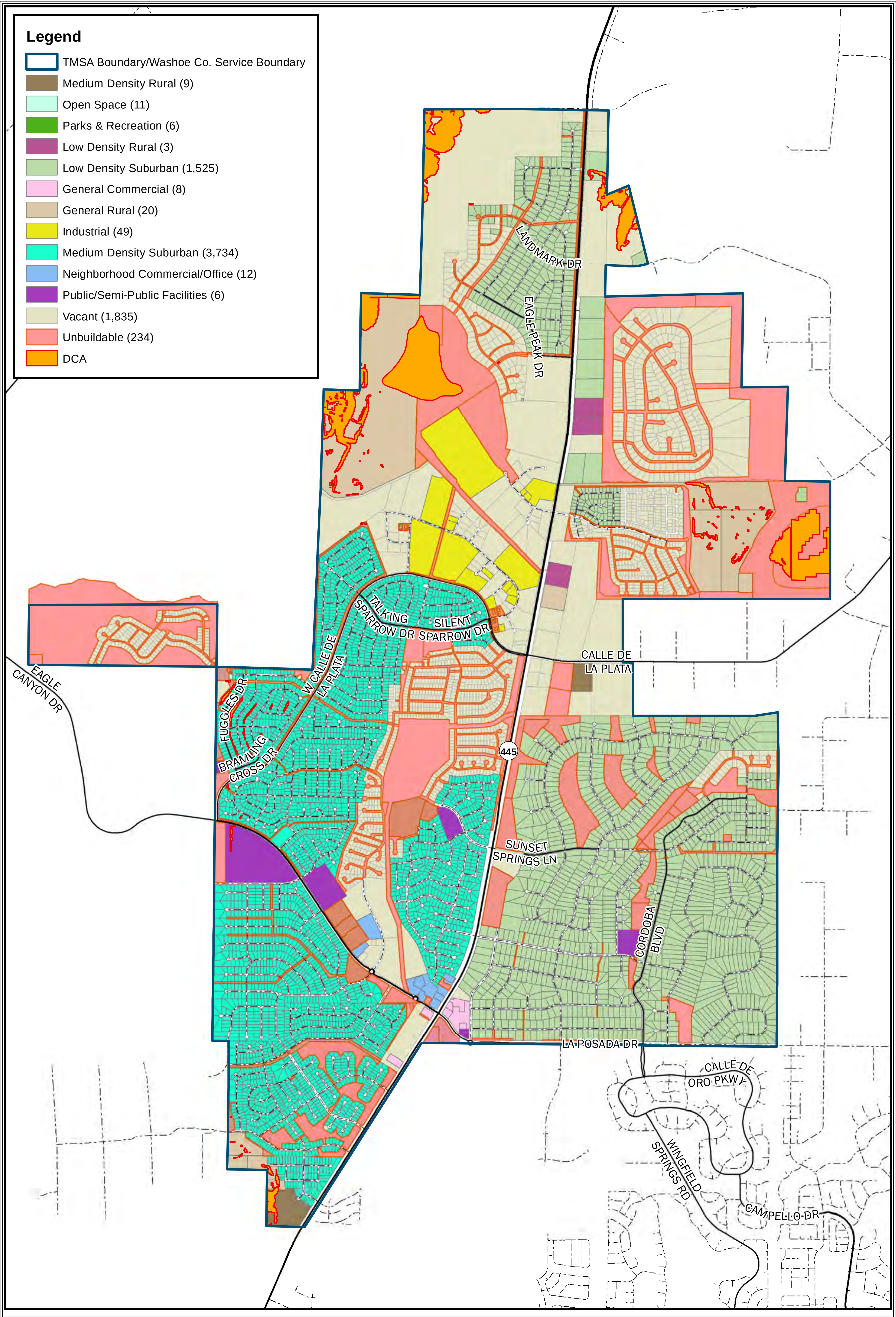

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Figure 2 - Existing Zoning

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2.2 EXISTING AND HISTORIC SEWER FLOWS

In the winter of 2011 the County conducted a flow study, which consisted of 30-days of flow monitoring at 8 different locations in the System (Spanish Springs Valley Sewer Collection System Flow Monitoring, CH2MHILL, June 7, 2011). The monitoring results characterized dry weather flows for 7 individual sub-areas, with the meter data at a single location being deemed unsuitable for analysis. Figure 3 provides a map of the existing System with the flow monitoring manholes indicated. The flow monitoring results were used to develop sub-area diurnal curves and to calibrate the hydraulic model for system capacity assessment on an average day dry weather flow (ADWF) basis.

County staff used this data, potable water consumptive use data, and wastewater generation rates to assess the ADWFs for the System. The County found that the average day metered sewer flow data more closely matched the average daily consumptive use of potable water in the area for the time period of January through March in 2011. The existing condition model wastewater flow totals were developed on a consumptive use basis.

The existing ADWF flows were applied to 89 manholes across the system and resulted in the City of Sparks Interceptor totals listed in Table 1. These manholes as well as the City of Sparks Interceptors are shown on Figure 3 as well. The existing system flow total was found to be 684,200 gallons per day (gpd).

Table 1 – Existing Sewer Loading and Flows

City of Sparks Interceptor	Average Flow (gpd)	Peak Flow (gpd)
Northwest	633,000	1,290,240
Northeast	51,200	212,216

As of October 2015, County records indicate 3,444 residential and 70 commercial customers connected to the System. Per the 2005, *Interlocal Agreement to Provide Sanitary Sewer Service in Spanish Springs Valley* between the City of Sparks and Washoe County, all connection fees and system reserve capacity shall be made on an Equivalent Residential Unit (ERU) basis with an average daily flow of 270 gallons per day (gpd) per ERU. This document will maintain this convention and will convert all non-residential connections to an ERU basis for consistency. Table 2 provides a breakdown of existing customers as well as an estimate of the existing ERU count.

Table 2 – Existing Spanish Springs Sewer Customers

Connection Type	# of Connections	# of ERUs
Residential	3,444	3,444
Commercial*	70	731
Total	3,514	4,175

* 70 commercial connections are comprised of 144 acres of property zoned commercial and 187 acres of property zoned industrial.

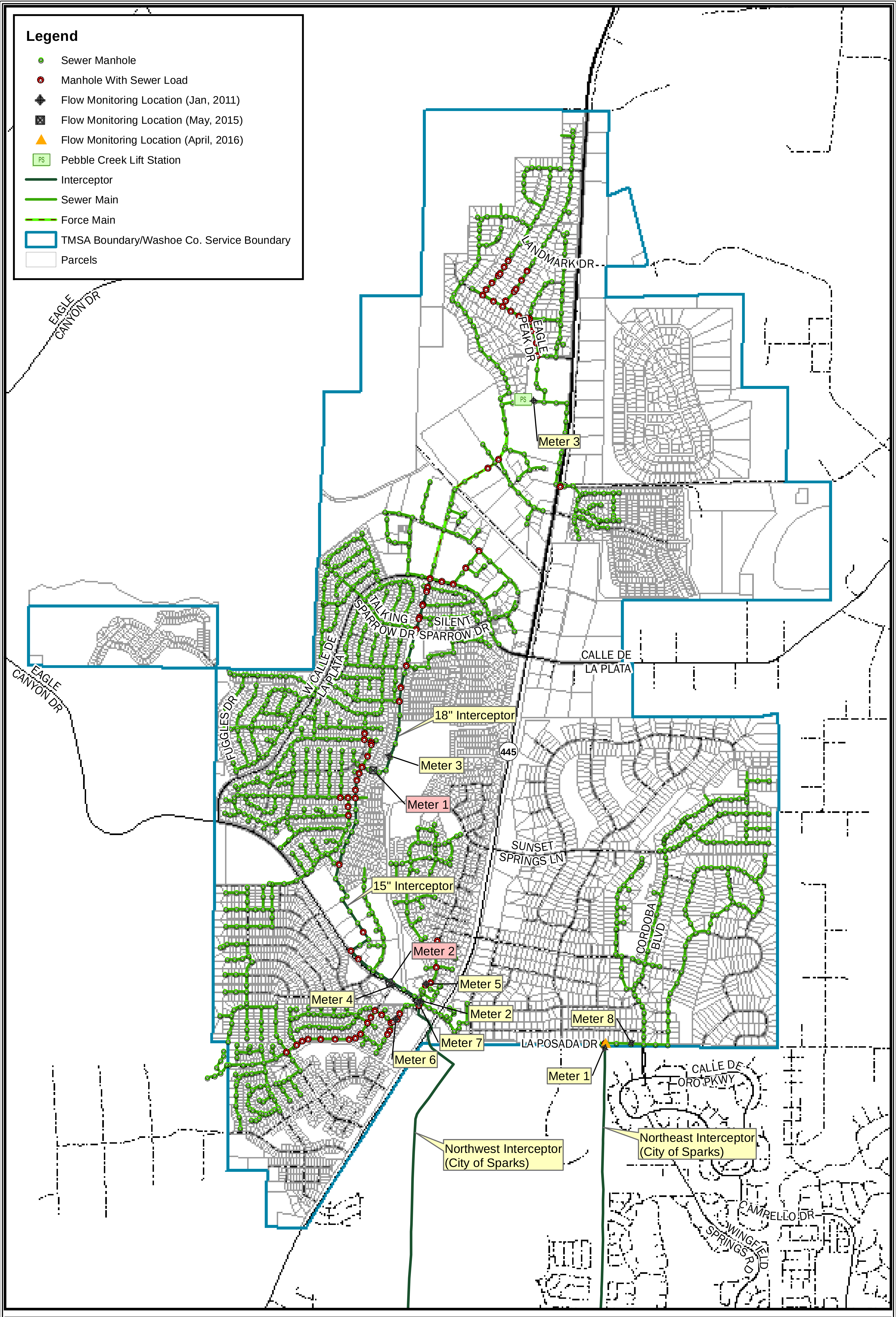

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Figure 3 - Spanish Springs Sewer Collection System

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2.3 EXISTING SYSTEM CAPACITY

The performance of the System was assessed against three discrete criteria:

1. The maximum depth of flow in System pipes or conduits was assessed against the overall diameter of the pipe. The depth to diameter ratio can be abbreviated as d/D, and the maximum allowable value was set at 0.8 or 80%. This value is equivalent to Washoe County Engineering Design Standard 2.1.02.04. Pipes with a d/D ratio exceeding 80% shall be considered to be “surcharged” pipes and in exceedance of their capacity.

2. Inside of manholes it is common for the surface elevation of the sewer flow to exceed the connected top of pipe elevations during events of high flow. Flow surface elevations which exceed a set distance from the ground surface or rim elevation of the manhole is a metric used to measure the “surcharging” of a manhole. The County has set the manhole surcharging limit at 0.0’ or rather any manhole which does not “spill” sewer flows onto the ground surface is not considered to be surcharged.

3. The number of times a lift station pump turns on and off in an hour is an operational guidance set forth by the Nevada Division of Environmental Protection (NDEP) Technical Document WTS-14. The document recommends a minimum of 10 minutes between successive starts per hour, which is approximately equivalent to less than 6 starts per hour.

An evaluation of the existing flow condition model results reveals that there are not any areas of the System which are over capacity. However, an area of the System which will exceed the capacity criteria as a result of future development is the southern portion of the 15 inch interceptor between Shaw Middle School and the intersection of Eagle Canyon Dr. and Pyramid Highway. This is supported by depth to diameter (d/D) ratios for these pipes exceeding 80% in the Buildout and Buildout + Septic flow scenarios. Table 3 provides a summary of the remaining capacity for the 21 pipes along this section of the existing interceptor.

Table 3 – Remaining Capacity of Pipes in Critical Section

Pipe ID	Remaining Capacity (ERUs)
302401222	3,165
302401221	1,413
302401123	2,514
302401122	2,178
302401121	2,429
302401120	1,935
302401119	671
302401118	517
302402029	2,518
302402028	2,376
302402027	6,556
302401097	2,323
302401096	1,828
302402026	2,960
302402025	1,934
302402207	3,002
302402024	2,256
302402023	1,852
302402022	3,752
302402021	3,767
302402174	1,565

*Pipes are listed in order from North to South

The available capacity shown in Figure 4 is expressed in terms of ERUs to provide a normalized unit of wastewater generation. For instance, if a commercial building or parcel is found to generate 4,000 gpd than that connection would be equivalent to 15 ERUs. The remaining capacity value for each pipe was derived by taking the difference between the 80% full flow estimate and the maximum existing flow for each pipe, dividing the difference by a peaking factor of 2.0, and finally dividing resultant by 270 gpd per ERU. The development of the peaking factor is discussed in detail in Section 3.1.1.

These results indicate that the existing System has the capacity to serve peak wastewater flows for up to 517 additional ERUs in the future. However, the location of new development in the Spanish Springs Valley plays a significant role as to when the System exceeds its capacity. For example, the addition of 1,000 ERUs in the northern half of the System will have less impact than 1,000 ERUs in the western or southern reaches of the System. And finally, the addition of 1,000 ERUs in the southeast portion of the System will not impact the existing system capacity bottleneck in any way.

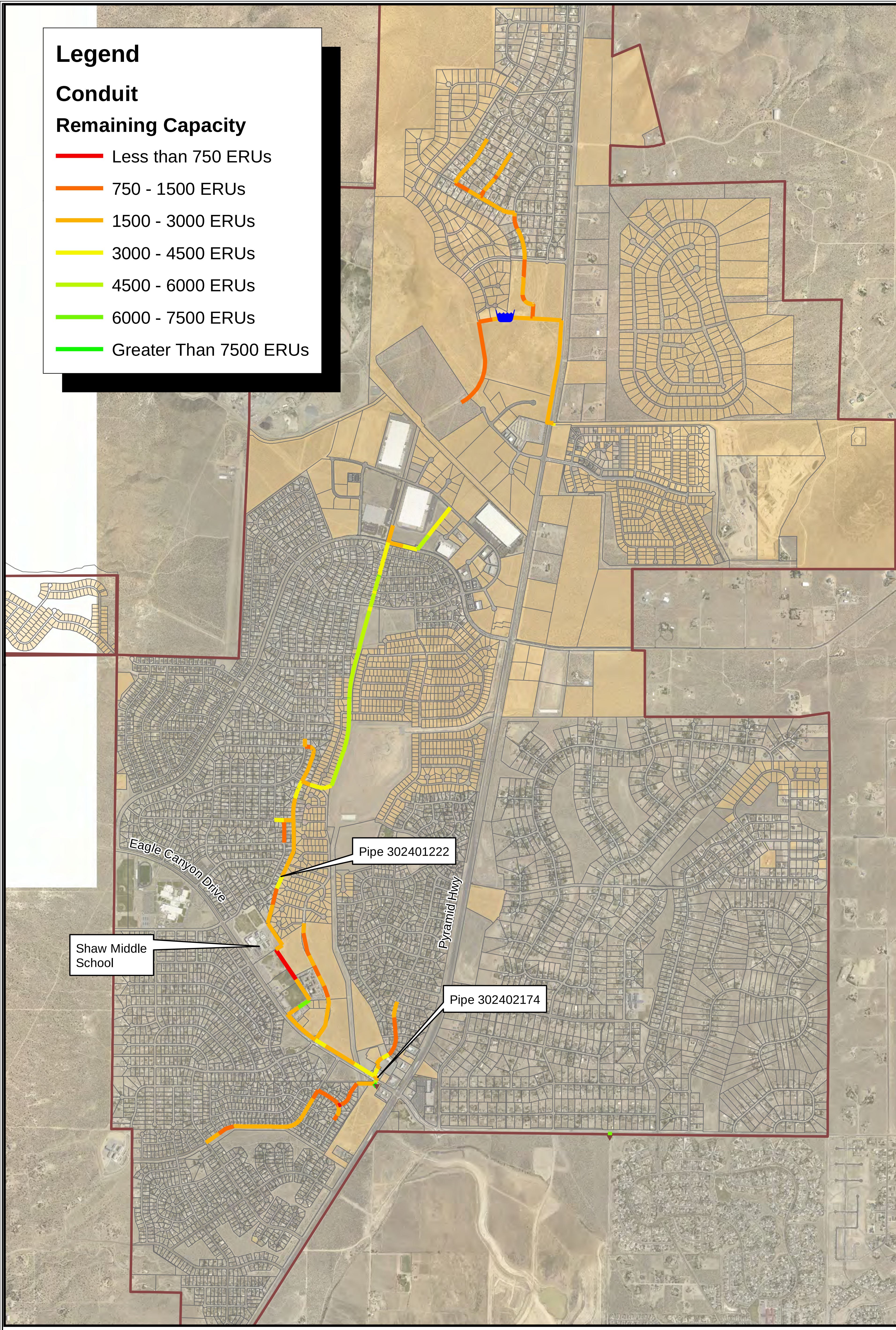

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Figure 4 - Existing System Capacity

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2.4 FUTURE WASTEWATER FLOW SUMMARY

Based on existing customer data and future wastewater flow projections, the System has a maximum potential flow total of 2,038,350 gpd for an estimated ERU total of 9,260. Tables 4 and 5 provide a complete accounting for both of these estimates. All values in Table 5 include existing flow totals in addition to the named flow condition total. Sections 2.8 through 2.9 detail the methodology used to estimate the Buildout and Buildout + Septic flow totals provided in Tables 4 and 5.

Table 4 – Maximum Potential Connection Summary

Connection Type	# of Connections	# of ERUs
Existing Residential	3,444	3,444
Existing Commercial + Industrial	70	731
		Existing Total = 4,175
Buildout Residential	2,369	2,369
Buildout Commercial + Industrial	82	934
		Buildout Total = 3,303
		Existing + Buildout Subtotal = 7,478
Septic Residential	1,782	1,782
Existing + Buildout + Septic Total	**7,747**	**9,260**

Table 5 – Sewer Flow Summary

Interceptor	Existing Flow (gpd)	Buildout* (gpd)	Buildout + Septic* (gpd)
Northwest	633,000	1,504,000	1,762,000
Northeast	51,200	64,800	276,350
Total	684,200	1,568,800	2,038,350

*The values listed for Buildout and Buildout + Septic were taken from hydraulic model results and are within an acceptable tolerance (less than 1%) of theoretical totals.

2.5 GROWTH PROJECTIONS

In January of 2016, TMRPA provided data from a regional Housing Study which projects the demand for new housing in the Truckee Meadows region on an annual basis until the year 2035. The study found that the entire Truckee Meadows region will generate approximately 50,000 new housing units over the next 20 years and that the Spanish Springs Valley will account for 1,714 of these units. The data included 1,681 vacant parcels zoned for residential uses, with 1,614 of them projected to be developed by 2035. The projected ERU count for these 1,614 objects is 1,714 ERUs or 462,510 gpd. Previously presented in Table 4, the residential Buildout total for the System is approximately 2,369 ERUs. Therefore TMRPA projects that 72% of future residential connections will be developed by 2035 in the Spanish Springs Valley. A complete description of the study by TMRPA can be found in Appendix A.

Because TMRPA data did not include study of vacant land zoned for commercial or industrial uses, Farr West applied the same 72% interim buildout ratio to commercial and industrial parcels. As of 2016, the number of vacant parcels was 19 and 61 for commercial and industrial uses, respectively. Since the estimated Buildout total for commercial and industrial connection is 934 ERUs, the anticipated 2035 total becomes 72% of that value or 676 ERUs. Table 6 provides a breakdown of future residential and commercial connections on an annual basis.

Table 6 – Annual Development Projections

Year	Residential ERUs	Commercial / Industrial ERUs	Total ERUs	Running Total ERUs
2016	77	60	137	137
2017	76	12	88	225
2018	78	27	105	330
2019	78	42	120	450
2020	80	25	106	556
2021	79	43	123	679
2022	82	28	110	789
2023	83	31	114	903
2024	83	37	120	1,024
2025	86	25	111	1,135
2026	86	32	118	1,252
2027	86	41	127	1,380
2028	88	50	138	1,518
2029	90	17	107	1,625
2030	90	37	127	1,752
2031	92	30	122	1,874
2032	93	21	114	1,988
2033	98	66	164	2,152
2034	91	21	112	2,264
2035	97	29	126	2,390
Total	**1,714**	**676**	**2,390**	**-**

Since the remaining capacity of Pipe 302401118 is 517 ERUs, it is probable to assume that the remaining capacity in the pipe will be exceed by 2020. However, after a more complete review of where in the System these connections will be added, the anticipated year of exceedance will actually occur around 2025.

2.6 UNIT WASTEWATER GENERATION RATES

Wastewater generation rates sorted by land use are shown in Table 7. These rates were applied to all future unimproved parcels based on land use and parcel size (if applicable) as well as to existing septic users to estimate future wastewater flow.

Table 7 – Wastewater Generation Rates by Land Use Type

Land Usage Type	Wastewater Generation Rate
Single Family Units (1 ERU)	270 Gallons/Day
Parks and Open Space	664 Gallons/Day/Acre
General Commercial	780 Gallons/Day/Acre
General Industrial	457 Gallons/Day/Acre
Minor Improvements	780 Gallons/Day/Acre

For vacant parcels which did not have a land use listed in Table 7, the zoning designation and zoning density rate was used to estimate future sewer flows. An ERU estimate was developed by multiplying the aerial extents of a parcel (acre) by the appropriate zoning density found in Table 8. The ERU estimate was then multiplied by 270 gpd to produce a daily wastewater total.

Table 8 – Washoe County Zoning Density

Code	Name/Description	Dwelling Units per Acre (DU/AC)
LDR	Low Density Rural	0.1
MDR	Medium Density Rural	0.2
HDR	High Density Rural	not-designated
LDS	Low Density Suburban	1
MDS	Medium Density Suburban	3
HDS	High Density Suburban	7
LDU	Low Density Urban	10
MDU	Medium Density Urban	21
HDU	High Density Urban	41
GC	General Commercial	n/a
NC	Neighborhood Commercial/Office	n/a
TC	Tourist Commercial	n/a
I	Industrial	n/a
PSP	Public/Semi-Public Facilities	n/a
PR	Parks and Recreation	n/a
GR	General Rural	0.025
GRR	General Rural Residential	0.025
SP	Specific Plan	n/a
OS	Open Space	n/a
NOLU	No Land Use	n/a

2.7 FUTURE DEVELOPMENT

In total, there are approximately 1,800 parcels or 2,500 acres of buildable, vacant land in the Spanish Springs Valley. This collection of future developable land is primarily made up of low to medium density suburban uses with a small component of parcels zoned commercial or industrial.

In order to estimate the buildout condition of all vacant lots in the Spanish Springs Valley, Farr West incorporated the *parcelfabric* geodatabase created by TMRPA during a 2015 land use study. This database includes analysis of previously approved tentative maps and land use assumptions made by both TMRPA and Farr West. Figure 5 shows the zoning designations found in the database for all vacant land. Section 2.8.1 will provide an in depth discussion of the incorporation of the TMRPA data into the hydraulic model.

2.8 BUILDOUT SEWER FLOWS

Existing average day flows combined with the future development of vacant land results in a projected buildout sewer flow of 1,576,200 gpd or 7,478 ERUs. According to the current buildout plan, future development will contribute approximately 892,000 gpd of wastewater to the existing collection system. Table 9 provides a summary by land use of future sewer flows associated with the buildout of vacant parcels only. Calculations supporting this information can be found in Appendix B.

Table 9 – Buildout Sewer Flow Projections

Land Use	# of ERUs	# of Acres	Wastewater Generation Rate	Average Daily Flow (gpd)
Single Family Units	2,369	-	270	640,000
Parks and Open Space	-	24	664	16,000
General Commercial	-	93	780	72,000
General Industrial	-	360	457	164,000
Minor Improvements	-	-	780	-
			Total	892,000

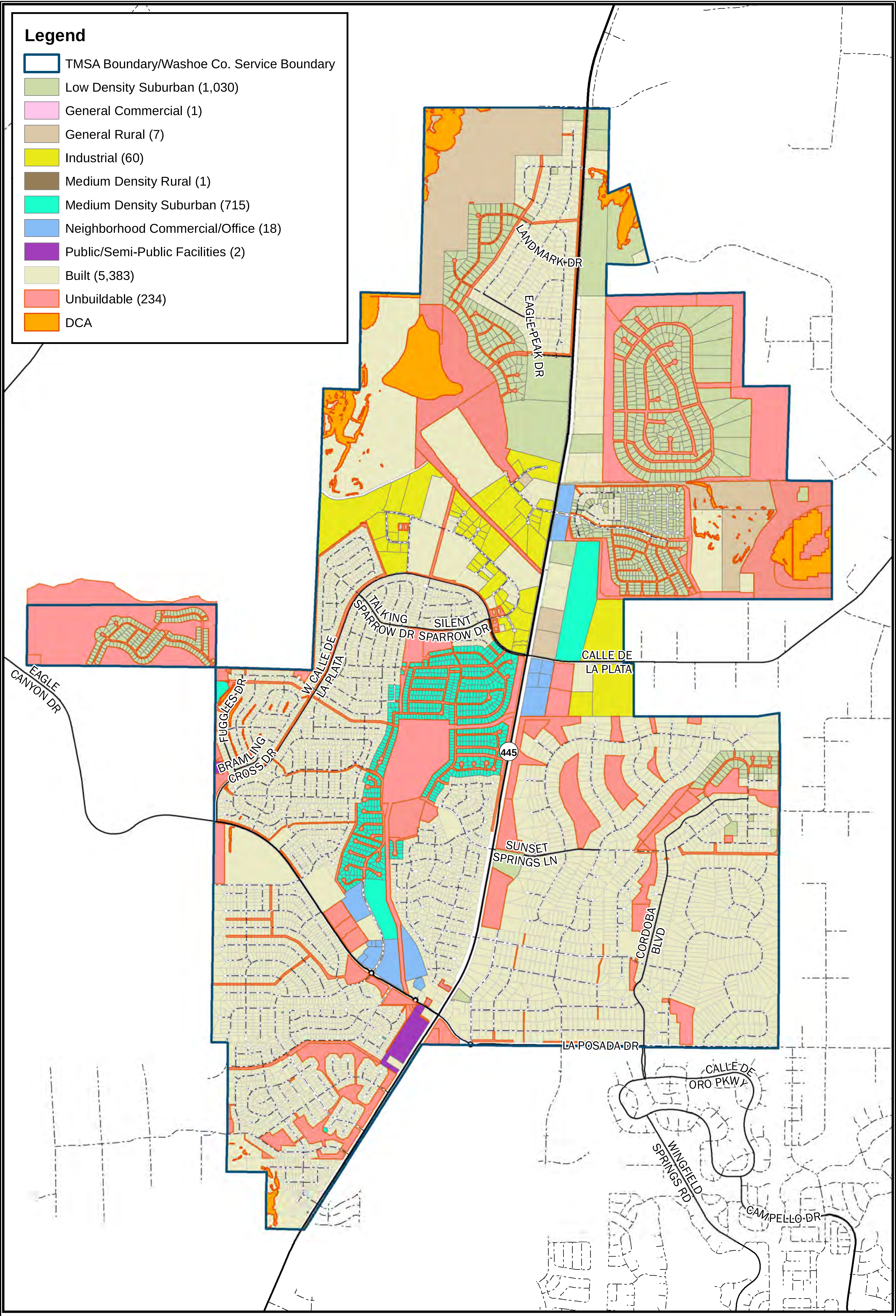

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Figure 5 - Approved Zoning for Unimproved Land

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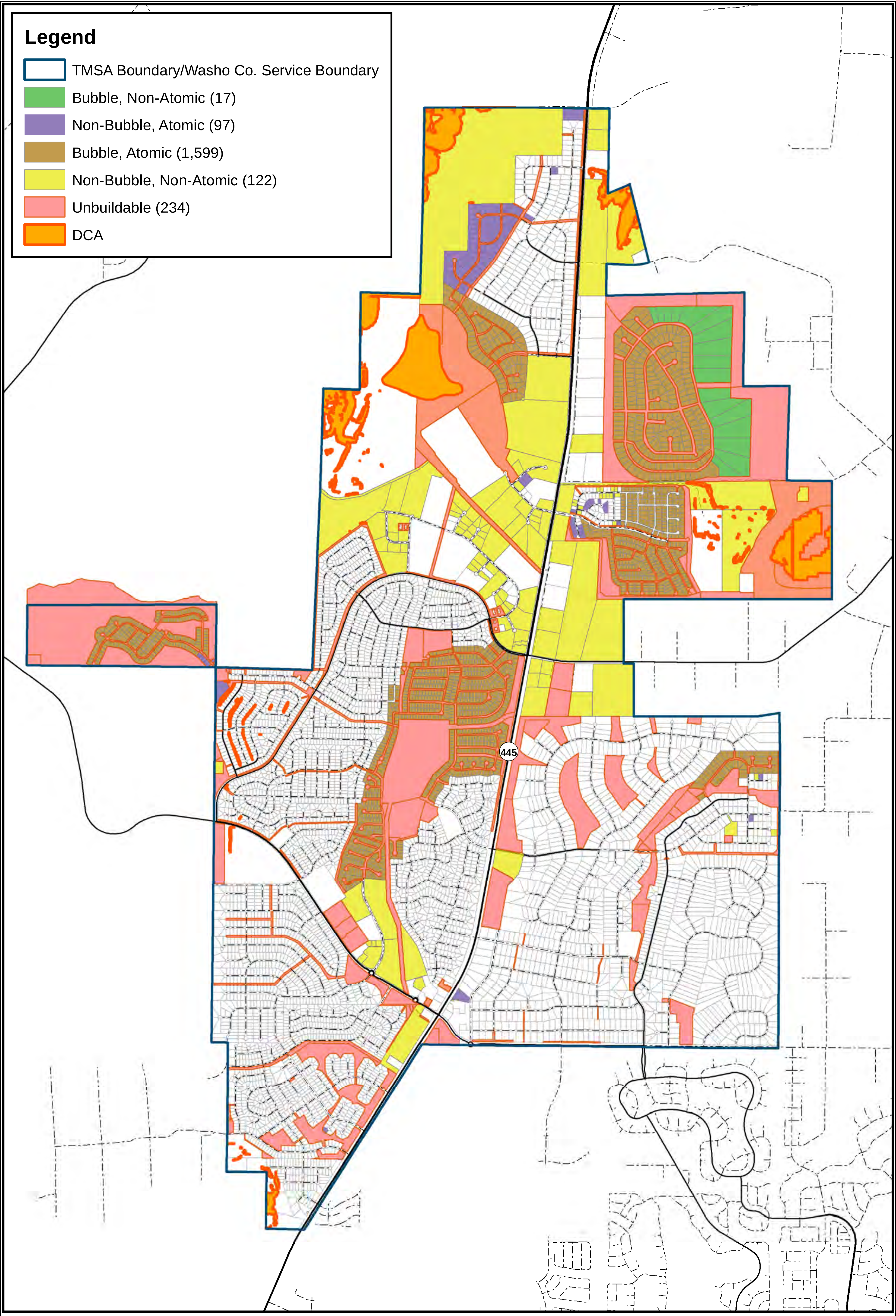
2.8.1 Estimating Buildout Sewer Flows using TMRPA Land Use Data

In 2011, TMRPA began conducting a land use study to give a realistic vision of future land use in Washoe County titled *Spanish Springs – Land Use Report* and is attached in Appendix A. The study provides a buildout growth assessment based on previously approved developments. These include developments in the final map, tentative map and planned unit development stages. The planning analysis completed by TMRPA has allowed for an accurate and reliable future buildout scenario to be created for the Spanish Springs area. This analysis provided the basis for the Buildout condition flow totals and ERU counts provided in this memorandum.

In order to determine the most probable locations for future development to occur, TMRPA used a variety of planning techniques and processes. The first process implemented was termed "bubble mapping." Bubble mapping is a method TMRPA created to track all vacant parcels which have been part of a previously approved final or tentative map. Of the 2,050 vacant parcels in the Spanish Springs Valley 1,616 of them were "bubbled." All of the bubble parcels were given a 1 ERU allocation per parcel. The second process identified all vacant parcels which could only support one dwelling unit or 1 ERU. These parcels were given a tracking field name of "Atomic." In total there were 1,696 parcels identified as atomic, with 1,599 of them also sharing a bubble designation. Bubble and atomic parcels account for 1,714 future ERUs. Figure 6 provides a map of TMRPA's vacant parcel classifications for further reference.

Finally, there were 122 parcels which were left without any classification. For these parcels the estimated future sewer flow was established by multiplying the parcel's aerial extent (acre) by the applicable wastewater generation rate found in Table 7. This total was then divided by 270 gpd to produce an ERU total. If a wastewater generation rate was not provided for the land use of the parcel in question, it became more appropriate to apply the County zoning density listed in Table 8. An ERU estimate was determined by multiplying the acreage of the parcel by the corresponding zoning density in dwelling units per acre (DU/AC) resulting in an equivalent dwelling unit or ERU count. In total, the 122 parcels which were not classified as either bubble or as atomic account for a future count of 1,590 ERUs.

Farr West met individually with both the County and TMRPA to discuss the analysis, interpretations and results of the *parcelfabric* data. Both the County and TMRPA agreed with Farr West's method of approach.



The data contained herein does not represent survey delineation and should not be construed as a replacement for the authoritative source. No liability is assumed by Farr West Engineering as to the sufficiency or accuracy of the data.

N

1 " = 2,500 '

Figure 6 -TMRPA Unimproved Land Use Assessment

FARR WEST ENGINEERING
5442 Longley Lane
Reno, NV 89511
(775) 851-4788
www.farrwestengineering.com

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2.9 BUILDOUT + SEPTIC SEWER FLOWS

The addition of flows from existing structures connected to on-site septic systems on top of existing average day flows and flows associated with the future development of vacant land results in a projected Buildout + Septic sewer flow of 2,057,2000 gpd or 9,260 ERUs. According to the septic conversion plan presented in Section 2.9.1, septic conversion flows will contribute approximately 481,000 gpd or 1,782 ERUs to the existing collection system.

2.9.1 SEPTIC TO SEWER

Another potential source of future sewer flow is the connection of 1,782 existing structures currently discharging to on-site septic tanks. Determining the additional flows that these septic systems would add to the collection system was accomplished by utilizing County-provided phase boundaries and parcel counts generated in the *2002 Spanish Springs Valley Nitrate Occurrence Project Facility Plan* (2002 Plan). The 2002 Plan was completed in response to a directive in 2000 by NDEP, which was issued in response to concerns of rising levels of nitrate in municipal water supply wells in the Spanish Springs Valley. The 2002 Plan included a study of the planning area, an alternative's analysis of potential mitigation options, and finally a recommended plan to implement a community sewering. Construction of the community sewering project was contingent on a variety of factors including continued need for the project as well as available funding. Due to current conditions in 2015, the need for this project is significantly reduced from that of the 2002 Plan.

Figure 7 shows the septic to sewer conversion phases created in the 2002 Plan and provides the lot counts broken down by phase. The phase boundaries were determined based on criteria such as septic tank density, proximity to municipal water supply wells, and the existing condition of the asphalt pavement in the neighborhood. There are some additional on-site systems in Spanish Springs which were not included in the study or in this analysis. These systems are generally on parcels greater than five acres in size and are not candidates for connection to the System.

To calculate the septic to sewer flow estimate, Farr West applied a 1 ERU per parcel allocation to the septic parcels located within the provided phase boundaries. Roads and common areas were excluded from the analysis. Phase 1a of the septic to sewer conversion was completed prior to the development of the existing sewer flows, so the addition of 211 lots was not considered in the septic to sewer flow estimate provided in this analysis. This created a future septic to sewer wastewater flow contribution of 481,000 gpd or 1,782 ERUs. For comparison, the 2002 plan provided an anticipated wastewater flow of 406,068 gpd for these same lots. The difference in the flow totals can be attributed to the 2002 Plan using a wastewater generation rate of 228 gallons per day per unit versus the 270 gallons per day per unit value used in this analysis. The proposed Septic to Sewer Conversion Project will add flow to both City of Sparks interceptors.

The addition of 1,782 ERU's on top of the Buildout estimate results in an exceedance of the 8,495 ERU capacity Washoe County has currently reserved in the City of Sparks Interceptors and at the Truckee Meadows Water Reclamation Facility (TMWRF). However, Washoe County may have additional TMWRF capacity beyond 8,495 ERUs as a result of capacity it subleases from the Sun Valley GID.

Washoe County currently subleases 1,777 ERUs (479,700 gpd) of TMWRF capacity from the Sun Valley GID. Due to annexations by the cities of Sparks and Reno, the Buildout potential of lands in the Sun Valley service area has been reduced to 1,001 ERUs. Therefore, a potential exists for Washoe County to allocate 776 ERUs of previously reserved TMWRF capacity for the addition of septic to sewer conversion connections. These calculations do not include any City of Sparks Interceptor capacity.

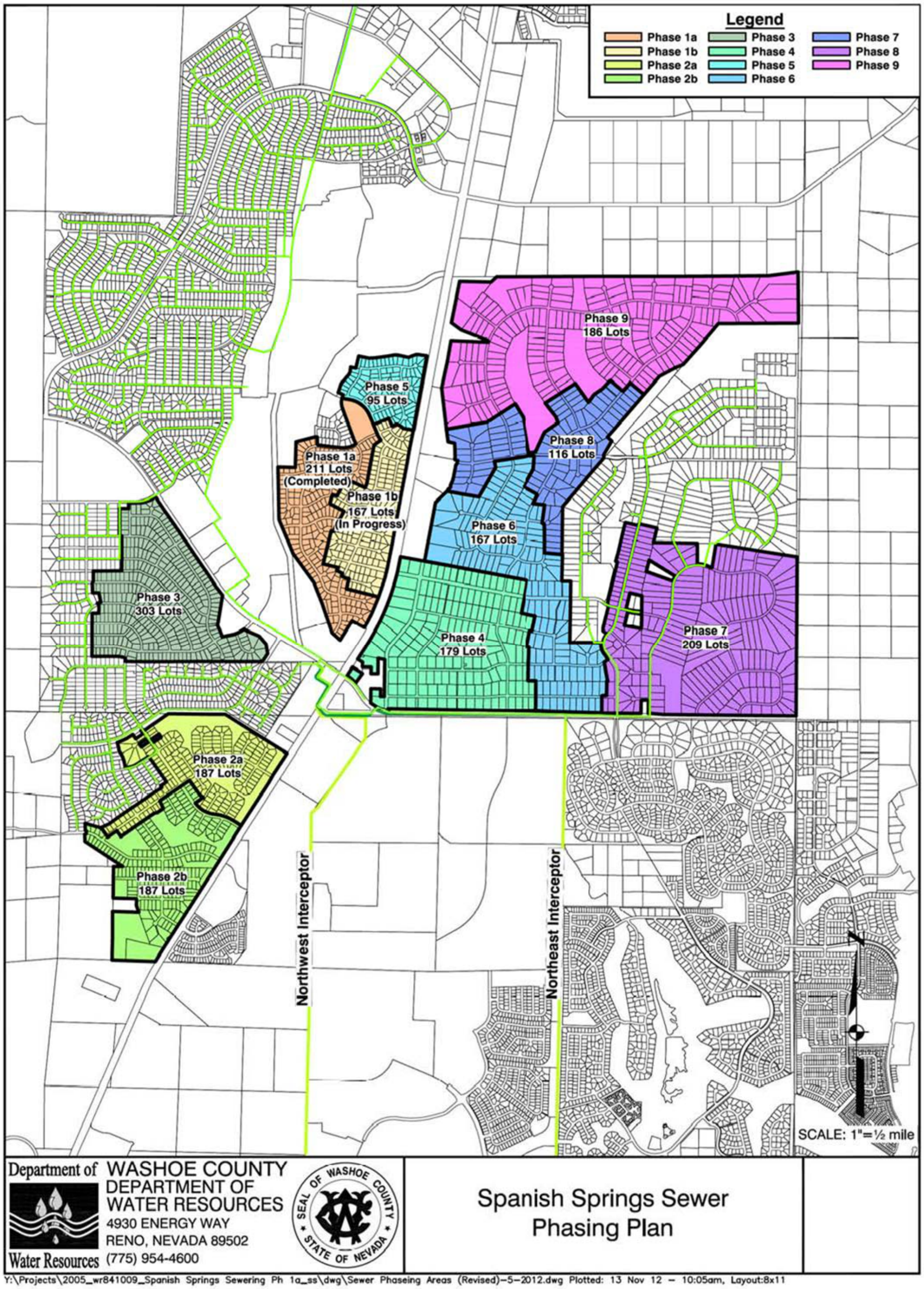


Figure 7 – Spanish Springs Septic Conversion Phasing Plan

2.10 CITY OF SPARKS AGREEMENT ANALYSIS

In 2005, the City of Sparks and Washoe County amended an agreement to provide Washoe County with necessary sewer capacity in the TMWRF and associated sewer interceptors, titled the *Interlocal Agreement to Provide Sanitary Sewer Service in Spanish Springs Valley.* The agreement states that of the 14.58 million gallons per day (MGD) capacity the City of Sparks owns at TMWRF, Washoe County has been allocated 2.29 MGD (8,495 ERU's). Per the estimate detailed in Section 2.2, Washoe County is currently utilizing 684,200 gpd or 4,170 ERUs of City of Sparks system capacity.

Based on existing sewer capacities, future buildout estimates, and the septic to sewer project; Washoe County's projected maximum wastewater flow for the Spanish Springs Valley is 2.06 MGD or 9,260 ERUs.

3.0 SEWER COLLECTION SYSTEM HYDRAULIC MODEL DEVELOPMENT

3.1 METHODOLOGY

In July of 2015, Farr West completed an existing condition hydraulic model update for the County using InfoSWMM® by Innovyze®. Existing flows were developed and allocated as previously discussed in Section 2.2, and the model was calibrated to match 1-minute flow monitoring results taken in the spring of 2015 at two separate locations. A key component of this calibration was getting the operation of the Pebble Creek Lift Station in the hydraulic model to match real world operations. Detailed information can be found in the *Spanish Springs Sewer Collection System Hydraulic Model Review and Validation – Summary of Findings Memorandum (July 2015),* attached in Appendix C. This report includes a summary of all operational setting values used in the 24-hour extended period simulation of dry weather wastewater flow in the Spanish Springs Valley.

In April of 2016, the County monitored wastewater flows at MH 300724021402 in order to verify wastewater flows into the Sparks Northeast Interceptor. The twenty-six day monitoring period yielded a sub-basin ADWF of 51,200 gpd and a peak flow of 212,216 gpd. The hydraulic model and this technical memorandum were updated to include these sewer flow rates for the east sub-basin.

3.1.1 SEWER LOADING ALLOCATION

Building upon the land use analysis discussed in Section 2.8.1, Farr West loaded the future wastewater flows into the hydraulic model. This was accomplished by clustering individual, vacant parcels future wastewater estimates into a larger, sub-region centroid.

The value of the SewerLoad[1] field of the centroid is simply the sum of the SewerLoad field for each parcel associated with that centroid. The SewerLoads were then applied to the nearest manhole using InfoSWMM's Dry Weather Flow (DWF) Allocator utility. With the SewerLoad

[1] The value of the SewerLoad field is equal to the average daily flow in gallons per minute (gpm). If a parcel has a SewerLoad value of 0.188 gpm, that would be equivalent to a daily flow of 270 gallons per day (gpd).

or DWF value assigned to manholes, the next step was to apply a pattern or diurnal curve to these manholes.

As a result of flow monitoring in 2011, the County developed eight unique diurnal curves to represent the eight different sub areas in the Spanish Springs system. Seven of these curves are shown in Figure 8, with the Eagle Canyon (EC-1) curve excluded due to its extremely high peaking factor. These curves all demonstrated a peak flow hour at approximately 10:00 am and have a peaking factor between 1.8 and 2.05.

Since these curves are an empirical representation of residential wastewater flows in the Spanish Springs Valley, Farr West wanted to take advantage of this data to the fullest extent possible. To develop the diurnal curve for future residential connections, Farr West took the average of the values of the seven curves. The resultant curve is shown in red, has a peaking factor of 1.93 and is shown in Figure 8. For the large vacant parcels zoned for commercial or industrial uses, Farr West utilized a pattern more representative of commercial and industrial uses. These patterns reflect a 24-hour operational duration for industrial uses and a more typical 6am to 8pm operational duration for commercial uses. Peaking factors of 1.2 and 2.0 were used for the industrial and commercial diurnal curves, respectively. These curves can be found in Appendix B.

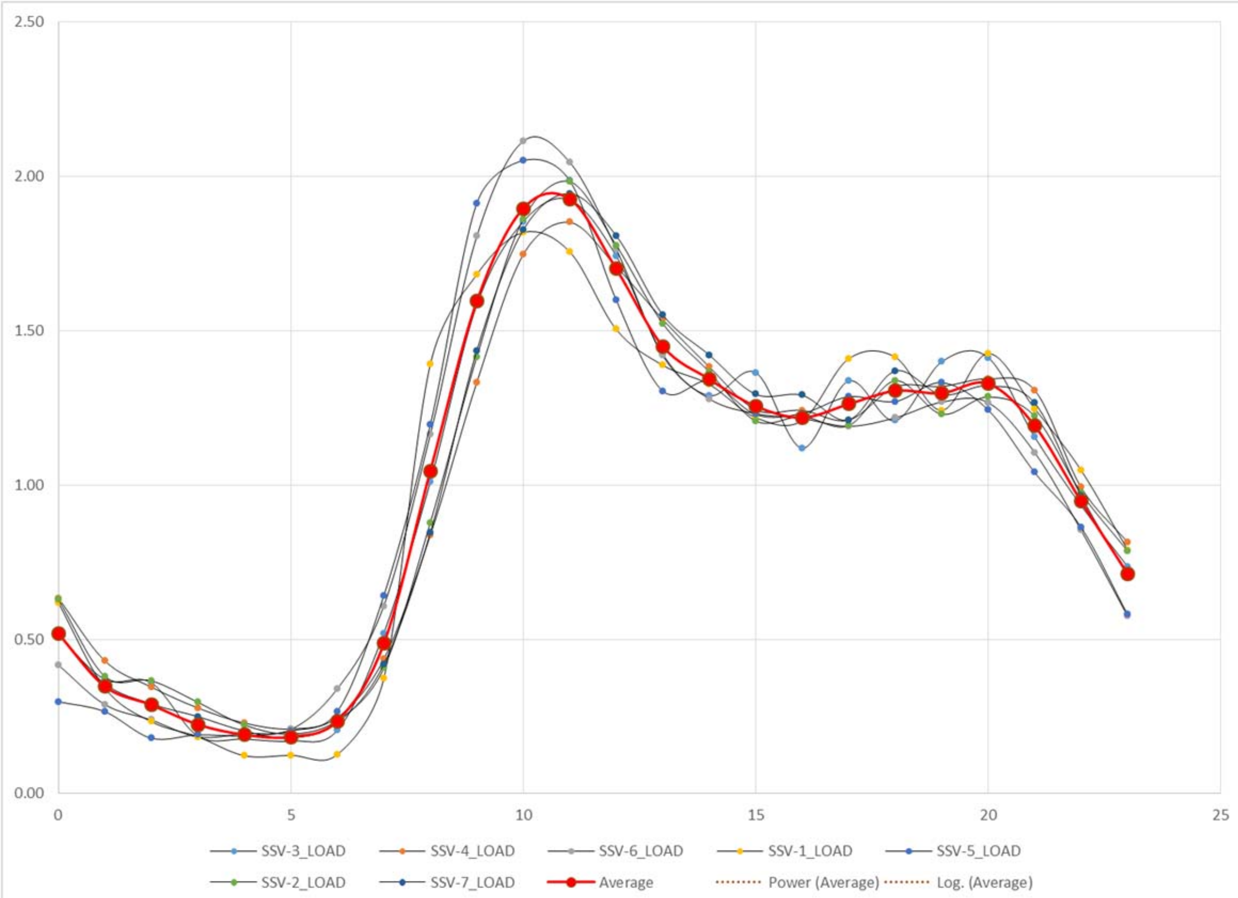


Figure 8 – System Diurnal Curves

3.1.2 Infiltration and Inflow Analysis

Farr West reviewed historical rainfall data over the time period in which flow monitoring results were available. The data showed that a small number of rainfall events occurred between January and March of 2011. The flow monitoring results on the days where precipitation was measured were reviewed, and no increase in sewer flows could be seen in the data. This further substantiates the County's findings that due to System age and deep groundwater levels, infiltration and inflow is not a contributing factor in the Spanish Springs wastewater collection system.

3.1.3 Model Assumptions

Since the hydraulic model has been previously calibrated to empirical data, the addition of future sewer flows did not require any significant assumptions or changes to the model. This section will document any assumptions made for the Buildout and Buildout + Septic flow scenarios.

Since some of the vacant parcels or tentative maps are not located near any existing sewer mains or manholes, Farr West added proposed sewer pipes along probable routes in order to connect the parcels to the existing system infrastructure. All of these pipes have been modeled as 8 inch PVC pipes at slopes of 0.005 ft/ft or greater. Second, for areas of future development which include a mix of primarily residential development with a small number of neighborhood commercial connections, the existing average diurnal curve or pattern was used for the entire development. And lastly, the operation settings of the Pebble Creek Lift Station were not modified even though the total volume of influent flow was approximately 7.5 times greater in the Buildout and Buildout + Septic flow scenarios. In these flow conditions, the lift station pumps achieve a maximum of 4 cycles per hour which is still below the NDEP Technical Document WTS-14 standard.

Table 10 – Pebble Creek Lift Station

Item	Value
Storage Type	Precast Concrete Wet Well
Storage Volume (Total)	11,469 Gallons
Storage Volume (Operating)	1,692 Gallons
Storage Dimensions	8' Diameter by 30.5' Deep
On/Off Set Points	On = 7.5'	Off = 3'
Design Flow Rate	1,300 gpm
Design Total Dynamic Head	60 ft
Pump Size	40 Hp
Electrical Service	460V/60Hz/3-Phase
# of Pumps	2
Pump Manufacturer	Gorman Rupp
Pump Model Number	T8A3-B /WW
Pump Type	Self-Priming Centrifugal Pump

Appendix A

Housing Study Overview

The Truckee Meadows Regional Planning Agency (TMRPA) is conducting a Housing Study to describe the current housing stock in the region and forecast future housing needs over the next 20 years based on demographic and socioeconomic trends that are likely to impact the type and location of future housing. To explore different potential patterns of growth that could occur in the future, the study will evaluate multiple growth scenarios. The fiscal impacts associated with these growth scenarios will also be evaluated to gain an understanding of how each scenario could affect the costs and revenues of public service providers in varying ways.

The first phase of the Housing Study focused on the demand for new housing in the Truckee Meadows region in comparison to the amount of buildable land that can accommodate future residential development. Work from this portion of the study revealed that approximately 50,000 new housing units will be needed in the Truckee Meadows region over the next 20 years and that the region has enough land zoned for residential uses within the Truckee Meadows Service Areas (TMSA) to meet this aggregate demand for new housing units.

The second phase of the Housing Study provides a more detailed evaluation of the type (i.e. density) and location of future housing units and how that could change based on demographic and socioeconomic trends, as well as costs to provide new infrastructure. In order to evaluate differential costs we have created multiple simulations of our residential future using geographic information systems (GIS). These simulations are included in data delivery as described below. Furthermore, we provide details explaining some of the rationale behind the creation of 4 distinct simulations.

Initial Data Delivery

The GIS data included with this report represent the first delivery of parcel-based simulations and includes scenarios **1a** and **1b** (described in detail below) with scenarios **2a** and **2b** to follow upon their completion. Furthermore, we include an Excel spreadsheet with specific data and field descriptions as well as a simple ArcMap map document for viewing the data. For questions or more information about this data delivery please contact Jeremy Smith (jsmith@tmrpa.org / 775-321-8390).

Files included in the TMRPA Housing Study – Initial Data Delivery:

1. *TMRPA_housingStudy_simulationData_description.docx* - this report which describes the rationale behind the scenarios being modeled. More detailed information about data construction and modeling methodology will be provided in a TMRPA Housing Study final report.
2. *TMRPA_housingStudy_simulationData_dataDictionary.xlsx* – list of feature classes included in the delivery and description of feature class attribute fields.
3. *TMRPA_housingStudy_simulationData_map.mxd* - simple map document showing the prediction data. Note that hexagon data are initially set to model year 2025.
4. *TMRPA_housingStudy_simulationData.gdb* – ArcGIS file geodatabse containing the simulation data.

Scenarios

Acknowledging that the future is inherently uncertain and that the exact type and location of future housing units will never be fully known, two scenarios with distinct spatial patterns of development will be evaluated: **1)** one based on a continuation of recent development trends, and **2)** another that explores a slightly more compact development pattern (i.e. somewhat higher densities, some additional redevelopment, and a greater proportion of new units within McCarran Boulevard when compared to the recent trends). These two scenarios represent "where" we are simulating future growth.

Future housing units are allocated to these scenarios using two distinct growth rates where **a)** follows the linear rate specified in the 2014 Washoe County Consensus Forecast and **b)** uses a polynomial curve that is consistent with the enhanced population projection included in the recently completed Northern Nevada Regional Growth Study commissioned by EDAWN (i.e. the EPIC study). In both temporal variations, we hold the forecasted number of new housing units expected by 2035 constant at 50,636. However, we recognize that enhanced economic development success may increase the rate of residential growth in the near-term (i.e. 5 to 10 years) and thus we have significantly front-loaded growth in the early years of the **b** variation (Figure 1). The decision to hold housing unit growth constant at 2035 was made in order to ensure an 'apples-to-apples' comparison of the scenarios and since it is yet unclear for how long the enhanced growth contemplated in the EPIC study will be sustained. These two rates effectively represent two variations of "when" we will achieve the forecasted residential growth. Combining the two scenarios with the two temporal variations creates 4 distinct simulations of the future. These 4 scenario variations are displayed in Table 1 and further described in the pages below.

Figure 1: Population Projections

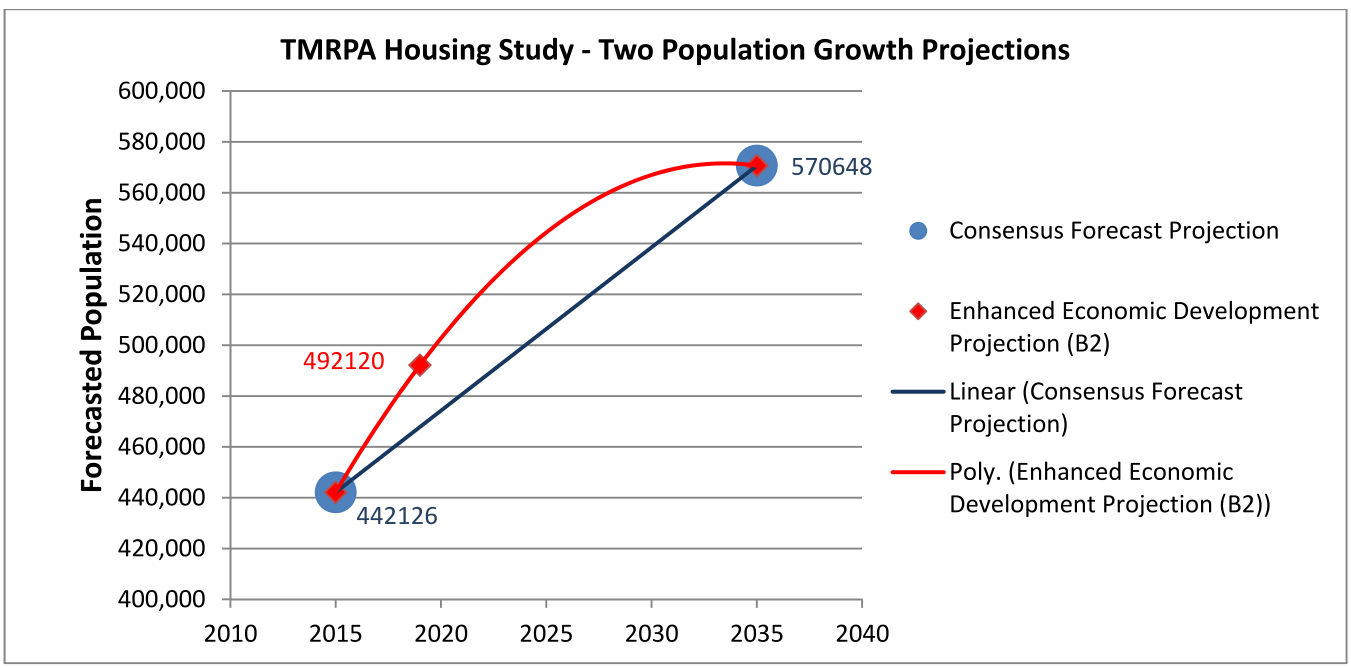


Table 1: Proposed Scenarios

Scenario 1: Recent Trend Development Pattern	**Scenario 2: More Compact Development Pattern**
1a: Recent trends + Consensus Forecast growth rate	**2a**: More compact development + Consensus Forecast growth rate
1b: Recent trends + accelerated growth in next five years	**2b**: More compact development + accelerated growth in next five years

The following 2 scenarios have been created and are included in this data delivery

Scenario 1a: Recent Trends + Consensus Forecast Growth Rate: This scenario projects forward the pattern of development observed from the past 15 years. This pattern is typified by detached single-family housing on relatively large lots located on the periphery of the region. While detached single-family housing accounts for 60% of housing units in this scenario, multi-family units are also modeled. Based on recent trends, these units are located in various areas throughout the region. This scenario also models population growth occurring at an average annual growth rate of 1.3%, as detailed in the adopted 2014 Washoe County Consensus Forecast.

Scenario 1b: Recent Trends + Accelerated Growth Rate: This scenario utilizes the same development pattern described in Scenario 1a. The timing of development is accelerated over the 2015-2020 timeframe based using the 2.3% average annual growth rate which is from Scenario B2, the highest growth rate contemplated in the EPIC Report. After 2020, the average annual growth rate declines until it reaches the Consensus Forecast projection for the year 2035.

The following 2 scenarios are still under development and will be delivered as soon as completed

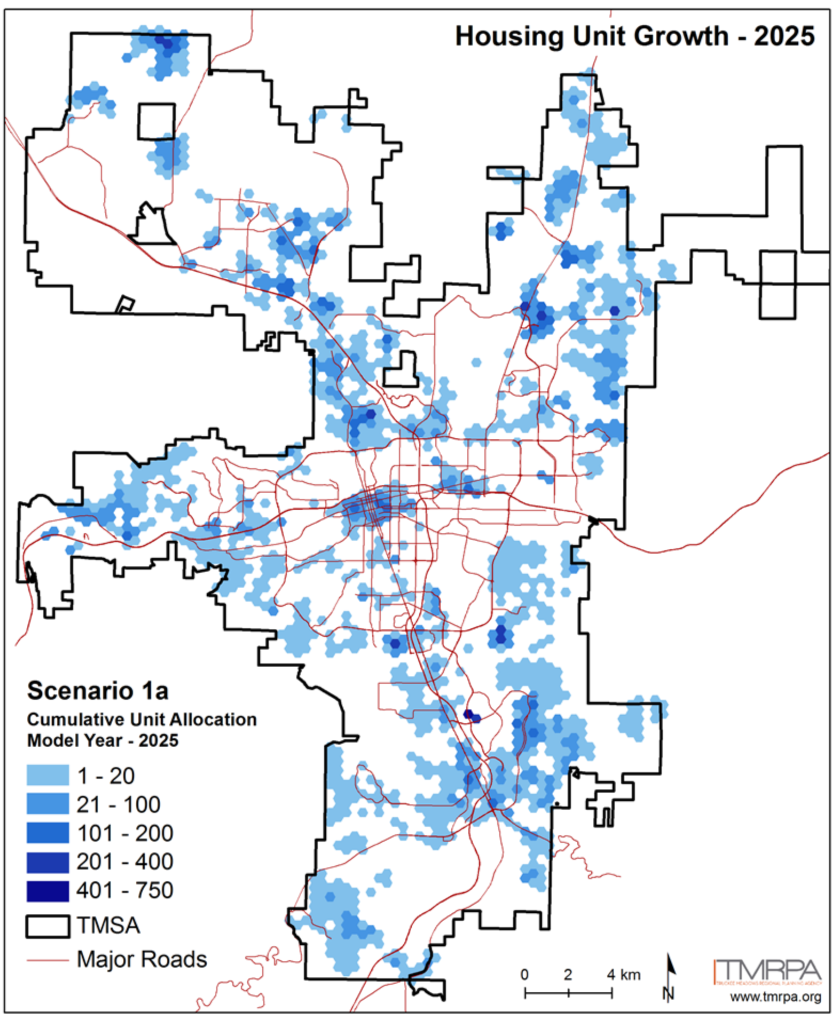
Scenario 2a: More Compact Development + Consensus Forecast Growth Rate: This scenario departs from the development trends observed over the past 15 years and models a more compact form of development that has a greater proportion of units locating within the McCarran ring. While a majority of new units are modeled as detached single-family homes, this scenario also shows a shift towards denser housing including small lot single-family homes, duplexes, and multi-family units, as well as additional redevelopment above that seen in the recent trend scenario. This scenario further models population growth occurring at an average annual growth rate of 1.3%, as detailed in the adopted 2014 Washoe County Consensus Forecast.

Scenario 2b: More Compact Development + Accelerated Growth Rate: This scenario utilizes the same development pattern described in Scenario 2a. The timing of development is accelerated over the 2015-2020 timeframe based using the 2.3% average annual growth rate detailed in the EPIC Report. After 2020, the average annual growth rate declines until it reaches the Consensus Forecast projection for the year 2035.

A quick note about our hexagon tessellations

Although all of our modeling work is completed using parcel-level information, sometimes parcels are not the best format for displaying results or for comprehending the amount and impact of development spatially. This is largely because each parcel has a unique approved density, shape and area. Just displaying parcels, say with a different color by model year for example, can be confusing since the size of a parcel alone does not accurately portray the number of units it can contribute to future build out when one considers the approved zoning designation. In other words, a small parcel in the core can often contribute many more units than a large parcel on the fringe due to their different approved unit densities. So, to create consistent and more easily comprehensible set of results (we hope!) we constructed a 40 acre hexagon tessellation that is irrespective of density, jurisdiction or other subarea geographies. Each hexagon simply reports the number of units that are forecast within its boundary. This framework allows for clear communication of results and quick visual (and analytical) comparison of results by scenario. We also plan to employ time-series animations of the hexagonal results for visualization of the pattern and amount of growth within our region over time. An example of the model results for scenario **1a** displayed as cumulative unit counts for the year 2025 is shown below in Figure 2.

Figure 2: Hexagon tessellation example – Scenario 1a/Model Year 2025



Land Use Data for the Spanish Springs

This report describes our efforts toward tracking individual developments throughout the many stages of the development pipeline and will give staff a realistic vision of future land uses that is based on approved local government zoning. Thus, the data compiled in association with this report allows contemplation of a full build-out scenario for the Spanish Springs service area that is rooted in our current understanding of what is approved.

This document and the descriptions herein are designed to be used in conjunction with related GIS deliverables. GIS data are delivered in ESRI file geodatabase format (ArcGIS 10.3.1). The file geodatabase named SpanishSprings_LandUseData.gdb contains the following relevant feature classes:

- *enhancedParcelData_SpanishSprings_06052015*– parcel-level accounting of built and vacant lands in the Spanish Springs service area including attribute fields that describe existing uses and development potential (see Appendix A for more details)
- *SpanishSprings_WC_TMSA*– Truckee Meadows Service Area part of Spanish Springs
- *TM_Boundaries* – the boundaries of active tentative maps (TM) in the Spanish Springs service area
- *DCA* – strict development constraints per the 2012 Regional Plan which include slopes of 30% or greater, public lands, AE floodways, 404 wetlands, and significant waterbodies

Approved Future Units

Since modeling efforts began in 2011, TMRPA has endeavored to track approvals for development in the final map, tentative map (TM) and planned unit development (PUD) stages. It is relatively easy to pinpoint final mapped parcels as they have been recorded and subdivided in the Washoe County Assessor's parcel data. The land use class field indicates a status of built or vacant.

However, it is more difficult to pinpoint the position and eventual build-out conditions of areas with approved tentative maps and/or approved planned unit development plans but that have yet to be subdivided by the assessor. Furthermore, tentative map areas that have not been final mapped often remain as large, multi-acre parcels in the assessor parcel data. To account for these areas where a future development is already contemplated, TMRPA staff has implemented a process by which we integrate future parcel subdivisions into the existing Washoe County Assessor parcel polygons. We call this process "bubble mapping" and an associated field in the enhanced parcel data is included in order to indicate which parcels have been "bubbled". An example of a large unsubdivided parcel that has been bubble mapped can be seen in Figure 1. Note that the bubbles retain the APN of the larger unsubdivided parent parcel.

Figure 1. Example of "bubble mapped" area where TMRPA enhanced parcels show more detail with regard to future units when compared to the Washoe County Assessor parcel data.

Our process for bubble mapping proceeds only when we have the associated map information detailing the future lot plans of a given TM. In some cases these data are unavailable and large unsubdivided parcels cannot be bubbled. In these instances, our estimates of future development rely on the approved dwelling unit per acre (DU/AC) densities of the appropriate Alt_Zoning code (see Appendix B). In the enhanced parcel GIS data, the Alt_Zoning field is comprised of both official zoning from the local jurisdictions and specific zoning designations based on TMRPA's work with TM data wherever it's applicable. So in other words, many of the Alt_Zoning field values are simply the officially adopted zoning of a given parcel.

The method of calculating dwelling units by applying the approved density of a given zoning code (i.e. DU/AC) to a parcel's areal extent is inherently less exact than associating a dwelling unit to a single subdivided residential lot. This is mainly due to the fact that not all areas of a large parcel can support residential lots. There are considerations for development constrained areas, roads, open space and other non-residential applications. In order to denote when a parcel can support only one dwelling unit we have implemented a second tracking field in the enhanced parcel data named "Atomic".

Atomic parcels are those that are slated to support only one dwelling unit and essentially the DU/AC measure does not matter. If the atomic attribute is false, one must fall back to the DU/AC approved density to calculate the number of potential dwelling units that the parcel in question could support. In these non-atomic cases it is often useful to employ an efficiency factor (for example 80%) to limit the calculation of dwelling units by areal extent and therefore account for alternative land uses within the large parcel. Please note that we only fill the “bubble” and “atomic” fields for vacant parcels. Built parcels should have a null value for these two tracking fields.

Figure 2. Map of the distribution of approved active tentative maps (TM) within the Spanish Springs service area.

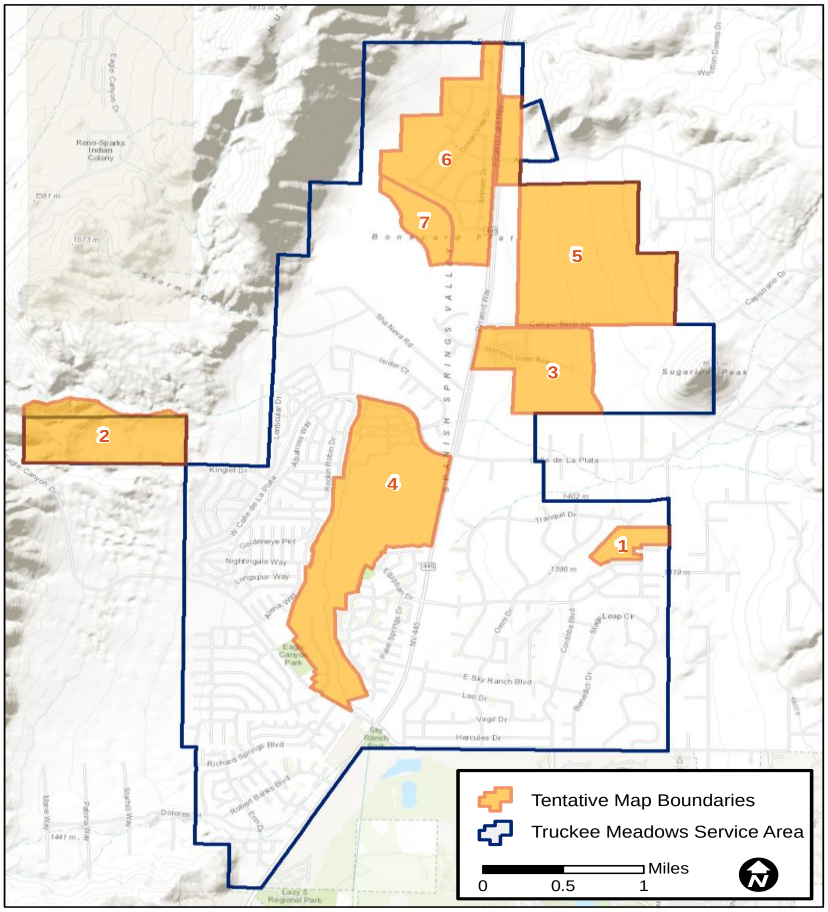
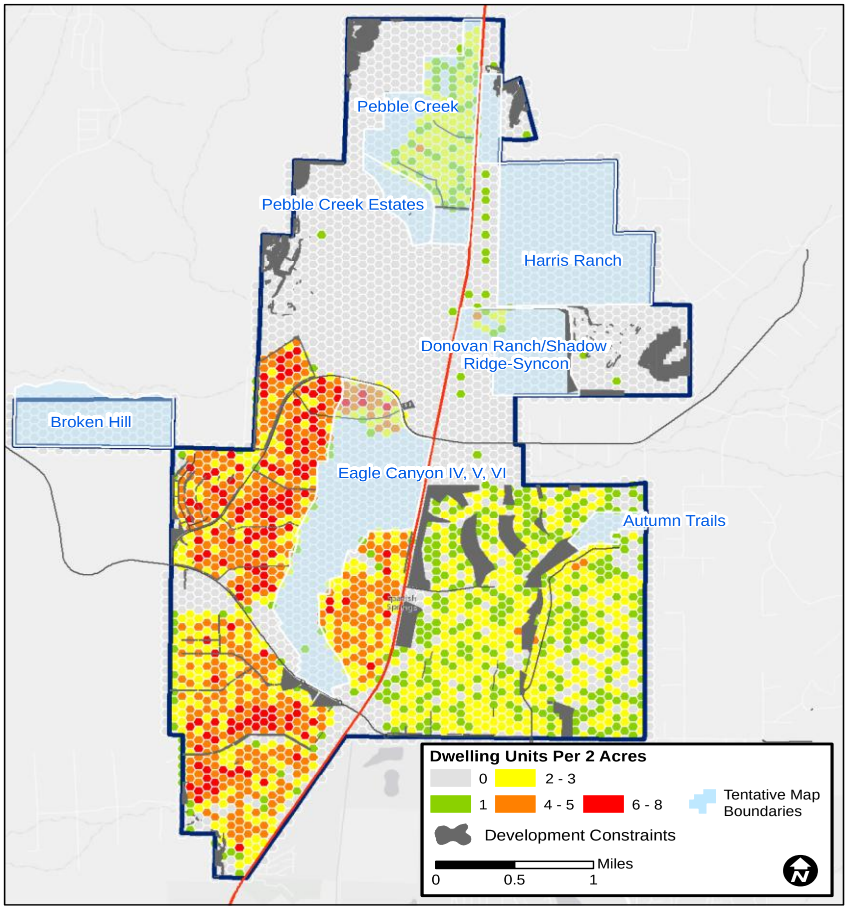


Table 1. Dwelling units in active tentative maps

ID	Location	Jurisdiction	DU Approved	DU Remaining	DU Existing
1	Autumn Trails	Washoe County	43	43	0
2	Broken Hill	Washoe County	170	170	0
3	Donovan Ranch/Shadow Ridge-Syncon	Washoe County	390	325	65
4	Eagle Canyon IV, V, VI	Washoe County	866	712	154
5	Harris Ranch	Washoe County	262	262	0
6	Pebble Creek	Washoe County	344	99	245
7	Pebble Creek Estates	Washoe County	83	83	0

Figure 3. Two acre hexagonal bins are used to help illustrate the density of built residential units within the Spanish Springs area as of 2013[1].



[1]2013 is the most recent dwelling unit point dataset currently available for the region

Contact

For more information regarding these or other relevant land use data, please contact the Truckee Meadows Regional Planning Agency (TMRPA) at 775-321-8385 or email Jeremy M. Smith, GIS Coordinator at jsmith@tmrpa.org or Damien Kerwin, GIS Planning/Analyst at dkerwin@tmrpa.org.

Appendix A. Field Descriptions

OBJECTID	Unique identifier automatically assigned by ArcGIS.
APN	Assessor Parcel Number from parcel vintage of 06/05/2015. Areas that have been "bubble mapped" by TMRPA retain their parent APN from the assessor data. Therefore, APNs can be repeated in some areas.
ZONING	Zoning designation directly from the Washoe County Assessor database.
YEARBLT	The year built from the Washoe County Assessor database.
SQFEET	Building square footage on built parcels from the Washoe County Assessor database.
LU_DESC	Land use description from the Washoe County Assessor database.
LU_CLASS	Land use class from the Washoe County Assessor database. **Indicates vacancy status.**
BLDG_DESC	Building description from the Washoe County Assessor database.
ALT_ZONING	TMRPA's enhanced zoning designations that include detailed distinction of parcels zoned "PUD" and tentative map specific designations in bubble mapped areas. Wherever applicable, the ALT_ZONING codes match the official zoning designations from the appropriate local jurisdiction.
DEV_CLASS	The development potential of a given parcel based on the Alt_Zoning designation. Dev_Class codes are as follows: 1 – residential only, 2- mixed-use, 3 – primarily commercial with a small chance for residential, 4 – non-residential, 5 – unbuildable.
DU_APPROVED	The dwelling units per acre approved for that specific Alt_Zoning designation.
TM	A boolean field indicating whether a parcel is part of an active tentative map. 1 = true, 0 = false
TM_NAME	The name of the tentative map.
PUD	A boolean field indicating whether a parcel is part of a planned unit development handbook. 1 = true, 0 = false
PUD_NAME	The name of the planned unit development.
BUBBLE	A boolean field that indicates whether a parcel has been "bubble mapped" by TMRPA. 1= true, 0 = false
JURIS	The jurisdiction that the parcel is contained within.
ATOMIC	A boolean field that indicates the number of dwelling units that can potentially be built on the parcel. A value of 1 indicates the lot is subdivided (or bubbled) to contain only 1 dwelling unit. A value of 0 indicates potential for multiple units on that parcel.
Final Mapped	A Boolean field that indicates whether or not the parcel has been final mapped by the assessor. This attribute is only applicable to Tentative Map and PUD areas.
Notes	Only applicable if the Zoning text originally said 'See Notes'. This alluded to the parcel overlapping two zoning areas and falling into an uncertain zoning designation. The text has been changed to the correct master zoning code, which was provided by Washoe County.
Shape_Length	The parcel polygon perimeter in feet.
Shape_Area	The parcel polygon area in square feet.

Appendix B. ALT_ZONING definitions

B.1 – Washoe County Zoning Codes

Code	Name/Description	DU/AC
LDR	Low Density Rural	0.1
MDR	Medium Density Rural	0.2
HDR	High Density Rural	not-designated
LDS	Low Density Suburban	1
MDS	Medium Density Suburban	3
HDS	High Density Suburban	7
LDU	Low Density Urban	10
MDU	Medium Density Urban	21
HDU	High Density Urban	42
GC	General Commercial	n/a
NC	Neighborhood Commerical / Office	n/a
TC	Tourist Commercial	n/a
I	Industrial	n/a
PSP	Public / Semi-Public Facilities	n/a
PR	Parks and Recreation	n/a
GR	General Rural	0.025
GRR	General Rural Residential	0.025
SP	Specific Plan	n/a
OS	Open Space	n/a
NOLU	No Landuse	n/a

Appendix C. Units Built since 2005 by TM

Autumn Trails

Year	DUs Built
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
Total DUs built in last 10 years	0

Broken Hill

Year	DUs Built
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
Total DUs built in last 10 years	0

Donovan Ranch

Year	DUs Built
2005	0
2006	0
2007	12
2008	9
2009	0
2010	0
2011	0
2012	0
2013	0
2014	30
2015	1
Total DUs built in last 10 years	52

Eagle Canyon

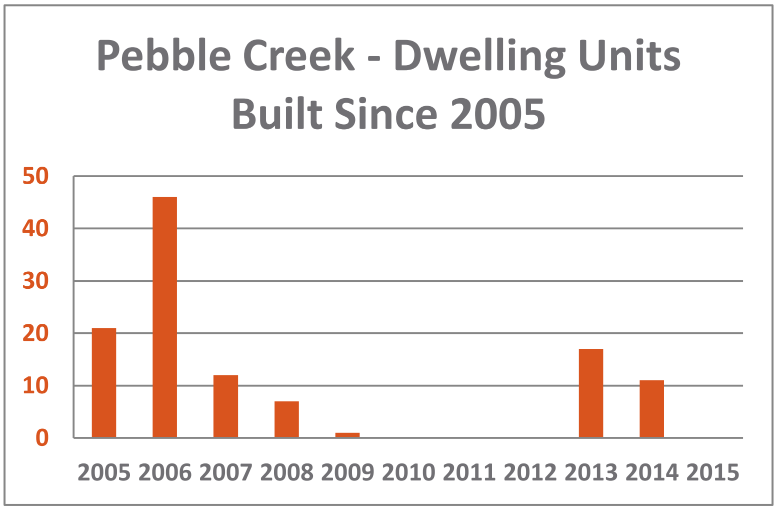
Year	DUs Built
2005	8
2006	107
2007	20
2008	20
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
Total DUs built in last 10 years	155

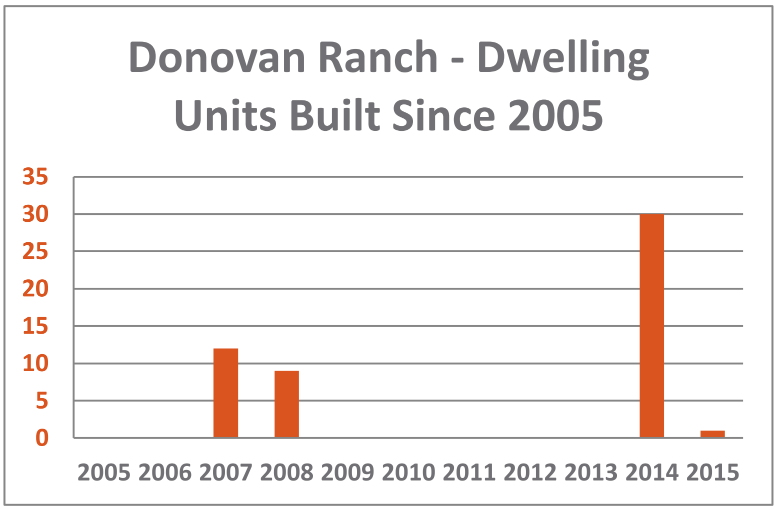
Pebble Creek

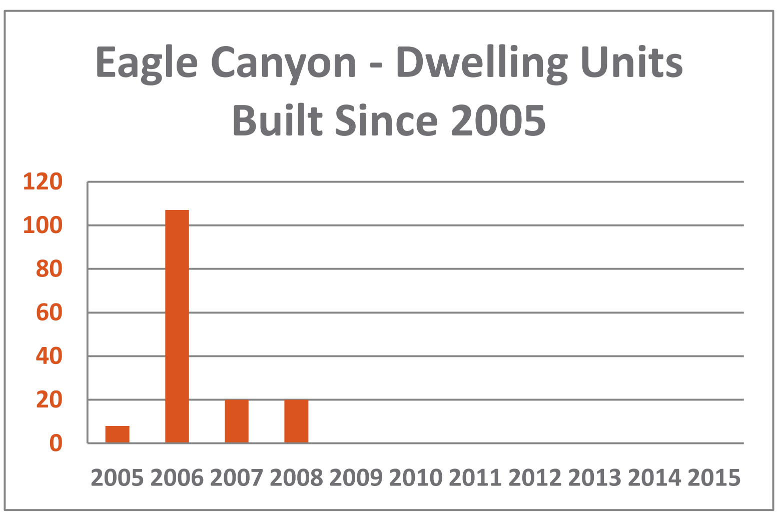
Year	DUs Built
2005	21
2006	46
2007	12
2008	7
2009	1
2010	0
2011	0
2012	0
2013	17
2014	11
2015	0
Total DUs built in last 10 years	115

Pebble Creek Estates

Year	DUs Built
2005	0
2006	0
2007	0
2008	0
2009	0
2010	0
2011	0
2012	0
2013	0
2014	0
2015	0
Total DUs built in last 10 years	0


Pebble Creek - Dwelling Units Built Since 2005
50
40
30
20
10
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Donovan Ranch - Dwelling Units Built Since 2005
35
30
25
20
15
10
5
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015


Eagle Canyon - Dwelling Units Built Since 2005
120
100
80
60
40
20
0
2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015

Appendix B

FUTURE PARCEL FLOW

		Removed		Future Sewer Flow				
Zoning	Counts	Dev_Class 5	Built	Bubble & Atomic	Bubble	Atomic	Neither	Total
GC	Parcels	-	7	-	-	-	1	1
	Acres	-	15.425635	-	-	-	0.080506	0.080506492
	EDU's	-	-	-	-	-	-	-
GR	Parcels	9	10	-	-	1	6	7
	Acres	63.740868	369.284233	-	-	1.998519739	551.839406	553.8379258
	EDU's	1.593521711	9.232105814	-	-	1	13.79598515	14.79598515
I	Parcels	8	42	-	-	-	61	61
	Acres	12.363576	197.217029	-	-	-	358.953543	358.9535434
	EDU's	-	-	-	-	-	-	-
LDR		-	3	-	-	-	-	-
		-	30.000552	-	-	-	-	-
		-	3.00005516	-	-	-	-	-
LDS	Parcels	102	1422	891	17	93	29	1030
	Acres	519.075145	1646.504518	495.6070129	130.6225561	79.25320158	404.022108	1109.504878
	EDU's	519.0751446	1646.504518	891	17	93	404.0221077	1405.022108
MDR	Parcels	-	6	-	-	-	1	1
	Acres	-	12.177819	-	-	-	0.057367	0.057367054
	EDU's	-	2.435563768	-	-	-	0.011473411	0.011473411
MDS	Parcels	57	3684	708	-	3	4	715
	Acres	66.171633	1366.368716	235.8802504	-	4.130131352	79.430603	319.4409846
	EDU's	198.5148982	4099.106149	708	-	3	238.2918084	949.2918084
NC	Parcels	-	9	-	-	-	18	18
	Acres	-	23.403355	-	-	-	92.458092	92.4580924
	EDU's	-	-	-	-	-	-	-
OS	Parcels	31	-	-	-	-	-	-
	Acres	335.185306	-	-	-	-	-	-
	EDU's	-	-	-	-	-	-	-
PR	Parcels	10	-	-	-	-	-	-
	Acres	82.693181	-	-	-	-	-	-
	EDU's	-	-	-	-	-	-	-
PSP	Parcels	4	5	-	-	-	2	2
	Acres	14.021374	93.941357	-	-	-	23.931775	23.9317747
	EDU's	-	-	-	-	-	-	-
Roadway	Parcels	8	0	-	-	-	-	-
	Acres	52.684141	23.403355	-	-	-	-	-
	EDU's	-	-	-	-	-	-	-
Total	Parcels	229	5188	1599	17	97	122	1835
	Acres	1145.9352237	3777.7265676	731.4872633	130.6225561	85.38185268	1510.773401	2458.265073
	EDU's	719.1835645	5760.2783912	1599	17	97	656.1213747	2369.121375
			Gallons per Day	431,730.00	4,590.00	26,190.00	429,265.35	

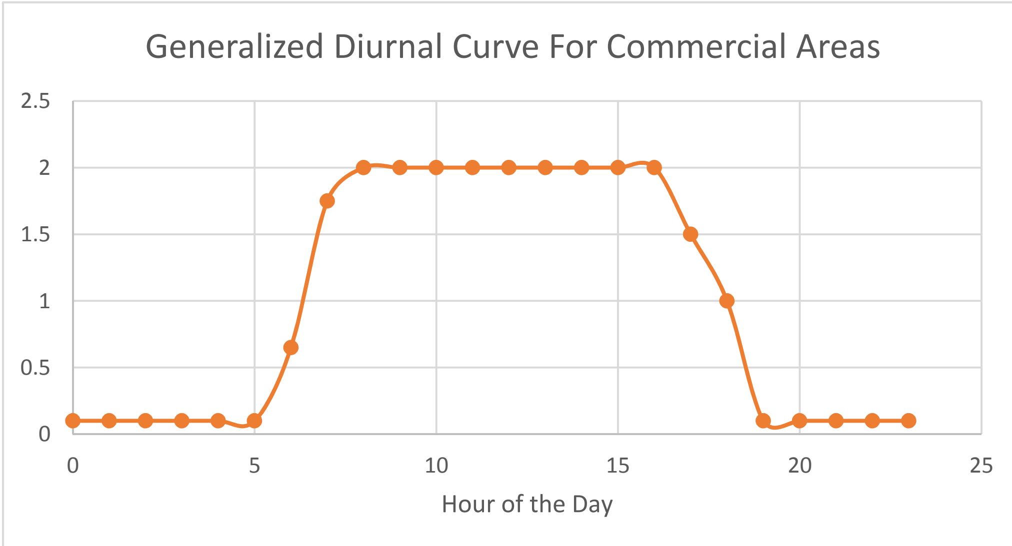
Sewer Flows	# of EDU's	# of Acres	gpd
Single Family Units	2,369.12	-	639,662.77
Parks and Open Space	-	23.93	15,890.70
General Commercial	-	92.54	72,180.11
General Industrial	-	358.95	164,041.77
Minor Improvements	-	-	-
		Total:	891,775.35

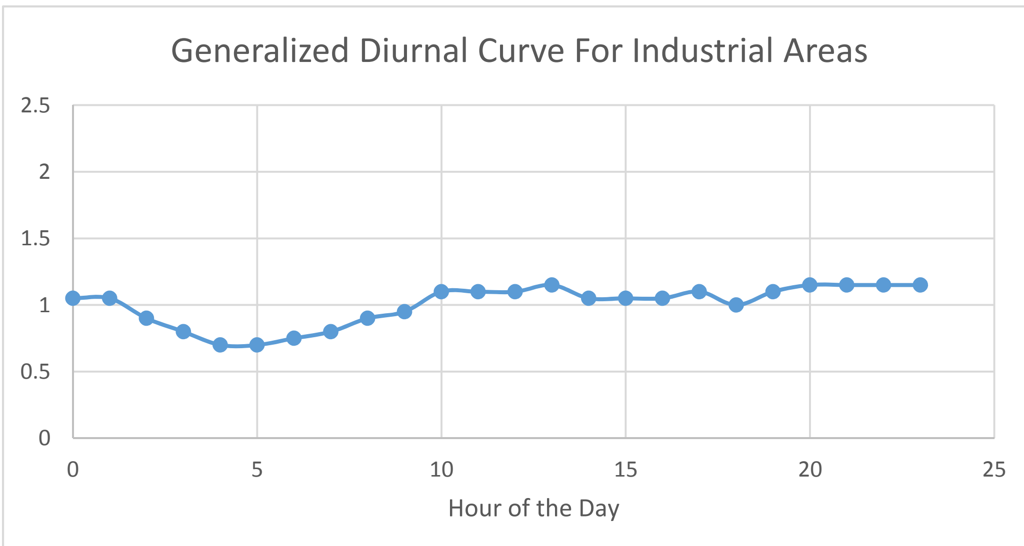
Sewer Flows

Single Family Units (EDU's)	270 Gallons/Day
Parks and Open Space	664 Gallons/Day/Acre
General Commercial	780 Gallons/Day/Acre
General Industrial	457 Gallons/Day/Acre
Minor Improvements	780 Gallons/Day/Acre

Washoe County Zoning Codes

Code	Name/Description	DU/AC
LDR	Low Density Rural	0.1
MDR	Medium Density Rural	0.2
HDR	High Density Rural	not-designated
LDS	Low Density Suburban	1
MDS	Medium Density Suburban	3
HDS	High Density Suburban	7
LDU	Low Density Urban	10
MDU	Medium Density Urban	21
HDU	High Density Urban	41
GC	General Commercial	n/a
NC	Neighborhood Commercial/Office	n/a
TC	Tourist Commercial	n/a
I	Industrial	n/a
PSP	Public/Semi-Public Facilities	n/a
PR	Parks and Recreation	n/a
GR	General Rural	0.025
GRR	General Rural Residential	0.025
SP	Specific Plan	n/a
OS	Open Space	n/a
NOLU	No Landuse	n/a


Generalized Diurnal Curve For Commercial Areas
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Hour of the Day


Generalized Diurnal Curve For Industrial Areas
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Hour of the Day

Appendix C

FARR WEST
ENGINEERING

July 1, 2015

Alan Jones, PE
Senior Licensed Engineer
Washoe County Community Services Department
1001 E. Ninth Street
Reno, NV 89512

RE: SPANISH SPRINGS SEWER COLLECTION SYSTEM HYDRAULIC MODEL REVIEW AND VALIDATION – SUMMARY OF FINDINGS MEMORANDUM

Dear Alan,

This memorandum serves as the summary of work completed by Farr West Engineering (Farr West) and as a basis for future Spanish Springs collection system hydraulic model updates. Washoe County Community Services Department – Water Resources (County) requested that Farr West review the existing model prepared by the County, and provide recommendations for improvements to the model. The information below describes our review of the existing model, modifications made to the model, a comparison of model results to flow monitoring results, and recommendations for future model calibration and improvements.

Existing Hydraulic Model Methodology

The County operates and maintains the wastewater collection system which serves the community of Spanish Springs in the Spanish Springs Valley area. The County has developed a hydraulic model of sewer interceptors 10-inches and greater for the Spanish Springs collection system. The model was built by County staff using InfoSewer hydraulic modeling software by Innovyze®. The model was constructed using a GIS database containing all pipes, manholes, and pump stations.

In 2011, the County performed 30 days of flow monitoring, at 8 different locations on the Spanish Springs collection system (*Spanish Springs Valley Sewer Collection System Flow Monitoring, CH2MHill, June 7, 2011*). The monitoring results characterized dry weather flows for 7 individual basins. The flow monitoring results were used to develop sub area diurnal curves and to calibrate the hydraulic model for system capacity assessment on an average day dry weather flow (ADWF) basis. County staff used this data, potable water consumptive use data, and design criteria sewer generation rates to develop the ADWFs for the Spanish Springs collection system. The County ultimately loaded the model based on individual sub basin potable water consumptive use data.

The initial run of the model produced results which indicate that during operation of the Pebble Creek lift station, downstream pipes and manholes operated at or above capacity for short durations of time. Flow monitoring results, however, did not indicate peak flows which would cause system capacity issues. Subsequently, the County followed up with additional flow monitoring at 15-minute intervals and eventually 1-minute intervals in attempts to validate the hydraulic model. Farr West used this data to investigate the hydraulic model for any limitations which may produce inaccurate estimations of sanitary flows and available system capacities.

Model Results and Remaining Capacity

The County installed flow meters to monitor sanitary flows at 1-minute intervals from April 16th through May 28th at manholes 300724060109 and 300724022102. These manholes, referred to in the data as Ruddy and Eagle, recorded a peak flow of 379.63 gallons per minute (gpm) and 699.13 gpm, respectively. The Ruddy peak flow was recorded on a weekday and the Eagle peak flow was recorded on the weekend. Figure 1 provides a profile for the 32 day flow monitoring at the Ruddy Manhole and Figure 2 provides a profile for the Eagle Manhole for the same period.

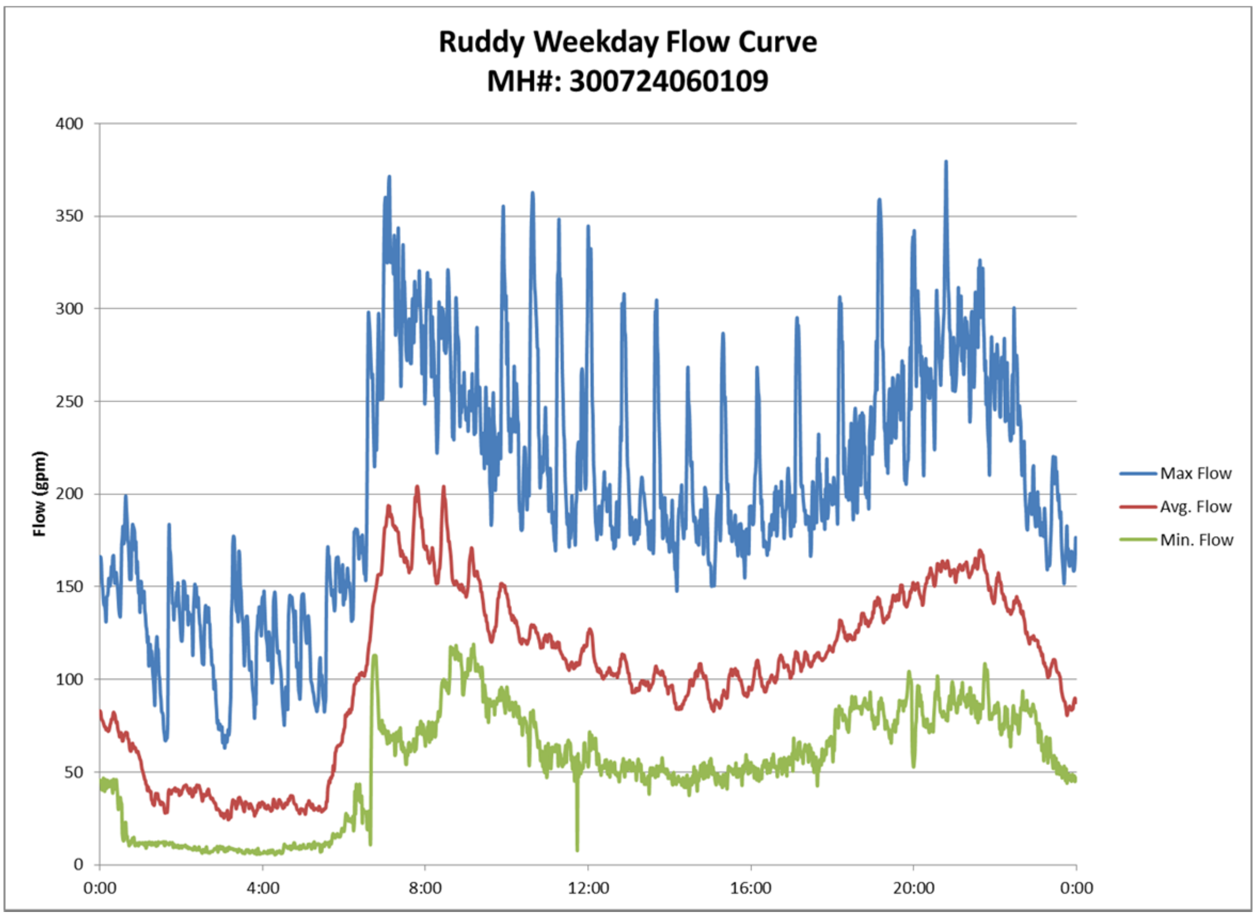


Figure 1 – Ruddy 1-Minute Flow Monitoring

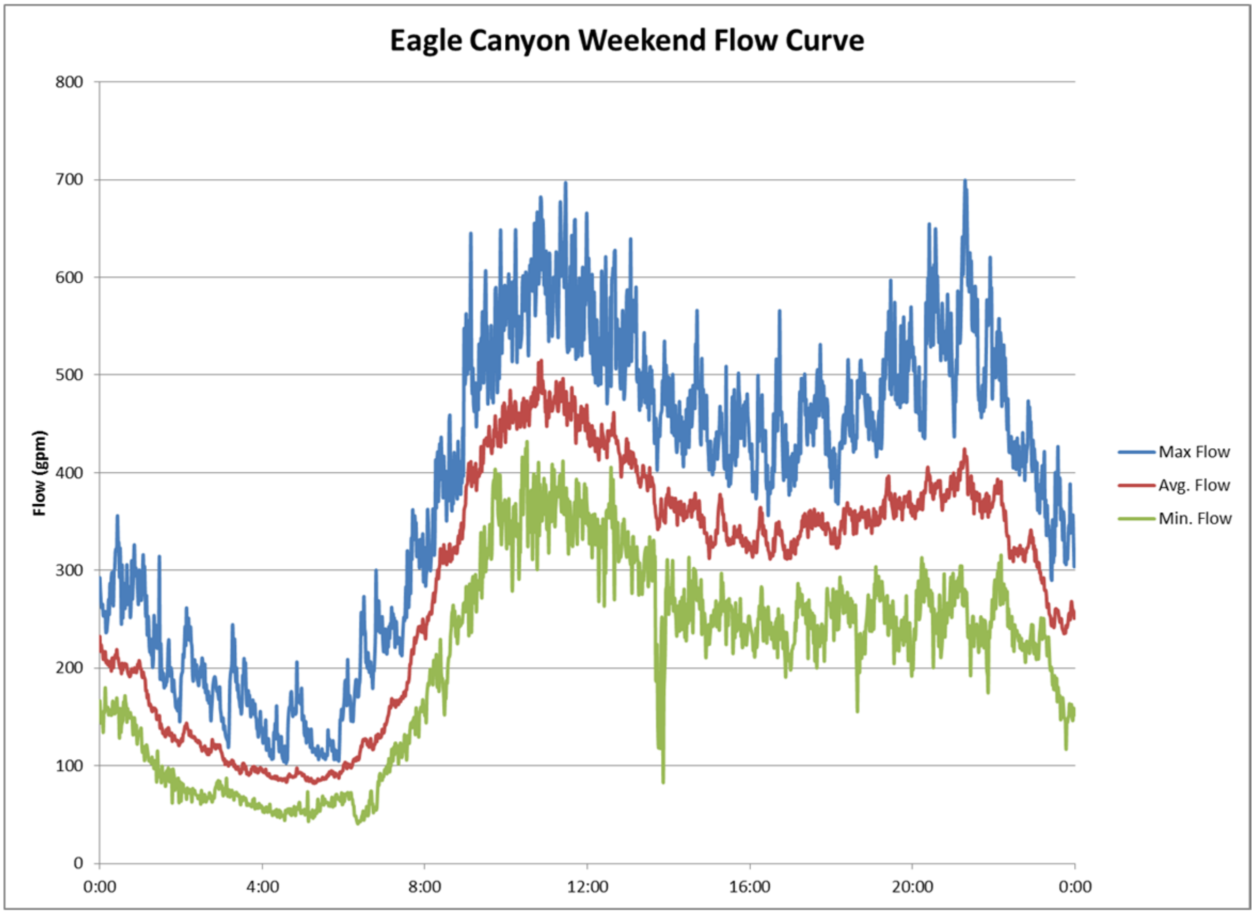


Figure 2 – Eagle 1-Minute Flow Monitoring

Both the Ruddy and Eagle manholes have a single 15-inch PVC pipe in and out of the manhole. Table 1 lists the hydraulic properties of the upstream pipes for the Ruddy and Eagle manholes. According to the 1-minute flow monitoring data, pipes 302406012 and 302402207 have approximately 75.1% and 66.2% capacity remaining for future use.

Table 1 – Flow Monitoring Location Capacity Summary

Pipe: 302406012 (Ruddy)		Pipe: 302402207 (Eagle)	
Material	PVC	Material	PVC
Diameter	15 inches	Diameter	15 inches
Length	309 ft	Length	270 ft
Slope	0.00246 ft/ft	Slope	0.00348 ft/ft
Peak Flow	379.63 gpm	Peak Flow	699.13 gpm
Depth	3.73 inches	Depth	5.06 inches
Depth/Max Depth	0.249	Depth/Max Depth	0.329
% Capacity Remaining	75.1 %	% Capacity Remaining	67.1 %
Maximum Capacity	1,557.73 gpm	Maximum Capacity	1,853.31 gpm

Farr West was provided with the existing model file and supporting flow monitoring data for its investigative efforts. Farr West performed all hydraulic modeling using InfoSWMM by Innovyze®

which utilizes the hydrologic, hydraulic, and flow routing equation(s) developed by the Environmental Protection Agency (EPA) for their Storm Water Management Model (SWMM). Because the existing model was in the InfoSewer format which uses a proprietary flow routing engine, the model required an importation process prior to any analysis being performed. Element geometry, pump and diurnal curves, and ADWF loading all came through the importation process without issue.

Since calculation or run settings do not translate from InfoSewer to InfoSWMM, Farr West performed multiple improvements in this area to provide a stable and representative model in the InfoSWMM format. Using empirical data, record drawing information, testimony from County staff and recommendations from Innovyze experts, Farr West used the options and modeling methods shown in Table 2 to provide a representative model.

Table 2 – Hydraulic Model Settings

Setting	Value
Routing Method	Dynamic Wave
Routing and Reporting Time Step	10 seconds
Inertial Terms	Dampen
Use Normal Flow Limit	Both
Force Main Equation	Hazen-Williams
Variable Time Step	Safety Factor =100% (Default)
Time Step for Conduit Lengthening	3 seconds
Maximum Trials per Time Step	20
Head Convergence Tolerance	0.0001
Hot Start File	Yes
Break Node	Junction: 10 X: 2306791.619692780 Y: 14917739.956544699 Invert Elevation: 4516.73 ft Surcharge Depth: 7.0 ft
Wet Well	Junction: 9002 Invert Elevation: 4486.75 Pipe Invert In: 4487.25

Figure 3 provides a profile of the 24 hour simulated ADWF in Pipe 302406012 upstream of the Ruddy Manhole. The hydraulic model suggests the pipe sees a peak flow of 362.44 gpm at a depth of 3.5 inches with 76.6 percent capacity remaining at peak flow. The hydraulic model provides a peak flow within 4.5 percent of the maximum flow measured during the 1-minute flow monitoring. Additional hydraulic results for Pipe 302406012 can be found in Table 3.

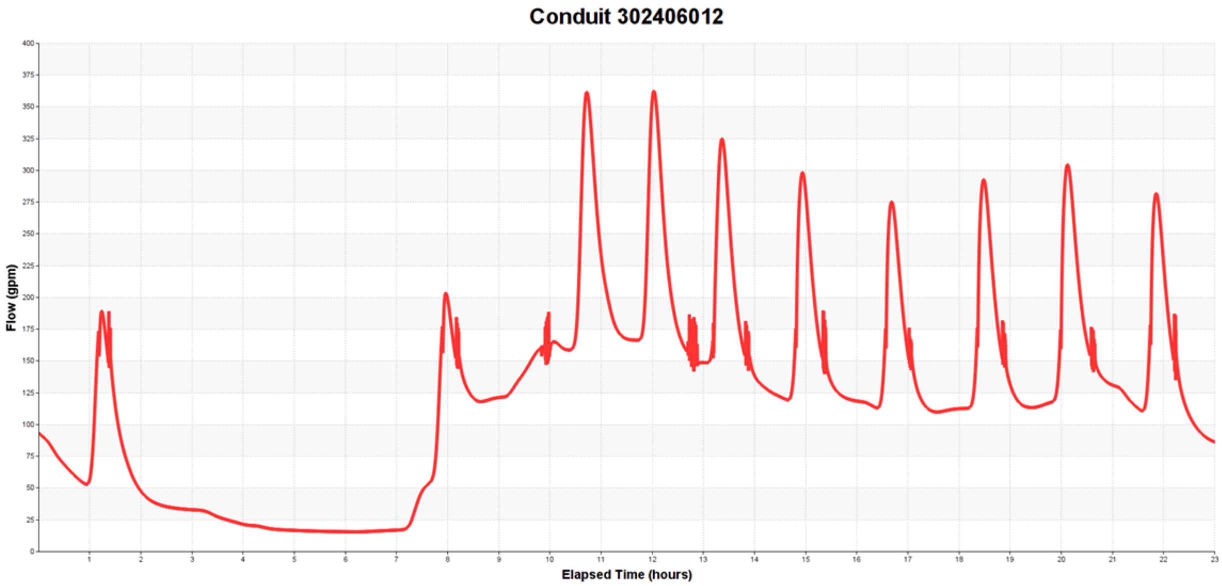


Figure 3 – Ruddy Flow per Hydraulic Model

Figure 4 provides a profile of the 24-hour simulated ADWF in Pipe 302402207 upstream of the Eagle Manhole. The hydraulic model suggests the pipe sees a peak flow of 663.74 gpm at a depth of 6.5 inches with 56.9 percent capacity remaining at peak flow. The hydraulic model provides a peak flow within 5.0 percent of the maximum flow measured during the 1-minute flow monitoring. Additional hydraulic results for Pipe 302402207 can be found in Table 3.

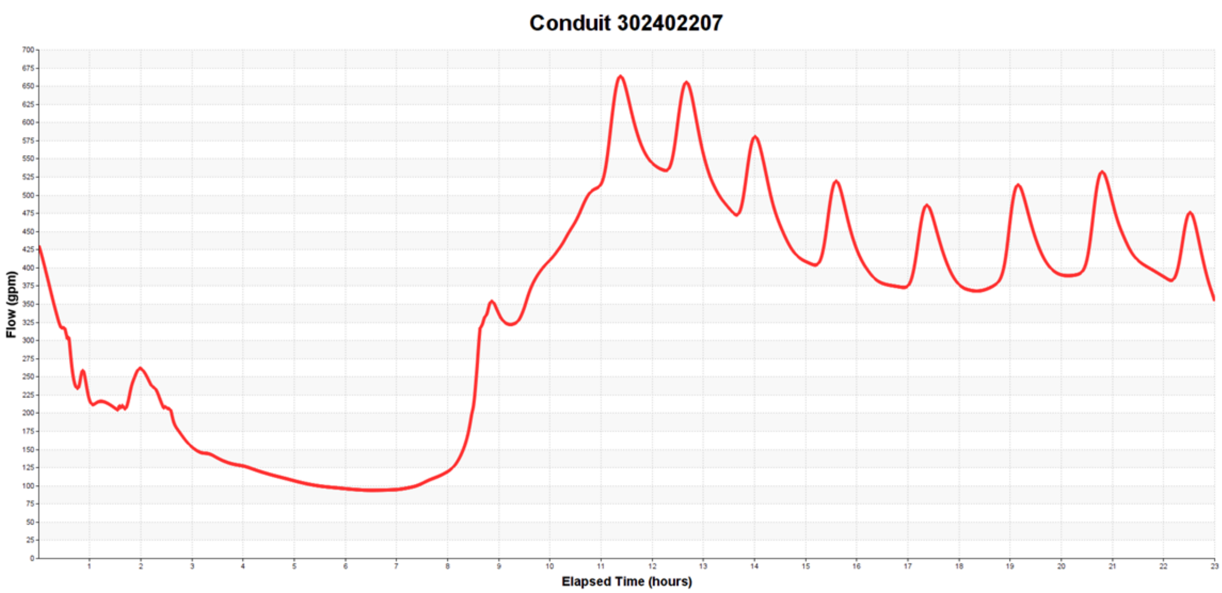


Figure 4 – Eagle Flow per Hydraulic Model

Table 3 – Hydraulic Modeling Results

Pipe: 302406012 (Ruddy)		Pipe: 302402207 (Eagle)	
Material	PVC	Material	PVC
Diameter	15 inches	Diameter	15 inches
Length	309 ft	Length	270 ft
Slope	0.00246 ft/ft	Slope	0.00348 ft/ft
Peak Flow	362.44 gpm	Peak Flow	663.74 gpm
Depth	3.51 inches	Depth	6.47 inches
Depth/Max Depth	0.234	Depth/Max Depth	0.431
% Capacity Remaining	76.6 %	% Capacity Remaining	56.9 %
Maximum Capacity	1,557.73 gpm	Maximum Capacity	1,853.31 gpm

The results presented in Table 3 were presented to the County as part of this evaluation. The County and Farr West were in agreement that the hydraulic model provides an accurate simulation of ADWF for the Spanish Springs collection system. It should be noted that pipe 302401119, located between pipes 302406012 and 302402207, had the highest depth to maximum depth ratio in the system with 38.6 percent capacity remaining during periods of peak flow.

A comparison to the 15-minute flow monitoring data yielded a peak flow tolerance ranging from 1 to 7 percent for five (5) of the seven (7) flow meters, with two of the monitoring sites exceeding 15 percent. The model results for these two manholes are greater than those recorded in the field. This result adds a level of conservatism to the model results.

Summary of Model Improvements

Farr West provided a hydraulic model review which yielded the following findings:

- Simulation time steps needed to be reduced to better simulate the operation of the Pebble Creek lift station.
- The addition of a break node at the discharge end of the force main will ensure that the force main remains full during the length of the simulation and reduce the attenuation affects seen in the original model runs.
- Use of a 'hot start' file will eliminate surges of flow seen during the initial time periods of the simulation.

After Farr West implemented the improvements discussed previously, the model did not exhibit any areas of the system which exceed capacity and provided results very near to empirical data. Model results are now within a 5 percent tolerance of the 1-minute flow monitoring results. The hydraulic model is now a useful tool to assess existing sanitary sewer flows in the Spanish Springs collection system.

Recommendations

Farr West has improved the hydraulic model into an accurate tool with which the County will be able to assess impacts of future development on the Spanish Springs collection system during existing system dry weather flow scenarios. The accuracy of a hydraulic model is always a work in progress due to system aging, service territory expansion, land use changes and population growth/decay. Farr West would recommend the County consider the following improvements to the model:

- Infiltration and Inflow: Even newly constructed systems experience some level of inflow and infiltration (I/I). Whether this is caused by storm events or a high groundwater table, the volume of I/I entering a system will affect the remaining capacity of a system. Extended flow monitoring should be performed during seasonal periods of probable rainfall and high groundwater with data being collected leading up to and after rainfall events. Leakage rates can be derived from the data which will be combined with a variety of storm events to further calibrate the model.
- Buildout: The addition of future development areas to a hydraulic model will provide the County with the ability to accurately assess system capacity restrictions for all flow scenarios. I/I rates can be used to generate peaking factors for wastewater generation rates so that proposed sewer loads can be applied appropriately. Once a buildout scenario is completed, the model will only require updating if significant changes to land use are made or if large developments are proposed.
- Additional Flow Monitoring: Since the average run time for the Pebble Creek lift station is around 2 minutes, additional 1-minute interval flow monitoring could be performed in various sub areas to further calibrate the model. While the County has extensive 15-minute flow monitoring data, the results are unlikely to indicate true peak flows on portions of the system downstream of the Pebble Creek lift station. Modifications to pipe material roughness variables or to the sanitary ADWF loading of the model will bring the hydraulic model results more in line with the larger set of empirical data generated by additional flow monitoring.

Farr West appreciates the opportunity to provide an analysis of the Spanish Springs hydraulic model for the County and is committed to providing any further clarification of the modeling efforts completed and the model results.

Please call me at 775-851-4788 with any questions or comments.

Sincerely,

Lucas Tipton, PE
Project Manager

FARR WEST ENGINEERING

TECHNICAL MEMORANDUM #2

WASHOE COUNTY COMMUNITY SERVICES DEPARTMENT

SPANISH SPRINGS SANITARY SEWER COLLECTION SYSTEM FACILITY PLAN

Prepared For: Alan Jones, P.E., Senior Licensed Engineer

Prepared By: Lucas Tipton, P.E.

Reviewed By: David Hunt, P.E.

Date: July 19, 2016

Subject: **Technical Memorandum No. 2 – Alternatives Evaluation and Preferred Project**

1.0 PURPOSE

The purpose of this memorandum is to develop infrastructure improvement alternatives which provide an adequate sanitary sewer collection system as a result of future development in the Spanish Springs Valley and to recommend a preferred project. The evaluation of project alternatives will include both non-economic and economic components. The non-economic analysis will compare the various project alternatives against a diverse set of criteria, and the economic analysis will include a planning level cost estimate for each project alternative. The most preferred alternative(s) as a result of this evaluation will progress into the development of the capital improvement program (CIP).

This memorandum includes:

- A sanitary sewer collection system analysis summary,
- A capacity assessment after the Buildout and Buildout + Septic flow conditions,
- A non-economic evaluation of improvement project alternatives,
- A comparison of improvement project costs,
- A recommended ranking of improvement projects, and
- A discussion of the preferred project.

2.0 SANITARY SEWER COLLECTION SYSTEM ANALYSIS

The available capacity of the Spanish Springs sanitary sewer collection system (System) has been previously assessed and discussed in Technical Memorandum #1 – Existing and Future Sewer Flows and Model Development (TM #1). A hydraulic model of the System was built in InfoSWMM® by Innovyze® and assessed at an existing condition as well as at four future stages of potential development.

Scenario Number	Scenario Name	Description
1	Buildout	The first stage is after 2,500 acres of undeveloped land comprised of single family residential, commercial or industrial land uses, is developed and shall be referred to as the Buildout flow condition.
2	Buildout + Septic*	The second stage is after all nine phases of the septic to sewer conversion projects are completed and connected to the existing collection system; this shall be referred to as the Buildout + Septic flow condition.
3**	2035	The third condition used projected growth estimates to develop a 20 year flow scenario in the year 2035, and shall be referred to as the 2035 flow scenario
4**	2025	The fourth flow condition was developed for the year when remaining existing system is expected to be exceeded.

* The Buildout + Septic flow condition represents the maximum potential flow for the System.

** Scenarios 3 and 4 do not include any contribution from septic to sewer connections.

3.0 CAPACITY ASSESMENT

The performance of the System was assessed against three discrete criteria:

1. The maximum depth of flow in System pipes or conduits was assessed against the overall diameter of the pipe. The depth to diameter ratio can be abbreviated as d/D, and the maximum allowable value was set at 0.8 or 80%. This value is equivalent to Washoe County Engineering Design Standard 2.1.02.04. Pipes with a d/D ratio exceeding 80% shall be considered to be “surcharged” pipes and in exceedance of their capacity.

2. Inside of manholes it is common for the surface elevation of the sewer flow to exceed the connected top of pipe elevations during events of high flow. Flow surface elevations which exceed a set distance from the ground surface or rim elevation of the manhole is a metric used to measure the “surcharging” of a manhole. Washoe County (County) has set the manhole surcharging limit at 0.0’ or rather any manhole which does not “spill” sewer flows onto the ground surface is not considered to be surcharged.

3. The number of times a lift station pump turns on and off in an hour is an operational guidance set forth by the Nevada Division of Environmental Protection (NDEP) Technical Document WTS-14. The document recommends a minimum of 10 minutes

between successive starts per hour, which is approximately equivalent to less than 6 starts per hour.

3.1 EXISTING

In the existing flow condition, there are not any pipes or manholes which exceed their capacity criteria as stated above. Further investigation of hydraulic profiles and maximum depths inside upstream and downstream manholes further supports this conclusion. The maximum number of pump starts per hour was determined to be 1, which is well below the recommended limit.

3.2 BUILDOUT

In the Buildout condition, conduit summary results indicate 5 pipes which exceed a d/D ratio of 80%. The asset ID's for these pipes are 302401122, 302401121, 302401120, 302401119, and 302402024. Further investigation of hydraulic profiles and maximum flow depths inside upstream and downstream manholes indicate that there are 3 additional pipes which exceed the 80% d/D criteria at either the upstream or downstream end of the pipe for a period of time during the 24-hour simulation. The maximum d/D relationships found for these pipes are detailed in Table 1.

Table 1 – Pipes Which Exceed Capacity Criteria in the Buildout Flow Condition

Pipe	Buildout Max d/D* (%)	Buildout Max d/D Calculated** (%)	Max Upstream End d/D*** (%)	Max Downstream End d/D*** (%)
302401119	100	100	100	100
302401121	100	77	100	100
302401120	100	100	100	100
302401122	89	82	86	99
302402024	82	100	79	86
302401118	79	100	100	55
302402023	74	100	90	57
302401221	74	100	93	56

* d/D value generated by InfoSWMM
** d/D value calculated using Manning's Equation
*** d/D value calculated from hydraulic grade line profile analysis by Professional Engineer

The flow depth to manhole rim variable is greater than zero for all system manholes, and the Pebble Creek lift station is projected to start a maximum of 4 times per hour during peak flow. Alternative improvement projects will be created to replace the pipes listed in Table 1 and resolve the system capacity exceedance caused by the Buildout flow condition. For additional information on the location of the surcharged pipes, please refer to Figure 1.

3.3 BUILDOUT + SEPTIC

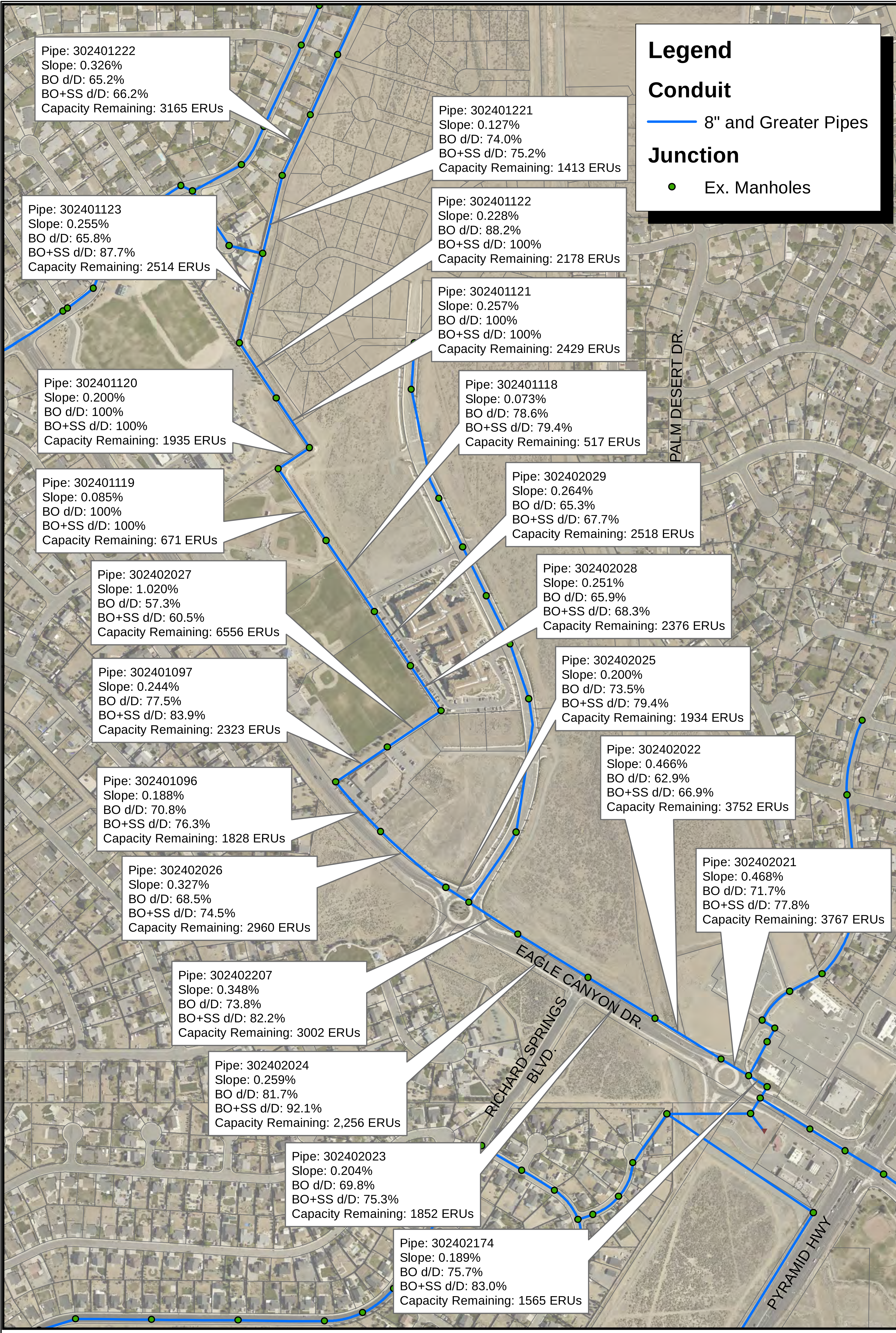
In the Buildout + Septic condition, conduit summary results indicate 8 pipes which exceed a d/D ratio of 80%. The asset ID's for these pipes are 302401122, 302401121, 302401120, 302401119, 302402024, 302401123, 302401097, and 302402174. Further investigation of hydraulic profiles and maximum flow depths inside upstream and downstream manholes indicate that there are 4 additional pipes which exceed the 80% d/D criteria at either the upstream or downstream end of the pipe for a period of time during the 24-hour simulation. The maximum d/D relationships found for these pipes are detailed in Table 2.

Table 2 – Pipes Which Exceed Capacity Criteria in the Buildout + Septic Flow Condition

Pipe	Buildout Max d/D* (%)	Buildout Max d/D Calculated** (%)	Max Upstream End d/D*** (%)	Max Downstream End d/D*** (%)
302401119	100	100	100	100
302401121	100	81	100	100
302401120	100	100	100	100
302401122	89	100	100	100
302402024	82	100	92	95
302401118	79	100	100	58
302402023	74	100	99	61
302401221	74	100	95	60
302401096	76	100	93	52
302401123	88	79	79	100
302401097	84	100	81	88
302402174	83	100	89	78

* d/D value generated by InfoSWMM
** d/D value calculated using Manning's Equation
*** d/D value calculated from hydraulic grade line profile analysis by Professional Engineer

The flow depth to manhole rim variable is greater than zero for all system manholes and the Pebble Creek lift station is projected to start a maximum of 4 times per hour during peak flow. Alternative improvement projects will be created to replace the pipes listed in Table 2 and resolve the system capacity exceedance caused by the Buildout + Septic flow condition. For additional information on the location of the surcharged pipes please refer to Figure 1.



The data contained herein does not represent survey delineation and should not be construed as a replacement for the authoritative source. No liability is assumed by Farr West Engineering as to the sufficiency or accuracy of the data.

N
1 " = 417 '

Figure 1 - Area of Interest Capacity Summary

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Reno, NV 89511
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4.0 ALTERNATIVES ANALYSIS

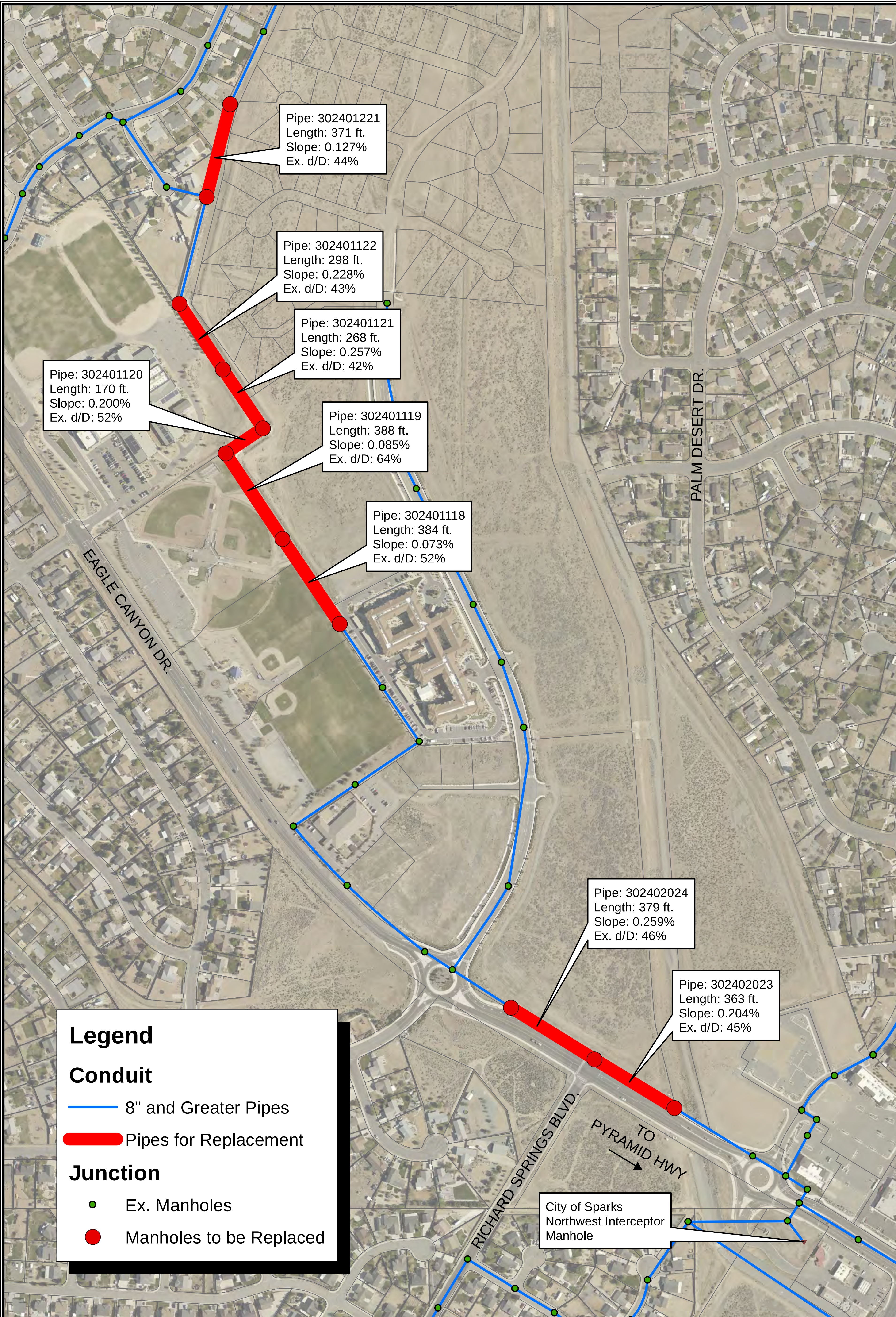
Three project alternatives have been created to address the system capacity issues found at either the Buildout or the Buildout + Septic flow conditions. The evaluation of each alternative will include a non-economic and economic component provided in Sections 4.2 and 4.3, respectively.

4.1 DESCRIPTION OF ALTERNATIVES

Project 1

Alternative Project 1 consists of upsizing surcharged pipes caused by the Buildout flow condition. Engineering analysis has identified eight pipes along a 5,500 linear feet (lf) section of 15-inch interceptor which exceed a d/D relationship of 80%. The proposed improvements will replace the eight existing 15-inch diameter pipes with 21-inch diameter pipes installed at the same slope as the existing sewer interceptor. Any manhole which is connected to the proposed 21-inch pipe will be replaced as well with a 60-inch diameter Type V manhole.

In general, the alignment sits adjacent to an existing residential neighborhood, a middle school, a park, and a roadway with vacant property to the northeast. The majority of the alignment is located in an unpaved corridor and provides a conducive environment for construction, maintenance and other activities requiring access. The replacement of pipes 302402024 and 302402023 will include the removal and replacement of approximately 50 lf of concrete sidewalk and 1,000 lf of an asphalt paved walking path. For further information see Figure 2.



The data contained herein does not represent survey delineation and should not be construed as a replacement for the authoritative source. No liability is assumed by Farr West Engineering as to the sufficiency or accuracy of the data.

N
1 " = 350 '

Figure 2 - Project 1: Meets Buildout Flow Condition

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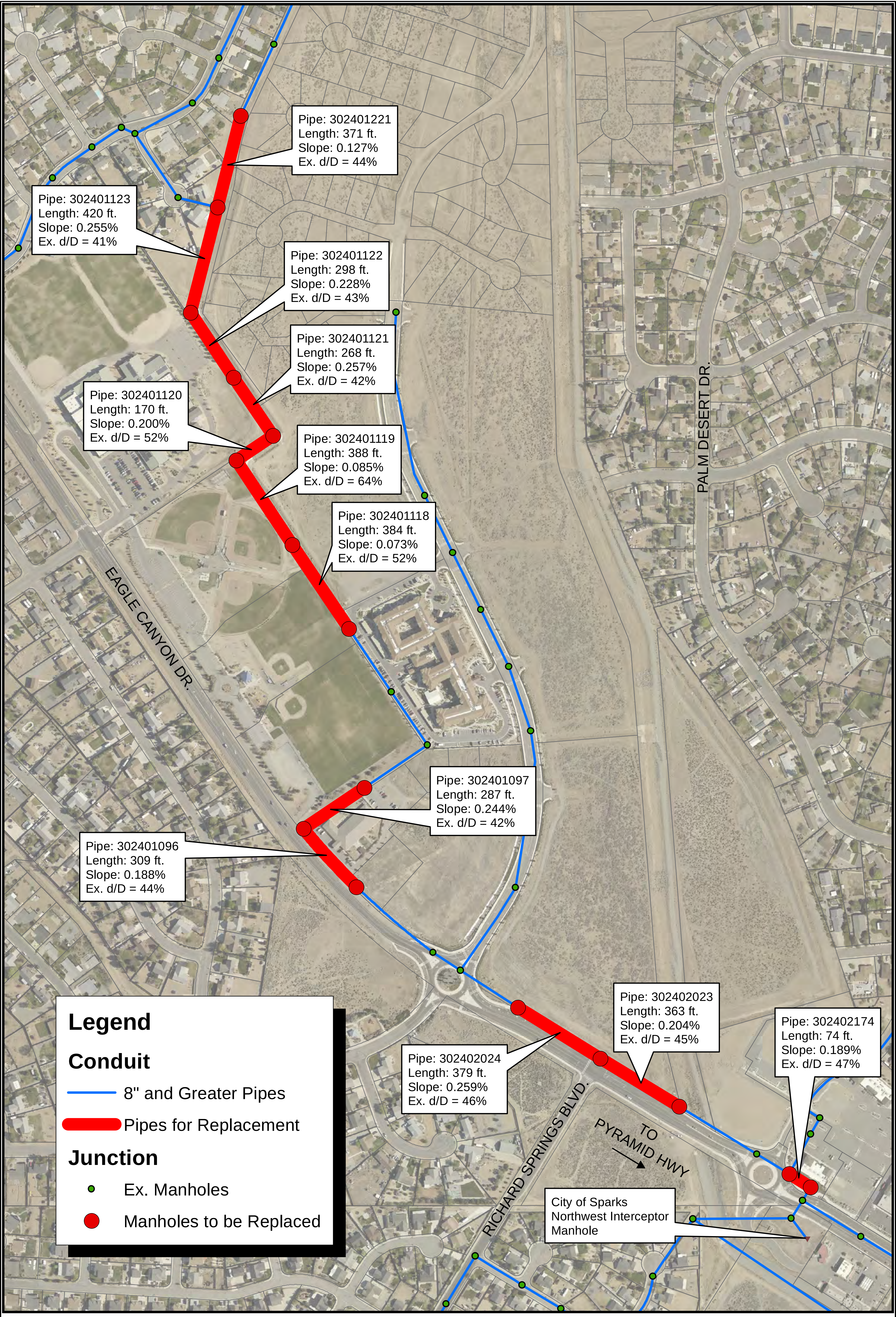
Project 2

Alternative Project 2 consists of upsizing surcharged pipes caused by the Buildout + Septic flow condition. Model results identified eight pipes along a 6,200 lf section of 15-inch interceptor which exceed a d/D relationship of 80%. The proposed improvements will replace the eight existing 15-inch diameter pipes with 21-inch diameter pipes installed at the same slope as the existing sewer interceptor. Any manhole which is connected to the proposed 21-inch pipe will be replaced as well with a 60-inch diameter Type V manhole.

In general, the alignment is in the same location as Project 1 with more pipe installed along Eagle Canyon Dr. There is a single 75-foot long pipe (Pipe 302402174) near the Eagle Canyon commercial development on Eagle Canyon Dr. which will require more rehabilitation to disturbed hardscaped and landscaped areas than that of the remainder of the alignment. The alignment does provide a conducive environment for construction, maintenance and other activities requiring access. See Figure 3 for further detail.



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N

1 " = 350 '

Figure 3 - Project 2: Meets Buildout + Septic Flow Condition

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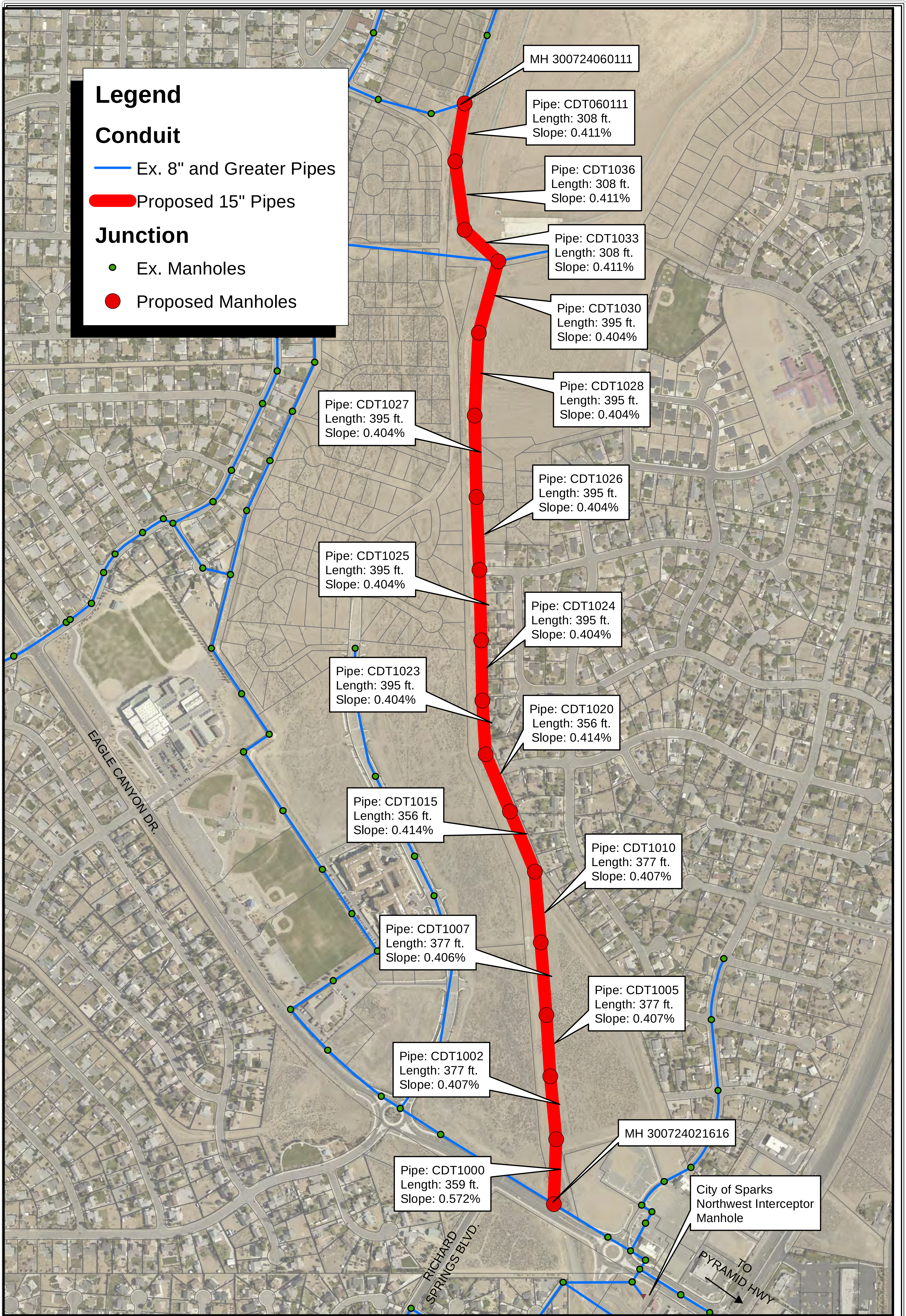
Project 3

Project 3 proposes a new 15-inch interceptor connected to existing manholes 330724060111 and 300724021616. At manhole 330724060111 sewer flows will be split into the new 15-inch interceptor and the existing 15-inch interceptor. At a location near manhole 300724021616, flows will be combined to route through existing infrastructure until it reaches the City of Sparks Northwest Interceptor terminal manhole. The new interceptor will be installed at a minimum slope of 0.004 ft/ft or greater for a length of approximately 6,300 lf. The design and construction of the flow splitting structure inside of manhole 330724060111 will ultimately determine the distribution of flow between the existing and proposed 15-inch interceptors.

The alignment will be installed entirely inside of an existing Washoe County parcel (APN: 532-020-04) which currently contains an unpaved, unlined drainage channel. The existing channel has an access road along its entire length which could also be used for sewer interceptor access. Ground survey and preliminary design will alter the alignment as shown on Figure 4 with the location of the terminal connection manhole likely to be placed further downstream than that of existing manhole 300724021616.

The new interceptor will also include the installation of eighteen 48-inch diameter Type 1A manholes, ranging from 5-feet deep to more than 18-feet deep. After construction of Project 3, all pipes in the system will be kept under the 80% d/D criteria in the Buildout flow condition. In the Buildout + Septic flow condition there is a single pipe which will slightly exceed the pipe surcharge criteria.



The data contained herein does not represent survey delineation and should not be construed as a replacement for the authoritative source. No liability is assumed by Farr West Engineering as to the sufficiency or accuracy of the data.

N

1 " = 500 '

Figure 4 - Project 3: 15" Parallel Interceptor

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4.2 Non-Economic Evaluation Method

The infrastructure improvement alternatives will be evaluated using a matrix comparison. The matrix will be used as a tool to identify the best alternative relative to the competing alternatives based on direct comparison. This section includes a brief description of the methodology used for the comparison. Descriptions of the various criteria and the specific weighting assigned to each criterion are discussed in the sections below.

Each alternative under consideration is scored based on a number of criteria developed by the project team. The relative value assigned to each criterion determines its importance, or weight, compared to the other criteria used in the evaluation. Ultimately, a final score will be summed for each alternative based on the alternative's ranking and the weighting of the criterion. This final score represents the alternative's overall ranking relative to the other alternatives with a higher score being preferable to a lower one. The final score will be used in the selection of the recommended alternative(s).

Each set of criteria and subcriteria will be assigned a weight based on the importance to the project as a whole, with a maximum of ten (10), representing critical importance, and a minimum of zero (0), representing least importance. Table 3 presents the scale used in the weighting of criteria.

Table 3 – Criteria/Subcriteria Weighting Scale

Verbal Scale	Numeric Scale
Critical	10
Very Important	7.5
Important	5
Less Important	2.5
Least Important	0

The sections below describe in more detail the weighting of the primary evaluation criteria and subcriteria.

4.3 Non-Economic Evaluation Criteria and Subcriteria

Seven non-economic evaluation criteria have been chosen to assess each alternative project. The seven evaluation criteria used were:

1. Right of Way Requirements
2. Constructability
3. Capacity Criteria
4. Design Criteria
5. Permitting
6. Operations and Maintenance
7. Timing of Improvements

This section will include a brief description of the weighting convention and ranking methodology used for this analysis.

Table 4 applies the weighting scale in Table 3 to each of the seven evaluation criteria listed above. The “Priority” in Table 4 represents a normalization of the weighting, which reflects the relative contribution that a particular criterion has on the overall ranking relative to the other criteria. This priority is expressed as a percentage of the sum of all criterion weights. In this case there are seven criteria categories that were weighted separately. These priorities reflect the total criteria scoring, equaling 100 percent.

Table 4 –Evaluation Criteria Weights and Priorities

Criteria	Weight	Priority
Right of Way Requirement	5	11.1%
Constructability	10	22.2%
Capacity Criteria	7.5	16.7%
Design Criteria	7.5	16.7%
Permitting	5	11.1%
Operations and Maintenance	7.5	16.7%
Timing of Improvements	2.5	5.6%
Total	**47.5**	**100%**

The seven main criteria listed above were broken down into a total of twenty-two (22) subcriteria, which are specific characteristics used to compare how well each alternative alignment meets each criterion. Each subcriterion was assigned a weight and a priority was calculated, similar to the seven main criteria (as described above). Finally, a matrix weight was calculated for each subcriterion. The matrix weight represents the weight of which a particular subcriterion carries compared to all other subcriteria identified in the analysis. The subcriterion matrix weight is based on the product of the subcriterion priority and the criterion priority. The overall matrix weight for each criterion is equal to that criterion’s priority. The matrix weight remains constant through the evaluation, unless criteria or subcriteria weighting is modified. Table 5 below summarizes the subcriteria weights, priorities, and matrix weights for the infrastructure improvement alternatives.

Ultimately, the last step in the evaluation will be to rank each of the alternative projects against each subcriterion and calculate the resulting score. For example, there are three alternative projects, and for each subcriterion an alignment will be ranked relative to how well it compares on a range from one (1) to three (3), with three representing the highest rank. The score for a given subcriterion is the rank divided by the number of alternatives and then multiplied by the matrix weight. These scores are then summed for all subcriterion for each alternative project to determine the highest scoring alternative.

Table 5 – Evaluation Subcriteria Weights, Priorities, and Matrix Weights

Subcriteria	Weight	Priority	Matrix Weight
Right of Way Requirements Weight = 5, Priority = 11.1%			
Existing Easement	5	18%	2.0
Length of Easement	5	18%	2.0
Temporary Construction Easement	7.5	27%	3.0
Area of Land to be Acquired	7.5	27%	3.0
Number of Adjacent Land Owners Affected	2.5	9%	1.0
Subtotal	27.5	100%	11.1
Constructability Weight = 10, Priority = 22.2%			
Bypass Pumping Required	5	15%	3.4
Traffic Control	5	15%	3.4
Special Construction Required	7.5	23%	5.1
Volume of Hardscape to be Replaced	5	15%	3.4
Depth of Installation	10	31%	6.8
Subtotal	32.5	100%	22.2
Capacity Criteria Weight = 7.5, Priority = 16.7%			
Pipe Surcharge Criteria met during BO Scenario	10	36%	6.1
Pipe Surcharge Criteria met during BO+Septic Scenario	7.5	27%	4.5
Manhole Surcharge Criteria met during all Flow Scenarios	5	18%	3.0
Maximum Lift Station Starts per Hour	5	18%	3.0
Subtotal	30	100%	16.7
Design Criteria Weight = 7.5, Priority = 16.7%			
Minimum Velocity	10	100%	16.7
Subtotal	10	100%	16.7
Permitting Weight = 5, Priority = 11.1%			
NDOT Permitting Required	5	50%	5.6
Environmental Permitting Required	5	50%	5.6
Subtotal	10	100%	11.1
Operations and Maintenance Weight = 7.5, Priority = 16.7%			
Level of Operator Attention	7.5	30%	5.0
Potential for Flushing	5	20%	3.3
Accessibility	7.5	30%	5.0
Operational Redundancy	5	20%	3.3
Subtotal	25	100%	16.7
Timing of Improvements Weight = 2.5, Priority = 5.6%			
Year of Replacement	2.5	100%	5.6
Subtotal	12.5	100%	14.3

Right of Way Requirements

Right of way (ROW) is an important criterion in determining the most preferred alternative project. By locating the corridor in a Public ROW or an existing easement, it reduces the potential for environmental impacts, property owner opposition, and legal project costs. A project which does not require the purchase of any permanent easement will preferred over a project which does. The length of easement will be determined from the length of pipe replaced, with a shorter length of pipe being preferred over a larger quantity. Temporary construction easements may also be required for any project which is adjacent to existing roadway or is accessed via private parcels. Each alternative project's requirement for property acquisition shall also be assessed as part of this criterion. A smaller area of land required will be preferable to a larger area and public or open space land uses will be preferred to that of private and residential type uses. And the final subcriterion will be evaluated on a basis which values fewer adjacent land owners over more.

Project 3 appears to have a reduced ROW or construction easement requirement to that of the other projects since the project is inside of an existing Washoe County parcel (APN: 532-020-04) and an access road already exists within the property boundary. Projects 1 and 2 will replace existing pipes and manholes in their current locations and should not require the acquisition of any property for the improvements to be constructed. The existing pipe is within a 20-foot wide sanitary sewer easement (parcel map 3952) for both projects. Project 3 will not have any length requirement for easements and Project 1 will have a shorter length of easement required than that of Project 2. Of note should be that the alignment of Project 3 is subject to change from the planning level alignment shown on Figure 4.

The need for temporary construction easements can be highly variable depending on the final engineering design and the capabilities of the contractor. However this analysis presumes that the Project 3 will not have a requirement for temporary construction easements since available space exists on APN: 532-020-04. Also Projects 1 and 2 are presumed to have an equivalent need for temporary construction easements.

Since land acquisition is not required by any of the three project alternatives, there is not a preference for any alternative as a result of this subcriterion. Project 1 transects the parcel lines of an existing residential development, a middle school, a public park, and three large unimproved private parcels zoned medium density suburban, neighborhood commercial and commercial. Project 2 affects the same parcels as Project 1 as well as two additional improved private parcels zoned neighborhood and general commercial. Project 3 is entirely contained in a single parcel zoned unbuildable and is owned by Washoe County. The alternative ranking for this subcriterion will be Project 3, Project 1, and finally Project 2.

Constructability

Constructability issues could have a significant impact on the project cost as well as future operation and maintenance. Projects which require a large amount of bypass pumping, service interruptions, special construction methods (i.e. jack and bore, directional drilling) and the removal and replacement of multiple types of surface coverings (i.e. asphalt, concrete sidewalk) are less preferred to projects which do not. Project 3 really stands out in this evaluation since the construction is proposed in an unpaved existing access road and would not require any bypass pumping or interruptions to the conveyance of wastewater flows. Project 3 also does not require as extensive of traffic control as the other projects during construction activities due to its location.

Also, deeper sewer pipes and manholes are typically more difficult and costly to inspect, repair and construct making them less preferred to that of a shallower sewer main. Table 6 details the depth of sewer pipes for each project alternative broken into four groups by depth: 0-10 feet, 10-15 feet, 15-20 feet, and 20+ feet.

Table 6 – Alternative Project Sewer Depths

Project	Pipe Length (0'-10' deep) (ft)	Pipe Length (10'-15' deep) (ft)	Pipe Length (15'-20' deep) (ft)	Pipe Length (>20' deep) (ft)	Total Length (ft)
1	566	1,313	742	-	2,621
2	566	1,733	1,103	309	3,711
3	3,270	2,630	370	-	6,270

It is anticipated that all of the alternative projects will be able to be constructed via conventional open trench construction. Based on this analysis Project 3 would be the most preferred, followed by Project 1, and finally Project 2.

Capacity Criteria

The capacity of the improved system was assessed against the surcharged pipe and manhole criteria discussed in Section 3.0 after the construction of each project alternative. A project which provides pipe and manhole surcharging depths below operational criteria standards would be preferred over a project which does not. All three projects will meet the capacity criteria in the Buildout flow condition.

After Project 1 is constructed, three pipes totaling 670 lf will still exceed an 80% d/D relationship during the Buildout + Septic flow condition. Project 3 improvements will still result in a single 74 lf pipe which exceeds the 80% d/D relationship in the Buildout + Septic flow condition. And finally, Project 2 will bring the entire System into conformance with the Buildout + Septic flow condition.

Design Criteria

This document will use the Washoe County Gravity Sewer Collection Design Standards as the design criteria for the alternative project evaluation. This included a minimum pipe size of 8-inches or greater in diameter, maintaining a depth of flow below 80% d/D, a manning's n value of 0.012 for PVC pipe and spacing new manholes no more than 400-feet apart.

The design standard does not specify a minimum slope per se; instead it references the minimum slope as the slope of pipe which maintains a flow velocity of at least 2.5 fps when flowing half full. Results and calculations provided in this section as well as Appendix A will provide further discussion on this topic. In general, a minimum design slope of 0.004 ft/ft was used for Project 3 and Projects 1 and 2 included pipes replaced at existing slopes, some of which are less than 0.004 ft/ft.

Project 1 replaces eight pipe sections with new 21-inch pipes which resulted in a maximum d/D of 58% for the improved pipes in the Buildout flow scenario. Pipe 302401120 is at a slope of 0.002 ft/ft and reaches a maximum velocity of 2.67 fps and a maximum d/D relationship of 49%. However, calculations using manning's formula suggest that pipe 302401120 would exceed 3.0 fps when flowing half full. This discrepancy is an example of the hydraulic modeling software providing a more thorough analysis than that which would be typically required for design. Of the eight pipes replaced in Project 1; pipes 302401119 and 302401118 have half full velocities less than 2.5 fps per manning's formula, and pipe 302401119 also has a maximum velocity less than 2.5 fps per hydraulic model results. Only pipe 302401119 will be considered to be under the flow velocity criterion. Summary tables of d/D and velocity values have been provided in Appendix A for additional detail.

Project 2 replaces twelve pipe sections with new 21-inch pipes which results in a maximum d/D of 60% for the improved pipes in the Buildout + Septic flow scenario. Pipe 302401120 is at a slope of 0.002 ft/ft and reaches a maximum velocity of 2.7 fps at a d/D of 56%. As with Project 1, alternate calculations suggest that this pipe will exceed 3.2 fps when flowing half full. Pipe 302401119 is at a slope of 0.00085 ft/ft and reaches a maximum velocity of 2.23 fps at a d/D of 60%. Like Project 1, this pipe is significantly below the flow velocity criterion.

Project 3 installs a parallel 15-inch interceptor to the east of the existing interceptor and maintains a maximum d/D relationship of 51% in the Buildout + Septic flow condition in the new pipes. Maximum flow velocities for all pipes are maintained greater than 3.4 fps for this flow condition. These results assume a split flow condition where the existing interceptor to the west will still be used to convey flow. This will be accomplished by designing and constructing a flow splitting manhole or vault in place of manhole 300724060111. To be considered in the design of this structure is to maintain enough flow in the existing interceptor to keep velocities as high as possible. Model results indicate that the existing interceptor will have 8 pipes flowing at a velocities less than 2.5 fps in the Buildout condition, and 6 pipes flowing less than 2.5 fps in the Buildout + Septic flow condition.

The result of this criterion is that Projects 1 and 2 are preferred to that of Project 3.

Permitting

Special permitting does not appear to be a significant factor for any of the four alternatives. NDOT encroachment permits or environmental permitting (i.e. NEPA, etc.) do not appear to be needed at this time. Standard permits such as Washoe County permitting and NDEP permitting will be similar for all alternatives.

Operations and Maintenance

The operations and maintenance (O&M) of sewer mains is a significant consideration in the overall project evaluation and preliminary design. This criterion attempts to evaluate for each alternative the degree of maintenance, accessibility, and operational flexibility for each project alternative in order to determine the O&M rankings.

Since all projects include similar components, the level of operator attention for maintenance and operations is similar for all project alternatives. This analysis will presume that the addition of assets to the System will also increase the level of operator attention. For this reason Projects 1 and 2 will be preferred to that of Project 3.

Another item which provides a potential for increased maintenance and/or repairs is flushing activities. Flushing of sewer interceptors is accomplished by providing a high pressure water jet into the main to move solids through the clogged pipe. These activities can be costly and labor intensive for operations staff or subcontractors hired by the County. For this subcriterion, alternative Project 3 ranks ahead of Projects 1 and 2. This is because Project 3 allows for flushing of existing pipes with regular System flows and not special equipment flushing via special equipment. With a simple modification in the flow splitting manhole, 100 percent of average System flows can be routed down the existing interceptor and provide a higher velocity flow to flush out existing 15-inch pipes.

All projects have very accessible locations with Project 3 being preferred to that of Project 1 and 2. Project 3 has an existing access road and would not require any traffic control or cause any public impact for repair and maintenance activities. Project 3 also provides the greatest level of operational redundancy or flexibility to that of Projects 1 and 2. This is because Project 3 will construct a new interceptor in addition to the existing interceptor, and Washoe County would have the ability to route all flow through either of the interceptors to accommodate repair or improvement activities. For all of the reasoning previously provided, Project 3 is the most preferred alternative on a future O&M basis.

Timing of Improvements

The existing 15-inch interceptor was installed in 1995 through 1997. The pipes installed have an anticipated useful life of 100 years and the manholes have an anticipated useful life of 50 years. Therefore, the scheduled date of replacement of the existing interceptor is sometime between 2045 and 2095. The date of which a project alternative is constructed can significantly affect the preference of one alternative over another. Analysis detailed in TM #1 predicts that the remaining capacity of the existing System will be exceeded by 2025. This date of exceedance is not close enough to the expected date of replacement to provide any benefit from Project 1 or 2. This criterion results in an equivalent ranking for all three infrastructure improvement alternatives.

4.4 NON-ECONOMIC EVALUATION RESULTS

This section includes the scored evaluation of infrastructure improvement alternatives. The main objective of this evaluation is to compare and rank alternatives, evaluate the non-economic impacts, and to identify a recommended preferred alternative for Washoe County to use in future capital improvement planning efforts. The results of this analysis are only a recommendation and may vary from the preferred alternative of Washoe County. Table 7 provides a summary of the weight and priority for each criterion and subcriterion, their associated matrix weights, and presents the overall score for each alternative.

TABLE 7 - NON ECONOMIC EVALUATION - IMPROVEMENT ALTERNATIVES

Criteria			Subcriteria									
Criteria	Weight	Priority (%)	Subcriteria	Weight	Priority (%)	Matrix Weight	Project 1		Project 2		Project 3	
							Rank	Score	Rank	Score	Rank	Score
ROW Requirements	5	11.1%	Existing Easement	5	18.2 %	2.0	2	1.3	2	1.3	3	2.0
			Length of Easement	5	18.2 %	2.0	2	1.3	1	0.7	3	2.0
			Temporary Construction Easement	7.5	27.3 %	3.0	2	2.0	2	2.0	3	3.0
			Area of Land to be Acquired	7.5	27.3 %	3.0	3	3.0	3	3.0	3	3.0
			Number of Adjacent Land Owners Affected	2.5	9.1 %	1.0	2	0.7	1	0.3	3	1.0
			Sub-total	**27.5**	**100.0 %**	**11.1**		**8.4**		**7.4**		**11.1**
Constructability	10	22.2%	Bypass Pumping Required	5	15.4 %	3.4	2	2.3	2	2.3	3	3.4
			Traffic Control	5	15.4 %	3.4	2	2.3	1	1.1	3	3.4
			Special Construction Required	7.5	23.1 %	5.1	3	5.1	3	5.1	3	5.1
			Volume of Hardscape to be Replaced	5	15.4 %	3.4	2	2.3	1	1.1	3	3.4
			Depth of Installation	10	30.8 %	6.8	3	6.8	1	2.3	2	4.6
			Sub-total	**32.5**	**100.0 %**	**22.2**		**18.8**		**12.0**		**19.9**
Capacity Criteria	7.5	16.7%	Pipe Surcharge Criteria met during BO Scenario	10	44.4 %	7.4	3	7.4	3	7.4	3	7.4
			Pipe Surcharge Criteria met during BO+Septic Scenario	7.5	33.3 %	5.6	1	1.9	3	5.6	2	3.7
			Manhole Surcharge Criteria met during all Flow Scenari	5	22.2 %	3.7	3	3.7	3	3.7	3	3.7
			Sub-total	**22.5**	**100.0 %**	**16.7**		**13.0**		**16.7**		**14.8**
Design Criteria	7.5	16.7%	Minimum Velocity	10	100.0 %	16.7	3	16.7	3	16.7	1	5.6
			Sub-total	**10**	**100.0 %**	**16.7**		**16.7**		**16.7**		**5.6**
Permitting	5	11.1%	NDOT Permitting Required	5	50.0 %	5.6	3	5.6	3	5.6	3	5.6
			Environmental Permitting Required	5	50.0 %	5.6	3	5.6	3	5.6	3	5.6
			Sub-total	**10**	**100.0 %**	**11.1**		**11.1**		**11.1**		**11.1**
O & M	7.5	16.7%	Level of Operator Attention	7.5	30.0 %	5.0	3	5.0	3	5.0	1	1.7
			Potential for Flushing	5	20.0 %	3.3	2	2.2	2	2.2	3	3.3
			Accessibility	7.5	30.0 %	5.0	2	3.3	2	3.3	3	5.0
			Operational Redundancy	5	20.0 %	3.3	2	2.2	2	2.2	3	3.3
			Sub-total	**25**	**100.0 %**	**16.7**		**12.8**		**12.8**		**13.3**
Timing of Improvements	2.5	5.6%	Year of Replacement	2.5	100.0 %	5.6	3	5.6	3	5.6	3	5.6
			Sub-total	**2.5**	**100.0 %**	**5.6**		**5.6**		**5.6**		**5.6**
Total	**45**	**100%**				**Total**		**86.3**		**82.2**		**81.4**

Weight = value assigned to given criterion (or subcriterion) with respect to the other criteria (or subcriteria).

Priority = the value of weights after normalization.

Matrix Weight = the subcriterion priority multiplied by the criterion priority.

4.5 COST COMPARISON

The comparative construction costs for each project alternative are summarized in Table 8. Detailed planning level cost estimates for each alternative were developed using Farr West Engineering's cost estimating data base for similar projects in Northern Nevada, recent bids and the 2014 Washoe County Bond Estimate Unit Pricing (Exhibit A). Estimates including administrative and design costs can be found in Appendix B.

Table 8 – Alternative Project Comparative Costs

Alternative	Comparative Cost ($)	Differential ($)
Project 1	568,440	-
Project 2	828,186	259,746
Project 3	858,046	289,606

4.6 ALTERNATIVES RANKING

Project 1 is the least costly alternative and scored highest in the non-economic evaluation. A drawback to Project 1 is that pipes in the System will still exceed 80% d/D in the Buildout + Septic flow condition. However, the probability is low that all nine phases of the septic to sewer conversion project will be constructed in the next 20 years. Project 2 is less preferred due to significantly higher construction costs and Project 3 scored the lowest out of all three projects in the non-economic evaluation. Table 9 provides a summary of the final alternative project rankings.

Table 9 – Alternative Project Ranking

Alternative	Rank	Score	Comparative Cost ($)	Differential ($)
Project 1	1	86.3	568,440	-
Project 2	2	82.2	828,186	259,746
Project 3	3	81.4	858,046	181,260

5.0 PREFERRED PROJECT

This Facility Plan has concluded that a single improvement project will be needed to collect, pump and convey wastewater flows for an additional 3,303 ERUs in the Spanish Springs service area. However, existing system capacity will first be exceeded after 1,135 ERUs are added to the System as a result of development, expected to occur by the year 2025. Since there is not a large number of future improvement projects to implement, a standard 5 or 10-year CIP is not warranted for this document. Instead, this section will discuss Project 1 in further detail.

It is recommended that Washoe County pursue the design and construction for the replacement of eight gravity sewer pipes and eleven existing sewer manholes by the year 2025. Starting just southeast of the intersection of Eagle Canyon Dr. and Richard Springs Blvd., existing 15-inch pipes 302402023 and 302402024 should be replaced with 21-inch SDR 35 PVC pipe. These pipe segments measure 363 and 379 lf respectively, and range from approximately 17 to 21 feet deep. Three existing 48-inch diameter Type 1A manholes will be replaced with new 60-inch

Type V manholes at their existing locations. The pipes will be installed to the north of Eagle Canyon Dr. inside an existing asphalt pavement pedestrian path. Existing sidewalk will need to be replaced at either end of this alignment.

The next segment of pipe to be replaced includes pipes 302401118, 302401119, 302401120, 302401121, and 302401122 which are located adjacent to the Eagle Canyon Park and Shaw Middle School. New 21-inch SDR 35 PVC pipe will be installed at depths ranging from 10 to 12-feet deep over a total length of 1,500 lf. Six existing manholes will be replaced in their current locations with new 60-inch Type V manholes. Replacement of the existing pipe will require an unpaved surface replacement on an existing dirt access road.

The final segment will replace existing pipe 302401221 and existing manholes 300724013005 and 300724013501. The 298-lf pipe averages a burial depth of 11-feet across its length and will be replaced with a new 21-inch SDR 35 PVC pipe. The pipe segment runs adjacent to three private residences in an unpaved dirt access road.

Construction vehicle access and materials staging is favorable and is likely to be provided from an existing road, Neighborhood Way, across unimproved parcels to the north of the alignment. The alignment for the project is also entirely inside of an existing 20-ft sanitary sewer easement per recorded document number 2086588 and parcel map 3952. Also, GIS data does not indicate any existing service connections along the length of interceptor which will be replaced with the preferred project.

Project quantities were generated from GIS data, aerial photos and the hydraulic model constructed as a part of this plan. Planning level cost estimates for the preferred project include a construction contingency of 20 percent to reflect unknown site conditions, volatility in the marketplace and other details which are currently unknown. The 28 percent allowance for engineering, administrative, legal and construction inspection costs is included to provide a conservative yet appropriate estimate for this planning document. A cost summary for the preferred project is provided in Table 10 and is further detailed in Appendix B.

Table 10 – Preferred Project Cost Estimate

Item	Cost
Construction Cost	$ 473,700
Contingency (20%)	$ 94,740
Total Improvements	**$ 568,440**
Engineering and Design (10%)	$ 56,900
Admin and Legal (8%)	$ 45,500
Materials Testing and Construction Inspection (10%)	$ 56,900
Engineering and Admin Costs	**$ 159,300**
Total	**$ 727,740**

Appendix A

Table 1A– Alternative Project 1 Design Criteria Summary

Pipe	Maximum Flow (gpm)	Maximum d/D (%)	Modeled Velocity (fps)	½ Full Velocity (fps)
302401122	1,436	40.4	3.51	3.42
302401121	1,436	39.6	3.61	3.63
302401120	1,436	49.8	2.67	3.20
302401119	1,434	58.4	2.19	2.09
302402024	1,545	44.1	3.49	3.64
302401118	1,431	47.9	2.81	1.93
302401221	1,348	43.2	3.02	2.55
302402023	1,544	43.0	3.48	3.23

Table 2A – Alternative Project 2 Design Criteria Summary

Pipe	Maximum Flow (gpm)	Maximum d/D (%)	Modeled Velocity (fps)	½ Full Velocity (fps)
302401122	1,519	41.6	3.57	3.42
302401121	1,518	40.8	3.67	3.63
302401120	1,518	51.7	2.70	3.20
302401119	1,516	60.3	2.23	2.09
302402024	1,693	46.5	3.50	3.64
302401123	1,477	40.5	3.60	3.61
302401097	1,526	44.8	3.26	3.53
302402174	1,854	55.0	3.05	3.11
302401118	1,513	49.3	2.86	1.93
302401221	1,382	43.8	3.04	2.56
302401096	1,590	44.0	3.47	3.10
302402023	1,692	45.2	3.57	3.23

Table 3A – Alternative Project 3 Design Criteria Summary

Pipe	Maximum Flow (gpm)	Maximum d/D (%)	Modeled Velocity (fps)	½ Full Velocity (fps)
CDT060111	899	46.8	3.56	3.68
CDT1036	896	46.6	3.56	3.65
CDT1033	891	47.4	3.47	3.64
CDT1030	939	48.2	3.58	3.65
CDT1028	935	48.1	3.57	4.32
CDT1027	932	48.0	3.57	3.65
CDT1026	929	47.9	3.57	3.68
CDT1025	925	47.8	3.56	3.63
CDT1024	922	47.7	3.56	3.63
CDT1023	918	48.0	3.52	3.63
CDT1020	956	48.4	3.62	3.63
CDT1015	954	48.4	3.61	3.63
CDT1005	948	48.6	3.57	3.63
CDT1007	951	48.5	3.59	3.63
CDT1002	947	46.3	3.80	3.67
CDT1000	946	50.5	3.39	3.67
CDT1010	952	48.5	3.59	3.67

Table 4A – Ten State Standard Minimum Recommended Slope*

Nominal Sewer Size	Minimum Slope in Feet per 100 Feet (ft/100ft)**
8-inch	0.40
10-inch	0.28
12-inch	0.22
15-inch	0.15
18-inch	0.12
21-inch	0.10
24-inch	0.08
27-inch	0.067
30-inch	0.058
33-inch	0.052
36-inch	0.046
39-inch	0.041
42-inch	0.037

*Values taken from Section 33.4 of the Recommended Standards for Wastewater Facilities – 2014 Edition.
**Slopes based on minimum velocity of 2.0 fps

Appendix B

Table 1B – Project 1 Cost Estimate

Item	Quantity	Unit	Description	Unit Price	Total
1	1	LS	Mob & Demob (5%)	$ 13,000.00	$ 13,000.00
2	20	DAY	Traffic Control	$ 1,000.00	$ 20,000.00
3	2,621	LF	Install 21” Sewer Main	$ 105.00	$ 275,200.00
4	26	DAY	Bypass Pumping	$ 2,000.00	$ 52,000.00
5	2	EA	Manhole 60" (0'-10' Deep)	$ 5,500.00	$ 11,000.00
6	6	EA	Manhole 60" (10'-15' Deep)	$ 6,500.00	$ 39,000.00
7	3	EA	Manhole 60" (15'-20' Deep)	$ 7,500.00	$ 22,500.00
8	100	LF	PCC Sidewalk with Base	$ 20.00	$ 2,000.00
9	1,000	LF	AC Trench Patch	$ 30.00	$ 30,000.00
10	1	LS	BMP's Installation & Maintenance	$ 3,000.00	$ 3,000.00
11	1	LS	Erosion Control - Permanent	$ 6,000.00	$ 6,000.00
				Sub-Total	**$ 473,700.00**
Construction Contingency (20%)					$ 94,740.00
				Total Improvements	**$ 568,440.00**
Engineering and Admin Costs					
Engineering and Design (10%)					$ 56,900.00
Admin and Legal (8%)					$ 45,500.00
Materials Testing and Const. Inspecting (10%)					$ 56,900.00
				Sub-Total Engineer and Admin	**$ 159,300.00**
				Total Cost	**$ 727,740.00**

Table 2B – Project 2 Cost Estimate

Item	Quantity	Unit	Description	Unit Price	Total
1	1	LS	Mob & Demob (5%)	$ 20,500.00	$ 20,500.00
2	25	DAY	Traffic Control	$ 1,000.00	$ 25,000.00
3	3,711	LF	Install 21" Sewer Main	$ 105.00	$ 389,655.00
4	37	DAY	Bypass Pumping	$ 2,000.00	$ 74,000.00
4	1,000	LF	PCC Sidewalk with Base	$ 20.00	$ 20,000.00
6	2	EA	Manhole 60" (0'-10' Deep)	$ 5,500.00	$ 11,000.00
7	7	EA	Manhole 60" (10'-15' Deep)	$ 6,500.00	$ 45,500.00
8	6	EA	Manhole 60" (15'-20' Deep)	$ 7,500.00	$ 45,000.00
9	1	EA	Manhole 60" (20'+ Deep)	$ 8,500.00	$ 8,500.00
10	1,150	LF	AC Trench Patch	$ 30.00	$ 34,500.00
11	150	LF	PCC Curb	$ 50.00	$ 7,500.00
12	1	LS	BMP's Installation & Maintenance	$ 3,000.00	$ 3,000.00
13	1	LS	Erosion Control - Permanent	$ 6,000.00	$ 6,000.00
				Sub-Total	**$ 690,155.00**
Construction Contingency (20%)					$ 138,031.00
				Total Improvements	**$ 828,186.00**
Engineering and Admin Costs					
Engineering and Design (10%)					$ 82,900.00
Admin and Legal (8%)					$ 66,300.00
Materials Testing and Const. Inspecting (10%)					$ 82,900.00
				Sub-Total Engineer and Admin	**$ 232,100.00**
				Total Cost	**$1,060,286.00**

Table 3B – Project 3 Cost Estimate

Item	Quantity	Unit	Description	Unit Price	Total
1	1	LS	Mob & Demob (5%)	$ 31,000.00	$ 31,000.00
2	5	DAY	Traffic Control	$ 1,000.00	$ 5,000.00
3	6,270	LF	Install 15" Sewer Main	$ 75.00	$ 470,250.00
4	75,240	SF	Install 8" of Type II Base	$ 1.20	$ 90,288.00
5	1	EA	Flow Splitting Vault	$ 15,000.00	$ 15,000.00
6	10	EA	Manhole 48"- 0-10' Deep	$ 4,750.00	$ 47,500.00
7	7	EA	Manhole 48"- 10-15' Deep	$ 5,750.00	$ 40,250.00
8	1	EA	Manhole 48"- 15-20' Deep	$ 6,750.00	$ 6,750.00
9	1	LS	BMP's Installation & Maintenance	$ 3,000.00	$ 3,000.00
10	1	LS	Erosion Control - Permanent	$ 6,000.00	$ 6,000.00
				Sub-Total	**$ 715,038.00**
Construction Contingency (20%)					$ 143,007.60
				Total Improvements	**$ 858,045.60**
Engineering and Admin Costs					
Engineering and Design (10%)					$ 85,900.00
Admin and Legal (8%)					$ 68,700.00
Materials Testing and Const. Inspecting (10%)					$ 85,900.00
				Sub-Total Engineer and Admin	**$ 240,500.00**
				Total Cost	**$1,098,545.60**