ASSESSMENT OF THE CITY'S EXISTING STORMWATER CONVEYANCE SYSTEM

Report

Prepared for:
City of Rocklin
Public Services Department – Public Works Division
4081 Alvis Court
Rocklin, CA 9567

Prepared by:
Michael Baker International
2729 Prospect Park Drive, Suite 220
Rancho Cordova, CA 95670

December 22, 2015

Michael Baker INTERNATIONAL

We Make a Difference

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2729 Prospect Park Drive, Suite 220,
Rancho Cordova , Ca, 95670
Office: 916.928.1113 | Fax: 916.928.1117

List of Exhibits Sections

1.0 Executive Summary

The City of Rocklin retained Michael Baker International (Michael Baker) to complete an assessment of the City's existing storm drain conveyance system. The scope included site visits to capture and record visual assessment data from all accessible public storm drain discharge outlets. Michael Baker pulled and organized thousands of data points and documents, and with the assistance of the City staff created a reliable document control system for tracking and recording project-related communication. Michael Baker consistently worked with City staff to ensure shared point access, to locate difficult or missing outlets in the field, and to successfully convert the City's existing GIS stormwater system to Local Government Information Model (LGIM) standards. The draft assessment serves two common goals:

1. Provide a comprehensive assessment of the City's public discharge outlets, capturing the existing conditions and delivering a reliable engineering determination for the benefit of MS4 permit compliance.

2. Analyze the diverse data captured through the updated GIS database and localize the physical data obtained from site visits and closed circuit television (CCTV) investigation in order to determine the state of the storm drain conveyance system and submit the assessment and recommendations.

With the above goals in mind, guidelines and recommendations include the following:

1. A clear road map with associated costs to address the discharge outlet facilities determined to have significant structural deterioration conditions and maintenance concerns.

2. Recommendation to initiate a citywide operation and maintenance program, with the associated cost, with the anchor of the program being the implementation of a comprehensive CCTV investigation and pipe cleaning operation on a regular basis.

3. Recommend an O&M program for the existing O/S separator

4. Recommend implementing a City wide filter inserts for inlets and catch basin, and an O&M program

5. Recommendation to initiate a corrugated metal pipe (CMP) replacement program, with the associated costs, with the CMP completely replaced or retrofitted within 5 years.

6. A similar recommendation for corrugated metal pipe arch (CMPA), with a goal that it be replaced within 20 years.

7. Guidelines on the costs associated with a storm drain pipe replacement/rehabilitation program, based on parameters such as material size and year of installation.

2729 Prospect Park Drive, Suite 220 | Rancho Cordova, CA, 95670
Office: 916.928.1113 | Fax: 916.361.1574

This report includes a detailed description of the site investigation assessment, the GIS update process, the associated results, and recommendations for the City to implement in order to provide a reliable storm drain conveyance system that operates as designed and maximizes the useful life of the facilities.

2.0 Background

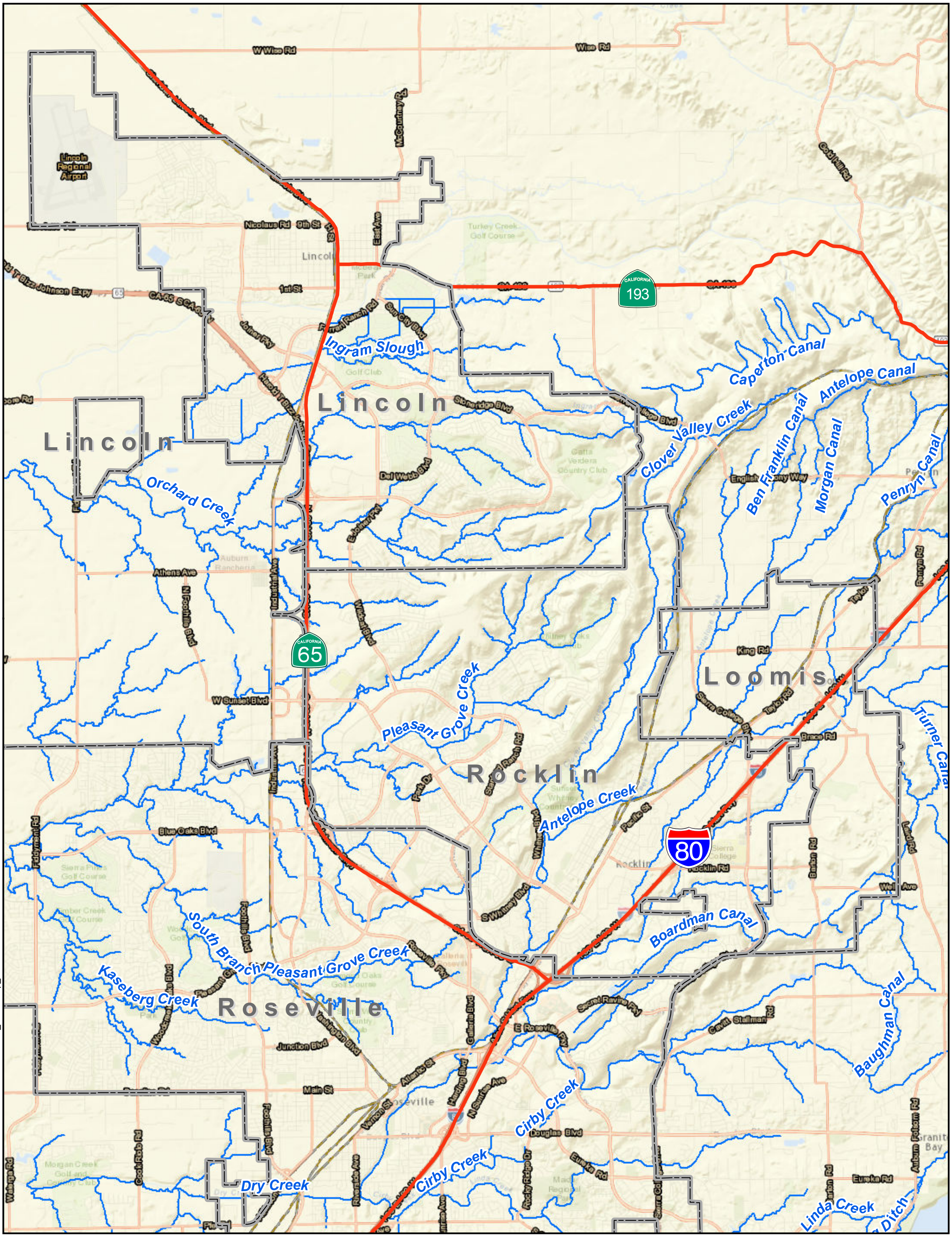
Rocklin is located in the western foothills of the Sierra Nevada range in the Loomis Basin. The city is located in the southern region of Placer County, California, and has an approximate population of 60,000. Bordering Rocklin are the cities of Roseville to the southwest, Granite Bay to the southeast, Loomis to the east, and Lincoln to the north. The city's topography consists of rolling hills ranging in elevation from 150 feet to 525 feet above sea level. The city has various seasonal creeks and a climate that fluctuates from dry hot summers to moderately wet winters with an average annual rainfall of 30 inches. Rocklin encompasses an area of approximately 20 square miles and has an average elevation of 250 feet above sea level in the older portions of the city.

The city is part of the Sacramento River Hydrologic Region that includes portions of over 20 counties which supply much of California's urban and agricultural water. Drainage within the city generally flows from east (Sierra Nevada foothills) to west. The watershed within the city drains into five stream systems: Pleasant Grove Creek, Clover Valley Creek, Antelope Creek, Secret Ravine Creek, and Sucker Creek. Sucker Creek is a perennial stream in the city and is a tributary to Secret Ravine Creek. Secret Ravine Creek, also a perennial tributary, is joined by Sucker Ravine near the southeastern portion of the city to drain the eastern side of the Loomis Basin. Antelope Creek and Clover Valley Creek join near the central area of the city and ultimately discharge into Dry Creek. Miners Ravine, a system south of Rocklin, also discharges into Dry Creek. Pleasant Grove Creek drains the Stanford Ranch area in the northern and western portion of the city and ultimately flows westward and joins the Sacramento River. Refer to Exhibit 1 below.

The City of Rocklin owns, operates, and maintains the stormwater collection system in the public right-of-way within the city limits. The City's stormwater collection system consists of a network of open channels, inlets, catch basins, gravity flow storm drain pipelines, retention basins, and infiltration basins that collect, store, and convey stormwater runoff. Water discharges to public channels, streams, creeks, rivers, and other bodies of water.

Federal environmental regulations based on the Clean Water Act (CWA) require the control of pollutants from Municipal Separate Storm Sewer Systems (MS4s), construction sites, and industrial activities. Discharges from such sources were brought under the NPDES permitting process by the 1987 CWA amendments and the subsequent 1990 promulgation of stormwater regulations by the US Environmental Protection Agency (USEPA). In California, the USEPA has delegated administration of the federal NPDES program to the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs or Regional Water Boards). In addition, the SWRCB and the nine RWQCBs have authority to regulate waste discharges to land that may affect water quality.

The Code of Federal Regulations (CFR), at 40 CFR 122.26(a)(iii) and (iv) (U.S. EPA, 1998), requires that NPDES stormwater permits be issued for discharges from large, medium, and designated small MS4s. The regulations define the term *Municipal Separate Storm Sewer Systems* to mean "a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains) owned or operated by a state, city, town, borough, or county."



10/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_CoverMap_8x11P.mxd

0 0.75 1.5
Miles

Source: City of Rocklin

CITY OF ROCKLIN

Rocklin Location Map

Exhibit 1

The City of Rocklin is designated a small MS4 because it is located in an urbanized area and has a population under 100,000.

Federal regulations allow two permitting options for stormwater discharge: individual permits and general permits. The SWRCB has elected to adopt a statewide General Permit for small MS4s. This option allows the small MS4 to sign onto the General Permit in lieu of developing a fully individualized program and allows the State to efficiently regulate numerous stormwater dischargers under a single permit. The City of Rocklin has opted to comply with the regulations through coverage under the State's General Permit.

The General Permit contains four basic requirements: discharge prohibition, effluent limitations, stormwater management program requirements, and reporting requirements.

The General Permit prohibits discharges of waste that are otherwise prohibited under state and regional water quality control plans. In addition, the General Permit prohibits discharges that cause or threaten to cause a nuisance, discharges that contain a reportable quantity of specified hazardous substances, and any other discharge except as allowed under the NPDES permit.

The General Permit requires permittees to reduce pollutants in stormwater. To satisfy this requirement, the small MS4s must develop and implement a stormwater management program (SWMP) designed to reduce the discharge of pollutants through the storm drain to the Maximum Extent Practicable (MEP) to protect water quality. An MS4 can satisfy this requirement through effective implementation of an SWMP. The City prepared and adopted a Revised SWMP in September 2003.

The City’s Environmental Services staff implement permit compliance tasks and track stormwater regulations on behalf of the City of Rocklin. City staff are responsible to document local permit compliance efforts in annual reports to the Central Valley Regional Water Quality Control Board.

The City of Rocklin's Stormwater Program's goals are to:

- Prevent stormwater pollution.
- Protect and enhance water quality in creeks and wetlands.
- Preserve beneficial uses of local waterways.
- Comply with state and federal regulations.

2.1 Purpose

The City contracted with Michael Baker International (Michael Baker) to perform an assessment of the City’s existing stormwater conveyance system. The City’s primary objectives for this project are to perform a visual assessment of the stormwater conveyance system to assess the overall condition of the system, update the stormwater GIS database with attribute information, identify capital improvement projects, and provide information necessary for the City to plan and budget for improvement projects in future years. In addition, the goal of this project is for the City to maintain compliance with the current MS4 permit requirements.

The purpose of the condition assessment report is to provide a professional evaluation of the existing storm drain infrastructure per the available historical records, site investigations, and limited CCTV investigation and to submit a determination that addresses the salient concerns with a road map that is aligned with the City’s objectives. The report prioritizes the critical conditions that require immediate and urgent attention with an associated cost for budgetary purposes to address the aforementioned concerns.

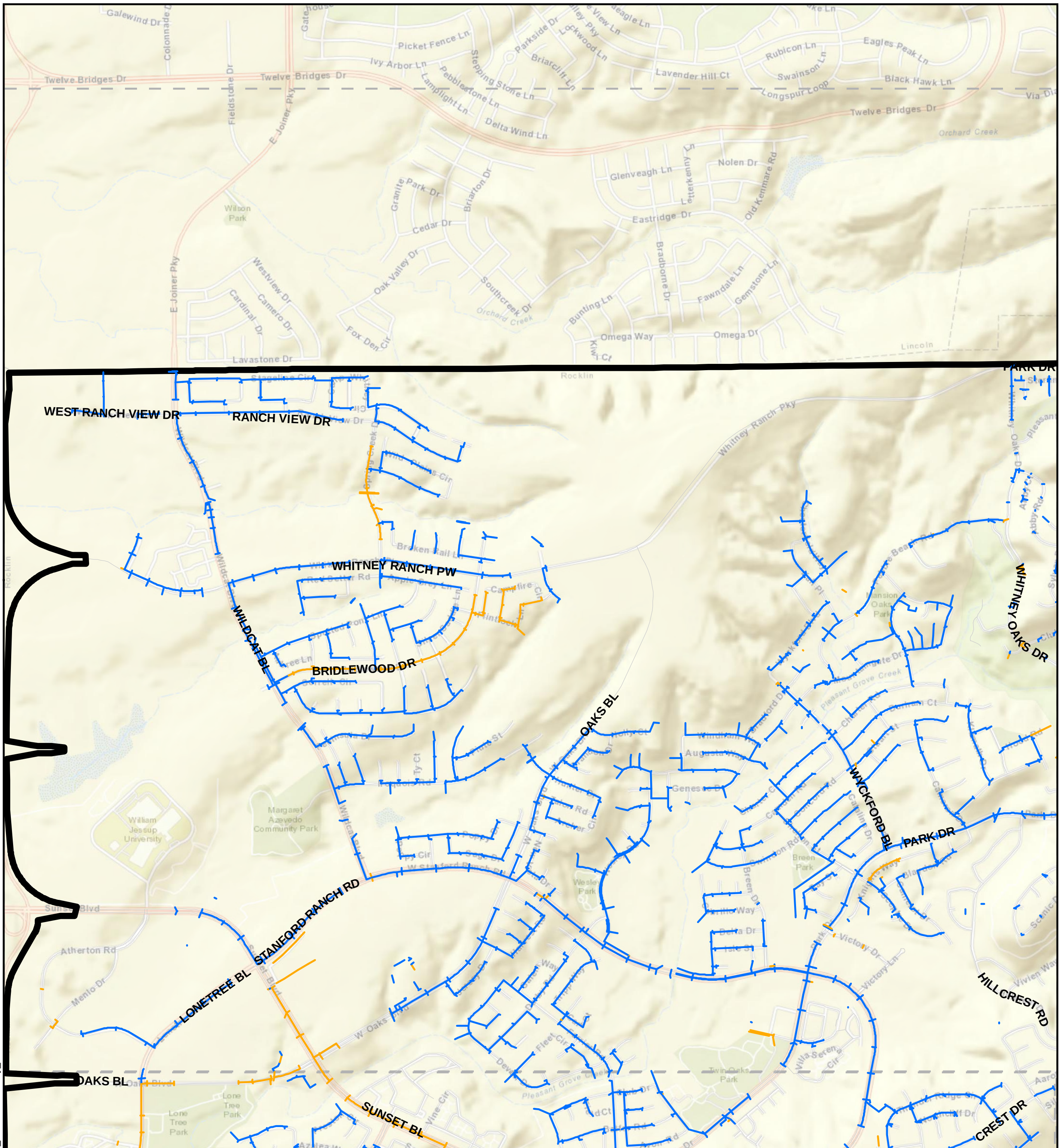
Recommendations include capital improvement projects to address immediate deficiencies and the implementation of maintenance programs to improve the operational capacity of the conveyance system and extend the life of the infrastructure. Furthermore, other concerns that were uncovered in the process of the assessment are highlighted, assessed, and correlated with cost for budgetary purposes. The conclusions and recommendations identified in this report are meant to substantiate future investments in the City's stormwater conveyance system.

3.0 Methodology

The evaluation of the City's existing stormwater conveyance system was based on the review of available historical data and the collection of field data via a physical site assessment of the public outlets and public ditches and a limited CCTV investigation. The outlet site assessment included determining a ranking (score) of each outlet's structural condition and maintenance condition, and other physical data was collected, photographed, recorded, and uploaded to the GIS system. In parallel, Michael Baker performed a comprehensive update of the City's existing GIS database of the storm drain system, working with City staff to develop a geodatabase schema, including domains, based on Esri's Local Government Information Model (LGIM). The City's existing GIS stormwater data was then configured and converted to the LGIM standard. The City's existing stormwater geodatabase was further updated with attribute data using available record drawings. The system geometry, pipe size, material, slope, rim elevation, and year built (if not given, year of record drawing) was input from the record drawing information, if available.

The GIS update process included the gathering of tract maps, roadway plans, infrastructure plans, and other available as-built data from the City. The as-built documents were correlated with a citywide index map, recorded on an integrated aerial map, and tracked manually as part of an intricate document control system. The data from the as-built documents was geographically transposed and the corresponding attribute fields were either verified or populated in the GIS database. It should be noted that attribute information for approximately 87% of the City's storm drain pipelines was found in the record documentation provided, and the GIS database was updated accordingly.

Exhibits 2 through 5 depict the City's storm drain pipeline locations and indicate facilities for which corresponding record information is not available. Note: For clarity purposes, the city was divided into four quadrants for the purpose of displaying information on exhibits in this report.



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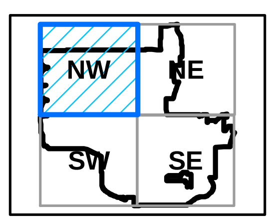
- No As Builts
- As Builts
- Road Centerlines
- Rocklin City Limits



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Michael Baker
INTERNATIONAL

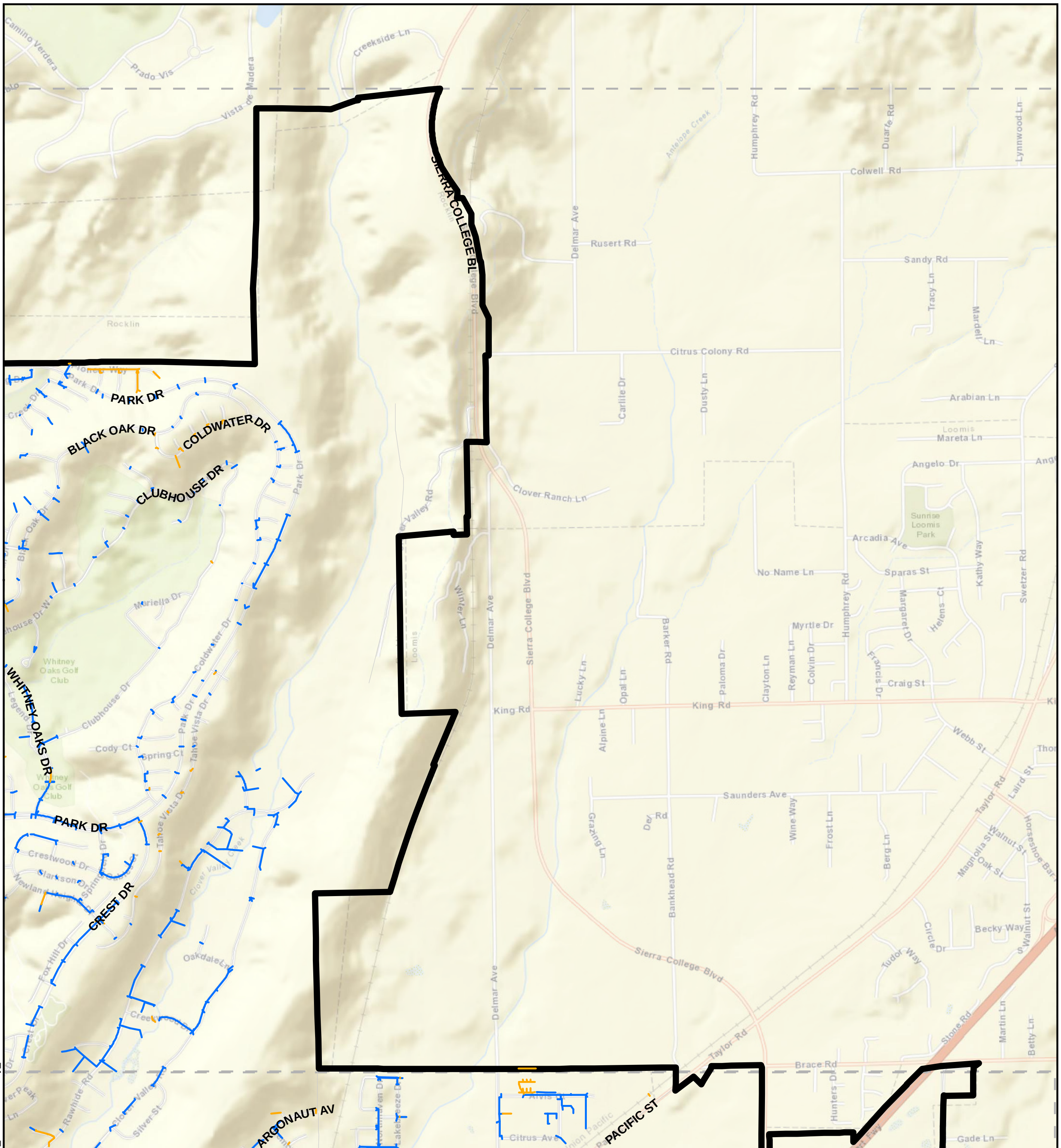
0 0.2 0.4
Miles

Source: City of Rocklin

CITY OF ROCKLIN

Summary of As-Builts NW

Exhibit 2



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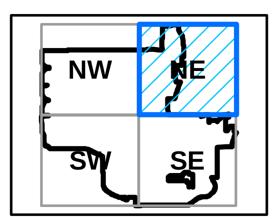
No As Builts	Road Centerlines
As Builts	Rocklin City Limits



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Michael Baker INTERNATIONAL

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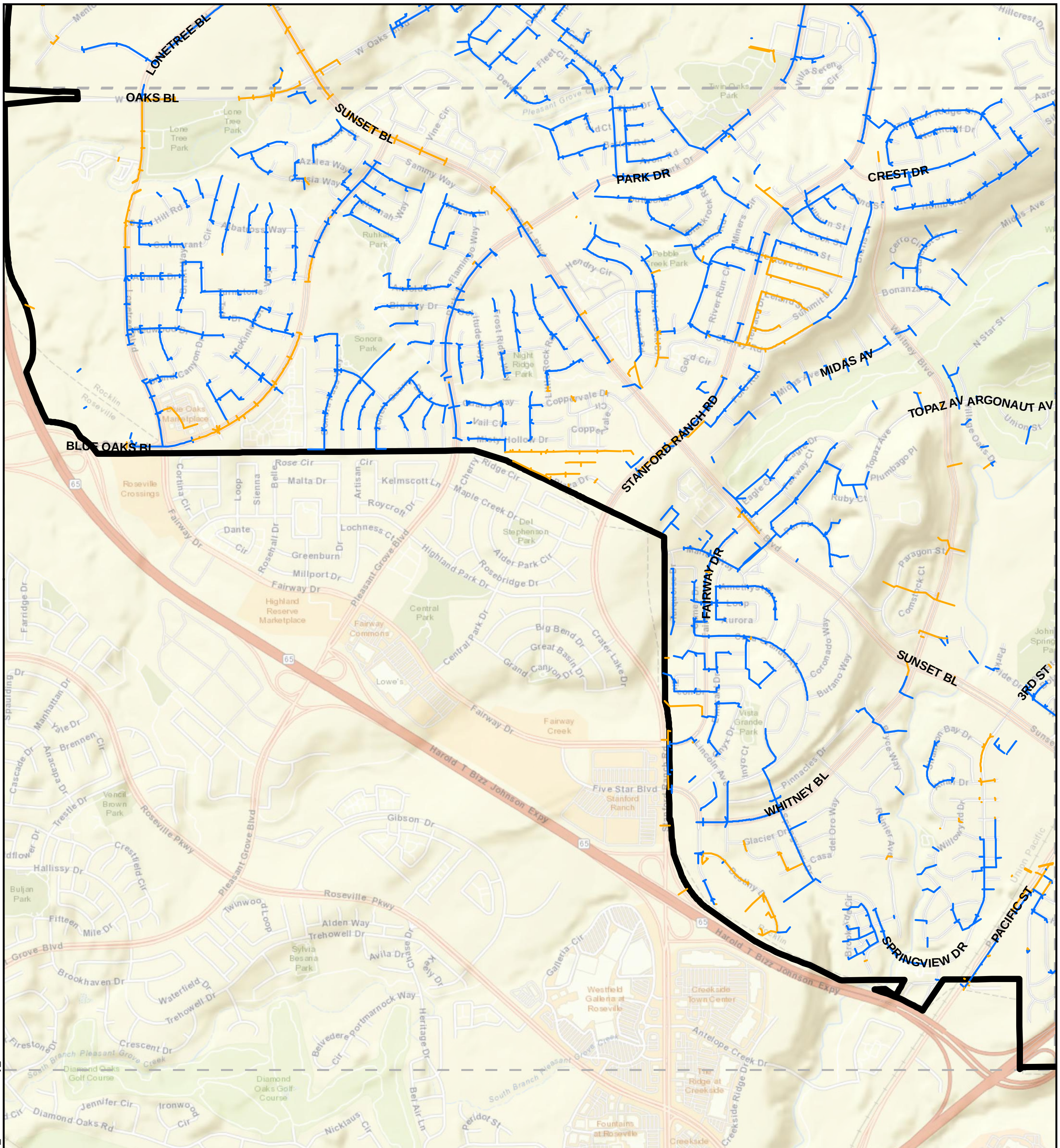
Source: City of Rocklin

CITY OF ROCKLIN

Summary of As-Builts NE

Exhibit 3



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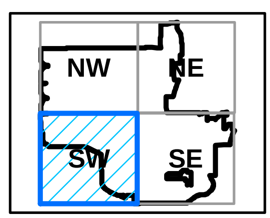
No As Builts

As Builts

Road Centerlines

Rocklin City Limits



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Michael Baker INTERNATIONAL

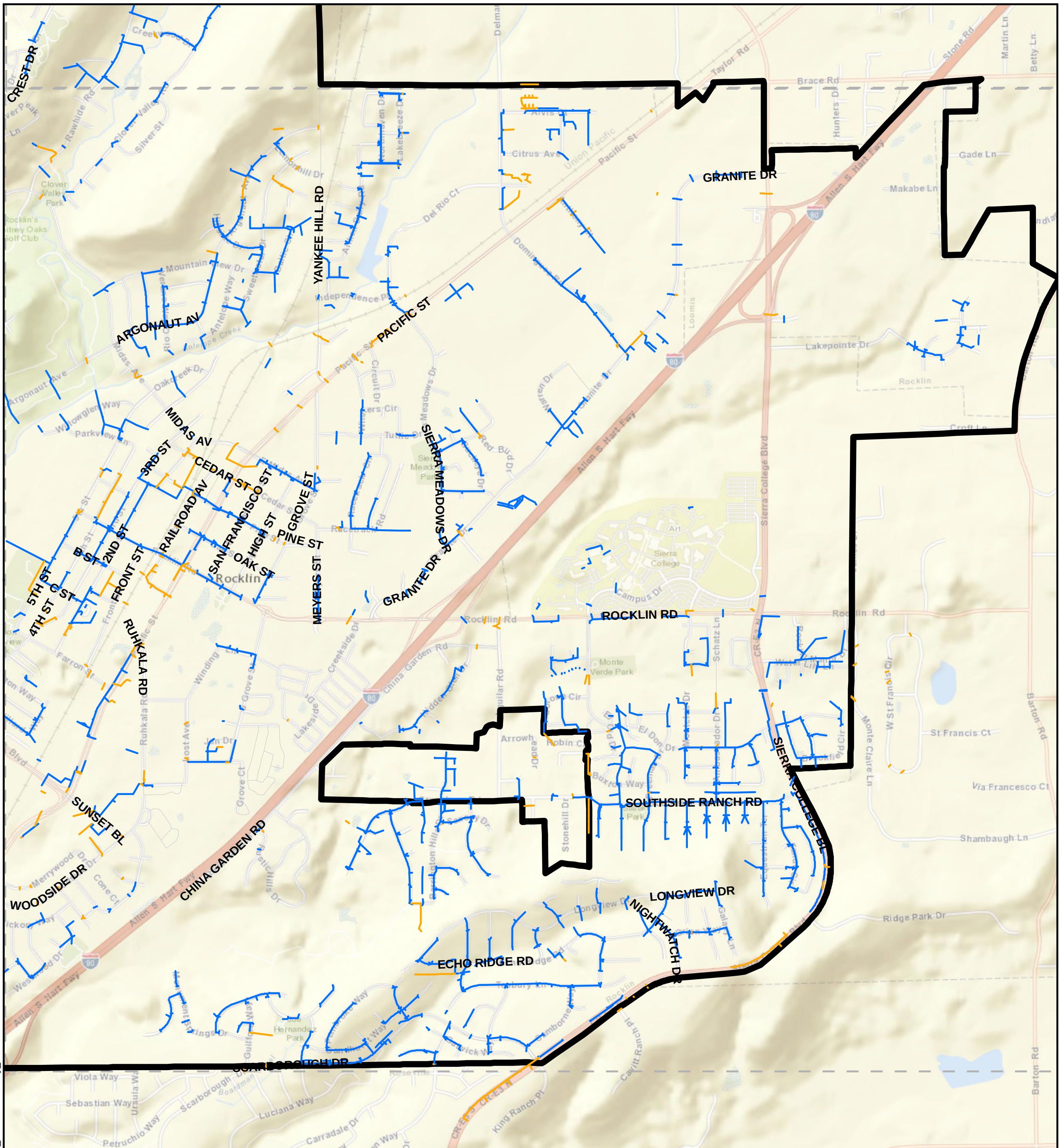
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

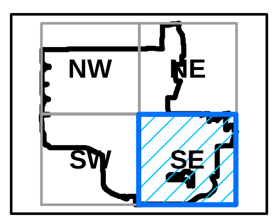
Summary of As-Builts SW

Exhibit 4



Legend

No As Builts
As Builts
Road Centerlines
Rocklin City Limits



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Michael Baker INTERNATIONAL

0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

Summary of As-Builts SE

Exhibit 5

To supplement the record documentation, various storm drain pipelines throughout the city were assessed by CCTV inspection. The inspection was conducted at various locations in Rocklin to assess the internal conditions of the various pipe diameters, material, and age. The results were considered a representative sample of the internal conditions of the storm drain pipes throughout the City's system.

The data collected during the physical assessments and the CCTV investigation, combined with the results of the ranking system, the historical data, and the industry best practices, were taken into account to develop a list of proposed improvement projects and operations programs to be implemented.

The recommendations developed herein were based on the following:

1. Attendance to urgent conditions that pertain to broken or damaged structures observed during inspection.
2. Maintenance of system capacity based on the observation of blocked/clogged pipelines.
3. Recommendations for replacement or rehabilitation of pipelines due their age or material (i.e., approaching the end of their useful life).
4. Cost effectiveness.
5. Limit of community disturbance.
6. Reasonable assumptions.

It is noted that this project specifically excluded private storm drain systems and facilities, and facilities outside of the city right-of-way and city limits.

4.0 Summary of Outlet Condition Assessments

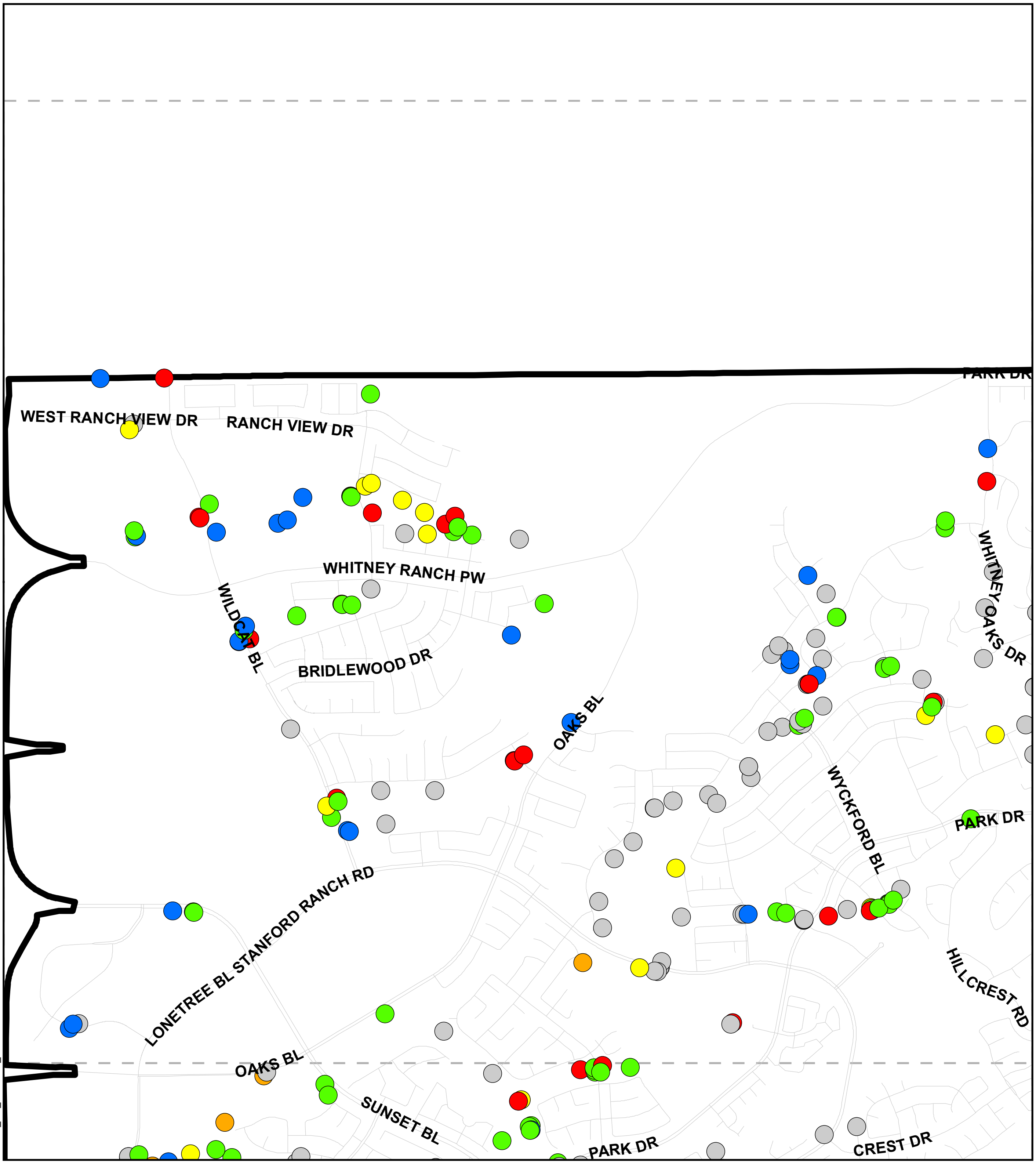
A visual condition assessment of the visible and accessible open sections of the existing storm drain system, including the discharge outlets and v-ditches, was conducted in 2015 during the months of June, July, and August. A custom iPad application utilizing the GIS database as the basis was used during the assessment to locate the facilities, take and upload photos, document collected data and observations, and rank each individual structure for maintenance and structural condition. A scale of 1 to 5, from worst to best, was used to rank the structural and maintenance conditions of each observed facility. Aspects such as concrete condition, screen functionality, connections, and overall life expectancy were assessed for the structures. Aspects such as debris accumulation and vegetation overgrowth which would impede water flow were assessed and ranked for maintenance.

A ranking of 5 is the best, used to indicate the structure is in top condition and does not require repair and/or replacement. A ranking of 1 is the worst, used to indicate that structural repairs and/or replacement are required for facilities to function appropriately. Rankings of 2, 3, and 4 were given to the facilities in the following condition, respectively: undesired, fair, and good. A similar ranking system applies to the maintenance assessment.

There are a total of 747 discharge outlets within the Rocklin city limits; 102 of these outlets are privately owned. Private discharge outlets were not included in this condition assessment. For this report, any discharge outlet that is privately owned or on property owned by a private organization such as a homeowners association is considered a "private" discharge outlet.

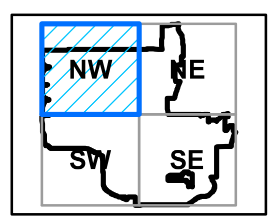
In total, there are 645 City-owned and City-maintained discharge outlets. Of those 467 discharge outlets were located, accessible, and could be visually inspected during the condition assessment. The remaining 177 discharge outlets were not visually inspected due to various interferences such as unable to traverse private property to access the facility, locked fences, overgrown brush, new construction, the facility could not be found, or the facility no longer exists. Access was prohibited to 46 facilities because the outlet or the area surrounding the outlet was overgrown with vegetation. It should be noted that in the GIS, the aforementioned facilities were included with a ranking of 1 for the maintenance condition, and a ranking of 0 was assigned for structural condition to indicate that the structure could not be visually inspected and that maintenance is required before an inspection can occur. In the table 1 and in this report, the 0 ranking is denoted as N/A or sometimes Not Visited. It is recommended that vegetation be cleared from these facilities to ensure they are functioning properly.

Exhibits 6 through 9 depict the location of each outlet structure in the City's storm drain system and color code each structure with its structural condition score. It is noted that all of the outlets are shown on the exhibits, with the label "Not Visited" indicating the facility is either private, could not be found, or could not accessed for a variety of reasons.



Legend

Not Visited
1
2
3
4
5
Road Centerlines
Rocklin City Limits



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Michael Baker
INTERNATIONAL

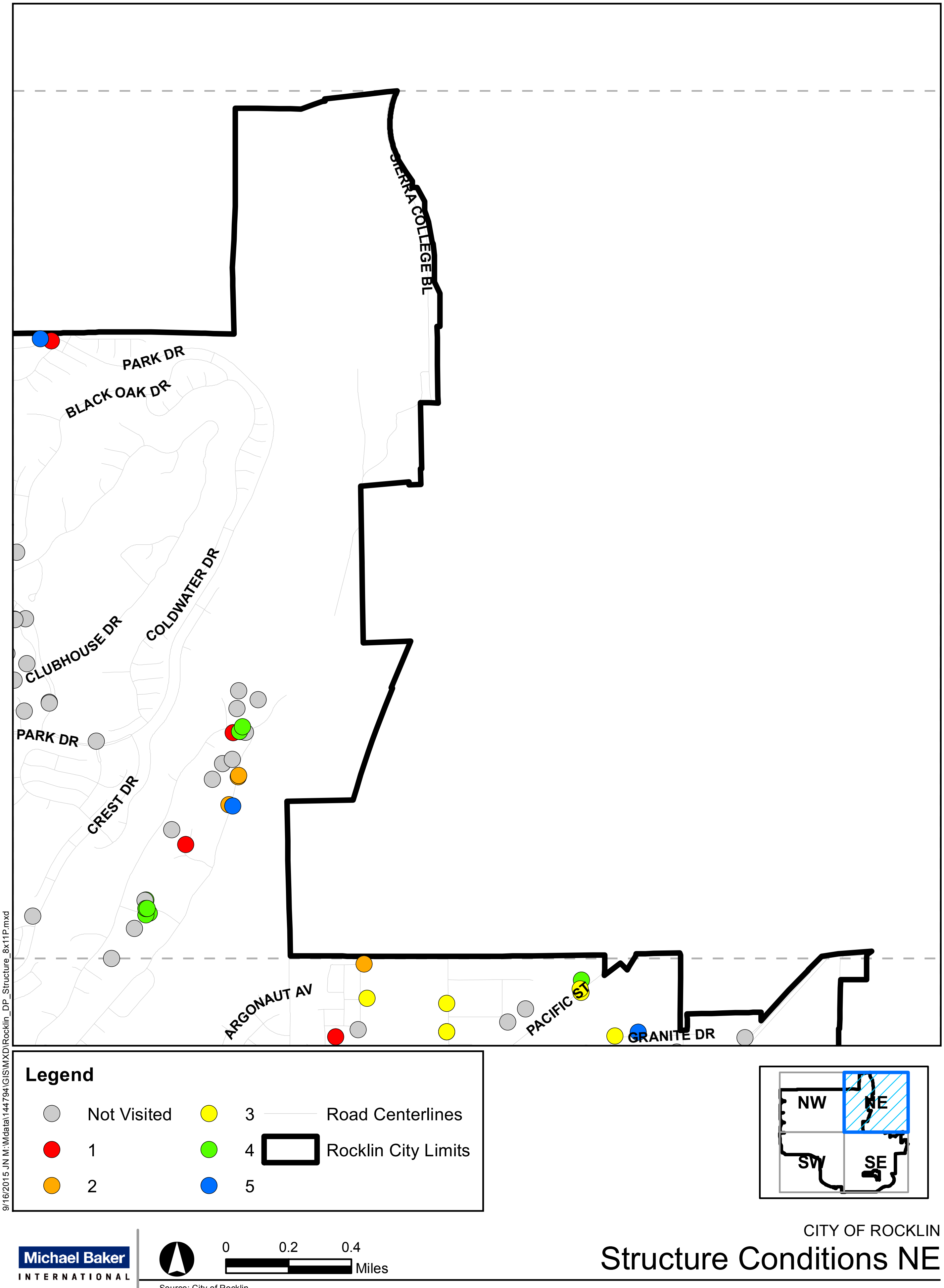
0 0.2 0.4
Miles

Source: City of Rocklin

CITY OF ROCKLIN

Structure Conditions NW

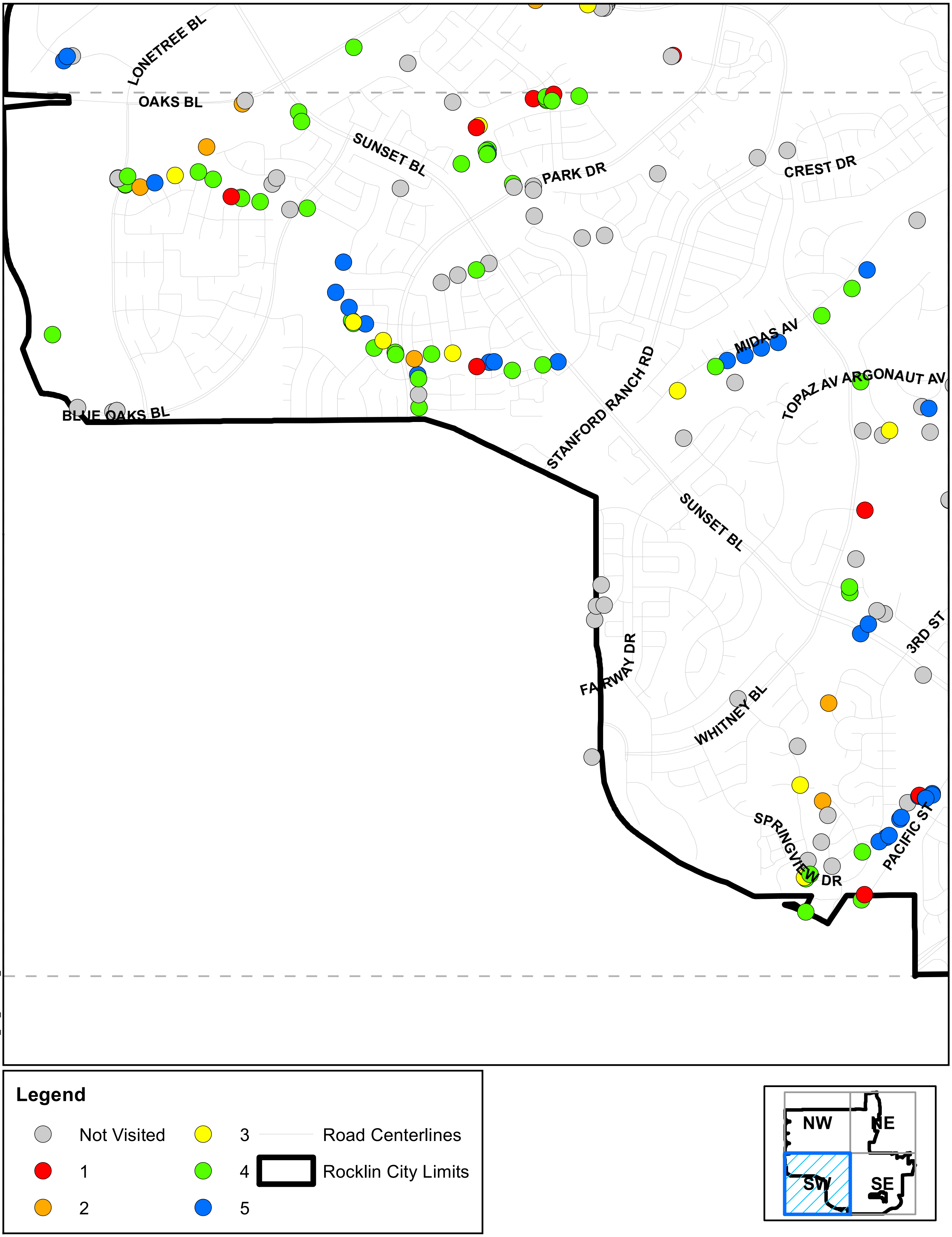
Exhibit 6



CITY OF ROCKLIN

Structure Conditions NE

Exhibit 7



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Michael Baker INTERNATIONAL

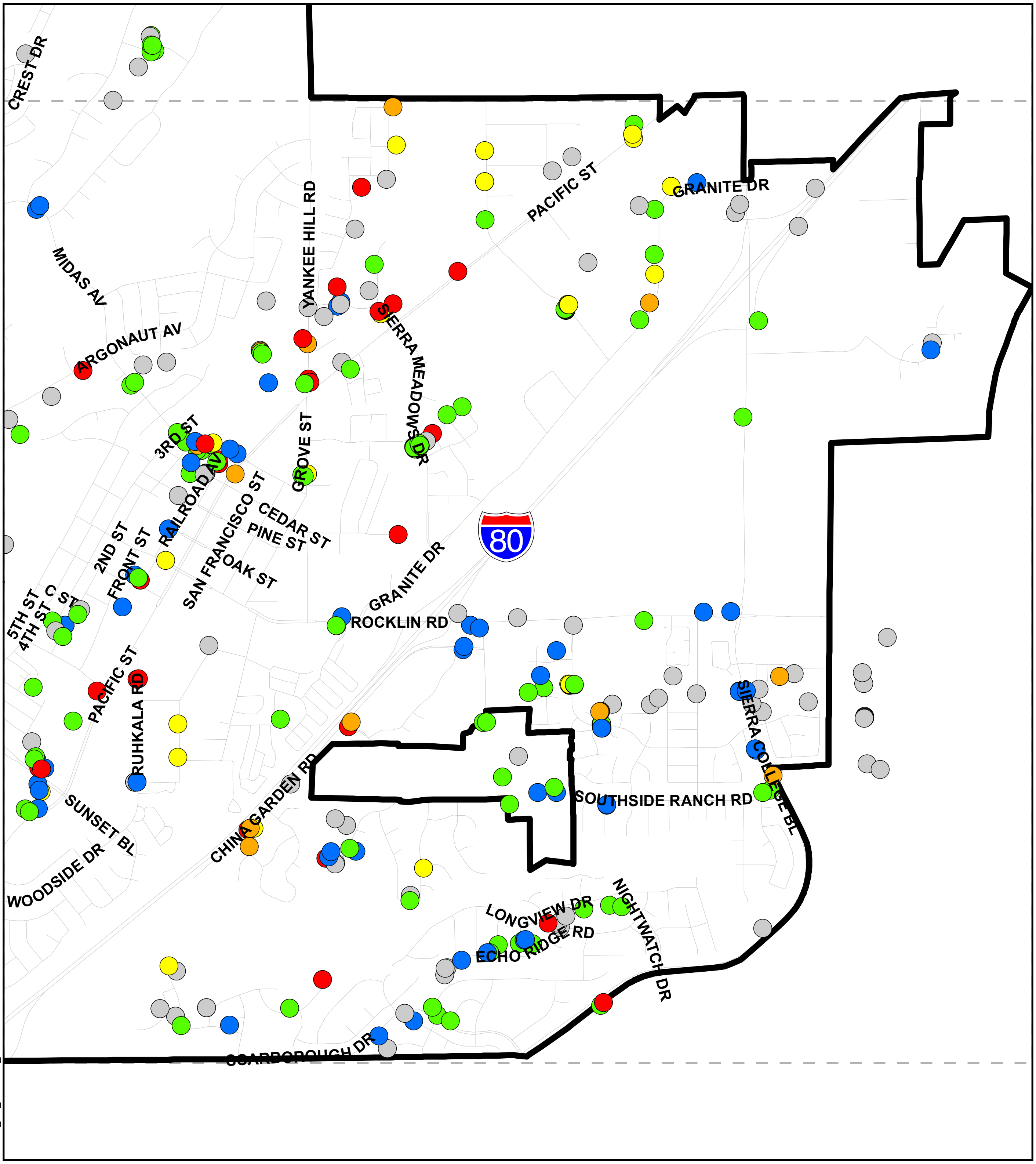
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

Structure Conditions SW

Exhibit 8



Legend

Not Visited	3	Road Centerlines
1	4	Rocklin City Limits
2	5	

9/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_DP_Structure_8x11P.mxd

Michael Baker INTERNATIONAL

0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

Structure Conditions SE

Exhibit 9

In order to clearly depict what a structural ranking of 5 looks like compared to a ranking of 1, example photos have been included herein. Photo 1 is an example of a structure with a ranking of 5 or good. The discharge pipes and screens are clear of debris, there are no breaks in the concrete, and all vegetation has been cleared from the vicinity. These structures are in good working condition and will function as designed.

Photo 1 – *Structural Ranking of 5*

Photo 2 is an example of a structure with a ranking of 1 or poor. This structure is located in what is considered Old Town Rocklin. The pipe is deformed and collapsed in on itself, with debris inside and near the outlet. This facility will not function appropriately and should be repaired or replaced.

Photo 2 – *Structural Ranking of 1*

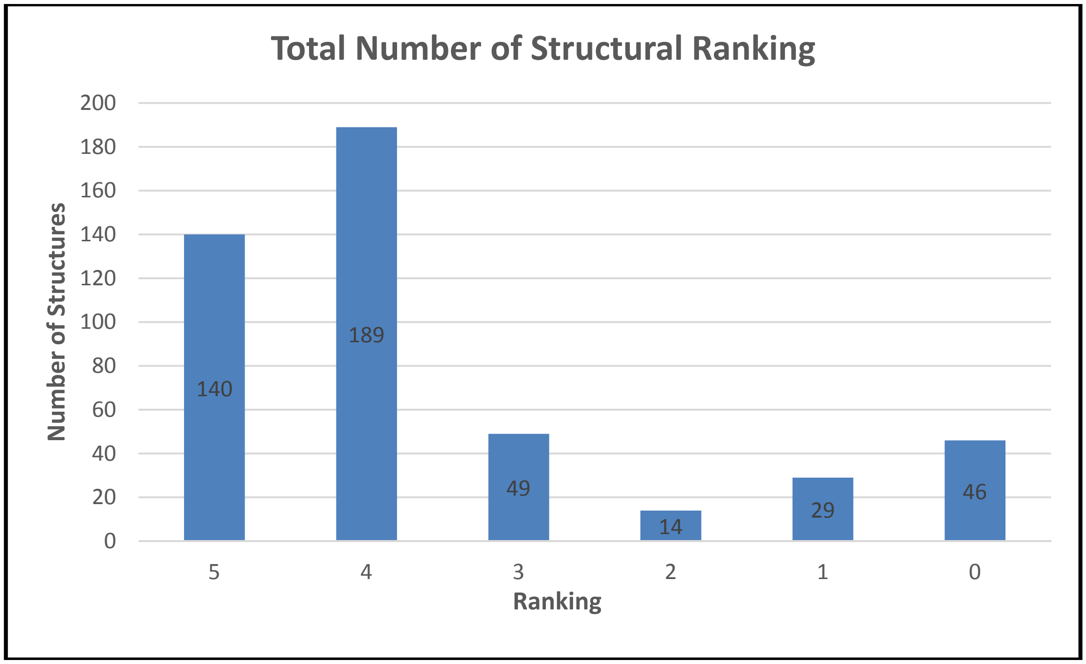
4.1 Structural Outlet Condition Assessment

Table 1 and Graph 1 summarize the number of outlet structures inspected, their ranks, and the percentage of structures with each ranking.

Table 1 – *Structural Condition Assessment*

Ranking	Number of City Outlet Structures	Ranking Percentage of System
5	140	30%
4	189	41%
3	49	10%
2	14	3%
1	29	6%
N/A	46	10%
Total	467	100%

Graph 1 – *Summary of Structural Ranking*



Note: 0 = N/A or not accessible.

Based on the discharge outlet condition assessment, 43 structures assessed were dilapidated and in poor condition, and thus ranked as a 1 or 2. These structures constitute 9% of the City's total outlet structures.

The 43 structures identified in poor condition were further evaluated and stratified into three priority categories: 39% or 17 structures appear to be severely damaged, 26% or 11 structures are moderately damaged, and 35% or 15 of the structures are damaged to a certain degree. Further analysis of the structural findings is provided in Section 7.4 of this report.

The 46 outlets that have not been structurally assessed (see Table 1) may have significant structural deficiency. It is not possible at this time to determine the extent of the damage, if any.

4.2 Maintenance Outlet Condition Assessment

Based on the field condition assessment, it was observed that 39% or 180 structures visited required immediate maintenance and were assigned a maintenance ranking of 1 or 2. Reference Table 2 and Graph 2 for a summary of findings of the maintenance assessment. It is recommended that the structures ranked 1 and 2 during the maintenance assessment be cleared of debris to allow proper functioning of the system.

As such, the adoption of a systematic maintenance program for debris clearing, system cleaning, and structural inspection is paramount to safeguard the integrity of the system and extend the life of the facilities. Considering that an additional 18% of the City's outlets, or 83, were assessed with a maintenance ranking of 3, it will be critical to implement a maintenance program to prevent those structures from deteriorating to the point of requiring repair or replacement.

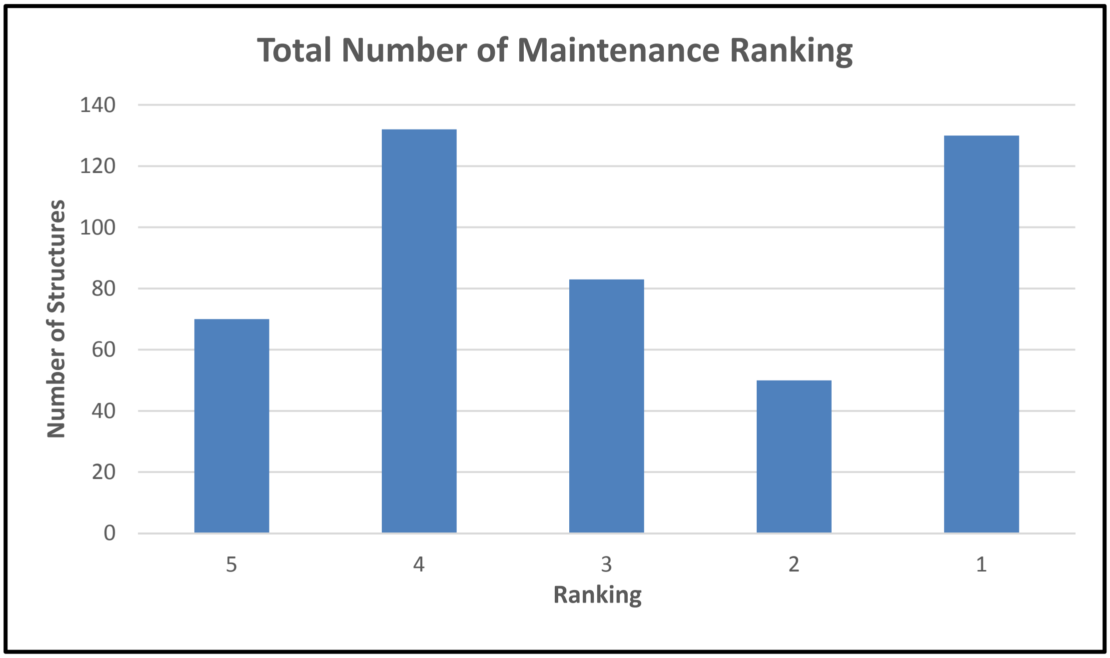
The maintenance assessment concluded that 180 outlet structures, or approximately 39% of the current system, that are ranked 1 or 2 should be immediately cleared and cleaned. The remaining 61% of the outlets require a maintenance plan that should be coordinated with the maintenance plan for the upstream pipes for flushing, cleaning, and CCTV investigation or pipe repair, rehabilitation, or replacement.

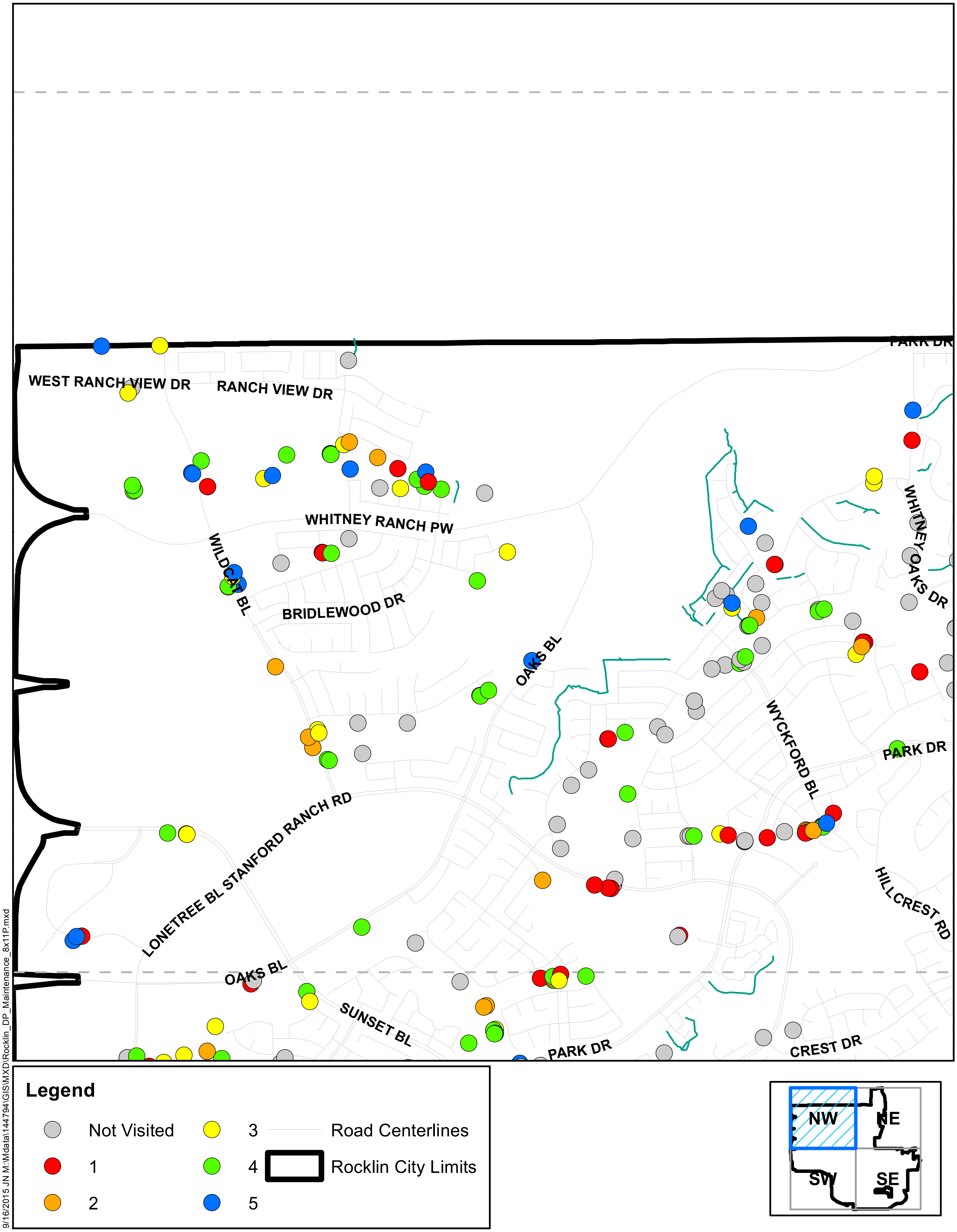
A regular maintenance program will increase the capacity of the system, extend the life of the system, and allow additional collection of data for the structural assessment. This will allow the City to prevent structural damage, repair damage before it gets too severe, and ultimately significantly reduce capital costs.

Table 2 – *Maintenance Condition Assessment*

Ranking	Number of City Outlet Structures	Ranking Percentage of System
5	70	15%
4	134	28%
3	83	18%
2	50	11%
1	130	28%
Total	467	100%

Graph 2 – *Summary of Maintenance Ranking*





Michael Baker INTERNATIONAL

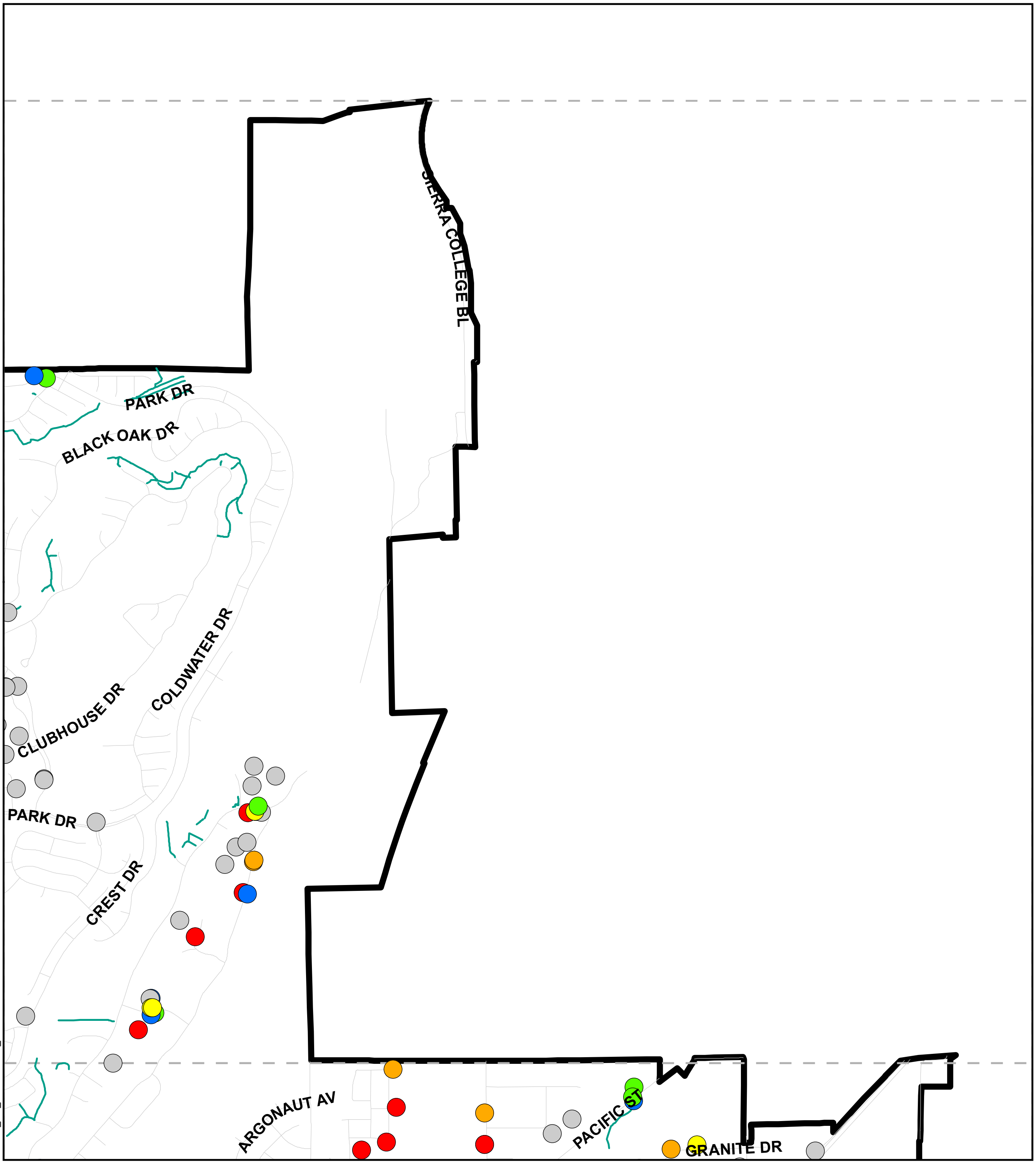
0 0.2 0.4 Miles

Source:

CITY OF ROCKLIN

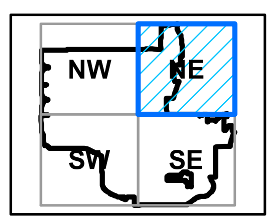
Maintenance Conditions NW

Exhibit 10



Legend

● (grey)	Not Visited	● (yellow)	3	—	Road Centerlines
● (red)	1	● (green)	4	▭	Rocklin City Limits
● (orange)	2	● (blue)	5		



Michael Baker INTERNATIONAL

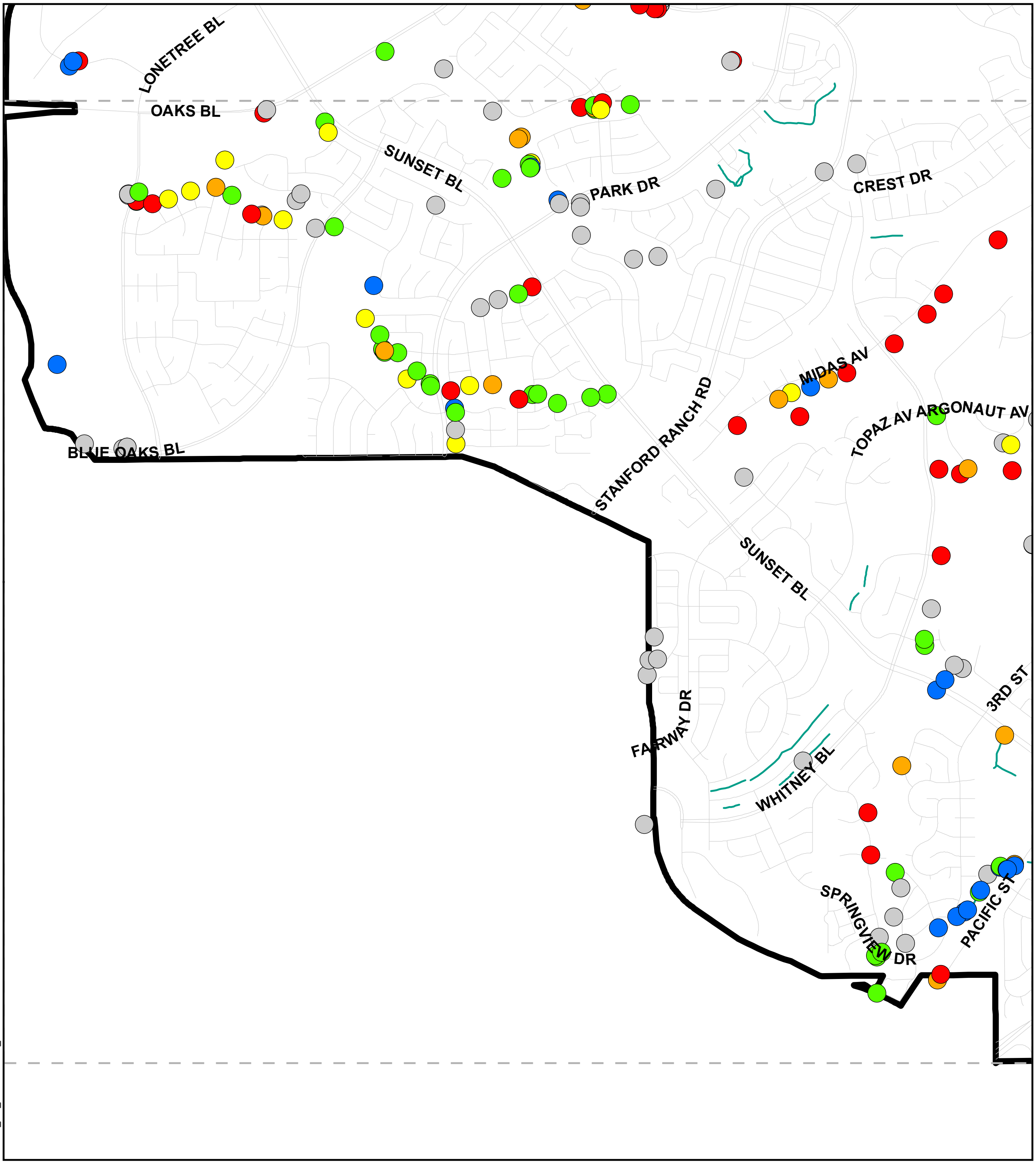
0 0.2 0.4 Miles

Source:

CITY OF ROCKLIN

Maintenance Conditions NE

Exhibit 11



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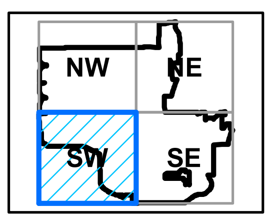
Legend

- Not Visited
- 1
- 2
- 3
- 4
- 5
- Road Centerlines
- Rocklin City Limits



Michael Baker INTERNATIONAL

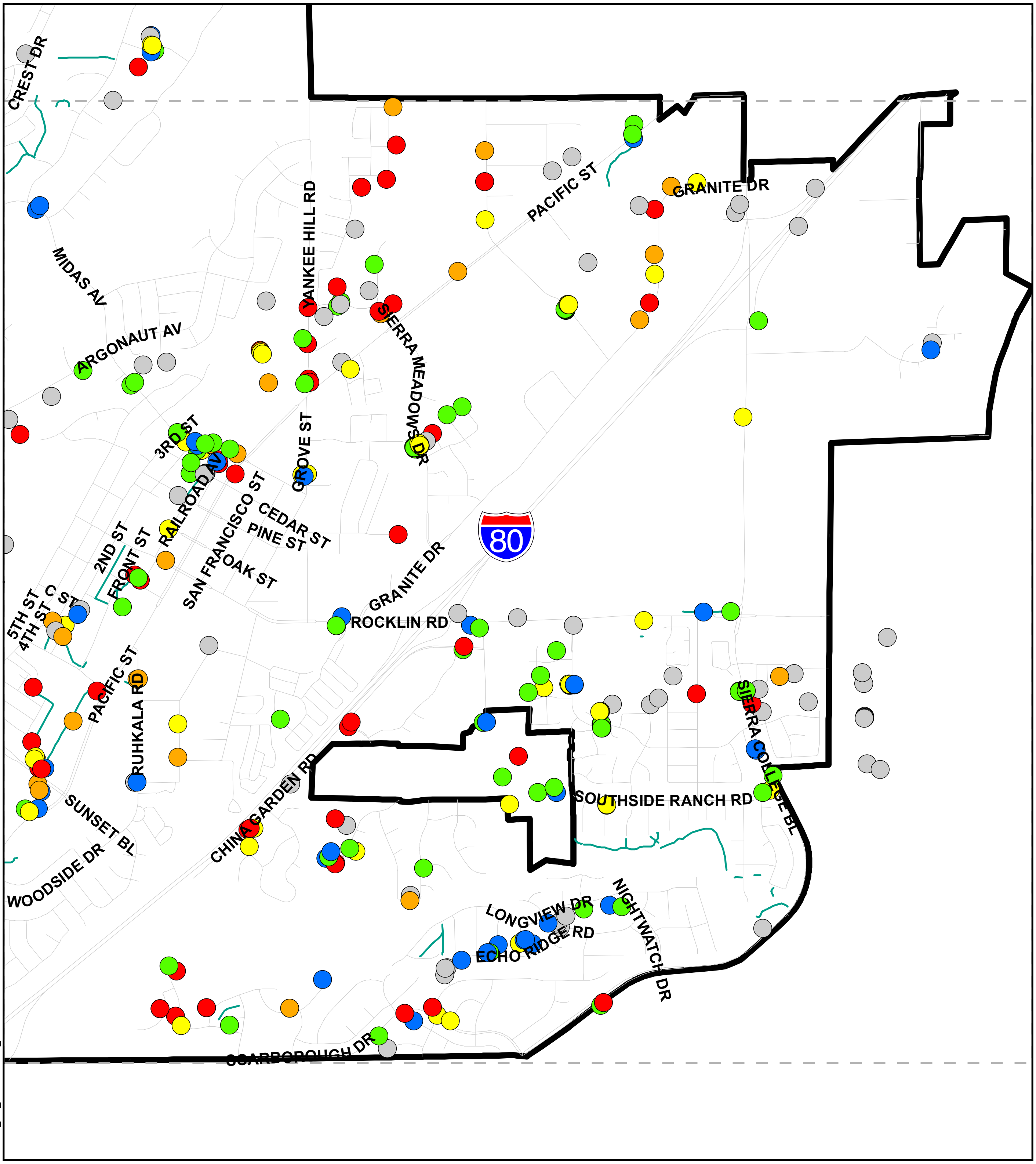
0 0.2 0.4 Miles

Source:

CITY OF ROCKLIN

Maintenance Conditions SW

Exhibit 12



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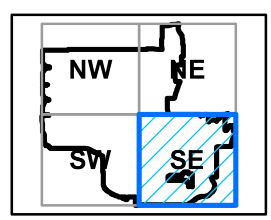
Legend

- Not Visited
- 1
- 2
- 3
- 4
- 5
- Road Centerlines
- Rocklin City Limits



Michael Baker INTERNATIONAL

0 0.2 0.4 Miles

Source:

CITY OF ROCKLIN

Maintenance Conditions SE

Exhibit 13

5.0 CCTV Investigation

A limited closed circuit television video (CCTV) pipe inspection was conducted to visually inspect sections of storm drain pipes in the area known as Old Town in Rocklin. The methodology developed to identify potential CCTV locations included the selection of pipe segments that represent a cross section of the City's current infrastructure, considering pipe diameter, material, year of installation, and location. The materials selected for inspection included reinforced concrete pipe (RCP), non-reinforced concrete pipe (CP), corrugated metal pipe (CMP), and asbestos cement (AC). Collectively these four materials constitute 90% of the pipes installed in Rocklin, with the vast majority, 56%, being RCP and CP, as discussed in Section 6.2, Pipe Material, Table 14-Life Expectancy of Pipe Material, of this report.

Five locations were identified in or near Old Town Rocklin in which to perform the CCTV investigation. All five locations selected have pipes that were installed prior to 1990 and are of varying length and diameter. Because approximately 24% of the City's total storm drain system comprises RCP pipe, for redundancy, two locations containing RCP were chosen (Area 1 and Area 5) for investigation. The CCTV investigation was conducted for a total of approximately 4,740 linear feet of pipe. Table 3 describes each area investigated with pipe information based on the GIS and as-builts. The locations of the CCTV areas are also shown in Figures 1 through 4.

Table 3 – *Selected CCTV Areas*

Description	Length (LF)	Material	Size	Year of Installation
Area 1	928	RCP	36"–42"	1981
Area 2	660	CMP/CP	10"–18"	1978
Area 3	1,334	CMP	15"–48"	1978/1987
Area 4	1,028	AC	15"–24"	1987
Area 5	721	RCP	24"–27"	1975
Total	4,671			

For reference, see Appendix A for the complete CCTV report, including exhibits of all five inspected areas identifying gravity mains, manholes, and inlets, as well as the findings and results.

5.1 Results of CCTV Investigations

On September 24 and 25, 2015, Pro-Pipe Professional Pipe Services, a division of Hoffman Southwest Corporation, conducted CCTV inspections of all five areas selected. The notable outcomes of the CCTV pipe assessment are summarized below by area. For the areas investigated as a part of this project, it was generally noted that significant pipe blockages were encountered, as summarized in Table 4.

Table 4 – *Summary of Percentage of Pipes Blocked*

% of Pipe Blockage	% of Pipe Conditions
0%–5%	48%
6%–25%	40%
26%–60%	4%
61%–100%	8%
Total	100%

Approximately 4,671 linear feet were identified for the initial CCTV investigation. Approximately 374 linear feet of pipe, or 8%, could not be inspected due to debris and blockage in the pipes.

Area 1

Area 1 is located on Midas Avenue between Pacific Street and Grove Street, containing manholes SDMH-2827 through SDMH-2524. Area 1 has a total pipe length of 914 linear feet and was divided into five sections for the CCTV inspections (see Figure 1). Installed in 1981, the pipe material of this section is reinforced concrete pipe (RCP), which has a life expectancy of approximately 90 years.

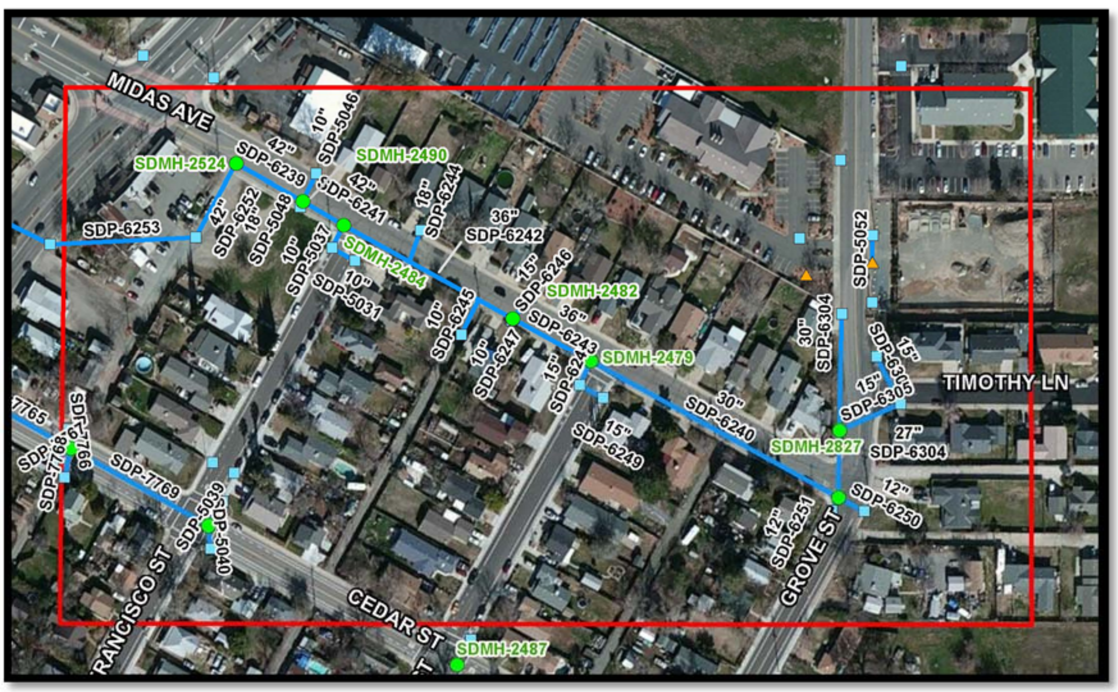


Figure 1 – CCTV Area 1

- Section 1 of Area 1 is between manholes SDMH-2827 and SDMH-2479 with a pipe diameter of 30 inches. No issues were cited in the CCTV report.

- Section 2 of Area 1 is between manholes SDMH-2479 and SDMH-2482 with a pipe diameter of 36 inches. At approximately 117 feet from SDMH-2479, infiltration leaking was detected near a joint.

- Section 3 of Area 1 is between manholes SDMH-2482 and SDMH-2484 with a pipe diameter of 36 inches. Slight sagging in the pipe was located approximately 242 feet from SDMH-2482.

- Section 4 of Area 1 is between manholes SDMH-2484 and SDMH-2490 with a pipe diameter of 42 inches. No issues were cited in the CCTV report.

- Section 5 of Area 1 is between manholes SDMH-2490 and SDMH-2524 with a pipe diameter of 42 inches. Multiple cracks were found approximately 44.1 feet into the pipe from SDMH-2490. The treatment of cracks could include a CIPP treatment.

Table 5 – *Area 1 CCTV Summary*

Area 1 Summary – Reinforced Concrete Pipe Installed in 1981							
Section No.	**Diameter (inches)**	**Length (ft)**	**% CIPP**	**% Replaced**	**Description of Damage**	**Recommendation**	**Cost**
1	36	384.86	0%	0%	No damage	N/A	N/A
2	42	120.34	.3%	0.0%	Infiltration leaking near joint for approximately 3 feet	Cured-in-place patching	$855
3	42	258.27	0%	0%	Slight sagging in pipe for roughly 16 feet	N/A	N/A
4	42	64.67	0%	0%	No damage	N/A	N/A
5	42	100.57	6.10%	0%	Multiple cracks manhole for approximately 57 feet between SDMH-2827 and SDMH-2479	Cured-in-place patching	$28,728
Total		**928.71**	**6.40%**	**0.00%**			**$29,583**

The RCP in this area is approximately 35 years old. The CCTV inspection for Area 1 indicated that the overall life expectancy of RCP (90 years) is an appropriate assumption. Small areas may require attention, but this system is functioning appropriately and is not expected to deteriorate in the foreseeable future.

Area 2

Area 2 is located on Winners Circle between manhole SDMH-2525 and an outlet south of Tuttle Drive. Area 2 was divided into seven sections for the CCTV inspections and has 554 feet of corrugated metal pipe (CMP) and 109 feet of non-reinforced concrete pipe (CP). All of the Area 2 pipelines were installed in 1978. The life expectancies of CMP and CP are 45 years and 75 years, respectively.

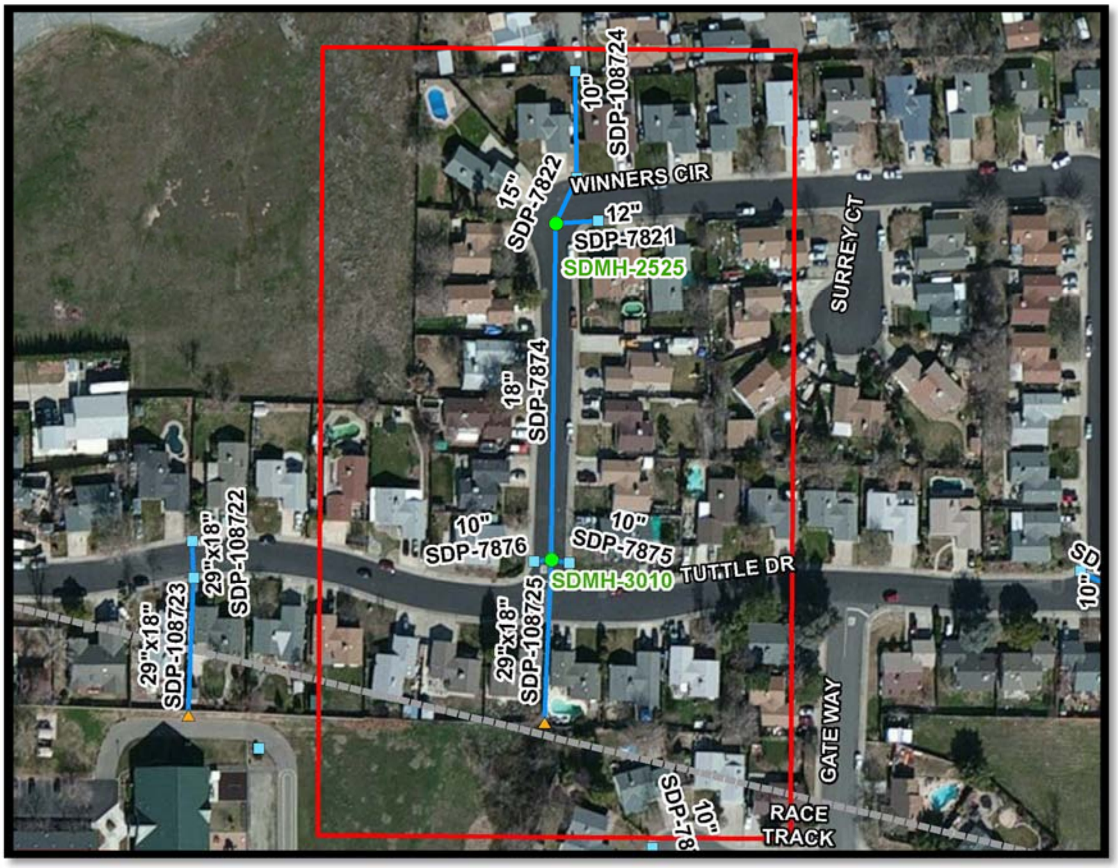


Figure 2 – CCTV Area 2

- Section 6 of Area 2 is between the Winners Circle inlet and manhole SDMH-2525 with pipe material of CMP and a pipe diameter of 15 inches. The survey began at the downstream manhole SDMH-2525. Due to severe debris, the survey was abandoned approximately 11 feet into the survey. It was also observed that the pipe was deformed.

- Section 7 of Area 2 is between an inlet located on Jamerson Drive and an inlet on Winners Circle. The pipe material of this section is CP and the pipe has a diameter of 10 inches; the pipe ID is SDP-108724. This portion of the survey began at the Winners Circle inlet. The survey was abandoned approximately 1 foot into the survey due to severe debris.

- Section 8 of Area 2 is between manholes SDMH-2525 and SDMH-3010. The pipe material of this section is CMP and the pipe has a diameter of 18 inches. This portion of the survey began at manhole SDMH-2525 but was abandoned approximately 290 feet into the system due to severe debris. Deformation of the pipe was reported as well as surface corrosion.

- Section 9 of Area 2 is pipe ID SDP-108725, which is between manhole SDMH-3010 and the discharge point. The pipe material of this section is CMP and the pipe has a diameter of 21 inches. This portion of the survey began at manhole SDMH-3010 and was abandoned immediately due to severe pipe deformation. It is apparent that there is a large amount of debris in this section of the pipe as well.

- Section 10 of Area 2 is the reverse of Section 8. The survey began at manhole SDMH-3010 and proceeded upstream toward manhole SDMH-2525. The Section 8 inspection was abandoned due to severe debris approximately 290 feet downstream of SDMH-2525. The diameter of this section is 18 inches. This section was also noted to have severe deformation in the pipe, with approximately 25% of the cross-sectional area full of debris.

- Section 11 of Area 2 is the reverse of Section 7 and began at the Jamerson Drive inlet and proceeded toward the Winners Circle outlet. The inspection was abandoned immediately due to severe debris, which covered approximately 40% of the cross-sectional area.

- Section 12 of Area 2 is the reverse inspection of Section 6, which was abandoned due to severe debris. Section 12 began at the Winners Circle outlet and proceeded toward manhole SDMH-2525. This portion of the inspection was also abandoned immediately due to severe debris.

The system in Area 2 is approximately 37 years old. The CCTV investigation indicated several pipe deformations in multiple locations. When visibility is unconstrained by debris, it was observed that bottom sections of the pipe were significantly corroded. Since the non-reinforced (CP) portions were inaccessible due to sedimentation buildup, CP pipes were not observed. It should be noted that section 7 requires swift attention. Because the pipe in this section has portions that are completely disintegrated, the likelihood of pipe failure in the near future is probable. Furthermore, the spot retrofitting of CMP as a one-off project is acceptable; however, if the partial treatments of CMP are applied on a wide scale, operation has significant drawbacks. Reference Section 7.3 of this report for further discussion. All of the surveys for Area 2 were abandoned before completing the pipe CCTV, due to either debris, deformation, or corrosion. It is an option to flush and reinspect the pipe again with CCTV before replacing the pipe section that was abandoned. Table 6, however, shows an alternate scenario in the event that the entire abandoned section is replaced in addition to the sections that are recommended for replacement due to CCTV observations.

Table 6 – *Area 2 CCTV Summary*

Area 2 Summary – Corrugated Metal Pipe and Concrete Pipe Installed in 1978							
Section No.	Diameter (inches)	Length (ft)	% CIPP	% Replaced	Description of Damage	Recommendation	Cost
6	15	50.34	0%	7.6%	Severe debris and pipe deformed; survey abandoned after 11.77 feet	Replace pipe section	$ 18,070
7	10	106.61	0%	16.14%	This section is concrete pipe; survey abandoned after 1 foot due to severe debris	Replace pipe	$ 25,583
8	18	338.24	10.3%	0%	survey abandoned after 290.52 feet due to debris and corrosion	Clean debris-filled pipe section and CIPP section	$ 14,694
9	21	165.25	0%	25.00%	Pipe severely deformed so survey was abandoned	Replace pipe section	$ 83,215
Total		**660.44**	**10.3%**	**48.7%**			**$ 141,562**

Area 3

Area 3 is located on Springview Drive between Woodbridge Way and Twin Creeks Lane. For the CCTV inspection, Area 3 was divided into eight sections. Per GIS and as-built data, the pipe material was originally thought to be non-reinforced concrete; however, the CCTV inspections found all segments of the pipe material to be corrugated metal (CMP). All sections of Area 3 were installed in 1978 and therefore have a current age of 37 years. CMP has a life expectancy of approximately 45 years.

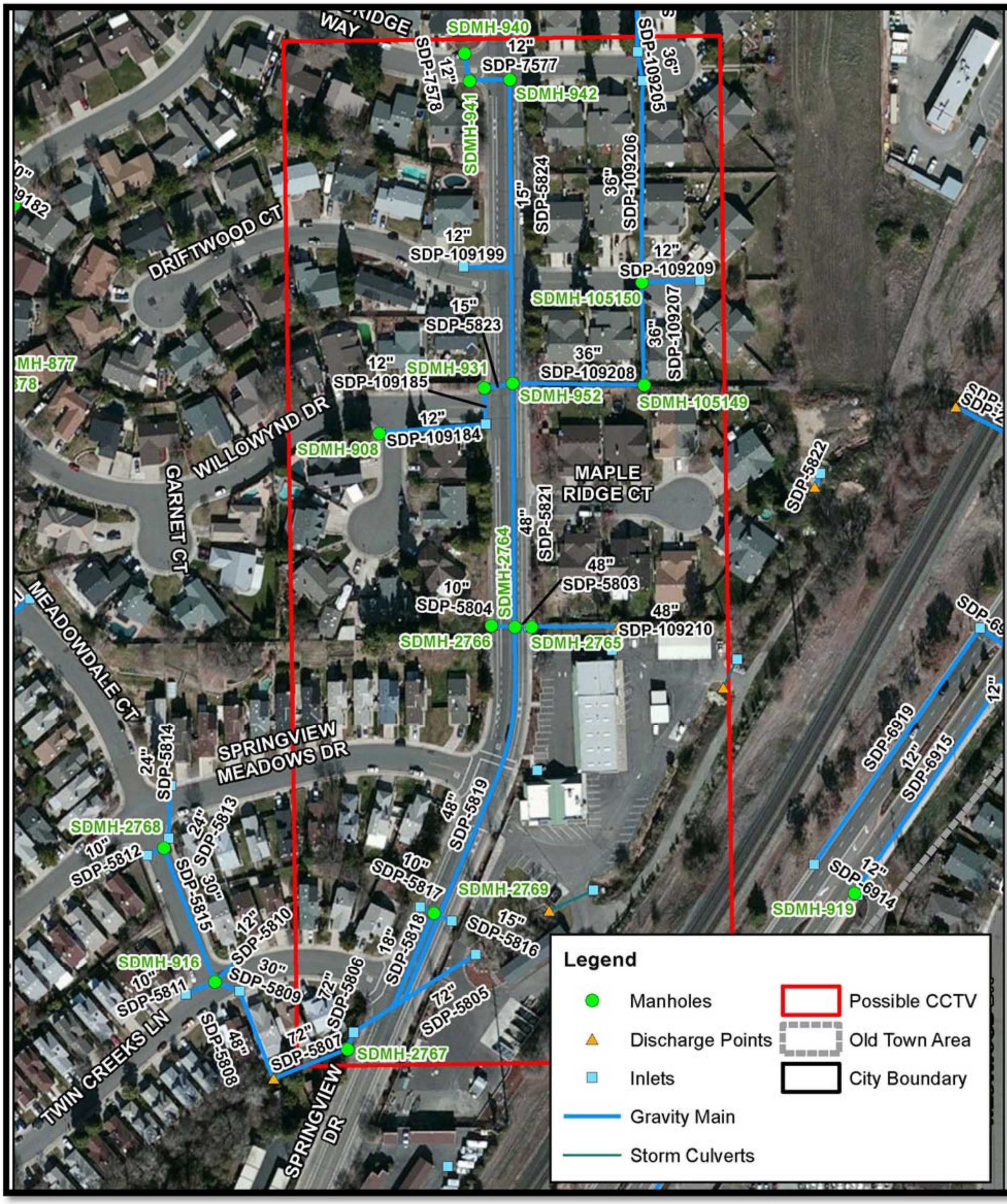


Figure 3 – CCTV Area 3

- Section 8 of Area 3 is between manholes SDMH-952 and SDMH-2764. The pipe has a diameter of 48 inches. It was observed that the system had a water level of 10% of the cross-sectional area at the time of inspection. Settled gravel and settled compacted deposits were found starting at approximately 125 feet in from SDMH-952.

- Section 9 of Area 3 is pipe ID SDP-5819, which is between manhole SDMH-2764 and a 72-inch main line, pipe ID SDP-5805. The pipe has a diameter of 48 inches. Water level at time of inspection was noted to be 5% of the cross-sectional area. Several sections of the system were observed to have approximately 15% to 25% of the cross-sectional area filled with debris. At approximately 393 feet from manhole SDMH-2764, a break was observed in the line located near a joint. Surface corrosion was also present. Due to the age of this pipe, replacement of the existing section is recommended.

- Section 10 of Area 3 is between manhole SDMH-2769 and the 72-inch main line. The pipe has a diameter of 18 inches. Surface corrosion was noted in several locations, and settlement of debris ranged from 5% to 15% of the pipe cross section in various locations within the system.

- Section 11 of Area 3 is between manholes SDMH-942 and SDMH-952. The pipe has a diameter of 15 inches. Starting from manhole SDMH-942, the system had progressive accumulation of debris until the survey was abandoned approximately 54 feet from manhole SDMH-942. Pipe corrosion was also noted during inspection.

- Section 12 of Area 3 is between manholes SDMH-941 and SDMH-942. The pipe diameter is 12 inches. Surface corrosion was noted during inspection.

- Section 13 of Area 3 is between manholes SDMH-940 and SDMH-941. The pipe has a diameter of 12 inches. The survey was abandoned due to a sharp turn in the system that the camera could not navigate.

- Section 14 of Area 3 is between manholes SDMH-940 and SDMH-941, which is the same as section 13. The pipe has a diameter of 12 inches. The survey was abandoned approximately 20 feet from manhole SDMH-940 because the pipe alignment was too skewed.

- Section 15 of Area 3 is between manholes SDMH-942 and SDMH-952, which is the same as section 11. The pipe has a diameter of 15 inches. At the time of inspection, the water level was noted to be approximately 20% of the cross-sectional area. A pipe sag was noted, as well as pipe corrosion. The survey was abandoned approximately 190 feet from manhole SDMH-952 due to a tap break-in intruding into pipe.

The CCTV investigation of Area 3 indicated that the approximate life expectancy of 45 years is appropriate for CMP systems. When visible, lower sections of pipe were observed to have significant corrosion. Due to the age of this pipe and the fact that leaks, intrusions, and corrosion were detected, it is recommended that this section be rehabilitated and replaced, as the pipe may fail in the foreseeable future.

Table 7 – *Area 3 CCTV Summary*

Area 3 Summary – Corrugated Metal Pipe Installed in 1978 and 1987							
Section No.	Diameter (inch)	Length (ft)	% CIPP	% Replaced	Description of Damage	Recommendation	Cost
8	48	322.86	0%	0%	Debris covering 15% of the pipe	Scour and clean pipe	$3,229
9	48	525.37	0%	7%	Debris for part of the pipe, the pipe is broken, and corrosion is present for roughly 80 feet (1987)	Scour and clean pipe, and replace section	$107,574
10	18	140.32	9%	0%	Deposits for most of the pipe length	Scour and clean and CIPP line	$25,933
11/15	15	255.00	19%	0%	Survey abandoned at 55 feet due to severe debris and obstacles; break in as well	Scour and clean/CIPP entire length	$45,623
12	12	55.53	0%	4%	Severe corrosion and minor debris	Scour and clean/replace entire length	$15,368
13/14	12	35	N/A	N/A	Severe debris and too sharp of turn to CCTV	N/A	N/A
	Total	**1334**	**28%**	**11%**			**$194,497**

Area 4

Area 4 is located near the intersection of Sunset Boulevard and 3rd Street. For the CCTV inspection, Area 4 was divided into four sections. Per the GIS and as-built drawings, the pipe material for Area 4 was thought to be asbestos cement (AC); however, the CCTV investigation lists the material as non-reinforced concrete pipes (CP). For this report, it was assumed that the pipe material is AC. All sections in Area 4 were installed in 1987, giving them a current age of 28 years. Asbestos cement pipes have an approximate life expectancy of 70 years.

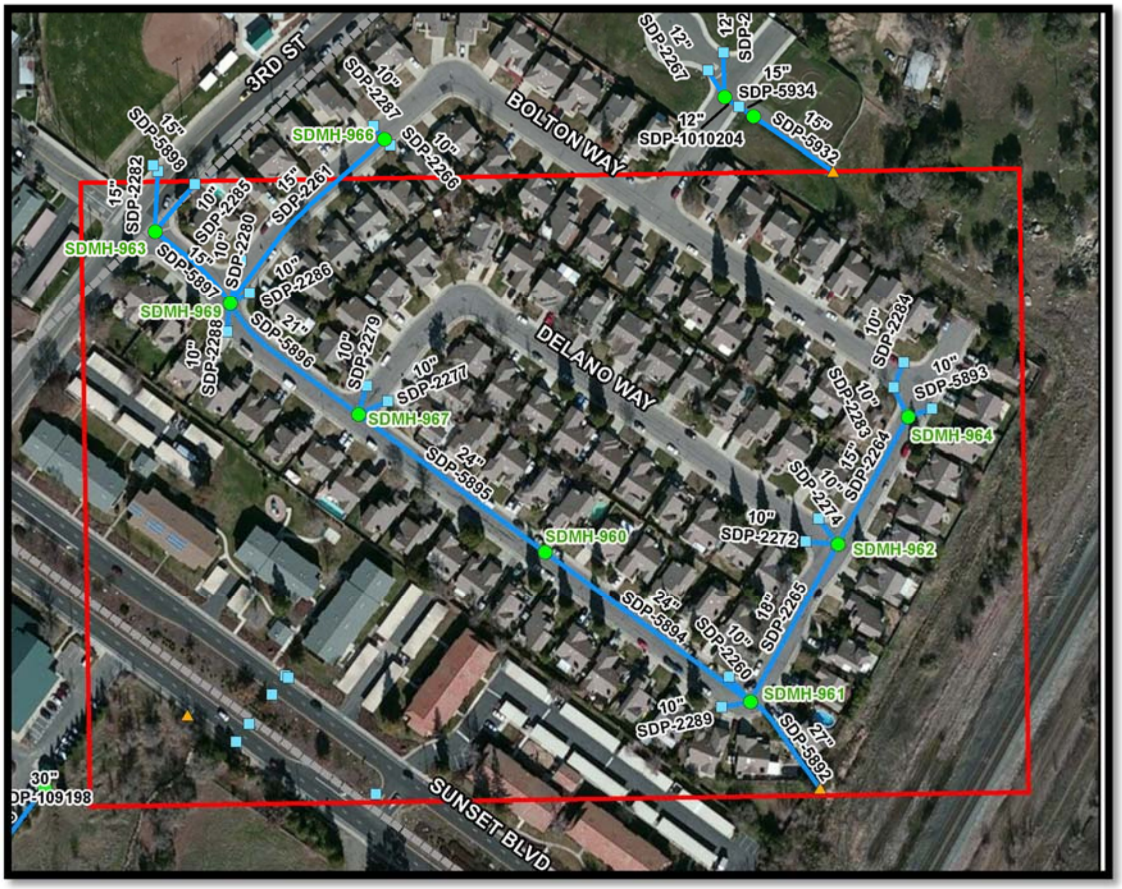


Figure 4 – CCTV Area 4

- Section 1 of Area 4 is located between manholes SDMH-969 and SDMH-967. The pipe has a diameter of 21 inches. No issues were cited during the CCTV inspection.

- Section 2 of Area 4 is located between manholes SDMH-967 and SDMH-960. The pipe has a diameter of 24 inches. No issues were cited during the CCTV inspection.

- Section 3 of Area 4 is located between manholes SDMH-960 and SDMH-961. The pipe has a diameter of 24 inches. Debris and rocks were noted ranging from 5% to 15% of the pipe's cross-sectional area.

- Section 4 of Area 4 is located between manhole SDMH-961 and the discharge point located in the field near the railroad. The pipe has a diameter of 27 inches. A break in the pipe was noted approximately 5 feet from manhole SDMH-961. Roots are growing into the pipe approximately 20 feet from the manhole.

It is recommended that the AC pipes be slip-lined rather than replaced, due to the potential environmental implications.

Table 8 – *Area 4 CCTV Summary*

Area 4 Summary – Asbestos Cement Pipe Installed in 1975							
Section No.	Diameter (inches)	Length (ft)	% CIPP	% Replaced	Description of Damage	Recommendation	Cost
1	21	227.43	0%	0%	None	N/A	N/A
2	24	308.72	0%	0%	None	N/A	N/A
3	24	340.66	0%	0%	Mild debris	Clean and scour	$850
4	27	151.10	2.00%	0%	Root infiltration at the joint for 20-foot portion of the pipe	Clean/scour/CIPP	$6,661
Total		**1,027.91**	**2.00%**				**$7,511**

Area 5

Area 5 is located on Racetrack Drive and is intersected by Racetrack Circle. For the CCTV inspection, Area 5 was divided into three sections. The pipe material in this section is reinforced concrete pipe (RCP). All systems in this section were installed in 1975, giving them a current age of 40 years. RCP has an approximate life expectancy of 90 years.

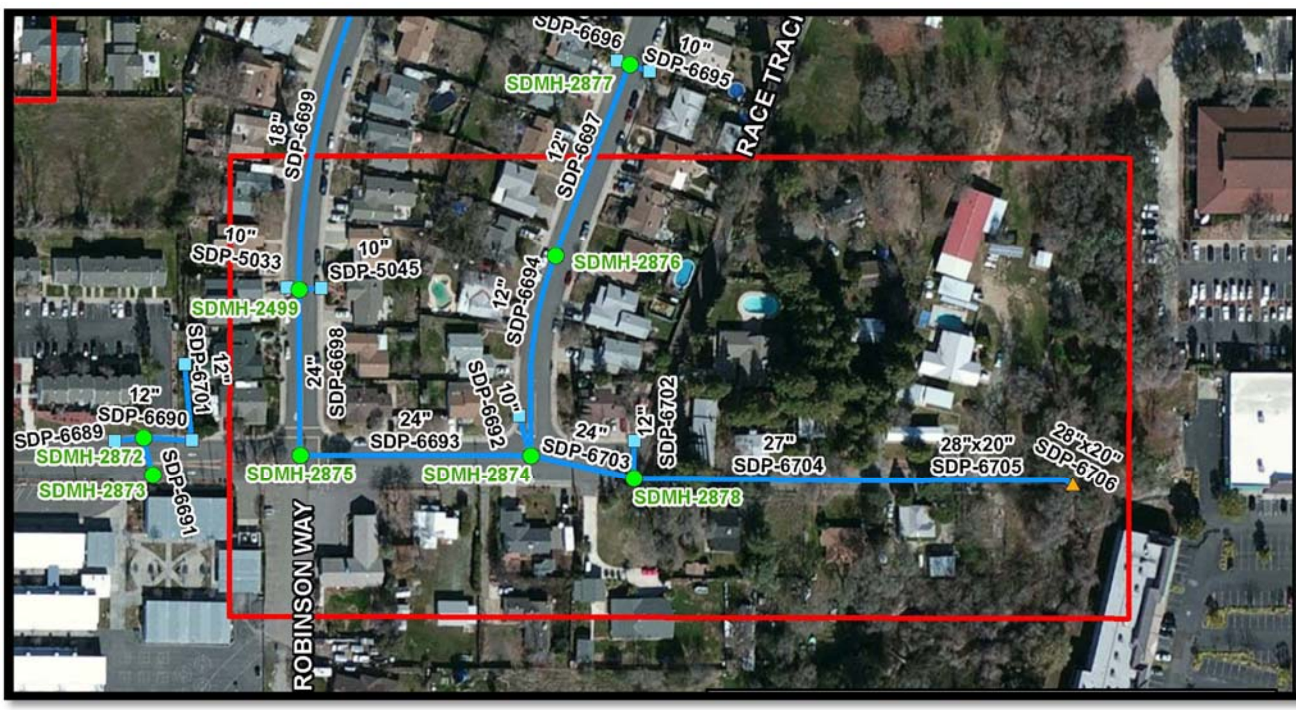


Figure 5 – CCTV Area 5

- Section 5 of Area 5 is located between manholes SDMH-2875 and SDMH-2874. The pipe has a diameter of 24 inches. Debris in the system was observed to be 5% to 15% of the cross-sectional area in various locations throughout the system. Roots growing into the pipe were located approximately 215 feet from manhole SMDH-2874 near a joint.

- Section 6 of Area 5 is located between manholes SDMH-2874 and SDMH-2878. The pipe has a diameter of 24 inches. Roots were located approximately 7 feet from manhole SDMH-2874. Debris was noted to accumulate in approximately 10% of the cross-sectional area. Manhole SDMH-2878 has been paved over, preventing access. A slip line could be used to repair this section.

- Section 7 of Area 5 is located between manhole SDMH-2878 and the discharge outlet. The pipe has a diameter of 27 inches. This section of pipe joints has been slightly damaged by roots.

Even though reinforced concrete has a life expectancy of 90 years, the terrain and environment need to be considered. Areas with a high density of trees are at risk of root intrusion and infiltration despite the pipe material. Roots can be managed with a regular cleaning and maintenance program. An alternative is to slip-line the existing pipe with a high density polyethylene (HDPE) or polyvinyl chloride (PVC) pipe with no joints or to line the pipe.

Table 9 – *Area 5 CCTV Summary*

Area 5 Summary – Reinforced Concrete Pipe Installed in 1975							
Section No.	Diameter (inch)	Length (ft)	% CIPP	% Replaced	Description of Damage	Recommendation	Cost
5	24	263.63	10.5%	0%	Deposits of settled gravel, roots at 15 joints per 5' CIPP	Scour and clean, and spot repair	$21,805
6	24	107.49	2.0%	%0	Deposits settled and fine root joints for 90 feet	Clean/scour and spot repair	$4,153
7	27	349.95	5.5%	0%	Deposits settled and fine root joints for the majority of the pipe; medium joint intrusion at 8 joints per 5' CIPP	Clean/scour and spot repair	$12,849
Total		**721.07**	**18%**	**0%**			**$38,808**

A summary showing the results from the entire system is provided below.

Table 10 – *Summary of CCTV Findings*

Summary of Pipe CCTV Results			
Material	**Installation Year**	**% CIPP Repair**	**% Replacement**
Non-Reinforced Concrete Pipe	1981	0%	16%
Corrugated Metal Pipe	*1978*	*42%*	*44%*
Asbestos Cement Pipe	1975	2%	0%
Reinforced Concrete Pipe	1975/1981	18%	0%

Table 11 – *Summary of Cost Due to CCTV Findings*

Summary of CCTV Repair and Rehabilitation Costs		
Material	**Length (ft)**	**Replacement/Repair Cost**
Non-Reinforced Concrete Pipe	107	$25,583
Corrugated Metal Pipe	*1,888*	*$313,705*
Asbestos Cement Pipe	1,028	$7,511
Reinforced Concrete Pipe	1648	$68,391
Total with CMP	**4,671**	**$415,190**
Total without CMP	**Total Cost without CMP***	**$101,485**

* CMP cost replacement is addressed comprehensively in Section 7.3 of this report.

** The summary of cost are not representative, additional construction costs and fees are applicable.

6.0 Summary of Existing Stormwater System Attributes

As-built drawings of the roadways, storm drain facilities, and other infrastructure projects in Rocklin were collected and reviewed. Storm drain information pertaining to pipe attributes such as date installed, age of pipe, material, and diameter was identified on each as-built and used to update the GIS database. Data from the City's updated GIS system was used to create the tables and graphs included in this report depicting the overall storm drain system in the city.

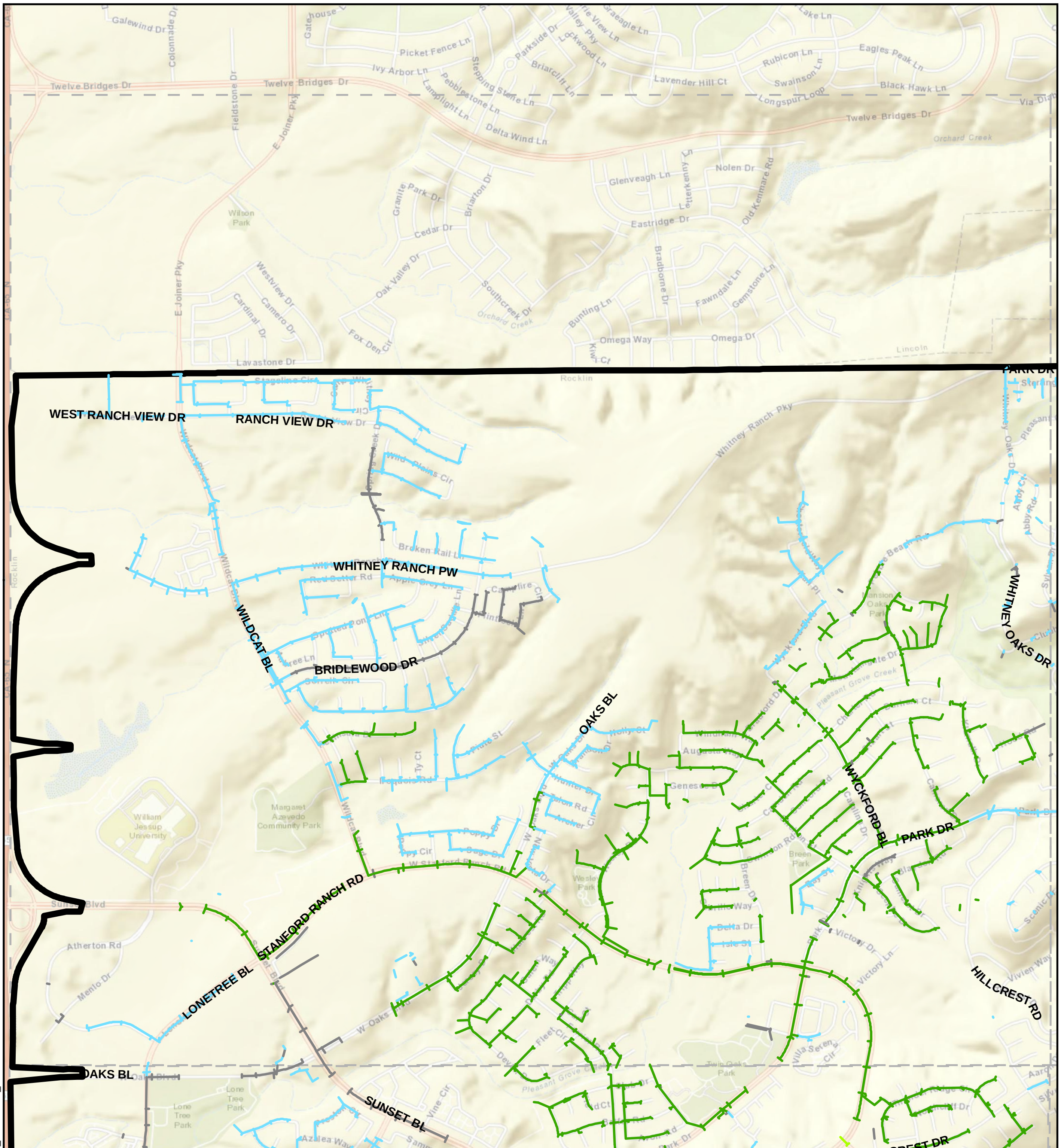
6.1 Pipe Installation Year

The city has approximately 697,760 linear feet of storm drain pipes (132 miles). The attributes examined as a part of this project include the installation year, pipe material, and pipe diameter. Approximately 13% of the storm drain pipes in the city have an unknown attribute or attributes. These unknown attributes are ascribed to a lack of record documentation or to inadequate information present on the obtained drawings. The City should make continued efforts to further identify these unknown attributes, either through field data acquisition or by locating additional record information. It is recommended that the GIS database be regularly updated as new information is obtained.

Approximately 21% of the known pipes in the city were installed between the years 1960 and 1989. This equates to approximately 148,320 linear feet (LF) of pipe (28 miles). Over 65% (459,450 LF or 87 miles) of the known pipes in Rocklin were installed after the year 1990. Table 12 lists the percentages and total pipe lengths per year of installation, grouped by decade, starting in 1960.

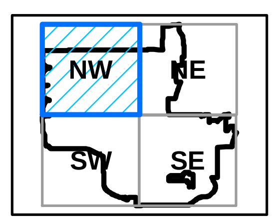
Table 12 – *Summary of Pipes Lengths Based on Installation*

Year Grouping	Install Year	Pipe Length (ft)	Pipe Length (ft)	% of System
No Data	0	89,991	89,991	12.9%
1960-1969	1960	1,249	16,198	2.3%
	1962	155		
	1963	6,987		
	1964	3,503		
	1965	4,049		
	1968	256		
1970-1979	1974	366	26,409	3.8%
	1975	2,949		
	1976	1,213		
	1977	8,848		
	1978	7,079		
	1979	5,955		
1980-1989	1980	1,154	105,713	15.2%
	1981	2,362		
	1982	1,538		
	1983	8,746		
	1984	1,575		
	1985	3,671		
	1986	12,860		
	1987	28,166		
	1988	29,183		
	1989	16,457		
1990-1999	1990	25,341	197,617	28.3%
	1991	12,288		
	1992	68,853		
	1993	18,333		
	1994	1,690		
	1995	1,719		
	1996	25,205		
	1997	33,362		
	1998	5,336		
	1999	5,490		
2000-2009	2000	42,201	261,713	37.5%
	2001	33,007		
	2002	35,514		
	2003	13,543		
	2004	39,905		
	2005	41,209		
	2006	38,565		
	2007	13,863		
	2008	3,600		
	2009	306		
2010-2015	2011	26	120	0.0%
	2014	94		
		Total Linear Feet	**697,761**	**100.0%**



Legend

1960 - 1969	1980 - 1989	2000 - 2009	Road Centerlines
1970 - 1979	1990 - 1999	2010 - 2014	Rocklin City Limits
		Unknown	



0 0.2 0.4 Miles

Source: City of Rocklin

Michael Baker INTERNATIONAL

CITY OF ROCKLIN

System by Install Year:NW

Exhibit 14

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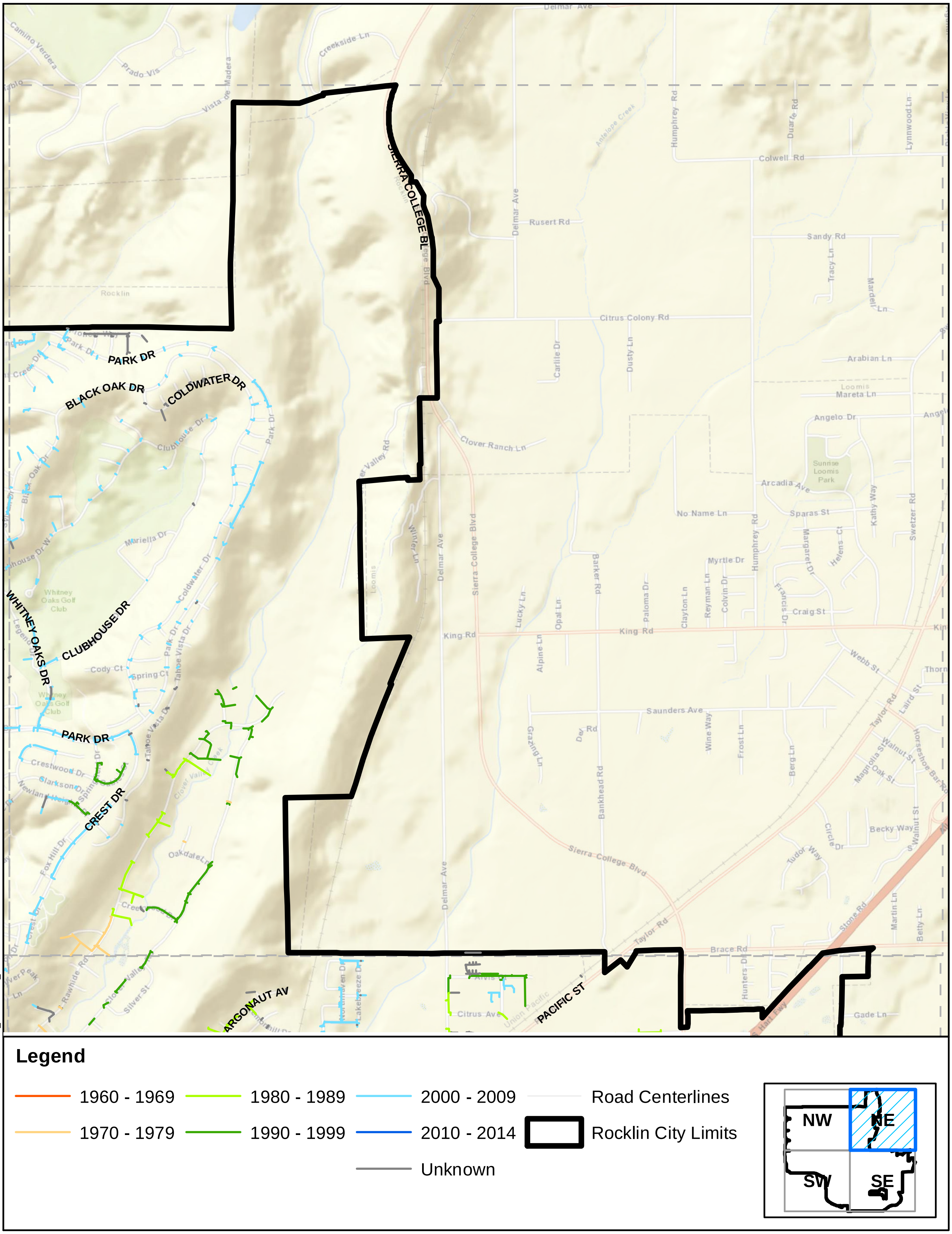

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Michael Baker INTERNATIONAL

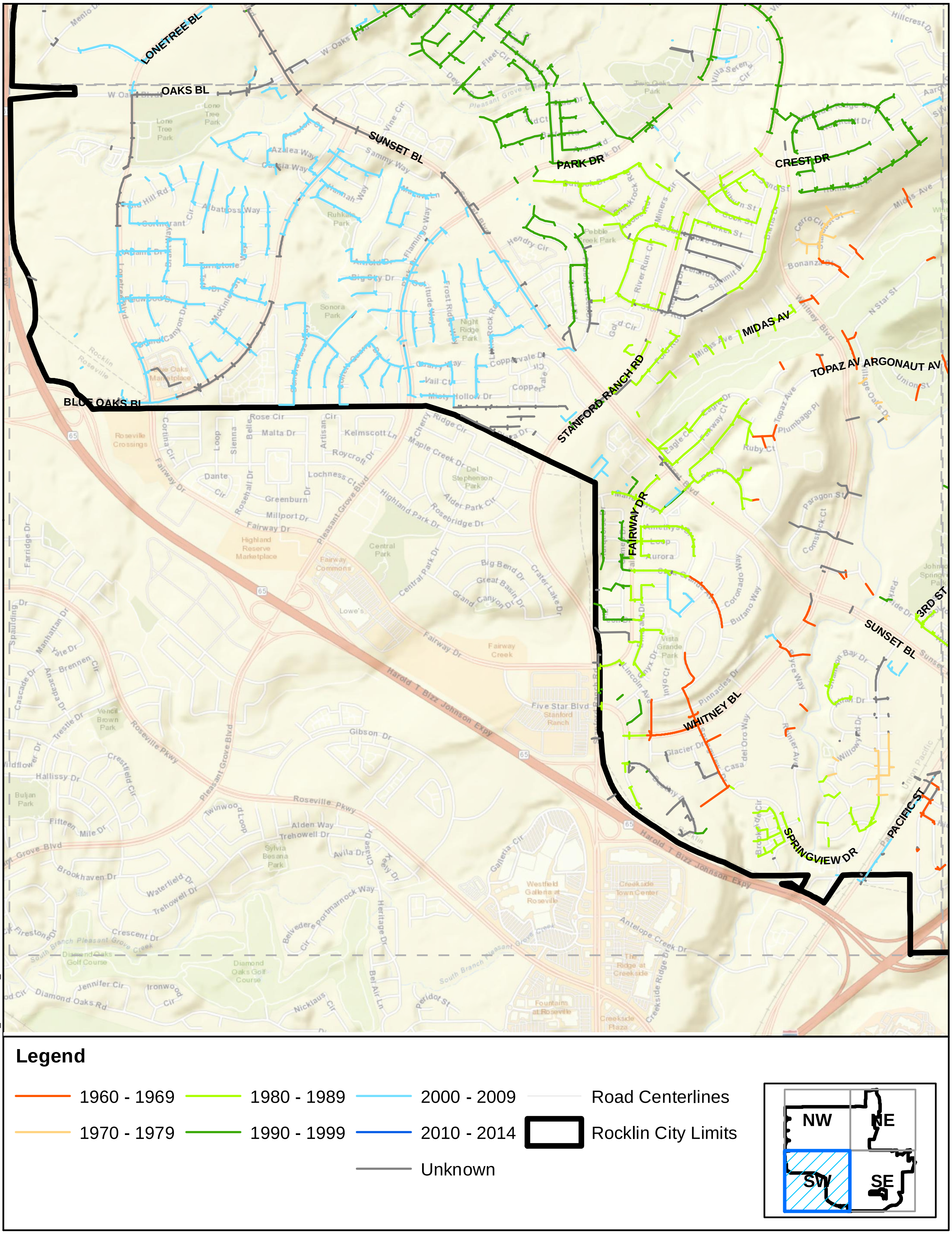
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

System by Install Year:NE

Exhibit 15



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Michael Baker INTERNATIONAL

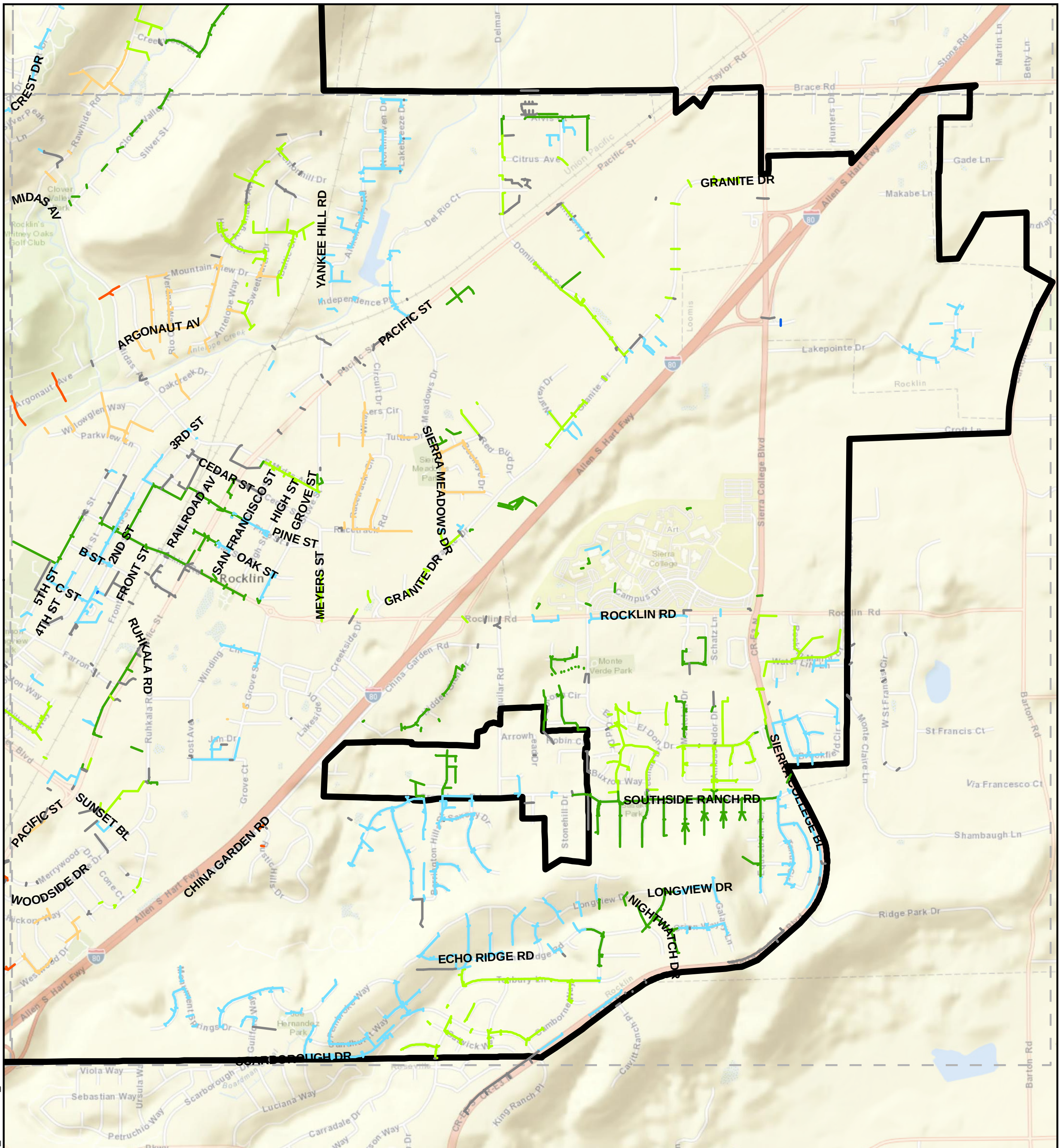
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

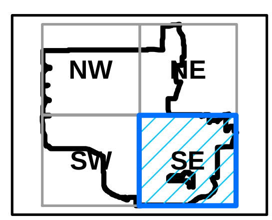
System by Install Year:SW

Exhibit 16



Legend

- 1960 - 1969
- 1970 - 1979
- 1980 - 1989
- 1990 - 1999
- 2000 - 2009
- 2010 - 2014
- Unknown
- Road Centerlines
- Rocklin City Limits



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Michael Baker INTERNATIONAL

0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

System by Install Year:SE

Exhibit 17

6.2 Pipe Material

Approximately 16 different pipe materials are used throughout the City's storm drain system, although many are minor variations of the same core material. Most prevalent materials used are non-reinforced concrete (CP), reinforced concrete pipe (RCP), and high density polyethylene (HDPE), as depicted in Graph 3. Table 13 lists all of the different pipe materials, material abbreviations, and life expectancy as identified in the GIS database. Table 14 summarizes the total linear feet of pipe in the system per material and the system percentage per material. It should be noted that CP, RCP, and HDPE have a life expectancy of 75, 90, and 100 years, respectively. Life expectancies are estimated based on research and historical data, and results will vary depending on geography, installation methods, environmental conditions, and many other factors.

Table 13 – *Life Expectancy of Pipe Material*

Pipe Material (abbreviation)	Material Description	Life Expectancy (years)
AC	asbestos cement	70
ACPP	American concrete pressure pipe	100
CIPP	cured in place	50
CMP	corrugated metal	45
CMPA	corrugated metal pipe arch	45
CP	concrete (non-reinforced)	75
CSB	concrete segments (unbolted)	75
CSP	corrugated steel pipe	45
DIP	ductile iron pipe	60
HDPE	high density polyethylene	100
PE	polyethylene	90
PVC	polyvinyl chloride (plastic)	90
RCP	reinforced concrete pipe	90
SDR	plastic	90
SP	steel	50
VCP	vitrified clay pipe	90
UNK	unknown	55

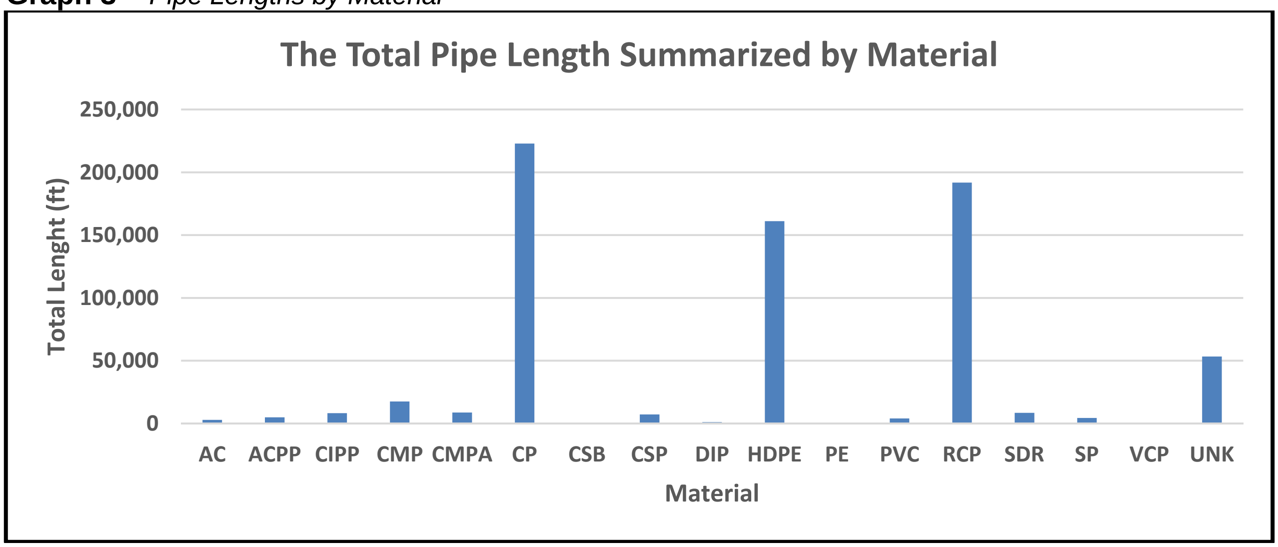
Exhibits 18 through 21 indicate the location of the pipes with a color-coded scheme that correlates to the material. The exhibits are intended to illustrate the concentration and clustering of the various pipe materials within the city limits. The materials of utmost concern are associated with an expected life cycle of 50 years or less and generally are metallic. Metallic pipes are much more susceptible to failure due to corrosion. Exhibits 26 through 29 identify the locations of all of the metallic pipes in the City's system.

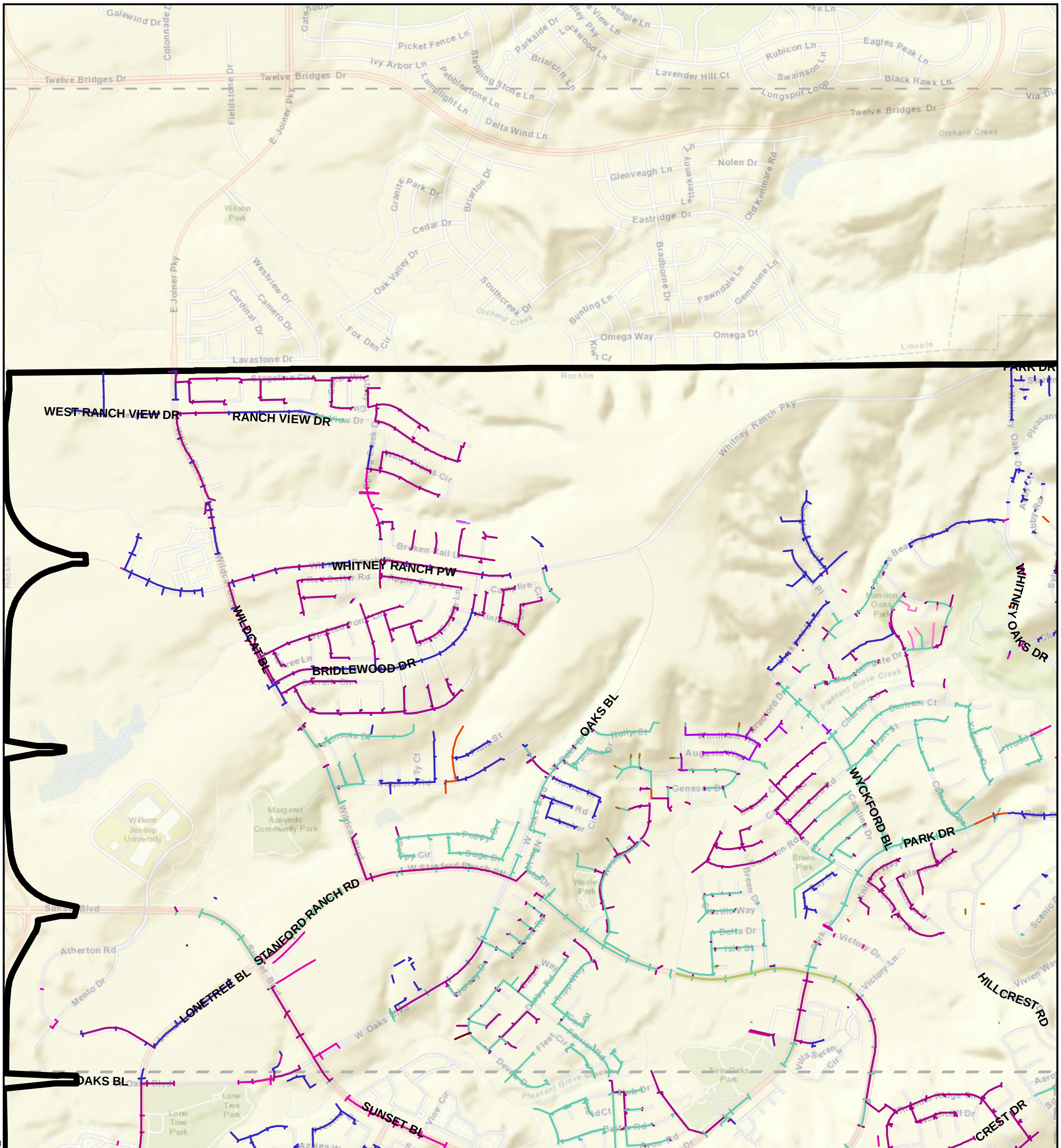
Table14 indicates the percentage of pipe materials installed in the city, noting that the majority of the pipes are CP and RCP, followed by HDPE.

Table 14 – *Percentage of Material in System*

Material	Length Total (ft)	% of System
AC	2,856	0.4%
ACPP	4,963	0.7%
CIPP	8,269	1.2%
CMP	17,508	2.5%
CMPA	8,750	1.3%
CP	222,829	31.9%
CSB	183	0.0%
CSP	7,209	1.0%
DIP	1,144	0.2%
HDPE	161,139	23.1%
PE	295	0.0%
PVC	4,016	0.6%
RCP	191,831	27.5%
SDR	8,513	1.2%
SP	4,431	0.6%
VCP	441	0.1%
UNK	53,383	7.7%
Total Length	**697,762**	**100.0%**

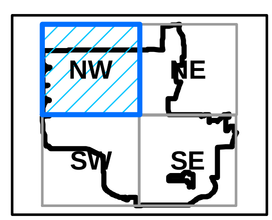
Graph 3 – *Pipe Lengths by Material*





Legend

AC	CMP	DIP	RCP	Unknown
CP, CAP	CMPA	HDPE	SDR	Road Centerlines
CIP	CSB	PE	SP	Rocklin City Limits
CIPP	CSP, CSPA & RIB	PVC	VCP	



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Material8x11P.mxd

Michael Baker INTERNATIONAL

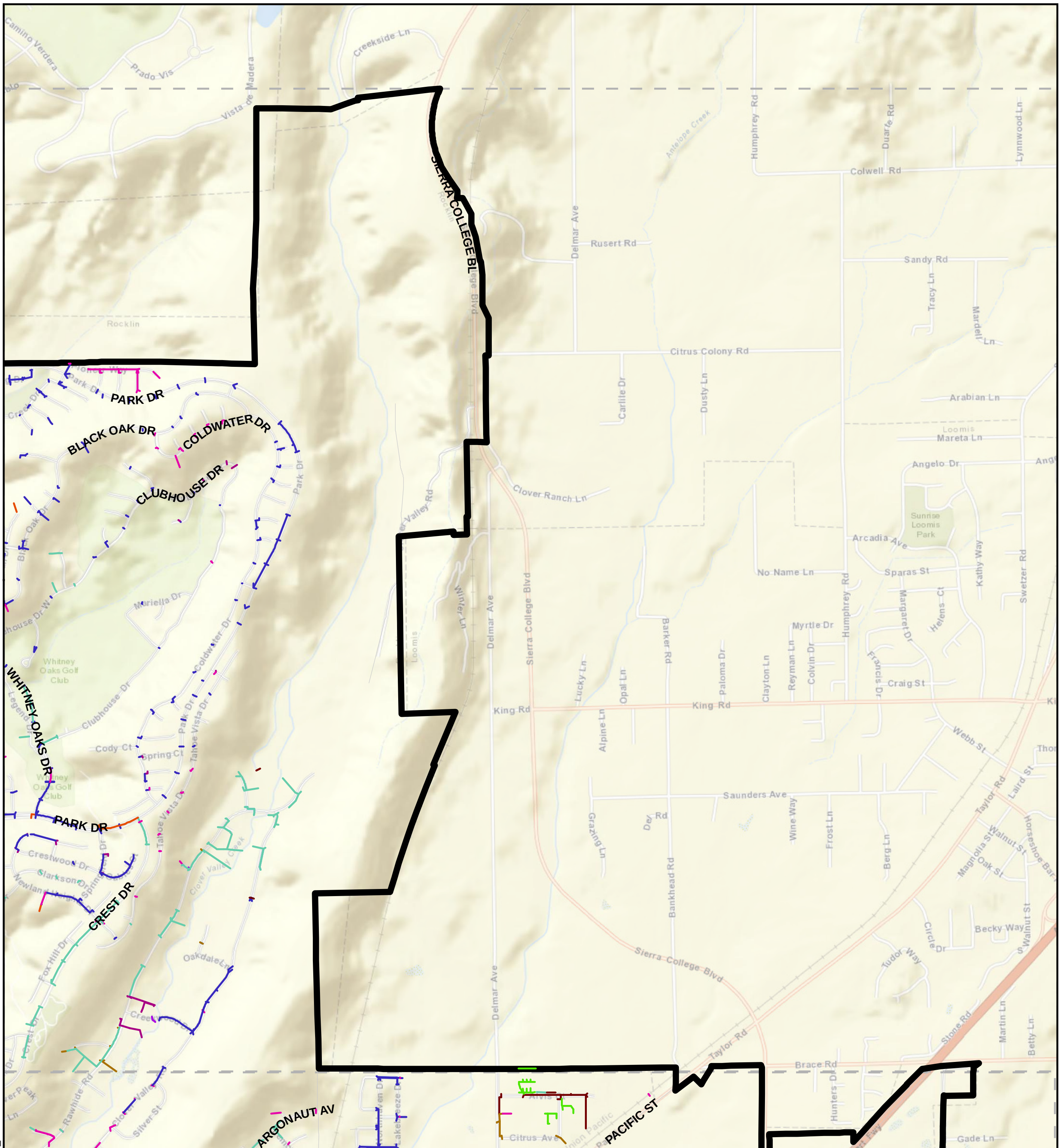
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

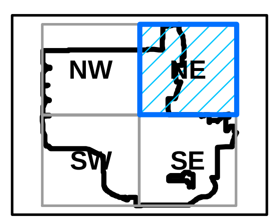
System by Material:NW

Exhibit 18



Legend

AC	CMP	DIP	RCP	Unknown
CP, CAP	CMPA	HDPE	SDR	Road Centerlines
CIP	CSB	PE	SP	Rocklin City Limits
CIPP	CSP, CSPA & RIB	PVC	VCP	



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Material8x11P.mxd

Michael Baker INTERNATIONAL

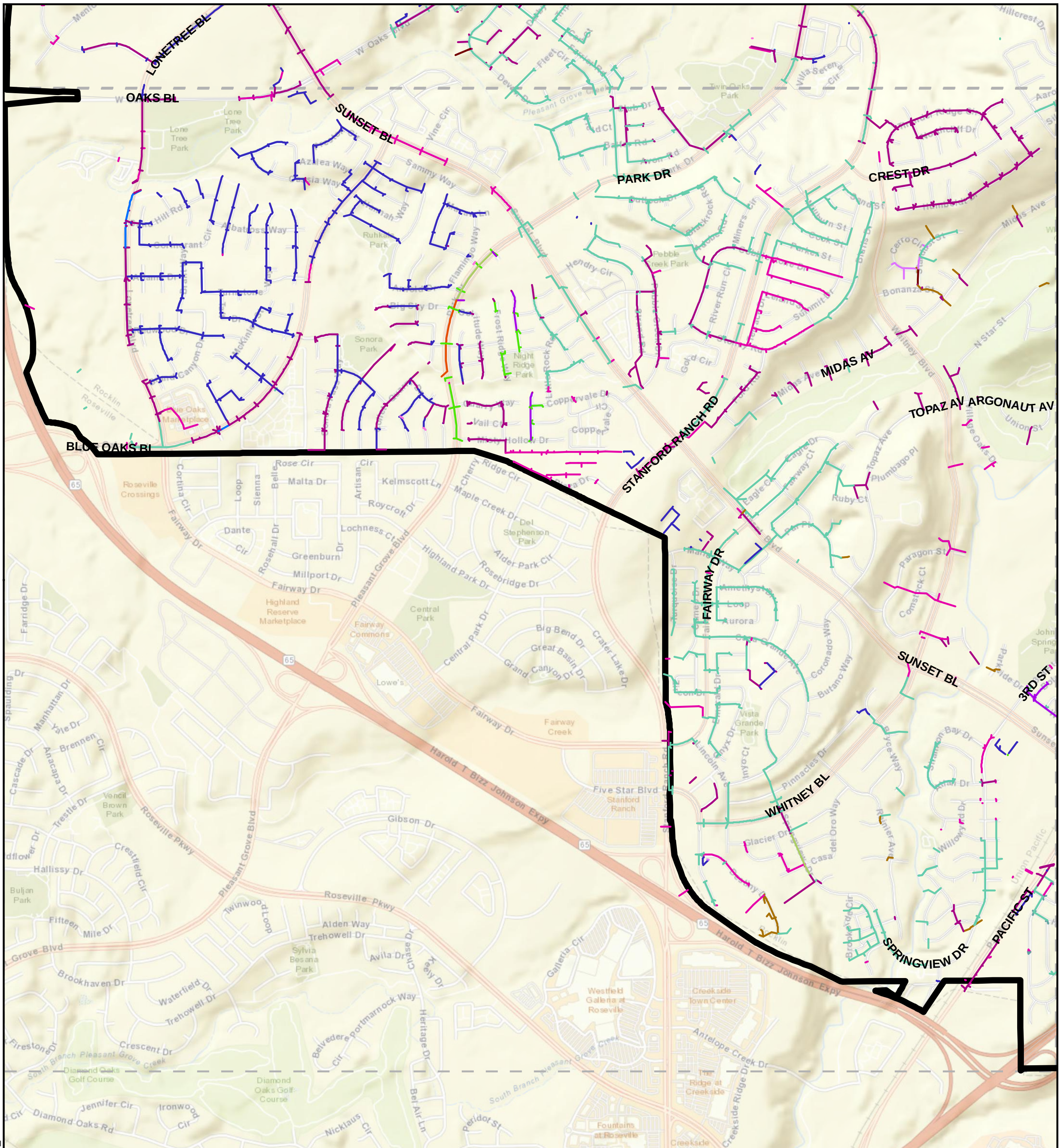
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

System by Material:NE

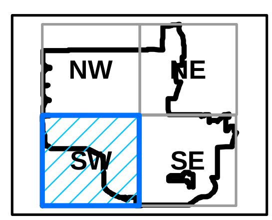
Exhibit 19



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Material8x11P.mxd

Legend

AC	CMP	DIP	RCP	Unknown
CP, CAP	CMPA	HDPE	SDR	Road Centerlines
CIP	CSB	PE	SP	Rocklin City Limits
CIPP	CSP, CSPA & RIB	PVC	VCP	



Michael Baker INTERNATIONAL

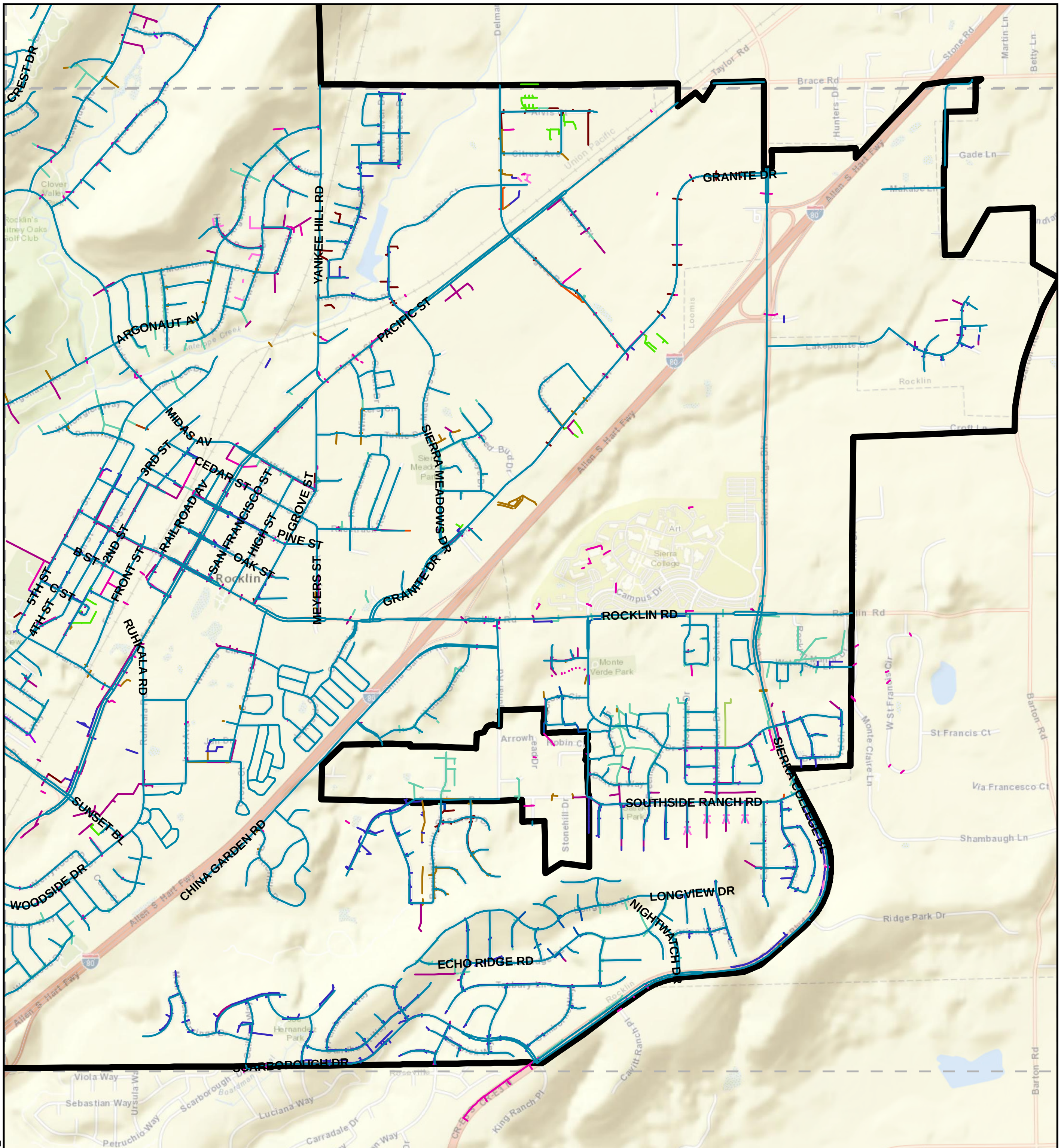
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

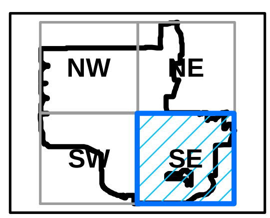
System by Material:SW

Exhibit 20



Legend

- AC
- CP, CAP
- CIP
- CIPP
- CMP
- CMPA
- CSB
- CSP, CSPA & RIB
- DIP
- HDPE
- PE
- PVC
- RCP
- SDR
- SP
- VCP
- Unknown
- Road Centerlines
- Rocklin City Limits



Source: City of Rocklin

Michael Baker INTERNATIONAL

CITY OF ROCKLIN

System by Material:SE

Exhibit 21

12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Material8x11P.mxd

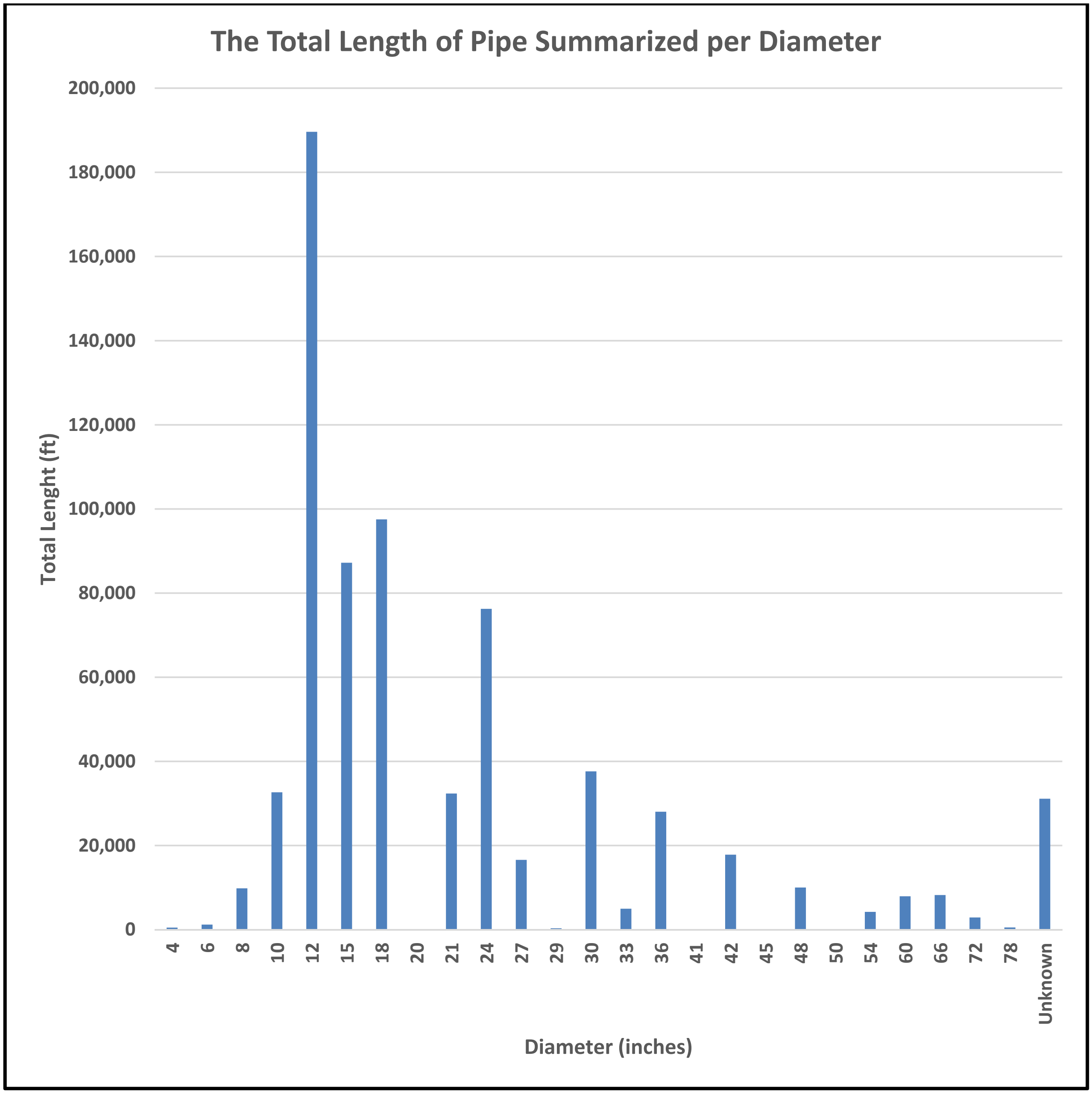
6.3 Pipe Diameter

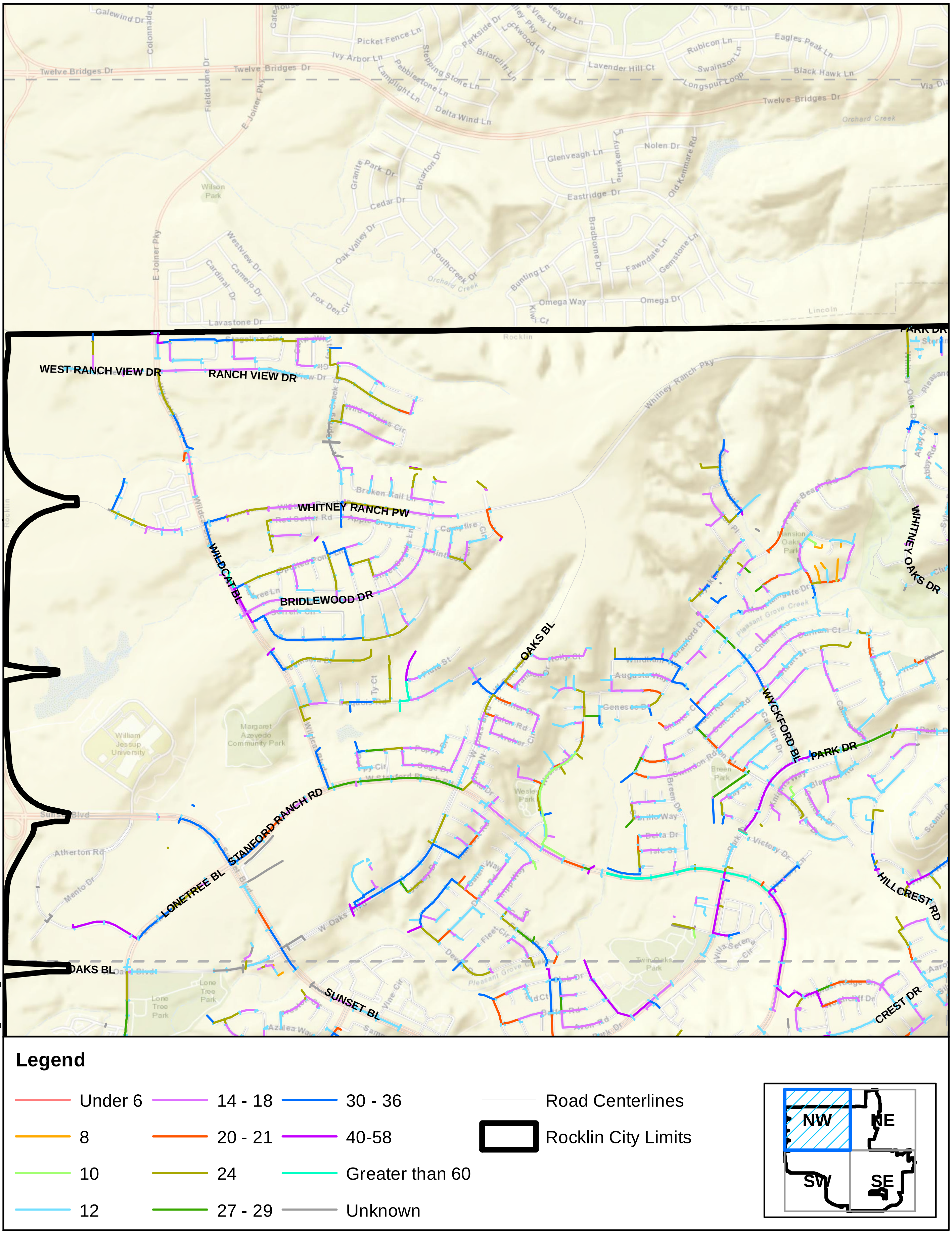
The storm drain pipes found in the city range from 2 to 72 inches in diameter. Clogging is a common issue found with small diameter pipes and can result in flooding. For this report, small diameter pipes are considered any pipe with a diameter of 8 inches or less. It was found that approximately 11,521 LF of pipes in the city, or approximately 2.2% of the system, can be classified as having a small diameter. The pipe diameter most common throughout the system is 12 inches, equating to approximately 189,631 LF or 36% of the total system. Table 15 lists a summary of pipe diameters for the existing known pipes. Exhibits 22 through 25 indicate the pipe diameter with a color-coded scheme that correlates to the diameter.

Table 15 – *Pipe Diameter and Total Percentage of System*

Diameter (inches)	Diameter Count (# of GIS segments)	Length Total (ft)	Length Total (miles)	% of System
4	8	494	0.1	0.1%
6	22	1,211	0.2	0.2%
8	155	9,816	1.9	1.4%
10	539	32,644	6.2	4.7%
12	3,538	189,631	35.9	27.2%
15	802	87,217	16.5	12.5%
18	709	97,536	18.5	14.0%
20	1	34	0.0	0.0%
21	213	32,368	6.1	4.6%
24	572	76,270	14.4	10.9%
27	90	16,603	3.1	2.4%
29	3	341	0.1	0.0%
30	276	37,618	7.1	5.4%
33	34	4,967	0.9	0.7%
36	190	28,028	5.3	4.0%
41	1	58	0.0	0.0%
42	105	17,818	3.4	2.6%
45	2	37	0.0	0.0%
48	71	10,017	1.9	1.4%
50	2	69	0.0	0.0%
54	28	4,235	0.8	0.6%
60	40	7,939	1.5	1.1%
66	34	8,241	1.6	1.2%
72	14	2,907	0.6	0.4%
78	3	541	0.1	0.1%
Unknown		31,122	5.9	4.5%
Total		**697,762**	**132.2**	**100.0%**

Graph 4 – *Pipe Diameter*





12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Diameter_8x11P.mxd

Michael Baker INTERNATIONAL

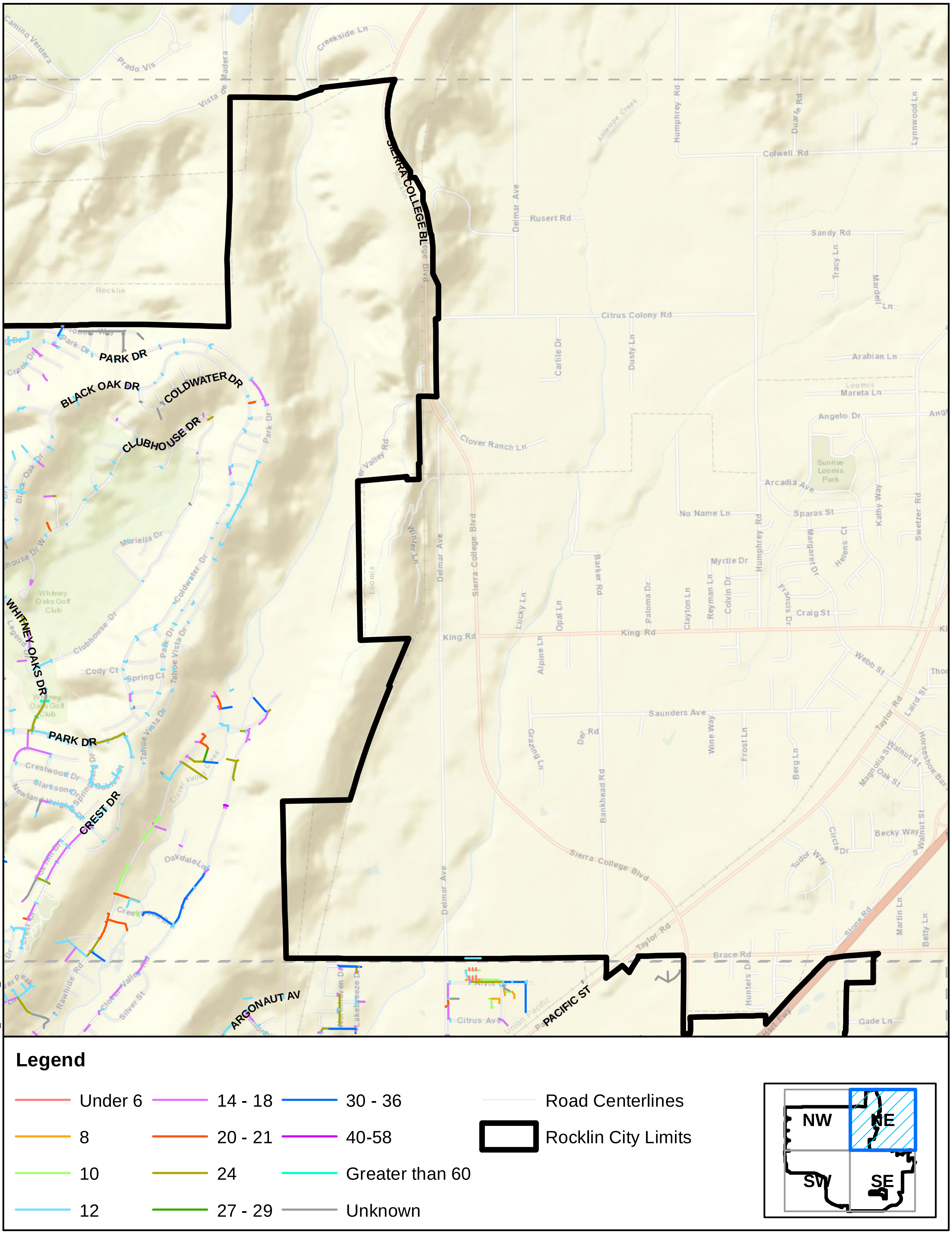
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

System by Diameter: NW

Exhibit 22



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Diameter_8x11P.mxd

Michael Baker INTERNATIONAL

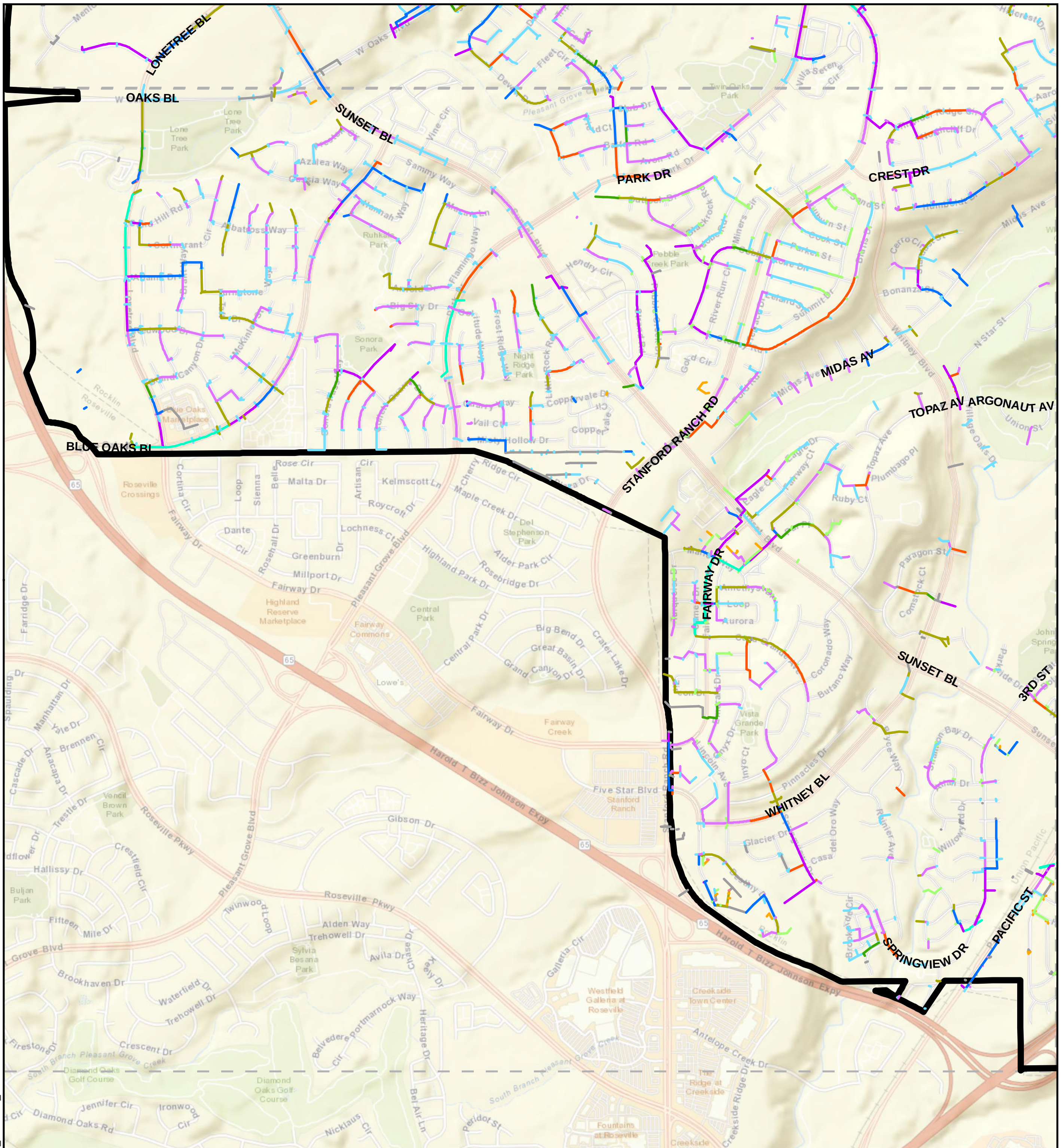
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

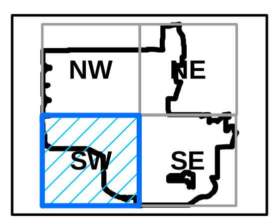
System by Diameter: NE

Exhibit 23



Legend

Under 6	14 - 18	30 - 36	Road Centerlines
8	20 - 21	40-58	Rocklin City Limits
10	24	Greater than 60	
12	27 - 29	Unknown	



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Diameter_8x11P.mxd

Michael Baker INTERNATIONAL

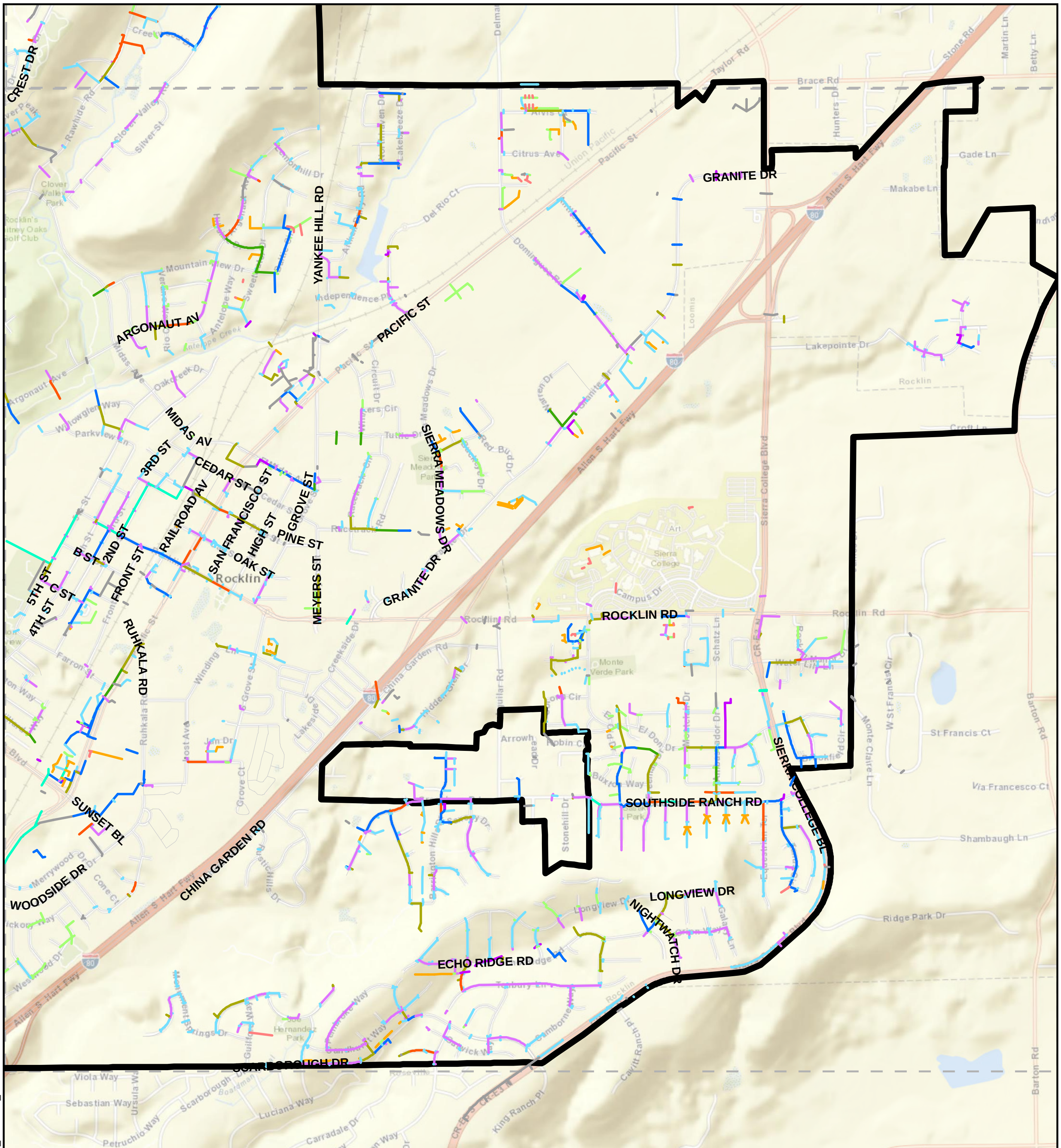
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

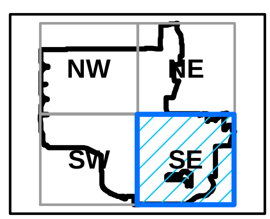
System by Diameter: SW

Exhibit 24



Legend

Under 6	14 - 18	30 - 36	Road Centerlines
8	20 - 21	40-58	Rocklin City Limits
10	24	Greater than 60	
12	27 - 29	Unknown	



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Diameter_8x11P.mxd

Michael Baker INTERNATIONAL

0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

System by Diameter: SE

Exhibit 25

7.0 System Cost Assessment and Analysis

The preceding sections identified many of the observations based on the field assessments, investigations, and pipeline attributes, with calculations associated directly with the CCTV inspection conducted in the field. This section will focus on compiling those observations and data into a coherent strategy that will take into account six analyses:

1. Cost of all applicable pipe replacements based strictly on the expected life cycle of the pipe material and year of installation, over a 20-year planning forecast (2035) – Section 7.1

2. Unit cost for the trenchless pipe replacement options, primarily CIPP, as its versatility allows for comparison across multiple materials and diameters – Section 7.2

3. Comprehensive CMP and CMPA cost analysis combining cost of pipe replacement and rehabilitation. The percentage of pipe replacement is extrapolated from the CCTV data – Section 7.3

4. Rehabilitation cost for the discharge outlet structures ranked 1 and 2 and classified into three risk categories – Section 7.4

5. Cost to address maintenance issues at discharge outlets ranked 1 and 2 – Section 7.4

6. Cost analysis for CCTV and cleaning the entire storm drain conveyance system, with the percentage of clogging extrapolated from the CCTV data – Section 7.5

7.1 Cost Analysis of Pipe Replacement Due to Age and Material

Based on the as-built research compiled, reviewed, verified, and updated in the City of Rocklin's GIS database, the data for pipe material, diameter, and year of installation was extracted. Each pipe segment in the system was assigned an expected replacement year based on the pipe installation year and the pipe material's expected useful life. The general assessment is that the City's storm drain conveyance system can be classified as relatively new, as most of the system was constructed within the last 55 years.

However, documentation does not exist for portions of the system in Old Town, which were likely installed more than 55 years ago. In addition, portions of the system in Old Town are described as "Chinese drains." These parts of the system are undocumented and are typically found when uncovered during other construction projects. It is likely that the age of the Chinese drains extends well beyond 80 years.

An analysis was prepared to determine the replacement cost for each pipe segment in the City's system based on the installation year and its expected useful life. The analysis assumed replacement with the same pipe diameter with a material of HDPE or equivalent. The following tables and graphs depict the replacement schedule over the next 20 years, without considering any other variable.

The cost estimates summarized in Tables 16 through 24 should be considered the theoretical pipe replacement value for the system over the next 20 years.

Table 16 – *Theoretical CIPP Replacement Cost*

Replacement Year	Pipe Length (ft)	Cost
2013	669	$674,846
2015-2035 (9% CIPP unknown)	**105**	**$105,939**
Total	**774**	**$780,785**

Table 17 – *Theoretical AC Replacement Cost*

AC		
Replacement Year	Pipe Length (ft)	Cost
2016	95	$22,871
Total	**95**	**$22,871**

Table 18 – *Theoretical CMPA Replacement Cost*

CMPA		
Replacement Year	Pipe Length (ft)	Cost
2022	69	$ 82,607
2024	248	$ 256,363
2030	157	$ 63,276
2034	1732	$ 867,149.
2035	67	$ 19,339
Total	**2,273**	**$1,288,734**

Table 19 - *Theoretical Replacement CMP Cost*

CMP		
Replacement Year	Pipe Length (ft)	Cost
2008	529	$ 219,692
2009	1025	$ 784,722
2013	104	$ 30,015
2020	152	$ 58,095
2021	42	$ 18,255
2022	1092	$ 262,140
2023	929	$ 464,681
2024	1102	$ 453,694
2025	211	$ 52,479
2028	105	$ 30,361
2032	410	$ 656,282
2034	2068	$ 1,229,881
2035	30	$ 12,927
2015-2035 (7% CMP unknown)	1,226	$ 672,001
Total	**9,026**	**$4,945,225**

Table 20 – *Theoretical HDPE Replacement Cost*

HDPE		
Replacement Year	Pipe Length (ft)	Cost
2016	0	0
Total	**0**	**0**

It's assumed that the 7,592 LF of unknown HDPE Installation date are installed 1980, matching the oldest record for City of Rocklin. As such, 2087 will be the first replacement, based on lifecycle.

Table 21 – *Theoretical CP Replacement Cost*

CP		
Replacement Year	Pipe Length (ft)	Cost
2035	837	$208,440
Total	**837**	**$208,440**

Table 22 – *Theoretical RCP Replacement Cost*

RCP		
Replacement Year	Pipe Length (ft)	Cost
2016	0	0
Total	**0**	**0**

It's assumed that the 24,722 LF of unknown RCP Installation date are installed 1962, matching the oldest record for City of Rocklin. As such, 2052 will be the first replacement, based on lifecycle.

Table 23 – *Theoretical CSP Replacement Cost*

CSP		
Replacement Year	Pipe Length (ft)	Cost
2020	171	$123,147
2024	147	$37,894
2034	2431	$1,170,630
Total	**2,749**	**$1,331,671**

Table 24 – *Theoretical Unknown Pipe Material Replacement Cost*

Unknown		
Replacement Year	Pipe Length (ft)	Cost
2015	5,010	$2,204,312
2025	5,010	$2,204,312
Total	**10,020**	**$4,408,624**

With regard to the replacement cost for pipes of unknown materials, many assumptions were made and applied to the data to determine the replacement year and cost. Below is a summary of the assumptions and guidelines followed to determine the cost of these pipes.

- The system includes a total of 89,991 LF of pipes of unknown Installation date
  - 39,893 LF material is unknown – which are assumed to be installed per the oldest recorded date of installation for the particular material by the City.
  - 50,098 LF material is unknown:
    - An assumed material life cycle for unknown pipe material is 55 years.
    - Assume 10% built in 1960; Replace 5,010 LF/2015
    - Assume 10% built in 1970; Replace 5,010 LF/2025
    - Assume 35% built in 1980; Replace 17,534 LF/2035
    - Assume 25% built in 1990; Replace 12,525 LF/2045

- Assume 20% built in 2000; Replace 10,020 LF/2055
- The weighted replacement cost is estimated as $440 per linear foot – estimated based on the weighted average for CMP pipe replacement.

As such, the theoretical cost of pipe replacement (the sum of the totals shown in Tables 16 through 24) over 20 years (2015–2035), based on pipe material and expected life cycle, is the following:

In 20 years is estimated 16,774 LF of pipe could be replaced. The replacement value of the existing storm drain pipes is estimated at $12,986,350, with consideration for mobilization (5%), traffic control (3%), CCTV for replacement lines (80$/lf), soft cost (6%) the replacement value for storm drain system is estimated at $16,289,209.

$16,289,209 representing the replacement value of **16,774 LF of** pipes within 20 years inclusive of mobilization, traffic control, and CCTV, i.e year 2035. We extrapolate the replacement value for the Storm drain system for year 2020 including **for mobilization (5%), traffic control (3%), CCTV for replacement lines (80$/lf), soft cost (6%) is estimated at $5,583,609.**

$5,583,609 value proposition includes 2,117 LF of CMP, as such, if we removal the CMP from the 2020 replacement, the total replacement value for the storm drain system is estimated at $3,971,241 inclusive of mobilization, traffic control, and soft costs.

$3,971,241 includes removal of 695 LF of CIPP, 95 LF of AC, 171 LF of CSP, and 5,010 LF of unknown pipe.

NOTE: The fees presented herein are an estimate, which can vary greatly depending on the conditions of the soil, depth of pipe, number of project, contractor experience and multiple of externalities. This value provided herein is for general estimation purpose only.

However, the upkeep and upgrade of the storm drain system requires a combined approach of proactive maintenance, rehabilitation, and replacement. Table 25 provides the typical unit rates for pipe replacement, while Table 26 in Section 7.2 illustrates the rates for pipe retrofitting.

Table 25 – *Summary of Cost Basis for Pipe Replacement*

Replacement with HDPE	Unit Cost	Unit
4" Diameter Replacement	$96.00	/LF
8" Diameter Replacement	$192.00	/LF
10" Diameter Replacement	$240.00	/LF
12" Diameter Replacement	$288.00	/LF
15" Diameter Replacement	$360.00	/LF
18" Diameter Replacement	$432.00	/LF
21" Diameter Replacement	$504.00	/LF
24" Diameter Replacement	$576.00	/LF
27" Diameter Replacement	$648.00	/LF
29" Diameter Replacement	$696.00	/LF
30" Diameter Replacement	$720.00	/LF
33" Diameter Replacement	$792.00	/LF
35" Diameter Replacement	$840.00	/LF
36" Diameter Replacement	$864.00	/LF
42" Diameter Replacement	$1,008.00	/LF
47" Diameter Replacement	$1,128.00	/LF
48" Diameter Replacement	$1,152.00	/LF
50" Diameter Replacement	$1,200.00	/LF
54" Diameter Replacement	$1,296.00	/LF
55" Diameter Replacement	$1,320.00	/LF
56" Diameter Replacement	$1,344.00	/LF
58" Diameter Replacement	$1,392.00	/LF
60" Diameter Replacement	$1,440.00	/LF
66" Diameter Replacement	$1,584.00	/LF
72" Diameter Replacement	$1,728.00	/LF
78" Diameter Replacement	$1,872.00	/LF

7.2 Rehabilitation Methodologies

Whenever possible, it is recommended that pipe repairs be performed at the point of deficiency or rehabilitated in lieu of complete pipe replacement. Performing spot repairs and/or rehabilitation is typically more cost effective, is environmentally friendly, has less impact on the community, and is quicker to complete. Many factors need to be considered when selecting the proper method to repair or rehabilitate an existing pipeline, including the pipe's existing condition and hydraulic capacity, environmental conditions, community impact, cost, and schedule.

Although standard open trench pipe replacement is still widely used for storm drain pipe construction, the benefits of trenchless technologies have made it a viable alternative. Trenchless technologies provide techniques for the installation or renewal of underground utilities with a minimum disturbance of the surface. Utilizing trenchless technologies usually represents a significant savings when compared with open trench methods, especially when storm drain depths are in the range of 10–20 feet. A number of trenchless and semi-trenchless methods are available for pipeline rehabilitation. The technologies currently in use which were considered for structural and semi-structural pipe rehabilitation and/or replacement include:

- **Centrifugally Cast Concrete Pipe (CCCP)** – Can be applied to CMP, cast iron, steel plating, and clay. Minimal flow reduction for pipes larger than 30 inches.
- **Cured-in-Place Pipe (CIPP) (Greenbook 500-1.4)** – The CIPP lining process involves inserting and inverting a resin-saturated felt tube into the existing pipe (like a very large inside-out sock). The tube is inflated to conform to the interior of the host pipe and hot air, steam, or water is circulated throughout the tube to cure (harden) the resin. When the curing process is complete, a new pipe is created that no longer has the joints, cracks, and holes that allowed infiltration and roots to enter the pipe and cause operational problems such as blockages and overflows. The finished product has an estimated 50-year design life. This method can also be used to make spot repairs or sectional spot repairs.
- **Folded Pipe (fold and form, deformed/reformed) (Greenbook 500-1.7)** – A prefabricated HDPE (high density polyethylene) pipe, that has been collapsed in upon itself so that it is U-shaped, is pulled through an upstream manhole by a cable from the downstream manhole. Heat and pressure are applied to the U-shaped pipe, causing it to revert to its original round profile.
- **Machine Spiral Wound PVC Pipe Liner (Greenbook 500-1.13)** – Panels of PVC are spirally wound into the existing pipe. This can be performed on pipe diameters from 6 inches to 30 inches. The advantage to this method is that no bypassing of sewer lines is needed during lower flow conditions.

CCTV inspection videos often show a pipe segment to be in overall good condition, with the exception of one location where there is a large fracture or other failure in the pipe. For locations such as this, it is often recommended that a spot repair be performed on the failure location. Methods for performing spot repairs include open trench replacement and trenchless technologies. The trenchless technologies most commonly in use today for performing spot repairs include:

- **Cured-in-Place Pipe (CIPP) for Spot Repair (Greenbook 500-1.2)** – Spot repair CIPP involves the same steps as a CIPP of a full pipe segment. Spot repair CIPP can range from 3 feet to 30 feet.
- **Trenchless Sleeve** – This method involves inserting a prefabricated stainless steel sleeve into the host pipe. The sleeve is located over the failure and expanded outward to provide a structurally sound and sealed pipe section.
- **Slip-Lining with Polyethylene** – Three types of polyethylene pipe can be used for slip-lining: (1) smooth polyethylene with mechanical joints, (2) smooth polyethylene with fused joints, and (3) corrugated polyethylene pipe. The practicality of continuous slip-lining of failing culverts with polyethylene pipe. In the 1990s, some of the major railroads installed this type of liner with very positive results. A coupling system is available for jointing high-density polyethylene pipes by screwing together bell-and-spigot ends.

Trenchless lining technologies are advantageous when the existing host pipe is of sufficient size to meet the hydraulic performance requirements and when the existing pipe is not experiencing significant structural failure. Trenchless lining technologies are not recommended if a pipe upsize is required to meet performance requirements or if the existing pipe has a negative slope or significant sags. Under these circumstances, trenchless lining technologies are recommended. The costs associated with CIPP are shown in Table 26.

Table 26 – *Cost Basis for CIPP Trenchless Lining*

CIPP Trenchless Lining	Unit Cost	Unit
8" Diameter Trenchless Lining	$96.00	/LF
10" Diameter Trenchless Lining	$120.00	/LF
12" Diameter Trenchless Lining	$144.00	/LF
15" Diameter Trenchless Lining	$180.00	/LF
18" Diameter Trenchless Lining	$216.00	/LF
21" Diameter Trenchless Lining	$252.00	/LF
24" Diameter Trenchless Lining	$288.00	/LF
27" Diameter Trenchless Lining	$324.00	/LF
29" Diameter Trenchless Lining	$348.00	/LF
30" Diameter Trenchless Lining	$360.00	/LF
36" Diameter Trenchless Lining	$432.00	/LF
42" Diameter Trenchless Lining	$504.00	/LF
54" Diameter Trenchless Lining	$648.00	/LF

7.3 Rehabilitation and R&R Cost Analysis Based on CCTV Investigation

The CCTV investigation was planned to inspect approximately 4,671 linear feet (LF) of pipe. The inspection collected data on approximately 4,300 LF of pipe. The difference in planned versus actually inspected pipes is because surveys were abandoned due to severe pipe deformation, debris buildup, and intrusions that prevented the camera from extending farther down the line.

Damage to pipes can occur for a number of reasons, including damage during installation, environmental stress, slope erosion, abrasive erosion, pipe corrosion, loss of joint integrity, and breaches due to root intrusion. Cracks, leaks, misalignment, thinning of walls, corrosion, rusting, decay, root growth, and pipe deformation are some of the visual signs of pipe damage. Generally, before pipe repair occurs, the cause of damage should be identified. Understanding the underlying issues causing pipe damage assists with identifying potential problem areas and the most cost effective solution. Creating and implementing cost-effective maintenance plans will ensure all systems are functioning at optimal capacity and the life expectancy of pipes can be maintained.

The limited CCTV investigations partially confirmed that the 90-year life estimate for RCP appears to be appropriate, unless the pipes are installed near deep-rooted trees. As a rule of thumb, systems located in areas with dense tree growth should be inspected for root intrusion and maintained to ensure the expected life span is achieved. However, the same conclusion cannot be reached for CMP and CMPA.

Referencing Table 11, Summary of Cost due to CCTV Findings, from Section 5.1, a total of 823 linear feet of CMP requires replacement. A total of 1,888 LF of CMP was investigated with CCTV.

Percentage of CMP that require replacement = (**823/1888) x 100** = +/- **45%**

The case for CMP/CMPA replacement and/or retrofitting as a system:

Based on the CCTV investigation of the corrugated metal pipe (CMP) systems installed in 1978 and/or 1987, 45% of the pipe was found to require replacement or retrofit to continue functioning as designed. The findings indicate that 55% of the CMP is meeting its life-cycle expectancy after approximately 30 years, while the remaining 45% suffers moderate signs of corrosion, oxidation, and loss of galvanization, including moderate pitting that has resulted in significant clogging starting 28–37 years after installation. It should be expected, in the event the CMP is untreated, that the steel pipe will continue to oxidize, weakening the structural integrity of the pipe and causing a full loss of functionality.

The City may consider rehabilitating only the damaged portions of the CMP. This approach is feasible in the short term in localized areas that are at a lower or limited risk of flooding and road failure and other risks in case of pipe failure. However, it is important to note that rehabilitating only portions of the CMP will not extend the life cycle of the pipe, as the remainder of the CMP that was not treated may still fail sooner.

Therefore, the recommended approach for the CMP is to completely rehabilitate or replace it, rather than patch-fix the failing segments.

The GIS data indicates that 52% of the CMP will reach the end of its expected 45-year life cycle by the year 2035. It's relevant to note that by the year 2027, 13,000 linear feet of CMP in the city will be older than 30 years, by year 2035 all the CMP in the City will be older than 30 years old. Based on the CCTV data, it is highly probable that 45% of the CMP in the city will be dilapidated by 2020. For CMPA, this milestone will be achieved by the year 2035.

While other metallic pipes, steel pipe (SP) and ductile iron pipe (DI or DIP), are also at risk for corrosion damage, it's noted that the expected life for those materials is longer than CMP, with the SP replacement year starting in 2046 and the DI replacement year starting in 2039. Since this analysis is considering a 20-year planning horizon (concluding in 2035), it would be consistent to delay the retrofitting or replacement of the other steel pipes.

An analysis of all CMP and CMPA was conducted based on the length and diameter, and the values were correlated with the replacement cost/diameter and rehabilitation cost/diameter. The costs are summarized in Table 27. It is assumed, based on the CCTV findings for CMP, that 45% of the pipe needs to be replaced, while 55% can be rehabilitated. As such, the total costs shown in Table 27 can be annualized over 5 years, with a priority for CMP/CMPA to be completely replaced by 2020.

Table 27 – *CMP/CMPA Pipe Replacement and Repair Cost – exclude design and construction fee*

Material	Length of Pipe to Replace (feet)	Cost to Replace	Length of Pipe to CIPP (feet)	Cost to CIPP	Total Cost for Pipe Repair
CMP	7,878	$3,471,831	9,629	$2,121,675	**$5,593,506**
CMPA	3,938	$2,090,861	4,813	$1,277,748	**$3,368,609**
Total	*11,816*	*$5,562,692*	*14,442*	*$3,399,423*	***$8,962,115***

The estimate fee to design and construct the CMP/CMPA replacement and repair cost is noted in the below Tables 27- A and 27- B as follows:

The Grand total to complete the CMP works is estimated to be $7,887,929, whereas, the CMPA work is estimated at $4,598,297, the Sum Total of CMP and CMPA $12,486,226.

NOTE: The fees presented herein are an estimate, which can vary greatly depending on the conditions of the soil, depth of pipe, number of project, contractor experience and multiple of externalities. This value provided herein is for estimation purpose. It should be noted that <u>for CMP replacement and/or CIPP analysis the following was assumed</u>:

- Assumed 14 Total Project, spread among 4 quadrants.
- 8 Projects are located in the SE quadrant.
- The Number of projects are geographically based, with consideration to the number of streets, diameter sizes, length of pipes, and estimated value of bid.
- The value provided herein for separation of CIPP and R&R of pipes are empirical, it's envisioned that a SD system will either be replaced or treated, however, there may be occasions that warrant both treatments that can be evaluated on a case by case.
- It's recommended the SD system to be flushed and CCTV prior to engagement
-The existing conditions, depth, geology, location, and a host of unknown external factors can impact the estimate.

Similar assumptions were complete for the CMPA, however, consideration was for 8 projects in total, 5 to be located in the SE quadrant.

Table 27- A – *Estimated **CMP** Pipe Replacement and Repair Cost Project per Quadrant*

Description		CMP Geographic location per Quadrant			
	unit	NW	NE	SW	SE
CIPP		$ 34,433	$ 78,400	$ 660,214	$ 1,348,570
R&R		$ 56,345	$ 128,290	$ 1,080,350	$ 2,206,751
CIPP/R&R Total		**$ 90,777**	**$ 206,690**	**$ 1,740,564**	**$ 3,555,322**
No. Project		**1**	**1**	**4**	**8**
CIPP/R&R Per Project		$ 90,777	$ 206,690	$ 435,141	$ 444,415
Mobilization/Project	5%	$ 4,539	$ 10,335	$ 21,757	$ 22,221
Traffic Control/Project	3%	$ 2,723	$ 6,201	$ 13,054	$ 13,332
CCTV/project	(80$/lf)	$ 34,781	$ 42,216	$ 74,006	$ 128,450
Sub Total Fee Per Project		**$ 132,820**	**$ 265,441**	**$ 543,958**	**$ 608,419**
Sub Total Fee Per Quadrant		**$ 132,820**	**$ 265,441**	**$ 2,175,832**	**$ 4,867,348**
Total Cost		**$ 7,441,442**			
Eng. Soft Cost	6%	**$ 446,487**			
Grand Total (CMP)		**$ 7,887,929**			

Basis of Estimate

est. no. street		*5*	*4*	*12*	*33*
avg. lf/st		*87*	*132*	*308*	*389*
No. Project		*1*	*1*	*4*	*8*
est. lf/project		*435*	*528*	*1233*	*1606*

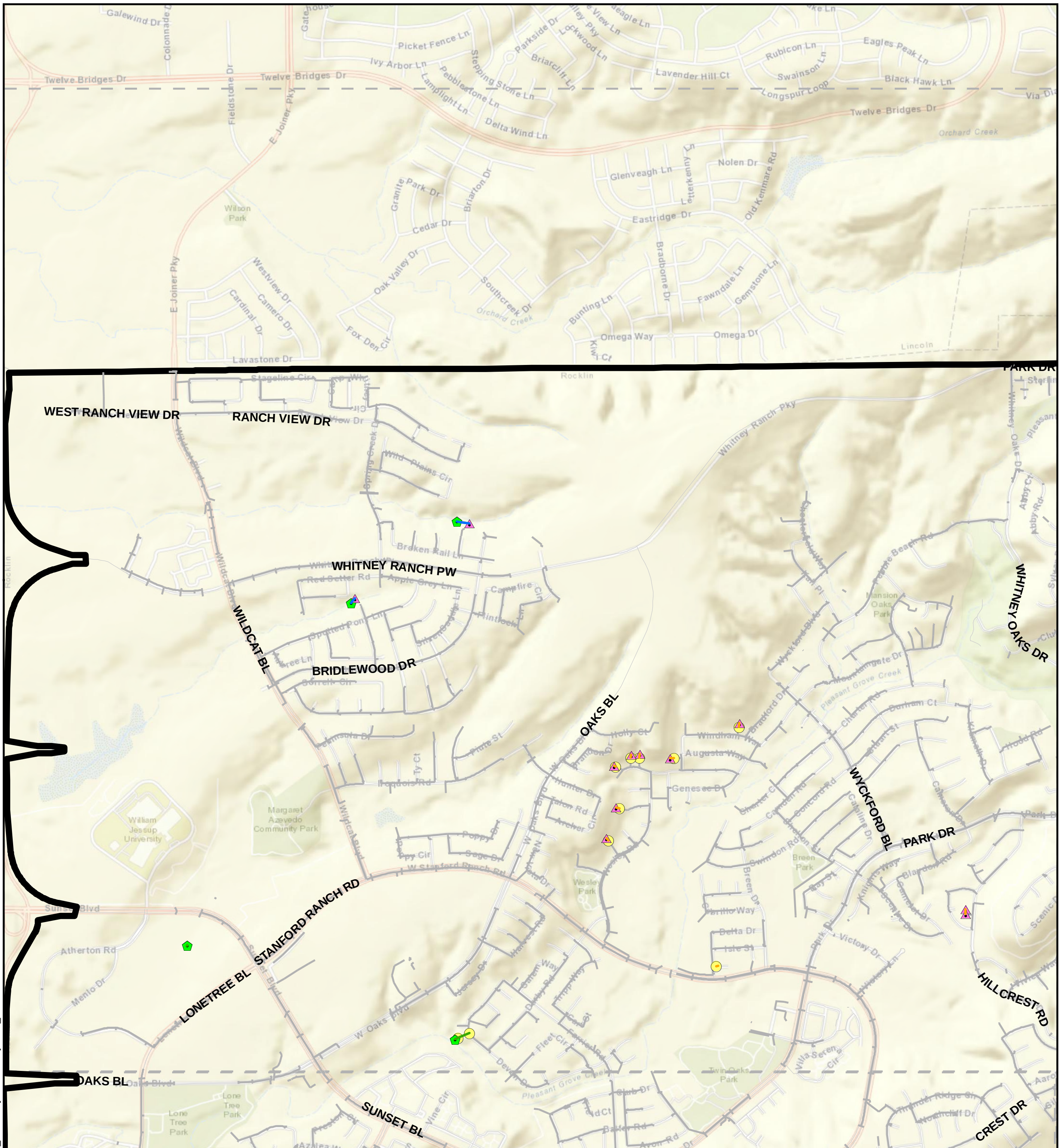
Table 27- B– *Estimated **CMPA-** Pipe Replacement and Repair Cost Project per Quadrant*

Description		CMPA Geographic location per Quadrant			
	unit	NW	NE	SW	SE
CIPP		$ 67,177	$ 28,035	$ 68,860	$ 1,113,646
R&R		$ 109,926	$ 45,876	$ 112,681	$ 1,822,330
CIPP/R&R Total		**$ 177,102**	**$ 73,911**	**$ 181,541**	**$ 2,935,976**
No. Project		$ 1	$ 1	$ 1	$ 5
CIPP/R&R Per Project		**$ 177,102**	**$ 73,911**	**$ 181,541**	**$ 587,195**
Mobilization/Project	5%	$ 8,855	$ 3,696	$ 9,077	$ 29,360
Traffic Control/Project	3%	$ 5,313	$ 2,217	$ 5,446	$ 17,616
CCTV/project	(80$/lf)	$ 19,583	$ 10,879	$ 19,873	$ 129,934
Sub Total Fee Per Project		**$ 210,853**	**$ 90,703**	**$ 215,937**	**$ 764,104**
Sub Total Fee Per Quadrant		**$ 210,853**	**$ 90,703**	**$ 215,937**	**$ 3,820,522**
Total Cost		**$ 4,338,016**			
Eng. Soft Cost	6%	**$ 260,281**			
Grand Total (CMPA)		**$ 4,598,297**			

Basis of Estimate

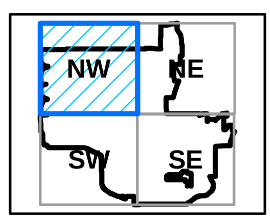
est. no. street		*1*	*1*	*1*	*14*
avg. lf/st		*245*	*136*	*248*	*580*
No. Project		*1*	*1*	*1*	*5*
est. lf/project		*245*	*136*	*248*	*1624*

Reference Exhibits 26 through 29 for the locations of all metallic storm drain pipes in Rocklin.



Legend

Inlets	CIP	DIP	Road Centerlines
Discharge Points	CMP	SP	Rocklin City Limits
Manholes	CMPA		



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Summary of Metal System_8x11P.mxd

Michael Baker
INTERNATIONAL

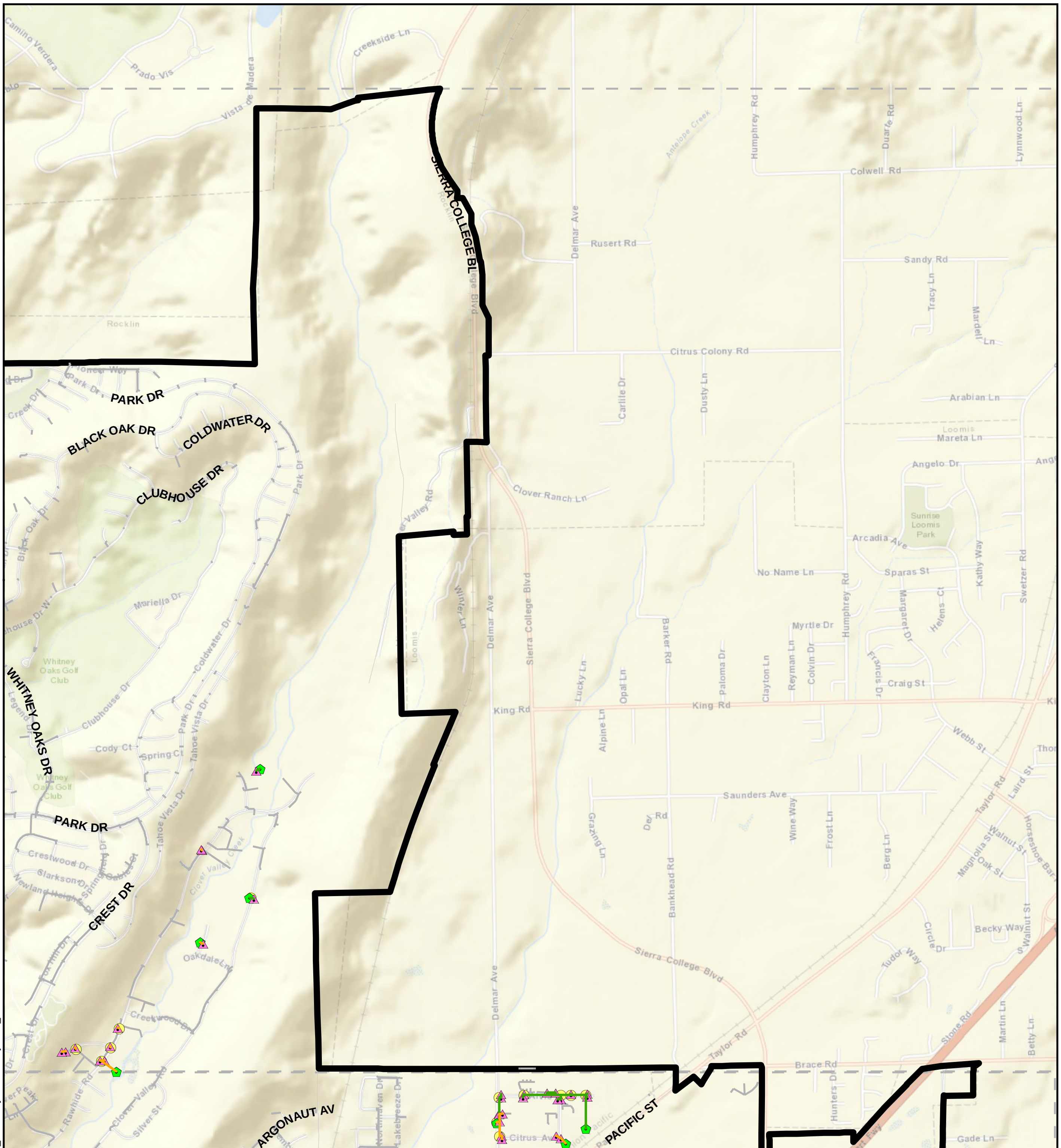
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

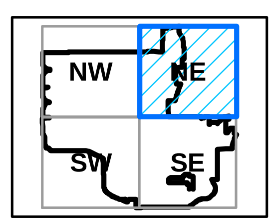
Summary of Metal System: NW

Exhibit 26



Legend

- Inlets
- Discharge Points
- Manholes
- CIP
- CMP
- CMPA
- DIP
- SP
- Road Centerlines
- Rocklin City Limits



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Summary of Metal System_8x11P.mxd

Michael Baker INTERNATIONAL

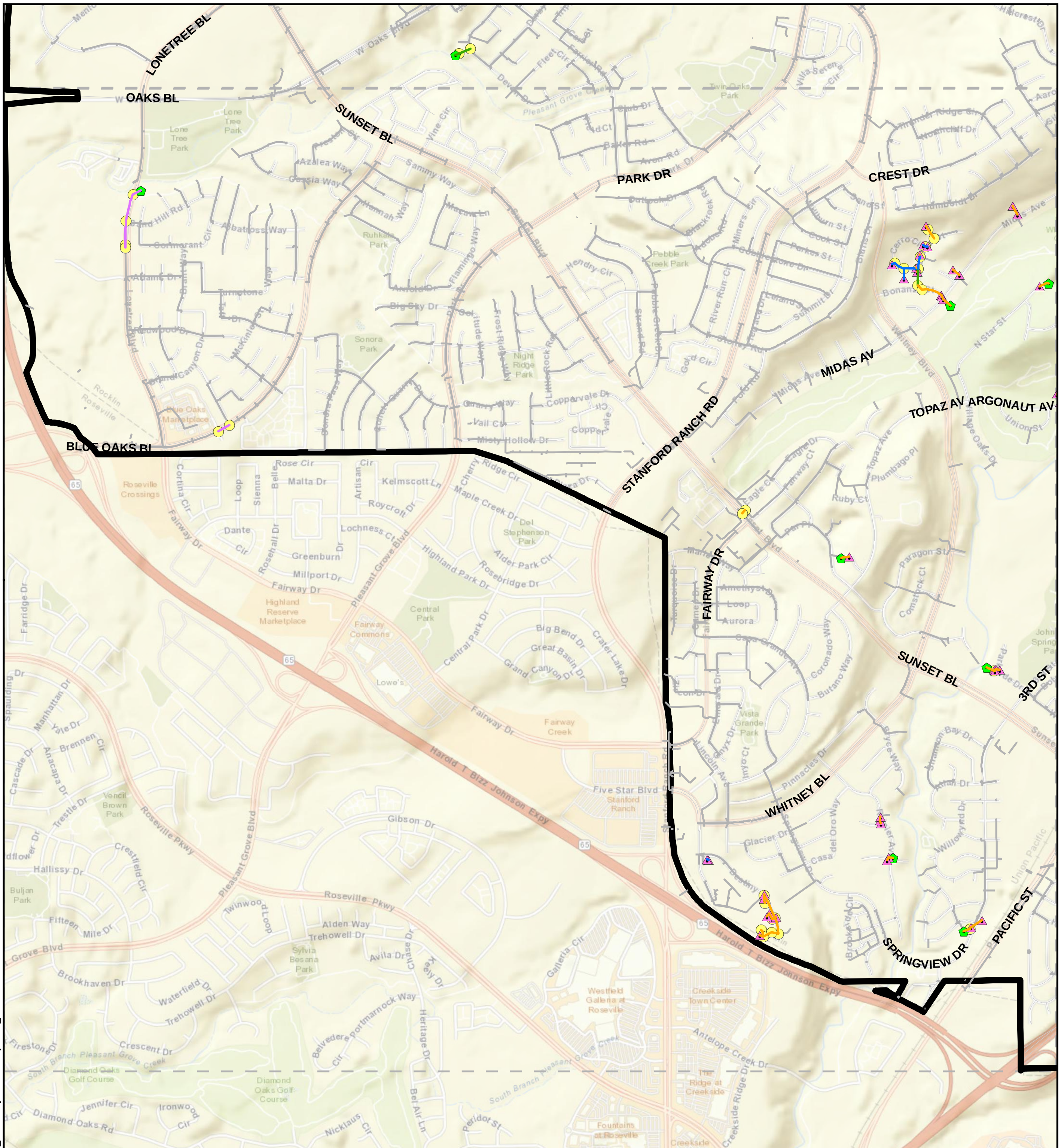
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

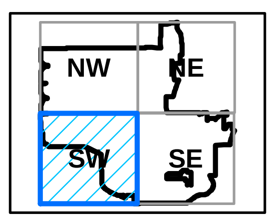
Summary of Metal System: NE

Exhibit 27



Legend

Inlets	CIP	DIP
Discharge Points	CMP	SP
Manholes	CMPA	
Road Centerlines	Rocklin City Limits	



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Summary of Metal System_8x11P.mxd

Michael Baker INTERNATIONAL

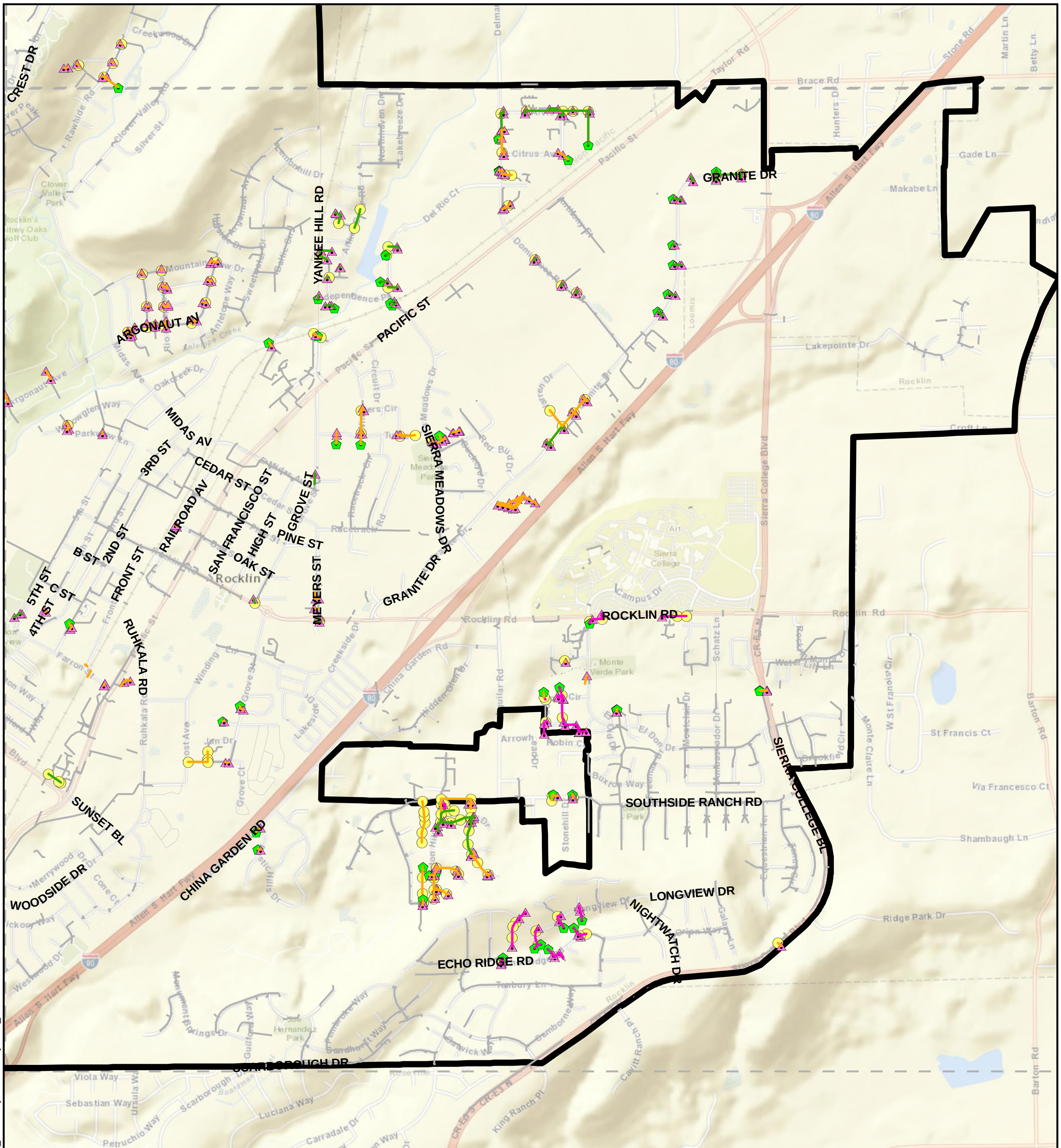
0 0.2 0.4 Miles

Source: City of Rocklin

CITY OF ROCKLIN

Summary of Metal System: SW

Exhibit 28

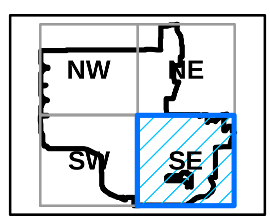


Legend

Inlets	CIP	DIP
Discharge Points	CMP	SP
Manholes	CMPA	

Road Centerlines

Rocklin City Limits



12/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_Summary of Metal System_8x11P.mxd

Michael Baker INTERNATIONAL

0 0.2 0.4 Miles

Source: City of Rocklin

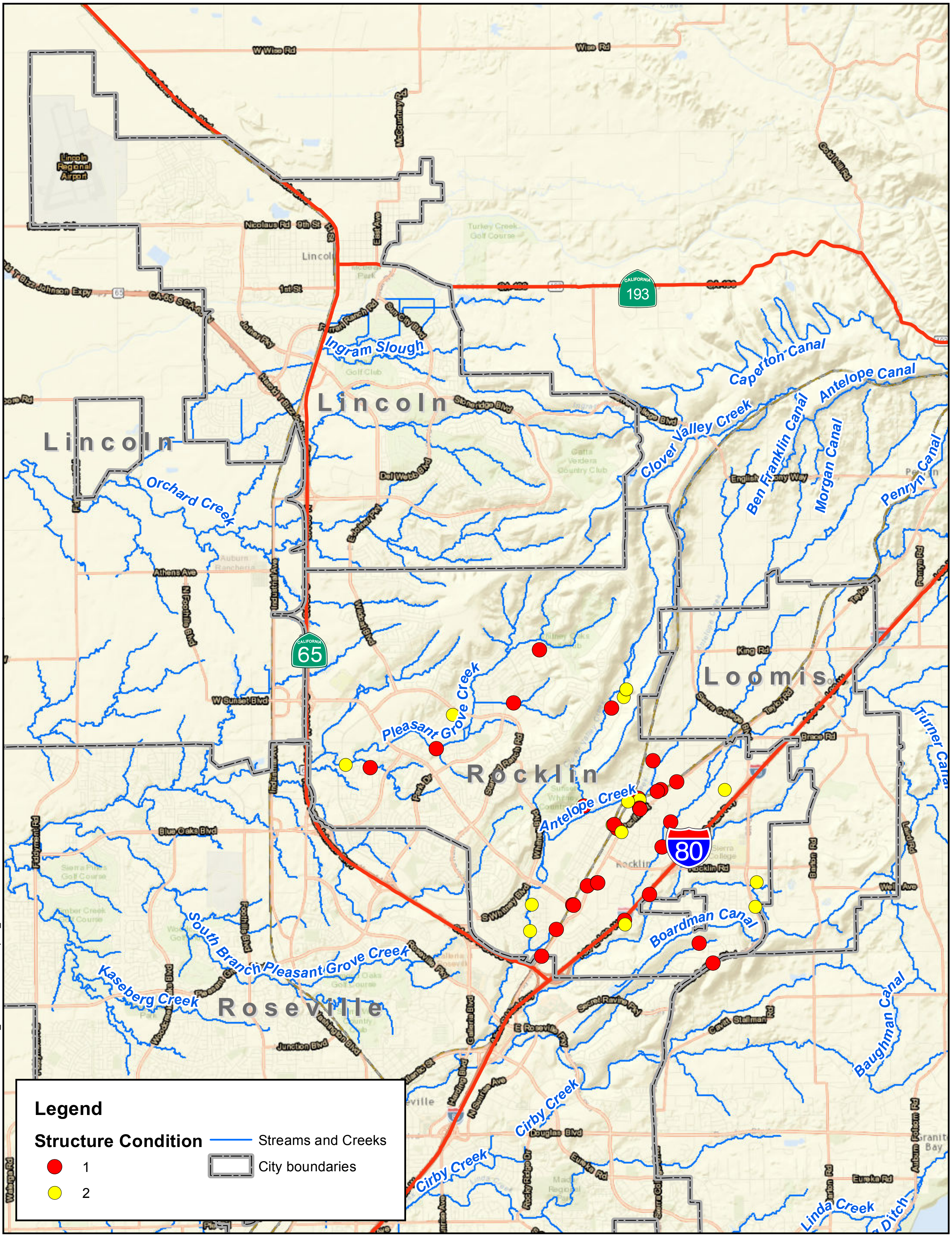
CITY OF ROCKLIN

Summary of Metal System: SE

Exhibit 29

7.4 Discharge Outlet Analysis

The objective of this analysis is to prioritize, quantify, and establish a cost estimate to improve the damaged storm drain outlets. Since specific dimensional data and design data were not determined as a part of this effort, the recommended improvements are approximated to achieve a target budget for outlet repair or replacement. The structural outlet assessment included for budgeting purposes is for the 43 outlets ranked as a 1 or 2, as discussed earlier in Section 4.1. Similarly the maintenance assessment for the outlets that will be quantified into a cost estimate will primarily address the 180 observed maintenance conditions that are ranked 1 or 2, as discussed earlier in Section 4.2. Exhibits 30 and 31 identify the locations of the outlets receiving a structural and maintenance ranking 1 and 2 in the city and their relation to the receiving bodies of water.



10/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_OverallStructuralMapDP_8x11P.mxd

Michael Baker INTERNATIONAL

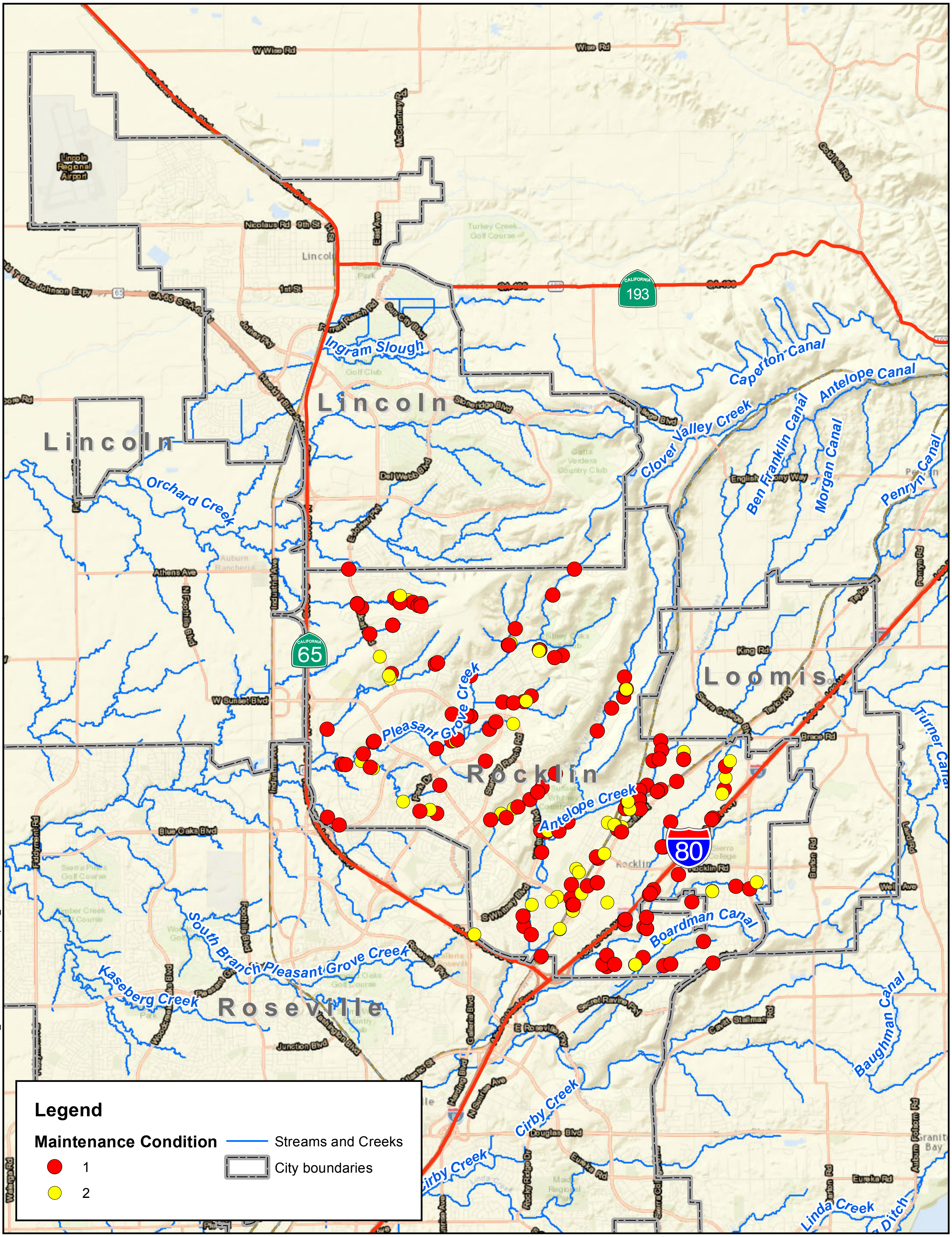
0 0.75 1.5 Miles

Source: City of Rocklin

CITY OF ROCKLIN

Discharge Point Structure Condition Locations

Exhibit 30



10/16/2015 JN M:\Mdata\144794\GIS\MXD\Rocklin_OverallMaintenanceMapDP_8x11P.mxd

Michael Baker INTERNATIONAL

0 0.75 1.5 Miles

Source: City of Rocklin

CITY OF ROCKLIN

Discharge Point Maintenance Condition Locations

Exhibit 31

7.4.1 Cost Analysis for Prioritized Outlets with Structural Concerns

As identified in Section 4.1, there are 43 outlets with significant structural damage observed. To assist with the priority of repair or replacement, these outlets were further prioritized into three classifications of damage:

Severe is a high priority. Refers to the damaged outlets which are recommended to be replaced first. There are a total of 17 outlets in this category.

Critical is a medium-high priority, below severe. Refers to the outlets structurally impacted; however, the extent of damage cannot be fully assessed due to obstructions. Further clearing and removal of debris is required to determine the full extent of the damage and replacement costs. There are a total of 11 outlets in this category.

Marginal is a lower priority than critical. The extent of the damage cannot be fully assessed due to obstructions. Clearing and removal of debris is required to determine the full extent of the damage and replacement costs. There are a total of 15 outlets in this category.

It's important to acknowledge that these assessments and recommendations for repair/replacement are initially provided as a guideline. It is critical that further operational details, such as a hydraulic analysis, be performed to determine the outlets' capacity and whether the existing diameters are adequate.

Notwithstanding the above, many of the assessed outlets are metal (CMP) pipes. In general, CMP pipes are the weakest link in the chain of structures, road network, and other physical connections and connectors. The CMP outlets tend to rust, decay, and deteriorate and subsequently adversely impact both the environment—through direct deposit of sediment into streams—and safety—through voids originating beneath the road surface, embankment, or channel. Many of the potential failures in the outlets result in sediment discharges into streams that may adversely affect water quality, aquatic habitat, and in extreme cases result in backflows into the drainage system, creating flooding or other hazardous events.

Structural failures to the outlets include corrosion of the pipes, deformation and distortion of the concrete walls, invert deterioration from abrasion, scour, and settlement of the surrounding soils. Over time, the wear of material in corrugated metal pipes is greater than in smooth surface pipes because of the additional detrimental effect of abrasive material striking the upstream face of corrugations (protective coating materials applied in corrugated metal pipe typically do not fill the corrugations).

To quantify the associated costs to repair the damaged outlets, a matrix was devised to correlate the photos taken in the field with a narrative and to as-built drawings where available. The matrix includes required improvements, such as screen, headwall, riprap, pipe replacement, pipe repair, and incidentals that may be required such as additional pipes, aprons, etc. Note: Further explanation of each component is provided in Section 8, Water Quality. An appraisal was made with regard to determining the conceptual quantities that may be required to repair or replace a given outlet. Furthermore, a unit cost was assigned to each outlet, based on historical references. The following unit costs and assumptions were used to determine the basis of the cost estimate:

Headwall concrete = 1,500 CY
Screen = $3,000–$9,000 EA
Riprap = $60/CF
Pipe replacement = $300/LF
Concrete/repairs/misc. = varies $50/LF–$245/LF

The cost for structural replacement should be considered a rough order of magnitude, pending further information. Table 29 summarizes the expected treatment/repairs and includes an estimated total cost associated with each outlet with an observed structural deficiency.

Table 29 – *Replacement Priority for Structural Ranking 1 and 2*

No	Rank	Field Description	Screen	Head-wall	Riprap	Pipe R&R	Repair	Others	Estimated Cost
1	Severe	Embankment has eroded, causing concrete structure to break in two. Rebar is now protruding out of remaining concrete structure. Photo #0665	x	x	x			x	$22,666
2	Severe	Concrete structure has decayed and is covered by sedimentation. Photo #0211	x	x	x	x		x	$27,500
3	Severe	Surrounding asphalt has decayed, causing pressure to system and damaging discharge pipe. Pipe has decayed and water is flowing out from concrete edge. Photo #0278			x	x	x	x	$9,000
4	Severe	System has collapsed and has debris lodged inside. Photo #0568	x	x	x	x	x	x	$36,500
5	Severe	Concrete structure is dilapidated and impacted with sedimentation. Photo #0202	x	x	x	x		x	$35,500
6	Severe	System has separated in two approximately 15' from discharge outlet. System is impacted with sedimentation. Photo #0317	x	x	x	x		x	$23,600
7	Severe	Metal system has decayed and is breached by large tree. Photo #0511	x	x	x	x		x	$33,500
8	Severe	Erosion of embankment. Lower section of pipe has completely corroded away. Photo #0610	x	x	x	x		x	$37,000
9	Severe	Lower section of pipe has completely corroded away. Photo #0326			x			x	$5,500
10	Severe	Discharge pipe has collapsed and is impacted with debris. Photo #0228			x			x	$5,000
11	Severe	Metal discharge pipe has collapsed and is impacted with debris. Photo #0252	x	x	x	x	x	x	$59,325
12	Severe	Structure originally was not represented on GIS but was identified and added to system during inspection. Structure is dilapidated with sedimentation filling the bottom of the pipe. Photo # 0322.		x	x	x		x	$38,500
13	Severe	Structure is damaged and impacted with sedimentation. Photo #0448	x	x	x	x		x	$25,000
14	Severe	Structure originally was not represented on GIS but was identified and added to system during inspection. Erosion has caused pipe to be unearthed and system has separated. Photo #0554	x	x	x	x		x	$30,000
15	Severe	Structure originally was not represented on GIS but was identified and added to system during inspection. Pipe has various holes through top portion of pipe. Photo #0617			x	x		x	$9,500

No	Rank	Field Description	Screen	Head-wall	Riprap	Pipe R&R	Repair	Others	Estimated Cost
16	Severe	Structure is damaged and pipe is corroded. Impacted with sedimentation. Photo #0558	x		x			x	$7,000
17	Severe	Metal reinforcement is visible due to decaying concrete pipe. Impacted with sedimentation. Photo #0151	x	x	x			x	$15,000
18	Critical	Metal pipe is corroded and impacted with sedimentation. Photo #0445			x	x		x	$5,400
19	Critical	Concrete pipe is dilapidated and completely impacted with sedimentation. Photo #0383	x		x		x	x	$8,160
20	Critical	Structure is damaged. Metal shoot has detached from structure. System is impacted with sedimentation. Photo #0374	x		x	x		x	$21,000
21	Critical	Pipe is covered with sedimentation and is completely impacted. Photo #0561	x	x	x	x		x	$36,000
22	Critical	Pipe is covered with sedimentation and is completely impacted. Photo #0181			x			x	$4,500
23	Critical	Structure originally was not represented on GIS but was identified and added to system during inspection. System appears abandoned and is impacted. Photo #0640	x					x	$10,500
24	Critical	Structure originally was not represented on GIS but was identified and added to system during inspection. System appears abandoned and is impacted. Photo #0639	x	x	x			x	$24,000
25	Critical	Structure originally was not represented on GIS but was identified and added to system during inspection. Pipe is corroded and impacted with sedimentation. Photo #0625	x	x	x	x		x	$24,500
26	Critical	Metal pipe is dilapidated with sections torn from main structure. System is impacted. Photo #0495	x		x	x		x	$14,000
27	Critical	Pipe is damaged and impacted with sedimentation. Photo #0198	x	x	x			x	$15,500
28	Critical	Erosion of embankment. Structure is dilapidated and impacted with sedimentation. Photo #0385	x	x	x	x		x	$28,000
29	Marginal	Structure screen is broken. System is impacted with sedimentation. Photo #0457	x		x			x	$7,000
30	Marginal	Structure's flow door and pipe are corroded, with dense foliage overtaking system. Photo #0503			x	x		x	$20,200
31	Marginal	Structure not visible due to erosion. Assumed pipe is impacted. Plywood has been placed over discharge pipe. Photo #0443	x	x	x		x	x	$28,400
32	Marginal	Structure not visible. Assumed pipe is impacted. Photo #0680			x			x	$5,000
33	Marginal	If structure or discharge pipe exist, it is buried under rock and debris. Photo #0566			x			x	$5,000
34	Marginal	Structure severely overgrown by vegetation and is impacted with sedimentation. Photo #0475	x	x	x	x		x	$36,500
35	Marginal	Structure originally was not represented on GIS but was identified and added to system during inspection. Structure is completely impacted. Photo #0562	x	x	x	x		x	$37,000
36	Marginal	Structure is damaged and impacted with garbage and debris. Large rock has been placed over discharge outlet. Photo #0235	x	x	x			x	$22,000

No	Rank	Field Description	Screen	Head-wall	Riprap	Pipe R&R	Repair	Others	Estimated Cost
37	Marginal	Structure originally was not represented on GIS but was identified and added to system during inspection. Pipe is corroded and impacted. Photo #0612	x	x	x	x		x	$42,500
38	Marginal	Structure originally was not represented on GIS but was identified and added to system during inspection. Structure is damaged. Photo #0540	x	x	x			x	$37,000
39	Marginal	Structure is damaged and impacted with sedimentation. Photo #0199			x			x	$4,000
40	Marginal	The embankment has eroded and the structure is dilapidated. Photo #0262	x	x	x			x	$27,500
41	Marginal	Structure is decaying and is impacted with sedimentation. Photo #0413	x	x	x			x	$27,500
42	Marginal	Extremely dense foliage around structure, which appears to be damaged. Water current flowing through. Photo #0266	x	x	x			x	$15,000
43	Marginal	High volume of water flowing during inspection. Extremely dense foliage near structure. Photo # 0200			x			x	$4,500
								Subtotal	$930,751
								Contingency	$279,226
								Total	**$1,209,977**

The cumulative results of Table 29 are summarized in Table 30, while the cost for each category is identified as a lump sum effort.

Table 30 – *Cost Summary of Replacement Priority for Structural Ranking 1 and 2*

Replacement Priority for 1 & 2 Structural Rankings	%	No.	Cost
Severe	39%	17	$546,119
Critical	26%	11	$249,028
Marginal	36%	15	$414,830
Total	**100%**	**43**	**$1,209,977**

7.4.2 Cost Analysis for Prioritized Maintenance Outlets

As identified in Section 4.2 and Table 2 specifically, 180 outlets are ranked as 1 or 2 for maintenance. The scope of services that will be considered to address the observed concerns would typically involve the following:

- Heavy clearing: thick shrubs, tall and medium growth
- Medium to heavy grubbing: adjusting loose riprap, exposing outlets
- Medium scattering, collecting, bundling, hauling, and disposal of removed material

- Topographical terrain – distributed between ground slope: gentle (under 20%), moderate (20%–45%), and steep (over 45%)

The maintenance services can be comfortably completed by a two-man crew with chain saws, hand tools, and pickup trucks. The area of work per outlet is typically 20 feet by 20 feet, or 400 square feet.

To determine the maintenance costs at 180 outlets, the time to complete the clearing and grubbing at each location was estimated. A constraining factor in determining the associated costs is the time consideration for mobilization, demobilization, travel time, and other miscellaneous downtime. If mobilizing and demobilizing for each location takes on average 10 minutes, a total of 20 minutes, plus travel time of 15 minutes to each location, the total downtime is 35 minutes per location.

The last demobilization to home bases should be assumed to be 30 minutes, instead of the typical 15 minutes. The dump truck would need to unload at the yard or dump. The distance/time from the yard to the work location is unknown. Actual work on clearing on grubbing should be comfortably completed within 40 minutes, considering the topographic challenges are evenly distributed across the sites.

Based on these assumptions, it's estimated that a two-man crew will be able to complete six site visits per day (refer to Table 31). Considering a unit cost of $500 per day per crew, the cost for maintenance is estimated at $15,000 to complete maintenance of the 180 outfalls in 30 working days. Table 31 estimates the time needed for the maintenance of 30 structures within one year. It is estimated that in the second year, 217 structural outlets would require maintenance, which would take approximately 37 days to complete. As a result, the estimated maintenance cost is 37 days at a unit cost of $500 per day, or $18,500 in the second year.

Table 31 – *Summary of Daily Trips in One Working Day*

Estimated Time to Clear and Grub								
No. Outlets	**1**	**2**	**3**	**4**	**5**	**6**		**Total**
Time	**Min**	**Min**	**Min**	**Min**	**Min**	**Min**	**Min**	**Min**
Dump							30	
Drive	15	15	15	15	15	15		120
Mobilize	10	10	10	10	10	10		60
Work	40	40	40	40	40	40		240
Demobilize	10	10	10	10	10	10		60
Total 1 Day- 480 Minutes								480

If the City chooses to implement a routine program to clean the existing storm drain system, many of the clogged outlets will be unclogged by the pipe cleaning. Therefore, the cleaning program should be closely coordinated with the outlet maintenance program.

7.5 Comprehensive CCTV and Pipe Flushing Program

It's recommended that a program be included for regular CCTV inspections and pipe flushing. As noted in the site assessment, a significant number of outlets were inundated with sediment, gravel, and debris, and there were a number of incidents where the outlets couldn't be located or were barely visible due to complete immersion with sediment. Furthermore, the CCTV investigation revealed that 8% of the pipes were too clogged to pass a camera, and the survey was abandoned.

As such, a matrix was developed that correlated all 697,761 LF of pipe in Rocklin's current system with the CCTV results. Per the pipe diameters, an estimate was generated using a dynamic unit cost for pipe flushing and CCTV. The CCTV investigation's revelation of clogged pipes was extrapolated over the total storm drain system to generate the cost estimate. Reference Table 32 for the results.

Table 32 – *CCTV and Pressure Cleaning Program*

Diameter (inches)	Length Total (ft)	0–5% Clogged	6%–25% Clogged	26%–60% Clogged	61%–100% Clogged	Sum Cost for Pipe Cleaning	Sum CCTV Inspection
2–6	1,319	$379.87	$527.60	$76.50	$242.70	$1,226.67	$923.30
8–15	281,623	$94,625.33	$132,560.04	$21,150.21	$99,599.44	$347,935.02	$197,136.10
18	89,249	$32,129.64	$49,979.44	$9,281.90	$37,841.58	$129,232.56	$62,474.30
20–21	28,740	$28,740.00	$28,740.00	$28,740.00	$28,740.00	$114,960.00	$28,740.00
24	68,937	$28,126.30	$45,498.42	$9,237.56	$37,501.73	$120,364.01	$55,149.60
27–30	48,979	$21,158.93	$37,224.04	$7,726.26	$31,296.86	$97,406.09	$39,183.20
33–36	31,590	$14,405.04	$24,008.40	$5,180.76	$20,975.76	$64,569.96	$25,272.00
41–54	28,848	$13,847.04	$29,172.88	$5,803.39	$23,444.35	$72,267.66	$24,002.65
55–Unknown	104,972	$55,425.22	$142,761.92	$7,712.61	$111,690.21	$317,589.96	$125,966.40
	684,257	**$288,837.37**	**$490,472.74**	**$94,909.19**	**$391,332.63**	**$1,265,551.93**	**$558,847.55**
Sub Total						**$1,265,551.93**	**$558,847.55**
Contingency (20%) mobilization/Traffic control/multiple projects						**$1,518,662.32**	**$670,617.06**
Common Total							**$2,189,280**
Credit (CCTV completed)							**$(12,570.00)**
		TOTAL					**$2,176,710**

8.0 Water Quality

The work completed and documented in this report addresses Section E.11.f of the City's Municipal Separate Storm Sewer System (MS4) Phase II National Pollutant Discharge Elimination System (NPDES) permit conditions and requirements specifically in several ways:

- Assessed and ranked in order of priority the replacement and maintenance for all accessible and public outlets in the city.
- Assessed a representative sample of the conveyance system that is historically problematic, located in the Old Town area.
- Developed and proposed a procedure to assess and prioritize storm drain system maintenance, including for the structures that were inspected and/or reviewed.

A total of 467 outlets were visually assessed, and 57% of these outlets were prone to sedimentation settlement, debris, litter, and root infiltration and classified as high priority areas. It should be noted that approximately 10% of the assessed outlets were observed to be impacted, requiring repair or other structural modification in order for the conveyance system to function as designed.

While a comprehensive preliminary engineering assessment will need to be completed by the City or the consultant engineer to warrant the specific improvements, based on the visual observation, the typical repairs to the outlets are expected to include the addition of the following:

Pipe screens: Stainless steel bars that are typically spaced 8 inches on center connected to the outlets to allow stormwater to pass through to the connecting system and prevent large objects from entering the system to create blockages. The screen can be removable or nonremovable.

Un-grouted riprap: A section of rock protection placed at the outlet end of the culverts, conduits, or channels. The purpose of the rock outlet protection is to reduce the depth, velocity, and energy of water such that the flow will not erode the receiving downstream reach. This standard applies to the planning, design, and construction of rock riprap and gabions for protection of downstream areas. It does not apply to rock lining of channels or streams. This applies to (1) culvert outlets of all types; (2) pipe conduits from all sediment basins, dry stormwater ponds, and permanent-type ponds. The design of rock outlet protection depends entirely on the location. Pipe outlets at the top of cuts or on slopes steeper than ±10% are not usually protected by rock aprons or riprap sections due to re-concentration of flows and high velocities encountered after the flow leaves the apron. Many counties and state agencies have regulations and design procedures already established for dimensions, type and size of materials, and locations where outlet protection is required. Where these requirements exist, they must be followed.

Concrete headwalls: Headwalls should be flush with the end of the culvert. Headwall “wings” (extensions) help mold and direct channel flow into the culvert and protect the area around the inlet from scour. Headwalls may be of poured concrete, constructed of concrete blocks, or other material. The concrete headwalls can stabilize culvert outlets and entrances and improve flow efficiency at inlets, limit erosion control, and extend the life of the system.

Replacement and/or rehabilitation of the outlet pipe: Damaged pipes are flow constrictors and as such add undue strain to the entire system, including sediment collection, abrasion to the conveyance system, and an increase of the hydraulic grade line. In severe cases, they can cause flooding and potential damage to property. The replacement of damaged pipes or rehabilitation of impacted pipes should maintain the existing diameter and slope.

Analysis from Old Town Rocklin

A separate assessment was conducted in the Old Town area of Rocklin. A CCTV investigation was completed for approximately 4,300 LF of varying pipe diameter and material. An analysis of the CCTV results indicates that 8% of the assessed pipes are severely clogged, meaning the internal cross-sectional area of the pipe is blocked in a range from 61% to 100%. Reference Table 33 for the representative amount of pipe blockages/clogging based on the CCTV sample performed for this project.

Table 33 – *Representative Clogging of Pipes Based on CCTV*

Percentage of clogging in pips			
0–5% clogging in pipes	6%–25% clogging in pipes	26%–60% clogging in pipes	61%–100% clogging in pipes
48%	40%	4%	8%

If the CCTV data is considered representative of the system as whole, with approximately 697,762 LF of total storm drain pipe in the city, approximately 54,740 LF of pipe (approximately 8%) are assumed to be severely clogged. These existing conditions further exacerbate the functionality of the conveyance system, and in time of heavy rain may lead to flooding and property damage, and further impact the streams and channels.

There was a correlation between the CCTV data and the location of the pipes, with tree root intrusion accounting for 70% of the pipes that were severely damaged. While it's not part of the report to correlate tree locations with the installed storm drain pipes, however, its is acceptable to assume that the priority for cleaning and CCTV investigation would be for pipes that are located near dense vegetation and trees.

Preventive Maintenance

It is recommended that the City apply preventive maintenance efforts to reduce the quantity of trash, litter, and large sediments from building up and blocking the underground conveyance system. This can be accomplished through a combination of public education and outreach, installation and regular maintenance of filters in catch basins and inlets, and regular street sweeping.

Furthermore, considering the pervasiveness of the sediment and debris accumulation in the pipes and at the outlets, it is recommended that the City actively flush/clean and CCTV the entire storm drain network. In addition, it is suggested that the City further refine the budgetary costs provided in this report and improve the planning and execution of the operation and maintenance strategies for the system. System cleaning will contribute greatly to the quality of the discharge in the neighboring creeks and channels and will provide a valuable tool for inspection and assessment.

The accumulation of trash impacts aquatic life in streams, rivers, and the ocean as well as terrestrial species in adjacent riparian and shore areas. It's understood that trash, particularly plastics, persists for years. It concentrates organic toxins, entangles and ensnares wildlife, and disrupts feeding when animals mistake plastic for food and ingest it. Additionally, trash creates aesthetic impacts, impairing enjoyment of waterways.

One method to reduce trash impact would be to capture it at the source with the addition of filter inserts, which are removable curb inlet inserts that capture trash before it enters the drainage system. Various types of filters are available and vary by the facility in which they are used. Skimmer boxes are designed for grated inlets and can be used for retrofit applications. They can provide multistage filtration and are effective at removing trash, as well as other pollutants, including total suspended solids (TSS), phosphorus, and metals. Catch basin inserts can capture sediment and trash while allowing high flows to bypass, and they are available in various sizes. Filters can be perforated meshes similar to pipe screens or they can be made of fibrous material that replicates a biofiltration process.

Typically, prior to the implementation of citywide best management practice (BMP) improvements, the City embarks on a comprehensive study evaluating the effectiveness of structural and nonstructural BMPs as part of an integrated system of water quality management. Notwithstanding the above, there is a strong correlation between the inlets that drain to the outlets that were ranked 1 or 2 for maintenance and the upstream catch basins.

The City currently operates a series of water quality treatment structures such as oil/sand separators. The Oil/Sand separators are typically located prior to the outfall and on an average the structures assist with maintaining the water quality in the area of influence. The Oil/Sand separators may operate by receiving volume or flow based. While the research did not include hydraulic analysis of the Oil/Sand separators, the location near the outfalls and their connection to inlets in series, is a positive indication of the logical functionality of the structures. With proper maintenance the Oil/Sand Separators can great contribute to meeting the water quality requirements.

The Oil/Sand Separator include a maintenance program that is recommended by the manufacturer, however, typically these type of structures are checked every six months, and based on the consistency of the structures' performance the maintenance adjusts.
There are approximately 146 structures in the City. Noting that a structure was not located in the NE quadrant.

Quadrant	OS Structure	MH with OS	Yearly Inspections	Maintenance Fee	Total O&M Fee
NW	53	10	$ 37,800.00	$ 37,800.00	$ 75,600.00
NE	0	0	$ -	$ -	$ -
SW	34	1	$ 21,000.00	$ 21,000.00	$ 42,000.00
SE	40	8	$ 28,800.00	$ 28,800.00	$ 57,600.00
Sub-Total	**127**	**19**	$ 87,600.00	$ 87,600.00	$ 175,200.00
Total	**146**		**$ 175,200.00**	**$ 175,200.00**	**$ 350,400.00**

The maintenance is typically performed by the manufacture, and would include inspection for damage, removal of parts, filters, and vacuuming. These fees, vary based on contract and assorted external conditions. However, it's reasonable to assume that City can inspect each structure and determine the next step, if any. The inspection would be a $600 inspection year, considering 2 hours of staff to visit every six months, billed at $150/hr. However, it is recommended to establish a maintenance program to assist with up-keeping these facilities. It would be reasonable to assume $50 a month for each structure set aside in the event an inspection yields the need for repair.

The O/S structures located near the outlets and connected to inlets in series may not be as vulnerable to other inlets in the City that lack sediment protection. Considering that on average the 146 O/s separator are connected to 4 inlets, we can assume that 580 inlets are in better condition than the remaining 4,416 inlets.

A typical filter insertion would cost $800. With approximately 5,000 inlets in Rocklin, a trash capture program would cost $4,000,000 to execute as a whole. In addition, it's recommended to implement a citywide filter insert maintenance. These inserts should be removed and cleaned monthly or bimonthly. Typical labor to commit to such program would be .5 hour per inlet, bimonthly that will amount to $2,250,000 when the program is mature.

The Program can be phased, in such a manner, where approximately 400 inlets located in the NE Quadrant are provided with inserts. The total cost is approximately $320,000. In addition a maintenance of $180,000 a year should be allocated.

In California, urban stormwater is listed as the primary source of impairment for 10% of all rivers, 10% of all lakes and reservoirs, and 17% of all estuaries (2010 Integrated Report). Although these numbers may seem low, urban areas cover just 6% of the land mass of California and so their influence is disproportionately large. Urbanization causes changes in the landscape, including increased loads of chemical pollutants, increased toxicity, changes to flow magnitude, frequency, and seasonality of various discharges, physical changes to stream, lake, or wetland habitats, changes in the energy dynamics of food webs, sunlight, and temperature, and biotic interactions between native and exotic species. In addition to surface water impacts, urbanization can alter the amount and quality of stormwater that infiltrates and recharges groundwater aquifers.

Regular Maintenance Inspections

One method to reduce trash, debris, and infiltration of sediments in the system is to account for the condition of all inlets and catch basins. It is recommended that the City maintain an inventory of inlets, catch basins and underdrains and use a checklist from this inventory to account for inlets during inspections. Inlets should be inspected often, especially in the spring and autumn and after storm events, checking them for signs of corrosion, joint separation, bottom sag, pipe blockage, piping, fill settling, cavitation of fill (sinkhole), sediment buildup within the inlets, effectiveness of the present inlet/outlet inverts, etc. Inlet and outlet channels should be checked for signs of scour, degradation, aggradation, debris, channel blockage, diversion of flow, bank and other erosion, flooding, etc. The City should practice preventive maintenance to avoid clogging of pipes and other situations that may damage the culvert or diminish its design function.

9.0 Recommendations

Based on the results of the outlet site assessment, limited CCTV investigation, and desktop analysis of pipe age and material, it is recommended that the City implement the following actions:

1. Replace and/or repair the 43 damaged outlets, prioritizing the structures with severe damage to be completed in the first year, critical structures to be completed in the second year, and marginal structures to be completed in years 3–5.
2. Replace and/or rehabilitate all CMP in the city over 5 years.
3. Establish a replacement program for CMPA starting in 2016 and complete in 2035.
4. Establish a systematic rehabilitation and replacement program for all storm drain pipes expected many to reach the end of their useful life over the next 20 years.
5. Establish a systematic method to clear, clean, and maintain the 180 existing storm drain outlets with an observed maintenance concern.
6. Implement a citywide storm drain CCTV program with a goal to inspect all storm drain pipes in the system within 5 years.
7. Implement an annual citywide flushing and cleaning program to be coordinated with CCTV efforts.
8. Explore options to stop trash and debris from entering the system at the source, such as the installation of inlet filters in all of the City's inlets.

Table 34 – Capital Improvement Costs with O&M Recommendations

Capital Improvement Projects		Capital Improvement Projects				
Years	**5**	1	2	3	4	5
Description of Projects	**Projects**	2016	2017	2018	2019	2020
Item 1 - R&R Structural Outlets - Reference Table 29, Section 7.4.1	**$ 1,209,977.17**	**$ 1,209,977.17**				
* R&R - 17 Structural Outlets - Severe right away	*$ 546,119.17*					
* R&R - 11 Structural Outlets - Critical may wait to be completed by next yearar)	*$ 249,028.00*					
* R&R - 15 Structural Outlets - Marginal no later than a full year	*$ 414,830.00*					
Item 2 - R&R SD Pipes for Areas (1-5) - Reference Section 5.1, Table 11	**$ 101,485.00**	**$ 101,485.00**				
*Area (1)	*$29,583*	$29,583				
(Area 2) CP replacement	*$25,583*	$25,583				
* (Area 4)	*$7,511*	$7,511				
* (Area 5)	*$38,808*	$38,808				
Item 3 - R&R SD Pipes due to install date - Reference Section 7.1, Table 16-24 (Exclude CMP/CMPA)	**$ 3,971,241.00**	**$ 3,857,510.94**			**$ -**	**$ 113,730.06**
CIPP		**$ 462,236.22**				
AC		$ 63,183.37				
HDPE						
CP						
RCP						
CSP						$ 113,730.06
UNK		$ 3,332,091.34				
Item 4 - CMP and CMPA Full replacement program - Refernce Section 7.3, Table 27	**$ 9,037,503.25**	**$ 1,807,500.65**	**$ 1,807,500.65**	**$ 1,807,500.65**	**$ 1,807,500.65**	**$ 1,807,500.65**
CMP(spread over 5 years equal)= (7,887,929/5) =1,577,585.80	**$7,887,929**	$ 1,577,585.80	$ 1,577,585.80	$ 1,577,585.80	$ 1,577,585.80	$ 1,577,585.80
CMPA (spread over 20) ($4,598,297/20) = 229,914.85$/year	**$ 1,149,574.25**	$ 229,914.85	$ 229,914.85	$ 229,914.85	$ 229,914.85	$ 229,914.85
Sub-Total CIP Projects (for five years)	**$ 14,320,206.42**	**$ 6,976,473.76**	**$ 1,807,500.65**	**$ 1,807,500.65**	**$ 1,807,500.65**	**$ 1,921,230.71**
O&M Costs (for 5 years)	**$ 8,746,747.86**					
Total Budgetary cost (for five years)	**$ 23,066,954.28**					
Sum of Operation & Maintenance (to be annualized 5 years)	**$ 8,746,747.86**	**$ 1,100,099.57**	**$ 1,380,099.57**	**$ 1,852,599.57**	**$ 2,088,849.57**	**$ 2,325,099.57**
Item A- C&G Maintenance Outlets - reference Section 4.2 & 7.5	$33,500.00	$ 6,700.00	$ 6,700.00	$ 6,700.00	$ 6,700.00	$ 6,700.00
* C&G - 180 Main Structural Outlets - (30*500) (1st year)	$ 15,000.00					
C&G - 217 Structural Outlets) (37*500) (2nd year)	$ 18,500.00					
Item B - Comprehensive Pipe Cleaning program & CCTV - reference Section 7.3	$2,114,997.86	$ 422,999.57	$ 422,999.57	$ 422,999.57	$ 422,999.57	$ 422,999.57
Flushing and Cleaning (assume to go in parallel with CMP 5 year replacement)	$ 1,463,882.84	$ 292,776.57	$ 292,776.57	$ 292,776.57	$ 292,776.57	$ 292,776.57
CCTV (assume to go in parallel with CMP 5 years replacment)	$ 651,115.02	$ 130,223.00	$ 130,223.00	$ 130,223.00	$ 130,223.00	$ 130,223.00
Item C - Comprehensive Filter Insert Program - reference Section 8	$ 6,598,250.00	$ 670,400.00	$ 950,400.00	$ 1,422,900.00	$ 1,659,150.00	$ 1,895,400.00
Filter Inserts replace 2,500 inserts in 5 years	$ 2,000,000.00		$ -	$ -	$ -	$ -
400 filter insert first year		$ 320,000.00				
525 filter insert following year until 2020			$ 420,000.00	$ 420,000.00	$ 420,000.00	$ 420,000.00
Maintenace of Filter Inserts per 2500/5year	$ 1,125,000.00		$ 180,000.00	$ 652,500.00	$ 888,750.00	$ 1,125,000.00
Maintenance of O/S seperator	$ 1,752,000.00	$ 350,400.00	$ 350,400.00	$ 350,400.00	$ 350,400.00	$ 350,400.00