5.0 Existing Collection System Evaluation

To properly manage a facility, you must understand its operational characteristics. You must know how big it is and how it operates under normal and stressed conditions. The methods employed assure that the City knows more about its collection system asset than ever before. Now that the tools and the datasets have been created, regular maintenance will ensure their accuracy and continual usefulness in proper management.

To build understanding of the hydraulic operations of the system, the original Geographic Information System (GIS) was updated based on the most recent plan sets. These newly digitized features were added to the existing GIS to create a complete representation of the sanitary sewer system. Flows from previous measurements were applied to determine the hydraulic characteristics of the City of Rancho Palos Verdes collection system. Combining these into the hydraulic model allowed testing of the hydraulic capacity of the system under a variety of real and projected conditions. The models reflect the way that the system responds to changes in flows or in piping configurations. The details listed below will provide the user with an understanding of the methods by which the model was developed.

5.1 Updating the GIS

DUDEK previously created a GIS of the sanitary system for the Sanitary Sewer Master Plan in 2004; the main task for this 2009 Master Plan was to update the GIS. Newly provided plans for the areas of Abalone Cove, portions of Tract No. 46422, Tract No. 40640, Tract No. 52666, and Terransea were added to the GIS. Terransea is a site opening in June 2009 that contains approximately 8,500 linear feet of pipeline, 2 pump stations, 43 manholes, and 54 cleanouts.

Although the gravity portion of Abalone Cove was included in the 2004 Master Plan, house laterals and a few pipes have been added to support the inclusion of the grinder pumps. In all there were 41 grinder pumps, 3 duplex grinder pumps serving more than one residence, and approximately 18,500 linear feet of low pressure pipe within the system. There are also 3 larger lift stations and 19,000 feet of force mains. The following table shows the amount of new pipes and nodes that were digitized since the last master plan in 2004:

Table 5-1 Newly Digitized Features

	Number of Features
Low Pressure Pipe (feet)	18,549
Forcemain (feet)	2,232
Gravity Pipe (feet)	28,596
Manholes	97
Grinder Pumps	44
Pump Stations	6

To make the GIS as consistent as possible, the existing attributes from the original sewer pipes and manholes were filled in for the newly digitized sewer lines and nodes. The following table lists the attributes that are stored for each of the pipe segments in the collection system.

Table 5-2 Pipe Data Entities

Attribute	Description
PlanNo	The construction drawing number
SheetNo	The sheet within the construction drawing
RecordNo	Additional information related to location
HotLink	Connection to the as-built, CCTV inspection results
TractNo	Adjacent tract number
StreetName	Street that facility is located in or near
PIPE_LOCN	Whether in easement or roadway
LotNo	Adjacent lot number
UpID	Upstream structureID
UpStation	Upstream structure station
UpInvert	Upstream invert elevation
UpGround	Upstream ground elevation
Type	Gravity, pressure, or low pressure
Diameter	Diameter of pipe in inches
Material	Construction material (PVC, VCP, CI, etc.)
Slope	The calculated slope
DnID	Downstream structure ID
DnStation	Downstream structure station
DnInvert	Downstream invert elevation
DnGround	Downstream ground elevation
YearBuilt	Year of construction
Length	Length of pipe in feet
Curve Data	Used for describing curved pipes
Notes	User notes regarding facility
PipeID	Unique identifier for pipe segment

Attribute	Description
JUR	Jurisdiction that owns pipe
MMS	LA County Maintenance Record ID
FM_Basin	Flow measurement basin ID
CAP_OV	If the pipe exceeds the recommended capacity
SD	Proximity to stormdrain structures
CCTV_Year	The year the pipe was CCTV inspected
PACP_Rate	Rating assigned during CCTV inspection
Priority	Priority based on condition and capacity
Area	Location in city

This information supports a broad range of decision support requests. For instance, knowing the age and material of all pipes, the inspection, replacement and rehabilitation programs can be directed to the area of greatest need. Prior to having access to this data, there was no logical method of directing these efforts.

5.1.1 GIS Datasets

The GIS contains all information that was available at the beginning of the project plus an additional 20 sets of plans that were later found not to be a part of the previously scanned imagery. These have been scanned and are indexed to the GIS shapefiles. This allows the staff to select a pipe on screen and retrieve the scanned image of the construction drawing for greater detail.

The following set of figures shows the usefulness of the GIS and how it can be used.
Figure 5-1 is the collection system color coded by year constructed
Figure 5-2 is the collection system color coded by pipe diameter
Figure 5-3 is the collection system color coded by pipe material

Figure 5-1 Collection System by Year

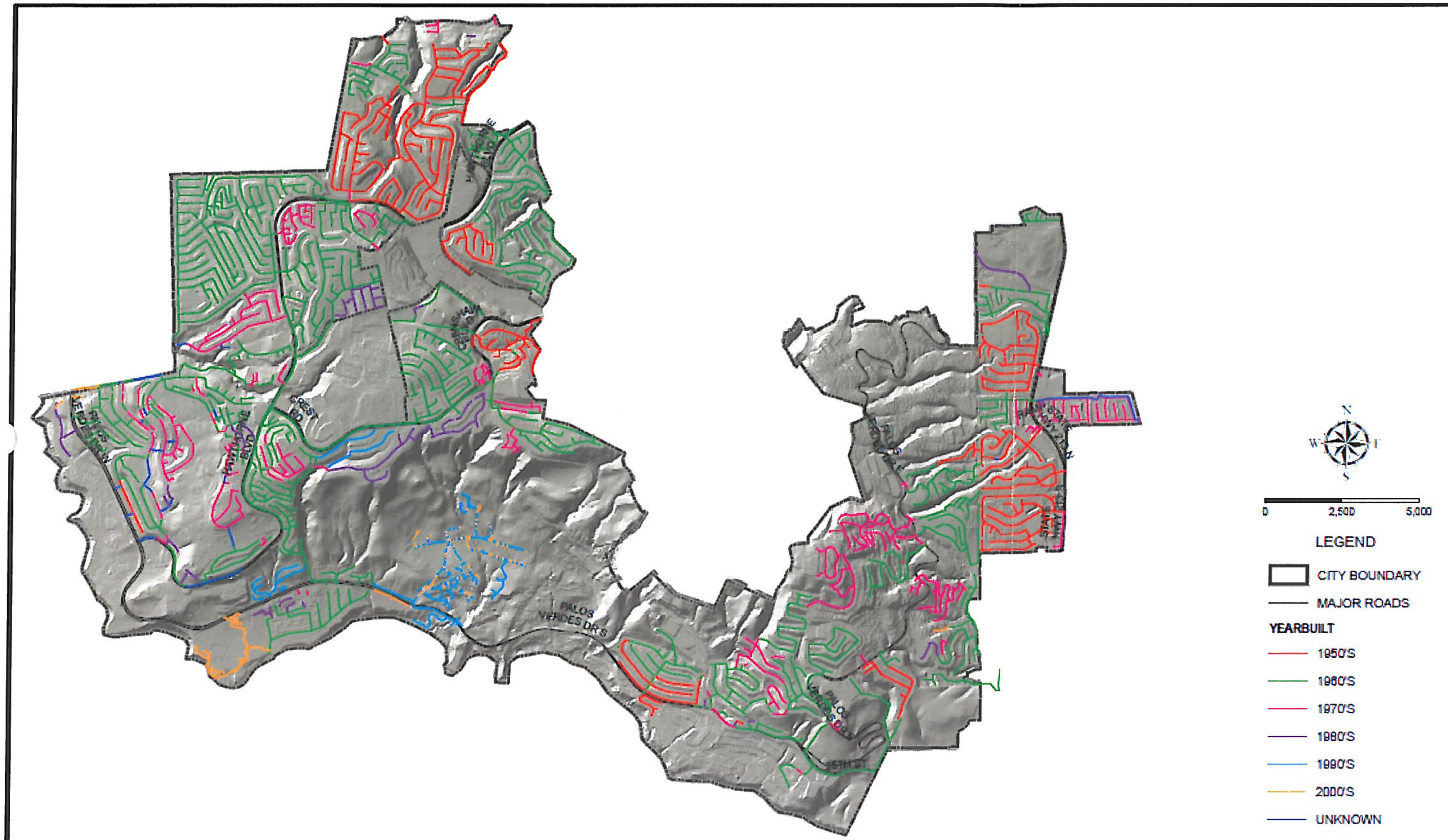


FIGURE 5-1
SANITARY SEWER COLLECTION SYSTEM BY YEAR CONSTRUCTED

Figure 5-2 Collection System by Pipe Diameter

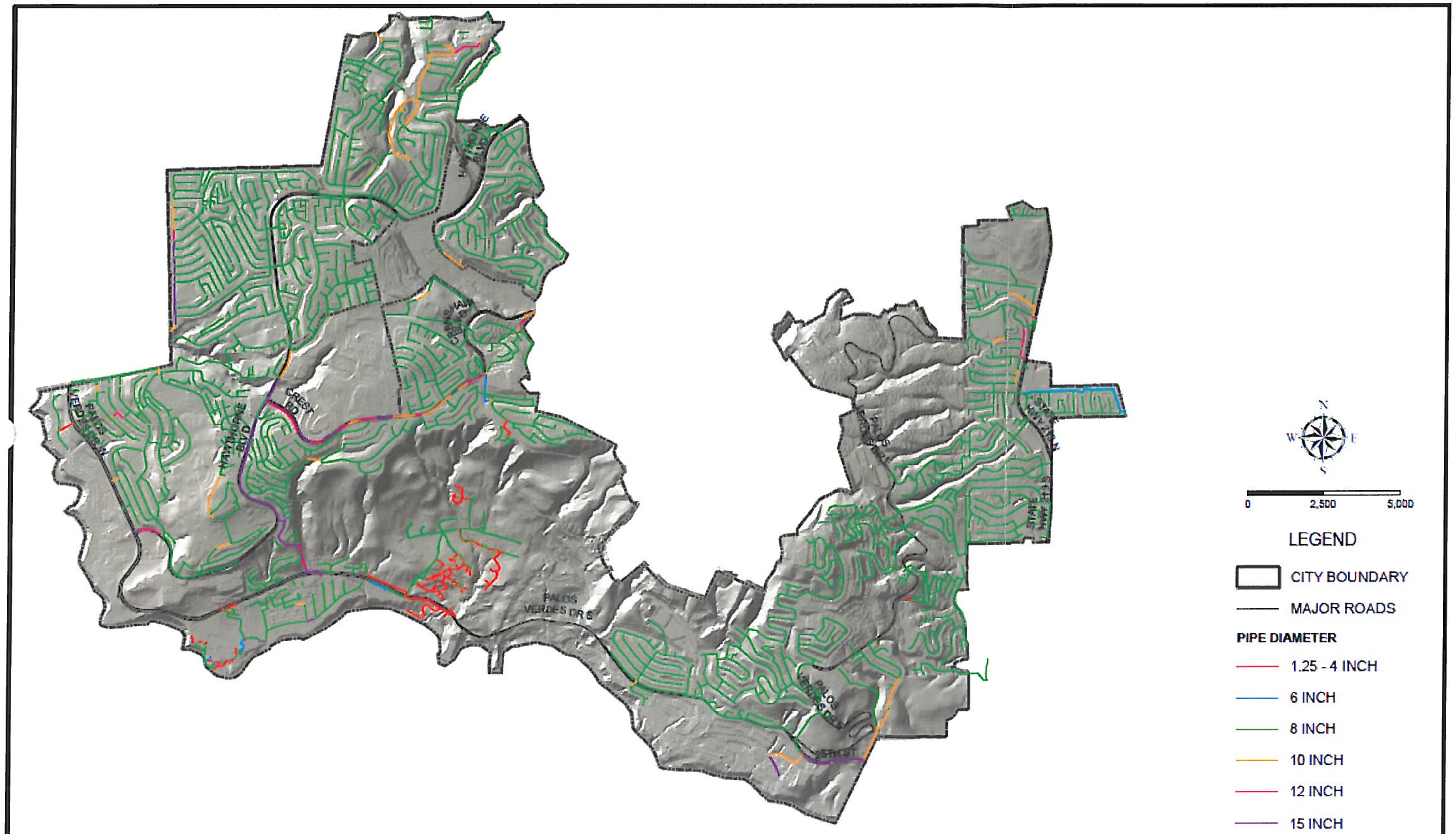


FIGURE 5-2
SANITARY SEWER COLLECTION SYSTEM BY PIPE DIAMETER

Figure 5-3 Collection System by Pipe Material

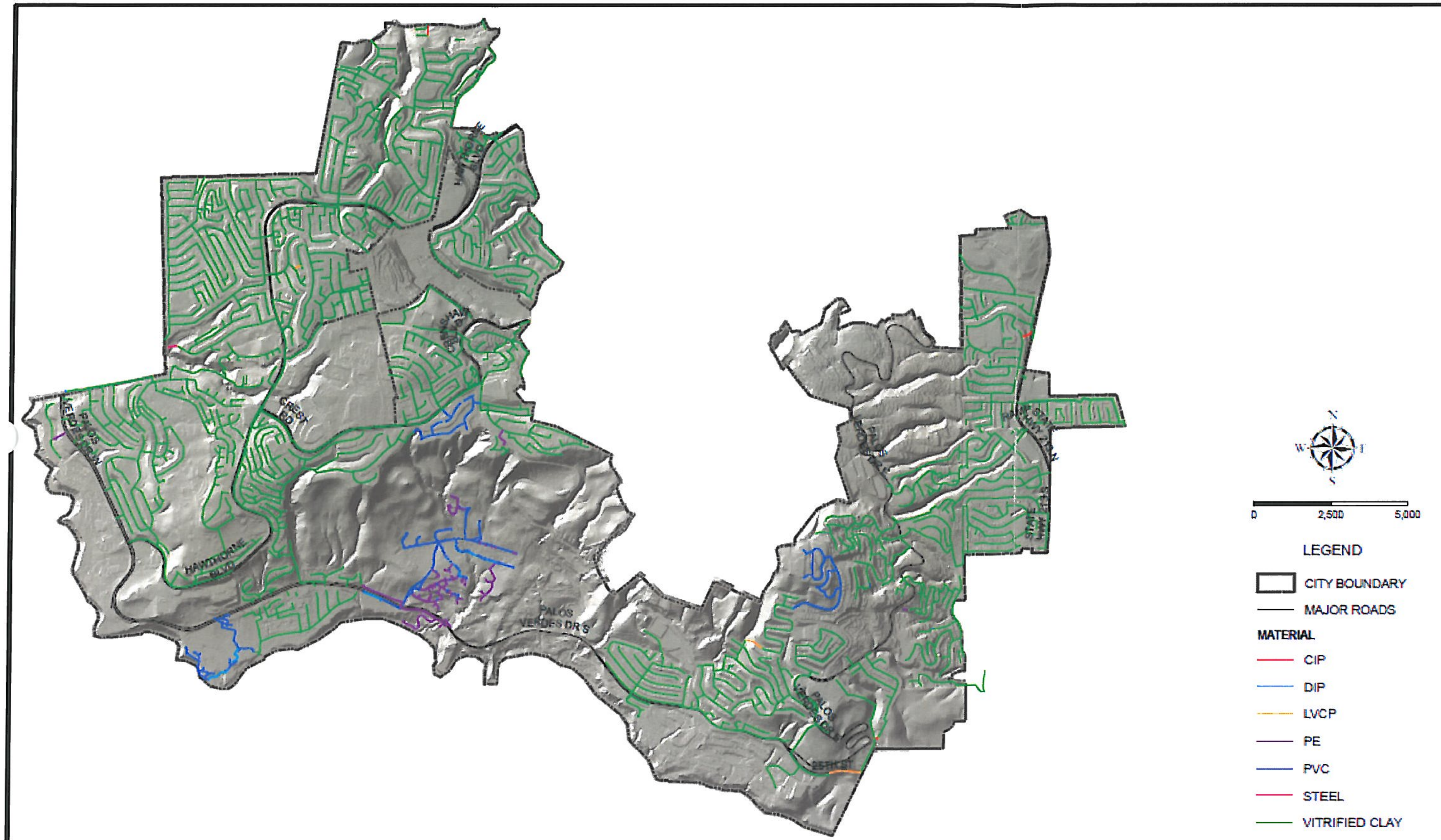


FIGURE 5-3
SANITARY SEWER COLLECTION SYSTEM BY PIPE MATERIAL

5.2 Updating the Hydraulic Model

The GIS data set was used to create a Hydra database and graphic file to perform the hydraulic analysis. All pipes and facilities are included in the model and in the GIS. The modeled features in the system include:

Table 5-3 Modeled Features

Feature	Number
Diversions	16
Pipes	3,812
Manholes	3,828
Outfalls	54
Pumps	56
Split Manholes	16
Total	**7,782**

The primary attributes of the system include:

- Length (Feet) = 790,000 feet
- Length (Miles) = 150 miles
- Number of Pipes = 3,812
- Number of Manholes = 3,914
- Largest Pipe Diameter = 15 inches
- Number of Drainage Basins = 53
- Oldest Pipe Age = 54 years
- Dominant Pipe Material = Clay (87%)
- Primary Lift Stations = 17

5.2.1 Abalone Cove Modeling

The conveyance system in Rancho Palos Verdes contains a large number of grinder pumps and gravity connections in the Abalone Cove Landslide Area. Since Abalone Cove is located on shifting land, that is prone to landslides, grinder pumps have been installed to transport the household flows into the main sewer system. The grinder pumps store the household waste until enough has accumulated to turn the pump on. The pump then grinds the waste into slurry, which is discharged into the main sewer system. These facilities typically serve individual homes and discharge into low pressure sewer systems that are above the ground. As part of this update, a capacity analysis was not performed on the grinder pumps. A detailed grinder pump specific model will be prepared as a part of the complete review of the Abalone Cove area. Approximately 880 linear feet of pipeline is over capacity for the existing flow conditions, and 1,708 linear feet are over capacity for the 2.5 safety factor flow condition.

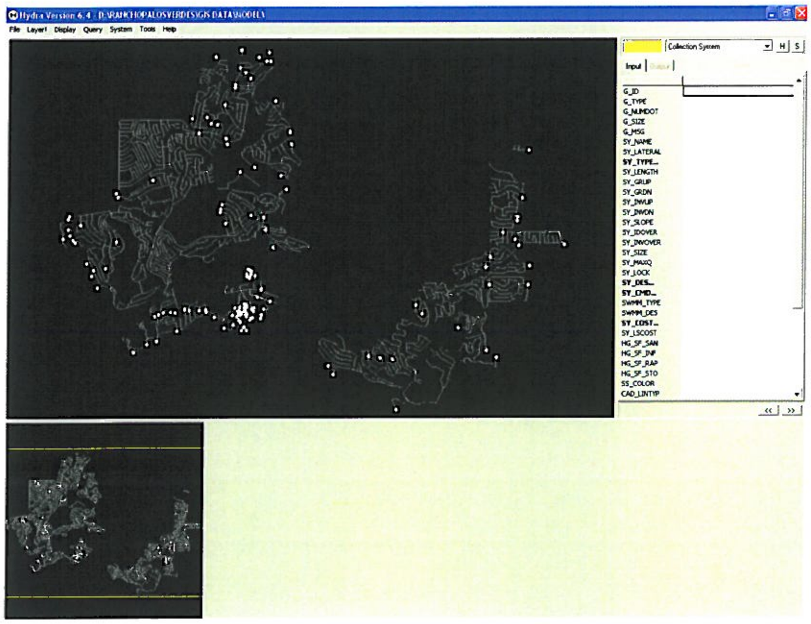
Hydraulic modeling of the collection system allows us to analyze the performance of the system under a variety of conditions. The primary purpose of the hydraulic model is to identify capacity limitations that may exist in the system and to estimate the cost to restore capacity. All models are representations. The hydraulic model of the collection system is composed of two primary aspects. These are the conveyance system (pipes, manholes, pumps, etc.) and the flows to be conveyed. Accurate models require that both of these representations be as accurate as possible.

5.2.2 The Conveyance System

To model the conveyance system, the updated GIS dataset was converted to the format necessary for the hydraulic model. The model that was selected for this analysis was the Hydra model produced by Pizer, Incorporated. This is a commercial, publicly available model that has seen widespread use over the past 30 years and the same model that was used in the 2004 master plan.

The converted GIS files are then used to determine the design capacity of each pipe segment. Figure 5-9 shows a screen shot of the hydraulic model prepared for the Rancho Palos Verdes collection system. The fact that all pipes are modeled allows us to develop an unprecedented view of the collection system. The entire system was checked for continuity to ensure that all outfalls, split manholes, pumps, and force mains had been labeled. Each of these features affects the flow direction of the system and for accurate model representation; these features need to be labeled correctly.

Figure 5-4 Hydra Model of RPV System



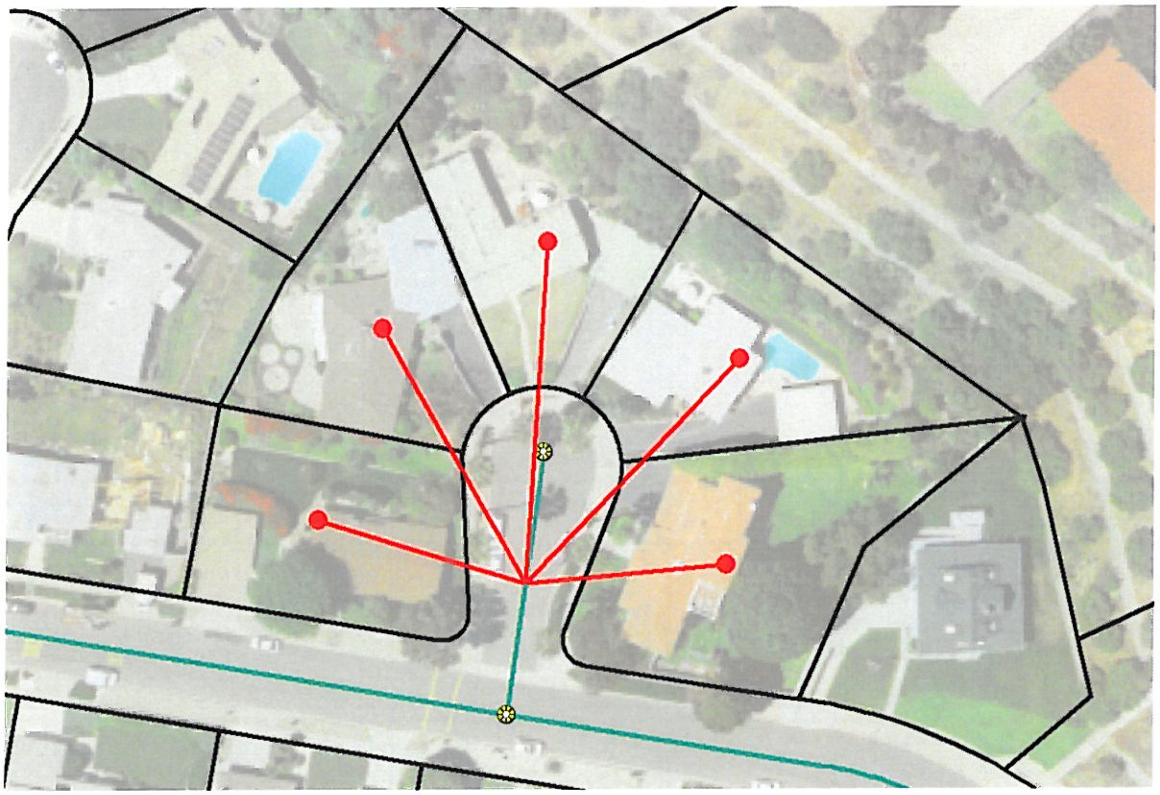
5.2.3 The Flows

The accurate representation of the flows is based on the flow measurements that were observed in the field. Hydra is a model that requires the flow to be defined by daily volume and by hourly variation. This allows the model to accurately route flows through the system to determine the downstream effects. The flow at each of the metering stations was analyzed and a volume and diurnal curve was developed.

Using a combination of the GIS and Hydra datasets, the upstream contributing acreage, number of parcels and feet of tributary pipe were calculated. This allowed us to calculate the flow per acre, flow per parcel and flow per foot respectively. This information was applied to each of the measured basins and to those basins which were not directly measured.

Flows were allocated to each parcel based on the area of the parcel. The flows calculated for each lot, or parcel, were then injected into the nearest pipeline in the model. This allowed the flows to be distributed over the entire collection system. The following figure shows how flows from each parcel were injected into the nearest pipeline. Since there was not a drastic climate change since the last Master Plan, the same flows were used for this master plan as were used in 2004.

Figure 5-5 Flow Injected From Parcels



5.3 CCTV Inspection

The following section introduces the concepts of the CCTV inspection program. Since the 2004 document was prepared the County has increased its CCTV inspections within the City. The current program indicates that the preliminary findings were an accurate reflection of the overall condition of the system.

In addition to the capacity analysis performed using design data, it is important to observe first hand the actual physical condition of the system. The best available technology for this is through closed circuit television (CCTV) inspection.

In this method of inspection a television camera traverses the inside of the sewer pipe and sends back images to a video recorder. An operator views the image on the screen and makes audio notes and database entries related to what is being observed.

Figure 5-6 CCTV Camera

Figure 5-7 CCTV Truck

5.3.1 Flow Generation and Allocation

Flows for the Average Dry Weather (ADW) condition were obtained by loading each parcel in each measured basin with its flow based on its' area based flow factor. The flow for each parcel was further defined with its metered hourly variation of flow.

Flows for those parcels outside the average flow per acre was applied to the parcel and the hourly variations were defined with a maximum peaking factor of 2.03. The flows were then allocated from the parcel GIS to the nearest pipeline as previously shown.

5.3.2 Capacity Analysis

To determine the effects of the flow loading and allocation, a calibration comparison was made between the modeled flows and the measured flows. The following table shows the results of that comparison.

Table 5-4 Model and Meter Flow Comparisons

Calibration Results				
Metered Basin ID	Model ID	Modeled mgd	Measured mgd	Difference % Msrd.
1	2293	0.040	0.040	0.13%
2	1797	0.761	0.760	0.13%
3	1124	0.665	0.690	-3.66%
4	1045	0.158	0.150	5.51%
5	88	0.393	0.400	-1.81%
6	627	0.100	0.100	0.13%
7	686	0.444	0.430	3.36%
8	2692	0.096	0.110	-12.50%

The predicted (modeled) and measured flows are within good calibration limits. This indicates that our modeled assumptions are valid for these basins. Given the calibration results and the number of pipes that are expected to flow more than half full, the overall capacity analysis shows that the collection system has adequate capacity for dry weather conditions. None of the lines identified as flowing more than half full are causing a critical surcharge condition.

To determine the hydraulic capacity of the system to increased flows like that which they may have experienced in wet weather, all flows were multiplied by a safety factor of 2.5.
The capacity criteria were also increased to allow flow to attain a depth/diameter ratio of 0.9 or 90% of full pipe diameter. This allowance is a widely accepted value for wet weather flows. The results of this showed that of the 3,812 gravity pipes in the system, 71 now exceeded the desired depth/diameter ratio. This represents around 1.9% of the entire system. Again this is

outstanding hydraulic performance. Many systems see more than 25% of their collection system exceeding this performance criterion.

Table 5-5 Capacity Performance (2009)

Flow Load	Deficient Segments	% Deficient
Average Dry Weather	14	0.37%
2.5 x ADW	71	1.9%

Each of the flow scenarios discussed here are presented in Figure 5-8 and Figure 5-9.

Figure 5-8 Existing Capacity Restrictions

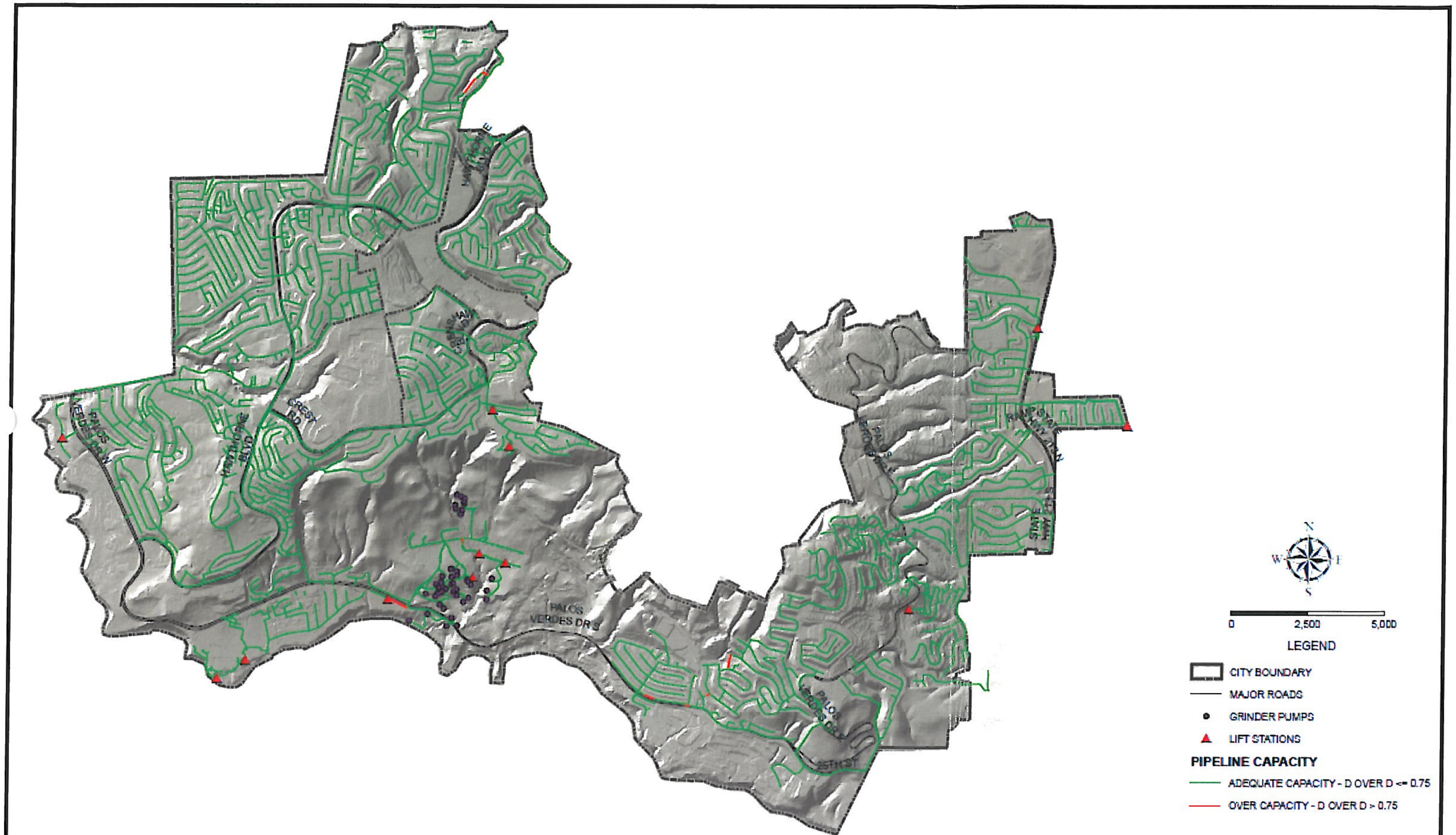


FIGURE 5-8
SANITARY SEWER COLLECTION SYSTEM WTIH EXISTING CAPACITY RESTRICTIONS

Figure 5-9 Capacity Restrictions Safety Factor = 2.5

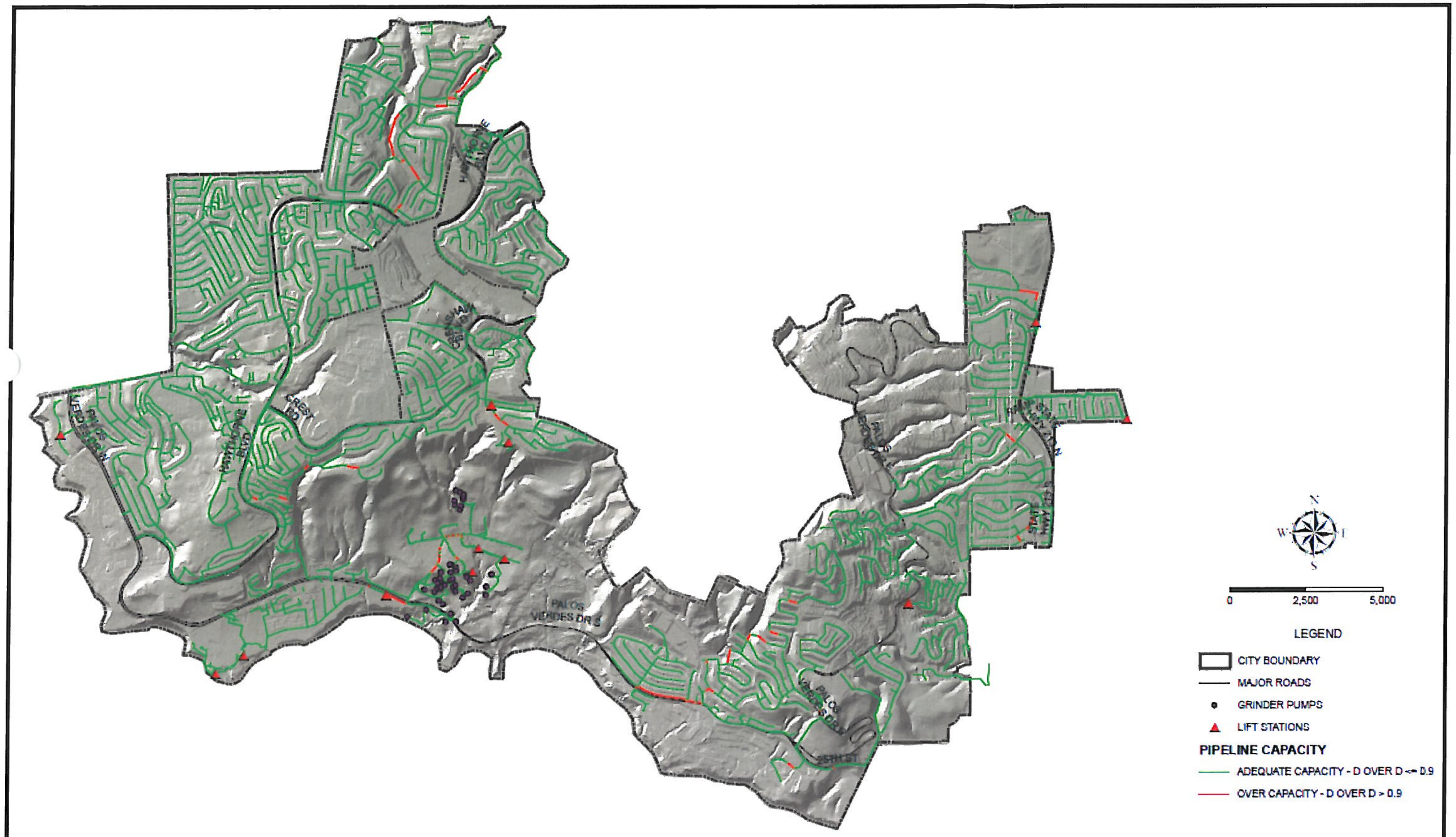


FIGURE 5-9
CAPACITY RESTRICTIONS SAFETY FACTOR: 2.5

5.4 County CCTV Inspection (2005-2006/2007)

In the fiscal years 2005-2006/2007 the county CCTV inspection program Y0TV0506F inspected an additional 76,591 linear feet of sewer pipeline or 10.6% of the entire system. A primary advantage of this inspection was that the county has adopted the relatively new national standard for establishing the condition of the sewer pipes. These codes are assigned to each segment based on a certified operator using the Pipeline Assessment and Certification Program (PACP) coding scheme. The condition codes are provided for cleanliness are called Maintenance codes and those related to cracked pipes are called Structural codes. Each has a similar scale that varies from 1-5 from better to worse condition. The codes and the observed conditions are:

(1) Excellent
(2) Good
(3) Fair
(4) Poor
(5) Need immediate attention (really bad!)

Of the 388 pipe segments that were CCTV inspected, 42 were given a Structural Quick Rating of 4 or 5, meaning they were either in poor structural condition or had structural defects that required immediate attention.

Of the approximately 388 pipeline segments that were CCTV inspected, 79 were given a Pipeline Assessment and Certification Program (PACP) Maintenance Quick Rating of 4 or 5, indicating blockages, either due to roots, fats, or grease. This represents approximately 20.4% of the pipelines observed.

These assessments, as provided by the LACSMD are provided in tables Table 5-6, Table 5-7 and Figure 5-13.

Table 5-6 Maintenance Rating[3]

Defect Grade	Pipe Length (ft)	Percent Total Inspected Pipe Length	No. Segments	Percent Cumulative
1. Excellent	3,922	5.1%	23	5.1%
2. Good	46,753	61.1%	235	66.2%
3. Fair	9,898	12.9%	51	79.1%
4. Poor	15,497	20.2%	76	99.3%
5. Immediate Attention	521	0.7%	3	100%
Total	**76,591**	**100%**	**388**	

[3] Consolidated Sewer Maintenance District Condition Assessment Program Report Project Y0TV0506F

Table 5-7 Structural Rating[3]

Defect Grade	Pipe Length (ft)	Percent Total Inspected Pipe Length	No. Segments	Percent Cumulative
1. Excellent	40,577	53%	212	53%
2. Good	6,308	8.2%	30	61.2%
3. Fair	21,148	27.6%	104	88.8%
4. Poor	4,974	6.5%	24	95.3%
5. Immediate Attention	3,584	4.7%	18	100%
Total	**76,591**	**100%**	**388**	

At the time of the preparation of this draft report the review of the County condition coding for the recent CCTV, Fiscal Years, 2007-2008 and 2008-2009 work has not been provided.

5.5 Known Sanitary Sewer Overflows (SSOs)

Known overflow locations, provided by the County were also mapped to determine the overall nature of these occurrences. It is apparent from a review of these that the County is well aware of the frequency of occurrence of overflows. Given the funding limitations described by the County, it is unlikely that a clear program for reducing the number and frequency of overflows in Rancho Palos Verdes exists. Updated known overflow locations are shown in Figure 5-12.

The following tables show the overflow characteristics found in the States CWIQS system.

Table 5-8 SSO Characteristics

2007-2009	SSOs	SSO Vol.	Recover	To Surface	Length	Frequency	Volume to surface waters
Responsible Agency	**(count)**	**(Gallons)**	**(Gallons)**	**(Gallons)**	**(Miles)**	**(SSO/100 mi.)**	**(gallons/100 mi.)**
West Hollywood	20	8,800	3,210	4,650	39.4	50.7	11,802.00
Palos Verdes Estates	37	8,465	2,161	3,475	76.4	47.8	4,495.40
Rancho Palos Verdes	38	13,425	3,140	8,025	138.8	27.0	5,707.60
Rolling Hills Estates	7	1,285	245	50	32.4	21.4	152.9
Hawaiian Gardens	3	601	101	500	15.7	19.1	3,184.70

This table indicates that the City has more SSOs than any other agency maintained by the LACSMD. When normalized to consider the length of the system, the City ranks third of the highest five ranked systems. The SSO frequency is a further indicator of the physical condition of the system.

The following table shows the same comparisons for the highest frequency (SSO/100 mi.) for all agencies in Los Angeles County.

Table 5-9 Top 10 SSO Frequency LA County

2007-2009	SSOs	SSO Vol.	Recovered	To Surface	Length	Frequency	Volume to surface waters
Responsible Agency	(count)	(Gallons)	(Gallons)	(Gallons)	(Miles)	(SSO/100 mi.)	(gallons/100 mi.)
CSU Dominguez Hills	37	113,674	6,174	0	3.0	284.6	-
UC Los Angeles	4	17,340	1,300	15,940	2.0	133.3	**531,333**
Los Angeles Cnty DPW	2	400	250	0	2.9	51.2	-
West Hollywood	20	8,800	3,210	4,650	39.4	50.7	**11,802**
Palos Verdes Estates	37	8,465	2,161	3,475	76.4	47.8	**4,495**
Whittier City	75	15,352	985	445	214.0	35.0	**208**
Beverly Hills	31	6,032	2,960	1,409	98.0	31.6	**1,438**
LA County Sanitation Districts	5	3,750	0	1,700	14.6	28.9	**9,827**
Rancho Palos Verdes City	38	13,425	3,140	8,025	138.8	27.0	**5,708**
LA County Sanitation Districts	4	275	75	0	15.3	25.9	-

Note that in Table 5-9 three of the top five communities are located on "the hill." This seems to indicate that a shared physical characteristic contributes to the frequency and amount of overflows. Factors that are likely to create this situation are the dominant construction material and techniques and the steep slopes. The steep slopes would result in a downward stress on the pipe joints which could enlarge the gap at the joint. This pulling apart could result in more root intrusion and structural cracking. The following table shows the PACP rating (1=Excellent – 5 = Worst), slope and length of pipe.

Table 5-10 Pipe Rating and Slope

PACP Rating	Slope										
	0-0.5%	0.5-1%	1-2%	2-3%	3-4%	4-5%	5-6%	6-7%	7-8%	8-9%	>9%
	Pipe Length (ft)										
1 - Excellent	8,075	2,076	5,142	2,165	2,569	1,810	2,577	2,021	2,204	2,631	9,366
2 - Good	414	254	199	857	639	718	1,529	254	0	0	1,150
3 - Fair	3,010	1,079	2,324	1,414	2,344	1,188	1,702	2,158	2,105	1,021	2,315
4 - Poor	1,081	0	1,090	0	0	0	468	182	647	216	986
5 – Immediate Attention	368	142	622	218	121	685	889	143	136	0	1,127

5.5.1 System Evaluation Conclusion

In conclusion, the CCTV inspections performed in 2004 and in 2006 shows that the actual physical condition of the collection system is deteriorated with maintenance defects in over 20% of the system and structural defects in over 10%. Some pipes have both maintenance and structural defects. The frequency and widely dispersed nature of the overflows indicates a system that needs continuing, consistent maintenance and a watchful eye on the cracked pipes and root intrusion areas. Based on the results of the hydraulic model, no overflows were predicted in the properly cleaned system in the existing or future dry conditions.

Figure 5-10 Area of CCTV Inspection by Year

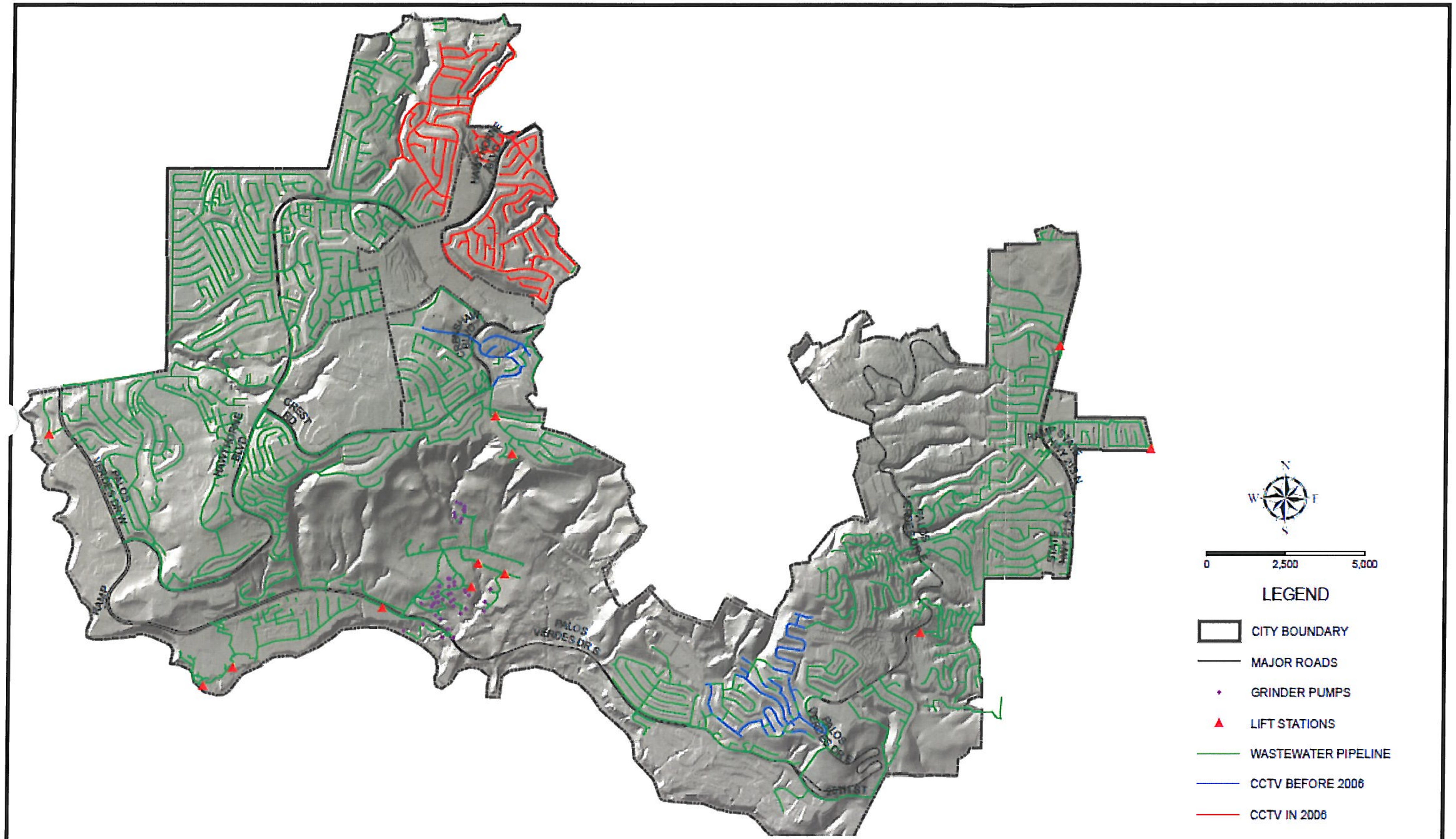


FIGURE 5-10
SANITARY SEWER COLLECTION SYSTEM WITH OBSERVATIONS IN CCTV LINES

Figure 5-11 Frequency of CCTV Observations

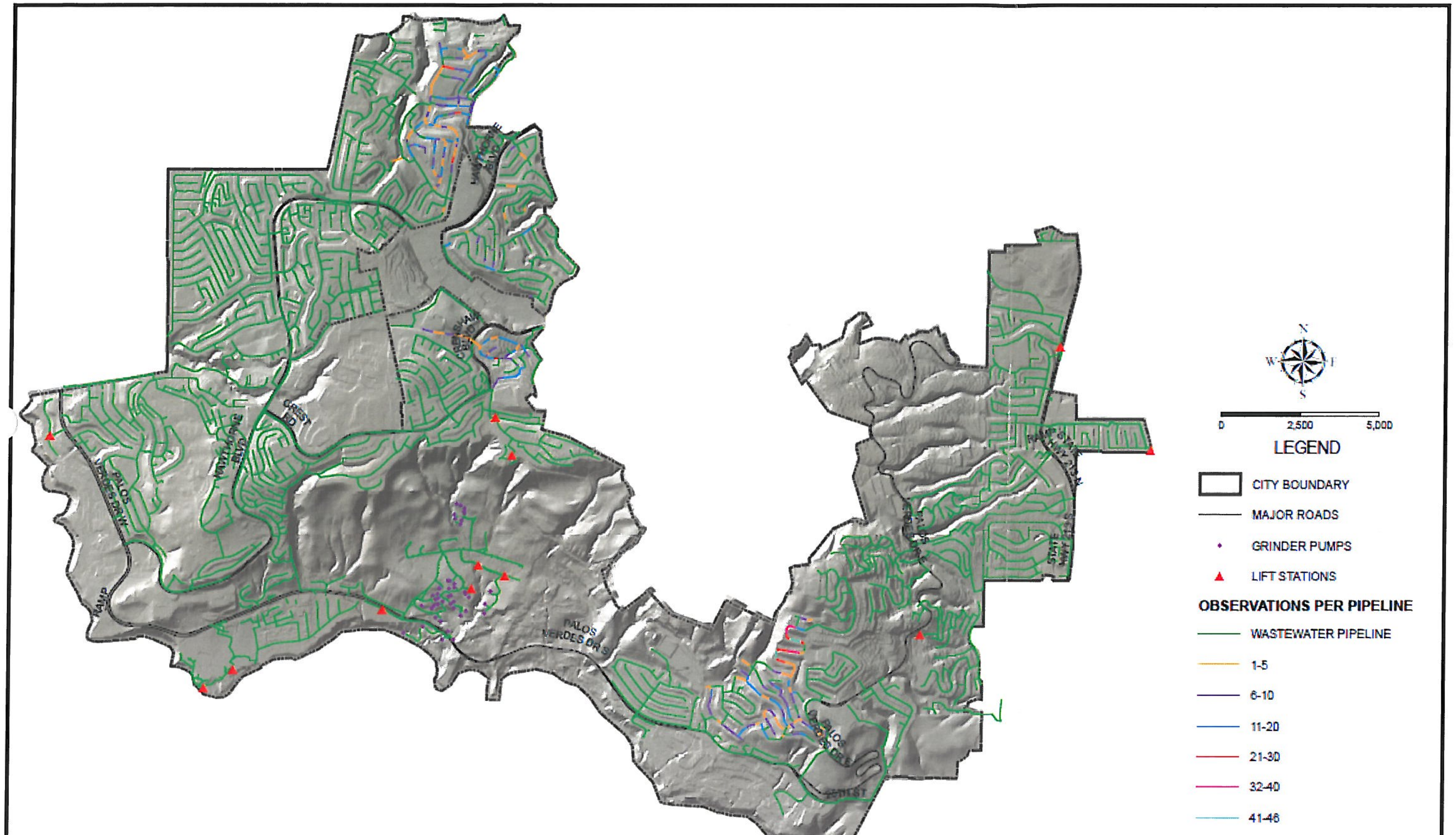


FIGURE 5-11
SANITARY SEWER COLLECTION SYSTEM WITH OBSERVATIONS IN CCTV LINES

Figure 5-12 Known Overflow Locations

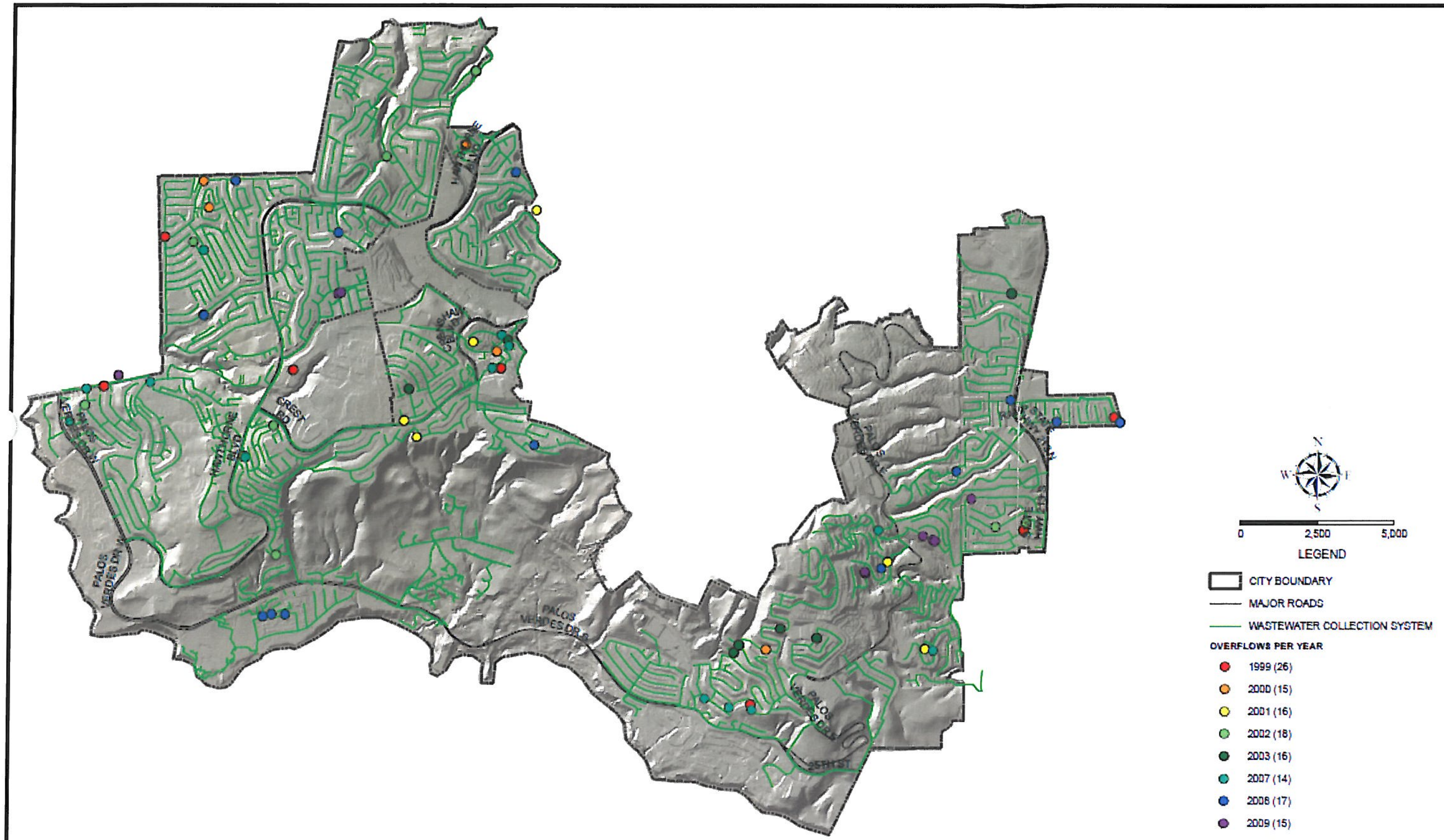


FIGURE 5-12
SANITARY SEWER COLLECTION SYSTEM WTIH SEWAGE OVERFLOW LOCATIONS

Figure 5-13 PACP Grade