CITY OF LODI
INFORMAL INFORMATIONAL MEETING
"SHIRTSLEEVE" SESSION
CARNEGIE FORUM, 305 WEST PINE STREET
TUESDAY, FEBRUARY 4, 2003

An Informal Informational Meeting ("Shirtsleeve" Session) of the Lodi City Council was held Tuesday, February 4, 2003, commencing at 7:00 a.m.

A. ROLL CALL

Present: Council Members – Beckman, Hansen, Howard, Land, and Mayor Hitchcock

Absent: Council Members – None

Also Present: City Manager Flynn, City Attorney Hays, and City Clerk Blackston

B. CITY COUNCIL CALENDAR UPDATE

City Clerk Blackston reviewed the weekly calendar (filed).

C. TOPIC(S)

C-1 "Overview of City's drainage system and design criteria"

With the aid of overheads (filed), Public Works Director Prima explained that the area along the river drains by gravity toward the river when the water is at low elevations. In general, however, all the ground in Lodi slopes away from the river. Area E, i.e. Parkwest, Lodi West, the area around General Mills and south to Lodi Avenue, drains to a pump station at Lodi Lake that is pumped into the river. The basins that serve Area E are Parkwest and Glaves Park. Area B on the east side is handled by the Shady Acres pump station and drains into the Woodbridge Irrigation District (WID) canal. Areas A and D drain to the WID canal via the Beckman pump station. Area C on the east side is handled by Pixley Park and the ditch along Beckman Road. The Cluff pump station lifts the water out to the river near the CalWaste facility. Area G, i.e. DeBenedetti Park and all the new area developing on the west side, drains to Beckman Park. The Beckman pump station actually has two pump stations. One was built in the 1970s and had major modifications in the early 1990s to add on a lower level pump station that serves the west side.

Mr. Prima reported that the minimum pipe size installed today is 12 inches and the largest pipes are 72 inches. There is a lot of 8 and 10 inch pipe that was installed many years ago. He stated that in the 1950s Lodi had a lot of drainage problems. The City hired an engineering firm to review the situation, which resulted in the 1958 Wilsey and Ham study. There were six alternatives, one of which involved installing ditches running north and south to a major east west interceptor with a large ditch out to the Delta. This was thought to be a safety hazard and aesthetically unpleasant. In 1963 the Blair-Westfall study proposed the use of detention basins to hold water during peak storms. Mr. Prima read the following statement from the Blair-Westfall study, "In view of the flat terrain, the existence of large ponding areas by virtue of the curb to curb storage possibilities, and further surface storage in the backyards of residential developments, the return frequency selected for this report was considered economical and adequate." Mr. Prima pointed out that they were acknowledging at that time that water is stored on the streets and in yards during large storms.

Mr. Prima described how the drainage collection system works. He reported that the basins are designed to hold the 100-year storm volume; however, the system cannot collect the water that fast so there will be flooding in the streets before the water gets to the basin. Storage in basins are designed to hold water for major storm events, i.e. 100-year, 48 hour duration storm with 4.8 inches of rain. The collection system adopted by Council in 1965 proposed a ten-year frequency. Mr. Prima stated that a year or two later the standard plans changed those numbers, as to the amount of rainfall they were handling and it did not give a return frequency. He believed what happened was when they analyzed the master plan they analyzed the trunk lines and looked at the City in 10- to 30-acre sections and determined that the pipe was sufficient enough for a ten-year frequency. However, when it came time to start analyzing the collection system that gets to those trunk lines (the 12 and 24 inch lines that go out into the neighborhoods) they realized it would not work. Mr. Prima stated that the hydraulic grade line they were calculating would have been "coming out of the ground" using the ten-year storm numbers, so they had to reduce them and went down to what amounts to a two-year storm.

Mr. Prima explained that the return frequency, or recurrence interval, estimates the probability of a certain level of an event. A 100-year storm means that there is a 1% chance this year that there will be a storm of that size. The two-year event that the City has now in its collection system criteria means that there is a 50/50 chance that in any given year a storm of that level will occur. Mr. Prima reported that the system works better when the basins are empty. It is only when the basins start to get full or there is a huge downpour that the system fills up faster and street flooding occurs. Since the original plan was done in 1963, the C factor (runoff coefficient) for impervious area has been increased from 0.35 to 0.4. A time concentration of 25 minutes is allowed for residential areas. Mr. Prima indicated that the collection systems now being installed on newer homes moves drainage water quickly out to the street, almost doubles the amount of rainfall that must be designed in the City's collection system, and decreases the time to 10 minutes. In reply to Mayor Pro Tempore Howard, Mr. Prima stated that he would be factoring this in new subdivisions. He then suggested that the problem might correct itself when these fragile plastic drainage pipes plug up or disintegrate over time.

Mayor Pro Tempore Howard replied that public education would be beneficial to explain that without these drainage pipes on homes, or when they no longer function properly, water will naturally collect in the backyard and by doing so it eases the burden on street drainage and resultant flooding.

In response to Mayor Hitchcock, Mr. Prima acknowledged that if basins were larger the water would not back up into the collection system as often. He noted that the basins were designed to share as parks as well, so there was a conscious effort to avoid putting water in the basins. A weir structure prevents water from getting into the basin until it rises to a certain level. Mr. Prima stated that the upland/lowland ratio change at DeBenedetti Park was compensated for by enlarging the lowest areas. He noted that the design volume for DeBenedetti Park that was set in the 1980s has always been maintained.

In answer to Council Member Hansen, Mr. Prima explained that there is a gate in Lower Sacramento Road at Elm Street that separates the E area from the area to the east. It is possible that street flooding in the area of Peterson Park had occurred because water was flowing backwards from the eastern area. Mr. Prima stated that he would be making a capital budget request for a control system to correct this situation.

Mr. Prima reported that the City still has a number of drop inlet style catch basins, which are inefficient. In addition, when water flows into the storm basins, it flows through a rack that can fill up with trash. Mr. Prima stated that he would also be making a capital request to replace or rebuild some of the City's pumps, such as the Lodi Lake pump station.

Referencing exhibit E (filed) Mr. Prima reported that there are 41 trouble spots for flooding. Approximately half of these problems are related to the drop inlet catch basins and one third are pipe related issues. He stated that a rough estimate to fix these problems is $2 million. The City has over 400 drop inlet catch basins and it costs approximately $10,000 each to replace them.

Council Member Land noted that five of the locations had capacity related problems. There are safety issues with vehicles traversing flooded streets and causing wakes. During heavy rainstorm periods the City needs a flood patrol that is available to put up barricades and detour traffic to alternate routes.

Mr. Flynn replied that the City has a new system in place where certain staff will be assigned on a standby basis during storm periods to respond immediately when flooding occurs.

Council Member Land suggested ameliorating the debris problem by placing signs informing residents to move their cars on certain days when street sweeping is scheduled.

PUBLIC COMMENTS:

- Del Smith stated that the Wine and Roses facility parking lot has flooded twice in the past one and a half years. He questioned whether the pump problem at Lodi Lake is contributing to the situation. He reported that he paid $150,000 in storm drainage fees and asked whether new subdivisions were paying their share to adequately support their own drainage.

  Mr. Prima explained that the storm drainage development impact mitigation fees pay for basin development, pumps associated with new basins, and trunk lines 30 inches and larger. He reported that there are trunk lines in the vicinity of Wine and Roses that were paid for out of the drainage fund.

  In summary, Mr. Prima stated that Council needs to focus on what level of protection it wants to see and allow staff to work out the details as to how to design it.

- Judy Kosaka reported that her property on Lockeford Street has flooded every year for the past 20 years and believed that it was an inordinate amount of time to wait for assistance from the City. She asked that at least some improvements be made to correct the situation.

D. COMMENTS BY THE PUBLIC ON NON-AGENDA ITEMS

None.

E. ADJOURNMENT

No action was taken by the City Council. The meeting was adjourned at 8:35 a.m.

ATTEST:

Susan J. Blackston
City Clerk

Mayor's & Council Member's Weekly Calendar

WEEK OF FEBRUARY 4, 2003

Tuesday, February 4, 2003

7:00 a.m.	Shirtsleeve Session 1. Overview of City's drainage system and design criteria (PW)
7:30 a.m.	Chamber of Commerce Grape Day, Hutchins Street Square, Crete and Kirst Halls.

Wednesday, February 5, 2003

7:00 p.m.	City Council Meeting (Note: Closed Session 6:15 p.m.)

Thursday, February 6, 2003

Friday, February 7, 2003

Noon	Government Relations Committee Meeting, Lodi Chamber of Commerce Conference Room, 35 South School Street.
5:00 -7:00 p.m.	**Hitchcock.** Lodi Wine Live, Lodi Wine and Visitor Center, 2545 West Turner Road.

Saturday, February 8, 2003

Reminder	**Howard.** APPA Legislative Rally, Washington D.C. February 8 -12, 2003.

Sunday, February 9, 2003

Monday, February 10, 2003

Disclaimer: This calendar contains only information that was provided to the City Clerk's office

CITY OF LODI

COUNCIL COMMUNICATION

AGENDA TITLE: Overview of City's Drainage System and Design Criteria

MEETING DATE: February 4, 2003 (Shirtsleeve Session)

PREPARED BY: Public Works Director

RECOMMENDED ACTION: None

BACKGROUND INFORMATION: Recent intense storms have drawn attention to a few locations in the City that have relatively frequent drainage problems. Staff has been directed to bring back to the Council recommendations for improvements to one location – Lockeford Street near Loma Drive. Knowing that other locations will eventually need to be addressed and that there are some system-wide improvements that are also needed, Public Works staff felt that an overview of the storm drain system – how it works and how it is designed – would be useful background information for the Council.

We wish to stress that drainage design has a high degree of "art" as well as science behind it and that having one set of uniform design standards for the entire City is not practical, although having a uniform goal of maintaining some level of flooding protection is appropriate. However, determining that level and achieving it may be difficult and will likely be expensive.

The following attachments are being provided as background material:

- Exhibit A – Draft slides outlining the presentation. These are being updated and the presentation on Tuesday will be expanded from these and new copies will be provided.
- Exhibit B – Background on what a "100-Year Storm" really means. This information was recently prepared for the Parks & Recreation Commission as it pertained to DeBenedetti Park, but the concepts are applicable to the entire City.
- Exhibit C – Excerpt from the 1963 Storm Drain Master Plan – This document is the basis from which the basin system was developed and explains many of the concepts still used in developing the City's storm drainage system. Some annotations have been added by hand.
- Exhibit D – Internal memo concerning storm drain design in Lodi West. This memo was prepared in response to concerns over localized street ponding in one of Lodi's newer subdivisions. The preliminary conclusion is that our Design Standards and practices should be changed if this type of flooding is to be reduced.
- Exhibit E – List of problem areas. This list is used by Street Division staff to prioritize areas that need to be checked during storms, in addition to responding to calls from citizens. We have added the "apparent" cause, although they have not all been verified through an engineering analysis. We should note that this list was much longer in years past. At one time, the City devoted a large portion of Federal Revenue Sharing funds to making drainage improvements.

The last slide in Exhibit A summarizes the issue and the direction staff feels we should pursue. In short, we need to recognize that under some storm conditions, streets will be flooded. We need to develop a goal that applies to how we analyze and address existing problem areas, and we should improve our Design Standards that are applied to new developments.

FUNDING: None needed at this time.

Richard C. Prima, Jr.
Public Works Director

Attachments
cc: Wally Sandelin, City Engineer
George Bradley, Street Superintendent
Engineers and Developers

APPROVED: ______________________________
H. Dixon Flynn -- City Manager

CCDrainageSystemOverview 01/29/03

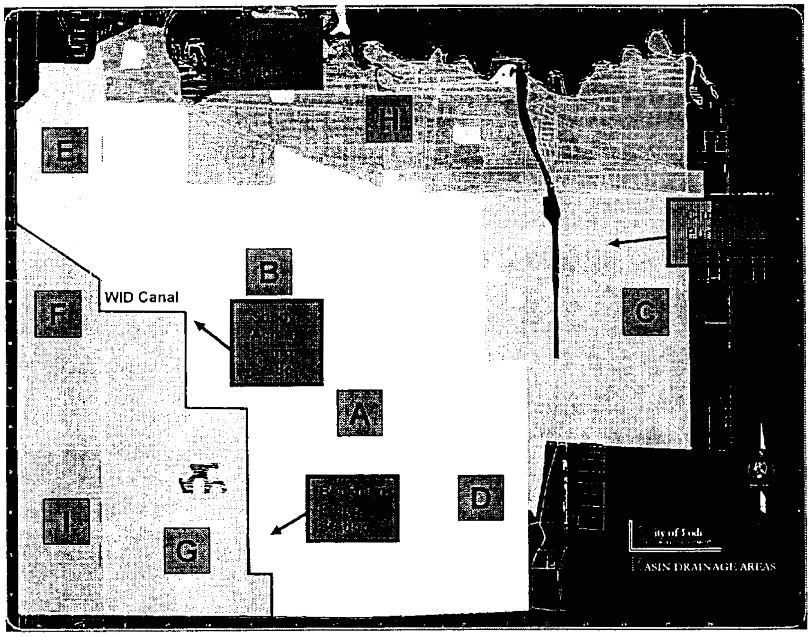
Filed 2-4-03
(Amended)

Lodi's Drainage System Overview

For City Council Shirtsleeve
Presentation
February 4, 2003

Lodi's Drainage System Overview

- City Drainage System Map – sub areas and general system
- Brief history of Lodi's system
- How a collection system works
- Storage versus collection
- Playing the Odds – Just what is a 100-yr storm?
- Standards – Then and now
- Operational Issues
- Now What?



Lodi's Drainage System
System Map Notes

- "H" Area generally drains to River
- "E" & West Portion of "B" drain to River via Lodi Lake Pump Station
- East Portion of "B" drains to WID Canal via Shady Acres Pump Station
- "C" Drains to River via Cluff Pump Station
- "A" & "D" drain to WID Canal via Beckman Pump Station
- "G", future "F" & "I" drain to WID Canal via Beckman Pump Station (Beckman Pump Station is actually two stations at one location)
- Some drainage areas have definite boundaries, others are very "soft" with old, interconnecting pipes
- Basins provide "overflow" for limited system capacity, most are interconnected with only simple controls

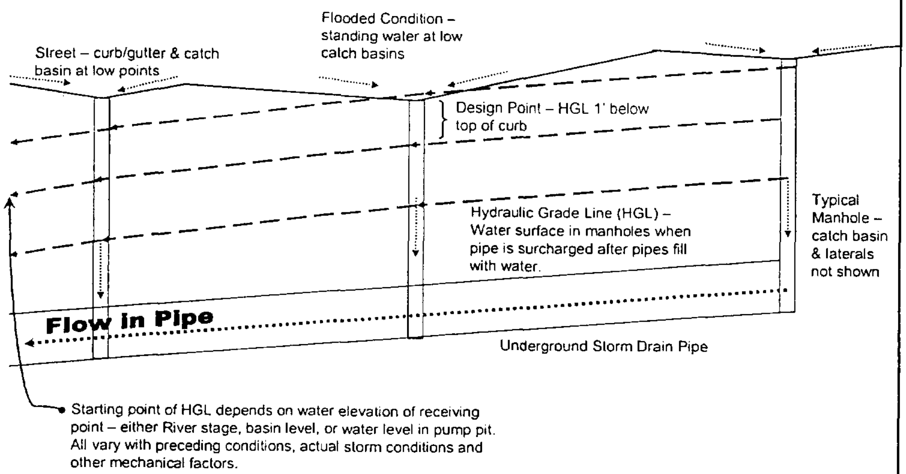
Lodi's Drainage System
Brief History

- 1950's – combination of gravity flow and pumping to River, two pumped outfalls to WID canal.
- System inadequate for large storms, more intensive land development or growth.
- 1958 Study by Wilsey & Ham Engineers studied various alternatives and recommended a gravity drainage network to the Delta. $ for plan not approved.

Lodi's Drainage System
Brief History (cont'd)

- 1963 Study by Blair-Westfall proposed basin concept, eventually approved.
- Study notes about design of the collection system: *"In view of the flat terrain, the existence of large ponding areas by virtue of the curb to curb storage possibilities, and further surface storage in the backyards of residential developments, the return frequency selected for this report was considered economical and adequate."*

Lodi's Drainage System
How The Collection System Works



Lodi's Drainage System
Storage vs. Collection

- Storage (in basins) designed to hold water for major storm events to minimize property flooding. (100-Yr, 48-hour duration storm – 4.8" of rain)
- **However** – the collection system cannot handle rainfall during major events.
- Collection system initially proposed for 10-yr frequency, later changed to 2-year; relied on short term storage in streets and yards.

Lodi's Drainage System
"100-Year Storm"

- Statistical Technique – Used to *estimate* probability of occurrence of a given event.
- 100-Year Event – Means a 1% chance of happening in any given year.
- 2-Year Event – Means a 50/50 chance of happening in any given year.

Lodi's Drainage System
Standards – Then & Now

- Q = CiA
  - Q = runoff to be handled at a given point – catch basin, manhole, pipe run (cubic ft. per second)
  - C = runoff coefficient – examples

Land Use	1966 Std.	Present Std.
Residential	0.35	0.4
Industrial	0.6	0.9
Commercial	0.5 to 0.7	0.8

  - A = area of land contributing to given point (acres)

Lodi's Drainage System
Standards – Then & Now (cont'd)

- i = Rainfall intensity (inches per hour); varies with time of concentration, Tc.
- Note rainfall intensity nearly doubles from 2-yr to 10-yr event.

Tc (minutes)	i (2 yr storm)	i (10 yr storm)
10	1.29	2.30
15	1.00	1.80
25	0.73	1.30
60	0.42	0.76
120	0.27	0.50

Lodi's Drainage System
Standards – Then & Now (cont'd)

- Main criterion for collection system design is that the theoretical water surface during a 2-Year storm stays at least 1 foot below the top of curb when the basins are 1 foot below the maximum design water level.

Lodi's Drainage System
Standards – Then & Now (cont'd)

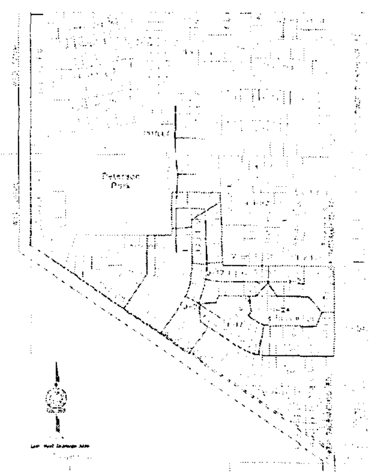
Problems with this criterion:

- No standard for situations controlled by pump stations or River elevation.
- System performs differently under conditions when basins are empty, and that difference varies with location in the City.

Lodi's Drainage System
Capacity Problem…

Lodi's Drainage System
Capacity Problem…

EXHIBIT A



City of Lodi
Public Works Department
Lodi West Drainage Study - Ponderosa Drive/Court

EXHIBIT D
01/01/2002

Hydraulic Grade Line Elevation Table

	Junction					
	J-17	J-27	I-17	I-17	I-23	I-24
TOC Grade	37.39	37.94	36.60		37.05	37.20
Scenario				above (-) the TOC		
A	33.37	34.00	34.30	-2.30		
B	35.27	35.45	35.70	-0.90	35.73	35.65
C	35.95	36.41	**36.91**	0.31	36.56	36.37
D	37.21	37.79	**38.50**	1.90	**37.92**	**37.74**
E	36.35	36.02	**36.75**	0.15		
F	37.21	37.39	**38.11**	1.51		
G	35.95	36.02	36.24	-0.36		
H	37.21	37.09	**37.60**	1.00		
I	33.87	34.21	34.95	-1.92		
J	35.27	35.61	36.06	-0.52		
K	35.80	36.14	**36.59**	-0.01		

Bold face number indicate flooding condition.

Scenario Description

A - 2 year storm, basin is empty
B - 2 year storm, basin is at Design HGL (33.50) per Design Standards
C - 10 year storm, basin is empty
D - 10 year storm, basin is at Design HGL
E - Same as C, with 15" pipe (P-39)
F - Same as D, with 15" pipe (P-39)
G - Same as C, with 15" pipes (P-38 & P-39)
H - Same as D, with 15" pipes (P-38 & P-39)
I - Same as A. Time of concentration reduced to 15 min instead of 25 min
J - Same as B. Time of concentration reduces to 15 min
K - Same as B. Time of concentration is 20 min and runoff coeff is 0.5

Lodi's Drainage System
Capacity Problem…

City of Lodi
Public works Department
Storm Drainage Study - Runoff Coefficient

Exhibit E
01/16/2003

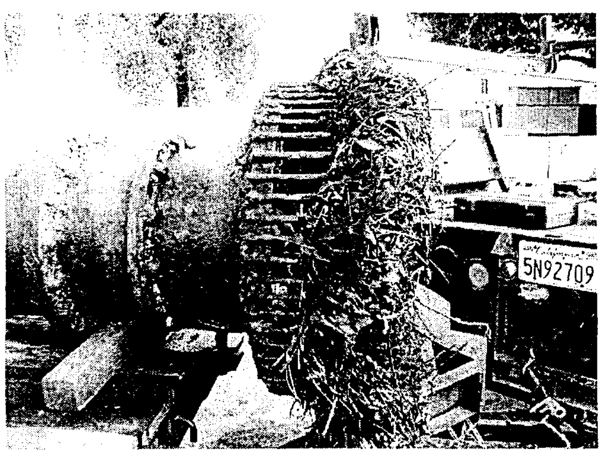
New Subdivision	Number of Lot Studied	Average Lot Size	Average Imper. Area	% Imper. Area	Landuse
Lodi West (1)	6	5.925	3.772	64%	R-2
Lodi West (2)	6	8.190	5.057	62%	R-1/R-2
Century Meadows	5	5.650	3.129	55%	R-2
Richards Ranch	5	5.000	2.948	59%	R-2
			Average	*60%*	
Older Area					
Lockeford & Cross	5	6.659	3.319	50%	R-2
Shady Acre	5	9.037	5.501	61%	R-1

Impervious area is made up of roof area, driveways, walkways, and paved patio.
Swimming pool is not included in the study.

Lodi's Drainage System
Operational Issues

- Basin Controls – Fixed weirs, manual slide gates with no flow measurement.
- Control Information – Need improved SCADA.
- Storm Basin Inlets – Big problem with plugging from trash.
- Drop Inlets – Old-style catch basins in streets quickly plug with leaves & debris, but are readily cleaned when manpower is available.
- Pump Problems – Old-style "ditch" pumps can't handle trash, pump station design/capacity issues.

Lodi's Storm Drain System
Clogged Pump At Lodi Lake



Lodi Lake Pump Station, Dec. 2002

Lodi's Storm Drain System
Typical Trouble Locations

- Per Exhibit E – 41 locations or general areas that need extra attention during storms.
- Half have problems related to Drop Inlet Catch Basins & about a third due to pipe issues.
- Very roughly $2,000,000 to fix problems if the fix can be done locally.
- Over 400 drop inlet catch basins in the system; typical fix involves moving catch basin to allow for handicap ramp and changing SD lateral; cost is about $10,000 each.

Lodi's Drainage System
Now What?

- In General – The system works well, recognizing differences in land use & development form; and, that the system was designed to flood streets.
- Specific Problem Areas – Do exist and need to be addressed within budgetary constraints.
- Design Standards – Should be tweaked to address new development forms and weak points.
- Criteria for Existing Areas – A "no flooding..." goal should be defined.
- System Control – An overall system analysis and operational manual need to be done.

Storm Water Storage Issues & DeBenedetti Park

Statistical techniques, through a process called frequency analysis, are used to estimate the probability of the occurrence of a given event. The recurrence interval (sometimes called the return period) is based on the probability that the given event will be equalled or exceeded in any given year. For example, there is a 1 in 100 chance that 3.7 inches of rain will fall in Lodi in a 24-hour period during any given year. Thus, a rainfall total of 3.7 inches in a consecutive 24-hour period is said to have a 100-year recurrence interval. The City's adopted standard for basin storage is a 100-year, <u>48-hour</u> storm, which corresponds to 4.8 inches of rain over a 48 hour period.

The term "100-year storm" is used in an attempt to simplify the definition of a rainfall event that statistically has a 1-percent chance of occurring in any given year. In other words, over the course of 1 million years, these events would be expected to occur 10,000 times. The amount of rainfall in any given storm has no influence on a future storm event. These events, as well as any recurring events, are assumed to be statistically independent of each other.

Therefore, each year begins with the same 1-percent chance that a 100-year event will occur. The following table presents these relationships:

Recurrence interval, in years	Probability of occurrence in any given year	Percent chance of occurrence in any given year	DeBenedetti Storage Volume (Acre feet)
100	1 in 100	1	202
50	1 in 50	2	177
25	1 in 25	4	160
10	1 in 10	10	127
5	1 in 5	20	100
2	1 in 2	50	25

The design for DeBendetti Park includes a "low-flow" area, which will receive the "first flush" of a storm, thus providing water quality benefits in compliance with the new storm water regulations. The initial design for this area provided a storage volume of approximately 50 acre feet. This design resulted in a basin depth of over 40 feet, down to 12 feet below sea level. This depth is unacceptable for a number of reasons and needs to be raised to at least sea level. This change by itself reduces storage by less than 20 acre feet. However, the current design concept includes a control structure that would allow the "low-flow" area to fill to near full-basin depth before water is spilled to the play fields. The "low-flow" area storage volume with this concept is approximately 100 acre feet, thereby reducing the frequency at which the play fields would be flooded.

The above material was adapted from the following report and the data for Lodi added by City staff:

Effects of August 1995 and July 1997 Storms in the City of Charlotte and Mecklenburg County, North Carolina
Prepared by Jerald B. Robinson, William F. Hazell, and Wendi S. Young
USGS Fact Sheet FS-036-98--April 1998

December 3, 2002

6. PROPOSED STORM DRAINAGE MASTER PLAN

Report – Basis for most of Lodi's Storm Basin System

Misc Notes & Comments
Jan 2003

DESIGN CRITERIA

Consideration of various design criteria is essential in the correlation of rainfall rates to storm water runoff.

Discussions of the various factors involved in determining the required collection and disposal capacities follow.

RAINFALL INTENSITY

Storm water runoff occurs essentially after the demands of soils, vegetation and surface retention have been satisfied. In determining the peak rate of runoff, it is first necessary to examine the intensity of rainfall for storms of various return periods and duration. Rainfall-Intensity-Duration-Frequency values were obtained for this report from a recent State of California Department of Water Resources Precipitation Depth-Duration-Frequency Curve for Lodi. This curve, as shown on Figure 6-1, was prepared in 1962 and covers a period of 48 years: 1898 to 1912 and 1927 to 1961.

The rainfall intensities used in the design of the collection system herein generally correspond to the 10-year return period used in the Wilsey and Ham Report. In view of the flat terrain, the existence of large ponding areas by virtue of the curb to curb storage possibilities, and further surface storage in the backyards of residential developments, the return frequency selected for this report was considered economical and adequate.

Stds used since 1966 are for a 2-yr storm

COEFFICIENT OF RUNOFF

The percentage of rainfall which runs off a given drainage area is called the coefficient of runoff. This coefficient considers the possibility of the design storm occurring at a time when the soils in the area are still wet from previous storms.

This coefficient is relative to the type of soil, the amount of impervious area, the type of vegetal cover, and the percentage of surface retention occurring in the drainage area. The duration of the storm and the slope of the ground have substantial effects in determining the quantities of storm runoff that must be handled.

The coefficient of runoff, C, for the residential areas was determined on the basis of 65% of the area as lawn and garden and 35% as impervious surfaces. Due to the flat slope of the terrain in the Lodi area, it was estimated that little runoff from the backyard area reaches the street. The coefficients of runoff used in this report were based on the ultimate development of the study area. These coefficients are tabulated below:

Not the case in new developments

Type of Development	Coefficient of Runoff, C	City Standards 1966	1976	1991
Parks and Recreation	0.10	-	0.1	0.2 (Minimums)
Residential	0.35	0.4	0.4	0.4
Schools and Apartments	0.40	0.5	0.5	0.5
Commercial (Some Pervious Area)	0.50	-	-	-
Light Industry and Manufacturing	0.60	0.6	0.9	0.9
Business (Mostly Impervious)	0.65	} 0.7	0.8	0.8
Major Commercial and Business	0.75			

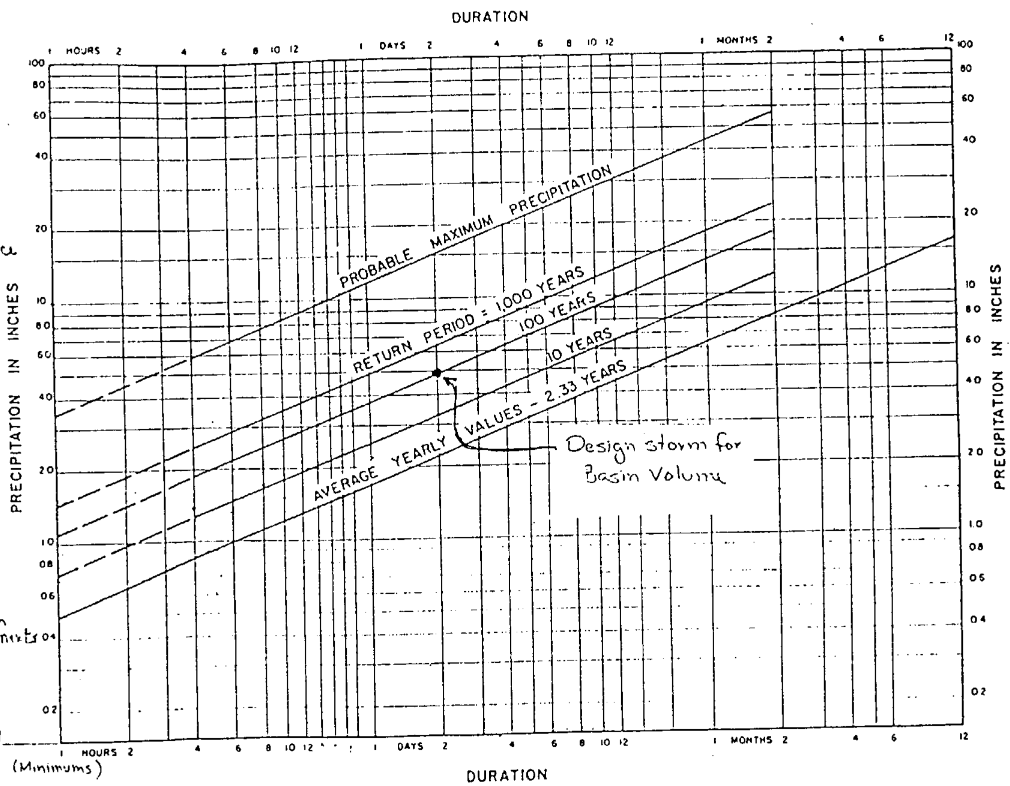


Fig. 6-1 PRECIPITATION DEPTH - DURATION - FREQUENCY CURVES

EXHIBIT C

TIME OF CONCENTRATION

The time required for storm water to flow in the form of runoff from the most distant point in a drainage area to a collection inlet is called the time of concentration for this area. It is also the period of the design storm which will produce the peak flow in the storm drain system. In residential areas, studies have shown that the time for rainfall to runoff from roof-to-gutter varies from 10 to 25 minutes. Due to the extreme flat slope of the Lodi area and the detention effect of the pervious areas, a roof-to-gutter time of 25 minutes was selected for the residential areas. Commercial areas were attributed a roof-to-gutter time of 10 minutes on the basis of large impervious areas with little time of detention. The total time of concentration was then determined by adding the time of flow from roof-to-gutter to the time of travel in the gutter. The latter was obtained by dividing the maximum length of travel in the gutter by 75% of the maximum velocity of gutter flow. The gutter velocities were determined by the method outlined in the Highway Research Board Proceedings of 1946.

Also questionable in new developments

VOLUME OF RUNOFF

The analysis of the volume of storm water runoff is necessary in determining the capacity of storage required in the proposed retention and recharge basins. In considering proposed disposal systems, integrated with available supplemental pumping, a total volume design storm of a 100-year frequency 48-hour duration was chosen as adequate to satisfy a maximum runoff condition. Therefore, for storms of durations which exceed 48 hours, adequate pumping is available for disposal of runoff which exceeds the 100-year 48-hour design storm volume.

As an added factor of safety, no allowance was made for the volume of recharge which is accomplished during the storm duration. With a recharge rate of 0.5 to 2.0 feet per day on a 10 acre site, the volume of storm water recharge during the design storm would be from 10 to 40 acre feet in 48 hours.

Recharge never implemented

CALCULATION OF PEAK RATE OF RUNOFF

A requisite to the sound design of any drainage system is a simple and practical method to determine the peak discharge of flow expected to enter and flow in the storm drain system. One of the well-known contributions by sewerage engineers is the Rational Formula, which was developed primarily for estimating rates of runoff for urban areas. The Rational Formula is expressed as:

$$Q = CiA$$

Where Q = Rate of runoff in cubic feet per second, cfs Still used

C = Coefficient of runoff,

i = Rainfall intensity in inches per hour,

A = The drainage area in acres.

It is assumed that the maximum rate of flow, due to a certain rainfall intensity over the drainage area, is produced by that rainfall which is maintained for a period equal to the time of concentration of flow at the point under consideration. The critical duration of rainfall is therefore equal to the time of concentration.

FORMULA FOR GRAVITY FLOW IN CLOSED CONDUITS

One of the most widely used formulas for determining the capacity of a channel or conduit is the Chezy-Manning equation:

$$Q = \frac{0.463}{n} D^{8/3} S^{1/2}$$

Where Q is the flow in the conduit expressed in cubic feet per second, D is the conduit diameter expressed in feet, S is the slope of the channel and "n" is a dimensionless empirical constant equal to the roughness coefficient of the channel or conduit.

For reinforced concrete pipes of diameter less than 48 inches, a Manning roughness coefficient, "n", equal to 0.013 was selected. For larger reinforced concrete pipes, a value of 0.011 was used. In the case of cast-in-place concrete pipes, 30 inches or smaller and larger than 30 inches, roughness coefficients of 0.015 and 0.013 were used respectively.

SAMPLE CALCULATIONS:

(1) Physical Characteristics of Drainage Area:

Drainage Area: 10 acres

Runoff Coefficient: 0.35 (Residential area)

Street Slope: 0.20%

Length of Gutter Flow: 1000 feet

Velocity of Flow: 1.3 feet per second (H.R.B. Proceeding, 1946, pg. 150)

Roof-to-Gutter Time: 25 minutes

(2) Calculation of Runoff:

$$\text{Time of Concentration} = 25 + \frac{1000}{1.3 \times 60} = 38 \text{ minutes}$$

Intensity at 38 minutes = 0.56 (Calculated from Figure 6-1)

$Q = CiA$

$0.35 \times 0.56 \times 10$

$= 1.96$ cubic feet per second

(3) Determination of Pipe Size:

$Q = 1.96$ cubic feet per second

Roughness Coefficient: $n = 0.013$ (For reinforced concrete pipes less than 48 inches in diameter)

Minimum Pipe Size = 12 inches diameter

Minimum Slope = 0.050 feet per 100 feet

$$Q = \frac{0.463}{n} D^{8/3} S^{1/2}$$

$$1.96 = \frac{0.463}{0.013} D^{8/3} S^{1/2}$$

$$\text{or: } D^{8/3} S^{1/2} = \frac{0.013 \quad 1.93}{0.463}$$

$$= 0.054$$

The following pipe diameters can satisfy the equation above:

D = 12",	S = 0.292 foot per 100 feet	v = 2.4 feet per second
D = 15",	S = 0.089 " " "	v = 1.5 " " "
D = 18",	S = 0.03 " " "	v = 1.1 " " "

The low velocity resulting in the 18 inch pipe is conducive to clogging. The hydraulic slope required for the 12 inch pipe exceeds the normal ground slope, thereby requiring increased pipe depths. For greater flow, therefore, the choice of the 15 inch pipe will most nearly satisfy the velocity and slope conditions.

Because of the debris often carried into a storm drain system, modern design practice usually specifies a minimum diameter of 8 to 15 inches. It is recommended that no pipe less than 12 inches be used for the Lodi area system.

(4) Total Volume of Runoff for Design Storm:

Drainage Area — 500 acres

Average Coefficient of Runoff — C 0.50

Equivalent Impervious Area CA = 0.50 X 500 = 250 acres

100-year 48-hour Design Storm — 4.8 inches = 0.4 feet

Total Runoff Volume — 250 X 0.4 = 100 acre feet

PIPE INSTALLATION

Recent installations of cast-in-place concrete pipe have effected substantial savings in cost over conventional precast reinforced concrete pipe construction. By allowing the use of cast-in-place concrete pipe, savings ranging from 20% to 60% have been experienced. The actual successful experience of cast-in-place concrete pipe installations under severe conditions has demonstrated the unusual load carrying capacity of this type of pipe.

It is recommended that cast-in-place concrete pipe be used in areas of future urban developments. Since these areas are practically free of underground utilities, the use of this type of pipe would be readily adaptable. The use of precast reinforced concrete pipe has been proposed for presently developed areas.

Adequate protection from structural damage due to vehicle live loads can be insured by using a minimum of 3 feet of cover as measured from the crown of pipe to the finished grade of the pavement.

DRAINAGE AREA DISCUSSION

The entire study area has been divided into eight subdrainage areas, namely: Drainage Areas A, B, C, D, E, F, G and H. The boundaries of these areas were influenced by the geographic and hydrologic characteristics of the area as well as the means of final disposal.

The proposed layout of pipelines as indicated in Figure 6-2 represents only the required major collector and interceptor facilities. The existing inlets and laterals in the developed areas will be served by the proposed interceptor pipelines. The locations and sizes of inlets and lateral lines for the future areas of development will be dependent upon future street grades and street patterns. Summaries of cost estimates for these major facilities are broken down in Table 6-3 through Table 6-12.

DRAINAGE AREA "A"

This area is generally bounded by the Woodbridge Irrigation Canal, the Southern Pacific Railroad, West Tokay Street, and Harney Lane. The storm drainage facilities proposed for this area consist of an interceptor trunk line originating at Sacramento Street and terminating, by way of Lane and Cardinal Avenues, in the proposed retention Basin A-1 located immediately north of the sewage treatment plant. The purpose of this pipeline is to intercept the existing 24 inch storm drains in Sacramento Street and Church and Lee Avenues as well as the 18 inch storm drains in Crescent and Fairmont Avenues. Capacities in the existing storm drains would then be made available for the drainage of the area south of Park and Cardinal Streets. Additional capacity would also be available in the existing 30 inch and 42 inch storm drains in Kettleman Lane, which then would provide drainage for the area of present and future subdivision developments south of Kettleman Lane. The drainage of this area is presently restricted by the lack of capacity in the 30 inch

MEMORANDUM, City of Lodi, Public Works Department

To: Wally Sandelin, City Engineer

From: Lyman Chang, Associate Civil Engineer

Date: February 6, 2002

Subject: Lodi West Storm Drainage Analysis

This report is to summarize the storm drainage analysis in the Lodi West Area at Ponderosa Court.

Background Information:

The area around Ponderosa Court at Lodi West Subdivision experiences relatively frequent storm drainage problems. The storm water backs up from the catch basins and extends up to the concrete driveways in front of residents' garage. The design of the storm drainage system for this subdivision is based on the current Design Standards. Since similar flooding problems have occurred in other new subdivisions in the City, review of the design criteria is also included in this study.

Setting up the storm drain model:

The area of study is shown on the Exhibit A. The STORMCAD software by Haestad Methods was used to model the storm drainage system in the area as shown on Exhibit B. This software uses similar calculating methods to the City's Design Standards in the storm drain calculations. All pipe sizes, inverts, top of manhole/catch basin elevations, and areas of storm drainage contribution were taken from the improvement plans and storm drainage master plans for this area.

Per City's Design Standards, a 2-year storm is used to calculate peak flow in the storm drainage system. In order to evaluate the performance of the storm drainage system under a 10-year storm event, a 10-year storm rainfall intensity curve was developed based on the 2-year storm model. The 10-year model was based on the ratio between the 2-year storm rainfall and the 10-year storm rainfall as shown on the Duration Frequency Curve for the City. The result rainfall intensity curve is shown on Exhibit C.

The runoff coefficient (C=0.4) is based on the City's Design Standards for low density development in the study area.

The design hydraulic grade line (HGL) at Peterson Park (E-Basin) is 33.50 which is one foot below the maximum water level at the basin.

Running the Scenario:

Different scenarios were set up to model different storm events. The scenarios are listed in the table on Exhibit D. Since the area of interest is at Ponderosa Court (I-17), only the results of the selected manholes/catch basins are shown in the table. Please note that Junction I-23 at Douglas Fir Drive and I-24 at Knobcone Lane are also shown for comparison purposes.

During a 2-year storm event when the basin is empty (Scenario A), The HGL at Ponderosa Court (I-17) is well below the top of curb. If the basin is at the design HGL when the second storm comes (Scenario B), the HGL at Ponderosa Court is about 0.9 feet below the top of curb which meets our current Design Standards. Design Standards allow the HGL to be a minimum of one foot below the top of curb.

During a 10–year storm event with the basin empty (Scenario C), the HGL at Ponderosa Court is about 0.45 feet above the top of curb (flooding condition). If the basin happens to be at the design HGL level (back-to-back storm event), then the HGL at this catch basin would rise to 1.14 feet above the top of curb, hence a major flooding would occur (Scenario D). As for comparison, the catch basins at Douglar Fir Drive (I-23) and Knobcone Lane (I-24) would experience no flooding when the basin is empty and only minor flooding when the basin is at the design HGL level. **Being the lowest point in the surrounding area, I-17 would be most likely to be flooded during any intense storm event** as the scenarios have indicated.

Similar flooding problems have occurred in the newer subdivisions that were designed to the current Design Standards. This could be caused by unusually heavy rainfall and also by the new development practices in the City.

In the newer subdivisions, the roofing material has changed from wood shingles to concrete tile. Backyards of the home are plumbed with yard drains that directly discharge into the street at the back of the sidewalk. The floor plans of the newer homes also have increased while the lots sizes are smaller than the older subdivisions. This type of development would decrease the time of concentration and increase the runoff from the lots. By increasing the runoff coefficient from 0.4 to 0.5 and decreasing the time of concentration from 25 minutes to 20 minutes, the results in Scenario K shown that I-17 at Ponderosa Court would experience minor street flooding during a 2-year storm event when the basin is at the design HGL level (Scenario K). The impact of the increase runoff and the decrease time of concentration would definitely affect the storm drainage performance in the newer subdivision developments.

Recommendations:

1. The current Design Standards using a 2-year storm to design the storm drainage collection system provide reasonable protection against flooding in the City during most storm events. If the residents would like a higher protection level, a 5-year storm may be used. The cost of the storm drainage system will increase because of the larger pipe size.

2. As shown on the analysis results, the change in time of concentration does not affect the HGL greatly, although I suspect the time of concentration in the newer subdivisions would be less than the current Design Standards (25 minutes).

3. As shown in the analysis, a slight increase in the runoff coefficient would greatly increase the HGL at the upstream end of the storm drainage system. The runoff coefficient (C factor) is related to the type of soil, vegetation cover, and

percentage of the impervious surface in the area. In the 1963 Storm Drain Master Plan which the current storm drain design standards are based on, the C factor for the residential areas was based on 35% impervious area and 65% lawn and garden. The newer subdivisions today can have the average of 60% impervious area and 40% lawn and garden (Exhibit E). This would require a change in the runoff coefficient in designing the storm drainage system. I recommend the runoff coefficient for future R-2 developments to be a minimum of 0.5 instead of 0.4 as shown in the current Design Standards.

4. Based on the past performance of the collection system throughout the City, the current catch basin design should be adequate to handle the design runoff for a 2-year storm event. There may be some minor backup during a 10-year storm event, but a properly designed system should prevent major street flooding. In the newer subdivisions, however, the increase runoff and the decrease in time of concentration may require the catch basins to be spaced closer together to handle the extra storm water in a shorter period of time.

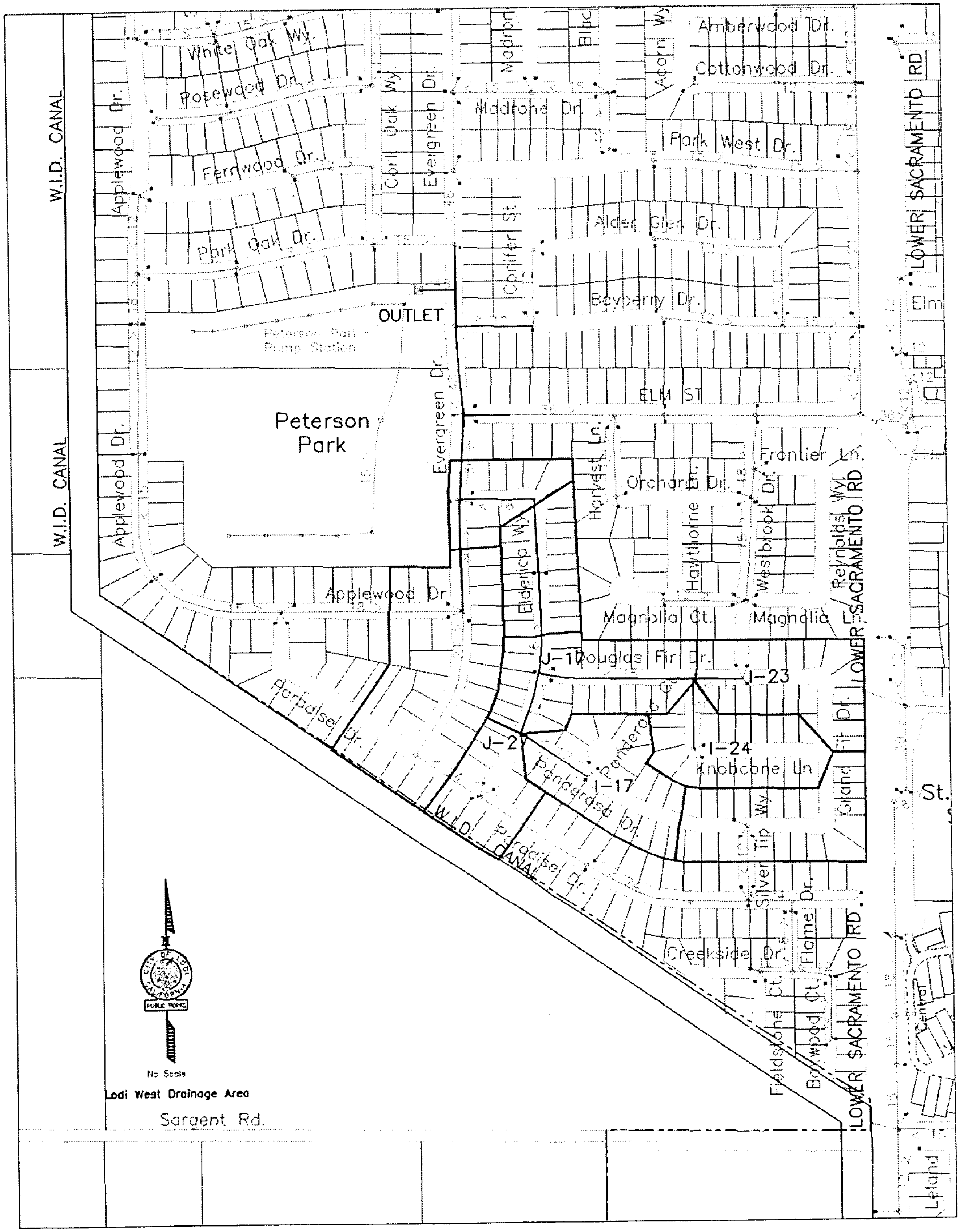
I hope this report would answer the questions you have for this area. Please call me at x2665 if you would like further discussions.

Lyman Chang
Associate Civil Engineer

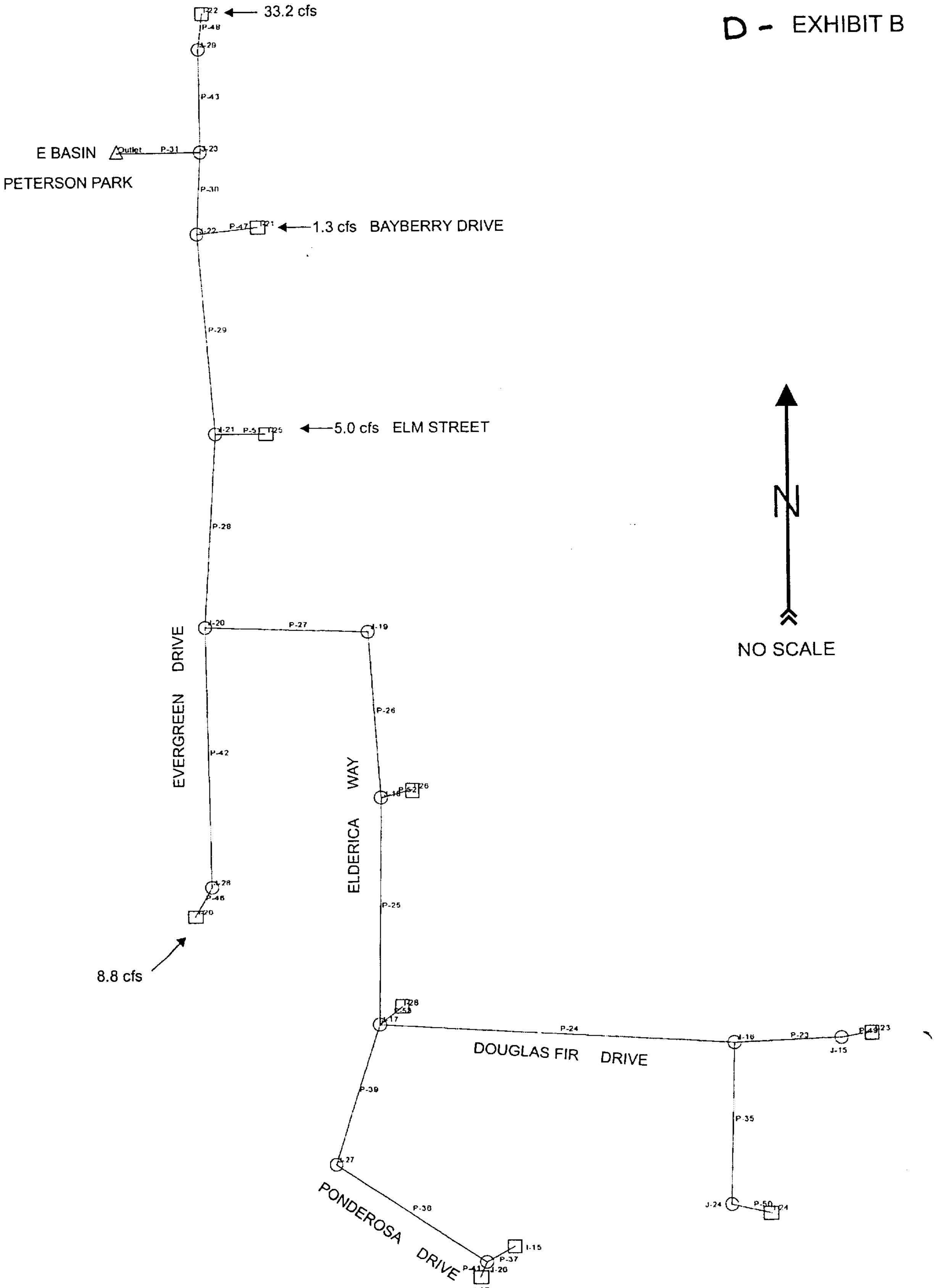
Attachments

Cc: Public Works Director

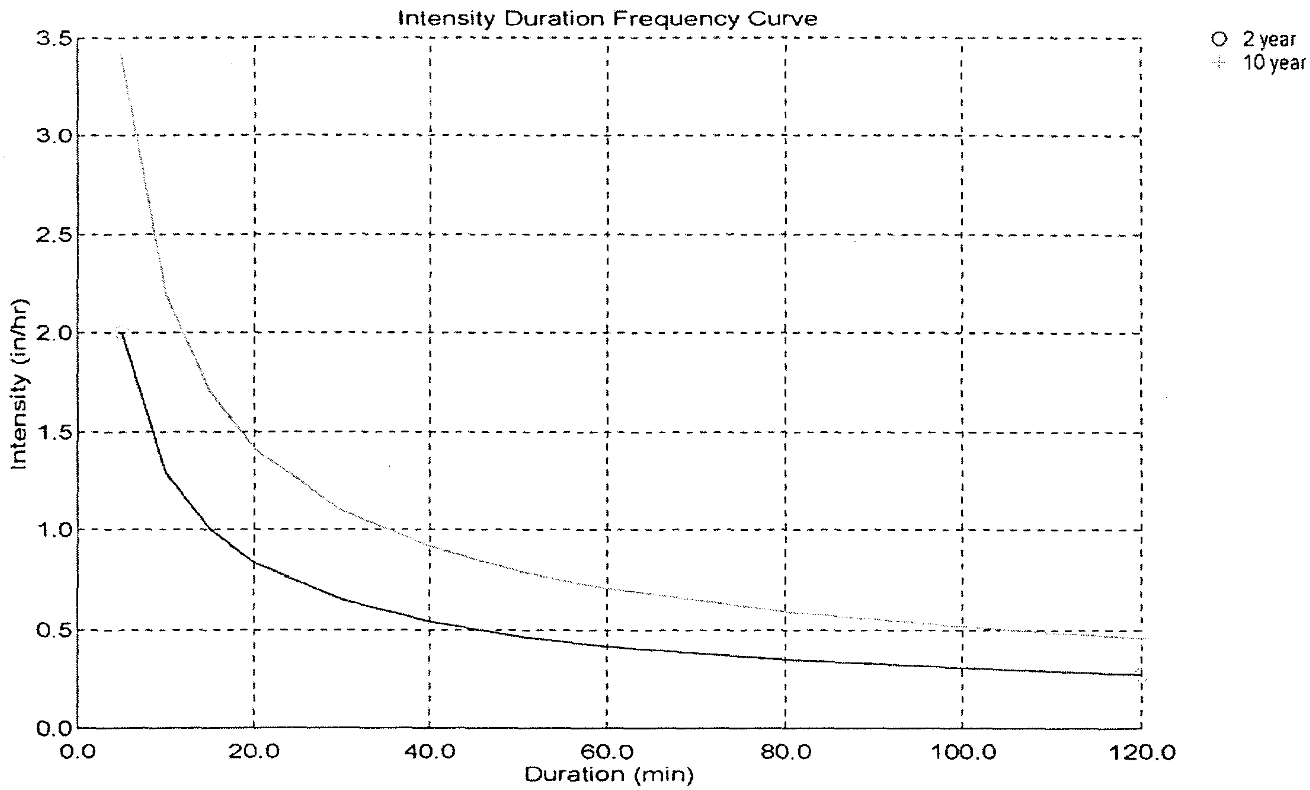
D - EXHIBIT A


W.I.D. CANAL
W.I.D. CANAL
White Oak Wy.
Rosewood Dr.
Fernwood Dr.
Park Oak Dr.
Applewood Dr.
Applewood Dr.
Applewood Dr.
Madrone Dr.
Amberwood Dr.
Cottonwood Dr.
Park West Dr.
Alder Glen Dr.
Bayberry Dr.
Conifer St.
Evergreen Dr.
Evergreen Dr.
Evergreen Dr.
OUTLET
Peterson Park Pump Station
Peterson Park
ELM ST
Elm
LOWER SACRAMENTO RD
LOWER SACRAMENTO RD
LOWER SACRAMENTO RD
LOWER SACRAMENTO RD
Frontier Ln.
Orchard Dr.
Harvest Ln.
Hawthorne
Westbrook Dr.
Reynolds Wy.
Eldenica Wy.
Magnolia Ct.
Magnolia Ln.
J-10
Douglas Fir Dr.
I-23
J-2
I-24
Knobcone Ln
I-17
Ponderosa
Paradise Dr.
Grand Fir Dr.
Silver Tip Wy.
W.I.D. CANAL
Flame Dr.
Creekside Dr.
Fieldstone Ct.
Boxwood Ct.
St.
Central
Leland
No Scale
Lodi West Drainage Area
Sargent Rd.

D - EXHIBIT B


33.2 cfs
E BASIN
PETERSON PARK
Outlet
P-31
P-43
P-30
P-29
P-28
P-27
P-26
P-42
P-25
P-24
P-23
P-35
P-39
P-38
1.3 cfs BAYBERRY DRIVE
5.0 cfs ELM STREET
N
NO SCALE
EVERGREEN DRIVE
ELDERICA WAY
8.8 cfs
DOUGLAS FIR DRIVE
PONDEROSA DRIVE
J-15
J-24
I-15
I-17

D- EXHIBIT C



Intensity Duration Frequency Curve
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Intensity (in/hr)
0.0
20.0
40.0
60.0
80.0
100.0
120.0
Duration (min)
2 year
10 year

City of Lodi **D - EXHIBIT D**
Public Works Department
Lodi West Drainage Study - Ponderosa Drive/Court 01/31/2002

Hydraulic Grade Line Elevation Table

	Junction					
	J-17	**J-27**	**I-17**	**I-17**	**I-23**	**I-24**
TOC Grade	37.36	37.94	36.60		37.36	37.20
Scenario				above/below TOC		
A	33.87	34.05	34.30	-2.30		
B	35.27	35.45	35.70	-0.90	35.73	35.65
C	35.85	36.41	**36.91**	0.31	36.56	36.37
D	37.21	37.78	**38.50**	1.90	**37.92**	**37.74**
E	35.85	36.02	**36.75**	0.15		
F	37.21	37.38	**38.11**	1.51		
G	35.85	36.02	36.24	-0.36		
H	37.21	37.38	**37.60**	1.00		
I	33.87	34.21	34.68	-1.92		
J	35.27	35.61	36.08	-0.52		
K	35.80	36.14	**36.59**	-0.01		

Bold face number indicate flooding condition.

Scenario Description

A - 2 year storm; basin is empty
B - 2 year storm; basin is at Design HGL (33.50) per Design Standards
C - 10 year storm; basin is empty
D - 10 year storm; basin is at Design HGL
E - Same as C; with 15" pipe (P-39)
F - Same as D; with 15" pipe (P-39)
G - Same as C; with 15" pipes (P-38 & P-39)
H - Same as D; with 15" pipes (P-38 & P-39)
I - Same as A; Time of concentration reduced to 15 min instead of 25 min
J - Same as B; Time of concentration reduces to 15 min
K - Same as B; Time of concentration is 20 min and runoff coeff is 0.5

City of Lodi
Public works Department
Storm Drainage Study - Runoff Coefficient

D - **Exhibit E**

01/16/2003

New Subdivision	**Number of Lots Studied**	**Average Lot Size**	**Average Imper. Area**	**% Imper. Area**	**Landuse**
Lodi West (1)	6	5,925	3,772	64%	R-2
Lodi West (2)	6	8,190	5,057	62%	R-1/R-2
Century Meadows	5	5,650	3,129	55%	R-2
Richards Ranch	5	5,000	2,948	59%	R-2
			Average	***60%***	
Older Area					
Lockeford & Cross	5	6,659	3,319	50%	R-2
Shady Acre	5	9,037	5,501	61%	R-1

Impervious area is made up of roof area, driveways, walkways, and paved patio.
Swimming pool is not included in the study.

EXHIBIT E

Storm Drain Frequent Problem Areas

Location	Type of Problem
Central Avenue - Tokay to Kettleman	Small Lines, Tree Roots, Drop Inlet Catch Basins
Church Street - Chestnut to Tamarack	Large Quantities of leaves plug up SICB repeatedly
Corbin Lane & Virginia	N/W line half full of concrete, needs replacement
Daisy - Bel Air to California	Drop Inlet Catch Basin, gathers debris during storm
Edgewood Drive	Drop Inlet Catch Basin, gathers debris during storm
Elm Street - Hutchins to Church	Tree Roots in old lines
Grant & Eureka	Small Lines, Tree Roots, Drop Inlet Catch Basins
Greenwood & Edgewood	One corner has a line problem, will be video inspected
Ham & Louie	Large Quantities of Debris plug up SICB repeatedly
Holly & Lake	Siphon drains, level dependant on flow in gutter
Holly & Mills	Drop Inlet Catch Basin, gathers debris during storm
Hutchins - Tokay to Tamarack	Large Quantities of leaves plug up SICB repeatedly
Hutchins & Oak	Tree Roots in old lines
Laurel Avenue, north of Turner (dead end)	Capacity problem, one line at North end drains the block
Lawrence Track all, lots of D.I.'s in that area	Drop Inlet Catch Basin, gathers debris during storm
Leland Court	Capacity problem, Lowest area of that part of the system
Lockeford , 400 block W.	Large Quantities of Leaves & Debris plug up SICB repeate
Lockeford Street - Main to 600 Block East Lockeford	Drop Inlet Catch Basin, gathers debris during storm
Lockeford, 1600-1700 blocks W.	Capacity problem
Lodi Avenue - east of Virginia to Corinth	Large Quantities of Leaves & Debris plug up SICB's repeat
Lowe & Village - Church to Sacramento	Drop Inlet Catch Basin, gathers debris during storm
Lower Sacramento by Food-4-Less	Drop Inlet Catch Basin, gathers debris during storm
Mills Avenue - Jerry to Ayers	Large Quantities of Leaves & Debris plug up SICB's repeat
Normandy - Charleston to Normandy Court	Siphon drains, level dependant on flow in gutter
Paradise & Applewood	Capacity problem, Lowest area of that part of the system
Park & Sacramento	Debis from Industrial area, Plugs up SICB's
Pine Street - Hutchins to Ham	Drop Inlet Catch Basin, gathers debris during storm
Pleasant & Lockeford	Large Quantities of Debris plug up SICB repeatedly
Pleasant & Oak	Drop Inlet Catch Basin, gathers debris during storm
Public Safety Parking Lot, driveways onto Elm Street	Grated Trough plugs up, very small lines (3"), Tree Roots
Rimby & Crescent	Drop Inlet Catch Basins by Nichol's School
School Street - De Force to Forrest	Large Quantities of Leaves & Debris plug up SICB repeate
Tokay & Fairmont	Large Quantities of leaves plug up SICB repeatedly
Tokay & Lee	Drop Inlet Catch Basin, gathers debris during storm
Turner Road - East of Ham Lane	Large Quantities of Debris plug up SICB repeatedly
Turner Road -Mills to Laurel	Large Quantities of Leaves & Debris plug up SICB's repeat
Turner Road Underpass	Drop Inlet Catch Basin, gathers debris during storm
Vine & Cherokee	Drop Inlet Catch Basin, gathers debris during storm
Vista 1518-1524, mid-block	Capacity problem, ties into Vine Street
Washington Street - Tokay to Vine	Drop Inlet Catch Basin, gathers debris during storm
Woodhaven & Inglewood	Drop Inlet Catch Basin, gathers debris during storm