CITY OF ANAHEIM

Master Plan of Storm Drainage for Anaheim Barber City Channel Tributary Area

JUNE 2009
MASTER PLAN OF STORM DRAINAGE FOR
ANAHEIM BARBER CITY CHANNEL
TRIBUTARY AREA

June 2009

Prepared for

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1. Executive Summary

1.1 General

The primary objective of this report is to evaluate the storm drainage system within the Anaheim Barber City Channel Tributary Area (ABCCTA) in the City of Anaheim in order to identify storm drainage system needs to reduce street flooding within the study area shown in Figure 1.

ABCCTA within the City of Anaheim consists of Drainage Areas 4, 12, 14 and 19 through 23. Runoff from Drainage Areas 4 and 12 is carried in storm drains across the City limit and discharge into the ABC Channel approximately 2,000 feet downstream within the City of Stanton. Runoff from Drainage Area 14 is carried southerly on Euclid Street and discharged into the ABC Channel near the southerly boundary of the City. Runoff from Drainage Areas 19 through 23 discharges into the ABC Channel via inlets and storm drain pipes within the city limits. Runoff in Drainage Area 14 travels from north to south through Euclid Street storm drain line which discharges into the ABCC approximately 1,800 feet south of the Katella Avenue.

This report discusses and identifies existing deficient drainage areas within the ABCCTA in the City of Anaheim that are subject to flooding, recommends drainage improvements to reduce or eliminate the deficiencies, and presents the probable cost for construction of these improvements.

1.2 Drainage Area 4

Drainage Area 4 as defined on the City Drainage District Maps includes a large portion of the unincorporated area of the County. Since this report is only concerned with areas within the limits of the City of Anaheim, the portion of Drainage Area 4 in the unincorporated County area is not included in the analysis. Therefore, Drainage Area 4 is divided into two separate areas.

The northerly portion drains approximately 230 acres and is generally bounded by Orange Avenue on the north, Nutwood Street on the east, Mojeska Park and Ball Road on the south and the westerly City limit on the west.

The southerly portion drains approximately 38 acres, and is generally bounded by the Union Pacific Railroad easement on the north, Brookhurst Street on the east, Katella Avenue on the south and the westerly City limit on the west.

Generally, water flows over land to streets and then through pipes from the northeast to the southwest, and ties into the Gilbert Street storm drain (C03 P08) at the City limits with the City of Garden Grove.

Runoff from the northerly portion of Drainage Area 4 is collected in a storm drain in Ball Road, which then turns south at South Gilbert Street and travels approximately 1.4 miles through unincorporated County and the City of Garden Grove before discharging into the ABC Channel.
Runoff from the southerly portion of Drainage Area 4 travels west in Katella Avenue, which then joins the flow in the S. Gilbert Street storm drain and drains to the ABC Channel.

The City of Anaheim Storm Drainage Manual for Public and Private Drainage Facilities defines the allowable flooded width on local streets and arterials. Hydraulic analysis indicates that the City’s flooded width criteria along portions of Ball Road, Brookhurst Street, Coventry Drive, Valley Street, and Agate Street are not satisfied. The proposed improvements in Area 4 consist of construction of new storm drains in these streets at an estimated construction cost of $3,807,000.

### 1.3 Drainage Area 12

Drainage Area 12 drains approximately 792 acres and is generally bounded by Ball Road and Orange Avenue on the north, Euclid Street on the east, Katella Avenue on the south, and Brookhurst Street on the west. Generally, water flows over land from the northeast to the southwest and then from north to south via the Brookhurst storm drain which discharges into the ABCC approximately 2,200 feet south of Katella Avenue, in the City of Garden Grove.

Hydraulic analysis indicates that the City’s flooded width criteria are not met in the following:

1. Katella Avenue  
2. W. Crone Ave  
3. S. Trident St.  
4. W. Chalet Ave  
5. S. Hacienda St.  
6. Dallas Dr.  
7. W. Harriet Lane

Improvements to the existing facilities are recommended to satisfy the City’s requirement of conveying the 10-year storm event and also the flooded width criteria. The improvements consist of parallel storm drains, relief drains, extensions of existing systems, and replacement of existing facilities. The estimated cost for constructing the improvements is $16,357,000.

### 1.4 Drainage Area 14

Drainage Area 14 drains approximately 633 acres, and is generally bounded by Broadway on the north, ABC Channel and the Union Pacific Railroad easement on the east, Southerly City limit on the south, and Euclid Street on the west. Generally, water flows over land and then through pipes from north to south through Euclid Street storm drain line which discharges into the ABCC approximately 1,800 feet south of the Katella Avenue.

The capacity of the existing facilities ranges from 20 percent to 100 percent of a 10-year storm, which means that at certain locations, the City’s flooded width criteria during a 10, 25 and 100-year storm event are not met. Improvements to the existing facilities are recommended to satisfy the City’s requirement of conveying the 10-year storm event and also the flooded width criteria. The improvements consist of parallel storm drains, relief drains, extensions of existing systems, and replacement of existing facilities. The estimated cost for constructing the improvements is $6,732,000.

### 1.5 Drainage Area 19

Drainage Area 19 drains approximately 643 acres, and is generally bounded by East Street on the east, Ball Road and Vermont Avenue on the south, Walnut Street on the west, with
the northerly boundary of the Drainage Area meandering along Lincoln Avenue, Santa Ana Street and Broadway. Generally, water flows over land and then through pipes from east to west and ties into the South Street storm drain flowing westerly which joins Walnut Street storm drain and continues south to ABCC.

The capacity of the existing facilities ranges from 37 percent to 100 percent of a 10-year storm which means that at certain locations, the City’s flooded width criteria during a 10, 25 and 100-year storm event are not met. Improvements to the existing facilities are recommended to satisfy the City’s requirement of conveying the 10-year storm event, and also to satisfy the flooded width criteria. The improvements consist of parallel storm drains, relief drains, extensions of existing systems, and replacement of existing facilities. The estimated cost for constructing the improvements is $13,867,000. This includes approximately $1,702,000 in storm drain improvement costs within the I-5 Freeway right-of-way.

### 1.6 Drainage Area 20

Drainage Area 20 drains approximately 815 acres. A large portion of the Drainage Area is on the east side of the I-5 Freeway and is generally bounded by State College Road on the east, Ball Road on the south, and Vermont Avenue on the east and north. Flow from the east side of the I-5 is carried across the Freeway through two underground conduits along Ball Road. The flow is then augmented by the runoff from the portion of Drainage Area 20 west of the I-5. The portion of the Drainage Area west of the I-5 is generally bounded by the I-5 on the east, Disneyland Theme Park on the south, Union Pacific Railroad track on the west and Ball Road on the north. Generally, water flows over land and then through pipes from east to west and discharges directly into the ABC Channel.

The capacity of the existing facilities ranges from 17 percent to 100 percent of a 10-year storm which means that at certain locations, the City’s flooded width criteria during a 10, 25 and 100-year storm events are not met. Improvements to the existing facilities are recommended to satisfy the City’s requirement of conveying the 10-year storm event, and also to satisfy the flooded width criteria. The improvements consist of parallel storm drains, relief drains, extensions of existing systems, and replacement of existing facilities. The estimated cost for constructing the improvements is $30,952,000.

### 1.7 Drainage Area 21

Drainage Area 21 drains approximately 305 acres, and is generally bounded by Ball Road on the north, Harbor Blvd and Walnut Street on the east, Katella Avenue and Cerritos Avenue on the south and ABC Channel on the west. Generally, water flows over land and then through pipes from east to west and discharges directly into the ABC Channel.

The capacity of the existing facilities ranges from 30 percent to 100 percent of a 10-year storm which means that at certain locations, the City’s flooded width criteria during a 10, 25 and 100-year storm event are not met. Improvements to the existing facilities are recommended to satisfy the City’s requirement of conveying the 10-year storm event, and also to satisfy the flooded width criteria. The improvements consist of parallel storm drains, relief drains, extensions of existing systems, and replacement of existing facilities. The estimated cost for constructing the improvements is $2,677,000.
1.8 Drainage Area 22

Drainage Area 22 drains approximately 940 acres, and is generally bounded by Lewis Street and the Union Pacific Railroad easement on the east, Katella Avenue on the south, Ninth Street and Walnut Street on the west and Ball Road on the north. Generally, water flows over land and then through pipes from east to west and drains into the double 8’ x 8.5’ RCB storm drain in Katella Avenue.

The capacity of the existing facilities ranges from 16 percent to 100 percent of a 10-year storm which means that at certain locations, the City’s flooded width criteria during a 10, 25 and 100-year storm event are not met. Improvements to the existing facilities are recommended to satisfy the City’s requirement of conveying the 10-year storm event, and also to satisfy the flooded width criteria. The improvements consist of parallel storm drains, relief drains, extensions of existing systems, and replacement of existing facilities. The estimated costs for constructing the improvements is $13,381,000. This includes approximately $1,208,000 in storm drain improvements costs within the I-5 Freeway right-of-way.

1.9 Drainage Area 23

Drainage Area 23 drains approximately 266 acres, and is generally bounded by West Street on the east, South City limits on the south, west City limits on the west and Katella Avenue on the north. Generally, runoff from ¾ of the Drainage Area flows over land and then through pipes from east to west and discharges into the ABC Channel via Euclid Street storm drain. Runoff from Stoddard Park is collected at a sump inlet within the Park and is pumped directly into the ABC Channel, without impacting runoff on any of the City streets. Runoff from a small portion of the Drainage Area immediately west of Stoddard Park sheet flows to inlets at the intersection of Eileen Drive and Flippen Way drains directly into the ABC Channel. The rest of the Drainage Area located east of Jannette Lane surface drains southerly via Jacalene Lane into the City of Garden Grove.

The capacity of the existing facilities ranges from 66 percent to 100 percent of a 10-year storm which means that at certain locations, the City’s flooded width criteria during a 10, 25 and 100-year storm event are not met. Improvements to the existing facilities are recommended to satisfy the City’s requirement of conveying the 10-year storm event, and also to satisfy the flooded width criteria. The improvements consist of parallel storm drains, relief drains, extensions of existing systems, and replacement of existing facilities. The estimated cost for constructing the improvements is $3,529,000.
Figure 1 Study Area
Figure 2 Proposed Improvements
2. Introduction

2.1 Purpose

The purpose of the City of Anaheim Master Plan of Storm Drainage for the Anaheim-Barber City Channel Tributary Area (ABCCTA) is:

1. To identify deficiencies in the flow capacity of the streets based on the maximum allowable flooded width and depth specified in the City’s Storm Drainage Manual for Public and Private Drainage Facilities, dated August, 2005.

2. To provide comprehensive long-range planning for the implementation and development of drainage facility improvements in the area.

3. To determine the cost of implementing the facilities, and discuss funding of the improvements.

2.2 Background

In 1973, the City published a Master Plan of Drainage for the City of Anaheim that divided the City into 43 drainage areas. The Master Plan of Flood Control & Drainage Facilities in Orange County, last revised by OCFCD on February 10, 1999, identified ABC Channel as Facility C03.

Drainage Areas 14, and 19 through 22 drain into the ABC Channel within the City of Anaheim. Runoff from all but 35 acres of the easterly portion of Drainage Area 23 also discharges into the ABC Channel immediately downstream of the City limit. Runoff from Drainage Areas 4 and 12 crosses the City limits and continues southerly approximately 2,000 feet through the City of Garden Grove before discharging into the ABC Channel.
3. Technical Criteria

3.1 Hydrologic Analysis

The hydrologic analysis for the City of Anaheim Master Plan of Storm Drainage for the ABCCTA was performed in accordance with the City of Anaheim Department of Public Works Storm Drainage Manual, dated August of 2005. The methods, data, and criteria integrated and incorporated are consistent with accepted methods of analyzing storm water runoff throughout Orange County as outlined in the Orange County Hydrology Manual, except where superseded by the City’s Storm Drainage Manual.

GIS Facility Maps and AutoCAD drawings were obtained from the City, which contained streets, existing facilities, and drainage areas for the ABCCTA. The drainage patterns were revised after a review of project plans to reflect new development in the area. A field review was then conducted, and the drainage patterns were further refined. Land use data was obtained from the City of Anaheim’s May 2004 General Plan and soils information was obtained from the 1986 Orange County Hydrology Manual. Land use, soils information and subarea information was input into the Advanced Engineering Software Computer Program RATOC which is based on the 1986 Orange County Hydrology Manual.

3.2 Hydraulic Analysis

Street flooded width analyses were performed in accordance with the City of Anaheim Department of Public Works Storm Drainage Manual, dated August of 2005. Results of the street flow hydraulic analysis are summarized in spreadsheets in Appendices A and B. The street segments that do not meet the City’s flooded width criteria are identified on the spreadsheets in Appendices A and/or B.

The proposed storm drains were analyzed using Manning’s Equation for uniform steady state flow. The analysis assumed uniform flow in pipes. The input data consisted of the peak flow, the pipe slope, friction coefficient and diameter. Results of the analysis can be found in Appendices A and B.

The hydraulic analysis assumed that the streets would be free and clear of any major obstructions and that the storm drains would be adequately maintained so that blockage would not occur. Street capacity analyses assumed that all streets conformed to the City of Anaheim’s typical street sections. Street widths were determined from street plans and as-built drawings.

The results of hydraulic analysis in some cases indicate that in order to meet the City’s maximum flood width criteria, it would be necessary to construct new storm drain improvements that would impact more than two traffic lanes in the street. This would likely have a very significant impact on traffic and utility service. Therefore, it may be more practical to mitigate street flooding with the combined use of storm drain improvements and development of retarding basins on properties adjacent to the street such as parks and school athletic fields. The development of retarding basins must be studied and analyzed at the project level and may require but not limited to the following actions:
• the acquisition of property  
• re-grading of the terrain to effectively collect surface run-off  
• the possible relocation of private property as well as commercial businesses from whom land has been purchased  
• pest abatement or treatment of stagnant water  
• the installation of pumps, pipes, valves and fences

3.3 Flow at City Boundary

The ABCCTA is bordered on the south by Garden Grove. This study evaluates the capacity of each proposed storm drain facility up to the City limit. The approach for the proposed hydraulics at the boundary of the City limit is to recognize the adjacent agency’s downstream parameters. The latest Master Plan of Drainage for the City of Garden Grove was published in September of 1991. According to this master plan, the existing downstream facilities at the City limits are adequate per that agency’s criteria. In this study, when existing downstream facilities are determined to be unable to convey the flow from the City of Anaheim’s master plan storm drain at the City limits, excess flow at the City boundary is proposed to be resurfaced onto the street through equalizers. However, this report recommends that the City consider storing the flow in underground systems as a means of peak flow mitigation, whenever possible.
4. Drainage Area 4

Drainage Area 4 as defined on the City Drainage District Maps includes a large portion of the unincorporated area of the County. Since this report is only concerned with areas within the limits of the City of Anaheim, that portion of Drainage Area 4 found within the unincorporated County area is not included in the analysis. Therefore, Drainage Area 4 is divided into two separate areas.

The northerly portion drains approximately 230 acres and is generally bounded by Orange Avenue on the north, Nutwood Street on the east, Mojeska Park and Ball Road on the south and the westerly City limit on the west.

The southerly portion drains approximately 38 acres, and is generally bounded by the Union Pacific Railroad easement on the north, Brookhurst Street on the east, Katella Avenue on the south and the westerly City limit on the west.

Generally, water flows over land to streets from the northeast to the southwest. Over 90% of the northerly portion of Drainage Area 4 drains directly to the Ball Road storm drain (Facility No. B01-P03). Runoff from the rest of the northerly portion also drains westerly on the surface of Colchester Drive and Vancouver Drive and crosses the City limit onto unincorporated County land. This runoff then flows southerly and is picked up in the Ball Road storm drain (B01-P03). This line joins Facility C03-P08 at South Gilbert Street, which runs south and continues through unincorporated County area and the City of Garden Grove, and discharges into the ABC Channel approximately 2,000 feet downstream of Katella Ave.

Runoff from over 80% of the southerly portion drains south onto Katella Avenue via a parkway culvert and the end of the Gardenaire Lane cul-de-sac and crosses the City limit onto unincorporated County land. Runoff from the rest of the southerly portion also drains westerly on the surface of Crestwood Lane and crosses the City limit onto unincorporated County land. This runoff then flows southerly onto Katella Ave outside the City boundary.

4.1 Hydrologic Analysis

The hydrologic analysis for Drainage Area 4 was performed in accordance with the hydrologic criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 4 can be found in Appendix D. The following table highlights the flow rates at the key drainage nodes for the Area. Table 1 shows associated drainage areas and flows for 10-, 25-, and 100-year storm events.
### Table 1 – Drainage Area 4 Summary of Hydrology

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<th>25-Year Flow (cfs)</th>
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<td>Vancouver Dr at City Limit</td>
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<td>23</td>
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<td>453</td>
<td>Crestwood Lane at City Limit</td>
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<td>12</td>
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<td>20</td>
</tr>
<tr>
<td>459</td>
<td>Ball Road at City Limit</td>
<td>31</td>
<td>44</td>
<td>55</td>
<td>73</td>
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### 4.2 Analysis of Existing Improvements

Runoff in Drainage Area 4 is conveyed via street curb and gutters and underground storm drains. As shown in Table 1, runoff concentrates at five points along the City limit. The following is a description of each concentration point:

1. Ball Road is an east-west primary arterial that crosses the City limit between Brookhurst Street and S. Gilbert Street. The tributary area to this street consists mostly of single family residential areas and some commercial developments. An existing storm drain in the street varying in diameter from 48” to 72” collects the runoff and carries it westerly towards S. Gilbert Street. Hydraulic analysis indicates the street does not meet the maximum flooded width criteria for the 10-, 25- and the 100-year storms between Coventry Drive and the City limit. In addition to Ball Road, this study found that portions of Agate Street, Chateau Avenue, Valley Street, Coventry Drive and Brookhurst Street, tributary areas to Ball Road, also do not meet the City’s maximum flooded width criteria.

2. Colchester Drive is an east-west residential street located north of Vancouver Drive. The tributary area to this street is made up of single family residential areas. This street complies with the City’s maximum flooded width criteria.

3. Vancouver Drive is an east-west residential street located north of Ball Road. The tributary area to this street is made up of single family residential area. This street complies with the City’s maximum flooded width criteria.

4. Crestwood Lane is an east-west residential street located immediately south of the railroad easement. Hydraulic analysis of the street flow indicates this street complies with the City’s maximum flooded width criteria.

5. Katella Avenue is an east-west primary arterial. Hydraulic analysis indicates the street meets the City’s flooded width criteria between Brookhurst Street and the City limit.

The existing street flow hydraulic calculations for Drainage Area 4 can be found in Appendices A and B.
4.3 Proposed Improvements

As discussed under Section 4.2, runoff from Drainage Area 4 concentrates at five (5) different points along the City limit. Of these five locations only Ball Road fails to meet the City’s maximum flooded width criteria. The specific recommendations for the area are discussed in more detail below.

In addition to the hydraulic deficiency in Ball Road, this study found that portions of other streets within the tributary area to Ball Road do not meet the City’s maximum flooded width criteria.

This report recommends construction of new storm drain improvements to convey the full flow of the 10 year storm along the following streets:

1. Install 800 Ft of 30” RCP in Agate Street from Niobe Ave to Chateau Ave
2. Install 1170 Ft of 30” RCP in Chateau Avenue from Agate Street to Valley Street
3. Install 1060 Ft of 48” RCP in Valley Street from Niobe Ave to the upstream end of the existing storm drain at the intersection of Coventry Drive and Minerva Avenue.

Furthermore, as shown in Appendix B, in order to meet the flood width criteria, it will be necessary to improve the existing storm drain capacity in Coventry Drive, Brookhurst Street and Ball Road. The alternatives for increasing the storm drain capacity in these street segments are presented below.

Drainage Area 4 Alternative Improvements:

**Alternative 1 (Recommended)** - This alternative calls for replacing the existing 54” RCP in Coventry Drive between Minerva Avenue and Ball Road and in Minerva Ave between Coventry Dr and Valley St with a new 8’ x 4.5’ RCB. The reason for using a box conduit is the limitation on the depth of cover. A pipe with an equivalent conveyance would have a diameter of 78” and would not have the 30” minimum required depth of cover.

This study also considered alternatives to installation of a new conduit in this street by constructing a retarding basin within the drainage area. The only site within the drainage basin is the 4.5 acre athletic field at Barton Clara Elementary School located at the intersection of Chateau Ave and Agate St. However, a retarding basin on this lot may be too far upstream of the drainage area outlet to have a significant impact on the peak flow.

It also calls for replacing 650’ of the existing 42” RCP along Brookhurst Street north of Ball Road with a new 48” RCP. Finally, in order to comply with the flood width criteria, this Alternative calls for replacing the existing 60” to 69” RCP in Ball Road between Coventry Drive and Brookhurst Street with a 78” RCP and the existing 72” RCP between Brookhurst Street and the City limit with a 90” RCP. At the City limit the 90” RCP transitions back to an existing 72” RCP and creates a condition where excess flows are to be expected. To handle excess pipe flows at the City limits, it is necessary to install an equalizer structure to allow the flows that exceed the capacity of the 72” RCP, to flow back out to the street surface.
Alternative 2 - This alternative uses the flow capacity of the existing storm drain improvements and augments them with new parallel storm drains. Therefore, this Alternative calls for constructing a 60” RCP parallel to the existing 54” RCP in Coventry Drive between Minerva Avenue and Ball Road; a 24” RCP parallel to the existing 42” RCP along Brookhurst Street north of Ball Road; and a 60” RCP parallel to the existing 60” to 69” RCP in Ball Road between Coventry Drive and Brookhurst Street.

In order to determine the full cost of Alternative 2, it will be necessary to perform detailed analysis of its impact on the existing utilities. Since that level of analysis is beyond the scope of this report, it is recommended to use Alternative 1 for budgeting purposes. However, during final design, it is recommended to analyze the feasibility of constructing the parallel storm drains in Alternative 2.

4.4 Cost Estimates

The estimated cost summarized in Table 2 include construction, engineering, design, surveying, and construction management. Pipe costs are per linear foot of pipe and have been increased to include excavation, shoring, bedding, backfill, compaction, removal of excess material, and trench resurfacing. The detailed cost estimates for Drainage Area 4 can be found in Appendix E.

Since the construction of the recommended facilities will be spread out over a number of years, the total cost of master plan implementation will be subject to future construction cost increases. Therefore, it is recommended that the funding programs established for implementation of the Master Plan of Storm Drainage make provisions for the increased cost of deferred construction. Inflation factors should be applied to reflect a specific year’s total cost over the 2008 total costs. Summarized in Table 2 are the construction cost estimates by project location for Drainage Area 4.
Table 2 – Drainage Area 4 Cost Estimate (2008 Dollars)

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<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Chateau Ave (from Valley to Agate St)</td>
<td>New</td>
<td>30” RCP</td>
<td>$634,000</td>
</tr>
<tr>
<td>4</td>
<td>Agate St (from Chateau to Niobe Ave)</td>
<td>New</td>
<td>30” RCP</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Valley St (from Niobe to Minerva)</td>
<td>New</td>
<td>48” RCP</td>
<td>$475,000</td>
</tr>
<tr>
<td>4</td>
<td>Coventry Dr/Minerva Av (from Ball Rd to Valley St)</td>
<td>Replacement per Alternative 1</td>
<td>8’x4.5’ RCB</td>
<td>$677,000</td>
</tr>
<tr>
<td>4</td>
<td>Brookhurst St (from Ball to Brookmore)</td>
<td>Replacement per Alternative 1</td>
<td>48” RCP</td>
<td>$426,000</td>
</tr>
<tr>
<td>4</td>
<td>Ball Rd (from Brookhurst to Coventry)</td>
<td>Replacement per Alternative 1</td>
<td>78” RCP</td>
<td>$1,595,000</td>
</tr>
<tr>
<td></td>
<td>(from Perdido to Brookhurst)</td>
<td>Replacement per Alternative 1</td>
<td>90” RCP</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>$3,807,000</td>
</tr>
</tbody>
</table>
5. Drainage Area 12

Drainage Area 12 drains approximately 792 acres and is generally bounded by Ball Road and Orange Avenue on the north, Euclid Street on the east, Katella Avenue on the south, and Brookhurst Street on the west. Generally, water flows over land and in storm drains and is collected in the Brookhurst-Cerritos-Nutwood storm drain (C03-P09). This storm drain crosses the City limit into the City of Garden Grove at Katella Avenue. The storm drain line then continues south and discharges into the ABCC approximately 2,200 feet south of Katella Avenue.

5.1 Hydrologic Analysis

The hydrologic analysis was performed for Drainage Area 12 in accordance with the criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 12 can be found in Appendix D. The following table shows the flow rates at the outlet of the Drainage Area for 10-, 25-, and 100-year storm events.

<table>
<thead>
<tr>
<th>Node</th>
<th>Location</th>
<th>Drainage Area (ac)</th>
<th>10-Year Flow (cfs)</th>
<th>25-Year Flow (cfs)</th>
<th>100-Year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1275</td>
<td>Brookhurst Street at City Limit</td>
<td>792</td>
<td>708</td>
<td>900</td>
<td>1211</td>
</tr>
</tbody>
</table>

5.2 Analysis of Existing Improvements

Presently the main storm drain in Drainage Area 12 begins in Nutwood Street approximately 1,400 feet north of Ball Road and continues south to Cerritos Avenue, where it turns westerly and continues to Brookhurst Street.

Hydraulic analysis indicates with the exception of small segments of W. Crone Ave and S. Trident Street, the roadways in Drainage Area 12 north of Ball Road meet the flooded width criteria. However, Katella Avenue from Brookhurst Street to Humor Drive (about 4,300 feet east) along with several local streets south of Ball Road do not meet the maximum flooded width requirement. This segment of Katella Avenue does not currently have any significant storm drainage facilities.

The existing street flow hydraulic calculations for Drainage Area 12 can be found in Appendices A and B.
5.3 Proposed Improvements

As mentioned under Section 5.2, several streets in Drainage Area 12 do not meet the City’s allowable flood width requirement. This report recommends construction of new storm drain improvements to convey the full flow of the 10 year storm along the following streets:

- Install 175 Ft of 36” RCP in S. Trident Street from Crone Ave to Niobe Ave.
- Install 775 Ft of 42” RCP in W. Crone Ave. from Broadview Street to S. Trident Street
- Install 310 Ft of 36” RCP in S. Trident Street from Ball Road to W. Juno Ave.
- Install 925 Ft of 39” RCP in W. Chalet Ave from Nutwood St to S. Hacienda St.
- Install 1075 Ft of 39” RCP in S. Hacienda St. from Chanticleer Road to Cerritos Ave.
- Install 1050 Ft of 51” RCP in Dallas Drive from Woodworth Road to Cerritos Ave.
- Install 475 Ft of 45” RCP in W. Harriet Lane from Pembroke Lane to Scarborough Lane
- Install 525 Ft of 39” RCP in Pacific Ave. from Lamar St. to 550 ft. East
- Install 550 Ft of 42” RCP in Lamar St. from W. Harle Ave to Pacific Ave.
- Install 235 Ft of 42” RCP in W. Harle Ave. from Brookhurst St. to Lamar St.
- Install 1700 Ft of 60” RCP in Katella Ave. from Brookhurst St. to Dallas Drive
- Install 2550 Ft of 54” RCP in Katella Ave. from Dallas Drive to Humor Drive

There is currently a storm drain system at the downstream end of each of the street segments listed above. This report recommends construction of new storm drains within these street segments that would tie into the existing systems downstream.

The following street segments that do not meet the maximum flooded width requirement currently have underground storm drain systems but do not have sufficient flow capacity. As shown in Appendix B, it will be necessary to improve the storm drain capacity on Brookhurst, Nutwood, and a short length on Katella. Alternatives 1 and 2 below provide the approximate sizes of conduits to replace or augment the existing storm drain capacity, respectively.

Drainage Area 12 Alternative Improvements:

Alternative 1 (Recommended)- This Alternative calls for replacing the existing 60” RCP in Cerritos with a 10’ x 6’ RCB east of Dallas Dr. and a 12’ x 9’ RCB west of Dallas Dr.; replacing the existing 39” RCP and 48” RCP in Nutwood with a new 54” RCP and a 10’ x 5’ RCB respectively; and replacing 160’ of existing 33” RCP in Katella with a new 60” RCP. It also calls for replacing the existing 63” RCP in Brookhurst with a 10’ x 8’ DRCB all the way to the City limit.

At the City limit the 10’ x 8’ DRCB transitions back to an existing 66” RCP and creates a condition where excess flows are to be expected. To handle excess pipe flows at the City limits, it is necessary to install an equalizer structure to allow the flows that exceed the capacity of the 66” RCP, to flow back out to the street surface.
**Alternative 2**- This Alternative calls for constructing a 9’ x 8’ RCB parallel to the existing 63” RCP in Brookhurst; constructing parallel to the existing 60” RCP an 84” RCP east of Dallas Dr. and a 126” RCP west of Dallas Dr. in Cerritos; constructing a 42” RCP parallel to the existing 39” RCP and constructing a 72” RCP parallel to the existing 48” RCP in Nutwood; and constructing a 57” RCP parallel to the existing 33” RCP in Katella.

In order to determine the full cost of Alternative 2, it will be necessary to perform detailed analysis of its impact on the existing utilities. Since that level of analysis is beyond the scope of this report, it is recommended to use Alternative 1 for budgeting purposes. However, during final design, it is recommended to analyze the feasibility of constructing the parallel storm drains in Alternative 2.

In order to minimize the size of the proposed storm drain improvements in Brookhurst St., this report also recommends the City consider constructing a retarding basin within Modjeska Park located at the northwest corner of Woodworth Road and Nutwood St.

### 5.4 Cost Estimates

Summarized in Table 4 are the construction cost estimates by project location for Drainage Area 12. The cost estimates were prepared as discussed in Section 4.4. The detailed cost estimates for Drainage Area 12 can be found in Appendix E.
### Table 4 – Drainage Area 12 Cost Estimate (2008 Dollars)

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>S. Trident St (from Crone to Niobe)</td>
<td>New</td>
<td>36&quot; RCP</td>
<td>$123,000</td>
</tr>
<tr>
<td>12</td>
<td>Crone Ave (from Broadview to Trident)</td>
<td>New</td>
<td>42&quot; RCP</td>
<td>$332,000</td>
</tr>
<tr>
<td>12</td>
<td>S. Trident St (from Ball to Juno)</td>
<td>New</td>
<td>36&quot; RCP</td>
<td>$168,000</td>
</tr>
<tr>
<td>12</td>
<td>W. Chalet Ave (from Nutwood to Hacienda)</td>
<td>New</td>
<td>39&quot; RCP</td>
<td>$371,000</td>
</tr>
<tr>
<td>12</td>
<td>Hacienda St (from Chanticleer to Cerritos)</td>
<td>New</td>
<td>39&quot; RCP</td>
<td>$429,000</td>
</tr>
<tr>
<td>12</td>
<td>Dallas Dr (from Woodworth to Cerritos)</td>
<td>New</td>
<td>51&quot; RCP</td>
<td>$489,000</td>
</tr>
<tr>
<td>12</td>
<td>Harriet Ln (from Pembroke to Scarborough)</td>
<td>New</td>
<td>45&quot; RCP</td>
<td>$229,000</td>
</tr>
<tr>
<td>12</td>
<td>Pacific Ave (from Lamar to 550’ East)</td>
<td>New</td>
<td>39&quot; RCP</td>
<td>$246,000</td>
</tr>
<tr>
<td>12</td>
<td>Lamar St (from Harle to Pacific)</td>
<td>New</td>
<td>42&quot; RCP</td>
<td>$259,000</td>
</tr>
<tr>
<td>12</td>
<td>Harle Ave (from Brookhurst to Lamar)</td>
<td>New</td>
<td>42&quot; RCP</td>
<td>$144,000</td>
</tr>
<tr>
<td>12</td>
<td>Katella Ave (from Brookhurst to Dallas)</td>
<td>New/Replacement per Alternative 1</td>
<td>60&quot; RCP</td>
<td>$1,896,000</td>
</tr>
<tr>
<td>12</td>
<td>Nutwood St (from Chateau Ave to Ball Rd)</td>
<td>Replacement per Alternative 1</td>
<td>54&quot; RCP</td>
<td>$3,116,000</td>
</tr>
<tr>
<td>12</td>
<td>Cerritos Ave (from Ball Rd to Cerritos Ave)</td>
<td>Replacement per Alternative 1</td>
<td>10’x5’ RCB</td>
<td>$3,516,000</td>
</tr>
<tr>
<td>12</td>
<td>Brookhurst St (from Cerritos to Katella)</td>
<td>Replacement Per Alternative 1</td>
<td>10’x8’ DRCB</td>
<td>$5,039,000</td>
</tr>
<tr>
<td></td>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>$16,357,000</strong></td>
</tr>
</tbody>
</table>
Drainage Area 14

Drainage Area 14 drains approximately 633 acres, and is generally bounded by Broadway on the north, ABC Channel and the Union Pacific Railroad easement on the east, Southerly City limit on the south, and Euclid Street on the west. Generally, water flows over land and then through pipes from north to south through Euclid Street storm drain (C03-P10) which discharges into the ABCC approximately 1,800 feet south of the Katella Avenue.

6.1 Hydrologic Analysis

The hydrologic analysis was performed for Drainage Area 14 in accordance with the criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 14 can be found in Appendix D. The following table shows the flow rates at the outlet of the Drainage Area for 10-, 25-, and 100-year storm events.

<table>
<thead>
<tr>
<th>Node</th>
<th>Location</th>
<th>Drainage Area (ac)</th>
<th>10-Year Flow (cfs)</th>
<th>25-Year Flow (cfs)</th>
<th>100-Year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>14119</td>
<td>Euclid Street at ABC Channel</td>
<td>633</td>
<td>485</td>
<td>613</td>
<td>832</td>
</tr>
</tbody>
</table>

6.2 Analysis of Existing Improvements

Presently the main storm drain in Drainage Area 14 begins at the intersection of Gilbuck Drive and Brande Avenue and continues west to Euclid Street through Brande Avenue, Loara St, and Crone Avenue. It then continues south along Euclid Street storm drain (C03-P10) until reaching the ABCC. The storm drain varies in size from 45-inch RCP to a 10.5-foot x 9-foot reinforced concrete box (RCB) and can convey a maximum of 618 cfs during a 10-year storm.

The City’s maximum flooded width criteria is not satisfied for Crone Avenue between Arden Street and Euclid Street. The storm drain along Crone Street has a capacity of 147 CFS, which is greater than the peak 10-year runoff. However, the residual 100-year flow on the street exceeds the street flow capacity. Further downstream, the storm drain also fails to remove enough flow from the street in the event of a 100-year storm to meet the flooded width criteria on Euclid Street between Chalet Avenue and Palais Road. Lastly, the storm drain is also found to have insufficient capacity in the event of a 100-year storm from the Southern Pacific Railroad through the remainder of the storm drain to the ABCC.

Hydraulic analysis indicates the following street segments do not meet the City’s maximum flood width requirements:
1. Gilbuck Drive from Rene Drive to Brande Ave
2. Loara Street from Tedmar Ave Avenue to Brande Ave
3. Loara Street from Beacon Ave to Ball Rd
4. Ball Road from Roberts St to Gilbuck Drive
5. Chanticleer Road from west end cul-de-sac to Loara St
6. Cerritos Avenue from Euclid St to 1400 feet to the east
7. Crone Ave from Arden St to Euclid St
8. Euclid St from Chalet Avenue to Buena Vista Ave
9. Euclid Street from the Union Pacific Railroad to ABC Channel

The existing street flow hydraulic calculations for Drainage Area 14 can be found in Appendices A and B.

**6.3 Proposed Improvements**

As discussed under Section 6.2, several streets in Drainage Area 14 do not meet the City’s allowable flood width requirement. Several of these street segments currently have no underground storm drain improvements. This report recommends extending existing storm drains in order to convey the full flow of the 10 year storm along the following streets.

- Install 1025 Ft of 42” RCP in Gilbuck from W. Brande to W. Central Park Ave
- Install 1475 Ft of 39” RCP in Loara Street from Brande Ave to Tedmar Ave.
- Install 700 Ft of 45” RCP in Loara Street from Ball Rd to just past Minerva Ave.
- Install 850 Ft of 45” RCP in Ball Rd (south side) from Roberts St to Loara St.
- Install 1175 Ft of 36” RCP in Ball Rd (south side) from Loara St to Gilbuck Dr.
- Install 1525 Ft of 42” RCP in Chanticleer Road from Loara Street to Euclid Street replacing an existing surface storm structure connecting Chanticleer to Euclid.
- Install 1300 Ft of 39” RCP in Cerritos Avenue from Euclid Street to the east.

There is an existing storm drain at the downstream end of each of the street segments listed above. The proposed storm drains within these street segments would tie into the existing systems downstream.

The following street segments that do not meet the maximum flooded width requirement currently have underground storm drain systems but do not have sufficient flow capacity. As shown in Appendix B, it will be necessary to improve the storm drain capacity in Crone Ave., and Euclid St. Alternatives 1 and 2 below provide the approximate sizes of conduits to replace or augment the existing storm drain capacity, respectively.
Drainage Area 14 Alternative Improvements:

**Alternative 1-** This Alternative calls for replacing the existing 6.5’ x 4’ RCB in Crone Ave between Euclid Street and the west side of Willow Park with a new 72” RCP; replacing the existing 8.5’ x 7’ RCB in Euclid Street between Chalet Avenue and Chanticleer Rd with a new 11’x7’ RCB; replacing the existing 10.5’ x 9’ RCB in Euclid Street from the Southern Pacific Rail Road to ABC Channel with a new 7.5’x9’ DRCB, reinforcing the structure through the railroad right-of-way for 24’.

**Alternative 2 (Recommended) -** This Alternative calls for constructing a 30” RCP or 1.5’ x 4’ RCB parallel to the existing 6.5’ x 4’ RCB in Crone Ave between Euclid Street and the west side of Willow Park; constructing a new 60” RCP or 3.5’ x 7’ RCB parallel to the existing 8.5’ x 7’ RCB in Euclid Street between Chalet Avenue and Chanticleer Rd; constructing a new 42” RCP or 1.5’ x 9’ RCB parallel to the existing 10.5’ x 9’ RCB in Euclid Street from the Southern Pacific Rail Road to Sumac Lane and a new 69” RCP or 3.5’ x 9’ RCB parallel to the existing 10.5’ x 9’ RCB between Sumac Lane and the ABC Channel.

It is recommended to construct new RCB conduits attached to existing storm drains per Alternative 2. This option is anticipated to have the least impact on traffic and utilities. Also, flow will be more readily distributed by providing equalizer windows between the new and existing box conduits.

In order to minimize the size of the storm drain improvements in Euclid St., this report also recommends the City consider constructing a retarding basin within Loara High School athletic field located at 1765 W. Cerritos Ave. Refer to Section 3.2 for more information.
6.4 Cost Estimates

Summarized in Table 6 are the construction cost estimates by project location for Drainage Area 14. The cost estimates were prepared as discussed in Section 4.4. The detailed cost estimates for Drainage Area 14 can be found in Appendix E.

Table 6 – Drainage Area 14 Cost Estimate (2008 Dollars)

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Gilbuck Dr (from Central Park Ave fork to Brande)</td>
<td>New</td>
<td>42&quot; RCP</td>
<td>$429,000</td>
</tr>
<tr>
<td>14</td>
<td>Loara St (from Tedmar and Brande)</td>
<td>New</td>
<td>39&quot; RCP</td>
<td>$545,000</td>
</tr>
<tr>
<td>14</td>
<td>Loara St (Between Minerva and Ball)</td>
<td>New</td>
<td>45&quot; RCP</td>
<td>$227,000</td>
</tr>
<tr>
<td>14</td>
<td>Ball Rd (from Roberts to Loara)</td>
<td>New</td>
<td>45&quot; RCP</td>
<td>$759,000</td>
</tr>
<tr>
<td>14</td>
<td>Ball Rd (from Loara to Gilbuck)</td>
<td>New</td>
<td>36&quot; RCP</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Chanticleer Rd (from west end cul-de-sac to Loara)</td>
<td>New</td>
<td>42&quot; RCP</td>
<td>$607,000</td>
</tr>
<tr>
<td>14</td>
<td>Cerritos Ave (from Euclid to 1400ft eastward)</td>
<td>New</td>
<td>39&quot; RCP</td>
<td>$498,000</td>
</tr>
<tr>
<td>14</td>
<td>Crone Ave (from Arden to Euclid)</td>
<td>Parallel RCB per Alternative 2</td>
<td>1.5’X4’ RCB</td>
<td>$309,000</td>
</tr>
<tr>
<td>14</td>
<td>Euclid St (from Chalet to Chanticleer)</td>
<td>Parallel RCB per Alternative 2</td>
<td>3.5’X7’ RCB</td>
<td>$576,000</td>
</tr>
<tr>
<td>14</td>
<td>Euclid St (Union Pacific Railroad to Sumac)</td>
<td>Parallel RCB per Alternative 2</td>
<td>1.5’X9’ RCB</td>
<td>$2,782,000</td>
</tr>
<tr>
<td></td>
<td>(Sumac to ABC Channel)</td>
<td>Parallel RCB per Alternative 2</td>
<td>3.5’X9’ RCB</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>$6,732,000</td>
</tr>
</tbody>
</table>
6. Drainage Area 19

Drainage Area 19 drains approximately 643 acres, and is generally bounded by East Steet on the east, Ball Road and Vermont Avenue on the south, Union Pacific Railroad and Walnut Street on the west, with the northerly boundary of the Drainage Area meandering along Santa Ana Street, South Street, Lincoln Avenue, and Broadway. Generally, water flows over land and then through pipes from east to west and ties into the South Street storm drain flowing westerly across the I-5 Freeway which then joins the Walnut Street storm drain flowing south then Ball Road storm drain flowing west to the ABC Channel.

7.1 Hydrologic Analysis

The hydrologic analysis was performed for Drainage Area 19 in accordance with the criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 19 can be found in Appendix D. The following table shows the flow rates at the outlet of the Drainage Area for 10-, 25-, and 100-year storm events.

<table>
<thead>
<tr>
<th>Node</th>
<th>Location</th>
<th>Cumulative Drainage Area (ac)</th>
<th>10-Year Flow (cfs)</th>
<th>25-Year Flow (cfs)</th>
<th>100-Year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>West Bellevue Drive &amp; I-5 Fwy</td>
<td>484</td>
<td>537</td>
<td>667</td>
<td>859</td>
</tr>
<tr>
<td>1978</td>
<td>Ball Road at ABC Channel</td>
<td>643</td>
<td>615</td>
<td>786</td>
<td>1067</td>
</tr>
</tbody>
</table>

7.2 Analysis of Existing Improvements

Currently the major storm drain system Drainage Area 19 begins in South St. east of S. East St. and continues west along South St. and confluences with several laterals. The line continues to Harbor Blvd, where it confluences with a major storm drain system at the intersection of South Street and Harbor Blvd. The Harbor Blvd storm drain line begins as a 24” RCP at a flow bifurcation structure on a 93” RCP at the intersection of Harbor Blvd and Lincoln Blvd. It continues south and crosses under a 42” RCP at Broadway. Excess flow from the lateral is then forced up an existing junction structure box to the 42” RCP in Broadway. The lateral continues south and increases to a 72” RCP before it confluences with the 78” mainline RCP in South St and transitions to a 96” RCP in South St.

The storm drain continues west to Bellevue Drive, where it turns southerly and transitions to a 12’x 6’ RCB. The RCB then turns westerly and crosses under the I-5 Freeway to Hampshire Drive, then south on Walnut St., west on Ball Road and discharges into the ABC Channel.
As shown in Appendix B, the estimated flow diverted from the 93” RCP in Lincoln Blvd to the 24” lateral in Harbor Blvd is estimated to be 24 CFS. This analysis assumes flows in excess of this amount in the lateral, will be diverted to the 42” RCP in Broadway.

The following street segments do not meet the City’s flooded width criteria:

1. Harbor Blvd from Santa Ana St to South St.
2. South St. from Harbor Blvd to Bellevue Dr.
3. Bellevue Dr. from South St. to I-5
4. Hampshire Ave. from Disneyland Dr. to Walnut St.
5. Walnut St. from Hampshire Ave. to Ball Road
6. Ball Road from Walnut St. to ABC Channel

The existing street flow hydraulic calculations for Drainage Area 19 can be found in Appendices A and B.

### 7.3 Proposed Improvements

As discussed under Section 7.2, several streets in Drainage Area 19 do not meet the City’s allowable flood width requirement. A few of the street segments currently do not have underground storm drain improvements.

This report recommends construction of new storm drain improvements to convey the full flow of the 10 year storm along the following street segments:

- Install 700 Ft of 39” RCP in West St from Santa Ana St. to Water St.
- Install 810 Ft of 39” RCP in Janss St from Water St. to South St.
- Install 270 Ft of 39” RCP in Dickel St. from Hampshire. to Clementine St.
- Install 530 Ft of 39” RCP in Hampshire Ave. from Harbor Blvd to Dickel St.

The remaining street segments that do not meet the flood width requirement currently have underground storm drains but do not have sufficient flow capacity. Appendix B provides the specific improvement options for the street segments listed in Section 7.2 in order to meet the flood width criteria.

Alternatives 1 and 2 below provide the approximate sizes of conduits to replace or augment each existing storm drain capacity, respectively. Alternative 3 is a combination of Alternatives 1 and 2 where the smaller sized conduits are removed and replaced and the larger conduits are protected in place and augmented with new parallel conduits.
Drainage Area 19 Alternative Improvements:

**Alternative 1-**

- **Harbor Blvd from Santa Ana St to South St.-** Remove and replace existing 60” and 72” RCP from Santa Ana to South St with a new 84” RCP.

- **South St. from Harbor Blvd to Bellevue Dr.-** Appendix B shows the proposed new conduits as RCP. However, because of the large sizes of the required pipes, it is recommended to replace the existing storm drains with reinforced concrete box conduits, as follows:
  - **South St. from Harbor to Citron St.** - Remove and replace existing 96” RCP with a new 8.5’ x 8’ RCB.
  - **South St. from Citron St. to Bellevue Dr.-** Remove and replace existing 96” RCP with a new 12’ x 9.5’ RCB.

- **Bellevue Dr. from South St. to I-5-** Remove and replace existing 12’ x 6’ RCB with a new 11.5’ x 9’-7” RCB.

- **CalTrans I-5 Crossing at Hampshire from W. Bellvue to Disneyland Dr.-** Remove and replace the existing 12’ x 6’ RCB with a 13.5’ x 10’ RCB.

- **Hampshire Ave. from Disneyland Dr. to Walnut St.-** Remove and replace existing 2-8’ x 5’ RCB with a new 2-9.5’ x 8’ RCB.

- **Walnut St. from Hampshire Ave. to Ball Road-** Remove and replace existing 6.75’ x 10.5’ RCB with a new 13’ x 11.5’ RCB.

- **Ball Road from Walnut St. to ABC Channel-** Remove and replace existing 6.5’ x 11’ RCB with a new 13’ x 11.5’ RCB.

**Alternative 2-**

- **Harbor Blvd from Santa Ana St to South St.-** Construct a new 72” RCP parallel to the existing 60” and 72” RCP between Santa Ana and South St.

- **South St. from Harbor Blvd to Bellevue Dr.-** It is also possible to increase the underground storm drain capacity by constructing new storm drains as shown below. However, this option would require extensive utility relocation and may create conflicts with existing sanitary sewer laterals.
  - **South St. from Harbor to Citron St.-** Construct a new 51” RCP parallel to the existing 96” RCP.
  - **South St. from Citron St. to Bellevue Dr.-** Construct a 114” RCP parallel to the existing 96” RCP.

- **Bellevue Dr. from South St. to I-5-** Construct a new 10.5’ x6’ RCB parallel to the existing 12’ x 6’ RCB.

- **CalTrans I-5 Crossing at Hampshire from W. Bellvue to Disneyland Dr.-** Construct a new 8.5’ x 6’ DRCB parallel to the existing 12’ x 6’ RCB.

- **Hampshire Ave. from Disneyland Dr. to Walnut St.-** Construct a new 10.5’ x 5’ DRCB parallel to the existing 2-8’ x 5’ RCB.
- **Walnut St. from Hampshire Ave. to Ball Road**- Construct a new 9’ x 6.5’ DRCB parallel to the existing 6.75’ x 10.5’ RCB.
- **Ball Road from Walnut St. to ABC Channel**- Construct a new 9’ x 6.5’ DRCB parallel to the existing 6.5’ x 11’ RCB.

**Alternative 3- (Recommended)**

- **Harbor Blvd from Santa Ana St to South St.**- Remove and replace existing 60” and 72” RCP from Santa Ana to South St with a new 84” RCP.
- **South St. from Harbor Blvd to Bellevue Dr.**- Appendix B shows the proposed new conduits as RCP. However, because of the large sizes of the required pipes, it is recommended to replace the existing storm drains with reinforced concrete box conduits, as follows:
  - **South St. from Harbor to Citron St.**- Remove and replace existing 96” RCP with a new 8.5’ x 8’ RCB
  - **South St. from Citron St. to Bellevue Dr.**- Remove and replace existing 96” RCP with a new 12’ x 9.5’ RCB
- **Bellevue Dr. from South St. to I-5**- Construct a new 10.5’ x6’ RCB parallel to the existing 12’ x 6’ RCB.
- **CalTrans I-5 Crossing at Hampshire from W. Bellvue to Disneyland Dr.**- Construct a new 8.5’ x 6’ DRCB parallel to the existing 12’ x 6’ RCB
- **Hampshire Ave. from Disneyland Dr. to Walnut St**.- Construct a new 10.5’ x 5’ DRCB parallel to the existing 2-8’ x 5’ RCB.
- **Walnut St. from Hampshire Ave. to Ball Road**- Construct a new 9’ x 6.5’ DRCB parallel to the existing 6.75’ x 10.5’ RCB.
- **Ball Road from Walnut St. to ABC Channel**- Construct a new 9’ x 6.5’ DRCB parallel to the existing 6.5’ x 11’ RCB.
7.4 Cost Estimates

Summarized in Table 8 are the construction cost estimates by project location for Drainage Area 19. The cost estimates were prepared as discussed in Section 4.4. The detailed cost estimates for Drainage Area 19 can be found in Appendix E.

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Harbor Blvd. (from Santa Ana to South)</td>
<td>Replacement per Alternative 3</td>
<td>84&quot; RCP</td>
<td>$1,383,000</td>
</tr>
<tr>
<td>19</td>
<td>South St. (from Harbor to Citron) (from Citron to Bellvue)</td>
<td>Replacement per Alternative 3</td>
<td>8.5’X8 RCB</td>
<td>$2,691,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12’X9.5’ RCB</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Bellvue Dr. (from South to I-5)</td>
<td>New Parallel per Alternative 3</td>
<td>10.5’X6’ RCB</td>
<td>$790,000</td>
</tr>
<tr>
<td>19</td>
<td>CalTrans I-5 crossing (from Belvue to Disneyland Dr.)</td>
<td>New Parallel per Alternative 3</td>
<td>8.5’ x 6’ DRCB</td>
<td>$1,702,000</td>
</tr>
<tr>
<td>19</td>
<td>Hampshire Ave. (from Disneyland Dr to Walnut)</td>
<td>New Parallel per Alternative 3</td>
<td>10.5’ x 5’ DRCB</td>
<td>$3,380,000</td>
</tr>
<tr>
<td>19</td>
<td>Walnut St. (from Ball to Hampshire)</td>
<td>New Parallel per Alternative 3</td>
<td>9’ x 6.5’ DRCB</td>
<td>$894,000</td>
</tr>
<tr>
<td>19</td>
<td>Ball Rd. (from Walnut to ABC Channel)</td>
<td>New Parallel per Alternative 3</td>
<td>9’ x 6.5’ DRCB</td>
<td>$2,067,000</td>
</tr>
<tr>
<td>19</td>
<td>West St. (from Water to Santa Ana)</td>
<td>New</td>
<td>39” RCP</td>
<td>$302,000</td>
</tr>
<tr>
<td>19</td>
<td>Jansss St. (from Water to South)</td>
<td>New</td>
<td>39” RCP</td>
<td>$330,000</td>
</tr>
<tr>
<td>19</td>
<td>Dickel/Hampshire (from Clementine to Harbor)</td>
<td>New</td>
<td>39” RCP</td>
<td>$328,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$13,867,000</td>
</tr>
</tbody>
</table>

Table 8 – Drainage Area 19 Cost Estimate (2008 Dollars)
7. Drainage Area 20

Drainage Area 20 drains approximately 815 acres and comprises of two general areas: a larger eastern portion and a smaller western portion. The large portion of the Drainage Area is located the east side of the I-5 Freeway and is generally bounded by State College Road on the east, Ball Road on the south, Harbor Blvd on the west and has a northern boundary that meanders along Vermont Avenue, South Street, East Street, and Broadway. Flow from this large eastern portion of the Drainage Area is carried westward across the I-5 Freeway via two underground conduits along Ball Road. The smaller portion of the Drainage Area west of the I-5 is generally bounded by the I-5 on the east, Disneyland Theme Park on the south, Walnut Street on the west and Ball Road on the north. Generally, water flows over land and then through pipes from east to west and discharges directly into the ABC Channel.

8.1 Hydrologic Analysis

The hydrologic analysis was performed for Drainage Area 20 in accordance with the criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 20 can be found in Appendix D. The following table shows the flow rates at the outlet of the Drainage Area for 10-, 25-, and 100-year storm events.

<table>
<thead>
<tr>
<th>Node Location</th>
<th>Drainage Area (ac)</th>
<th>10-Year Flow (cfs)</th>
<th>25-Year Flow (cfs)</th>
<th>100-Year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 Ball Road at Harbor Blvd</td>
<td>320</td>
<td>318</td>
<td>408</td>
<td>553</td>
</tr>
<tr>
<td>2018 Harbor Blvd at Ball Road</td>
<td>443</td>
<td>356</td>
<td>464</td>
<td>634</td>
</tr>
<tr>
<td>2016 Ball Road Downstream of I-5</td>
<td>778</td>
<td>652</td>
<td>847</td>
<td>1168</td>
</tr>
<tr>
<td>2021 Ball Road at ABC Channel</td>
<td>815</td>
<td>652</td>
<td>847</td>
<td>1168</td>
</tr>
</tbody>
</table>

8.2 Analysis of Existing Improvements

The major storm drain in Drainage Area 20 runs along Ball Road and discharges directly into the ABC Channel. The storm drain varies from 36” RCP east of East St. to a double 7’ x 7’ RCB at the ABC Channel. Seven storm drain laterals feed into this storm drain within Drainage Area 20. The largest of these laterals is along Harbor Blvd, which consists of a 90” RCP and turns westerly at Ball Road and continues parallel to the storm drain in Ball Road until it crosses the I-5 Freeway and then confluences with the storm drain mainline. The confluence of these two storm drains is marked as node 2016 on the hydrology map. Table 9 above provides a summary of the drainage area and peak flows at this node.
The City’s flooded width criteria are not satisfied along Ball Road, Harbor Blvd, Turin Avenue, Avocado St. and Norman Ave.

The existing street flow hydraulic calculations for Drainage Area 20 can be found in Appendices A and B.

### 8.3 Proposed Improvements

As discussed under Section 8.2, several streets in Drainage Area 20 do not meet the City’s allowable flood width requirement. Several of these street segments currently have no underground storm drain improvements.

This report recommends construction of new storm drain improvements to convey the full flow of the 10 year storm along the following street segments:

- Install 450 Ft of 30” RCP in Elder St from Elm St to Santa Ana St
- Install 1705 Ft of 48” RCP in Santa Ana St from Elder St to join existing storm drain at Haven Dr
- Install 480 Ft of 42” RCP in South St from Elder St to join existing storm drain at Barrett St
- Install 490 Ft of 36” RCP in Diana Ave from the cul-de-sac to Verde St
- Install 800 Ft of 39” RCP in Verde St from Diana Ave to Tyrol Ave
- Install 375 Ft of 39” RCP in Tyrol Ave from Verde St to Wayside St
- Install 290 Ft of 39” RCP in Wayside St from Tyrol Ave to Vermont Ave
- Install 1275 Ft of 39” RCP in Vermont Ave from Wayside St to Join existing storm drain at Avocado St
- Install 585 Ft of 42” RCP in Norman Ave from McCloud St to Avocado St.
- Install 435 Ft of 42” RCP in Avocado St from Norman Ave to Turin Ave
- Install 850 Ft of 51” RCP in Turin Ave from Avocado to join the existing Storm Drain at the intersection of East St and Turin Ave.

The remaining street segments that do not meet the flood width requirement currently have underground storm drains but do not have sufficient flow capacity. As shown in Appendix B, in order to meet the flood width criteria, it will be necessary to improve the storm drain capacity in Ball Road and Harbor Blvd.

Alternatives 1 and 2 below provide the approximate sizes of conduits to replace or augment the flow capacity of each existing storm drain, respectively. Alternative 3 is a combination of Alternatives 1 and 2 where the smaller sized conduits are removed and replaced and the larger conduits are protected in place and augmented with new parallel conduits.
Drainage Area 20 Alternative Improvements:

Alternative 1-

- **Ball Road from East St. to Olive St.**- Replace existing 36” RCP and 48” RCP with 10’x4’ RCB.
- **Ball Road from Olive St. to Ox Rd.**- Replace existing 48”, 51”, 54”, and 57” RCP lines with 10’x5.5’ RCB from Olive St. to Ox Rd.
- **Ball Road from Ox Rd to ABC Channel**- Replace existing 2-7’x7’ and 2-8’x6’-2” RCB with 2-12.5’ x 7’ RCB.
- **East St from Turin Ave to Ball Rd**- Replace existing 36” RCP with 10’ x 4’ RCB.
- **East St from Santa Ana St to South St**- Replace existing 54” RCP with 72” RCP.
- **East St from South St to Vermont Ave**- Replace existing 84” RCP with 102” RCP.
- **Vermont Ave from East St to Harbor Blvd**- Replace existing 90” RCP with 9.5’ x 9’ RCB.
- **Harbor Blvd from Vermont Ave to Ball Rd**- Replace existing 90” RCP with 10.5’ x 8’ RCB.

Alternative 2-

- **Ball Road from East St. to Olive St.**- Install new parallel 51” RCP.
- **Ball Road from Olive St. to Ox Rd**- Install new parallel 96” RCP.
- **Ball Road from Ox Rd to ABC Channel**- Install new parallel 12.5’x7’ RCB.
- **East St from Turin Ave to Ball Rd**- Install new parallel 72” RCP.
- **East St from Santa Ana St to South St**- Install new parallel 60” RCP.
- **East St from South St to Vermont Ave**- Install new parallel 102” RCP.
- **Vermont Ave from East St to Harbor Blvd**- Install new parallel 93” RCP.
- **Harbor Blvd from Vermont Ave to Ball Rd**- Install new parallel 96” RCP.

Alternative 3 (Recommended) -

- **Ball Road from East St. to Olive St.**- Replace existing 36” RCP and 48” RCP with 10’x4’ RCB.
- **Ball Road from Olive St. to Ox Rd**- Replace existing 48”, 51”, 54”, and 57” RCP lines with 10’x5.5’ RCB from Olive St. to Ox Rd.
- **Ball Road from Ox Rd to ABC Channel**- Install new parallel 12.5’x7’ RCB.
- **East St from Turin Ave to Ball Rd**- Replace existing 36” RCP with 10’ x 4’ RCB.
- **East St from Santa Ana St to South St**- Replace existing 54” RCP with 72” RCP.
• **East St from South St to Vermont Ave**- Replace existing 84” RCP with 102” RCP.

• **Vermont Ave from East St to Harbor Blvd**- Replace existing 90” RCP with 9.5’ x 9’ RCB.

• **Harbor Blvd from Vermont Ave to Ball Rd**- Replace existing 90” RCP with 10.5’ x 8’ RCB.

In order to minimize the size of the storm drain improvements in Ball Road, this report also recommends the City consider constructing a retarding basin within Traveler’s World RV Park located at 333 W. Ball Road. Refer to Section 3.2 for more information.
8.4 Cost Estimates

Summarized in Table 10 are the construction cost estimates by project location for Drainage Area 20. The cost estimates were prepared as discussed in Section 4.4. The detailed cost estimates for Drainage Area 20 can be found in Appendix E.

### Table 10 – Drainage Area 20 Cost Estimate (2008 Dollars)

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Norman Ave/Avocado St (from Turin Ave to McCloud St)</td>
<td>New</td>
<td>42” RCP</td>
<td>$428,000</td>
</tr>
<tr>
<td>20</td>
<td>Turin Ave. (from Avocado to East)</td>
<td>New</td>
<td>51” RCP</td>
<td>$395,000</td>
</tr>
<tr>
<td>20</td>
<td>East St. (from Turin to Ball)</td>
<td>Replacement per Alternative 3</td>
<td>10’X4’ RCB</td>
<td>$1,408,000</td>
</tr>
<tr>
<td>20</td>
<td>East St. (Santa Ana to South) (South to Vermont)</td>
<td>Replacement per Alternative 3</td>
<td>72” RCP</td>
<td>$2,924,000</td>
</tr>
<tr>
<td>20</td>
<td>East St. (Santa Ana to South) (South to Vermont)</td>
<td>Replacement per Alternative 3</td>
<td>102” RCP</td>
<td>$2,129,000</td>
</tr>
<tr>
<td>20</td>
<td>Harbor Blvd. (from Vermont to Ball)</td>
<td>Replacement per Alternative 3</td>
<td>10.5’X8’ RCB</td>
<td>$2,129,000</td>
</tr>
<tr>
<td>20</td>
<td>Ball Road (East St to Olive St) (East St to Ox St)</td>
<td>Replacement per Alternative 3</td>
<td>10’X4’ RCB</td>
<td>$8,256,000</td>
</tr>
<tr>
<td>20</td>
<td>Ball Road (East St to Olive St) (East St to Ox St)</td>
<td>Replacement per Alternative 3</td>
<td>10’X5.5’ RCB</td>
<td>$8,256,000</td>
</tr>
<tr>
<td>20</td>
<td>Ball Road (Ox St. to ABC Channel)</td>
<td>New Parallel per Alternative 3</td>
<td>12.5’X7’ RCB</td>
<td>$4,806,000</td>
</tr>
<tr>
<td>20</td>
<td>Santa Ana St (Haven Dr to Elder St)</td>
<td>New</td>
<td>48” RCP</td>
<td>$715,000</td>
</tr>
<tr>
<td>20</td>
<td>South (Elder St to Barrett St)</td>
<td>New</td>
<td>42” RCP</td>
<td>$222,000</td>
</tr>
<tr>
<td>20</td>
<td>Diana Ave (Cul-de-sac to Verde) Verde St/ Tyrol Ave/ Wayside St</td>
<td>New</td>
<td>36” RCP</td>
<td>$705,000</td>
</tr>
<tr>
<td>20</td>
<td>Vermont Ave (from Wayside to Avocado St.)</td>
<td>New</td>
<td>39” RCP</td>
<td>$491,000</td>
</tr>
<tr>
<td>20</td>
<td>Vermont Ave (from East St to Harbor Blvd)</td>
<td>Replacement per Alternative 3</td>
<td>9.5’X9’ RCB</td>
<td>$8,283,000</td>
</tr>
<tr>
<td>20</td>
<td>Elder St (Between Elm St and Santa Ana St)</td>
<td>New</td>
<td>30” RCP</td>
<td>$190,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$30,952,000</strong></td>
</tr>
</tbody>
</table>
8. Drainage Area 21

Drainage Area 21 drains approximately 305 acres, and is generally bounded by Ball Road on the north, Harbor Blvd and Walnut Street on the east, Katella Avenue on the south and ABC Channel on the west. Generally, water flows over land and then through pipes from east to west and discharges directly into the ABC Channel.

9.1 Hydrologic Analysis

The hydrologic analysis was performed for Drainage Area 21 in accordance with the criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 21 can be found in Appendix D. The following table shows the flow rates at the outlet of the Drainage Area for 10-, 25-, and 100-year storm events.

<table>
<thead>
<tr>
<th>Node</th>
<th>Location</th>
<th>Drainage Area (ac)</th>
<th>10-Year Flow (cfs)</th>
<th>25-Year Flow (cfs)</th>
<th>100-Year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21023</td>
<td>ABC Channel at Cerritos</td>
<td>63.8</td>
<td>81</td>
<td>100</td>
<td>132</td>
</tr>
<tr>
<td>21024.5</td>
<td>ABC Channel Downstream of Cerritos Ave (Ninth)</td>
<td>132</td>
<td>167</td>
<td>206</td>
<td>271</td>
</tr>
<tr>
<td>21037</td>
<td>ABC Channel at Castle Ave and Hampstead St</td>
<td>36</td>
<td>43</td>
<td>53</td>
<td>69</td>
</tr>
<tr>
<td>21057</td>
<td>ABC Channel at Calle De Las Estrellas</td>
<td>58</td>
<td>69</td>
<td>86</td>
<td>113</td>
</tr>
<tr>
<td>21065</td>
<td>ABC Channel at Kimberly Ave</td>
<td>7</td>
<td>11</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>21069</td>
<td>ABC Channel Upstream of Katella Ave</td>
<td>6</td>
<td>11</td>
<td>13</td>
<td>17</td>
</tr>
<tr>
<td>21075</td>
<td>ABC Channel Downstream of Katella Ave</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

9.2 Analysis of Existing Improvements

Presently the major storm drain in Drainage Area 21 is a 72” RCP and a 48” RCP along Cerritos Ave that both discharge directly into the ABC Channel. The main tributary lateral to this line is a 72” RCP in Walnut Avenue. A 42” RCP in Magic Way discharges into the Walnut Ave storm drain.

The City’s flooded width criteria is not satisfied along Cerritos Ave between the ABC Channel and Walnut Ave, along Walnut Ave between Cerritos Ave and Magic Way, along Magic Way between Walnut Ave and Disneyland Dr. and along Calle De Las Estrellas between Ninth St and Hampstead St.
The existing street flow hydraulic calculations for Drainage Area 21 can be found in Appendices A and B.

9.3 Proposed Improvements

As discussed under Section 9.2, several streets in Drainage Area 21 do not meet the City’s allowable flood width requirement.

This report recommends construction of new storm drain improvements to convey the full flow of the 10 year storm along the following street segment:

- Install 250 Ft of 36” RCP in Calle De Las Estrellas from Ninth St up to Hampstead St. This line would tie into the existing 42” RCP at Ninth St.

The pipe diameter for the recommended storm drain lines is designed to carry the full calculated 10 year flow.

The remaining street segments that do not meet the flood width requirement currently have underground storm drains but do not have sufficient flow capacity. As shown in Appendix B, in order to meet the flooded width criteria, it will be necessary to increase the storm drain pipe sizes in Cerritos Avenue between the ABC Channel and Walnut Avenue, in Walnut Avenue between Cerritos Avenue and Magic Way, and in Magic Way between Walnut Avenue and Disneyland Drive.

Alternatives 1 and 2 below provide the approximate sizes of conduits to replace or augment the each existing storm drain capacity, respectively.

Drainage Area 21 Alternative Improvements:

Alternative 1 (Recommended) - This Alternative calls for:

- Replacing the existing 48” RCP in Cerritos Avenue between ABC Channel and Walnut Avenue with a new 7’x4’ RCB.
- Replacing the existing 72” RCP in Walnut Avenue between Cerritos Avenue and Magic Way with a new 81” RCP.
- Replacing the existing 48” RCP in Magic Way between Walnut Avenue and Disneyland Drive with a new 78” RCP.
- Replacing the existing 18” in Laster Ave. between the end of the cul-de-sac on Laster Ave. and the ABC Channel with a new 21” RCP.

Alternative 2 - This Alternative calls for:

- Constructing a 66” RCP parallel to the existing 48” RCP in Cerritos Avenue between ABC Channel and Walnut Avenue.
- Constructing a 45” RCP parallel to the existing 72” RCP in Walnut Avenue between Cerritos Avenue and Magic Way.
- Constructing a 69” RCP parallel to the existing 48” RCP in Magic Way between Walnut Avenue and Disneyland Drive.
• Constructing a 12” RCP parallel to the existing 18” RCP in Laster Ave. between the end of the cul-de-sac on Laster Ave. and the ABC Channel.

In order to determine the full cost of Alternative 2, it will be necessary to perform detailed analysis of its impact on the existing utilities. Since that level of analysis is beyond the scope of this report, it is recommended to use Alternative 1 for budgeting purposes. However, during final design, it is recommended to analyze the feasibility of constructing the parallel storm drains in Alternative 2.

9.4 Cost Estimates

Summarized in Table 12 are the construction cost estimates by project location for Drainage Area 21. The cost estimates were prepared as discussed in Section 4.4. The detailed cost estimates for Drainage Area 21 can be found in Appendix E.

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>Calle de las Estrellas (from Ninth to Hampstead)</td>
<td>New</td>
<td>36” RCP</td>
<td>$142,000</td>
</tr>
<tr>
<td>21</td>
<td>Magic (from Walnut to Disneyland)</td>
<td>Replacement per Alternative 1</td>
<td>78” RCP</td>
<td>$928,000</td>
</tr>
<tr>
<td>21</td>
<td>Walnut (from Magic to Cerritos)</td>
<td>Replacement per Alternative 1</td>
<td>81” RCP</td>
<td>$652,000</td>
</tr>
<tr>
<td>21</td>
<td>Cerritos (from Walnut to ABC Channel)</td>
<td>Replacement per Alternative 1</td>
<td>7’X4’ RCB</td>
<td>$846,000</td>
</tr>
<tr>
<td>21</td>
<td>Laster (from west end cul-de-sac to ABC Channel)</td>
<td>Replacement per Alternative 1</td>
<td>21” RCP</td>
<td>$109,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>$2,677,000</td>
</tr>
</tbody>
</table>
9. Drainage Area 22

Drainage Area 22 drains approximately 940 acres, and is generally bounded by Ball Road and Cerritos Avenue on the north, Lewis Street and the Union Pacific Railroad easement on the east, Katella Avenue on the south, and Ninth Street and Walnut Street on the west. Generally, water flows over land and then through pipes from east to west and drains into the double 8’ x 8.5’ RCB storm drain in Katella Avenue.

10.1 Hydrologic Analysis

The hydrologic analysis was performed for Drainage Area 22 in accordance with the criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 22 can be found in Appendix D. The following table shows the flow rates at the outlet of the Drainage Area for 10-, 25-, and 100-year storm events.

<table>
<thead>
<tr>
<th>Node</th>
<th>Location</th>
<th>Drainage Area (ac)</th>
<th>10-Year Flow (cfs)</th>
<th>25-Year Flow (cfs)</th>
<th>100-Year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2294</td>
<td>Katella Ave (at Ninth St)</td>
<td>940</td>
<td>883</td>
<td>1107</td>
<td>1404</td>
</tr>
</tbody>
</table>

10.2 Analysis of Existing Improvements

Presently, the major storm drain system in drainage area 22 consists of a 51” RCP originating at Allec St. on Cerritos Ave. running west to Anaheim Blvd, where the stream turns south in a 60” RCP line to Katella Ave. The line crosses under interstate 5 as a private Caltrans line for this portion of the run. The drain turns west and runs along the northerly side of Katella Ave to harbor where 2 parallel 63” RCP and 72” RCP lines confluence with the main storm drain line on northerly side of Katella. The main line becomes a 12’x7” RCB continuing to the west. Along the way, a 66” RCP cross-connector diverts some of the flow from the northerly line to a line running along the southerly side of Katella (to be described shortly), two laterals from Disneyland (66” RCP and a 36” RCP) join the main northerly line, and another two parallel lines (48” RCP and 42” RCP) transition together just before confluencing with the main northerly line at Disneyland Drive. The main line continues past Disneyland Drive to the west in a 12.5’x7.5’ RCB to a point just east of Walnut St where it confluences with the southerly Katella storm drain line.

The City’s flooded width criteria are not satisfied along Allec St. from Cerritos Ave to approximately 2,100 feet upstream, along Palais Road and Claudina, Guinida Lane, Winston Road, Palm St., Anaheim Blvd at the I-5, Manchester Ave between Harbor and I-5, Katella Ave between Harbor and Ninth, and Walnut St.

The existing street flow hydraulic calculations for Drainage Area 22 can be found in Appendices A and B.
10.3 Proposed Improvements

As discussed under Section 10.2, several streets in Drainage Area 22 do not meet the City’s allowable flood width requirement.

This report recommends construction of new storm drain improvements to convey the full flow of the 10 year storm along the following street segments:

- Install 1425 Ft of 51” RCP in Allec St from Cerritos Ave. to the north
- Install 590 FT of 39” RCP in Allec St from the end of the 51” RCP to the north.
- Install 925 Ft of 42” RCP in Claudina from Palais Rd. to the northwest.
- Install 675 Ft of 45” RCP in Palais Rd from Anaheim Blvd to Claudina
- Install 250 Ft of 39” RCP in Palm St from the existing 36” RCP to Winston Rd
- Install 600 Ft of 39” RCP in Winston Rd from Palm St to Claremont St.
- Install 925 Ft of 39” RCP in Guinida Lane from Palm St to the east.

The pipe diameters for these recommended storm drain lines are designed to carry the full calculated 10 year flow.

The remaining street segments that do not meet the flood width requirement currently have underground storm drains but do not have sufficient flow capacity. As shown in Appendix B, in order to meet the flood width criteria, it will be necessary to improve the storm drain capacity in Cerritos Ave., Katella Ave., Anaheim Blvd, Manchester Ave, Walnut St., and Ninth St.

Alternatives 1 and 2 below provide the approximate sizes of conduits to replace or augment the each existing storm drain capacity, respectively. Alternative 3 is a combination of Alternatives 1 and 2 where the smaller sized conduits are removed and replaced and the larger conduits are protected in place and augmented with new parallel conduits.

Drainage Area 22 Alternative Improvements:

Alternative 1 - This Alternative calls for:

- Replacing the existing 42” to 51” RCP in Cerritos Ave with a 60” RCP from Anaheim to Allec.
- Replacing the existing 36” RCP in Manchester Ave with a 42” RCP from Harbor to Interstate 5 Freeway.
- Replacing the existing 2-6’ x 5’ RCB in Anaheim Blvd with a 2-7’x5’ RCB from Disney Way to Anaheim Way.
- Replacing the existing 63” RCP in Anaheim with a 8’ x 5’ RCB from Katella to Disney Way.
- Replacing the existing 42” RCP in Walnut St with a 48” RCP from Katella to Kimberly.
Replacing the existing 63” & 60” RCP on the northerly side of Katella with 10’ x 5’ RCB between Anaheim and Harbor.

Replacing the 12’x7” RCB on the northerly side of Katella with 2-8.5’X7’ RCB from Harbor to halfway between Harbor and Disneyland.

Replacing the existing 10’x4’ TRCB just upstream of Walnut on Katella with a 10.5’x4’ pentuple (5) RCB squash box.

Replacing the existing 12.5’ x 7.5’ RCB on the northerly side of Katella with 2-10.5’ x 7.5’ RCB halfway between Harbor and Disneyland to Walnut.

Replacing the existing 2-8’x 8.5’ RCB on Katella with 2-12’x8.5 RCB between Walnut and Ninth and replacing the 96” RCP connector to the ABC Channel with a 9.5’x8’ TRCB.

Replacing the existing 27” RCP with a 30” RCP on Ninth St from Katella to Holgate.

**Alternative 2-** This Alternative calls for:

- Constructing a 39” RCP parallel to the existing 51” RCP in Cerritos Ave from Anaheim to Allec.
- Constructing a 27” RCP parallel to the existing 36” RCP in Manchester Ave from Harbor to Interstate 5 Freeway.
- Constructing a 3’x5’ RCB parallel to the existing 2-6’ x 5’ DRCB in Anaheim Blvd from Disney Way to Anaheim Way.
- Constructing a 66” RCP in Anaheim parallel to the existing 63” RCP from Katella to Disney Way.
- Constructing a 30” RCP parallel to the existing 42” RCP in Walnut St from Katella to Kimberly.
- Constructing a 78” RCP parallel to the existing 63” and 60” RCP respectively on the northerly side of Katella between Anaheim and Harbor.
- Constructing a 5’X7” RCB parallel to the existing 12’x7’ RCB on the northerly side of Katella from Harbor to halfway between Harbor and Disneyland.
- Constructing a 8’X7’ RCB parallel to the existing 12.5’ x 7.5’ RCB on the northerly side of Katella halfway between Harbor and Disneyland to Walnut.
- Constructing a 11’x4’ DRCB squash box parallel to the existing 10’x4’ TRCB just upstream of Walnut on Katella.
- Constructing a 10’X8.5’ RCB parallel to the existing 2-8’x8.5’ RCB on Katella from Bayless to Walnut.
- Replace the existing 96” RCP with a 9.5’x8’ TRCB, connecting both the existing 8’x8.5’ DRCB and the proposed 10’x8.5’ RCB together, routing the combined flow into the ABC Channel.
- Constructing a 12” RCB parallel to the existing 27” RCP on Ninth St from Katella to Holgate.
Alternative 3 (Recommended) - This Alternative calls for:

- Replacing the existing 42” to 51” RCP in Cerritos Ave with a 60” RCP from Anaheim to Allec.
- Replacing the existing 36” RCP in Manchester Ave with a 42” RCP from Harbor to Interstate 5 Freeway.
- Constructing a 3'x5' RCB parallel to the existing 2-6' x 5' DRCB in Anaheim Blvd from Disney Way to Anaheim Way.
- Replacing the existing 63” RCP in Anaheim with a new 8’ x 5’ RCB from Katella to Disney Way.
- Replacing the existing 42” RCP in Walnut St with a 48” RCP from Katella to Kimberly.
- Replacing the existing 63” & 60” RCP on the northerly side of Katella with 10’ x 5’ RCB between Anaheim and Harbor.
- Constructing a 5’x7’ RCB parallel to the existing 12’x7’ RCB on the northerly side of Katella from Harbor to halfway between Harbor and Disneyland.
- Constructing a 8’x7’ RCB parallel to the existing 12.5’ x 7.5’ RCB on the northerly side of Katella halfway between Harbor and Disneyland to Walnut.
- Constructing a 11’x4’ DRCB squash box parallel to the existing 10’x4’ TRCB just upstream of Walnut on Katella.
- Constructing a 10’x8.5’ RCB parallel to the existing 2-8’x8.5’ RCB on Katella from Ninth to Walnut.
- Replace the existing 96” RCP with a 9.5’x8’ TRCB, connecting both the existing 8’x8.5’ DRCB and the proposed 10’x8.5’ RCB together, routing the combined flow into the ABC Channel.
- Replacing the existing 27” RCP with a 30” RCP on Ninth St from Katella to Holgate.

On Katella Avenue at Ninth St, there is an existing inverted siphon that passes underneath a 24” sewer line that will require a more detailed analysis during the final design.

In order to minimize the size of the storm drain improvements in Katella Ave., this report also recommends the City consider constructing a retarding basin within one or both of the following sites:

1. The north portion of the parking lot on the south side of Katella Ave between S. Harbor Blvd and S. Haster St.
2. The existing commercial lot at the northeast corner of the intersection of East Katella Ave and South Haster St.

Refer to Section 3.2 for more information.
10.4 Cost Estimates

Summarized in Table 14 are the construction cost estimates by project location for Drainage Area 22. The cost estimates were prepared as discussed in Section 4.4. The detailed cost estimates for Drainage Area 22 can be found in Appendix E.
Table 14 – Drainage Area 22 Cost Estimate (2008 Dollars)

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Allec St (from Cerritos to 1425' N/O Cerritos)</td>
<td>New</td>
<td>51” RCP</td>
<td>$835,000</td>
</tr>
<tr>
<td>22</td>
<td>Allec St (from 1425' N/O Cerritos to 2015' N/O Cerritos)</td>
<td>New</td>
<td>39” RCP</td>
<td>$316,000</td>
</tr>
<tr>
<td>22</td>
<td>Palais Rd (from Anaheim to Claudina)</td>
<td>New</td>
<td>45” RCP</td>
<td>$384,000</td>
</tr>
<tr>
<td>22</td>
<td>Claudina St (from 925’ N/O Palais to Palais)</td>
<td>New</td>
<td>42” RCP</td>
<td>$371,000</td>
</tr>
<tr>
<td>22</td>
<td>Guinida Ln (between Palm &amp; Iris)</td>
<td>New</td>
<td>39” RCP</td>
<td>$145,000</td>
</tr>
<tr>
<td>22</td>
<td>Palm St (from Winston to 250' N/O Winston)</td>
<td>New</td>
<td>39” RCP</td>
<td>$265,000</td>
</tr>
<tr>
<td>22</td>
<td>Winston Rd (from Palm to Claremont)</td>
<td>New</td>
<td>39” RCP</td>
<td>$1,052,000</td>
</tr>
<tr>
<td>22</td>
<td>Cerritos Ave (from Anaheim to Allec)</td>
<td>Replacement per Alternative 3</td>
<td>60” RCP</td>
<td>$1,208,000</td>
</tr>
<tr>
<td>22</td>
<td>Anaheim Blvd (Disney Way to Anaheim Way)</td>
<td>New per Alternative 3</td>
<td>3'X5' RCB</td>
<td>$343,000</td>
</tr>
<tr>
<td>22</td>
<td>Manchester Ave (from Harbor to 5-Fwy)</td>
<td>Replacement per Alternative 3</td>
<td>42” RCP</td>
<td>$460,000</td>
</tr>
<tr>
<td>22</td>
<td>Walnut St (from Katella to Kimberly)</td>
<td>Replacement per Alternative 3</td>
<td>48” RCP</td>
<td>$143,000</td>
</tr>
<tr>
<td>22</td>
<td>Ninth St (between Katella and Holgate)</td>
<td>Replacement per Alternative 3</td>
<td>30” RCP</td>
<td>$7,859,000</td>
</tr>
<tr>
<td>22</td>
<td>Katella Ave (from ABC to Bayless)</td>
<td>Replacement per Alternative 3</td>
<td>9.5’X8’ TRCB</td>
<td>$13,381,000</td>
</tr>
<tr>
<td>22</td>
<td>Katella Ave (from Bayless to Walnut)</td>
<td>New per Alternative 3</td>
<td>10’X8.5’ RCB</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Katella Ave (Squash box upstream of Walnut)</td>
<td>New per Alternative 3</td>
<td>11’X4’ DRCB</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Katella Ave (North side from Walnut to Midway between Disneyland Dr and Harbor)</td>
<td>New per Alternative 3</td>
<td>8’X7’ RCB</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Katella Ave (North side from midway between Disneyland Dr and Harbor to Harbor)</td>
<td>New per Alternative 3</td>
<td>5’X7’ RCB</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Katella Ave (North side from Anaheim to Harbor)</td>
<td>Replacement per Alternative 3</td>
<td>10’X5’ RCB</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL                                                   | $13,381,000
10. Drainage Area 23

Drainage Area 23 drains approximately 266 acres, and is generally bounded by West Street and Jacalene Lane on the east, the City of Garden Grove on the south, Euclid Street on the west, and Katella Avenue on the north. Generally, runoff from 72% of Drainage Area 23 flows over land and then eventually captured into the main storm drain pipe on Orangewood Avenue. This pipe flow continues to travel from east to west. It turns north on Euclid Street and eventually discharges into the ABC Channel. Runoff from Stoddard Park is collected at a sump inlet within the Park and is pumped directly into the ABC Channel, without impacting runoff on any of the City streets. Runoff from a small portion (8%) of Drainage Area 23, immediately west of Stoddard Park, sheet flows to inlets at the intersection of Eileen Drive and Flippen Way, and drains directly into the ABC Channel. The east portion of Drainage Area 23 located east of Jannette Lane surface drains southerly via Jacalene Lane across the city boundary and into the City of Garden Grove.

Lastly, the remaining south portion of Drainage Area 23, located south of Orangewood Avenue, surface drains across the city boundary and into the City of Garden Grove. However, the city boundary encloses this area from the West, South, and East. Runoff on Cindy Lane and Ord Way flows toward the west boundary, turns south on Euclid Street and flows across the city boundary approximately 100 feet south of Ord Way. Runoff on Della Lane, Loara Street, and Waverly Way flows across the city boundary to the South. Finally, surface flow from Atlanta Street travels south and turns east on Ord Way and flows across the city boundary to the East and into the City of Garden Grove.

11.1 Hydrologic Analysis

The hydrologic analysis was performed for Drainage Area 23 in accordance with the criteria outlined in Chapter 3 and can be found in Appendix C. The hydrology map for Drainage Area 23 can be found in Appendix D. The following table shows the flow rates at the outlet of the Drainage Area for 10-, 25-, and 100-year storm events.
11.2 Analysis of Existing Improvements

Presently the major storm drain in Drainage Area 23 runs along Euclid St to Orangewood Avenue, and along Orangewood Avenue to Ninth St.

The City’s flooded width criteria are not satisfied along Wakefield Avenue from Gail Lane to Jannette Lane, Gail Lane from Wakefield to Orangewood Avenue, Orangewood Avenue from Gail Lane to Ninth Street and from Eileen Drive to Euclid Street, and lastly Euclid Street from Cindy Lane to the southern city boundary near Ord Way.

The existing street flow hydraulic calculations for Drainage Area 23 can be found in Appendices A and B.

11.3 Proposed Improvements

As discussed under Section 11.2, several streets in Drainage Area 23 do not meet the City’s allowable flood width requirement. This report recommends constructing the following storm drain improvements to convey the full flow of the 10 year storm along the following street segments:

- Install 870 Ft of 51” RCP in Wakefield Ave from Janette Lane to S. Gail Lane and in S. Gail Lane from Wakefield Ave to Orangewood Ave
- Install 210 Ft of 54” RCP in Orangewood Ave from S. Gail Lane to Ninth St.
- Install 870 Ft of 33” RCP in Euclid Street from Cindy Lane to the southern most city boundary (near Ord Way). The adjacent City of Garden Grove has a proposed 39”

Table 15 – Drainage Area 23 Summary of Hydrology

<table>
<thead>
<tr>
<th>Node</th>
<th>Location</th>
<th>Drainage Area (ac)</th>
<th>10-Year Flow (cfs)</th>
<th>25-Year Flow (cfs)</th>
<th>100-Year Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2307</td>
<td>Jacalene Lane at City Boundary</td>
<td>35</td>
<td>44</td>
<td>54</td>
<td>71</td>
</tr>
<tr>
<td>2383</td>
<td>Waverly Way at City Boundary</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>2388</td>
<td>Ord Way at City Boundary</td>
<td>8</td>
<td>11</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>2389.3</td>
<td>Loara St at City Boundary</td>
<td>9</td>
<td>11</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>2390.4</td>
<td>Della Lane at City Boundary</td>
<td>9</td>
<td>13</td>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>2391.6</td>
<td>Euclid St at City Boundary</td>
<td>19</td>
<td>22</td>
<td>27</td>
<td>36</td>
</tr>
<tr>
<td>2373</td>
<td>Flippen Dr at ABC Channel</td>
<td>18</td>
<td>28</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>2359</td>
<td>Euclid St at ABC Channel</td>
<td>164</td>
<td>146</td>
<td>185</td>
<td>248</td>
</tr>
</tbody>
</table>
RCP to be installed beginning at this same (city boundary) location to carry the flow further south along Euclid St. It is recommended that this 33” RCP be installed concurrently, and be tied into the City of Garden Grove’s 39” RCP.

As shown in Appendix B, in order to meet the flood width criteria, it will be necessary to improve the storm drain capacity in Orangewood Ave between Euclid St and Ninth St.

Alternatives 1 and 2 below provide the approximate sizes of conduits to replace or augment the existing storm drain capacity in Orangewood Ave., respectively.

**Drainage Area 23 Alternative Improvements:**

**Alternative 1 (Recommended)** - This Alternative calls for:

- Replacing the existing 72” RCP in Orangewood Ave from Eileen Dr to Euclid St.
- Replace the existing 72” RCP in Euclid St. with a new 96” RCP from Orangewood Ave to the ABC Channel.
- Construct 2- 9’x3’ RCB squash boxes in parallel with the existing 10’x3’ RCB at the corner of Orangewood and Euclid.
- Construct 2- 9’x3’ RCB squash boxes in parallel with the existing 10’x3’ RCB in Euclid just upstream of the ABC Channel.

**Alternative 2** - This Alternative calls for:

- Constructing a 75” RCP parallel to the existing 72” RCP in Orangewood Ave from Eileen Dr to Euclid St.
- Constructing a 75” RCP parallel to the existing 72” RCP in Euclid St from Orangewood Ave to the ABC Channel.
- Construct 2- 9’x3’ RCB squash boxes in parallel with the existing 10’x3’ RCB at the corner of Orangewood and Euclid.
- Construct 2- 9’x3’ RCB squash boxes in parallel with the existing 10’x3’ RCB in Euclid just upstream of the ABC Channel.

In order to determine the full cost of Alternative 2, it will be necessary to perform detailed analysis of its impact on the existing utilities. Since that level of analysis is beyond the scope of this report, it is recommended to use Alternative 1 for budgeting purposes. However, during final design, it is recommended to analyze the feasibility of constructing the parallel storm drains in Alternative 2.
11.4 Cost Estimates

Summarized in Table 16 are the construction cost estimates by project location for Drainage Area 23. The cost estimates were prepared as discussed in Section 4.4. The detailed cost estimates for Drainage Area 23 can be found in Appendix E.

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Street</th>
<th>Type of Facility</th>
<th>Size</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Wakefield Ave (from Gail to Janette)</td>
<td>New</td>
<td>51&quot; RCP</td>
<td>$402,000</td>
</tr>
<tr>
<td>23</td>
<td>Gail Ln (from Orangewood to Wakefield)</td>
<td>New</td>
<td>51&quot; RCP</td>
<td>$515,000</td>
</tr>
<tr>
<td>23</td>
<td>Orangewood Ave (from Ninth to Gail)</td>
<td>New</td>
<td>54&quot; RCP</td>
<td>$151,000</td>
</tr>
<tr>
<td>23</td>
<td>Orangewood Ave (from Eileen to Euclid)</td>
<td>Replacement per Alternative 1</td>
<td>96&quot; RCP</td>
<td>$1,431,000</td>
</tr>
<tr>
<td>23</td>
<td>Euclid St (from Cindy to city boundary near Ord Way)</td>
<td>New</td>
<td>33&quot; RCP</td>
<td>$323,000</td>
</tr>
<tr>
<td>23</td>
<td>Euclid St (from Orangewood to ABC Channel)</td>
<td>Replacement per Alternative 1</td>
<td>96&quot; RCP w/ 2-9'X3' RCB Squash Boxes</td>
<td>$707,000</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>$3,529,000</td>
</tr>
</tbody>
</table>
11. Storm Drain Impact and Improvement Fee

To finance storm drain improvements and to mitigate the flooding and storm drainage impacts caused by new development and/or by additions and expansions to existing development within the South Central City Area of the City of Anaheim, the City Council previously adopted an ordinance and storm drain impact fee. The ordinance for storm drainage impact and improvement fee for the South Central Area can be found under Chapter 10.14 of the Anaheim Municipal Code.

The storm drain impact fees for the South Central Area can be obtained from the current Fee Schedule of the City of Anaheim Department of Public Works. A portion of the ABC Channel Tributary Area is within the South Central Area and the storm drain impact and improvement fee will be used to finance the improvements for this area which includes Drainage Areas 14 and 19 through 23. Table 17 provides a total summary cost estimate for these Drainage Areas, as well as Drainage Areas 4 and 12, which are outside the boundaries of the South Central Area.

Table 17 – Cost Summary of Storm Drainage in ABC Channel Tributary Area (2008 Dollars)

<table>
<thead>
<tr>
<th>Drainage Area</th>
<th>Cost (2008 Dollars)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Area 4</td>
<td>$3,807,000</td>
</tr>
<tr>
<td>Drainage Area 12</td>
<td>$16,357,000</td>
</tr>
<tr>
<td>Drainage Area 14</td>
<td>$6,723,000</td>
</tr>
<tr>
<td>Drainage Area 19</td>
<td>$13,867,000</td>
</tr>
<tr>
<td>Drainage Area 20</td>
<td>$30,952,000</td>
</tr>
<tr>
<td>Drainage Area 21</td>
<td>$2,677,000</td>
</tr>
<tr>
<td>Drainage Area 22</td>
<td>$13,381,000</td>
</tr>
<tr>
<td>Drainage Area 23</td>
<td>$3,529,000</td>
</tr>
<tr>
<td><strong>TOTAL (ABC Channel Area)</strong></td>
<td><strong>$91,293,000</strong></td>
</tr>
</tbody>
</table>