EXHIBIT A.B.

Town of Moraga

Storm Drainage Needs Study

Prepared by:

Storm Water Consulting Inc.

SWC Project No. 2006-37
December, 2006
(Updated: April, 2008)

Town of Moraga

Storm Drainage Needs Study

Moraga, California

December, 2006
(Updated: April, 2008)

Prepared by:

Storm Water Consulting Inc.

SWC Project No. 2006-37

Table of Contents

Report	Page
Introduction	**1**
Limits of Study	**3**
Field Reconnaissance and Drainage Structure Inventory	**4**
Hydrology	**5**
Capacity Evaluations and Proposed Upgrades	**7**
Upgrade and Replacement Infrastructure Costs	**8**
Impact Fees	**11**
Storm Drainage Design Guidelines for New Development	**15**
Dual-Use Facility Design Guidelines	**17**
References	**19**

List of Tables

Table 1 – Summary of 100-Year Discharges Adopted by FEMA
Table 2 – Estimated 100-Year Discharges at Selected Intermediate Locations
Table 3 – Proposed Drainage Structure Upgrades and Replacements
Table 4 – Preliminary Opinion of Probable Cost for Proposed Storm Drainage Infrastructure Upgrades and Replacements
Table 5 – Percent Impervious Values Attributable to Different Land Uses
Table 6 – Proposed Storm Drainage Impact Fees Applicable to New Development Areas

List of Exhibits

Exhibit A – Map Showing Major Creeks, Locations of Existing Drainage Structures and Proposed Drainage Upgrades
Exhibit B – Selected Sub-basin Areas Used to Prorate FEMA Discharges

Appendix

Table A-1 – Prorated Estimates of 100-Year Discharges Worksheet
Table A-2 – Capacities of Existing Drainage Structures
Table A-3 – Proposed Structures Hydraulic Data

Existing Drainage Structures Inventory Worksheets

Revised Tables 5.3 and 5.4 from AB 1600 Report (April 2008)

TOWN OF MORAGA
Storm Drainage Needs Study

Introduction

This report presents the results of a storm drainage needs study that has been performed for the Town of Moraga by Storm Water Consulting, Inc. (SWC). SWC has completed this work as a subconsultant to Harris & Associates. The report addresses storm drainage facility needs along the major creeks extending through the Town and presents technical information supporting the adoption of storm drainage impact fees that may be assessed to new development proposed in the future within the Town limits.

The following information is included in this report:

- Listing of the major creeks that have been evaluated.
- Inventory of existing drainage structures.
- Estimates of 100-year peak runoff rates along the major creeks.
- Capacity summaries for existing drainage structures.
- Recommended drainage structure upgrades and replacements.
- Opinions of probable cost for recommended drainage structure upgrades and replacements.
- Impact fee calculations.
- Storm drainage design guidelines to be applied to new development projects.
- Design guidelines for dual-use detention facilities that incorporate storm drainage and recreation elements.

Work tasks completed as a part of the preparation of this storm drainage needs study include the following:

- Review of plans, documents, base maps, standards and other pertinent information made available by the Town.
- Review of *Stormwater Requirements for Development Applications (Stormwater C.3 Guidebook)* as published by the Contra Costa County Clean Water Program.

- Field reconnaissance and inventory of existing drainage structures.

- Review of the Flood Insurance Study published by the Federal Emergency Management Agency (FEMA) for the Town and the hydrologic analysis contained therein for the Town's major creeks. A subsequent prorating of discharges determined by FEMA was performed by SWC to estimate discharge magnitudes at additional locations along the major creeks.

- Identification of drainage facility upgrades and replacements that are needed along the major creeks to accommodate new development and desired system capacities. The type and size of upgrades and replacements were determined using empirical hydraulic methods and procedures contained in Hydraulic Engineering Circulars published by the U.S. Department of Transportation.

- Preparation of an opinion of probable cost for proposed storm drainage facility upgrades and replacements.

- Allocation of upgrade and replacement costs among proposed new development land uses based on a percent impervious approach. Existing and proposed land uses and acreages for development within the Town limits were provided by Harris & Associates.

- Calculation of storm drainage impact fees.

Limits of Study

This study has been limited to an evaluation of the major creeks that are listed in the FEMA Flood Insurance Study published for the Town of Moraga dated November 19, 1980. These major creeks include the following:

- Laguna Creek
- Moraga Creek
- South Branch Moraga Creek
- Larch Creek
- Ivy Drive Tributary
- Corliss Drive Tributary
- St. Mary's Road Tributary
- Las Trampas Creek

The reaches of these major creeks that were evaluated herein are the same reaches evaluated by FEMA. Essentially, all reaches of these creeks within the Town limits were included, with the exception of the upstream headwaters for a few of the creeks having smaller contributing watersheds. The major creeks are depicted on Exhibit A.

Minor creeks and local drainage concerns are outside of the scope of this study and have not been addressed herein or incorporated into the impact fee analysis.

Field Reconnaissance and Drainage Structure Inventory

A field reconnaissance was performed by Storm Water Consulting, Inc. on July 26, 2006 for the purpose of characterizing the major creeks and identifying and measuring existing cross-drainage structures and conduits (to the extent readily accessible in the field).

Drainage structures include cross-drainage facilities, consisting of short span (less than 100 feet in length) pipes, box culverts, or bridge crossings at streets and private driveways and long span (several hundred feet in length) storm drainage conduits under existing buildings, structures, streets, open space areas and parking facilities. Decorative bridge crossings of Moraga Creek within the Moraga Country Club area were not evaluated.

As a part of the field reconnaissance effort, a field inventory and measurement process was completed to determine the location, size and hydraulic characteristics of the existing cross-drainage structures and conduits. The data that was collected included measurement of drainage structure dimensions, approximate height dimensions from invert to top of roadway, materials, shape, and a description of inlet conditions. Photographs were also taken of these drainage structures and conduits.

The drainage structures and conduits were named and have been labeled and listed (including their sizes and types) on Exhibit A. Drainage structure inventory data sheets are included in the Appendix. Photographs of the drainage structures are not included in this report, but electronic versions have been separately provided to the Town.

Hydrology

The FEMA Flood Insurance Study for the Town of Moraga includes the results of hydrologic analyses that were performed for the Town's major creeks using a regional regression analysis. As a part of preparing the Flood Insurance Study (in conjunction with the accompanying Flood Insurance Rate Maps and Flood Boundary and Floodway Maps), FEMA determined regulatory floodplain limits for the 100-year and 500-year return period storm events and determined peak discharges and water surface elevations for the 10-year, 50-year, 100-year and 500-year return period storm events at designated locations along the study creeks. Given that the 100-year return period storm event is the regulatory storm event that is applied to major creeks mapped by FEMA per the Town's Flood Hazard Area Regulations (Moraga Municipal Code, Title 8, Chapter 8.108), the 100-year storm was adopted as the appropriate level of service for major drainage facilities serving the Town in this storm drainage needs study. 100-year peak discharges determined by FEMA for the Town's major creeks are listed on Table 1 below.

Table 1
Summary of 100-Year Discharges Adopted by FEMA

Major Creek Name (and) - Location on Creek	**Drainage Area (square miles)**	**100-Year Discharge (cubic feet per second)**
Moraga Creek		
- At Corporate Limits	2.0	1100
- At Confluence w/ Laguna Creek	7.0	3800
- At Upper San Leandro Reservoir	9.9	5000
Ivy Drive Tributary		
- At Confluence w/ Moraga Creek	0.5	310
Larch Creek		
- At Larch Avenue	0.3	150
South Branch Moraga Creek		
- At Corporate Limits	1.2	640
- At Confluence w/ Moraga Creek	2.1	1050
Laguna Creek		
- At Rheem Boulevard	1.5	850
- At Corliss Drive	2.4	1300
- At Confluence w/ Moraga Creek	3.8	2100
Corliss Drive Tributary		
- At Confluence w/ Laguna Creek	0.4	280
St. Mary's Road Tributary		
- At Confluence w/ Laguna Creek	0.8	480
Las Trampas Creek		
- At St. Mary's Road	3.2	1500

In the FEMA Flood Insurance Study, 100-year peak discharges were not computed at every drainage structure location and were only computed at specific locations along each major creek. As a part of preparing this storm drainage needs study, it was also necessary to formulate estimations of intermediate 100-year peak discharges at several locations in an effort to derive a reasonable value to be applied to capacity evaluations for each drainage structure. This was accomplished by dividing applicable 100-year peak discharges contained in the FEMA Flood Insurance Study by their contributing watershed areas to determine unit discharge rates in cubic feet per second (cfs) per acre. Once cfs/acre values were computed for applicable locations on a given major creek from the FEMA Flood Insurance Study, the watershed areas contributing runoff to selected intermediate drainage structure locations were delineated on U.S. Geological Survey quadrangle maps and were measured in acres. Delineations of these intermediate watershed areas are shown on Exhibit B. The computed watershed areas (acres) were multiplied by the applicable unit discharge rates (cfs/acre) for the appropriate creek and location to derive a 100-year peak discharge estimate at intermediate locations. Table 2, below, provides estimates of 100-year discharges at intermediate locations along the major creeks. A more complete table that presents the derivation of unit discharge rates and 100-year discharge estimates at selected intermediate locations is provided on Table A-1 contained in the Appendix.

Table 2
Estimated 100-Year Discharges at Selected Intermediate Locations

Major Creek Name (and) - Location on Creek	**Drainage Area (acres)**	**100-Year Discharge (cubic feet per second)**
Laguna Creek		
- At Woodford Drive	91	81
- At SE Corner Campolindo HS	232	206
- At Carroll Ranch	561	499
St. Mary's Road Tributary		
- At Stafford Drive	85	80
South Branch Moraga Creek		
- At Camino Pablo Road	883	715

Capacity Evaluations and Proposed Upgrades

The capacities of each cross-drainage structure and conduit were estimated using empirical hydraulic methods and procedures contained in the publication entitled *Hydraulic Design of Highway Culverts, Hydraulic Design Series No. 5* dated September 1985, published by the U.S. Department of Transportation. For short culverts (pipe or box) that cross local streets and roadways, inlet conditions will control culvert capacity, and inlet control charts were used to determine capacity based on available headwater (HW), culvert geometry, culvert material, and inlet conditions. The capacities of long culverts that function as storm drainage conduits are controlled by culvert geometry, roughness, and slope and were determined based on uniform flow, in the absence of more detailed design information. For uniform flow, the energy grade line in the conduit is parallel to the invert profile, and Manning's equation can be used to compute the normal flow depth. Table A-2 contained in the Appendix shows the capacity of existing drainage structures based on inlet control or uniform flow conditions.

The estimated 100-year discharges were subsequently compared with the conveying capacities of the existing cross-drainage structures and conduits. In general, the capacity evaluations indicated that the majority of the Town's drainage structures serving the major creeks equaled or exceeded the level of service standard of the 100-year return period storm. However, if an existing drainage structure was determined to have less than the necessary capacity to convey the estimated 100-year peak discharge, that drainage structure was selected to be upgraded or replaced, with sizing being established using the inlet control and uniform flow capacity approach that was used to evaluate the capacities of existing drainage structures. Proposed drainage structure upgrades and replacements are shown on Table 3, below. Drainage structure locations are depicted on Exhibit A. Table A-3 in the Appendix provides a more detailed listing of these drainage structure upgrades and replacements and includes pertinent hydraulic data.

Table 3
Proposed Drainage Structure Upgrades and Replacements

Major Creek	Structure I.D.	Proposed Upgrade/Replacement
Laguna Creek	LC2A	1 – 54" RCP
	LC2B	2 – 54" RCPs
	LC3A	1 – 84" RCP
	LC3B	1 – 8' X 8' CBC
	LC5	Add 2 – 96" RCPs
	LC9	2 – 10' x 8' CBCs
St. Mary's Road Tributary	STM1	Add 1 – 60" CMP & Headwall
	STM3	Add 1 – 36" HDPE Pipe
Ivy Drive Tributary	ID2	Add 1 – 48" RCP
South Branch Moraga Creek	SMC2	Add 1 – 78" CMP

Upgrade and Replacement Infrastructure Costs

The cost of constructing the recommended upgrades and replacements to the Town's storm drainage facilities listed on Table 3 has been estimated to be $3,727,510 as shown on Table 4. The cost estimate is a current order of magnitude estimate that utilizes unit costs that have been selected based on a review of recent construction bids for similar projects, previous studies, and industry standardized cost data. They are tied to the June 2006 Engineering News Record Construction Cost Index (ENR CCI) of 8441 for the San Francisco Average, and should be adjusted accordingly for future construction time frames.

The proposed replacement of selected existing drainage conduits along Laguna Creek (Structure #'s LC2B, LC3A, AND LC3B) will require extensive excavation as the depth of existing facilities along these structure segments varies between 15 feet and 30 feet. An additional line item has been added to the cost estimate for these deeper facilities to represent deep excavation, based on an assumed trench side slope of 1.5:1 in conformance with CAL/OSHA requirements.

The estimated costs are considered "order of magnitude" estimates and are acceptable for use in initial budgeting and for impact fee calculation purposes. Final project costs will be dependent on a number of factors at the time of bidding, including final design and project scope of work, labor and material costs, number of competing projects, allotted construction schedule, and time of year, among other things. Order of magnitude estimates are appropriate for planning level work, but it is important to note that they have been made without the benefit of detailed project specifications and design drawings.

Included in the cost estimate shown on Table 4 are soft cost mark-ups to account for additional requirements associated with administrative, management and design work, as well as contingencies. These soft cost mark-ups are considered to fall into the following four (4) categories:

Construction Contingency – Due to the fact that there are many unknowns related to a given project at the master planning level (i.e. site conditions, unforeseen constraints, details of design alternatives, construction schedule uncertainty, etc.), a 15 percent construction contingency is added to the construction cost estimate.

Design and Planning – These services typically include management of consultant agreements, preliminary site investigations, feasibility studies, plans and specifications, surveying and staking, and geotechnical reports. The cost of this work is estimated to be 10 percent of the estimated construction cost.

Construction Management – This category primarily covers management of the construction contract, sampling and testing of materials, and site inspections

during construction. This work is estimated to be 10 percent of the estimated construction cost.

Program Implementation – Among other things, this category includes management and administrative costs, environmental review, permits, regulatory compliance, financing expenses, and legal review. This work is also estimated to be 5 percent of the estimated construction cost.

The actual costs for each item category of the soft cost mark-ups will vary according to many individual project factors (i.e. complexity of the project, existing site conditions, etc.), but, in general, they are supported historically as appropriate mark-up estimates for planning purposes (standardized as a percentage relative to the estimated construction cost).

TABLE 4
TOWN OF MORAGA - STORM DRAINAGE NEEDS STUDY
Proposed Storm Drainage Infrastructure Upgrades and Replacements
PRELIMINARY OPINION OF PROBABLE COST

Item	Linear Feet	Cubic Yards/ Linear Foot	Quantity	Unit	Unit Cost	Total Cost
Cross-Culverts and Conduits						
LC2A (1 - 54" RCP)	400		400	LF	450	180,000
LC2B (2 - 54" RCPs)	400		800	LF	450	360,000
LC2B (Deep Excavation)	400	19.167	7,667	CY	10	76,668
LC3A (1 - 84" RCP)	600		600	LF	900	540,000
LC3A (Deep Excavation)	600	43.981	26,389	CY	10	263,886
LC3B (1 - 8' x 8' CBC)	300	1.115	335	CY	1000	334,500
LC3B (Deep Excavation)	300	61.111	18,333	CY	10	183,333
LC5 (Add 2 - 96" RCPs, 230 LF, Each)	230		460	LF	1000	460,000
LC9 (2 - 10' x 8' CBCs)	30	1.804	54	CY	1000	54,120
STM1 (Add 1 - 60" CMP and Headwall)	150		150	LF	500	75,000
STM3 (Add 1 - 36" HDPE Pipe)	50		50	LF	300	15,000
ID2 (Add 1 - 48" RCP)	100		100	LF	400	40,000
SMC2 (Add 1 - 78" CMP)	100		100	LF	800	80,000
Subtotal Construction						**$ 2,662,507**
Design and Planning @ 10%						266,251
Construction Management @ 10%						266,251
Contingency @ 15%						399,376
Program Implementation @ 5%						133,125
TOTAL ESTIMATED COST						**$ 3,727,510**

In providing this preliminary opinion of probable cost, it is recognized that the Town, Harris & Associates and Storm Water Consulting do not have control over the costs of labor, equipment or materials, or over the Contractor's methods of determining prices or bidding. This preliminary opinion of probable cost is based on reasonable professional judgment and experience and does not constitute a warranty, express or implied, that the Contractor's bids or the negotiated price of the Work will not vary from the values contained herein.

Impact Fees

The Town has previously invested in the funding and construction of its existing storm drainage infrastructure, which includes many pipes, culverts, and bridges. These facilities have been constructed using a variety of funding sources. New development will increase the rate and/or duration of runoff production during the 100-year storm and other storms by replacing natural ground cover with varying degrees of impervious surfaces, such as streets, buildings, parking areas, and hardscape features. The storm drainage facility upgrades and replacements recommended in this study will accommodate the additional runoff attributable to new development during the 100-year storm. At the same time, existing storm drainage facilities that are not proposed to be upgraded or replaced will benefit new development by facilitating its use of available capacity and excess capacity.

The implementation of storm water quality measures as a part of new development in conformance with requirements set forth per the Contra Costa County Clean Water Program (which is addressed further in the following section of this study), will mitigate the impact of new development for lower magnitude storms having shorter return periods. However, these measures will not mitigate increases in the rates and/or durations of runoff produced by new development during major storms such as the 100-year storm.

It is recommended that the upgrades and replacements identified in this study be funded by new development through the adoption of storm drainage impact fees. Recommended impact fees have been calculated in this study based on a fair share allocation of costs among new residential units and acres of new non-residential development. Assumptions regarding future new development within the Town (land use, acreages, and number of units within residential land use areas) have been provided by Town staff as assisted by Harris & Associates. The fair share allocation of costs acknowledges that different land uses have differing levels of runoff production. This is due to differences in the amount of *impervious surfaces* inherently incorporated into new development for a given land use. For example, an acre of single family residential development will generate less runoff than an acre of commercial development, as the commercial land use creates a greater amount of impervious ground cover (buildings, parking lots, etc.).

Based on prior experiences, technical information and design standards adopted by other communities, the percent impervious values represented on Table 5 have been utilized in the fair share allocation of costs in the impact fee analysis.

Table 5
Percent Impervious Values Attributable to Different Land Uses

Land Use Classification	Percent Impervious
Single Family Detached Residential	40%
Multi-Family Residential	55%
Senior Housing	70%
Commercial	90%
Hotel	90%

In calculating storm drainage impact fees, the following new development areas were excluded from the fair share cost allocation:

- *Palos Colorados* – This project is an "approved" project for which development requirements have already been established.

- *Indian Valley* – This proposed project in its entirety will drain to Indian Creek which discharges to San Leandro Creek at the upper San Leandro Reservoir, south of the Town Limits. As such, this proposed development will not drain to any of the major creeks traversing through the Town.

- *Eastern 2/3 of the Northeast Area (including Ranch Laguna)* – This proposed new development area will drain to Las Trampas Creek and the City of Lafayette to the east and north of the Town limits. As such, this development area will not drain to any of the major creek segments traversing through the Town.

- *Bollinger* – This proposed project in its entirety will drain to Las Trampas Creek and the City of Lafayette to the north. No storm drainage upgrades are proposed within the easternmost portions of the Town that drain to Las Trampas Creek.

These new development areas will not be required to pay the storm drainage impact fees presented in this study. Site specific development requirements for these projects will be established at the time that the environmental review and development review processes are initiated by the Town.

The procedure used to calculate storm drainage impact fees is detailed below:

1. The total upgrade and replacement infrastructure cost to be shared by new development was estimated to be $3,727,510.

2. New development acreages by land use category were converted to percentages of the total new development acreage.

3. The percentages of total new development acreage for each land use category were weighted by their *percent impervious cover* value and proportional funding factors were recomputed (in percent) for each land use category, with the composite values totaling 100%.

4. The total infrastructure cost was multiplied by the proportional funding percentage for each land use to yield the total funding responsibility pertinent to each land use, in dollars.

5. The total funding responsibility for each land use was divided by the number of acres attributable to each land use to yield a “per acre” impact fee for each land use category.

6. For the residential land use categories, the total funding responsibility for each land use was also divided by the number of units attributable to each residential land use type to yield a “per residential unit” impact fee.

These calculations and the recommended storm drainage impact fees to be assessed to new development areas within the Town (excluding the new development areas cited on the previous page) are presented on Table 6.

TABLE 6
TOWN OF MORAGA - STORM DRAINAGE NEEDS STUDY
Proposed Storm Drainage Impact Fees Applicable to New Development Areas - Bollinger, Indian Valley and Portion of Northeast Excluded

Total Infrastructure Cost	Land Use Category	Acreage by Land Use Category	Proportional Land Use Area	Percent Impervious	Proportional Funding Factor (Land Use % times % Impervious)	Proportional Funding Responsibility (Funding Factor % of Total)	Total Fee Responsibility	Impact Fee (Per Acre)	Total Planned Residential Units	Impact Fee (Per Residential Unit)
	Single Family Detached Residential	179.5	89.44%	40%	0.3577	82.6%	$ 3,080,516	$ 17,162	408	$ 7,550
	Multi-Family Residential	8.0	3.99%	55%	0.0219	5.1%	$ 188,778	$ 23,597	50	$ 3,776
$ 3,727,510	Senior Housing	6.0	2.99%	70%	0.0209	4.8%	$ 180,197	$ 30,033	200	$ 901
	Commercial*	5.0	2.49%	90%	0.0224	5.2%	$ 193,069	$ 38,614	N/A	N/A
	Hotel	2.2	1.10%	90%	0.0099	2.3%	$ 84,950	$ 38,614	N/A	N/A
		200.7	100.00%		0.4329	100.0%	$ 3,727,510			

*Includes Mixed Use Commercial Units

Storm Drainage Design Guidelines for New Development

This section discusses storm drainage requirements associated with the Contra Costa Clean Water Program and recommended additional storm drainage requirements for new development areas within the Town.

Contra Costa Clean Water Program

Contra Costa County and its municipalities (including the Town of Moraga) are governed by an NPDES Municipal Stormwater Permit established by the California Regional Water Quality Control Board. This NPDES permit was amended in 2003 by Water Quality Order No. R2-2003-0022, with the amendment incorporating a provision that established additional requirements that are separate from and in addition to requirements for erosion and sediment control and pollution prevention measures during construction already in effect per the NPDES permit and other Water Quality Orders. The added provision is referred to as the "C.3" requirements associated with the NPDES permit.

The C.3 requirements are described in detail in a document published by the Contra Costa Clean Water Program entitled *Stormwater Quality Requirements for Development Applications, Stormwater C.3 Guidebook,* dated October 2006. The document cites that "Every application for a development project, including but not limited to a rezoning, tentative map, parcel map, conditional use permit, variance, site development permit, design review, or building permit that is subject to the development runoff requirements in the Contra Costa Countywide NPDES Municipal Stormwater Permit shall be accompanied by a Stormwater Control Plan that meets the criteria in the most recent version of the Contra Costa Clean Water Program *Stormwater C.3 Guidebook".*

The most current version of the *Stormwater C.3 Guidebook* includes the following measures and statements:

- Requirements apply to projects that create or replace impervious area totaling 10,000 square feet or more.
- Project site designs must minimize the area of new roofs and impervious paving.
- Runoff from impervious areas must be captured and treated.
- The required Stormwater Control Plan must identify potential sources of stormwater pollutants in the development and corresponding Best Management Practices to apply to each potential source.
- Projects that create or replace an acre or more of impervious area must ensure that runoff does not exceed pre-project peaks and durations. This

requirement numerically applies to the more frequent runoff producing storm events and not rare storm events, such as the 100-year storm.

- Applicants must prepare operation and maintenance plans and execute agreements to ensure the stormwater treatment devices are maintained in perpetuity.

The *Stormwater C.3 Guidebook* contains specific requirements and procedures for sizing and designing facilities and for preparing the Stormwater Control Plan and should be consulted and utilized as a part of the design of new development projects in the Town of Moraga.

Recommended Additional Storm Drainage Requirements

In conjunction with implementing the C.3 requirements for new development, the following additional measures are recommended, as applicable:

- If the proposed development does not discharge runoff directly to one of the major creeks listed in this study, the capacity of the creeks and/or storm drainage facilities that will convey discharged runoff to one of the major creeks will need to be analyzed to determine if there is an increased potential for downstream flooding. If any significant increased potential for downstream flooding is noted, the potential condition will need to be mitigated by augmented onsite detention and/or appropriate downstream capacity enhancing improvements as a development requirement.

- Points of drainage discharge shall be consistent with existing conditions, unless there is a public interest in making minor adjustments that result in a reduction in downstream flooding potential.

- Major creeks and minor tributaries should be retained in their natural or current condition to the degree possible.

- Segments of major creeks passing through or adjacent to new development areas shall be dedicated to the Town as a condition of project development.

Dual-Use Facility Design Guidelines

The larger new development projects proposed within the Town may be required to incorporate onsite stormwater detention measures to attenuate peak runoff rates discharged downstream to pre-development levels. By combining lands allocated to stormwater detention with lands allocated to parks, the Town may be able to effectively increase its available park land by utilizing functional dual-use design practices within consolidated facilities. Many communities have been able to effectively convert stormwater lands to dual-use facilities that augment the size and functionality of active and passive recreation sites.

An optimized dual-use detention facility will serve to:

- Maximize efficient use of land
- Satisfy detention needs for reducing peak flood flows
- Provide water quality treatment
- Expand community recreational opportunities, with minimal "down time" for recreation elements
- Incur reasonable maintenance requirements and costs
- Serve as a functional open space amenity.

There are several fundamental guidelines that should be followed when incorporating recreation elements into stormwater detention facilities. They are:

- Low flow must be accommodated in a manner that confines the frequent inundations to areas that will create minimal nuisance or disruption of recreational uses and will characteristically require only limited maintenance.
- Contouring within detention facilities is recommended to create internal elevation variations (or tiers) that have differing frequencies and depths of inundation and differing flood risk.
- Internal drainage within detention facilities should provide for positive flow across elevated tiers and to the lowest lying areas of the facilities.
- Internal slopes should be flat enough to allow for mowing of turf areas and to allow other routine recreational-related maintenance activities to occur.
- Hydraulic design components should be included as needed (inflow structures, outflow structures, pump stations, sediment basins, spillways, surcharge structures, etc.).

- Other requirements as dictated by jurisdictional regulations and policies, local site conditions or additional functional uses should be followed.

In general, passive recreational elements should be incorporated in portions of detention facilities having the greatest potential flood risk and frequency. Active recreation elements are more suitable in areas within detention facilities having lesser degrees of flood risk and frequency.

References

Aliquot Associates, Inc., May 1983. *Improvement Plans, Carroll Ranch.*

CAL/OSHA, February 2006. *California Code of Regulations, Title 8, Subchapter 4: Construction Safety Orders, Article 6: Excavations, Section 1541.1: Requirements for Protective Systems.*

California Regional Water Quality Control Board, San Francisco Bay Region, February 19, 2003. *Contra Costa Countywide NPDES Municipal Stormwater Permit Amendment, Order No. R2-2003-0022.*

Contra Costa County Clean Water Program, October 2006. *Stormwater Quality Requirements for Development Applications, Stormwater C.3 Guidelines.*

Contra Costa County Clean Water Program Website, 2006.

Federal Emergency Management Agency (FEMA), November 19, 1980. *Flood Insurance Study, Town of Moraga, California, Contra Costa County.*

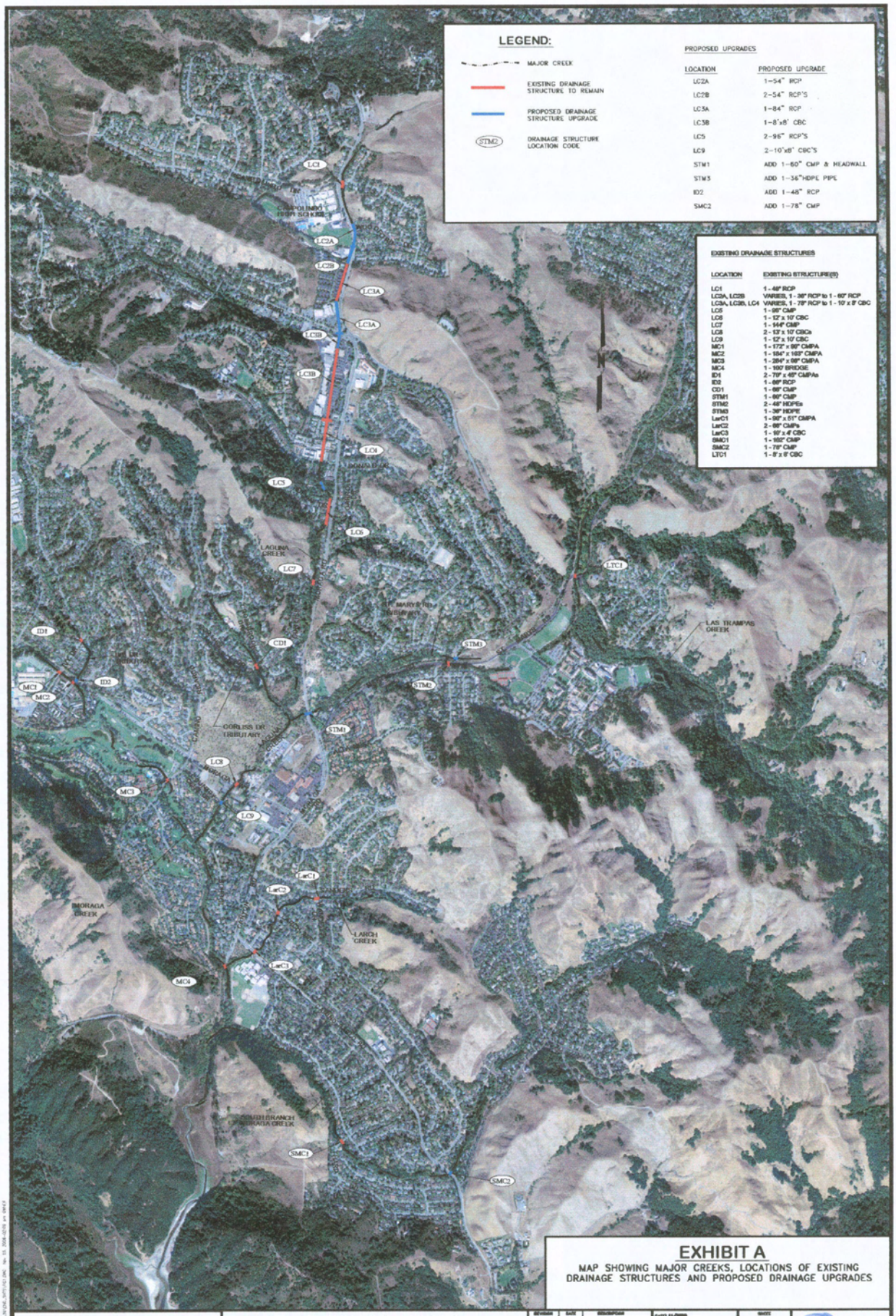
Federal Emergency Management Agency (FEMA), May 19, 1981. *Flood Boundary and Floodway Maps, Town of Moraga, California, Panels 2, 3, 4, 6, and 7.*

Harris & Associates, June 2006. *Town of Moraga Vacant Acres and Land Use Assumptions.*

Terraserver/Air Photo USA, November 2005. *Aerial Photography.*

U.S. Department of Transportation, Federal Highway Administration, September 1985. *Hydraulic Design of Highway Culverts, Hydraulic Design Series No. 5.*

U.S. Geological Survey (USGS) Quadrangle Maps. *Oakland East and Las Trampas Ridge.*



LEGEND:

- MAJOR CREEK
- EXISTING DRAINAGE STRUCTURE TO REMAIN
- PROPOSED DRAINAGE STRUCTURE UPGRADE
- (STM2) DRAINAGE STRUCTURE LOCATION CODE

PROPOSED UPGRADES

LOCATION	PROPOSED UPGRADE
LC2A	1-54" RCP
LC2B	2-54" RCP'S
LC3A	1-84" RCP
LC3B	1-8'x8' CBC
LC5	2-96" RCP'S
LC9	2-10'x8' CBC'S
STM1	ADD 1-60" CMP & HEADWALL
STM3	ADD 1-36"HDPE PIPE
ID2	ADD 1-48" RCP
SMC2	ADD 1-78" CMP

EXISTING DRAINAGE STRUCTURES

LOCATION	EXISTING STRUCTURE(S)
LC1	1 - 48" RCP
LC2A, LC2B	VARIES, 1 - 36" RCP to 1 - 60" RCP
LC3A, LC3B, LC4	VARIES, 1 - 78" RCP to 1 - 10' x 8' CBC
LC5	1 - 96" CMP
LC6	1 - 12' x 10' CBC
LC7	1 - 144" CMP
LC8	2 - 13' x 10' CBCs
LC9	1 - 12' x 10' CBC
MC1	1 - 172" x 86" CMPA
MC2	1 - 184" x 103" CMPA
MC3	1 - 264" x 96" CMPA
MC4	1 - 100' BRIDGE
ID1	2 - 70" x 45" CMPAs
ID2	1 - 60" RCP
CD1	1 - 66" CMP
STM1	1 - 60" CMP
STM2	2 - 48" HDPEs
STM3	1 - 36" HDPE
LaC1	1 - 90" x 51" CMPA
LaC2	2 - 66" CMPs
LaC3	1 - 10' x 4' CBC
SMC1	1 - 102" CMP
SMC2	1 - 78" CMP
LTC1	1 - 8' x 8' CBC

EXHIBIT A

MAP SHOWING MAJOR CREEKS, LOCATIONS OF EXISTING DRAINAGE STRUCTURES AND PROPOSED DRAINAGE UPGRADES

TOWN OF MORAGA
STORM DRAINAGE NEEDS STUDY

CONTRA COSTA COUNTY CALIFORNIA

REVISION	DATE	DESCRIPTION

SCALE: 1"=800'

SHEET 1 OF 1

Storm Water Consulting Inc.

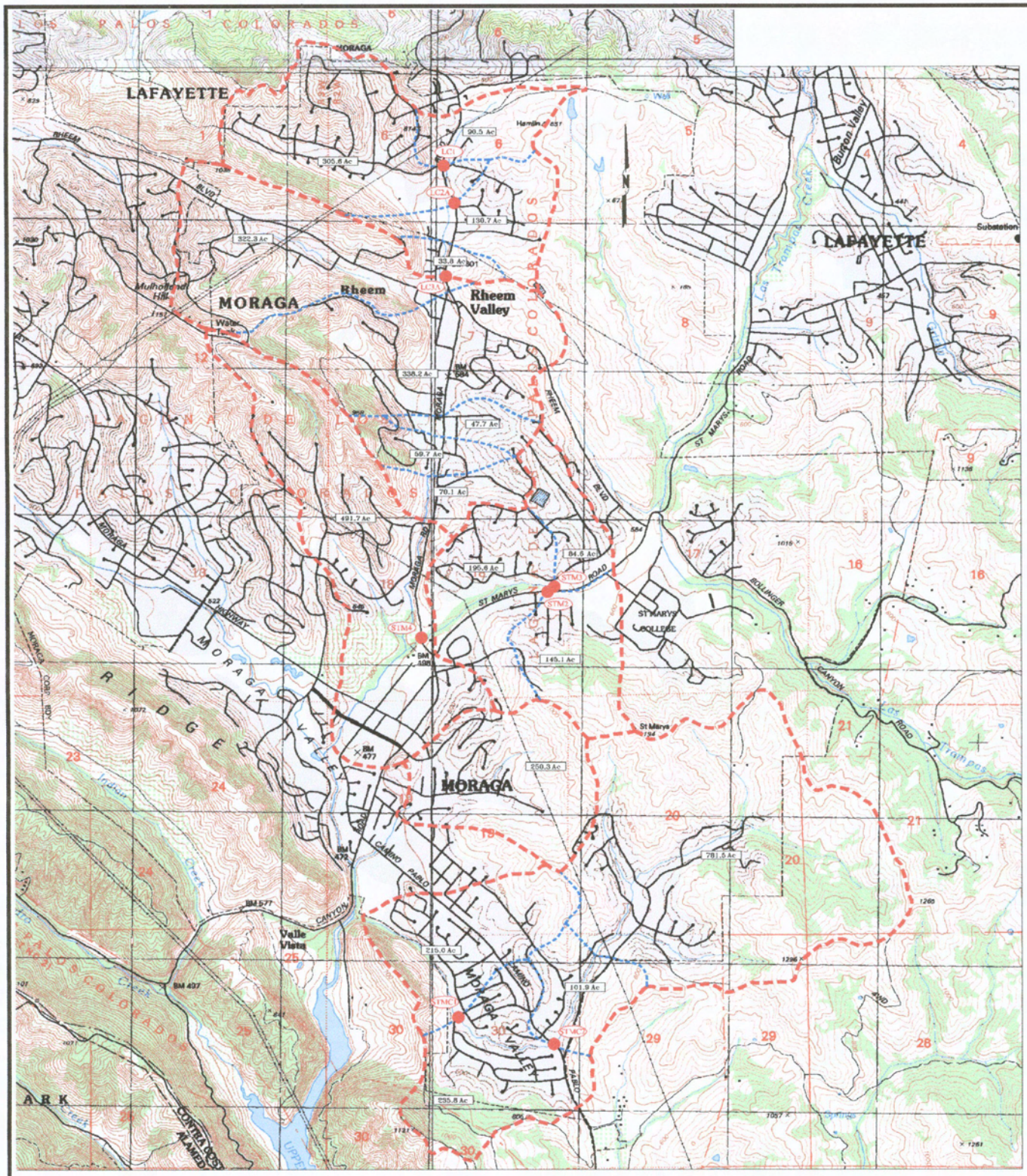


EXHIBIT B

SELECTED SUB-BASIN AREAS
USED TO PRORATE FEMA DISCHARGES

Harris & Associates	TOWN OF MORAGA STORM DRAINAGE NEEDS STUDY CONTRA COSTA COUNTY CALIFORNIA	REVISION / DATE / DESCRIPTION	DATE: AUGUST 2006 SCALE: 1"=800'	SHEET 1 OF 1	Storm Water Consulting Inc.

APPENDIX

Table A – 1
Table A – 2
Table A – 3

Existing Drainage Structures Inventory Worksheets

Revised Tables 5.3 and 5.4 from AB 1600 Report (Program Implementation Mark-Up Factor Eliminated from Tables Per Town Direction, April 2008)

TABLE A-1
TOWN OF MORAGA
Storm Drainage Needs Study
Prorated Estimates of 100-Year Discharges Worksheet

Stream Name	Location	FEMA Drainage Area (sq-mi)	FEMA 100-Year Flow (cfs)	FEMA cfs/acre	Structure	Structure Location	Drainage Area (acres)	Estimated 100-YEAR Flow (cfs)
	FEMA Flood Insurance Study Data				FEMA Data Used to Estimate 100-Year Flow (area x cfs/acre)			
Laguna Creek		1.5	850	0.89	LC2A	Woodford Dr to SE Corner of High School	91	81
				0.89	LC2B	High School to Carroll Ranch	232	206
				0.89	LC3A	Carroll Ranch to Rheem Blvd.	561	499
	Rheem Blvd.			0.89	LC3B	From Rheem Blvd. South	960	854
	Conf. w/ Moraga Crk	3.8	2100	0.86	LC9	Country Club Drive	2432	2092
St. Mary's Road Trib.	Conf. w/ Laguna Crk	0.8	480	0.94	STM1	Moraga Road	512	481
				0.94	STM3	Stafford Drive	85	80
Ivy Dr. Tributary	Conf. w/ Moraga Crk	0.5	310	0.97	ID2	Moraga Way	320	310
S. Branch Moraga Creek		1.22	640	0.81	SMC2	Camino Pablo Road	883	715

Prepared by:
Harris and Associates
Storm Water Consulting, Inc.

Prepared for:
Town of Moraga
Table A-1.xls

TABLE A-2

TOWN OF MORAGA

Storm Drainage Needs Study

Capacities of Existing Drainage Structures

Stream Name	Location	Structure I.D.	Size	HW	Capacity Inlet Cont (cfs)*	Capacity Unif. Flow (cfs)	Pipe Slope (ft/ft)	Capacity Inlet Cont Other** (cfs)
Laguna Creek	Campolindo Dr.	LC1	1-48" RCP	10'	185	97	0.0109	
	Woodford Dr.	LC2	1-36" RCP	5'	60			
	Donald Dr.	LC4 Outlet	1-10'x8' CBC			1548	0.0099	
	Hacienda/Pavilion	LC5	1-96" CMP	8'	400			
	Devin Dr.	LC6	1-12'x10' CBC	20'	2220	3179	0.0141	
	Corliss Dr.	LC7	1-12' CMP	20'	2000			
	Moraga Way	LC8	2-13'x10' CBC	10'	2392			
	Country Club Dr.	LC9	1-12'x10' CBC	13'	1524			
Moraga Creek	Ivy Dr	MC1	1-172"x90" CMPA	11'	1000	921	0.0089	940
	Miramonte Dr.	MC2	1-184"x103" CMPA	11'		1208	0.0089	990
	St. Andrews Dr.	MC3	1-22'x8' CMPA	16'		1142	0.0046	2000
	Canyon Road	MC4	Bridge					
Ivy Dr. Tributary	Ivy Dr.	ID1	2-70"x45" CMPA	5'	280			
	Moraga Way	ID2	1-66" RCP	7'	210			
Corliss Dr. Trib.	Corliss Dr.	CD1	1-66" CMP	8'	245			
St. Mary's Rd. Trib.	Moraga Road	STM1	1-60" CMP	10'	220	328	0.0375	
	St. Mary's Road	STM2	2-48" HDPE (CMP)	5'	176			
	Stafford Dr.	STM3	1-36" HDPE (CMP)	4'	45			
Larch Creek	Wandel Dr.	LacC1	1-90"x51" CMPA	6.5'	240	550	0.059	240
	Camino Pablo Rd.	LacC2	2-66" CMP	8'	490			
	Larch Avenue	LacC3	1-10'x4' CBC	5.5'	330			
S Branch Moraga Ck.	Tharp Dr.	SMC1	1-102" CMP	13'	800			
	Camino Pablo Rd.	SMC2	1-78" CMP	10'	400			
Las Trampas Ck.	St. Mary's Road	LTC1	1-8'x8' CBC	30'	1600			
Laguna Creek	Carroll Ranch	1	1-60" RCP			223	0.0098	
	Carroll Ranch	2	1-72" RCP			367	0.01	
	Carroll Ranch	3	1-84" RCP			548	0.0098	
	Carroll Ranch	4	1-78" RCP			454	0.01	

***** Using Inlet Control Charts based on size and shape of the culvert

****** Using Inlet Control Charts based on cross sectional area of the culvert

TABLE A-3
TOWN OF MORAGA
Storm Drainage Needs Study
Proposed Structures Hydraulic Data

Stream Name	Location	Structure I.D.	100-Yr. Flow (cfs)	Proposed Structure Size	HW	Capacity Inlet Control (cfs)	Capacity Unif. Flow (cfs)	Pipe Slope (ft/ft)
Laguna Creek	Woodford Dr. to SE Corner of High School	LC2A	81	1-54" RCP	5'	105		
	High School to Carroll Ranch	LC2B	206	2-54" RCPs	5'	210		
	Carroll Ranch to Rheem Blvd.	LC3A	499	1-84" RCP			596	0.01
	From Rheem Blvd. South	LC3B	854	1-8'x8' CBC			1208	0.01
	Hacienda/Pavilion	LC5	1300	Add 2-96" RCPs	8'	1300		
	Country Club Road	LC9	2092	2-10'x8' CBCs	13'	2200		
St. Mary's Rd. Trib.	Moraga Road	STM1	481	Add 1-60" CMP & Headwall	10'	500	940	0.0375
	Stafford Dr.	STM3	80	Add 1-36" HDPE Pipe	4'	98		
Ivy Dr. Tributary	Moraga Way	ID2	310	Add 1-48" RCP	7'	360		
S. Branch Moraga Creek	Camino Pablo Rd.	SMC2	715	Add 1-78" CMP	10'	800		

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Campolindo Drive

Crossing Designation : LC1

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

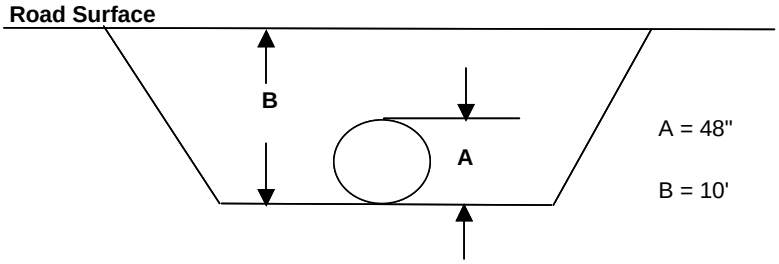


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : RCP; old but appears to be in good condition; Inlet projecting

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Woodford Drive

Crossing Designation : LC2

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

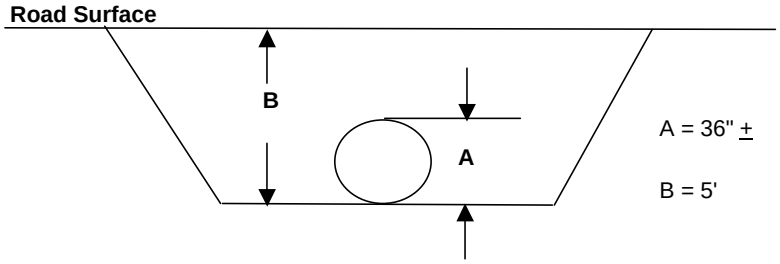


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : RCP; poor inlet conditions; downstream system piecemealed together

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Donald Drive

Crossing Designation : LC4 Outlet

Type of Structure

Culvert : ☐ **Circular** ☐ **Arch** ☒ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 10' **Rise** 8'

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

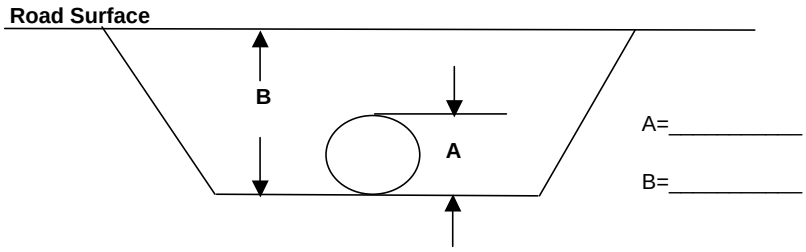


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CBC; Sediment in lower portions of culvert. Standing water at outlet.

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Under Building

Crossing Designation : LC5

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

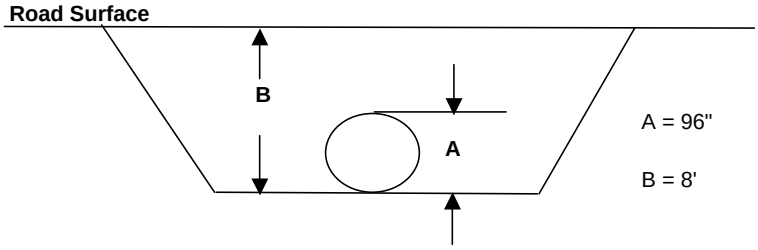


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; fairly new; good condition; concrete headwall and wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Devin Drive

Crossing Designation : LC6

Type of Structure

Culvert : ☐ **Circular** ☐ **Arch** ☒ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 12' **Rise** 10'

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

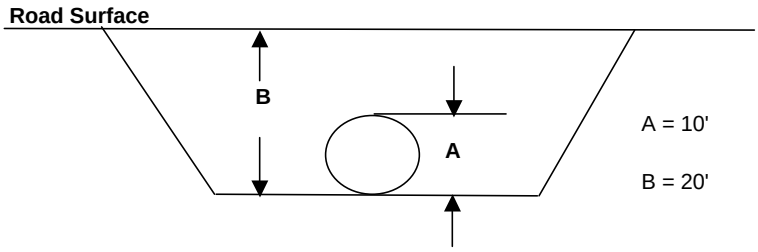


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CBC; good condition; concrete headwall and wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Corliss Drive

Crossing Designation : LC7

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** 12' **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

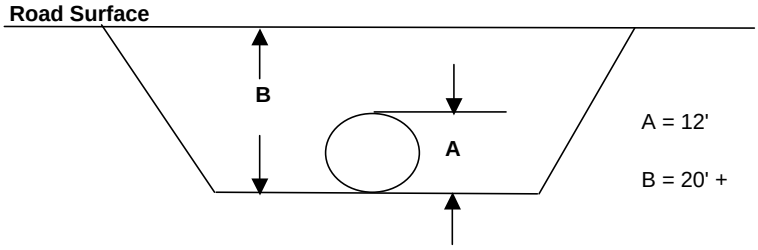


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; good condition; vertical headwall

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Moraga Way

Crossing Designation : LC8

Type of Structure

Culvert : ☐ **Circular** ☐ **Arch** ☒ **Box** **No. of Units or Cells** 2

Length _____ **Diameter** _____ **Span** 13' **Rise** 10'

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** 1

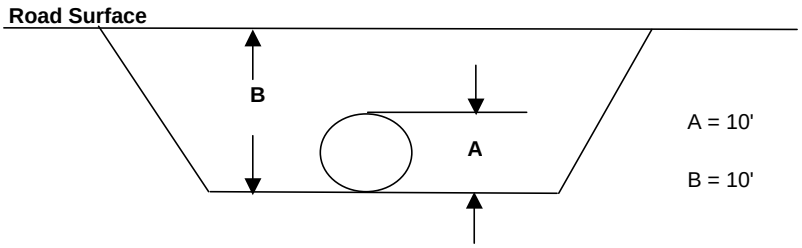


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CBC; concrete headwall and wingwalls; old structure in good condition, lots of vegetation at outlet

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Laguna Creek

Location : Country Club Drive

Crossing Designation : LC9

Type of Structure

Culvert : ☐ **Circular** ☐ **Arch** ☒ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 12' **Rise** 10'

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

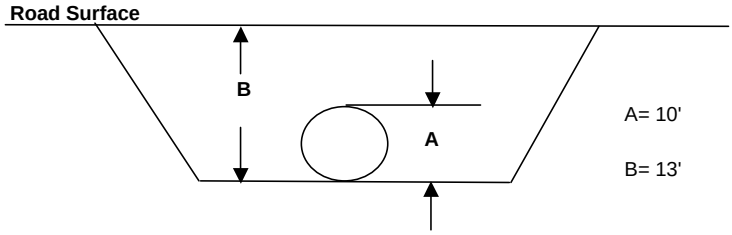


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CBC; fairly new; concrete headwall, no wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Moraga Creek

Location : Ivy Drive

Crossing Designation : MC1

Type of Structure

Culvert : ☐ **Circular** ☒ **Arch** ☐ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 172" **Rise** 90"

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

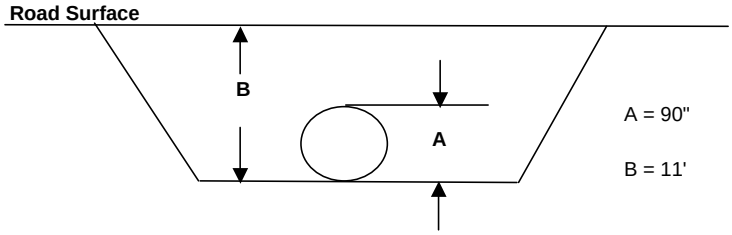


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMPA; no real headwall; vertical sandbags create headwall at inlet

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Moraga Creek

Location : Miramonte Drive

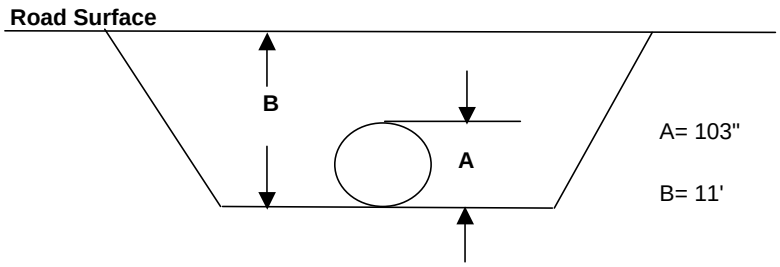
Crossing Designation : MC2

Type of Structure

Culvert : ☐ **Circular** ☒ **Arch** ☐ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 184" **Rise** 103"

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____



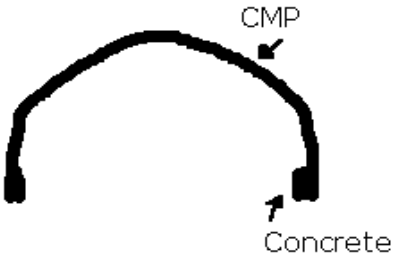


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; Arch over channel bed; concrete headwall and wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Moraga Creek

Location : St. Andrews Drive

Crossing Designation : MC3

Type of Structure

Culvert : ☐ **Circular** ☒ **Arch** ☐ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 22' **Rise** 8' ±

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

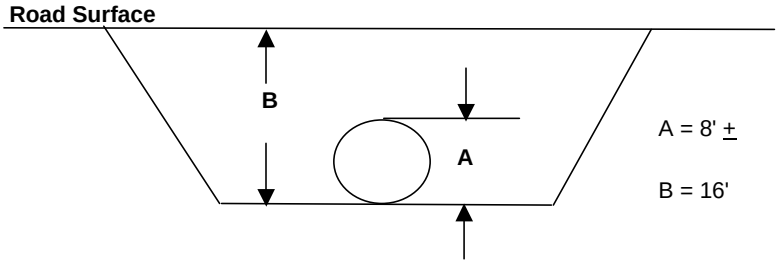


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP Arch over flat base, unusual concrete inlet structure

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Moraga Creek

Location : Canyon Road

Crossing Designation : MC4

Type of Structure

Culvert : ☐ **Circular** ☐ **Arch** ☐ **Box** **No. of Units or Cells** _____

Length _____ **Diameter** _____ **Span** _____ **Rise** _____

Bridge : **Span** 100' **Channel Width** 45' **Height** 16' **No. of Pier Columns** 2

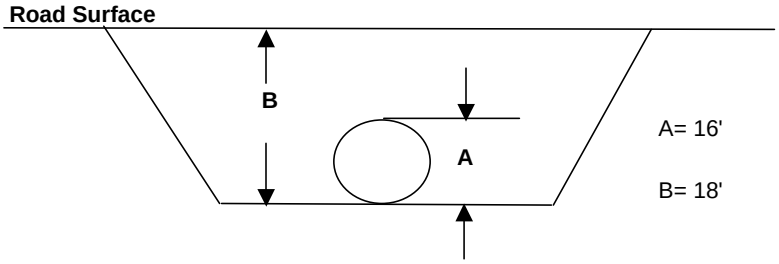


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : Natural Creek Crossing; Old Bridge

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Ivy Drive Tribulatary

Location : Ivy Drive

Crossing Designation : ID1

Type of Structure

Culvert : ☐ **Circular** ☒ **Arch** ☐ **Box** **No. of Units or Cells** 2

Length _____ **Diameter** _____ **Span** 70" **Rise** 45"

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

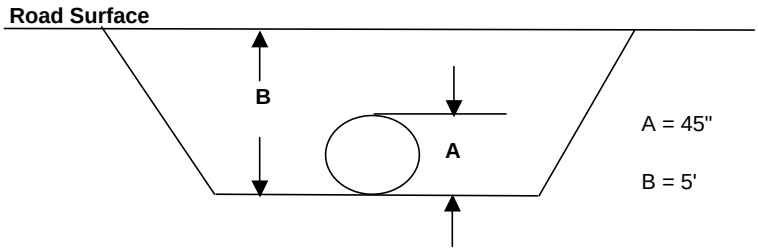


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMPA; concrete headwall and wingwalls; lots of vegetation

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Ivy Drive Tributary

Location : Moraga Way

Crossing Designation : ID2

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** 66" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

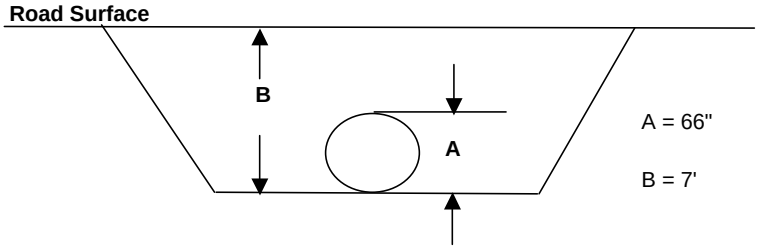


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : RCP; vertical concrete headwall, no wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Corliss Drive Tributary

Location : Corliss Drive (near Cross Brook Drive)

Crossing Designation : CD1

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** 66" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

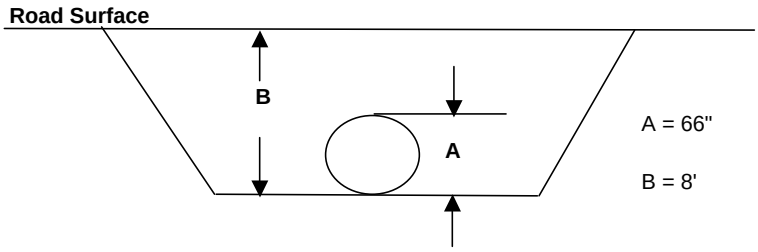


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; good condition; vertical headwall

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : St. Mary's Road Tributary

Location : Moraga Road

Crossing Designation : STM1

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** 60" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

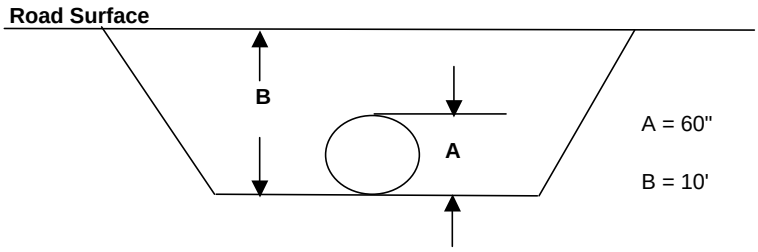


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; mitered inlet, no headwall

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : St. Mary's Road Tributary

Location : St. Mary's Road

Crossing Designation : STM2

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 2

Length _____ **Diameter** 48" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

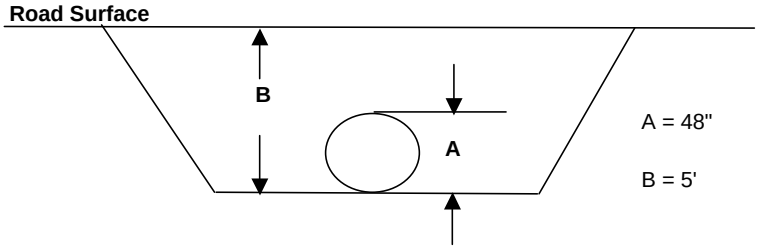


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : HDPE; inlets projecting

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : St. Mary's Road Tributary

Location : Stafford Drive

Crossing Designation : STM3

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** 36" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

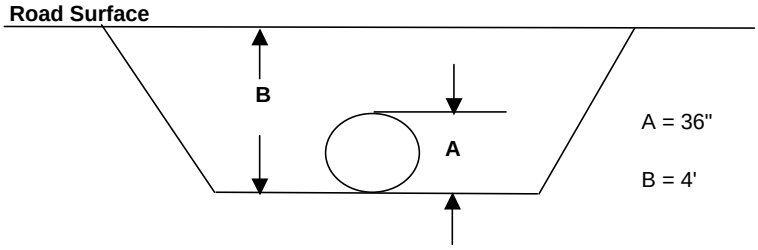


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : HDPE; inlet projecting

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Larch Creek

Location : Wandel Drive

Crossing Designation : LarC1

Type of Structure

Culvert : ☐ **Circular** ☒ **Arch** ☐ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 90" **Rise** 51"

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

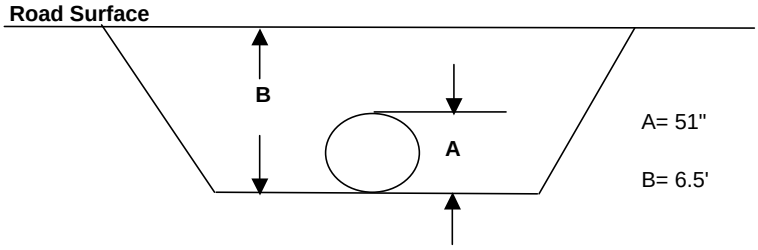
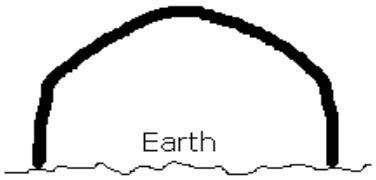


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**



Additional Notes : CMP Arch over natural channel bottom; concrete headwall and wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Larch Creek

Location : Camino Pablo Road

Crossing Designation : LarC2

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 2

Length _____ **Diameter** 66" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

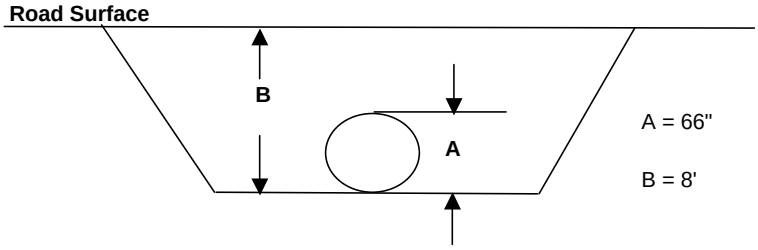


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; concrete headwall, no wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Larch Creek

Location : Larch Avenue

Crossing Designation : LarC3

Type of Structure

Culvert : ☐ **Circular** ☐ **Arch** ☒ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 10' **Rise** 4'

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

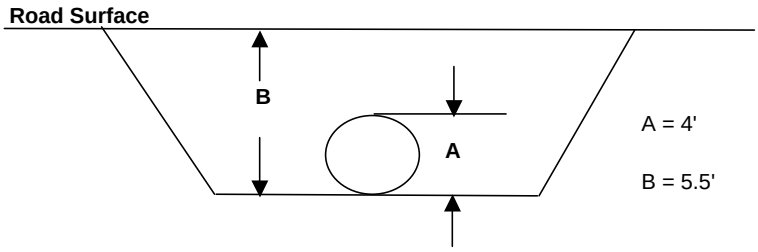


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CBC; concrete headwall, no wingwalls, silted

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : South Branch Moraga Creek

Location : Tharp Drive

Crossing Designation : SMC1

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** 102" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

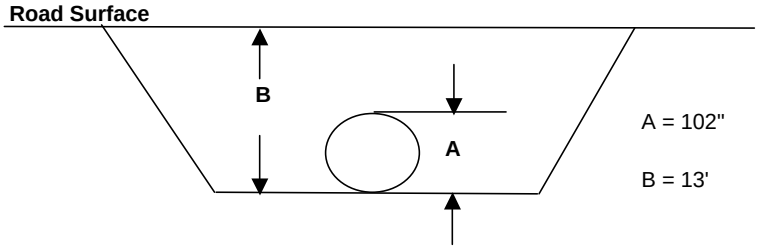


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; concrete headwall and wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : South Branch Moraga Creek

Location : Camino Pablo Road

Crossing Designation : SMC2

Type of Structure

Culvert : [X] **Circular** [ ] **Arch** [ ] **Box** **No. of Units or Cells** 1

Length _____ **Diameter** 78" **Span** _____ **Rise** _____

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

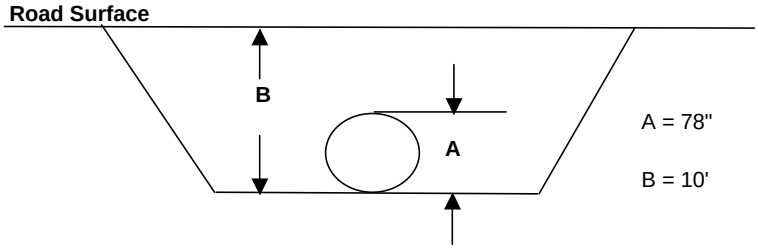


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CMP; concrete headwall and wingwalls

TOWN OF MORAGA
Storm Drainage Needs Study
Existing Drainage Structures Inventory

Stream Name : Las Trampas Creek

Location : St. Mary's Road

Crossing Designation : LTC1

Type of Structure

Culvert : ☐ **Circular** ☐ **Arch** ☒ **Box** **No. of Units or Cells** 1

Length _____ **Diameter** _____ **Span** 8' **Rise** 8'

Bridge : **Span** _____ **Width** _____ **Height** _____ **No. of Pier Columns** _____

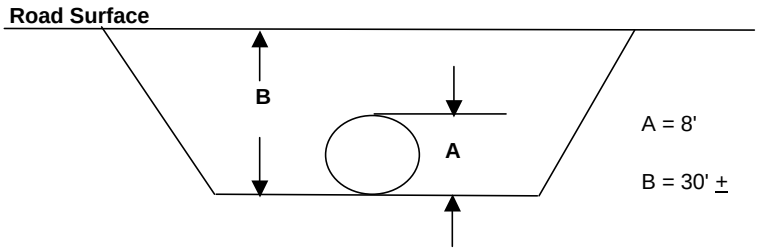


Photo No. _____ **Inlet**
Photo No. _____ **Outlet**

Additional Notes : CBC; concrete headwall

Table 5.3
Town of Moraga
Proposed Storm Drainage Infrastructure Upgrades and Replacements
Preliminary Opinion of Probable Cost

Item	Linear Feet	Total Cost
Cross-Culverts and Conduits		
Laguna Creek		
Woodford Drive to SE Corner Campolindo HS (1 - 54" RCP)	400	180,000
SE Corner Campolindo HS to NE Corner Carroll Ranch (2 - 54" RCPs)	400 each	436,668
SE Corner Carroll Ranch to Rheem Blvd. (1 - 84" RCP)	600	803,886
North Portion Rheem Valley Shopping Center Parking Lot (1 - 8' x 8' CBC)	300	517,833
Hacienda/Pavillion (Add 2 - 96" RCPs)	230 each	460,000
Country Club Drive (2 - 10' x 8' CBCs)	30	54,120
St. Mary's Road Tributary		
Moraga Road (Add 1 - 60" CMP and Headwall)	150	75,000
Stafford Drive (Add 1 - 36" HDPE Pipe)	50	15,000
Ivy Drive Tributary		
Moraga Way (Add 1 - 48" RCP)	100	40,000
South Branch Moraga Creek		
Camino Pablo Road (Add 1 - 78" CMP)	100	80,000
Subtotal Construction		**$ 2,662,507**
Design and Planning @ 10%		266,251
Construction Management @ 10%		266,251
Contingency @ 15%		399,376
TOTAL ESTIMATED COST		**$ 3,594,384**

Table 5.4
Town of Moraga
Storm Drainage Impact Fees

Total Infrastructure Cost	Land Use Category	Acreage by Land Use Category	Percentage Fee Allocation	Total Fee Responsibility	Impact Fee (Per Acre)	Total Planned Residential Units	Impact Fee (Per Residential Unit)
$ 3,594,384	Single Family Detached Residential	179.5	82.6%	$ 2,970,497	$ 16,549	408	$ 7,281
	Multi-Family Residential	8.0	5.1%	$ 182,036	$ 22,755	50	$ 3,641
	Senior Housing	6.0	4.8%	$ 173,762	$ 28,960	200	$ 869
	Commercial*	5.0	5.2%	$ 186,173	$ 37,235	N/A	N/A
	Hotel	2.2	2.3%	$ 81,916	$ 37,235	N/A	N/A
		200.7	100.0%	$ 3,594,384			

*Includes Mixed Use Commercial Units

Storm Water Consulting, Inc.
1899 Sapphire Way
El Dorado Hills, CA 95762
Ph (916) 801-3962
www.stormwaterconsulting.com