THE CITY OF RANCHO PALOS VERDES

Drainage Master Plan Development Program

Prepared for
City of Rancho Palos Verdes
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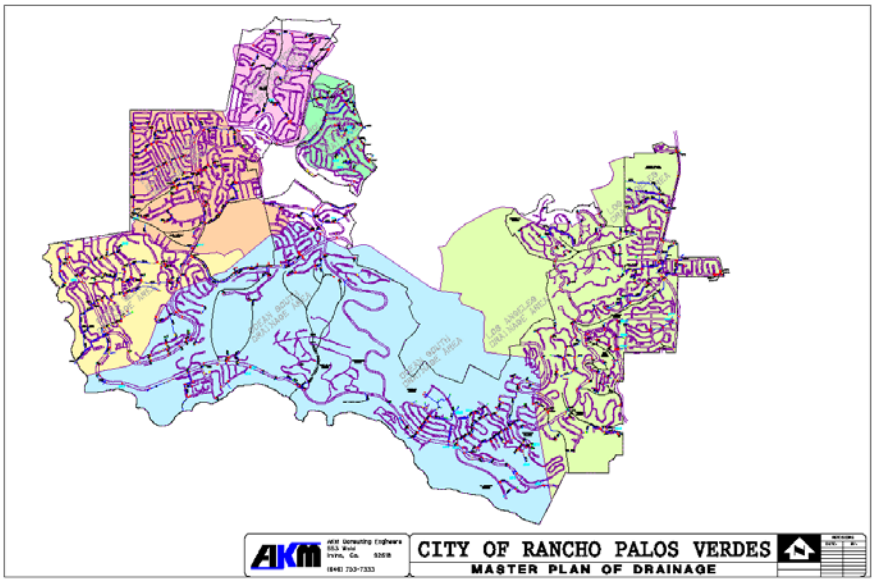
1 INTRODUCTION

RBF Consulting has been retained by the City of Rancho Palos Verdes to prepare a planning document to guide the development and implementation of a new comprehensive drainage master plan program on the City's GIS platform. The primary goal is the integration of existing programs and systems to create a living document which will allow staff to better understand the drainage deficiencies and more effectively utilize the limited maintenance and capital project funds. The City is comprised of approximately 14 square miles on the Palos Verdes Peninsula in the southwest portion of Los Angeles County. The majority of the City drains to natural canyon systems with direct discharge to the ocean. The current planning document for the City's storm drain system is the Master Plan of Drainage Update prepared in November 2004. That master plan updated the previous study which was completed in 1998. The master plan had divided the City into six (6) separate drainage areas (Figure 1-1).

Figure 1-1. Watershed areas



In 2005, the property owners approved the Storm Drain User Fee which provides funding for the City's storm drain improvement and maintenance program. The user fee was established based on 38 high-priority projects identified in the 2004 Master Plan. In 2007, the voters approved Measure C to amend the User Fee ordinance to include an Oversight Committee and a 10-year sunset on the user fee. The user fee program is currently set to expire on June 30, 2016.

1.1 Purpose of the Proposed Project

The goal of the drainage master plan program will be to identify the steps, schedule, and cost to implement a comprehensive master plan of drainage for the City. In order to be a comprehensive plan the program will need to include; development of a verified inventory database; update of the hydrology and hydraulic calculations; integration of the assessment of pipe conditions and remaining service life; identification of required improvements and cost estimates; address current and future water quality requirements; and develop a scheme for the prioritization and implementation for the recommended improvements. To be effective, the plan needs to be integrated with the City's GIS system and incorporate drainage master plan information in a user-friendly application to allow annual updates as necessary to reflect new data and completed projects.

This document will review the City's current storm drain master plan, water quality programs, and system components to develop a program for the overhaul and implementation of a new drainage master plan and capital improvement program.

1.2 Program Objectives

The overall goal of the drainage master plan program report is to recommend a strategy to implement a comprehensive "living" drainage master plan for the City. The specific objectives of this study include:

1. Review current master plan studies, GIS databases and mapping, video inspection and storm drain lining programs, and water quality programs and permit requirements;
2. Identify and evaluate available hydrology and hydraulic computer modeling software and provide a recommendation for a preferred software package;
3. Review past and current water quality City efforts related to the drainage master plan;
4. Identify current and forecast future water quality requirements;
5. Recommend water quality efforts that should be incorporated into the development of the drainage master plan;
6. Evaluate GIS systems and identify recommendations to integrate with the master plan; and,
7. Identify a recommended drainage master plan program including a scope of work, implementation schedule, and program cost.

All hydrology and hydraulic design criteria are based on the Los Angeles County Department of Public Works Hydrology Manual dated January 2006, and the Los Angeles County Flood Control District Hydraulic Design Manual dated March 1982 as the primary references.

Water Quality recommendations consider the following documents:

- Municipal Stormwater Permit for the County of Los Angeles and the Incorporated Cities Therein (Order No. 01-182) Amended April 14, 2011.
- Machado Lake Pesticides and PCBs TMDL Final Staff Report (November 22, 2010)
- Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrients) TMDL Draft Staff Report (April 2008)
- Machado Lake Trash TMDL Final Staff Report (July 11, 2007)
- Santa Monica Bay Bacteria Dry Weather TMDL Staff Report (January 14, 2002)
- Santa Monica Bay Bacteria Draft Implementation Plan Jurisdictional Group 7 (March 15, 2005)

- Santa Monica Bay Nearshore and Offshore Debris TMDL Final Staff Report (October 25, 2010)
- Proposed NPDES Permit for South Bay Cities Memorandum (March 22, 2011)

The GIS system and data recommendations will be based on the City's existing implementation of ESRI based GIS software including ArcGIS, ArcGIS Server, and SDE at versions 9.3.1 with anticipation of an upgrade to version 10 in the near future.

1.3 Previous Studies, Regulations, and Existing Programs

The following previous studies, video inspection and lining programs, storm water regulations and existing water quality programs, and GIS systems were evaluated as part of the program development. The following sections provide a summary of the review.

City of Rancho Palos Verdes Master Plan of Drainage Update (AKM, 2004)
This study was an update to the City's previous master plan of drainage that was prepared in January 1998. The study included a new hydrologic analysis to incorporate the hydrology changes outlined in the June 2002 Addendum to the 1991 LA County Hydrology/Sedimentation Manual. The study identified deficiencies based on storm drain capacity and prepared recommendations to alleviate the problems. The criteria for the deficiencies and prioritization were based on the methods in the 1998 master plan. Updated cost estimates were developed for the proposed drainage improvements.

The study used the Modified Rational Method (MORA) computer program for the hydrology analysis. The MORA program has been superseded by the Los Angeles County Modified Rational Method (MODRAT) and is no longer accepted by LA County due to problems identified in the source code. Hydraulic calculations for the capacity analysis and required storm drain sizing appear to have been completed using normal depth calculations based on Manning's equation. No assessment of the storm drain physical condition and remaining service life was included in the report.

The key issues with the 2004 master plan are the outdated hydrology analysis and the lack of a physical condition assessment for the existing storm drain pipe facilities. The deficiencies and recommendations only focused on storm drain capacity issues and neglected the condition of the pipes and the remaining service life. Other issues include the simplified hydraulics for pipe sizing, and the lack of compatibility with the City's GIS system. The simplified hydraulic modeling does not allow for future maintenance of master plan to incorporate new drainage facilities constructed by public works or development projects and identify impacts or benefits to the master plan hydrology and hydraulics associated with the improvements. The current models also do not allow the systems to be integrated with City's GIS database.

Master Plan of Drainage for the City of Rancho Palos Verdes (AKM, 1998)
This study was the first drainage master plan for the City after it's incorporation in 1973. The purpose of the study was to identify existing facilities, evaluate the capacities and conditions of the existing storm drain systems, identify hydraulic deficiencies, and recommend a prioritized list of drainage improvement projects and associated capital costs. The study was performed in accordance with the Los Angeles County Department of Public Works (LADPW) hydrology and hydraulic criteria established at that time. Hydrology was completed using the County's Modified Rational Method program, and the hydraulics were performed using normal depth calculations.

The study identified drainage system deficiencies and determined required facility sizes. It also included a visual inspection of accessible inlet and outlet structures. However, the recommended improvements were only based on hydraulic deficiencies. The recommended improvements were then prioritized based on the magnitude and overall impact of the deficiencies. While the report noted that many of the City's storm drains were corrugated metal pipes which were nearing the end of their service life, the recommended improvements focused on the elimination of hydraulic deficiencies.

Storm Drain Video Inspection and Lining Programs
The City has an extensive system of corrugated metal pipes that are nearing or have exceeded their service life, and has adopted a program to complete on-going video inspections of the City's existing storm drain systems. The goal of the inspection program is to identify facilities in need of rehabilitation and repair. As a result of the inspections, numerous storm drains were identified to be lined to repair the systems and extend their service life. The repairs focus on extending the facility service life, but do not take into account any hydraulic deficiencies within the existing facilities. The City's 5-Year model includes on-going funds for storm drain inspection and lining projects.

1.3.1 Water Quality

The study reviewed the current MS4 permit, TMDLs the City is subject to, past and ongoing City water quality activities including TMDLs implementation, and forecasted future water quality requirements based on recent trends in water quality regulations and MS4 permits. The following are the results of the study:

MS4 Permit (Order 01-182) & Future MS4 Permit

The Los Angeles County Flood Control District, the County of Los Angeles, and 84 incorporated cities therein discharge waste from their Municipal Separate Storm Sewer Systems (MS4). These discharges were previously regulated under countywide waste discharge requirements contained in Order No. 01-182 adopted by this Regional Board on December 13, 2001. Order No. 01-182 was subsequently amended by this Regional Board on September 14, 2006 by Order No. R4-2006- 0074 to incorporate the Santa Monica Bay Beaches Dry Weather Bacteria TMDL (SMB Bacteria TMDL), on August 9, 2007 by Order No. R4-2007-0042 to incorporate the Marina del Rey Harbor Mothers' Beach and Back Basins Bacteria TMDL, and December 10, 2009 by Order No. R4-2009-0130 to incorporate the Los Angeles River Watershed Trash TMDL. As a result of a legal challenge to Order No. R4-2006-0074, the Los Angeles Superior Court issued a peremptory writ of mandate on July 23, 2010 requiring the Regional Board to void and set aside Order No. R4-2006-0074 amending Order No. 01-182. While Order No. R4-2006-0074 was ultimately voided and set aside, the Permittees in the Santa Monica Bay Watershed Management Area were required to comply with the requirements of that amendment for approximately four years until such time as those provisions were voided. (LARWQCB, 2011) The MS4 permit was reissued on April14, 2011 to incorporate the Santa Monica Bay TMDL provisions. The reissuance of the permit did not make any other changes to the existing permit.

As a Permittee identified in the Permit the City is subject to the program elements identified in the permit and has specific responsibilities identified in Part 3. Section E. of the Permit. ~~There have been s~~Significant changes in MS4 permits ~~that~~ have been adopted throughout California in recent years. The LA Regional Board identified that adoption of the 4th Term MS4 Permit for Los Angeles County and its incorporated cities is tentatively scheduled for April of 2012. There

are three areas in the new permit that will likely affect the Drainage Master Plan Development Program. One area is regional retrofit requirements. Many of the new MS4 permits require Permittees to implement a retrofit program for existing development. The requirements include the development of retrofit studies to identify opportunities for regional and sub-regional treatment of runoff from existing development. The second area is the requirement to implement offsite mitigation for LID implementation if it is deemed infeasible to implement LID onsite for a development. This will require the identification of areas where offsite mitigation can be implemented. Sites will likely need to be identified in each of the City's sub-watersheds. The third area is the incorporation of TMDLs into MS4 permits. TMDL implementation will likely require implementation of BMPs to achieve compliance for each jurisdiction. Identification of locations for structural BMPs will be critical to achieve TMDL compliance. The Los Angeles Regional Board has also identified that watershed based permits may be an option for the Los Angeles Area. In response to this potential option the South Bay Cities have developed a one page memorandum identifying the potential benefits of a watershed based permit. The City of Rancho Palos Verdes was identified as one of the cities potentially interested in a watershed based permit.

Total Maximum Daily Loads

The City is subject to the following TMDLs:

- Machado Lake Pesticides and PCBs TMDL
- Machado Lake Eutrophic, Algae, Ammonia, and Odors (Nutrients) TMDL
- Machado Lake Trash TMDL
- Santa Monica Bay Bacteria Dry Weather TMDL
- Santa Monica Bay Bacteria Wet Weather TMDL
- Santa Monica Bay Nearshore and Offshore Debris TMDL
- Los Angeles and Long Beach Harbors Toxic and Metals TMDL

The City is engaged in the multiple activities for compliance with these TMDLs. The City is currently engaged in collection of data for the Santa Monica Bay Bacteria TMDLs. The City is beginning to coordinate with other stakeholders for the Santa Monica Bay Nearshore and Offshore Debris TMDL. For the Machado Lake Nutrient TMDL the City is engaged with the other peninsula cities in monitoring and implementation activities including joint public outreach, a literature review on source control activities, and ongoing City source control activities. The City is also engaged in coordination activities with other stakeholders for the Machado Lake TMDLs. The City has not begun identification of regional or sub-regional BMP locations for any of the TMDLs the City is subject to.

1.3.2 Geographic Information Systems

The City currently has a GIS system which is operated and maintained by a non-profit organization, Palos Verdes on the Net (City GIS Provider). The system includes a full range of current GIS software including ArcGIS Desktop (ArcView/ArcInfo), ArcGIS Server, and ArcSDE. Palos Verdes on the Net maintains an ArcGIS Server Intranet site using the .Net API which provides internal mapping for the layers of data which have already been created. Data layers are currently maintained in version 9.3.1 of the GIS, however, there are plans to upgrade to version 10 shortly. Licensing for this upgrade has already been secured. Any work done to support the Stormwater Master Plan should be compatible with existing City GIS resources as operated and maintained by the City GIS Provider.

The GIS implementation and data layers for the City are among the most complete of most cities in the region. The data layers which affect the Drainage Master Plan and modeling efforts are nearly complete and up to date. However, some key issues exist which warrant examination. The key issues with the current GIS program include software versioning, data gaps, and data organization issues. For the software versioning, there are some data compatibility issues with GIS based "add-on" applications including some stormwater modeling software. We have outlined compatibility with the software identified in the Master Plan recommendations in that section of this report. In reviewing the existing data, we have identified some minor data gaps which will need to be filled to complete the process of modeling required by the master plan. While the data is well maintained and several projects are underway for the maintenance and upgrade of information necessary for the stormwater master plan project, some data organizational issues still exist which will affect the City's ability to assemble an effective model and develop the "living" master plan. Most notably is the lack of a consistent stormwater feature numbering system.

2 MASTER PLAN NEEDS ASSESSMENT

Based on the review of previous studies, water quality regulations and existing programs, and from discussions with City staff and consultants, a needs assessment was prepared to identify the recommended elements and tasks to be included in the drainage master plan. The following sections discuss the results of the master plan needs assessment.

2.1 Hydrologic Analysis Assessment

In January 2006, the LADPW released the latest version of their Hydrology Manual. The manual compiled information from previous additions of the LA Hydrology Manual and the 2002 Hydrology Manual Addendum. The new manual sets forth standards for hydrology calculations done under Public Works' jurisdiction, and by the Cities in Los Angeles County, including Rancho Palos Verdes, that have adopted the LA Hydrology Manual as the standard for their City.

The hydrology analysis completed for the City's previous master plan is based on the standards from the previous LA Hydrology Manual and the 2002 Addendum. Any new update to the master plan needs to include a new hydrology study to address the current design standards. In addition, with the January 2006 manual, the County has stopped using the MORA computer program for the hydrology calculations. The MORA program has been superseded by the LA County Modified Rational Method (MODRAT).

A new hydrology study will be required to be conducted with the development of the new drainage master plan. The study should utilize one of the available hydrologic software packages that include the MODRAT program. Section 2.3 provides a detailed review of the available software packages and provides a recommendation for use in the City's new master plan.

Project Recommendation:

1. ***Prepare new hydrology using the January 2006 LA County Hydrology Manual***

2.2 Hydraulic Analysis Assessment

The aforementioned hydraulic calculations for the capacity analysis and required storm drain facility sizing were completed using normal depth calculations based on Manning's equation. The capacity analysis was used to determine the level of deficiency by comparing the capacity of the system with the calculated design discharge (from the hydrology study) at the same location.

A critical step in updating the masterplan is to understand how the existing storm drain systems operate hydraulically with a higher degree of accuracy. The previous masterplan had just utilized "normal depth" to estimate capacity, however, if the storm drain has a "backwater" condition or other hydraulic restriction then this type of analysis is not accurate. A more detailed water surface profile analysis is necessary to understand if the hydraulic gradeline is fully contained within the system for the design storm event. The advantages of performing this type of modeling is that future improvements of the storm drain (or segments of the system) can be modeled to identify the benefits or impacts associated with a project. The water surface model can be used to easily evaluate the effects of any corrective measures of identified hydraulic deficiencies, optimizing the cost effectiveness of the design solution. Future connections or extensions will also have a water surface control to begin the design of those facilities. Numerous water surface profile models are available for use in the City's master plan update. A

key consideration is to evaluate and consider software models that can be integrated with the hydrologic modeling software and the City's GIS platform. Section 2.3 provides a detailed review of the available software packages and provides a recommendation for use in the City's new master plan.

Project Recommendation:

2. ***Prepare detailed water surface profile hydraulic calculations for existing and recommended storm drain systems***

2.3 Stormwater Hydrology and Hydraulic Models

The City is located in Los Angeles County and follows the recommendations and guidelines for hydrology studies as outlined in the LA County Hydrology Manual dated January 2006. The County has developed a modified rational method (MODRAT) for use in preparing hydrology studies. MODRAT is the standard method for hydrologic studies within the county. Chapter 15 of the Hydrology Manual identifies computer programs that have been reviewed and approved by the County for use in the preparation of hydrologic studies. The following programs/vendors are listed in Table 15.1 of the manual:

1. Watershed Modeling System (WMS), Version 7.1 or later;
2. XP-SWMM, Version 9.0 and later;
3. HEC-HMS, Version 2.2.2 or later;
4. LAR04;
5. RETARD; and,
6. TC_calculator.

The following subsections review each of the software programs identified in the LA County Hydrology Manual, and provide a recommended software package for use in the City's new master plan.

2.3.1 Watershed Modeling System

The Watershed Modeling System (WMS) is probably the most popular computer software for preparing hydrologic studies using the MODRAT program. The program provides a user-friendly interface combined with GIS tools and automated watershed delineation and hydrologic modeling. These features make the program easy to use and allow the hydrologic modeling to be integrated with and take advantage of the City's GIS databases. Key features of the software include:

- Automatically delineate a watershed and sub-basins using digital terrain data
- Compute hydrologic basin data such as time of concentration and watershed parameters
- Subdivide watersheds automatically to obtain flow rates at specific concentration points
- Manipulate stream networks to represent man-made features or proposed improvements
- Override automated basin boundaries to reflect drainage systems and previous studies

The WMS software does include packages that run hydraulic models; however, the available models do not include the capabilities to run detailed water surface profile calculations for underground storm drain systems. This is the main disadvantage of the program. A separate hydraulic modeling program will be required for the storm drain system hydraulics. However, the program does have the capabilities to link with other software packages that do run storm drain water surface profile models.

2.3.2 XP-SWMM

The XP-SWMM program is based on the Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM). EPA-SWMM is a free program that was originally developed in 1971 and is one of the most widely used storm water programs in the world. The most current version, EPA-SWMM 5.0.021 was released in 2010. SWMM is a dynamic hydrology and hydraulics software program capable of performing both hydrologic analyses and detailed storm drain hydraulics. However, the EPA-SWMM program does not include the LA County MODRAT program. XP Software is a third party vendor that has enhanced the user interface and function of the EPA-SWMM program. XP Software has worked with the LA County Department of Public Works to incorporate the MODRAT program in the SWMM package. In addition to the hydrologic program, XP Software has incorporated the County's Water Surface and Pressure Gradient (WSPG) hydraulic modeling program as an add-on to the XP-SWMM program. The WSPG program is a steady flow hydraulic model that is commonly used to analyze and size storm drain systems. It is a steady flow model that computes the system hydraulics based on a peak flow rate determined from the hydrologic analysis. The SWMM engine also includes a more advanced hydrodynamic modeling capability for gradually varied unsteady flow through a drainage network. The calculations more accurately model flow through the system including an accounting of storage in the pipe system. Key features of the software include:

- Hydrologic and hydraulic modeling capabilities allow for integrated analysis of hydrology and storm drain facility sizing
- Includes LA County MODRAT hydrology and WSPG hydraulic models
- Provides 1 and 2 dimensional hydrodynamic modeling capabilities
- Dynamic link with WMS hydrology output
- Incorporates GIS data linking abilities

XP Software provides a version of the software specifically for stormwater, XP-STORM. This is a reduced cost version of XP-SWMM and provides all the same features except for the wastewater modules which are not necessary for a storm drain master plan.

XP has recently incorporated LA County's Water Surface and Pressure Gradient (WSPG) computer program into the XP environment. The program was implemented by XP Software in conjunction with the LADPW, and is available in three forms:

1. WSPG 2010 – a no cost stand alone product that implements the WSPG program.
2. XP-WSPG 2010 – a new stand alone product that includes the LA County MODRAT hydrologic program with the WSPG calculations.
3. XP-WSPG add-on module to XP-SWMM and XP-STORM – an add-on module that provides the WSPG calculations in the comprehensive XP-SWMM and XP-STORM models.

The WSPG program is the LADPW recommended model for computing water surface profile calculations for open and pressure flow storm drain systems. The advantage of the XP-WSPG 2010 program is that includes the LA County MODRAT program or can be linked with the WMS program to import flow rates directly from the model.

2.3.3 Remaining Computer Models

The HEC-HMS and RETARD programs are generally used for reservoir routing and do not include the MODRAT program developed by LA County for the preparation of hydrology

studies. LAR04 and Tc_Calculator are basic programs that implement MODRAT. The Tc_Calculator is for single subareas and small watersheds and is not appropriate for master plan studies. LAR04 can be used for larger watersheds, but does not include hydraulics or GIS capabilities. While the LAR04 program has a low price of $750, it does not provide features for the integration of the master plan with the City's GIS database.

2.3.4 Software Recommendation

The WMS computer software is recommended for the development of hydrology analysis for the City's storm drain master planning. The program is well known to LA County, and is widely used for hydrologic modeling. The program includes all the capabilities necessary for the preparation of the watershed hydrology and can link effectively with the City's GIS database. In conjunction with the WMS program, it is recommended that the XP-WSPG computer software be used to model to the storm drain system hydraulics. Users of the combined systems can automatically delineate catchments and quickly estimate watershed parameters and do hydrologic analysis in WMS, and then run the storm drain hydraulics in XP-WSPG for in-depth hydraulic modeling. These models can be run on an individual PC or through the City's server.

Both of these recommended modeling software products have extensive GIS integration capabilities, but each approach this integration in a different manner. The WMS software in its recommended version of 8.4 is integrated directly into ArcGIS and is compatible with both the 9.3.1 and 10 versions of ArcGIS desktop software currently in use at the City. Therefore, while some work will need to be done to build and verify the appropriate GIS topology and implement a consistent and complete feature numbering system, the City's existing GIS data and software will support the modeling using WMS directly.

XP Software approaches GIS integration in a different manner. The required features needed for modeling will need to be exported from the City's GIS into the model using a transfer data format such as "shapefile". For this effort a complete and unique feature numbering system must be in place as this will form the unique connection between the model data and the features in the City's GIS. Once the modeling is complete, the City's geodatabase can be updated both with missing information and model results because the City's database is ODBC compliant. This data transfer and return of results mechanism is independent of the version of ArcGIS the City is using at the time.

The WMS and XP software both have subscription or purchase options for the programs. The subscription price is an annual fee for the use of the program and includes all future updates to the program. The purchase price is to buy a license for the current version of the software. The purchase package also includes an optional support package to get unlimited support and annual updates for a yearly maintenance fee of approximately 15% of the purchase price.

Purchase Prices:
WMS (Hydrology Package): $2,000
XP-WSPG: $1,895
Total Annual Maintenance Fees: $585

Subscription Prices:
WMS (Hydrology Package): $399 per year

Project Recommendation:

3. Use the WMS and XP-WSPG hydrology and hydraulic software packages to model the system hydrology and hydraulics and integrate with the City's GIS platform.

2.4 Integration of On-going Video Inspection and Storm Drain Lining Projects

The City has on-going programs to perform video inspection of the existing storm drain systems and installing storm drain lining for those facilities that are in need of repair to extend the service life of the system. The programs are designed to identify and repair existing systems, but do not take into account issues associated with the hydraulic capacity of the storm drain. The video inspection and storm drain lining programs need to be integrated with the drainage master plan to be a comprehensive document and make informed decisions regarding the expenditure of capital improvement funds. An integrated document will allow the City to determine whether an older system in need of lining should be repaired or improved with a new pipe to also address potential hydraulic deficiencies.

Project Recommendation:

4. Integrate the video inspection and storm drain lining projects with the recommended improvements in the Drainage Master Plan. Include remaining service life in the criteria for the prioritization of recommended improvements and incorporate into hydraulic models (change in effective diameter and n-value).

2.5 Stormwater Water Quality Requirements

The Drainage Master Plan should incorporate opportunities to address water quality as the City is subject to existing and new regulations that require water quality to be addressed by structural BMPs. The City is subject to numerous TMDLs where structural BMPs may need to be implemented on a regional and sub-regional basis to meet compliance. The Los Angeles Regional Board in a meeting on May 25, 2011 identified the tentative schedule for adoption of the new MS4 permit for Los Angeles County. A draft of the new permit will be released in January of 2012 with an adoption hearing date targeted for April 2012. The new MS4 Permit will likely include requirements related to the identification and implementation of regional or sub-regional structural BMPs. These requirements will likely include identification of opportunities for regional and sub-regional retrofit of existing development with structural BMPs, a Low Impact Development (LID) offset program for mitigation of development projects that cannot meet LID requirements, and identification of structural BMP sites that could help mitigate the affects of hydromodification. The Drainage Master Plan Program should evaluate how these regulatory drivers will likely affect the need for the structural BMPs within the city by analyzing future development in the City, evaluating TMDLs requirements, and evaluating potential retrofit and hydromodification requirements of the new MS4 permit.

The Drainage Master Plan should incorporate a system-wide evaluation to identify opportunities to incorporate regional and sub-regional structural retrofit BMPs. The study will identify locations either adjacent to or incorporated within where it is feasible to incorporate structural BMPs to improve water quality. The study will use a GIS model to identify potential BMP locations and potential constraints for implementation of BMPs. The results of the GIS model should be verified with field visits. Based on site constraints and the regulatory needs for each site a BMP should selected for each site. Constructability and costs should be analyzed for each site. Conceptual exhibits should then be developed for each site. Prioritization of sites can then

be analyzed through a detailed analysis of water quality benefits through water quality modeling, regulatory drivers, constructability, and life-cycle costs.

The retrofit study will identify opportunities to augment the City storm drain system with regional and sub-regional water quality BMPs. These potential BMP sites provide a tool that the City can use to help meet compliance with the multiple TMDLs the City is subject to and the anticipated upcoming requirements of the new MS4 Permit.

Project Recommendation:

5. ***Prepare a phased BMP Retrofit Study in conjunction with the drainage master plan update. Incorporate potential BMP retrofit sites into the storm drain capital improvement plan.***

2.6 Geographic Information Systems

The City is currently using ArcGIS Desktop (ArcView/ArcInfo), ArcGIS Server, and ArcSDE as operated and maintained by Palos Verdes on the Net (City GIS Provider). The City GIS Provider maintains an ArcGIS Server Intranet site using the .Net API which provides internal mapping for the layers of data which have already been created.

For the success of the Stormwater Master Plan project, it will be extremely important that work with regard to the GIS data, the Integrated Project Viewer application, and the project deliverables be coordinated closely with the City's GIS Provider. Also, the City and its City GIS Provider must maintain strong lines of communication. City staff should provide updated information to the City GIS Provider on a regular and scheduled basis and the City GIS Provider should provide timely updates to the GIS to support City services and provide complete access through the most current implementation of the City's GIS viewer. The viewer application to be used by City staff should be user friendly and require little or no training of staff to fully utilize. We recommend that the City also develop a written procedure for the maintenance of the City's data to clarify the responsibilities of each party and to clearly identify when a third party contractor should be retained to provide GIS work that requires specific Engineering, Surveying, Environmental or Planning expertise.

Data layers required for the drainage master plan may include the following layers and their sources are listed.

Table 2-1. Required GIS data layers

Description	Source
Contours and Digital Elevation Model (DEM)	LAR-IAC Project
Citywide Aerial Imagery (4" or 6" Pixel Resolution)	LAR-IAC Project
Storm Drain Pipe Network	City of Rancho Palos Verdes
Catch Basin and Structure Locations	City of Rancho Palos Verdes
Flow Direction	City of Rancho Palos Verdes
Stream & Channel Network	City of Rancho Palos Verdes
Drainage Area Boundaries	City of Rancho Palos Verdes
FEMA Flood Zones (FIRM)	FEMA
Parcels	Los Angeles County

Public Owned Parcels	Los Angeles County
Land Use: Existing and Proposed	City/Los Angeles County
Vacant Lands	City/Los Angeles County
Street Centerlines	Los Angeles County
Hydrologic Soil Types	NCRS
Groundwater Basins	Watermaster
Depth to Groundwater	Watermaster
WQ Monitoring Data (Surface and/or Groundwater)	City/CoLA/Watermaster
Known Contaminant Plumes	Watermaster
Geologic Conditions / Landslides	City of Rancho Palos Verdes
Flood Control Retarding Basin Locations	City/Los Angeles County
Rainfall Data	City/Los Angeles County
Rain Gauge Station Data	City/Los Angeles County
Stream Gauge Stations and Data	City of Rancho Palos Verdes
Designated Environmental Sensitive Areas	LACo/USFWS/CDFG
Protected Habitat Areas	LACo/USFWS/CDFG
Environmental Cleanup Sites	City/CoLA/CEPA/EPA
Environmental Issues	City of Rancho Palos Verdes
Existing and Proposed Treatment Best Management Practices (BMP)	City of Rancho Palos Verdes

To accomplish the City's Drainage Master Plan will require acquisition of some datasets from outside sources. In particular, the availability of recent high resolution aerial photography and topography is necessary to perform the evaluation, analysis, and modeling in the master plan project. The City has the opportunity to participate in the County of Los Angeles' LAR-IAC project. This project can provide the City with current (2011) 4" pixel resolution aerial photography and 2' contour topography. Since this is a joint effort with the County and many local cities, the cost of this project and acquiring the necessary data is much lower than trying to acquire it independently. For these reasons, it is recommended that the City take advantage of this data opportunity to support the drainage master plan project.

We have reviewed the City's existing stormwater feature GIS data and find it to be relatively complete and accurate. As part of this review, the City's Consultant Tracy Lenoker Associates provided a copy of the City's current Stormwater Facility GIS data. As a Professional Engineer, Tracy Lenoker provided the City with GPS survey and engineering data conversion for the stormwater system. Other GIS data was reviewed from the County of Los Angeles and the City of Rancho Palos Verdes and included:

- Parcels
- Street Centerlines
- Storm Drain Pipes
- Storm Drain Structures
- City Boundary

The stormwater data was reviewed for topological errors to ensure that pipe segments are snapped at end points and to verify structures are connected to pipe segments. With a preliminary review

of the data's topology we found very few errors in the data. A preliminary review of the pipe segments to verify that pipes were drawn to represent the downward flow direction was also completed. By having the pipe directions drawn in this manner they will represent flow direction in the stormwater model. During this review we determined that most segments were flowing in the downhill direction and most line segments were correct with some minor corrections required before modeling could be performed.

As part of the study, RBF reviewed the City's stormwater pipe segments and structure points. We found that there were 3,613 storm drain structures features and 3,420 pipe segments within the City's data. Fields in the stormwater data sets were reviewed for a better understanding of completeness in the attributes. It should be noted that some attributes may also be incorrect and should be checked as part of the master plan project. The following is a statistical break down of the data.

Stormwater Pipe Segments:

- 73% of the pipe segments have a pipe diameter, based on "Diameter" Field
- 65% have an attribute in the "FILENAME" field. It is assumed that this field is used to link as-built drawings.
- 99% of pipes had an associated owner, based on "Owner" field
- 26% of the pipes material was unknown, based on "Material" field
- All pipes had a Pipe Number, based on "Pipe_No" field
- 68% of the pipes had a slope greater than 0, based on the "Slope" field
- 73% of the pipes had a year of construction with the latest recorded date of 1949, based on the "YR_CONST" field

Stormwater Structures:

- 65% have an attribute in the "FILENAME" field. It is assumed that this field is used to link as-built drawings.
- All structures have an associated Id number based on the "ST_ID" field
- 25% of the structures have a Dimension based on the "DIM" field
- 66% of the structures had a year of construction with the latest recorded date of 1949, based on the "DATE_CONST" field
- 68% of the structures have an invert elevation, based on the "INVERT" field
- 19% of the structures have a Rim Elevation, based on the "RIM_ELEV" field
- All features have a Structure Type based on the "ST_TYPE" field

The overall assessment of the stormwater GIS feature data topology is good and nearly ready for modeling. Attributes within the data appear to be about 65% complete. With this initial assessment we conclude that although the data appears to be in pretty good shape, data verification with as-built drawings and field data, and filling of the data gaps must be accomplished before stormwater modeling can take place.

The City's current GIS stormwater features also lack a consistent and complete numbering mechanism. We recommend that at the onset of the drainage master plan project, the City undertake a complete renumbering of the stormwater features including pipes, structures and channels. A common numbering scheme for a network of this nature is to number each of the structures using a conventional sequential numbering based on the watershed or sub-watershed. The pipes and channels would then be numbered uniquely using the upstream and downstream

structure reference. This approach easily supports the modeling needs and provides a logical approach to the City's stormwater infrastructure.

The City's current pipe assessment data seems to be well organized and available for use in the drainage master plan project. One issue is that not all the CCTV videos have been associated to the pipes in the City's GIS. Further complicating this matter is the lack of the consistent numbering system over time. This data gap must be corrected and the remaining CCTV videos and associated pipe assessment results must be associated to the correct stormwater features in the GIS. Once this issue has been corrected, future field data collection work should be done using the feature numbering developed under the master plan project to prevent this problem from reoccurring in the future.

Another deficiency in the existing data came to light in discussions with the City's GIS consultant Tracy Lenoker. It should be noted that there has been insufficient record keeping over time with regard to the slip lining of some of the City's stormwater pipes. This information should be identified in the field assessment and added to the GIS database. The data represented in the GIS therefore, includes the original construction while the pipes in the field have been retrofit. We recommend that the master plan consultant work closely with City Engineering and Maintenance staff to identify the locations of these data deficiencies and update the GIS where appropriate before beginning the master plan modeling process. Further field review and pipe assessment will be required to reach an acceptable level of data accuracy with this data gap.
The City is in the process of acquiring the Cityworks comprehensive asset management system software from Azteca Software. This software meets all the requirements for integration into the GIS capabilities and software outlined in these recommendations. The Cityworks software is compatible with both versions 9.3.1 and 10 of ArcGIS and supports ArcGIS Server applications. The data stored in the asset management components of the City's GIS (such as work orders, repairs, cleaning, as well as NPDES inspections) will then be available for use within the City's other GIS applications including the "living" Drainage Master Plan application described below.

To enhance the development and continued use of the "living" drainage master plan at the City, an enhancement to the City's existing GIS viewer application is recommended. Such an application has been successfully deployed on similar projects leading to reduced costs over time, improved access to information, and distributed availability in the office and in the field. The recommended environment for the application is ArcGIS Server using the Silverlight API. Silverlight is a media rich extension of the basic ArcGIS Server .Net environment and will allow for ease of adding and accessing site photos, CCTV videos, and other supporting information related to the stormwater features. This new web based application will allow for much wider access and use within the City and out to the Internet if desired for secured remote access by field crews or City consultants. The advantages of this web based approach are as follows:

Online interactive web sites prepared as part of a Systemwide mapping tool for the County of San Bernardino.

- Early implementation provides both the consultant team and the City Engineering staff with access to all available data in a common environment with no software;

- Access is available to anyone with a web browser and Internet connection who has the appropriate login credentials;
- No training necessary, ease of use is similar to using Google Maps or Bing;
- The Web maps are fast and intuitive to use;
- Can provide access control (user/password) to provide security and limit or enhance data available based on login;
- Updates and changes to the data are represented immediately on the map without redistributing data;
- Additional City data layers, such as parcels, soils, habitat, sensitive species, and easements can be easily added;
- The application is managed centrally, so updates and added features become active and available immediately upon posting;
- Eliminates costly management and patching of workstation based software and data;
- Can be hosted by Palos Verdes on the Net who already possess the necessary software and licensing;
- Uses Microsoft Silverlight technology for media rich interactive environment to support video inspections, photos, scanned documents, as well as the feature rich mapping environment;
- All source code developed by consultants can be provided to the City for future enhancements and additional features;
-

We anticipate that in order to provide the forward thinking of a "living" drainage master plan, the application will have functionality both during plan development and following delivery and acceptance of the plan by the City. During plan development, the web based GIS application will serve as an over-the-shoulder review tool which will be deployed immediately. Development of the Integrated Project Viewer Application should occur prior to commencing the Drainage Master Plan in order for it to provide maximum benefit to the project. Then during field data collection phases for CCTV video, snapshots, manhole and structure inspections, collection of missing pipe and manhole attributes, the contractor will be posting these to the GIS Application site on a regular basis. This will allow the City to follow along as the work is completed and comment directly on any issues observed so they can be corrected while the crews are still in the field. This will eliminate or at least minimize the issues that will crop up after the physical submittal, minimize City staff review time at the end of the project, and minimize the need for the contractor to redeploy the field crews to recollect and resubmit data (time consuming and costly to all parties). After completion of the field work, the development and results of the modeling can be demonstrated in the viewer application allowing a more collaborative model development process between the model consultant and City staff. Following submittal of the final Drainage Master Plan, the City will have continued access to all of the stormwater data, modeling results, and most notably the supporting reference material such as CCTV videos, observation snapshots, and scanned documents such as previous studies and as-built record drawings.

An additional recommended feature which should be deployed as a part of the Drainage Master Plan GIS viewer application is an online "Problem Action Form" Quality Control function. This web based database tool has been deployed on similar projects with great success. This function will allow the contractor in the field, the consultant developing the model, or City office or field staff to raise an issue and attach a screen shot, photo, video reference, and a comment. Each such issue is assigned a tracking number and can be addressed immediately by the Project Manager or the City after they receive an email alerting them to the problem. Once an issue is resolved to the satisfaction of both the City and its contractors, it is marked as "Resolved" and archived. The

addition of the GIS functionality takes this process one step further in that it will map the location of the issue that has come up and can display the issue's location as an orange caution triangle on the online map. As they are resolved, they turn green for clear easy identification of open issues. This will allow the City to not only view the text about what a problem is as it arises (such as "Manhole not found in this location"), but to see the context of the issue with the surrounding aerial photo, the other District facilities, the easements and the parcels. Also, since this is an integral function of the City's GIS, such problems and their resolution will remain part of the permanent record for City stormwater features for future reference.

Project Recommendations:

6. ***Complete storm drain data gaps in the existing GIS database***
7. ***Develop a web-based interactive map browser to facilitate the master plan development and functionality***
8. ***Develop and incorporate an integrated numbering system for the storm water facilities***

Other Recommendations

- ***Develop City Data Maintenance Plan for Engineering and Planning GIS data layers***
- ***Keep GIS Viewer Application updated and designed for ease of use to streamline staff efficiency***

3 MASTER PLAN PROGRAM RECOMMENDATION

The results of the review and needs assessment were used to generate a list of project recommendations to be included in a new drainage master plan program for the City. These recommendations are used as the basis for development of a detailed scope of work and implementation strategy.

3.1 Drainage Master Plan Recommendations

Eight (8) recommendations were identified as part of the Needs Assessment for the development of a comprehensive drainage master plan program for the City. The recommendations include:

1. Prepare new hydrology using the January 2006 LA County Hydrology Manual
2. Prepare detailed water surface profile hydraulic calculations for existing and recommended storm drain improvements
3. Use the WMS and XP-WSPG hydrology and hydraulic software packages to model the system hydrology and hydraulics and integrate with the City's GIS platform
4. Integrate the video inspection and storm drain lining projects with the recommended improvements in the Drainage Master Plan. Include remaining service life in the criteria for the prioritization of recommended improvements and incorporate into hydraulic models (change in effective diameter and n-value)
5. Prepare a phased BMP Retrofit Study in conjunction with the drainage master plan update. Incorporate potential BMP retrofit sites into the storm drain capital improvement plan
6. Complete storm drain data gaps in the existing GIS database
7. Develop a web-based interactive map browser to facilitate the master plan development and functionality
8. Develop and incorporate an integrated numbering system for the storm water facilities

A work plan and proposed scope of work was developed to incorporate these recommendations into a new drainage master plan program. The following outline scope of work is proposed for the development of the storm drain master plan:

1. Data Collection
2. Existing Facilities Survey and Inventory
3. GIS Database Development
4. Watershed Hydrology Analysis
5. Drainage System Hydraulic Modeling/Alternatives Analysis
6. Water Quality Program Tasks
7. Capital Improvement Program Development
8. Drainage Master Plan Document
9. Administration and Project Management

3.2 Proposed Scope of Work

The following tasks identify a proposed scope of work to develop a comprehensive new drainage master plan and incorporate the recommendations from the needs assessment.

Task 1 Data Collection

Task 1.1 Review and Compile Existing Watershed and Drainage Facility Data

A-E will provide services to research, collect and review existing background data. Data collection includes existing City GIS drainage and watershed maps, utility index map, soils data, "as-built" construction drawings for the local storm drain facilities, existing hydraulic and master plans of drainage, previous project reports, proposed development tentative maps or hydrology studies, EIR's, floodplain mapping, ownership data, geotechnical data, County master plans, land use data, topography, Army Corps of Engineers' reports, proposed development plans, NPDES Permits, Notice of Violations (NOVs), existing water quality facility as-builts, and receiving water TMDL listings. In addition, a field reconnaissance investigation of the project study watershed area will be performed. The field investigation will include a verification of the watershed conditions and accuracy of the existing improvement plans. Field reconnaissance of the project site and the immediate adjacent conditions of the surrounding watershed will assess flow restrictions and general surface flow patterns. A field review with ground photo inventory and analysis will be included in the final report of critical areas of interest or locations of severe flooding. Identify data gaps in GIS database and as-built plans found in the field investigation. Document data gaps for inventory in Task 2.1 and incorporation into the GIS database development (Task 3).

Task 1.2 Identification of Existing Initial Needs Assessment

A-E will prepare a qualitative assessment of the drainage constraints and conditions based upon existing data of the watershed and historical flooding problems for this area. Existing conditions and current design criteria will be evaluated to formulate initial assessment of the drainage needs. A-E will identify and summarize critical drainage related problems, including existing flood hazard zones and published floodplain and will identify existing physical or regulatory constraints based upon the baseline information researched for the watershed.

Task 1.3 Establish Engineering Design Criteria

A-E will provide preliminary engineering services to establish the design criteria for hydraulic and hydrologic design requirements prior to initiating the preliminary design process. The necessary planning criteria and standards will be established to ensure that the required level of flood protection is provided to meet the various jurisdictional agency requirements, and are in conformance with the City and guidelines. All elements of the Master Plan of Drainage will be prepared in accordance with the procedures established by the LA County Department of Public Works. This work item will include establishment of the following critical design features:

- Hydraulic controls
- Street inlet requirements
- Outlet requirements
- Local drainage system hydraulic modeling
- Review of master plan design assumptions
- Distribution of flows to the proposed storm drain and street section

- Critical design water surfaces (committed elevations)
- Allowable street flooding and storage
- Deficiency upgrade requirements
- Allowable design deviations (i.e., min. Flood protection levels)
- Establish water quality design criteria
- Evaluate Notices of Violation and/or areas of water quality concern

A memo summarizing the recommended design criteria and guidelines will be prepared for review. This document will serve as a initial reference framework for future decisions as work progresses and unique opportunities are encountered.

Task 2 Existing Facilities Field Survey and Inventory

Task 2.1 Field Facility Inventory

A-E will perform an "above-ground" field review and inspection of existing storm drain lines and channel facilities (laterals and private lines are excluded from this study). This inventory will include drainage facilities throughout the City. Facility inventory will also include existing facilities by other agencies, i.e. Caltrans, LA County. A-E will provide GPS land survey to determine the coordinates of the manhole covers. Depths of manholes can be measured where possible to determine accurate invert elevations where accessible, and or not clearly defined on as-built plans. Manhole locations located within heavily traveled right-of-way will be verified for location only, but invert elevations may not be field verified. These inverts will be acquired by as-built, or by evaluating the invert elevations of adjacent manholes within the same system (upstream and/or downstream). A-E shall develop a program to acquire missing invert data as part of the City's regular maintenance program, or during CCTV inspections.

The investigation will identify missing or incorrect data by field investigation, review of as-builts and interviews with City staff. A-E will also verify the facility information in comparison to the plan data, and augment data gaps with available information. The inspection will include limited field measurements, if possible, for depth of pipe, pipe size, and pipe condition (if visible). This task does not include enclosed space work or CCTV review of pipe characteristics. Catch basins and manholes will be located based on a GPS field inventory. Information will be recorded and provided to the City for delivery into the City database, including:

- Pipe materials
- Pipe Size
- Age of Construction
- Referenced Construction Plans
- GPS Location
- Invert Elevation

Task 3 GIS Database Development

Task 3.1 GIS Organization & Project Data Collection

The success of this project will be dependent on both the expertise of the A-E Team and its teamwork with the City. Upon kickoff of the Master Plan Project, A-E's GIS Manager will enter discussions with the City to review the schedule for the GIS scope of work, review and request available data and documentation, and agree upon GIS deliverables, project milestones, and

delivery dates. A-E will present in greater detail the project approach and take the time to build the relationships with the City, its IT and GIS staff, and other contractors that will be necessary for ongoing effective communication.

A-E will collect the necessary data and documents for the project. It is assumed that the City will have all the as-built drawings scanned and saved to a DVD or a portable data storage drive. A-E to sit down with the appropriate City staff member to review approximately 10% of the as-built scans so both the A-E and the City can discuss any potential problems identified. A-E will then take the scanned drawings for review, catalog and organization of the drawings so that they can be easily used by the engineering staff and linked to the GIS data where needed. As A-E is reviewing and cataloging the as-built scans they will identify scans that are unreadable and send a list to the City of unreadable scans to have the City re-scan the hard copy as-builts and send new TIF or PDF images of the drawing sets.

The objectives of the project initiation will be to:

- Administer and coordinate work for timely and effective completion;
- Document the City's project and ongoing GIS priorities;
- Set up and maintain appropriate communications;
- Gather GIS data;
- Review and collect Scanned as-built drawings
- Setup GIS status reports; and
- Setup GIS milestone dates.

Task 3.2 Complete As-built Indexing

A-E will provide as-built geocoding and indexing to incorporate the drainage as-built drawing sheets with a link to the storm drain segments retrievable from a GIS based mapping application. We understand that approximately 1100 pipes remain to be linked to the appropriate as-built drawing file. The budget for this task includes logging the as-builts from the TIF or PDF file format provided by the City. Each sheet where a pipe reference is missing and has not yet been accomplished by City staff will be reviewed to verify that the quality is sufficient for this application and to extract specific information to be used in the indexing process. From each sheet, A-E to extract attributes for the Street Name, Date of the Drawing, Drawing Number, File Number, pipe and/or structure size, material and Work Order Number where available. This vital information will be imperative for development of the facility mapping and data modeling to be accomplished in other tasks and for searching and displaying the attributes in the online mapping application.

A-E to create a GIS index of the drawing sheets and where necessary verify or link each image file to the appropriate stormwater facility segment or feature for retrieval either through a query or by selecting the storm drain segment graphically on the project online mapping application. Should multiple as-builts relate to the same drainage segment (very common), a list of the matching drawings will be provided in a pop-up window in the project web mapping application (task later in this scope) for the user to look through to find a desired drawing. For this as-built linking and indexing task, an estimated total of 4 minutes of Technician or Analyst time for each drawing sheet to be reviewed, the attributes gathered, the street and location to be identified and logged and to build the index. This process includes a thorough QC process to improve the accuracy of the delivered product.

Task 3.3 Establish City Numbering Scheme for Storm Drain Facilities

A-E to work the City to review the state of the City's current GIS Stormwater Facility numbering scheme(s) and begin implementation of a consistent and comprehensive numbering scheme which will support the City's Drainage Master Plan project needs, the City's future Asset Management application (Cityworks), and future maintenance of the GIS data . Upon gaining a thorough understanding of the City's current numbering systems, A-E will review with City staff our recommendation on how to number the stormwater facilities so that the structures will tie to the storm drain pipes consistently and can be easily updated and maintained. The system will be one that will allow the City the maximum amount of flexibility in the numbering while allowing for easy updates in the future. The City's GIS data attributes will be updated to the new numbering scheme while the existing numbering will be archived and eliminated from the live data set and still be available for future reference if required.

Task 3.4 Acquire Outside Data

A-E will work with the City to identify and gather necessary information and data that will assist in the completion of the Drainage Master Plan. Data that is anticipated to be collected includes orthorectified aerial photography and topography from the LA County LAR-IAC program, and LA County as-builts for facilities within the City. Additional data include LA County, private, and Caltrans stormwater facility data, FEMA Firm data, Land Use data, Watermaster subsurface data (if available and applicable). It is assumed that the cost of obtaining data from the various sources will be paid for by the City and A-E will seek approval from the City before the purchase of any data.

Task 3.5 Facility Mapping Tool

To streamline the project production and provide City staff with a tool for over the shoulder review and comment throughout the project, A-E will create a custom GIS based secure online interactive mapping site based on the information developed in other components of this project or as provided by the City. The interactive web mapping site will serve two purposes, one as a project management tool and two as a future data viewer to provide for a "living" master plan document. As a project management tool the viewer will allow the City to monitor the progress and results of the drainage master plan. As new data comes online the City can make comments to the web mapping tool and send an email to A-E staff to make corrections. Viewer components at a minimum will include the stormwater facility pipes and structures, water quality facilities identified in this MPD, model results, CCTV video, in pipe observation snapshots, BMP's, drainage areas, and associated attributes such as physical characteristics and ownership. A-E will also use County of Los Angeles base data where appropriate within licensing agreements or as provided by the City. The site will possess basic interactive mapping functionality. The site will be password protected to limit access to designated City staff, authorized contractors and consultants and A-E team members.

A-E will further develop a Project Portal Page for the Project to present the purpose and mission of the project and provide ready access in a central site to project documents and resources. The home page will present a City "branded" appearance to the project data and provide links to PDF documents such as studies, reports, and maps used in the development and execution of this project, as well as to provide ready access to the interactive mapping tool and linked as-built drawing scans.

The site will also act as an enhanced document management application with the ability to link documents, snapshots, and studies or reports to the map for easy reference and download by City staff or other project stakeholders such as consultants or the public. Should the City desire additional functionality, documents can be easily uploaded by City staff on an on-going basis or will be included initially as provided by the City or from the other components of this project. Support for the data layers developed under this project has been included. Additional functionality is provided for the City to review the ongoing work during master plan development and to provide comments in the form of "Problem/Action" forms. These forms can be filled out by the City or A-E staff throughout the project and will be linked to the mapped features developed in the project. Once the details of the issue have been logged, an email will be sent to the relevant project participants for follow-up and resolution. This approach provides a centralized location for both the City and A-E team members to go to for research and reference of relevant project data, as well as to view and print maps of the work in progress and completed. The site will also keep a log of identified issues and their resolution as a future reference and to be included in the final report.

The scope includes a brief workshop with City staff to determine appropriate symbolization and colors for the layer's features to be displayed on the site and in the final atlas maps. For GIS data, it is assumed that the necessary or desired attributes will be complete and organized, that the feature data will be clean and ready to build any required topology (no gaps or overshoots and closed polygons) and that the data will be delivered back to the City as either an ESRI shapefile or file geodatabase. At the conclusion of the project A-E will provide the City with all the source programming that was used to create the site. By giving the City all the source code it will allow the City to keep the site up to date into the future. The site will be hosted online by A-E during the development of the Master Plan. After delivery of the master plan document, the City can take the application in-house for continued use of the "living" master plan, or continue to host the site at A-E for a nominal hosting fee. Assistance in installation and implementation of the programming, data, and mapping application on City systems will be accomplished at A-E's contracted hourly rates as needed.

Task 4 Watershed Hydrology Analysis

Task 4.1 Delineate Existing Watershed Characteristics

A-E will review and validate the drainage areas within the existing City of Rancho Palos Verdes Master Drainage Study dated 2004 (AKM, 2004), A-E will update boundaries based on field investigations and modeling results based on the latest digital topography completed (or purchased) by the City. Boundaries for the Drainage Basin Areas will be determined and the minimum critical hydrologic concentration points will be established to assist in the development of the watershed model and analysis requirements for the hydraulic design. A watershed map with the delineation of the watershed Drainage Basins will be updated to document the mapping for the proposed hydrologic modeling. The watershed map will determine the average characteristic parameters associated with the modified or updated watershed subareas necessary for the application of hydrologic analysis. Obtain and review available data for parameter estimation in the precipitation-runoff model including infiltration, vegetation cover, impervious cover, hydrologic soils data, slopes, and watershed hydraulic efficiency. Field verification of watershed boundaries will be preformed for areas with conflicts or incomplete data.

Task 4.2 Rational Method Hydrology Analysis

A-E will prepare a rational method hydrology analysis for the watershed to quantitatively estimate the "ultimate" land use watershed condition surface runoff flowrates for the 10-, 25-, and 50-year (Capital Flood) storm return periods based upon full conveyance of the drainage systems for all storm events. The MODRAT hydrology model in the WMS software will be used to develop a GIS-based link-node model for critical concentration points previously identified in the mapping phase. Flowrates developed will be limited in minimum tributary drainage area size to the master plan or primary backbone facility systems only. Hydrology calculations will be completed in accordance with the LA County Hydrology Manual.

Task 5 Drainage System Hydraulic Modeling/Alternatives Analysis

Task 5.1 Existing Municipal Storm Drain - Hydraulic Model Preparation

A-E will perform a hydraulic analysis of the conveyance "capacity" of the existing City backbone storm drain system including large subsurface storm drains and channels. The hydraulic analysis will be based upon evaluation of the hydraulic grade line, rather than "normal depth" calculations. Hydraulic grade line (HGL) calculations will be performed utilizing the XP-WSPG computer program. The hydraulic model developed as part of this task will provide the baseline model to identify system deficiencies and to test the modification alternatives of the recommended storm drain improvements. (The storm drain water surface profile models will only be generated for the main "collector" or "trunk" storm drain lines, and the private or local facilities outside of public right-of-way intercepting the lot/building surface drainage will not be analyzed). The water surface data and hydraulic information will be summarized in tabular format for each reach or element of the facility with critical areas highlighted to allow easy use and review.

Task 5.2 Existing Municipal Storm Drain - Capacity Analysis and Hydraulic Deficiency Identification

The hydraulic models generated for the "existing" mainline storm drain systems will be analyzed in a sensitivity analysis to determine the maximum hydraulic "capacity" of the system. The maximum allowable hydraulic capacity will be defined as the highest elevation of the hydraulic grade line below the street that allows the surface inlets to function. A sensitivity analysis will be performed by factoring the "design" discharges to a lower amount until the storm drain operates without causing flooding of surface inlets. The hydraulic model will be used to quantify ~~a~~ any deficiency ~~numerical amount~~ of hydraulic conveyance ~~that~~ in the existing system ~~is deficient~~. The hydraulic capacity will be converted to "level of flood protection" numerical value through a ratio of the capacity flowrate to the calculated design flowrate.

Task 5.3 Street Flooded Width Calculations

The results of the hydrology hydraulic capacity analysis will be used to perform street flooded width calculations at critical street locations to ensure conformance with City drainage design criteria. The street flooded width analysis will be based on normal depth calculations and using City of Rancho Palos Verdes standard street sections. The street flooded width calculations will be used to identify locations that do not meet City criteria and therefore, may require additional underground storm drain improvements.

Task 5.4 Deficiency Removal and Alternatives Formulation / Feasibility Analysis

A-E will develop preliminary alternatives formulation for removal of hydraulic deficiencies within the existing "mainline" storm drain improvements. The conceptual assessment will focus on either: (1) increasing the hydraulic capacity through enlarged drainage facilities or new

parallel system adjacent to existing facilities, (2) constructing a diversion system, or (3) constructing detention storage for flow reduction and water quality benefits. The overall watershed system will be divided into study reaches for refined analysis on a reach-by-reach basis. A list of potential design options will be identified which meet the primary flood protection objectives and major constraints associated with the alternatives will be discussed. A feasibility analysis will be performed to screen the alternatives and develop the recommended alternative based on selection criteria, including downstream constraints, ownership issues, minimal costs and public impacts.

The proposed increased pipe sizing will be based upon water surface profile hydraulic calculations for the updated design flowrates. Preliminary horizontal and vertical alignments will be developed for the recommended facilities. The lengths and elevation data will be used for detailed hydraulic analysis and cost estimating purposes. Recommended drainage improvements to remove hydraulic deficiencies of the municipal storm drain systems will be analyzed in XP-WSPG, developed in the previous tasks to verify operation. The sizing of the modifications to the existing storm drain sizes will be adjusted using the water surface profile model to optimize the performance of the system and identify impacts and benefits associated with a recommended project.

Task 6 Water Quality Program Tasks

Task 6.1 Water Quality Regulatory BMP Requirements

The New Development section of the new MS4 permit for Los Angeles County will likely include requirements associated with the Low Impact Development alternatives and In-lieu programs. The potential exists for the City to implement watershed-based structural BMPs to provide an offset to those development projects that are determined to be technically infeasible to implement onsite LID BMPs. A-E will coordinate with the City Planning Department to forecast future development in the City and then evaluate the potential for implementation of watershed-based structural BMPs as part of an LID In-lieu program. A-E will evaluate the implementation of LID structural BMPs at the sub-regional and regional basis within the City. A-E will also evaluate the potential retrofit and hydromodification requirements of the new permit. A-E will evaluate the TMDLs the City is subject to and identify subwatersheds where structural BMPs will likely be necessary. The results of the LID offset evaluation, retrofit and hydromodification evaluation, and TMDL evaluation will be incorporated into a technical memorandum identify potential future structural BMP needs in the City.

Task 6.2 BMP Retrofit Opportunities

A-E will prepare a study to identify and evaluate potential structural BMP opportunities within the City. This study will be based the technical approach that has been implemented in other BMP retrofit studies in California. The technical approach will identify structural BMP retrofit sites and assesses and potential BMP types for each site. The BMP Retrofit task will include two phases, Phase I: GIS Watershed Analysis and Phase II: BMP Assessment and Prioritization.

Phase I: GIS Watershed Analysis encompasses a desktop level analysis to identify potential structural BMP opportunities with the City. Phase I includes:

- Data collection and coordination with City staff.
- Identification of existing regional structural BMPs in the City
- Desktop identification of potential BMP retrofit sites

- Identification of potential site constraints for each potential BMP site
- Initial water quality assessment
- Integrated BMP needs assessment (in association with results of Task 5.1)
- Identification of potential BMPs types (including Low Impact Development) for each site

The results of Phase I will be discussed with the City prior to proceeding with Phase II.
Phase II: BMP Assessment and Prioritization encompasses a more detailed assessment of the potential BMP for each site and the development of an implementation strategy for the identified BMP retrofit sites.

Phase II includes:

- Field verification for each identified BMP retrofit site
- Planning and constructability analysis for each site
- Conceptual exhibits for each site
- Life Cycle Cost (capital program and O&M)
- Identification of funding opportunities (i.e. grants)
- Water quality assessment
- BMP implementation prioritization and BMP site selection

The results of the BMP implementation prioritization will be an implementation strategy that will serve as a Water Quality BMP Facilities Plan that can be incorporated into the Drainage Master Plan. The results of Phase II will be provided in an overall BMP Retrofit Study Report/Water Quality BMP Facilities Plan.

Task 7 Capital Improvement Plan Development

Task 7.1 Identification of Recommended Improvements

The capital improvement program (CIP) will incorporate the results of the drainage system pipe condition assessment (by others) and the capacity analysis. A-E will formulate and recommend alternatives for the repair, rehabilitation, and improvements to the storm drainage system that will satisfy the established objectives. The identification of the recommended improvements will incorporate the results of the condition inspection and the capacity analysis. Consideration will be given to deficiencies in remaining service life and hydraulic capacity.

A-E's recommendations will consider improving the water quality of the storm water runoff, addressing both operational and structural control measures in accordance with the MS4 permit and the other associated storm water quality management plans. A-E will identify all upgrades to the drainage system. Once the criteria for setting priorities have been established, projects will be ranked and preliminary costs will be developed.

Task 7.2 Implementation Program and CIP Schedule

Provide engineering services to generate a recommended prioritization and schedule for implementing the required drainage facilities to correct existing service life and hydraulic deficiencies. A-E will develop the criteria for prioritizing system improvements. Results of the capacity analysis will be integrated with the condition assessment results, reports of local flooding, and maintenance records to set priorities for system improvements. A listing of recommended improvements and their priority will be presented to the City for review.

A schedule will be developed that outlines the recommended implementation of facilities based upon the projected funding availability. The recommended improvements will incorporate a phased approach based upon risk characterization, potential impacts, and prioritization. The recommended alternatives will include a plan and schedule for implementation based on a priority rating and timeline determined in conjunction with the City. The City will provide A-E an estimate of the dollar amount that can be dedicated annually to capital improvement projects. Using this information, a plan and schedule for replacement and rehabilitation will be established over a time frame will be defined by the City.

Task 7.3 Preliminary Drainage Facilities Quantity and Construction Cost Estimate

Preliminary construction quantity estimates will be performed for the recommended drainage improvements. A preliminary estimated cost of construction will be generated from the quantity estimate using approved unit costs from the City. Unit costs will be based upon the most current cost information for recent similar projects in the area compiled by A-E and approved by the City. The total project costs for each facility will then be estimated which include line items for project design, survey, geotechnical, administration and construction support. In addition, intangible costs for facilities will be investigated, such as environmental mitigation, if these are determined to be critical for a particular system. Major physical constraints will be included in the estimate such as (1) land acquisition, (2) street paving and traffic control, and (3) utility relocation or protection.

Task 8 Drainage Master Plan Document

Task 8.1 Draft Report – Updated Master Plan of Drainage Document

A-E will provide engineering services for the compilation of a new Master Plan of Drainage to support the proposed hydrology analysis and recommended drainage facilities. The written report will serve as the technical documentation for the preliminary engineering design and selection of the recommended watershed improvements. This report will include the background for the watershed investigation, hydrologic modeling, hydraulics analysis, alternatives analysis, storm drain design and sizing, and flood protection requirements. This document will serve to reference the design assumptions, guidelines, and criteria developed for the project. The text of the document will be prepared in MS WORD.

The draft Report will also serve as the initial engineering submittal package for the plan for review by the City. The engineering analysis and associated documentation will include (1) hydrology analysis, (2) watershed evaluation (3) existing systems hydraulic capacity, (4) facility design considerations, (5) required systems hydraulics, (6) feasibility alternative investigation and design selection matrix, (7) facility construction costs, and (8) Water Quality Assessment.

Task 8.2 Final Report –Master Plan of Drainage

A final report will be prepared which incorporates comments and modifications from the draft review(s) by the City. A copy of all files will also be provided on a CD.

Task 8.3 Final Drainage Exhibits / Maps

Provide engineering services to generate the final drainage map exhibits associated with the master plan of drainage. These drainage exhibits will consist of the following:

- Updated Drainage Index Map (Drainage Basins)

- Watershed Hydrology Map (Basins and Drainage Areas)

The hydrology maps will be prepared on the developed base sheets, modifying the existing drainage and will include the hydrologic concentration points or nodes clearly identified and the associated design discharge. Facility maps will indicate the recommended sizes and lengths for the backbone infrastructure. The drainage index map will be prepared at a suitable scale for use by City. Maps will be created using the GIS shapefiles generated during the project and electronic copies of all maps will be provided in PDF format.

Task 8.4 Atlas Map Creation

At the completion of the Drainage Master Plan process, A-E will assemble field books to provide City Engineering and Maintenance staff with hard copy maps of the entire stormwater system. A-E will create four sets of 1" = 200' (17 x 22-inch) atlas maps of the stormwater system, once the data has been attributed into the geodatabase and quality checked. Additional sets can be produced at an additional cost. These atlas maps will represent the GIS storm water system similar to the City's existing atlas maps with the new data created under this project. A-E will utilize the City's existing grid if possible and desired by the City. The layout that will accommodate approximate 17 x 22-inch maps at this scale will be determined by the City and A-E. This scope includes two City review cycles to approve the atlas sheet layout and content. A-E will prepare an automated "ESRI Map Book" solution that will allow the City to re-create the 17 x 22-inch atlas sheets that A-E will provide as part of the final deliverable using ESRI's ArcGIS desktop application.

The atlas maps will include industry standard symbolization; attribute labels of features and items that the City determines necessary as part of an annotation feature class suitable for 17 x 22-inch mapping. A-E will provide the City one set of ten representative sheets at 17 x 22 inches as well as PDF files for review. A-E will then review the City comments and make necessary changes. Atlas maps are anticipated to be black and white for ease of plotting and reduced cost to the City for future reproduction. The deliverables for this task include:

- One set of 17 x 22-inch storm water utility atlas pages and PDF files (for review)
- Four sets of 17 x 22-inch final color storm water utility atlas bound for converted drawings similar to water and sewer atlas books
- Automated process for future atlas sheet creation

Task 9 Administration and Project Management

Task 9.1 Project Management, Meetings and Coordination

A-E shall conduct project management activities to ensure adherence to schedule and budget, as well as documentation of communication between the A-E and City, as required. Coordinate and attend project meetings with City staff such as project kickoff, monthly progress meetings, design submittal reviews, and as needed to review design issues. Provide written meeting minutes for each of these meetings. A-E shall provide written monthly updates of project progress to the City.

Task 9.2 QA/QC

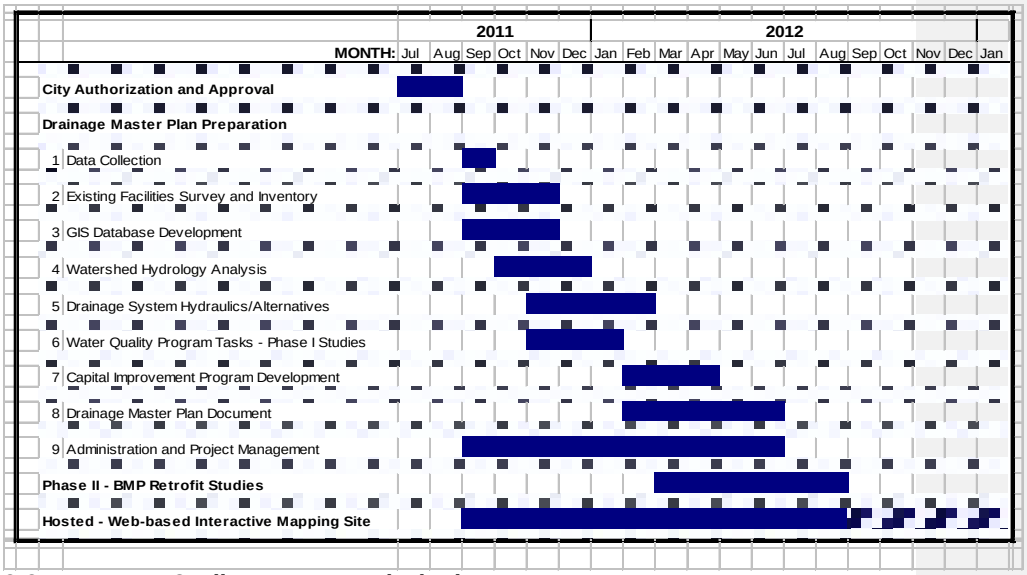
A-E will perform continual QA/QC as part of our standard project management. The QA/QC includes frequent progress checks and reviews as the project progresses. For the master plan of drainage QA/QC would occur during all tasks involving calculations or deliverable products.

3.3 Implementation Schedule

The implementation strategy is a living document that reflects the schedule and overall plan for the City to develop and implement the drainage master plan program. The purpose of the strategy is to provide the City with an outline of the various tasks involved with the implementation of the program and the estimated schedule for completion.

The task descriptions in the proposed scope of work provide an overview of the specific elements required to implement the program and the City responsibilities involved in the task. The schedule has been prepared to include all of the tasks necessary for the initial implementation of the program. On-going maintenance and updates can be completed by a consultant or the City after the completion of the initial project.

Table 3-1. Implementation Time Estimate



3.3.1 Water Quality Program Task Phasing

The Water Quality Regulatory BMP Requirements task is designed to more thoroughly analyze the water quality regulatory requirements the city is subject to, to better understand the structural BMP requirements. Evaluation of the structural BMP requirements of adopted TMDLs should take place as part of the Drainage Master Plan. This will allow the City to understand the drainages in the City that will need structural BMPs for TMDL compliance. This will help inform the identification of sites in the BMP Retrofit Opportunities task. The other element of this task is to evaluate the requirements of the new MS4 permit and the future development in the City to identify which sites would be needed for an LID offset program. This evaluation should take place after the release of the draft MS4 permit.

The BMP Retrofit Opportunities task is divided into two phases. Phase I should take place as part of the development of the Drainage Master Plan as Phase I is a desktop analysis to identify sites

for potential inclusion of structural water quality BMPs. Phase I should happen as the master plan is being developed so that these potential sites can be incorporated as a section of the master plan, which gives the City a pool of sites to choose from to meet TMDLs and the upcoming requirements of the new MS4 Permit. The new permit requirements affecting the Drainage Master Plan will likely include retrofit of existing development, an LID offset program including offsite regional BMPs to mitigate sites that cannot implement LID onsite, and hydromodification requirements. Although the anticipated requirements of the new MS4 Permit have been identified here having an understanding of the actual requirements in the new Permit, which is scheduled for adoption in April 2012, is prudent before proceeding with Phase II of the BMP Retrofit Opportunities Study. Phase II will more thoroughly evaluate each of identified BMP sites with an understanding of site constraints from field visits, costs, and selection of BMPs based on these site constraints and the regulatory purpose of the sites based on TMDL requirements and the requirements of the new MS4 permit. Because we do not know for sure what the new requirements of the MS4 permit are, Phase II of the BMP Retrofit Opportunities Study should commence after release of the draft MS4 Permit.

3.4 Program Cost Estimates

The City has tentatively budgeted $225,000 in the draft Fiscal Year (FY) 2011-12 Budget, along with approximately $470,000 carryover from FY 2010-11 for the development of the drainage master plan program. It is anticipated that the majority drainage master plan implementation would occur in FY 2011-12. An additional $30,000 per year for the remaining four years in the City's 5-Year Plan is also included for the program.

A preliminary budgetary estimate for the drainage master plan implementation was developed as part of this study. The budget for the project was developed based on our understanding of the recommended scope of work and specific conditions of the City. The storm drain video inspection work is being completed under a separate program and is budgeted through FY 2015-16, therefore no additional budget is provided here.

TASK		FEE
DRAINAGE MASTER PLAN		
1	Data Collection	$10,000
2	Existing Facilities Survey and Inventory	$75,000
3	GIS Database Development	$55,000
4	Watershed Hydrology	$40,000
5	Drainage System Hydraulics / Alternatives	$120,000
6	Water Quality Program Tasks – Phase I Studies	$140,000
7	Capital Improvement Program Development	$25,000
8	Drainage Master Plan Document	$50,000
9	Administration and Project Management	$20,000
	Subtotal	$535,000
	Deliverables/Reproduction/Software	*$15,000*
	Drainage Master Plan Total	$550,000
WATER QUALITY STUDIES – PHASE II		
	BMP Retrofit Studies	$200,000

TOTAL FEE	**$750,000**

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