PROJECT STUDY REPORT
SAN RAMON CANYON DRAINAGE SYSTEM

PREPARED FOR:
CITY OF RANCHO PALOS VERDES
PUBLIC WORKS DEPARTMENT

PREPARED BY:

Harris & Associates

34 EXECUTIVE PARK, SUITE 150
IRVINE, CA 92614-4705
(949) 655 - 3900

January 11, 2011

Prepared By:

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Randall Berry, PE

RCE # 44642

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Reviewed By:

_____

Alan Braadvedt

Senior Project Manager

Approved By:

_____

Ron Dragoo, PE

Senior Engineer of Public Works

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I. EXECUTIVE SUMMARY

Introduction:

Harris & Associates was retained by the City of Rancho Palos Verdes (RPV) to define the drainage problems in the San Ramon Canyon, identify alternative solutions to the problems and present the findings in a Project Study Report (PSR). The PSR is intended to evaluate and present information regarding at least three alternative solutions and to aid in identifying specific environmental, geotechnical, right-of-way and other construction related elements. Information presented in the PSR represents planning level construction estimates and includes soft costs which help in programming the required budget for the selected design alternative. Furthermore, information presented in the PSR will assist those involved in determining how to proceed with programming and engineering design decisions to manage the runoff that flows through the canyon and minimize erosion and the resulting flooding and debris on 25th Street.

Background:

San Ramon Canyon conveys storm water runoff generated within the canyon and the upstream tributary watershed approximately 3,300 feet downstream. The runoff is then received by a storm drain inlet system at 25TH Street. The existing inlet cannot accommodate the water and debris that are delivered to it. The first 1,000-feet of the canyon, beginning at the upstream end of the canyon's existing storm drain outlet, are relatively stable. The next 1,500-feet pass through the dormant South Shores Landslide with unstable, 30-foot high, vertical canyon walls. These vertical walls extend for several hundred feet as they pass through the Tarapaca Landslide. This landslide is moving westward and is forcing the streambed in that direction, thereby undermining the Palos Verdes Drive East (PVDE) switchbacks and a sewer line located adjacent to the roadway. The last 800-feet of the drainage course navigate what used to be a 25-foot deep canyon with a pipe placed in the invert of the canyon, where the 25TH Street embankment was constructed across the canyon. This section of the canyon is now completely filled with debris generated from the canyon. The erosive forces of the runoff continue to generate large amounts of debris, which are deposited on 25th Street during most storms, typically blocking access along the road.

Roadway flooding and debris deposits on 25th Street have been a problem for area residents and commuters for many years. Downstream development within the natural drainage path included the installation of a drainage system that did not anticipate or accommodate the amount of debris that is currently generated within the canyon. The inlet system that was originally installed at the base of the roadway fill was extended vertically in the 1990's to accommodate canyon sediment as it rose to a level that now matches the adjacent roadway. The localized Tarapaca Landslide began to move shortly after the millennium which significantly increased the amount of debris generated within the canyon. The low strength of the surface soil in the canyon near the switchbacks coupled with the westerly migration of the streambed is a concern specific to the stability of the PVDE switchbacks and adjacent sewer line. A shelf ready, early action construction project is being designed to facilitate efforts to stabilize the slopes adjacent to the lower PVDE switchback roadway, if the encroachment of erosion should continue.

This ongoing cycle of flooding and deposition of rock and mud on 25th Street threatens the safety of downstream residents in the Palos Verdes Shores Mobile Home Park. Road closures and the cleanup of the mud and rock debris is an ongoing maintenance problem that restricts through traffic and emergency access to the Palos Verdes Peninsula. All vehicles, including safety personnel, are prevented from using the roadway until the mud/debris has been cleared.

A solution to this continuing flooding is long overdue. The question this PSR is seeking to answer is which solution will best serve residents, commuters, the City of Rancho Palos Verdes (RPV), the City of Los Angeles (CLA) and Los Angeles County (LAC).

Alternatives:

The terms of the Project Study Report (PSR) assignment required Harris to investigate at least 3-alternative designs and assess each on a number of criteria including effectiveness of the design concept, constructability, geological feasibility, coordinating with other agencies, environmental impacts and required mitigation, schedule, cost and others. Six alternatives were investigated, including a do-nothing option, leaving the canyon in an "as-is" condition, and another "cheap-fix" upgrade solution for the existing system. The PSR and appendices detail each of these alternatives. The conclusion reached was that Alternative 1A is the preferred design. Although estimated to be 7% more costly than the lowest cost feasible solution, the design is infinitely superior and has far fewer administrative, environmental and uncertain issues associated with it.

Recommended Alternative 1A – Mid-canyon inlet with "tunnel alignment" Storm Drain outletting to bluff:

Alternative 1A consists of the construction of a mid-canyon inlet structure, located slightly up-stream of the upper switchback. The inlet structure is connected to the ocean with a 3,900-foot long, 54-inch pipe in a "tunnel alignment" that outlets below the oceanfront bluffs. The entire length of this storm drain (SD) alignment falls within the City of Rancho Palos Verdes (RPV) allowing RPV sole jurisdiction and is almost entirely within City owned land, requiring only construction easements. The inlet structure will be located in the "middle" of San Ramon Canyon, which will intercept flood waters north of the Tarapaca Landslide.

The storm drain conveys flows from the inlet structure southwesterly through a tunnel approximately 1,900-feet in length to a point just south of Palos Verdes Drive South (PVDS). From there, the next 1,700-feet of the pipeline will be constructed, using the standard open trench (cut and cover) type of construction running parallel to the City boundary adjacent to Palos Verdes Shores Mobile home Park in the City of Los Angeles. The pipe will be installed within an existing dedicated 100-foot wide utility easement within Palos Verdes Shoreline Park that was specifically set aside for utilities such as this proposed storm drain. The 100-foot wide easement has less strict environmental impact requirements, serves as a firebreak for the adjacent mobile home park and includes an informal hiking trail to the ocean. The final 300-feet of pipe from the bluff top to the beach will run in a 38% sloped "slant drain" tunnel to an outlet structure located at the base of the bluff.

The portion of the canyon downstream of the mid-canyon inlet structure, which runs through the Tarapaca landslide, will be filled with up to 30-feet of dirt. This is proposed to eventually stabilize the canyon slopes and create an elevated creek bed with flatter side slopes. This portion of the canyon would convey nothing more than side slope run-off. An access road from PVDE along the westerly side of the canyon would be constructed to provide access for maintenance of the upstream inlet structure.

The complete cost (construction plus soft costs) of this Preferred Alternative is estimated to be $19.2 million.

Conclusion / Recommendations:

The recommended Alternative for the San Ramon Canyon Drainage Systems is **Alternative 1A.** The advantages of this mid-canyon inlet with "tunnel alignment" storm drain outletting to the foot

of the bluff, combined with the disadvantages associated with other alternatives, make this the recommended project solution. This recommended alternative has a competitive construction cost and potential fast track implementation schedule, is the most environmentally compatible, requires the least amount of right-of-way or drainage easements and falls entirely within the City of Rancho Palos Verdes' jurisdiction.

This recommendation is also supported for the following reasons:

1. It diminishes the erosion and undercutting in the canyon to nearly negligible, thereby protecting PVDE switchbacks and adjacent sewer.
2. It substantially reduces the amount of flow being delivered to the existing CLA storm drain at 25th Street.
3. It diminishes erosion and minimizes debris transport to allow "clear water" flows to reach the existing CLA storm drain at 25th Street.
4. It provides a design that will accommodate flow from the side slopes within the canyon.
5. It provides a design that will restore and protect the existing streambed.
6. It provides the highest level of flood protection (except for a slightly higher level provided by Alternative 2A, which costs more and has more significant environmental impacts)

Alternative 1A also rated number 1 in the objective "Risk Chart" (**see page 28 of this PSR**) while the "No Project" alternative rated last. Although the "No Project" alternative would cost nothing today, it could potentially be most expensive long-term solution. Further, doing nothing to improve conditions could compromise the lower PVDE switchback in the next 5 to 7 years, based on the present rate of erosion estimated at five feet per year. Additionally, doing nothing could compromise the existing sewer line in the next 2 to 3 years.

As part of this PSR, Harris & Associates has identified a conceptual plan for a "shelf ready" Early Action PVD Switchback Stabilization Project that will stabilize the lower PVDE switchback and protect the existing sewer line in case delays occur in the implementation of the recommended San Ramon Canyon Storm Drain construction due to funding, easement acquisitions and/or lengthy outside agency approvals. Final design of the Early Action project should be completed by Spring 2011.

II. INTRODUCTION

Harris & Associates (H&A) was retained by the City of Rancho Palos Verdes (RPV) to provide a comprehensive Project Study Report (PSR), including preliminary concept design alternatives for the San Ramon Canyon Drainage System. The PSR effort also includes a separate "shelf-ready" construction project which would serve as an interim stabilization measure for Palos Verdes Drive East (PVDE) should it prove to be necessary, before funding the ultimate final design and construction can be completed. The PSR also included an investigation of the project site for existing conditions including geology, biological assets, topography, etc. H&A sub-contracted the following services to the following companies to capitalize upon their expertise:

KDM Meridian – Aerial Mapping / Survey / Right-of-Way / Base Sheets for Plans (**Appendix A**)
GMU Geotechnical Inc. – Geotechnical Study Report (**Appendix B**)
SFC Consulting – Environmental Assessment / Expanded Initial Study (**Appendix C**)

EXISTING LOCATION MAP

A. Project Limits

The subject San Ramon Canyon Drainage System falls within of the jurisdictions of the City of Rancho Palos Verdes (RPV), and City of Los Angeles (CLA) San Pedro community and is generally bounded by:

Boundary Edge: Defining Feature (***Applicable City Jurisdiction***)

- **Northwest:** Palos Verdes Drive-East (PVDE) "switchbacks" (***RPV***)
- **Southwest:** Palos Verdes Shoreline Park / Open Space (***RPV***)
- **South:** Pacific Ocean
- **Southeast:** Palos Verdes Shores Mobile Home Park & Golf Course (***CLA***)
- **Northeast:** Friendship County Park (***LA County owned / RPV***) & Tarapaca Road (***RPV***)
- **North:** Calle Aventura, PVDE and San Ramon Drive (***RPV***)

B. Purpose & Need

The primary goals of this PSR and associated preliminary concept design alternatives are to protect Palos Verdes Drive-East (PVDE) switchbacks and to provide all-weather access on 25th Street/Palos Verdes Drive-South (PVDS). The PSR is intended to review, evaluate and present solutions to mitigate drainage and erosion problems experienced within the San Ramon Canyon, which is located within the RPV and CLA. These problems affect the stability of the lower PVDE switchback and access on 25th Street / PVDS. In addition, secondary goals are to improve stormwater quality and the stabilization of adjacent roadways, slopes and properties.

The periodic flooding associated with almost every storm event is exacerbated by movement at the Tarapaca Landslide that provides a continuous source for new sediment to the creek bed, which in turn is transported downstream to 25th Street. A cycle of erosion of the toe of the Tarapaca Landslide and subsequent land movement refills the creek bed with newly loosened sediment and makes the implementation of a project solution all the more urgent. Further, the Tarapaca Landslide is redirecting powerful storm flows towards the toe of the opposite (westerly) slope, below the lower PDVE switchback. This results in a loss of buffer between the roadway and edge of the vertical canyon erosion of approximately five feet per year (estimated).

There are a number of interim solutions that the CLA may consider taking to protect 25th Street and the residents below the 25th Street roadway embankment. These would largely involve the relief of hydraulic pressure against the embankment and could include boring pressure relief conduits through the embankment; the installation of vertical sub-soil drainage stacks that drain into the existing storm drain under the road, etc. These potential projects would be outside the City of RPV's jurisdiction and are therefore beyond the scope of this PSR, however they have been raised here for consideration by the CLA.

Concern and support for a solution in the local community is growing rapidly as expressed at several community meetings specifically held to discuss the issue. The public is well aware that the present condition threatens to disrupt an all-weather public access, a continuous evacuation corridor for the Palos Verdes Peninsula and emergency responder access along the 25th Street / PVDS and PVDE transportation corridors. It is also important to note that the existing condition poses a significant threat to life and property from flooding and debris flows at 25th Street and the Palos Verdes Shores Mobile Home Park immediately downstream.

Additional issues that will also be remedied as part of all alternatives are as follows:

Surface Drainage Erosion at PVDE Switchbacks: The existing drainage from the PVDE switchbacks is intercepted by several small culverts that outlet at various locations on the westerly San Ramon Canyon slopes. As part of the the San Ramon Canyon Improvements project, these existing drainage improvements will be closely analyzed and recommendations will be made to reduce erosion and improve the conveyance of these flows. Initial improvements being considered include:

1. Installation of energy dissipators, such as rip rap downstream of the culvert outlets

2. Improved inlet grating to prevent obstructions

3. Surficial backfill / grading downstream of the existing outlets where erosion has occurred

Tarapaca Road Cul-De-Sac Down-Drain Stabilization: The Tarapaca Road cul-de-sac currently drains to an inlet with a "down-drain" corrugated metal pipe (CMP) outlet along the easterly canyon slope that has several concrete and steel anchors holding the pipe in place along its alignment. During a January 2010 storm event the outlet pad at the canyon bottom was considerably undermined. As part of any alternative solution pursued, this area should be shored up and protected to prevent any further erosion and undermining of the existing drain outlet. The catch basin inlet along Tarapaca Road should also be closely analyzed during the PS&E phase to determine its adequacy of intercepting a 50-year storm event. Additional inlets maybe needed to make sure that surface flows do not bypass catch basins or overtop street curbs.

Water Quality Issues: Although a significant amount of the project flows are from natural canyon runoff there are also residential roadways and PDVE runoff that are tributary along the top of the ridge. Presently the "first flush" flows from the streets above are absorbed into the pervious natural canyon invert, which essentially eliminates the need for related water quality treatment systems to protect the runoff to the ocean. Further, as part of any design alternative pursued, a low flow diversion system will be incorporated into the mid-canyon inlet structure to allow "first flush" flows and other low flows to be conveyed to the natural canyon downstream so that the canyon creek bed does not become completely dry. Methods of interception of sediment and debris will also be reviewed as part of the design of the upstream inlet structure, with more stringent requirements for collection applying to any alternative outletting the CLA storm drain in 25th Street. However, natural sediment that is generated by the canyon is not a pollutant, which is why any alternative outletting directly to the beach will allow "bulked" flows to pass. For the new beach outlet alternatives the conveyance of natural canyon sediment will reduce the amount of maintenance and debris removal required at the mid-canyon inlet structure.

C. Objectives

This PSR details the existing conditions and known history of the existing geology, drainage and erosion problems. It defines the hydrologic conditions and hydraulics of the existing CLA Storm Drain downstream of 25th Street as well as for the proposed alternative alignments. It includes the analysis and evaluation of impacts and the feasibility of several alternative alignments (including establishing a list of associated pros and cons, required outside agency approvals, land acquisition / easement needs and costs, geotechnical constraints, environmental impacts and mitigation costs, and realistic implementation schedules associated with each alternative). The alternatives considered will also be well detailed via preliminary concept design plans.

Further, for reference purposes, various exhibits within the report depict the following:

- Existing Facilities Exhibit – this map shows existing City of Los Angeles owned and maintained storm drain facilities beginning at 25th Street (**see Appendix D)**
- Hydrology map showing the drainage area tributary to the existing City of Los Angeles owned and maintained storm drain south of 25th Street, which outlets to the Pacific Ocean (**see Appendix D**)
- Hydrology and Hydraulic calculations for the 50-year storm event peak discharge (Q_{50}) for the existing City of Los Angeles owned and maintained storm drain south of 25th Street, which outlets to the Pacific Ocean (**see Appendix D**)
- Detailed write up and analyses of the various design alternatives (**see Appendix E**)
- Hydrology map and calculations for the 50-year and 100-year storm event peak discharge (Q_{50} and Q_{100}) for the drainage area tributary to the San Ramon Canyon north of 25th Street (**see Appendix F**)
- Preliminary Conceptual Storm Drain Plan and Profile Sheets for each alternative alignment solution, including supporting hydraulic calculations (**see Appendix G**)
- Detailed cost estimates for each alternate alignment solution (**see Appendix H**)

III. SETTING

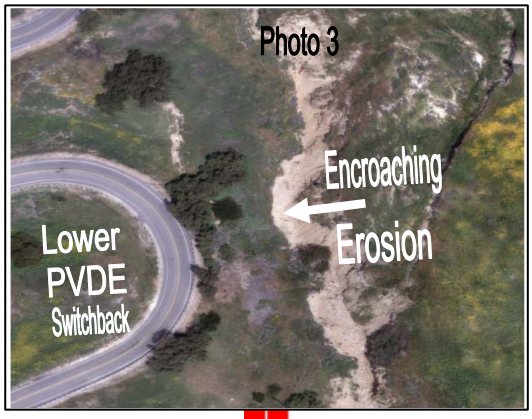
PVDS / 25th Street is the main East-West access route for the south side of the Palos Verdes Peninsula. Within the City of Los Angeles (CLA), it crosses the natural San Ramon Canyon drainage system. The road was built upon 25-feet of imported fill embankment placed in the canyon. A culvert was placed at the bottom of the embankment to allow canyon drainage to pass downstream. Over the years the canyon upstream of the road has been filled flush to the roadway surface with sediment (**see Photo 1: San Ramon Canyon looking south toward 25th Street**).

Photo 1

San Ramon Canyon consists of moderate to steep sloping terrain that yields fast flowing runoff. This runoff collects within the natural canyon channel. The total watershed area upstream of 25th Street is 187 acres, of which 160 acres is in RPV, including 3 acres of Los Angeles County (LAC) owned land at Friendship Park. The remaining 27 acres are within the CLA. The steep watershed concentrates run-off in high flow rates (**Q_{100} = 262 cfs** and **Q_{50} = 217 cfs**). The high velocity flows occur over relatively short durations and are capable of conveying a considerable amount of debris.

Photo 2

Photo 3



The periodic flooding associated with almost every storm event is significantly exacerbated by the Tarapaca Landslide (**see Photo 2: Tarapaca Landslide looking east from PVDE switchbacks**). The landslide provides a continuous source for new sediment to the creek bed, which in turn is transported downstream to 25th Street. A cycle of undercutting of the toe of the Tarapaca Landslide and subsequent land movement refills the creek bed with newly loosened sediment. Then rainstorms of even modest intensity transport material downstream and begin to undercut the toe again. Further, changes to the streambed alignment, caused by this repeating cycle, have redirected powerful storm flows towards the opposite wall of the canyon. The wall of this canyon supports the two PDVE switchbacks (**see Photo 3: Aerial view of existing erosion at the lower PVDE switchback**) resulting in an erosion rate estimated to be about five feet per year. Geologists estimate that PVDE could be destabilized if the canyon walls are eroded an additional 35-feet towards the roadway.

The situation is further impacted by the constraints of the existing inlet structure at 25th Street. The culvert under 25th Street was originally constructed as a 42-inch CMP crossing. A roadway embankment over the culvert was constructed using 25-feet of imported fill. Debris laden flow which is constricted through the culvert has led to the silting up of the canyon and inlet, which eventually filled the 25-foot deep canyon to the level of the 25th Street roadway (**see Photo1 on previous page and Section A-A on next page**). Over the past 40 to 50 years, as sediment built up, the original inlet pipe was extended vertically upward multiple times to the new/raised sediment surface to allow at least some of the surface flow to make it to the culvert crossing. Per CLA staff, inlet maintenance and sediment excavation was originally prevented due to lack of an access/maintenance easement onto the private property upstream of 25th Street. More recently, growing environmental constraints contributed to CLA's limited maintenance efforts for fear of disturbing nesting birds, etc. and/or incurring fines for lack of proper environmental studies and clearances to do the required maintenance work.

The presently configured inlet upstream of 25th Street consists of a raised galvanized steel cage (**see Photo 4: Existing Inlet at 25th Street**) over an inlet opening that consists of only two 12-inch CMP (**see Photo 5**) oriented to flow northerly. These are intuitively deficient to convey the peak flows generated from San Ramon Canyon, which are flowing south. Moderate rainfall can quickly overwhelm the two pipes resulting in saturation of the accumulated sediment upstream of the road and at times ponding above the roadway grade. Ponding depths have reached as high as two-feet above the road surface (**see Photos 6 & 7: 25th Street flooding and regularly occurring debris accumulation, respectively**). The contrasting views of Photos 4 and 7 create "before" and "after" views of the sediment accumulation that regularly occurs at 25th Street. Even with the two additional existing catch basin inlets on the south side of 25th Street there is insufficient capacity to convey flow to the existing 25th Street Storm Drain. This flooding cycle occurs regularly during the rainy season between October 15 and April 15 each year.

Photo 4

Photo 5

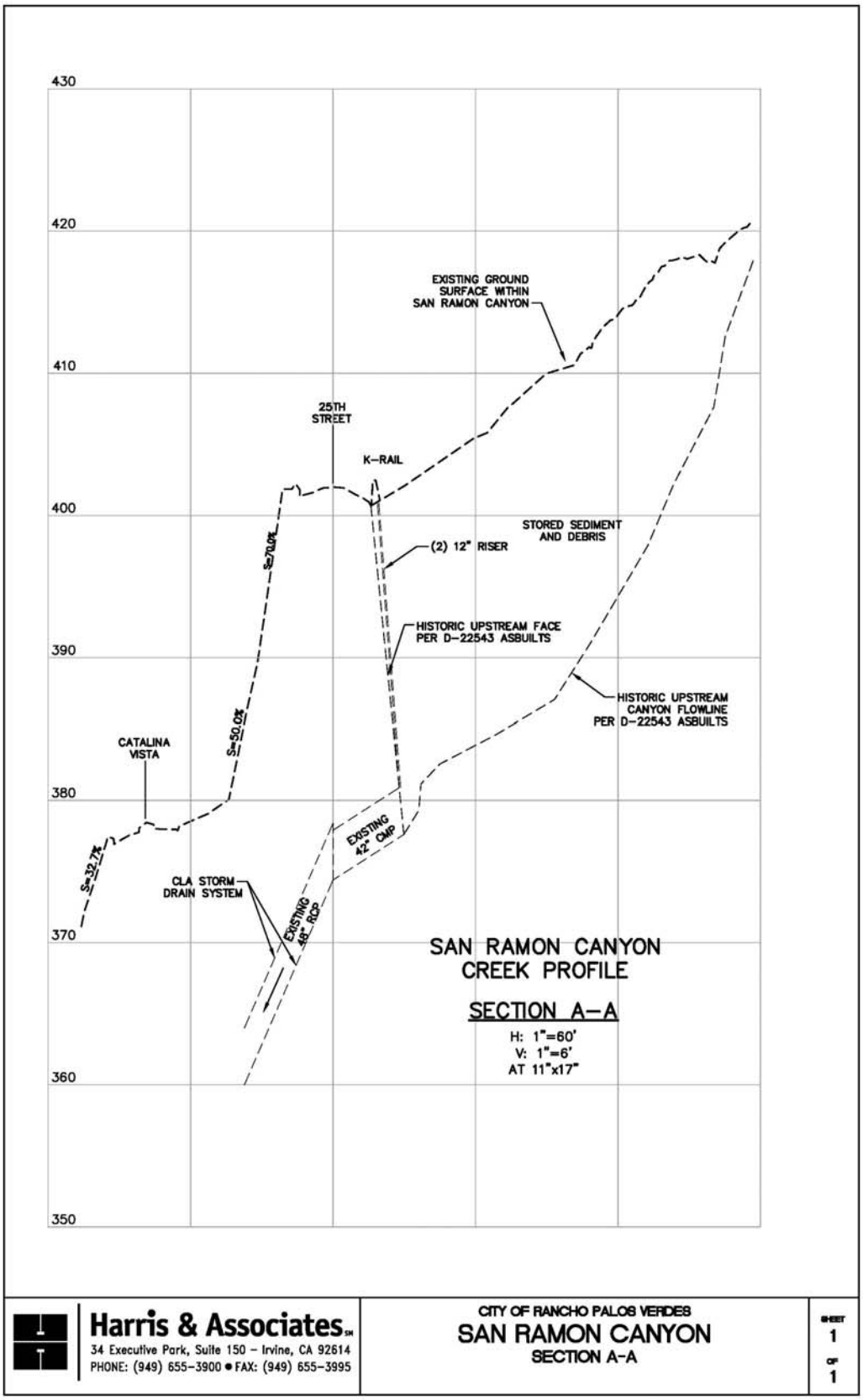

430
420
410
400
390
380
370
360
350
EXISTING GROUND SURFACE WITHIN SAN RAMON CANYON
25TH STREET
K-RAIL
STORED SEDIMENT AND DEBRIS
(2) 12" RISER
S=70.0%
HISTORIC UPSTREAM FACE PER D-22543 ASBUILTS
HISTORIC UPSTREAM CANYON FLOWLINE PER D-22543 ASBUILTS
CATALINA VISTA
S=50.0%
S=32.7%
EXISTING 42" CMP
CLA STORM DRAIN SYSTEM
EXISTING 48" RCP
SAN RAMON CANYON
CREEK PROFILE
SECTION A-A
H: 1"=60'
V: 1"=6'
AT 11"x17"
Harris & Associates
34 Executive Park, Suite 150 – Irvine, CA 92614
PHONE: (949) 655-3900 • FAX: (949) 655-3995
CITY OF RANCHO PALOS VERDES
SAN RAMON CANYON
SECTION A-A
SHEET 1 OF 1

Photo 6

Photo 7

When flooding is severe enough to over top the concrete barrier K-rails, a buildup of water against the perimeter wall on the south side of 25th Street occurs. This wall was built along the northerly edge the Palos Verdes Shores Mobile Home Park (**See Photos 6 & 8**). The existing block wall is permanently leaning from the strain of past debris-laden ponding in the roadway (**see Photo 8: Perimeter wall is "bowed" (see black arrow) from flooding pressures**). The distress on this perimeter wall is significant because it is essentially performing as the "last line of defense" to hold back the 25th Street floodwaters. If toppled over, the result will be a flash flood down the 25-foot high 2:1 road embankment, and through the mobile home park potentially risking both life and property. A flash flood could potentially also erode the downstream embankment of the roadway where it is breached, releasing stored sediment currently held in place by the road (**see Photo 9: Aerial view of 25th St at mobile home park).**

Photo 8

Photo 9

The City of RPV has had an informal agreement with the City of Los Angeles to share in the effort to prepare for storm events and to clean up the area after flooding occurs. This agreement is in the process of being formalized. The 25th Street right-of-way extends only 15' north of the edge of the paving, which severely limits the ability of the Agencies to clean out the area around the inlet to the drain at the toe of the embankment. The area beyond the right-of-way- is privately owned and completely within the City of Los Angeles. RPV had repeatedly urged CLA to contact the owner to obtain an easement, however are not aware of any progress in that regard.

NOTE: Photo 9 actually captures the regular debris removal operation is in progress, with the k-rail removed and an excavator filling a dump truck with accumulated sediment. The flooding of 25th Street requires action to periodically close all or portions of the road until flooding subsides and the debris is removed, as was the case during the January 19, 2010 storm event (**see Photo 6**). Debris removal was accomplished with only minor street road closures during the December 2010 multi day storm events. After each storm even, maintenance is performed to remove the debris from the street and to reduce the elevation of the debris fill behind the K-rails (**see Photos 7 & 9**).

IV. AGENCY INVOLVEMENT

The importance of keeping 25th Street open at all times is of utmost concern to the City of Rancho Palos Verdes (RPV), City of Los Angeles (CLA) and Los Angeles County (LAC). For several years RPV has been closely monitoring the situation. They have been looking for solutions and funding and have met regularly with key staff members from CLA and LAC to identify the issues relating to the drainage system and investigate solutions to stop the flooding cycle.

Most recently, as part of this PSR process, RPV held a meeting on June 17, 2010 with CLA and LAC staff with renewed energy and urgency. RPV discussed the project issues, the role of each agency, and the possibility of coming to an agreement / game plan to move a project solution forward. A summary of the key items discussed during this meeting are as follows:

- LAC indicated that while Los Angeles County Flood Control District (LACFCD) has flood-control interest in this community, they do not have a jurisdictional interest.

- There is a maintenance agreement currently being developed between RPV and CLA for pre-storm preparedness and post-storm clean up at 25th Street and San Ramon Canyon.

- CLA has applied for a grant with the Federal Emergency Management Agency (FEMA) to improve the existing inlet at the north side of the 25th Street. The funding request was denied.

- RPV requested that CLA immediately approach the owner of the property upstream of 25th Street to determine if they would be receptive to granting a temporary easement for emergency maintenance and grading of a debris basin before the winter storms of 2010 & 2011. RPV requested that H&A prepare an exhibit illustrating an "25th Street Interim Basin Grading" solution to temporarily provide debris storage capacity for the pending storm season (**see Appendix I**). RPV sent this exhibit to CLA, to be used for contacting the property owner. RPV has not heard back whether this request was successful at time of this writing.

- CLA confirmed that they support RPV's efforts to pursue a comprehensive solution, however they clarified that they are severely short on drainage improvement funds.

V. COMMUNITY INVOLVEMENT

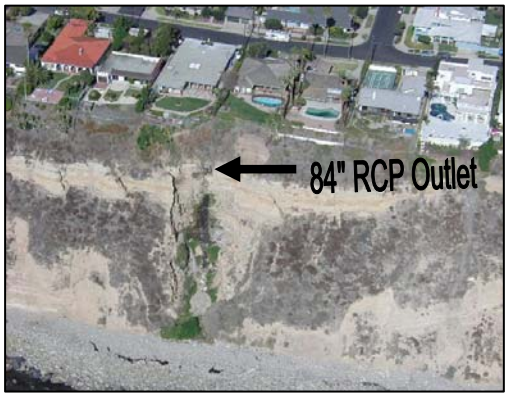
Public support for the project is growing along with their concerns about the dangerous conditions at 25th Street during storm events. Public comments have confirmed that now that this PSR process is underway, they are more confident that their issues are being addressed. Community support and involvement will be a key element in procuring future funding for the project.

In order to keep the general public informed and to improve communication, RPV has proactively taken the following steps:

- Established a link on the City's website for easy access and updated project information
- City Council regularly discusses the project status and welcomes input from the community
- Periodically notices are issued to people signed up on their "ListServ" program so that updates on the project can be e-mailed to their home computers
- RPV held an "information gathering" meeting on Wednesday, May 12, 2010, at Miraleste Intermediate School to introduce the PSR team, discuss the study elements, allow the public to voice their concerns, and to distribute a public opinion survey that the public filled out and returned to the City with their written suggestions, questions and concerns.
- RPV held a "progress meeting" on Wednesday, July 21, 2010, again at Miraleste Intermediate School, to update the general public on the status of the engineering, geotechnical and environmental investigations. Preliminary concept designs were presented to present the alternatives considered, show the direction the City is heading, and solicit additional community feedback.

VI. EXISTING CITY OF LOS ANGELES (CLA) STORM DRAIN AT 25TH STREET

Photo 10



As part of this PSR, a detailed hydrology and hydraulics (H&H) analysis was performed on the existing CLA storm drain that begins at 25th Street and runs to the ocean discharge point on the bluff. This study included a detailed confirmation of the tributary area boundaries in the field. The existing storm drain that accepts the San Ramon Canyon runoff has its headworks just upstream of 25th Street (**see Photos 4, 5 & 7**), is owned and maintained by the CLA, and has a mainline pipe size that ranges from a 42-inch CMP, to 48-inch reinforced concrete pipe (RCP), to 72-inch RCP to eventually to an 84-inch RCP that outlets from mid-bluff face into the Pacific Ocean (**see Photo 10**).

Since CLA was not able to provide the requested H&H analysis and/or supporting data, H&A was directed by RPV to perform a detailed H&H analysis of the existing storm drain system. This analysis is important for any design alternative that would use the CLA storm drain as an outlet system. Based on a detailed confirmation of the drainage boundary, the use of the LACFCD approved software WMS 8.0 for hydrology, and WSPG software for hydraulics, it was determined that the existing storm drain south of 25th Street, is "technically" adequate (**see "QUALIFICATION" discussion that follows**) to handle the flows produced by a 50-year storm re-occurrence. By the time it daylights out of the coastal bluff face, the existing storm drain conveys a total Q_{50} = 490 cfs, which is generated by a total tributary area of 375 acres (**see Appendix D for the Hydrology Map & calculations for the existing system**).

QUALIFICATION: Although the existing CLA storm drain south of 25th Street was "technically" determined to be hydraulically adequate, there are several significant issues associated with this system that make a "qualification" statement necessary. These issues undermine the confidence of the system's long-term ability to perform. In addition to the previously identified upstream inlet / debris basin deficiencies, the following should be addressed if a solution is selected that allows improved canyon flow into this system:

- In order to convey the 50-year storm event peak flow rate, velocities as high as 48 feet per second (33 mph) are calculated (**see Appendix D**). These resulting velocities are well beyond the recommended maximum of 20 fps +/- for the reinforced concrete pipe material utilized within the existing system. Based on the as-builts available through the City's website (NavigateLA.lacity.org), the existing storm drain was not constructed to have an extra-thick PCC cover over the interior steel reinforcement or a steel plate lining to be able to handle high velocities as is recommended when velocities exceed 20 fps. This means that one of two things will happen if the existing CLA storm drain is to be utilized as the outlet system for RPV's proposed storm drain at San Ramon Canyon. Either the interior concrete lining over the steel reinforcement in the RCP will be pre-maturely worn and scoured, requiring an accelerated future replacement or the flows simply will not be able to pass as quickly as required. The second result means that something less than a 50-year storm event peak discharge would be conveyed by the storm drain and would likely cause flows to continue to back up on 25th Street. This may result in continued flooding at 25th Street even with an improved storm drain system in place. This would also be the case if/when a storm larger than 50-year storm event peak discharge is experienced.

- CLA provided closed circuit television (CCTV) inspection videos of portions of their existing storm drain south of 25th Street (performed on March 8, 2001 and August 9, 2007). The videos covered approximately 760 lineal feet of 48-inch RCP (from as-built station 19+15.59 to the existing inlet at the north side of 25th Street, **see Appendix D for CLA Storm Drain As-builts**). The length of pipe that was video inspected is approximately one third of the total existing storm drain length. The video showed that there were several serious physical defects in the existing system including: several separated pipe joints (**see Photo 11 where an offset pipe joint has been backfilled with rocks and mortar**) and other condition issues that prevented the CCTV inspection from proceeding any farther. Due to the importance of knowing the condition of the entire existing storm drain system it is recommended that CLA perform a detailed CCTV video inspection of the entire length of the storm drain to fully assess its condition. This is especially important if the 25th Street Storm Drain is going to be utilized as the downstream outlet system for the proposed San Ramon Canyon drainage system.

Photo 11

- A detailed review of the as-built plans for the existing CLA storm drain south of 25th Street (**see Appendix D**) revealed that the system was constructed in multiple phases over many years. The storm drain includes multiple sharp horizontal angle points and multiple sharp vertical grade breaks all along its alignment. Such angle points and grade breaks are not conducive to good long-term hydraulic performance and are also typically an increased source for localized wear, scouring, pulled joints, etc. This is especially concerning given the high velocity requirements and poor physical condition of the existing drainage system as previously mentioned.

- Since the existing CLA storm drain system is presently only being supplied with the minimal flows intercepted by a few catch basin inlets at 25th Street, the existing storm drain has yet to experience the predicted high velocities under the present developed tributary conditions upstream. The existing storm drain may have experienced a large magnitude storm in the past that was able to flow directly into the upstream inlet with impediment from accumulated debris. However, that would have been before the subsequent 40-years of upstream development, which changed the runoff characteristics, and increased the amount of runoff the system must now convey. Again, this is a source of significant concern given the high velocity requirements and poor existing physical condition of the existing drainage system.

- A portion of the existing storm drain system passes under residential dwellings within the Palos Verdes Shores Mobile Home Park (**see previous "Existing Location Map"**), which is not a standard practice and the associated risk should be revisited if additional flows are to be introduced into the existing drainage system.

- The existing mid-bluff outlet (**see Photo 10**) also presents a serious CLA storm drain system deficiency that needs to be remedied before any additional flow can be conveyed by this existing system. This concern is twofold because, in addition to the lacking hydraulic capacity, the long-term stability of the bluff (and adjacent houses) is at stake and subject to undermining due to unchecked erosion. Even now, with lesser flows, the adjacent residents complain about the windswept "back-spray" that inundates their properties, which would only worsen with increased flows.

VII. PROPOSED STORM DRAIN STANDARDS AND DESIGN CRITERIA

A. Storm Drain Design Standards and Pending MTD Process

Although the proposed storm drain improvements will likely be constructed by RPV, one of the alternatives proposes to construct a portion of the storm drain within the CLA's boundary. This proposed alternative would connect to the CLA drainage system thus it would have to be reviewed and approved by CLA. RPV is also considering the alternative of transferring the maintenance of this storm drain alternative within the RPV boundary over to LAC through the Miscellaneous Transfer Drain (MTD) process. If the MTD process is pursued it will require the review and approval by the Los Angeles County Public Works Land Development Department (LAC)

However, it should be noted that the MTD process will likely not be allowed for any tunnel option that outlets onto the beach. As was the case with RPV's McCarrell Canyon Storm Drain Project, two factors will make any coastal bluff tunnel alternative non-transferable:

1. As was the case with the RPV's McCarrell Canyon Storm Drain Project, the geotechnical determination that the bluff stability has a factor of safety (FS) less than 1.5. (Note a FS = 1.0 means the bluff slope is in imminent danger of failing.)

2. The lack of a drivable maintenance access road to the outlet structure on the beach would most likely make any coastal bluff tunnel alternative non-transferable.

Further, any alternative that connects to a CLA storm drain would be complicated by the fact that LAC has a standing agreement with CLA not to accept the transfer of any CLA storm drains because CLA is required to maintain its own drainage systems. Conversations to date with LAC staff have not ruled out entirely as to whether they would accept the San Ramon Canyon Drainage System through the MTD process. However LAC made it clear they would require a drivable access road along the entire drainage system alignment. Presently, grading an access road in San Ramon Canyon is not envisioned to be practical, given the narrowness of the canyon, the anticipated non-drivable rip rap energy dissipator "drop structures" and the desire to keep the environmentally sensitive creek as natural as possible after construction. See **Appendix F** for the discussion section comparing each alternative and for additional information regarding the feasibility of pursuing the MTD process.

Regardless of whether the MTD process will be pursued, as an appropriate precaution, the most conservative storm drain design criteria will be utilized throughout the preliminary design analysis of this PSR. The design criteria utilized is consistent with the Los Angeles County Public Works Hydrology Manual, dated January 2006, the Los Angeles County Flood Control District Hydraulic Design Manual, dated March 1982, and Los Angeles County Public Works Standard Plans, 2000 Editions.

B. Storm Drain Design Criteria

See **Appendix J** for Table 1 which illustrates the primary criteria followed for the storm drain design analyses.

C. Storm Drain Hydrology and Sediment Production

As part of this PSR a detailed confirmation of the tributary drainage boundaries was performed for both the San Ramon Canyon and the entire existing CLA Storm Drain system from 25th Street down to the beach outlet, including all tributary lateral systems. The Modified Rational Method hydrology criteria used for this study are outlined in the latest Los Angeles County Public Works Hydrology Manual, dated January 2006. The program Watershed Modeling System (WMS) software package[1] was utilized to perform the detailed hydrology analysis. The site is located within Los Angeles County Debris Potential Area (DPA) Zone 6 and soil type numbers 2 and 17. These parameters establish that **the natural San Ramon Canyon is capable of generating 5,434 cubic yards of debris**. This debris volume would have to be addressed in any CLA inlet structure / debris basin design due to their design requirement to accept only "clear flows" into their drainage systems.

1. MODRAT Interface by the Environmental Modeling Research Laboratory at Brigham Young University, Version 8.0, build date February 23, 2007, copyright 2006, serial 101693.

Peak flow rates were calculated for two different levels of storm reoccurrence, namely, a 50-year storm (**Q_{50} = 217 cfs**) and a 100-year storm (**Q_{100} = 262 cfs**) and the results are listed in the alternative storm drain discussion section. CLA and LAC only require that the proposed San Ramon Canyon Drainage System be designed to convey a Capital Flood (50-year storm event peak discharge, Q_{50}). Design flow for alternatives using the existing CLA system utilized a 50-year storm event peak discharge. This is because a 50-year storm event peak discharge is all the existing CLA storm drain system is capable of accepting. However, for alternatives not using the CLA storm drain as an outlet a 100-year storm event peak discharge design flow is recommended, since only a minor pipe upsizing is required (from a 48-inch to 54-inch diameter) to provide this level of protection. Utilizing this larger pipe size also may actually reduce the bottom line construction cost due to the smaller annular backfill required in the proposed 80-inch tunnel cross section.

Preliminary level (30% +/- complete) storm drain "plan and profile" sheets and typical cross sections have been prepared for the various alternative storm drain alignments (**see Appendix G**).

D. Storm Drain Hydraulics

All mainline storm drain hydraulic modeling was performed utilizing Water Surface Pressure Gradient (WSPG) Computer Hydraulic Analysis Program[2]. The WSPG program computes and plots uniform and non-uniform steady flow water surface profiles and pressure gradients in open channel or closed conduits with regular or irregular cross sections. The computational procedure is based on solving Bernoulli's equation for the total energy at each section and Manning's formula for friction loss between the sections in a stretch of pipe.

The Manning's equation is the most commonly used flow resistance formula for the analysis of open channel and gravity flow pipe systems. The equation modified to English Units is show below:

$$Q = \frac{1.486\, A\, R^{2/3}\, S^{1/2}}{n}$$

Where:
- A = Area of pipe (sf)
- Q = Sewer flow (cfs)
- 'n' = Manning's roughness coefficient
- S = Slope of Energy Grade Line (ft/ft)
- R = Hydraulic Radius (ft)

Since the recommended storm drain pipe material is high density polyethylene (HDPE) (due to the proposed steep installation profile slopes) the 'n' value of 0.012 applies to the evaluation of both the tunnel and canyon alternatives above 25th Street. Downstream of 25th Street a Manning's n = 0.013 was utilized for the existing RCP system.

Using the WSPG program, each of the alternative alignment scenarios were studied to produce the resulting storm drain hydraulic grade line (HGL) and are as shown on the conceptual storm drain plan and profiles sheets (**see Appendix G**).

2. LACFCD F0515P, software package by Woodcrest Engineering, 15790 Rancho Viejo, Riverside, CA 92506, Copyright 1996).

VIII. ENVIRONMENTAL REQUIREMENTS

A. Environmental Clearance Jurisdictional Agencies

Per SFC Consultant's *Expanded Initial Study* (**see Appendix C**) there are no riparian plant species, hydric soils or conducive hydrology to support a wetlands habitat within the affected project area. However, San Ramon Canyon is still a jurisdictional drainage course that is under the jurisdiction of the Army Corp of Engineers (ACOE) as part of the River and Harbors Act. It is also under the jurisdiction of the California Department of Fish and Game (CDFG) and the Los Angeles Regional Water Quality Control Board (LARWQCB). If a drainage alternative is chosen that would put an outlet structure on the beach it will come under the jurisdiction of the ACOE (again as part of the River and Harbors Act) and the LARWQCB. Permits from these agencies will likely be required for impacts to jurisdictional waters. Impacts to biological species and habitat will be mitigated through the Natural Community Conservation Plan (NCCP) as discussed below. To avoid reproducing all of the environmental findings and recommendations the referenced report is considered an integral part of this PSR.

B. Natural Community Conservation Plan (NCCP)

Fortunately RPV anticipated the need to repair or improve drainage systems in several canyon areas throughout the City and realized that these drainage projects would necessitate work in potentially sensitive habitat areas. Thus they established a citywide Natural Community Conservation Plan (NCCP). This plan identified biological resource areas and established habitat preserves, such as the Palos Verdes Shoreline Park / Open Space site (south of 25th Street / PVDS and west of San Pedro / CLA). It was estimated that these future City drainage improvement projects would result in a cumulative combined loss of 10-acres of Coastal Sage Scrub (CSS) habitat and 24-acres of non-native grassland. This anticipated loss has already been mitigated through dedication of City property, resulting in 30-acres of offsite CSS mitigation and 12-acres of offsite non-native grassland mitigation. **See the mitigation measure discussion item that follows.**

C. Environmental Clearance Obstacles

Alternatives 1A (with tunnel alignment that outlet directly to the beach) is estimated to impact approximately 0.04 acres of jurisdictional waters in San Ramon Canyon. The impact area on the bluff face is estimated to be 0.02 acres and extends onto the beach area below. Alternative 1B (same as Alternative 1A but extending storm drain to connect to the upper canyon outlet structure) is estimated to impact approximately 0.06 acres of jurisdictional waters in San Ramon Canyon. The impact area on the bluff face is estimated to be 0.02 acres and extends onto the beach area below.

Alternatives 2A (with canyon alignment that outlet to the 25th Street storm drain) is estimated to impact approximately 0.79 acres of jurisdictional waters in San Ramon Canyon, with limited or no impact to the beach bluff (except if required to improve the existing mid-bluff outlet). Alternative 2B (same as Alternative 2A but extending storm drain to connect to the upper canyon outlet structure) is estimated to impact approximately 0.81 acres of jurisdictional waters in San Ramon Canyon, with limited or no impact to the beach bluff (except if required to improve the existing mid-bluff outlet).

The following are the jurisdictional agencies, along with the permits and requirements of each, for the San Ramon Canyon Storm Drain Project:

1. **Army Corp of Engineers (ACOE):** Section 9 and Section 10 of the Rivers and Harbors Act, especially due to the grading within San Ramon Canyon the project, will likely require a Section 10 permit.

2. **California Department of Fish and Game (CDFG):** A CDFG 1602 permit will be required to address impacts to the maintained drainage channel. CDGG will request the regional board to review their recommendation and hence issue a 401 permit.

3. **Los Angeles Regional Water Quality Control Board (LARWQCB):** Permanent Best Management Practices (BMP's) will be required for long-term maintenance and water quality purposes. Also a National Pollutant Discharge Elimination System (NPDES) construction document will be required either as part of the LARWQCB requirements or as part of the LAC Municipal Separate Storm Sewer System (MS4) Permit.

4. **Coastal Resource Management (CRM) District:** The study area lies within the Coastal Resources Management (CRM) District with a terrestrial designation CRM-10. The area contains some terrestrial wildlife value and the offshore waters are protected in this CRM. All marine resources (i.e. kelp beds, abalone habitat, rock reef habitat, etc.) are to be protected against impacts should the new ocean outlet alterative (1A, 1B) be selected.

5. **City Natural Community Conservation Plan (NCCP):** See previous discussion item and mitigation measures that follow.

D. Mitigation Measures Required:

1. **Canyon Invert Fill:** Re-vegetation of the streambed and affected canyon slopes with native vegetation will be required. Re-vegetation activity will include a plant palette, consistent with the Resource Agency and Native Plant Society criteria, that lists exact species of plants to be restored and the native plants be used derived from local genetic sources. NOTE: the Upper-Canyon Connection Alternatives 1B and 2B will have more significant impacts regarding the invert filling operations than the Mid-Canyon Inlet Alternatives 1A and 2A simply because more pristine canyon will be disturbed by fill and grading. Further, it has been noted that the upper canyon is more stable, suffers less from erosion, has more bedrock outcroppings and has a rockier invert in general. This is largely what is driving the Mid-Canyon Inlet Alternatives 1A and 2A to stop where they do. Upstream of that point, the canyon is more natural and stable therefore, there is less need to improve / disturb it. Many hilltop homes look down to this natural upper canyon thus their pristine canyon views would also be impacted by Alternatives 1B and 2B.

2. No significant loss to raptors and migratory birds or their habitats are expected, and therefore no mitigation is required. As a Best Management Practice (BMP), we recommend that if grading or construction occurs between March 1 and August 31, the area should be monitored on a regular basis for 30 days prior to any disturbance. This is done to ensure that no nesting is occurring. Monitoring would require a short period of observation (approximately one hour) to ensure that no birds were coming and leaving

their nests on a regular basis. If birds are using a nest in the area, then it would be recommended that either construction be rescheduled to after the breeding season or that a qualified biological monitor be present during construction to ensure that nesting birds do not abandon the nest until the young are fully fledged.

3. **BMP's:** Best Management Practices (BMP's) shall be implemented for the project and are included in the Mitigation Monitoring Program for water quality. The PS&E construction document preparation phase for the alternative ultimately chosen would also fully detail the construction BMP requirements.

4. **Cultural Resources:** No cultural resources were found to exist within or adjacent to the project area. However, mitigation has been provided in order to off-set the potential for unknown buried prehistoric or historic archaeological remains.

5. **Native American Consultation:** A record search of the sacred land file has failed to indicate the presence of Native American cultural resources in the immediate area. The Gabrielino/Tongva Tribal Council recommended monitoring during grading of the inlet structure area.

IX. GEOTECHNICAL REQUIREMENTS

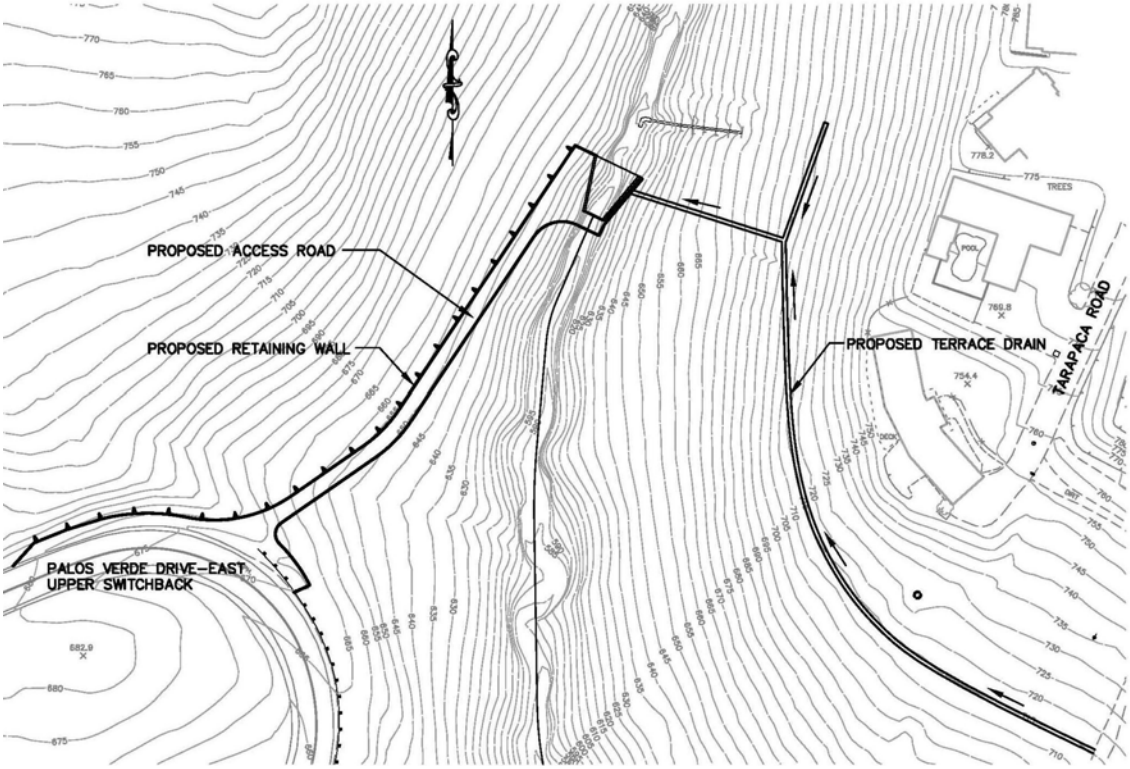
Per GMU Geotechnical's *Geotechnical Study Report* (**see Appendix B**) all of the proposed design alternatives are considered feasible as long as the recommendations in the report are followed. Based on the results of GMU Geotechnical's investigation and analyses, the following ten (10) conclusions were presented:

1. Design Alternatives 1A, 1B, 2A, 2B, 3 and 4 are considered to be feasible, provided the design considerations and recommendations for additional work presented in this report are followed.
2. The site is predominately underlain by the South Shores landslide, an ancient, dormant landslide complex.
3. The site includes the Tarapaca Landslide.
4. None of the design alternatives will adversely impact the repaired San Ramon Canyon failure area, located offsite to the north.
5. Groundwater should not be a significant impact to any of the design alternatives for the project.
6. The site will be subject to seismic hazards in the future; however, none of the design alternatives will increase the likelihood or magnitude of these impacts.
7. It is feasible to stabilize the Tarapaca Landslide and reduce erosion at the toe through the construction of a gravity-type buttress (fill).
8. The switchbacks of PVDE are currently considered to have safety factors[3] at or greater than 1.3. Approximately 35 to 40 feet of additional lateral erosion/failure would have to occur before the factor of safety is reduced to 1.0 (imminent failure) at the lower switchback.
9. The existing 8-inch sewer line east of the PVDE switchbacks should be protected as soon as possible in order to avoid damage to the line from canyon wall erosion, since this sewer line is actually closer to the San Ramon Canyon erosion than the PVDE road.

3. Safety factor = the ratio of the maximum stress that a structural part or other piece of material can withstand to the maximum stress estimated for it in the use for which it is designed, and in this applicable case of slope stability FS = 1.5 is considered "safe" and FS = 1.0 is considered to be in imminent danger of failure.

10. The initially proposed conceptual easterly canyon access road would have required significant corrective grading and/or stabilization of the cuts; therefore, the road has been located to a more favorable site on the westerly canyon slope.

The last geotechnical item # 10 above, regarding the lack of suitability of the placing an access road to the mid-canyon inlet structure on the easterly canyon slope, came after H&A had already developed a conceptual easterly access road layout (**see Appendix G**). Instead an access road to the mid-canyon inlet structure on the westerly canyon slope will be recommended and only terrace drains & down drains will be constructed on the easterly canyon slope to keep surface water from flowing into the top of the Tarapaca Landslide "head-scarp" (which is the open gap at the top of the slide area which is visible in Photo 2). A conceptual illustration of the new westerly canyon slope access road and easterly canyon slope terrace / down drains is shown on the below.



X. STORM DRAIN DESIGN ALIGNMENT ALTERNATIVES

The aerial topographic survey specifically obtained for this study was used to layout out and analyze several alternate storm drain design alignments. The alternative alignments were narrowed down to two (2) primary storm drain alignments, each with a "sub-option" extension to the Upper San Ramon Canyon, as well as a low-cost possible alternative, and a "No Project" or do nothing alternative. This resulted in a **total of six (6) alternatives (1A, 1B, 2A, 2B, 3 & 4)** being considered for the San Ramon Canyon Drainage Study (**see Appendix F & G**). Following is a brief summary of each alternative alignment, including pros and cons that will help determine the preferred solution for the San Ramon Canyon Drainage System **(see Appendix F for a more complete explanation of each alternative).**

A. Alternative 1A – Mid-canyon inlet with "tunnel alignment" that outlets to the bluffs

Alternative 1A consists of a mid-canyon inlet with 54-inch HDPE pipe in a "tunnel alignment" that outlets to the bluffs. The entire length of this storm drain alignment falls within the City of Rancho Palos Verdes (RPV) allowing RPV sole jurisdiction. The upstream terminus is a proposed inlet structure in the "middle" of San Ramon Canyon at a location that was strategically chosen to intercept flood waters above the Tarapaca Landslide. At this location bedrock "daylights" in the existing canyon bottom and side walls (**see Photos 12 & 13: Bedrock at "mid-canyon" invert and downstream adjacent wall**).

Photo 12

Photo 13

The 54-inch storm drain pipe would then convey flows to the southwest in an 80-inch diameter tunnel approximately 1,900-feet in length with no horizontal or vertical grade breaks (to facilitate construction) to a launching pit location just south of 25th Street / PVDS (**see Photo 14**). (The tunnel construction will actually proceed uphill from the launching pit until it daylights in the canyon invert just downstream of the proposed inlet structure location.) The method of installation going downstream from the launching pit then changes to open trench. Open trench construction involves surface excavation of a trench, placing pipe and backfilling. At the

Photo 14

upstream end of the open trench reach there is a horizontal angle point and vertical grade break in order to bring the alignment parallel with the RPV and CLA boundary line. The alignment will remain within an existing 100-foot wide utility easement dedicated within the RPV-owned Palos Verdes Shoreline Park and Open Space that was specifically set aside for utilities such as this proposed storm drain. The 100-foot wide easement has lesser environmental impact requirements and also serves as a firebreak for the adjacent mobile home park and a hiking trail path passes through it to the ocean (**see Photo 14**).

The open trench reach proceeds downstream approximately 1,700-feet to a point 200-feet from the ocean bluff top where a second launching pit is proposed (**see Photo 15**). From the launching pit, which will require tunneling to proceed downstream due to the intent to minimize access impacts on the beach, a 38% sloped slant drain would be tunneled for approximately 300-feet. The tunnel will "daylight" at the bottom of the bluff face (**see Photo 16)**, which would be similar to the recent McCarrell Canyon Storm Drain slant drain tunnel outlet & structure **(see Photo 17**). The slant drain will be comprised of an 80-inch diameter tunnel with a 54-in HDPE pipe placed inside. The outlet structure would be constructed at the bottom of the bluff, with the pipeline above the high tide mark.

Photo 15

Photo 16

Alternative 1A Facts:

- Tributary area = 123.7 acres
- Q_{50} = 144 cfs (FYI only)
- Q_{100} = 170 cfs (Actual system accommodates Q_{100})
- Mid-canyon inlet structure
- 80-inch diameter x 1,900 foot tunnel
- 80-inch diameter x 295 foot slant drain tunnel
- 48-inch HDPE mainline (req'd for Q_{100})
- 54-inch HDPE mainline x 4,095 foot (recommended to minimize the PCC annular backfill in the tunnel & allow a future liner, if needed)
- Bluff bottom outlet structure
- Total Cost: **$19.2 million**

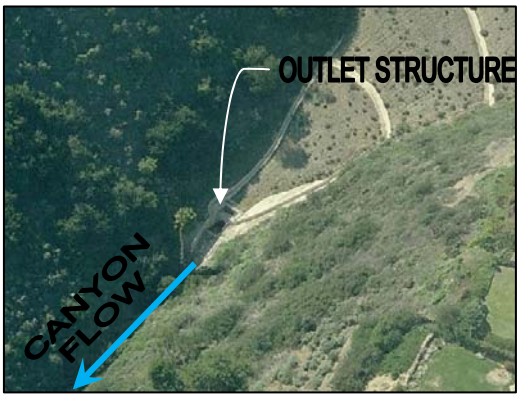
Photo 17

To end the cycle of the canyon's historical erosion problems generated and fed by the Tarapaca Landslide, a "gravity buttress" fill of approximately 20 to 30-feet in depth would be placed just downstream of the new mid-canyon inlet structure along the entire length of the existing Tarapaca Landslide (**see Section E-E on Alternative 1A, Sheets 5 of 6 and 6 of 6 in Appendix G**) which would raise the existing canyon's invert and flatten the side slopes of the canyon.

The "gravity buttress" fill within the canyon would also support Palos Verdes Drive East switchbacks. The fill combined with the proposed storm flow diversion, decreases to negligible the threat of a potential failure of the switchbacks that is deemed possible if the present rate of erosion toward the switchbacks is not addressed. The interception of the canyon flows at mid-canyon and the raising of the invert by filling the canyon would prevent significant erosion of the canyon invert and, as a collateral benefit, would eventually stabilize the Tarapaca Landslide (**see previous Photo 2**). Ungrouted rip rap rock energy dissipators are proposed at regular intervals to flatten the canyon invert grade and concentrate the energy dissipation to these rock-lined areas. The interception of the flow at mid-canyon would also significantly decrease the amount of flows that is currently reaching the existing CLA storm drain system at 25th Street. This should result in elimination of the flooding and debris deposition at 25th Street (**see Photos 6 & 7 of PSR**).

B. Alternative 1B – <u>Upper</u>-canyon inlet with "tunnel alignment" that outlets to the bluffs

Photo 18



Alternative 1B consists essentially of the same design approach and alignment as Alternative 1A with some exceptions. Instead of constructing a large mid-canyon inlet within San Ramon Canyon, a smaller mid-canyon inlet would be constructed and the proposed storm drain alignment would be extended upstream. The upper canyon reach would consist of a 48-inch HDPE pipe installed within "prepared canyon bottom backfill" that would be imported and placed along the natural canyon invert (**see Alternative 1B conceptual plans and Typical Section D-D in Appendix G**). The proposed pipe installation would extend an additional 1,300-feet upstream of the Mid-Canyon inlet structure location, and would be connected with a junction structure to the existing upper San Ramon Canyon storm drain outlet pipe (**see Photo 18**). The existing outlet structure was constructed as part of the slope repair and terrace drain construction performed in 2002 and would be removed to allow for the pipe-to-pipe junction structure connection. The 48-inch HDPE pipe in this upper-canyon alignment would be placed above a perforated 12-inch diameter pipe in a sub-drain rock galley (**see Typical Section D-D in Appendix G**). No excavation below the existing canyon floor would be done. The placement of the storm drain would be on top of "bedding" which would be placed above the canyon floor.

The remaining alignment downstream would be the same as Alternative 1A with the only difference that a small mid-canyon inlet structure would be required to pick up flows that are tributary to the natural canyon slopes before they can continue down towards the Tarapaca Landslide. This smaller Alternative 1B mid-canyon inlet would be located where the larger Alternative 1A mid-canyon inlet would be. This would be the last chance to intercept any additional surface flows that are tributary to the natural canyon slopes (and from the down

drain for the Tarapaca Road cul-de-sac and Tarapaca Slide "brow ditch" above the head-scarp).

The thought process driving this "sub-alternative" is that since the main line storm drain flows have already been collected from the housing tract above San Ramon Canyon and confined to a pipe it may be advantageous to keep these flows in a pipe rather than allowing these concentrated flows to again flow free in the natural channel bottom (**see Photo 19**).

Photo 19

Alternative 1B Facts:

- Tributary area = 98 acres (top connection point)
- Tributary area = 123.7 acres (as alignment leaves Cyn into tunnel)
- Q_{50} of 122 cfs (FYI only, top connection point)
- Q_{50} = 144 cfs (FYI only, as alignment leaves Cyn into tunnel)
- Q_{100} of 143 cfs (Actual system accommodates Q_{100}, top connection point)
- Q_{100} = 170 cfs (Actual system accommodates Q_{100}, as alignment leaves Canyon into tunnel)
- Upper-canyon connection junction structure
- 48-inch HDPE mainline (req'd for a Q_{100}) use in upper canyon to tunnel diversion
- Small mid-canyon inlet structure
- 80-inch diameter x 1,900 foot tunnel
- 80-inch diameter x 295 foot slant drain tunnel
- 54-inch HDPE mainline (use from tunnel to beach, recommended to minimize the PCC annular backfill in the tunnel & allow a future liner, if needed)
- Bluff bottom outlet structure
- Total Cost: **$23.2 million**

C. Alternative 2A – Mid-canyon inlet with "canyon alignment" outletting to 25th St SD

Alternative 2A consists of a mid-canyon inlet, at the same location as Alternative 1A, with a 48-inch HDPE pipe in a "canyon alignment" down San Ramon Canyon past the Tarapaca Landslide. This alternative would outlet into the existing CLA Storm Drain at 25th Street (**see previous Photos 4 – 9 and Section A-A on page 9 showing the existing San Ramon Canyon intersection with 25th Street**). The majority of the length of this storm drain alignment falls within the RPV, however the most downstream portion will pass through private property within CLA and as such RPV will not have sole jurisdiction over this alternative. Similar to the other mid-canyon inlet Alternative 1A, the proposed upstream inlet structure location was strategically chosen to intercept flood waters above the Tarapaca Landslide where bedrock "daylights" in the existing canyon bottom and side walls (**see previous Photos 12 & 13**).

The storm drain then conveys flows southerly in a "canyon alignment" along San Ramon Canyon (**see previous Photo 1**) past the Tarapaca Landslide (**see previous Photo 2**) approximately 1,900-feet in length where it will connect to the existing CLA storm Drain at 25th Street (**see Appendix D for CLA storm drain as-built plans**). A small portion of 42-inch CMP was left in place under 25th Street when CLA constructed the 48-inch RCP storm

drain downstream. Since the 42-inch CMP was left in place, half the width of 25th Street will now need to be open cut to an approximate 30-foot depth to remove this 42-inch bottleneck. Because "clear water" will have to be delivered to the CLA storm drain system per their requirements, a very large debris basin structure would be require at the mid-canyon inlet. It is envisioned that the debris basin and inlet structure for Alternative 2A and 2B will be significantly larger than the inlet structure required for Alternative 1A and 1B) because "bulked" flows will be allowed in Alternatives 1A and 1B.

The proposed storm drain construction will follow along the canyon's horizontal alignment above the existing canyon floor with a minimum cover of 5-feet to the proposed new and raised canyon invert such that no trenching will be required within the canyon floor (**see Section C-C on Alternative 2A and two plan & profile sheets 1 of 2 and 2 of 2 in Appendix G**). The proposed pipe slope will range from 21.5% maximum to 6.0% minimum. The proposed canyon installation will require a fill along the canyon of up to 30-feet at some locations. The elevated creek bed and steep side canyon slopes would be graded to have less severe slopes similar to all of the other alternatives. The filling of the canyon would again act as a buttress for both the Tarapaca Landslide and the PVDE switchbacks to drastically reduce the potential for future slope failures.

Unfortunately the CLA storm drain, beginning at 25th Street and downstream to the existing mid-bluff outlet, has some known deficiencies that were identified in a CCTV inspection provided by CLA (separated pipe joints). It was also noted on the CLA SD record plans, there is insufficient concrete cover over the interior reinforcement steel to withstand the anticipated high velocity flows and abrupt horizontal angle points and vertical grade breaks. In addition, the substandard bluff outlet is eroding the bluff face (**see previous discussion section VI. "Existing CLA Storm Drain At 25th Street" for more detailed information**). Note that the correction of the previously identified 25th Street Storm Drain system deficiencies would need to be constructed in addition to the construction described here.

Alternative 2A Facts:

- Tributary area = 184 acres
- Q_{50} = 219 cfs (Actual downstream existing system accommodates Q_{50})
- Q_{100} = 263 cfs (FYI only)
- Mid-canyon inlet structure
- 48-inch HDPE mainline
- CLA 25th Street storm drain outlet / connection
- Total Identified Cost: In City of Rancho Palos Verdes **$12.4 million**
  In City of Los Angeles **$5.5 million**

D. Alternative 2B – Upper-canyon inlet with "canyon alignment" outletting to 25th St SD

Alternative 2B consists essentially of the exact same design approach and alignment as Alternative 2A with some exceptions. Instead of constructing a large mid-canyon inlet within San Ramon Canyon, a smaller mid-canyon inlet would be constructed and the proposed storm drain alignment would be extended upstream. The upper canyon reach would consist of a 48-inch HDPE pipe installed within "prepared canyon bottom backfill" that would be imported and placed along the natural canyon invert exactly the same way as Alternative 1B would be extended above Alternative 1A (**see Alternative 2B conceptual plans and Typical Section D-D in Appendix G**). The proposed pipe would extend an additional 1,300-feet upstream of the Mid-Canyon inlet structure location and would connect with an existing

upper San Ramon Canyon storm drain outlet pipe with a junction structure (**see previous Photo 18**). The 48-inch HDPE pipe in this upper-canyon alignment would be placed above a perforated 12-inch diameter pipe (**see Typical Section D-D in Appendix F**). No excavation below the existing canyon floor would be done. The placement of the storm drain would be on top of "bedding" which would be placed above the canyon floor and covered.

The remaining alignment downstream would be the same as Alternative 2A with the only difference that smaller mid-canyon inlet structure would be required. This mid-canyon inlet would intercept any additional surface flows that are tributary to the natural canyon slopes. It would also intercept flows from the down drain for the Tarapaca Road cul-de-sac and the ditch just above the distinct step along the upslope edge (head-scarp) of the Tarapaca Slide.

Alternative 2B Facts:

- Tributary area = 98 acres (top connection point)
- Tributary area = 184 acres (northerly side of 25th Street)
- Q_{50} of 122 cfs (top connection point)
- Q_{50} = 219 cfs (northerly side of 25th Street)
- Q_{100} = 143 cfs (FYI only, top connection point)
- Q_{100} = 263 cfs (FYI only, top connection point)
- Upper-canyon connection junction structure
- 48-inch HDPE mainline in upper & lower canyons
- Small mid-canyon inlet structure
- CLA 25th Street storm drain outlet / connection
- Total **Identified** Cost: In City of Rancho Palos Verdes **$15.9 million**
  In City of Los Angeles **$5.5 million**

E. Alternative 3 (Low Cost): Upsize 25th Street inlet and line existing canyon invert

Alternative 3 is a low cost approach that proposes to line the existing stream bed with ungrouted rip rap materials that would reduce erosion in the streambed and would also include constructing a very large debris basin just upstream of 25th Street to capture sediment and pass only clear water flows to the CLA storm drain at 25th Street. The maintenance cost for the large debris basin would be more substantial and ongoing because accumulated debris would have to be cleared for the proper functioning of the inlet.

This alternative would not address the Tarapaca Landslide, so there would continuously be debris flowing to the existing CLA storm drain system, and continued pressure on the PVDE roadway.

Alternative 3 Facts:

- Tributary area = 187 acres
- Q_{50} = 144 cfs
- Q_{100} = 217 cfs
- Ungrouted rip rap lined creek bed
- Upper 25th Street inlet structure with large debris basin
- CLA 25th Street storm drain outlet / connection
- Total Cost: **$3.7 million**

F. Alternative 4 – "No Project" Alternative / Leave Existing Conditions "As Is"

Alternative 4 proposes to leave conditions as they presently exist. As a result of proceeding with this alternative, the City should expect continued flooding and sediment deposition at 25th Street during moderate rain events every winter (**see previous Photos 6 & 7**). Continued flooding at 25th Street could even ultimately result in significant losses to property and is potentially life threatening if the ponding should breach the mobile home perimeter wall and continue unchecked downstream of 25th Street. The City could also expect the eventual failure of the lower PVDE switchback after a 5 to 7 year period if erosion is allowed to continue in conjunction with the Tarapaca Landslide debris deposition cycle (**see previous Photo 2**). Essentially the "No Project Alternative" would allow all of the previously detailed potentially dangerous conditions to remain and carries considerable risk from both a maintenance and access standpoint and a future liability/claim standpoint. This "no project" alternative is NOT to be confused with a "no cost" alternative. It could likely end up costing much more than any of the other alternatives in the long-term if a serious "claim" should ever arise. Such a serious claim would likely require that one of the other alternatives be constructed in addition to the cost of settling the claim.

Alternative 4 Facts:

- Tributary area = 187 acres
- Q_{50} = 144 cfs
- Q_{100} = 217 cfs
- Tarapaca Landslide to continue cycle of uncheck debris flow
- Existing deficient inlets at 25th Street
- Existing deficient mid-bluff outlet structure
- Total Present Cost: Annual Maintenance
- Total Future Cost: Unlimited maintenance costs, loss of emergency access to the Palos Verdes Peninsula and unlimited future claim liability (property damage / loss of life)

DECISION/RISK ANALYSIS

				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
San Ramon Canyon Drainage Study				**Project Cost**	**Project Schedule**	**Construct -ability Issues**	**Availability of Materials**	**Contractor's Expertise Required**	**R/W and Easement Requirements**	**Environmental Impacts**	**Geotechnical Issues**	**Flood Protection**	**Impacts to the CLA**	**Impacts to LA County**	**Impacts to Private Residents**	**Impacts to Traffic**	**Resulting Service Life**	**Future Maintenance Issues**
Weighting Factor				5	3	4	2	2	2	5	4	4	3	3	3	3	3	3
Option No.	Rank	Raw Score	Weighted Score															
Mid-Canyon Inlet with "tunnel alignment" SD outletting to bluff ($19.2 million) will accommodate a 100-year storm																		
1A	**1**	28.5	92	1	2	2	2	1.5	2	2	2	2	2	2	2	2	2	2
Upper-Canyon Inlet with "tunnel alignment" SD outletting to bluff ($23.2 million) will accommodate a 100-year storm																		
1B	**2**	19.5	61	0.5	1.5	1	1.5	1.5	1	1	1	1.5	2	1.5	1.5	1.5	1.5	1
Mid-Canyon Inlet with "canyon alignment" outletting to 25th Street SD ($18.0 million) will accommodate a 50-year storm																		
2A	**3**	16.5	55	2	1	1	1.5	2	0.5	1	1	1.5	0.5	1.5	1	1	0.5	0.5
Upper-Canyon Inlet with "canyon alignment" outletting to 25th Street SD ($21.4 million) will accommodate a 50-year storm																		
2B	**4**	12	36.5	0.5	0.5	0.5	1.5	1.5	0.5	0.5	0.5	1	0.5	1.5	1	1	0.5	0.5
Low Cost- Upsize 25th Street inlet structure/debris basin & line canyon ($3.7 million) will accommodate less than a 50-year storm																		
3	**5**	11	34	1	1	1	1.5	1.5	1	0.5	1	0	0.5	0.5	0.5	0.5	0.5	0
No Project - Leave Conditions "as is" (unlimited maintenance & damage claims) will accommodate less than a 10-year storm																		
4	**6**	6	20.5	1.5	1	1	1.5	1	1	1	1	-1	0	0	0	0	-1	-1

Raw Score = Sum of all Raw Scores
Weighted Score = Sum of Weighting factor x Raw Score

Scoring Legend		
2	=	Alt. Is best solution among alternatives
1.5	=	Alt. Is a very good solution
1	=	Alt. is an acceptable solution
0.5	=	Alt. Is a marginal solution
0	=	Not Acceptable
-1	=	Alt. Is an inferior solution with problems

Weighting Legend		
5	=	Most Important / Sensitive Issue
4	=	More Important / Sensitive Issue
3	=	Average Importance / Sensitive Issue
2	=	Less Important / Sensitive Issue
1	=	Least Important / Sensitive Issue

XI. RECOMMENDED ALTERNATIVE

The recommended alignment is Alternative 1A. Its advantages, combined with the disadvantages associated with other Alternatives 1B, 2A, 2B, 3 & 4, make this the recommended project solution for the following reasons:

- Rated number 1 in the Risk Chart on the previous page
- It is the arguably the least expensive alternative (only 7% more costly than Alternative 2A's identified costs), while providing the greatest flood protection (greater than Q_{100}) of any alternative (except for the more expensive and environmentally undesirable upper-canyon extension Alternative 1B). Thus it could be argued that it potentially provides the most value (benefit per cost). NOTE: If Alternative 2A solution were to be pursued its lengthy time schedule would likely trigger the need for an interim project to stabilize the PVDE switchbacks (**see discussion item that follows**), which would result in additional total project costs.
- It meets all project goal requirements for stabilizing Tarapaca Landslide and delivering significantly less storm flows to 25th Street, which are also likely to be classified as acceptable "clear flows" to LAC's storm drain. Most of the non-diverted flow will be potentially "absorbed" into the permeable rocky river bed upstream of 25th Street before ever reaching the system.
- It requires the shortest design time and construction schedule, thus providing potential relief per an expedient schedule possible of any alternative. This would likely prevent the need for an interim project to stabilize the PVDE switchbacks.
- It is the least environmentally impacting, since it would disturb the least amount of sensitive natural canyon via the tunnel alignment. It also requires the least amount of environmental mitigation, and conserves the maximum amount of long-term maintenance resources with less truck trips to haul away fine sediment.
- The tunnel alignment does not require trenching across 25th Street / PVDS (or PVDE) and thus minimizes public inconvenience and traffic impacts during construction.
- The entire project alignment falls within the City of Rancho Palos Verdes' jurisdiction, which will reduce the costs and length of time needed for design preparation and processing for outside agency approvals.
- Alternative 1A would require the least amount of right-of-way and easements needed for its construction.

XII. MAINTAINING PALOS VERDES DRIVE EAST (PVDE) SWITCHBACK STABILITY

The upper PVDE switchback was found to be more stable than the lower switchback because it has a larger offset from the San Ramon Canyon creek bed. It also has not experienced as much erosion primarily because it is

upstream of the Tarapaca Landslide and thus does not have falling debris pushing flows westerly toward the switchback. The stability of the lower PVDE switchback was analyzed to have an existing safety factor of 1.4 (FS = 1.0 means failure could be imminent). An analysis was performed to see how much more of the existing canyon wall would have to be eroded in order to bring the factor of safety (FS) of the lower switchback to a value of 1.0. The existing slope face would have to be eroded back approximately 35-feet from where it presently stands before the roadway would be in a state of imminent failure. The upper PVDE switchback was analyzed to have an existing safety factor of 1.3 and in order to bring it down to a safety factor of 1.0 the canyon wall would have to be eroded back 40-feet before the roadway would be in a state of imminent failure. Based on recent data, it is estimated that the present rate of erosion of the canyon, westward in the vicinity of the lower switchback, is approximately 5-feet per year. If the erosion were to continue unchecked at this rate, the lower PVDE switchback could be destabilized within 5 to 7-years. It is important that an accurate monitoring system be installed to provide more scientific data on the rate of erosion. Immediate installation of a monitoring system is highly recommended to establish a true rate of erosion.

An additional concern is the safety of the existing 8-inch sewer line, which is located between the San Ramon Canyon and the PVDE switchbacks. Even less erosion is required to compromise the existing sewer since it is closer to the canyon edge. If a permanent solution is implemented rapidly and both PVDE and the Tarapaca Landslide are stabilized then a separate sewer relocation project may not be warranted. However, if a viable solution is not implemented, continued erosion in this area may result in the failure of the existing sewer line. If delays are encountered then RPV should consider relocating or otherwise protecting the existing sewer line, especially in the area of the lower switchback, where the line appears to be closest to the top of the eroded canyon wall.

It is recommended that PVDE and the sewer be protected if permanent improvements to address the erosion within the canyon are not constructed before the estimated 5 to 7-years during which time it is feared that unchecked erosion could destabilize the lower PVDE switchback. RPV may wish to pursue a separate interim construction project that would improve the stabilization of the PVDE switchbacks and sewer in the interim if a lengthy delay is experienced to fund, design and construct the recommend San Ramon Canyon Drainage Improvement project.

Recommended Separate Interim Project to Stabilize PDVE Switchbacks and Sewer:

In conformance with recommendations in GMU Geotechnical's Report (**see Appendix B**), the following are alternative projects, which could be pursued by RPV to address the stability of the PVDE switchbacks and sewer as a separate interim project (the cost of each was rated as $ expensive, $$ more expensive and $$$ most expensive):

A. **Cast-in-drilled-hole (CIDH) Piles:** Installation of CIDH piles into the existing slope outside of the PVDE switchbacks, especially the lower switchback, would be one possible solution to enhance the stability of the switchbacks as a separate interim project. This solution has the advantage of relatively easy access from the lower PVDE switchback where the CIDH pile caissons would be placed at an 8-foot spacing (on center), to a depth of approximately 50-feet, and would require approximately eighty (80) caissons total.

CIDH piles solution construction cost estimate = $$ (detail analyses pending)
A list of "pros" & "cons" associated with this interim solution are as follows:

PROS:

- This solution has the advantage of relatively good access from the lower switchback where the CIDH pile caissons would be placed.
- This solution is technically feasible and will have less extensive negative grading impacts than are associated with any other solution requiring access / work within the San Ramon Canyon creek bed and slopes.
- This solution would be considered the most permanent of all the "interim" switchback stabilization solution alternatives.
- Will provide protection to existing sewer line.

CONS:

- This might be considered a costly "interim" switchback stabilization solution, as it would become redundant once permanent solution is installed.
- The contractor may encounter difficult, but not insurmountable, drilling conditions.
- In addition to the difficulty of the drilling installation, this solution would have potentially significant traffic impacts on PVDE.

B. **Canyon Bottom Rip Rap Installation:** Installation of ungrouted rip rap or similar type of revetment in the canyon bottom could be placed as another possible interim project solution to enhance the stability of the switchbacks. The intent would be to control and reduce the amount of erosion encroachment towards the PVDE switchbacks.

Rip Rap solution construction cost estimate = $ (**see Appendix H**)
A list of "pros" & "cons" associated with this interim solution are as follows:

PROS:

- This is the least costly "interim" switchback stabilization "build" solution.
- This solution is "technically" feasible to provide "temporary" relief from erosion as long as the rip rap rock can be placed in a way to form a trapezoidal creek bottom and a suitable installation method can be devised without triggering land movement in the adjacent steep canyon slopes.

CONS:

- This solution has the disadvantage of requiring very difficult and impactful access, most likely directly from 25th Street, with a temporary access road likely graded up the canyon from the bottom.
- This solution is less desirable from an environmental perspective due to the associated negative grading impacts to allow access and work within the San Ramon Canyon creek bed and slopes
- This solution is considered to provide only "temporary" relief because it would not place a significant enough "buttress" fill to hold back the Tarapaca Landslide, thus any future movement would simply bury the rip rap rock, with a potential net affect as if it were never placed.

- Installation would be difficult. The reason this is dissimilar to the proposed "buttress fill" grading operations called for in the primary alternative solutions detailed elsewhere is that this interim solution will not have the benefit of: 1) as thoroughly studied designs that the future alternatives will have; 2) two access roads; or 3) the luxury of utilizing an intended "controlled" knock down of adjacent slopes as part of a buttress fill placement, thus prolonging the dangerous vertical slope conditions with workers potentially in harm's way.

C. **Gravity Buttress Fill at the Tarapaca Landslide:** A third and final build option as an interim stabilization measure for the PVDE switchbacks would be the installation of a 20'-30' high "gravity buttress" fill for about 750' along the toe of the Tarapaca Landslide. This would require a fabric wrapped rock sub-drain with 12-inch perforated PVC pipe and a 48-inch HDPE flexible pipe system buried along the invert of the canyon bottom. This solution would also require an inlet structure and access to this for maintenance.

Gravity Buttress solution construction cost estimate = $$$ (**see Appendix H**)

A list of "pros" & "cons" associated with this interim solution are as follows:

PROS:

- Although very costly, the gravity buttress fill solution is actually one portion of option 2 long-term permanent solution. It really is much more than an "interim" switchback stabilization solution, this is more permanent which could be established as part of the permanent solution. However the inlet structure would become redundant.
- This solution is feasible (see detailed discussion in Alternative 1A and other alternative write-ups).

CONS:

- This solution will require a major access road from the PVDE switchbacks, although it will not have as extensive of a mid-canyon inlet structure in place. This would add to the risk of clogging and/or an emergency overflow down the canyon. This will likely snowball into the implementation of the full "canyon alignment" solution to the City boundary, with only a missing link in the downstream connect to the storm drain at 25th Street and larger / fully accessible upstream inlet structure. This seems ambitious as an "interim" solution, potentially redundant if the tunnel alternative is pursued, and may not even be allowed by CLA even as a temporary interim solution.
- This solution has the disadvantage of requiring very difficult and environmentally impactful access, most likely directly from 25th Street, with a temporary access road likely graded up the canyon from the bottom.
- This solution is not desirable from an environmental perspective due to the associated negative grading impacts to allow access and work within the San Ramon Canyon creek bed and slopes. It is assumed this solution would be performed on an emergency fast-track basis and as such would not have the benefit of the full environmental mitigation and feedback process.
- This solution is considered to provide only "temporary" relief because it would not place the ultimate mid-canyon inlet structure, full access road and direct connection to the 25th Street storm drain.

- The deficient inlets at 25th Street would still be overwhelmed, if not more so, and would continue to experience flooding at 25th Street.

D. **"No Interim Project" Alternative**: The City of Rancho Palos Verdes may choose to proceed with no interim action to protect the switchbacks at this time. It is only recommended that RPV consider this "No Interim Project" Alternative if the previously detailed recommended San Ramon Canyon Drainage solution is implemented quickly, within 5-years maximum. If a long-term solution for San Ramon canyon cannot be implemented within 5-years then one of the "interim" project solutions should be considered. This is important because waiting longer than 5-years has the potential to change this "no cost" "No Interim Project" solution into a very costly condition if the PVDE switchbacks were to fail. Costs include potential loss of life, loss of emergency access along PVDE, and the cost of emergency repairs and related liability claims.

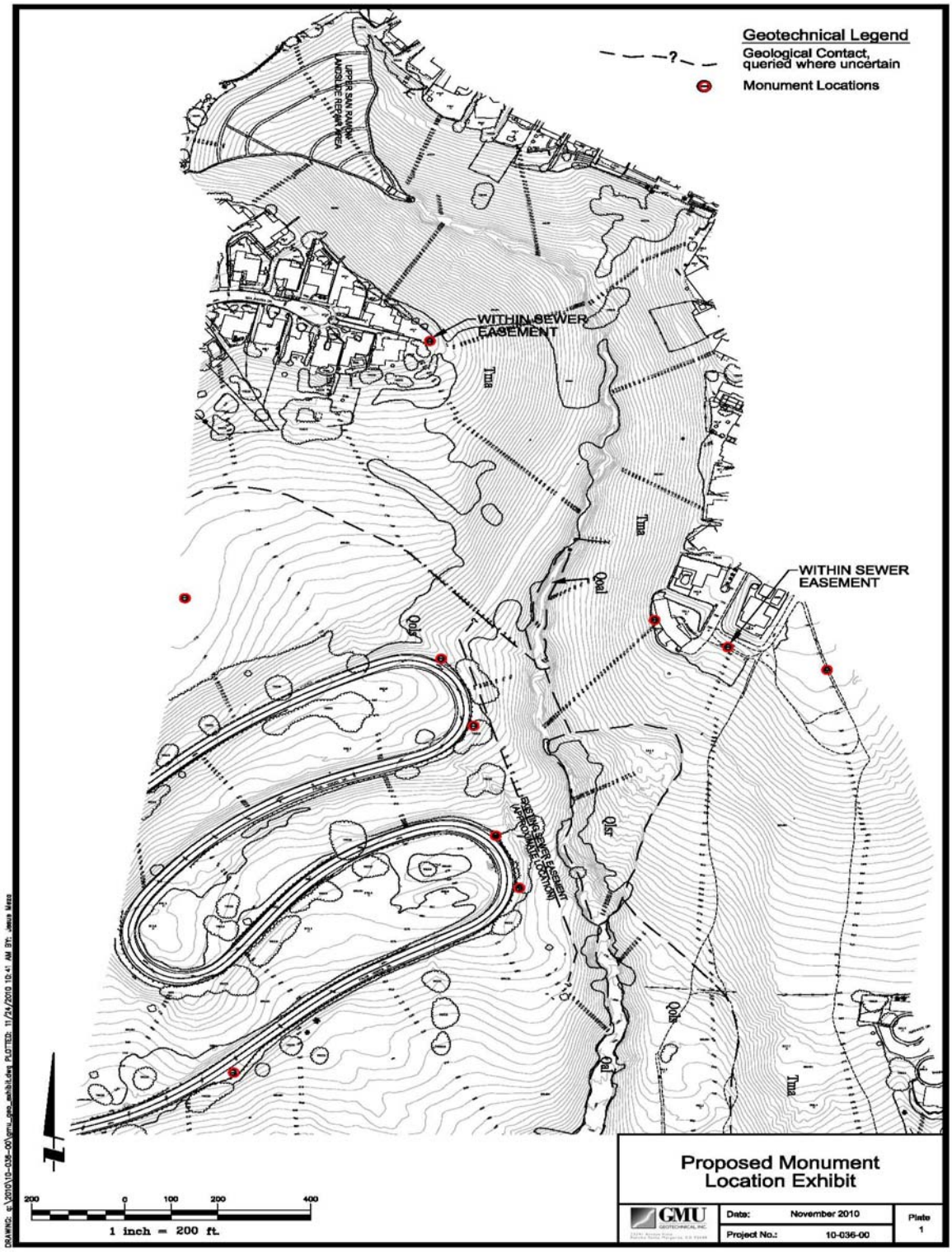
Note: RPV staff has instructed Harris & Associates to prepare a set of "shelf-ready" plans and specifications for the CIDH Pile interim solution for the City's potential use in bringing a construction contractor on board, should the previously recommended San Ramon Canyon Drainage solution not be implemented quickly.

Note: None of the proposed interim solutions will reduce the flooding and danger at 25th Street.

XIII. CANYON SLOPE MONITORING

There is an additional short-term and long-term benefit from the knowledge of any land movements that might be taking place before and after construction, with the specific intent of measuring any that happen during or because of our construction. To this end several slope monitoring monuments will be installed to periodically monitor the land movement within the San Ramon Canyon. They will be installed as deep as 10-feet in some locations to make sure they reach bedrock or the solid equivalent. A tripod auger rig will drill a 12-inch diameter hole to a depth of up to 10-feet and a 6-inch PVC sleeve will be installed with a fixed survey rod cemented in the center. This would have an access cover that can be removed to enable periodic GPS survey readings. The proposed **ten (10) locations** for the survey monuments are shown on the map on the next page.

These monuments will be surveyed periodically using GPS methods that are tied into the existing City GIS system and control networks. The first survey will be done to establish the baseline position of each monument from which all future measurements will be referenced. The frequency of subsequent surveys will be as often as every 6 months, depending on the movement noted and could be isolated to chosen specific locations where movement is noted on a more frequent basis.


Geotechnical Legend
Geological Contact, queried where uncertain
Monument Locations
WITHIN SEWER EASEMENT
WITHIN SEWER EASEMENT
Tma
Qsl
Qal
Qls
Qls
Qal
Qls
Tma
1 inch = 200 ft.
Proposed Monument Location Exhibit
GMU GEOTECHNICAL, INC.
Date: November 2010
Project No.: 10-036-00
Plate 1