



**Santa Ana Regional Interceptor (SARI)**

**Repairs to Unlined Reinforced Concrete Pipe (RCP)**

**Reaches IV-A and IV-B**

## **PRELIMINARY DESIGN REPORT (FINAL)**

**September 2009**



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**Santa Ana Watershed Project Authority**

**Santa Ana Regional Interceptor (SARI)  
Repairs to the Unlined Reinforced Concrete Pipe (RCP)  
Reaches IV-A and IV-B Design Services**

**Preliminary Design Report**

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## 1.0 Executive Summary

This preliminary design report (PDR) addresses the repair strategies, project issues and costs, and presents a recommended work plan to address the sections of unlined sacrificial reinforced concrete pipe (RCP) upstream of Prado Dam along Reaches IV-A and IV-B. Installed in the early 1980's, these segments represent the only portions of the SARL pipeline network that contain unlined RCP. The pipe reaches addressed in this report are identified in Table 1 and consist of roughly 5 miles of 27", 3 miles of 36" and 3 miles of 42" pipe.

Core samples completed by Kreiger & Stewart in 2004 and subsequent condition assessment reports recommended that SAWPA consider rehabilitation of these pipelines to prolong their service life. The Army Corps of Engineers (ACOE) recently completed the initial phases of the Prado Dam project, which has also heightened the concern over the long-term structural integrity of these pipelines. The Prado Dam project will create a seasonal water conservation pool at an elevation of 505 feet, which will pond water, up to 30 feet, and has the potential to deposit an additional 20 feet of sediment over certain sections of the pipelines over the next 30 years.

The rehabilitation options considered in this evaluation included slip-lining the existing pipelines with either a segmental pipe liner or a continuous pipe liner, cured-in-place pipe (CIPP), and spiral wound liner. In addition to meeting the new loading conditions imposed by the Prado Dam project, the recommended techniques have been evaluated based on the following factors:

- |                            |                                      |
|----------------------------|--------------------------------------|
| ❖ Hydraulic Capacity       | ❖ Mitigation/Permitting Requirements |
| ❖ Water Conservation Pool  | ❖ ACOE Dike Construction             |
| ❖ Service Life             | ❖ Existing Pipeline Flow             |
| ❖ Right-of-Way Acquisition | ❖ Structural Design                  |
| ❖ By-pass Pumping          | ❖ Constructibility                   |

This PDR supplements the Technical Memorandum (TM), prepared by RBF Consulting, dated March 2009. The TM evaluated relocation of the existing pipeline outside of the Prado Basin using either gravity pipelines or pump stations and force mains. These options were rejected for their capital and long-term operation and maintenance costs.

The evaluation of rehabilitation alternatives and the review of the associated project issues have resulted in the development of the following plan of action to extend the service life of the Reach IV-A and IV-B pipelines.

### 1. Lower Portion of Reach IV-A and Reach IV-B

The lower portion of Reach IV-A begins at Prado Dam at Maintenance Access Structure (MAS) 4A-0010 and extends north to the junction of Reach IV-D at MAS 4A-0180. This section is 42" diameter and is mostly located within the Prado Basin area. MAS 4A-0010 through 4A-0160 are within the conservation pool impact area.

The portion of Reach IV-B under consideration is 36" diameter and begins at MAS 4B-0010 and extends east to MAS 4B-150. MAS 4B-0010 through 4B-0070 are within the conservation pool impact area.



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It is recommended that these segments be rehabilitated with a segmental slip-liner pipe designed specifically to meet the loading conditions imposed by the operation of Prado Dam and the anticipated sediment loading over the next 30 years. New water-tight maintenance access structures should be included in this project to eliminate water intrusion. Fiberglass and High Density Polyethylene (HDPE) pipe can be fabricated with gasketed flanges to develop water-tight structures. Once installed, maintenance activities for these segments can be limited to video inspections on a 3 to 5-year rotation.

The benefits of this option include minimal environmental impact during construction, elimination of the need for sewage by-pass pumping within the environmentally sensitive area behind Prado Dam, no requirement for right-of-way acquisition, minimal long-term operation and maintenance, slight reduction in hydraulic capacity, minimization of overall project risk and cost competitiveness

Though the pipe alignments will remain within the limits of the conservation pool and therefore, inaccessible for many months of the year, access to these pipelines is infrequent and maintenance requirements can be scheduled around the seasonal levels of the conservation pool. Location is not considered a fatal flaw, and through comparison of the other alternatives, the segmental slip-liner provides the best apparent option for these segments.

The estimated construction cost for this option is \$18,962,000, which can be broken down as \$10,633,000 for the lower portion of Reach IV-A and \$8,329,000 for Reach IV-B. The estimated cost per foot for this option is \$583.

## **2. Upper Portion of Reach IV-A**

The upper portion of Reach IV-A is 27" diameter and begins near the junction with Reach IV-D at MAS 4A-0180 and continues north to MAS 4A-0680. It is located beyond the limits of the Prado Dam wetland area and is mostly within City streets and previously disturbed areas.

It is recommended that this section be rehabilitated with a CIPP liner. Existing flows in this reach are more manageable to pump by-pass (less than 1 million gallons per day [mgd]) and the work environment conveys much less risk than the environmentally sensitive wetland areas. Loading conditions on the pipeline are not expected to change significantly over time, which provides an ideal situation for a partially deteriorated (PD) CIPP installation. Traffic control mitigation will be required and permits from various municipalities and Caltrans will be required. CIPP is recommended over the spiral wound process because of its longer performance record in the Southern California region, greater number of qualified contractors available to perform the work and overall confidence in the product to extend the service life of this portion of Reach IV-A.

Existing easements over the pipeline through this reach will be used for the project. In addition, from MAS 4A-0550 through the terminus at MAS 4A-0680, Inland Empire Utility Agency (IEUA) maintains a parallel a 15-foot wide sewer easement. Representatives from IEUA have agreed to allow SAWPA to use this easement for construction access. A temporary 20-foot wide construction easement has been identified between MAS 4A-0230 and 4A-0280, where the pipeline is located within private property (Assessor's Parcel Numbers [APN] 1033-082-09 and 1033-082-10).

The estimated construction cost for this option is \$5,473,000, which is \$219 per foot.

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### **3. Value Engineering Review**

During the Pre-Design phase of the project, SAWPA conducted a 3-day value engineering (VE) session to review the design concepts and environmental impacts associated with the project. The VE panel consisted of the following individuals:

Mr. George Bartolomei – VE Team Facilitator  
Mr. Michael Fleury, P.E., Carollo Engineers, Pipeline Rehabilitation Engineer  
Mr. Casey Smith, SAK Construction, Pipeline Rehabilitation Contractor  
Mr. Michael Benner, AECOM, Environmental Specialist

Design team members from RBF Consulting and SAWPA also participated in the session.

The VE team reviewed engineering and environmental documents previously completed for the project, visited the project site and performed an independent alternative analysis. The team developed a number of design/constructibility considerations that should be evaluated by the design team as the project progresses into the final design phase. The primary conclusion from the VE session was the rehabilitation solutions recommended by the design team are the most appropriate for the conditions to be encountered and the project should proceed accordingly. Cost data for the project was reviewed on a limited basis by the VE team. Overall, the project's construction cost estimate was considered to be satisfactory at this stage of the design, but the VE team recommended further analysis as the design details are developed.

A copy of the VE report and the designer's response to the design/constructibility considerations are included in Appendix Q.

## 2.0 Introduction

The Santa Ana Regional Interceptor (SARI) pipeline conveys primarily highly saline, non-domestic wastewater from industrial dischargers and municipal desalter facilities within Orange, Riverside and San Bernardino Counties, see Figure 1. Constructed in the late 1970's through early 1980's, the SARI pipeline is a network of collector pipelines totaling 93 miles throughout the Lower and Upper Santa Ana Watersheds.

The Santa Ana Watershed Project Authority (SAWPA) was formed in 1972 to plan and construct the SARI pipeline network with the goal of protecting and improving ground and surface water quality of the Santa Ana River Watershed. SAWPA is a joint powers agency and consists of five municipal member agencies: Eastern Municipal Water District, Western Municipal Water District, Inland Empire Utilities Agency, Orange County Water District and San Bernardino Valley Municipal Water District. SAWPA owns, operates and maintains 72 miles of the SARI pipeline within Riverside and San Bernardino Counties from the Orange/Riverside County line. This portion of the SARI network is divided into Reaches I through V. Orange County Sanitation District manages and maintains the remainder of the SARI pipeline within the Lower Santa Ana Watershed inside Orange County.

Portions of the SARI pipeline network within Reaches IV-A and IV-B were installed using unlined sacrificial reinforced concrete pipe (RCP), see Figures 2 and 3. These sections are identified in Table 1 and consist of roughly 5 miles of 27", 3 miles of 36" and 3 miles of 42" pipe. All of these segments are located within or in the immediate drainage tributary to the environmentally sensitive Prado Basin.

**Table 1 – Summary of Unlined RCP – Reach IV-A and Reach IV-B**

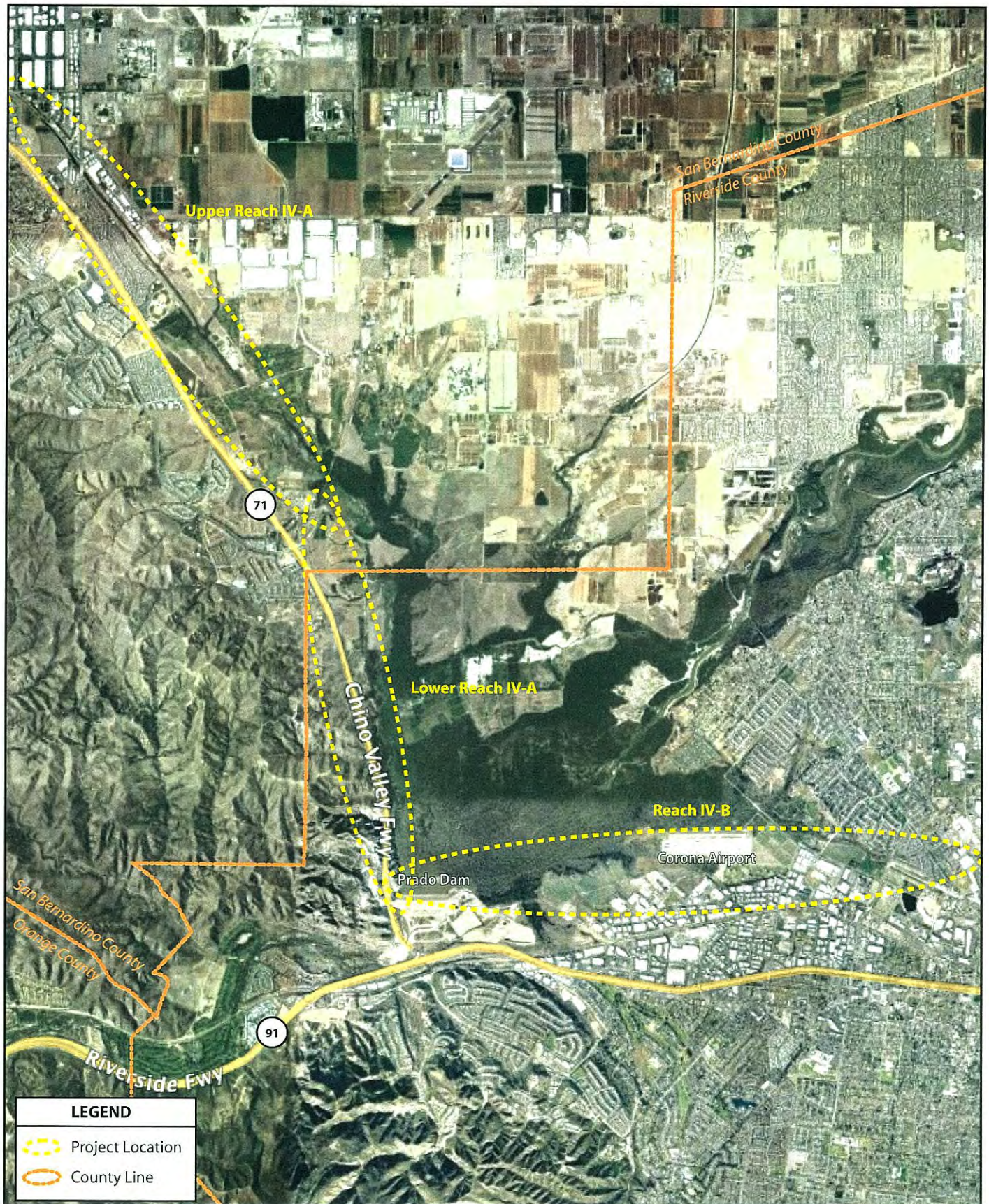
Pipe Diameter	Length	Description
27" Pipe	25,023 Linear Feet	Reach IV-A MAS IV-A-0180 to MAS IV-A-0680 Upper Reach IV-A
36" Pipe	15,949 Linear Feet	Reach IV-B MAS IV-B-0010 to MAS IV-B-0150 Lower Reach IV-B
42" Pipe	16,555 Linear Feet	Reach IV-A MAS IV-A-0010 to MAS IV-A-0180 Lower Reach IV-A

Previous condition assessments using CCTV video inspection and core samples of the pipe wall have been performed on these pipe segments and have revealed deterioration of the interior pipe wall is occurring. Additionally, the loading conditions on the lower portion of Reach IV-A and the westerly portion of Reach IV-B are expected to change significantly in the near future. A recently completed project by the Army Corps of Engineers (ACOE) has raised the height of Prado Dam by 28 feet and raised the spillway elevation by 20 feet. A new water conservation pool will be created to support an aquifer recharge and groundwater augmentation program to be implemented by the Orange County Water District. The conservation pool behind the dam will be set at elevation 505, which will inundate the SARI pipelines near the dam by approximately 30 feet of water. The ACOE will adjust the pool elevation seasonally to provide flood protection during the winter months and









Santa Ana Regional Interceptor (SARI) Repairs to Unlined RCP  
Reaches IV-A and IV-B

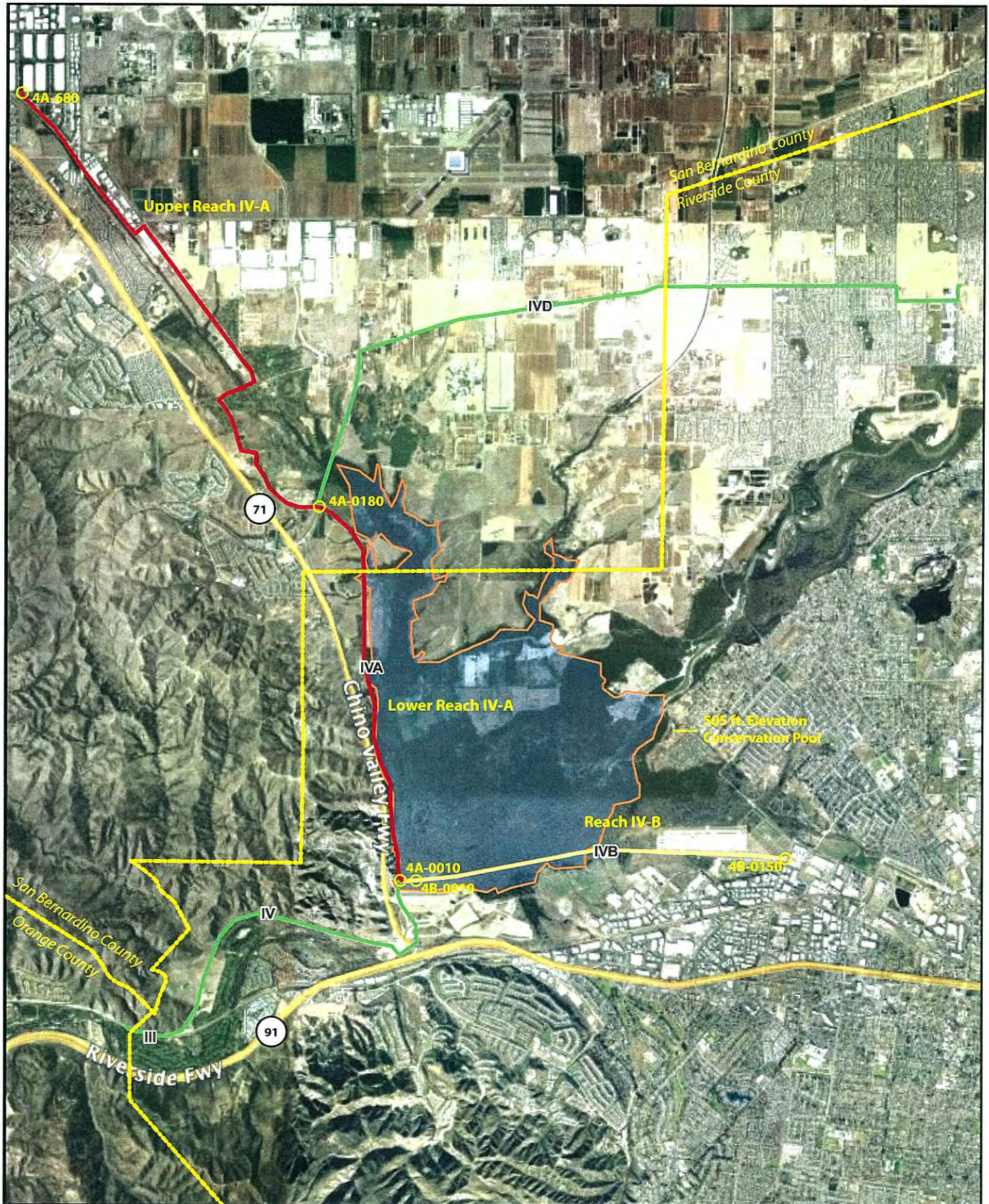
## Vicinity Map

Figure 2



Not to Scale  
Source: Google Earth 2007





Not to Scale  
Source: Google Earth 2007

Santa Ana Regional Interceptor (SARI) Repairs to Unlined RCP  
Reaches IV-A and IV-B

## Pipeline Locations



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groundwater recharge during the spring and summer months. Over the next 30 years, the sediment deposition behind the dam is expected to rise by up to 20 feet.

The combined effect of on-going structural deterioration, additional sediment loading and the fiscal and environmental impact of a pipeline failure demand an aggressive rehabilitation program be considered. This Preliminary Design Report (PDR) will evaluate the appropriate rehabilitation options, related construction costs and present the associated project issues and permitting requirements necessary to develop a recommended project for SAWPA's consideration.

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## **3.0 Existing Conditions**

### **3.1 Lower Portion of Reach IV-A**

The lower portion of Reach IV-A was constructed in 1981 and begins at the base of Prado Dam at MAS 4A-0010. It extends north to the junction of Reach IV-D at MAS 4A-0180. This section is 42" diameter and is located entirely in the environmentally sensitive Prado Basin, which is owned and maintained by the ACOE. The as-built drawings indicate over 90% of the length for this portion of Reach IV-A is within the 505 water conservation pool inundation area.

The section of pipe south of MAS 4A-0010 to the junction of Reach IV-B was recently replaced with High Density Polyethylene (HDPE) pipe as part of the Prado Dam project. This section of Reach IV-A is not a part of this project.

The existing pipe was installed with an average slope of 0.1%. Assuming a design depth to diameter (D/d) ratio of 75%, the maximum design capacity for the lower portion of Reach IV-A is 29.1 cubic feet per second (cfs), or 18.9 mgd.

Based on flow data provided by SAWPA, combined flow from MAS 4D-0080 (Euclid flowmeter) and MAS 4A-0360 (Pine flowmeter) shows this segment to have a fairly uniform flow during the week of 5 mgd. Peak flows up to 7.3 mgd were reached during the mid morning between 9am and 11am in the winter months and stayed more uniform during the summer, with peak flows only reaching 6 mgd. Review of the CCTV video inspection performed in 2008 shows the flow at an approximate D/d level of 35%. This corresponds to a flow of approximately 8 cfs or 5.4 mgd, which is consistent with the flow data provided by SAWPA.

The only connecting lateral on this segment is the 42" diameter Reach IV-D connection, immediately south of MAS 4A-0180. The connecting MAS is labeled 4D-0010.

### **3.2 Reach IV-B**

The portion of Reach IV-B under consideration is 36" diameter and begins at MAS 4B-0010 near the base of Prado Dam and extends east to MAS 4B-0150. MAS 4B-0010 through 4B-0070, roughly 50% of the segment, is within the conservation pool impact area.

The section of pipe west of MAS 4B-0010 to the junction of Reach IV-A was recently replaced with HDPE pipe as part of the Prado Dam project. This section of Reach IV-B is not a part of this project.

The existing pipe was installed with an average slope of 0.38%. Assuming a design D/d ratio of 75%, the maximum design capacity for Reach IV-B is 37.6 cfs (24.4 mgd).

Flow data provided by SAWPA from MAS 4B-0110 shows this segment to have a fairly uniform flow of 4.5 mgd during the week with peak flows up to 6.2 mgd at early afternoon between noon and 2 pm. Review of the CCTV video inspection performed in 2008 shows the flow at an approximate D/d level of 30%. This corresponds to a flow of approximately 8 cfs or 5.4 mgd, which is consistent with the flow data provided by SAWPA.

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This segment contains one connecting lateral as noted below:

Station 136+62.04	MAS 4B-0120	18" diameter from the Corona WWTP Truck Dump Station
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### 3.3 Upper Portion of Reach IV-A

The upper portion of Reach IV-A is 27" diameter and begins at the junction with Reach IV-D at MAS 4A-0180 and continues north to MAS 4A-0680. It is located beyond the limits of the Prado Dam wetland area and is mostly within City streets and previously disturbed areas. The northerly section of this reach is located within an easement along the rear property line of an industrial subdivision. Coordination will be required with the property owners and/or existing tenants to gain access to the existing access structures through this reach.

This reach also contains two inverted siphons and a section of five 10-inch diameter HDPE pipes in place of the 27" pipe. The siphons are located between MAS 4A-0360 and 4A-0370 and MAS 4A-0622 and 4A-0624 and contain 18" and 24" barrels. The five barrel pipe section is a 50 foot long segment between MAS 4A-0644 and 4A-0650. The five barrel section will not be included in the scope of work for this project and the siphons will be evaluated further to determine if their condition warrants rehabilitation.

The existing pipe was installed predominately with a slope of 0.2%. Assuming a design D/d ratio of 75%, the maximum design capacity for the upper portion of Reach IV-A is 12.6 cfs (8.1 mgd).

Flow data provided by SAWPA from MAS 4A-0360 (Pine flowmeter) shows this segment to have a uniform flow of 0.4 mgd during the week days, with a drop to 0.12 to 0.20 mgd on weekends. Peak flows throughout the day reach as high as 1.0 mgd. Review of the CCTV video inspection performed in 2008, shows the flow at a D/d level of 0.15. This corresponds to a flow of approximately 0.7 cfs or 0.5 mgd, which is consistent with the flow data provided by SAWPA.

North of MAS 4A-0620, there are currently no users connected to the system and correspondingly, no flow in the pipeline. This section of Reach IV-A is proposed to be bid as an optional bid item and will be included in the work as budget allows.

This segment contains four connecting laterals as noted below:

Station 257+04.30	MAS 4A-0380	15" diameter – IEUA Connection
Station 280+20.00	MAS 4A-0450	8" diameter
Station 368+04.41	MAS 4A-0570	Mission Uniform connection
Station 384+28.35	MAS 4A-0620	OLS Energy

### 3.4 Structural Investigation

CCTV inspection of these pipelines indicates interior surface erosion has occurred and many sections contain a significant layer of bio-growth that is blistering and collapsing into the flow stream. In 2004, Kreiger & Stewart (K&S) performed a limited physical inspection of these pipelines, wherein six (6) core samples were taken from the concrete pipe walls. The results from four samples taken from the 27" RCP along Reach IV-A showed non-structural surface corrosion has occurred within the

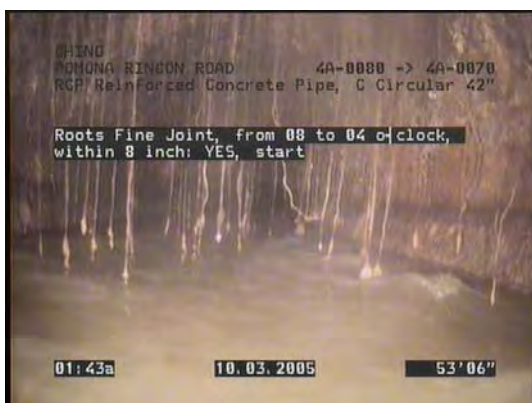
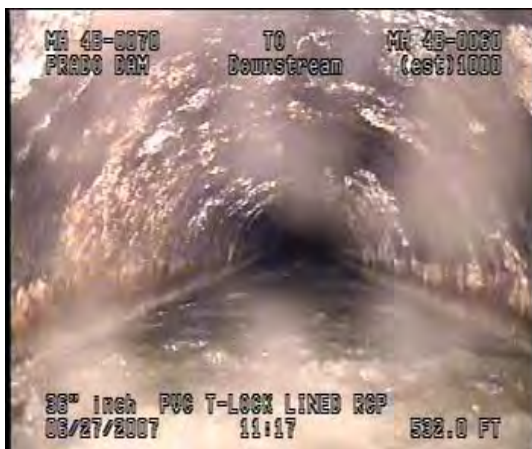


sacrificial portion of the pipe wall only. Since the pipeline's fabrication drawings were unavailable, the true extent of deterioration from the original thickness could not be determined.

The two samples taken within Reach IV-B indicate a reduction in concrete thickness from 5.125 inches to 4.92 inches, a loss of nearly ¼-inch. Concrete cover over the inner reinforcing steel cage has been reduced from 1.25 inches to 0.92 inch. The concrete loss noted was evaluated over the current 25-year service life of the pipeline and extrapolated theoretically to another 30 years at the same loss rate before the reinforcing steel is exposed. Due to live and dead loads on the pipeline, K&S recommended that SAWPA consider long term structural rehabilitation options within a 10 year time horizon to prolong the service life of these pipelines. This recommendation was made prior to the development of the proposed water conservation pool program and the expected sediment deposition over the pipeline.

There were no samples taken from the 42" RCP portion of Reach IV-A, which according the CCTV videos contains considerably more flow than the 27" section and contains a greater quantity of bio-growth on the pipe walls and root intrusion.

An analysis to quantify the amount of debris within the pipeline was performed using the available CCTV videos provided by SAWPA. A summary of the debris calculation is included as Appendix R.



**Interior Pipeline Photos of Reach IV-A and Reach IV-B**

## 4.0 Rehabilitation Options

The technical memorandum prepared by RBF Consulting, dated March 2009, evaluated a number of pipeline rehabilitation techniques that have been used successfully in Southern California. The methods considered included live-stream segmental slip-lining, continuous slip-lining with a by-pass, cured-in-place pipe (CIPP) with a by-pass and spiral wound lining. A discussion of each option is as follows:

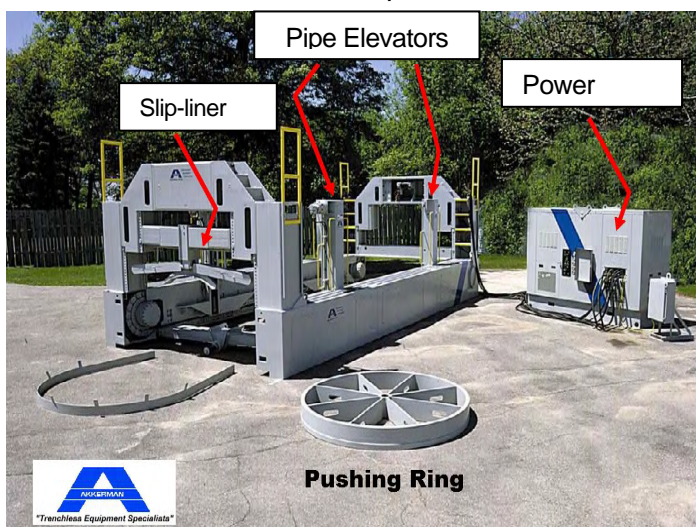
### 4.1 Slip-lining

Slip-lining is a technique that inserts a new pipeline inside of an existing pipeline. There are two slip-lining options that can be considered. Option A is live-stream segmental slip-lining where individual sections of pipe with flush wall bell and spigot joints (typically 20 foot long sections) are inserted into the existing pipe and pushed into place. The benefit of this technique is it can be performed with pipes at 100% flow capacity without by-passing the flow. It is preferred, however, to perform this work with the flow at less than 50% of the pipe diameter. Option B is a continuous pipe liner, fabricated from HDPE. The individual HDPE pipe sections are fused together on the surface and then pulled into the existing pipeline as one continuous liner. This option eliminates pipe joints within the existing pipe and minimizes the potential for joint infiltration in the future. A by-pass pumping system would be required with Option B to divert flow around the work zone. The resulting product under both options would provide comparable hydraulic flow characteristics to the existing pipeline.

#### 4.1.1 Option A - Live-stream Segmental Slip-lining Process

The slip-lining process is completed as follows:

1. A shored and lined construction pit is installed around the existing pipeline. The top half of the pipeline is cut out to expose the flow and provide access into the existing pipeline. A slip-liner rig is then installed within the pit.
2. The slip-liner pipe is then installed on the pipe elevator and lowered into position.





4. The liner is mated with the adjacent pipe joint and pushed into the existing pipeline with a hydraulic jack on the slip-liner rig.
5. This process continues until the receiving pit is reached. Push lengths of up to 5,000 feet have been successful and are dependent on the pipeline slope, horizontal and vertical curves within the alignment, the overall total weight to be pushed, and the friction within the host pipe to overcome.
6. The annular space between the liner pipe and the existing pipe is filled with a pressure grout.
7. The construction pit is dewatered and is typically reconstructed as an access structure.



Slip-liner pipe material available in the 27"-42" diameter range includes centrifugal cast fiberglass reinforced mortar pipe manufactured by Hobas, filament wound fiberglass pipe (similar to Bondstrand manufactured by Ameron), Vylon Polyvinyl Chloride (PVC) and HDPE. All four materials are corrosion resistant to brine wastewater and domestic wastewater and possess a low friction coefficient ("n" value) of 0.009, which compared to original concrete pipe at 0.013 provides a 30% increase in flow capacity. The presence of the bio-growth film inside the existing pipeline has increased the pipeline's interior roughness and correspondingly has increased the "n" value to an estimated 0.018 to 0.020. The reduced friction coefficient of the slip-liner pipe, therefore overcomes any reduction in flow carrying capacity of the reduced pipe diameter.

The smooth-walled, corrosion-resistant slip-liner pipe materials are not as susceptible to biogrowth or the accumulation of mineral and/or grease deposits as the unlined RCP and with a periodic cleaning program of 3 to 5 years, the hydraulic properties of the slip-liner pipeline can be maintained.

Based on the average slope of 0.38% within the 36" Reach IV-B and an existing "n" value of 0.018, the existing flow capacity at a D/d ratio of 75% is 27.2 cfs, 17.6 mgd. By comparison, a 30" slip-liner pipe with an "n" value of 0.009 provides 33.4 cfs, 21.6 mgd. As noted above, at a D/d ratio of 0.75, the original design capacity of the Reach IV-B pipeline was 37.6 cfs, 24.4 mgd.



Based on the average slope of 0.1% within the 42" Reach IV-A and an existing "n" value of 0.018, the existing 75% flow capacity is 21.0 cfs, 13.6 mgd. By comparison, a 36" diameter slip-liner pipe with an "n" value of 0.009 has a 75% flow capacity of 27.9 cfs, 18.1 mgd. As noted above, at a D/d ratio of 0.75, the original design capacity of the Reach IV-A pipeline was 29 cfs, 18.9 mgd.

**Table 2 – Slip-Liner Flow Comparison Summary**

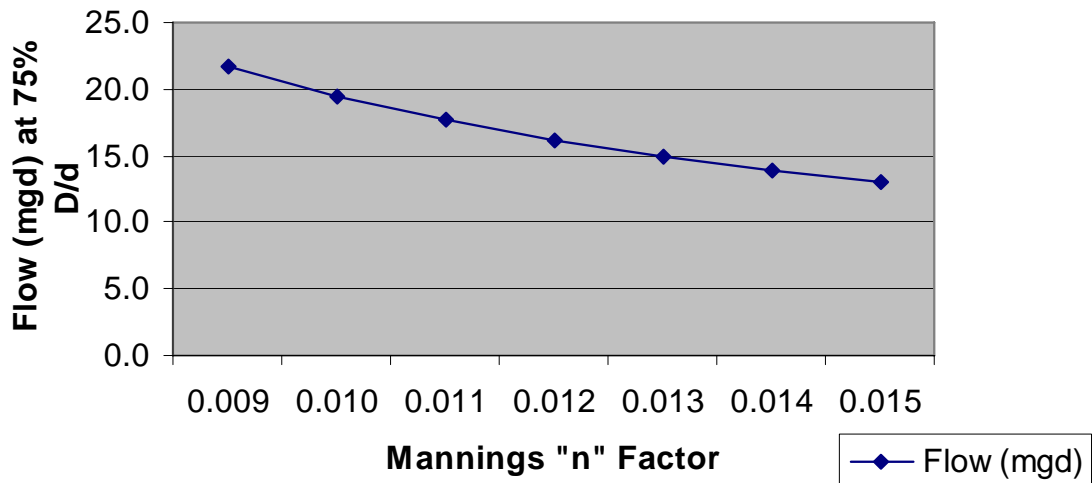
<b>Reach IV-B</b>	<b>Diameter (inches)</b>	<b>Slope (ft/ft)</b>	<b>n</b>	<b>Capacity (mgd)</b>
Original Design Capacity at 75% full and n=0.013	36	0.0038	0.013	24.4
Current Design Capacity at 75% full and n=0.018	36	0.0038	0.018	17.6
Proposed Design Capacity at 75% full and n=0.009	30	0.0038	0.009	21.6
<b>Lower Reach IV-A</b>	<b>Diameter (inches)</b>	<b>Slope (ft/ft)</b>	<b>n</b>	<b>Capacity (mgd)</b>
Original Design Capacity at 75% full and n=0.013	42	0.001	0.013	18.9
Current Design Capacity at 75% full and n=0.018	42	0.001	0.018	13.6
Proposed Design Capacity at 75% full and n=0.009	36	0.001	0.009	18.1

Operation and Maintenance (O&M) requirements for the slip-line option are projected to be similar to conventional sewer maintenance practices for pipelines of this size and flow characteristics. Periodic cleaning and jetting of debris on a 3 to 5 year cycle is recommended. More frequent cleaning cycles should be implemented as conditions warrant. Based on the inspection of similar pipelines, the smooth wall and corrosion resistant liner material of the slip-liner pipe will resist the development of bio-growth inside the pipe and only minor accumulations of grease, mineral deposits and sediment are expected in between cleaning cycles. Video inspection of the pipeline should occur prior to each cleaning cycle to establish operational conditions of the system. The video will assist SAWPA in determining the need for a more frequent cleaning cycle.

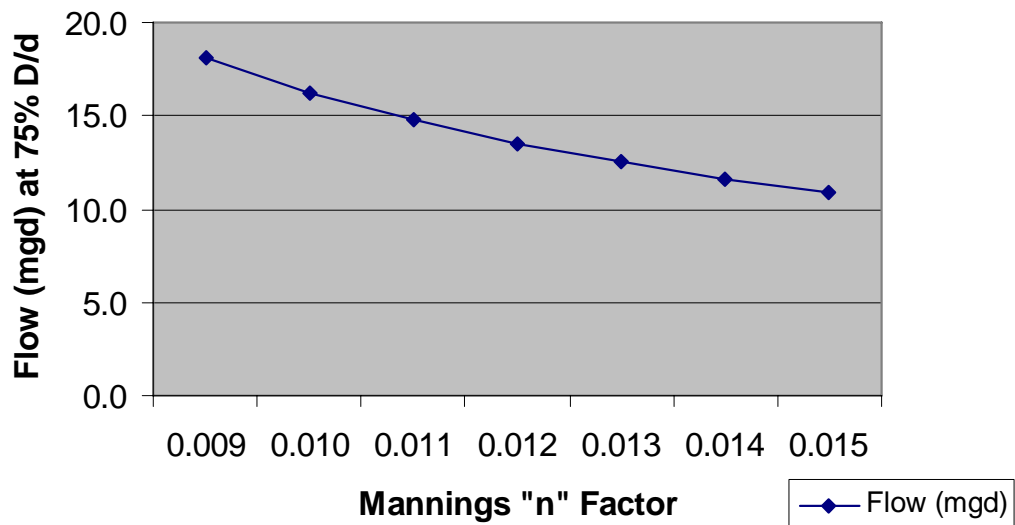
For illustration of the importance of periodic cycle, the following graphs have been developed for Reach IV-B and the lower portion of Reach IV-A to demonstrate the impact of a reduced "n" value on the hydraulic performance of the slip-liner pipeline. As noted above in Table 2, the design capacity of Reach IV-B at 75% full is 21.6 mgd and Reach IV-A is 18.1 mgd when the initial design "n" value of 0.009 is used. The capacity reduces by nearly 40% as the "n" values increase to 0.015.

SAWPA's ability to maintain the "n" value near 0.009 will be dependent on the cleaning cycle as plastic or resin based pipe materials under the expected flow conditions (flow quantity and quality) are not expected to deteriorate substantially over time. Debris accumulation will have the greatest impact on the flow conveyance capacity of the pipeline.

### Flow Comparison with Variable "n" Factor Reach IV-B



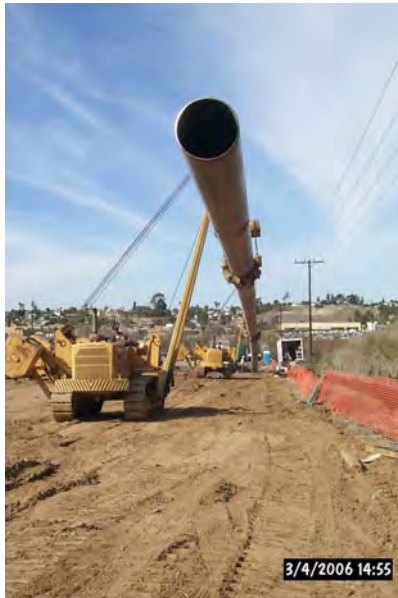
### Flow Comparison with Variable "n" Factor Lower Reach IV-A



#### 4.1.2 Option B - Continuous Slip-lining Process

The process for Option B would begin with a similar access pit as described above in Option A. A pump by-pass system would be installed in the immediate upstream MAS adjacent to the work area similar to the photo shown at the right. A high-line pipeline would be installed on grade to discharge the by-passed flow into the nearest MAS downstream of the work area.

Butt fusing individual segments of HDPE pipeline would be performed at grade for the full length of the insertion. Piping would be strung out upstream of the work area. A pulling head would be attached to the downstream end of the pipe.



**Continuous Segment of  
HDPE Pipe**



**Typical Sewer By-Pass  
Pumping System**

A steel cable would be inserted into the pipeline between the access pits and attached to the pulling head. At the downstream access pit, the cable would be pulled back with a hydraulic winch. As the cable advances through the pipe, the new HDPE liner would be drawn into place as one continuous pipe liner.

Hydraulic impacts under Option B would be similar to those presented in Table 2 for Option A.

O&M requirements for this option will be as discussed above for the segmental alternative.

#### 4.2 Cured-In-Place Pipe (CIPP)

The CIPP process inserts an epoxy resin impregnated felt tube into the existing pipeline between access structures. Once in place, the tube is filled with hot water or steam to activate the resin. Once the resin has cured, the resin/felt structure creates a structural pipe liner inside the existing pipeline that provides excellent corrosion resistance. The benefit of this technique is it creates a new structural pipe liner with excellent corrosion resistant and hydraulic properties that conforms to the interior diameter of the host pipe without excavating to expose the host pipe. The CIPP process would create a finished product similar to the Option B slip-liner described above, with the benefit of a larger finished inside pipe diameter.

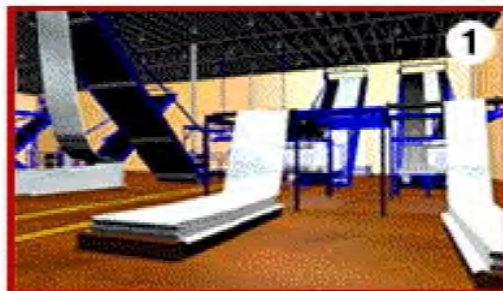
A CIPP liner would improve the Manning's "n" from the original concrete pipe value of 0.013 to an estimated 0.010. The increase in hydraulic capacity will more than offset the reduction in pipe

diameter for the finished product. For example, in the upper portion of Reach IV-A, the 27" pipe at a slope of 0.2% with an "n" value of 0.013, the 75% D/d design capacity is 12.6 cfs (8.2 mgd). The finished CIPP liner would result in an inside diameter of approximately 26.1" and would yield a 75% D/d design capacity of 15 cfs (9.7 mgd) or an increase of 19%. Greater increases in capacity can be expected for the Lower Reach IV-A and Reach IV-B sections as the "n" value for these sections appears to be closer to 0.018 because of the bio-growth inside the pipe.

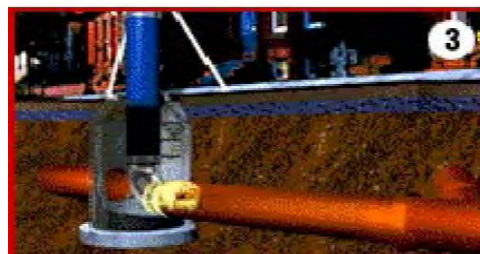
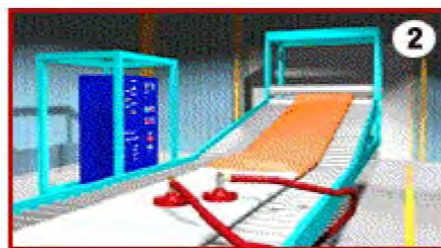
#### 4.2.1 Process

The typical CIPP process for a sanitary sewer installation is as follows:

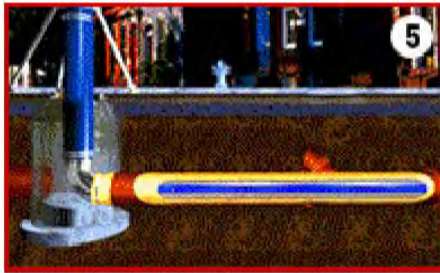
1. The felt tube liner is cut at the factory into specific lengths corresponding to the length of each pipe reach (MAS to MAS) to be lined.
2. The felt tube is impregnated with resin designed to meet the specific conditions of the waste stream and the structural requirements of the project.
3. The liner is then trucked to the job site where it is inserted into the MAS and pushed through the host pipe with water pressure. The host sewer pipe must be thoroughly cleaned prior to the insertion and all existing flow and flow from connecting laterals must be diverted around the pipe reach being lined.



4. The felt tube expands into the host pipe conforming to the interior walls of the pipe and is designed to extend between two adjacent access structures.
5. Once the tube is fully inserted, the water inside the tube is heated to activate the resin. The resin cures to create a felt reinforced corrosion resistant liner. Water used during the cure process is released and discharged downstream in the sewer system. Typically, once the water has properly cooled (less than 100° F), it contains 20-30 parts per million (ppm) of styrene resin. Discharging the cooled cure water to the sanitary sewer has not been identified as a threat to wastewater treatment plants during more than 30 years of CIPP construction in the United States. Water (condensate) from a steam cure process typically has 5 - 30 ppm of styrene, but the quantity of water from a steam cure process is significantly less than from a water cure. No impacts associated with this process have been identified as well. A guideline for handling styrene-based resins used for CIPP is included in Appendix P.



6. The final step is to use a remote controlled lateral cutting device to reopen all lateral service connections and install a lateral “top hat” which is a short stub that fits into the lateral pipeline while the brim of the top hat is secured to the inner wall of the new liner.



CIPP is available from a number of supplier/installers in Southern California and is typically provided in a liner thickness that addresses either a full deterioration (FD) condition of the host pipe or a partial deterioration (PD). The FD condition assumes the host pipe can no longer support any of the design loads (earth and live loading) and the new CIPP liner must act as a “new pipe” within the host pipe. The PD condition assumes the host pipe has minor structural deficiencies, but can still meet all loading conditions. The difference in the liner thickness between the two conditions is typically on the order of 0.10” (approximately 15-30% of the total liner thickness), which can translate to significant cost for a project with miles of large diameter CIPP to perform. CIPP design is performed in accordance with ASTM F1216; *Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube*.

A key factor with CIPP is whether the felt tube can be delivered to the job site already impregnated with resin. The pipe diameters and the lengths of pipe runs between access structures on Reaches IV-A and IV-B stretch the conventional limits for a factory delivered felt/resin tube. Once the resin is added to the felt, the tube becomes very heavy and with pipe lengths over 1,000 feet, the resulting tube weight may exceed the load carrying capacity of a refrigerated truck.

The alternative to factory delivered, is to perform the “wet-out over the hole”, meaning the resin is added to the tube in the field immediately prior to insertion into the MAS. The determination of which option to use is dependent on the length of the individual pipe reach and the pipe diameter.

Regardless of which CIPP method is employed, all flow within the pipeline must be stopped and by-passed around the work area. The MAS directly upstream from the insertion MAS is used as the pump-out MAS. The by-passed flow is conveyed in a highline, usually a steel or aluminum pipeline, laid on the ground adjacent to the MAS downstream of the last MAS involved with the CIPP process. The pumping equipment consists of skid-mounted self-priming pumps with sufficient capacity to provide 100% redundancy. The access road along the pipe corridor can be used for the highline.

An alternative to the pump by-pass system is to coordinate with the individual dischargers to temporarily reduce or eliminate their discharges to the SARI pipeline. If the flow is reduced sufficiently, then either “in-pipe storage” or “pump and truck” options can be considered. These alternatives to the pump/highline system is practical where the flow is very low, such as in the sections of the upper portion of Reach IV-A and where the highline pipe would cross a public thoroughfare.



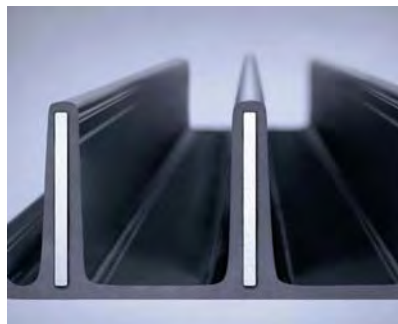
Typically the CIPP felt/resin tube is hauled to the job site in refrigerated trucks to keep the resin from activating prematurely. At the site, the truck feeds the felt tube through a tower placed over the MAS and into the pipe. Support equipment for this operation includes a water truck, water heating equipment and generator. An area equivalent to a 50-foot radius around the MAS is required.

An access road along the pipeline corridor is required, as the insertion process will continue from MAS to MAS. The access road may be used to stage equipment noted above if a 50-foot radius clearing is not available at each MAS and a more linear set-up is required. For linear set-ups, a 20 foot wide by 80 foot long staging area is required at the insertion MAS, with 20 foot by 40 foot areas required at the receiving MAS and the associated access structures used for the by-pass pumping.

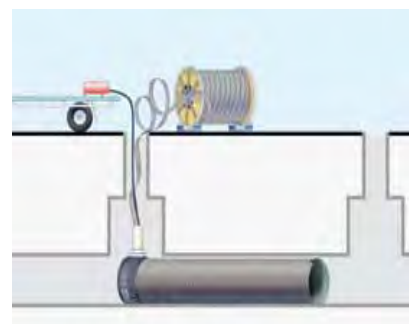
O&M requirements of CIPP will be similar to those described for the slip-liner pipe in Section 4.1.1 above. The finished CIPP liner will possess sufficient hardness to withstand standard trunk sewer cleaning and jetting equipment. The cleaning cycle for CIPP is also estimated to be 3 to 5 years.

### 4.3 Spiral Wound Process

The spiral wound process uses a narrow liner strip, approximately 6 inches wide, along with a mechanical winding machine to spirally wind the new liner within the existing pipe. The liner has a wall profile that is smooth on the interior and can be provided with reinforced steel strips to provide the structural strength needed for a project. The reinforced steel is completely encapsulated with the corrosion-resistant properties of the liner material. On small diameter pipelines, less than 30 inches, the liner and profile section can be fabricated completely of corrosion-resistant PVC. Edge seams are designed to lock adjoining liner strips together to complete a continuous liner between access structures.



**Encapsulated Steel Reinforcing**



**Spiral Winding Set-up**



**Inter-locking Edge Seam**



**Spiral Winding Machine**

Typically on pipelines less than 30 inches in diameter, the liner is expanded to match the host pipe's diameter and on pipelines greater than 30 inches, the annular space between the liner and the host pipe is grouted once the spiral winding is complete. The hydraulic properties of the finished liner are similar to CIPP.



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The process has the following benefits:

- a. Can be utilized under live flow conditions, up to 25% of the pipe's D/d ratio
- b. Installed along pipeline curves
- c. Access is via an existing MAS
- d. The work area footprint is very small, limited to the liner spool and support vehicles

The process has some disadvantages to be considered as well, such as:

- a. It is a new process in the United States and few projects in the 27"-42" pipe diameter range have been completed.
- b. Correspondingly, there are very few contractors familiar with the process, which would yield a limited pool of potential bidders for the project.
- c. Joints are continuous in this process and each joint is a potential failure point in the future.
- d. Working under live-flow conditions creates the potential for debris to become lodged in the joint during the winding process. This impedes the winding process and, depending on the quantity of debris, may necessitate pump by-passing to eliminate or reduce the quantity of flow in the pipeline, negating the cost benefit of the option.

O&M requirements for the spiral winding process are expected to be similar to those described for the slip-liner pipe in Section 4.1.1 above. However, the cleaning equipment selected should not drag along the liner as there is potential to catch a joint seam. Hydro-scour equipment would be the preferred choice for this option. The cleaning cycle for this process is also estimated to be 3 to 5 years with video inspection to confirm the frequency.

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## **5.0 Project Issues**

### **5.1 505 Water Conservation Pool and Sediment Loading**

The Prado Dam project and the subsequent implementation of the 505 elevation water conservation pool program create significant impacts to the rehabilitation of the lower portion of Reach IV-A and Reach IV-B. This issue does affect the rehabilitation program being evaluated for Upper Reach IV-A. The selected rehabilitation method needs to withstand the additional sediment loading anticipated with the program, provide long-term structural and water-tight joint integrity and provide long-term internal corrosion resistance. The 505 impact area extends to the majority of Lower Reach IV-A and roughly 50% of Reach IV-B, as shown in Figure 3. Additionally, the finished repair must provide a maintenance-free structure as the pipeline will be submerged for many months of the year and environmental access restrictions prohibit construction activity for much of the remainder of the year. This rehabilitation project must, therefore, be completed in a manner that yields the above design elements while providing the least amount of environmental disturbance and environmental risk during its implementation.

The live-stream segmental slip-lining option (Option A) meets the criteria listed above with the negative element of reducing the conveyance capacity of the structure. The continuous slip-lining option (Option B) meets the design criteria, but would require by-pass pumping within the environmentally sensitive Prado Basin and the wall thickness for the HDPE pipe would be greater than Option A. The CIPP process can also be designed to meet the criteria list above but will also require by-pass pumping and would be susceptible to root intrusion behind the liner given the heavy vegetation in the Basin. Also, the long runs between access structures (+1,000 feet) and larger pipe diameter creates concern with the consistency/quality of the epoxy curing process. The spiral wound process would provide roughly 40 times more joint length per pipe section than the segmental slip-lining process. Each joint is an avenue for future root intrusion given the heavy vegetation in the Basin.

Given the conditions imposed by the water conservation program within the lower portion of Reach IV-A and Reach IV-B, the segmental slip-lining process best meets the design objectives for this project.

### **5.2 Structural Design**

The revised operational scheme, seasonal flood storage conditions for Prado Dam and expected sedimentation require an evaluation of long-term performance of flexible slip-liner pipeline products. Flexible pipelines derive their strength from sidewall support. Under standard trench loading conditions, native soil material, trench width and bedding material combine to determine the available sidewall conditions for the pipe and allow determination of appropriate pipe stiffness (PS) to maintain deflection within design tolerance. Manufacturers of flexible pipe commonly reference an acceptable deflection allowance as 5 percent. Given the critical nature of this installation, it is recommended to establish the maximum deflection allowance at 3 percent.

With the water conservation pool proposed at elevation 505, the hydrostatic load on the pipe will be increased and pipe buckling and wall crushing are other pipe design parameters that must be considered. The maximum probable flood (MPF) event should also be evaluated in these calculations to determine the pipeline's reaction to this temporary load.

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Pipe calculations, shown in Appendix E, have been developed to examine three loading conditions described below. Condition 2 is designated as the governing design parameters and Condition 3 is a fatal flaw check on the pipeline's performance during the 500 year MPF event. Any excessive deflection observed during the MPF will be relieved once the flood level subsides. The fatal flaw check is to evaluate the potential of a catastrophic collapse.

### **Pipeline Loading Conditions**

1. Existing pipe conditions with 15 feet of cover and the water pool level at 505
2. 15 feet of cover + 20 feet of additional sediment with the water pool at 505
3. 15 feet of cover + 20 feet of sediment + Maximum Probable Flood at 590

Sample calculations to determine the recommended pipe stiffness value were obtained from Hobas Pipe and are included in Appendix E. Similar calculations will be secured from Ameron Pipe for their Bondstrand pipe during the final design phase.

A critical element in the calculations is the estimation of the E' value, which defines the side wall strength of the combined trench design and native soil conditions. The estimated E' value for the alluvial material found within the Prado Basin is 1,000 pounds per square inch (psi), as noted in the Preliminary Geotechnical Report, see Appendix N. However, given the proposed condition that the new slip-liner pipe will eliminate the corrosive environment within the RCP, the RCP can be expected to act as a structural host pipe for an extended time into the future. With the annular space grouting between the slip-liner pipe and the RCP, the finished product will be similar to a concrete encased pipeline. An E' value for a firm sidewall support condition, such as crushed rock, is on the order of 3,000 psi. The slip-liner condition will meet or exceed the equivalent E' for crushed rock and this value is appropriate for use in the calculations.

Using these design parameters, the calculations show that a PS of 95 psi is required to meet the project's loading requirements. Further analysis will be performed to determine the location along each pipeline alignment where the PS design can be reduced.

The Hobas pipe design with a PS value of 95 provides an inside pipe diameter of 36" and 30" with wall thicknesses of 1.15" and 0.98" for Lower Reach IV-A and Reach IV-B, respectively. Bondstrand fiberglass pipe can be fabricated with similar structural qualities, and therefore, similar hydraulic properties, to Hobas. A comparable HDPE pipe has a DR rating of 17 and has a wall thickness of 2.25" for 36" nominal pipe and 1.88" for 30" pipe. The corresponding inside diameters are 33.8" and 28.2". The reduced inside diameters will further reduce the hydraulic capacity of the pipeline by 15%. This reduction in capacity must be considered in the final design when specifying allowable pipe materials.

### **5.3 Flotation Analysis**

Pipeline flotation is a concern on larger diameter pipes, where there is a limited amount of soil cover and the groundwater is at or near the surface. Buoyancy uplift forces can exceed the soil loading under these conditions and cause the pipeline to float. It becomes especially critical when light-weight plastic pipelines are installed and if there is a potential for the pipe to be dry during periods of high groundwater.

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The existing pipe installations along the lower portion of Reach IV-A and Reach IV-B were evaluated for their depth of cover and the development of buoyancy forces. In all locations within these reaches, assuming the water table was at the surface, the weight of the saturated soil cover was sufficient, in excess of 5 feet, to counteract buoyancy forces regardless of the pipeline materials and flow in the pipeline, see Appendix E.

The potential for flotation will also be minimized under all the rehabilitation options because of the weight of the existing concrete pipe. Though not included in the calculations, the weight of the existing pipeline will add a factor of safety to the installation.

The design of new access structures must also consider flotation. Lightweight, corrosion-resistant structures fabricated from fiberglass or HDPE will “float” under high groundwater and shallow soil cover conditions. The preliminary MAS design presented in Appendix S will address this issue by the installation of reinforced concrete around each structure. The weight of the concrete surrounding each MAS will more than counter the corresponding buoyancy forces.

## **5.4 ACOE Dike Construction**

As supplemental projects to the Prado Dam project, the ACOE is planning to construct two dike/levee projects within the Reach IV-A and Reach IV-B project area. These projects are the Alcoa Dike and the Yorba Slaughter Adobe Dike.

The Alcoa Dike is intended to protect the Alcoa Aluminum Plant in Corona, immediately to the east of Smith Avenue and Butterfield Drive. The dike will cross the 36” Reach IV-B pipeline in between MAS 4B-0140 and 4B-0150 and will place an additional 30 feet of embankment material over the pipeline. The top of the dike elevation will match the finish grade of Butterfield Drive, see Figure 4.

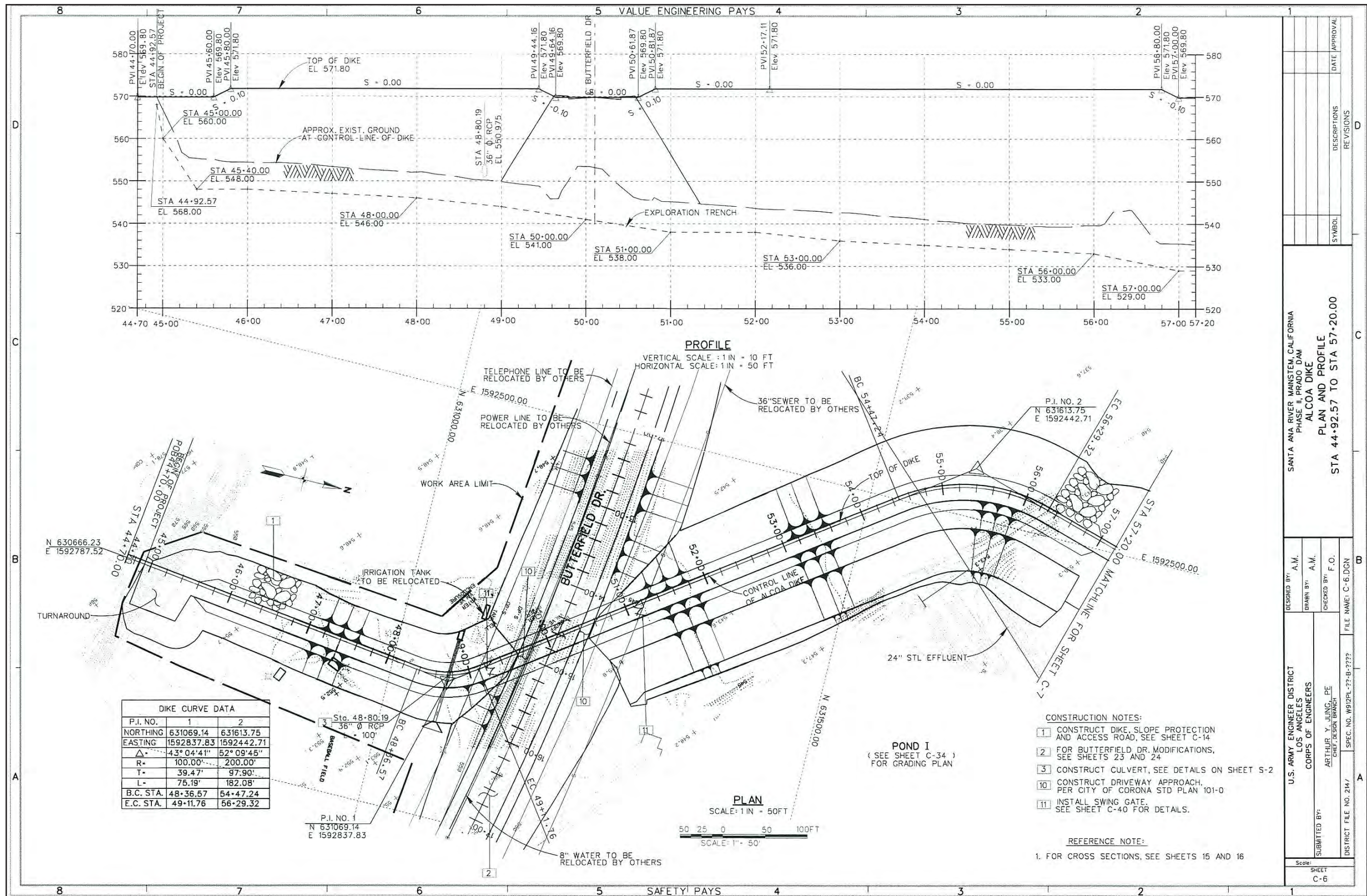
The Yorba Slaughter Adobe Dike is intended to protect the historic adobe farmhouse located north of Euclid Ave (State Route 83) along Ponomo-Rincon Road. The dike will be constructed along Upper Reach IV-A between MAS 4A-0240 and 4A-0280. As shown on Figure 5, the dike’s footprint will impact the pipeline between MAS 4A-0240 and 4A-0250, and according to the proposed construction plans, the additional embankment material in this area will not exceed 5 feet. The pipeline in this area will be on the “wet” side of the dike and will be exposed to flood stage loading conditions. The existing access structures are designed as pressure manholes and can withstand the expected hydraulic pressure generated by the maximum probable flood event. It is recommended that the existing structures be inspected during the final design phase to determine if rehabilitation measures are required.

The rehabilitation technique selected for these two areas must have the structural capacity to accommodate the additional soil placed over the pipeline alignment.

## **5.5 Season Work Restrictions**

The environmental setting for the lower portion of Reach IV-A and Reach IV-B presents considerable challenge for the execution of the pipeline’s rehabilitation. The upper portion of Reach IV-A is beyond the sensitive environmental habitat area and within previously developed area and does not have the same season work constraints as discussed below for the other two segments of the project.











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The Prado Basin is recognized as one of the most high quality riparian/wetland habitats in Southern California. As such, any construction activity is closely scrutinized by the environmental resource agencies, with the ACOE as the lead agency. Typically, construction in high quality habitats is prohibited during the breeding season, which extends annually from March 15 to September 25.

Additionally, the Prado Basin serves as a flood impoundment reservoir for the Santa Ana watershed, which covers more than 2,800 square miles and extends to the San Bernardino Mountains. During the winter season, November thru March, rainfall in the watershed inundates much of the area surrounding Reaches IV-A and IV-B. The size of the watershed also provides the potential for flash flood conditions. Construction during the winter months is anticipated to be highly risky and mostly un-productive due to saturated soil conditions.

The combination of the breeding season and wet weather season restrictions leaves limited time throughout the year for the rehabilitation work to be performed. Consequently, it is imperative that SAWPA and ACOE negotiate a construction schedule that respects the importance of the breeding season while permitting construction to proceed during portions of the summer and early fall months (July through October). The preferred approach would permit construction to proceed over the shortest duration possible. Extending the construction period over many years would only increase the quantity and potential for impacts to the habitat area and have a significant escalating effect on the project's cost.

With the need for less access points into the existing pipeline, the slip-lining process would create less overall disturbance to the habitat area than the other rehabilitation processes being considered. Both CIPP and spiral wound methods would need access at every MAS while the slip-lining process can span multiple MAS runs with one access pit. Impacts to the habitat area caused by the various construction alternatives were identified and quantified in the project's environmental impact report (EIR). Appropriate mitigation for the selected alternative and impact area will be negotiated with the resource agencies during the final design.

## **5.6 Right-of-Way and Temporary Construction Easement Requirements**

The lower portion of Reach IV-A and all of Reach IV-B within the project area are located on parcels owned by the ACOE. There are no dedicated easements for the pipelines in these parcels. The ACOE grants a right of entry through their permitting process. The permit will include a description of the total area needed for permanent use for access structures and access roads and the area needed for temporary construction ingress and egress and staging areas. The rehabilitation method selected for each pipeline reach will determine the total impact area. Regardless of which method is selected, it is recommended that a permanent 10 foot wide access road be granted along the pipeline route and a 50-foot diameter clearing be provided around each MAS for future maintenance activities. Temporary construction impacts beyond these suggested limits will be mitigated as part of the project.

Upper Reach IV-A contains segments within private property, ACOE property and public right-of-way, as shown in Appendix J. From MAS 4A-0190 through 4A-0230, the pipeline is within ACOE property. A similar right-of-way permit as described above is expected for this segment. From MAS 4A-0230 through 4A-0280, the pipeline is located within private property (APN 1033-082-09 and 1033-082-10). There is an existing 20-foot wide easement through these parcels. An additional 20-foot wide temporary construction easement is recommended through these parcels for ingress and egress of equipment. As shown in Figure 5, these parcels will be severely impacted by the construction of the

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Yorba Slaughter Dike. The dike also has a similar footprint to Reach IV-A. Coordination with the ACOE will be required to determine construction sequencing and easement requirements, as it is believed the ACOE has already initiated the property acquisition process for their project.

From MAS 4A-0280 through 4A-0550, the pipeline is within public right-of-way or within lands under jurisdiction of the ACOE. No easements are anticipated for this section of the project. All work will be contained within the public right-of-way.

From MAS 4A-0550 through the terminus at MAS 4A-0680, the pipeline is located within a 20-foot wide easement through an industrial subdivision. Adjacent to the SAWPA easement is a 15-foot wide sewer easement for the Inland Empire Utility Agency (IEUA). Representatives from IEUA have agreed to allow SAWPA to use this easement for construction access.

Currently, most of this 35-foot easement area is being used by the industrial tenants for storage of materials. SAWPA will need to work with individual tenants during the course of construction to move these materials to permit construction access. In addition, the project's rehabilitation method should be chosen to minimize the amount of temporary construction easements (TCE) needed. TCE through this area will impact the day-to-day operations of these industrial tenants, which will escalate the financial value of any TCE acquired by SAWPA for the project. Both the CIPP and the spiral wound process could be implemented using only the existing permanent easements. The slip-lining process would require a substantial amount of additional TCE and would severely impact business operations of the tenants.

## **5.7 Traffic Control Permit Requirements**

The lower portion of Reach IV-A does not encroach within the public right-of-way and therefore will not require traffic control permits.

Reach IV-B will utilize existing thoroughfares for access to the pipeline alignment. Smith Avenue, Butterfield Drive and the entrance road to the Corona Airport will be impacted by the project. However, no lane closures or detours are anticipated. It is likely that the City of Corona will impose work hour restrictions on the construction operation or limitations on equipment/material deliveries. Additionally, work in this area must be coordinated with the ACOE for their construction of the Alcoa Dike project.

Along the upper portion of Reach IV-A, traffic control permits will be required from the City of Chino for work within Rincon/Pomona Road, Pine Avenue, Central Avenue and El Prado Road. Preliminary traffic control concepts have been developed to allow the construction to proceed in the most efficient manner. As shown in Appendix M, a combination of flagging operations and lane closure/detour operations are proposed for the work within the City of Chino.

Similar to the work requirements described in Section 5.4, the slip-lining process will encumber too much area within the right-of way and is not appropriate for consideration for this segment of the project. The CIPP and the spiral wound process would only require access through the existing access structures and could be implemented within the traffic control limitations imposed by the City of Chino. The pump by-pass hose required for the CIPP process will cross public roads at several locations. In these areas, the final design will evaluate various options, such as smaller diameter and multiple pipes on the surface with a ramp over the pipes, shallow trench burial, temporarily stopping

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discharge into the SARI pipeline and pump and truck around the work zone. Each location will be evaluated independently for the most appropriate solution.

## 5.8 Flow Restrictions/Interruptions during Construction

A summary of the existing flow by pipeline segment is shown in Table 3.

**Table 3 – Summary of Existing Flows**

Pipeline Reach	Low Flow (mgd)	Avg. Flow (mgd)	Peak Flow (mgd)
Lower Portion of Reach IV-A	2.5	5.0	7.2
Upper Portion of Reach IV-A	0.12	0.4	1.0
Reach IV-B	1.0	4.5	6.2

The volume and consistency of flow throughout the day and week from the lower portion of Reach IV-A and Reach IV-B indicates that interrupting flow would create a significant impact to the dischargers on the system. Implementing a by-pass system to divert the quantity of flow around the work area would pose significant challenges and risk. A by-pass system capable of pumping up to 7 mgd would require an equivalent of 5,000 gallon per minute (gpm) pumps. The system would need to run 24/7 during the construction operation and provide sufficient redundancy for emergency conditions. A sample quote for a by-pass system is included as Appendix I.

The highly sensitive environmental setting of the lower portion of Reach IV-A and Reach IV-B suggest that by-passing the flow should be avoided and a rehabilitation method should be implemented that does not require flow by-pass. Segmental slip-lining and the spiral wound process can be performed under the existing flow conditions. CIPP and continuous slip-lining require flow by-pass.

In the upper portion of Reach IV-A, the current flow and the environmental conditions would allow a by-pass system. A by-pass system to achieve a peak flow of 700 gpm is readily available. The low flows on weekends are such that flow could be stopped temporarily to allow the rehabilitation process to proceed without a by-pass system in place. This would be particularly helpful on the MAS segments that cross a public thoroughfare and would eliminate the need for installing a by-pass hose across the road.

As noted in Section 3, there are currently no users connected to the system north of MAS 4A-0620, and correspondingly, no flow in the pipeline.

The CIPP or the spiral wound process could be used effectively in the upper portion of Reach IV-A given the limited flow in the pipeline.

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## 6.0 Recommended Project

The technical memorandum, prepared by RBF Consulting, dated March 2009, considered additional project alternatives to the rehabilitation techniques presented herein above. Relocation of the pipelines outside of the Prado Basin via gravity pipelines or pump stations and force mains were considered. These options proved to be too costly in capital cost as well as long-term operation and maintenance and were rejected from further consideration. This pre-design report, in conjunction with the technical memorandum and the supporting environmental impact report, recommends internal rehabilitation as the most cost effective method to prolong the service life of the Reach IV-A and Reach IV-B pipelines. The various techniques presented herein, however, are not suitable for all project conditions and the advantages and disadvantages of each technique must be considered to develop the Recommended Project.

### 6.1 Recommended Project – Lower Portion of Reach IV-A and Reach IV-B

These two project segments have very similar project conditions as summarized below:

- ❖ Located within the environmental sensitive habitat
- ❖ Work area is governed by the ACOE
- ❖ Flow conditions are fairly uniform throughout the day and week
- ❖ Flow varies from 4 mgd to 7 mgd
- ❖ D/d ratios vary from 30% to 45%
- ❖ Limited potential to reduce or minimize flows significantly
- ❖ Future sediment deposition of up to 20 feet projected
- ❖ Future water conservation pool maintained at 505 elevation
- ❖ Flood stage up to elevation 590 projected
- ❖ Long runs between access structures, over 1,000 feet

The environmental setting, flow conditions and loading factors indicate that the best apparent rehabilitation option for these two segments is live-stream slip-lining. The benefits of this option include minimal environmental impact during construction, elimination of the need for sewage bypass pumping within the environmentally sensitive area behind Prado Dam, no requirement for right-of-way acquisition, minimal long-term operation and maintenance, slight reduction in hydraulic capacity, suitability for the long distance between MAS reaches, minimization of overall project risk and cost competitiveness.

The layout of the proposed access pits for Lower Reach IV-A and Reach IV-B are shown in Appendices A and B, respectively. For Reach IV-A, 14 access pits are proposed, and for Reach IV-B, 10 pits are proposed. Each pit will require a tightly shored excavation (approximately 12 feet wide by 30 feet long) around the existing pipe. The depth of the excavation will extend 3 feet below the pipeline to allow placement of the fabric-encased crushed rock bedding and new MAS foundation slab. The depth of excavation will vary from 10 feet to 18 feet. An average of 200 cubic yards of material will be excavated for each pit. Much of this material will need to be disposed of off-site.



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Dewatering is anticipated for each access pit to lower the groundwater table a minimum of 2 feet below the bottom of the excavation. The dewatering system will likely involve deep wells surrounding the exterior of the pit as well as a submersible trash pump inside the shored excavation. As noted in the draft geotechnical report, see Appendix N, the estimated dewatering rate for each pit is on the order of 400-500 gpm (note: this rate is consistent with the dewatering program completed in 2008 during the Prado Dam project, which relocated portions of Reach IV-A at MAS 4A-0010 and Reach IV-B at MAS 4A-0010). Geotechnical borings, to be performed during the final design phase, will identify existing soil conditions and groundwater levels. Data from these borings will be provided in the project's construction documents to establish baseline soil conditions.

It is anticipated that dewatering effluent will be surface-discharged under a National Pollutant Discharge Elimination System (NPDES) permit from the Regional Water Quality Control Board (RWQCB). SAWPA is working with the RWQCB to secure this permit. At a minimum, settling tanks and sediment filters will be required on the dewatering system to minimize the amount of sediment in the dewatering effluent. An alternative dewatering plan would discharge the effluent into the SARI pipeline. Conveyance costs associated with discharge volume make this option more costly than the surface discharge option.

The work area required for the standard slip-lining process consists of two construction pits (12 foot by 30 foot), a 12-foot wide access road to each pit, preferably continuous along the pipeline corridor, and a staging area for materials adjacent to each pit. The access road can be used to stage pipe, and therefore, should be wide enough to allow vehicles and pipe storage.

The total impact area will be on the order of 3,000 square feet for the pits and an additional 10,000 to 15,000 square feet for adjacent staging areas. Combined, the impact area should not exceed 0.5 acre for each slip-lining set-up. The existing access road along the pipe corridor will be used to the greatest extent possible to minimize disturbance within the Prado Basin. Additional areas for equipment and material storage will be required. These areas will be located in upland, previously disturbed locations as indicated on project layout drawings shown in Appendices A and B.

Prior to slip-lining, the pipe reach must be thoroughly cleaned of debris accumulated within the pipeline and material that has adhered to the pipe walls. A mandrel matching the diameter of the intended slip-liner pipe is then pulled through the pipe to ensure the proper internal diameter has been achieved. All debris removed from the pipeline will be disposed of off-site at an approved landfill. A bid item will be provided in the contract documents to address the cleaning and disposal effort. The estimated quantity of debris to be removed has been developed from observation of the CCTV videos provided by SAWPA. The quantity summary is as follows with the detail estimate shown in Appendix R:

#### **Estimated Quantity of Debris within the Pipe Reach**

Reach IV-A Lower – 323 cubic yards  
Reach IV-B – 312 cubic yards

Scheduling and project sequencing will be similar for both pipeline reaches, and the ACOE permit requirements will dictate if the work will be performed simultaneously or sequentially. Set up of the initial construction pits is estimated to take 2-3 weeks. This is the critical path for the project, and it is anticipated that the contractor will furnish multiple access pit crews to reduce the overall project duration. Pipe cleaning and disposal is a float item within the schedule but should not be completed too far in advance of the slip-lining work. Once each pit is opened and the slip-liner rig is installed, the

slip-lining process can proceed. Consideration should also be given to slip-lining in both directions to minimize the number set-ups of the slip-lining equipment. For slip-liner pipe in the 36" to 42" range with 20-foot joint sections, it is expected that average production rates of up to 1,000 feet per day can be achieved. Curved alignment sections with shorter pipe lengths will have considerably lower production rates. Once the slip-liner pipe is in place, the annular space between the liner and the host pipe is grouted. MAS construction at the access pit is the remaining item to complete construction.

Access structures for each reach must be designed to withstand the Maximum Probable Flood condition, which will inundate the Prado Basin to elevation 590. Pressure-tight access covers and risers will be required. MAS covers will be designed to facilitate CCTV camera and manned access by using 5-foot diameter outer covers with a 3-foot diameter inner cover.

To complete the quantities shown in Table 1, the preliminary completion schedule for each reach is as follows:

**Table 4 – Construction Schedule Summary for Slip-lining Process**

<b>Pipe Diameter</b>	<b>Length</b>	<b>Average Production Rate<sup>1</sup></b>	<b>Estimated Construction Duration</b>
36" Pipe	15,949 Linear Feet	150 feet per day	25 weeks
42" Pipe	16,555 Linear Feet	150 feet per day	25 weeks

<sup>1</sup> Average Production Rate is inclusive of preparatory work, such as construction of access pits, pipe cleaning and debris removal, pipe installation, grouting, access pit closure and maintenance access structure installation.

Given the constraints of working within the endangered species breeding season (March 15 to September 25), the rainy season (November to April) and surface water impoundment in the Prado Basin following the rainy season, it is unlikely that a continuous construction period of 25 weeks (6-7 months) will be feasible. It is more likely that the construction duration will span over two seasons, and possibly a third, depending on permit conditions from the ACOE. During the first year, the Contractor should attempt to clear as much of the access road and access pit locations as possible, as well as perform as much of the slip-lining work in the more upland portions of each reach. Subsequent construction season(s) will then be able to focus on the slip-lining work. A construction schedule will be detailed once the permit conditions are identified by the ACOE.

## **6.2 Recommended Project – Upper Portion of Reach IV-A**

The conditions associated with this reach demand a different approach than the previously described pipe segments. The conditions for this reach can be summarized as follows:

- ❖ Located within mostly previously disturbed and developed property
- ❖ Flow conditions vary through the week and drop sharply on weekends
- ❖ Flow varies from 0.1 mgd to 1 mgd
- ❖ D/d ratios vary from 5% to 15%
- ❖ Potential to reduce flows significantly or eliminate temporarily

- ❖ No additional future loading on the pipe
- ❖ Located within public right-of-way
- ❖ Shorter runs between access structures
- ❖ Impacts to traffic and businesses must be minimized

The existing flow conditions, smaller diameter pipe, shorter MAS runs, traffic control requirements and consideration of temporary construction easement requirements indicate that either the CIPP or spiral wound techniques would be suitable rehabilitations. Slip-lining would be too disruptive to the surrounding community and the reduction in hydraulic capacity would be significant. The benefits of the internal lining options include relatively quick installation between MAS set-ups (approximately 2 days per MAS segment), minimal staging area impact, limited traffic control requirements, increased hydraulic capacity over the existing pipeline, minimal long-term operation and maintenance, low overall project risk and higher cost effectiveness over other methods.

The evaluation to select either CIPP or the spiral wound process or permit both techniques must consider the history of proven success of each process, available pool of contractors in the Southern California area and potential failure modes. CIPP has a strong track record of pipeline rehabilitation throughout the United States and in other countries; there are a number of firms in southern California that specialize in this process that will ensure a competitive bid environment for SAWPA. Given proper installation, the potential failure modes of CIPP are considered to be limited in this situation because of the development surrounding the alignment and limited lateral connections. The spiral wound process, on the contrary, is relatively new to the United States and is gaining acceptance as more projects are completed. However, it lacks a pool of experienced contractors to perform this work and the number of joint seams within each MAS reach is a cautionary red flag as a potential failure point in the future. Although the project setting is suitable for spiral wound, the limited history and limited contractor pool raises sufficient concern to not recommend this process for the rehabilitation of the upper portion of Reach IV-A.

The MAS locations along the upper portion of Reach IV-A are shown in Appendix C. A total of 66 MAS runs are included in this reach. North of MAS 4A-0620, there is no flow in the system. A total of 14 MAS segments are included in this section with no flow, which will be set up as an optional bid item and included in the work as project funding permits.

The upper portion of Reach IV-A has received minimal flow since it was placed into service, typically operating at 10-20% of capacity. CCTV video inspection shows the pipeline to be in good condition with some debris accumulation, but has no evidence of structural deterioration (see photo at right). Future loading on the pipeline is not expected to change substantially as the pipeline is located mostly in public roads and within previously developed property. The pipeline is, therefore, a candidate for a partial deterioration (PD) installation.



**Typical Interior Condition  
Reach IV-A Upper**

Calculations for loading conditions (see Appendix E) anticipated in the upper portion of Reach IV-A indicate the liner thickness can be reduced from 0.42" to 0.34"

by using the PD versus FD criteria. This reduction of nearly 20% would result in an estimated \$500,000 savings over the length of the project.

A pump by-pass system will be required for the CIPP process. This system will pump out of the MAS immediately from the work area and discharge at the nearest MAS downstream of the work zone. Depending on flow and the length between access structures, the by-pass may be set up to allow multiple MAS segments to be completed at one time. Where the pipeline crosses a public road, SAWPA will be consulted to determine if the flow can be stopped temporarily, typically over a 24-hour period, to permit the CIPP process to proceed without a by-pass. If this arrangement is not acceptable for the discharger, a pump-and-truck approach or storage of flow inside the pipe will be considered around the CIPP work area.

Once the by-pass system is in place, the cleaning process can proceed. As described for the slip-lining process, a bid item will be provided to cover the debris removal and disposal off-site. CIPP installation, for 27" diameter and with MAS lengths between 300 and 500 feet, is expected to proceed with the felt tube liner delivered to the site with the epoxy resin impregnated at the factory. Each MAS run will take 12-18 hours to complete and another 24 hours to cure properly before flow is restored into the pipeline. Under appropriate conditions and short reaches between access structures, the CIPP process can be installed through multiple access structures. On average, it is expected that the CIPP installation crew will complete 2,000 feet per week of finished CIPP.

To complete the quantities shown in Table 1, the preliminary completion schedule for each reach is shown in Table 5. Depending on funding and other project constraints, the schedule below can be accelerated by adding additional CIPP crews and dividing the project into multiple phases. This reach will not be impacted by breeding season or rainy season restrictions as described above in Section 6.1. It is anticipated that work can proceed year-round through the upper portion of Reach IV-A.

**Table 5 – Construction Schedule Summary for the CIPP Process**

<b>Pipe Diameter</b>	<b>Length</b>	<b>Number of MAS segments</b>	<b>Cleaning and By-pass Pumping</b>	<b>CIPP Insertion</b>	<b>Estimated Construction Duration</b>
27" Pipe	25,023 Linear Feet	66	15 weeks	15 weeks	30 weeks

A staging area for storage of equipment and materials will be required for the CIPP process. A portion of the shooting range parking, near the intersection of Euclid Avenue and Pomona-Rincon Road, would be an ideal location. It is recommended that SAWPA negotiate a temporary construction staging area at the location shown in Appendix C.

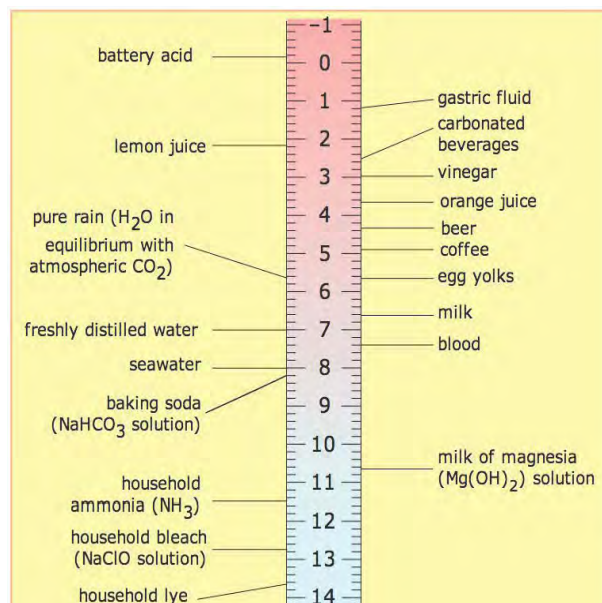
### **6.3 Alternative Liner Resins**

Both rehabilitation options presented above are confronted with the issue of which resin material to use for the internal corrosion resistant liner, polyester or vinyl ester. Polyester (PE) resin is the standard resin material used in CIPP applications across the United States and Hobas pipe uses this resin as their standard liner material. Vinyl ester (VE) resin is generally recommended in applications where the pH of the wastewater is very caustic, in the range of 12 or greater. The figure below shows

the pH level for a variety of commonly used liquids. Recent wastewater samples from the SARI pipeline indicate the pH level varies from 7.1 to 7.7.

The controversy regarding PE and VE developed through the Green Book committee which publishes the Standard Specifications for Public Works Construction (Green Book). This document is used by many municipalities in the Southern California area to determine the minimum acceptable level of material quality and construction execution for public works projects. The committee has long held that plastic pipe materials and resins used to convey wastewater must pass a stringent corrosion resistance test, commonly referred to as the “Pickle Jar” test. Only VE equivalent resins will pass this test and therefore, CIPP liner suppliers, fiberglass pipe and other vendors must supply projects in Southern California with VE resin.

There is much debate in the industry whether VE resin is needed for typical wastewater conveyance projects. The committee has evaluated vendor testimony over the past 20 years and reviewed American Society for Testing and Materials (ASTM) test results using PE resin, but, has held the VE standard for use by the Green Book. VE resin is typically 10-15% more expensive than PE resin, which is the primary driver for much of the debate.



**pH Values for Common Liquids**

Based on the current sample results from the SARI pipeline, PE resin is suitable for both the slip-lining and CIPP portions of the project. Using PE over VE resin is estimated to save \$1,000,000 on both segments of the project. The decision to use PE should be based on the expected wastewater quality in the future. If the quality is likely to remain consistent with the current flow, PE resin would be a viable selection.

It is important, however, not to limit the options in the future and make a short-term choice strictly based on capital cost savings. There is not a second opportunity to rehabilitate these pipelines and the future alternative to install a new more corrosion-resistant pipeline to accommodate dischargers that need a VE resin type liner will be much more costly than the cost savings realized by using PE resin on this project.

It is recommended that SAWPA evaluate the PE versus VE issue to determine the appropriate material to meet the short-term and long-term needs of the SARI pipeline system.

#### **6.4 Recommended Project – Pre-Qualification Program**

The work defined above is considered to be highly specialized but there is not a separate Contractor's license for these two processes that would define the minimum level of competence required for the work. Given the highly sensitive project setting, accelerated project schedule requirements and associated impact to all stakeholders and permitting agencies, it is recommended that the project proceed with a Contractor's pre-qualification program.



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The program would first publicly solicit statement of qualifications (SOQ) from Contractors interesting in bidding the project. Using only information provided in the SOQ, a review panel would develop a short-list of firms that demonstrate the level of competence, satisfactory past performance, financial, management and insurance requirements deemed necessary for this project. Contractors on the short-list would then be invited to submit a bid on the project. Bids would not be accepted from any other Contractor. A separate short-list would be developed for the CIPP and slip-lining processes.

The objective of the program is to ensure Contractors bidding on the project have the requisite experience to complete the work. The project schedule does not allow for this determination to occur after the bids have been submitted.

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## 7.0 Project Cost

### 7.1 Lower Portion of Reach IV-A and Reach IV-B

Typical costs for slip-lining work in the Southern California region are estimated to be \$10 per inch diameter per linear foot of host pipe, which equates to the following:

- ❖ Reach IV-A: 42" Pipe = \$420 per linear foot
- ❖ Reach IV-B: 36" Pipe = \$360 per linear foot

These costs are based on standard access requirements within paved or readily accessible locations, Green Book specifications and non-prevailing wage rates and include the liner pipe, host pipe cleaning, grouting and clean-up. Costs for installation of the construction pits (excavation, shoring, backfill, MAS installation and closure), dewatering and environmental restoration and mitigation must be added. In addition to base construction costs, sales tax, general contractor overhead, profit and, at this level of the project, a 10% contingency have been added. An additional factor that adds to the project cost is the need for shorter pipe segments to traverse tight radius curves within the existing pipeline. Unburdened pipe material cost for standard 36" diameter 20-foot long segments is \$110 per foot, whereas 6-foot segments are \$175 per foot. On the 30" diameter pipe, the variation is \$90 versus \$145. See Appendix F for budgetary pipeline unit prices.

On the lower portion of Reach IV-A, it is estimated that 30% of the slip-liner material will need to be short sections and on Reach IV-B, it is estimated that 25% of the project will need short sections.

The total estimated cost for the slip-lining portion of the project is \$18,962,000, which equates to an average cost per foot of \$583. Detailed construction cost estimates are included in Appendix F.

### 7.2 Upper Portion of Reach IV-A

Costs for large diameter CIPP work using the PD design criteria in the Southern California region are estimated to be \$5 per inch diameter per linear foot of host pipe, which equates to the following:

- ❖ Reach IV-A: 27" Pipe = \$135 per linear foot

These costs include the CIPP liner installation, host pipe cleaning, lateral cut-ins and clean-up. Costs for installation and maintenance of the by-pass pumping system, traffic control and environmental restoration and mitigation must be added.

The cost of the by-pass pumping system is based on the pumping rates, project duration, length of by-pass between suction and discharge MAS, operation and maintenance. A sample quote was obtained from Rain for Rent (see Appendix I) for a 2,500 gpm by-pass system. The price quoted assumed a one month operating period and 8 hours per day of pumping. With consideration to sales tax, 24-hour operation surcharge, 24-hour supervision, maintenance, relocation costs and CIPP production rates, the estimated cost for the by-pass pumping for the upper portion of Reach IV-A is \$80,000 per month. This amount may be reduced as further investigations proceed to temporarily shut-down discharges into the system.

Traffic control costs are based on the conceptual traffic control plans presented to the City of Chino, which specify full time flaggers for the portion along Pomona-Rincon Road and northbound lane

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closure and detour for work on El Prado Road. Additional traffic control set-ups will be required where crossing Mountain Avenue, Pine Avenue and Central Avenue.

Soft costs for sales tax, general contractor overhead, profit and contingency have also been added to the estimated construction cost. The total estimated cost for the CIPP portion of the project is \$5,473,000, which equates to an average cost per foot of \$219. Detailed construction cost estimates are included in Appendix F.

The estimate construction cost summary is shown in Table 6.

**Table 6 – Construction Cost Summary**

<b>Pipe Reach</b>	<b>Length</b>	<b>Estimated Construction Cost</b>
Reach IV-A 27" Pipe CIPP	25,023 Linear Feet	\$5,473,000
Reach IV-B 36" Pipe with 30" Slip-Liner	15,949 Linear Feet	\$8,329,000
Reach IV-A 42" Pipe with 36" Slip-Liner	16,555 Linear Feet	\$10,633,000
Totals	57,527 Linear Feet	\$24,435,000

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## **8.0 Permit Requirements**

The Project will result in temporary impacts to the Santa Ana River within the Prado Dam basin. The Santa Ana River is tributary to the Pacific Ocean and as such falls under the jurisdictions of the ACOE, RWQCB, and the California Department of Fish and Game (CDFG). A complete discussion of the biological impact and mitigation measures is provided in the Certified EIR for the SARI Repairs Upstream of Prado Dam (Reaches IV-A and IV-B) dated May 2009, Section 5.2.8.

### **8.1 Army Corps of Engineers**

The ACOE regulates discharges of dredged or fill material into Waters of the United States. Waters of the United States include wetlands and non-wetland bodies of water that meet specific criteria. The ACOE regulatory jurisdiction pursuant to Section 404 of the Federal Clean Water Act (CWA) is founded on a connection, or nexus, between the water body in question and interstate commerce.

The project will not result in any temporary impacts to any ACOE wetland or nonwetland jurisdiction waters. Permanent impacts to ACOE jurisdictional wetlands will total approximately 0.0014 acre and permanent impacts to ACOE jurisdictional non-wetlands will total approximately 0.0014 acre. As such, the project total ACOE impacts will total approximately 0.0028 acre. Impacts to the jurisdictional waters will be mitigated at a 1:1 to ratio as described in the EIR.

### **8.2 California Department of Fish & Game**

Unlike the ACOE, CDFG regulates not only the discharge of dredged or fill material, but all activities that alter streams and lakes and their associated habitat. The CDFG, through provisions of the California Fish and Game Code (Sections 1601-1603), is empowered to issue agreements for any alteration of a river, stream, or lake where fish or wildlife resources may be adversely affected. Streams (and rivers) are defined by the presence of a channel bed and banks, and at least an intermittent flow of water. The CDFG typically extends the limits of their jurisdiction laterally beyond the channel banks for streams that support riparian vegetation.

The proposed project will temporarily impact approximately 2.6 acres of vegetated and 5.5 acres non-vegetated CDFG jurisdictional areas along the lower portion of Reach IV-A and 4.6 acres vegetated and 2.2 acres non-vegetated CDFG jurisdictional areas along Reach IV-B as a result of the vegetation clearing associated with the temporary access road and construction staging areas (see Appendix G). The majority of the temporary impacts will be associated with the Live Stream Slip-lining of Reach IV-B and Lower Reach IV-A. The remaining impacts will be associated with the CIPP repair option on Upper Reach IV-A. The area impacted within Prado Basin is considered high quality habitat by the CDFG and is known as breeding locations for a number of listed endangered species, such as the Least Bells Vireo and Southwestern Willow Flycatcher. Stringent permit requirements are anticipated for work within this area and a CDFG-approved biologist will be required on-site during construction. A summary of impact areas is included in Appendix G.

### **8.3 Regional Water Quality Control Board**

The regulatory jurisdiction of the RWQCB is pursuant to Section 401 of the Federal CWA. The RWQCB typically regulates discharges of dredged or fill material into Waters of the United States, however they also have regulatory authority over waste discharges into Waters of the State, which may be isolated, under the Porter-Cologne Water Quality Control Act issued by the State Water

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Resources Control Board. The role of the RWQCB is to ensure that disturbances in the stream channel do not cause water quality degradation.

The following measures are proposed to ensure water quality impacts are reduced to less than significant.

Project-proposed Best Management Practices (BMPs) will only be utilized during project construction and therefore, long-term maintenance requirements will not be necessary. The following construction BMPs will require a biologist on-site during construction and dewatering activities to ensure impacts to water quality remain less than significant. If the disturbed areas are less than one acre:

- ❖ Applicants shall prepare an erosion control plan.
- ❖ Dewatering activities may require a permit from the Regional Water Quality Control Board.

In addition, during construction, riparian vegetation adjacent to dewatering areas shall be monitored by a permitted biologist for signs of plant stress. Supplemental water shall be added to this vegetation as needed, and in areas where dewatering is necessary, a permitted biologist shall be retained to monitor the site for sensitive species.

## **8.4 Caltrans**

The segment of the upper portion of Reach IV-A between MAS 4A-0180 and 4A0-0190 crosses Euclid Avenue, which is designated as State Route 83 and falls under Caltrans jurisdiction. An encroachment permit is required for work in accordance with the Caltrans Encroachment Permit Manual. On behalf of SAWPA, RBF has submitted the standard encroachment permit application to the Caltrans District 8 office and has received the approved permit. The signed encroachment permit is included as Appendix K.

The approved permit, along with associated conditions of the permit and fees will be included in the bid documents for the project. The selected contractor for the rehabilitation work will be required to obtain the permit to perform work within the Caltrans right-of-way directly from Caltrans, and pay all inspection and permit fees.

## **8.5 Geotechnical Permit**

In support of the final design, it is recommended that soil borings be performed along the lower portion of Reach IV-A and Reach IV-B. The borings, along with the follow-on laboratory analysis, will determine existing soil conditions and groundwater levels that will be encountered during the slip-lining process. Access along these two pipeline alignments must be secured from the ACOE via a letter of permission (LOP). An anticipated condition of the LOP is the soils work must be completed outside of the breeding season, which ends on September 25.

SAWPA will prepare and submit the LOP based on the recommended soil boring locations shown in Appendix D. All supporting data for the project description and environmental constraints can be obtained from the ACOE 404 permit application.



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## 9.0 Project Funding

SAWPA has applied for project funding through the State of California's Clean Water State Revolving Fund (SRF) Program. If the application is successful, then specific contracting requirements will be required as part of the project's contract documents. For example, the project will fall under the State's prevailing wage and labor code provisions, work force diversity and disadvantaged business participation goals. Currently, the State requires female participation of 6.9% on construction contracts and 19% for minorities for projects within Riverside and San Bernardino Counties. Employment and subcontractor advertising is required by potential Contractors during the bid period to demonstrate "good faith" efforts to achieve the stated participation goals.

Additional reporting and accounting practices will be required by the construction contractor to comply with the SRF program. SAWPA's construction management representative will also be required to review the contractor's documents prior to submittal to the State. Failure to follow the SRF program guidelines may delay funding for the project and may trigger a lengthy audit/investigation of the project's contractual and financial procedures.

The table of contents for the SRF contract boilerplate is included herein as Appendix L. The entire boilerplate will be provided with the contract documents.

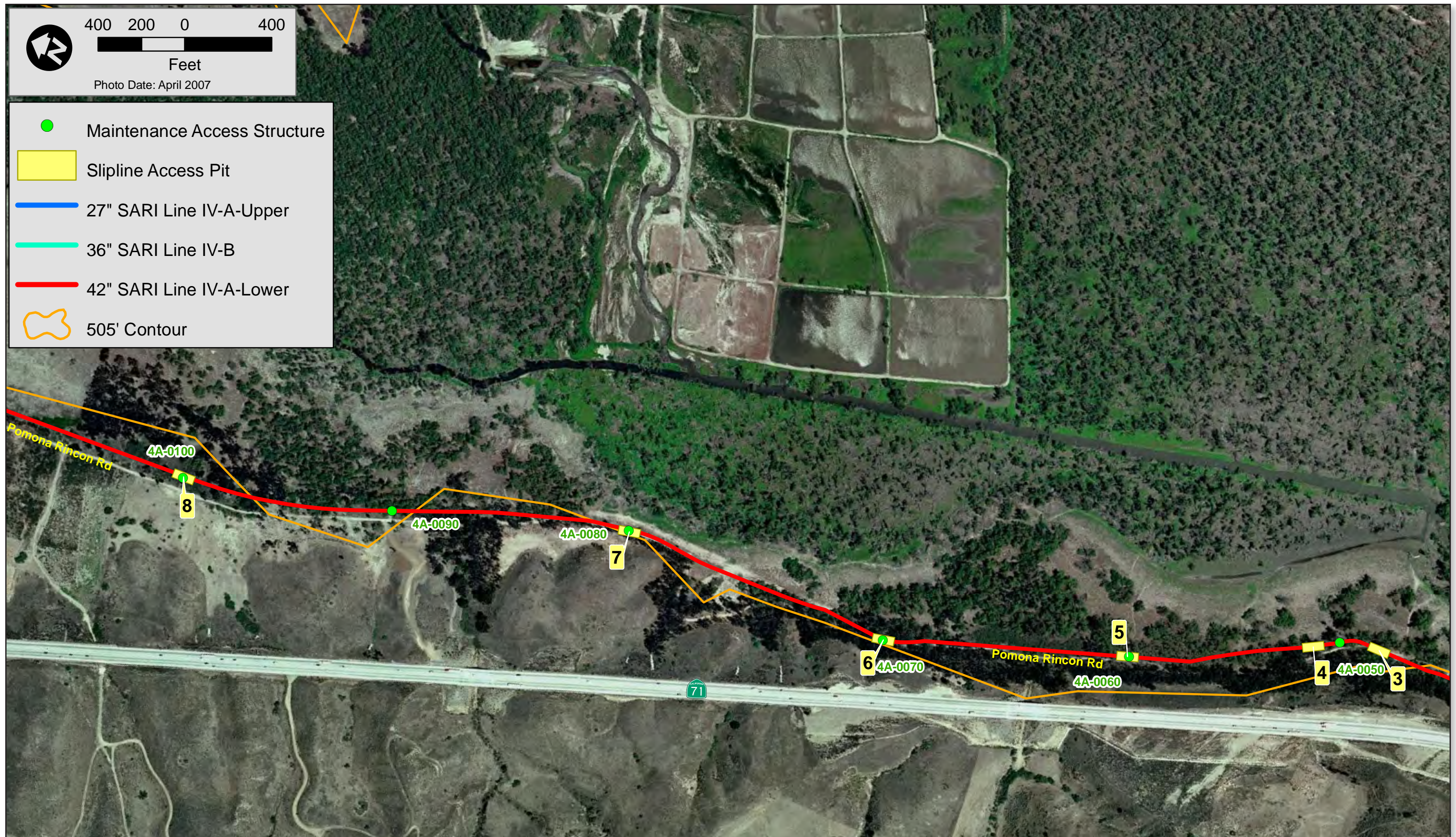
SAWPA has also sought funding through the American Recovery and Reinvestment Act (ARRA), commonly referred to as "Stimulus" funds. This is a federal program and accordingly, federal contracting requirements will be required.

**Appendix A**  
**Preliminary Design – Reach IV-A Lower**













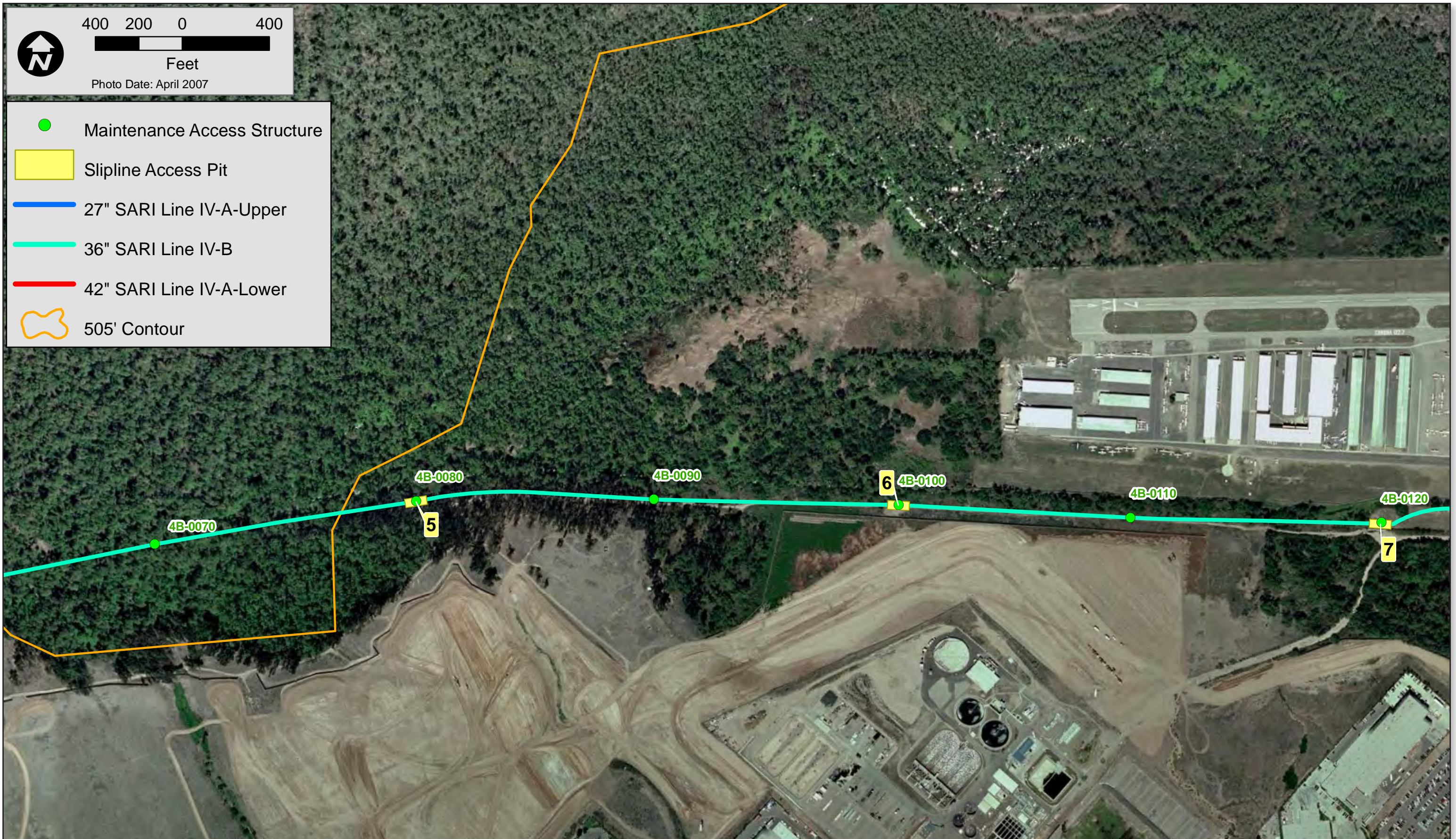


**Appendix B**  
**Preliminary Design – Reach IV-B**

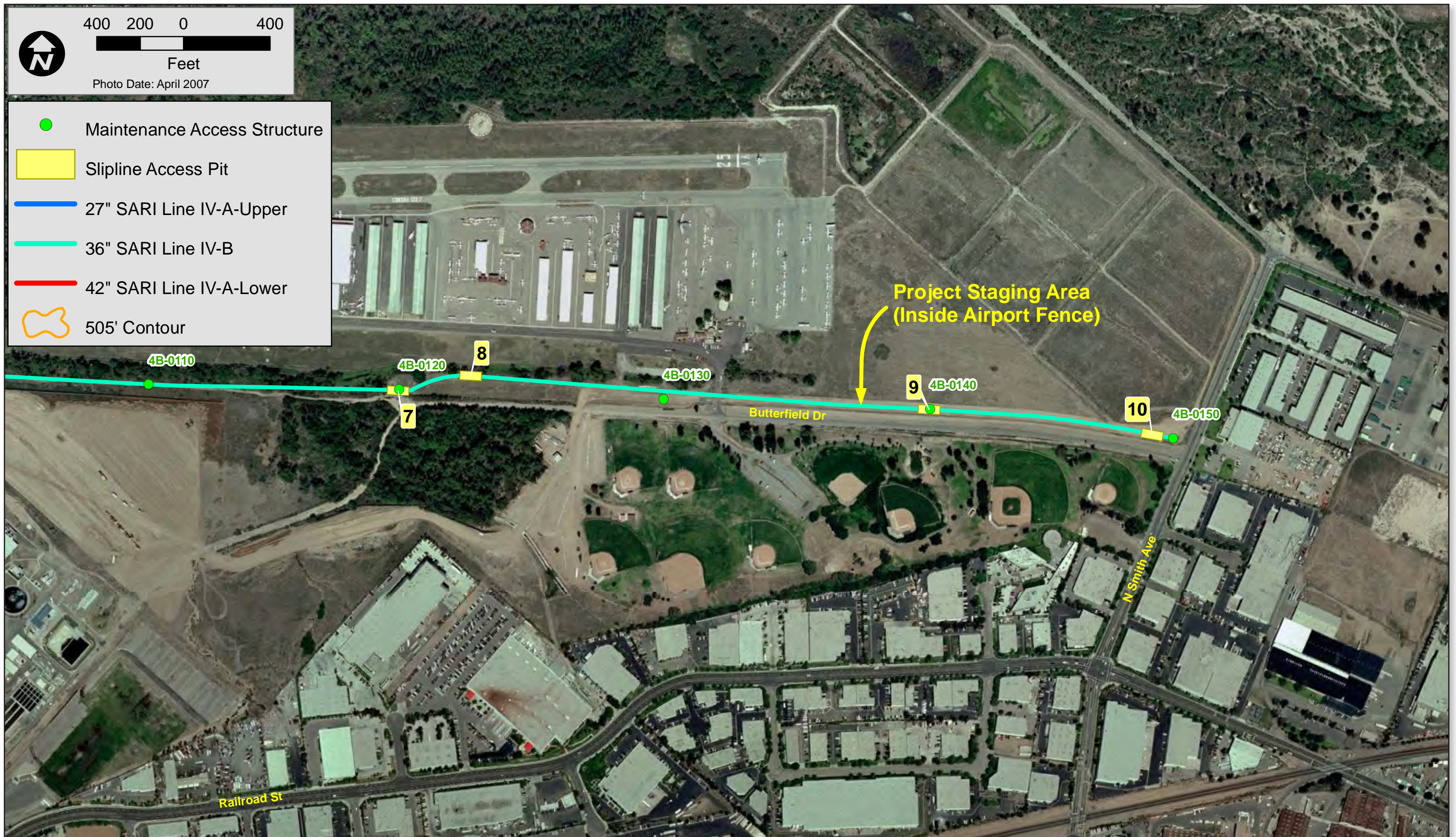














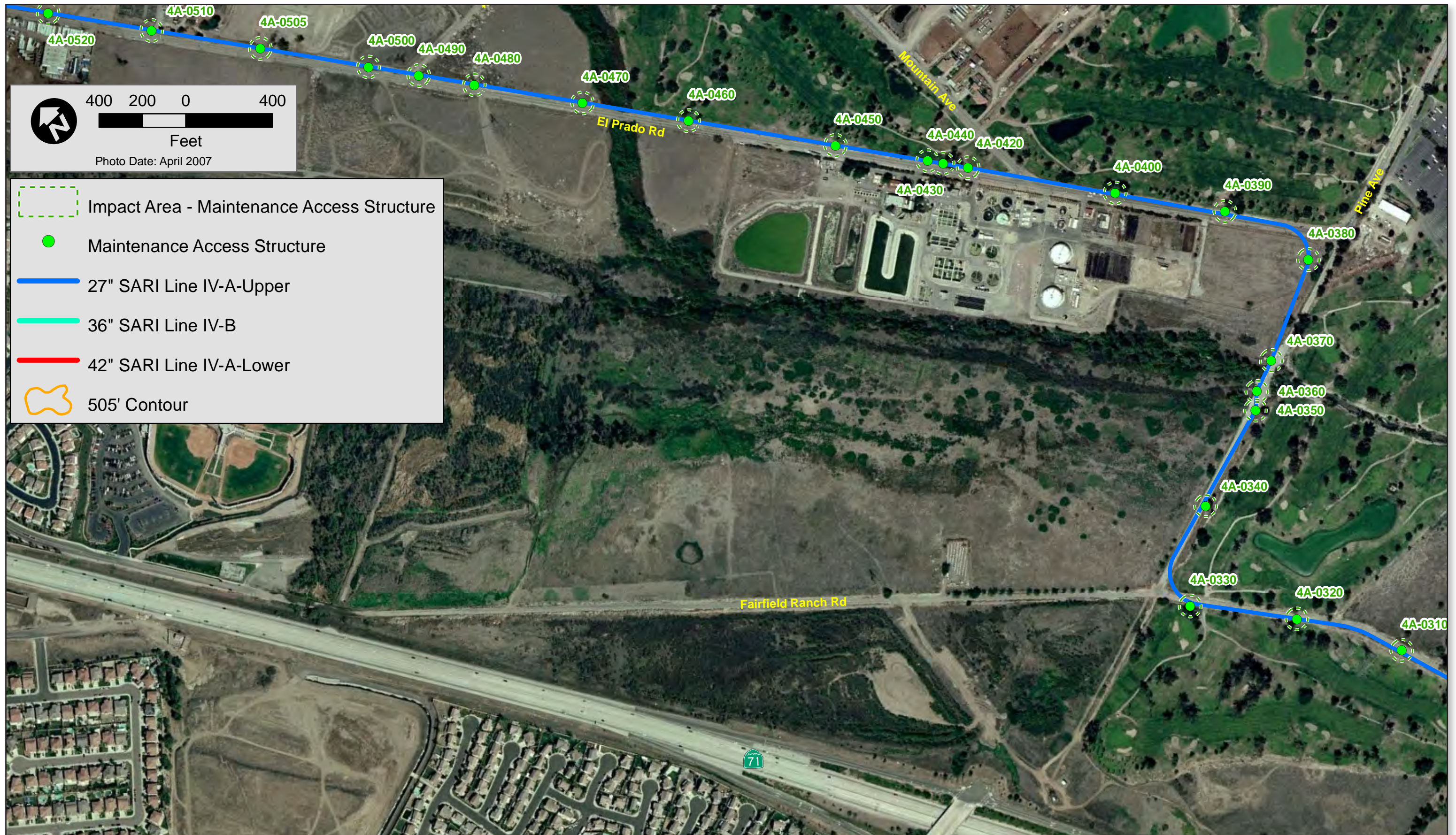
## **Appendix C**

### **Preliminary Design – Reach IV-A Upper**

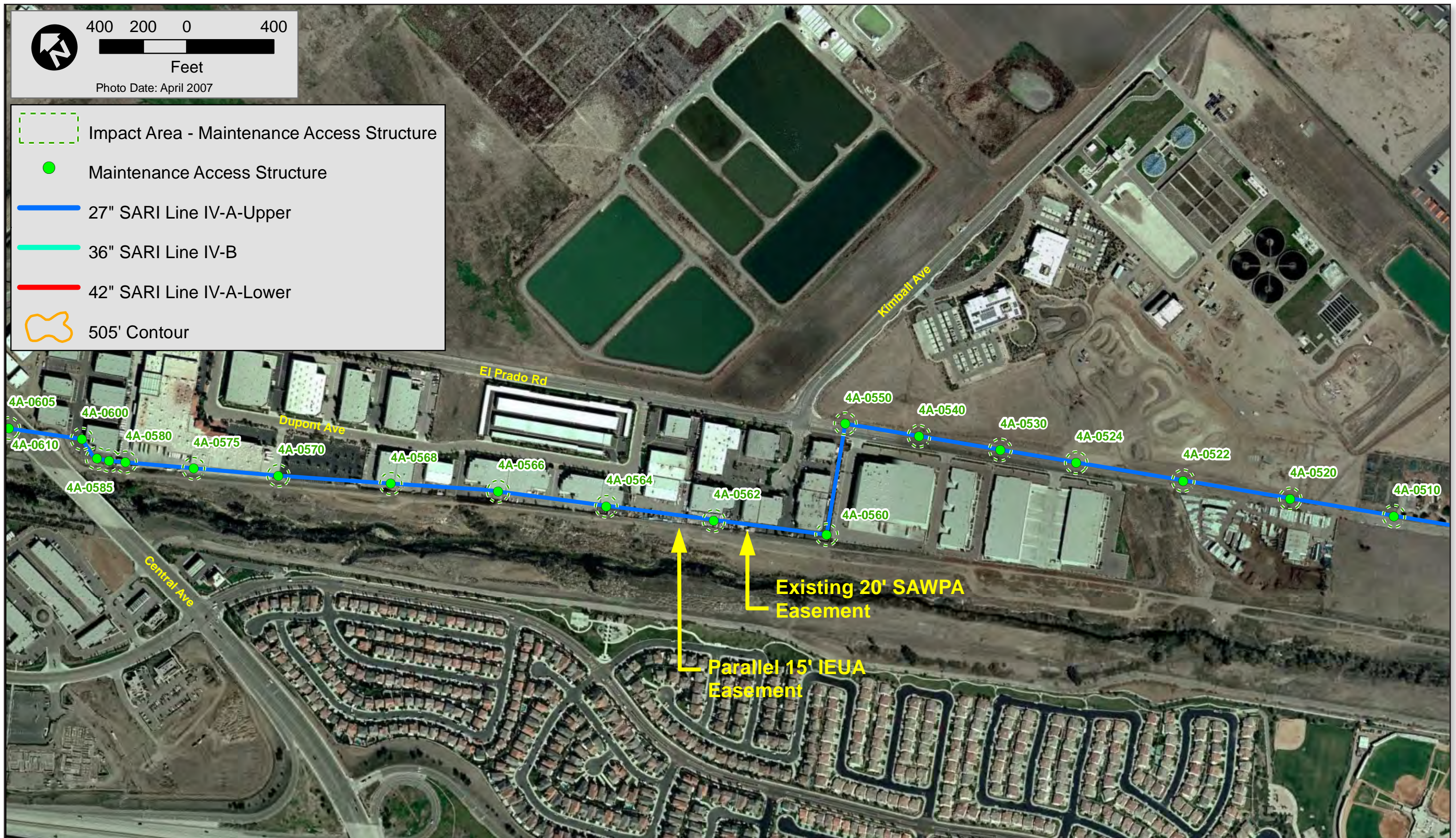












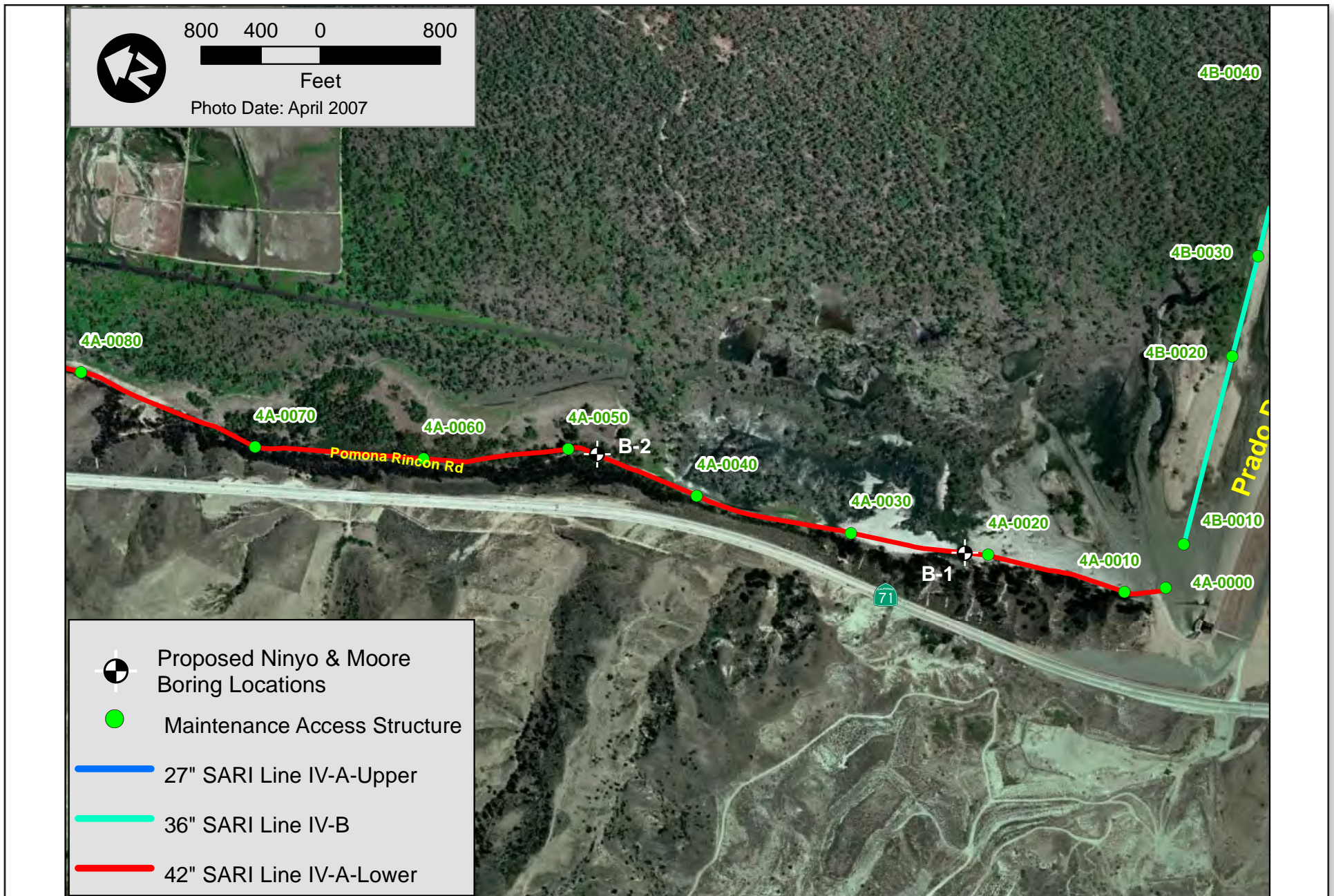






## **Appendix D**

### **Geotechnical Boring Locations**

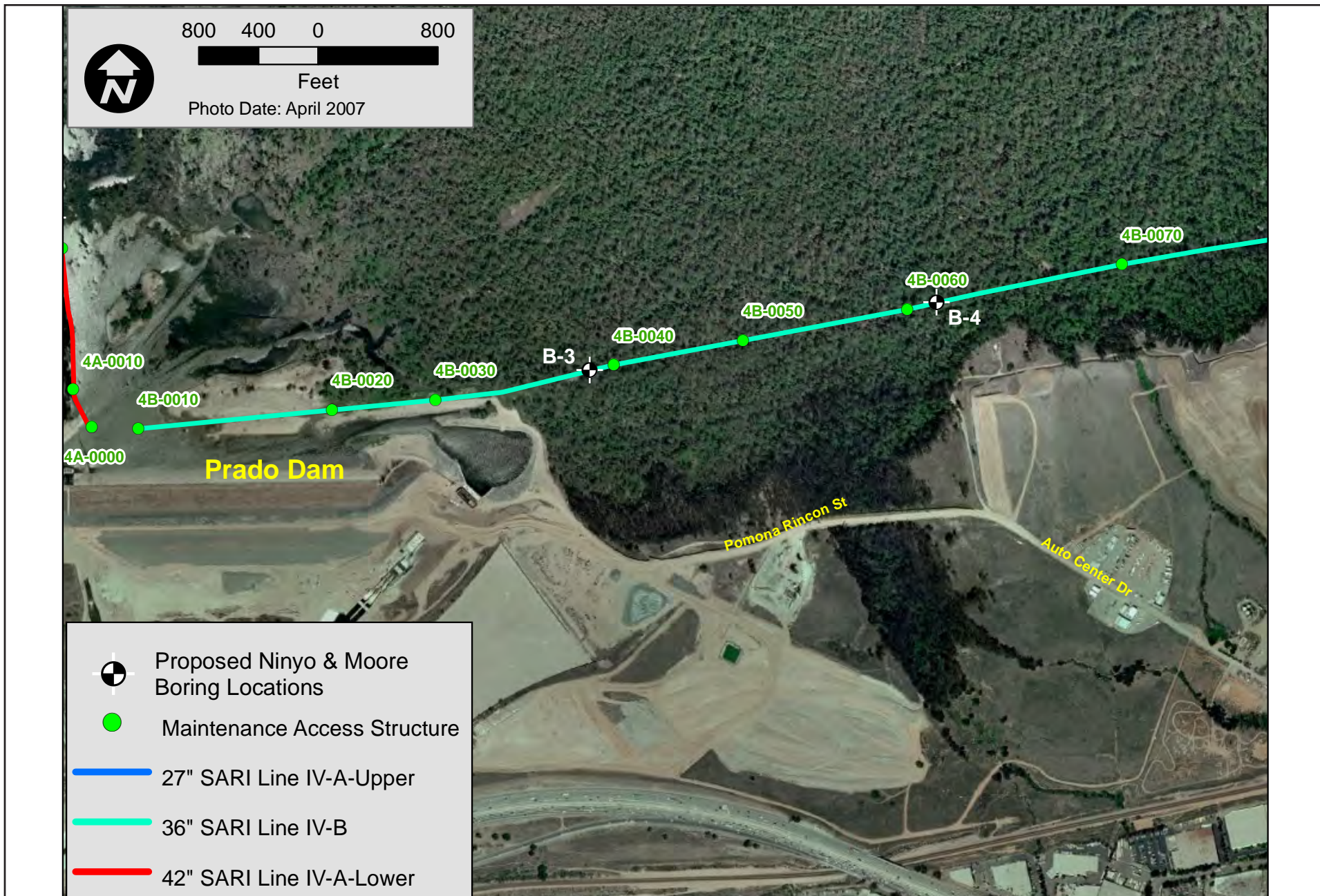


Santa Ana Regional Interceptor (SARI) Repairs to Unlined RCP  
Reaches IV-A and IV-B

## Proposed Boring Locations - Reach IV-A

Figure D-1









## **Appendix E Calculations**

# Hobas Pipe USA

## Buried Pipe Design Analysis



### Summary of Project Information

Job Name:	Santa Ana River Interceptor Sewer Rehab - Reach 4A
Installation:	Grouted Slipline Installation with Flush Relining Joint
Location:	Santa Ana, CA
Engineer:	RBF Consulting

### Summary of Project Conditions

Nominal Diameter of Pipe	36 in.
Nominal Pipe Stiffness	95 psi
Depth of Burial of Pipe (Height of soil column)	15 ft.
Depth of Water Table Above Pipe	50 ft.
Live Load	0 psi
Native Soil Constrained Modulus, $M_{sn}$	3000 psi (SPT N $\geq$ 8 bpf)

### Summary of Design Analysis / Results

	Actual	Allowable	
Deflection, as percent of diameter	0.53	5.0	Max
Wall Crushing, safety factor	15.70	5.0	Min
Ring Bending Strain, calculated deflection, %	0.04	0.62	Max
Ring Bending Strain, maximum deflection, %	0.36	0.62	Max
Buckling, constrained, safety factor	8.58	2.5	Min



****Project Conditions and Assumptions****				
Pipe Properties				
Nominal Pipe Diameter, $D_n$		36 in.		
Outside Diameter of Pipe Barrel, OD		38.3 in.		
Outside Diameter of Joint, $OD_2$		38.3 in.		
Minimum Pipe Stiffness, PS		95 psi		
Minimum Total Wall Thickness, $T_t$		0.9 in.		
Minimum Liner Thickness, $T_L$		0.04 in.		
Depth of Shelf, $D_{shelf}$		0.27 in.		
Depth of Gasket Groove, $D_{gg}$		0.23 in.		
Ult Comp Strength, $S_{ac}$		10500 psi		
Hoop Flexural Modulus of Pipe, $E_{hf}$		1.90E+06 psi		
Installation Conditions				
Soil Weight, $W_s$		120 lb/ft <sup>3</sup>		
Water Weight, $W_w$		62.4 lb/ft <sup>3</sup>		
Soil Cover Depth, $H_s$		15 ft.		
Live Load Load, $L_L$ (at pipe depth)		0 psi		
Live Load Type		HS-20		
Water Table Depth, $H_w$		50 ft.		
Assumed @ Grade (worst case for buckling)				
Native Soil Constrained Modulus, $M_{sn}$		3000 psi		(SPT N $\geq$ 8 bpf)
(Native Material)				

Factors and Coefficients					
Bedding Coefficient, $K_x$ .....	0.083				
(degree of support provided by grout)					
Pipe Shape Factor, $D_f$ .....	3				
(relates pipe deflection to strain)					
Deflection Lag Factor, $D_L$ .....	1		(max load used)		
(to compensate for the load increase with time)					

Minimum Load / Safety Factors					
Maximum Recommended Deflection, %.....	5.0				
Minimum Wall Crushing Safety Factor.....	5.0				
Minimum Ring Bending Strain Safety Factor.....	1.5		(.62% Strain)		
Minimum Buckling Safety Factor.....	2.5				
Minimum Pushing Capacity Safety Factor.....	3.0				

Pipe Geometry					
Outside Diameter, OD.....	38.3 in.				
Mean Diameter, $D_m$ .....	37.44 in.		(O.D. - $T_{str}$ = $D_m$ )		
Mean Radius, $R_m$ .....	18.72 in.		(1/2 of $D_m$ )		
Total Wall Thickness, $T_t$ .....	0.9 in				
Liner Thickness, $T_L$ .....	0.04 in				
Structural Wall Thickness, $T_{str}$ .....	0.86 in		( $T_{str}$ = $T_t$ - $T_L$ )		
Nominal Interior Diameter, I.D.....	36.3 in				



**** Analysis ****				
<b>Pipe Stiffness</b>	(at 5% deflection)			per ASTM D2412-92
Hoop Flexural Modulus, $E_{hf}$		1.90E+06 psi		
Structural Thickness, $T_{str}$		0.86 in		
Mean Radius, $R_m$		18.72 in		
P.S.	=	$E_{hf} \times I / (.149 \times R_m^3)$		
		$I = (T_{str}^3) / 12$		
	=	$E_{hf} \times T_{str}^3 / (.149 \times R_m^3 \times 12)$		
		$R_m(5\%) = R_m \times 1.025$		
	=	$E_{hf} \times T_{str}^3 / (.149 \times 1.025 R_m^3 \times 12)$		
	=	95.66 psi		
<b>Loads</b>				
Soil Weight, $W_s$		120 pcf		
Water Weight, $W_w$		62.4 pcf		
Soil Cover Height, $H_s$		15 ft.		
Water Table Height, $H_w$		50 ft.		
Soil Load, $L_s$	=	$W_s \times H_s / 144$	12.50 psi	
Water Load, $L_w$	=	$W_w \times H_w / 144$	21.67 psi	
Live Load, $L_L$	=	HS-20	0.00 psi	
$R_w$	=	Water buoyancy factor		
$R_w$	=	$1.0 - .33 (H_w / H_s)$	0.67	
Total Load	=	$L_s(R_w) + L_w + L_L$	30.04 psi	
<b>Wall Crushing</b>				
Compressive Strength, $S_{ac}$		10500 psi.		
Structural Thickness, $T_{str}$		0.86 in.		
Outside Diameter, OD		38.30 in.		
Total Load, $T_L$		30.04 psi		
Capacity	=	$S_{ac} \times T_{str}$		
	=	9030 lb/in		
Load	=	$(OD / 2) (Total Load)$		
	=	575.30 lb/in		
F of S	=	Capacity / Load		
	=	15.70 > 5 O.K.		

Deflection			
Deflection Lag Factor, $D_L$		1	
Bedding Coefficient, $K_x$		0.083	
Minimum Pipe Stiffness, PS		95 psi	
Soil Load, $L_s$		12.50 psi	
Live Load, $L_L$		0.00 psi	
Native Soil Constrained Modulus, $M_{sn}$		3000 psi	
Deflection	=	$\frac{K_x(D_L(L_s + L_L))}{(.149)(PS) + (.061)(M_{sn})}$	
	=	0.53 % < 5% OK	

Bending Strain (corresponding to calculated deflection)			
Pipe Shape Factor, $D_t$		3.0	
Total Thickness, $T_t$		0.9 in.	
Mean Diameter, $D_m$		37.44 in.	
Calculated Deflection, Defl		0.53 %	
$e_b$	=	$D_t(Defl)(T_t/D_m)$	
	=	0.04 % < .62% OK	

Bending Strain (corresponding to max deflection)			
Pipe Shape Factor, $D_t$		3.0	
Total Thickness, $T_t$		0.9 in.	
Mean Diameter, $D_m$		37.44 in.	
Max Recommended Deflection, Defl		5.00 %	
$e_b$	=	$D_t(Defl)(T_t/D_m)$	
	=	0.36 % < .62% OK	

Buckling			
Native Soil Constrained Modulus, $M_{sn}$		3,000 psi	
Minimum Pipe Stiffness, PS		95 psi	
$R_h$	=	$11.4/(11+(D_m)/(H_s)(12))$	
	=	1.017	
Critical Buckling	=	$(0.267)(PS)^{.33}(M_s)^{.67}(R_h)$	
$Q_{cr}$	=	257.79 psi	
Total Buckling	=	$R_w(\text{Soil Load}) + (\text{Hydrostatic Load}) + (\text{Live Load})$	
$Q_t$	=	30.04 psi	
F of S	=	$Q_{cr} / Q_t$	
	=	8.58 > 2.5 O.K.	



Maximum Pushing Load			
Outside Diameter of Pipe, OD		38.30 in.	
Structural Thickness, $T_{str}$		0.86 in.	
Depth Gasket Groove, $D_{gg}$		0.23 in.	
Depth Shelf, $D_{shelf}$		0.27 in.	
Axial Compressive Stress, $S_{ac}$		10500 psi	
Factor of Safety, FS		3.00	
$T_{strgg} = T_{str} - D_{gg} - D_{shelf}$			
Structural Thickness Under Gasket Groove, $T_{strgg}$		0.36 in.	
$(D_{m\ gg} = OD - 2(D_{gg}) - 2(D_{shelf}) - T_{str\ gg})$			
Mean Diameter Under the Gasket Groove, $D_{m\ gg}$		36.94 in.	
Allowable Capacity = $(D_{m\ gg})(\pi)(T_{str\ gg})(S_{ac})/F.S.$			
	=	146223 lb	
	=	73 US Tons	
Since All Checks are O.K. The Design is Acceptable and Appropriate.			

# SANTA ANA WATERSHED PROJECT AUTHORITY

## REPAIRS TO UNLINED RCP REACHES IV-A AND IV-B PIPELINE

### STRUCTURAL CALCULATIONS

1-year		Total Load on Conduit (lbs/ft)	Deflection of Pipe (%) (Eq 7.11)	Outside Dia of Pipe (in)	Soil Height of cover to Pipe (ft)	Water Height of cover to Pipe (ft)	Value of 'E' for lowa Formula (Tab 9-10)	Total Load (psi)	Soil Load (psi)	Water Load (psi)	Water Buoyancy Factor	Deflection Lag	Pipe Stiffness (psi)	Wall Crushing Capacity (lb/in)	Wall Crushing Load (lb/in)	Wall Crushing F of S	Bending Strain (Calc Deflection)	Bending Strain (Max. Deflection)	Critical Buckling (psi)	total Buckling (psi)	Buckling F of S	Pipe Thickness (in)
		Wc	ΔY	Bc	Hs	Hw	E'	Pt	Ps	Pw	Rw	DL	PS	CS	CS	CS	eb	eb	qa	qa	qa	t
30" Hobas		8800.00	0.53	32.00	15	50	3000	22.92	12.50	21.67	-0.10	1.00	88.0	7350.00	366.67	20.05	0.04	0.35	254.79	20.42	12.48	0.70
36" Hobas		10532.50	0.53	38.30	15	50	3000	22.92	12.50	21.67	-0.10	1.00	95.0	9030.00	438.85	20.58	0.04	0.36	261.21	20.42	12.79	0.86

#### Case 1 Basis of Design

Invert of Pipe = 470  
 Finish Grade = 488  
 Water Elevation = 523  
 Hoop Flexural Modulus (E)= 1.90E +06 psi  
 Soil Density (Ws)= 120 lb/ft³  
 Water Density (Ww)= 62.4 lb/ft³

Ult. Compressive Strength = 10,500 psi  
 Bedding Constant (K) = 0.083 (grouling support)

1-year		Total Load on Conduit (lbs/ft)	Deflection of Pipe (%) (Eq 7.11)	Outside Dia of Pipe (in)	Soil Height of cover to Pipe (ft)	Water Height of cover to Pipe (ft)	Value of 'E' for lowa Formula (Tab 9-10)	Total Load (psi)	Soil Load (psi)	Water Load (psi)	Water Buoyancy Factor	Deflection Lag	Pipe Stiffness (psi)	Wall Crushing Capacity (lb/in)	Wall Crushing Load (lb/in)	Wall Crushing F of S	Bending Strain (Calc Deflection)	Bending Strain (Max. Deflection)	Critical Buckling (psi)	total Buckling (psi)	Buckling F of S	Pipe Thickness (in)
		Wc	ΔY	Bc	Hs	Hw	E'	Pt	Ps	Pw	Rw	DL	PS	CS	CS	CS	eb	eb	qa	qa	qa	t
30" Hobas		3904.00	0.53	32.00	15	32	3000	10.17	12.50	13.87	0.30	1.00	88.0	7350.00	162.67	45.18	0.04	0.35	254.79	17.57	14.50	0.70
36" Hobas		4672.60	0.53	38.30	15	32	3000	10.17	12.50	13.87	0.30	1.00	95.0	9030.00	194.69	46.38	0.04	0.36	261.21	17.57	14.87	0.86

#### Case 2 Basis of Design

Invert of Pipe = 470  
 Finish Grade = 488  
 Water Elevation = 505  
 Hoop Flexural Modulus (E)= 1.90E +06 psi  
 Soil Density (Ws)= 120 lb/ft³  
 Water Density (Ww)= 62.4 lb/ft³

Ult. Compressive Strength = 10,500 psi  
 Bedding Constant (K) = 0.083 (grouling support)

20-years		Total Load on Conduit (lbs/ft)	Deflection of Pipe (%) (Eq 7.11)	Outside Dia of Pipe (in)	Soil Height of cover to Pipe (ft)	Water Height of cover to Pipe (ft)	Value of 'E' for lowa Formula (Tab 9-10)	Total Load (psi)	Soil Load (psi)	Water Load (psi)	Water Buoyancy Factor	Deflection Lag	Pipe Stiffness (psi)	Wall Crushing Capacity (lb/in)	Wall Crushing Load (lb/in)	Wall Crushing F of S	Bending Strain (Calc Deflection)	Bending Strain (Max. Deflection)	Critical Buckling (psi)	total Buckling (psi)	Buckling F of S	Pipe Thickness (in)
		Wc	ΔY	Bc	Hs	Hw	E'	Pt	Ps	Pw	Rw	DL	PS	CS	CS	CS	eb	eb	qa	qa	qa	t
30" Hobas		12185.60	1.13	32.00	32	32	3000	31.73	26.67	13.87	0.67	1.00	88.0	7350.00	507.73	14.48	0.08	0.35	266.92	31.73	8.1	0.70
36" Hobas		14584.64	1.12	38.30	32	32	3000	31.73	26.67	13.87	0.67	1.00	95.0	9030.00	607.69	14.86	0.08	0.36	263.81	31.73	8.31	0.86

#### Case 3 Basis of Design

Invert of Pipe = 470  
 Finish Grade = 505  
 Water Elevation = 505  
 Hoop Flexural Modulus (E)= 1.90E +06 psi  
 Soil Density (Ws)= 120 lb/ft³  
 Water Density (Ww)= 62.4 lb/ft³

Ult. Compressive Strength = 10,500 psi  
 Bedding Constant (K) = 0.083 (grouling support)

30-years		Total Load on Conduit (lbs/ft)	Deflection of Pipe (%) (Eq 7.11)	Outside Dia of Pipe (in)	Soil Height of cover to Pipe (ft)	Water Height of cover to Pipe (ft)	Value of 'E' for lowa Formula (Tab 9-10)	Total Load (psi)	Soil Load (psi)	Water Load (psi)	Water Buoyancy Factor	Deflection Lag	Pipe Stiffness (psi)	Wall Crushing Capacity (lb/in)	Wall Crushing Load (lb/in)	Wall Crushing F of S	Bending Strain (Calc Deflection)	Bending Strain (Max. Deflection)	Critical Buckling (psi)	total Buckling (psi)	Buckling F of S	Pipe Thickness (in)
		Wc	ΔY	Bc	Hs	Hw	E'	Pt	Ps	Pw	Rw	DL	PS	CS	CS	CS	eb	eb	qa	qa	qa	t
30" Hobas		22944.00	1.13	32.00	32	122	3000	59.75	26.67	52.87	-0.26	1.00	88.0	7350.00	956.00	7.69	0.08	0.35	256.92	45.98	5.59	0.70
36" Hobas		27461.10	1.12	38.30	32	122	3000	59.75	26.67	52.87	-0.26	1.00	95.0	9030.00	1144.21	7.88	0.08	0.36	263.81	45.98	5.74	0.86

#### Case 4 Basis of Design

Invert of Pipe = 470  
 Finish Grade = 505  
 Water Elevation = 595  
 Hoop Flexural Modulus (E)= 1.90E +06 psi  
 Soil Density (Ws)= 120 lb/ft³  
 Water Density (Ww)= 62.4 lb/ft³

Ult. Compressive Strength = 10,500 psi  
 Bedding Constant (K) = 0.083 (grouling support)

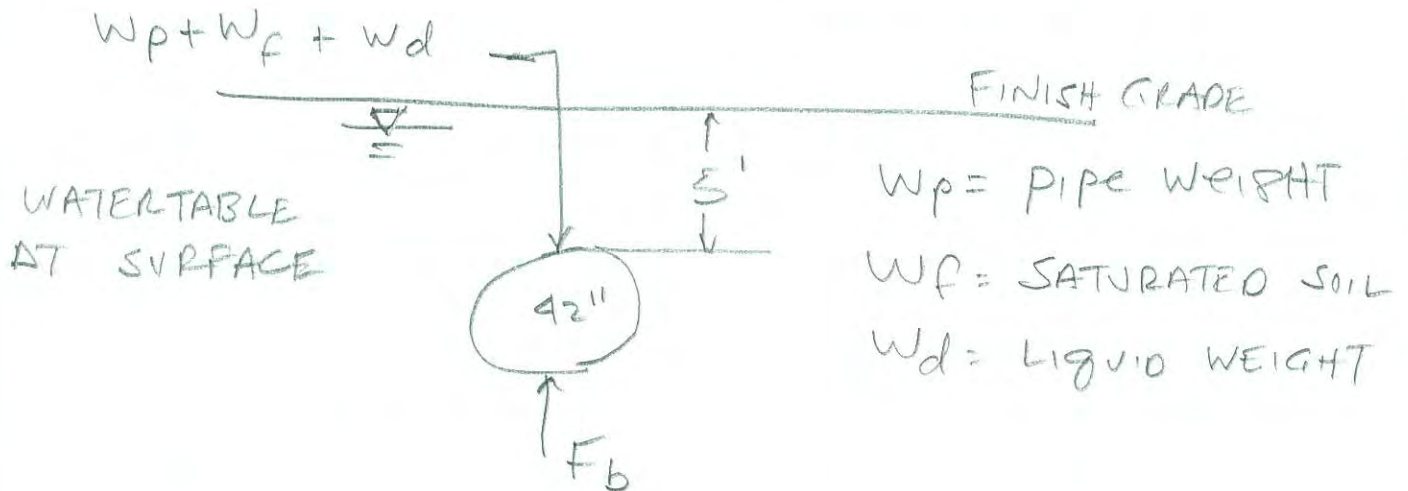


JOB NAME SAWPA UNLINED RCP  
JOB NO. 25-103871  
SHEET NO. 1 OF         
DESIGNED BY O.O. DATE 7/29/09  
CHECKED BY J.H. DATE 7/29/09

FLOTATION CALC

CHECK MINIMUM SOIL COVER  
TO PREVENT FLOTATION.

FROM REVIEW OF AS-BUILT DRAWINGS, MINIMUM  
SOIL COVER FOR REACH IV-A & IV-B IS  
5' ON REACH IV-A, 42" PIPE



$$\begin{aligned}
 F_b &= \gamma \frac{\pi}{4} (O.D.)^2 = 62.4 \frac{\pi}{4} \left( \frac{42'' + 5'' + 5''}{12} \right)^2 \\
 &= 62.4 \frac{\pi}{4} (4.3')^2 \\
 &= 905 \text{ lb/ft}
 \end{aligned}$$

JOB NAME SAWPA UNLINED RCP  
JOB NO. 25-103871  
SHEET NO. 2 OF 2  
DESIGNED BY \_\_\_\_\_ DATE \_\_\_\_\_  
CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

FLOTATION CALC.

$$\begin{aligned} W_P &= (O.D.^2 - I.D.^2) \frac{\pi}{4} \times 150 \frac{lb}{ft} \\ &= (4.3^2 - 3.5^2) \frac{\pi}{4} \times 150 \\ &= 734 \frac{lb}{ft} \end{aligned}$$

$$W_f = \left( 120 \frac{lb}{ft^3} - 62.4 \frac{lb}{ft^3} \right) \left( \frac{D^2 (4 - \pi)}{8} + DH_s \right)$$

See EGN 8.3

$$\begin{aligned} &= 57.6 \left( \frac{4.3^2 (4 - \pi)}{8} + (4.3)(5) \right) \\ &= 57.6 (1.98 + 21.5) \\ &= 1352.4 \frac{lb}{ft} \end{aligned}$$

$W_f > F_b \Rightarrow$  NO FLOTATION REGARDLESS  
OF PIPE MATERIAL AND  
LIQUID LEVEL IN PIPE



## Book 2: Chapter 8 - Groundwater Flotation

A buried pipe or manhole may be subject to flotation from high groundwater levels around the pipe. While lightweight polyethylene is easily handled and installed, its lesser weight compared to that of metal or concrete pipe, compels design evaluation of groundwater flotation effects.

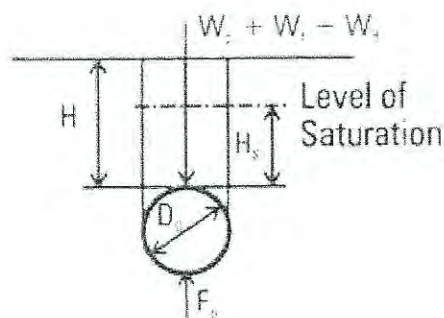
Flotation may occur when the groundwater around the pipe produces a buoyant force greater than the downward force of the soil prism above the pipe plus the weight of the pipe and its contents. When flooded some soils may lose cohesiveness, which may allow the pipe to float out of the ground. Groundwater saturation may also cause significant reduction of soil support around the pipe, and allow the pipe to buckle from the external hydrostatic pressure.

**Table 8-1 Typical soil Densities**

Soil Type	Density, lb/ft <sup>3</sup>	
	Saturated	Dry
Sands and Gravels	118-150	93-114
Silts and Clays	87-131	37-112
Glacial Tills	131-150	106-144
Crushed rock	119-137	94-125
Organic Silts and Clays	81-112	31-94

Several design checks are available to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern. A quick rule of thumb is that when buried in common saturated soil (about 120 lb/ft<sup>3</sup>) with at least one and one half pipe diameters of cover, pipe is generally not subject to groundwater flotation. However, groundwater flotation should be checked if the pipe is buried in lighter soils, or with lesser cover, or the pipe frequently has little liquid flow during high groundwater conditions.

**Figure 8-1 Groundwater Flotation  
(Empty Pipe)**



## Groundwater Flotation of Pipe

For 1 foot of an empty pipe, flotation will occur if

$$F_b > W_p + W_f + W_d \quad (8-1)$$

Where

$F_b$  = buoyant force, lb/ft

$$F_b = \gamma_G \frac{\pi D_o^2}{4} \quad (8-2)$$

$\gamma_G$  = specific weight of groundwater, lb/ft<sup>3</sup>  
(fresh water = 62.4 lb/ft<sup>3</sup>)  
(seawater = 64.0 lb/ft<sup>3</sup>)

$D_o$  = pipe outside diameter, ft

$W_p$  = empty pipe weight, lb/ft

$$W_f = (\omega_d - \omega_G) \left( \frac{D_o^2 (4 - \pi)}{8} + D_o H_s \right) \quad (8-3)$$

$W_f$  = weight of flooded soil, lb/ft

$\gamma_d$  = specific weight of dry soil, lb/ft<sup>3</sup>

$H_s$  = level of groundwater saturation above pipe, ft

$W_d$  = weight of dry soil, lb/ft

$$W_d = \omega_d (H - H_s) D_o \quad (8-4)$$

$H$  = height of cover above pipe, ft

$H_s$  = level of groundwater saturation above pipe, ft

When an area is flooded, the soil particles are buoyed by their immersion in the liquid. The effective weight of flooded soil is the soil's dry density less the density of the flooding liquid. For example, a soil of 120 lb/ft<sup>3</sup> dry density has an effective density of 57.6 lb/ft<sup>3</sup> when completely immersed in fresh water (120 - 62.4 = 57.6 lb/ft<sup>3</sup>).

If the pipe contains a liquid, then the weight of the liquid will reduce the possibility of groundwater flotation. For 1 foot of pipe containing a liquid

$$F_b > W_p + W_f + W_d + W_L \quad (8-5)$$

Where

$W_L$  = weight of the liquid in the pipe, lb/ft

When a pipe is 100% full of liquid, the liquid weight is

$$W_{L,100\%} = \omega_L \frac{\pi D_i^2}{4} \quad (8-6)$$

And if 50% full, the liquid weight is

$$W_{L,50\%} = \omega_L \frac{\pi D_i^2}{8} \quad (8-7)$$

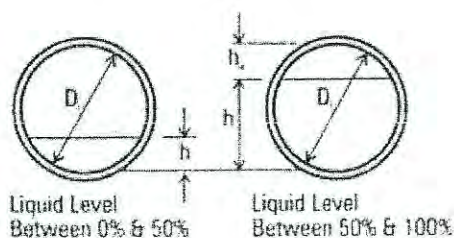
Where



$\gamma_L$  = specific weight of the liquid in the pipe, lb/ft<sup>3</sup>  
 $D_I$  = pipe inside diameter, ft

For pipe liquid levels between empty and half-full (0% to 50%) or between half-full and full (50% to 100%) as illustrated in Figure 8-2, Formulas 8-8 and 8-9 provide an approximate liquid weight with an accuracy of about  $\pm 10\%$ .

**Figure 8-2 Pipe Liquid Level**



For a liquid level between empty and half-full, the weight of the liquid in the pipe is approximately

$$W_L = \omega_L \frac{4 h^3}{3} \sqrt{\frac{D_I - h}{h} + 0.392} \quad (8-8)$$

Where

$h$  = liquid level in the pipe, ft

For a liquid level between half-full and full, the weight of the liquid in the pipe is approximately

$$W_L = \omega_L \left( \frac{\pi D_I^2}{4} - 1.573 h_e \right) \quad (8-9)$$

Where

$h_e$  = height above liquid in pipe, ft

$$h_e = D_I - h \quad (8-10)$$

### **Groundwater Flotation of Manholes**

Compared to pipe, manholes are less resistant to groundwater flotation because the manhole riser eliminates the soil prism load that exists above buried pipe. Under some groundwater conditions, the frictional resistance of the soil surrounding the manhole riser, and the soil prism load over the manhole stub-outs may not be adequate to prevent flotation; so anti-flotation anchors may be required.

Anti-flotation anchors are reinforced concrete slabs that are placed above the manhole stub-outs. The anchors provide additional weight to counteract buoyant forces against the manhole base.

Anti-flotation anchors are installed beside the manhole shaft above the manhole stub-outs.

## Design Guide

### Insituform® Pipe Thickness Calculation for Gravity Applications

Enter your project information below.

Pipe Diameter	<input type="text" value="27"/>	inches
Pipe Length	<input type="text" value="700"/>	feet
Soil Cover (depth) <i>Depth to top of pipe from ground surface.</i>	<input type="text" value="10"/>	feet
Ground Water Depth <i>Depth from water level to bottom of pipe.</i>	<input type="text" value="5"/>	feet
Pipe Ovality (1 to 10%) <i>Ovality, is the out of roundness of the existing pipe in percentage.</i>	<input type="text" value="1"/>	%
Is there a Live Load acting on the pipe? <i>Live load for this calculation = H20 truck loading = 16,000 lbs.</i>	<input checked="" type="radio"/>	<input type="radio"/>
Pipe Structural Condition <i>PD = existing pipe with minor structural deficiencies, it still supports all loads. FD = existing pipe in poor structural condition, it cannot withstand existing loads.</i>	<input checked="" type="radio"/>	<input type="radio"/>
Factor of Safety <i>Traditionally, 2.0 is appropriately used. However, in man-entry pipe applications, a factor of safety of 1.5 can be applied.</i>	<input checked="" type="radio"/>	<input type="radio"/>



## Design Guide

### Insituform® Pipe Design Thickness

Pipe Diameter	27 inches	
Resin System $E_i=400,000\text{psi}$	0.31 inches 7.8 mm	Enhanced Resin
Resin System $E_i=300,000\text{psi}$	0.34 inches 8.6 mm	Standard Resin
Would you like to determine a flow comparison for this project?	<input type="button" value="Yes"/>	

These designs are based on the following typical field parameters:

Pipe Design= Gravity Flow	Flexural Strength = 4,500 psi
Modulus of Elasticity = 400ksi and 300ksi	Soil Density = 120 Lbs/cu.ft.
Soil Modulus for pipes deeper than 20ft. = 1,500psi	Enhancement Factor = 7
Soil Modulus with Live Load or for pipes at a depth of 10-20 feet = 1,000 psi	Poisson's ratio = 0.3
Soil Modulus without Live Load or pipes at a depth less than 10 feet = 700 psi	Live Load H20 = 16,000 Lbs.
	Safety Factor = 2

This wall thickness requirement is based on the design equations X1.1, X1.3 and X1.4 of the design appendix of ASTM F1216. The wall thickness of an Insituform® pipe can be manufactured to the requirements of the site, and can be varied along the pipeline route. There are other design equations and limitations in ASTM F1216 that are too complex for this simplified design. Although this design is believed accurate for the purpose of familiarization of the factors affecting design, contact Insituform® for assistance before specifying the project details.

## Design Guide

### Insituform® Pipe Thickness Calculation for Gravity Applications

Enter your project information below.

Pipe Diameter	<input type="text" value="27"/>	inches
Pipe Length	<input type="text" value="700"/>	feet
Soil Cover (depth) <i>Depth to top of pipe from ground surface.</i>	<input type="text" value="10"/>	feet
Ground Water Depth <i>Depth from water level to bottom of pipe.</i>	<input type="text" value="5"/>	feet
Pipe Ovality (1 to 10%) <i>Ovality, is the out of roundness of the existing pipe in percentage.</i>	<input type="text" value="1"/>	%
Is there a Live Load acting on the pipe? <i>Live load for this calculation = H20 truck loading = 16,000 lbs.</i>	<input checked="" type="radio"/>	<input type="radio"/>
Pipe Structural Condition <i>PD = existing pipe with minor structural deficiencies, it still supports all loads. FD = existing pipe in poor structural condition, it cannot withstand existing loads.</i>	<input type="radio"/>	<input checked="" type="radio"/>
Factor of Safety <i>Traditionally, 2.0 is appropriately used. However, in man-entry pipe applications, a factor of safety of 1.5 can be applied.</i>	<input checked="" type="radio"/>	<input type="radio"/>



## Design Guide

### Insituform® Pipe Design Thickness

Pipe Diameter	27 inches	
Resin System $E_i=400,000\text{psi}$	0.38 inches 9.7 mm	Enhanced Resin
Resin System $E_i=300,000\text{psi}$	0.42 inches 10.6 mm	Standard Resin
Would you like to determine a flow comparison for this project?	<input type="button" value="Yes"/>	

These designs are based on the following typical field parameters:

Pipe Design= Gravity Flow	Flexural Strength = 4,500 psi
Modulus of Elasticity = 400ksi and 300ksi	Soil Density = 120 Lbs/cu.ft.
Soil Modulus for pipes deeper than 20ft. = 1,500psi	Enhancement Factor = 7
Soil Modulus with Live Load or for pipes at a depth of 10-20 feet = 1,000 psi	Poisson's ratio = 0.3
Soil Modulus without Live Load or pipes at a depth less than 10 feet = 700 psi	Live Load H20 = 16,000 Lbs.
	Safety Factor = 2

This wall thickness requirement is based on the design equations X1.1, X1.3 and X1.4 of the design appendix of ASTM F1216. The wall thickness of an Insituform® pipe can be manufactured to the requirements of the site, and can be varied along the pipeline route. There are other design equations and limitations in ASTM F1216 that are too complex for this simplified design. Although this design is believed accurate for the purpose of familiarization of the factors affecting design, contact Insituform® for assistance before specifying the project details.

JOB NAME \_\_\_\_\_

JOB NO. \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

DESIGNED BY \_\_\_\_\_ DATE \_\_\_\_\_

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

REACH IV-A LOWER

36" ID PIPE @ 0.1% SLOPE  
@ D/d OF 75% HAS Q =

$$Q = \frac{.422}{.009} (3)^{2.67} (.001)^{1/2}$$

KING'S  
HANDBOOK

$$= 27.86 \text{ cfs (18.1 mgd)}$$

HDPE WITH ID = 33.8"

$$Q = \frac{.422}{.009} \left( \frac{33.8}{12} \right)^{2.67} (.001)^{1/2}$$

$$= 23.54 \text{ cfs (15.3 mgd)}$$

$$\text{REDUCTION} = \frac{23.54 - 27.86}{27.86} \times 100 =$$
$$15.5\%$$





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JOB NAME \_\_\_\_\_

JOB NO. \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

DESIGNED BY \_\_\_\_\_ DATE \_\_\_\_\_

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

REACH IV-B

30" ID PIPE @ 0.38% SLOPE  
@ D/d = 75% HAS Q =

$$Q = \frac{.422 (2.5)^{2.67} (.0038)^{1/2}}{.009}$$

$$= 33.37 \text{ cfs (21.6 mgd)}$$

HOPE WITH ID = 28.2"

$$Q = \frac{.422 \left( \frac{28.2}{12} \right)^{2.67} (.0038)^{1/2}}{.009}$$

$$= 28.3 \text{ cfs (18.3 mgd)}$$

$$\begin{aligned} \text{REDUCTION} &= \frac{28.3 - 33.37}{33.37} \times 100 \\ &= 15.2\% \end{aligned}$$

JOB NAME \_\_\_\_\_

JOB NO. \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

DESIGNED BY \_\_\_\_\_ DATE \_\_\_\_\_

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

REACH IV-A UPPER

27" pipe @  $N = .013$   $D/d = 0.75$   
Slope = .002

$$Q = \frac{.422}{.013} (2.75)^{2.67} (.002)^{1/2}$$

$$= 12.6 \text{ cfs (8.2 mgd)}$$

CIPP LINER

26.1" pipe @  $N = .010$   $D/d = .75$   
Slope = .002

$$Q = \frac{.422}{.010} \left( \frac{26.1}{12} \right)^{2.67} (.002)^{1/2}$$

$$= 15.0 \text{ cfs (9.7 mgd)}$$

$$\text{INCREASE} = \frac{15 - 12.6}{12.6} \times 100$$

$$= 19\%$$



## **Appendix F**

### **Preliminary Cost Estimate**

**Construction Cost Estimate - Preliminary**  
**Santa Ana Watershed Project Authority**  
**Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B**  
**Summary**

**Est. Date:** September 16, 2009  
**Job No:** 25-103871

**Est. By:** J. Bowdan  
**Chk'd By:** J. Harris

Section	Description	Material Cost	Equip	Labor Cost	Total
	Reach IV-A Lower and Reach IV-B	\$8,818,675	\$4,456,950	\$1,010,790	\$14,286,415
	Reach IV-A Upper	\$1,751,610	\$1,551,150	\$890,230	\$4,192,990
	<b>Subtotal - Direct Costs</b>	<b>\$10,570,285</b>	<b>\$6,008,100</b>	<b>\$1,901,020</b>	<b>\$18,479,405</b>
8.75%	Sales Tax	\$924,900			\$924,900
	<b>Subtotal</b>	<b>\$11,495,185</b>	<b>\$6,008,100</b>	<b>\$1,901,020</b>	<b>\$19,404,305</b>
6%	Prime Contractor's Home Office	\$689,711	\$360,486	\$114,061	\$1,164,258
	<b>Subtotal</b>	<b>\$12,184,896</b>	<b>\$6,368,586</b>	<b>\$2,015,081</b>	<b>\$20,568,563</b>
8%	Prime Contractor's Profit	\$974,792	\$509,487	\$161,206	\$1,645,485
	<b>Subtotal</b>	<b>\$13,159,688</b>	<b>\$6,878,073</b>	<b>\$2,176,288</b>	<b>\$22,214,048</b>
10%	Contingency	\$1,315,969	\$687,807	\$217,629	\$2,221,405
	<b>Total</b>	<b>\$14,475,656</b>	<b>\$7,565,880</b>	<b>\$2,393,916</b>	<b>\$24,435,453</b>



**Construction Cost Estimate - Preliminary**  
**Santa Ana Watershed Project Authority**  
**Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B**  
**Summary - CIPP**  
**Reach IV-A Upper**

**Est. Date:** September 16, 2009  
**Job No:** 25-103871

**Est. By:** J. Bowdan  
**Chk'd By:** J. Harris

Section	Description	Material Cost	Equip	Labor Cost	Total
15065	Cured-in-Place Pipe	\$1,751,610	\$1,551,150	\$890,230	\$4,192,990
	<b>Subtotal - Direct Costs</b>	<b>\$1,751,610</b>	<b>\$1,551,150</b>	<b>\$890,230</b>	<b>\$4,192,990</b>
8.75%	Sales Tax	\$153,266			\$153,266
	<b>Subtotal</b>	<b>\$1,904,876</b>	<b>\$1,551,150</b>	<b>\$890,230</b>	<b>\$4,346,256</b>
6%	Prime Contractor's Home Office	\$114,293	\$93,069	\$53,414	\$260,775
	<b>Subtotal</b>	<b>\$2,019,168</b>	<b>\$1,644,219</b>	<b>\$943,644</b>	<b>\$4,607,031</b>
8%	Prime Contractor's Profit	\$161,533	\$131,538	\$75,492	\$368,562
	<b>Subtotal</b>	<b>\$2,180,702</b>	<b>\$1,775,757</b>	<b>\$1,019,135</b>	<b>\$4,975,594</b>
10%	Contingency	\$218,070	\$177,576	\$101,914	\$497,559
	<b>Total</b>	<b>\$2,398,772</b>	<b>\$1,953,332</b>	<b>\$1,121,049</b>	<b>\$5,473,153</b>
	Total Cost Per Foot				\$218.72

**Construction Cost Estimate - Preliminary**  
**Santa Ana Watershed Project Authority**  
**Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B**  
**Summary - Slip-Lining**  
**Reaches IV-A Lower and Reach IV-B**

**Est. Date:** September 16, 2009  
**Job No:** 25-103871

**Est. By:** J. Bowdan  
**Chk'd By:** J. Harris

Section	Description	Material Cost	Equip	Labor Cost	Total
02223	Trenching, Excav, Backfill & Compaction	\$2,236,250	\$1,571,750	\$415,750	\$4,223,750
03300	Cast-in-Place Concrete	\$840,000	\$960,000	\$120,000	\$1,920,000
15064	Slip-Liner Pipe	\$5,742,425	\$1,925,200	\$475,040	\$8,142,665
	<b>Subtotal - Direct Costs</b>	<b>\$8,818,675</b>	<b>\$4,456,950</b>	<b>\$1,010,790</b>	<b>\$14,286,415</b>
8.75%	Sales Tax	\$771,634			\$771,634
	<b>Subtotal</b>	<b>\$9,590,309</b>	<b>\$4,456,950</b>	<b>\$1,010,790</b>	<b>\$15,058,049</b>
6%	Prime Contractor's Home Office	\$575,419	\$267,417	\$60,647	\$903,483
	<b>Subtotal</b>	<b>\$10,165,728</b>	<b>\$4,724,367</b>	<b>\$1,071,437</b>	<b>\$15,961,532</b>
8%	Prime Contractor's Profit	\$813,258	\$377,949	\$85,715	\$1,276,923
	<b>Subtotal</b>	<b>\$10,978,986</b>	<b>\$5,102,316</b>	<b>\$1,157,152</b>	<b>\$17,238,455</b>
10%	Contingency	\$1,097,899	\$510,232	\$115,715	\$1,723,845
	<b>Total</b>	<b>\$12,076,884</b>	<b>\$5,612,548</b>	<b>\$1,272,868</b>	<b>\$18,962,300</b>
	Total Cost Per Foot				\$583.38



**Construction Cost Estimate - Preliminary**  
**Santa Ana Watershed Project Authority**  
**Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B**

**Est. Date:** September 16, 2009  
**Job No:** 25-103871

**Est. By:** J. Bowdan  
**Chk'd By:** J. Harris

**Submittal Status:** Preliminary

Section	Description	Qty.	Units	Mat. Cost	Labor Cost	Equip. Cost	Total Insll'd Cost	Total Mat. Cost	Total Labor Cost	Total Equip. Cost	Total Cost
	<b>Lower Portion of Reach IV-A and IV-B</b>										
<b>2223</b>	<b>Trenching, Excav, Backfill &amp; Compaction</b>										
	Access Pit Excavation	4,800	CY		\$40.00	\$10.00	\$50.00	\$0	\$192,000	\$48,000	\$240,000
	Trench Bedding	750	CY	\$35.00	\$5.00	\$1.00	\$41.00	\$26,250	\$3,750	\$750	\$30,750
	Pit Shoring	24	EA	\$20,000.00	\$5,000.00	\$5,000.00	\$30,000.00	\$480,000	\$120,000	\$120,000	\$720,000
	Dewatering System	24	EA	\$70,000.00	\$40,000.00	\$5,000.00	\$115,000.00	\$1,680,000	\$960,000	\$120,000	\$2,760,000
	Backfill and Compact	700	CY		\$30.00	\$10.00	\$40.00	\$0	\$21,000	\$7,000	\$28,000
	Clear Access Road	35,000	SY	\$0.00	\$5.00	\$2.00	\$7.00	\$0	\$175,000	\$70,000	\$245,000
	Misc. Access Road Requirements	1	LS	\$50,000.00	\$100,000.00	\$50,000.00	\$200,000.00	\$50,000	\$100,000	\$50,000	\$200,000
	<b>Total - 02223</b>							\$2,236,250	\$1,571,750	\$415,750	\$4,223,750
<b>3300</b>	<b>Cast-in-Place Concrete</b>										
	Concrete Structures	24	EA	\$35,000.00	\$40,000.00	\$5,000.00	\$80,000.00	\$840,000	\$960,000	\$120,000	\$1,920,000
		0	EA					\$0	\$0	\$0	\$0
	<b>Total - 03300</b>							\$840,000	\$960,000	\$120,000	\$1,920,000
<b>15064</b>	<b>Slip-lining Pipe</b>										
	30" Pipe - 20 foot sections	11,949	LF	\$125.00	\$50.00	\$10.00	\$185.00	\$1,493,625	\$597,450	\$119,490	\$2,210,565
	30" Pipe - 6 foot sections	4,000	LF	\$180.00	\$50.00	\$10.00	\$240.00	\$720,000	\$200,000	\$40,000	\$960,000
	36" Pipe - 20 foot sections	10,555	LF	\$160.00	\$50.00	\$10.00	\$220.00	\$1,688,800	\$527,750	\$105,550	\$2,322,100
	36" Pipe - 6 foot sections	6,000	LF	\$240.00	\$50.00	\$10.00	\$300.00	\$1,440,000	\$300,000	\$60,000	\$1,800,000
	Annular Grout	2,000	CY	\$175.00	\$100.00	\$50.00	\$325.00	\$350,000	\$200,000	\$100,000	\$650,000
	Site Mitigation	1	LS	\$50,000.00	\$100,000.00	\$50,000.00	\$200,000.00	\$50,000	\$100,000	\$50,000	\$200,000
	<b>Total - 15064</b>							\$5,742,425	\$1,925,200	\$475,040	\$8,142,665
	<b>SubTotal - Lower Portion of Reach IV-A and IV-B</b>							\$8,818,675	\$4,456,950	\$1,010,790	\$14,286,415
	<b>Upper Portion of Reach IV-A</b>										
<b>15065</b>	<b>Cured-in-Place Pipe</b>										
	27" CIPP	25,023	LF	\$70.00	\$50.00	\$10.00	\$130.00	\$1,751,610	\$1,251,150	\$250,230	\$3,252,990
	Pump By-pass System	8	Month	\$0.00	\$0.00	\$80,000.00	\$80,000.00	\$0	\$0	\$640,000	\$640,000
	Traffic Control	6	Month	\$0.00	\$50,000.00	\$0.00	\$50,000.00	\$0	\$300,000	\$0	\$300,000
	<b>Total - 15065</b>							\$1,751,610	\$1,551,150	\$890,230	\$4,192,990
	<b>SubTotal - Upper Portion of Reach IV-A</b>							\$1,751,610	\$1,551,150	\$890,230	\$4,192,990

## **Appendix G**

### **Impact Area Summary**



**SANTA ANA WATERSHED PROJECT AUTHORITY  
REPAIRS TO UNLINED RCP, REACHES IV-A AND IV-B  
IMPACT AREA SUMMARY TABLE  
LOWER REACH IV-A**

Access Pit Location No.	Type of Access Pit	Dimensions of Cleared Area		Cleared Area (SF)	Percentage of Vegetated Area	Impact Area Vegetated (SF)	Percentage of Non-Vegetated Area	Impact Area Non-Vegetated (SF)	Comments
1	Termination	100	100	10,000	50.00%	5,000	50.00%	5,000	MAS 4A-0010
2	Insertion	150	100	15,000	50.00%	7,500	50.00%	7,500	MAS 4A-0030
3	Termination	150	80	12,000	50.00%	6,000	50.00%	6,000	
4	Insertion/Termination	150	80	12,000	50.00%	6,000	50.00%	6,000	MAS 4A-0050
5	Insertion	150	80	12,000	100.00%	12,000	0.00%	0	MAS 4A-0060
6	Termination	100	80	8,000	100.00%	8,000	0.00%	0	MAS 4A-0070
7	Insertion	200	80	16,000	100.00%	16,000	0.00%	0	MAS 4A-0080
8	Termination	100	80	8,000	100.00%	8,000	0.00%	0	MAS 4A-0100
9	Insertion	150	150	22,500	0.00%	0	100.00%	22,500	MAS 4A-0120
10	Insertion/Termination	150	100	15,000	0.00%	0	100.00%	15,000	
11	Termination	150	80	12,000	25.00%	3,000	75.00%	9,000	
12	Insertion/Termination	150	80	12,000	25.00%	3,000	75.00%	9,000	MAS 4A-0010
13	Insertion	150	80	12,000	50.00%	6,000	50.00%	6,000	MAS 4A-0160
14	Termination	150	150	22,500	0.00%	0	100.00%	22,500	MAS 4D-0010
Access Road		16,500	10	165,000	20.00%	33,000	80.00%	132,000	
Totals (SF)						113,500		240,500	
Totals (Acres)						2.6		5.5	

**SANTA ANA WATERSHED PROJECT AUTHORITY  
REPAIRS TO UNLINED RCP, REACHES IV-A AND IV-B  
IMPACT AREA SUMMARY TABLE  
REACH IV-B**

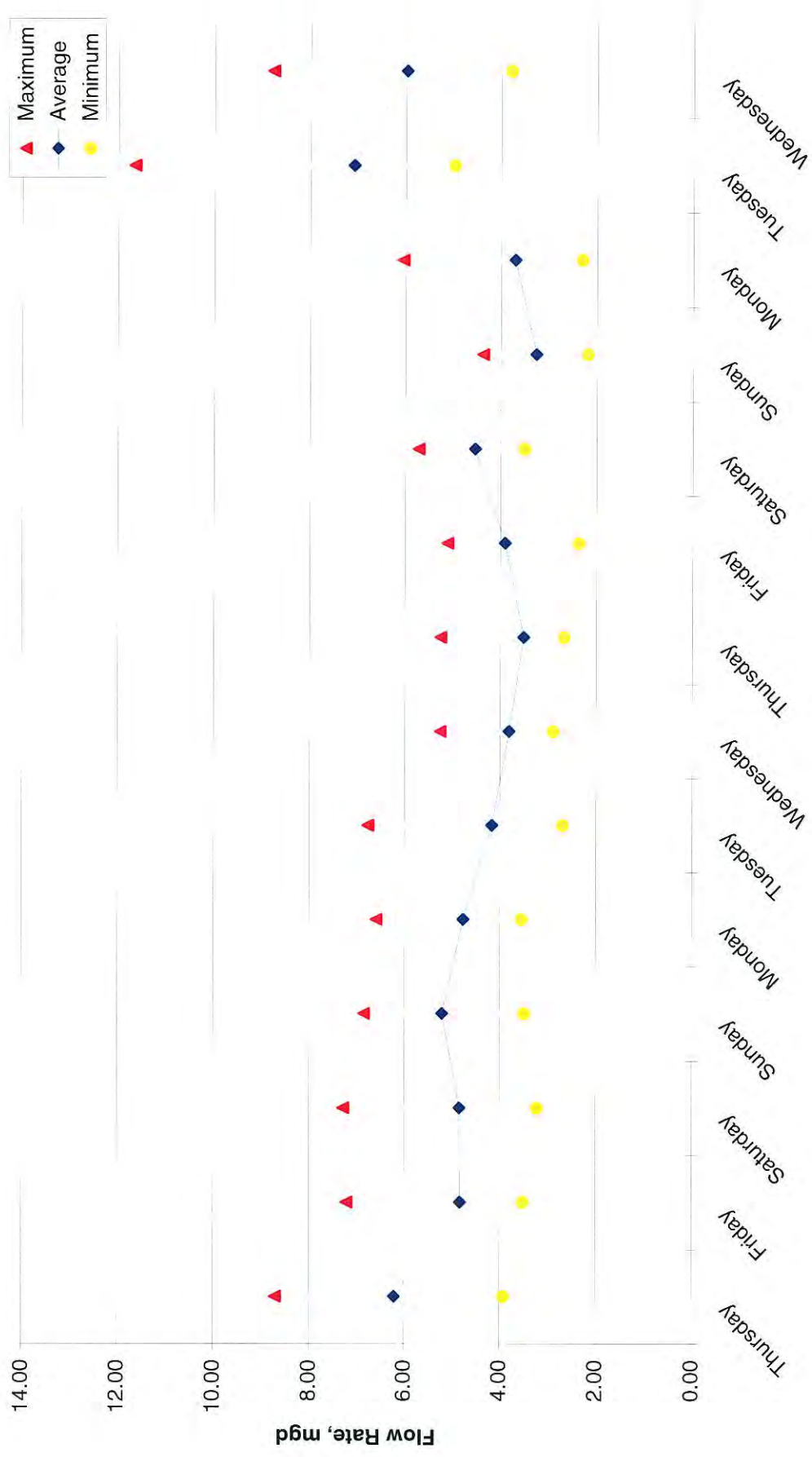
Access Pit Location No.	Type of Access Pit	Dimensions of Cleared Area		Cleared Area (SF)	Percentage of Vegetated Area	Impact Area Vegetated (SF)	Percentage of Non-Vegetated Area	Impact Area Non-Vegetated (SF)	Comments
1	Termination	100	100	10,000	100.00%	10,000	0.00%	0	MAS 4B-0010
2	Insertion	200	80	16,000	50.00%	8,000	50.00%	8,000	MAS 4B-0030
3	Insertion	150	150	22,500	100.00%	22,500	0.00%	0	MAS 4B-0040
4	Insertion	150	150	22,500	100.00%	22,500	0.00%	0	MAS 4B-0060
5	Insertion	150	150	22,500	100.00%	22,500	0.00%	0	MAS 4B-0080
6	Insertion	150	100	15,000	100.00%	15,000	0.00%	0	MAS 4B-0100
7	Insertion	200	80	16,000	100.00%	16,000	0.00%	0	122+50
8	Insertion	150	150	22,500	100.00%	22,500	0.00%	0	128+00
9	Insertion	200	40	8,000	0.00%	0	100.00%	8,000	MAS 4B-0140
10	Insertion	100	100	10,000	0.00%	0	100.00%	10,000	MAS 4B-0150
Access Road		13,200	10	132,000	78.00%	102,960	22.00%	29,040	Wetland impacts end at MAS 4B- 0120
Totals (SF)						241,960		55,040	
Totals (Acres)						5.6		1.3	



## **Appendix H**

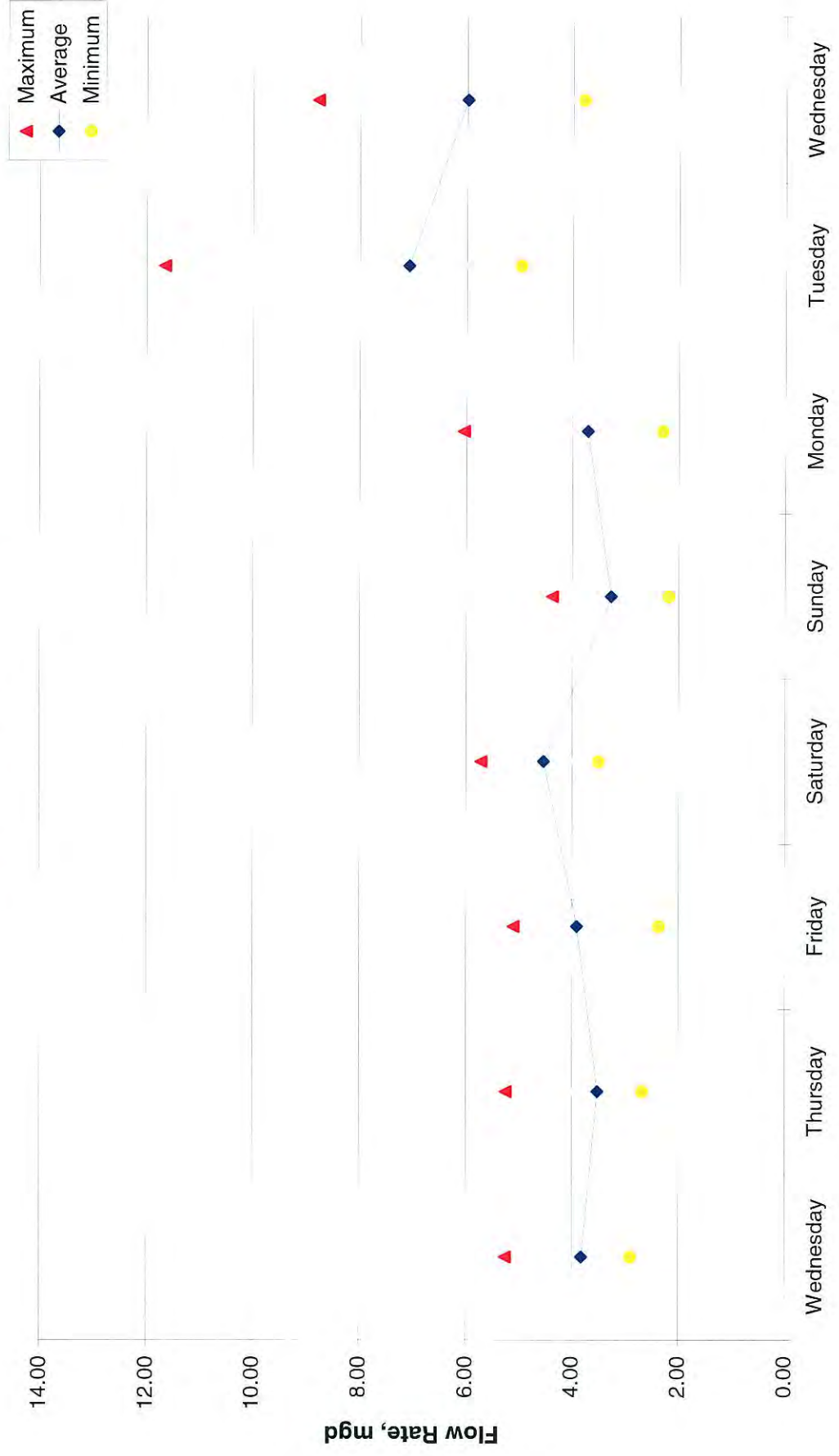
### **Flow Data from Meter Stations**

Reach Lower IV-A  
Pine Flow Meter & Euclid Flow Meter (Winter)  
All Matching Data (Thursday - Wednesday)

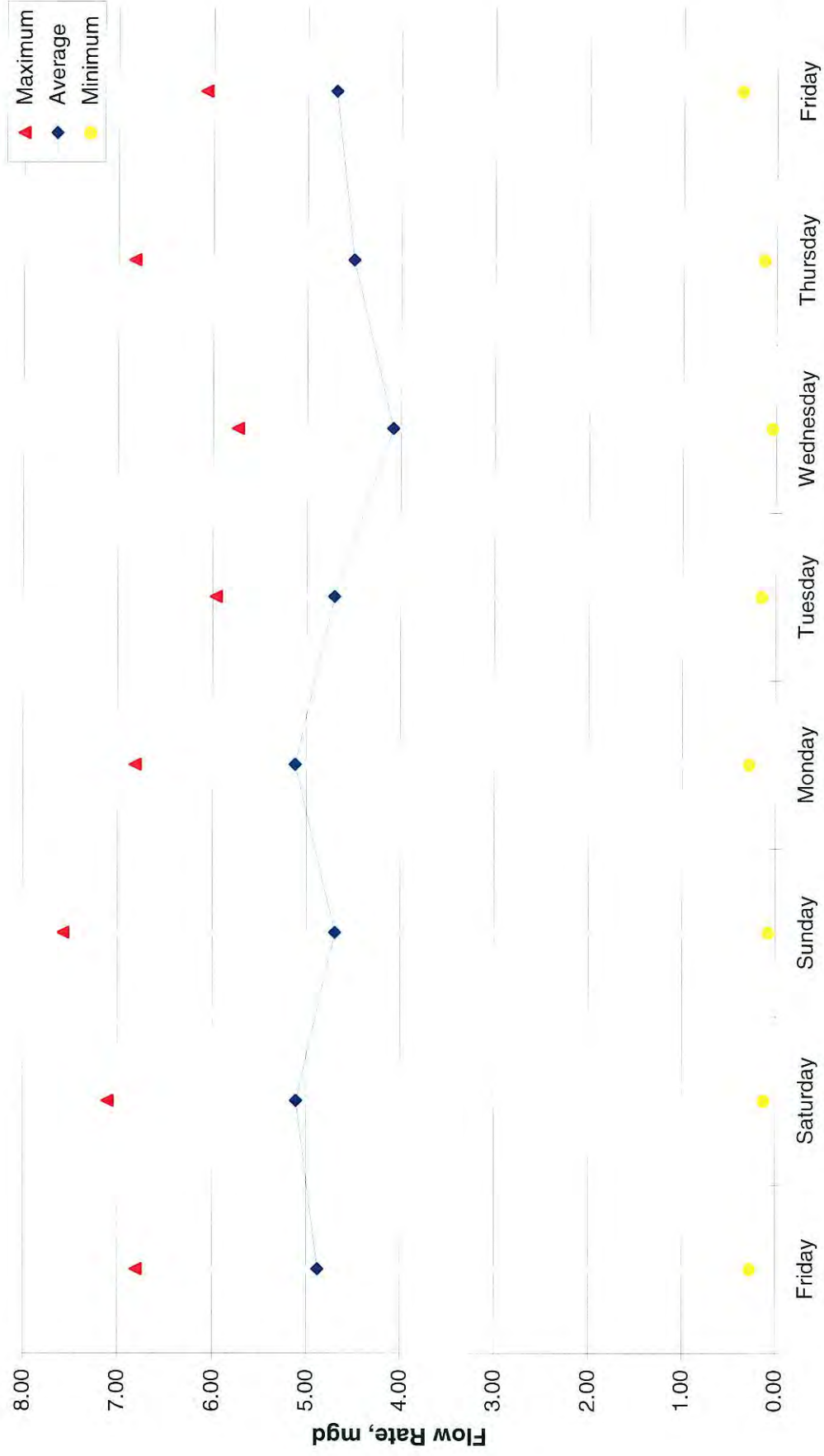




Reach Lower IV-A  
Pine Flow Meter & Euclid Flow Meter (Summer)  
Period: 1 Week (Wed. to Wed.)

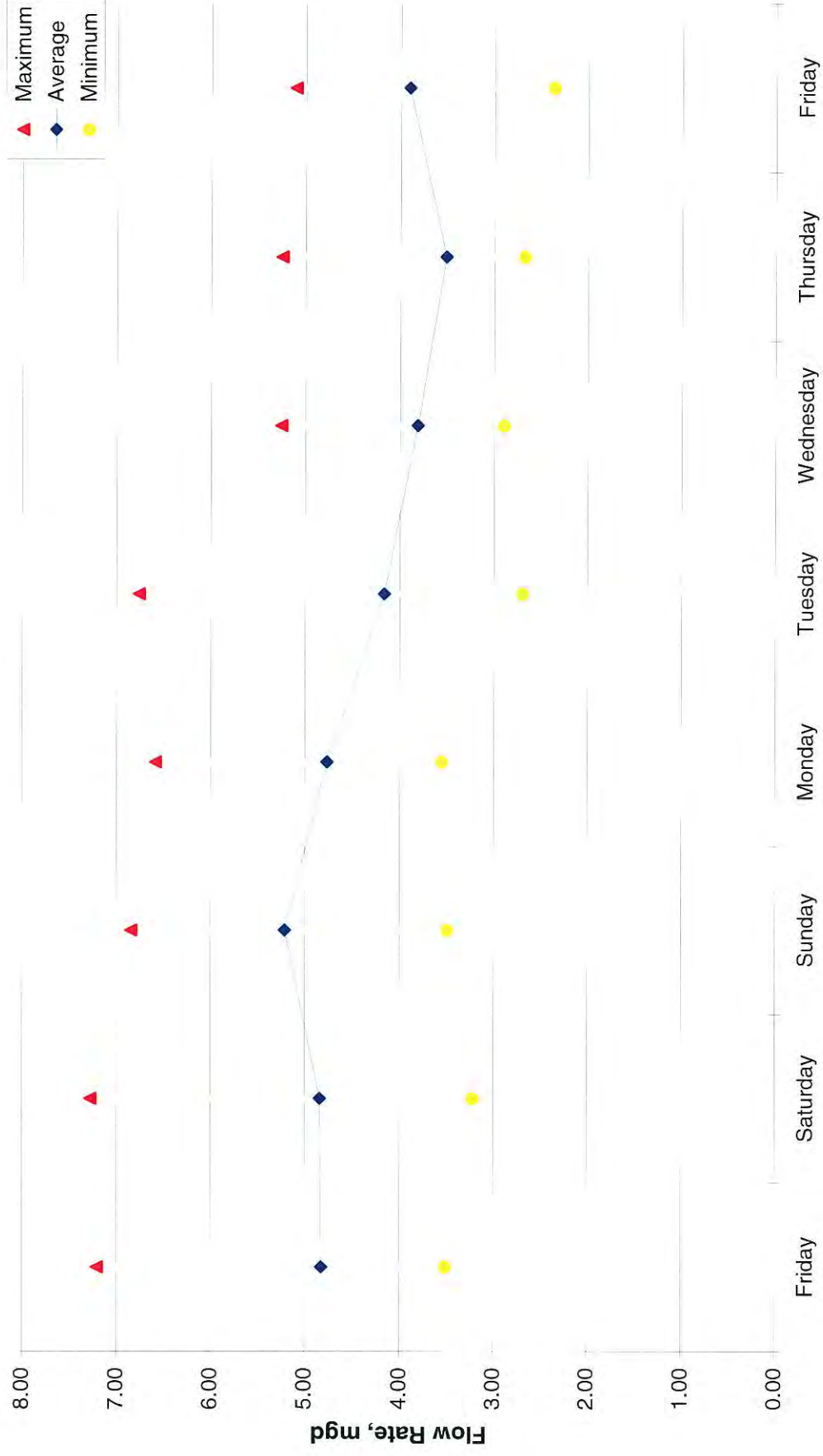


Reach Lower IV-A  
Pine Flow Meter & Euclid Flow Meter (Summer)  
Period: 1 Week (Fri. to Fri.)

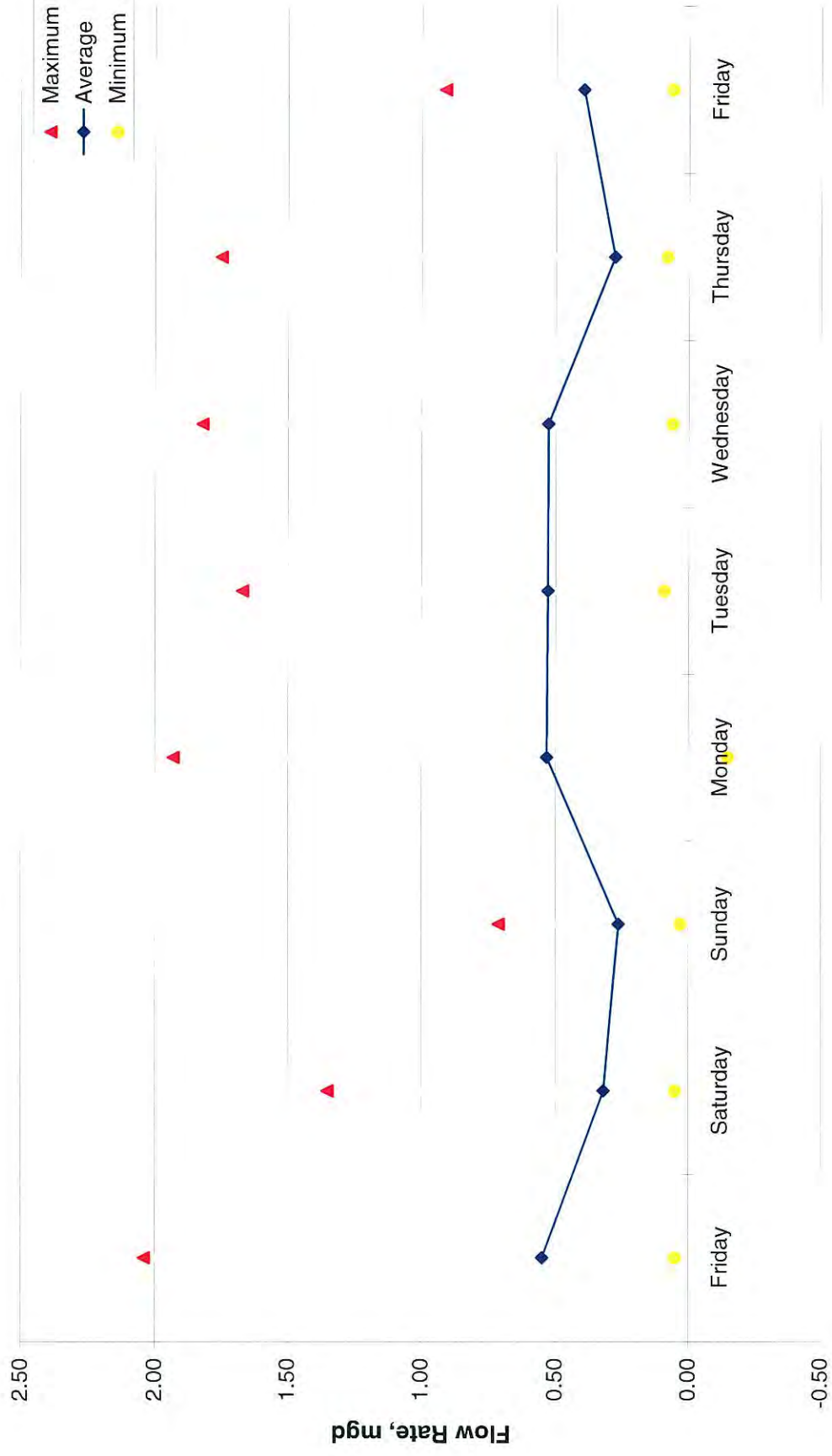




Reach Lower IV-A  
Pine Flow Meter & Euclid Flow Meter (Summer)  
Period: 1 Week (Fri. to Fri.)

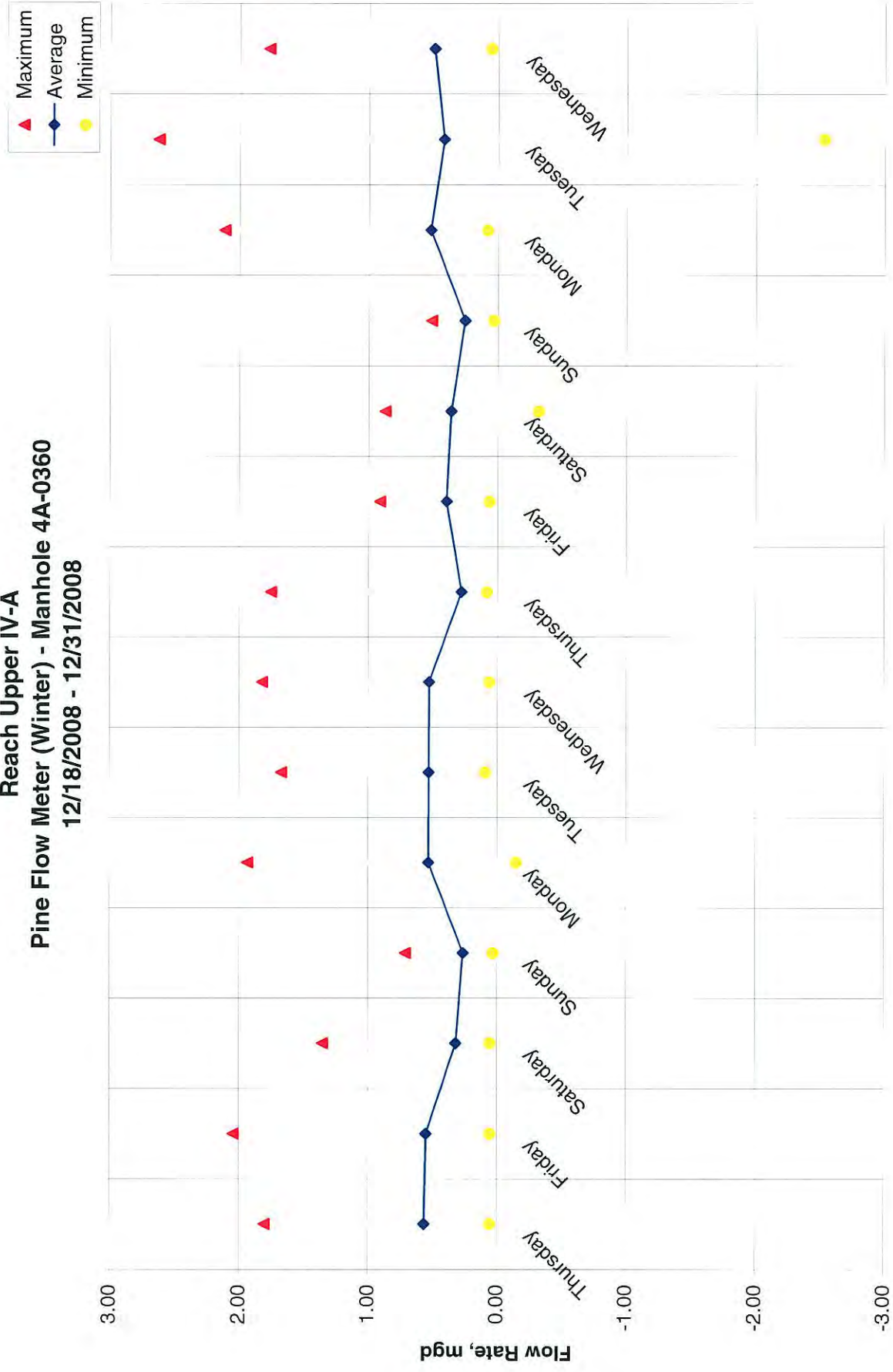


Reach Upper IV-A  
Pine Flow Meter (Winter)  
Period: 1 Week (Fri. to Fri.)  
Dates: 12/19/08 - 12/27/08





Reach Upper IV-A  
Pine Flow Meter (Winter) - Manhole 4A-0360  
12/18/2008 - 12/31/2008

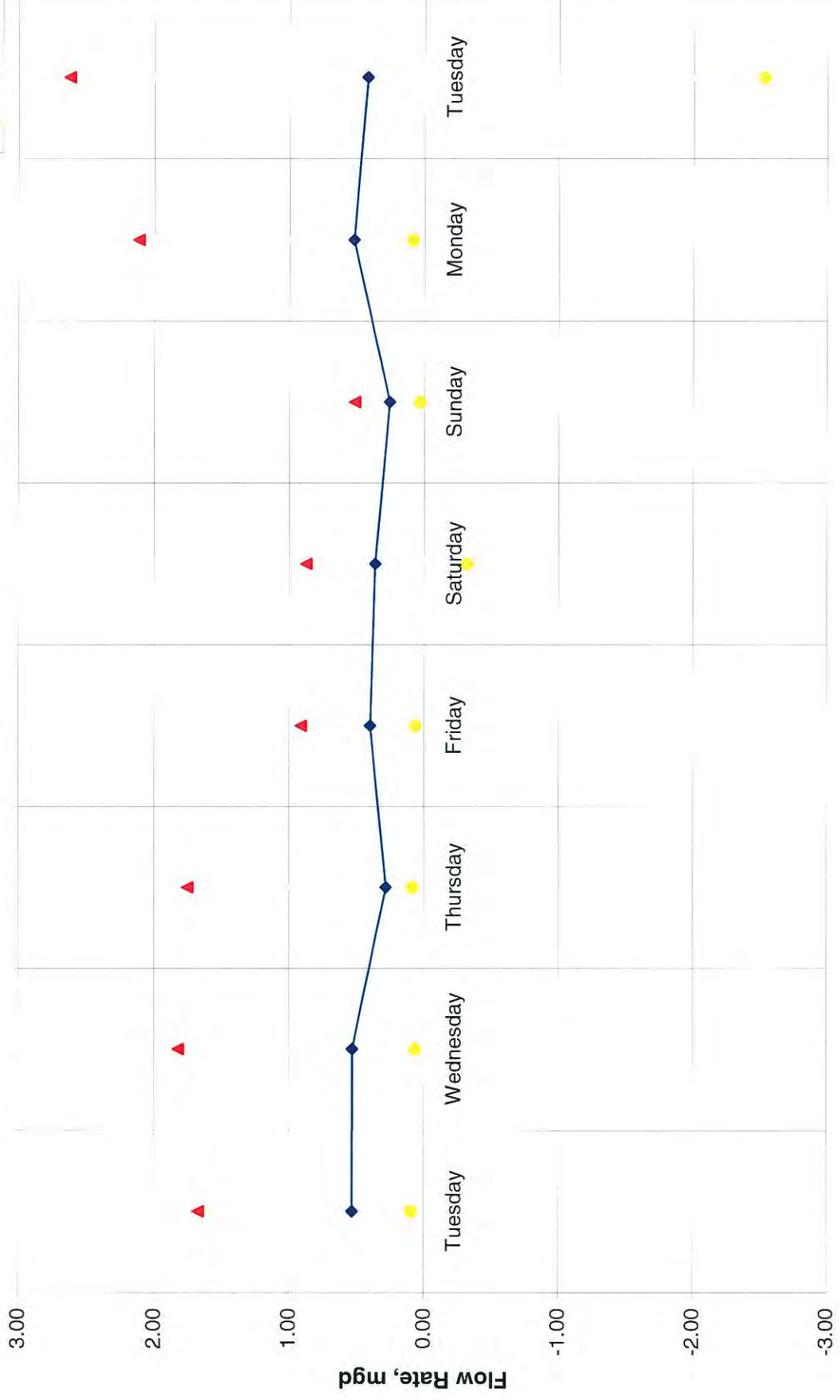


# Reach Upper IV-A

## Pine Flow Meter (Winter)

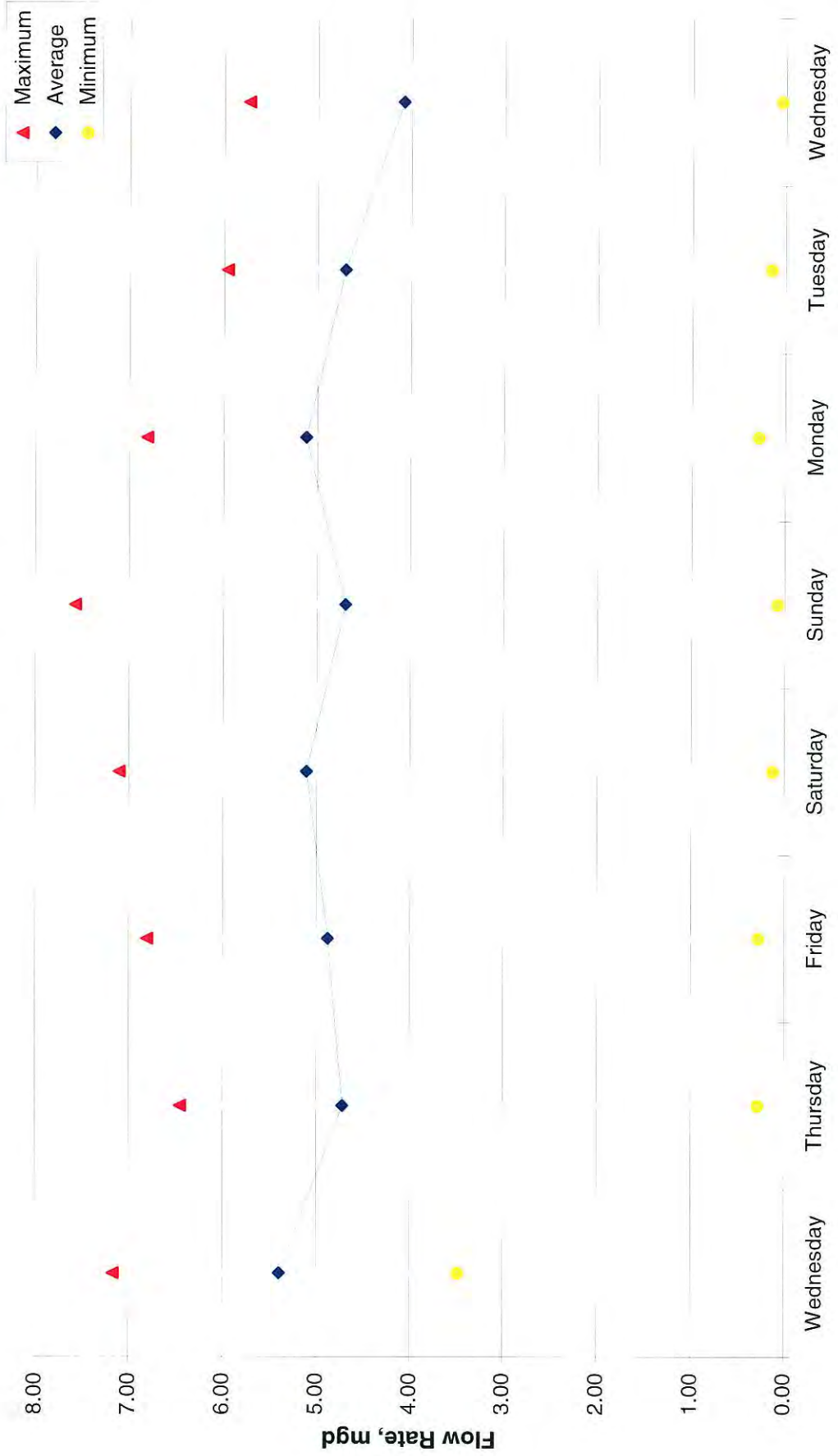
Period: 1 Week (Tues. to Tues.)

Dates: 12/24/08 - 12/31/08

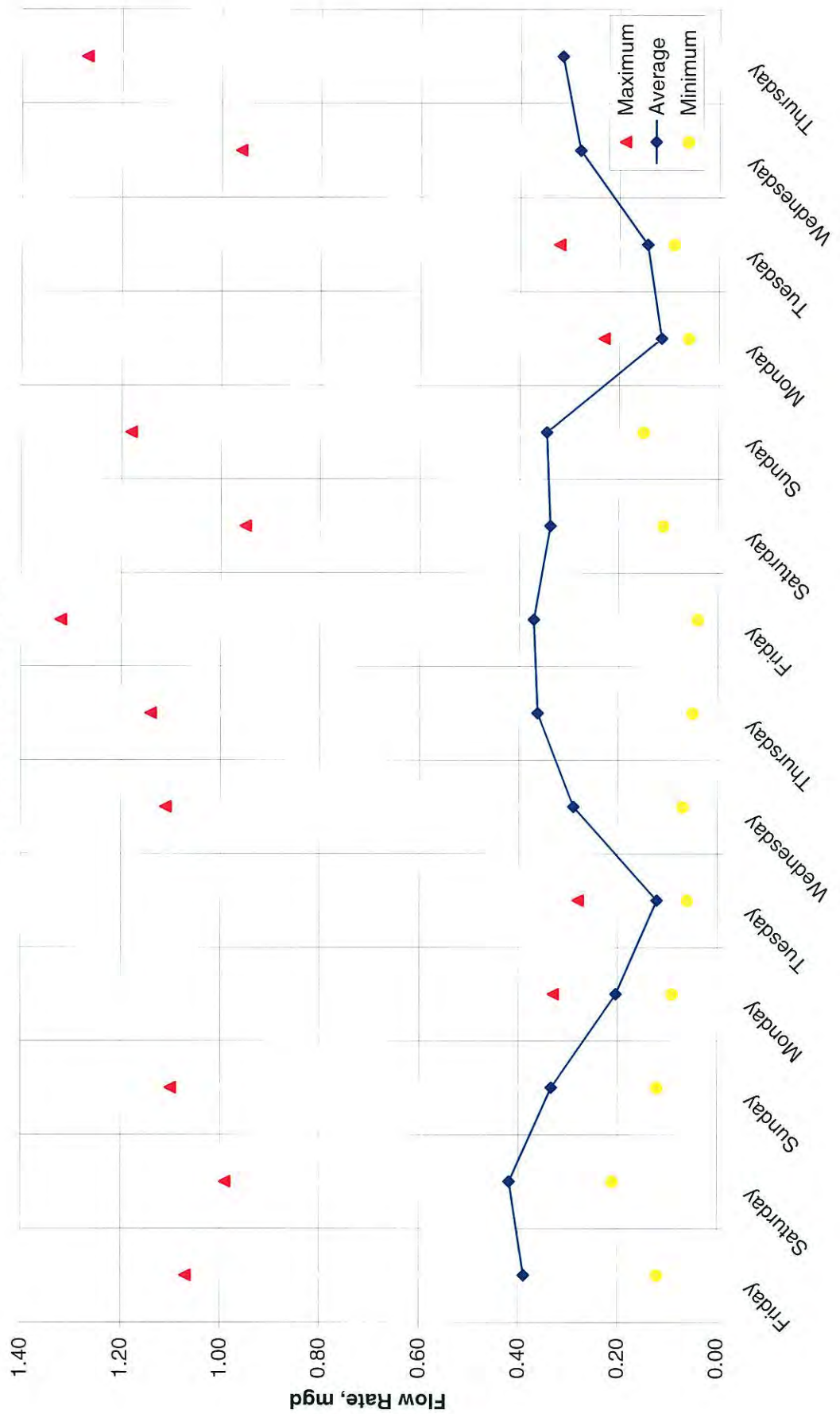




Reach Upper IV-A  
Pine Flow Meter & Euclid Flow Meter (Summer)  
Period: 1 Week (Wed. to Wed.)

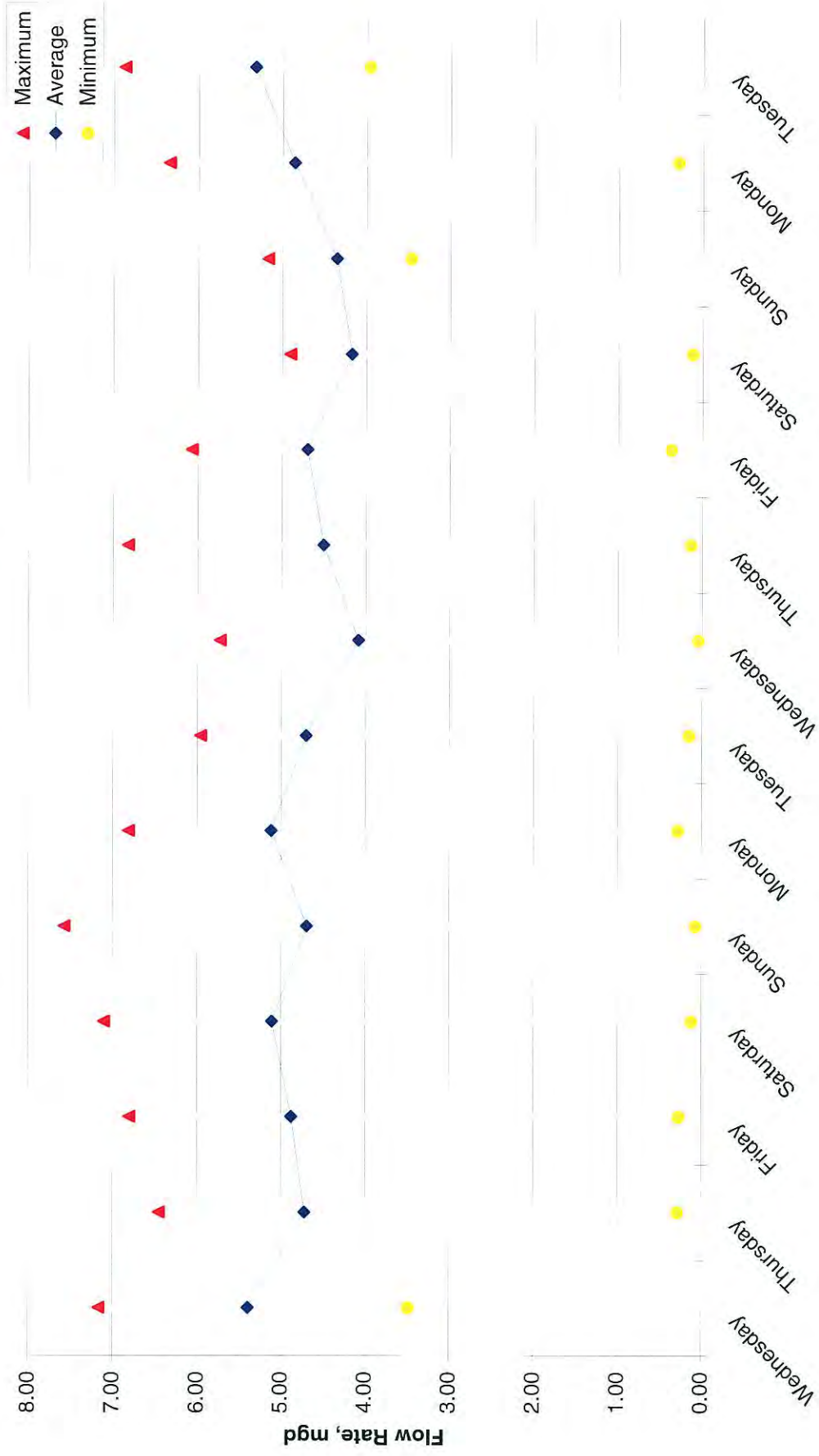


Reach Upper IV-A  
Pine Flow Meter (Summer) - Manhole 4A-0360  
06/17/2009 - 06/30/2009

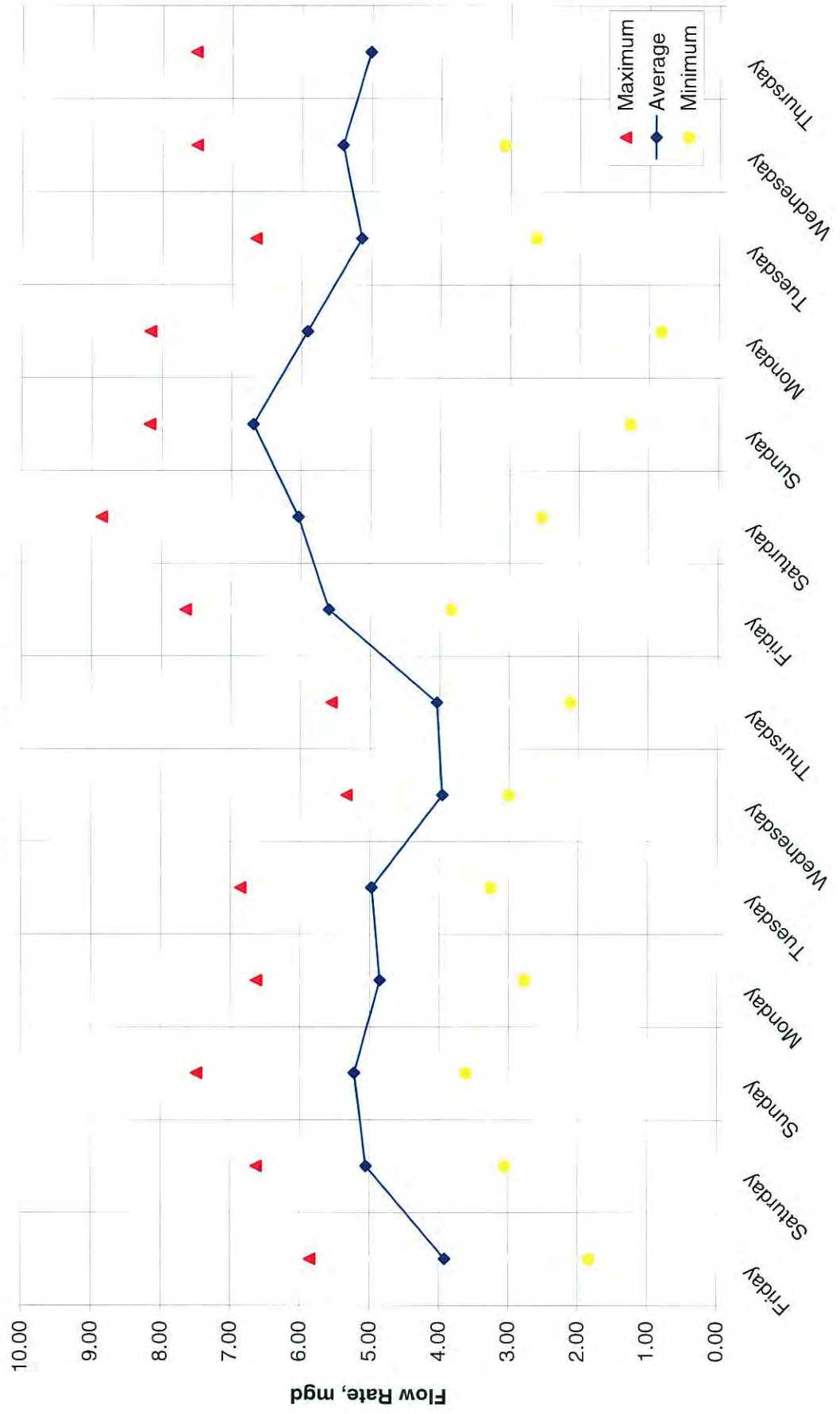




Reach Upper IV-A  
Pine Flow Meter & Euclid Flow Meter (Summer)  
All Matching Data (Wednesday - Tuesday)

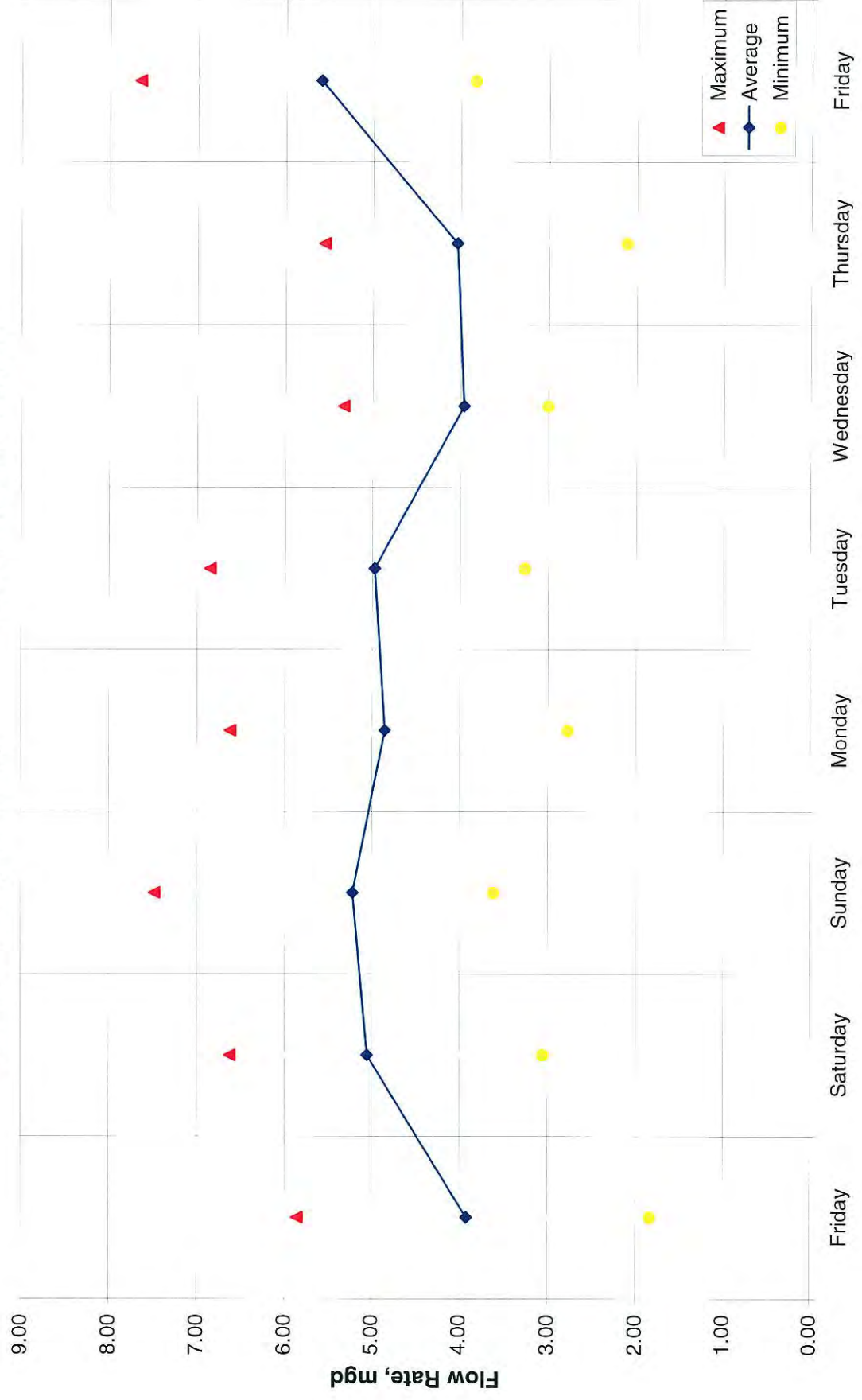


Reach IV-B  
Corona Flow Meter (Winter) - Manhole 4B-0110  
11/28/2008 - 12/11/2008

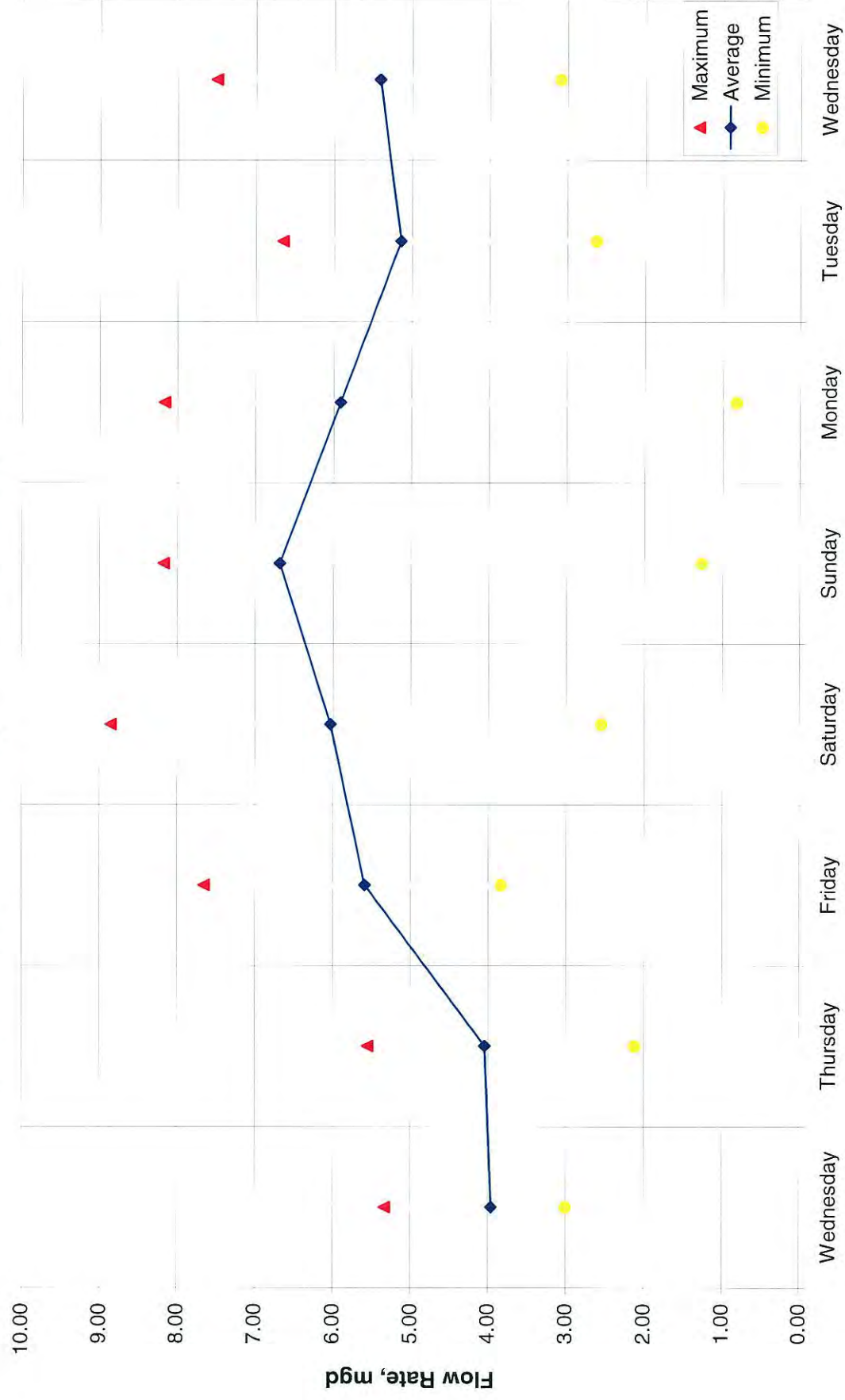




Reach IV-B  
Corona Flow Meter (Winter)  
Period: 1 Week (Fri. to Fri.)  
Dates: 11/28/08 - 12/05/08

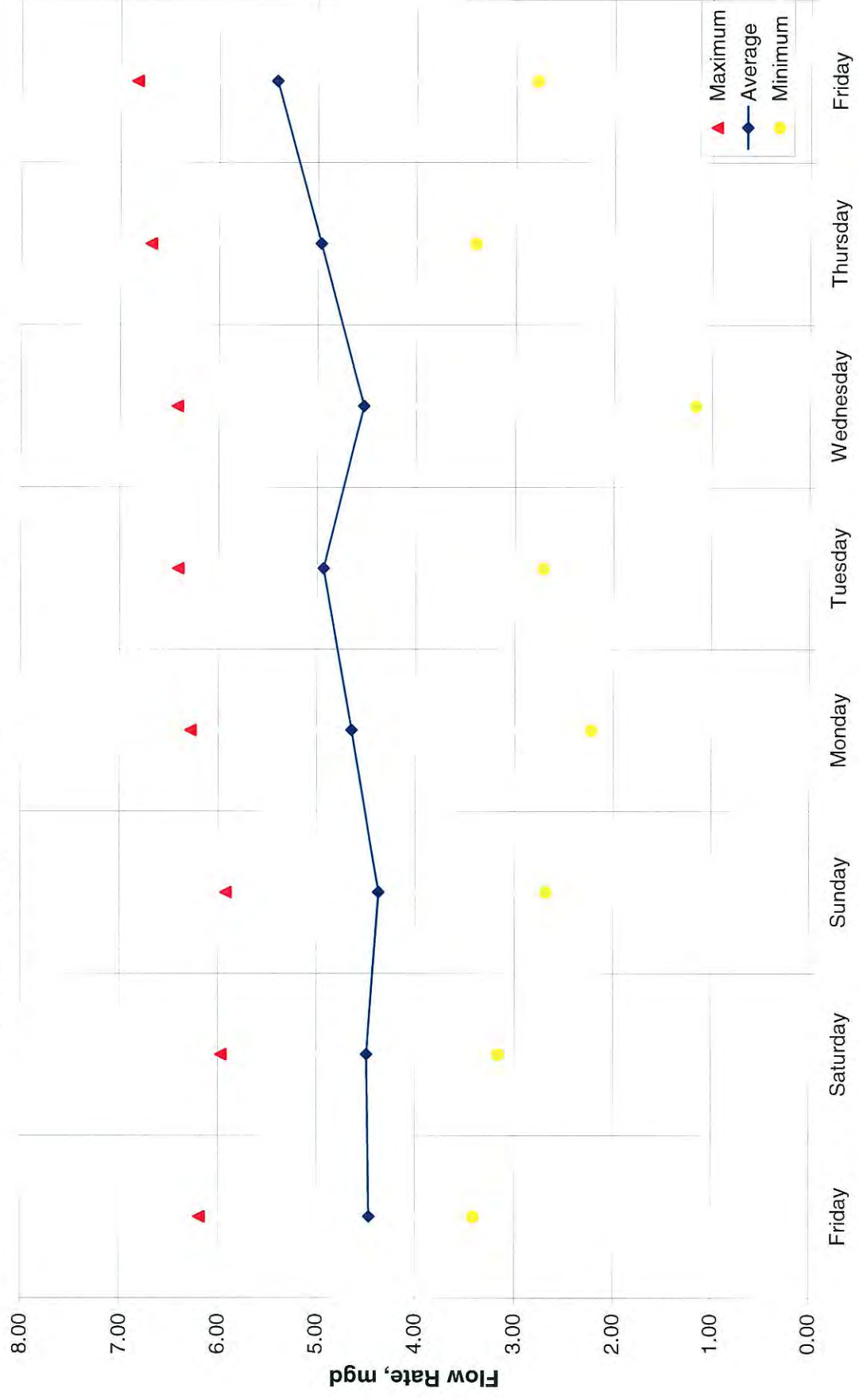


Reach IV-B  
Corona Flow Meter (Winter) - 4B-0110  
Period: 1 Week (Wed. to Wed.)  
Dates: 12/03/08 - 12/10/08

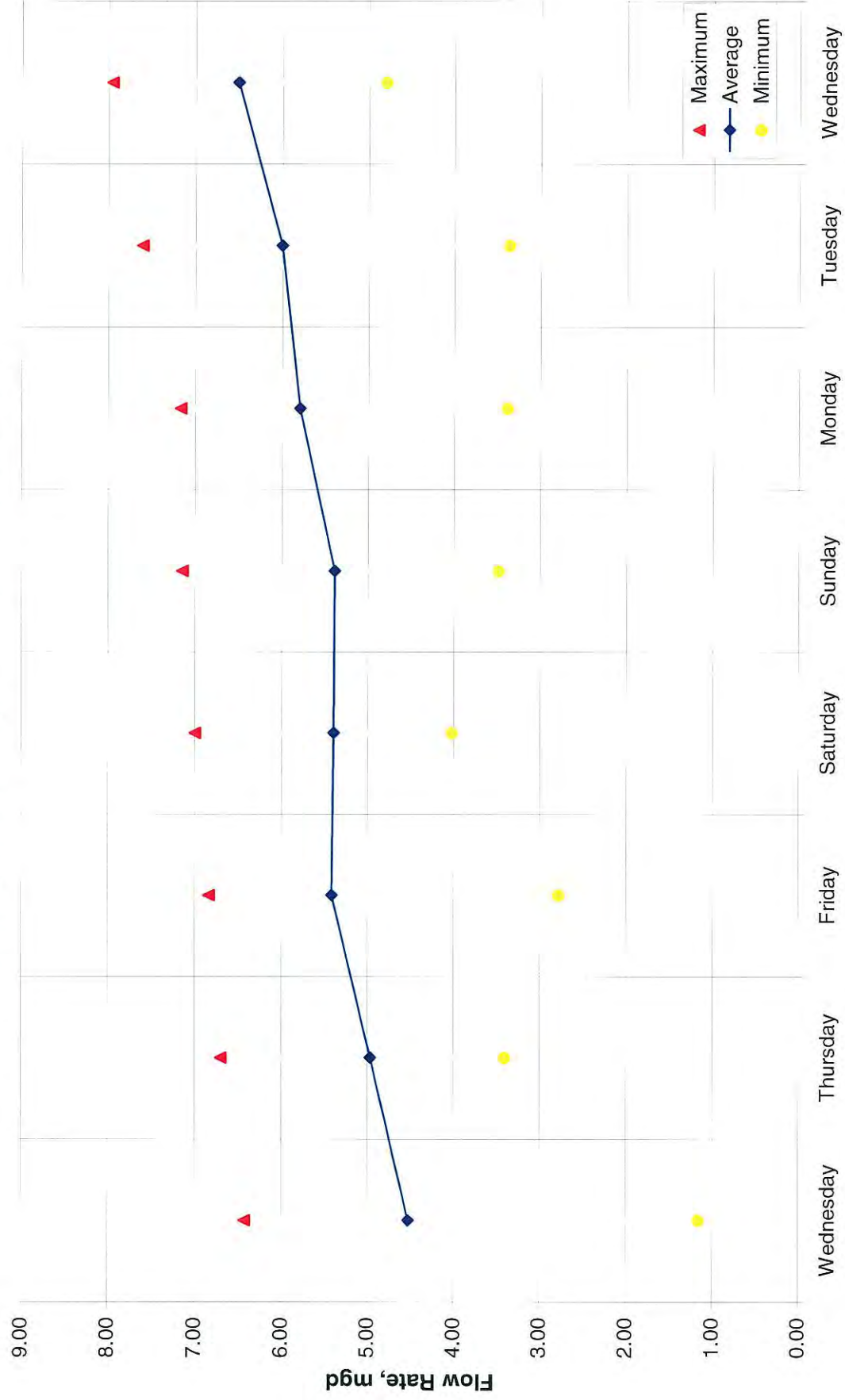




Reach IV-B  
Corona Flow Meter (Summer) - Manhole 4B-0110  
Period: 1 Week (Fri. to Fri.)  
Dates: 5/30/08 - 6/6/08

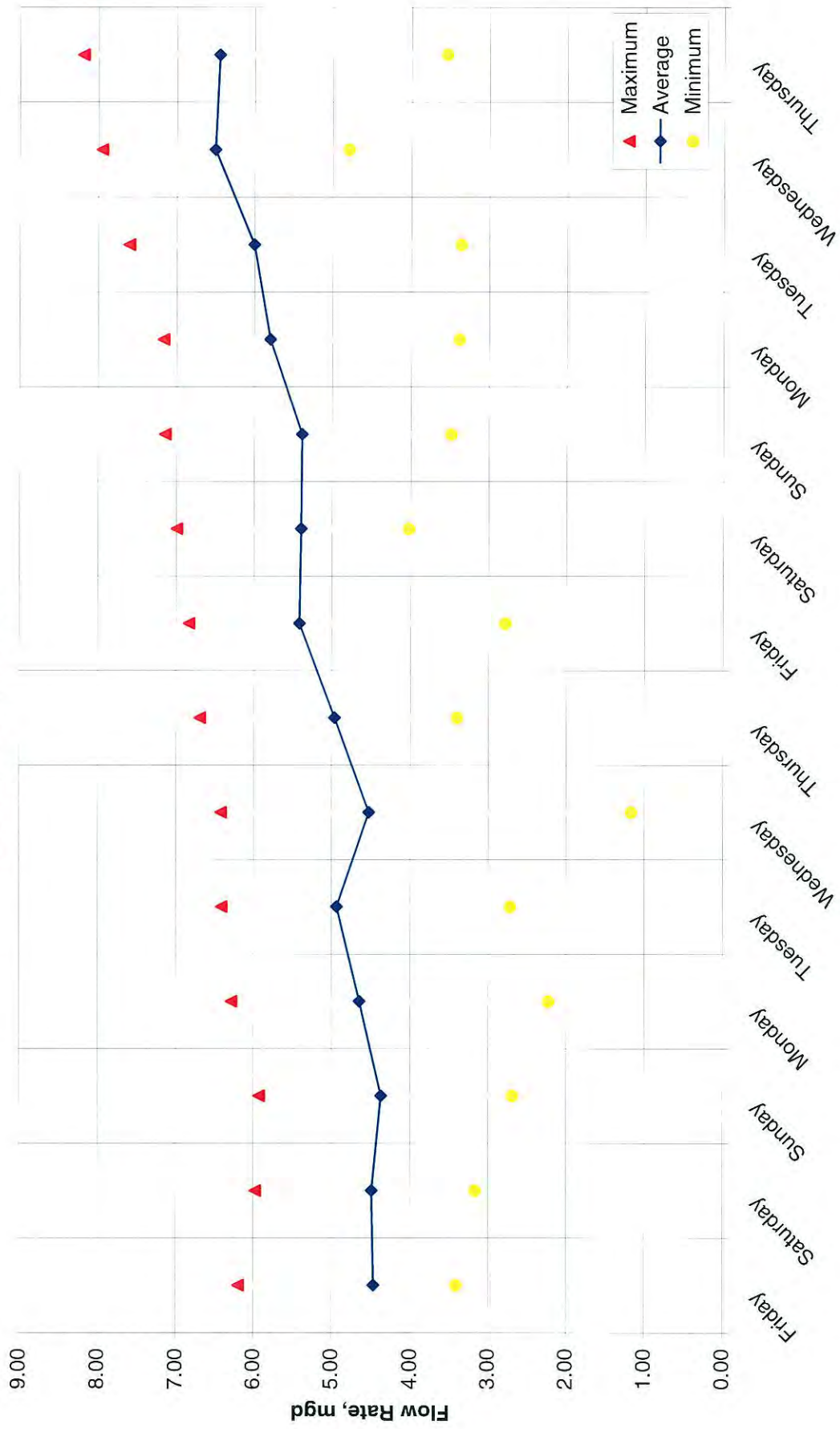


Reach IV-B  
Corona Flow Meter (Summer) - Manhole 4B-0110  
Period: 1 Week (Wed. to Wed.)  
Dates: 6/4/08 - 6/11/08





Reach IV-B  
Corona Flow Meter (Summer) - Manhole 4B-0110  
05/30/2008 - 06/12/2008



## **Appendix I**

### **By-Pass System Quote**



## Custom Estimate Developed Especially for:

John H. Harris  
Rbf Consulting  
9755 Clairemont Mesa Blvd 100  
San Diego, CA 92124  
Phone: 858-614-5016  
Fax: 858-614-5001

Prepared on 7/9/2009 by:



Rain  
for  
Rent

Michelle Gordon  
6400 Fischer Road  
Riverside, CA 92507  
Phone: 951-653-2171  
Fax: 951-656-1926

[www.rainforrent.com](http://www.rainforrent.com)



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Rain  
for  
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## Rental Estimate

www.rainforrent.com

6400 Fischer Road  
Riverside, CA 92507  
Phone: 951-653-2171  
Fax: 951-656-1926

Estimate Number: 10-036-283995

Prepared By: Michelle Gordon

Job Description:

\*Revised Budgetary Estimate for 36" Sewer  
Bypass/Elevation: 678'/Specific Gravity: 1/Rental Start Date:  
TBD/Rental Duration: 1 Cycle/Job is non-prevailing wage.  
(Estimate is for 1 Cycle = 28 days)

Customer: Rbf Consulting

Customer ID: Q23662

Address: 9755 Clairemont Mesa Blvd 100

City/State: San Diego, CA 92124

Contact: John H. Harris

Office: 858-614-5016

Fax: 858-614-5001

Location:

Highway 71 and Euclid Avenue Chino, CA and proceeds  
North along Prado Road.

Application: Sewer Bypass Materials: Raw Sewage Flow: 2500 gpm Suction Lift: 20 feet (ground level)  
Friction Loss: 36 psi Static Head: Open Dump

\*Rain for Rent Cycle = 28 Days.

### Rental Items

Qty	Unit	Duration	Item	Description	Day	Week	*Cycle	Extension
1	Each	1 *Cycle	+811045	PUMP-TRASH DV300i SKID - PRIMARY W/FLOATS	\$686.88	\$2,060.66	\$6,182.00	\$6,182.00
1	Each	1 *Cycle	+811045	PUMP-TRASH DV300i SKID - BACKUP W/FLOATS	\$454.55	\$1,363.66	\$4,091.00	\$4,091.00
1	Each	28 Day	+670502	SPILLGUARD-12'X50'X1'	\$24.00	\$0.00	\$0.00	\$672.00
10	Each	1 *Cycle	726314	ADAPT 12 FLGXGRV STL	\$0.00	\$0.00	\$24.06	\$240.60
8	Each	1 *Cycle	721198	ELL-IND-GRV-45DEG 12 GAL-STL	\$0.00	\$0.00	\$20.00	\$160.00
4	Jnt	1 *Cycle	950905	PIPE-IND-GRV 12x5 STL IPS 10GA	\$0.00	\$0.00	\$29.72	\$118.88
2	Each	1 *Cycle	722442	HOSE-RED STRIPE GRVxGRV 12x25	\$0.00	\$0.00	\$698.00	\$1,396.00
2	Each	1 *Cycle	721191	ELL-IND-GRV-90DEG 12 GAL-STL	\$0.00	\$0.00	\$48.13	\$96.26
100	Jnt	1 *Cycle	970930	PIPE-IND-GRV 12x30 ALUM 94	\$0.00	\$0.00	\$51.19	\$5,119.00
4	Jnt	1 *Cycle	970910	PIPE-IND-GRV 12x10 ALUM 94	\$0.00	\$0.00	\$28.18	\$112.72
4	Jnt	1 *Cycle	970905	PIPE-IND-GRV 12x5 ALUM 94	\$0.00	\$0.00	\$20.80	\$83.20
2	Jnt	1 *Cycle	970903	PIPE-IND-GRV 12x3 ALUM 94	\$0.00	\$0.00	\$10.41	\$20.82
2	Jnt	1 *Cycle	970901	PIPE-IND-GRV 12x1 ALUM 94	\$0.00	\$0.00	\$10.41	\$20.82
4	Each	1 *Cycle	721191	ELL-IND-GRV-90DEG 12 GAL-STL	\$0.00	\$0.00	\$48.13	\$192.52
4	Each	1 *Cycle	721197	ELL-IND-GRV-45DEG 10 GAL 10GA	\$0.00	\$0.00	\$20.00	\$80.00
4	Each	1 *Cycle	721218	ELL-IND-GRV-22.5DEG 12 GAL 10G	\$0.00	\$0.00	\$20.00	\$80.00
4	Each	1 *Cycle	721237	ELL-IND-GRV-11.25DEG 12 GAL	\$0.00	\$0.00	\$20.00	\$80.00
1	Each	1 *Cycle	721190	TEE-IND-GRV 12 GALV-STL 10GA	\$0.00	\$0.00	\$86.63	\$86.63
3	Each	1 *Cycle	323195	AIR VENT TEE 12" GROOVE	\$0.00	\$0.00	\$120.58	\$361.74
1	Each	1 *Cycle	321695	VALVE SPLIT-DISC-CHK PC-150 12	\$0.00	\$0.00	\$264.00	\$264.00
2	Each	1 *Cycle	720681	GATE VALVE 12" CAST IRON	\$0.00	\$0.00	\$118.00	\$236.00
2	Each	1 *Cycle	720457	TEE-RED 12x12x3 GRXGRXMIPT	\$0.00	\$0.00	\$86.63	\$173.26
2	Each	1 *Cycle	721083	GATE VALVE BR 3	\$0.00	\$0.00	\$23.41	\$46.82
2	Each	1 *Cycle	320025	ADAPTER 3MIPTX21/2FNST #72	\$0.00	\$0.00	\$26.65	\$53.30
157	Each	1 *Cycle	720770	CPLR-IND-GRV 12 HW STL 77	\$0.00	\$0.00	\$10.00	\$1,570.00
1	Each	1 *Cycle	MRC	MISC PIPE AND FITTINGS, IF NEEDED	\$0.00	\$0.00	\$441.44	\$441.44



Rental Sub Total: \$21,979.01

Sub Total: \$21,979.01

\*The Terms and Conditions of the Rain For Rent Rental and Acute Hazardous Waste Agreements, Credit Application, Invoice and this estimate contain the complete and final agreement between Rain For Rent and Customer and no other agreement in any way modifying or adding to any of said Terms and Conditions will be binding upon Rain For Rent unless made In writing and signed by a Rain For Rent Corporate Officer.

\*Payment terms are net 30 days from invoice date. A 1.5%/month late charge will be made on any past due invoices.

\*Estimate is valid for 30 days and is subject to credit approval.

\*Availability subject to change without notice.

\*Estimates are based on Customer supplied information and are subject to change based on actual requirements and usage.

Est. Delivery Hauling	\$800.00
Est. Pick-up Hauling	\$800.00

Est. Install Labor	\$4,500.00
Est. Removal Labor	\$4,500.00

Est. Services	\$0.00
Est. Fuel Surcharge	\$0.00

( Does Not Include Sales Tax )

Estimate Total: \$32,579.01

Date Prepared: 7/9/2009

Valid Until: 8/08/2009

\_\_\_\_\_  
Customer

\_\_\_\_\_  
Date

By signing this estimate, customer represents that customer has read and agreed to all terms of this estimate, including those on Terms & Conditions page and those on the Additional Specifications page (if applicable).



Estimate Number: 10-036-283995

## **Additional Specifications**

The following is for budgetary purposes only. Recommendation is for a 2500 gpm sewer bypass for RBF Consulting in the City of Chino, CA. Site elevation is 678' ASL. Maximum suction lift will be 20' and will require 30' of hose/pipe. Discharge is 3,000' and has not change in elevation. Discharge is open.

Rain for Rent Engineering recommends the use of (1) DV-300i pump @ 2500 gpm for primary pumping, (1) Additional DV-300i pump should be onsite for mechanical failure redundancy. Suction will be 12"x30' heavy duty suction hose. Discharge will be 12"x300' industrial groove aluminum pipe.

1. The rental rate for pumps and equipment with hour meters are based on an 8 hour day or 48 hour running week. The rental rate will be multiplied by 1.5 for greater than 8 hours per day or 49-96 operating hours per week and multiplied by 2.0 for more than 16 hours per day or 96 operating hours per week. Customer will be invoiced for 24 hours per day if the hour meter has stopped functioning.

2. Customer is responsible for all routine maintenance including fuel fluids, lubrication and filters. Engines require service every 150 hours that can be provided upon request for an additional service charge of \$327.16 and \$175.00 per service trip, see Terms and Conditions #26. Customer must notify Rain for Rent how they want to handle maintenance.

3. Fuel consumption for the DV-300i estimated duty point is 1.5 gph and fuel tank capacity is 300 gallons per pump.

4. AQMD Permit Fee is \$75.00 each per cycle for the DV-300i pumps.

5. A fuel surcharge will be invoiced on the transportation only, see Terms and Conditions #21.

6. Environmental Recovery Fee is \$35.00 per pump.

7. Customer us have forklift or backhoe to help off load and set in place pump. If not a boom truck can be used at an additional charge of \$165.00 an hour portal to portal. Customer must have forklift or backhoe to help load pump back onto Rain for Rent truck when equipment comes off of rent too or we can use a boom truck at an additional cost of \$165.00 an hour portal to portal. Customer to let Rain for Rent know how they want to handle this.

8. Estimate only, billing will reflect materials utilized +/- . Additional labor will be added due to circumstances beyond our control.

9. A 500 gallon fuel nurse tank can be rented at an additional cost of \$300.00.

10. Estimate does not include tax.

11. This estimate is based on non prevailing wage. If this project is to be found prevailing wage the labor rate will be adjusted.

12. Customer must provide all safety control.

13. Rain for Rent must do a final job walk prior to any equipment being delivered or installed to jobsite location.





Estimate Number: 10-036-283995

## **Terms & Conditions**

### **Additional Terms**

1. A cycle is defined as 4 weeks. A week is defined as one third of a cycle and a day is one third of a week. Customers will be invoiced at the appropriate cycle, weekly or daily rate based on actual equipment usage except for filtration, pipe, hose and fittings which will be billed at the cycle rates only and will not be pro-rated.
2. The rental rate for pumps and equipment with hour meters are based on an 8 hour day or 48 hour running week. The rental rate will be multiplied by 1.5 for greater than 8 hours per day or 49-96 operating hours per week and multiplied by 2.0 for more than 16 hours per day or 96 operating hours per week. Customer will be invoiced for 24 hours per day if the hour meter has stopped functioning.
3. Overtime will be invoiced at 1.5 times the regular rate for work occurring outside of normally scheduled business hours and 2.0 times the regular rate for work occurring on company recognized holidays.
4. Customer shall pay for any changes to work scope including but not limited to schedule changes, material, labor, third party, permit, fee or service costs. It is the Customer's responsibility to cooperate in the timely processing, approval and payment of any charges within Rain For Rent's invoice terms.
5. Customer is responsible to determine the suitability of equipment for the application.
6. Delivery, Return, Installation and Removal costs are estimated. Customer will be invoiced for actual time. Transportation will be invoiced on a Portal to Portal basis.
7. Customer is responsible for flushing and cleaning tanks, roll off boxes, pipelines, pumps, filters and other Rain for Rent equipment prior to return.
8. Customer is responsible for equipment, repairs, maintenance and damage, excluding normal wear and tear. All returned equipment is subject to inspection by Rain for Rent personnel. Damages and accrued rent will be invoiced to Customer while equipment is out of service for repairs.
9. The Customer cannot alter the equipment without Rain For Rent's prior written approval.
10. Customer will provide "all risk" property insurance for rented equipment.
11. Customer will not allow any equipment to come in contact with any substance that will cause corrosion, damage or leakage.
12. The Customer assumes all risks of loss due to operation and use of the equipment.
13. Customer is responsible to obtain any permits, licenses, certificates, bonds and give all notices required by law.
14. The rental period begins the day the equipment is delivered and continues until returned to Rain For Rent's facility unless written confirmation of the release is provided to the Customer before that time.
15. Rental equipment must be returned to the renting Rain for Rent branch unless agreed to in writing before the rental period begins.
16. All material that comes in contact with Rain For Rent equipment including media is the responsibility of Customer as generator. Rain For Rent shall not be responsible for any fines or sanctions as a result of Customer's use of the equipment.
17. The equipment is sold "AS IS, WHERE IS" in its present condition. Seller makes no warranties, expressed or implied of any kind whatsoever with respect to the equipment. Buyer agrees that buyer has purchased the equipment based on his judgement and evaluation, without reliance upon any statements of representations of seller, and that seller is not responsible for any defects in its operation or for any repairs, parts or services, unless otherwise noted.
18. De-watering, Roll-off, Vacuum boxes and similar equipment are not liquid tight. Rentee accepts full responsibility for all losses, damages and costs caused by or arising out of spills, leakage or discharge from this equipment.
19. Customer will use the equipment in a careful and proper manner and in accordance with safety rules, industry standards, manufacturer's specifications, recommendations, regulations and applicable laws
20. Customer shall be responsible for environmental fees covering waste fluid, fuel, filter and other disposal costs.
21. A Fuel Surcharge will be calculated and invoiced based on the diesel fuel price as published by the Department of Energy on <http://tonto.eia.doe.gov/oog/info/wohdp/diesel.asp>
22. Customer shall pay Rain For Rent additional expenses caused by site, soil or underground conditions, including, but not limited to, rock formations, environmental conditions, regulations or restrictions, hard pan, boulders, cesspools, gas lines, water lines, drain pipes, underground electrical conduits or other above ground or underground obstructions.
23. Customer shall be responsible for acquiring and paying for, if necessary, all public and private property easements required by the project.
24. The estimated labor component of this quote is based on non-prevailing wage rates. If prevailing wage laws are applicable, Customer must notify Rain For Rent in writing before Rain For Rent estimate completed. If Rain For Rent was not properly notified, Customer shall promptly pay any change orders that adjust wages to prevailing wage rates. Customer is responsible for providing applicable prevailing wage rates to Rain for Rent. Rain For Rent will provide certified payrolls on a bi-weekly basis if notified in writing 10 days before the start of the project.
25. Customer is prohibited from deducting retention from Rain For Rent invoices and charging Rain for Rent liquidated damages.
26. Customer is responsible for all routine maintenance including fuel, fluids, lubrication and filters every 150 hours on engine driven equipment. Rain For Rent will charge Customer for servicing any equipment that is on rent or returned that has not been serviced in 150 hours. Rain For Rent can provide field service upon request for an additional service charge. Rain For Rent must be notified 2 business days in advance to schedule required field service.
27. This estimate excludes any additional costs to Rain For Rent associated with Owner Controlled Insurance (OCIP) or WRAP insurance programs that will be added to Rain For Rent's prices.
28. Customer is responsible to provide freeze protection for all equipment on site.
29. Customer will be responsible for security, traffic control and road crossings. Traffic control shall meet all applicable Federal, State, and Municipal laws and regulations to assure a safe work environment.

30. Cold Weather Packages for tanks consist of up to 4 tank heaters and a submersible pump which is designed for use in a non-combustible or corrosive environment.
31. Tank heaters are operated on 120 volts, 12.5 amps each or 50 amps total. The submersible pump operates at 120 volts, 10 amps.
32. Customer is responsible for electrical connections and compliance with applicable permits, regulations and code requirements.
33. Tank Cold Weather Packages are not to be used in combustible or corrosive environments.
34. Tank Cold Weather Packages are a preventative measure that may keep fluids inside the tank from freezing. RFR will not guarantee fluids from freezing and any resulting damages.

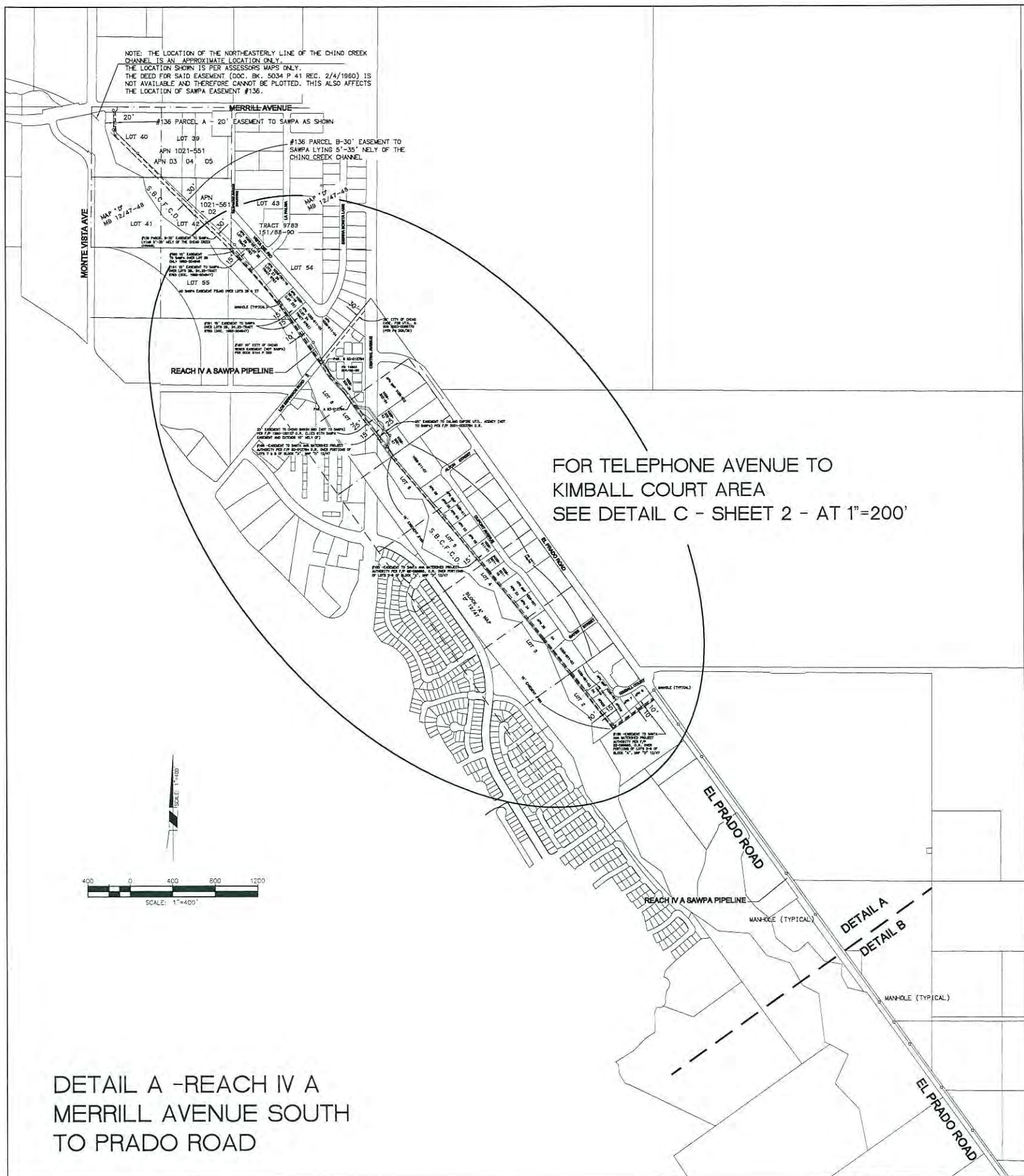
### **Job Specific Terms**

35. Customer is responsible for any certifications or permits required for the sewage bypass project.
36. Customer will provide written verification of maximum or peak flow rates and any additional wet weather flow rates additional charges will be incurred if flow rates are exceeded.
37. Rain for Rent recommends a 100% backup system including all components for any sewage pumping or piping project.
38. Customer is to supply contact names, phone numbers, and emergency contact number for job superintendent.
39. Rain for Rent will not operate or monitor the bypass system. The customer is responsible for the onsite management and operation of the system.
40. At no charge to Rain For Rent and at their request the Customer will supply equipment to complete onsite bypass installation, including but not limited to: forklift, crane truck, backhoe, vacuum truck, light towers, etc.
41. Customer will be responsible for providing a portable restroom and clean water on site.
42. Customer must supply clean water source for hydrostatic test.
43. Rain for Rent will hydrostatically test the sewage bypass piping to insure the soundness of the piping and gaskets.
44. The Customer will be responsible for any leakage from the bypass system.
45. Rain for Rent will supply isolation valves and chlorination / flush/ hydrostatic test ports at the beginning and end of the sewage bypass piping.
46. Customer will be responsible for cleaning, pigging and flushing of Rain for Rent rental equipment with clean, chlorinated water and swab dry prior to equipment release and return to Rain for Rent.
47. Customer will be responsible for routine pump maintenance including fuel, changing fluids and filters every 150 hours.
48. Customer is responsible for periodic testing of the automatic backup start system (float style). Daily testing is recommended.
49. Rain For Rent will not supply, install, maintain or remove the sewer line plug except it may remove the plug in case of emergency. Customer will fully indemnify Rain for Rent for any loss or damage caused by the removal or failure of the sewer line plug.
50. Customer must notify Rain for Rent immediately of any spill so that any necessary repairs to the bypass system can be made and to minimize service interruption.
51. Rain for Rent installation is limited to equipment set up, suction, discharge and pipeline assembly. All trenching, grading, trench plate and associated site construction is the responsibility of the customer.
52. Customer is responsible for site odor control and sand bagging storm drains.
53. Customer is responsible for spill prevention, control and countermeasure plan (SPCC).
54. Customer shall hold harmless, indemnify and defend Rain For Rent from any claims whatsoever, arising from or related to (A) any pollution, contamination, environmental impairment and/or similar condition directly or indirectly caused by or resulting in whole or in part from Customer's use of any Equipment or (B) any environmental statutory or regulatory compliance requirements applicable to any equipment (or any use thereof) and required under any and all foreign or domestic federal, state or local laws, ordinances, regulations, codes, or requirements of any governmental authorities which regulate or impose standards of liability or conduct concerning air, water, soils, wetlands and watercourses, solid waste, hazardous waste and/or materials, worker and community right-to-know, noise, resource protection, health protection and similar environmental, health, safety, and land use concerns as may now or at any time hereafter be in effect. This indemnification shall survive the termination of the agreement.

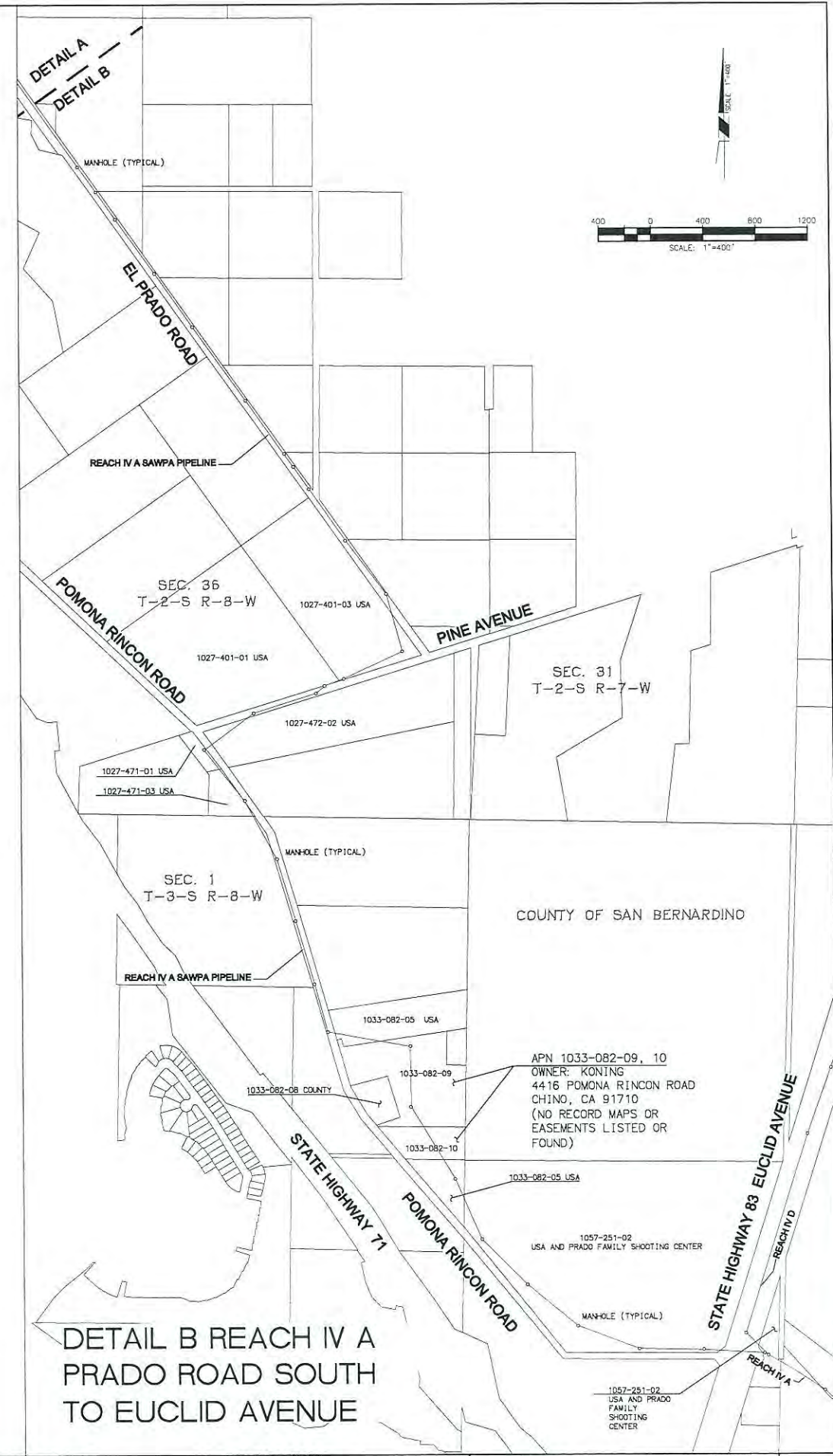


## **Appendix J**

### **Right-of-Way and Easement Map**



DETAIL A -REACH IV A  
MERRILL AVENUE SOUTH  
TO PRADO ROAD



DETAIL B REACH IV A  
PRADO ROAD SOUTH  
TO EUCLID AVENUE





DETAIL C - KIMBALL COURT TO TELEPHONE AVENUE

PREPARED FOR: SANTA ANA WATERSHED PROJECT AUTHORITY  
PROJECT SITE: CITY OF CHINO, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA  
PORTIONS OF SANTA ANA WATERSHED PROJECT AUTHORITY SARI PIPELINE - REACH IV A  
EXISTING KNOWN EASEMENTS EXHIBIT

SURVEY PARTY: CHIEF REVIEW  
SURVEY DATE: JULY 2, 2009  
DRAWN BY: D. WARSOLINI  
JOB NO.: 08-15-103029  
PLOT DATE: 08/05/09  
SCALE: 1"=200'  
NOTEBOOK: ---

PLANNING ■ DESIGN ■ CONSTRUCTION  
**RBF**  
CONSULTING  
9755 CLAYMONT MESA BOULEVARD, SUITE 100  
SAN DIEGO, CALIFORNIA 92124-0024  
619.454.5000 • FAX 619.454.5001 • WWW.RBF.COM

SHEET  
2 OF 2

## **Appendix K**

### **Caltrans Encroachment Permit**





23 JUL 09 12 23

July 23, 2009

PERMIT OFFICE JN-25-103871.001

State of California  
Department of Transportation - District 8  
Office of Permits, MS-619  
464 West 4<sup>th</sup> Street  
San Bernardino, CA 92401-1400  
Attention: Mr. Kevin Dinh

**SUBJECT:    REPAIRS TO UNLINED RCP, REACHES IV-A AND IV-B PROJECT  
REQUEST FOR CALTRANS ENCROACHMENT PERMIT  
TO PERFORM REHABILITATION TO EXISTING 27-INCH RCP  
WITHIN SR-83 (EUCLID AVENUE) AT POMONA RINCON ROAD  
ON BEHALF OF SANTA ANA WATERSHED PROJECT AUTHORITY**

Dear Mr. Dinh:

On behalf of Santa Ana Watershed Project Authority (SAWPA), RBF Consulting is hereby submitting the attached application for Caltrans encroachment permit to perform rehabilitation of an existing 27-inch reinforced concrete pipe (RCP) within SR-83 at Pomona Rincon Road. The proposed rehabilitation requires that SAWPA place a cured-in-place liner within the RCP, which currently carries industrial waste sewer to the Orange County Sanitation District. The liner insertion and receiving areas will be placed outside Caltrans R/W, with no soil disruption or traffic impacts anticipated.

The following items are submitted for distribution:

1. Encroachment permit application
2. Six (6) copies of RCP Repairs Exhibit
3. Letter of Authorization allowing RBF Consulting to process the Permit

Should you have questions or require additional information, please contact me at (949) 855-5700. SAWPA would like this Permit to be current from September 1, 2009 through August 31, 2010. Thank you for your attention to this request.

Sincerely,

David P. Brandt  
Senior Project Coordinator  
Land Development/Transportation - Planning

H:\pdata\25-103871\Permits\Caltrans\07212009 Caltrans Permit LTR (Pipe Rehab SR-83).doc

PLANNING ■ DESIGN ■ CONSTRUCTION

14725 Alton Parkway, Irvine, CA 92618-2027 ■ P.O. Box 57057, Irvine, CA 92619-7057 ■ 949.472.3505 ■ Fax 949.472.8373

Offices located throughout California, Arizona & Nevada ■ [www.RBF.com](http://www.RBF.com)

printed on recycled paper

Mr. Kevin Dinh  
July 23, 2009  
Page 2

Enclosures

cc: David Ruhl / SAWPA\*  
Jennifer Chan, John Harris / RBF\*  
Carlos Ortiz, John Dorado / RBF\*  
\*(with enclosures)





STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION  
**ENCROACHMENT PERMIT**  
 TR-0120 (REV. 6/2000)

In compliance with (Check one):

- ☒ Application of \_\_\_\_\_ July 23, 2009
- ☐ Utility Notice \_\_\_\_\_ of \_\_\_\_\_
- ☐ Agreement \_\_\_\_\_ of \_\_\_\_\_
- ☐ R/W Contract \_\_\_\_\_ of \_\_\_\_\_

Permit No. <u>08-09-N-DM-0577</u>	
Dist/Co/Rte/PM <u>08-SBD-83 PM 0.558</u>	
Date <u>08/11/2009</u>	
Fee Paid \$ <u>EXEMPT</u>	Deposit \$ <u>EXEMPT</u>
Performance Bond Amount (1) \$ <u>0.00</u>	Payment Bond Amount (2) \$ <u>0.00</u>
Bond Company _____	
Bond Number (1) _____	Bond Number (2) _____

TO: Santa Ana Watershed Project Authority  
 W.O. 25-103871.001  
 11615 Sterling Avenue  
 Riverside, CA 92503

Attn: David P. Ruhl (951) 354-4223

, PERMITTEE

and subject to the following, PERMISSION IS HEREBY GRANTED to:

Enter State Route 83 (Euclid Avenue) at Pomona Rincon Road in the City of Chino, County of San Bernardino to install epoxy liner inside the existing 27-inch RCP between MH4A-0180 and MH4A-0190 per plan date stamped August 11, 2009 by California Department of Transportation, District 8 Encroachment Permits Office, and/or as directed by the Department Representative.

Notwithstanding General Provision #4, your contractor is required to apply for and obtain an encroachment permit prior to starting any work within the State right-of-way. The contractor is required to submit one copy of the bonds and deposit \$410 at the time of application.

A pre-job meeting with the assigned Department Representative, Ray Behbahani, 909-383-6348, is required prior to start of any work under this permit. Failure to do so may result in permit revocation with no prejudice.

**THIS PERMIT IS NOT A PROPERTY RIGHT AND DOES NOT TRANSFER WITH THE PROPERTY TO A NEW OWNER.**

The following attachments are also included as part of this permit (Check applicable):

- ☒ Yes ☐ No General Provisions
- ☒ Yes ☐ No Utility Maintenance Provisions
- ☒ Yes ☐ No Storm Water Special Provisions
- ☒ Yes ☐ No Special Provisions
- ☐ Yes ☒ No A Cal-OSHA permit, if required: Permit No. \_\_\_\_\_
- ☐ Yes ☒ No As-Built Plans Submittal Route Slip for Locally Advertised Projects
- ☐ Yes ☒ No Storm Water Pollution Prevention Plan / Water Pollution Control Plan

In addition to fee, the permittee will be billed actual costs for:

- ☐ Yes ☒ No Review
- ☐ Yes ☒ No Inspection
- ☒ Yes ☐ No Field Work

(if any Caltrans effort expended)

- ☐ Yes ☒ No The information in the environmental documentation has been reviewed and considered prior to approval of this permit.

This permit is void unless the work is completed before August 11, 2010

This permit is to be strictly construed and no other work other than specifically mentioned is hereby authorized.

No project work shall be commenced until all the other necessary permits and the environmental clearances have been obtained.

PERMIT ENGINEER: John Mutyaba  
 COPIES TO:  
 Mtlce Supt: Dave Hennings  
 Field Permit Engineer: Ray Behbahani  
 File: 08-09-N-DM-0577  
 RBF Coordinator: Dave Brandt

APPROVED:

RAYMOND W. WOLFE, PhD, District Director

BY:

*Fareha Zinnurayen*

FAREHA ZINNURAYEN, P.E., District Permit Engineer



PAGE 1: ATTACHED TO AND MADE PART OF PERMIT NO. 08-09-N-DM-0577

In addition to the attached General Provisions, the following checked special provisions are applicable:

☒ A PRE-JOB MEETING WITH THE ASSIGNED DEPARTMENT'S REPRESENTATIVE, Ray Behbahani, 909-383-6348 IS REQUIRED PRIOR TO START OF ANY WORK UNDER THIS PERMIT. FAILURE TO DO SO WILL RESULT IN PERMIT CANCELLATION AND RESUBMITTAL MAY BE REQUIRED.

☐ Notwithstanding General Provision #4, your contractor is required to apply for and obtain an encroachment permit prior to starting work. A fee/deposit of \$                      for inspection, and \$                      for electrical equipment is required at the time of application.

☒ You are required to submit an approved Storm Water Pollution Prevention Plan (SWPPP) for projects with a cumulative disturbed soil area equal or greater than 1 acre, and an approved Water Pollution Control Program (WPCP) for projects with a disturbed soil area less than 1 acre, unless otherwise required by other agencies (RWQCBs, U.S. Army Corps of Engineers, Department of Fish and Game, etc.).

☐ Upon the expiration of this permit, the Permittee is required to apply for the countywide annual maintenance permit for this new facilities installed under the Permit No.:                                     .

☒ The Permittee is required to apply for a separate permit to maintain and/or replace in kind of these facilities on each occurrence upon the expiration of this permit.

☐ The Permittee shall provide the stage construction traffic handling plans, work schedule and a list of all sub-contractors to the Department's Representative at the time of the pre-construction meeting or prior to start construction.

☒ All traffic control, signing and striping shall comply with 2006 California MUTCD. It is available at: [http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/ca\\_mutcd.htm](http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/ca_mutcd.htm)

☒ Contractor shall comply with Department 2006 Standard Specifications, Department 2006 Standard Plans, Revised Standard Plans and the project special provisions. The latest Revised Standard Plans are available at: [http://www.dot.ca.gov/hq/esc/oe/project\\_plans/HTM/stdplans-US-customary-units-new06.htm](http://www.dot.ca.gov/hq/esc/oe/project_plans/HTM/stdplans-US-customary-units-new06.htm)

☒ All personnel shall wear hard hats and orange or lime vests, shirts or jackets as appropriate while on State property.

☒ The Permittee's work shall be subordinated to any operations which the Department may conduct and shall not delay, nor interfere with the Department's Forces or Department's Contractors.

☒ Attention is directed to Standard Specifications Section 7-1.11, Preservation of Property, and Business and Professions Code, Section 8771. The Permittee shall physically inspect the work site and locate survey monuments prior to work commencement. Monuments shall be referenced or reset in accordance with the Business and Professions Code.

☒ No lane may be closed or obstructed at any time unless specifically allowed per the encroachment permit,



PAGE 2: ATTACHED TO AND MADE PART OF PERMIT NO. 08-09-N-DM-0577

shown in approved traffic control plans, and/or as directed by the Department's Representative.

☒ Except for installing, maintaining and removing traffic control devices, any work encroaching within 3 feet of the edge of a travel lane for areas with a posted speed limit below 45mph, or 6 feet of the edge of a travel lane, for areas with a speed limit posted at 45mph or higher, shall require closing of that travel lane. Any work encroaching within 6 feet of the edge of the shoulder, shall require closing of that shoulder. Permittee shall notify the Department's Representative, and obtain approval of, all traffic control, lane closures or detours, at least seven (7) WORKING DAYS prior to setting up of any traffic control.

☒ Traffic control is generally authorized between 9:00 AM and 3:00 PM only on Monday through Thursday and until 1:00 PM on Fridays, excluding holidays except specified in the Permit. Lane closure is not allowed on Saturdays, Sundays and designated holidays. The designated holidays are: January 1st, the third Monday in January, the second and third Mondays in February, March 31, the last Monday in May, July 4th, the first Monday in September, the second Monday in October, November 11th, Thanksgiving Day, the day after Thanksgiving Day, and December 25th. When a fixed holiday falls on Saturday, the preceding Friday shall be designated as holiday.

☒ Should any deviation from these procedures or conditions be observed, all work shall be suspended until satisfactory steps have been taken to ensure compliance.

☒ If time extension is necessary, a request for time extension and the accompanying attachments must be made a minimum of two (2) weeks prior to completion date stated on face of permit. If work has not been started before completion date, the permit will be voided. Failure to comply with rules and regulations stated on permit will jeopardize future permit privileges.

☐ "AS-BUILT" PLANS ARE REQUIRED UPON COMPLETION OF ALL WORK. PLEASE REFER TO THE GENERAL PROVISION TR-0046, ITEM 22 FOR THE "AS-BUILT" REQUIREMENTS. NO FINAL INSPECTION WILL BE PERFORMED UNTIL THE DEPARTMENT IS IN RECEIPT OF "AS-BUILT" PLANS.

☒ No vehicle or equipment shall be stored overnight within the right of way; it shall be removed immediately at the completion of the day's work. Refueling of vehicle or equipment within the right of way is strictly prohibited.

☒ Required traffic control devices shall be installed around fixed objects to warn the motoring public for safety. Personal vehicles of the contractor shall not be parked within freeway right of way.

☒ No materials or waste shall be stockpiled within State right of way.

☒ Except as specifically provided herein, all requirements of the Vehicle Code and other applicable laws must be complied with in all particulars.

☒ When traffic cones or delineators are used to delineate a temporary edge of traffic lane, the line of cones or delineators shall be considered to be the edge of the traffic lane. The permittee shall not reduce the width of the existing lane to less than 10 feet without written approval from the Department's Representative.

☒ Excavations made within the limits of the right of way shall be backfilled and resurfaced to original condition before leaving the work area unless otherwise authorized by the Department's Representative.

☒ Permittee shall be responsible for arranging the services of a qualified traffic control contractor to provide



PAGE 3: ATTACHED TO AND MADE PART OF PERMIT NO. 08-09-N-DM-0577

ry needed traffic control.

☒ The permittee shall arrange a meeting between his field representative, traffic control contractor, Department's Representative and/or CHP at least two (2) weeks prior to start of any work covered under this permit to arrange date and time of starting work and determine appropriate methods of handling traffic. At least 3 working days notice shall be given to the Caltrans representative and/or the CHP, prior to the meeting to allow time to arrange for attendance.

☒ A copy of this permit, complete with all attachments, shall be kept by permittee/contractor working under this permit and must be shown to the Department Permit Inspector, Department's Representatives, or Law Enforcement Officer, on demand.

☒ The permittee shall be responsible for notifying the appropriate utility companies or underground service alert prior to any excavation work.

☒ The permittee shall notify the California Highway Patrol Area Commander at least 72 hours prior to implementing traffic control.

☒ When the work area encroaches upon a sidewalk, walkway, or crosswalk area, special consideration must be given to pedestrian safety. Protective barricades, fencing, handrails and bridges, together with warning and guidance devices and signs must be utilized so that the passageway for pedestrians, especially blind and other physically handicapped, is safe and well defined and shown on the approved permit plan.

☒ Pedestrian walkways and canopies within State Right of Way shall comply with the requirements of the applicable local agency or of the latest edition of the Uniform Building Code whichever contains the higher standards.

[For City or County projects with utility relocations:]

☒ If existing public or private utilities conflict with the construction PROJECT, PERMITTEE will make necessary arrangements with the owners of such utilities for their protection, relocation, or removal. PERMITTEE shall inspect the protection, relocation, or removal of such facilities. Total costs of such protection, relocation, or removal which STATE or PERMITTEE must legally pay, will be borne by PERMITTEE. If any protection, relocation, or removal of utilities is required, including determination of liability for cost, such work shall be performed in accordance with STATE policy and procedure. PERMITTEE shall require any utility company performing relocation work in the STATE's right-of-way to obtain a State Encroachment Permit before the performance of said relocation work. Any relocated utilities shall be correctly located and identified on the as-built plans.

[For other projects with utility relocations:]

☐ If existing public or private utilities conflict with the construction PROJECT, PERMITTEE will make necessary arrangements with the owners of such utilities for their protection, relocation, or removal. PERMITTEE shall inspect the protection, relocation, or removal of such facilities. Total costs of such protection, relocation, or removal shall be borne by PERMITTEE in compliance with the terms of the Highway Encroachment Permits, Case Law, Public Utility Regulations, and Property Rights. PERMITTEE shall require any utility company performing relocation work in the STATE's right-of-way to obtain a State Encroachment Permit before the performance of said relocation work. Any relocated utilities shall be correctly located and identified on the as-built plans.



PAGE 4: ATTACHED TO AND MADE PART OF PERMIT NO. 08-09-N-DM-0577

In addition to the attached General Provisions (TR-0045), the following special provisions are also applicable.

1. Drains must be restricted to the exclusive purpose of draining rain water from the roof of permittee's building and/or paved parking lot. Drains if used for any other purpose, such as draining waste water or domestic supply water into the highway, will not be authorized. Drains shall be installed at right angles to the curb line unless otherwise authorized.
2. Removal of PCC Sidewalks or Curbs: Concrete sidewalks or curbs shall be saw cut to the nearest score marks and replaced equal in dimension to that removed with score marks matching existing adjacent sidewalk or curb.
3. After pipe drains are installed, curb and sidewalk shall be replaced with Portland Cement Concrete in accordance with State Standard Specifications.

PAGE 5: ATTACHED TO AND MADE PART OF PERMIT NO. 08-09-N-DM-0577

PERMIT NO.: 08-09-N-DM-0577

CO/RTE/PM: 08/SBD/83/0.558

### PRECONSTRUCTION MEETING AGREEMENT

I, \_\_\_\_\_, acting as an authorized agent for the permittee, \_\_\_\_\_, do hereby agree to personally accomplish or have another designated person arrange for all involved company representatives to attend a pre-construction meeting with the authorized Department's Representative at \_\_\_\_\_, as specified on this permit. Such meeting must be held two (2) days or more prior to the planned start of the work on this project. The Authorized Department's Representative shall have complete authority to determine whether the permit conditions, either implied or written, have been complied with. The Department's Representative may then allow the permit work to proceed as appropriate. The Pre-construction Meeting Record below must be signed by both the Department's Representative and the permittee before the permit work may start.

I have read and understand the attached General Provisions TR-0045 and other attached provisions of this permit.

This agreement or a copy thereof, must be mailed back to the Department's District 8 Encroachment Permit Office at 464 W. 4th. Street, MS 619, San Bernardino, CA 92401-1400, within three (3) working days prior to the pre-construction meeting. Failure to return this form could delay the release of your bonds. A copy of this document shall be at the job site at all times when work is in progress and failure to do so may result in the suspension of work, as directed by the Department's Representative.

It is the permittee's responsibility to insure that the Department's Representative is notified of work completion and that the attached Completion Notice is mailed to the Department's Permit office.

Signature Date

Print or Type Name

Position or Title



PAGE 6: ATTACHED TO AND MADE PART OF PERMIT NO. 08-09-N-DM-0577

**PRECONSTRUCTION MEETING RECORD**

Department's Representative

Date

Permittee's Representative

Date

Date Work May Begin: \_\_\_\_\_

PAGE 7: ATTACHED TO AND MADE PART OF PERMIT NO. 08-09-N-DM-0577

PERMIT NO.: 08-09-N-DM-0577  
CO/RTE/PM: 08/SBD/83/0.558

DEPARTMENT OF TRANSPORTATION-DISTRICT 8  
ENCROACHMENT PERMITS OFFICE  
464 W. 4th. Street, MS 619  
San Bernardino, CA 92401-1400

**100% COMPLETION NOTICE**

Work on Permit No.: 08-09-N-DM-0577 has been completed. A final inspection meeting was held on

Permittee's Representative

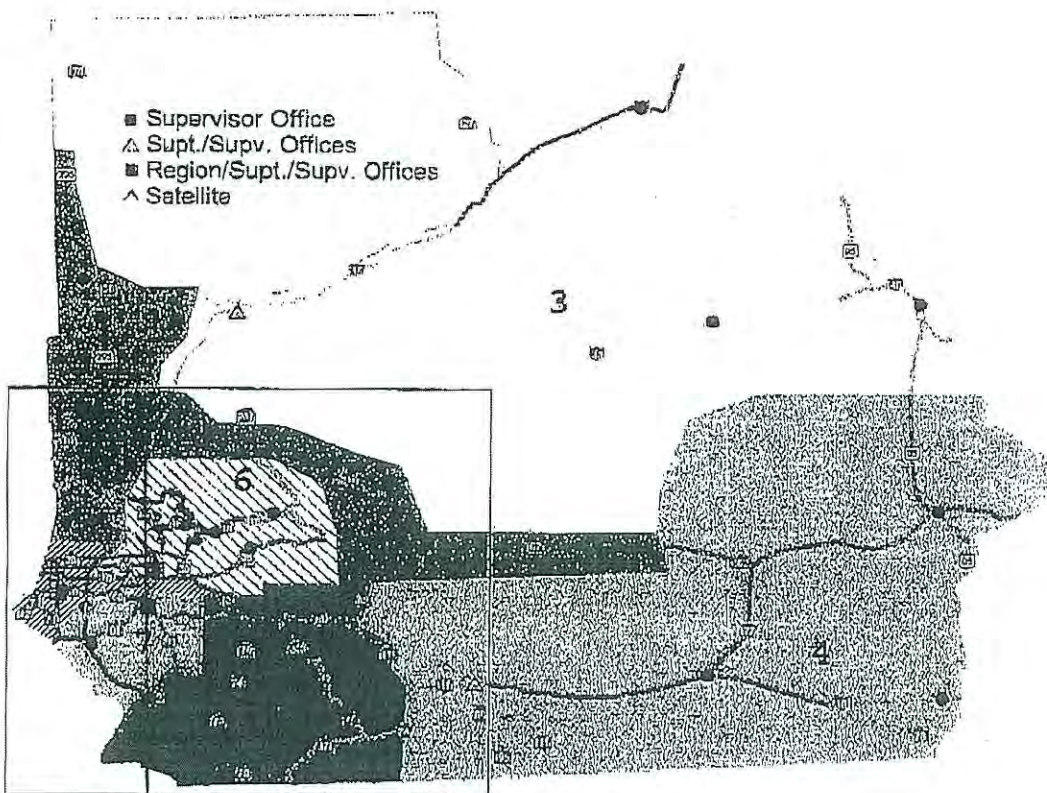
Date

Department's Representative

Date

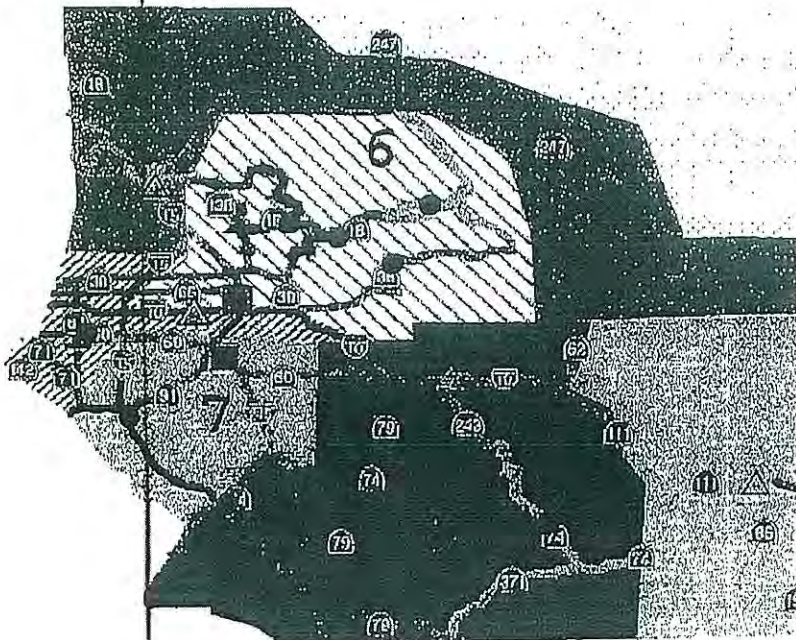
FAILURE TO COMPLETE AND RETURN THIS TO THE DISTRICT PERMITS OFFICE MAY CAUSE A DELAY  
IN THE RELEASE OF YOUR BONDS.



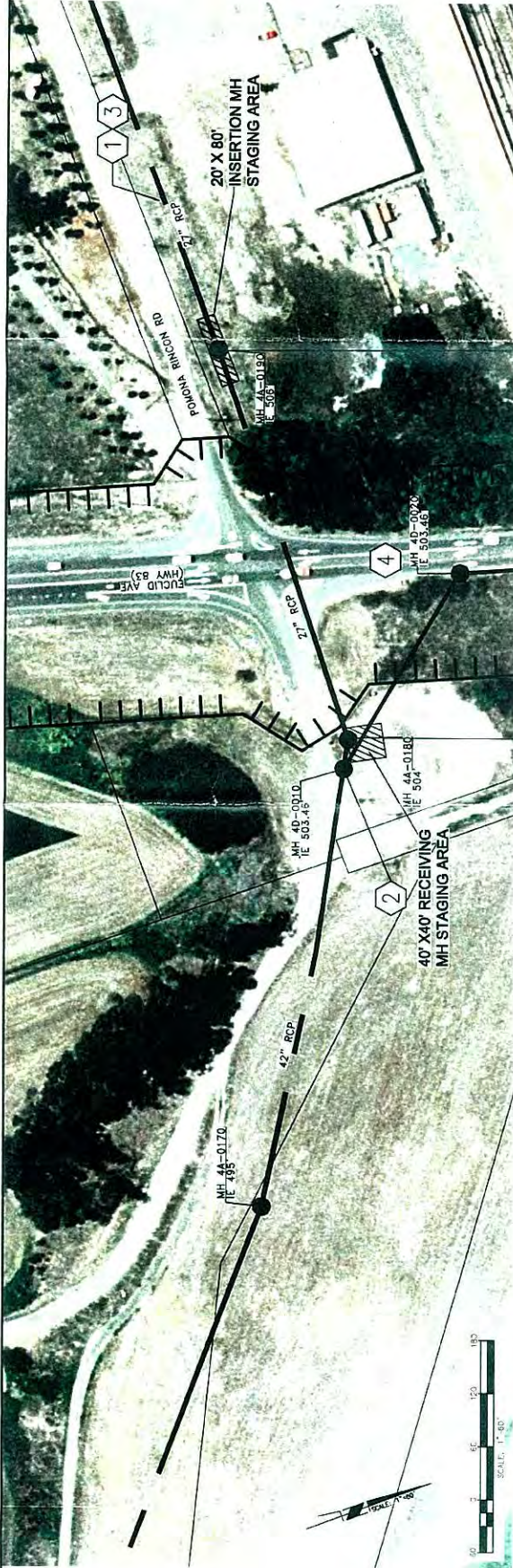


## District 8 Maintenance

Area	Phone
1. Colton Area	909-877-2646
2. Victorville Area	760-249-3251
3. Barstow Area	760-252-2314
4. Indio Area	760-775-4256
5. Banning Area	951-654-7935
6. Mountain Area	909-867-2102
7. Riverside Area	951-686-3646







REHAB EXISTING 27" PIPE WITH CIPP PER SPEC.

PERFORM WORK BETWEEN SATURDAY (12 AM) AND SUNDAY (6 PM) DURING LOW FLOW

CONSTRUCTION NOTES

- 1 ALL FLOW WITHIN EXISTING PIPE SHALL BE STOPPED AT MH 4A-0200. PUMPED OUT AND TRUCKED TO MH 4D-0010
- 2 MH 4D-0010 - DISCHARGE MH FOR PUMPED FLOW
- 3 EXISTING FLOW ON WEEKENDS IS APPROXIMATELY 20 GALLONS PER MINUTE
- 4 NO STAGING OF EQUIPMENT OR MATERIALS TO BE PERFORMED WITHIN CALTRANS RIGHT-OF-WAY

PROJECT NUMBER: 3/2/2011



DATE	BY	CHKD BY	APP'D BY
3/2/2011	JB	JB	JB
3/2/2011	JB	JB	JB
3/2/2011	JB	JB	JB
3/2/2011	JB	JB	JB



9756 CLAREMONT MEADOW BLVD., SUITE 100  
SAN DIEGO, CA 92124-1324  
658.814.5000 • FAX 658.814.5001

SANTA ANA WATERSHED PROJECT AUTHORITY  
11816 STERLING AVENUE • RIVERSIDE, CA 92503  
(951) 354-4220 • WWW.SAWPBA.ORG

REPAIRS TO UNLINED RCP, REACHES IV-A AND IV-B  
EUCALID AVE (HWY 83) CROSSING  
CALTRANS RIGHT-OF-WAY

THIS DRAWING IS THE PROPERTY OF RBF CONSULTING. IT IS TO BE USED ONLY FOR THE PROJECT AND LOCATION SPECIFICALLY IDENTIFIED HEREON. IT IS NOT TO BE REPRODUCED, COPIED, OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, WITHOUT THE WRITTEN PERMISSION OF RBF CONSULTING.



**Appendix L**  
**State Revolving Fund Contract Information**

CLEAN WATER STATE REVOLVING FUND (CWSRF) PROGRAM  
STATE WATER RESOURCES CONTROL BOARD  
DIVISION OF FINANCIAL ASSISTANCE

CONSTRUCTION CONTRACT REQUIREMENTS (CCR)  
AND  
BOILERPLATE (BP)

***Special Note: This document is only guidance and does not relieve Agencies with the burden of confirming that all federal, state, and local laws for contracting have been included in the Plans and Specifications for a project funded by the CWSRF Program. This document requires Agency's legal counsel review to include all current contractual requirements in Plans and Specifications.***

Division of Financial Assistance  
1001 I Street, Sacramento CA 95814  
Phone: (916) 341-5700 Fax: (916) 341-5707  
[http://www.waterboards.ca.gov/water\\_issues/programs/grants\\_loans/srf/index.shtml](http://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/index.shtml)

Issued Date: May 12, 2009



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## INSTRUCTIONS

This guidance document contains federal and state requirements for projects funded under the Clean Water State Revolving Fund (CWSRF) Program. The *CONSTRUCTION CONTRACT REQUIREMENTS* (CCR) section calls attention to state laws that CWSRF applicants must follow. The *BOILERPLATE* (BP) includes requirements that construction contractors must meet. This document is only guidance and does not relieve Agencies with the burden of confirming that all federal, state, and local laws for contracting have been included in the Plans and Specifications for a project funded by the CWSRF Program. This document requires Agency's legal counsel review to include all current contractual requirements.

Applicants for CWSRF funds are required to complete the CCR Checklist (page CCR-8) and return it to the Division of Financial Assistance (DFA) with the plans and specifications. The contents of the CCR and BP are to be included in the contract specifications. We recommend that the BP be inserted, unchanged and in its entirety, into the contract specifications. We will review the plans and specifications for conformity to the CCR Checklist and BP. Non-compliance with the provisions in the CCR and BP may impact eligibility and/or award of construction contract.

### **BOILERPLATE AND CCR FORMS TO BE COMPLETED:**

All items to be submitted to DFA with Approval-to-Award package, except Item 1 that is to be submitted with the 90% Plans and Specifications.

<b>Forms completed by Recipient</b>		
<i>Item No.</i>	<i>Description</i>	<i>Page No.</i>
1	Construction Contract Requirements Checklist	(CCR-13)
2	DBE Form 6, Positive Effort Certification	(BP-21)
<b>Forms completed by Prime Contractor and submitted with Bid to Recipient *</b>		
3	Escrow agreement for security deposits in lieu of retention	(CCR-9)
4	<b>Form 4 Prime Contractor Selected DBEs</b>	(BP-19)
5	<b>Non-Collusion Affidavit</b>	(BP-38)
<b>Forms completed by Low Bidder &amp; submitted within 2 weeks after Bid Opening to Recipient</b>		
6	DBE Form 1, "Good Faith" Effort List of Subcontractors Solicited	(BP-16)
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9	DBE Form 5, Summary of Bids Received from Subcontractors	(BP-20)
<b>Forms submitted by winning bidder within 2 weeks of contract award to Recipient</b>		
10	Certification of Nondiscrimination Clause	(BP-27)
11	Certification of Non-Segregated Facilities	(BP-33)
12	Drug-Free Workplace Certification	(BP-34)

**NOTE:** **Form 4** and the **NOTARIZED Non-Collusion Affidavit** must be submitted with the bid. Without these documents, the bid shall be rejected as non-responsive. The Escrow agreement for security deposits in lieu of retention is an optional for the Prime Contractor.

The electronic versions of the CCR and BP are available by contacting your Project Manager at the State Water Board.

## **Appendix M**

### **Traffic Control Exhibits**





# LEGEND:

 FULL ROAD CLOSURE, LOCAL ACCESS ONLY

 FLAGGER CONTROL AT ALL TIMES

PROJECT ENGINEER 57535 12/31/2009  
RCE NO. EXP. DATE



REV	DATE	DESCRIPTION	APP

DESIGN BY:	
CHECKED BY:	
DATE:	



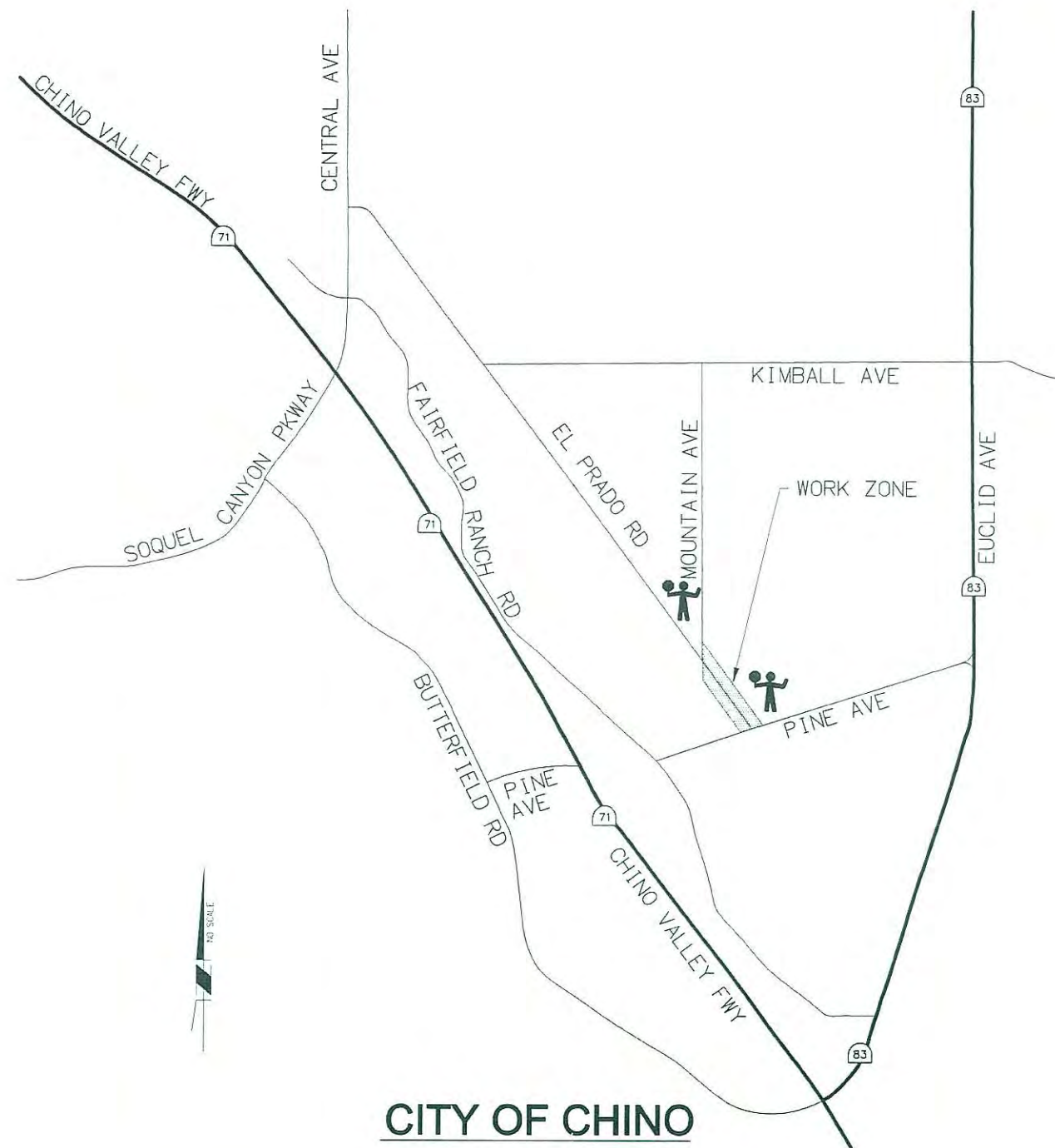
PLANNING ■ DESIGN ■ CONSTRUCTION  
9755 CLAIREMONT MESA BLVD., SUITE 100  
SAN DIEGO, CA 92124-1324  
858.614.5000 • FAX 858.614.5001

## SANTA ANA WATERSHED PROJECT AUTHORITY

11615 STERLING AVENUE • RIVERSIDE, CA 92503  
(951) 354-4220 • www.sawpa.org


DRAWING NO.	
FILE NO.	
SHEET	

WARNING  
1/2  
IF THIS BAR DOES  
NOT MEASURE 1"  
THEN DRAWING IS  
NOT TO SCALE.

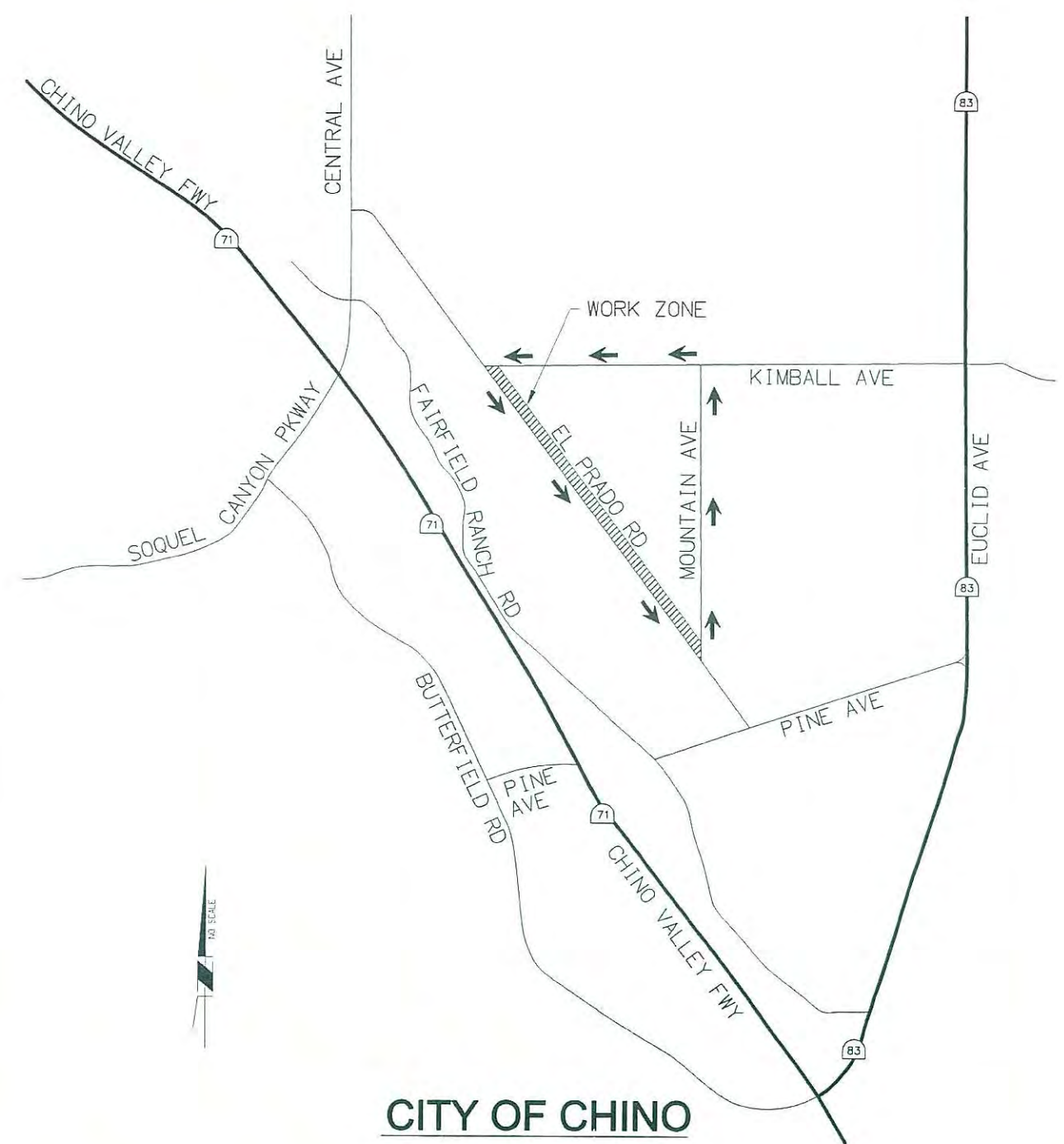


## CITY OF CHINO STAGE 1

### LEGEND:

 FULL NORTH BOUND LANE CLOSURE WITH FLAGGER CONTROL

 FLAGGER CONTROL AT ALL TIMES



## CITY OF CHINO STAGE 2

 FULL NORTH BOUND LANE CLOSURE, DETOUR TO MOUNTAIN AVE

PROJECT ENGINEER 57535 12/31/2009  
RCE NO. EXP. DATE



REV	DATE	DESCRIPTION	APP
1		RECORD DRAWINGS	

DESIGN BY:  
DRAWN BY:  
CHECKED BY:  
DATE



PLANNING ■ DESIGN ■ CONSTRUCTION  
9755 CLAIREMONT MESA BLVD., SUITE 100  
SAN DIEGO, CA 92124-1324  
858.614.5000 • FAX 858.614.5001

### SANTA ANA WATERSHED PROJECT AUTHORITY

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(951) 354-4220 • www.sawpa.org

DRAWING NO.  
SHEET

WARNING  
IF THIS BAR DOES  
NOT MEASURE 1"  
THEN DRAWING IS  
NOT TO SCALE.





## **Appendix N**

### **Draft Geotechnical Report**



**PRELIMINARY GEOTECHNICAL EVALUATION  
SANTA ANA REGIONAL INTERCEPTOR (SARI)/  
REPAIRS TO THE UNLINED  
REINFORCED CONCRETE PIPE (RCP)/  
REACHES IV-A AND IV-B  
SAN BERNARDINO AND  
RIVERSIDE COUNTIES, CALIFORNIA**

**PREPARED FOR:**

RBF Consulting  
3300 East Guasti Road, Suite 100  
Ontario, California 91761

**PREPARED BY:**

Ninyo & Moore  
Geotechnical and Environmental Sciences Consultants  
5710 Ruffin Road  
San Diego, California 92123

July 31, 2009  
Project No. 106480002

July 31, 2009  
Project No. 106480002

Mr. John Harris  
RBF Consulting  
9755 Clairemont Mesa Boulevard, Suite 100  
San Diego, California 92123

Subject: Preliminary Geotechnical Evaluation  
Santa Ana Regional Interceptor (SARI)/  
Repairs to the Unlined Reinforced Concrete Pipe (RCP),/  
Reaches IV-A and IV-B  
San Bernardino and Riverside Counties, California

Dear Mr. Harris:

In accordance with your authorization, we have performed a preliminary geotechnical evaluation for the Santa Ana Regional Interceptor (SARI) Pipeline Repair Project (the project). This report provides a summary of our preliminary findings, conclusions, and recommendations regarding geotechnical conditions relative to the project. This report is provided for planning purposes and with the understanding that Ninyo & Moore will be performing a subsurface evaluation in the near future to facilitate the actual geotechnical design for the project.

We appreciate the opportunity to be of service.

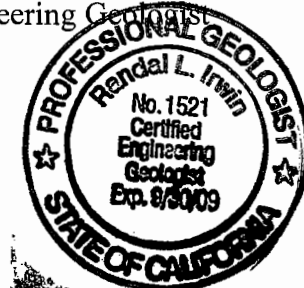
Respectfully submitted,  
**NINYO & MOORE**



Andres Bernal, Ph.D., G.E. 2715  
Senior Project Engineer



Randal L. Irwin, C.E.G. 1521  
Chief Engineering Geologist



Gregory T. Farrand, C.E.G. 1087  
Principal Geologist



EFL/AB/RI/GTF/gg

Distribution: (1) Addressee



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**Appendix**

- Appendix A – Typical Earthwork Guidelines



## **1. INTRODUCTION**

In accordance with your request, Ninyo & Moore has performed a preliminary geotechnical evaluation for the Santa Ana Regional Interceptor Repairs to the Unlined Reinforced Concrete Pipe within Reaches IV-A and IV-B Project (the project). The purpose of this study was to evaluate the anticipated geotechnical characteristics of the geology and soils along the subject pipeline routes. Subsurface exploration and laboratory testing were not included in the scope of this preliminary evaluation.

## **2. SCOPE OF SERVICES**

Ninyo & Moore's scope of services for this evaluation included the following:

- Review of pertinent, available geologic technical literature including topographic, fault hazard maps, geologic maps and publications, aerial photographs, and reports. Documents pertaining to our evaluation are listed in the References section of this report.
- Performing a field reconnaissance of the pipeline routes by a California Certified Engineering Geologist from our firm.
- Compilation and analysis of data obtained, with particular emphasis on potential geologic considerations relative to the project.
- Preparation of this report presenting our preliminary findings, conclusions, and recommendations regarding the anticipated geotechnical characteristics within the project area.

## **3. PROJECT LOCATION AND DESCRIPTION**

The project is located in the southwest portion of San Bernardino County and the northwest portion of Riverside County in the vicinity of Prado Dam, north and west of the City of Corona (Figure 1). The project involves the repair and rehabilitation of Santa Ana Regional Interceptor (SARI) Reaches IV-A and IV-B (Figure 2). Reaches IV-A and IV-B were constructed in the 1980's and consist of unlined reinforced concrete pipelines (RCP) which carry primarily saline, non-domestic wastewater from industrial discharge, power plants, and municipal desalter facilities. The lower portion of Reach IV-A consists of 42-inch diameter pipe and extends north from Prado Dam at the junction with Reach IV-B to the junction with Reach IV-D at Highway 83

(Euclid Avenue), with a length of about 3.2 miles. The upper portion of Reach IV-A consists of 27-inch diameter pipe and extends north from the junction with Reach IV-D, approximately 4.7 miles to an area south of the City of Chino. The section of Reach IV-B included in this project extends from Prado Dam east past Corona Airport towards the City of Corona for a distance of approximately 3.1 miles. This section of pipeline is 36 inches in diameter.

Recent changes to Prado Dam have raised the crest and spillway of the dam to create a water conservation pool behind (upstream of) the dam which will support an aquifer recharge and groundwater augmentation program. The elevations of the pool will be adjusted seasonally to provide flood protection during the winter months and groundwater recharge during the summer. The existing SARI pipelines and manholes near the dam will be submerged under the higher water levels and eventually covered by the increased sedimentation reducing access to the pipelines.

Previous surveys of the interior of the pipelines have identified evidence of decay and bio-growth, which inhibits the flow of water through the pipe. A number of the joints within the pipeline have been found to leak. The subject project will involve the rehabilitation of three segments of the existing pipeline to extend the service life of the upper and lower portions of Reach IV-A, and Reach IV-B. Temporary access roads along the pipeline and some limited clearing and excavation may be required to expose the existing manholes for access to the pipeline by construction trucks and personnel. It is our understanding that the pipeline repair for the lower portion of Reach IV-A and Reach IV will be accomplished using an in-place lining method and excavations to approximately 15 feet depth at up to ten locations will occur at each reach. Rehabilitation of the upper portion of Reach IV-A will be done using the existing manholes. No additional excavation is anticipated for this work.

#### **4. TOPOGRAPHY**

Both pipeline routes cross areas of slight relief. The lowest point of Reach IV-A is at its south end (lower portion), at the junction with Reach IV-B near the Prado Dam, with an elevation of roughly 490 feet relative to mean sea level (MSL). Its highest point is at its north end (upper portion) where it reaches an elevation of approximately 610 feet MSL. The lowest point of



Reach IV-B is at its west end, at the junction with Reach IV-A with an elevation of about 490 feet MSL. Reach IV-B near the Corona Airport is at an elevation of approximately 525 feet MSL and the pipeline segment ends at an elevation of 540 feet MSL at its eastern terminus. Figure 4 is a topographic map of the study area.

## **5. GEOLOGY**

The following sections present our findings relative to the regional geology and the local geology of the study area based on our review of pertinent, available geologic technical literature and our field reconnaissance.

### **5.1. Regional Geology**

The project area is situated in the northern section of the Peninsular Ranges Geomorphic Province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California (Norris and Webb, 1990). The province varies in width from approximately 30 to 100 miles. In general, the province consists of rugged mountains underlain by Jurassic metavolcanic and metasedimentary rocks, and Cretaceous igneous rocks of the southern California batholith. The portion of the province that includes the project area consists generally of Quaternary alluvial deposits and uplifted and dissected Tertiary sedimentary rocks.

The study area is located in the Chino Basin, bordered to the west by the Chino (or Puente) Hills and to the south by the Santa Ana Mountains. The primary tributary to the Chino Basin is the Santa Ana River on which the Prado Dam has been constructed. Other tributaries include Chino Creek, Cucamonga/Mill Creek, and Temescal Creek. Southwest of the study area, the Santa Ana River separates the Chino Hills to the north and the Santa Ana Mountains to the south in an area referred to as the Santa Ana Narrows, a natural geomorphic constriction.

## **5.2. Study Area Geology**

Based on our literature review, including published geologic maps, geotechnical reports, and our geologic field reconnaissance the study area is underlain generally by artificial fill, alluvium and Tertiary sedimentary rocks. Figure 3 is a geologic map of the area. The following unit descriptions are based on our field observations, and literature review.

### **5.2.1. Artificial Fill**

Areas of man-made artificial fill are present along the pipeline alignments. These soils occur in areas of existing improvements and especially as trench backfill over the pipelines. It is expected that these soils were largely derived from nearby sources consisting primarily of alluvium.

### **5.2.2. Alluvium**

The pipeline routes are located in Holocene- and late Pleistocene-age alluvial deposits of the Chino Basin. The geotechnical investigation that was conducted for Reach IV-A (ConverseWardDavisDixon, 1981) concluded that the alluvial soils along that pipeline route consist primarily of silty and clayey soils with lesser intervals of sandy soils. Published descriptions of the alluvium in the study area describe it as unconsolidated to compact clay and silty clay with varying amounts of fine sand and organic materials and unconsolidated fine to coarse sand with minor intervals of gravel and silt (Cox and Morton, 1978).

### **5.2.3. Tertiary Sedimentary Rocks**

Tertiary-age sedimentary rocks have been mapped to the west of Reach IV-A and to the south of Reach IV-B, and probably underlie both pipeline alignments at depth. In the site vicinity the Tertiary sedimentary rocks have been mapped largely as strata of the Miocene-age Puente Formation (Fife et al., 1976). The Puente Formation consists of marine sedimentary rocks, generally consisting of shale, siltstone, sandstone, and conglomerate (Gray, 1961).



## 6. GROUNDWATER

Groundwater levels can be expected to coincide largely with the elevations of the water impounded behind Prado Dam, particularly for the southern part of pipeline IV-A and the westerly portion of pipeline IV-B. The new water conservation pool behind the dam will be set at an elevation of 505 feet MSL. The pool elevation will be adjusted seasonally, downward during the winter months to provide flood protection. Therefore, the higher groundwater levels during the season will be at an elevation of roughly 505 feet MSL.

## 7. FAULTING AND SEISMICITY

According to the tectonic setting and the historical record, the study area is in a region that is characterized by a high level of seismicity. Historical earthquakes of magnitude 6.0 or greater with epicenters within approximately 62 miles (100 km) of the study area are shown in the following table.

**Table 1 – Historical Earthquakes that Affected the Study Area**

Date	Magnitude (M)
November 22, 1800	6.5
December 8, 1812	6.9
July 22, 1899	6.5
December 25, 1899	6.6
September 20, 1907	6.0
May 15, 1910	6.0
April 21, 1918	6.8
July 23, 1923	6.2
March 11, 1933	6.3
February 9, 1971	6.4
July 8, 1986	6.1
June 28, 1992	6.5
January 17, 1994	6.7

As shown on Figure 5, the active northwest trending Chino fault is mapped as underlying pipeline IV-B just east of Prado Dam and as crossing beneath the lower portion of pipeline IV-A. A State of California Earthquake Fault (Aquist-Priolo) Zone has been established on the Chino fault in the study area. According to the California Geological Survey (CGS), the Chino fault is

capable of generating an earthquake of Magnitude of 6.7 (Cao et. al., 2003). The Chino fault can be considered to have a potential for ground surface rupture due to movement on the fault. Figure 6 shows the approximate site location relative to the major faults in the region. The following table lists active faults (or potential seismic sources) within approximately 62 miles (100 kilometers) of the pipeline routes. The approximate fault-to-site distances were evaluated using the computer program FriskSP (Blake, 2001).

**Table 2 – Principal Active Faults**

<b>Fault</b>	<b>Distance (miles)<sup>1</sup></b>	<b>Maximum Moment Magnitude<sup>1,2</sup></b>
Chino	0 (crosses pipeline routes)	6.7
Whittier	2	6.8
Elsinore (Glen Ivy)	2	6.8
Puente Hills Blind Thrust	13	7.1
San Jose	14	6.4
Cucamonga	17	6.9
Sierra Madre	17	7.2
San Joaquin Hills	17	6.6
San Jacinto (San Bernardino)	23	6.7
San Jacinto (San Jacinto Valley)	25	6.9
Newport-Inglewood	25	7.1
Clamshell-Sawpit	27	6.5
Raymond	27	6.5
San Andreas	28	8.0
Upper Elysian Park Blind Thrust	29	6.4
Cleghorn	31	6.5
Verdugo	34	6.9
Palos Verdes	36	7.3
North Frontal	36	7.2
Hollywood	37	6.4
San Jacinto (Anza)	43	7.2
Coronado Bank	46	7.6
Sierra Madre	46	6.7
Santa Monica	46	6.6
San Gabriel	47	7.2
Northridge	51	7.0
Elsinore (Julian)	51	7.1



**Table 2 – Principal Active Faults**

<b>Fault</b>	<b>Distance (miles)<sup>1</sup></b>	<b>Maximum Moment Magnitude<sup>1,2</sup></b>
Malibu Coast	52	6.2
Pinto Mountain	54	7.2
Rose Canyon	54	7.2
Helendale-S. Lockhardt	55	7.3
North Frontal	57	6.7
Santa Susana	57	6.7
Anacapa-Dume	61	7.5
<b>Notes:</b>		
<sup>1</sup> Blake (2001)		

Recently (July 29, 2008), the Magnitude 5.4 Chino Hills Earthquake occurred in the Chino Hills, a few miles west of the northern terminus of pipeline IV-A. At present, the earthquake has not been associated with a specific geologically mapped fault, but occurred between the mapped traces of the Chino and Whittier faults (Hauksson et al., 2008). The Chino and Whittier faults are branches of the Elsinore fault zone, mapped approximately 2 miles south of the study area.

### **7.1. Liquefaction**

Liquefaction is the phenomenon in which loosely deposited, saturated granular soils (located below the water table) with clay contents (particles less than 0.005 mm) of less than 15 percent, liquid limit of less than 35 percent, and natural moisture content greater than 90 percent of the liquid limit undergo rapid loss of shear strength due to development of excess pore pressure during strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to rapid rise in pore water pressure, and it eventually causes the soil to behave as a fluid for a short period of time. Liquefaction is known generally to occur in saturated or near-saturated cohesionless soils at depths shallower than 50 feet below grade. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

It is estimated that the portions of both pipeline routes are (or will be) in saturated alluvial soils. As discussed many of the alluvial soils have high silt and clay contents and, accordingly, have a relatively low potential to liquefy. However, some of the intervals of sandy alluvial soils that are saturated in the study area may have a potential for liquefaction during a major seismic event. Due to the induration/cementation of the underlying sedimentary rocks, these materials are not prone to liquefaction.

## **8. LANDSLIDING**

Several landslides are mapped in the Chino (or Puente) Hills just west of the study area (Tan, 1988). Due to the relatively slight relief of the pipeline routes, landslides are not a consideration with respect to the project. However, landslides may be activated due to changes in the ground-water level. Additional site specific studies may be recommended during the field investigation phase of the project.

## **9. EXPANSIVE SOILS AND COMPRESSIBLE SOILS**

Expansive soils are soils that undergo volumetric change with change in water content. The soil will swell with increase in moisture content and will shrink with decrease in moisture content. Soils with high shrink-swell potential generally contain high percentages of certain clay minerals and can cause extensive damage to surface structures and improvements, especially concrete slabs and flatwork placed on soils at surface grade. Soils in the study area that have a relatively high clay content may exhibit expansive characteristics during inundations of the water conservation pool.

Loose or compressible soils may also be found in the study area, particularly, in alluvial soils or poorly compacted fill. Compressible soils can be susceptible to settlement when additional loads such as sediment loads are placed on them.

## **10. AGRICULTURAL SOILS**

From an agricultural perspective, based on Soil Survey information from the United States Department of Agriculture (2008), soils classified as loam, sand loam or silt loam primarily underlie the



pipeline routes. A loam is a friable soil containing a relatively equal mixture of sand and silt and a somewhat smaller portion of clay. The term sand loam or silt loam indicates a predominant constituent. Alluvium is the primary parent material of the agricultural soils delineated in the study area.

## 11. CONCLUSIONS

Based on the results of our study, it is our opinion that the pipeline repair project is feasible from a geotechnical perspective. Further, it is our opinion that the project will not have significant impacts on the geologic or geotechnical conditions as long as the project is conducted through proper design and construction techniques. The following sections discuss site-specific geologic and geotechnical issues.

- The active Chino fault crosses the lower portion of Reach IV-A and the westerly portion of Reach IV-B. A State of California Earthquake Fault Zone has been established on the Chino fault in the study area. Accordingly, it can be assumed that the Chino fault poses a potential for ground surface rupture due to movement on the fault.
- In addition to the Chino fault, there are several active faults in the region. Accordingly, the study area is subject to ground shaking due to earthquakes. Historically, the study area has experienced a relatively high level of seismicity.
- Based on our review of background information landslides have not been reported along the pipeline routes. Further, evidence of deep-seated landslides was not observed in our review of aerial photographs or during our field reconnaissance.
- It is expected that there is a potential for liquefaction to occur along portions of the pipeline alignments as a result of ground shaking during a major seismic event.
- Expansive soils may be present along the pipeline route. In general, expansive soils have little effect on buried pipelines of typical construction. Treatment of expansive soils, if present at or near grade of new surface improvements sensitive to the action of expansive soils, could include removal and replacement with non-expansive soils, lime treatment, moisture conditioning, or utilization of special foundations.
- Compressible soils are probably present in areas along the pipeline routes. Buried pipelines typically do not cause underlying soils to settle as they represent less load than the weight of the soil mass removed to place the pipe. Loads imposed by surface improvements may cause compressible soils to settle. Means to remedy compressible soils include compaction grouting, and removal and recompaction (to improve their density).

- The majority of the pipeline repair will involve lining of the existing pipe to extend its service life. The upper portion of Reach IV-A will be repaired through existing manholes and minimal disruption to soil profiles that are present is anticipated. However, excavations to approximate depths of 15 feet will be performed for the lower portion of Reach IV-A and for Reach IV-B. It is anticipated that dewatering will be necessary for these excavations.

## **12. PRELIMINARY RECOMMENDATIONS**

The following sections include our preliminary geotechnical recommendations for the pipeline repair project. These recommendations are based on our geologic reconnaissance of the site geotechnical conditions and our understanding of the planned project, and do not include subsurface exploration information. A detailed subsurface evaluation program is recommended, and the proposed boring locations are shown in Figure 7. Boring locations were selected from evaluation from anticipated geologic conditions and from our understanding of the project design and may be modified during the field investigation based on existing conditions.

We recommend that the site earthwork and construction be performed in accordance with the following recommendations, the applicable requirements of governing agencies, and the Typical Earthwork Guidelines included in Appendix A. In the event there are conflicting earthwork specifications between applicable standards and the following recommendations, we recommend that the more stringent requirements be followed. Recommendations regarding the potential settlement of the pipeline during site inundation and burial with up to 20 feet of sediment will be addressed after the completion of our subsurface explorations and laboratory testing.

### **12.1. Shoring**

It is anticipated that the lower portion of Reach IV-A and Reach IV-B will be rehabbed using the live stream slip-lining process, including excavations at up to ten locations along each reach. The existing pipe sections will be exposed, cut out, and a new slip-liner pipe will be installed by jacking to the next access pit. It is our understanding that the access pits may be up to 15 feet deep, 15 feet wide, and 30 feet long. It is anticipated that each access pit will require shoring and, based on existing conditions at the time of construction, may also re-



quire dewatering. The upper portion of Reach IV-A will be rehabbed using access through existing manholes, and no excavation is anticipated.

We anticipate that shoring systems with bracing will be installed for trenches or other excavations over 4 feet deep. The shoring system should be designed using the lateral earth pressures based on the results of the subsurface exploration.

We anticipate that settlement of the ground surface will occur behind the shoring wall during excavation. The amount of settlement depends heavily on the type of shoring system, the shoring contractor's workmanship, and soil conditions. We recommend that structures/improvements in the vicinity of the planned shoring installation be reviewed with regard to foundation support and tolerance to settlement. Possible causes of settlement that should be addressed include settlement during shoring installation, excavations, construction vibrations, dewatering, and removal of the support system.

The contractor should retain a qualified and experienced engineer to design the shoring system. We recommend that the contractor take appropriate measures to protect workers. Occupational Safety and Health Administration (OSHA) requirements pertaining to worker safety should be observed.

## **12.2. Excavation Bottom Stability**

In general, we anticipate that the bottom of the excavations will be stable and should provide suitable support to the proposed improvements. However, excavations that are close to or below the water table may be unstable. In general, unstable bottom conditions may be mitigated by overexcavating the excavation bottom to suitable depths and replacing with compacted fill. Recommendations for stabilizing excavation bottoms should be based on evaluation in the field by Ninyo & Moore at the time of construction.

### **12.3. Construction Dewatering**

Groundwater may be encountered during excavation operations at the project site. A specialty dewatering contractor should be consulted. Dewatering measures during excavation operations should be prepared by the contractor's engineer and reviewed by the district design engineer. Considerations for construction dewatering should include pumping or dewatering well locations, anticipated drawdown, volume of pumping, potential for settlement, and groundwater discharge. Dewatering rates are anticipated to be 100 to 1,000 cubic feet per day or more but will vary significantly based on conditions exposed at the site. Disposal of groundwater should be performed in accordance with guidelines of the Regional Water Quality Control Board (RWQCB).

### **12.4. Lateral Pressures for Thrust Blocks**

Thrust restraint for buried pipelines may be achieved by transferring the thrust force to the soil outside the pipe through a thrust block. Lateral earth pressures for design of thrust blocks will be provided based on the results of the upcoming subsurface exploration for the project.

### **12.5. Modulus of Soil Reaction**

We anticipate some trenching will be used on this project. The modulus of soil reaction is used to characterize the stiffness of soil backfill placed at the sides of buried flexible pipelines for the purpose of evaluating deflection caused by the weight of the backfill above the pipe. Preliminarily, for pipelines constructed in fill, we recommend that a modulus of soil reaction of 1,000 pounds per square inch (psi) be used for design, provided that granular bedding material is placed adjacent to the pipe, as recommended in this report.

### **12.6. Pipe Bedding**

We recommend that pipes be supported on 6 inches or more of granular bedding material such as sand with a Sand Equivalent (SE) value of 30 or more. Bedding material should be placed around the pipe and 12 inches or more above the top of the pipe in accordance with the recent edition of the Standard Specifications for Public Works Construction ("Green-



book"). We do not recommend the use of crushed rock as bedding material. It has been our experience that the voids within a crushed rock material are sufficiently large to allow fines to migrate into the voids, thereby creating the potential for sinkholes and depressions to develop at the ground surface. Where wet and loose or soft soil conditions are encountered, the trench excavation should be extended to approximately 1 foot or more below the pipe invert elevation and should be backfilled with gravel wrapped in filter fabric.

Special care should be taken not to allow voids beneath and around the pipe. Compaction of the bedding material and backfill should proceed up both sides of the pipe. Trench backfill, including bedding material, should be placed in accordance with the recommendations presented in this report.

#### **12.7. Trench Backfill**

Trench backfill material should be comprised of low-expansion-potential granular soil and should be free of trash, debris, roots, vegetation, or deleterious materials. Backfill should generally be free of rocks or hard lumps of material in excess of 3 inches in diameter. Rocks or hard lumps larger than about 3 inches in diameter should be broken into smaller pieces or should be removed from the site. Wet materials generated from on-site excavations should be aerated to a moisture content near the laboratory optimum to allow compaction.

On-site clayey and organic soils encountered during excavation should be selectively removed and stockpiled separately. The clayey and organic soils are not considered suitable for trench backfill and should be disposed of off site.

Imported materials should consist of clean, granular materials with a low expansion potential, corresponding to an expansion index of 50 or less as evaluated in accordance with the American Society for Testing and Materials (ASTM) Test Method D4829. The corrosion potential of proposed imported soils should also be evaluated if structures will be in contact with the imported soils. Import material should be submitted to the geotechnical consultant for review prior to importing to the site. The contractor should be responsible for the uniformity of import material brought to the site.

#### **12.8. Fill Placement and Compaction**

Fill and trench backfill should be compacted in horizontal lifts to a relative compaction of 90 percent or more as evaluated by ASTM D 1557. Aggregate base and the upper 12 inches of subgrade beneath pavement areas should be compacted to a relative compaction of 95 percent or more. Fill soils should be placed at or above the laboratory optimum moisture content as evaluated by ASTM D 1557. The optimum lift thickness of fill will depend on the type of compaction equipment used, but generally should not exceed 8 inches in loose thickness. Special care should be taken to avoid pipe damage when compacting trench backfill above the pipe.

### **13. LIMITATIONS**

The field evaluation and geotechnical analyses presented in this report have been conducted in accordance with current engineering practice and the standard of care exercised by reputable geotechnical consultants performing similar tasks in this area. No warranty, implied or expressed, is made regarding the conclusions, recommendations, and professional opinions expressed in this report. Variations may exist and conditions not observed or described in this report may be encountered. Our preliminary conclusions and recommendations are based on an analysis of the observed conditions and the referenced background information.

The purpose of this report was to evaluate geologic and geotechnical conditions within the project site and to provide a preliminary geotechnical evaluation. This report does not have the benefit of subsurface exploration or laboratory testing, and should be considered preliminary and for planning purposes.

It is understood that Ninyo & Moore will be performing a subsurface evaluation for this project in the near future. Based on the result of that evaluation, our conclusions and recommendations for design will be supplemented and may be modified significantly.



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NOT TO SCALE



NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

REFERENCE: PIPELINE LOCATIONS, SANTA ANA REGIONAL INTERCEPTOR PIPELINE REPAIR, RBF CONSULTING.

**Ninyo & Moore**

## REACHES IV-A AND IV-B

FIGURE

PROJECT NO.

DATE

SANTA ANA REGIONAL INTERCEPTOR PIPELINE REPAIR  
SAN BERNARDINO AND RIVERSIDE COUNTIES, CALIFORNIA

**2**

106480002


7/09



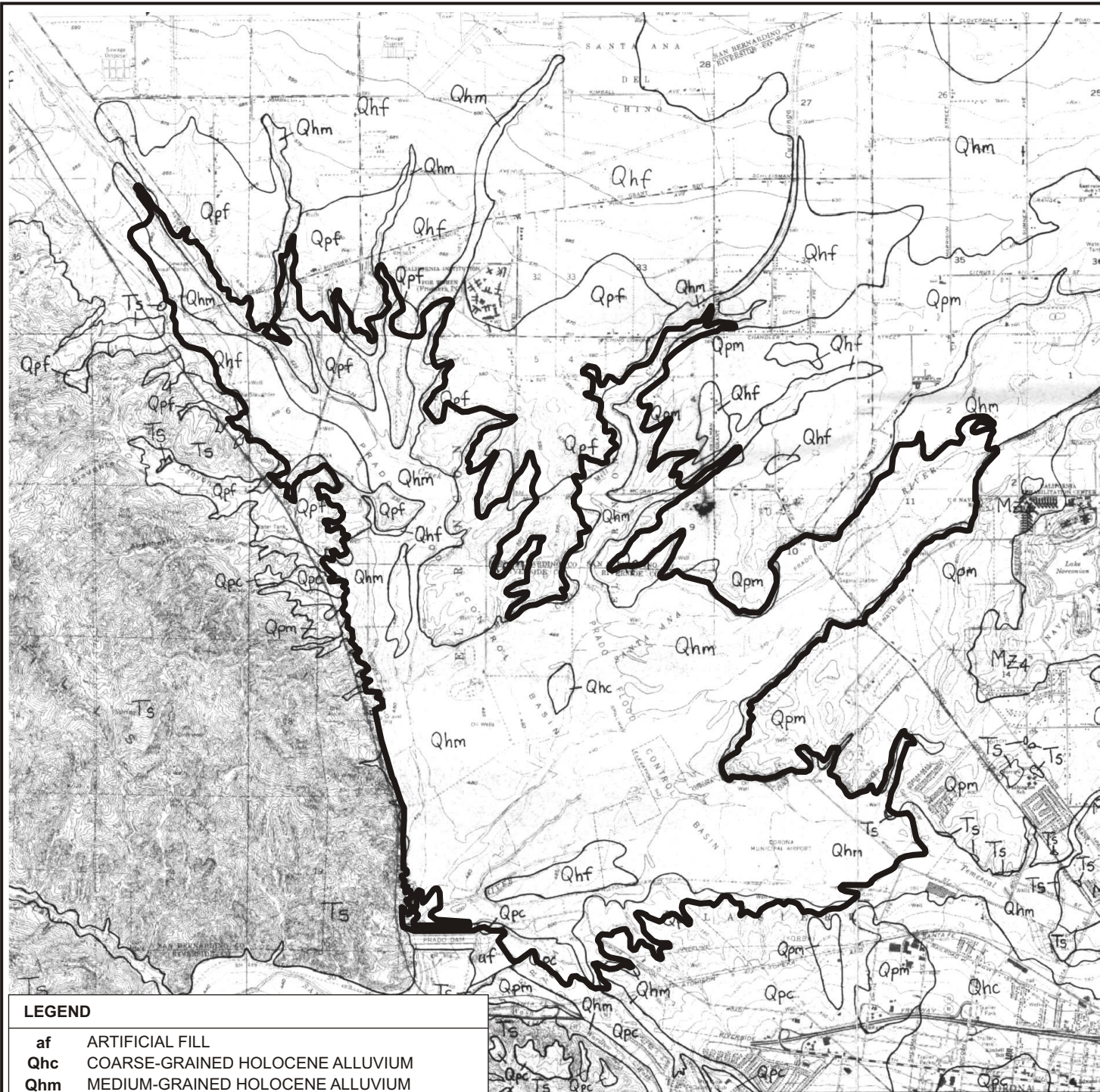


NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.

REFERENCE: PIPELINE LOCATIONS, SANTA ANA REGIONAL INTERCEPTOR PIPELINE REPAIR, RBF CONSULTING.

		OPTIONAL PARTIAL REALIGNMENT- REACH IV-B	FIGURE
PROJECT NO.	DATE	SANTA ANA REGIONAL INTERCEPTOR PIPELINE REPAIR SAN BERNARDINO AND RIVERSIDE COUNTIES, CALIFORNIA	3
106480002	7/09		





#### LEGEND

- af ARTIFICIAL FILL
- Qhc COARSE-GRAINED HOLOCENE ALLUVIUM
- Qhm MEDIUM-GRAINED HOLOCENE ALLUVIUM
- Qhf FINE-GRAINED HOLOCENE ALLUVIUM
- Qpc COARSE-GRAINED LATE PLEISTOCENE ALLUVIUM
- Qpm MEDIUM-GRAINED LATE PLEISTOCENE ALLUVIUM
- Qpf FINE-GRAINED LATE PLEISTOCENE ALLUVIUM
- Ts TERTIARY SEDIMENTARY ROCKS
- Mz4 JURASSIC METAMORPHOSED VOLCANIC AND SEDIMENTARY ROCK

APPROXIMATE SCALE

0 5000 10000 FEET

NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.



REFERENCE: COX, B.F., AND MORTON, D. M., 1978, PRELIMINARY MAP OF SURFICIAL MATERIALS IN NORTHWESTERN RIVERSIDE AND SOUTHWESTERN SAN BERNARDINO COUNTIES, CALIFORNIA.

**Ninyo & Moore**

#### GEOLOGIC MAP

FIGURE

PROJECT NO.

DATE

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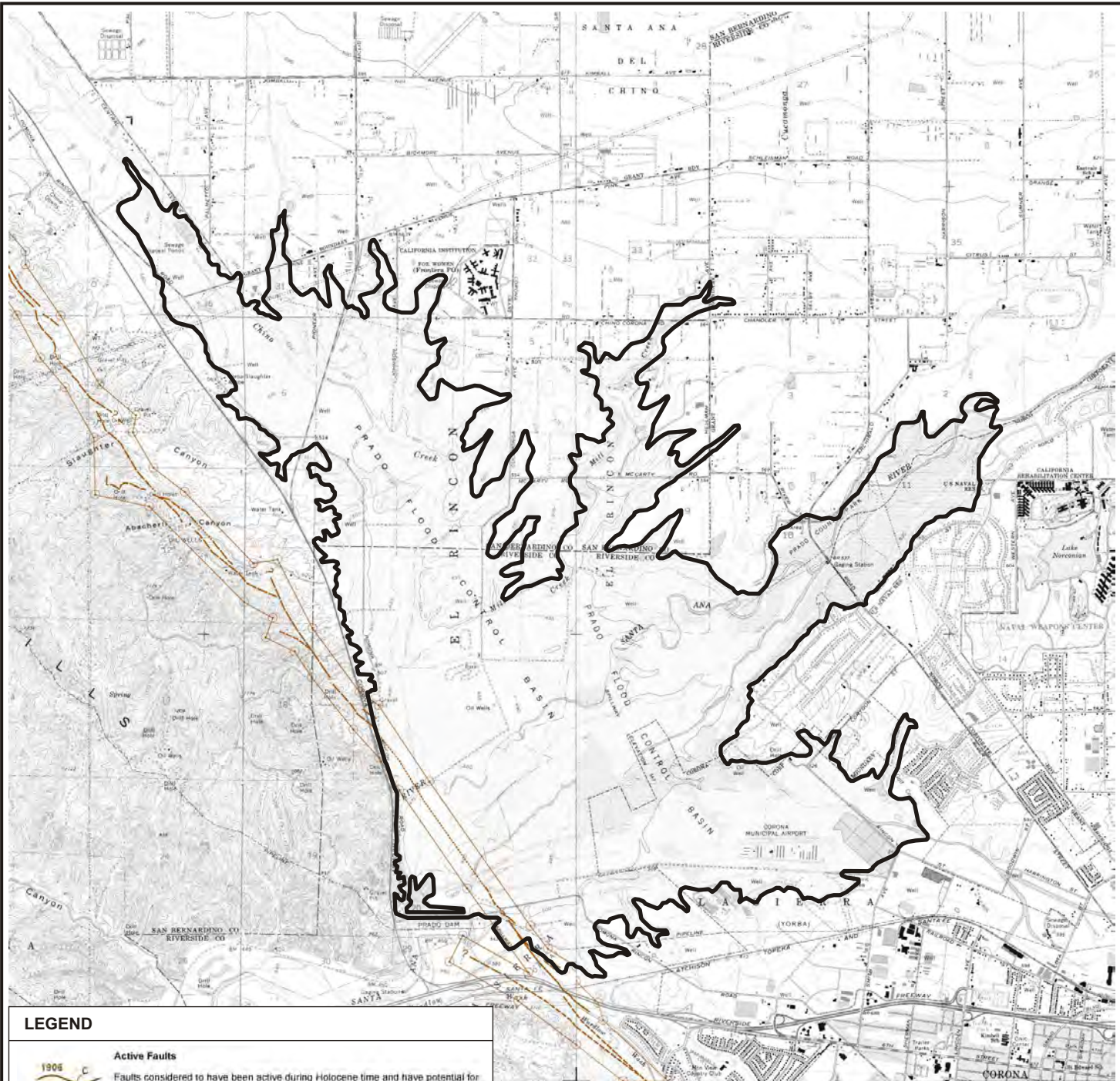
7/09

SANTA ANA REGIONAL INTERCEPTOR PIPELINE REPAIR  
SAN BERNARDINO AND RIVERSIDE COUNTIES, CALIFORNIA

**4**







**LEGEND**



**Active Faults**

Faults considered to have been active during Holocene time and have potential for surface rupture; solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed; query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by fault creep.

**Earthquake Fault Zone Boundaries**



These are delineated as straight-line segments that connect encircled turning points so as to define Earthquake Fault Zone segments.



Seaward projection of zone boundary

**APPROXIMATE SCALE**



NOTE: ALL DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE.



REFERENCE: 2003, STATE OF CALIFORNIA EARTHQUAKE FAULT ZONES, PRADO DAM AND CORONA NORTH QUADRANGLES.

**Ninyo & Moore**

**EARTHQUAKE FAULT ZONE MAP**

FIGURE

PROJECT NO.

DATE

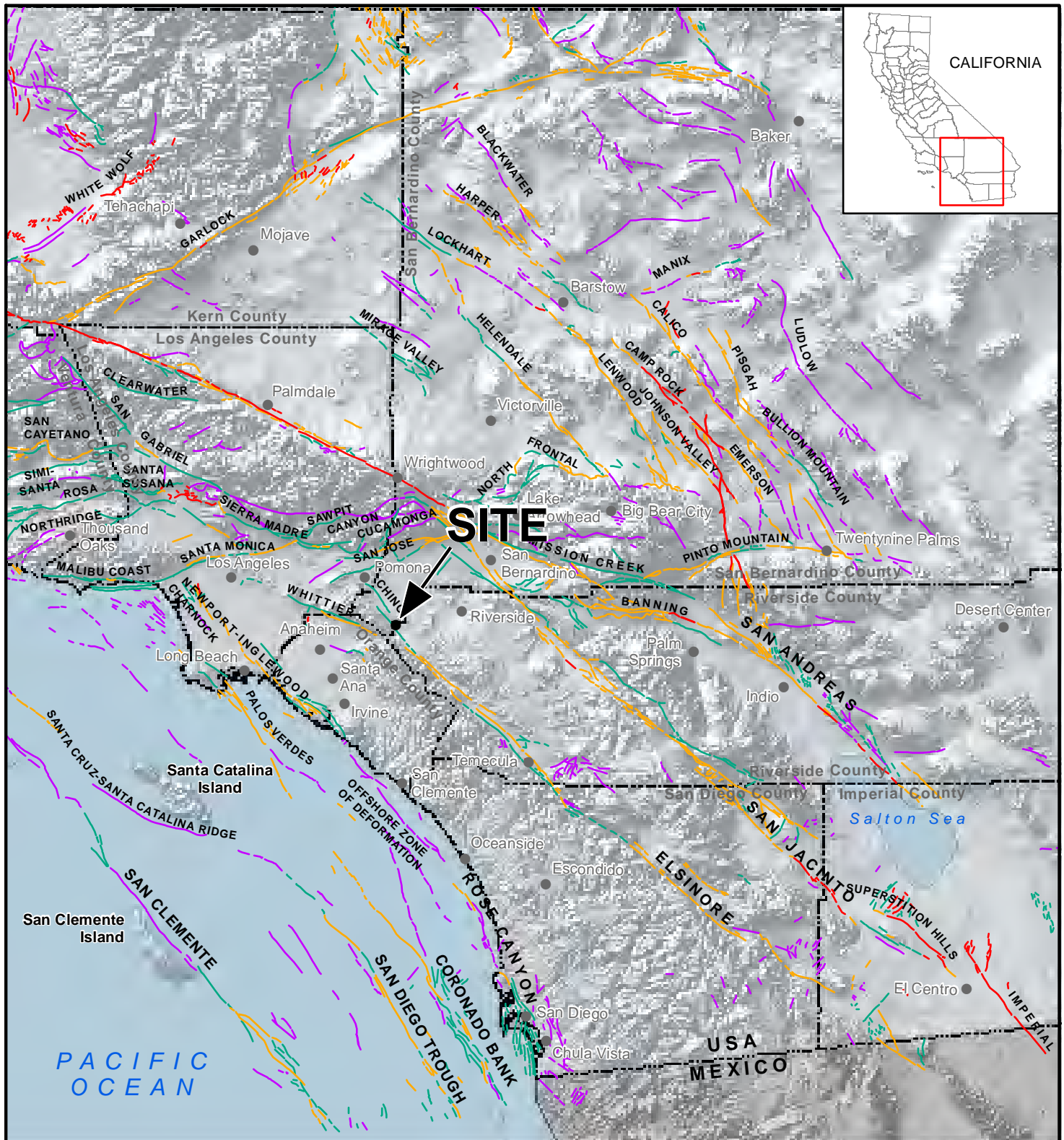
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SANTA ANA REGIONAL INTERCEPTOR PIPELINE REPAIR  
SAN BERNARDINO AND RIVERSIDE COUNTIES, CALIFORNIA

**6**





SOURCE: FAULTS - CA DEPT OF CONSERVATION, 2000; BASE - ESRI, 2008

#### LEGEND

##### CALIFORNIA FAULT ACTIVITY

- |   |  |
|---|--|
| <span style="color: red;">—</span> HISTORICALLY ACTIVE                    | <span style="color: magenta;">—</span> QUATERNARY (POTENTIALLY ACTIVE) |
| <span style="color: orange;">—</span> HOLOCENE ACTIVE                     | <span style="color: gray;">—</span> STATE/COUNTY BOUNDARY              |
| <span style="color: green;">—</span> LATE QUATERNARY (POTENTIALLY ACTIVE) |  |

NOTES: ALL DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE



APPROXIMATE SCALE



**Ningo & Moore**

## FAULT LOCATION MAP

FIGURE

PROJECT NO.

DATE

106480002

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SANTA ANA REGIONAL INTERCEPTOR PIPELINE REPAIR  
SAN BERNARDINO AND RIVERSIDE COUNTIES, CALIFORNIA

**7**

**APPENDIX A**  
**TYPICAL EARTHWORK GUIDELINES**



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## **TYPICAL EARTHWORK GUIDELINES**

### **1. GENERAL**

These guidelines are presented as general procedures for earthwork construction. They are to be utilized in conjunction with the project plans. These guidelines are considered a part of the geotechnical report, but are superseded by recommendations in the geotechnical report in the case of conflict. Evaluations performed by the consultant during the course of construction may result in new recommendations which could supersede these specifications and/or the recommendations of the geotechnical report. It is the responsibility of the contractor to read and understand these Guidelines as well as the geotechnical report and project plans.

- 1.1. The contractor shall not vary from these Guidelines without prior recommendations by the geotechnical consultant and the approval of the client or the client's authorized representative. Recommendations by the geotechnical consultant and/or client shall not be considered to preclude requirements for approval by the jurisdictional agency prior to the execution of any changes.
- 1.2. The contractor shall perform the earthwork operations in accordance with these specifications, and shall be responsible for the quality of the finished product notwithstanding the fact that earthwork will be observed and tested by the geotechnical consultant.
- 1.3. It is the responsibility of the contractor to notify the geotechnical consultant and the jurisdictional agencies, as needed, prior to the start of work at the site and at any time that earthwork resumes after interruption. Each step of the earthwork operations shall be observed and documented by the geotechnical consultant and, where needed, reviewed by the appropriate jurisdictional agency prior to proceeding with subsequent work.
- 1.4. If, during the earthwork operations, geotechnical conditions are encountered which were not anticipated or described in the geotechnical report, the geotechnical consultant shall be notified immediately and additional recommendations, if applicable, may be provided.
- 1.5. An as-built geotechnical report shall be prepared by the geotechnical consultant and signed by a registered engineer. The report documents the geotechnical consultants' observations, and field and laboratory test results, and provides conclusions regarding whether or not earthwork construction was performed in accordance with the geotechnical recommendations and the plans.



- 1.6. Definitions of terms utilized in the remainder of these specifications have been provided in Section 6.

## **2. OBLIGATIONS OF PARTIES**

The parties involved in the projects earthwork activities shall be responsible as outlined in the following sections.

- 2.1. The client is ultimately responsible for each of the aspects of the project. The client or the client's authorized representative has a responsibility to review the findings and recommendations of the geotechnical consultant. The client shall authorize the contractor and/or other consultants to perform work and/or provide services. During earthwork the client or the client's authorized representative shall remain on site or remain reasonably accessible to the concerned parties to make the decisions that may be needed to maintain the flow of the project.
- 2.2. The contractor is responsible for the safety of the project and satisfactory completion of pipeline installation and other associated operations, including, but not limited to, earthwork in accordance with the project plans, specifications, and jurisdictional agency requirements. The contractor shall further remain accessible during non-working hours times, including at night and during days off.
- 2.3. The geotechnical consultant shall provide observation and testing services and shall make evaluations to advise the client on geotechnical matters. The geotechnical consultant shall report findings and recommendations to the client or the client's authorized representative.
- 2.4. Prior to proceeding with any earthwork operations, the geotechnical consultant shall be notified two working days in advance to schedule the needed observation and testing services.
  - 2.4.1. Prior to any significant expansion or reduction in the grading operation, the geotechnical consultant shall be provided with two working days notice to make appropriate adjustments in scheduling of on-site personnel.
  - 2.4.2. Between phases of earthwork operations, the geotechnical consultant shall be provided with two working days notice in advance of commencement of additional operations.

### **3. SITE PREPARATION**

Site preparation shall be performed in accordance with the recommendations presented in the following sections.

- 3.1. The client, prior to any site preparation or earthwork, shall arrange and attend a pre-construction meeting between the contractor, the design engineer, the geotechnical consultant, and representatives of appropriate governing authorities, as well as any other involved parties. The parties shall be given two working days notice.
- 3.2. Demolition in the areas to be graded shall include removal of pavements, and other manmade surface and subsurface improvements. Demolition of utilities shall include capping or rerouting of pipelines at the project perimeter.
- 3.3. The debris generated during demolition operations shall be removed from areas to be graded and disposed of off site at a legal dump site. Demolition operations shall be performed under the observation of the geotechnical consultant.

### **4. TRENCH BACKFILL**

The following sections provide recommendations for backfilling of trenches.

- 4.1. Trench backfill shall consist of granular soils (bedding) extending from the trench bottom to 1 or more feet above the pipe. On-site or imported fill which has been evaluated by the geotechnical consultant may be used above the granular backfill. The cover soils directly in contact with the pipe shall be classified as having a very low expansion potential, in accordance with UBC Standard 18-2, and shall contain no rocks or chunks of hard soil larger than 3/4-inch in diameter.
- 4.2. Trench backfill shall, unless otherwise recommended, be compacted by mechanical means to 90 percent relative compaction as evaluated by ASTM D 1557. Backfill soils shall be placed in loose lifts 8 inches thick or thinner, moisture conditioned, and compacted in accordance with the recommendations of the geotechnical report and of these guidelines. The backfill shall be tested by the geotechnical consultant at vertical intervals of approximately 2 feet of backfill placed and at spacings along the trench of approximately 100 feet in the same lift.
- 4.3. Jetting of trench backfill materials is generally not a recommended method of densification, unless the on-site soils are sufficiently free-draining and provisions have been made for adequate dissipation of the water utilized in the jetting process.
- 4.4. If it is decided that jetting may be utilized, granular material with a sand equivalent greater than 30 shall be used for backfilling in the areas to be jetted. Jetting shall gener-



ally be considered for trenches 2 feet or narrower in width and 4 feet or shallower in depth. Following jetting operations, trench backfill shall be mechanically compacted to the specified compaction to finish grade.

- 4.5. Trench backfill which underlies the zone of influence of foundations shall be mechanically compacted to a relative compaction of 90 percent as evaluated by ASTM D 1557. The zone of influence of the foundations is generally defined as the roughly triangular area within the limits of a 1:1 (horizontal:vertical) projection from the inner and outer edges of the foundation, projected down and out from both edges.
- 4.6. Trench backfill within slab areas shall be compacted by mechanical means to a relative compaction of 90 percent as evaluated by ASTM D 1557. For minor interior trenches, density testing may be omitted or spot testing may be performed, as deemed appropriate by the geotechnical consultant.
- 4.7. When compacting soil in close proximity to utilities, care shall be taken by the contractor so that mechanical methods used to compact the soils do not damage the utilities.
- 4.8. Clean granular backfill and/or bedding materials are not recommended for use in slope areas unless provisions are made for a drainage system to mitigate the potential for buildup of seepage forces or piping of backfill materials.
- 4.9. The contractor shall exercise the specified safety precautions, in accordance with OSHA Trench Safety Regulations, while conducting trenching operations. Such precautions include shoring or laying back trench excavations at 1:1 or flatter, depending on material type, for trenches in excess of 5 feet in depth. The geotechnical consultant is not responsible for the safety of trench operations or stability of the trenches.

## 5. SITE PROTECTION

The site shall be protected as outlined in the following sections.

- 5.1. Protection of the site during the period of construction shall be the responsibility of the contractor unless other provisions are made in writing and agreed upon among the concerned parties. Completion of a portion of the project shall not be considered to preclude that portion or adjacent areas from the need for site protection, until such time as the project is finished as agreed upon by the geotechnical consultant, the client, and the regulatory agency.
- 5.2. The contractor is responsible for the stability of temporary excavations. Recommendations by the geotechnical consultant pertaining to temporary excavations are made in consideration of stability of the finished project and, therefore, shall not be considered to preclude the responsibilities of the contractor. Recommendations by the geotechnical

cal consultant shall also not be considered to preclude more restrictive requirements by the applicable regulatory agencies.

- 5.3. Precautions shall be taken during the performance of site clearing, excavation, and grading to protect the site from flooding, ponding, or inundation by surface runoff. Temporary provisions shall be made during the rainy season so that surface runoff is away from and off the working site. Where low areas cannot be avoided, pumps shall be provided to remove water as appropriate during periods of rainfall.
- 5.4. Following periods of rainfall, the contractor shall contact the geotechnical consultant and arrange a walk-over of the site in order to visually assess rain-related damage. The geotechnical consultant may also recommend excavation and testing in order to aid in the evaluation. At the request of the geotechnical consultant, the contractor shall make excavations in order to aid in evaluation of the extent of rain-related damage.
- 5.5. Rain- or irrigation-related damage shall be considered to include, but may not be limited to, erosion, silting, saturation, swelling, structural distress, and other adverse conditions noted by the geotechnical consultant. Soil adversely affected shall be classified as "Unsuitable Material" and shall be subject to overexcavation and replacement with compacted fill or to other remedial grading as recommended by the geotechnical consultant.



## 6. DEFINITIONS OF TERMS

ALLUVIUM:	Unconsolidated detrital deposits deposited by flowing water; includes sediments deposited in river beds, canyons, flood plains, lakes, fans at the foot of slopes, and in estuaries.
AS-GRADED (AS-BUILT):	The site conditions upon completion of grading.
BEDROCK:	Relatively undisturbed in-place rock, either at the surface or beneath surficial deposits of soil.
BORROW (IMPORT):	Any fill material hauled to the project site from off-site areas.
CIVIL ENGINEER:	The Registered Civil Engineer or consulting firm responsible for preparation of the grading plans and surveying, and evaluating as-graded topographic conditions.
CLIENT:	The developer or a project-responsible authorized representative. The client has the responsibility of reviewing the findings and recommendations made by the geotechnical consultant and authorizing the contractor and/or other consultants to perform work and/or provide services.
COLLUVIUM:	Generally loose deposits, usually found on the face or near the base of slopes and brought there chiefly by gravity through slow continuous downhill creep (see also Slope Wash).
COMPACTION:	The densification of a fill by mechanical means.
CONTRACTOR:	A person or company under contract or otherwise retained by the client to perform, excavation, pipeline installation, and other site improvements.
DEBRIS:	The products of clearing, grubbing, and/or demolition, or contaminated soil material unsuitable for reuse as compacted backfill, and/or any other material so designated by the geotechnical consultant.
ENGINEERED FILL:	A fill which the geotechnical consultant or the consultant's representative has observed and/or tested during placement, enabling the consultant to conclude that the fill has been placed in substantial compliance with the recommendations of the geotechnical consultant and the governing agency requirements.

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ENGINEERING GEOLOGIST:	A geologist registered by the state licensing agency who applies geologic knowledge and principles to the exploration and evaluation of naturally occurring rock and soil, as related to the design of civil works.
EROSION:	The wearing away of the ground surface as a result of the movement of wind, water, and/or ice.
EXCAVATION:	The mechanical removal of earth materials.
EXISTING GRADE:	The ground surface configuration prior to grading; original grade.
FILL:	Any deposit of soil, rock, soil-rock blends, or other similar materials placed by man.
FINISH GRADE:	The as-graded ground surface elevation that conforms to the grading plan.
GEOFABRIC:	An engineering textile utilized in geotechnical applications such as subgrade stabilization and filtering.
GEOTECHNICAL CONSULTANT:	The geotechnical engineering and engineering geology consulting firm retained to provide technical services for the project. For the purpose of these specifications, observations by the geotechnical consultant include observations by the geotechnical engineer, engineering geologist and other persons employed by and responsible to the geotechnical consultant.
GEOTECHNICAL ENGINEER:	A licensed civil engineer and geotechnical engineer, registered by the state licensing agency, who applies scientific methods, engineering principles, and professional experience to the acquisition, interpretation, and use of knowledge of materials of the earth's crust to the resolution of engineering problems. Geotechnical engineering encompasses many of the engineering aspects of soil mechanics, rock mechanics, geology, geophysics, hydrology, and related sciences.
GRADING:	Any operation consisting of excavation, filling, or combinations thereof and associated operations.
LANDSLIDE DEPOSITS:	Material, often porous and of low density, produced from instability of natural or manmade slopes.



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OPTIMUM MOISTURE:	The moisture content that is considered optimum relative to compaction operations.
RELATIVE COMPACTION:	The degree of compaction (expressed as a percentage) of a material as compared to the dry density obtained from ASTM test method D 1557.
SITE:	The particular parcel of land where earthwork is being performed.
SLOPE WASH:	Soil and/or rock material that has been transported down a slope by gravity assisted by the action of water not confined to channels (see also Colluvium).
SLOUGH:	Loose, uncompacted fill material generated during grading operations.
SOIL:	Naturally occurring deposits of sand, silt, clay, etc., or combinations thereof.

**Appendix O**  
**Draft Project Specifications – Table of Contents**



**Santa Ana Regional Interceptor (SARI)  
Repairs to the Unlined Reinforced Concrete Pipe (RCP)  
Reaches IV-A and IV-B Design Services**

**Project Specifications**

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**Appendix P**  
**Guideline for the Use and Handling of Styrenated Resins in Cured-in-Place Pipe**



# Guideline for the Use and Handling of Styrenated Resins in Cured-in-Place-Pipe

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Interplastics, Inc.  
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September, 2008

## Disclaimer

This document presents a state-of-the-art guideline for the use and handling of styrene based resins in the CIPP pipeline rehabilitation industry. Following these guidelines does not guarantee that environmental damage, property damage, personal injury, or other damage or injury will not occur at, on, or near a CIPP installation site. CIPP projects and the associated risks vary tremendously and must be evaluated on a case-by-case basis. Some project circumstances may pose environmental risks completely unassociated with styrene. In addition, downstream sewers and receiving waters are variable, not only from place to place but also from time to time, and the discharge of cure water and condensates must be thoroughly evaluated for each installation. This document is not intended as a substitute for professional advice pertaining to the use and handling of styrene based resins, and it is recommended that a professional be consulted for such purposes. NASSCO makes no warranty of any kind whatsoever, whether express or implied, with respect to the guidelines set forth in this document. NASSCO disclaims any and all liability, including but not limited to property damage, personal injury, or any other manner of damage or injury arising out of the use of this document or the use and handling of styrene based resins in the CIPP pipeline rehabilitation industry.

## **EXECUTIVE SUMMARY**

Styrenated resin systems as they are currently used today in cured in place pipe (CIPP) rehabilitation systems produce a safe and environmentally sound solution to the challenges of the need for restoring the nation's failing infrastructure. While current thought by U.S. academics assessing the overall use of styrene is leaning toward the conclusion that one might "reasonably anticipate styrene to be carcinogenic", a study carried out by the ECETOC (European Centre for Econtoxiology and Toxicology of Chemicals) concluded that "the carcinogenic potential of styrene, if one exists at all, is rated so low that occupational or environmental exposure to styrene is unlikely to present any carcinogenic hazard to man." The risk associated with styrene's use in CIPP is minimal and well within the Clean Water Acts' original intent of keeping the environment as free as is practical of chemical pollutants. CIPP installation sites managed with good housekeeping will present little opportunity for human health risks and/or environmental risks.

Although styrene occurs naturally in many foods such as cinnamon, coffee, and strawberries, styrene derived from petroleum and natural gas by-products have raised many questions about whether its usage in polyester and vinyl ester resin systems commonly used in CIPP to rehabilitate piping systems has the potential to adversely affect human health and/or the environment. While the CIPP process is a potential source of styrene, studies done to date have concluded that these type resin systems do not appear to be a significant source of styrene or any of the other volatile organic compounds (VOCs) that are typically of concern in occupational or air quality studies.

In a study undertaken by the Toronto Works and Emergency Services in 2001, AirZOne, Inc. conducted an investigation of the airborne concentrations of styrene and 24 other VOCs in eight randomly selected residences during the rehabilitation of sewers with CIPP installation. The study also measured ambient air quality, emissions from manholes and occupational exposure from these compounds. Air sampling was executed in three phases, before, during, and after the CIPP's installation. Styrene levels were elevated significantly during the CIPP installation in just two homes where the homes' traps were engineered to be dry in order to simulate a worst case scenario; the levels, although elevated, proved not to be a health concern. Levels measured in these eight homes were 0.1 to 0.2ppm. Styrene emissions from manholes during the CIPP process ranged from 0.16ppm to 3.2ppm. Personal exposure of the installation personnel in the breathing zone ranged from 0.08 to 0.5ppm. Styrene in the breathing zone was well below the industry's voluntary occupational limit of 50ppm for the installation personnel.

Independent, peer reviewed scientific journals have published numerous studies on the fate of styrene and its natural occurrence in the environment. "Biodegradation of Styrene in Samples of Natural Environments" by Min Hong Fu and Martin Alexander of Cornell University, concluded that styrene will be rapidly destroyed by biodegradation in most environments having oxygen; although the rates may be slow at low concentrations in lake waters and in environments at low pH. "Desorption and Biodegradation of Sorbed Styrene in Soil and Aquifer Solids" by Min Hong Fu, Hilary Mayton, and Martin Alexander of Cornell University, concluded that being broken down by microbes is a major fate mechanism by which styrene is destroyed in soils. The "Ecotoxicity Hazard Assessment of Styrene" by J.R. Cushman concluded that styrene was shown to be moderately toxic to fathead minnows, daphnids, and amphipods. It was further shown to be highly toxic to green algae, and slightly toxic to earthworms. There was no indication of a concern for chronic toxicity based on these studies. Styrene's potential impact on aquatic and soil environments, it was concluded, is significantly mitigated by the rapid rate at which it evaporates and biodegrades in the environment. And finally, Martin Alexander, in his "The Environmental Fate of Styrene", concluded that transport of styrene in nature is "very limited" because of its volatility from soils and surface waters, its rapid destruction in air, and its biodegradation in soils and surface and ground waters.



Because the styrene odor can be detected at such low concentrations (0.4 to 0.75ppm, depending on one's ability to detect odors), styrene's odor can be considered a nuisance to those not used to working around it. Some people are offended by this odor and are fearful of it; even though the concentrations they smell present no harm to them. To minimize odor problems during the installation of CIPP, residents should be advised to ensure that their sewer traps are in a proper state of repair. In cases of damaged, dry, or non-existent traps, the areas or rooms where floor drains or access to traps are located should be ventilated, if possible, by leaving doors or windows open to the outside during the CIPP installation process.

The CIPP installation contractor should practice good housekeeping and protect the project site such that any accidental resin spillage can be cleaned up and properly disposed of by the contractor. Given the nature of these resin systems to resist movement once placed in the tube's fiber matrix only very small quantities should be anticipated; excepting in the case of over-the-hole saturation installations.

The impact of styrene concentrations in the process water when discharged directly into a sewer collection system is insignificant. An eight inch pipeline 650 linear feet in length will discharge approximately 1700 gallons of water to the receiving sewer. At a typical concentration of 20ppm, the resultant discharge would be less than 0.3 pounds of styrene. A 48-inch pipeline 650 linear feet in length will discharge approximately 61,300 gallons of water to the collection system; which, again, amounts to approximately 10.2 pounds of styrene at a concentration level of 20ppm. With the assimilative capabilities of the downstream flows, no harm is thus anticipated to the wastewater treatment works and/or the POTW's discharge requirements.

Based upon the above given discharge quantities of typical CIPP installations, a CIPP installation contractor discharging these same quantities of process water to a ditch or other waterway is expected to meet the requirements of the EPA's small quantity generator exemption. In fact, due to the nomadic nature of the installer's discharges, a case could be made that the discharges fall under the category of non-point source contributions. However, the installation contractor is still advised to consider the negative impacts of the temperature of the water at discharge if the receiving drainage conveyance contains aquatic organisms that can be harmed by the possible sudden drop in available oxygen due to the large temperature difference between the process water and the receiving water body's temperature.

Any time an environmental release of a hazardous substance exceeds its reportable quantity as defined in 40 CFR Part 302, the contractor shall report this release immediately to the National Response Center (NRC). The reportable quantity for styrene per 40 CFR § 302.4 is 1000 pounds (or 2500 pounds of resin). Quantities below this amount are to be handled by the contractor in an expeditious manner; but do not require reporting.

## **INTRODUCTION**

Styrene is the ideal monomer used for cross-linking polyester and vinyl ester resins. Although alternative monomers have been extensively investigated, none of those monomers have matched the overall performance of styrene. Over the last 30 years the increasing awareness of the need to limit the effects of styrene exposure have lead the polyester resin processing industry to pursue strategies to reduce exposure in the manufacturing and processing plant environment. Most, if not close to all, of the studies undertaken to date have centered on these producers and users environments which are dramatically different than the work environment of the CIPP installation contractor. Given the desire to address the rehabilitation industry's need for standards in the proper safe use and handling of styrenated resins for CIPP, NASSCO created a styrene task force to review the technical information available from these studies and current CIPP installation practices to produce this CIPP specific guideline. In addition to this guideline, NASSCO has prepared an Inspector Training Course to properly equip the owner and the project engineer with the necessary knowledge to ensure that a proper installation is achieved which will minimize the potential for release of styrene to the environment.

Polyester and vinyl ester resin systems have been used for more than 35 years in CIPP. During this timeframe there have been no noted serious consequences to their usage in CIPP. However, as no definitive document for these resin systems as used in this specific application existed, the unknown has given rise to speculation as to their safety with respect to the work force involved, the general public when the odors enter the structures connected to the piping under rehabilitation, and to the greater downstream environment from where the work is taking place.

Styrene is a common chemical compound found where we live and work. Indoor sources of styrene emissions include off-gassing of building materials and consumer products and tobacco smoke. Styrene is emitted from glued carpet, floor waxes and polishes, paints, adhesives, putty, etc.; and infiltration of gasoline-related VOCs from attached garages is well documented.

Styrene, with its low vapor pressure, is expected to exist solely as a vapor in the ambient atmosphere (Hazardous Substances Data Bank 2008). In its vapor phase it is expected to react rapidly with hydroxyl radicals and with ozone. Half-lives based on these reactions have been estimated to range from 0.5 to 17.0 hours (Luderer et al. 2005). Atmospheric washout (the removal from the atmosphere of gases and sometimes particles by their solution in or attachment to raindrops as they fall) is not expected to be an important process because of these rapid reaction rates and styrene's relatively high Henry's law constant (the extent to which a gas dissolves into a liquid is proportional to its vapor pressure). Outdoor air monitoring by the EPA for 259 monitoring sites involving some 8,072 observations in 2007 showed that the mean concentrations for these sites ranged from 0.028 to 5.74 ppb. The primary sources of styrene in outdoor air include emissions from industrial processes involving styrene and its polymers and copolymers, vehicle emissions, and other combustion processes.

Volatilization and biodegradation are expected to be the major fate and transformation processes in water. Again, based on its Henry's law constant, styrene is expected to volatilize rapidly from environmental waters; the extent of volatilization depends on the water depth and turbulence with low volatilization occurring in stagnant, deep water. The estimated volatilization half-life of styrene in a river three feet deep with a current of three feet per second and wind velocity of 9.5 feet per second is roughly three hours. Half-lives have been estimated from one hour for a shallow body of water to 13 days in a lake. Some biological oxygen demand studies have shown styrene to be biodegradable. Cohen et al. 2002 found that styrene generally does not persist in water because of its biodegradability and volatility.

## **MATERIAL FACTS**

Styrene Monomer	
<b>Property</b>	<b>Value</b>
Auto-ignition Temperature (in air)	914°F
Boiling Point:	
14.7 psi	293°F
1.9 psi	180°F
0.6 psi	130°F
Color	Colorless
Corrosivity	Non-corrosive to metals except copper and alloys of copper
Density (in air):	
32°F	7.71 lbs/US Gallon
68°F	7.55 lbs/US Gallon
122°F	7.33 lbs/US Gallon
Solubility: Styrene in Water	
32°F	0.018 gms/100 gmsH <sub>2</sub> O
104°F	0.040 gms/100 gmsH <sub>2</sub> O
176°F	0.062 gms/100 gmsH <sub>2</sub> O
Solubility: Water in Styrene	
32°F	0.020 gms/100 gms styrene
104°F	0.100 gms/100 gms styrene
176°F	0.180 gms/100 gms styrene
Vol. Shrinkage upon Polymerization, typ.	17%

## **RECEIVING AND STORING CIPP RESINS AND INITIATION CHEMICALS**

Resins should be received and stored in controlled conditions. Today's state of the art facilities for tube saturation (wet out) consist of temperature controlled storage tanks mounted outside in a spill prevention area with interconnecting piping to the static mixing (and resin system disbursement) unit inside the saturation shop. This minimizes the typical styrene concentration in the work area to less than 0.5ppm, well below the industry's voluntary standard of 50ppm (for an 8-hour work period). The remainder of the facilities in use varies from working with resin stored in totes to resin stored in drums; and catalyzed by combining the initiators, typically Perkadox and Trigonox, with the resin directly in the drums or in a vat (batch mixing) using a mixing blade. These latter methodologies can, without proper ventilation create styrene concentrations around 2-3ppm in the work area. A well ventilated work area is recommended if mixing is to be done in this fashion.



Based on studies to date, worker exposure to concentrations between 20 and 50ppm have been shown to produce no negative health effects. At concentrations above 50ppm, reversible effects on the central nervous system have been observed. With increasing exposure levels, e.g. levels of 200ppm, a distinct irritation of mucous membranes can result. Such effects are reversible and similar in character to exposure to solvents without adequate ventilation or after excessive intake of alcohol. According to a study carried out by the ECETOC (European Centre for Econtoxiology and Toxicology of Chemicals), the carcinogenic potential of styrene, if one exists at all, is rated so low that occupational or environmental exposure to styrene is unlikely to present any carcinogenic hazard to man.

## Drums and Totes

Drums and totes of resin should not be allowed to stand in the sun for more than a few hours. As soon as possible after being received, drums and totes should be moved to a cool, shaded area. In hot weather they can be cooled with a water spray. It is advisable that inventories utilizing these two storage methods be kept to a minimum during summer months and that the resin be stored no longer than is necessary. Having the resin manufacturer acknowledge your usage rates and tailoring any additional inhibitor needs to compensate for the storage environment is strongly recommended.

Inhibitors are customarily added to resin systems to prevent polymer formation and oxidative degradation during shipment and storage. Inhibitors prevent polymerization in two ways; (1) they can react with and deactivate the free radicals in a growing polymer chain and (2) they can act as an antioxidant and prevent polymerization by reacting with oxidation products in the styrene monomer. Sufficient oxygen must be present for this inhibition to be realized. In the absence of oxygen, polymerization will take place as if no inhibitor were present. The rate of the inhibitor's depletion is dependent on the set of environmental conditions seen in the storage environment. Heat, water, and air can greatly accelerate the depletion of the inhibitor; with heat being the most influential. The table below illustrates the effects of temperature and oxygen levels on the storage time of styrenated resin systems.

Temperature	12ppm Inhibitor		50ppm Inhibitor Saturated w/ Air
	Saturated w/ Air	Less than 3ppm O <sub>2</sub>	
60°F	6 months	10 to 15 days	1 year
85°F	3 months	4 to 5 days	6 months
110°F	8 to 12 days	Less than 24 hours	Less than 30 days

The safe storage and use of resins in non-bulk packaging is described in the National Fire Protection Association's (NFPA) code 30, chapter 4. Although each state can enforce other fire codes, such as the UFC and BOCA, the NFPA codes serve as a good initial planning document. It is strongly recommended that contractors engaged in their own saturating their tubes consult this book if they intend to store resins in non-bulk packaging.

## Bulk Storage Tanks

In designing bulk storage facilities, certain basic factors must be considered. Resins containing the styrene monomer can be stored for relatively long periods of time if simple, but carefully prescribed conditions are met. In addition to the usual precautions taken with flammable liquids against fire and explosion hazards, precautions must also be taken against conditions that would promote the formation of polymer and oxidation products. To accomplish this, the design and construction of a satisfactory bulk storage system for styrenated resin systems

requires careful consideration to eliminate excessive temperatures and to prevent contamination of the resin from infrequently used lines and other equipment.

Vertical storage tanks are commonly used for large volume storage. Horizontal storage tanks are equally satisfactory for resin storage; but are used for smaller volumes such as are typical of CIPP saturation facilities. The inlet and outlet piping is normally located near the bottom. To facilitate mixing where external refrigeration or heating are employed, it is recommended that either the inlet or outlet line operate through a floating swing-pipe adjusted so that the resin is always either withdrawn or discharged a few inches below the surface. Warm resin is withdrawn from the top, circulated through the chiller, and discharged to the bottom of the tank; cooling the tank from the bottom up.

A self-supporting-type dome roof is recommended for vertical storage tanks. This type of construction simplifies the installation of tank linings and permits the rapid drainage of uninhibited condensed vapors back into the liquid resin, thus reducing the polymer and stalactite problem. Roof and sidewall openings above the normal liquid levels in the tank should be of large diameter and the number kept to as few as practical. Large diameter openings are easily lined and can also be used for dual service features.

Insulation and temperature control equipment are key elements of a well done bulk storage system. The resin should be kept around 65°F (between 60°F and 75°F is acceptable) to facilitate the saturation process and allow for proper maintenance of the calibration of the resin mixing system.

The working capacity of the storage tanks should be, within reason, based upon the installer's resin usage. A general rule of thumb is that a bulk tank system should be of a size to allow for the turning of the resin inventory every 45 days. Given that a full truckload shipment is approximately 4,500 gallons, a typical system would have a minimum storage volume of 5,500 to 6,000 gallons to ensure that the system does not completely empty prior to receiving another resin shipment.

Requirements of diking, tank spacing, and other features of safety are detailed in guidelines set by the National Fire protection Association (see NFPA 30, Chapter 2). These, as well as local building codes and governmental regulations, should be consulted since some requirements vary with the size and configuration of the installation.

### **Organic Peroxides**

All peroxides are heat sensitive to some degree and require a controlled temperature for storage. Storage temperatures should be kept at, or below, 59°F for longer shelf life and stability. Prolonged storage at temperatures greater than 68°F is not recommended. Perkadox 16 will degrade if stored at elevated temperatures leading to gassing and potential container rupture which can result in a fire and/or explosion. Prolonged storage of Trigonox above 80°F is not recommended. All storage should be done in the peroxides' original containers away from flammables and all sources of heat, sparks, or flames; out of direct sunlight; and away from cobalt naphthenate, other promoters, accelerators, oxidizing or reducing agents, and strong acids or bases.

## **HANDLING CIPP RESINS AND INITIATION CHEMICALS**

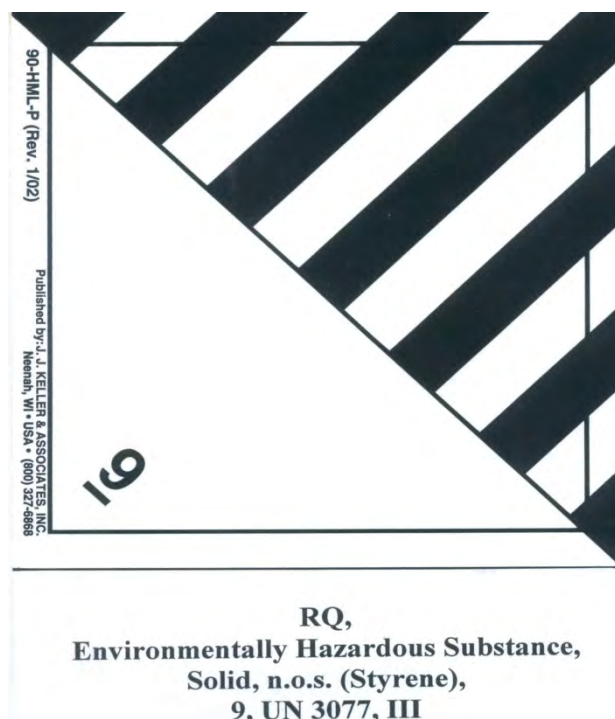
Styrene based polyester resins are sensitive to contact with both heavy metals and red metals. Interaction with these metals is not predictable as in some cases they will inhibit the cure; and in others they will accelerate it. Common metals to avoid are; copper, brass, beryllium, chromium, lead and galvanized metal. The recommended metals or plastics to be used for storage and piping are carbon steel, stainless steel, aluminum, polyethylene, polypropylene, and Teflon. Resin transfer hoses must be chemically resistant and approved for use with styrene.

## **TRANSPORTATION OF RESIN-SATURATED TUBES**

Per previous correspondence with the Federal Highway Transportation Agency, the resin-saturated tube is considered an acceptable “container” for shipment to the project site from the saturation shop. Currently, each tube is to be identified on its end with a class 9 placard and a description of its contents as shown in the figure to the right. If any one tube being transported in the truck exceeds 1000 pounds of styrene (approximately 2500 pounds of resin), then the truck itself must be placarded with the class 9 placard bearing the UN 3077 designation.

The transporting truck should be equipped with provisions to keep the saturated tubes out of direct sunlight and at or below 40°F. The floor should be insulated well enough to keep any heat from the roadway generating heat in the stored liners.

Depending upon the number of tubes being shipped and/or the residence time in the truck, styrene concentration levels in the air space of the storage box can reach approximately 90ppm. While this level can be irritating to the eyes, it will not produce any harm to the workers (NIOSH allowable concentration for work areas is 215ppm STEL, or short term exposure limit) and dissipates quite rapidly once the doors are opened.



## **CIPP INSTALLATION PRACTICES**

All CIPP resin systems require that good housekeeping be practiced by the installation team on the project site. Provisions must be made by the contractor in advance for containing any accidental spillage of the resin on the work area. Further, if more than 2500 pounds of resin (1000 pounds of styrene) is spilled, the spill must be reported to the appropriate local pollution control authorities. Spills less than this “reportable quantity” are to be handled in a responsible manner by the contractor. Absorption with an inert material and placing in an appropriate waste disposal container is the industry standard for handling small spills on the ground. Some absorbing agents, such as untreated clays and micas, will cause an exothermic reaction which might ignite the styrene monomer. For this reason, absorbing agents should always be tested for their effect on the polymerization of the monomer before they are used on larger spills. Claymax®, a loose “vermiculite-like” material has been found to be an effective absorbent. Oil dry, kitty litter and sand will also work well. If the spill occurs on a hard surface, the area should be scrubbed with soap and water after the bulk of the spill has been cleaned up by the absor-



bent material. If the spill gets into a waterway, the spill must be contained using a floating dike similar to those used for oil spills. The resin can then be picked up by vacuuming the resin into a vacuum truck and subsequently placed in an appropriate waste disposal container.

Water inversions require that consideration be given to the temperature of the process water and any styrene content it may have after the CIPP installation has been completed. Depending on the volume of water used in the processing and the receiving environment (sanitary sewer, drainage ditch, waterway, etc), the water may require transportation and/or treatment prior to its final disposition. As stated in the introduction of this guideline, styrene readily dissipates through volatilization and degradation. In order to ensure that the cured liner remains tight fitting and dimensionally stable with the release of the cure water, the standard in the industry is to require that the cool down be continued until the temperature of the liner (and the surrounding ground) is no more than 100°F. During the cool down process a small hole is made in the downstream end to release hot water as cold water is introduced at the boiler truck to facilitate this effort. Process water once the liner temperature reads 100°F will probably have a temperature around 90°F or less which has been observed to have a styrene concentration in the range of 20 to 25ppm. The releasing of the process water directly to the sewer is not a problem due to the benefits of dilution in the downstream wastewater.

Process water released directly to a surface water course such as a drainage ditch or waterway must consider the allowable styrene concentration with respect to the receiving environment and the possible oxygen depleting capabilities of the process water's elevated temperature. Based upon the exhaustive literature review of the quick volatilization of the styrene and its potential to result in any long-term harm to plant and animal life, discharges of process water having the normal concentration levels of styrene and temperature at cool-down directly to a dry waterway should pose no harm. Further, while the common practice of many CIPP installers is to transport the process water to the nearest wastewater treatment facility, releases of process waters to ditches and/or waterways containing water and/or aquatic life containing no more than a concentration of 25ppm styrene and a temperature approximately equal to that of the receiving waterway should not create any environmental harm (see note below). For projects requiring large quantities of process water to be directly discharged to the environment, it is recommended that an engineering analysis be undertaken to determine the assimilative capacity of the receiving stream with respect to the temperatures and styrene concentrations anticipated.

Note: A typical 24-inch diameter culvert 100 linear feet in length will require around 2400 gallons of water to process. If released at 25ppm, the amount of styrene anticipated in its release is approximately 0.45 pounds.

Air inversion of the resin-saturated tube and curing the liner by the introduction of steam into the pressurized air flow greatly reduces the amount of styrene that will potentially be released into the environment. This is because the very quick cross-linking of the resin effectively binds up the styrene to a much higher degree using this method for curing. Most of the styrene released in this method of curing will be in the vapor form and requires little or no action on the contractor's part so long as the discharge point is maintained 6-inches above ground. The condensate generated in the pipeline being processed should be minimized by maximizing the flow of air for the site-specific conditions. The small volume of condensate produced during processing should be detained in a temporary impoundment if the quantity is expected to be discharged to a ditch or waterway containing water and/or aquatic life. Measurements made to date have shown that the condensate will probably have a concentration of around 30ppm. Depending upon the assimilative capacity of the receiving waterway, the condensate may be released once it has cooled to near ambient temperature (which will also result in a drop in the styrene concentration due to volatilization); or it can be retrieved into the steam generation system's water storage tank for later use in the production of steam during curing of the next CIPP.

It is imperative that the processing of the liner, whichever method of curing is used, is properly completed. Properly cured liners release little or no styrene to the environment. Thermocouples placed strategically in the liner-host pipe interface are a must. A written curing schedule developed for a CIPP system acknowledging the conditions present in the curing environment and the resin system proposed will lead to a proper cure and a long CIPP life; and no environmental impact.

## **SUMMARY**

Proper curing and handling of CIPP systems should be done using the following guidelines:

### **Water Curing**

#### Sanitary Sewers

1. Cure resin system per written curing schedule
2. Release process water to the sewer after per industry standards during/after cool-down.

#### Storm Sewers and Culverts

1. Cure resin systems per written curing schedule
2. Based upon receiving waterway's assimilate capabilities
  - a. Discharge water once at ambient air temperature
  - b. Discharge water once styrene concentration is confirmed to be at or below 25ppm;  
or
  - c. Transport process water to nearest wastewater treatment facility

### **Steam Curing**

#### Sanitary Sewers

1. Cure resin system per written curing schedule
2. Release condensate water directly to receiving sewer while processing

#### Storm Sewers and Culverts

1. Cure resin system per written curing schedule
2. Based upon receiving waterway's assimilative capabilities
  - a. Detain condensate in a lined holding pond until it cools to ambient
  - b. Discharge water once styrene concentration is confirmed to be less than 25ppm; or
  - c. Retrieve condensate by pumping it into the steam generation truck's reservoir; or
  - d. Transport condensate to nearest wastewater treatment facility.

Any residual styrene concentrations from a properly cured resin system that are taken into the runoff water from storm events will typically be short-lived, in the range of less than 1.0ppm and therefore pose no significant environmental threat.

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\* indicates the paper was peer reviewed prior to publication.



## **Appendix Q**

### **Value Engineering Report**



**SANTA ANA WATERSHED PROJECT AUTHORITY**

***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

August 31 – September 2, 2009

**FINAL REPORT**

Prepared by

**VALUE MANAGEMENT INSTITUTE**

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**SANTA ANA WATERSHED PROJECT AUTHORITY**

***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

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# **SECTION I - EXECUTIVE OVERVIEW**

SANTA ANA WATERSHED PROJECT AUTHORITY  
***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

**Project Background and Description**

SAWPA was formed in 1972 to plan and construct facilities with the goal of protecting and improving ground and surface water quality of the Santa Ana River Watershed. SAWPA is a joint powers agency and consists of five member agencies: Eastern Municipal Water District, Western Municipal Water District, Inland Empire Utilities Agency, Orange County Water District and San Bernardino Valley Municipal Water District. SAWPA owns, operates and maintains 72 miles of the Santa Ana Regional Interceptor (SARI) pipeline network within Riverside and San Bernardino Counties upstream from the Orange/Riverside County line.

The SARI pipeline conveys primarily highly saline, non-domestic wastewater from industrial dischargers and municipal desalter facilities within Riverside and San Bernardino Counties to the Orange County Sanitation District wastewater treatment facility.

Beginning construction in the late 1970s, the SARI pipeline is a network of collector pipelines totaling 93 miles and extends from the Upper Santa Ana Watershed to the Pacific Ocean. Reach IV-A serves the Chino Basin area and Reach IV-B serves the southwestern portion of the City of Riverside and the City of Corona. SARI Reach IV-A and Reach IV-B were constructed in the early 1980s and are two of the older portions of the pipeline and are in need of repair and rehabilitation to prevent potential leaks into the groundwater and surface water within the Prado Dam basin area.

The pipelines are constructed of unlined, reinforced concrete pipe (RCP). As part of an ongoing maintenance program consistent with the Statewide General Waste Discharge Requirements as adopted by the State Water Resources Control Board, SAWPA had performed inspections on the pipeline. Previous surveys of the interior pipelines have identified evidence of decay and bio-growth which inhibits the flow of water through the pipe. The Project proposes to rehabilitate segments of the existing pipeline to extend the service life of the Reach IV-A and Reach IV-B pipelines.

In addition to making repairs to extend the service life of the existing pipelines, the repairs to the pipelines are also necessary to meet the new loading conditions created by raising the height of the Prado Dam. A recent project completed by the United

States Army Corps of Engineers (ACOE) has raised the height of Prado Dam by approximately 28 feet and proposes to raise the spillway elevation by 20 feet. The Orange County Water District will implement an approved water conservation pool to support an aquifer recharge and groundwater augmentation program. The conservation pool behind the dam will be set at an elevation 505 feet amsl, which will periodically inundate the SARI pipelines near the dam by approximately 30 feet of water.

Over the next 30 years, the sediment deposition behind the dam is expected to rise 20 feet. The proposed Project will strengthen the pipeline to resist the increased weight over the pipeline from the water conservation efforts. This will result in inundation of greater lengths of pipeline for longer periods of time, which will restrict access to the pipeline for all or most of the year. Increased sedimentation will also restrict access to the pipeline by covering the existing manholes. The pipeline is currently unlined. Lining the pipeline will prevent deterioration of the pipeline concrete and joints. Deterioration of the concrete has the potential to impact the structural integrity of the pipeline.

The purpose of the proposed Project is to repair the existing SARI Pipeline along Lower Reach IV-A, Upper Reach IV-A, and Reach IV-B. The repairs are needed to rehabilitate the aging pipeline to avoid leaking industrial brine water into the groundwater table and extend the useful life of the existing pipeline. If the industrial brine water leaked and contaminated the water conservation pool behind the Prado Dam, the effects would be catastrophic to the vegetation and wildlife species relying on the conservation pool habitat as a vital life-supporting resource.

By undertaking the proposed Project, SAWPA proposes to repair approximately 11 miles of the existing SARI pipeline to extend the useful life of the pipeline and to prevent future leaks into the water table due to decaying pipeline. SAWPA proposes to complete this Project consistent with local and regional land use goals and policies and within the limits of all applicable local, state, and federal government regulations. The objectives of this Project are to:

- Utilize repair techniques that are financially feasible and provide interim solutions while SAWPA investigates permanent and regional solutions for the SARI line;
- Improve the condition of the SARI pipeline to avoid leakage of untreated industrial wastewater and potential collapse of the pipeline;
- Repair the pipeline using advanced technologies and existing roadways to minimize impacts to sensitive wetland and upland habitats;
- Utilize existing infrastructure to the maximum extent possible;



- Minimize the need for future repair work since access to the pipeline within the 505-foot elevation of the conservation pool will be restricted for most of the year; and,
- Provide repairs that will extend the useful life of the pipeline segments by 50 years, providing SAWPA a buffer of time to safely continue existing pipeline operations while investigations for a permanent and regional solution for the SARI line are occurring.

As one of many steps taken to assure a quality project throughout design and construction, SAWPA elected to convene a Value Engineering Workshop to review project progress, and offer suggestions for further improvements in project functionality and cost effectiveness. A VE Team met for three days (31 August – 2 September 2009), and this report contains the results of that effort.

SANTA ANA WATERSHED PROJECT AUTHORITY  
***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

**Summary List of Developed Options**

**PROPOSAL #**      **ITEM**

**Environmental (E)**

E – 1.0	Project Description Elements (avoidance, minimization, mitigation, schedule)
E – 2.0	Develop Bird Accounting Parcel Program

**Design (D)**

D – 1.0	Optimize Manhole Design
D – 2.0	Identify Siphon Access / Rehab Requirements
D – 3.0	Assess Hobas versus HDPE Selection
D – 4.0	Evaluate Structural Capacity of Existing RCP
D – 5.0	Optimize Dewatering Approach
D – 6.0	Confirm Design Strategies
D – 7.0	Evaluate Cost Estimate

**Constructability (C)**

C – 1.0	Modify Slip-lining Access Locations
C – 2.0	Extend Contract Duration
C – 3.0	Identify Staging / Laydown Areas
C – 4.0	Evaluate U-V Pipe Lining
C – 5.0	Eliminate or Modify Water Bypass Requirements
C – 6.0	Postpone Upper Reach IV-A (27” pipeline) Segments
C – 7.0	Reduce Contractor Risk

SANTA ANA WATERSHED PROJECT AUTHORITY  
***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

**VE Team Leader Comments and Observations**

This was the first recent SAWPA VE Workshop, and a few “lessons learned” came from this exercise. Having the full support of SAWPA staff and RBF design personnel throughout the Workshop were key to the very open exchange of ideas that began with the opening discussions of project “drivers” and other requirements, and continued through the final day. Information provided by SAWPA was excellent, and included all the important design documentation, plus video clips of internal pipeline conditions, a disk with the environmental report and concerns, and other data. Some productivity was lost due to time constraints, and a more detailed cost estimate would have enabled a more comprehensive analysis of potential cost impacts.

The first day field trip emphasized the rather restrictive site conditions, with the need to access structures and move equipment through dense and almost impenetrable brush in an extremely sensitive environmental habitat. A further complexity for contractors will be the demands of breeding bird conditions that will restrict visual, movement and noise construction elements.

The good news resulting from the field trip was confirming these conditions only existed in the lower reaches, and that the upper IV-A area was a more normal pipeline installation, with many manholes, and generally open access to all planned CIPP insertion points. It was also outside the more environmentally sensitive Prado Basin and Conservation Pool limits, and was not subjected to changes initiated by the COE that will raise hydraulic and sediment loading on the lower reaches. Flow in the upper IV-A reach was also relatively minimal.

These conditions lead the VE Team to concentrate their efforts on the lower reaches, which were also the areas for the higher cost slip lining construction approach. Environmental concerns again dictated higher cost, because CIPP presented more risk of spillage with the water bypass needs. A number of team proposals were developed to improve the manhole design and enhance the slip lining installation process. The need for an extended pipeline life is critical in the lower reaches because once the Prado Dam and Conservation Pool fill, pipeline access is basically denied.



Since many of the VE Team proposals to improve lower reach construction and reliability will add cost, Team members looked to the IV-A upper reach for opportunities to reduce cost. Since CIPP is a very cost effective lining process that utilizes the existing manholes as insertion points, is located outside the more environmentally sensitive Prado Basin habitat and Conservation Pool limits and not subject to sedimentation loading there is an opportunity to temporarily delay rehabilitation of this reach if funding for the project is limited. Low flow conditions also provided opportunity to review planned installation procedures, and the need for manhole and siphon structural rehabilitation.

The Brainstorming List contains a number of items that will and / or should be considered as the design progresses from this Preliminary Phase. Many of the developed proposals also contain a checklist of items that would be candidates for subsequent review by the SAWPA Board, and the Design Group.

# **SECTION II - VALUE ENGINEERING PROPOSALS**

**Environmental – E-1.0 through E-2.0**



# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

E-1.0

DATE

9/2/2009

SHEET NO.

1 of 5

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Project Description Elements (avoidance, minimization, mitigation, schedule)

## ORIGINAL DESIGN

The project description components are defined. Project components may further be defined/refined in consideration of regulatory opportunities/approvals.

## PROPOSED CHANGE

Tailor project description/components to segment/tier activities to provide avoidance, minimization and mitigation strategies. This project description organization is in response to direction received from the United States Fish and Wildlife Service (USFWS) meeting on August 31, 2009.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

E-1.0

DATE

9/2/2009

SHEET NO.

2 of 5

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Project Description Elements (avoidance, minimization, mitigation, schedule)

## ADVANTAGES

- Serves to organize project components/activities chronically or geographically to demonstrate SAWPA's efforts to avoid a substantive effect on least Bell's vireo or potentially Southwestern Willow Flycatcher during the breeding season.
- This documentation will assist in obtaining Section 7 of the FESA compliance; a compliance requirement of the project which also facilitates FCWA, CDFG, and RWQCB.

## DISADVANTAGES

Minor labor and coordination efforts.

## JUSTIFICATION (essay-type rationale)

By providing the USFWS with a tiered project description that illustrates the SAWPA effort to construct the project in an environmentally-sensitive manner, the USFWS can better understand the construction requirements/challenges within the context of the bird-breeding season. In this manner, both SAWPA and USFWS can discuss avoidance, minimization and mitigation strategies and proceed with the final Biological Assessments/Biological Opinion with the underlying goal of concluding a No Jeopardy decision and allow construction to proceed. The objective is to obtain Section 7 concurrence by 12/1/2009.



Project: SARI Repairs Unlined RCP Project

## CALCULATIONS

### BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

E-1.0

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The project description must include the entire limits of disturbance and clearly distinguish, excavation, the vegetation clearing, equipment and stockpile locations, daylight and any nighttime operations (i.e. lighting/illumination issues), road use and construction duration. This is particularly relevant to those activities that take place during the breeding season. It will be important to provide USFWS with the temporal losses anticipated with willows, mulefat and eucalyptus, including tree count information. This is basic information for the Biological Assessment.

In response to USFWS's request for information presented to SAWPA on August 31, 2009; a description of project activities should be addressed with the following considerations:

Emphasize project components to demonstrate actions and activities are programmed to take place strategically outside the conservation pool and breeding habitat season as practicable.

Sample work activities include:

1. Storage of pipe (i.e. laydown area)
2. Widen roads from 10 to 20 feet
3. Establish working limits at manhole (100x150 feet)
4. Access from road to working limits
5. Equipment storage locations
6. Contractor trailer locations
7. Slip-lining activities





Project: SARI Repairs Unlined RCP Project

## CALCULATIONS

### BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

E-1.0

4 of 5

1. The storage of pipe off the immediate project area and well away from any ESA or ERA - AVOIDANCE
2. Widen the road in dry season outside the breeding season. This may require two pass-throughs for initial clearing in late summer/early fall 2010 including removal of large trees in riparian area and late summer/early fall 2011 - AVOIDANCE
3. Establish working limits in upper reaches - AVOIDANCE
4. Establish working limits adjacent to breeding habitat at same time as road widening (non-breeding season) - AVOIDANCE
5. Establish access road to work limits (same as 3 above) - AVOIDANCE
6. Establish equipment storage locations well away from ESAs and ERAs - AVOIDANCE
7. Establish contractor trailer locations, perhaps at ACOE field offices, well away from ESAs and ERAs - AVOIDANCE
8. Slip-lining activities should occur, optimally, as a sequential project from the higher elevation to lowest elevation although some time lapse may occur before proceeding downstream. Slip-lining can occur after establishment of all work areas. Working areas described above may be accommodated either outside the breeding season or well away from ESAs and ERAs. These activities occur between August/September 2010 and August/September 2011.

Slip-lining activities may commence in the upland during the breeding season. Slip-lining activities can take place in lower riparian where breeding least Bell's vireo and Southwestern Willow Flycatcher are not substantially present.



Project: SARI Repairs Unlined RCP Project

# CALCULATIONS

## BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

E-1.0

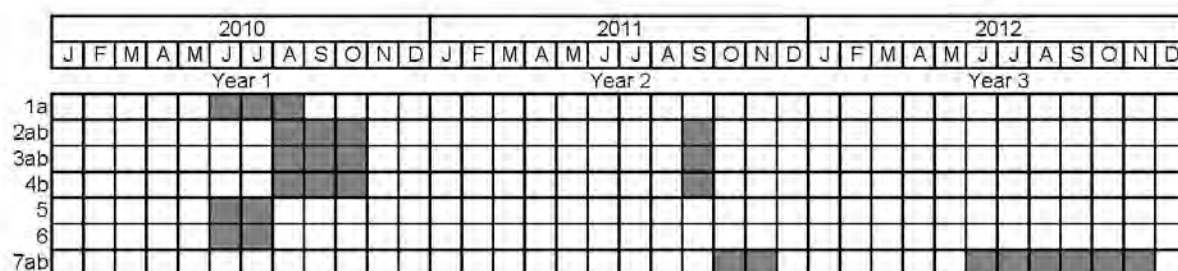
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Slip-lining activities within the breeding areas and adjacent to habitat can be implemented generally between 4A-0010 to 4A-0030 and 4B-0120 to 4B-0030, if the work can be accomplished during the non-breeding season (e.g. August 2011 through October 2012) assuming all work areas needed are processed.

If slip-lining activities cannot be completed prior to the upcoming storm season in late 2011; then work may need to commence in the breeding season in the following year in 2012 or until breeding season is completed.

Slip-lining activities that occur in breeding season would incorporate minimization/mitigation strategy including the placement of noise curtains to reduce noise exposure and obstruct line-of-sight with construction equipment in operation. During slip-lining activities the bird accounting parcel program may be in place to provide further assurances towards environmental compliance per CEUA and Biological opinion.

Potential Construction Schedule



a - Work in areas adjacent to breeding habitat  
b - Noise curtain installation

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

E-2.0

DATE

9/2/2009

SHEET NO.

1 of 4

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Develop Bird Accounting Parcel Program

## ORIGINAL DESIGN

Not specifically accounted as a project tracking component; although mitigation program in EIR provides the foundation.

## PROPOSED CHANGE

Conduct proactive bird surveys within determined corridor limit and determine presence, breeding status, nest status and determine nest abandonment. The Bird Accounting Program takes the mitigation program and further refines its utility for permitting consideration and scheduling work activities.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION



# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

E-2.0

DATE

9/2/2009

SHEET NO.

2 of 4

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Develop Bird Accounting Parcel Program

## ADVANTAGES

- Provides justification to begin/re-start work within established 500-foot buffer.
- Validates/identifies need/location of sound barrier (i.e. noise-attenuation curtain).

**Note:** Program basis for implementation established at permitting phase. Its utility dependent on use of noise barrier as allowed by the USFWS.

## DISADVANTAGES

Minor labor and cost during least Bell's vireo breeding season mid-March through mid-August. Actual protocol surveys including Southwestern Willow Flycatcher (April 10 - July 31)

## JUSTIFICATION (essay-type rationale)

For a reasonable and limited investment this Bird Accounting Parcel Program provides compliance documentation for the Federal Endangered Species Act, provides breeding/nesting status and locations, confirms location and geographic orientation of sound barrier and allows construction to occur during breeding season.



Project: SARI Repairs Unlined RCP Project

## CALCULATIONS

### BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

E-2.0

3 of 4

It will be critical to address the locations of listed species including the least Bell's vireo and Southwestern Willow Flycatcher, due to their potential to affect the construction schedules.

The Team will implement a comprehensive and effective bird survey and monitoring program prior to construction activities to assess the location and status of territory and nest activity within an appropriate area around the manhole locations as well as the access roads. A fundamental purpose of the surveys and monitoring is to track the presence of nesting birds during the spring breeding season.

The focus of the effort is a radius/buffer of a minimum of 500 feet from the location of the manholes. There is a 300 to 500 foot No Work Zone with either birds considered "special status" or State or Federal threatened or endangered. The Team will map nesting birds within the 500-foot survey area and potentially slightly beyond pending the terrain and anticipated bird movement. The survey/monitoring effort will result in a bird accounting program for each manhole work area where specific bird use areas within the established survey/monitoring boundaries are monitored and reported. GPS units will be used to establish coordinates of the bird locations and nesting activity along with the project work limits established for each of the manhole locations.

Each parcel can be numbered and information updated as the nesting season progress. It is important to recognize that the 500-foot survey area relates to the listed species whereas the 300 foot buffer is for non-listed special status species.

The biological/nest monitors would potentially release certain manhole locations as birds complete their breeding programs and abandon nests. In this manner. Any restrictions associated with nest presence can be removed and work may commence assuming other restrictions do not apply.

Survey efforts will focus on locating all nesting sites (i.e., breeding territories) within 500 feet of the disturbance limits for the project. Specifically, each manhole will be surveyed and continuously monitored throughout the migratory nesting season with the purpose of relieving restrictions on work activities. It is anticipated that once nesting activities within 500 feet of each manhole work area have ceased and birds have not attempted to re-nest, manholes can be "cleared" by the biologists and construction can begin.

Another important consideration is the use of a noise curtain and how the placement between the construction equipment (cranes, bulldozer, and tractor) and the nest location may result in substantive sound attenuation assuming direct line of sight can be broken.

Pending outcome of the permit conditions; if it is determined that sound barriers may be utilized in the work area during construction, they may be installed/oriented prior to the breeding season as a proactive activity or installed/oriented at the time the birds arrive to react to their arrival. A proactive approach is desirable to minimize uncertain conditions for the contractor. Silencers on construction equipment engines may reduce noise curtain requirements.



SARI Repairs  
Unlined RCP Project

SKETCH DETAIL

PROPOSED DESIGN

SCALE

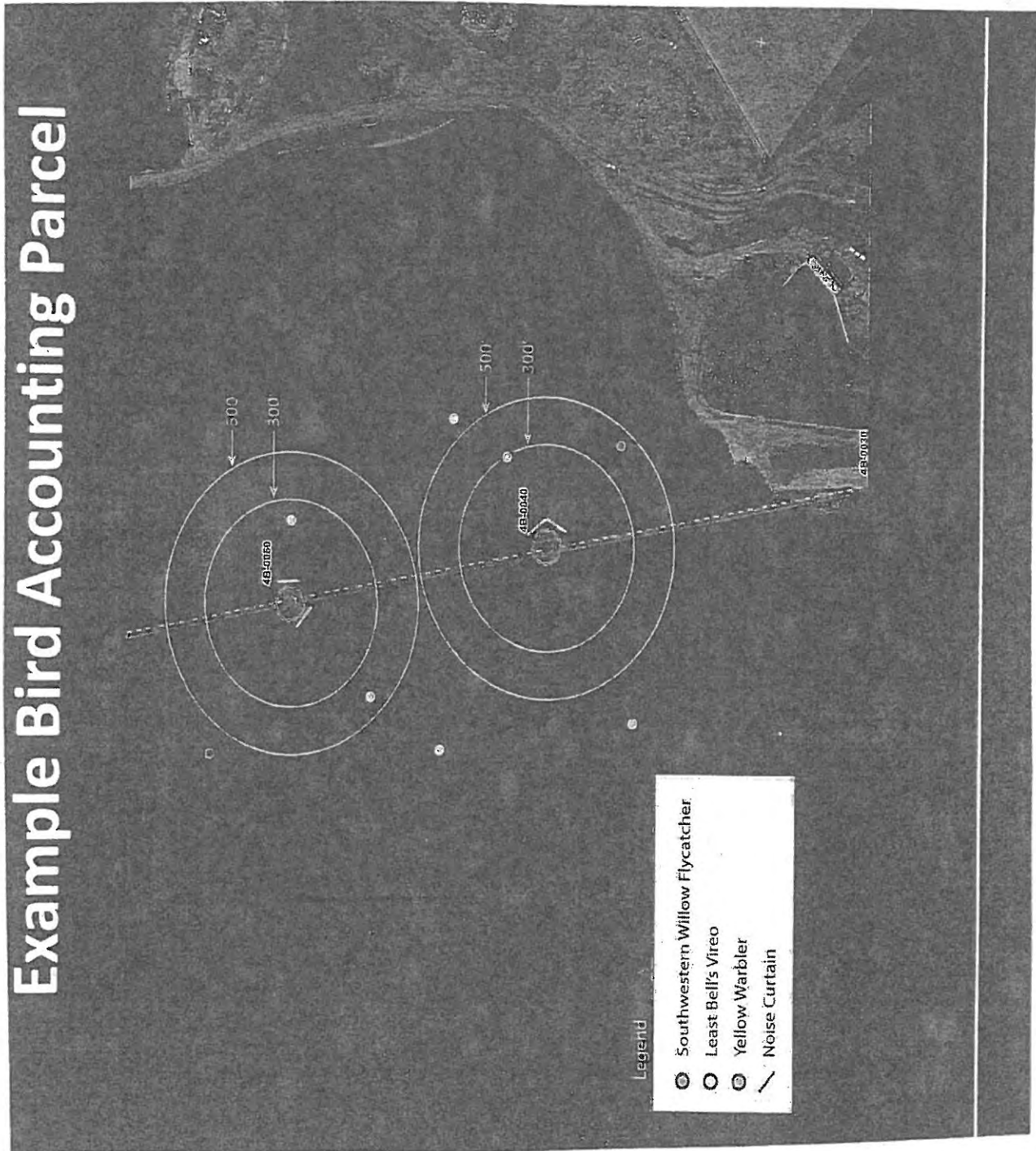
PROPOSAL NO.

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Example Bird Accounting Parcel





**Design – D-1.0 through D-7.0**

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

D-1.0

DATE

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SHEET NO.

1 of 4

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Optimize Manhole Design

## ORIGINAL DESIGN

Utilize slip-lining access pits for new FRP manholes. See original design sketch Sheet No. 3. Slip-line through existing manholes and abandon for access.

## PROPOSED CHANGE

Based on the high groundwater table and poor soil conditions, the design needs to ensure that the new manhole is stable. Special attention needs to be given to the dimension of the concrete slab underneath the encasement. In addition, ensuring a stable sub-base that precludes fine material movement is important. See proposed concept sketch Sheet No. 4.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

D-1.0

DATE

9/2/2009

SHEET NO.

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PROJECT SARI Repairs Unlined RCP Project

ITEM Optimize Manhole Design

## ADVANTAGES

- Ensures stable manhole that deals with high groundwater and poor soil conditions.
- Minimizes loading on new FRP pipe not in existing pipe.
- Provides provision for future extension at top of manhole by providing flanged and gasketed top lid.

## DISADVANTAGES

- Added cost
- Redesign required

## JUSTIFICATION (essay-type rationale)

Within the lower sections of IV-B and IV-A it is imperative that the design provide a system that will last for 50 years with minimal maintenance. Leakage or failure of this system is unacceptable!







**SARI Repairs**  
**Unlined RCP Project**

**SKETCH DETAIL**

PROPOSED DESIGN

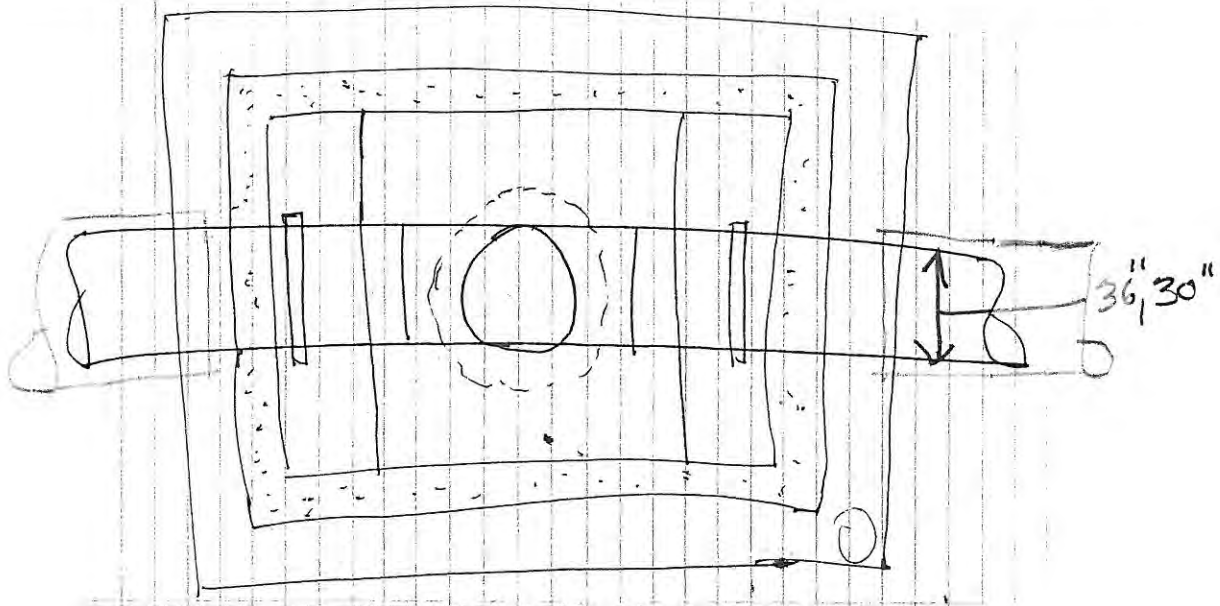
SCALE

PROPOSAL NO.

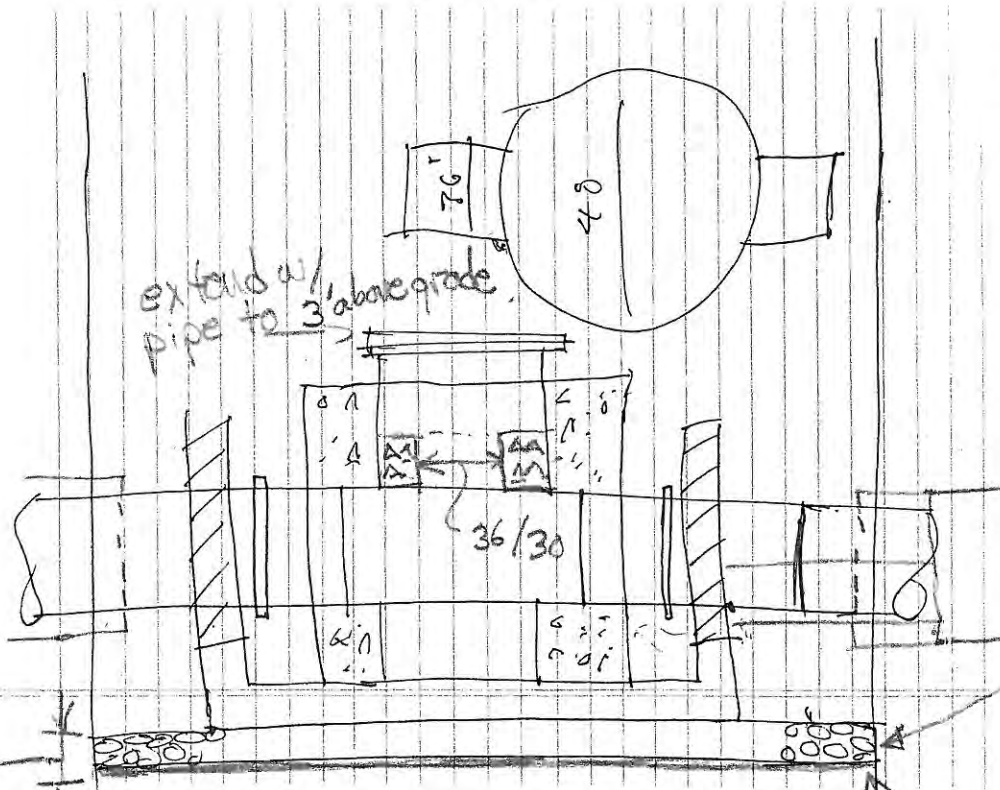
SHEET NO.

D-10

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PLAN



SECTION

Concrete  
Base  
dimensions  
based on  
Geotech  
info.

Felt fabric  
wrap  
around  
drain rock

Geogrid underlain  
by felt fabric

18" MIN.  
95%  
compaction

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

D-2.0

DATE

9/2/2009

SHEET NO.

1 of 2

PROJECT SARI Repairs Unlined RCP Project

ITEM Identify Siphon Access /Rehab Requirements

## ORIGINAL DESIGN

- Utilize existing 3'-0" manhole lids for access to accomplish CIPP rehabilitation.
- CIPP rehabilitation of siphon pipes.

## PROPOSED CHANGE

- Remove concrete lid with access manhole and replace with new concrete lid and 4'-6" x 4'-6" Bilco hatch.
- Do not CIPP rehabilitation the siphon pipes.

COST SUMMARY

TOTAL LABOR  
AND MATERIAL

MARK-UP

TOTAL COST

LIFE CYCLE COST

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION



# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

D-2.0

DATE

9/2/2009

SHEET NO.

2 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Identify Siphon Access / Rehab Requirements

## ADVANTAGES

- CIPP insertion enhanced.
- Enhanced maintenance access.
- Eliminating CIPP rehabilitation has a potential cost savings of \$150,000.

## DISADVANTAGES

- Additional cost for hatch, but reduces risk of CIPP insertion problem.

## JUSTIFICATION (essay-type rationale)

Contractor would probably request to remove the lid for construction and convince SAWPA that hatch would facilitate future maintenance. Change order would be issued at greater cost than including in bid document. VE Team inspected siphon access during their fieldtrip, and they appeared to be in excellent condition.

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

D-3.0

DATE

9/2/2009

SHEET NO.

1 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Assess Hobas versus HDPE Selection

## ORIGINAL DESIGN

The TM evaluated Hobas (centrifugal cast fiberglass reinforced mortar pipe, Vylon PVC and High Density Polyethylene (HDPE). Based on the PDR, the Hobas pipe was recommended for the slip-lining portion of the project. The major justification is that the extra thickness of the HDPE would reduce the capacity for future flows. For the 42-diameter RCP, the inside diameter would be 31.511" with a reduction of 22.5% capacity based on DR-17. For the 36-diameter RCP, the inside diameter would be 28.009" with a reduction of 14.7% capacity based on DR-17.

## PROPOSED CHANGE

None. Validation of direction taken by designer.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION



# SARI Repairs Unlined RCP Project

## CALCULATIONS

BACKUP DATA AND  
ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

D-3.0

2 of 2

From FM.

Table 4-10 was developed using Formula 4-30 where  $d_1$  = the liner ID, and  $d_2$  = the existing sewer ID.

Table 4-9 Comparative Flows for Slipliners

Existing Sewer ID, in	Liner OD, in.	Liner DR 32.5			Liner DR 26			Liner DR 21			Liner DR 17		
		Liner ID, in.†	% flow vs. concrete	% flow vs. clay	Liner ID, in.†	% flow vs. concrete	% flow vs. clay	Liner ID, in.†	% flow vs. concrete	% flow vs. clay	Liner ID, in.†	% flow vs. concrete	% flow vs. clay
4	3.500	3.272	97.5%	84.5%	3.215	93.0%	80.6%	3.147	87.9%	76.2%	3.064	81.8%	70.9%
6	4.500	4.206	64.6%	56.0%	4.133	61.7%	53.5%	4.046	58.3%	50.5%	3.939	54.3%	47.0%
6	5.375	5.024	103.8%	90.0%	4.937	99.1%	85.9%	4.832	93.6%	81.1%	4.705	87.1%	75.5%
8	6.625	6.193	84.2%	73.0%	6.085	80.3%	69.6%	5.956	75.9%	65.8%	5.799	70.7%	61.2%
8	7.125	6.660	102.2%	88.6%	6.544	97.5%	84.5%	6.406	92.1%	79.9%	6.236	85.8%	74.4%
10	8.625	8.062	93.8%	81.3%	7.922	89.5%	77.6%	7.754	84.6%	73.3%	7.549	78.8%	68.3%
12	10.750	10.049	103.8%	90.0%	9.873	99.1%	85.9%	9.665	93.6%	81.1%	9.409	87.1%	75.5%
15	12.750	11.918	90.3%	78.2%	11.710	86.1%	74.6%	11.463	81.4%	70.5%	11.160	75.7%	65.6%
15	13.375	12.503	102.5%	88.9%	12.284	97.8%	84.8%	12.025	92.4%	80.1%	11.707	86.1%	74.6%
16	14.000	13.087	97.5%	84.5%	12.858	93.0%	80.6%	12.587	87.9%	76.2%	12.254	81.8%	70.9%
18	16.000	14.956	101.7%	88.1%	14.695	97.0%	84.1%	14.385	91.7%	79.4%	14.005	85.3%	74.0%
21	18.000	16.826	92.3%	80.0%	16.532	88.1%	76.3%	16.183	83.2%	72.1%	15.755	77.5%	67.1%
24	20.000	18.695	85.6%	74.2%	18.369	81.7%	70.8%	17.981	77.2%	66.9%	17.506	71.9%	62.3%
24	22.000	20.565	110.4%	95.7%	20.206	105.3%	91.3%	19.779	99.5%	86.2%	19.256	92.6%	80.3%
27	24.000	22.434	101.7%	88.1%	22.043	97.0%	84.1%	21.577	91.7%	79.4%	21.007	85.3%	74.0%
30	28.000	26.174	115.8%	100.4%	25.717	110.5%	95.8%	25.173	104.4%	90.5%	24.508	97.2%	84.2%
33	30.000	28.043	108.0%	93.6%	27.554	103.0%	89.3%	26.971	97.3%	84.3%	26.259	90.6%	78.5%
36	32.000	29.913	101.7%	88.1%	29.391	97.0%	84.1%	28.770	91.7%	79.4%	28.009	85.3%	74.0%
36	34.000	31.782	119.5%	103.6%	31.228	114.1%	98.9%	30.568	107.7%	93.4%	29.760	100.3%	86.9%
42	36.000	33.652	92.3%	80.0%	33.065	88.1%	76.3%	32.366	83.2%	72.1%	31.511	77.5%	67.1%
48	42.000	39.260	97.5%	84.5%	38.575	93.0%	80.6%	37.760	87.9%	76.2%	36.762	81.8%	70.9%
54	48.000	44.869	101.7%	88.1%	44.086	97.0%	84.1%	43.154	91.7%	79.4%	42.014	85.3%	74.0%
60	54.000	50.478	105.1%	91.1%	49.597	100.3%	86.9%	48.549	94.8%	82.1%	47.266	88.2%	76.5%

† Liner ID calculated per Formula 4-1.

DR 135  
Pg. 8



# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

D-4.0

DATE

9/2/2009

SHEET NO.

1 of 1

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Evaluate Structural Capacity of Existing RCP

## ORIGINAL DESIGN

Appendix E of the PDR provides the basis for the Hobas design. Based upon the condition of the existing pipe, the E' was increased from 1,000 psi to 2,000 psi (equivalent for crushed rock bedding). Based on the other loading conditions, the calculations show that a PS of 95 psi (worst case). Optimizing may be possible during the final design.

## PROPOSED CHANGE

After reviewing the assumption and calculations, the VE Team agrees that the current design assumes the maximum benefit of the existing RCP pipe.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

D-5.0

DATE

9/2/2009

SHEET NO.

1 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Optimize Dewatering Approach

## ORIGINAL DESIGN

Dewatering anticipated for each access pit to lower the groundwater table a minimum of 2 feet below the bottom of the excavation. The estimated dewatering rate for each pit is 400-500 gpm. Discharge would be via an NPDES permit.

## PROPOSED CHANGE

Utilize upcoming geotechnical investigation to get a true estimate of potential dewatering quantities and difficulty. Also, suggest installing monitoring wells for use during the actual construction. Suggest dewatering discharge water into the SARI to minimize the adverse effect of discharge near the work areas.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

**DESIGN SUGGESTION**

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

D-5.0

DATE

9/2/2009

SHEET NO.

2 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Optimize Dewatering Approach

## ADVANTAGES

- Reduces contractor risk

## DISADVANTAGES

- Additional cost to project

## JUSTIFICATION (essay-type rationale)



# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

D-6.0

DATE

9/2/2009

SHEET NO.

1 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Confirm Design Strategies

## ORIGINAL DESIGN

For lower Reaches IV-A and IV-B the design strategy is segmented Hobas pipe with FRP manholes at the access pits. The upper Reach IV-A strategy was CIPP rehabilitation with no information on manholes and structure rehabilitation at the two siphons. The design team evaluated spiral wound as an alternative to CIPP and decided to only use FRP based on limited history and limited contractor pool. The VE Team concurs with eliminating the spiral wound alternative.

## PROPOSED CHANGE

Lower Reaches IV-A and IV-B

- Segmented slip-lining with Hobas but add equivalent design with Ameron Bondstrand and/or future pipe.
- Provide additional access pits w/o manholes to facilitate slip-lining (see other write-up).
- Slip-line through existing manholes and abandon manholes

Upper Reach IV-A

- Use partially deteriorated criteria for CIPP design (10.5 – 13.5 mm)
- Rehab existing manholes (66) by epoxy coating
- No CIPP of siphons but epoxy coat inlet/outlet structures

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

D-6.0

DATE

9/2/2009

SHEET NO.

2 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Confirm Design Strategies

## ADVANTAGES

- Alternate pipe materials will reduce material cost by 10-15%.
- Additional access pits w/o manholes will help facilitate the insertion process especially at sweeps or shallow bends.
- Using partially deteriorated CIPP will help reduce cost while still ensuring a 50 year life.
- The siphon pipes probably do not require rehabilitation based on my experience.

## DISADVANTAGES

- Additional cost for access pits
- Some redesign required

## JUSTIFICATION (essay-type rationale)

Project is under considerable constraint due to environmental concerns (leakage into sensitive areas) and load condition changes (dam raise and conservation pool). Design strategies have accommodated these issues.

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

D-7.0

DATE

9/2/2009

SHEET NO.

1 of 3

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Evaluate Cost Estimate

## ORIGINAL DESIGN

Lower portion of Reach IV-A and IV-B \$18.2M

Upper portion of Reach IV-A \$6.5M

Total \$24.7M

## PROPOSED CHANGE

Add manhole rehab and siphon structure rehab (4 structures) in upper portion of Reach IV-A.

New total project cost \$25.1M

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION





Project: SARI Repairs Unlined RCP Project

## CALCULATIONS

### BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

D-7.0

2 of 3

Based on the preliminary construction cost estimate, the project totals are as outlined below:

Lower portion of Reaches IV-A and IV-B \$13,684,760

Upper Portion of Reach IV-A                      \$ 5,013,450

Total    \$18,698,210

W/markups \$18,224,244

32%                      6,547,700

Increase              \$24,771,944

Missing items:

Manhole rehab on Reach IV-A upper epoxy coated

66 manholes @ 10' riser (avg) x \$305/ft = \$201,300

Siphon rehab (2) :

Coating of interior                                      \$ 50,000

Remove roof and reinstall w/Bilco hatch      \$100,000

W/markups    \$150,000

Total Project = \$25,123,244

Note: Other unit values seemed reasonable based on the PDR level estimate.



# SARI Repairs Unlined RCP Project

## CALCULATIONS

BACKUP DATA AND  
ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

D-7.0

3 of 3

Construction Cost Estimate - Preliminary  
Santa Ana Watershed Project Authority  
Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B

Submittal Status: Preliminary

Est. By: J. Bowdan  
Chkd By: J. Harris

Date: July 28, 2009  
25-103781

Item	Description	Qty.	Units	Mat. Cost	Labor Cost	Equip. Cost	Total Ins'd Cost	Total Mat. Cost	Total Labor Cost	Total Equip. Cost	Total Cost
<b>Lower Portion of Reach IV-A and IV-B</b>											
2223	Trenching, Excav, Backfill & Compaction	3,400	CY								
	Access Pit Excavation	500	CY								
	Trench Bedding	17	EA	\$35.00	\$5.00	\$10.00	\$50.00	\$17,500	\$2,500	\$34,000	\$170,000
	Pit Shoring	17	EA	\$20,000.00	\$5,000.00	\$5,000.00	\$30,000.00	\$340,000	\$85,000	\$85,000	\$20,500
	Devaltering System	17	EA	\$50,000.00	\$40,000.00	\$5,000.00	\$95,000.00	\$850,000	\$880,000	\$85,000	\$1,615,000
	Backfill and Compact	500	CY		\$30.00		\$40.00	\$0	\$15,000	\$5,000	\$20,000
	Clear Access Road	35,000	SY	\$0.00	\$5.00	\$2.00	\$7.00	\$0	\$175,000	\$70,000	\$245,000
	Misc. Access Road Requirements	1	LS	\$50,000.00	\$100,000.00	\$50,000.00	\$200,000.00	\$50,000	\$100,000	\$50,000	\$200,000
	<b>Total - 02223</b>							\$1,257,500	\$1,193,500	\$329,500	\$2,780,500
3300	Cast-in-Place Concrete										
	Concrete Structures	17	EA	\$35,000.00	\$40,000.00	\$5,000.00	\$80,000.00	\$595,000	\$680,000	\$85,000	\$1,360,000
		0	EA					\$0	\$0	\$0	\$0
	<b>Total - 03300</b>							\$595,000	\$680,000	\$85,000	\$1,360,000
15064	Slip-Lining Pipe										
	30" Pipe	15,949	LF	\$180.00	\$50.00	\$10.00	\$240.00	\$2,870,820	\$797,450	\$159,490	\$3,827,760
	36" Pipe	16,555	LF	\$240.00	\$50.00	\$10.00	\$300.00	\$3,973,200	\$827,750	\$165,550	\$4,966,500
	Annular Grout	2,000	CY	\$125.00	\$100.00	\$50.00	\$275.00	\$250,000	\$200,000	\$100,000	\$550,000
	Site Mitigation	1	LS	\$50,000.00	\$100,000.00	\$50,000.00	\$200,000.00	\$50,000	\$100,000	\$50,000	\$200,000
	<b>Total - 15064</b>							\$7,144,020	\$1,925,200	\$475,040	\$9,544,260
	<b>SubTotal - Lower Portion of Reach IV-A and IV-B</b>							\$8,996,520	\$3,798,700	\$889,540	\$13,684,760
<b>Upper Portion of Reach IV-A</b>											
15065	Cured-in-Place Pipe										
	27" CIPP	25,023	LF	\$85.00	\$55.00	\$10.00	\$150.00	\$2,126,955	\$1,376,265	\$250,230	\$3,753,450
	Pump By-pass System	12	Month	\$0.00	\$0.00	\$0.00	\$0.00	\$0	\$0	\$960,000	\$960,000
	Traffic Control	6	Month	\$0.00	\$50,000.00	\$0.00	\$50,000.00	\$0	\$300,000	\$0	\$300,000
	<b>Total - 15065</b>							\$2,126,955	\$1,676,265	\$1,210,230	\$5,013,450
	<b>SubTotal - Upper Portion of Reach IV-A</b>									\$1,210,230	\$5,013,450

Handwritten notes and calculations in the right margin, including a circled '3,551,000' and other figures.

PDR - Appendix F

**Constructability – C-1.0 through C-7.0**



# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

C-1.0

DATE

9/2/2009

SHEET NO.

1 of 4

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Modify Slip-lining Access Locations

## ORIGINAL DESIGN

The current design, while conceptual, focuses on maximizing slip-line push lengths, based on manufacturer guidelines and not on potential for pushed to hang up in radiused pipe. This potential to "hang up" increases the probability of more slip-line access points, both for insertion and termination.

## PROPOSED CHANGE

- Factor in 3 types of slip-line access points for:
  1. Insertion pit w/permanent Hobas tee
  2. Termination pit w/permanent Hobas tee
  3. Temporary insertion and termination pits w/no resulting Hobas tee
- Space to ensure CCTV maximum length not exceeded
- Insertion pits and termination pits are sized differently

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

C-1.0

DATE

9/2/2009

SHEET NO.

2 of 4

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Modify Slip-lining Access Locations

## ADVANTAGES

- More realistic, taking into account constructability issues, future maintenance and access issues, and ensuring pipeline and manhole system is homogeneous.

## DISADVANTAGES

- Redesign will be required

## JUSTIFICATION (essay-type rationale)

More realistic approach to the short term constructability and long term function, inspection and maintenance of system.



# SARI Repairs Unlined RCP Project

## CALCULATIONS

BACKUP DATA AND  
ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

C-1.0

3 OF 4

LOWER IV-A

OWNER: Santa Ana Watershed Project Authority  
PROJECT: SARI Lower Reach IV-A

DESIGN - FROM PLANS

U/S ACCESS	U/S TYPE	D/S ACCESS	D/S TYPE	DIAM.	LENGTH	COMMENTS
160+49	Use Existing MH	140+49	Insertion Pit	36	2,000	
140+49	Insertion Pit	127+12	Termination Pit	36	1,337	
127+12	Termination Pit	112+99	Insertion Pit	36	1,413	
112+99	Insertion Pit	80+13	Termination Pit	36	3,286	Too Long
80+13	Termination Pit	21+00	Insertion Pit	36	5,913	Too Long
21+00	Insertion Pit	1+00	Termination Pit	36	2,000	
				36		
				36		
				36		
				36		
				36		
				36		

15,949

Insertion Pits 3  
Termination Pits 3

3 HIGHER # IN COST ESTIMATE

OWNER: Santa Ana Watershed Project Authority  
PROJECT: SARI Lower Reach IV-A

PROPOSED

U/S ACCESS	U/S TYPE	D/S ACCESS	D/S TYPE	DIAM.	LENGTH	COMMENTS
160+49	Use Existing MH	140+49	Insertion Pit	36	2,000	Max Push Length
140+49	Insertion Pit	127+12	Termination Pit	36	1,337	Pivot Point
127+12	Termination Pit	122+12	Insertion Pit	36	500	Pivot Point
122+12	Insertion Pit	102+12	Termination Pit	36	2,000	Max Push Length
102+12	Termination Pit	82+12	Insertion Pit	36	2,000	Max Push Length
82+12	Insertion Pit	62+12	Termination Pit	36	2,000	Max Push Length
62+12	Termination Pit	42+12	Insertion Pit	36	2,000	Max Push Length
42+12	Insertion Pit	22+12	Termination Pit	36	2,000	Max Push Length
22+12	Termination Pit	1+00	Insertion Pit	36	2,112	Max Push Length

15,949

Insertion Pits 5  
Termination Pits 4

Hobas Tees 8

Approx

\$ 200,000.00 Insertion Pit Cost \$ 1,000,000  
\$ 75,000.00 Termination Pit Cost \$ 300,000  
\$ 1,300,000

NOTE: NUMBER OF PITS INCREASE, BUT APPROX.  
50% PITS ARE SMALLER, THUS MINIMAL  
EFFECT ON COST



## SARI Repairs Unlined RCP Project

## CALCULATIONS

## BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

C-1,0

4 OF 4

LOWER IV-B

OWNER: Santa Ana Watershed Project Authority

OWNER: Santa Ana Watershed Project Authority  
PROJECT: SARI Lower Reach **IV-B DESIGN - FROM PLANS**

[illegible]

16.589

Insertion Pits	3
Termination Pits	3

3 Higher\* IN COST ESTIMATE

OWNER: Santa Ana Watershed Project Authority

OWNER: Santa Ana Watershed Project Authority  
PROJECT: SARI Lower Reach IV-6 **PROPOSED**

[illegible]

16.589

Insertion Pits	6	Hobas Tees	9
Termination Pits	5		

Approved

\$ 200,000.00	Insertion Pit Cost	\$ 1,200,000
\$ 75,000.00	Termination Pit Cost	\$ 375,000
		<u>\$ 1,575,000</u>

NOTE: NUMBER OF PITS INCREASE, BUT APPROX 50% PITS ARE SMALLER, THUS MINIMAL EFFECT ON COST.

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

C-2.0

DATE

9/2/2009

SHEET NO.

1 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Extend Contract Duration

## ORIGINAL DESIGN

While it is possible to slip-line 33,000' x 36" and 42" segmental pipe (Hobas or equal) within a construction season, this project has constructability issues that may hinder production. These issues include working in wetlands, access to the work-site by construction vehicles and personnel, dewatering and effect on excavations, slip-line of radius bends, and environmental issues.

## PROPOSED CHANGE

- Extend contract duration to allow for phasing work to accommodate constructability issues.
- Use contract incentives to encourage contractor to complete in construction season (demonstrating ability to minimize issues), and penalizing for late completion (inability to manage issues)

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

C-2.0

DATE

9/2/2009

SHEET NO.

2 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Extend Contract Duration for Lower Reaches IV-A and IV-B

## ADVANTAGES

- Recognizes constructability issues and that they may impact productivity on project (i.e. costs), but engages contractor's creativity in quickly resolving issues, with potential reward or penalty.
- Empower contractor to resolve constructability issues, within environmental guidelines.

## DISADVANTAGES

- Because of OCWD requirements, project may not allow for project running into second construction season.
- Some may oppose any incentives to contractor to perform other than as contracted.

## JUSTIFICATION (essay-type rationale)

The constructability issues and their magnitude are highly debatable, sometimes appearing to be more important than the slip-line work itself. It is important not to impose false, unrealistic expectations on the project, but at the same time, engage the contractor's creativity and willingness to resolve these issues quickly and effectively.



# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

C-3.0

DATE

9/2/2009

SHEET NO.

1 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Identify Staging / Laydown Areas

## ORIGINAL DESIGN

Environmental constraints may limit construction crews, equipment and materials to the access roads, area around existing manholes, and areas around insertion and termination pits. This suggests limited workspace that may require modification for additional staging and laydown.

## PROPOSED CHANGE

- Project trailer near existing COE trailers (power, water, sewer)
- Separate staging areas for lower Reaches IV-A and IV-B (equipment)
- Separate laydown areas for lower Reaches IV-A and IV-B (pipe)

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

C-3.0

DATE

9/2/2009

SHEET NO.

2 of 2

PROJECT SARI Repairs Unlined RCP Project

ITEM Identify Staging / Laydown Areas

## ADVANTAGES

- Provides contractor with ability to more efficiently locate materials and equipment for work.
- Provides safe, secure area for resources not currently in use.
- Provides central location for workers to begin work, and receive work assignments for each project phase.

## DISADVANTAGES

- May have environmental limitations

## JUSTIFICATION (essay-type rationale)

This is an unusual project because of site access limitations which affect the contractors project productivity, as well as costs, providing more accessible areas for staging and laydown, will allow contractor to increase productivity.

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

C-4.0

DATE

9/2/2009

SHEET NO.

1 of 3

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Evaluate U-V Pipe Lining

## ORIGINAL DESIGN

Standard CIPP, using heat cure, vinyl ester resin, per LA Green Book spec.

## PROPOSED CHANGE

Investigation into U-V light cure pipe rehabilitation method for upper Reach IV-A, including approximately 25,000' x 27".

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION



# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

C-4.0

DATE

9/2/2009

SHEET NO.

2 of 3

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Evaluate U-V Pipe Lining

## ADVANTAGES

- Uses new technology

## DISADVANTAGES

- May have diameter, thickness and length limitations
- May use “promoter” in resin that is a class 1 carcinogen
- Cost

## JUSTIFICATION (essay-type rationale)

SAWPA asked that the Team relay any knowledge and/or information on U-V light cure.



Project: SARI Repairs Unlined RCP Project

## CALCULATIONS

### BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

C-4.0

3 of 3

Limitations – contact Downstream Services to verify (800) 262-0999

- Thickness and diameter – 10.5m may be maximum thickness using light. For 27mm pipe diameter, this may not be a limitation, knowing the condition of pipe (i.e. PD design).
- Length – the light train length governs the installation length of the tube. Assume light train maximum length = 300'. Compare to maximum CIPP length of 2,000' for this diameter.
- Promoter for resin may be a carcinogen – contact Mike Gosselin of Integrated Chemical and Equipment Corp at (860) 664-3951 office or (203) 260-8888 cell.
- Cost – 8" material costs for U-V light cure are 40% higher than CIPP heat cure. This should be heightened as diameter increases. Labor and equipment should be same for both methods.

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

C-5.0

DATE

9/2/2009

SHEET NO.

1 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Eliminate or Modify Water Bypass Requirements

## ORIGINAL DESIGN

Present plan is to rent a bypass system with necessary pipelines, pumps and other equipment for use when installing CIPP in the upper IV-A (27" pipe).

## PROPOSED CHANGE

Review flow conditions at key points along this reach, and where appropriate, plug upstream line and allow flow to accumulate in line until it can be released back into the pipeline system. Develop other "stoppage" options that could eliminate/reduce bypass pumping requirements.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

**DESIGN SUGGESTION**



# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

C-5.0

DATE

9/2/2009

SHEET NO.

2 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Eliminate or Modify Water Bypass Requirements

## ADVANTAGES

- Potential cost savings
- No need for additional work space to accommodate bypass pipe and equipment
- Eliminates potential for spillage
- More aesthetically pleasing in business area

## DISADVANTAGES

- Will require assessment and monitoring
- May require negotiation with businesses to reduce flow during “curing” cycle

## JUSTIFICATION (essay-type rationale)

This is an unusual project because of site access limitations which affect the contractor's project productivity, as well as costs. Providing more accessible areas for staging and laydown will allow contractor to increase productivity.

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

C-6.0

DATE

9/2/2009

SHEET NO.

1 of 3

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Postpone Upper Reach IV-A (27" pipeline) Segments

## ORIGINAL DESIGN

Present design involves full design and construction of upper Reach IV-A with a 27" CIPP lining.

## PROPOSED CHANGE

Postpone construction of incremental segments of this reach as necessary to keep project within budget limits.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

C-6.0

DATE

9/2/2009

SHEET NO.

2 of 3

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Postpone Upper Reach IV-A (27" pipeline) Segments

## ADVANTAGES

- Very low risk not to reline
- Area is accessible for future installation
- Pipe relining would be driven by "need"
- Budget would be available to pay for added construction in other more critical areas

## DISADVANTAGES

- Would require additional contracting
- Project completion would be delayed

## JUSTIFICATION (essay-type rationale)

The IV-A upper reach existing pipeline is in good condition, and carries minimum flow. It is not in the Prado Basin conservation pool area, and therefore not subjected to the additional structure loads or access conditions as the lower IV-A 42" reach or the IV-B 36" reach.





Project: SARI Repairs Unlined RCP Project

## CALCULATIONS

### BACKUP DATA AND ASSUMPTIONS

SCALE

PROPOSAL NO.

SHEET NO.

C-6.0

3 of 3

Potential cost deferments:

- Postpone IV-A from MAS 0620-0680 (3,250' at 192.65/ft = \$626,000)
- Postpone the total IV-A 27" CIPP reach (from the cost estimate \$5,013,450)
- Costs also carry an additional mark-up of approximately 25%

# VALUE ENGINEERING PROPOSAL



PROPOSAL NO.

C-7.0

DATE

9/2/2009

SHEET NO.

1 of 2

**PROJECT** SARI Repairs Unlined RCP Project

**ITEM** Reduce Contractor Risk

## ORIGINAL DESIGN

PDR has limited discussion on contractor risks.

## PROPOSED CHANGE

Identify contractor risks so that the design documents can mitigate for a lower construction cost.

**COST SUMMARY**

**TOTAL LABOR  
AND MATERIAL**

**MARK-UP**

**TOTAL COST**

**LIFE CYCLE COST**

ORIGINAL DESIGN

PROPOSED CHANGE

SAVINGS

## DESIGN SUGGESTION

# ADVANTAGES/DISADVANTAGES PROPOSAL JUSTIFICATION



PROPOSAL NO.

C-7.0

DATE

9/2/2009

SHEET NO.

2 of 2

PROJECT SARI Repairs Unlined RCP Project

ITEM Reduce Contractor Risk

## ADVANTAGES

- Limited access to work areas
- Dewatering at access pits
- Rain events
- Environmental requirements
- Conservation pool impacts (seasonal storage)
- Contract documents clarity
- Cleaning of calcium deposits
- Sag sections
- Working in wetlands
- Slip-lining radius bends
- CIPP cure water release
- Stream crossing requirements
- Hauling requirements

Addressing these items will reduce risk and related costs.

## DISADVANTAGES

## JUSTIFICATION (essay-type rationale)



# **SECTION III - VALUE ENGINEERING PROCESS**

SANTA ANA WATERSHED PROJECT AUTHORITY  
***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

**Conduct of the Study**

**INFORMATION PHASE**

The Value Engineering Team Workshop activity began on Monday, August 31, 2009, at Santa Ana Watershed Project Authority (SAWPA) headquarters, 11615 Sterling Avenue, Riverside, CA 92503. SAWPA Program Manager **David Ruhl** opened the session with a welcome and an overview of project goals. RBF Design Group Project Manager **John Harris** also participated in this introduction process, followed by Value Engineering Team members and other attendees introducing themselves, and their roles in the VE Workshop. Certified Value Specialist **George Bartolomei** then presented an overview of the VE process and planned activities for this project.

Due to high temperatures in the area, it was decided to conduct the project site visit immediately following the VE orientation, for the comfort of all participants. VE Team members **Michael Brenner** (AECOM – Environmental), **Michael Fleury** (Carollo – Design) and **Casey Smith** (SAK Construction – Constructability) made up the remaining members of the field trip group. By having all VE Team members, RBF and SAWPA personnel in one vehicle, participants were able to carry on project discussions throughout the ½ day trip.

The ‘wilderness road’ through the heavily vegetated areas of reaches IV-B and lower IV-A was a dramatic indicator of the habitat restrictions that would be imposed on any contractor working in this region. The brush was extremely dense, and access to some manholes was impossible, even with the existing rough maintenance road. This challenge to an appropriate working area will be even further complicated by noise, line-of-sight and mating season restrictions imposed by the nesting of the protected least Bell’s vireo in this habitat. Another factor that will weigh heavily on working conditions here is the impact of rain accumulation in these low lying areas, where a number of small streams still crisscross the alignment, in spite of the unusually dry seasons we have been experiencing over the past few years.

As the group progressed along the route of each reach, stops were made to inspect pipeline and manhole conditions, as well as access. Flow in the upper IV-A was very low, and this was reported as a normal condition for this reach. Environmentally

sensitive areas were few, and access was completely open along this reach, a marked difference from the conditions along the lower reaches.

The remainder of the day was spent in Design Group presentations to bring the VE Team up to speed on project details and requirements, and conducting open discussion to identify areas of concern / opportunity. The next morning was spent identifying and listing key functions that would help separate needs and wants of this project. These were meant to redefine requirements in this Value Engineering terminology, and to begin the process of exploring alternatives “outside the box”. This session concluded with a review / discussion of major functions, drivers, opportunities and constraints in the project.

## **CREATIVE PHASE**

During this session the Team “brainstormed” 56 ideas relating to potential functional and constructability project improvements. (Section III, Brainstorming Results, has a complete list of these ideas, in addition to their subsequent rating and cross reference to developed proposals). While some of the ideas may appear to be out of the project scope, it is important to remember that the success of this phase relies on recording all ideas and delaying evaluation to that planned process.

## **ANALYSIS PHASE**

The ideas generated by Creative Phase participants were broad in scope, and covered a wide variety of options, some outside the scope of this project. A streamlined system (SIRRS – Simplified Idea Rating/Ranking System) was then used to evaluate each idea in terms of its appropriateness to identified requirements. The purpose of this approach is to explore the greatest range of options to obtain the maximum value for each dollar spent on this project. This ranking process is also a time management tool to aid the Team in focusing on key ideas during the Development phase. An article explaining this technique may be found in the Appendix of this report, as one of the VE handouts.

The ranking process normally uses a two component point approach to evaluate each idea. Two scoring categories, 1) Acceptability and 2) Potential Cost Impact (Savings), each with a maximum possible score of five (5) points are used to rank each idea. Due to limited Team time and general nature of the cost data, it was decided to forgo the cost ranking element and concentrate on those ideas that would best serve the technical needs of this project. The final ranking of each idea is shown on the Brainstorming Results sheets, presented in Section III. These ‘Acceptability points’ were assigned by User and Design Group participants, in a general discussion with all attendees.



The SIRRS points were assigned as follows:

ACCEPTABILITY	POINTS
Excellent Idea, Highly Desired	5
Good Idea, Worth Pursuing	4
Feasible Idea, Some Potential	3
Fair Idea, Low Priority	2
Poor Idea, Lowest Priority	1
Do Not Evaluate	0

The final result of this Phase was to identify 23 ideas ranking 3 or higher, as potential candidates for further analyses and incorporation as VE option proposals.

### **DEVELOPMENT PHASE**

In addition to the SIRRS rankings as a guide for time management, each Team member selected those items they felt most qualified to further define with detailed cost and technical data, advantages and disadvantages, sketches as appropriate, and any calculations necessary to support each proposal. This Development Phase process resulted in a total of 16 Design Suggestions, incorporating 37 of the 56 “brainstormed” ideas. (See Section III Brainstorming List for tally of developed ideas)

### **PRESENTATION PHASE**

The final afternoon of the VE Workshop was conducted with representatives from SAWPA and the Design Group. The various options, with calculations, sketches, and rough cost estimate worksheets were discussed with participants, along with a Summary listing of all developed options. Each option was presented by the VE Team member who was knowledgeable of that particular option. The purpose of the discussions was to assure that all participants had a clear understanding of concepts being discussed, including assumptions, calculations, and any other data developed by the VE Team members.

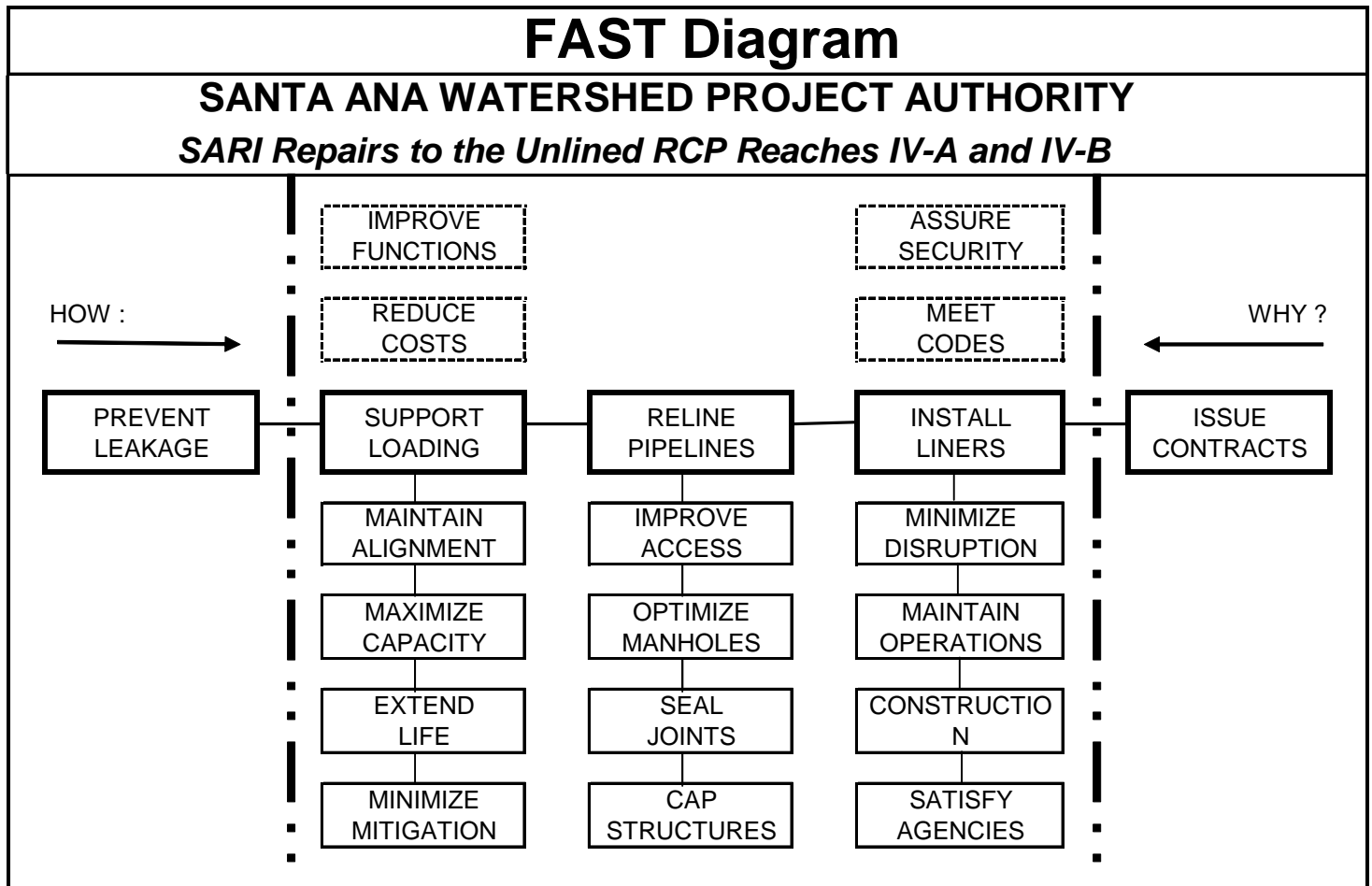
SANTA ANA WATERSHED PROJECT AUTHORITY  
***SARI Repairs to the Unlined RCP  
 Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

**Functional Definitions**

PREVENT	LEAKAGE	CAP	STRUCTURES
SUPPORT	LOADS	EXTEND	STRUCTURES
EXTEND	LFE	REFURBISH	MANHOLES
LINE	PIPELINES	BYPASS	WASTEWATER
INSERT	SEGMENTS	EXCLUDE	WASTEWATER
INSTALL	CIPP	RETAIN	WASTEWATER
SEAL	JOINTS	LIMIT	WASTEWATER
ACCESS	MANHOLES	MAINTAIN	ALIGNMENT
CLEAR	ROADS	MINIMIZE	MITIGATION
CLEAR	AREAS	MINIMIZE	DISRUPTION
RETAIN	HABITAT	MAINTAIN	OPERATIONS
MITIGATE	CHANGES	MINIMIZE	NOISE
CONSTRUCT	PITS	MAXIMIZE	CAPACITY
DEWATER	PITS	IDENTIFY	LAYDOWN
INSTALL	EQUIPMENT	STAGE	CONSTRUCTION
UTILIZE	EQUIPMENT	ACCOMMODATE	GROWTH
REMOVE	EQUIPMENT	OPTIMIZE	COSTS
STAGE	MATERIALS	ENHANCE	FUNCTIONS
OPEN	PIPELINES	MEET	CODES
CLEAN	PIPELINES	ASSURE	SAFETY
GROUT	LINERS	SATISFY	AGENCIES

## Functional Analysis System Technique Diagram



## FUNCTIONAL ANALYSIS SYSTEM TECHNIQUE

For those unfamiliar with FAST diagrams, the functional “critical path” is shown by the row of heavily lined boxes. Moving to the right should answer HOW functions are being accomplished; moving to the left should answer the WHY question. Vertical dashed lines define the Project Scope addressed by the VE Team. Upper left functions in dotted boxes are Design/VE Team objectives, and upper right functions in the dotted boxes are inherent project requirements. Functions shown vertically under each heavy box are those which are intended to be accomplished concurrently with their respective critical path functions.



SANTA ANA WATERSHED PROJECT AUTHORITY

***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

**Brainstorming Ideas / Ranking / Development**

<u>Idea #</u>	<u>Description</u>	<u>Acceptability</u>	<u>DEV.</u>
1.	Optimize manhole access locations	5	C – 1.0
2.	Categorize access types	5	C – 1.0
3.	Minimize manhole size and number	5	C – 1.0
4.	Increase vegetation clearing	2	C – 3.0
5.	Optimize schedule with migratory bird demands	3	E – 1.0, 2.0
6.	Issue separate clearing contract	DNE	
7.	Reduce contractor risk	4	C – 7.0
8.	Identify / quantify mitigation requirements	2	E – 1.0
9.	Identify staging areas	3	C – 3.0
10.	Use contractor incentives	2	C – 2.0
11.	Optimize manhole design	4	D – 1.0
12.	Phase / sequence construction	4	C – 2.0
13.	Identify long lead item procurements	2	
14.	Perform dewatering tests	2	D – 5.0
15.	Develop rain contingency plan	2	C – 7.0
16.	Specify bird accounting program	4	E – 2.0
17.	Install monitoring wells	2	D – 5.0
18.	Bid alternative pipe materials	3	D – 6.0
19.	Identify work hour restrictions	DNE	
20.	Evaluate pump bypass requirements	2	C – 5.0
21.	Clarify vegetation dewatering requirements	DNE	
22.	Develop cure water release and test needs	2	C – 7.0
23.	Delay 27" upper reach construction	3	C – 6.0
24.	Maximize liner capacity	2	D – 3.0
25.	Assure environmental conditions are addressed in design	3	E – 1.0
26.	Assess segmented reach contracting options	2	
27.	Optimize personnel / trucking sequencing	DNE	
28.	Identify traffic control	DNE	
29.	Clarify noise curtain options in design	2	E – 1.0
30.	Develop emergency response plan	DNE	
31.	Establish clear working limits	DNE	
32.	Provide contractor training	DNE	
33.	Enhance grouting for added structural support	DNE	
34.	Identify alternate access from dam	DNE	
35.	Identify laydown areas	2	C – 3.0
36.	Offset pits to avoid water	DNE	

**SANTA ANA WATERSHED PROJECT AUTHORITY**

***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**VALUE ENGINEERING WORKSHOP**

**Brainstorming Ideas / Ranking / Development**

<u>Idea #</u>	<u>Description</u>	<u>Acceptability</u>	<u>DEV.</u>
37.	Extend contract duration	3	C – 2.0
38.	Optimize dewatering approach	3	D – 5.0
39.	Evaluate participation goals	DNE	
40.	Address upper reach IV-A access key points	DNE	
41.	Assess structural capacity of existing RCP	5	D – 4.0
42.	Assess bypass flow needs beyond manhole 620	3	C – 5.0
43.	Evaluate siphon access	3	D – 2.0
44.	Do not rehab siphons	3	D – 2.0
45.	Develop segment staging plan	DNE	
46.	Identify stream crossing requirements	2	C – 7.0
47.	Verify design consistency with EIR	2	E – 1.0
48.	Assess Hobas versus HDPE for slip lining	4	D – 3.0
49.	Assess need for manhole rehabilitation	3	D – 6.0
50.	Identify hauling requirements	2	C – 7.0
51.	Document tree removal program	DNE	
52.	Assess impact of lowering conservation pool	DNE	
53.	Coordinate with OCWD regarding conservation pool impacts	DNE	
54.	Assess design strategies	5	D – 6.0
55.	Evaluate U-V type lining applications / limitations	3	C – 4.0
56.	Evaluate cost estimate	4	D – 7.0

**NOTES**

DEV = Reference to Developed Proposal (Section II) addressing this idea.

Ideas NOT incorporated into proposals are candidates for further review.

DNE = Do not evaluate (already planned / being done, already discussed and dismissed, etc.)

# APPENDIX



## SANTA ANA WATERSHED PROJECT AUTHORITY

# ***SARI Repairs to the Unlined RCP Reaches IV-A and IV-B***

### **Value Engineering Workshop Agenda**

The value engineering workshop for the subject project will be conducted for 3 days, from **August 31 – September 2**. Meetings will be held in the “Consultant’s Room” at the Santa Ana Watershed Project Authority, 11615 Sterling Avenue, Riverside, CA 92503.

<b>MONDAY</b>	0800 – 0830	<b>Participant Welcome</b>	David Ruhl, Project Manager SAWPA
		<b>Project Overview</b>	John Harris, Project Manager RBF
		<i>The Project Managers will discuss functional goals and requirements, and potential opportunities for the VE Study effort, and participants in the Value Engineering Team Study (VETS) will be introduced by their respective principals.</i>	
	0830 - 0845	<b>VE Study Overview</b>	George Bartolomei, CVS-Life Value Management Institute
		<i>The VETL will review VE methodology, discuss roles and responsibilities, and outline activities planned for the week.</i>	
	0845 – 0915	<b>Travel to Project Site</b>	
	0915 - 1230	<b>Site Visit</b>	V.E. Team, Design Groups, SAWPA Representatives
		<i>The V.E. teams will match up with their contemporaries, and Review site particulars, with emphasis on identifying Project “drivers”, and specific design concerns/opportunities.</i>	
	1230 – 1300	<b>Return to Conference Room</b>	

## MONDAY (CONTINUED)

1300 - 1400 Buffet Lunch

1400 - 1600 **Project Briefing** Design Group(s)

*The design team(s) and consultants will discuss the project requirements and proposed design solutions, including alternatives considered. Questions from the Pre-Study Review will be addressed as part of this briefing, by design Teams and/or SAWPA representatives, as appropriate. The V.E. Team will ask questions as appropriate to completely understand the project requirements as established by the user and incorporated in the present design solution(s).*

1600 - 1700 **Function Analysis** V.E. Team, Design Groups,  
SAWPA Representatives

*Participants will review Project information, and identify the key functions required and/or desired in this Project. These functions will later be developed into a F.A.S.T. diagram to show their interrelationships.*

**TUESDAY** 0800 - 0900 **Functional Review** V.E. Team, Design Groups,  
SAWPA Representatives

*The VETL will lead a discussion of the functions established in the function analysis session, to solicit additional input from the Design Groups and SAWPA Representatives, and to assure the functions listed represent a fair “redefinition” of Project requirements in these Value Engineering terms.*

0900 - 1030 **Creative Phase** V.E. Team, Design Groups,  
SAWPA Representatives

*Attendees will creatively review, (Brainstorm), and tabulate possible design alternatives for the facilities. While the designer's solution will serve as the "baseline", this session will also identify alternatives not in the recommended solution, but perhaps deserving of further investigation. Generally, a brainstorming session will produce between 50 and 75 creative design alternatives.*

*During the creative phase, the team will not judge the ideas, and discussion will be limited, to assure focus on the rapid generation of concepts “outside the box”.*

## TUESDAY (CONTINUED)

1030 – 1200    **Analysis Phase**                      V.E. Team, Design Groups,  
SAWPA Representatives

*During this phase, the user, designers, and other appropriate parties will rank all of the ideas or alternatives according to their potentials for life-cycle (25-year) cost reduction and the potential for acceptance. A Simplified Idea Rating/Ranking System (SIRRS ) VE methodology will be used. At the conclusion of this session, all participants will have a total insight on the ideas that will be developed in further detail.*

1200 - 1300    Buffet Lunch

1300 – 1330    **Project Assignments**                      V.E Team (others by choice)

*Each team member will be assigned a number of ideas for further development. The ideas will be those with the highest rankings. In general, the ideas will be assigned according to technical discipline: pipeline, hydraulics, structural, civil, geotechnical, environmental, constructability, etc.*

1330 - 1700    **Development Phase**                      V.E. Team (others by choice)

*During the development phase, each team member will gather information and prepare written proposals for those ideas assigned to him/her. These may require additional discussions with the designer, user, outside contractors and suppliers, and other specialists to fully define the alternative. The team members will prepare sketches, perform calculations and develop other data to support each proposal. In addition, team members will prepare area estimates of costs for individual alternatives as originally designed, and as proposed by the V.E. team. Life-cycle costs for operation, maintenance and related annual costs will also be considered.*

**WEDNESDAY**    0800 - 1230    **Development Phase (Continued)** V.E. Team (others by choice)

1230 - 1300    Buffet Lunch

1300 - 1500    Finalize Proposals, prepare Summary, run copies    VETL



**WEDNESDAY (CONTINUED)**

1500 - 1630    **VE Team Report**                      V.E. Team, Design Groups,  
                         **SAWPA Representatives, others**

*The Value Engineering Team will discuss the alternatives developed in the course of the study. Each proposal will be reviewed in detail, to the extent that all assumptions made in developing the proposals are clearly understood. The intent is to give a clear understanding of the proposal's intent rather than to reach any conclusions regarding potential for design incorporation.*

1630 - 1700 **Conclusion** VMI / SAWPA

*The workshop will be concluded. A summary of results will be distributed, and draft copies of key proposals may be available upon request. The typed final report will be delivered to SAWPA within ten working days of the conclusion of the study. Resolution meeting schedules will be developed.*

**NOTES:**

1. V.E. team members should bring to the workshop on Monday morning any technical and pricing reference manuals which may be used during the study. These may include design handbooks, code documents, estimating price guides, and related documents. Calculators, pencils, sketch paper, scales, and other similar items will also be useful.
2. It is critical that outside telephone calls and other interruptions of the study team members be held to an absolute minimum during the week to allow for efficient, uninterrupted concentration on the Value Engineering Study.
3. There will be a 1015 Coffee Break each day except Monday, and 1430 afternoon Break each day.

Questions concerning the Value Engineering Study should be directed to:

## SAWPA:

David P. Ruhl, P.E., Program Manager, [druhl@sawpa.org](mailto:druhl@sawpa.org)  
Phone: 951-354-4223, Cell: 951-538-3250, Fax: 951-352-3422

**VMI:**

George Bartolomei, CVS, [gbartolomei@sbcglobal.net](mailto:gbartolomei@sbcglobal.net)  
Phone: 858- 271- 8035

**UPDATED: 08/28/09**

**SANTA ANA WATERSHED PROJECT AUTHORITY**

***SARI Repairs to the Unlined RCP  
Reaches IV-A and IV-B***

**Value Engineering Participant List**

Name	REPRESENTING / Role	Phone	Daily Log In				Email
			31	1	2		
Bartolomei, George	Value Management Institute / VE Team Leader	858-271-8035	X	X	X		gbartolomei@sbcglobal.net
Beehler, Jeff	SAWPA - Program Manager	951-354-4234		X	X		jbeehler@sawpa.org
Benner, Michael	AECOM / VE Team - Environmental	714-648-2044.	X	X	X		michael.benner@aecom.com
Cantú, Celeste	SAWPA - General Manager	951-354-4229			X		ccantu@sawpa.org
Fleury, Michael	Carollo Engineering / VE Team - Design	951-662-5145	X	X	X		mfleury@carollo.com
Haller, Rich	SAWPA - Executive Manager, E&O	951-354-4223	X	X	X		rhaller@sawpa.org
Harris, John	RBF Consulting - Design Lead	858-614-5016	X	X	X		jharris@rbf.com
Jewell, Alex	RBF Consulting - Design	858-614-5085			X		ajewell@rbf.com
Norton, Mark	SAWPA - Water Resources & Planning Manager	951-354-4221			X		mnorton@sawpa.org
Quintero, Carlos	SAWPA - Project Manager	951-354-4239		X	X		cquintero@sawpa.org
Ruhl, David	SAWPA - Program Manager	951-354-4223	X	X	X		druhl@sawpa.org
Schultz, Steve	MWWD	951-354-5130		X	X		sschultz@mwwd.com
Smith, Casey	SAK Construction / VE Team - Constructability	602-300-1241	X	X	X		csmith@sakconst.com
	<b>UPDATED: 09/08/09</b>						

## **Value Engineering Handout Materials**

## THE VALUE APPROACH

$$\text{VALUE} = \frac{\text{PERFORMANCE}}{\text{COST}}$$

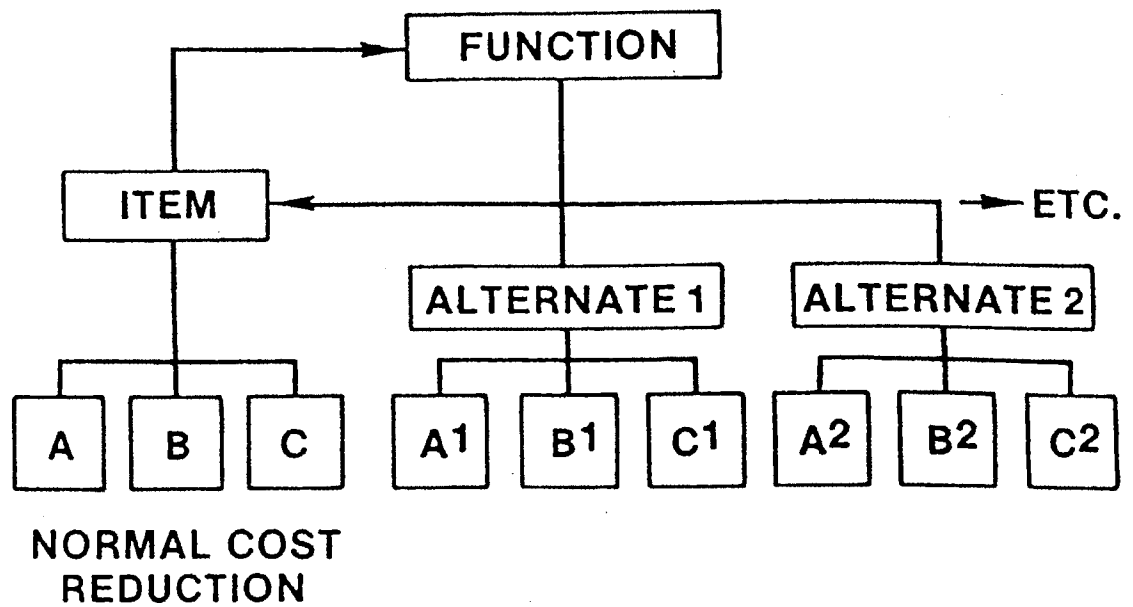
$$= \frac{\text{FUNCTION}}{\text{COST}}$$

$$\uparrow \text{VALUE} = \frac{\text{FUNCTION}}{\downarrow \text{COST}}$$

$$\uparrow \text{VALUE} = \frac{\uparrow \text{FUNCTION}}{\text{COST}}$$



## COST REDUCTION VS VALUE ENGINEERING



## **VALUE ENGINEERING JOB PLAN**

**1.) Information Phase.** *Designers explain their designs, concentrating on functions. The team examines, in a planned approach, the project documents. A site visit is planned whenever possible, as a key element in understanding some of the project challenges. The VE Study Team must operate in an open and creative atmosphere where team members can question and discuss design concepts and approaches, and begin to identify fresh new approaches and/or solutions that could enhance the final design. The VE Team Leader (VETL) must establish the VE Job Plan and orchestrate the study to keep the team focused on VE methodology. The Information Phase is conducted to assure the VE Team understands the project scope through the eyes of the designers and users, and how the existing design evolved.*

**2.) Creative Phase.** *The Creative Thinking Phase follows immediately. This phase is where the team uses creative thinking to consider alternative methods of achieving the required functions of the project. Spontaneous creative thinking is conducted in a manner that excludes critique or judgment of any idea that would impede the flow of alternatives and dampen creativity.*

**3.) Evaluation Phase.** *Analysis of ideas is conducted to identify those with highest potential for project Value Improvement. Feasibility of the alternatives is examined and ideas are ranked using the SIRRS technique. This organizes the list in order of potential project enhancement, considering economic and non-economic factors. This meeting will result in prioritizing potential Value Engineering proposals, which will be further developed with calculations and other documentation to support management incorporation decisions.*

**4.) Development Phase.** *Communication with other study participants and designers is essential to clarify ideas and coordinate technical considerations, to assure each proposal will have the highest potential for acceptance in the Presentation Phase. Each proposal is developed to the extent that designers and managers have enough information to evaluate the proposals. This includes, but is not limited to, Before and After descriptions, sketches, advantages/disadvantages, detailed cost estimates and calculation sheets that provide a means to track and understand intent and impact of each developed idea.*

**5.) Presentation Phase.** *When the Development Phase is completed an oral discussion of each proposal will be held with appropriate project personnel. The purpose of this discussion is to assure that all in attendance understand the basic changes being presented as "design options". Team members will each incorporate any pertinent comments in their draft proposals, and a summary of VE Proposals and Design Suggestions will be prepared. All this data will be included in the Final Value Engineering Study report.*

# Interactions

The Society of American Value Engineers

Vol. 20, No. 11

November 1995

## Rating system helps VE study team focus on the best ideas

By George Bartolomei, CVS;  
859/271-8035

The Simplified Idea Rating/Ranking System (SIRRS) is used during the evaluation phase of the VE job plan as a quick but effective means to boil down the 100 to 150 ideas that are generated during the speculation phase to a more manageable 20 or 30 ideas for further definition by the VE study team during the development phase. For the most effective results, designers, program personnel and users (if available) are completely involved in the process and, as a group, account for 50 percent of the rating points assigned to each idea.

The SIRRS uses a two-component point approach to evaluate each idea. The scoring categories can be set up as

desired by the agencies involved, but basically should reflect two inputs: an indication of the interest and potential (acceptability) for implementation by the D/P/U group (designer, program personnel and users), and an indication of potential cost impact by the VE study team. The two groups are given five points to allocate for each idea being ranked. Each group must arrive at a consensus input. The benefits of the open discussion in coming to this consensus will be expanded upon later.

In the box below is a typical point allocation spread. (Note: Ideas with zero acceptability points are an indication of designer/user sensitivity to local issues. Ideas with zero cost-impact points are discussed in the context of item potential for a value-added option

development, often a cost adder due to a possible program oversight, design improvement or safety issue.)

Each idea listed in the speculation phase is reviewed one by one, points assigned by the two groups are added, and a total is recorded for every idea. With the five-point system in place, a perfect 10 would represent a concept that is highly desired by the D/P/U group and potentially results in a 10 percent or more reduction in project cost. The VE study team can then enter the development phase with a list of ideas that rate 10 points, nine points, eight points and so on, thereby concentrating their efforts on those ideas with the highest potential for acceptability and positive cost impact. In general, a one-week (40-hour) VE study will develop

approximately 20 to 30 ideas that rate six points or more in the five-point (10-point total) system illustrated.

*continued on page 4*

Following is a typical spread for point allocation:

Points	Acceptability (D/P/U group)	Points	Potential Cost Impact (VE study team)
5	Excellent idea, highly desired	5	Dollar figure, cost savings of 10 percent or higher of project cost, i.e., for a \$60 million project, \$6 million or more
4	Good idea, worth pursuing	4	Dollar range, i.e., \$1 million to \$6 million
3	Feasible idea, some potential	3	Dollar range, i.e., \$500,000 to \$999,999
2	Fair idea, low priority	2	Dollar range, i.e., \$250,000 to \$499,999
1	Poor idea, lowest priority	1	Dollar range, i.e., \$0 to \$249,999
0	Do not evaluate	0	Negative cost impact, adds dollars

# SIRRS

*Continued from page 1*

In practice, to further support the VE team as an extension of the D/P/U group, ideas that have the same total points are prioritized for subsequent development on the basis of the D/P/U input. For instance, a seven-point creative idea rated 4/3 indicates an acceptability of four points (good idea, worth pursuing) and a potential cost impact of three points (dollar range between \$500,000 and \$999,999, in the example used). Another seven-point idea might be rated 2/5, with an acceptability of two points (fair idea, low priority) and a potential cost impact of five points (10 percent or more of project cost). In this case, the VE study team would address the 4/3 idea first, even though the 2/5 idea had a higher cost savings potential. This helps to confirm the VE thrust to apply the team experience in areas that make more sense to the ultimate decision makers and users and are driven mainly by value, not cost reduction.

Another rule of thumb that proved successful in conveying this VE role is a dedicated effort by the VE team members to provide a write-up on any creative idea that is awarded five points by the D/P/U group. This response to highly desired input reinforces the VE team thrust to be a support function, rather than some sort of review or audit activity. Any idea with highly desired input is also a stronger candidate for eventual implementation, which is the only way any VE ideas can contribute to enhancing the project under study.

During the mechanics of rating each idea, one technique that brings out the best in participating attendees is to divide the audience into two groups. This can be accomplished simply by using different colored marking pens while listing the points allocated to each idea. If, for instance, the acceptability points (D/P/U group) are listed with a green marker, and the cost-impact points (VE team and, in some cases, designer cost personnel) are listed with a red marker, the VE team leader (or recorder) can merely address the groups as "green team" and "red team" for desired responses.

While the SIRRS can be used without D/P/U participation, it requires acceptability points to be assigned by the VE team, based on their project perceptions. This precludes receiving direct input in the evaluation process and also reduces the dynamics and effectiveness of the team-rating approach.

One of the benefits of requiring a consensus decision in each group for rating each idea is the open discussion that results. All participants receive insight about some of the potentially obscure project drivers. In the drive to reach consensus, group members express their feelings, frustrations, potential miscommunications and a wide variety of possible implementation influences, particularly in the IVP/U group charged with assigning acceptability points.

It is not uncommon that, in these D/P/U group discussions, some members will give an idea five points, and others in the same group will give it zero. With the VE leader holding firm for a consensus, the discussions are lively and enlightening, often putting on the table and resolving areas of miscommunication (particularly regarding the firmness of requirements).

The process can take two or more hours for 100 or more ideas, but the information it unearths and participation it stimulates is well worth the effort.

Having the D/P/U group intimately involved in the evaluation process stimulates a higher level of commitment from them in the ultimate incorporation of VE team study ideas into the project design. That participation also reinforces the team concept, with the VE group an integral part of the process, not an auxiliary activity. Designers, program personnel and users leave the evaluation session with a comfortable feeling that the effort is on track, and the final presentation will not be loaded with ideas that cannot be incorporated, but which must be addressed in final resolution meeting.

By listing the VE ideas and their point scores in the final report, those reviewing the report can also assess the value assigned to each idea and the basis for the score. It also gives the designers and program personnel a potential shopping list for additional ideas that might enhance the project, whether or not the VE team had time to develop those ideas into more formal VE proposals. Indicating which ideas were incorporated into what proposals is also an aid for future reviews; it also shows where one or more creative ideas may have been incorporated into a single option development. □

*This article is excerpted from a paper presented by the author at the National AASHTO (American Association of State Highway and Transportation Officials) VE Conference, Oct. 23-26, 1995, in Sacramento, Calif.*

**For Additional Information  
VALUE MANAGEMENT INSTITUTE**

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## **Area Cost Summaries**

**Construction Cost Estimate - Preliminary**  
**Santa Ana Watershed Project Authority**  
**Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B**  
**Summary**

**Est. Date:** July 28, 2009  
**Job No:** 25-103781

**Est. By:** J. Bowdan  
**Chk'd By:** J. Harris

Section	Description	Material Cost	Equip	Labor Cost	Total
	Reach IV-A Lower and Reach IV-B	\$8,996,520	\$3,798,700	\$889,540	\$13,684,760
	Reach IV-A Upper	\$2,126,955	\$1,676,265	\$1,210,230	\$5,013,450
	<b>Subtotal - Direct Costs</b>	<b>\$11,123,475</b>	<b>\$5,474,965</b>	<b>\$2,099,770</b>	<b>\$18,698,210</b>
8.75%	Sales Tax	\$973,304			\$973,304
	<b>Subtotal</b>	<b>\$12,096,779</b>	<b>\$5,474,965</b>	<b>\$2,099,770</b>	<b>\$19,671,514</b>
6%	Prime Contractor's Home Office	\$725,807	\$328,498	\$125,986	\$1,180,291
	<b>Subtotal</b>	<b>\$12,822,586</b>	<b>\$5,803,463</b>	<b>\$2,225,756</b>	<b>\$20,851,805</b>
8%	Prime Contractor's Profit	\$1,025,807	\$464,277	\$178,060	\$1,668,144
	<b>Subtotal</b>	<b>\$13,848,393</b>	<b>\$6,267,740</b>	<b>\$2,403,817</b>	<b>\$22,519,949</b>
10%	Contingency	\$1,384,839	\$626,774	\$240,382	\$2,251,995
	<b>Total</b>	<b>\$15,233,232</b>	<b>\$6,894,514</b>	<b>\$2,644,198</b>	<b>\$24,771,944</b>

**Construction Cost Estimate - Preliminary**  
**Santa Ana Watershed Project Authority**  
**Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B**  
**Summary - CIPP**  
**Reach IV-A Upper**

**Est. Date:** July 28, 2009  
**Job No:** 25-103781

**Est. By:** J. Bowdan  
**Chk'd By:** J. Harris

Section	Description	Material Cost	Equip	Labor Cost	Total
15065	Cured-in-Place Pipe	\$2,126,955	\$1,676,265	\$1,210,230	\$5,013,450
	<b>Subtotal - Direct Costs</b>	<b>\$2,126,955</b>	<b>\$1,676,265</b>	<b>\$1,210,230</b>	<b>\$5,013,450</b>
8.75%	Sales Tax	\$186,109			\$186,109
	<b>Subtotal</b>	<b>\$2,313,064</b>	<b>\$1,676,265</b>	<b>\$1,210,230</b>	<b>\$5,199,559</b>
6%	Prime Contractor's Home Office	\$138,784	\$100,576	\$72,614	\$311,974
	<b>Subtotal</b>	<b>\$2,451,847</b>	<b>\$1,776,841</b>	<b>\$1,282,844</b>	<b>\$5,511,532</b>
8%	Prime Contractor's Profit	\$196,148	\$142,147	\$102,628	\$440,923
	<b>Subtotal</b>	<b>\$2,647,995</b>	<b>\$1,918,988</b>	<b>\$1,385,471</b>	<b>\$5,952,455</b>
10%	Contingency	\$264,800	\$191,899	\$138,547	\$595,245
	<b>Total</b>	<b>\$2,912,795</b>	<b>\$2,110,887</b>	<b>\$1,524,018</b>	<b>\$6,547,700</b>
	<b>Total Cost Per Foot</b>				<b>\$261.67</b>



**Construction Cost Estimate - Preliminary**  
**Santa Ana Watershed Project Authority**  
**Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B**  
**Summary - Slip-Lining**  
**Reaches IV-A Lower and Reach IV-B**

**Est. Date:** July 28, 2009  
**Job No:** 25-103781

**Est. By:** J. Bowdan  
**Chk'd By:** J. Harris

Section	Description	Material Cost	Equip	Labor Cost	Total
02223	Trenching, Excav, Backfill & Compaction	\$1,257,500	\$1,193,500	\$329,500	\$2,780,500
03300	Cast-in-Place Concrete	\$595,000	\$680,000	\$85,000	\$1,360,000
15064	Slip-Liner Pipe	\$7,144,020	\$1,925,200	\$475,040	\$9,544,260
	<b>Subtotal - Direct Costs</b>	<b>\$8,996,520</b>	<b>\$3,798,700</b>	<b>\$889,540</b>	<b>\$13,684,760</b>
8.75%	Sales Tax	\$787,196			\$787,196
	<b>Subtotal</b>	<b>\$9,783,716</b>	<b>\$3,798,700</b>	<b>\$889,540</b>	<b>\$14,471,956</b>
6%	Prime Contractor's Home Office	\$587,023	\$227,922	\$53,372	\$868,317
	<b>Subtotal</b>	<b>\$10,370,738</b>	<b>\$4,026,622</b>	<b>\$942,912</b>	<b>\$15,340,273</b>
8%	Prime Contractor's Profit	\$829,659	\$322,130	\$75,433	\$1,227,222
	<b>Subtotal</b>	<b>\$11,200,398</b>	<b>\$4,348,752</b>	<b>\$1,018,345</b>	<b>\$16,567,495</b>
10%	Contingency	\$1,120,040	\$434,875	\$101,835	\$1,656,749
	<b>Total</b>	<b>\$12,320,437</b>	<b>\$4,783,627</b>	<b>\$1,120,180</b>	<b>\$18,224,244</b>
	Total Cost Per Foot				\$560.68



Construction Cost Estimate - Preliminary Santa Ana Watershed Project Authority Repairs to Unlined Concrete Pipe, Reach IV-A and IV-B											
Est. Date: July 28, 2009 Job No: 25-103781		Est. By: J. Bowdan Chk'd By: J. Harris		Submittal Status: Preliminary							
Section	Description	Qty.	Units	Mat. Cost	Labor Cost	Equip. Cost	Total Ins'd Cost	Total Mat. Cost	Total Labor Cost	Total Equip. Cost	Total Cost
Lower Portion of Reach IV-A and IV-B											
2223	Trenching, Excav, Backfill & Compaction										
	Access Pit Excavation	3,400	CY		\$40.00	\$10.00	\$50.00	\$0	\$136,000	\$34,000	\$170,000
	Trench Bedding	500	CY	\$35.00	\$5.00	\$1.00	\$41.00	\$17,500	\$2,500	\$500	\$20,500
	Pit Shoring	17	EA	\$20,000.00	\$5,000.00	\$5,000.00	\$30,000.00	\$340,000	\$85,000	\$85,000	\$510,000
	Dewatering System	17	EA	\$50,000.00	\$40,000.00	\$5,000.00	\$95,000.00	\$850,000	\$680,000	\$85,000	\$1,615,000
	Backfill and Compact	500	CY		\$30.00	\$10.00	\$40.00	\$0	\$15,000	\$5,000	\$20,000
	Clear Access Road	35,000	SY	\$0.00	\$5.00	\$2.00	\$7.00	\$0	\$175,000	\$70,000	\$245,000
	Misc. Access Road Requirements	1	LS	\$50,000.00	\$100,000.00	\$50,000.00	\$200,000.00	\$50,000	\$100,000	\$50,000	\$200,000
	Total - 02223							\$1,257,500	\$1,193,500	\$329,500	\$2,780,500
Cast-In-Place Concrete											
3300	Concrete Structures	17	EA	\$35,000.00	\$40,000.00	\$5,000.00	\$80,000.00	\$595,000	\$680,000	\$85,000	\$1,360,000
		0	EA					\$0	\$0	\$0	\$0
	Total - 03300							\$595,000	\$680,000	\$85,000	\$1,360,000
Slip-lining Pipe											
15064	30" Pipe	15,949	LF	\$180.00	\$50.00	\$10.00	\$240.00	\$2,870,820	\$797,450	\$159,490	\$3,827,760
	36" Pipe	16,555	LF	\$240.00	\$50.00	\$10.00	\$300.00	\$3,973,200	\$827,750	\$165,550	\$4,966,500
	Annular Grout	2,000	CY	\$125.00	\$100.00	\$50.00	\$275.00	\$250,000	\$200,000	\$100,000	\$550,000
	Site Mitigation	1	LS	\$50,000.00	\$100,000.00	\$50,000.00	\$200,000.00	\$50,000	\$100,000	\$50,000	\$200,000
	Total - 15064							\$7,144,020	\$1,925,200	\$475,040	\$9,544,260
	SubTotal - Lower Portion of Reach IV-A and IV-B							\$8,986,520	\$3,798,700	\$889,540	\$13,684,760
Upper Portion of Reach IV-A											
15065	Cured-In-Place Pipe										
	27" CIPP	25,023	LF	\$85.00	\$55.00	\$10.00	\$150.00	\$2,126,955	\$1,376,265	\$250,230	\$3,753,450
	Pump Bypass System	12	Month	\$0.00	\$0.00	\$80,000.00	\$80,000.00	\$0	\$0	\$960,000	\$960,000
	Traffic Control	6	Month	\$0.00	\$50,000.00	\$0.00	\$50,000.00	\$0	\$300,000	\$0	\$300,000
	Total - 15065							\$2,126,955	\$1,676,265	\$1,210,230	\$5,013,450
	SubTotal - Upper Portion of Reach IV-A							\$2,126,955	\$1,676,265	\$1,210,230	\$5,013,450

**SANTA ANA WATERSHED PROJECT AUTHORITY  
REPAIRS TO UNLINED RCP, REACHES IV-A AND IV-B  
VALUE ENGINEERING REVIEW SESSION  
RESPONSE TO COMMENTS**

Item No.	Comment No.	Type	VE Design Suggestions/Comments	Designer Response
1	E-1.0	Environmental	Tailor the project description/components to segment/tier activities to provide avoidance, minimization and mitigation strategies. This project description organization is in response to direction received from USFWS meeting on August 31, 2009. The design team should consider a 3 year construction schedule to maximize avoidance during the breeding season.	SAWPA is working directly with the resource agencies to sequence this project. The construction schedule has been revised from an aggressive 7-month construction window through the breeding season to an extended 2-year program. The VE team recommendation to extend the construction period to 3-years creates numerous complications for the contractor and SAWPA as too many variables come into play over such an extended period of time, such as the potential loss of experienced project manager for the Contractor, holding bid prices for this duration, implementation of the water conversation program in Prado Basin, opportunity for more nesting within cleared sites and opportunity for change of construction. It is likely that unforeseen conditions will expose SAWPA to change order requests and claims. The 2 year program is a good compromise.
2	E-2.0	Environmental	Develop bird accounting parcel program.	No exception taken to this comment. It is recommended that this work be completed in Year 1 of the construction effort to determine construction mitigation measures that will be needed for Year 2 construction.
3	D-1.0	Design	Optimize Manhole Design. Utilize slip-lining access pits for new FRP manholes,	No exception taken. The design will further develop the manhole design sketch provided in the VE study.
4	D-2.0	Design	Identify siphon access requirements and rehabilitation. A) Remove concrete lid at siphon structure on each side to provide access into each siphon barrel and replace with Bilco-type hatch cover. B) Delete CIPP of siphon barrels	A) No exception taken B) Noted - this comment will be discussed with SAWPA staff for inclusion as part of the base bid or an optional bid item.
5	D-3.0	Design	Assess Hobas vs HDPE	The VE team validated the design approach. No action required.
6	D-4.0	Design	Assess Structural Capacity of Existing RCP	The VE team validated the design approach. No action required.
7	D-5.0	Design	Optimize Dewatering Approach. Utilize geotechnical field exploration program to install monitoring wells to pump test groundwater conditions	The geotechnical engineer will provide a revised quote to install a pump test well and adjacent monitoring well and conduct a pump test program to simulate dewatering. The designer to contact Griffin Dewatering Company to discuss the dewatering program used for the relocation of the SARI pipeline near MAS 4A-0000 and MAS 4A-0010 and MAS 4B-0000 and MAS 4B-0010
8	D-6.0	Design	Confirm Design Strategies using CIPP for the Upper portion of Reach IV-A and Slip-lining for Lower Reach IV-A and IV-B	The VE team validated the design approach. No action required.
9	D-7.0	Design	Evaluate Cost Estimate	The VE team validated the cost estimate based on the preliminary design information provided.
10	C-1.0	Construction	Modify Slip-line Access points for Lower Reach IV-A and IV-B	No exception taken for Reach IV-A. The design will consider the potential for using insertion and termination pits and look at slip-lining in both directions. The slope along this reach is 0.001 which is conducive for this approach. On Reach IV-B, it is recommended to use only insertion pits and push the slip-liner pipe downstream. The slope on this reach is 0.0038 which create too great of a vertical difference on slip-lining runs (over 7 feet on runs of 2,000 feet).
11	C-2.0	Construction	Contract Duration for Lower Reach IV-A and IV-B. Extend contract duration to account for constructibility issues that will hinder production.	No exception taken. See response to comment E-1.0. A 2-year construction period is recommended.
12	C-3.0	Construction	Staging and Ly-down areas. Identify lay-down areas on the plans	No exception taken. Proposed staging areas will be shown on the design plans and on exhibits included in the final PDR.
13	C-4.0	Construction	Investigate the use of UV Light Cure Rehabilitation	No exception taken. The designer will discuss this method with a UV Liner contractor to determine its applicability to the project conditions.
14	C-5.0	Construction	Eliminate or modify by-pass in low flow areas during the CIPP process.	No exceptions taken. The designer will work with SAWPA and the dischargers to determine locations where flow can be suspended by the user, stored on-site by the user, stored inside the pipe or pumped and trucked around the work area. This will minimize some of the traffic control issues when crossing major streets, such as El Prado and Central Ave.
15	C-6.0	Construction	Postpone Segments in the Upper portion of Reach IV-A where there is no flow or is very minimal.	No exceptions taken. The designer and SAWPA to organize the bid schedule to make these sections as optional bid items and include them in the project based on the bid results for the rest of the project.

SANTA ANA WATERSHED PROJECT AUTHORITY  
REPAIRS TO UNLINED RCP, REACHES IV-A AND IV-B  
VALUE ENGINEERING REVIEW SESSION  
RESPONSE TO COMMENTS

Item No.	Comment No.	Type	VE Design Suggestions/Comments	Designer Response
16	C-7.0	Construction	Reduce Contractor Risk. Address risk factors in the contract documents to minimize contractor exposure,	No exception taken. The designer will identify such risk factors and provide specific requirements for the contractor to achieve. Specifically items noted by the VE team include: Limited Access at Pits - Work area limits will be identified on the plans that will balance the need for work space and limit environmental impact. Dewatering at Access Pits - Soil data to be provided to the Contractor that will show anticipated groundwater levels and soil types to be encountered. Rain Events - The construction season will be clearly delineated to the contractor and the risk/exposure to flood events when working in the Prado Basin. Evacuation plan and personnel safety plans will be required. Environmental Requirements - The designer is seeking to obtain specific construction requirements for inclusion in the contract documents based on the permit conditions from the resource agencies. The goal is to avoid non-specific/ interpretive type requirements that leave SAWPA and the construction exposed. Conservation Pool Impacts - SAWPA must work with OCWD to keep the water pool down during the construction period. Contract Document clarity - We concur. All work items must be specific, quantifiable and defined for the contractor and construction manager to perform their work in an efficient manner. This will also work to minimize construction claims.

## **Appendix R**

### **Estimated Debris and Observed D/d**



**Santa Ana Regional Interceptor (SARI)**  
**Repairs to Unlined Reinforced Concrete Pipe (RCP),**  
**Reaches IV-A and IV-B**  
**Estimated Debris and Observed D/d**

**Reach IV-A Lower**

Reach	Inspection Date	Diameter	Debris Type	Debris Start			Debris Mid			Debris End			Area (Ft) <sup>2</sup>	Remaining Area (Ft) <sup>2</sup>	Debris Area (Ft) <sup>2</sup>	Total Length (Ft)	Debris Volume (Ft) <sup>3</sup>	Debris Volume (Yd) <sup>3</sup>	Est Flow Depth (in)	Observed D/d
				top	btm	Avg	top	btm	Avg	top	btm	Avg								
4A-0020-4A-0010	no video	42																		
4A-0030-4A-0020	no video	42																		
4A-0040-4A-0030	no video	42																		
4A-0050-4A-0040	10/2/2005	42	sediment / bio-growth	0.75	2.50	1.63	0.50	2.00	1.25	1.25	3.00	2.13	9.62	8.87	0.75	928	694.33	25.72	15.00	0.36
4A-0060-4A-0050	10/2/2005	42	sediment / bio-growth	0.75	2.50	1.63	0.50	2.50	1.50	0.50	2.50	1.50	9.62	8.92	0.69	973	674.40	24.98	19.00	0.45
4A-0070-4A-0060	10/3/2005	42	sediment / bio-growth	0.50	2.00	1.25	0.50	2.00	1.25	0.50	2.00	1.25	9.62	9.05	0.56	1,145	645.55	23.91	17.00	0.40
4A-0080-4A-0070	10/3/2005	42	sediment / bio-growth	0.50	1.50	1.00	0.75	2.00	1.38	1.00	2.50	1.75	9.62	9.00	0.62	1,274	788.94	29.22	18.00	0.43
4A-0090-4A-0080	10/3/2005	42	sediment / bio-growth	0.50	1.50	1.00	0.75	2.00	1.38	0.50	2.00	1.25	9.62	9.07	0.55	1,097	598.03	22.15	19.00	0.45
4A-0100-4A-0090	10/4/2005	42	sediment / bio-growth	0.50	2.00	1.25	1.00	2.50	1.75	0.50	1.50	1.00	9.62	9.02	0.60	980	588.58	21.80	17.00	0.40
4A-0110-4A-0100	10/4/2005	42	sediment / bio-growth	0.50	2.00	1.25	0.75	2.00	1.38	1.00	3.00	2.00	9.62	8.92	0.69	1,023	709.18	26.27	19.00	0.45
4A-0120-4A-0110	10/5/2005	42	sediment / bio-growth / rocks	0.75	2.00	1.38	0.75	3.00	1.88	0.75	4.00	2.38	9.62	8.78	0.84	987	828.74	30.69	19.00	0.45
4A-0130-4A-0120	10/4/2005	42	sediment / bio-growth	0.50	1.50	1.00	0.75	2.00	1.38	1.00	3.00	2.00	9.62	8.96	0.66	788	517.03	19.15	19.00	0.45
4A-0140-4A-0130	10/5/2005	42	sediment / bio-growth	0.50	2.00	1.25	0.75	2.50	1.63	0.50	1.50	1.00	9.62	9.03	0.58	1,012	589.34	21.83	17.00	0.40
4A-0150-4A-0140	10/5/2005	42	sediment / bio-growth	0.50	1.50	1.00	0.50	2.50	1.50	0.50	3.00	1.75	9.62	8.98	0.64	834	531.91	19.70	15.00	0.36
4A-0160-4A-0150	11/7/2005	42	sediment / bio-growth / rocks	0.50	2.00	1.25	0.50	2.50	1.50	0.75	3.00	1.88	9.62	8.92	0.69	1,076	745.78	27.62	15.00	0.36
4A-0170-4A-0160	11/7/2005	42	sediment / bio-growth	0.75	1.00	0.88	0.75	2.00	1.38	0.75	2.00	1.38	9.62	9.07	0.55	980	534.33	19.79	9.00	0.21
4A-0180-4A-0170	9/12/2005	42	sediment / bio-growth	0.75	1.50	1.13	0.75	1.50	1.13	1.00	1.50	1.25	9.62	9.09	0.53	540	284.62	10.54	9.00	0.21
															Total Debris (Yd) <sup>3</sup>			323.36		



**Santa Ana Regional Interceptor (SARI)**  
**Repairs to Unlined Reinforced Concrete Pipe (RCP),**  
**Reaches IV-A and IV-B**  
**Estimated Debris and Observed D/d**

**Reach IV-A Upper**

Reach	Inspection Date	Diameter	Debris Type	Debris Start			Debris Mid			Debris End			Area (Ft2)	Remaining Area (Ft2)	Debris Area (Ft2)	Total Length (Ft)	Debris Volume (Ft3)	Debris Volume (Yd3)	Est Flow Depth (in)	Observed D/d
				top	btm	Avg	top	btm	Avg	top	btm	Avg								
4A-0190-4A-0180	9/12/2005	27	sediment / bio-growth	1.00	3.00	2.00	1.00	2.50	1.75	1.00	2.50	1.75	3.97	3.45	0.52	469	244.50	9.06	2.00	0.07
4A-0200-4A-0190	9/12/2005	27	sediment / bio-growth	1.00	2.00	1.50	1.25	2.50	1.88	1.50	2.50	2.00	3.97	3.46	0.51	492	251.13	9.30	3.00	0.11
4A-0210-4A-0200	9/11/2005	27	sediment / bio-growth / rocks	1.00	2.00	1.50	1.30	2.50	1.90	1.25	3.00	2.13	3.97	3.45	0.52	515	269.86	9.99	3.00	0.11
4A-0220-4A-0210	9/11/2005	27	sediment / bio-growth	0.75	2.25	1.50	0.75	2.00	1.38	0.50	2.50	1.50	3.97	3.56	0.42	496	207.36	7.68	3.00	0.11
4A-0230-4A-0220	9/11/2005	27	sediment / bio-growth / rocks	0.50	2.25	1.38	0.50	3.00	1.75	0.75	2.00	1.38	3.97	3.54	0.43	492	211.26	7.82	4.00	0.15
4A-0240-4A-0230	9/11/2005	27	sediment / bio-growth	0.50	1.50	1.00	0.50	2.00	1.25	0.75	2.25	1.50	3.97	3.61	0.36	504	180.99	6.70	4.00	0.15
4A-0250-4A-0240	9/11/2005	27	sediment / bio-growth	0.50	1.50	1.00	0.75	2.00	1.38	0.50	2.25	1.38	3.97	3.61	0.36	628	225.83	8.36	4.00	0.15
4A-0260-4A-0250	9/8/2005	27	sediment / bio-growth	0.50	1.75	1.13	0.75	1.75	1.25	0.50	1.75	1.13	3.97	3.64	0.34	498	167.48	6.20	8.00	0.30
4A-0270-4A-0260	9/8/2005	27	sediment / bio-growth	0.75	2.00	1.38	0.75	1.75	1.25	0.75	1.50	1.13	3.97	3.61	0.36	225	80.78	2.99	7.00	0.26
4A-0280-4A-0270	9/8/2005	27	sediment / bio-growth	0.50	2.00	1.25	0.75	2.00	1.38	1.00	2.50	1.75	3.97	3.56	0.42	378	157.95	5.85	6.00	0.22
4A-0290-4A-0280	9/8/2005	27	sediment / bio-growth	0.50	1.75	1.13	0.50	2.25	1.38	0.50	1.50	1.00	3.97	3.64	0.34	378	127.10	4.71	6.00	0.22
4A-0300-4A-0290	9/8/2005	27	sediment / bio-growth	0.75	1.50	1.13	1.00	2.00	1.50	1.00	1.50	1.25	3.97	3.60	0.37	504	186.91	6.92	6.00	0.22
4A-0310-4A-0300	9/7/2005	27	sediment / bio-growth / rocks	0.50	2.00	1.25	0.50	1.50	1.00	0.75	1.50	1.13	3.97	3.65	0.32	493	159.94	5.92	7.00	0.26
4A-0320-4A-0310	9/7/2005	27	sediment / bio-growth	0.50	2.00	1.25	0.75	2.00	1.38	0.50	2.00	1.25	3.97	3.60	0.37	510	189.17	7.01	7.00	0.26
4A-0330-4A-0320	9/7/2005	27	sediment / bio-growth	0.50	2.00	1.25	0.50	2.00	1.25	0.75	2.00	1.38	3.97	3.60	0.37	502	186.36	6.90	6.00	0.22
4A-0340-4A-0330	9/7/2005	27	sediment / bio-growth / rocks	0.50	1.50	1.00	0.50	1.75	1.13	0.50	2.50	1.50	3.97	3.63	0.35	518	180.02	6.67	9.00	0.33
4A-0350-4A-0340	9/7/2005	27	sediment / bio-growth	0.50	2.25	1.38	0.75	2.50	1.63	0.75	2.00	1.38	3.97	3.56	0.42	497	207.73	7.69	7.00	0.26
4A-0360-4A-0350	9/7/2005	27	sediment / bio-growth	0.75	1.50	1.13	0.75	2.00	1.38	0.25	2.00	1.13	3.97	3.63	0.35	87	30.27	1.12	8.00	0.30
4A-0370-4A-0360	no video	27																		
4A-0380-4A-0370	9/7/2005	27	sediment / bio-growth	0.50	3.00	1.75	0.50	2.00	1.25	0.50	2.50	1.50	3.97	3.54	0.43	496	212.94	7.89	7.00	0.26
4A-0390-4A-0380	9/7/2005	27	sediment / bio-growth / rocks	0.25	4.00	2.13	0.50	2.00	1.25	0.50	2.00	1.25	3.97	3.53	0.44	490	216.04	8.00	6.00	0.22
4A-0400-4A-0390	2/7/2007	27	sediment / bio-growth	0.25	1.25	0.75	0.25	1.25	0.75	0.25	1.00	0.63	3.97	3.77	0.21	513	105.58	3.91	8.00	0.30
4A-0420-4A-0400	2/7/2007	27	sediment / bio-growth	0.25	1.25	0.75	0.25	1.00	0.63	0.50	1.50	1.00	3.97	3.74	0.23	688	157.99	5.85	6.00	0.22
4A-0430-4A-0420	no video	27																		
4A-0440-4A-0430	1/28/2007	27	Sediment	0.25	0.50	0.38	0.25	0.50	0.38	0.25	0.50	0.38	3.97	3.86	0.11	71	7.78	0.29	3.00	0.11
4A-0450-4A-0440	1/28/2007	27	Sediment / Rocks	0.25	0.50	0.38	0.25	2.00	1.13	0.50	4.00	2.25	3.97	3.61	0.36	431	154.92	5.74	8.00	0.30
4A-0460-4A-0450	1/29/2007	27	Sediment	0.00	0.75	0.38	0.25	0.75	0.50	0.50	1.00	0.75	3.97	3.82	0.16	687	108.45	4.02	5.00	0.19
4A-0470-4A-0460	1/29/2007	27	Sediment	0.25	1.00	0.63	0.25	1.25	0.75	0.50	2.00	1.25	3.97	3.72	0.25	495	125.44	4.65	5.00	0.19
4A-0480-4A-0470	1/29/2007	27	Sediment	0.25	0.75	0.50	0.25	1.50	0.88	0.25	1.50	0.88	3.97	3.76	0.22	506	110.16	4.08	7.00	0.26
4A-0490-4A-0480	1/4/2007	27	Sediment	0.25	1.00	0.63	0.25	1.00	0.63	0.25	1.50	0.88	3.97	3.77	0.21	260	53.50	1.98	6.00	0.22
4A-0500-4A-0490	1/4/2007	27	Sediment	0.25	1.50	0.88	0.25	1.00	0.63	0.25	2.00	1.13	3.97	3.72	0.25	235	59.55	2.21	7.00	0.26
4A-0505-4A-0500	1/4/2007	27	Sediment / bio-growth	0.25	1.00	0.63	0.25	1.00	0.63	0.25	1.00	0.63	3.97	3.79	0.18	506	92.02	3.41	7.00	0.26
4A-0510-4A-0505	1/4/2007	27	Sediment / bio-growth	0.25	1.00	0.63	0.25	1.00	0.63	0.25	1.00	0.63	3.97	3.79	0.18	507	92.20	3.41	5.00	0.19
4A-0520-4A-0510	1/3/2007	27	Sediment	0.25	1.00	0.63	0.25	1.00	0.63	0.25	0.75	0.50	3.97	3.80	0.17	484	82.21	3.04	5.00	0.19
4A-0522-4A-0520	1/3/2007	27	Sediment / bio-growth	0.25	1.50	0.88	0.25	1.50	0.88	0.25	2.00	1.13	3.97	3.70	0.28	498	138.00	5.11	5.00	0.19
4A-0524-4A-0522	no video	27																		
4A-0530-4A-0524	12/4/2006	27	Sediment / bio-growth	0.50	1.00	0.75	0.50	1.00	0.75	0.50	1.00	0.75	3.97	3.76	0.22	354	77.07	2.85	4.00	0.15
4A-0540-4A-0530	11/29/2006	27	Sediment / bio-growth	0.25	1.50	0.88	0.25	1.50	0.88	0.25	1.00	0.63	3.97	3.74	0.23	379	87.03	3.22	4.00	0.15
4A-0550-4A-0540	11/29/2006	27	Sediment / bio-growth	0.25	2.00	1.13	0.25	2.00	1.13	0.25	2.00	1.13	3.97	3.65	0.32	343	111.23	4.12	4.00	0.15
4A-0560-4A-0550	11/13/2006	27	Sediment / bio-growth	0.50	1.50	1.00	0.25	1.00	0.63	0.25	1.50	0.88	3.97	3.73	0.24	516	124.63	4.62	5.00	0.19
4A-0562-4A-0560	11/13/2006	27	Sediment / bio-growth	0.25	0.75	0.50	0.25	1.00	0.63	0.25	1.50	0.88	3.97	3.78	0.19	522	101.18	3.75	6.00	0.22
4A-0564-4A-0562	1/29/2007	27	Sediment / bio-growth	0.25	0.75	0.50	0.25	1.00	0.63	0.25	1.00	0.63	3.97	3.80	0.17	499	84.76	3.14	5.00	0.19
4A-0566-4A-0564	11/13/2006	27	Sediment / bio-growth	0.25	0.75	0.50	0.25	0.75	0.50	0.25	0.50	0.38	3.97	3.84	0.13	502	67.16	2.49	9.00	0.33
4A-0568-4A-0566	11/13/2006	27	Sediment / bio-growth	0.25	0.50	0.38	0.25	0.50	0.38	0.25	0.75	0.50	3.97	3.85	0.12	494	60.12	2.23	5.00	0.19
4A-0570-4A-0568	10/31/2006	27	Sediment / bio-growth	0.25	0.50	0.38	0.25	0.50	0.38	0.25	1.00	0.63	3.97	3.84	0.13	519	69.43	2.57	4.00	0.15
4A-0575-4A-0570	10/31/2006	27	Sediment / bio-growth	0.25	0.75	0.50	0.25	0.50	0.38	0.25	0.75	0.50	3.97	3.84	0.13	390	52.17	1.93	4.00	0.15



**Santa Ana Regional Interceptor (SARI)**  
**Repairs to Unlined Reinforced Concrete Pipe (RCP),**  
**Reaches IV-A and IV-B**  
**Estimated Debris and Observed D/d**

**Reach IV-A Upper**

Reach	Inspection Date	Diameter	Debris Type	Debris Start			Debris Mid			Debris End			Area (Ft2)	Remaining Area (Ft2)	Debris Area (Ft2)	Total Length (Ft)	Debris Volume (Ft3)	Debris Volume (Yd3)	Est Flow Depth (in)	Observed D/d
				top	btm	Avg	top	btm	Avg	top	btm	Avg								
4A-0580-4A-0575	10/17/2006	27	Sediment / bio-growth	0.25	1.00	0.63	0.25	1.00	0.63	0.50	1.25	0.88	3.97	3.77	0.21	314	64.62	2.39	5.00	0.19
4A-0585-4A-0580	10/17/2006	27	Sediment / bio-growth	0.50	0.75	0.63	0.25	0.75	0.50	0.25	1.00	0.63	3.97	3.80	0.17	75	12.74	0.47	5.00	0.19
4A-0590-4A-0585	10/17/2006	27	Sediment	0.00	0.75	0.38	0.25	1.00	0.63	0.25	0.75	0.50	3.97	3.83	0.15	58	8.46	0.31	3.50	0.13
4A-0600-4A-0590	10/17/2006	27	Sediment	0.00	0.75	0.38	0.00	0.50	0.25	0.25	0.25	0.25	3.97	3.89	0.09	113	9.65	0.36	3.00	0.11
4A-0605-4A-0600	10/17/2006	27	Sediment	0.00	0.25	0.13	0.00	0.50	0.25	0.00	0.50	0.25	3.97	3.91	0.06	340	20.77	0.77	1.00	0.04
4A-0610-4A-0605	10/9/2006	27	Sediment	0.00	0.50	0.25	0.00	0.25	0.13	0.00	0.25	0.13	3.97	3.93	0.05	108	5.28	0.20	3.00	0.11
4A-0620-4A-0610	10/9/2006	27	Sediment	0.25	0.50	0.38	0.25	0.75	0.50	0.25	0.75	0.50	3.97	3.84	0.13	384	51.37	1.90	2.00	0.07
4A-0622-4A-0620	10/9/2006	27	Sediment	0.25	0.50	0.38	0.25	0.75	0.50	0.25	0.75	0.50	3.97	3.84	0.13	68	9.10	0.34	1.50	0.06
4A-0624-4A-0622	no video	27	Siphon																	
4A-0626-4A-0624	10/5/2006	27	Sediment / rocks	0.25	0.75	0.50	0.50	0.75	0.63	0.25	0.50	0.38	3.97	3.83	0.15	25	3.65	0.14	0.25	0.01
4A-0630-4A-0626	10/5/2006	27	Sediment / rocks	0.00	0.50	0.25	0.00	0.50	0.25	0.00	0.75	0.38	3.97	3.89	0.09	66	5.64	0.21	0.25	0.01
4A-0640-4A-0630	10/5/2006	27	Sediment	0.00	0.25	0.13	0.00	0.50	0.25	0.00	0.50	0.25	3.97	3.91	0.06	571	34.88	1.29	0.00	0.00
4A-0642-4A-0640	10/4/2006	27	Sediment	0.00	0.50	0.25	0.00	0.50	0.25	0.00	0.50	0.25	3.97	3.90	0.07	499	36.55	1.35	0.00	0.00
4A-0644-4A-0642	10/4/2006	27	Sediment	0.00	0.50	0.25	0.00	0.75	0.38	0.00	0.75	0.38	3.97	3.88	0.10	150	14.63	0.54	0.00	0.00
4A-0650-4A-0644	no video	10	5 - 10" lines																	
4A-0652-4A-0650	10/4/2006	27	Sediment	0.25	0.75	0.50	0.00	0.75	0.38	0.25	0.75	0.50	3.97	3.84	0.13	259	34.65	1.28	0.00	0.00
4A-0654-4A-0652	10/4/2006	27	Sediment	0.25	0.50	0.38	0.25	0.75	0.50	0.25	1.00	0.63	3.97	3.83	0.15	487	71.02	2.63	0.00	0.00
4A-0656-4A-0654	9/19/2006	27	Sediment	0.25	0.75	0.50	0.25	0.75	0.50	0.25	0.75	0.50	3.97	3.83	0.15	498	72.62	2.69	0.00	0.00
4A-0660-4A-0656	9/12/2006	27	Sediment	0.00	0.75	0.38	0.25	0.75	0.50	0.25	1.50	0.88	3.97	3.80	0.17	213	36.18	1.34	3.00	0.11
4A-0670-4A-0660	9/12/2006	27	Sediment	0.25	0.75	0.50	0.25	0.75	0.50	0.25	0.75	0.50	3.97	3.83	0.15	104	15.17	0.56	0.50	0.02
4A-0680-4A-0670	9/12/2006	27	Sediment	0.25	0.50	0.38	0.25	0.50	0.38	0.25	0.75	0.50	3.97	3.85	0.12	155	18.87	0.70	0.50	0.02
																Total Debris (Yd) <sup>a</sup>		234.89		



**Santa Ana Regional Interceptor (SARI)**  
**Repairs to Unlined Reinforced Concrete Pipe (RCP),**  
**Reaches IV-A and IV-B**  
**Estimated Debris and Observed D/d**

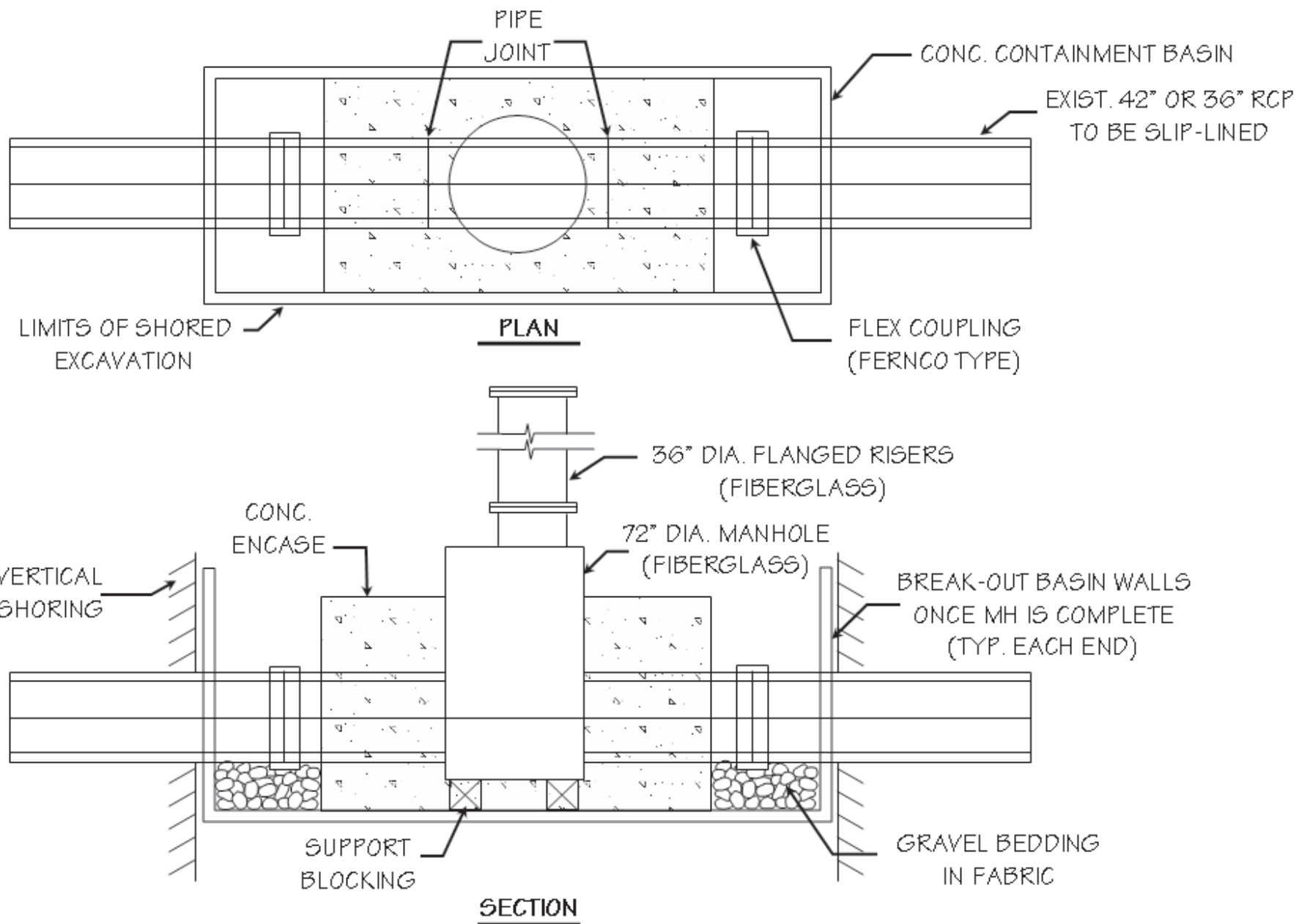
**Reach IV-B**

Reach	Inspection Date	Diameter	Debris Type	Debris Start			Debris Mid			Debris End			Area (Ft2)	Remaining Area (Ft2)	Debris Area (Ft2)	Total Length (Ft)	Debris Volume (Ft3)	Debris Volume (Yd3)	Est Flow Depth (in)	Observed D/d
				top	btm	Avg	top	btm	Avg	top	btm	Avg								
4B-0020-4B-0010	5/5/2008	36	Sediment / bio-growth	0.50	4.00	2.25	0.75	4.00	2.38	0.75	5.00	2.88	7.07	6.12	0.95	1305	1,236.07	45.78	9.00	0.25
4B-0030-4B-0020	5/5/2008	36	Sediment / bio-growth	0.75	2.00	1.38	0.75	3.00	1.88	0.50	3.00	1.75	7.07	6.43	0.64	695	444.12	16.45	10.00	0.28
4B-0040-4B-0030	5/5/2008	36	Sediment / bio-growth	0.75	1.50	1.13	1.00	3.00	2.00	0.75	3.00	1.88	7.07	6.43	0.64	1916	1,224.37	45.35	8.00	0.22
4B-0050-4B-0040	3/13/2008	36	Sediment / bio-growth	0.75	1.50	1.13	0.75	1.50	1.13	0.75	1.50	1.13	7.07	6.63	0.43	883	383.81	14.22	12.00	0.33
4B-0060-4B-0050	3/13/2008	36	Sediment / bio-growth	0.75	1.50	1.13	0.75	2.00	1.38	0.75	1.50	1.13	7.07	6.60	0.47	1120	522.27	19.34	12.00	0.33
4B-0070-4B-0060	3/13/2008	36	Sediment / bio-growth	0.75	2.00	1.38	0.50	3.00	1.75	0.50	4.00	2.25	7.07	6.38	0.69	1471	1,008.71	37.36	8.00	0.22
4B-0080-4B-0070	6/27/2007	36	Sediment / bio-growth	0.50	1.50	1.00	0.50	1.50	1.00	0.50	2.00	1.25	7.07	6.65	0.42	1218	510.11	18.89	14.00	0.39
4B-0090-4B-0080	6/28/2007	36	Sediment / bio-growth	0.75	1.50	1.13	0.75	1.50	1.13	0.50	1.50	1.00	7.07	6.65	0.42	1095	458.60	16.99	14.00	0.39
4B-0100-4B-0090	6/28/2007	36	Sediment / bio-growth	0.75	1.50	1.13	0.50	1.50	1.00	0.75	1.50	1.13	7.07	6.65	0.42	1124	470.74	17.43	15.00	0.42
4B-0110-4B-0100	9/19/2005	36	Sediment / bio-growth	0.50	2.00	1.25	0.50	1.50	1.00	0.50	1.50	1.00	7.07	6.65	0.42	1067	446.87	16.55	12.00	0.33
4B-0120-4B-0110	9/15/2005	36	Sediment / bio-growth	0.50	1.50	1.00	0.50	1.50	1.00	0.25	1.00	0.63	7.07	6.73	0.34	1162	394.22	14.60	13.00	0.36
4B-0130-4B-0120	1/11/2006	36	Sediment / bio-growth	0.25	1.50	0.88	0.25	2.00	1.13	0.25	1.50	0.88	7.07	6.69	0.37	1228	455.76	16.88	9.00	0.25
4B-0140-4B-0130	9/15/2005	36	Sediment / bio-growth	0.50	1.00	0.75	0.25	1.50	0.88	0.25	1.50	0.88	7.07	6.74	0.32	1229	397.33	14.72	11.00	0.31
4B-0150-4B-0140	1/11/2006	36	Sediment / bio-growth	0.25	1.50	0.88	0.25	2.00	1.13	0.50	2.00	1.25	7.07	6.65	0.42	1129	472.84	17.51	8.00	0.22
															Total Debris (Yd) <sup>a</sup>			312.07		



## **Appendix S**

### **Preliminary Maintenance Access Structure Design**



**Appendix T**  
**Response to Comments – Draft Pre-Design Report**

**Santa Ana Regional Interceptor Pipeline (SARI)  
Repairs to Unlined RCP  
Reaches IV-A and IV-B**

<b>PDR _Draft Comments provided by Rich Haller</b>	<b>Response to Comments</b>
1. Include design criteria for reconstructed Maintenance Access Structures: watertight, capable to withstand Maximum Probable Flood Condition, sized to allow for CCTV camera and line cleaning nozzle/hose entry/exit, etc.	OK. Working with Hobas and Ameron on a 6 foot diameter fiberglass structure that is concrete encased to prevent floatation. A 3-foot diameter access cover will be provided.
2. Are existing Maintenance Access Structures, if not reconstructed, adequate to withstand Maximum Probable Flood Condition or should all be reconstructed?	It appears all MAS were designed to water-tight based on the MPF. Existing MAS that remain should be rehab'd
3. Segmental slip lining - Live Stream - are there any considerations for a brine wastewater versus domestic wastewater (non-corrosive materials, safety)?	Review of the water quality data shows SARI wastewater to be fairly neutral pH-wise. Hobas, Ameron (fiberglass pipe) and or HDPE would appropriate pipe materials
4. Pipe Buoyancy Calculation - is calculation for groundwater conditions only worst case? At what water surface elevation is buoyancy a problem? Calculation should be made a Maximum Probable Flood Condition	Buoyancy uplift force does not change with height of water. The height of water is factored into the Wall buckling equation
5. Yorba Slaughter Dike - it appears MAS's will be on the "wet side" of the dike and therefore need to withstand Max Probable Flood Condition.	OK, noted
6. Check lateral information for Reach IV-A and IV-B which should be available from the CCTV info. Check "8" catch basin connection" term which is confusing; there are no catch basin connections.	OK
7. Section 4 text and Table 2:	OK, revised text
o Check the hydraulic capacity of Option A, Lower Reach IV-A. Text states 15.0 mgd, Table 2 states 18.1 mgd	Revised text
o Slip lining should provide the largest diameter possible to minimize the loss of design capacity. Will n=0.009 friction coefficient degrade over time?	Noted and n value should remain depending on cleaning program
o Highlight that Option A is based on Hobas. What are the cost implications of locking into one vendor? How does Hobas compare with Vylon PVC and HDPE?	HDPE is comparable but needs greater wall thickness, which reduces hydraulic capacity Vylon has limited strength capacity, plus experience on Mission Tunnel is poor. We are currently working with Ameron to determine the feasibility of using their fiberglass Bondstrand pipe.
8. Section 5.5 - add sentence that the EIR considered impacts/mitigations for spring/summer/fall work. Assess the cost impacts	Based on the VE session, we are looking at a 2-year construction period to work around the breeding season and minimize impacts



**Santa Ana Regional Interceptor Pipeline (SARI)  
Repairs to Unlined RCP  
Reaches IV-A and IV-B**

<b>PDR _Draft Comments provided by Rich Haller</b>	<b>Response to Comments</b>
of faster/dryer work conditions versus the added mitigation costs for spring/summer/fall work.	
9. Section 5.6 - I thought we standardized on a 50' radius to remain cleared around each manhole.	50' diameter is correct
10. Add brief discussion on O&M issues for all the re-lining methods presented.	ok
11. Dewatering - how will the risk of dewatering claims from the contractor be mitigated?	Provide soils data and expected groundwater levels as part of the construction documents. Dewatering is a performance requirement based on stated conditions. We need to be broad in our assessment of the potential soil conditions as the basin is likely to see a wide variety of sands,gravels and clayely soils.
12. Dewatering - water will most likely be discharge to a surface stream not the SARI. An application for an NPDES permit is being prepared. Water quality data from water samples collected during the soil borings will be required.	OK, noted
13. Construction cost estimate. What's changed since the last estimate which was \$20M? We are proceeding with a project financing plan based upon a total project cost of \$22.5M.	The slip line alignment has a number of alignment curves that will reduce production rates, and increase the unit cost of pipe
14. Permit requirements. Are impacted areas updated based upon the preliminary design or the same values used in the EIR?	Impact areas have been updated based on the current access pit locations
15. Section 8.5 - bird nesting season ends September 25th, not September 15th?	noted
16. Section 9.0 - where MBE, WBE requirements stated in the RFQ package?	Sub contractor information is not required as part of the RFQ program. It will be included in the final bid documents
17. Appendix O - clarify the intent to use/not use the Green Book. Add Summary of Work, Supplementary General Provision sections.	Green Book will be supplemented by technical specifications and special provisions provided by SAWPA

**Santa Ana Regional Interceptor Pipeline (SARI)**  
**Repairs to Unlined RCP**  
**Reaches IV-A and IV-B**

<b>PDR _Draft Comments provided by David Ruhl</b>		<b>Response to Comments</b>
1	Lateral Connections IVB - Information provided by SAWPA incorrect, no lateral connection at Sta. 69+06.17 and 92+06.19	Ok, Revised to show only one lateral on Reach IV-B
2	Section 3.3, Add location of 5 barrel crossing.	Ok and we have added to the plans
3	Provide table of slip liner material available sizes for Hobas, Vylon and HDPE. Are they all 30" and 36", include wall thickness.	Added discussion about Ameron Bondstrand fiberglass pipe
4	Will the selected pipe material have the same biogrowth issue? What is the projected "n" value over time for the pipe materials identified?	Yes, dependent on cleaning
5	Existing capacity and projected flow capacity for CIPP is not provided.	Provided
6	For CIPP what are the pipe segment lengths from MAS to MAS? Do we have any load capacity issues? Are there installation limitations? Can we skip a MAS for shorter pipe segments?	We will provide a table on the plans, no load issues, Yes - lining through MAS is OK.
7	Have you looked at fiberglass liners as a competitor to resin and felt liners.	UV liners would be an acceptable option however there are limitations on diameter and length for this size project.
8	For CIPP work within existing easements, we most likely will not have a 50 foot radius around each MAS but rather only the area within the existing easement. Should provide description of area required and ability to work within existing easement.	OK, noted. More linear set-up will be required
9	Working with businesses on upper Reach IVA should be an additional project issue. Access to easements, clearing easement and temporary easements if necessary.	SAWPA should work with tenants to move off easement, utilize parallel IEUA easement, line through some of the MAS to minimize disturbance and orient CIPP equipment to minimize impact are all options.
10	Reference the Least Bells Vireo and Southwestern Willow Flycatcher as endangered species.	OK
11	Section 5.6, provide table of impacted parcels, property owner, tenant, impacts to business, area required, is a temporary easement required.	Only TCE identified is near the Adobe slaughter Dike. Need additional 20-foot wide TC through two parcels
12	Table 4 is not consistent with text on page 21 stating 1,000 feet per day can be achieved.	Revised
13	Fish and Game will require on on-site biologist.	OK
14	Limited discussion on project phasing and construction	Revised construction sequence to use a two year construction window.

**Santa Ana Regional Interceptor Pipeline (SARI)  
Repairs to Unlined RCP  
Reaches IV-A and IV-B**

<b>PDR _Draft Comments provided by David Ruhl</b>		<b>Response to Comments</b>
	sequencing. Need more detail on how we will accomplish, clearing the access road, line cleaning, constructing access pits, installing slip line pipe, reconstructing the manhole ect. all within the small window and the constraints of working within prado. Most likely work below 505 elevation will not occur unit mid to late summer.	
15	staging areas, existing and proposed access road and existing and temporary easements were not included on plans.	Noted on plans on plans
16	Geotechnical borings that will be obtained after Sept 26th.	Ok,noted
	Missing Items	
1	Reconstructed MAS detail	Added
2	Access Pit Detail	Part of the MAS detail
3	Financing plan showing disbursement projections by month.	This can be developed once the construction period is confirmed with the resource agencies
4	Constructability review process	OK
	General Editing Comment	
1	Replace the term "Manhole" with "Maintenance Access Structure"	Ok, noted
2	Replace "Prado Dam Raise Project" with correct project name.	Ok, noted
	Items for consideration/discussion	
1	Add pipe survey to determine depth of cover over SARI at channel crossing locations	Ok, noted, to be part of the Bid documents
2	Include in Bid Sheet purchase of I Beams and Steal plates to be used as temporary bridges.	Ok, noted, to be part of the Bid documents

**Santa Ana Regional Interceptor Pipeline (SARI)  
Repairs to Unlined RCP  
Reaches IV-A and IV-B**

<b>PDR _Draft Comments provided by Carlos Quintero</b>	<b>Response to Comments</b>
1. Verify the number and location of laterals to Reach IV-A. The connection from OLS Energy is at MH 4A-0620; there is no flow upstream of this MH, the PDR indicates that there is no flow upstream of 4A-0580.	Ok, noted
2. Could you provide a table or a graph indicating the hydraulic capacity of the repaired segments of the SARI as the “n” value of the liner increases? What is a reasonable assumption for deterioration of the pipeline over time?	OK, added. Roughness will depend on the cleaning cycle
3. Does the 10% contingency cover unexpected bends or changes of slope in the pipeline that might require additional access pits?	10% accounts for unforeseen issue at this stage of the project.
4. Is there any testing required for the CIPP liner? Do we perform CCTV to make sure the liner attached correctly to the pipe?	the Specs will cover testing requirements and yes CCTV will be performed and no the liner does not attach to the host pipe
5. Are there any impacts to water quality as a result of the resins used during the CIPP installation?	No, the resin sets and cures prior to the water being released downstream. A discussion and appendix added to address this concern
6. Please indicate if there are any disadvantages of the spiral wound process. Only benefits are described in the PDR.	Ok
7. There is no discussion on the potential flotation of manholes.	OK, we are working on this concept which will include manhole flotation. Concrete encasement of manholes to eliminate flotation.
8. Under discussion of traffic control permit requirements, we need to make sure that there are no disruptions to the access road to the Corona Airport. Previous drawings showed an access pit near or at the intersection of the entrance to the airport, the drawings included as part of the PDR reflect a change of location.	Ok, noted
9. Will there be a staging area for excavated material from the access pits? Are we planning on using any imported soil for backfilling?	Most excavated material will be hauled off-site. Native material to be used as backfill. The plans will identify staging areas available
10. The PDR indicates that average production rates of up to 1,000 feet per day can be achieved for slip-lining (Page 21); however, Table 4 indicates an average production rate of 150 feet per day. This figure seems low compared to the 1,000 feet per day discussed earlier. What type of conditions/situations could we encounter that drive the average production rate so low?	The discrepancy has been clarified by adding a footnote to the production table
11. Is a 185 feet per day production for the CIPP reasonable? How long are the felt tube liners, on average? Do you install the liner taken to the site on the same day? Can you stop work without installing the total length of the felt tube liner delivered to the site? Are felt tube liners delivered daily to the site?	Contractors indicate up to 3,000 feet per week can be lined. Work must be continuous once started. Liners are delivered most likely twice a week depending on the length of runs to be performed in the week.
12. There is no discussion of staging areas, storage of pipe and/or materials.	Added to the plans
13. Under Project Funding, additional requirements might apply if ARRA (stimulus) funds are granted to SAWPA.	Ok, noted
14. SAWPA will provide maps with better resolution showing the proposed locations for soil borings.	Figures have been revised.
15. Do the scenarios provided in the calculations section consider the additionally expected 20 ft of sediment over the pipe as a result of raising Prado Dam?	Yes
16. Were there calculations made for the 42” pipe?	No, only 36” and 30” slip-liner pipe
17. Please verify the MH numbers in the drawings for Upper Reach IV-A are correct, some numbers are incorrectly listed as 4A-0010.	Ok, noted