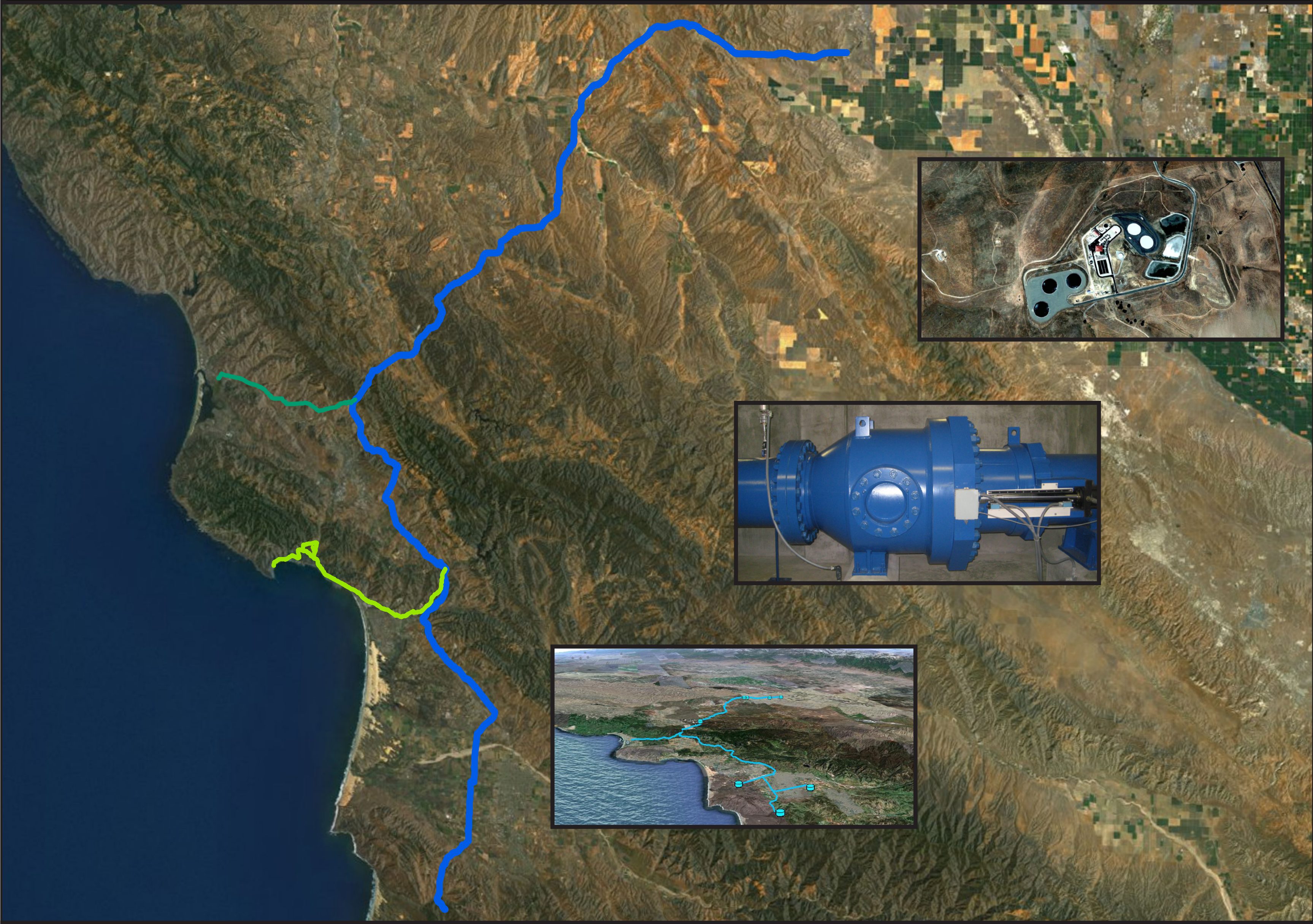
Capacity Assessment of the Coastal Branch, Chorro Valley, & Lopez Pipelines



• December 22, 2011 •

WSC
Water Systems Consulting, Inc.

San Luis Obispo County Flood Control & Water Conservation District

Capacity Assessment of the Coastal Branch, Chorro Valley and Lopez Pipelines

Prepared for:

Prepared Under the Responsible Charge of:

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California R.C.E. No. 63004, Expires 6/30/2012

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LIST OF ACRONYMS AND ABBREVIATIONS

afy	acre-feet per year
AWWA	American Water Works Association
CCWA	Central Coast Water Authority
cfs	cubic feet per second
CMC	California Men's Colony
CMCTO	California Men's Colony turnout
CVTO	Chorro Valley turnout
District	San Luis Obispo County Flood Control and Water Conservation District
DWR	California Department of Water Resources
MG	million gallons
EDV	energy dissipation valve
FCV	flow control valve
ft	Feet
ft/s	feet per second
GIS	geographic information systems
GPTO	Guadalupe turnout
HGL	hydraulic grade line
kW	Kilowatts
kWh	kilowatt hours
LPTO	Lopez turnout
Max	Maximum
MB	Morro Bay
MBTO	Morro Bay turnout
MGD	million gallons per day
NMFS	National Marine Fisheries Service
OCSD	Oceano Community Services District
PPWTP	Polonio Pass Water Treatment Plant
Project Team	District, CCWA and WSC
psi	pounds per square inch
RFP	request for proposal
SBTO	Santa Barbara county turnouts
SCADA	supervisory control and data acquisition
SCWC	Southern California Water Company turnout
sf	square feet
SMTO	Santa Maria turnout
SWP	State Water Project
TOC	Total Organic Carbon
USFWS	United States Fish & Wildlife Service
WSC	Water Systems Consulting, Inc. and its subconsultants, HDR Engineering, Inc. and GEI, Inc.

1 EXECUTIVE SUMMARY

1.1 PURPOSE

The San Luis Obispo County Flood Control and Water Conservation District (District), in coordination with the Central Coast Water Authority (CCWA), hired Water Systems Consulting, Inc. and its subconsultants GEI, Inc. and HDR Engineering, Inc. (collectively referred to as WSC) to prepare an assessment of the hydraulic capacity of Phase II (including the Coastal Branch Extension) of the Coastal Branch of the State Water Project (SWP) from Devil's Den Pumping Plant to Tank 5, including the Chorro Valley and Lopez pipelines in San Luis Obispo county. This capacity assessment summarizes the project background, source data and assumptions, analytical tools and methodologies, as well as the results and conclusions of the analysis. It also presents WSC's recommendations for the District and CCWA to consider as they work with the stakeholders of the Coastal Branch to rerate its capacity, and develop a new operations plan for this critical piece of regional infrastructure.

1.2 RESULTS

Table 1-1, Table 1-2, Table 1-3 and Table 1-4 summarize the results of the capacity analysis, and Figure 1-1 provides a comparison of the modeled capacity and contract flow rate (Baseline) for each turnout between the Polonio Pass Water Treatment Plant (PPWTP) and Tank 5.

Table 1-1. Coastal Branch pipeline capacity assessment results (instantaneous flow rate)[a]

	Baseline Contract flow rates (cfs)	Scenario #1 Equal % increase in flow to all turnouts (cfs)	Scenario #2 Equal % increase in flow; then max flow to CVTO (cfs)	Scenario #3 Equal % increase in flow; then max flow to LPTO (cfs)	Scenario #4 Equal % increase in flow; then max flow to SBTO (cfs)	Scenario #5 Max flow to LPTO; then max flow to CVTO (cfs)	Scenario #6 Max flow to SBTO; then max flow to CVTO (cfs)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (cfs)	Scenario #8 Equal % increase in flow; then max flow to Shandon (cfs)
Shandon	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	16.3
Subtotal-Flow into Tank 2	71.9	81.0	84.5	81.1	81.0	84.2	84.2	84.5	81.0
CVTO	3.5	4.0	7.5	4.0	4.0	7.5	7.5	7.5	4.0
Subtotal-Flow thru the EDV	68.4	77.0	77.0	77.2	77.0	76.7	76.7	77.0	77.0
LPTO	3.6	4.1	4.1	4.2	4.1	11.9	3.6	4.1	4.1
GPTO	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0
SMTO	26.9	30.2	30.2	30.2	30.3	26.9	30.3	30.2	30.2
SCWC	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9
Subtotal-Flow into Tank 5	36.2	40.7	40.7	40.7	40.8	36.2	40.8	40.7	40.7
Total Capacity	72.1	81.1	84.7	81.3	81.2	84.4	84.4	84.6	97.2

[a] Acronym definition: Chorro Valley Turnout (CVTO); Energy Dissipation Valve (EDV); Lopez Turnout (LPTO); Guadalupe Turnout (GPTO); Santa Maria Turnout (SMTO); Southern California Water Company Turnout (SCWC); Santa Barbara County SWP subcontractors (SBTO)

Table 1-2. Coastal Branch pipeline capacity assessment results (annual capacity)[a]

	Baseline Contract Flow Rates (afy)	Scenario #1 Equal % increase in flow to all turnouts (afy)	Scenario #2 Equal % increase in flow; then max flow to CVTO (afy)	Scenario #3 Equal % increase in flow; then max flow to LPTO (afy)	Scenario #4 Equal % increase in flow; then max flow to SBTO (afy)	Scenario #5 Max flow to LPTO; then max flow to CVTO (afy)	Scenario #6 Max flow to SBTO; then max flow to CVTO (afy)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (afy)	Scenario #8 Equal % increase in flow; then max flow to Shandon (afy)
Shandon	100	113	113	113	113	100	100	100	10,810
CVTO	2,338	2,633	4,975	2,633	2,633	4,980	4,980	4,980	2,633
LPTO	2,392	2,693	2,693	2,801	2,693	7,918	2,392	2,693	2,693
GPTO	605	681	681	681	682	605	683	681	681
SMTO	17,820	20,065	20,065	20,065	20,075	17,820	20,119	20,065	20,065
SCWC	550	619	619	619	620	550	621	619	619
Subtotal-Flow into Tank 5	24,011	27,036	27,036	27,036	27,050	24,011	27,108	27,036	27,036
Total Capacity	47,816	53,841	56,184	53,949	53,865	55,984	56,003	56,176	64,538

Table 1-3. Coastal Branch pipeline capacity assessment results (increase in annual capacity)[a]

	Scenario #1 Equal % increase in flow to all turnouts (afy)	Scenario #2 Equal % increase in flow; then max flow to CVTO (afy)	Scenario #3 Equal % increase in flow; then max flow to LPTO (afy)	Scenario #4 Equal % increase in flow; then max flow to SBTO (afy)	Scenario #5 Max flow to LPTO; then max flow to CVTO (afy)	Scenario #6 Max flow to SBTO; then max flow to CVTO (afy)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (afy)	Scenario #8 Equal % increase in flow; then max flow to Shandon (afy)
Shandon	13	13	13	13	0	0	0	10,710
CVTO	295	2,638	295	295	2,642	2,642	2,642	295
LPTO	301	301	409	301	5,526	0	301	301
GPTO	76	76	76	77	0	78	76	76
SMTO	2,245	2,245	2,245	2,255	0	2,299	2,245	2,245
SCWC	69	69	69	70	0	71	69	69
Subtotal-Flow into Tank 5	3,025	3,025	3,025	3,039	0	3,097	3,025	3,025
Total Capacity	6,025	8,368	6,133	6,049	8,168	8,187	8,360	16,722

[a] Annual capacity results assume continuous delivery at the scenario specific flow rates for 11 months and that there is sufficient sub-contractor demand to receive these flow rates.

Table 1-4. Coastal Branch pipeline capacity assessment results (HGL)

	Baseline Contract flow rates (ft)	Scenario #1 Equal % increase in flow to all turnouts (ft)	Scenario #2 Equal % increase in flow; then max flow to CVTO (ft)	Scenario #3 Equal % increase in flow; then max flow to LPTO (ft)	Scenario #4 Equal % increase in flow; then max flow to SBTO (ft)	Scenario #5 Max flow to LPTO; then max flow to CVTO (ft)	Scenario #6 Max flow to SBTO; then max flow to CVTO (ft)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (ft)	Scenario #8 Equal % increase in flow; then max flow to Shandon (ft)
Shandon	1,891	1,869	1,860	1,869	1,869	1,861	1,861	1,860	1,825
CVTO	1,512	1,487	1,477	1,487	1,487	1,478	1,478	1,477	1,487
LPTO	1,033	1,098	1,098	1,098	1,099	1,033	1,100	1,098	1,098
GPTO	848	868	868	868	868	848	869	868	868
SMTO	798	805	805	805	805	798	805	805	805
SCWC	791	797	797	797	797	791	797	797	797

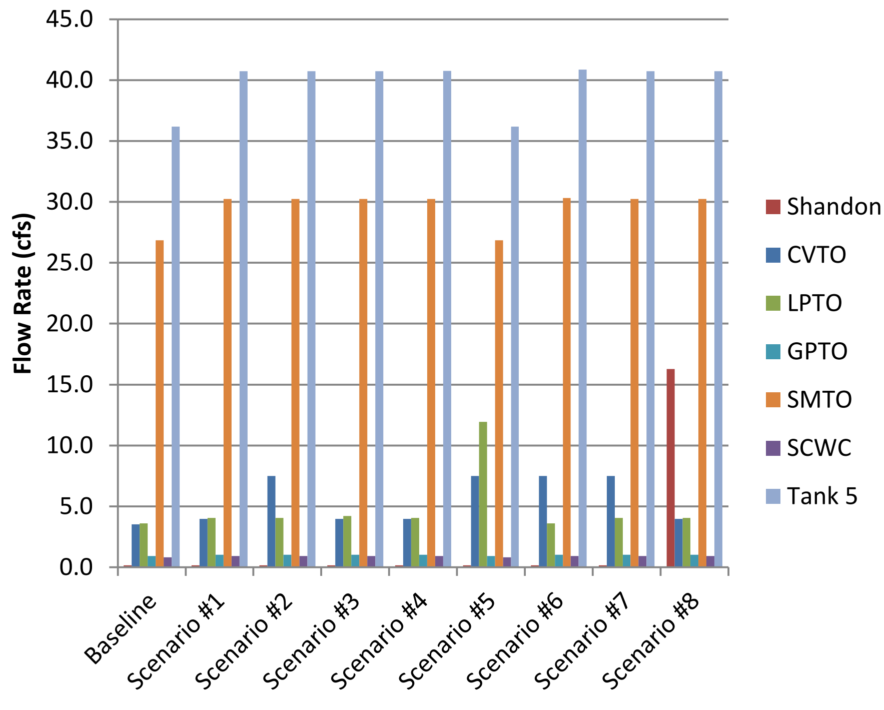

Figure 1-1. Comparison turnout flow rates for each scenario

1.3 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis and results described above, WSC developed the following conclusions and recommendations for the District and CCWA to consider.

1. **The Coastal Branch pipeline has significant excess capacity above its design value, especially for the turnouts north of the EDV.** For example, if all turnouts along the Coastal Branch were increased in equal percentage, rated pipeline capacity could be increased by approximately 12.6% (9.08 cfs) relative to delivery of the annual contract flow rates (assuming 11 months of operation per year).
2. **The PPWTP is currently limiting the overall capacity of the Coastal Branch.** WSC's simplified analysis of treatment plant capacity indicated that it is rated for continuous production at 76 cfs. By comparison, the modeling results indicate that the capacity of the Coastal Branch pipeline is in the range of 81 to 97 cfs, depending upon where the water is delivered, and the raw water pumping plants have a capacity in excess of 100 cfs.
3. **Increasing flow rates in the Coastal Branch pipeline will not adversely impact the hydraulic grade line (HGL) at the Santa Maria, Guadalupe and SCWC turnouts.** As shown in Table 1-4, under every capacity scenario, the pressures at every turnout downstream of the EDV are equal to or higher than when the pipeline is delivering contract flows. Although a lower hydraulic grade line (HGL) is predicted at Chorro Valley Turnout (CVTO) when the pipeline is operating at the higher flows,[a] there is still sufficient head to deliver contract flows.[b]
4. **Open channel flow along the Chorro Valley pipeline.** Eliminate open channel conditions, at low flows, within the Chorro Valley pipeline to ensure that all sections of the pipeline remain fully pressurized.
5. **Capacity of the Coastal Branch pipeline can be further increased with modest capital improvements.**
    a. <u>To further increase flows to Chorro Valley</u>, complete a thorough evaluation of the design pressure and current condition of the pipe segments downstream of the flow control valve, to confirm that 75 psi is an appropriate maximum working pressure, and to determine if additional working pressure could be sustained.
    b. <u>To further increase flows to Lopez</u>, consider implementing one of the improvements presented in the Lopez Pipeline Capacity Re-Evaluation Technical Memorandum dated 8/15/2011 (Appendix E) prepared by WSC, such as pigging the 33" section of the Lopez pipeline or upgrading the Oceano pipeline.
    c. <u>To further increase flows to Santa Barbara county</u>, complete a thorough evaluation of the design pressure and current condition of the pipe segments downstream of the EDV, to confirm that 385 psi is an appropriate maximum working pressure, and to determine if additional working pressure could be sustained.

[a] The predicted HGL at the CVTO under the eight capacity scenarios is anywhere from 25 to 35 feet lower than the HGL of the pipeline flowing at contract flow rates.
[b] The flow control valve at Site 3 burns anywhere from 679 to 837 feet of head prior to flows being delivered to Morro Bay and the California Men's Colony.

d. To further increase flows north of the Tank 2 (i.e. Shandon), evaluate adding a second sleeve valve at the inlet to Tank 2 and/or reducing the operating water level of Tank 2.

6. **Update the surge analyses for the Coastal Branch, Chorro Valley and Lopez pipelines.** The analyses should be updated to reflect higher flows, to validate and/or refine valve closing criteria and confirm the adequacy of existing surge controls to protect the infrastructure in the event of a pressure transient.
7. **Re-evaluate hydropower generation at the EDV.** Based on current contract rates, a 895 kW hydropower generation station at the location of the EDV could produce roughly 5 million kWh of renewable electricity per year without impacting the flow capacity of the pipeline.[a]
8. **Re-evaluate hydropower generation at the Chorro Valley pipeline Site 3.** Based on current contract rates, a 175 kW hydropower generation station at Site 3 could produce roughly 1 million kWh of renewable electricity per year without impacting the flow capacity of the pipeline.[a]

This capacity assessment models eight specific operating scenarios. The modeling work presented should not be considered exhaustive and the modeling of additional operating scenarios may be explored in the future. In addition, this capacity assessment does not consider the loss of operational flexibility that will occur as the pipeline becomes more fully utilized, nor does the capacity assessment address the potential limitations that may arise from pressure transient issues.

1.4 CAPACITY ASSESSMENT APPROACH

To assess the hydraulic capacity of the Coastal Branch, Chorro Valley and Lopez pipelines, WSC utilized calibrated hydraulic models for each pipeline and evaluated eight maximizing scenarios developed by the District, CCWA, WSC and a team of stakeholders[b] at a workshop on December 7, 2010. Model settings were manipulated to achieve the maximum capacity for each scenario. Table 1-5 summarizes the eight modeled scenarios.

[a] Analysis assumes hydroelectric plant operates at contract conditions for 11 months per year, with a plant efficiency of 70% and flow control losses of 30%.
[b] Stakeholders present at the workshop on December 7, 2010 included representatives from: the City of Morro Bay, California Men's Colony, City of Pismo Beach, City of Grover Beach, Nipomo Community Services District, San Miguelito Mutual Water Company and Avila Valley Mutual Water Company. Notes from the workshop are included in Appendix C.

Table 1-5. Stakeholder approved delivery scenarios for the Coastal Branch capacity assessment

Delivery Scenario	Scenario Parameters	Shandon (afy)	Chorro Valley Turnout (CVTO) (afy)	Lopez Turnout (LPTO) (afy)[a]	Santa Barbara Turnouts (SBTO) (afy)[b]
Baseline	Existing Contract Flows	100	2,338	2,392	42,986
1	Maximum equal % increase	100 + X%	2,338 + X%[c]	2,392 + X%	42,986 + X%
2	Max % increase at CVTO, Maintain equal % increase	100 + X%	2,338 + Y%[d]	2,392 + X%	42,986 + X%
3	Max % increase at LPTO, Maintain equal % increase	100 + X%	2,338 + X%	2,392 + Y%	42,986 + X%
4	Max % increase at SBTO, Maintain equal % increase	100 + X%	2,338 + X%	2,392 + X%	42,986 + Y%
5	Max % increase at LPTO w/CVTO Increase	100	2,338 + Z%[e]	2,392 + Y%	42,986
6	Max % increase at SBTO w/CVTO Increase	100	2,338 + Z%	2,392	42,986 + Y%
7	Max % increase at LPTO and SBTO w/ CVTO increase	100	2,338 + Z%	2,392 + Y%	42,986 + Y%
8	Max % increase at Shandon, Maintain equal % increase	100 + Z%	2,338 + X%	2,392 + X%	42,986 + X%

1.5 MODEL CALIBRATION

The hydraulic model for the Coastal Branch was initially calibrated using historic operations data (2010) from CCWA's SCADA system, recorded at 5 minute intervals. Data from 2010 was ideally suited for model calibration as it reflected the recent condition of the pipeline, encompassed a wide range of flows (9 to 63 cfs through the EDV) and all flow and pressure instrumentation was calibrated throughout the year. The preliminary model was used to predict flows and pressures in the pipeline for the purposes of a full-scale flow test. CCWA conducted the full-scale flow test, and WSC refined the calibration based on gathered data. WSC applied the same procedure to calibrate the Chorro Valley pipeline, and utilized the calibrated model for the Lopez pipeline that WSC developed previously.

[a] 2,392 afy represents the current annual allocation for the subcontractors served by the Lopez pipeline. The notes from the Scenario Development Workshop included the Shandon allocation in the LTPO allocation.
[b] 42,986 afy represents the current capacity annual allocation capacity for Santa Barbara county. The notes from the Scenario Development Workshop incorrectly indicate a value of 43,560.
[c] X% means equal increase from Scenario 1
[d] Y% means maximum increase
[e] Z% means highest remaining increase

1.6 PIPELINE MODELING

WSC developed geographic information system (GIS) based hydraulic models based on as-built records using ArcGIS® software from ESRI and WaterGEMS® software from Bentley Systems, Inc. Record data was supplemented with site visits to several of the key features along the pipelines. Friction losses were calculated using the Darcy-Weisbach formula in lieu of the Hazen Williams formula, which is an empirical simplification of the governing equations represented by the Darcy Weisbach formula.

1.7 OPERATIONAL CONDITIONS AND CRITERIA

WSC interviewed staff from the District and CCWA, and referred to water supply contracts, operations data and manuals for each pipeline to develop an understanding of operational conditions and criteria that may affect the pipeline capacity assessment. WSC summarized and documented operating conditions and criteria including:

- SWP Water Supply Agreements, Contract Water Types
- Conveyance Capacity, Drought Buffer and Dry Year Programs
- District SWP Allocation and Drought Buffer
- Santa Barbara County Allocation and Drought Buffer
- Daily Flow Variation
- Seasonal Flow Variation
- Annual Flow Variation
- Pipeline Maintenance
- Coastal Branch Pumping Plant Operations
- PPWTP Operations
- Energy Considerations
- Pipeline Hydraulic Criteria

2 PURPOSE AND INTRODUCTION

The District, in coordination with the CCWA, hired WSC to develop a capacity assessment of the Coastal Branch, Chorro Valley and Lopez pipelines. A copy of the Request for Proposal is included as Appendix B.

The purpose of this capacity assessment is to summarize the source data, methodologies, results and conclusions of a hydraulic study to determine the capacity of Phase II of the Coastal Branch of the SWP pipeline, including the Chorro Valley and Lopez pipelines. It is anticipated that this capacity assessment will be used by the stakeholders of the Coastal Branch, Chorro Valley and Lopez pipelines to revisit capacity and allocation along the pipelines.

To meet the project requirements, WSC developed GIS based hydraulic models for the Coastal Branch, Chorro Valley and Lopez pipelines, and evaluated eight water delivery scenarios for existing turnouts. The CCWA assisted WSC in development of the Coastal Branch pipeline model by producing GIS shapefiles for the Coastal Branch pipeline. The capacity assessment considered the documented operating limits of the pipelines and the pumping plants along the Coastal Branch, as well as the Chorro Valley and Lopez pipelines. This analysis does not include a complete evaluation of the capacity of the PPWTP. WSC worked collaboratively with the District and the CCWA (Project Team) throughout the project to gather and analyze relevant data, develop and refine methodologies and analyze and interpret results. Table 2-1 summarizes the meetings and workshops conducted by the Project Team, and notes for the meetings are contained in Appendix C.

The purpose of developing a robust hydraulic model of the Coastal Branch pipeline is to provide a tool for modeling a wide variety of potential operating scenarios in the future. This capacity assessment proceeded with a “Book-End” analysis approach, which systematically explored eight specific operating scenarios as a way to provide insight as to how flow rate could be maximized at selected locations. As the capacity assessment clearly demonstrates, hydraulic capacity of the pipeline is influenced by how the pipeline is operated.

This capacity assessment models eight specific operating scenarios. The modeling work presented should not be considered exhaustive and the modeling of additional operating scenarios may be explored in the future. In addition, this capacity assessment does not consider the loss of operational flexibility that will occur as the pipeline becomes more fully utilized, nor does the capacity assessment address the potential limitations that may arise from pressure transient issues.

Table 2-1. Summary of project related meetings

Description	Date(s)	Attendees	Purpose
Kickoff	9/21/10	District, CCWA, WSC, City of Morro Bay, California Men's Colony	➢ Review project goals ➢ Establish roles and responsibilities ➢ Discuss lines of communication and coordination needs ➢ Review available data and data needs ➢ Review project methodologies & strategies
Chorro Valley pipeline site visits	10/08/10	District, WSC	➢ Visit key facilities along the Chorro Valley pipeline to visually inspect existing facilities and compare to as-built records, interview operating staff, and obtain gage elevations
Coastal Branch site visit	10/12/10	CCWA, WSC	➢ Visit key facilities along the Coastal Branch to visually inspect existing facilities and compare to as-built records, interview operating staff, and obtain gage elevations
Progress meetings	Monthly	District, CCWA, WSC	➢ Summarize project progress to-date ➢ Discuss planned upcoming activities ➢ Review outstanding information needs ➢ Provide schedule updates ➢ Discuss coordination needs ➢ Discuss specific technical issues
Workshop #1 – Data Review and Model Development	11/22/10	District, CCWA, WSC	➢ Review data request ➢ Summarize data received to-date ➢ Identify data gaps and resolve questions/concerns with available data ➢ Review model development and project methodology ➢ Plan for obtaining required data
Workshop #2 – Scenario Development[a]	12/07/10	District, CCWA, WSC, City of Morro Bay, California Men's Colony, City of Pismo Beach, City of Grover Beach, Nipomo Community Services District, San Miguelito Mutual Water Company, Avila Valley Mutual Water Company, Oceano Community Services District	➢ Review model development and project methodology ➢ Develop modeling scenarios for the capacity assessment
Review Meeting #1 – Admin Draft Report	3/31/11	District, CCWA, WSC	➢ Review the Admin Draft Report and receive comments from the CCWA and the District
Review Meeting #2 – Draft Report[b]	4/21/2011	District, CCWA, WSC, City of Grover Beach, City of Santa Maria, City of Pismo Beach, San Miguelito Mutual Water Company, California Men's Colony	➢ Review the Draft Report and receive comments from the CCWA, District and SWP Subcontractors

[a] All District subcontractors and the City of Arroyo Grande were invited to Workshop #2 – Scenario Development
[b] All District and CCWA subcontractors were invited to Review Meeting #2 – Draft Report

3 BACKGROUND

3.1 OVERVIEW OF THE SWP COASTAL BRANCH

The Coastal Branch of the SWP conveys water from the California Aqueduct to San Luis Obispo and Santa Barbara Counties (Figure 3-1). The California Aqueduct is operated by the California Department of Water Resources (DWR). The Coastal Branch provides water to two State Water Project Contractors: the Santa Barbara County Flood Control and Water Conservation District (via the Central Coast Water Authority, a Joint Powers Authority) and the San Luis Obispo County Flood Control and Water Conservation District (District).

3.1.1 Description of Coastal Branch Facilities

Phase I of the Coastal Branch, which was placed into operation in 1968, connects to the California Aqueduct near Interstate 5 and conveys water though a 15-mile long canal through King and Kern Counties to the Devil's Den pumping plant forebay (1). Included in Phase I were two pumping plants: Las Perillas; and Badger Hill. Phase II of the Coastal Branch pipeline, which was placed into operation in August of 1997, begins at Devil's Den pumping plant and extends 101 miles to Tank No. 5 in northern Santa Barbara county. A schematic profile of Phase II of the Coastal Branch pipeline is shown in Figure 3-2, and the original design hydraulic profile is included as Appendix D.[a]

Phase II is divided into seven different reaches with varying diameters, and was constructed between 1995 and 1997 (Table 3-1). The Coastal Branch pipeline includes six turnouts to District pipelines and SWP subcontractors along its length, as summarized in Table 3-2.

Table 3-1. Phase II Coastal Branch pipeline sections summary (2)

Pipeline Section	Owner	Type	Pipe Diameter (in)	Length (miles)	Design Capacity (cfs)[b]
Reach 1	DWR	Steel	48	16.2	71
Reach 2	DWR	Steel	48	16.55	71
Reach 3	DWR	Steel	48	13.14	71
Reach 4	DWR	Steel	51	6.99	71
Reach 5A1	DWR	Steel	42	8.99	68
Reach 5A2	DWR	Steel	42/39	9.02	68
Reach 5B	CCWA	Steel	42	11.25	64
Reach 6	CCWA	Steel	42	16.82	33

[a] Before the pipeline was constructed, the CCWA purchased an additional 10% allocation of supply and capacity. To convey this increased capacity, the pipe diameter along the Santa Maria Valley was increased to 42-inches. These changes are not reflected in the original design hydraulic profile, presented in Appendix D.
[b] Pipeline design capacity after CCWA's purchase of an additional 10% of supply and capacity, which occurred prior to final design and construction of the pipeline. Design capacity was obtained from the Coastal Branch Treated Water Aqueduct Operations manual, which differs slightly from the Santa Barbara County State Water Supply Contract, Table B1 and B-2 (Amendment 18) (2) (4).

Table 3-2. Coastal Branch Pipeline Turnouts (2)

Turnout Name	Turnout Design Allocation (afy)[a]
Shandon	100
Chorro Valley	2,338
Lopez	2,392
Guadalupe	550
Santa Maria	20,108
So. Cal. Water	500
Tank 5	21,828

[a] Pipeline design capacity after CCWA's purchase of an additional 10% of supply and capacity, which occurred prior to final design and construction of the pipeline.

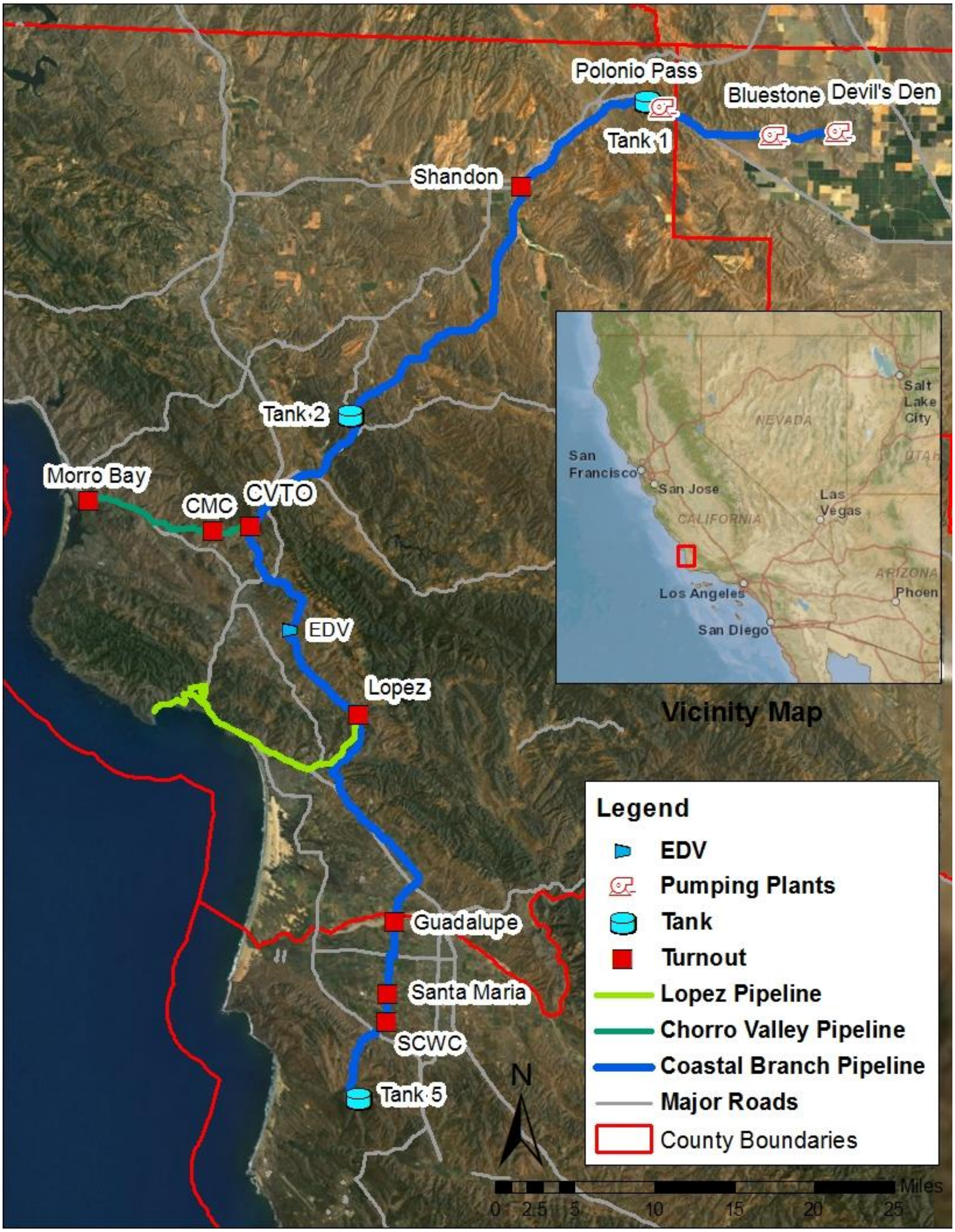

Figure 3-1. Coastal Branch pipeline schematic map (3)

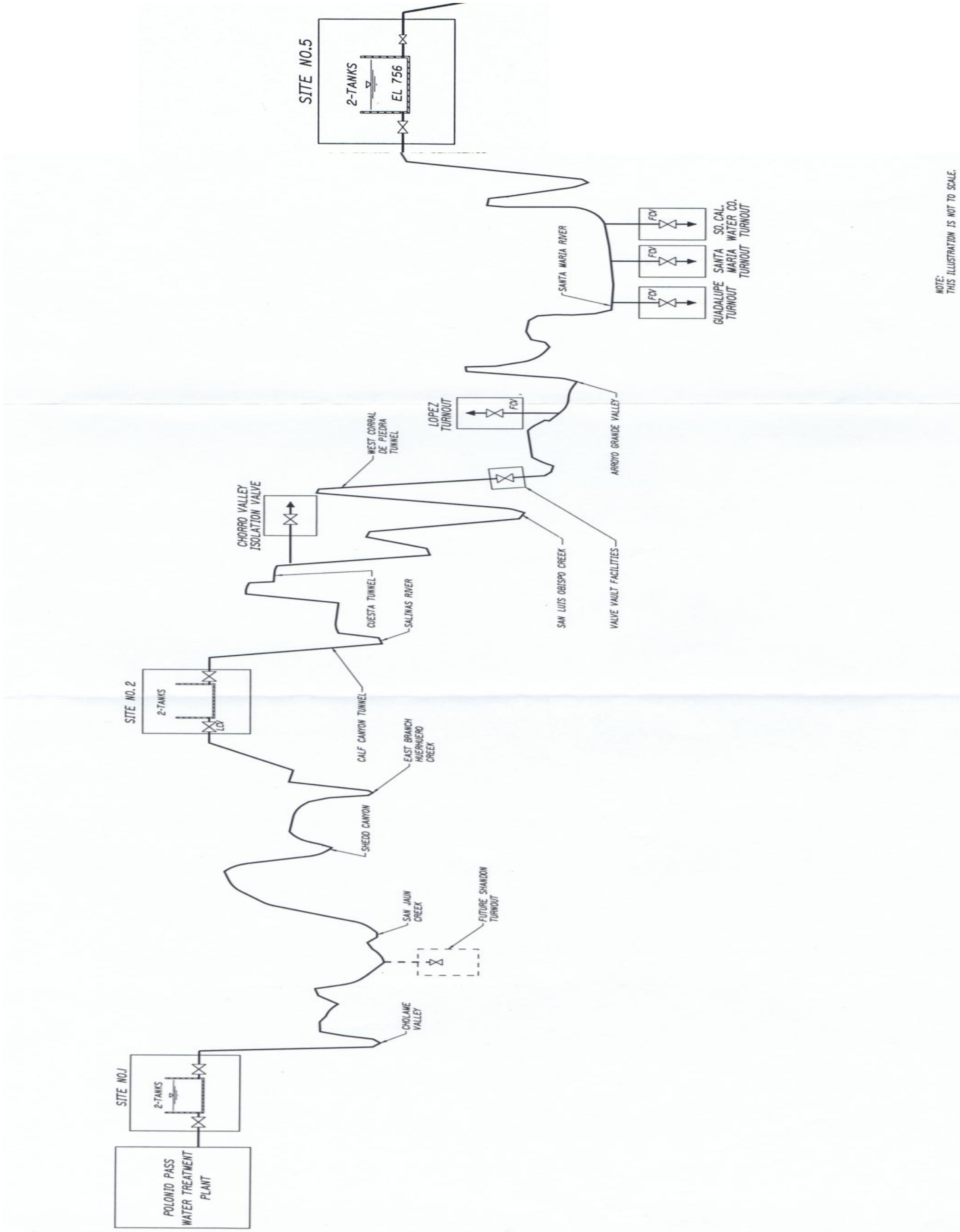

Figure 3-2. Coastal Branch pipeline schematic profile (2)

Raw water from Phase I of the Coastal Branch aqueduct is pumped to the PPWTP through three pumping plants: Devil's Den; Bluestone; and Polonio Pass. A summary of the pumping plant elevations and capacities is listed in Table 3-3.

Table 3-3. Phase II Coastal Branch pumping and water treatment plants

Facility	Owner	Inlet Elevation (ft)	Design Capacity (cfs)
Pumping Plant			
Devil's Den[a]	DWR	505	134
Bluestone[a]	DWR	1,020	134
Polonio Pass[a]	DWR	1,500	134
Water Treatment Plant			
Polonio Pass[b]	CCWA	2,022	66.5

The raw water pumping plants discharge to three raw water storage tanks at the PPWTP. The PPWTP treats the SWP raw water with a conventional sedimentation, filtration, and disinfection process. Treated water produced at the PPWTP is stored in two treated water storage tanks (Tank 1) that serve as a clearwell.

From the PPWTP, water flows via gravity to the Tank 2 site (Tank 2). Flow from Tank 1 to Tank 2 is controlled with a 24-inch sleeve valve located immediately upstream of Tank 2. From Tank 2, water flows to the junction of the Chorro Valley and Coastal Branch pipelines at the Chorro Valley turnout (CVTO). Flow through the CVTO is controlled with a 24-inch sleeve valve (Site 3) located on the Chorro Valley pipeline, approximately 2.3 miles from the CVTO.

Downstream of the CVTO, water passes through the Energy Dissipating Valve (EDV) control structure. At the EDV, two 24-inch sleeve valves are utilized to control flow and pressure through the section of the Coastal Branch pipeline from Tank 2 to Tank 5. The Lopez turnout (LPTO) is located downstream of the EDV. Flow to the Lopez pipeline is controlled through an 8-inch sleeve valve located at the LPTO.

Guadalupe (GPTO), Santa Maria (SMTO), and Southern California Water Company (SCWC) have individual turnouts located along the Coastal Branch pipeline, south of the LPTO in Santa Barbara county.

After the SCWC, the Coastal Branch pipeline traverses south before terminating at the Tank 5 site (Tank 5). Upstream of Tank 5 is an overflow standpipe, which is utilized to relieve excessive high pressure in the section of the Coastal Branch pipeline downstream of the EDV. The EDV also has a high pressure shut-off set point, which causes the EDV to close when excessive high pressure is sensed. Additional CCWA SWP subcontractors receive water through turnouts located downstream of Tank 5.

A summary of the storage facilities located along Phase II of the Coastal Branch pipeline is shown in Table 3-4.

[a] Obtained from the Coastal Branch Capacity Assessment RFP
[b] Obtained from the Operations Manual for the Central Coast Water Authority, Coastal Branch Treated Water Aqueduct (2)

Table 3-4. Coastal Branch pipeline storage facilities (2)

Tank Site	# of Tanks	Tank Diameters (ft)	Max W.S. Elevation (ft)	Minimum W.S. Elevation (ft)	Operating Depth (ft)	Operating Storage Capacity (MG)	Total Storage Capacity (MG)
Tank 1 (Raw Water)	3	230	2022	1998	24	22.4	24.2
Tank 1 (Treated Water)	2	205	1975	1964	11	5.4	9.9
Tank 2	2	140	1607	1595	12	2.8	6.4
Tank 5	2	140	773	756	17	3.9	6.4

3.1.2 Coastal Branch Operations

The CCWA operates the PPWTP and the treated water portion of the Coastal Branch pipeline. The CCWA controls flow through the pipeline by adjusting the flow control valves located upstream of Tank 2 and at the EDV. The flow control valves automatically modulate to maintain a pre-selected water level within the Tank 2 and Tank 5 storage facilities. Flow control valves at each turnout regulate flows at a constant rate to the individual subcontractors. Flow rate adjustments at each turnout are typically made once in a 24 hour basis, following the established delivery request protocols.

The CCWA adjusts the level of water within each of the storage tanks to control the available storage and the pipeline hydraulic residence time. According to the CCWA, during high demand periods the water level in the Coastal Branch pipeline tanks are maintained near the maximum operating range so that emergency storage is available in the event of a process upset. During periods of low demand, the CCWA operates these tanks near the minimum operating levels to decrease hydraulic residence times and to limit the potential for nitrification in the pipeline.

3.2 CHORRO VALLEY PIPELINE

3.2.1 Description of the Chorro Valley Pipeline

The Chorro Valley pipeline provides water to the California Men's Colony (CMC), the County Operations Center, and Cuesta College through the CMC turnout and to the City of Morro Bay through the Morro Bay turnout. The Chorro Valley Pipeline is owned by the District. Figure 3-3 shows the Chorro Valley pipeline and its major appurtenances.

Although the Chorro Valley pipeline includes a high pressure relief valve near the Chorro Valley Turnout, there is no automated pressure sustaining feature to ensure that the pipeline remains fully pressurized.

3.2.2 Chorro Valley Pipeline Operations

The Chorro Valley pipeline is operated by the District and the CCWA. The CCWA controls the flow rate through the CVTO and the upper section of the Chorro Valley pipeline with a flow control/pressure reducing sleeve valve located at Site 3. The CCWA has a high pressure setpoint of 75 psi immediately downstream of the Site 3 sleeve valve, see Figure 3-3. This set point is designed to protect thinner walled piping downstream of Site 3 from excessive pressures. The District controls flow rates downstream of Site 3 with a butterfly valve located at Site 5a. By restricting the flow through Site 5a, the District can control the flow rate to the Morro Bay and CMC tanks.

3.3 LOPEZ PIPELINE

3.3.1 Description of the Lopez Pipeline

Water from the LPTO enters the Lopez pipeline near the intersection of Orcutt Rd. and Lopez Dr., and is conveyed to the Lopez Water Treatment Plant where it discharges into the clearwell. Water from the Lopez reservoir is treated at the Lopez Water Treatment Plant and combined with SWP water for delivery through the Lopez pipeline. The Lopez pipeline consists of approximately 13 miles of pipeline and terminates in Port San Luis Obispo. Using the Lopez pipeline, the District delivers SWP to the following District SWP subcontractors: City of Pismo Beach; Oceano Community Services District (OCSD); San Miguelito Mutual Water Company; Avila Beach Community Services District; Avila Valley Mutual Water Company; and the San Luis Coastal Unified School District. A schematic diagram of the Lopez pipeline is shown in Figure 3-4.

3.3.2 Lopez Pipeline Operations

The District operates the Lopez pipeline and the Lopez Water Treatment Plant. Water from the SWP and the Lopez reservoir is delivered through the Lopez pipeline via gravity. Flow rates to the individual subcontractor turnouts are controlled with flow control valves and pump stations located along the Lopez pipeline. These valves are manually operated by District Employees at the request of the subcontractors.

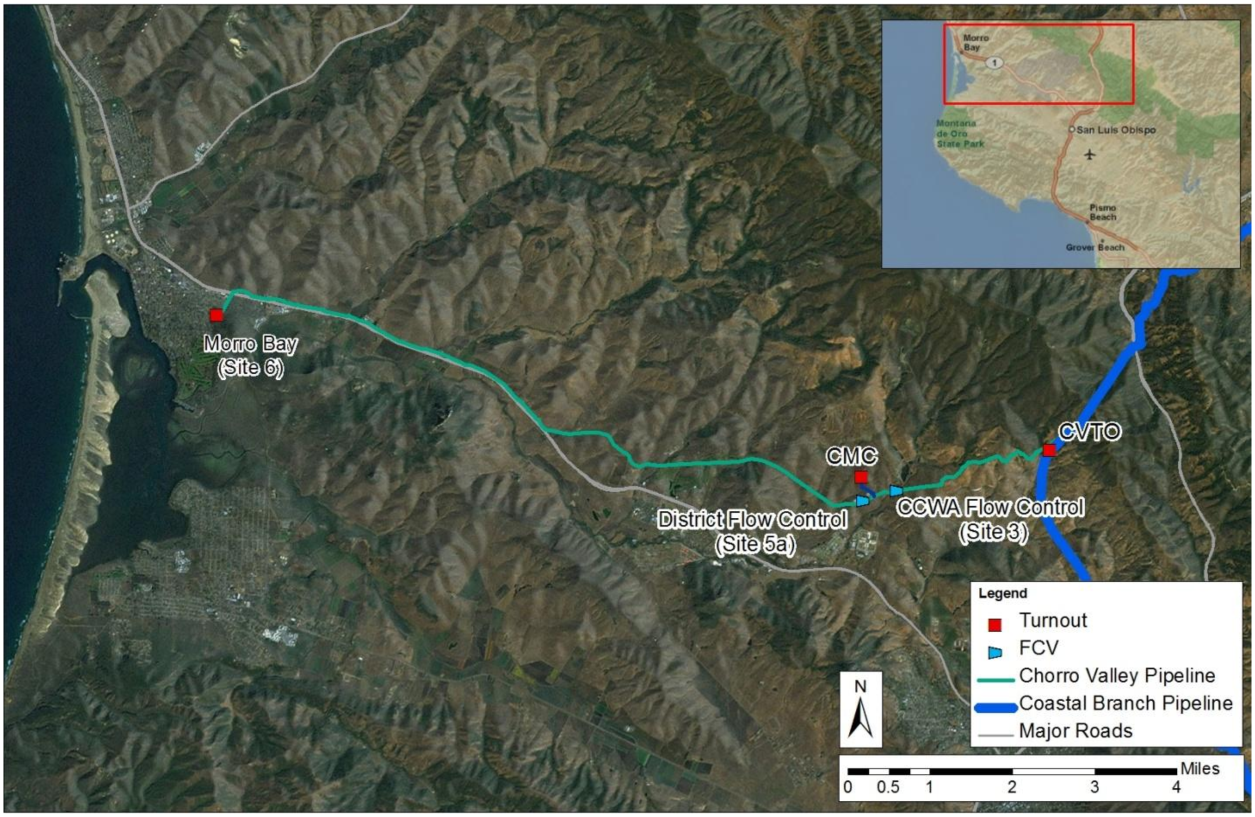

Figure 3-3. Chorro Valley pipeline

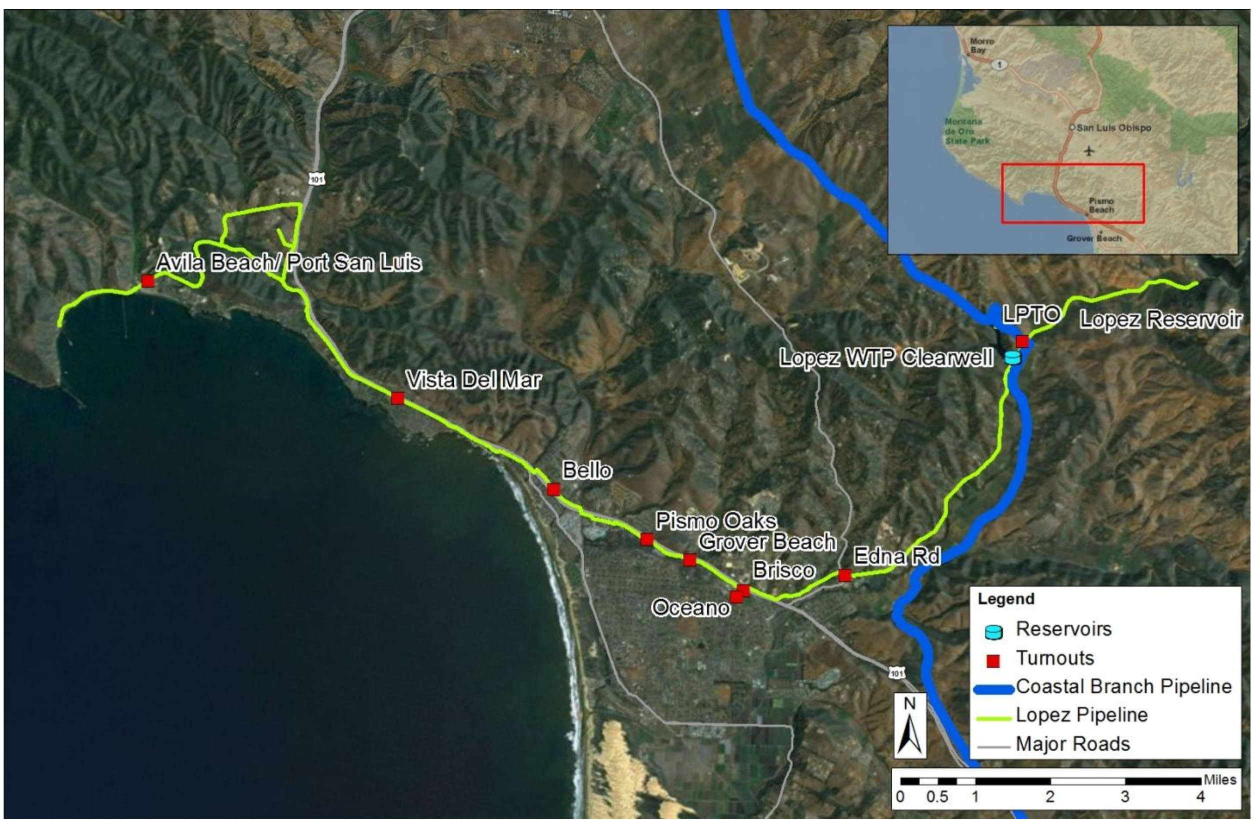

Figure 3-4. Lopez pipeline

4 OPERATIONAL CRITERIA EVALUATION

To guide the capacity evaluation and hydraulic modeling process, the Project Team evaluated numerous data sources to develop a set of operational criteria for the Coastal Branch, Chorro Valley and Lopez pipelines. The following section summarizes the key operational criteria considered in this analysis, including:

- SWP Water Supply Agreements, Contract Water Types
- Conveyance Capacity, Drought Buffer and Dry Year Programs
- District SWP Allocation and Drought Buffer
- Santa Barbara County Allocation and Drought Buffer
- Daily Flow Variation
- Seasonal Flow Variation
- Annual Flow Variation
- Pipeline Maintenance
- Coastal Branch Pumping Plant Operations
- PPWTP Operations
- Energy Considerations
- Pipeline Hydraulic Criteria

4.1 SWP WATER SUPPLY AGREEMENTS, CONTRACT WATER TYPES

4.1.1 SWP Water Supply Agreement

The contracts between the DWR and the 29 SWP water contractors define the terms and conditions governing the water delivery and cost repayment for the SWP. SWP Table A is an exhibit to these contracts. All water-supply related costs of the SWP are paid 100% by the contractors, and SWP Table A serves as a basis for allocating some of the costs among the contractors. In addition, SWP Table A plays a key role in the annual allocation of available supply among contractors. When the SWP was being planned, the amount of water projected to be available for delivery to the contractors was 4,173 thousand acre-feet per year. This was referred to as the maximum project yield. It was recognized that in some years the project would be unable to deliver that amount, and in other years project supply could exceed that amount. The SWP Table A amount was used as the basis for apportioning available supply to each contractor and as a factor in calculating each contractor's share of the SWP's costs. Other contract provisions permit changes to an individual contractor's SWP Table A under special circumstances.

Every year, DWR conducts modeling studies of the SWP system to determine the annual allocation, or percentage of the amount of Table A that can be delivered by the SWP system. This allocation is revised throughout the year as hydrologic conditions and other factors change.

4.1.2 SWP Contract Water Types

The SWP contracts define several classifications of water available for delivery to contractors under specific circumstances. All classifications are considered "project" water. Many contractors make frequent use of these additional water types to increase or decrease the amount available to them under SWP Table A.

- **SWP Table A Water.** Each contract's SWP Table A is the amount in acre-feet that is used to determine the portion of available supply to be delivered to that contractor. SWP Table A water is given first priority for delivery.
- **Carryover Water.** Pursuant to the long-term water supply contracts, contractors have the opportunity to carry over a portion of their allocated water approved for delivery in the current year for delivery during the next year. The carryover program was designed to encourage the most effective and beneficial use of water and to avoid obligating the contractors to use or lose the water by December 31 of each year. The water supply contracts state the criteria for carrying over SWP Table A water from one year to the next. Normally, carryover water is water that has been exported during the year from the delta, has not been delivered to the contractor during that year, and has remained stored in the SWP share of San Luis Reservoir to be delivered during the following year. Storage for carryover water no longer becomes available to the contractors if it interferes with storage of SWP water for project needs. Once this occurs, the carryover water is converted to Article 21 water at a defined rate, linked to the production rate of the Banks Pumping Plant.
- **SWP Article 21 Water.** SWP Article 21 of the contracts permits delivery of water excess to delivery of SWP Table A and some other water types to those contractors requesting it. It is available under specific conditions. SWP Article 21 water is apportioned to those contractors requesting it in the same proportion as their SWP Table A. All Article 21 water must be used and cannot be stored within the SWP system.
- **Turnback Pool Water.** Contractors may choose to offer their allocated SWP Table A water excess to their needs to other contractors through two pools in February and March. Contributing contractors receive a reduction in charges, and taking contractors pay extra.

4.2 CONVEYANCE CAPACITY, DROUGHT BUFFER AND DRY YEAR PROGRAMS

4.2.1 SWP Conveyance Capacity

The original 1963 SWP contract for Santa Barbara County Flood Control and Water Conservation District, now represented by CCWA, had a Table A amount of 60,000 afy. This was reduced to 57,700 afy in January 1964 (Amendment #2). In 1981, the Table A amount was reduced again to 45,486 afy (Amendment #9). In 1994, the SWP contract was amended (Amendment #16) to identify the proportionate share of the capital costs of project transportation facilities for Phase II Coastal Branch in Table B-1 and the proportionate share of the minimum costs of the project transportation for Phase II Coastal Branch in Table B-2. These tables document the pipeline flow capacity of 42,986 afy to the Santa Barbara county subcontractors in the Phase II Coastal Branch (4). The Table A amount was not changed due to the Goleta Valley Water District retaining 2,500 acre-feet in Table A with no associated pipeline capacity for use as drought buffer (42,986 + 2,500 = 45,486). The 42,986 afy represents the flow capacity of both the Table A amount of the Santa Barbara county participants, and the 10% drought buffer acquired by CCWA during the design phase of the Phase II Coastal Branch.

In the case of the District, the SWP contract has a Table A amount of 25,000 afy (5). However, there were no amendments documenting flow capacity modification for Phase II Coastal Branch. CCWA and the District have entered into a Master Water Treatment Agreement, which outlines the available capacity for treatment and conveyance for the District at 4,830 afy (6).

4.2.2 Drought Buffer

Drought buffer is a term used to identify a source of supply within the SWP system that acts to provide a higher level of reliability during times of drought. There are two forms of drought buffer that are utilized in the Coastal Branch and they are as follows:

- **Acquire or maintain a higher Table A amount than pipeline flow capacity (supply only).** By having a higher Table A amount than the pipeline capacity, the DWR allocation process will not impact pipeline delivery operations until the DWR allocation is reduced to a level where available Table A is equal to pipeline capacity. This is the technique currently in use by the District, as they have 25,000 afy in Table A amount and a pipeline conveyance capacity of only 4,830 afy. The Goleta Valley Water District, one of CCWA's member agencies, has 2,500 afy of this type of drought buffer.
- **Acquire or maintain higher Table A amount and pipeline capacity (supply & capacity).** This essentially is increasing both supply and conveyance as a method of providing reliable annual water deliveries. This is the technique primarily utilized by CCWA, as they have 42,986 afy in Table A amount and 42,986 afy in pipeline conveyance capacity.

4.2.3 Dry Year Programs

Dry Year Programs are methods of obtaining water from other sources, such as from other SWP contractors, during times of drought. The main advantage of the SWP system is that it provides the means for water transfers throughout the State of California. Water from other SWP contractors and other non-project water can be wheeled through the existing infrastructure, subject to a variety of conditions and approvals. Groundwater banks fall under this category as well as the San Luis Obispo County Dry Year Program.

In recent years, SWP contractors state-wide have not received their full Table A amounts due to dry conditions throughout the state, and court-ordered restrictions on pumping from the Delta. In 2008 and 2009, the District and CCWA had an agreement to transfer a portion of District's excess allocation to SWP contractors served by CCWA outside of the Turnback Pool (the San Luis Obispo County Dry Year Program). DWR allowed this agreement due to the statewide drought condition and the Governor's emergency declaration. This agreement allowed CCWA to maintain the reliability of its deliveries, however it expired in 2010.

4.3 DISTRICT SWP ALLOCATION AND DROUGHT BUFFER

The District has an agreement with DWR for 25,000 afy State Water Allocation (Table A amount). In 1993, the 4,830 afy of capacity secured for treatment and conveyance via the Master Water Treatment Agreement was subcontracted by the District to entities within San Luis Obispo County via ten water supply agreements. The District has also instituted a formal supply-only drought buffer program with its subcontractors (see Section 4.2.2). Certain subcontractors have subscribed for an additional 4,897 afy of the District's Table A water with no associated flow capacity in the Phase II Coastal Branch pipeline. The difference between the District's Table A amount and current subscribed allocation plus drought buffer represents 15,273 afy of unsubscribed SWP allocation, commonly referred to as the District's "excess allocation." The District's SWP allocations are summarized in Table 4-1 (7).

Table 4-1. District SWP allocation summary (2) (7)

	SWP Allocations (afy)		
SWP Sub-Contractor	**Water Service Amount**	**Drought Buffer (Supply)**	**Total Reserved**
Chorro Valley Turnout			
Morro Bay, City of	1,313	2,290	3,603
California Men's Colony	400	400	800
County Operations Center	425	425	850
Cuesta College	200	200	400
Subtotal 1	**2,338**	**3,315**	**5,653**
Lopez Turnout			
Pismo Beach, City of	1,240	1,240	2,480
Oceano CSD	750	-	750
San Miguelito MWC	275	275	550
Avila Beach CSD	100	-	100
Avila Valley MWC	20	60	80
San Luis Coastal USD	7	7	14
Subtotal 2	**2,392**	**1,582**	**3,974**
Shandon	100	-	100
Subtotal 3	**100**	**-**	**100**
Total	**4,830**	**4,897**	**9,727**
SLO county Table A Allocation			*25,000*
"Excess Allocation"			**15,273**

4.4 SANTA BARBARA COUNTY ALLOCATION AND DROUGHT BUFFER

The Santa Barbara County Flood Control and Water Conservation District (Santa Barbara county) has an agreement with DWR for 45,486 afy State Water Allocation (Table A amount). Currently, 39,078 afy of the total allocation is subscribed among fourteen CCWA subcontractors, plus 3,908 afy of drought buffer (supply & capacity) to partially firm up the reliability of those entitlements. Santa Barbara county's SWP allocations are summarized in Table 4-2 (2) (7).

Table 4-2. Santa Barbara county SWP allocation summary (2) (7)

	SWP Allocations (afy)			
SWP Sub-Contractor	**Water Service Amount**	**Drought Buffer (Supply + Capacity)**	**Drought Buffer (Supply)**	**Total Reserved**
City of Guadalupe	550	55		605
City of Santa Maria	16,200	1,620		17,820
Southern California Water Co.	500	50		550
Vandenberg AFB	5,500	550		6,050
City of Buelton	578	58		636
Santa Ynez ID No. 1	2,000	200		2,200
Carpinteria CWD	2,000	200		2,200
Goleta Valley WD	4,500	450	2500	7,450
La Cumbre MWC	1,000	100		1,100
Montecito WD	3,000	300		3,300
Morehart Land Co.	200	20		220
Santa Barbara Research Center	50	5		55
City of Santa Barbara	3,000	300		3,300
Total	**39,078**	**3,908**	**2,500**	**45,486**
SB county Table A Allocation				*45,486*

4.5 DAILY FLOW VARIATION

The Coastal Branch and Chorro Valley pipelines typically operate with little to no daily variation, providing constant deliveries to each of the subcontractor turnouts. To receive a change in Coastal Branch pipeline turnout flow rate, the subcontractors must submit a request, 24 hours in advance, to the CCWA using established flow request procedures. Subcontractors along the Chorro Valley and Lopez pipelines submit requests for flow rate changes to the District, who coordinates with the CCWA to implement the flow rate change.

4.6 SEASONAL FLOW VARIATION

Deliveries along the Coastal Branch pipeline are seasonal in nature. Coastal Branch deliveries to the San Luis Obispo and Santa Barbara county subcontractors for 2010 are shown in Figure 4-1. Deliveries peaked in August, indicating that subcontractors are utilizing supplies from the Coastal Branch to meet peak seasonal customer demands. Other than November, in which deliveries were most likely limited due to the annual pipeline outage for maintenance, February had the lowest deliveries in 2010.

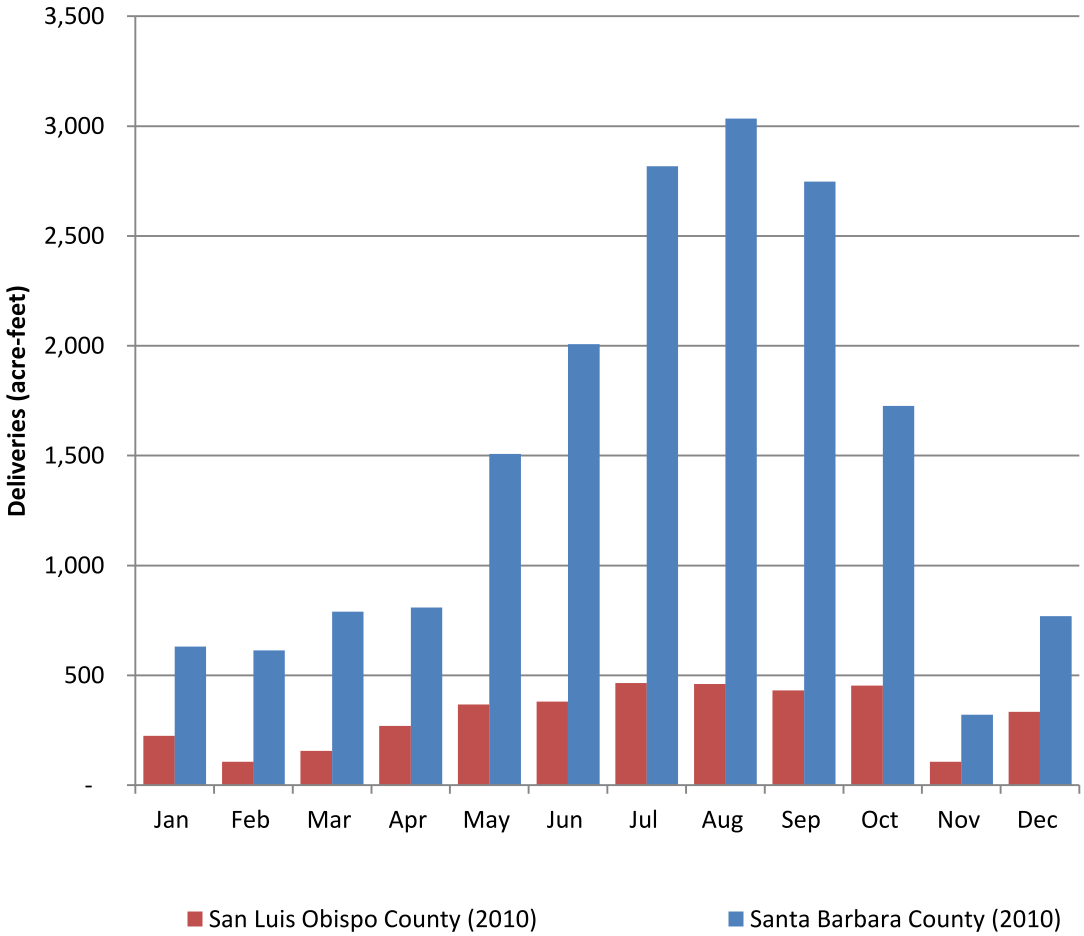

Figure 4-1. Coastal Branch pipeline 2010 deliveries

4.7 ANNUAL FLOW VARIATION

Annual deliveries over the last eleven years are shown in Figure 4-2. Average annual deliveries over that timeframe were 4,038 and 22,903 afy for San Luis Obispo and Santa Barbara counties, respectively. By comparison, San Luis Obispo county and Santa Barbara county have total Table A allocations of 25,000 and 45,486 afy respectively. In 2001, 2004, 2007 and 2008, Santa Barbara counties took more deliveries than their available Table A allocation, presumably through the management of Carry-Over water and participation in Dry Year programs.

DWR conducts a reliability study for the State Water Project (SWP) operation every two years to provide contractors with information about the SWP's ability to delivery water under current conditions as well as conditions 20 years into the future. The studies utilize an 82 year historical record of flows in the Delta and a sophisticated flow model known as CALSIM II. In the 2009 study, three areas of significant uncertainty for SWP water deliveries were identified. These areas of uncertainties are as follows:

- **Climate Change.** In 2009, DWR conducted a separate study on the potential impacts of climate change on water resource decisions in California. Twelve different future climate projections were used to assess the impacts at mid-century and end of century. The DWR reliability study selected one of the climate projections that would represent the median effects on the State Water Project operation, in terms of rainfall and run-off timing. Also, although there is a wide range of uncertainty for sea level rise, DWR assumed that sea level would rise by 1 foot mid-century and 2 feet at end of century for simplicity sake.
- **Delta Levee Failure.** The Delta is over 738,000 acres in size and interlaced with hundreds of miles of waterways. Much of the land within the Delta is below sea level and relies upon over 1,100 miles of fragile levees for flood protection. Failure of the levee system could result in large tracts of land being flooded, causing the flow dynamics within the delta to be temporarily (or permanently) changed, which could create the potential for seawater intrusion into the delta, as well as other water quality issues.
- **Operational restrictions arising from the USFWS and NMFS Biological Opinions.** These Biological Opinions can reduce the timing and overall water exports from the Delta. In the DWR reliability study, they assumed that the same restriction for fish protection would remain constant for the 20 year period.

Other important assumptions made in the DWR reliability report include (1) no infrastructure changes would occur and (2) weather patterns, i.e. droughts, would continue to be the same. The overall conclusions of the report indicated that the parameters that had the most impact on SWP reliability are Table A demands for water by the 29 SWP contractors and pumping limits imposed on the Banks Pumping Plant. The Biological Opinions would have the greatest impact on the Banks Pumping Plant Operation, while climate change will have the biggest impact on the Lake Oroville inflows. Most of the water exported from the Delta by the SWP relies upon water rights derived from Lake Oroville storage.

Figure 4-3 shows the 2009 SWP reliability projections for San Luis Obispo and Santa Barbara counties (2009) (8). It shows that DWR is anticipating availability of 100% allocation less than 5% of the time, and 60% or less allocation roughly 50% of the time.

Increasing the rated conveyance capacity of the Coastal Branch may affect annual variation in deliveries in three ways:

1. Actual annual deliveries could vary more from year to year as purveyors attempt to use the increased conveyance capacities to balance both current year water demand and the needs of future year reliability programs.

2. If the District allocates more of its Table A amount to subcontractors within the County, reliability may be impacted to individual subcontractors depending upon their pro-rata allocation increase, purchase of drought buffer and/or additional base allocation.
3. If the District increases utilization of its excess allocation, it may limit Santa Barbara's ability to benefit from future Dry Year Programs with the District.

Additional discussion on the reliability of SWP supply and demand variation for the SWP contractors can be found in the CCWA's Urban Water Management Plan (9).

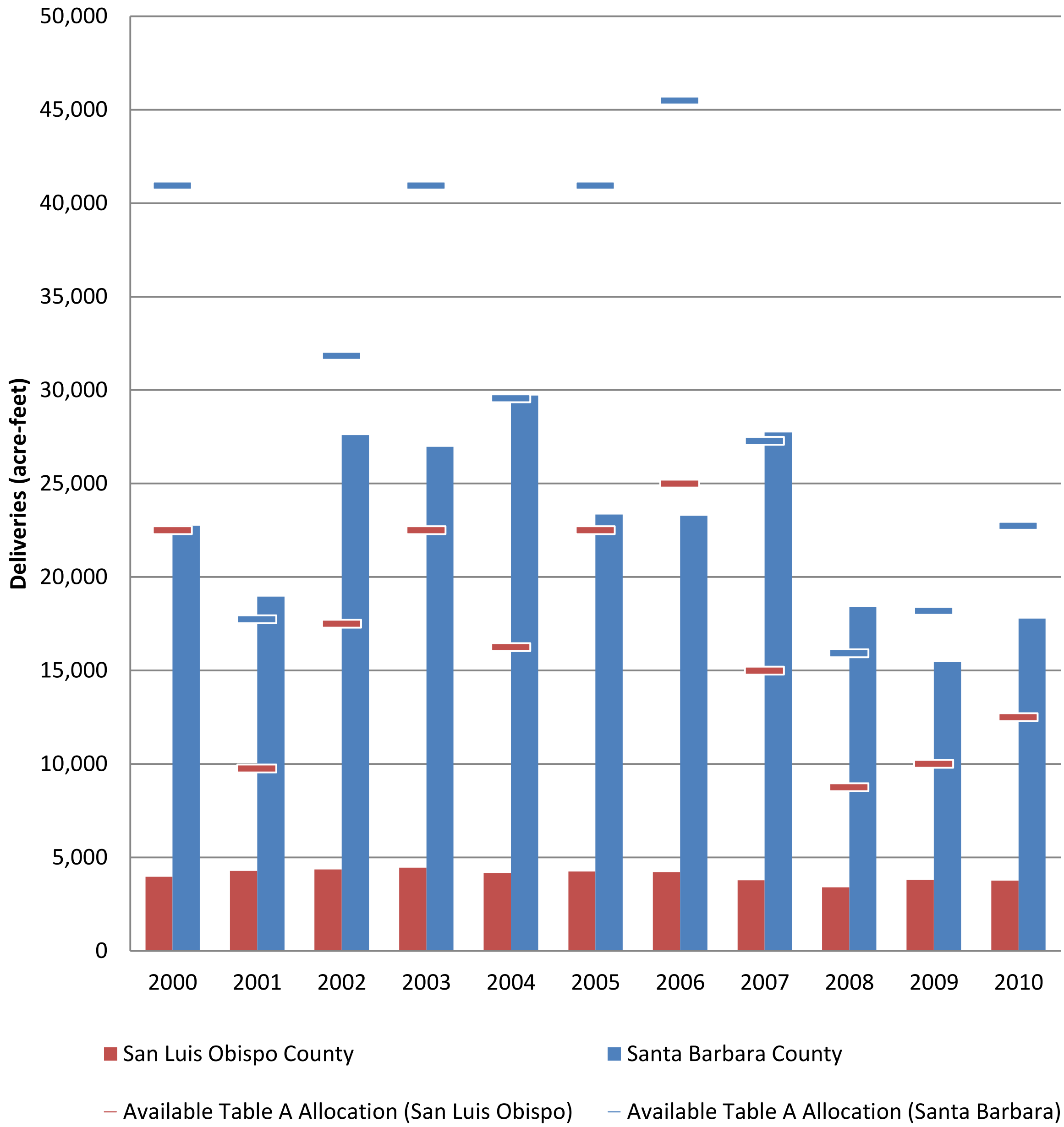

Figure 4-2. Annual Coastal Branch deliveries and available Table A allocations, 2000-2010

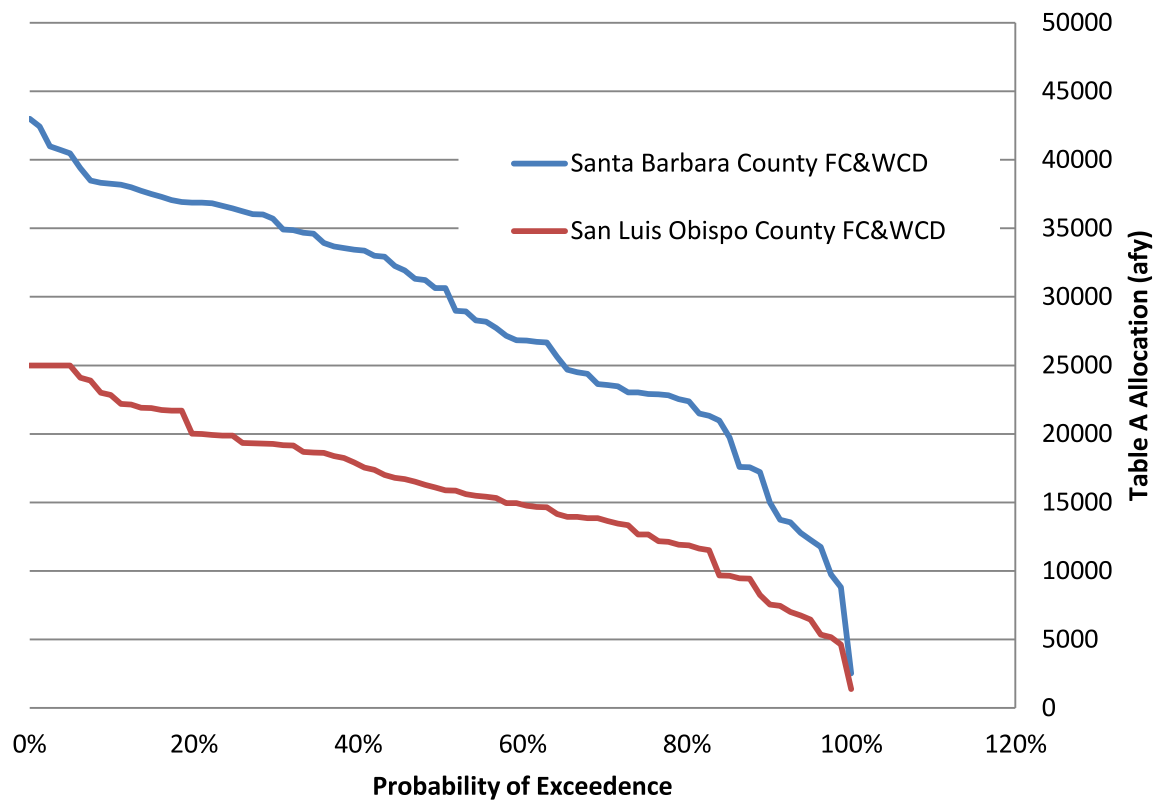

Figure 4-3. Table A Allocation reliability estimates from DWR based on 2009 conditions

4.8 PIPELINE MAINTENANCE

Phase II of the Coastal Branch pipeline is shut down for maintenance in late October or early November of each year, typically for two to three weeks. The longest shutdown, since the construction of Phase II, was four weeks from October 15, 2001 to November 15, 2001 for warrantee inspection of Reach 5B/6.

While no information has been compiled on system outages for inspection and repair of the Reach 1 facilities, it is probable that they are similar to that of the downstream reaches of the pipeline and are scheduled simultaneously. If so, they have no impact on conveyance capacity.

For the purposes of this capacity analysis, it is assumed that the Coastal Branch must deliver the contracted annual allocations in 11 months (with one month of downtime). Therefore, WSC calculated the monthly contract flow rates by dividing the annual allocations over an eleven month period.

4.9 COASTAL BRANCH PUMPING PLANT OPERATIONS

The three Reach 1 pumping plants, Devil's Den, Bluestone and Polonio Pass, are each equipped with six identical pumps with design points of 22.3 cfs at a total dynamic head of 555 feet (10). One unit at each pumping plant is a reserve unit. Table 4-3 summarizes Reach 1 pumping plant data, and Figure 4-4 shows flow data provided by the SWP, Division of Engineering from a past transient test (11).

Based on available data, the capacities of the Reach 1 pumping plants limit the capacity of Phase II to 111 cfs or less (Bluestone with 5 pumps in operation). Most likely, Devil's Den and Polonio Pass have lower capacities given the results of the pump test. Extrapolating Polonio Pass operation with 4 pumps to anticipated operation with 5 pumps would imply a maximum flow of 104 cfs (111*(87/93)).

Table 4-3. SWP Coastal Branch, Reach 1 pumping plant flow data (cfs) (11)

Pumping Plant	Pumps in operation				
	1	2	3	4	5
Devil's Den Pumping Plant		46		90	
Bluestone Pumping Plant	27	54		93	111
Polonio Pass Pumping Plant		44		87	

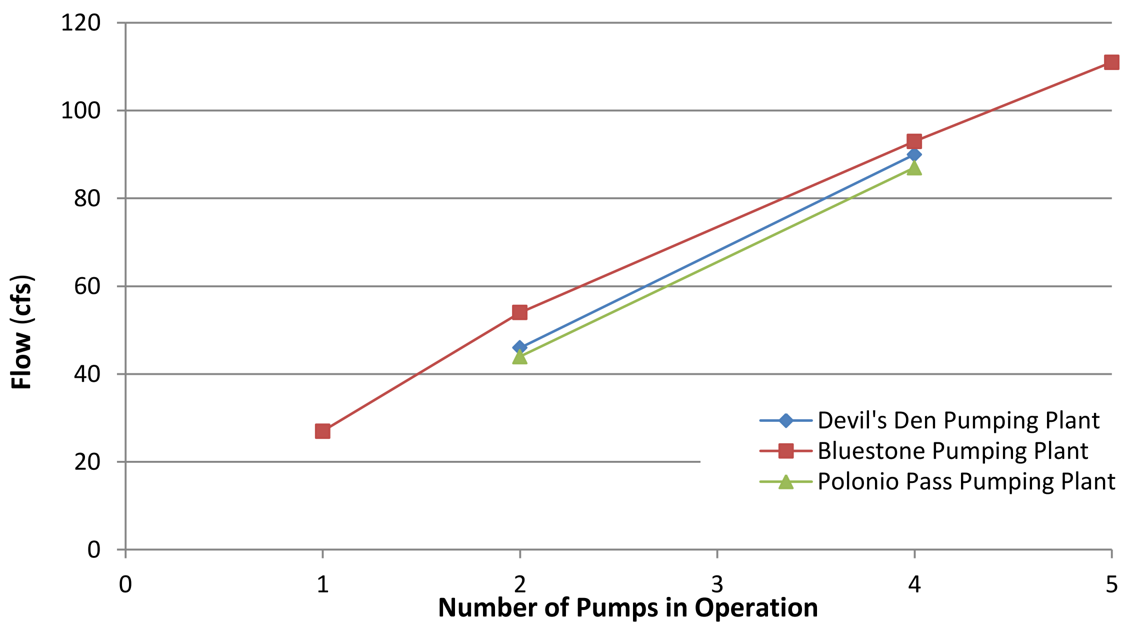

Figure 4-4. Reach 1 Pumping Plant Capacity (cfs) (11)

4.10 PPWTP OPERATIONS

As shown in Table 4-4, the capacity of the PPWTP limits the Coastal Branch Phase II to a flow of 76 cfs with a minimum allowance for filter downtime. Additional downtime or limitations of other plant processes occur under some conditions.[a] Those conditions are most likely to occur in the spring or immediately before or after winter shut downs to the conveyance facilities. No information has been compiled on the occurrence or frequency of complete shut downs of the PPWTP.

The design for the PPWTP included space and capacity for two additional filter bays. These filter bays could be installed and operated without significant modifications to the process piping.

Table 4-4. PPWTP simplified capacity summary (12)

Filter capacity	
Surface area of filters (sf)	715.5
Maximum flow rate (gpm/sf)[b]	6
Number of filters	8
Conversion factor from gpm to MGD	0.00144
Plant Capacity without down time (MGD)	49
Conversion factor from MGD to cfs	1.55
Plant Capacity without down time (cfs)	76.5
Adjustment for minimum down time of 1 hour in 80 hours[a]	98.75%
Plant Capacity with minimum down time (cfs)	75.6
Storage at Plant (Tank Site 1)	
Raw Water Storage (MG)	24
Raw Water Storage at Plant Capacity (hours)	12
Treated Water Storage (MG)	10
Finished Water Storage at Plant Capacity (hours)	5

4.11 ENERGY CONSIDERATIONS

DWR minimizes the cost of power by maximizing pumping during off-peak periods – usually at night – and selling power to other utilities and energy marketers during on-peak periods when power costs are higher.

The instantaneous flow capacity of Reach 1 of the Coastal Branch pipeline is larger than that of the downstream reaches. During the design of Reach 1, the DWR design team evaluated increasing the diameter of the pipeline to allow pumping off-peak as compared to assuming 24 hour pumping using a smaller diameter pipe. It was concluded that the cost of the larger diameter pipeline was more than off-set by the savings achieved through long term off-peak pumping.

[a] Under some raw water chemistry conditions, other plant processes become the limiting factor. High raw water Total Organic Carbon (TOC) during spring of each year has the potential of impacting production. High free ammonia and TOC in raw water immediately before and after winter shutdown has the potential of impacting production.
[b] Typical state-wide standard for rapid filtration is 6.0 gpm/ft2. The CCWA has a variance from the California Department of Public Health allowing operation at 6.5 gpm/sf if all filters are in operation.

The Coastal Branch Design HGL (Appendix D), shows an "Off-Peak Pumping Scheme" (13). The HGL shows design flows of 100 cfs and 71 cfs for Reach 1 and Reach 2 of the Coastal Branch pipeline, respectively. This ratio of 71 cfs to 100 cfs confirms the intent that the Reach 1 pumping plants would operate no more than 17 hours a day (24 * (71/100)). The Tank 1 Raw at the PPWTP provides the required equalization.

An increase in the deliveries made by the downstream reaches of the Coastal Branch pipeline would reduce the flexibility of operations of the Reach 1 pumping plants. Most likely, "Variable OMP&R component of Transportation Charges" per acre-foot of the SWP, which is dominated by energy cost, would increase for the Coastal Branch contractors, and possibly for all SWP contractors, if the rated capacity of the pipeline were increased.

4.12 PIPELINE HYDRAULIC CRITERIA

The Project Team established hydraulic criteria for the capacity assessment based on a review of relevant design reports, operations manuals, transient analysis reports, industry standards, and interviews with operations staff. Relevant hydraulic criteria include minimum and maximum pressure, maximum velocity and valve operating criteria.

4.12.1.1 Minimum Pressure Criteria

The Project Team established a minimum operating pressure for the Coastal Branch pipeline of 15 psi. The California Department of Public Health requires potable water system operators to maintain 5 psi of pressure within drinking water distribution systems (14) (15). To account for uncertainties in the model, the Project Team selected 15 psi as the minimum allowable pressure for determining the capacity of the Coastal Branch pipeline. Locations within close proximity to the free water surface storage facilities may not maintain the required 15 psi in all scenarios, due to the limited HGL in the tanks.

4.12.1.2 Maximum Pressure Criteria

The Coastal Branch pipeline is a falling head design, in which water from a high pressure source is delivered to a lower pressure zone through the use of an energy dissipating flow control valve. This design allows the piping downstream of the EDV to have a lower pressure class than the upstream piping. Due to this design, as flow rates increase, the pressures downstream of the EDV increase. Under current operations, the CCWA has a high pressure set-point alarm of 375 psi immediately downstream of the EDV. This set-point is designed to protect thinner walled piping downstream of the EDV from excessive pressures. The record data provided for the Coastal Branch does not include pressure class for every section of pipeline. Therefore, for this project and the flow test, the CCWA calculated that a maximum high pressure of 385 psi could be sustained downstream of the EDV during the brief period of the flow test.

Tank 5 operates as the pressure relief valve for the section of the Coastal Branch pipeline downstream of the EDV, and there are no valves between the EDV and the overflow standpipe immediately upstream of Tank 5. This section of pipeline provides and "un-valved path" that allows for atmospheric release into the Tank 5 containment area.

The Chorro Valley pipeline is configured similarly to the Coastal Branch pipeline, and the pressure downstream of the flow control/pressure reducing sleeve valve (Site 3) increases at higher flow rates. To protect the downstream piping from excessive pressures, a pressure relief valve was installed immediately downstream of the flow control valve. The set-point for the pressure relief valve is set at 75 psi. To ensure downstream pressures do not exceed the pipeline pressure class, WSC selected 75 psi as the maximum allowable pressure at the pressure relief valve downstream of Site 3.

4.12.1.3 Maximum Velocity Criteria

The Coastal Branch and Chorro Valley pipelines were constructed almost entirely with cement mortar lined steel pipe. To establish the velocity criteria for the Coastal Branch and Chorro Valley pipelines, WSC reviewed the American Water Works Association (AWWA) Standard C205-07 Cement-Mortar Protective Lining and Coating for Steel Water Pipe (16). The AWWA manual states that 20 ft/s is the maximum velocity that should be obtained within cement mortar lined steel pipe. Therefore, the Project Team established 20 ft/s as the maximum velocity for the Coastal Branch and Chorro Valley pipelines (Appendix C).

The pipeline velocities within the Coastal Branch pipeline are below 20 ft/s when the pipeline is flowing at its current design capacity, with the exception of the EDV. In the 24-inch sections of pipeline, within the EDV, the velocities can exceed 20 ft/s at flows above 62 cfs (current design capacity of the EDV is 68 cfs). However, the EDV piping is coated with a high solids epoxy, as opposed to cement mortar lined. The EDV flow control valves (810 Polyjet Bailey sleeve valves) have a maximum design flow capacity of 88 cfs (2). The EDV isolation valves (24-inch Flow Control Technologies Ball Valves) have a design flow capacity of 110 cfs (17).[a]

4.12.1.4 Valve Operating Criteria

In 1995, Flow Science completed an analysis of transient pressures based on valve opening and closing times from Tank 2 to Tank 5. The findings from this report indicated that the opening and closing of the EDV and Santa Maria turnout flow control valves must be performed over an extended duration to prevent developing transient pressures that exceed the pipeline pressure rating (18).

According to the Flow Science report, closing the EDV flow control valve over a 20 minute duration keeps transient pressures from exceeding the design HGL for the pipeline, based on current pipeline capacity. Additional analysis on the SMTO flow control valve indicated that a closing time of 5 minutes created only a minimal increase in transient pressures within the Coastal Branch pipeline. The closing times presented in the report are programmed into the CCWA's SCADA system to prevent transient pressures during flow rate changes (18).

Flow Science developed a report on transient pressures related to valve operating times for the Chorro Valley Pipeline in 1995. This report found that 10 minute valve opening and closing times were sufficient to prevent significant pressure surges, based on current pipeline capacity (19).

[a] Design flow capacity obtained from the AWWA Standard C507-5 and differs from the design flow capacity stated in the Operations Manual (16) (2).

5 PIPELINE MODELING

To perform the pipeline modeling and hydraulic assessment, WSC developed GIS based hydraulic models for the Coastal Branch, Chorro Valley, and Lopez pipelines. WSC created the Lopez pipeline model in a previous capacity evaluation project for the District. The results of the Lopez Pipeline Capacity Re-Evaluation determined that the Lopez pipeline has a maximum capacity of approximately 11.9 cfs. Details about the development of the Lopez pipeline model and results of the Lopez Pipeline Capacity Re-Evaluation are available in Appendix E.

5.1 MODEL DEVELOPMENT

To create the hydraulic models for the Coastal Branch, Chorro Valley, and Lopez pipelines, WSC developed geographic models in ArcGIS®, desktop GIS software from ESRI. The pipeline models were created using a combination of existing GIS shapefiles, as-built drawings, pipeline schematic drawings, operations manuals, and pipeline appurtenance inventory tables.

WSC developed the horizontal layout for each of the pipelines using existing GIS shapefiles and/or record drawings provided by the CCWA and the District. For the Coastal Branch pipeline, the CCWA assisted WSC in development of the hydraulic model by producing GIS shapefiles from the existing as-built drawings. To develop the vertical profiles for each of the pipelines, WSC utilized ArcGIS to create routes based on the existing pipeline stationing. WSC imported pipeline elevations into GIS as attribute data using the linear referencing tools in the ArcToolbox®. By combining the horizontal and vertical elements for each of the pipelines, WSC created spatially representative GIS shapefiles for the Coastal Branch and associated pipelines.

WSC incorporated appurtenances and related hydraulic facilities into the GIS shapefiles using the linear referencing tools or by hand. The resulting GIS shapefiles were reviewed thoroughly and compared against data provided in record drawings, operations manuals, site visits, and aerial images to verify that they accurately represent the Coastal Branch, Chorro Valley, and Lopez pipelines.

After completing the GIS representations of the pipelines, WSC imported the shapefiles into WaterGEMS® (V8i SELECT Series 1 (Build 08.11.01.32), a GIS enabled hydraulic modeling software product by Bentley. WSC then modified the pipeline appurtenances to represent the specific hydraulic features of the Coastal Branch, Chorro Valley, and Lopez pipelines. Following the final modifications, the Project Team reviewed the pipeline models against the reference drawings to check the accuracy of the model representations.

6 MODEL CALIBRATION

WSC calibrated the WaterGEMS® models using historical SCADA data and data obtained from flow tests performed by the CCWA and the District. The calibration process consisted of comparing observed pressures, specified flow rates and pipe headloss rates with modeled pressures under similar hydraulic conditions, and adjusting the pipeline roughness heights and minor loss coefficients to achieve correlation between the modeled and observed pressure values. WSC used pressure data for a wide range of flows to check that the pipeline models accurately represent hydraulic conditions for numerous flow scenarios.

When developing the model calibration approach, the project team evaluated using the Hazen William and the Darcy-Weisbach formulas to quantify pipeline roughness. The project team selected the Darcy–Weisbach formula because it utilizes the fundamental governing equations, and does not include empirical values. A detailed write-up on the project team's hydraulic modeling approach selection process is available in Appendix F.

6.1 COASTAL BRANCH PIPELINE

6.1.1 Historical Data Calibration

The CCWA maintains an extensive SCADA system to continuously monitor pipeline operations for the Coastal Branch pipeline. A detailed list of flow meters and pressure transmitters operated by the CCWA is available in Appendix G. CCWA's SCADA system records flow and pressure data at 5 minute intervals, and stores the data in a database. Utilizing historical data from 2010, WSC performed a preliminary calibration of the Coastal Branch pipeline. The CCWA's 2010 SCADA data provided excellent calibration because it spanned a wide range of flows (9 to 66 cfs through the EDV), reflected the recent condition of the pipeline and all pressure and flow instrumentation maintained calibration throughout the year.

For the preliminary calibration, WSC selected four different flow scenarios with flow rates ranging from 13 to 63 cfs through the EDV. WSC selected these flow rates to represent the wide range of flow rates seen in the Coastal Branch pipeline. To check that pressure data at these flow rates represented steady state conditions, WSC reviewed the historical data for a 24-hour period for each flow rate, and removed all data from periods where the flow and pressures did not match the steady state conditions. The selected pressure data were then averaged together to establish steady state pressures at the specified flow rates. WSC and the CCWA utilized the preliminarily calibrated Coastal Branch pipeline model to predict flows and pressures during the flow test and to check if the pipeline operational criteria restrictions would be exceeded.

6.1.2 Flow Test Procedures

The goal of the Coastal Branch pipeline flow test was to operate the pipeline at near maximum capacity to provide verification that the model accurately represents real world hydraulic conditions at high flow rates. To achieve a maximum flow rate during the flow test, the CCWA proposed lowering the water level in Tank 5, opening up the EDV sleeve valve and allowing water to flow from Tank 2 to Tank 5 until the EDV was fully open or the pre-defined operational criteria was exceeded. Once the maximum flow rate was reached, the flow rate was allowed to stabilize so that pressure data could be recorded under steady state conditions. After steady state data was recorded, the flow rate was returned to normal by slowly closing the EDV sleeve valve.

6.1.3 Flow Test Results

During the Coastal Branch pipeline flow test, the flow rate reached 72 cfs through the EDV before the CCWA stopped opening the EDV sleeve valve, due to pressures downstream of the EDV reaching 385 psi. The CCWA maintained the flow rate at 72 cfs for 20 minutes to allow steady state readings to be collected. The CCWA's SCADA system recorded flow and pressure data for the flow test. During the flow test, the CCWA monitored turbidity at several locations along the pipeline. No increase in turbidity was detected by the CCWA or their subcontractors.

6.1.4 Final Calibration

Using the flow and pressure data collected during the flow test, WSC performed a final calibration on the Coastal Branch pipeline. During the final calibration, minor losses were added immediately upstream of the CVTO (C=14) and immediately downstream of the EDV (C=40) to achieve correlation with the observed pressures. Following the calibration, the relative HGL error for all monitoring points was within 3.6%, and the absolute error within 23 ft. Relative and absolute HGL error are defined below. The detailed calibration calculations can be found in Appendix H.

Relative HGL error = (HGL observed – HGL model) / (HGL observed – elevation)

Absolute HGL error = (HGL observed – HGL model)

WSC developed a correlation plot for the Coastal Branch pipeline calibration that compares modeled HGL values against observed HGL values. Plotting modeled versus observed values should create a 45 degree line to show adequate correlation (+/- 3.6%). The correlation plot for the Coastal Branch pipeline model is shown in Figure 6-1.

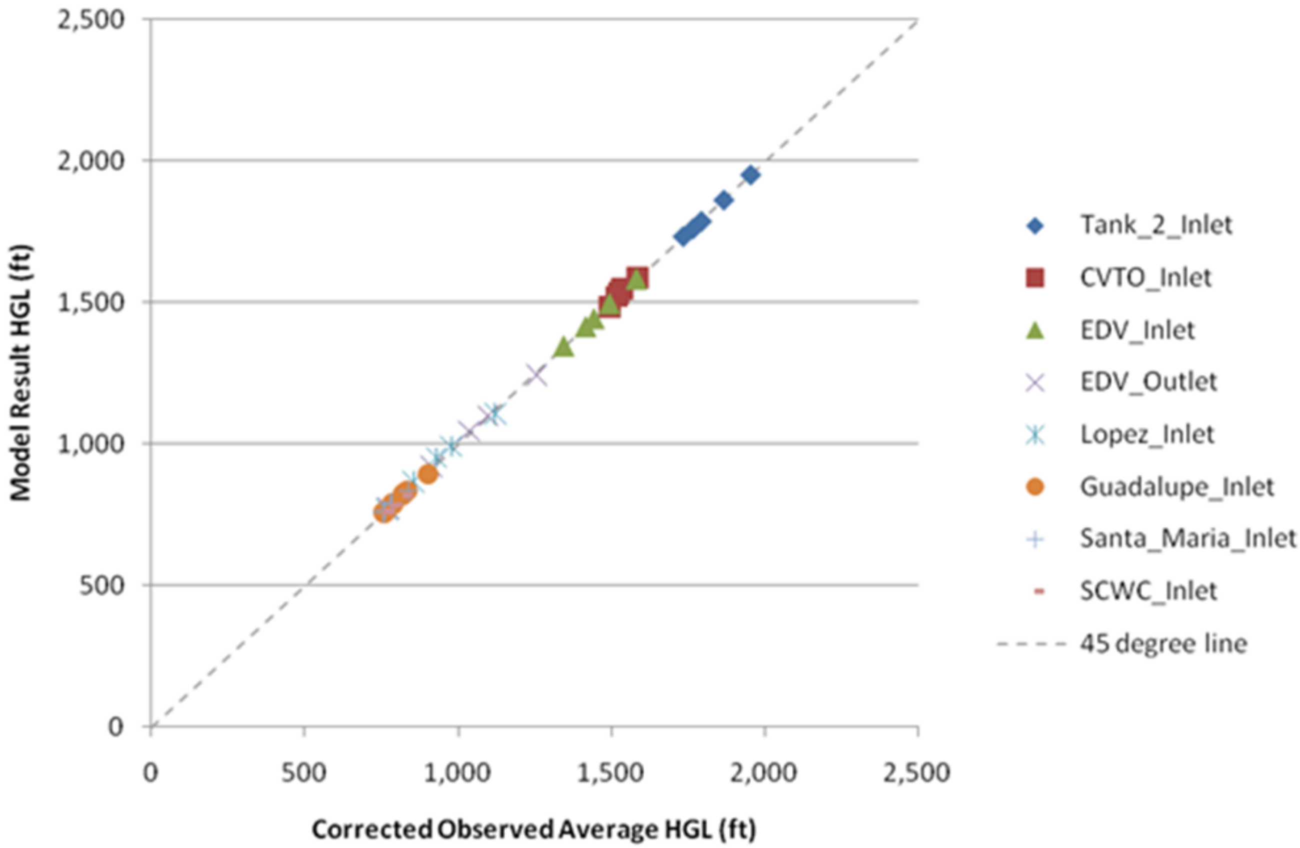

Figure 6-1. Coastal Branch pipeline model calibration correlation plot

6.2 CHORRO VALLEY PIPELINE

6.2.1 Historical Data Calibration

The District maintains a SCADA system for the Chorro Valley pipeline. To perform the initial calibration on the Coastal Branch pipeline, WSC selected flow and pressure data for four different flow rates that occurred in 2010. These flow rates ranged from 2.4 to 3.7 cfs through the CCWA flow control structure (Site 3) and encompassed the range of flow rates historically seen in the Chorro Valley pipeline. To obtain steady state values, the flows and pressures were selected during a time when minimal changes to the system are performed (2:00 AM) and the pipeline operations are stable. Additionally, the preceding and following flow rates and pressure values were reviewed to check that the data selected represented steady state conditions. However, due to the limited number of SCADA monitoring sites, approximately 50% of the pipeline could not be calibrated using historical data. Therefore, performing a flow test was necessary to create a fully calibrated model of the Chorro Valley pipeline.

6.2.2 Flow Test Procedures

WSC prepared a flow test plan for the Chorro Valley pipeline that detailed the duration and range of flow rates required to obtain hydraulic data necessary for calibration (Table 6-1). Flow rates through the pipeline were controlled with the CCWA flow control sleeve valve (Site 3) and the District butterfly valve (Site 5a).

Table 6-1. Chorro Valley pipeline flow test plan

				Flow Rate Targets (gpm)		
Test Group	Activity	Start Time	End Time	CCWA	CMC	MB
1	Record 10 (1 minute interval) readings	8:50 AM	8:59 AM	1,425	712	712
2	Adjust CCWA (Site 3) FCV	9:00 AM	9:10 AM	2,500	1,500	1,000
	Adjust District (Site 5a) FCV	9:10 AM	9:20 AM			
	Record 10 (1 minute interval) readings	9:50 AM	9:59 AM			
3	Adjust CCWA (Site 3) FCV	10:00 AM	10:10 AM	3,500	2,000	1,500
	Adjust District (Site 5a) FCV	10:10 AM	10:20 AM			
	Record 10 (1 minute interval) readings	10:50 AM	10:59 AM			
4	Adjust CCWA (Site 3) FCV	11:00 AM	11:10 AM	2,000	1,000	1,000
	Adjust District (Site 5a) FCV	11:10 AM	11:20 AM			
	Record 10 (1 minute interval) readings	11:50 AM	11:59 AM			

6.2.3 Flow Test Results

The District performed the Chorro Valley pipeline flow test on 10/20/10 and reached the target flow rates at Site 3. However, hydraulic limitations prevented the District from reaching the target flow rate of 1,500 gpm to Morro Bay. With Site 3 flowing at 3,500 gpm, and the Site 5a butterfly valve in the fully open position, the maximum flow rate achievable to Morro Bay was 1,145 gpm. To check that the values recorded represented steady state conditions, District personnel recorded pressure and flow data every minute for the last ten minutes of each test group. The final readings for each test group were then selected as the steady state values for each test group. Steady state results for the Chorro Valley flow test are shown in Appendix I.

6.2.4 Hydraulic Anomaly

When performing the final calibration on the Chorro Valley pipeline, WSC identified an anomaly in the historical flow and pressure data, and in the flow data collected during the flow test. In the section of pipeline between Site 5a and Site 6, WSC was unable to select a pipeline roughness height that accurately produced the observed amount of headloss at both high and low flow rates. The roughness height that produced the appropriate amount of headloss at high flow rates under-predicted the headloss observed at low flow rates. A full description of the hydraulic anomaly is provided in Appendix J.

Further investigation by the District determined that when the pipeline section to Morro Bay is operated at low flow, the HGL drops below the pipe elevation at the downstream high point (approximate model station 475+72). Under these conditions, the pipeline is no longer flowing full, which significantly decreases observed flows relative to modeled flows under the lower head conditions.

6.2.5 Final Calibration

After the District determined the source of the hydraulic anomaly, WSC completed the final calibration of the Chorro Valley pipeline. The model was calibrated for high flow rates because the hydraulic anomaly is only observed at low flow rates. WSC calibrated the Chorro Valley pipeline model to within a relative HGL error of 5% for all locations, except Site 3 Downstream. The maximum relative HGL error for Site 3 Downstream was 5.8%. The maximum absolute HGL error for the Chorro Valley Pipeline was less than 9 ft. The detailed calibration calculations can be found in Appendix K. The correlation plot for Chorro Valley pipeline displays an excellent correlation between the modeled and observed values with the exception of the Site 5a downstream readings under open channel conditions (Figure 6-2).

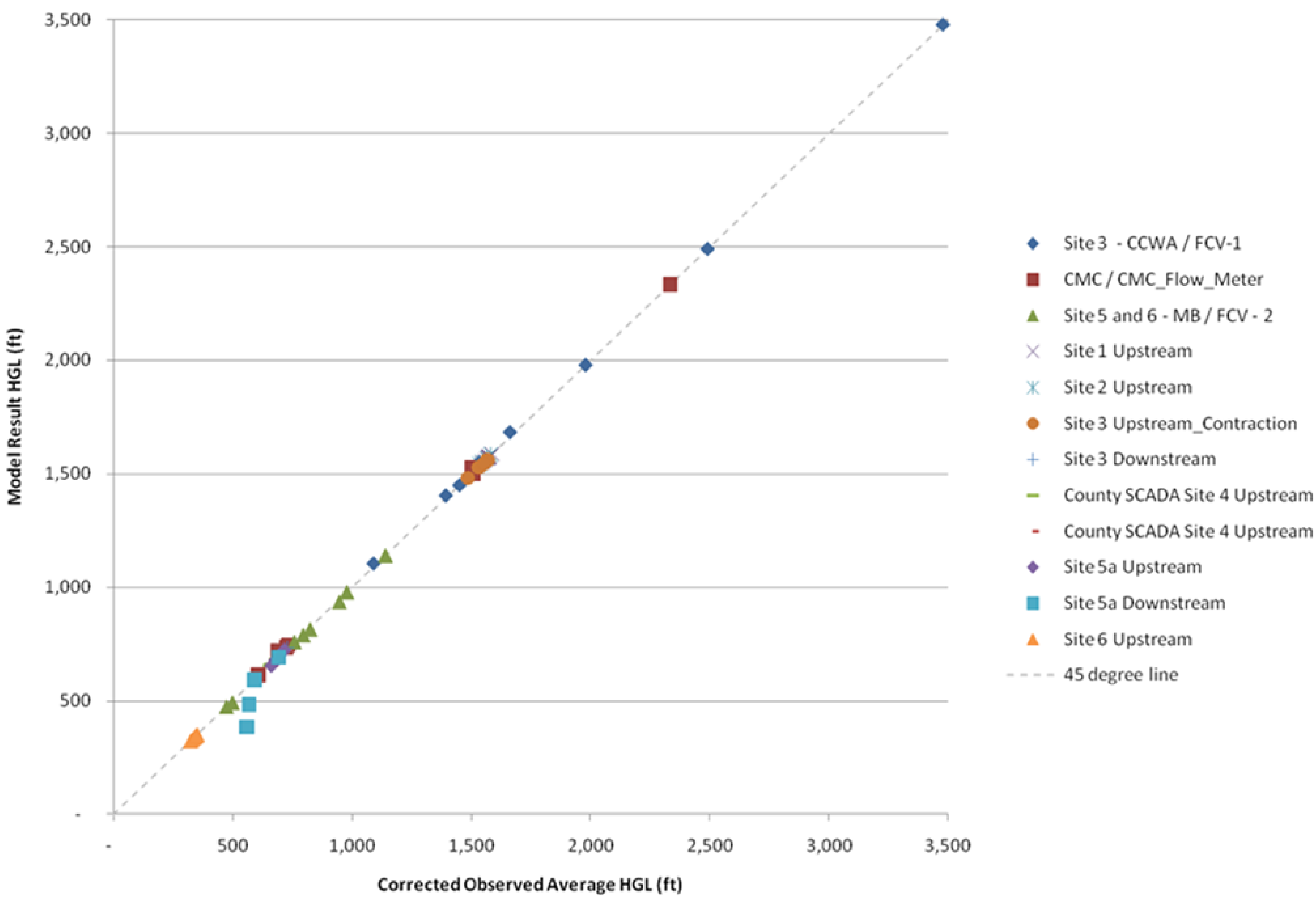

Figure 6-2. Chorro Valley pipeline model calibration correlation plot

7 CAPACITY ASSESSMENT APPROACH

To assess the capacity of the Coastal Branch pipeline, WSC utilized the calibrated hydraulic models for the Coastal Branch, Chorro Valley and Lopez pipelines to evaluate eight different SWP delivery scenarios. The Project Team determined that the capacity assessment of the Coastal Branch pipeline should evaluate the pipeline's capacity to deliver a specific volumetric flow rate, and not each turnout's capacity to receive the modeled flow rate. Fully evaluating each turnout's ability to receive increased flow rates requires a full analysis of the subcontractor's distribution systems, which was not included in the scope of this project.

7.1 STAKEHOLDER INVOLVEMENT

To ensure that the delivery scenarios represented the interests of all of the San Luis Obispo and Santa Barbara county SWP stakeholders, the Project Team organized a Scenario Development Workshop that included the following participants: the District; CCWA; WSC, City of Morro Bay; California Men's Colony (CMC); City of Pismo Beach; City of Grover Beach; Nipomo Community Services District; San Miguelito Mutual Water Company; OCSD; and the Avila Valley Mutual Water Company. During the workshop, the SWP stakeholders reviewed historic SWP deliveries for the Coastal Branch pipeline, projected demands for SWP water, and availability of SWP supplies. The stakeholders then evaluated numerous scenarios developed by the District. The scenarios selected by the stakeholders are listed in Table 7-1, and meeting notes from the Scenario Development Workshop are available in Appendix C. The selected scenarios were not intended to be exhaustive; rather, they were selected in an attempt to bracket the likely outcomes for apportioning excess capacity, inform negotiations among the stakeholders, and guide future analyses.

Table 7-1. Stakeholder approved delivery scenarios for the Coastal Branch pipeline (see Appendix C)

Delivery Scenario	Scenario Parameters	Shandon (afy)	Chorro Valley Turnout (CVTO) (afy)	Lopez Turnout (LPTO) (afy)[a]	Santa Barbara Turnouts (SBTO) (afy)[b]
Baseline	Existing Contract Flows	100	2,338	2,392	42,986
1	Maximum equal % increase	100 + X%	2,338 + X%[c]	2,392 + X%	42,986 + X%
2	Max % increase at CVTO, Maintain equal % increase	100 + X%	2,338 + Y%[d]	2,392 + X%	42,986 + X%
3	Max % increase at LPTO, Maintain equal % increase	100 + X%	2,338 + X%	2,392 + Y%	42,986 + X%
4	Max % increase at SBTO, Maintain equal % increase	100 + X%	2,338 + X%	2,392 + X%	42,986 + Y%
5	Max % increase at LPTO w/CVTO Increase	100	2,338 + Z%[e]	2,392 + Y%	42,986
6	Max % increase at SBTO w/CVTO Increase	100	2,338 + Z%	2,392	42,986 + Y%
7	Max % increase at LPTO and SBTO w/ CVTO increase	100	2,338 + Z%	2,392 + Y%	42,986 + Y%
8	Max % increase at Shandon, Maintain equal % increase	100 + Z%	2,338 + X%	2,392 + X%	42,986 + X%

7.2 MODELING APPROACH

To perform the Coastal Branch capacity assessment, WSC combined the Coastal Branch and Chorro Valley pipeline models within WaterGEMS®. This allowed WSC to calculate the results of the delivery scenarios with less iteration than if the pipeline models were separated. WSC then placed flow control valves and storage tanks downstream of each of the turnouts along the Coastal Branch pipeline. The turnouts along the Chorro Valley pipeline flow directly into existing storage tanks and did not require additional storage tanks for hydraulic modeling.

Initially, all turnouts were set at their maximum contract flow rates. The maximum instantaneous flow rate is equal to the annual allocation divided over an 11 month time period. The contract flow rates for the San Luis Obispo SWP subcontractors that receive SWP water through the Lopez pipeline were applied at the LPTO. The Santa Barbara county demands were separated into four separate turnouts: GPTO; SMTO; SCWC; and Tank 5 (representing all downstream subcontractors).

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[a] 2,392 afy represents the current annual allocation for the subcontractors served by the Lopez pipeline.
[b] 42,986 afy represents the current capacity annual allocation capacity for Santa Barbara county. The notes from the Scenario Development Workshop incorrectly indicate a value of 43,560.
[c] X% means equal increase from Scenario 1
[d] Y% means maximum increase
[e] Z% means highest remaining increase

According to the parameters of each scenario, WSC then increased the flow rates through the turnouts, by adjusting the settings for the flow control valves, according to each scenario's specifications until the previously specified operating criteria or the hydraulic capacity for the pipeline were exceeded.

Increased flows through the Chorro Valley pipeline were modeled to the individual sub-contractor turnouts. However, increased flow rates through the CVTO were not distributed on an equal percentage increase to the individual turnouts (Morro Bay and CMC). The flow rate to the Morro Bay turnout is hydraulically limited to approximately 2.8 cfs and any further increases in flow rate through the CVTO are delivered to CMC turnout.

Flows through the Lopez turnout were limited to the maximum capacity of the Lopez pipeline as determined by WSC in the Lopez Pipeline Capacity Re-Evaluation (Appendix E). The Lopez pipeline capacity re-evaluation determined that the maximum capacity of the Lopez pipeline was approximately 11.9 cfs.

WSC controlled modeled flow through the Coastal Branch and Chorro Valley pipelines by adjusting the settings on the EDV and Site 3 flow control valves respectively. By adjusting the flow control settings on the EDV and Site 3 flow control valves, the hydraulic model can mimic the operation of the CCWA controlled flow control valves. The flow control valves in the model adjust headloss as necessary to reduce the flow through the valve to the desired flow rate. This provides an accurate representation of the headloss through the flow control sleeve valves under various hydraulic conditions.

To mimic typical operations during high flow periods, the water levels in Tank 1, Tank 2, and Tank 5 in the modeling scenarios were set close to maximum operating range. The tank HGLs used in the model to determine the capacity of the Coastal Branch pipeline are listed in Table 7-2.

Table 7-2. Modeled Tank HGLs

Tank	Modeled Level (ft)	Modeled HGL (ft)
1	20	1975
2	27.7	1606.7
5	20.07	768

7.2.1 Subcontractor HGLs

For the analysis of pipeline hydraulic capacity, the water level for each turnout storage tank was set at 12 ft above pipeline grade to approximately represent 5 psi of pressure. This was a simplifying assumption that allowed the model to predict the pipeline's ability to deliver water to each of the Coastal Branch pipeline turnouts. Although, the water level in each turnout tank does not necessarily represent the hydraulic grade of the subcontractor's distribution systems it is impossible to represent actual HGL conditions downstream of the turnout under varying supply and demand scenarios without extensive modeling of the contractors' distribution systems, which is outside the scope of this assessment.

To address the issue of subcontractor HGL, the Project Team decided to include HGL information for the two subcontractors downstream of the EDV that do not have storage tanks immediately downstream of their turnouts: Santa Maria; and Southern California Water Company. Guadalupe's turnout does not have a storage tank, but the system HGL is close to their turnout elevation. Therefore, the GPTO does not require a significant head difference to receive contract flows. Table 7-3 lists the turnout HGLs use to represent the Santa Maria and Southern California Water Company distribution systems.

Table 7-3. Subcontractor Distribution System HGL

Turnout	Maximum Distribution System HGL (ft)
SMTO	419
SCWC	347

Given the hydraulic characteristics of the Coastal Branch pipeline, the HGL, downstream of the EDV, does not decrease from the HGL required to deliver contract flow rates, even at the higher flow rates. In fact, modeled pressures at the SMTO and SCWC are higher under the high flow scenarios than the contract flow rate scenario. Additionally, the HGL in Tank 5 acts as a "bulkhead" to help maintain the pipeline HGL.

7.3 MODELING UNCERTAINTY

This capacity assessment models eight specific operating scenarios. However, certain limitations in the model limit its ability to represent real world conditions. These limitations include:

- **Instrument Accuracy** - Errors in the flow test data, related to the accuracy of the pressure gages and flow meters, limit the accuracy of the model calibration (+/- 0.5% accuracy).
- **Calibration Error** - Absolute and relative HGL error related to the model calibration (see section 6 Model Calibration) limit the ability of the model to represent real world conditions (Coastal Branch pipeline +/- 3.6% accuracy, Chorro Valley pipeline +/- 5.8% accuracy).
- **Simplified Turnout Assumptions** - Variable conditions within the distribution systems downstream of each turnout can affect turnout capacity for a given HGL in the Coastal Branch pipeline.
- **Steady State Model** - Dynamic conditions within the pipeline that are not captured within a steady state model and may impact the maximum capacity of the pipeline.

8 CAPACITY ASSESSMENT RESULTS

Each of the scenarios was modeled using the combined Coastal Branch and Chorro Valley pipeline models. The flow rates presented for each of the scenarios represent the maximum flow achievable in the Coastal Branch pipeline within the parameters of each scenario and the operational criteria restrictions. Detailed descriptions of each of the scenarios are provided below, followed by summary tables combining the results for all the pipeline capacity assessment scenarios (Table 8-10, Table 8-11, Table 8-12 and Table 8-13). Additionally, detailed HGL diagrams for each of the Scenarios can be found in Appendix L.

8.1 BASELINE

The flow rates for the baseline scenario represent the existing SWP subcontractors taking deliveries at their contract rates, which for this capacity assessment is equal to the annual allocation divided over eleven months.[a] These flow rates were used as the baseline for which all the following scenarios were based on. The flow rates and HGLs associated with the Baseline scenario are shown in Table 8-1 below.

Table 8-1. Baseline results

	Subcontractors	Contract Rate (cfs)	Pipeline HGL (ft)
Shandon		0.15	1,891
CVTO	Morro Bay	1.98	
	CMC Contractors	1.55	
	Subtotal	3.52	1,512
LPTO		3.60	1,033
SBTO	Guadalupe	0.91	848
	Santa Maria	26.85	798
	So. Ca. Water Co.	0.83	791
	Tank 5	36.18	
	Subtotal	64.77	
	Total	**72.05**	

[a] For this capacity assessment it was assumed that there were 30.417 days per month.

8.2 SCENARIO #1

For Scenario #1, each turnout received an equal percentage increase from contract rates until: 1) the operational criteria for the pipeline were exceeded; or 2) the hydraulic capacity was reached. These flow rates were then used as the basis for Scenarios #2, 3, 4, and 8. The results of the capacity analysis for Scenario #1 indicated that flows to the CVTO, the LPTO, and the SBTO could be increased by 12.6 percent (9.08 cfs) above contract rates before the pipeline operational criteria were exceeded. Pressure limitations downstream of the EDV were the limiting factor for further increasing flow rates in Scenario #1. The results for Scenario #1 are shown in Table 8-2 below.

Table 8-2. Scenario #1 results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	0.17	0.02	1869
CVTO	Morro Bay	1.98	2.23	0.25	
	CMC Contractors	1.54	1.74	0.19	
	Subtotal	3.52	3.97	0.44	1487
LPTO		3.60	4.06	0.45	1098
SBTO	Guadalupe	0.91	1.03	0.11	868
	Santa Maria	26.85	30.24	3.38	805
	So. Ca. Water Co.	0.83	0.93	0.10	797
	Tank 5	36.18	40.74	4.56	
	Subtotal	64.77	72.93	8.16	
	Total	**72.05**	**81.13**	**9.08**	

8.3 SCENARIO #2

The equal percentage increases from Scenario #1 were used as the base flow rates for Scenario #2. Flows were then increased to the CVTO until the operational criteria or hydraulic capacity was reached. Under the parameters of Scenario #2, the flow rate through the Chorro Valley pipeline was increased by 112.8 percent (3.97 cfs) above the contract rate. The limiting factor for increasing flows in Scenario #2 was the downstream pressure limitation at the Site 3 flow control valve. The results for Scenario #2 are shown in Table 8-3 below.

Table 8-3. Scenario #2 results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	0.17	0.02	1860
CVTO	Morro Bay	1.98	2.78	0.80	
	CMC Contractors	1.54	4.72	3.17	
	Subtotal	3.52	7.50	3.97	1477
LPTO		3.60	4.06	0.45	1098
SBTO	Guadalupe	0.91	1.03	0.11	868
	Santa Maria	26.85	30.24	3.38	805
	So. Ca. Water Co.	0.83	0.93	0.10	797
	Tank 5	36.18	40.74	4.56	
	Subtotal	64.77	72.93	8.16	
	Total	**72.05**	**84.66**	**12.61**	

8.4 SCENARIO #3

Scenario #3 evaluated the pipeline's ability to deliver water to the LPTO beyond the equal percentage increases from Scenario #1. Flow to the LPTO was increased until the operational criteria or hydraulic capacity was reached. Under the parameters of Scenario #3, the flow rate to the LPTO was increased by 17.1 percent (0.62 cfs) above the contract rate. The limiting factor for Scenario #3 was the high pressure limit downstream of the EDV. The results for Scenario #3 are shown in Table 8-4 below.

Table 8-4. Scenario #3 results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	0.17	0.02	1869
CVTO	Morro Bay	1.98	2.23	0.25	
	CMC Contractors	1.54	1.74	0.19	
	Subtotal	3.52	3.97	0.44	1487
LPTO		3.60	4.22	0.62	
SBTO	Guadalupe	0.91	1.03	0.11	868
	Santa Maria	26.85	30.24	3.38	805
	So. Ca. Water Co.	0.83	0.93	0.10	797
	Tank 5	36.18	40.74	4.56	
	Subtotal	64.77	72.93	8.16	
	Total	**72.05**	**81.29**	**9.24**	

8.5 SCENARIO #4

Scenario #4 evaluated the ability of the pipeline to increase flows to the SBTO subcontractors beyond the equal percentage increase deliveries from Scenario #1. The flow rates to the Santa Barbara subcontractors were increased until the operational criteria or the hydraulic capacity of the pipeline was exceeded. Within the parameters of Scenario #4, the flow rate to Santa Barbara subcontractors was increased by 12.7 percent (8.20 cfs) from contract flow rates. The limiting factor for increasing flows to the Santa Barbara subcontractors in Scenario #4 was the high pressure limit downstream of the EDV. The results for Scenario #4 are shown in Table 8-5 below.

Table 8-5. Scenario #4 results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	0.17	0.02	1869
CVTO	Morro Bay	1.98	2.23	0.25	
	CMC Contractors	1.54	1.74	0.19	
	Subtotal	3.52	3.97	0.44	1487
LPTO		3.60	4.06	0.45	
SBTO	Guadalupe	0.91	1.03	0.12	868
	Santa Maria	26.85	30.25	3.40	805
	So. Ca. Water Co.	0.83	0.93	0.10	797
	Tank 5	36.18	40.76	4.58	
	Subtotal	64.77	72.97	8.20	
	Total	**72.05**	**81.17**	**9.11**	

8.6 SCENARIO #5

The intent of Scenario #5 was to maximize deliveries to the LPTO, and then evaluate the remaining capacity to increase flows to the CVTO, while maintaining contract flow rates to the SBTO. The analysis of the Scenario #5 determined that the flows to the LPTO could be increased by 231.0 percent (8.33 cfs) from contract flow rates. The flow rate increase to the LPTO was limited by the capacity of the Lopez pipeline, determined to have a capacity of approximately 11.9 cfs in the Lopez Pipeline Capacity Re-Evaluation (Appendix E). There was remaining capacity within the Coastal Branch pipeline to increase flows to the CVTO by 113.0 percent (3.98) above contract rates. The limiting factor for further increasing flows to the CVTO in Scenario #5 was the downstream pressure limitation at Site 3.

The analysis in Scenario #5 assumed that the entire capacity of the Lopez pipeline was available for SWP deliveries. However, under normal operating conditions, a significant portion of the Lopez pipeline is utilized for deliveries from the Lopez Water Treatment Plant. The results of Scenario #5 are shown in Table 8-6 below.

Table 8-6. Scenario #5 Results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	0.15	0.00	1861
CVTO	Morro Bay	1.98	2.78	0.80	
	CMC Contractors	1.54	4.72	3.18	
	Subtotal	3.52	7.50	3.98	1478
LPTO		3.60	11.93	8.33	
SBTO	Guadalupe	0.91	0.91	0.00	848
	Santa Maria	26.85	26.85	0.00	798
	So. Ca. Water Co.	0.83	0.83	0.00	791
	Tank 5	36.18	36.18	0.00	
	Subtotal	64.77	64.77	0.00	
	Total	**72.05**	**84.36**	**12.31**	

8.7 SCENARIO #6

The parameters for Scenario #6 included maximizing deliveries to the SBTO and then evaluating the remaining capacity to increase deliveries to the CVTO, while maintaining contract flow rates to the LPTO. The analysis of the Scenario #6 determined that the flows to the SBTO could be increased by 12.9 percent (8.36 cfs) from contract flow, and there was remaining capacity to increase flows to the CTVO by 113.0 percent (3.98 cfs) above contract rates. The limiting factor for maximizing flows to the SBTO was the downstream pressure at the EDV. The ability to deliver additional flows through Chorro Valley pipeline was restricted by the Site 3 downstream pressure limitation. The results of Scenario #6 are shown in Table 8-7 below.

Table 8-7. Scenario #6 results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	0.15	0.00	1861
CVTO	Morro Bay	1.98	2.78	0.80	
	CMC Contractors	1.54	4.72	3.18	
	Subtotal	3.52	7.50	3.98	1478
LPTO		3.60	3.60	0.00	
SBTO	Guadalupe	0.91	1.03	0.12	869
	Santa Maria	26.85	30.32	3.46	805
	So. Ca. Water Co.	0.83	0.94	0.11	797
	Tank 5	36.18	40.85	4.67	
	Subtotal	64.77	73.13	8.36	
	Total	**72.05**	**84.39**	**12.34**	

8.8 SCENARIO #7

The goal for Scenario #7 was to evaluate the Coastal Branch pipeline's capacity to maximize deliveries to the LPTO and SBTO on an equal percentage basis and then evaluate remaining capacity to deliver water to the CVTO. The results of Scenario #7 determined that the flows to the LPTO and SBTO could be increased by 12.6 percent (8.61 cfs) above contract flow rates and that capacity remained to increase flows to the CTVO by 113.0 percent (3.98 cfs) from contract flow rates. The limiting factor for maximizing flows to the LPTO and the SBTO was the downstream pressure limitation at the EDV. The ability of the Chorro Valley pipeline to deliver additional flows was limited by the downstream pressure criteria at Site 3. The results of Scenario #7 are shown in Table 8-8 below.

Table 8-8. Scenario #7 results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	0.15	0.00	1860
CVTO	Morro Bay	1.98	2.78	0.80	
	CMC Contractors	1.54	4.72	3.18	
	Subtotal	3.52	7.50	3.98	1477
LPTO		3.60	4.06	0.45	
SBTO	Guadalupe	0.91	1.03	0.11	868
	Santa Maria	26.85	30.24	3.38	805
	So. Ca. Water Co.	0.83	0.93	0.10	797
	Tank 5	36.18	40.74	4.56	
	Subtotal	64.77	72.93	8.16	
	Total	**72.05**	**84.65**	**12.60**	

8.9 SCENARIO #8

Scenario #8 evaluated the capacity of the Coastal Branch pipeline to deliver water through the Shandon turnout while maintaining the equal percent increases at all downstream turnouts from Scenario #1. The flow rate through the Shandon turnout was increased until the operational criteria or the hydraulic capacity of the pipeline was exceeded. Within the parameters of Scenario #8, the maximum percentage increase achievable through the Shandon turnout was 9,500 percent (16.14 cfs) above the contract rate while maintaining the increased flows from Scenario #1. The limiting factor for increasing flows to the Shandon turnout was the hydraulic capacity of the Tank 2 sleeve valve. The results for Scenario #8 are shown in Table 8-9 below.

Table 8-9. Scenario #8 results

	Subcontractors	Contract Rate (cfs)	Scenario Flow Rate (cfs)	Flow Rate Increase (cfs)	Pipeline HGL (ft)
Shandon		0.15	16.29	16.14	1825
CVTO	Morro Bay	1.98	2.23	0.25	
	CMC Contractors	1.54	1.74	0.19	
	Subtotal	3.52	3.97	0.44	1487
LPTO		3.60	4.06	0.45	
SBTO	Guadalupe	0.91	1.03	0.11	868
	Santa Maria	26.85	30.24	3.38	805
	So. Ca. Water Co.	0.83	0.93	0.10	797
	Tank 5	36.18	40.74	4.56	
	Subtotal	64.77	72.93	8.16	
	Total	**72.05**	**97.25**	**25.20**	

8.10 RESULTS SUMMARY

Table 8-10, Table 8-11, Table 8-12, and Table 8-13 and summarize the modeling results for the eight scenarios described above.

Table 8-10. Coastal Branch pipeline capacity assessment results (instantaneous flow rate)

	Baseline Contract flow rates (cfs)	Scenario #1 Equal % increase in flow to all turnouts (cfs)	Scenario #2 Equal % increase in flow; then max flow to CVTO (cfs)	Scenario #3 Equal % increase in flow; then max flow to LPTO (cfs)	Scenario #4 Equal % increase in flow; then max flow to SBTO (cfs)	Scenario #5 Max flow to LPTO; then max flow to CVTO (cfs)	Scenario #6 Max flow to SBTO; then max flow to CVTO (cfs)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (cfs)	Scenario #8 Equal % increase in flow; then max flow to Shandon (cfs)
Shandon	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	16.3
Subtotal-Flow into Tank 2	71.9	81.0	84.5	81.1	81.0	84.2	84.2	84.5	81.0
CVTO	3.5	4.0	7.5	4.0	4.0	7.5	7.5	7.5	4.0
Subtotal-Flow thru the EDV	68.4	77.0	77.0	77.2	77.0	76.7	76.7	77.0	77.0
LPTO	3.6	4.1	4.1	4.2	4.1	11.9	3.6	4.1	4.1
GPTO	0.9	1.0	1.0	1.0	1.0	0.9	1.0	1.0	1.0
SMTO	26.9	30.2	30.2	30.2	30.3	26.9	30.3	30.2	30.2
SCWC	0.8	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9
Subtotal-Flow into Tank 5	36.2	40.7	40.7	40.7	40.8	36.2	40.8	40.7	40.7
Total Capacity	72.1	81.1	84.7	81.3	81.2	84.4	84.4	84.6	97.2

Table 8-11. Coastal Branch pipeline capacity assessment results (annual capacity)[a]

	Baseline Contract Flow Rates (afy)	Scenario #1 Equal % increase in flow to all turnouts (afy)	Scenario #2 Equal % increase in flow; then max flow to CVTO (afy)	Scenario #3 Equal % increase in flow; then max flow to LPTO (afy)	Scenario #4 Equal % increase in flow; then max flow to SBTO (afy)	Scenario #5 Max flow to LPTO; then max flow to CVTO (afy)	Scenario #6 Max flow to SBTO; then max flow to CVTO (afy)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (afy)	Scenario #8 Equal % increase in flow; then max flow to Shandon (afy)
Shandon	100	113	113	113	113	100	100	100	10,810
CVTO	2,338	2,633	4,975	2,633	2,633	4,980	4,980	4,980	2,633
LPTO	2,392	2,693	2,693	2,801	2,693	7,918	2,392	2,693	2,693
GPTO	605	681	681	681	682	605	683	681	681
SMTO	17,820	20,065	20,065	20,065	20,075	17,820	20,119	20,065	20,065
SCWC	550	619	619	619	620	550	621	619	619
Subtotal-Flow into Tank 5	24,011	27,036	27,036	27,036	27,050	24,011	27,108	27,036	27,036
Total Capacity	47,816	53,841	56,184	53,949	53,865	55,984	56,003	56,176	64,538

[a] Annual capacity results assume continuous delivery at the scenario specific flow rates for 11 months and that there is sufficient sub-contractor demand to receive these flow rates.

Table 8-12. Coastal Branch pipeline capacity assessment results (increase in annual capacity)[a]

	Scenario #1 Equal % increase in flow to all turnouts (afy)	Scenario #2 Equal % increase in flow; then max flow to CVTO (afy)	Scenario #3 Equal % increase in flow; then max flow to LPTO (afy)	Scenario #4 Equal % increase in flow; then max flow to SBTO (afy)	Scenario #5 Max flow to LPTO; then max flow to CVTO (afy)	Scenario #6 Max flow to SBTO; then max flow to CVTO (afy)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (afy)	Scenario #8 Equal % increase in flow; then max flow to Shandon (afy)
Shandon	13	13	13	13	0	0	0	10,710
CVTO	295	2,638	295	295	2,642	2,642	2,642	295
LPTO	301	301	409	301	5,526	0	301	301
GPTO	76	76	76	77	0	78	76	76
SMTO	2,245	2,245	2,245	2,255	0	2,299	2,245	2,245
SCWC	69	69	69	70	0	71	69	69
Subtotal-Flow into Tank 5	3,025	3,025	3,025	3,039	0	3,097	3,025	3,025
Total Capacity	6,025	8,368	6,133	6,049	8,168	8,187	8,360	16,722

Table 8-13. Coastal Branch pipeline capacity assessment results (HGL)

	Baseline Contract flow rates (ft)	Scenario #1 Equal % increase in flow to all turnouts (ft)	Scenario #2 Equal % increase in flow; then max flow to CVTO (ft)	Scenario #3 Equal % increase in flow; then max flow to LPTO (ft)	Scenario #4 Equal % increase in flow; then max flow to SBTO (ft)	Scenario #5 Max flow to LPTO; then max flow to CVTO (ft)	Scenario #6 Max flow to SBTO; then max flow to CVTO (ft)	Scenario #7 Equal % increase in flow to LPTO & SBTO; then max flow to CVTO (ft)	Scenario #8 Equal % increase in flow; then max flow to Shandon (ft)
Shandon	1,891	1,869	1,860	1,869	1,869	1,861	1,861	1,860	1,825
CVTO	1,512	1,487	1,477	1,487	1,487	1,478	1,478	1,477	1,487
LPTO	1,033	1,098	1,098	1,098	1,099	1,033	1,100	1,098	1,098
GPTO	848	868	868	868	868	848	869	868	868
SMTO	798	805	805	805	805	798	805	805	805
SCWC	791	797	797	797	797	791	797	797	797

[a] Annual capacity results assume continuous delivery at the scenario specific flow rates for 11 months and that there is sufficient sub-contractor demand to receive these flow rates.

9 CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis and results described above, WSC developed the following conclusions and recommendations for the District and CCWA to consider.

1. **The Coastal Branch pipeline has significant excess capacity above its design value, especially for the turnouts north of the EDV.** For example, if all turnouts along the Coastal Branch were increased in equal percentage, rated pipeline capacity could be increased by approximately 12.6% (9.08 cfs) relative to delivery of the annual contract flow rates (assuming 11 months of operation per year).
2. **The PPWTP is currently limiting the overall capacity of the Coastal Branch pipeline.** WSC's simplified analysis of treatment plant capacity indicated that it is rated for continuous production at 76 cfs. By comparison, the modeling results indicate that the capacity of the Coastal Branch pipeline is in the range of 81 to 97 cfs, depending upon where the water is delivered, and the raw water pumping plants have a capacity in excess of 100 cfs.
3. **Increasing flow rates in the Coastal Branch pipeline will not adversely impact the HGL at the Santa Maria, Guadalupe and SCWC turnouts.** As shown in Table 8-13, the pressures at every turnout downstream of the EDV are equal to or higher under every capacity scenario than when the pipeline is delivering contract flows. Although a lower HGL is predicted at the CVTO when the pipeline is operating at the higher flows,[a] there is still sufficient head to deliver contract flows.[b]
4. **Open channel flow along the Chorro Valley pipeline.** Eliminate open channel conditions, at low flows, within the Chorro Valley pipeline to ensure that all sections of the pipeline remain fully pressurized.
5. **Capacity of the Coastal Branch pipeline can be further increased with modest capital improvements.**
    a. <u>To further increase flows to Chorro Valley</u>, complete a thorough evaluation of the design pressure and current condition of the pipe segments downstream of the flow control valve, to confirm that 75 psi is an appropriate maximum working pressure, and to determine if additional working pressure could be sustained.
    b. <u>To further increase flows to Lopez</u>, consider implementing one of the improvements presented in the Lopez Pipeline Capacity Re-Evaluation Technical Memorandum dated 8/15/2011 (Appendix E) prepared by WSC, such as pigging the 33" section of the Lopez pipeline or upgrading the Oceano pipeline.
    c. <u>To further increase flows to Santa Barbara county</u>, complete a thorough evaluation of the design pressure and current condition of the pipe segments downstream of the EDV, to confirm that 385 psi is an appropriate maximum working pressure, and to determine if additional working pressure could be sustained.

[a] The predicted HGL at the CVTO under the eight capacity scenarios is anywhere from 25 to 35 feet lower than the HGL of the pipeline flowing at contract flow rates.
[b] The flow control valve at Site 3 burns anywhere from 679 to 837 feet of head prior to flows being delivered to Morro Bay and the California Men's Colony.

   d. To further increase flows north of the Tank 2 (i.e. Shandon), evaluate adding a second sleeve valve at the inlet to Tank 2 and/or reducing the operating water level of Tank 2.

6. **Update the surge analyses for the Coastal Branch, Chorro Valley and Lopez pipelines.** The analyses should be updated to reflect higher flows, to validate and/or refine valve closing criteria and confirm the adequacy of existing surge controls to protect the infrastructure in the event of a pressure transient.

7. **Re-evaluate hydropower generation at the EDV.** Based on current contract rates, a 895 kW hydropower generation station at the location of the EDV could produce roughly 5 million kWh of renewable electricity per year without impacting the flow capacity of the pipeline.[a]

8. **Re-evaluate hydropower generation at the Chorro Valley pipeline Site 3.** Based on current contract rates, a 175 kW hydropower generation station at Site 3 could produce roughly 1 million kWh of renewable electricity per year without impacting the flow capacity of the pipeline.[a]

This capacity assessment models eight specific operating scenarios. The modeling work presented should not be considered exhaustive and the modeling of additional operating scenarios may be explored in the future. In addition, this capacity assessment does not consider the loss of operational flexibility that will occur as the pipeline becomes more fully utilized, nor does the capacity assessment address the potential limitations that may arise from pressure transient issues.

[a] Analysis assumes hydroelectric plant operates at contract conditions for 11 months per year, with a plant efficiency of 70% and flow control losses of 30%.

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APPENDIX A. CAPACITY ASSESSMENT CONTRIBUTOR BIOGRAPHIES

WSC
WATER SYSTEMS CONSULTING, INC.

Jeffery Szytel, P.E., M.S., M.B.A.

Mr. Szytel has more than thirteen years of experience in civil and environmental engineering specializing in water, wastewater and recycled water systems. His experience includes project and program management, capital improvement planning, water and wastewater treatment facility evaluation, optimization and design, hydraulic analysis, pilot studies, water and wastewater master planning, integrated resource planning, infrastructure planning and design, management consulting, and construction services.

Daniel Heimel, E.I.T, M.S.

Mr. Heimel has over seven years engineering and operations experience in the water and wastewater industry. He has worked for two public water utilities in an operations capacity and is very knowledgeable about the day-to-day operations that keep water supply, water treatment, and water distribution facilities functioning. His experience includes project and program management, hydraulic modeling, GIS implementation, water quality and drinking water utility regulatory compliance, sampling plan development and implementation, recycled water implementation, pilot studies, water quality and water supply watershed monitoring, groundwater recharge facility operations, and water quality data analysis.

HDR

Jeroen Olthof, P.E., M.S.

Mr. Olthof brings more than 14 years of experience in planning, design, and management of water and wastewater infrastructure. He specializes in hydraulic modeling of pipe networks, feasibility studies, infrastructure condition assessment, and comprehensive master planning. His experience includes database development and integration of geographic information systems (GIS) with hydraulic models, recycled water customer databases, and asset databases. He has developed and maintained custom databases to track recycled water customers and generate reports for regulatory agencies and other stakeholders. He has also developed condition assessment programs and decision algorithms to support capital improvement planning and maintenance optimization. He has published several technical papers on hydraulic modeling and infrastructure condition assessment

Sasa Tomic, Ph.D., P.E.

Dr. Tomic is a Senior Professional Associate and the National Hydraulic Modeling Lead for HDR. His responsibilities include national development, coordination, monitoring and improvement of technical competencies of business class staff and products to meet client needs and market drivers. His focus has been on the development and implementation of quality control and quality assurance procedures for hydraulic modeling projects.

With 18 years of experience in water resources industry and 12 years of experience in hydraulic modeling software development, Dr. Tomic provides a unique blend of practical, theoretical, and software development skills perfected as a designer of market-leading software applications, an advisor on the world's most challenging modeling projects, and as an international authority on water-resources computational science. He has been the product manager of Wallingford Software's InfoWorks and InfoNet water distribution solutions and the lead developer of Bentley's GEMS platform, for which he is the primary author of the US patent. Dr. Tomic has used this inside knowledge of modeling software automation technologies, including Wallingford Software's InfoLite and Bentley's WaterObjects.NET platforms, to integrate hydraulic models with geographic information systems (GIS), SCADA systems, and other corporate IT systems.

Dr. Tomic is an active member of AWWA and WEF modeling committees. He has conducted modeling software training, presented on dozens of conferences, published numerous technical papers, and collaborated on book chapters in area of water resources and computer science.

GEI Consultants

John Zoraster, P.E.

Mr. Zoraster has 30 years of professional experience in water resources planning and public works projects. His experience includes planning and implementation of capital improvement programs, conjunctive use projects, municipal water supply, recycled water, water system valuation and rate studies.

APPENDIX B. REQUEST FOR PROPOSAL PS-#1084 CAPACITY ASSESSMENT OF THE STATE WATER PROJECT COASTAL BRANCH

County of San Luis Obispo

GENERAL SERVICES AGENCY

Janette D. Pell, Director

Helen McCann, Department Administrator

REQUEST FOR PROPOSAL PS- #1084
Capacity Assessment of the State Water Project Coastal Branch

April 23, 2010

The San Luis Obispo County Flood Control and Water Conservation District (District) is currently soliciting proposals for professional services to complete a comprehensive capacity assessment and report for the Coastal Branch of the State Water Project (SWP).

Each proposal shall specify each and every item as set forth in the attached specifications. Any and all exceptions must be clearly stated in the proposal. Failure to set forth any item in the specifications without taking exception, may be grounds for rejection. The District reserves the right to reject all proposals and to waive any informalities.

If your firm is interested and qualified, please submit four [4] copies of your proposal by 3:00 p.m. on May 19, 2010 to:

County of San Luis Obispo
Debbie Belt, GSA - Purchasing
1087 Santa Rosa Street
San Luis Obispo, CA 93408

If you have any questions about the proposal process, please contact me. For technical questions and information contact the District Project Manager, Courtney Howard, at (805) 781-1016 or via email at choward@co.slo.ca.us.

Debbie Belt

DEBBIE BELT
Buyer – GSA - Purchasing
dbelt@co.slo.ca.us

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TO: ALL PROSPECTIVE PROPOSERS
SUBJECT: LOCAL PROPOSERS PREFERENCE

The County of San Luis Obispo has established a local vendor preference. All informal and formal Request for Proposals for contracts will be evaluated with a preference for local vendors. Note the following exceptions:

1. Those contracts which State Law or, other law or regulation precludes this local preference.
2. Public works construction projects.

A "local" vendor will be approved as such when, 1) It conducts business in an office with a physical location within the County of San Luis Obispo; 2) It holds a valid business license issued by the County or a city within the County; and 3) Business has been conducted in such a manner for not less than six (6) months prior to being able to receive the preference.

As of March 3, 1994 individual County Buyers evaluate RFP's (Request For Proposals) considering the local vendor preference described above. The burden of proof will lie with proposers relative to verification of "local" vendor preference. Should any questions arise, please contact a buyer at (805) 781-5200. All prospective proposers are encouraged to quote the lowest prices at which you can furnish the items or services listed in District proposals.

	YES	NO
Do you claim local vendor preference?		
Do you conduct business in an office with a physical location within the County of San Luis Obispo?		
Business Address: ______________________________ ______________________________		
Years at this Address: ______________________________		
Does your business hold a valid business license issued by the County or a City within the County?		
Name of Local Agency which issued license: ______________________________		

Business Name: ______________________________

Authorized Individual: ____________________ Title: ____________________

Signature: ____________________ Dated: ____________________

PROPOSAL SUBMITTAL AND SELECTION

1. All proposals, consisting of four (4) copies, must be received by mail, recognized carrier, or hand delivered no later than 3:00 p.m. on May 19, 2010. Late proposals will not be considered.

2. All correspondence should be directed to:

   San Luis Obispo County
   General Services Agency
   1087 Santa Rosa Street
   San Luis Obispo, CA 93408
   ATTENTION: DEBBIE BELT
   Telephone: (805) 781-5903

3. Costs of preparation of proposals will be borne by the proposer.

4. It is preferred that all proposals be submitted on recycled paper, printed on two sides.

5. Selection of qualified proposers will be by an approved District procedure for awarding professional contracts.

6. This request does not constitute an offer of employment or to contract for services.

7. The District reserves the option to reject any or all proposals, wholly or in part, received by reason of this request.

8. The District reserves the option to retain all proposals, whether selected or rejected. Once submitted, the proposals and any supplemental documents become the property of the District.

9. All proposals shall remain firm for ninety, (90) days following closing date for receipt of proposals.

10. The District reserves the right to award the contract to the firm who presents the proposal which in the judgment of the District, best accomplishes the desired results, and shall include, but not be limited to a consideration of the professional service fee.

11. Selection will be made on the basis of the proposals as submitted. The Selection Committee may deem it necessary to interview applicants. The District retains the right to interview applicants as part of the selection process.

12. The proceedings of the Selection Committee are confidential. Members of the Selection Committee are not to be contacted by the proposers.

PROPOSAL FORMAT

A qualifying proposal must address all of the following points:

1. Project Title

2. Applicant or Firm Name

3. Firm Qualifications – 50% of Total Score

   a. Names and qualifications of personnel to be assigned to this project. Each firm will be evaluated on the experience and education of the key personnel that will be assigned to the Project. (20%)

   b. Outline of recent projects completed that are directly related to this project. Consultant is required to demonstrate specific design and project expertise relating to hydraulic modeling, flow capacity analysis, reporting and the requirements of the Project Scope of Work. Knowledge of the State Water Project is also preferred. (20%)

   c. Qualifications and purpose of subcontractors, or joint venture firm, if appropriate. (5%)

   d. Client references from recent related projects, including name, address and phone number of individual to contact for referral. (5%)

4. Understanding of the Project – 25% of Total Score

   a. Understanding of the objectives of the District and Central Coast Water Authority in conducting this work effort and what needs to be accomplished to meet those objectives. (20%)

   b. Description of information to be provided by the District, Central Coast Water Authority, or other local or state agencies. Indication of additional research/information gathering required and participation/role of District, Central Coast Water Authority and other applicable agencies required. (5%)

5. Approach to the Project – 25% of Total Score

   a. Describe how the project team will approach accomplishing all aspects of the Project Scope of Work. (10%)

   b. Description of the organization and staffing to be used for the project. (10%)

   c. Provide a task completion schedule, estimating the anticipated time frame necessary to complete the Capacity Assessment and Report once a Notice to Proceed is issued. (5%)

6. Fees and Insurance

a. Propose total fixed fees to complete project as described under the Project Scope of Work. Provide a cost proposal containing estimated person-hours and respective billing rates plus other direct costs, structured similarly to the Project Scope of Work and task completion schedule so they may be integrated as exhibits to an agreement. Distinguish costs related to Reach 1 through 6 efforts and costs related to Chorro Valley and Lopez Pipeline efforts as practicable.

b. The selected Consultant shall negotiate with the District to execute an Agreement for Engineering Consulting Services. The District's standard Agreement form is attached as Attachment A.

c. The selected Consultant will be required to provide insurance coverage as shown in Sections 7 and 10 of the attached consultant agreement. This amount of insurance coverage shall be reflected in your estimated professional fee.

d. The Consultant shall provide within five (5) days after the Notice of Award is issued an endorsement of their liability insurance naming the District, San Luis Obispo County, Central Coast Water Authority, California Department of Water Resources, California Men's Colony, City of Morro Bay, and each of their directors, officers, employees and authorized volunteers as additionally named insured. This shall be maintained in full force and effect for the duration of the contract and must be in an amount and format satisfactory to the District.

e. The selected Consultant will need to indemnify the District, San Luis Obispo County, Central Coast Water Authority, California Department of Water Resources, California Men's Colony, City of Morro Bay and each of their directors, officers, employees and authorized volunteers as included in Section 8 and 10 of the attached consultant agreement.

7. Background

The San Luis Obispo County Flood Control and Water Conservation District (District), in coordination with the Central Coast Water Authority (CCWA), is soliciting RFPs for professional services to complete a comprehensive capacity assessment and report for Reaches 1 through 6 of the Coastal Branch of the State Water Project (SWP), and the District's Chorro Valley and Lopez Pipelines.

The Coastal Branch of the SWP serves two SWP Contractors: the Santa Barbara Flood Control and Water Conservation District (via CCWA, a Joint Powers Authority) and the District. Demands for water within the two agencies' service areas, and the reliability of the SWP itself, has reached a point where optimization of the capacity of Reaches 1 through 6 of the Coastal Branch, including the Chorro Valley Pipeline and Lopez Pipeline, has become necessary. First, however, the agencies must understand the capacity of the Coastal Branch.

As a consequence of materials sizing, and other hydraulic factors, it is believed that the capacity of the Coastal Branch may be different from its design capacity. CCWA previously led efforts to quantify the capacity of a majority of the Coastal Branch utilizing a pipeline modeling system with results that supported this belief. This assessment seeks to verify the previous modeling information through additional analysis and potentially development of additional information, and to evaluate the capacity of the Chorro Valley and Lopez pipelines as well.

System Description

The State Water Project encompasses a complex of reservoirs, pumping plants, power plants, canals, and tunnels that are owned and operated by the Department of Water Resources (DWR). This system transports water from the Sacramento-San Joaquin Delta to serve water to contractors in the San Francisco Bay area, the San Joaquin Valley, and Southern California.

As part of the original construction of the State Water Project, DWR constructed Phase I of the Coastal Branch. This portion of the system branches off from the main California Aqueduct in the southwestern corner of Kings County near Interstate 5. The Coastal Branch Phase I is a 15-mile canal that ends near Devils Den in northwestern Kern County.

Phase II of the Coastal Branch pipeline was constructed by DWR between 1995 and 1997 and was designed to supply State Water to the Counties of San Luis Obispo and Santa Barbara. The Phase II Coastal Branch pipeline extends from the terminus of the Phase I Coastal Branch canal to the Tank 5 facility in northern Santa Barbara County. The pipeline's largest diameter is 57 inches between the Devils Den Pumping Plant and Tank 1 and its smallest diameter is 42 inches along the southerly-most 48 miles.

Phase II of the Coastal Branch initially conveys water from the Phase I Coastal Branch canal to the Polonio Pass Water Treatment Plant. This section of pipeline is known as Reach 1 and it includes three pumping plants that are each designed to produce a maximum flow rate of 134 cubic feet per second and a total dynamic head of 555 feet

The Polonio Pass Water Treatment Plant, which is owned and operated by CCWA, receives raw water from Reach 1. Following treatment, the water is discharged to Tank 1, which constitutes the end of Reach 1. From Tank 1, water is discharged to Reaches 2 through 6 of the pipeline to convey treated water to both San Luis Obispo and Santa Barbara Counties. Flow through Reaches 2 through 6 is accomplished by gravity flow only. This section of the pipeline is owned by DWR, however, CCWA operates and maintains it pursuant to an operations and maintenance contract with DWR.

The terminus of the Phase II Coastal Branch is at the Tank 5 facility in northern Santa Barbara County. However, CCWA owns and operates a pipeline to deliver water from Tank 5 to the Lake Cachuma. Water is conveyed through this pipeline by gravity flow to the Santa Ynez Valley. At that point, the water is pumped to Lake Cachuma by the Santa Ynez Pumping Plant, which is owned and operated by CCWA.

Attachments B through E provide summary information on Phase II Coastal Branch pipeline, including design flow capacity, pipe diameters, pipe segment lengths, hydraulic grades, pipeline elevations, etc.

The District owns and operates the pipelines to convey State Water to users within the District via two turn-outs in San Luis Obispo County – Chorro Valley and Lopez. Attachments F and G include maps of these pipelines.

8. Purpose of the Capacity Assessment and Report

The main purpose of the Capacity Assessment and Report is to provide CCWA and the District (the Agencies) with a common understanding of the capacity of the Coastal Branch, including the Chorro Valley and Lopez pipelines, based upon established operational criteria. It is also important to have a common understanding of any facility limitations and what would be required to improve flow capacity. This common understanding will facilitate negotiations regarding the use of any capacity in excess of the design capacity upon which current service contracts are based. This project will consolidate, peer-review, and update as needed, the capacity assessment-related efforts of the individual agencies, and develop new information in order to determine the capacity of the Coastal Branch.

9. Scope of Work

The District and CCWA requires engineering services to evaluate the flow capacity of Reach 1 and Reaches 2 through 6 of Phase II, including the Chorro Valley and Lopez Pipelines, of the Coastal Branch. Capacity analysis of the Treatment Plant is specifically excluded from the Project's Scope of Work. The selected Consultant will work with both the District and CCWA in a collaborative manner. The Project Scope of Work is described below.

Task 1.0: Gather and Assess Existing Information

1.1 Reaches 1 through 6

This includes flow data, existing analyses and reports, historical operations and improvements. Perform a peer review of existing analyses as needed to determine their validity in assessing the capacity of the Coastal Branch. Interview staff of Agencies as needed.

Be advised that CCWA operates Reaches 2 through 6 of the pipeline and utilizes a Supervisory Control and Data Acquisition System. All operating data is archived and will be made available for use for this project.

1.2 Chorro Valley and Lopez Pipelines

This includes flow data, existing analyses and reports, historical operations and improvements. Perform a peer review of existing analyses as needed to determine their validity in assessing the capacity of the Chorro Valley and Lopez Pipelines. Interview staff of Agencies as needed.

Be advised that the District operates the Chorro Valley and Lopez Pipelines. All operating data is archived and will be made available for use for this project.

Task 2.0: Establish Operational Criteria

2.1 Reaches 1 through 6

Work with the District and CCWA, and any additional agencies necessary (i.e. DWR), to establish and document the operational criteria upon which the capacity assessment will be based. These criteria shall relate to peak and off-peak energy-rate pumping, seasonal water delivery peaking, stand-by equipment, time of operation, water treatment plant expansion, factors of safety, operational velocities and head losses, facility deterioration over time and other management considerations. It shall also be necessary to assess capacity under several scenarios using different sets of water delivery schedules.

2.2 Chorro Valley and Lopez Pipelines

Work with the District and any additional agencies necessary to establish and document the operational criteria upon which the capacity assessment for the Chorro Valley Pipeline will be based. These criteria shall relate to peak and off-peak energy-rate pumping, seasonal water delivery peaking, stand-by equipment, time of operation, water treatment plant expansion, factors of safety, operational velocities and head losses, facility deterioration over time and other management considerations. It shall also be necessary to assess capacity under several scenarios using different sets of water delivery schedules.

The hydraulic assessment for the Lopez Pipeline is being conducted by others, and will be made available for review, evaluation and incorporation into this assessment.

Task 3.0: Hydraulic Assessment

3.1 Reaches 1 through 6

Utilize applicable data and operational criteria to conduct a hydraulic assessment of each segment of the Coastal Branch, including flow capacities and any improvements necessary for restoring or improving flow capacity, in order to complete an overall Capacity Assessment and Report.

3.2 Chorro Valley and Lopez Pipelines

Utilize applicable data and operational criteria to conduct a hydraulic assessment of the Chorro Valley Pipeline, by conducting flow tests as needed and including flow capacities and any improvements necessary for restoring or improving flow capacity, in order to complete an overall Capacity Assessment and Report.

The hydraulic assessment for the Lopez Pipeline is being conducted by others, and will be made available for review, evaluation and incorporation into this assessment.

Task 4.0 Meetings

Proposals shall include an estimate of the number of meetings anticipated to be required to complete the Scope of Work. Distinguish meetings related to Reaches 1 through 6 efforts and meetings related to Chorro Valley and Lopez Pipeline efforts as practicable. It is anticipated that there will be a number of coordination meetings associated with the project. These meetings shall include, but are not limited to, the following:

1) Progress Reports/Updates: Provide regular updates to the Agencies via meetings in person, conference calls and/or emails as necessary with associated agendas/minutes/action items.

2) Coordination with other agency consultants who have conducted capacity analyses on specific segments.

3) Present the Public Draft of the report to agencies within the District and members of CCWA that receive State Water.

Task 5.0 Report

Provide interim Technical Memorandums to ensure the approach to completing the Capacity Assessment is understood by the Agencies and consultant. Distinguish reporting related to Reaches 1 through 6 efforts and reporting related to Chorro Valley and Lopez Pipeline efforts as practicable. Provide an Administrative Draft for review by the Agencies prior to submitting a Public Review Draft. Obtain and address comments/recommendations from agencies within the District and members of CCWA that receive State Water in order to provide a Final Report.

10. <u>Accomplishment Schedule</u>

RFPs shall include a schedule and a discussion of the tasks/timeframes necessary to complete the project.

11. <u>Agency-Furnished Information</u>

Information provided by the Agencies during the course of the project may include, but not be limited to, the following:

- Operational Data
- Capacity Studies
- Facility Plans
- Models
- As-Built Plans

ATTACHMENTS

Attachment A:	Template Agreement for Engineering Consulting Services
Attachment B:	Diagram of Coastal Branch
Attachment C:	Hydraulic Grade Line Diagram for Reaches 1 through 6.
Attachment D:	A Summary Table listing flow capacities along pipeline
Attachment E:	A Flow Capacity Analysis Report, Prepared by Penfield and Smith, Prepared for CCWA, Dated June 2005
Attachment F:	Chorro Valley Pipeline
Attachment G:	Lopez Pipeline

ATTACHMENT A

AGREEMENT FOR
ENGINEERING CONSULTING SERVICES
(NON-FEDERAL FUNDING)

THIS AGREEMENT, entered into this ___ day of _________, 20__, by and between the SAN LUIS OBISPO COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT, a political subdivision of the State of California, herein called "DISTRICT," and _____________., a corporation whose address is _________________________ herein called 'ENGINEER."

The DISTRICT department responsible for administering this AGREEMENT is the Department of Public Works, and all written communications hereunder with the DISTRICT shall be addressed to the Director of Public Works.

WHEREAS, the DISTRICT has need for special services and advice with respect to the work described herein; and

WHEREAS, ENGINEER warrants that it is specially trained, experienced, expert and competent to perform such special services;

NOW, THEREFORE, IT IS AGREED by the parties hereto as follows:

1. **Scope of Work.** ENGINEER shall, at its own cost and expense, provide all the services, equipment and materials necessary to complete the work described in Exhibit A, which is attached hereto and incorporated herein by this reference. All work shall be performed to the highest professional standard.

2. **Time for Completion of Work.** No work shall be commenced prior to ENGINEER'S receipt of the DISTRICT'S Notice to Proceed. All work shall be completed no later than ____________________, ____, 20____, provided, however, that extensions of time may be granted in writing by the Director of Public Works of the District, which said extensions of time, if any, shall be granted only for reasons attributable to inclement weather, acts of God, or for other cause determined in the sole discretion of the Director of Public Works of the District to be good and sufficient cause for such extensions.

3. Payment for Services:

a. Compensation. DISTRICT shall pay to ENGINEER as compensation in full for all work required by this Agreement a sum not to exceed the total Agreement amount of $_____________. ENGINEER'S compensation shall be based on actual services performed and costs incurred at the rates set forth for each task in the ENGINEER'S Cost Proposal attached hereto as Exhibit B, and incorporated herein by this reference. Progress payments will be made as set forth below based on compensable services provided and allowable costs incurred pursuant to this Agreement.

b. Reports and Billing Invoices: ENGINEER shall submit to the DISTRICT, on a monthly basis, a detailed statement of services performed and work accomplished during that preceding period, including the number of hours of work performed and the personnel involved. Billing invoices shall be based upon the ENGINEER'S cost proposal attached hereto as Exhibit B. For the purpose of timely processing of invoices, the ENGINEER'S invoices are not regarded as received until the monthly report is submitted. Any anticipated problems in performing any future work shall be noted in the monthly reports. The ENGINEER shall also promptly notify the DISTRICT of any perceived need for a change in the scope of work or services.

4. Accounting Records:

a. ENGINEER shall maintain accounting records in accordance with generally accepted accounting principles. ENGINEER shall obtain the services of a qualified bookkeeper or accountant to ensure that accounting records meet this requirement. ENGINEER shall maintain acceptable books of accounts which include, but are not limited to, a general ledger, cash receipts journal, cash disbursements journal, general journal and payroll journal.

b. ENGINEER shall record costs in a cost accounting system which clearly identifies the source of all costs. Agreement costs shall not be co-mingled with other project costs, but shall be directly traceable to contract billings to the DISTRICT. The use of worksheets to produce billings shall be kept to a minimum. If worksheets are used to produce billings, all entries should be documented and clearly traceable to the ENGINEER'S cost accounting records.

c. All accounting records and supporting documentation shall be retained for a minimum of five (5) years or until any audit findings are resolved, whichever is later. ENGINEER shall safeguard the accounting records and supporting documentation.

d. ENGINEER shall make accounting records and supporting documentation available on demand to the DISTRICT and its designated auditor for inspection and audit. Disallowed costs shall be repaid to the DISTRICT. The DISTRICT may require having the ENGINEER'S accounting records audited, at ENGINEER'S expense, by an accountant licensed by the State of California. The audit shall be presented to the District Auditor-Controller within thirty (30) days after completion of the audit.

5. **<u>Contingency Fund for Changes in Scope of Service.</u>** No change in the character or extent of the work to be performed by ENGINEER shall be made except through a signed written amendment to this Agreement. The amendment shall set forth the proposed changes in work, adjustment of time, and adjustment of the sum to be paid by DISTRICT to ENGINEER, if any. A contingency fund of __________ is hereby created to address such changes to the scope of services and/or completion date. The DISTRICT'S Board of Supervisors hereby delegates to the Director of Public Works and Transportation the authority to sign amendments to this Agreement that make reasonable modifications to the time of performance or the scope of services, provided that all such amendments do not cumulatively exceed the contingency fund. Any other amendments must be approved by the Board. These additional funds are intended to provide the DISTRICT with flexibility to respond to unanticipated events or conditions, and the ENGINEER has no right to make any claim against these funds except as so expressly provided in a written amendment to this Agreement.

6. **<u>Non-Assignment of Agreement.</u>** Inasmuch as this Agreement is intended to secure the specialized services of the ENGINEER, ENGINEER may not assign, transfer, delegate or sublet any interest herein without the prior written consent of DISTRICT and any such assignment, transfer, delegation, or sublease without the DISTRICT's prior written consent shall be considered null and void. This includes revisions to the project team as described in the organization chart (See Exhibit C).

7. **<u>Insurance.</u>** ENGINEER, at its sole cost and expense, shall purchase and maintain the insurance policies set forth below on all of its operations under this Agreement. Such policies shall be maintained for the full term of this Agreement and the related warranty period (if applicable) and shall provide products/completed operations coverage for four (4) years following completion of ENGINEER's work under this Agreement and acceptance by the District. Any failure to comply with reporting provisions(s) of the policies referred to above shall not affect coverage provided to the District, its officers, employees, volunteers and agents. For purposes of the insurance policies required hereunder, the term "District" shall include officers, employees, volunteers and agents of the DISTRICT, individually or collectively.

A. **MINIMUM SCOPE AND LIMITS OF REQUIRED INSURANCE POLICIES**

The following policies shall be maintained with insurers authorized to do business in the State of California and shall be issued under forms of policies satisfactory to the District:

1. **COMMERCIAL GENERAL LIABILITY INSURANCE POLICY ("CGL")**

Policy shall include coverage at least as broad as set forth in Insurance Services Office (herein "ISO") Commercial General Liability coverage. (Occurrence Form CG 0001) with policy limits not less than the following:

$1,000,000 each occurrence (combined single limit);
$1,000,000 for personal injury liability;
$1,000,000 aggregate for products-completed operations; and
$1,000,000 general aggregate.

The general aggregate limits shall apply separately to ENGINEER's work under this Agreement.

2. **BUSINESS AUTOMOBILE LIABILITY POLICY ("BAL")**

Policy shall include coverage at least as broad as set forth in Insurance Services Office Business Automobile Liability Coverage, Code 1 "Any Auto" (Form CA 0001). This policy shall include a minimum combined single limit of not less than One-million ($1,000,000) dollars for each accident, for bodily injury and/or property damage. Such policy shall be applicable to vehicles used in pursuit of any of the activities associated with this Agreement. ENGINEER shall not provide a Comprehensive Automobile Liability policy which specifically lists scheduled vehicles without the express written consent of District.

3. **WORKERS' COMPENSATION AND EMPLOYERS' LIABILITY INSURANCE POLICY ("WC / EL")**

This policy shall include at least the following coverages and policy limits:

1. Workers' Compensation insurance as required by the laws of the laws of the State of California; and
2. Employer's Liability Insurance Coverage B with coverage amount not less than one-million ($1,000,000) dollars each accident / Bodily Injury (herein "BI"); one-million ($1,000,000) dollars policy limit BI by disease; and, one-million ($1,000,000) dollars each employee BI disease.

4. **PROFESSIONAL LIABILITY INSURANCE POLICY ("PL")**

This policy shall cover damages, liabilities, and costs incurred as a result of ENGINEER's professional errors and omissions or malpractice. This policy shall include a coverage limit of at least One-Million Dollars ($1,000,000) per claim, including the annual aggregate for all claims (such coverage shall apply during the performance of the services under this Agreement and for two (2) years thereafter with respect to incidents which occur during the performance of this Agreement). ENGINEER shall notify the District if any annual aggregate is eroded by more than seventy-five percent (75%) in any given year.

B. **DEDUCTIBLES AND SELF-INSURANCE RETENTIONS**

Any deductibles and/or self-insured retentions which apply to any of the insurance policies referred to above shall be declared in writing by ENGINEER and approved by the District before work is begun pursuant to this Agreement. At the option of the District, ENGINEER shall either reduce or eliminate such deductibles or self-insured retentions as respect the District, its officers, employees, volunteers and agents, or shall provide a financial guarantee satisfactory to the District guaranteeing payment of losses and related investigations, claim administration, and/or defense expenses.

C. **ENDORSEMENTS**

All of the following clauses and endorsements, or similar provisions, are required to be made a part of insurance policies indicated in parentheses below:

1. A "Cross Liability", "Severability of Interest" or "Separation of Insureds" clause

(CGL & BAL);

2. The District, San Luis Obispo County, Central Coast Water Authority, California Department of Water Resources, California Men's Colony, City of Morro Bay and each of their officers, employees, volunteers and agents are hereby added as additional insureds with respect to all liabilities arising out of ENGINEER's performance of work under this Agreement (CGL & BAL);
3. If the insurance policy covers an "accident" basis, it must be changed to "occurrence" (CGL & BAL)
4. This policy shall be considered primary insurance with respect to any other valid and collectible insurance District may possess, including any self-insured retention District may have, and any other insurance District does possess shall be considered excess insurance only and shall not be called upon to contribute to this insurance (CGL, BAL, & PL);
5. No cancellation or non-renewal of this policy, or reduction of coverage afforded under the policy, shall be effective until written notice has been given at least thirty (30) days prior to the effective date of such reduction or cancellation to District at the address set forth below (CGL, BAL, WC /EL & PL);
6. ENGINEER and its insurers shall agree to waive all rights of subrogation against the District, its officers, employees, volunteers and agents for any loss arising under this Agreement (CGL); and
7. Deductibles and self-insured retentions must be declared (All Policies).

D. **ABSENCE OF INSURANCE COVERAGE**

District may direct ENGINEER to immediately cease all activities with respect to this Agreement if it determines that ENGINEER fails to carry, in full force and effect, all insurance policies with coverage's at or above the limits specified in this Agreement. Any delays or expense caused due to stopping of work and change of insurance shall be considered ENGINEER's delay and expense. At the District's discretion, under conditions of lapse, the District may purchase appropriate insurance and charge all costs related to such policy to ENGINEER.

E. **PROOF OF INSURANCE COVERAGE AND COVERAGE VERIFICATION**

Prior to commencement of work under this Agreement, and annually thereafter for the term of this Agreement, ENGINEER, or each of ENGINEER's insurance brokers or companies, shall provide District a current copy of a Certificate of Insurance, on an Accord or similar form, which includes complete policy coverage verification, as evidence of the stipulated coverage's. All of the insurance companies providing insurance for ENGINEER shall have, and provide evidence of, a Best Rating Service rate of A VI or above. The Certificate of Insurance and coverage verification and all other notices related to cancellation or non-renewal shall be mailed to:

Courtney Howard, Public Works Department
Room 207, County Government Center
San Luis Obispo CA 93408

8. Indemnification:

a. ENGINEER shall defend, indemnify and hold harmless the District, San Luis Obispo County, Central Coast Water Authority, California Department of Water Resources, California Men's Colony, City of Morro Bay, and each of their officers and employees from all claims, demands, damages, costs, expenses, judgments, attorney fees, liabilities or other losses (hereafter, collectively "claims") that may be asserted by any person or entity, and that arise out of , pertain to, or relate to the negligence, recklessness, or willful misconduct of the ENGINEER. The parties acknowledge that, in addition to whatever other acts or omissions may constitute negligence under applicable law, any act or omission of ENGINEER which constitutes a breach of any duty or obligation under, or pursuant to, this Agreement shall at a minimum constitute negligence, and may constitute recklessness or willful conduct if so warranted by the facts.

b. The preceding paragraph applies to any and all such claims, regardless of the nature of the claim or theory of recovery. For purposes of the paragraphs found in this section 8 of the AGREEMENT, 'ENGINEER" shall include the ENGINEER, and/or its agents, employees, sub-contractors, or other independent contractors hired, by, or directly responsible to, ENGINEER.

c. It is the intent of the parties to provide the DISTRICT, San Luis Obispo County, Central Coast Water Authority, California Department of Water Resources, California Men's

Colony, and the City of Morro Bay the fullest indemnification, defense, and "hold harmless" rights allowed under the law. If any word(s) contained herein are deemed by a court to be in contravention of applicable law, said word(s) shall be severed from this contract and the remaining language shall be given full force and effect. Nothing contained in the foregoing indemnity provisions shall be construed to require ENGINEER to indemnify DISTRICT, San Luis Obispo County, Central Coast Water Authority, California Department of Water Resources, California Men's Colony, and the City of Morro Bay against any responsibility or liability in contravention of Civil Code 2782 or 2782.8.

9. ENGINEER's Responsibility For Its Work.

a. ENGINEER has been hired by the DISTRICT because of ENGINEER's specialized expertise in performing the work described in the attached Exhibit A. ENGINEER shall be solely responsible for such work. The DISTRICT's review, approval and/or adoption of any designs, plans, specifications or any other work of the ENGINEER shall be in reliance on ENGINEER's specialized expertise and shall not relieve the ENGINEER of its sole responsibility for its work. The DISTRICT is under no duty or obligation to review or verify the appropriateness, quality or accuracy of any designs, plans, specifications or any other work of the ENGINEER, including but not limited to, any methods, procedures, tests, calculations, drawings or other information used or created by ENGINEER in performing any work under this Agreement.

b. All information which ENGINEER receives from DISTRICT should be independently verified by ENGINEER. ENGINEER should not rely upon such information unless it has independently verified its accuracy. The only exception to the foregoing arises when the DISTRICT has expressly stated in writing that certain information may be relied upon by the ENGINEER without the ENGINEER's independent verification. In such event, the ENGINEER is still obliged to promptly notify the DISTRICT whenever the ENGINEER becomes aware of any information that is inconsistent with any information which the DISTRICT has stated may be relied upon by the ENGINEER.

10. Insurance and Indemnification as Material Provisions. The parties expressly agree that the indemnification and insurance clauses in this Agreement are an integral part of the performance exchanged in this Agreement. The compensation stated in this Agreement includes compensation for the risks transferred to ENGINEER by the indemnification and insurance clauses.

11. **<u>ENGINEER'S Endorsement on Reports, etc.</u>** ENGINEER shall endorse all reports, maps, plans, documents, materials and other data in accordance with applicable provisions of the laws of the State of California.

12. **<u>Documents, Information and Materials Ownership.</u>** All documents, information and materials of any and every type prepared by the ENGINEER pursuant to this Agreement shall be the property of the DISTRICT. Such documents shall include but not be limited to data, drawings, specifications, reports, estimates, summaries, and such other information and materials as may have been accumulated by the ENGINEER in performing work under this Agreement, whether completed or in process. The ENGINEER shall assume no responsibility for the unintended use by others of any such documents, information, or materials on project(s) which are not related to the scope of services described under this Agreement.

13. **<u>Termination of Agreement Without Cause.</u>** DISTRICT may terminate this Agreement at any time by giving the ENGINEER 20 days written notice of such termination. Termination shall have no effect upon the rights and obligations of the parties arising out of any transaction occurring prior to the effective date of such termination. Other than payments for services satisfactorily rendered prior to the effective date of said termination, ENGINEER shall be entitled to no further compensation or payment of any type from the DISTRICT.

14. **<u>Termination of Agreement for Cause.</u>** If ENGINEER fails to perform ENGINEER'S duties to the satisfaction of the DISTRICT, or if ENGINEER fails to fulfill in a timely and professional manner ENGINEER'S obligations under this Agreement or if ENGINEER shall violate any of the terms or provisions of this Agreement or if ENGINEER, ENGINEER'S agents or employees fail to exercise good behavior either during or outside of working hours that is of such a nature as to bring discredit upon the DISTRICT, then DISTRICT shall have the right to terminate this Agreement effective immediately upon the DISTRICT giving written notice thereof to the ENGINEER. Termination shall have no effect upon the rights and obligations of the parties arising out of any transaction occurring prior to the effective date of such termination. ENGINEER shall be paid for all work satisfactorily completed prior to the effective date of such termination. If DISTRICT'S termination of the Agreement for cause is defective for any reason, including but not limited to DISTRICT'S reliance on erroneous facts concerning ENGINEER'S performance, or any defect in notice thereof, this Agreement shall automatically terminate without cause on the twentieth day following the DISTRICT'S written notice of termination for cause to the ENGINEER, and the DISTRICT'S maximum liability shall not exceed the amount payable to ENGINEER under paragraph 13 above.

15. Compliance with Laws: ENGINEER shall comply with all Federal, State, and local laws and ordinances that are applicable to the performance of the work of this Agreement.

16. Covenant Against Contingent Fees: ENGINEER warrants that it has not employed or retained any company or person, other than a bona fide employee working for ENGINEER, to solicit or secure this Agreement, and that it has not paid or agreed to pay any company or person, other than a bona fide employee, any fee, commission, percent, brokerage fee, gift, or any other consideration, contingent upon or resulting from the award or making this Agreement. For breach or violation of this warranty, DISTRICT shall have the right to annul this Agreement without liability, or, in its discretion to deduct from the Agreement price or consideration, or otherwise recover, the full amount of such fee, commission, percentage, brokerage fee, gift, or contingent fee.

17. Nondiscrimination: ENGINEER shall comply with the regulations relative to nondiscrimination in federally assisted programs of the Department of Transportation, Title 49, Code of Federal Regulations, Part 21, as they may be amended from time to time, which are herein incorporated by reference and made a part of this Agreement.

18. Disputes & Claims:

a. Notice of Potential Claim. The ENGINEER shall not be entitled to the payment of any additional compensation for any act, or failure to act, by the DISTRICT, or for the happening of any event, thing, occurrence, or other cause, unless ENGINEER has provided the DISTRICT with timely written Notice of Potential Claim as hereinafter specified. The written Notice of Potential Claim shall set forth the reasons for which the ENGIINEER believes additional compensation will or may be due, the nature of the cost involved, and, insofar as possible, the amount of the potential claim. The said notice as above required must have been given to the DISTRICT prior to the time that the ENGINEER shall have performed the work giving rise to the potential claim for additional compensation, if based on an act or failure to act by the DISTRICT, or in all other cases within 15 days after the happening of the event, thing, occurrence, or other cause, giving rise to the potential claim. It is the intention of this paragraph that differences between the parties relating to this

Agreement be brought to the attention of the DISTRICT at the earliest possible time in order that such matters may be settled, if possible, or other appropriate action promptly taken. The ENGINEER hereby agrees that it shall have no right to additional compensation for any claim that may be based on any such act, failure to act, event, thing, or occurrence for which no written Notice of Potential Claim as herein required was filed with the DISTRICT Director of Public Works.

b. Processing of Actual Claim. In addition to the above requirements for Notice of Potential Claim, a detailed, Notice of Actual Claim must be submitted in writing to the DISTRICT on or before the date of final payment under this Agreement. All such claims shall be governed by the procedures set forth in section 20104.2 and 20104.4 of the Public Contract Code, except that the word "claim" as used in said sections shall be construed as referring to any claim relating to this Agreement. The ENGINEER shall not be entitled to any additional compensation unless ENGINEER has (1) provided the DISTRICT with a timely written Notice of Actual Claim and (2) followed the procedures set forth in Public Contract Code section 20104.2 and 20104.4.

c. Claim is No Excuse. Neither the filing of a Notice of Potential Claim or of a Notice of Actual Claim, nor the pendency of a dispute or claim, nor its consideration by the DISTRICT, shall excuse the ENGINEER from full and timely performance in accordance with the terms of this Agreement.

19. ENGINEER is an Independent Contractor. It is expressly understood that in the performance of the services herein provided, ENGINEER shall be, and is, an independent contractor, and is not an agent or employee of DISTRICT. ENGINEER has and shall retain the right to exercise full control over the employment, direction, compensation, and discharge of all persons assisting ENGINEER in the performance of the services rendered hereunder. ENGINEER shall be solely responsible for all matters relating to the payment of his employees, including compliance with Social Security, withholding, and all other regulations governing such matters.

20. Entire Agreement and Modification. This Agreement constitutes the entire understanding of the parties hereto. ENGINEER shall be entitled to no other compensation and/or benefits than those specified herein. No changes, amendments or alterations shall be effective unless in writing and signed by both parties. Any changes increasing ENGINEER'S compensation and/or benefits must be approved by the DISTRICT'S Board of Supervisors; any other changes may be signed by the District Director of Public Works on behalf of the

DISTRICT. ENGINEER specifically acknowledges that in entering into and executing this Agreement, ENGINEER relies solely upon the provisions contained in this Agreement and no others.

21. Enforceability. If any term, covenant, condition or provision of this Agreement is held by a court of competent jurisdiction to be invalid, void or unenforceable, the remainder of the provisions hereof shall remain in full force and effect and shall in no way be affected, impaired, or invalidated thereby.

22. Warranty of ENGINEER. ENGINEER warrants that ENGINEER and each of the personnel employed or otherwise retained by ENGINEER for work under this Agreement are properly certified and licensed under the laws and regulations of the State of California to provide the special services herein agreed to.

23. Subcontractors

a. Other than work designated in Exhibits A and B to be performed by other persons, the ENGINEER shall perform the work contemplated with resources available within its own organization and no portion of the work shall be subcontracted without written authorization by the DISTRICT.

b. Any subcontract entered into by ENGINEER relating to this Agreement shall contain all the provisions contained in this Agreement.

c. Any substitution of subcontractors must be approved in writing by the DISTRICT in advance of assigning work to a substitute subcontractor.

24. Applicable Law and Venue. This Contract has been executed and delivered in the State of California and the validity, enforceability and interpretation of any of the clauses of this Contract shall be determined and governed by the laws of the State of California. All duties and obligations of the parties created hereunder are performable in San Luis Obispo County and such County shall be the venue for any action or proceeding that may be brought or arise out of, in connection with or by reason of this Contract.

25. Notices. Any notice required to be given pursuant to the terms and provisions hereof shall be in writing and shall be sent by first class mail to the District at:

Mr. Paavo Ogren, Director
San Luis Obispo County
Flood Control and Water Conservation District
Department of Public Works
County Government Center, Room 207
San Luis Obispo, CA 93408

and to the ENGINEER:

____

____

____

____

26. Cost Disclosure - Documents and Written Reports. Pursuant to Government Code section 7550, if the total cost of this Agreement is over $5,000, the ENGINEER shall include in all final documents and in all written reports submitted a written summary of costs, which shall set forth the numbers and dollar amounts of all contracts and subcontracts relating to the preparation of such documentation or written report. The Agreement and subagreement numbers and dollar amounts shall be contained in a separate section of such document or written report.

27. Findings Confidential. No reports, maps, information, documents, or any other materials given to or prepared by ENGINEER under this Contract which DISTRICT requests in writing to be kept confidential, shall be made available to any individual or organization by ENGINEER without the prior written approval of DISTRICT.

28. Restrictive Covenant. ENGINEER agrees that he will not, during the continuance of this Agreement, perform or otherwise exercise the services described in Exhibit A for anyone except for the DISTRICT, unless and until said DISTRICT waives this restriction.

29. Quality Control and Quality Assurance. ENGINEER shall provide a description of its Quality Control procedure. The process shall be implemented for all facets of work and a QC-QA statement and signature shall be placed on all submittals to the DISTRICT.

IN WITNESS THEREOF, DISTRICT and ENGINEER have executed this Agreement on the day and year first hereinabove set forth.

IN WITNESS THEREOF, the parties hereto have executed this Agreement, and this Agreement shall become effective on the date shown signed by the San Luis Obispo County Flood Control and Water Conservation District.

SAN LUIS OBISPO COUNTY
FLOOD CONTROL AND WATER
CONSERVATION DISTRICT

Date:____________ _____, 20__

By:____________________________
Chairperson of the Board
San Luis Obispo County Flood
Control and Water Conservation
District
State of California

ATTEST:

____
County Clerk and Ex-Officio Clerk of the
Board of Supervisors, San Luis Obispo County
Flood Control and Water Conservation District,
State of California

Date:__________________, 20__

ENGINEER

Date:____________ _____, 20__

By:____________________________

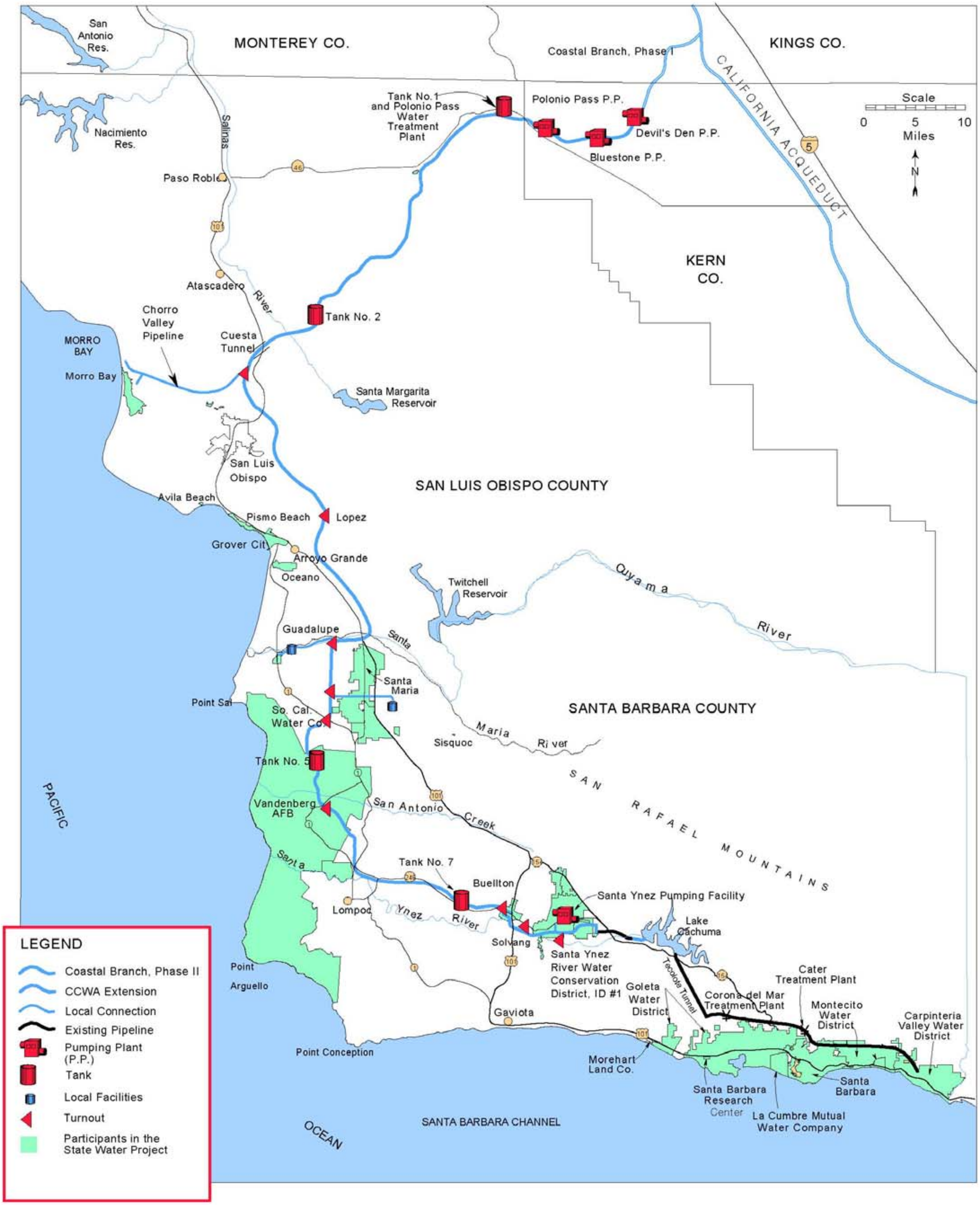
Title:___________________________

APPROVED AS TO FORM AND LEGAL EFFECT:
WARREN R. JENSEN
District Counsel

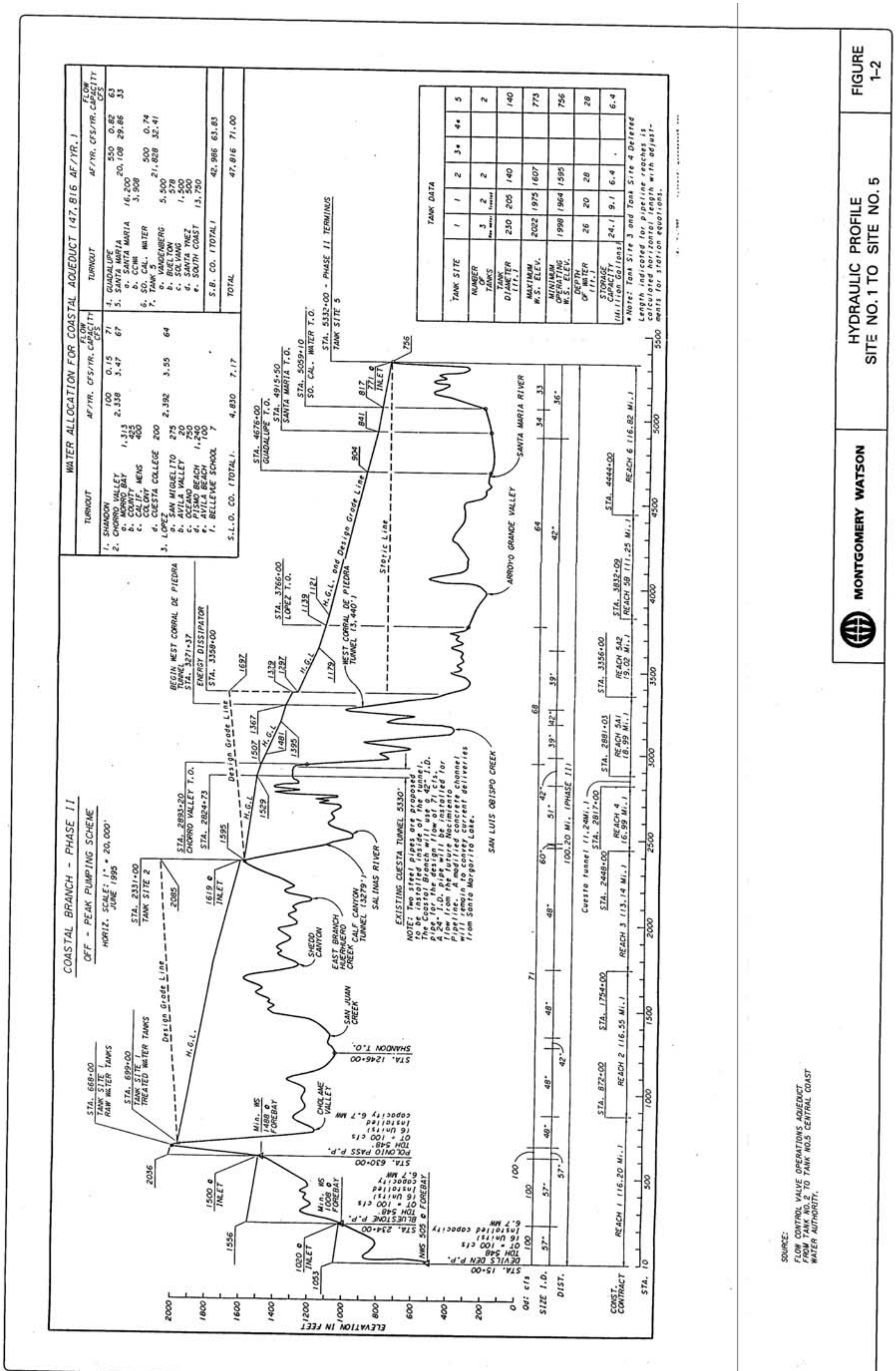
By:____________________________________
Deputy District Counsel

Date:__________________________________

ATTACHMENT B – Diagram of Coastal Branch



ATTACHMENT C – HYDRAULIC GRADE LINE DIAGRAM



ATTACHMENT D – SUMMARY TABLE FLOW CAPACITIES ALONG PIPELINE

TABLE 1-1
SUMMARY OF PROJECT FACILITIES

Facility/Name	Owner	Type[1]	Size/Number	Rated Capacity
Treatment Plant:				
Polonio Pass	CCWA	Conventional	1	43 mgd
Pipelines:				
Reach 1 (TW)	DWR	Steel[2]	48-inch	71 cfs
Reach 2	DWR	Steel[2]	48-inch	71 cfs
Reach 3	DWR	Steel[2]	48-inch	71 cfs
Reach 4	DWR	Steel[2]	51-inch	71 cfs
Reach 5A1	DWR	Steel[2]	42-inch	68 cfs
Reach 5A2	DWR	Steel[2]	42/39-inch	68 cfs
Reach 5B	CCWA	Steel[3]	42-inch	64 cfs
Reach 6	CCWA	Steel[3]	42-inch	33 cfs
Schedule A	CCWA	Steel[3]	39 inch	35/26 cfs
Schedule B	CCWA	Steel[3]	36 inch	26cfs
Schedule C	CCWA	Steel[4]	36 inch	26/22 cfs
SYID#1	CCWA	CCP[5]	30 inch	22 cfs
Tanks:				
No. 1 (TW)	DWR	Concrete	2 @ 205 ft	9.1 mgal
No. 2	DWR	Concrete	2 @ 140 ft	6.4 mgal
No. 5	CCWA	Concrete	2 @ 128 ft	5.0 mgal
No. 7	CCWA	Concrete	1 @ 128 ft	2.5 mgal
Pumping Plant:				
Santa Ynez	CCWA	Vert. Turbine	5 @ 5.5 cfs (4 duty, one standby)	22 cfs

TW = Treated Water.

(1) All pipe is mortar-lined.

Pipe Coatings:

(2) Coal Tar Enamel.

(3) Tape.

(4) Mortar.

(5) Concrete.

ATTACHMENT E

Pipeline System Modeling
Tank 1 to Santa Ynez Pump Facility
Definition of Available Extra Capacity

June 2005

Central Coast Water Authority

Penfield & Smith
ENGINEERS • SURVEYORS • PLANNERS

Central Coast Water Authority
Pipeline System Modeling
Tank 1 to Santa Ynez Pump Facility
Definition of Available Additional Capacity

Summary

This model development and calibration effort is in response to the desire of CCWA to have a high level of confidence regarding available additional capacity in the State Water pipeline from Tank 1 to its Santa Ynez Pump Facility.

The CCWA pipeline from Tank 1 to the Santa Ynez Pump Facility forebay (approximately 124 miles) was modeled using a series of Excel spreadsheets. The model was calibrated using data from the peak flows that occurred during July and September 2004 (flow out of Tank 1 over 70 cfs).

The model is based on the Hazen Williams formula which is used in all water system models. The C-factors used in the Hazen Williams formula generally range from 135 to 153 for mortar lined pipe. The C factors associated with the CCWA pipeline are shown in Table 1 below.

Table 1: Summary of C Factors

CCWA and DWR Design:	**135 throughout**
Model Calibration:	**150-156 upstream of Tank 5** **135 downstream of Tank 5**
Recommended:	**150 upstream of Tank 5** **135 downstream of Tank 5**

The difference in the C factors in the two portions of the pipeline appears to be a function of the alignment and valves along the pipeline and not the surface lining. For example, the DWR section of the pipeline is generally much straighter with fewer valves than the CCWA section of pipeline. The CCWA pipeline has numerous mitered turns and a series of isolation valves associated with avoiding large spills on chloraminated water into endangered species habitat. These miter turns and valves increase losses in the pipeline resulting in the relatively lower C factor. The entire pipeline with a couple of minor exceptions is mortar lined steel pipe.

One area of concern regarding the calibration effort is that the calibration relies heavily on pressure readings along the pipeline. During the calibration process we used five sets of pressure data from the following points:

Upstream of the Energy Dissipation Valve (EDV)
Downstream of the Energy Dissipation Valve (EDV)
At the SYID#1 Turnout

To confirm the accuracy of the model we used the calibrated model to calculate the pressures at the various turnouts. The results are shown below.

Table 2: Confirmation of Model Accuracy

Turnout	Pressure Reading Actual psi	Pressure Calculated by Model psi	Difference psi
Chorro	418	425	-7
Lopez	313	307	+6
Guadalupe	297	296	+1
Santa Maria	261	266	-5
SoCAL	265	268	-3
VAFB	17	17	0
Buellton	120	98	+22
Solvang	69	68	-1
SYID#1	40	40	0
Date	7-12-04		
Flow Tank 2	68.7	68.7	
Flow to Cachuma	18.8	18.8	
C Factor		150,150,135	

The model accurately estimated the pressure at the turnouts to within 1 to 2 percent except for the Buellton turnout. CCWA staff are investigating the data associated with the Buellton turnout pressure.

To further confirm the model calibration and accuracy we put the collected data into a WaterCad model. The WaterCad model was based on the modeling work done by Montgomery Watson in the 1990's. The WaterCad model duplicated the results obtained from the spreadsheet model. The simplicity and accuracy of the spreadsheet model for this single pipeline system, make it the best model to accurately and quickly run a variety of flow scenarios.

During the design of the pipeline during the early 1990s there was some concern that the C factor would degrade over time as the flow of water inside of the pipe caused the lining to become rougher. Our research has determined that the mortar lined pipe industry has now concluded that unless water velocities exceed approximately 14 feet per second, the mortar on the inside of the pipe will not become rougher over time. Based on the highest flows possible through the smallest portions of the pipeline, the worst case scenario involves 81 cfs through a short 42" diameter section of pipe with a water velocity of approximately 8.5 feet per second. Since the velocity of water in the pipeline is generally less than

6 feet per second, no roughening of the inside of the pipe is anticipated. Therefore the C factors estimated at this point in time should be good for the life of the pipe.

Based on our calibration work, our familiarity with the pipeline, our research, standard C-factors for pipes with the same lining and these test results we have a high level of confidence that the model reasonably calculates the friction losses along the pipeline and can be used to estimate maximum flows and pressures in the water line.

Results

The calibrated spreadsheet model was used to calculate maximum flows through the pipeline based on several criteria.

First flow data associated with CCWA entitlements and drought buffer were put into the model using a conservative C factor of 135 throughout the pipeline. This flow data is summarized in **Table 3: CCWA Turnout Demand Flows for Modeling Purposes**. The model confirmed that the CCWA water system can deliver to the turnouts all entitlements plus the drought buffer associated with each turnout. The flow rates assume that the CCWA pipeline will only be available 11 months each year due to downtime for maintenance.

The next model run used the C factor of 135 throughout to estimate additional capacity in the pipeline. This model run estimated that an additional 1.5 cfs of water could be added to the pipeline between Tank 1 and the Lopez Turnout. Additional capacity was not available below Tank 5. The 1.5 cfs is equivalent to 1,000 acre feet per year with one month of downtime for maintenance.

The next model run used a C factor of 150 above Tank 5 and 135 below Tank 5 as estimated during the calibration process. This model run estimated an additional 13.7 cfs of water could be added to the pipeline between Tank 1 and the Lopez Turnout (above entitlements plus drought buffer). Additional capacity was not available below Tank 5. The 13.7 cfs is equivalent to 9,100 acre feet per year with one month of downtime for maintenance.

The next model run was used to estimate the additional amount of water that could be removed from the pipeline in the Santa Maria Valley with 1.5 cfs removed from the pipeline at the Lopez turnout. This model run also used a C factor of 150 above Tank 5 and 135 below Tank 5 as estimated during the calibration process. The model estimated that an additional 7.5 cfs could be added to the pipeline between Tank 1 and Santa Maria Valley (in addition to the 1.5 cfs for Lopez). Additional capacity was not available below Tank 5. The 7.5 cfs to the Santa Maria Valley is equivalent to approximately 5,000 acre feet per year with one month of downtime for maintenance.

Table 3: CCWA Turnout Demand Flows For Modeling Purposes

PROJECT TURNOUT	Entitlment AFY	Drought Buffer AFY	Entitlement Plus Drought Buffer AFY	Turnout Raw cfs* cfs	Peak Turnout Demand ** cfs	Peak Turnout Demand gpm
PPWTP - Tank 1						
Tank 2						
Chorro	2,438		2,438	3.37	3.67	1,649
Energy Dissipation Valve						
Lopez	2,392		2,392	3.30	3.60	1,618
City of Guadalupe	550	55	605	0.84	0.91	409
City of Santa Maria	16,200	1,620	17,820	24.61	26.85	12,052
SCWC	500	50	550	0.76	0.83	372
Tank 5						
Vandenberg AFB	5,500	550	6,050	8.36	9.12	4,092
Tank 7						
City of Buellton	578	58	636	0.88	0.96	430
Santa Ynez ID#1 (Solvang)	1,500		1,500	2.07	2.26	1,014
Santa Ynez ID#1 ***	500	200	700	0.97	1.05	473
Pump Facility						
Lake Cachuma	13,750	1,375	15,125	20.89	22.79	10,229
Goleta WD	4,500					
Morehart Land Company	200					
La Cumbre Mutual WC	1,000					
Raytheon Systems Co.	50					
City of Santa Barbara	3,000					
Montecito WD	3,000					
Carpinteria Valley WD	2,000					
CCWA Subtotal	39,078					
SLOCFC&WCD Subtotal	4,830					
TOTAL	43,908	3,908	47,816	66	72.1	32,339

* AFY/724=cfs
**Raw cfs /11 months * 12 months (one month downtime)=Demand cfs
1 cfs for 1 year = 724 acre-feet per year
1 cfs for 11 months = 664 acre-feet per year
1 cfs = 448.83 gpm
***The Exchange Agreement allows SYID#1 to divert flow that would go to Lake Cachuma to its turnout during the summer months. This modeling effort assumes that the extra amount going to SYID#1 will not exceed the amount that would otherwise go to Lake Cachuma. Therefore the net result is that to upstream users there is no change in the demand downstream of SYID#1.

The last two columns of the table show the flow rates needed to deliver the base entitlement and drought buffer in 11 months leaving one month for maintenance downtime.

Note that the friction losses between Lopez turnout and the Santa Maria Valley (approximately 22 miles) means that more additional water can be taken out of the pipeline at Lopez Turnout than at the Santa Maria turnout.

A separate model run was made to estimate the additional amount of water that could be removed from the pipeline in the Santa Maria Valley with 2.3 cfs removed from the pipeline at the Lopez turnout (1,500 AFY). The model estimated that an additional 7.1 cfs could be added to the pipeline between Tank 1 and Santa Maria Valley (in addition to the 2.3 cfs for Lopez). Additional capacity was not available below Tank 5. The 7.1 cfs to the Santa Maria Valley is equivalent to approximately 4,700 acre feet per year with one month of downtime for maintenance.

Finally a model run was made to estimate the additional amount of water that could be removed from the pipeline in the Santa Maria Valley with no water removed from the pipeline at the Lopez turnout. The model estimated that an additional 8.4 cfs could be added to the pipeline between Tank 1 and Santa Maria Valley. Additional capacity was not available below Tank 5. The 8.4 cfs to the Santa Maria Valley is equivalent to approximately 5,600 acre feet per year with one month of downtime for maintenance.

Table 4: Model Run Results Additional Capacity Available

C Factor of 135 Throughout 124 Mile Pipeline

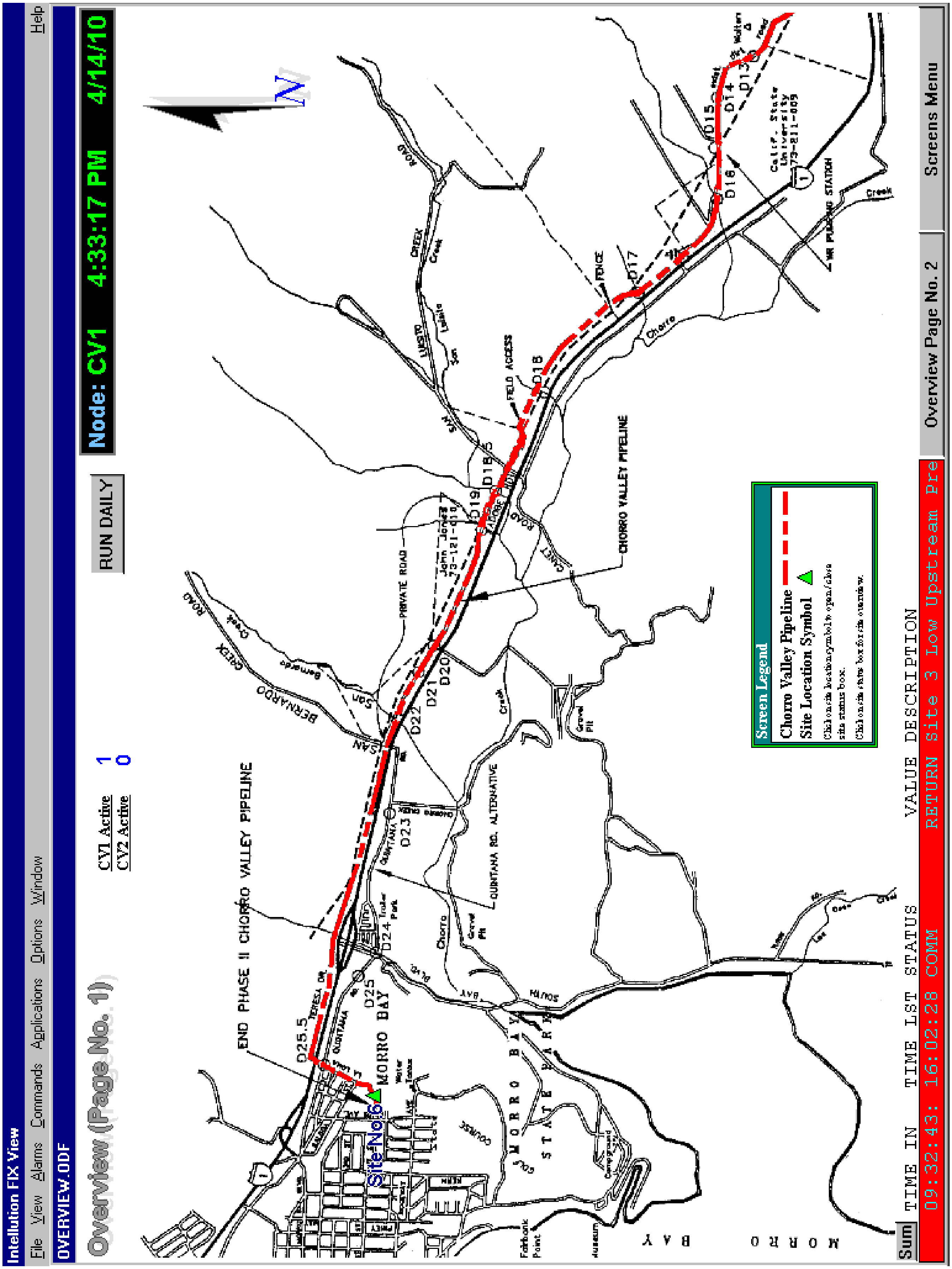
Entitlement with Drought Buffer &
Additional 1.5 cfs (1,000 AFY) to Lopez

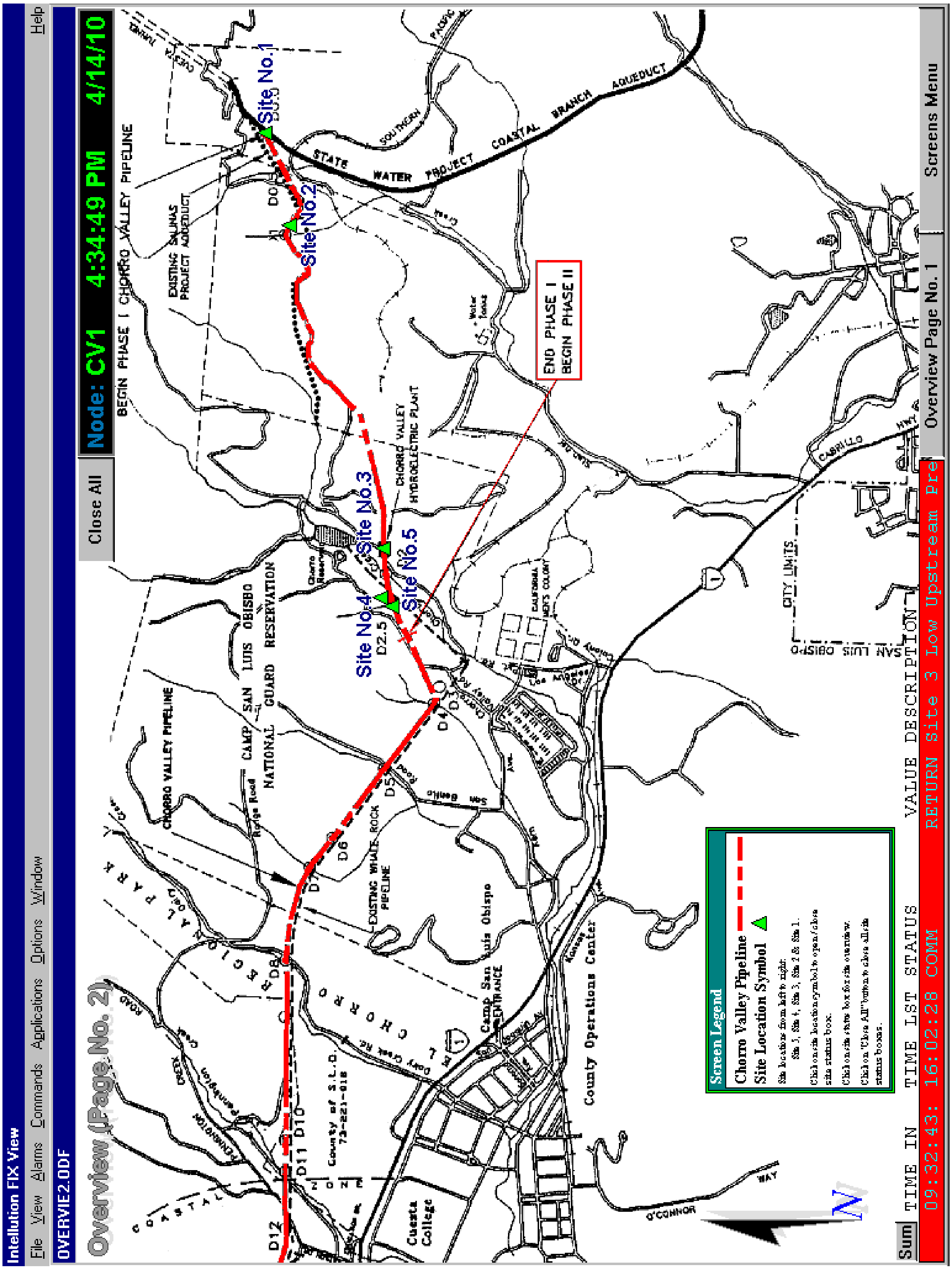
C Factor of 150 Upstream of Tank 5

Additional 13.7 cfs (9,100 AFY) to Lopez
or
Additional 1.5 cfs (1,000 AFY) to Lopez &
7.5 cfs (5,000 AFY) to Santa Maria Valley
or
Additional 2.3 cfs (1,500 AFY) to Lopez &
7.1 cfs (4,700 AFY) to Santa Maria Valley
or
Additional 8.4 cfs (5,600 AFY) to Santa Maria Valley

Additional capacity not available below Tank 5

ATTACHMENT F – CHORRO VALLEY PIPELINE

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Site No.2
Site No.3
Site No.4
Site No.5
END PHASE I
BEGIN PHASE II
BEGIN PHASE I CHORRO VALLEY PIPELINE
EXISTING SALINAS PROJECT AQUEDUCT
STATE WATER PROJECT COASTAL BRANCH AQUEDUCT
CHORRO VALLEY HYDROELECTRIC PLANT
CAMP SAN LUIS OBISPO NATIONAL GUARD RESERVATION
CHORRO VALLEY PIPELINE
EXISTING WHALE ROCK PIPELINE
CALIFORNIA MEN'S COLONY
CITY LIMITS
SAN LUIS OBISPO
County Operations Center
Cuesta College
O'CONNOR WAY
D12
D11
D10
D8
D7
D6
D5
D4
D2.5
Screen Legend
Chorro Valley Pipeline
Site Location Symbol
Overview Page No. 1
Screens Menu
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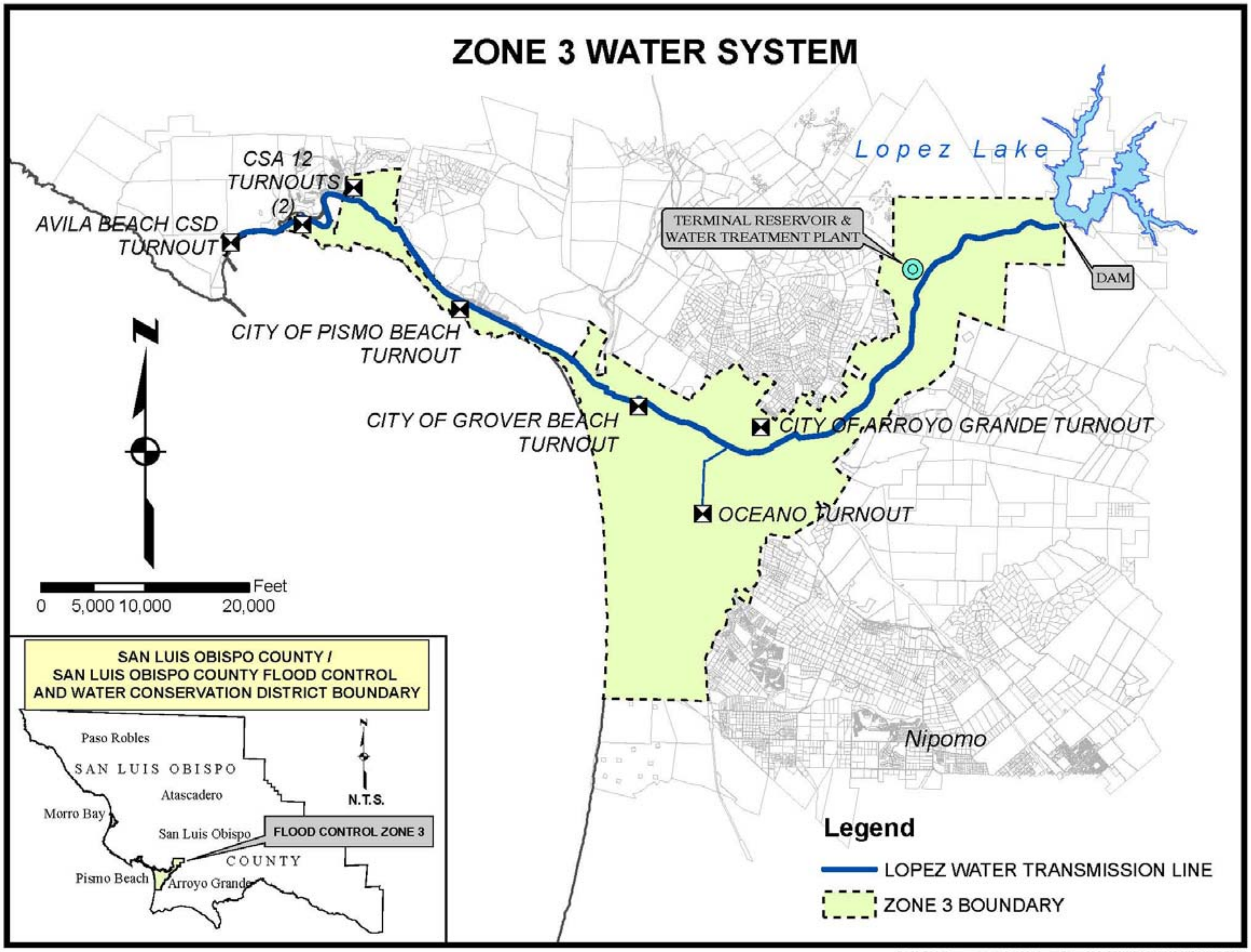
Sum

ATTACHMENT G – LOPEZ PIPELINE



FCZ3.PDF Prepared 11/15/2005 by D.Rion SLO COUNTY PUBLIC WORKS DEPT.

APPENDIX C. WORKSHOP AND MEETING NOTES

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Coastal Branch Capacity Assessment Kickoff Meeting

Date:	9/21/10
Time:	8:00 – 10:00 AM
Location:	WSC
Attendees:	Courtney Howard, John Brady, Drew Dudley, Jeff Szytel, Jeroen Olthof, Dan Heimel, Dylan Wade, Jason Meeks, Josie Gastelo, Bill Cook, Rudolf Vargas, Katie McQuaid (sign-in sheet attached)

Discussion Topics

1. Review goals and objectives of the capacity assessment
    a. Primary goal of the capacity assessment is to determine the feasibility of increasing SWP project imports to the Central Coast through the Coastal Branch pipeline, thereby optimizing the use of the existing infrastructure. This additional capacity would be utilized by existing SWP contractors and potentially by new customers.
    b. The County and CCWA expect that the Coastal Branch has additional capacity above and beyond DWR's design capacity. The Central Coast Water Authority (CCWA) previously contracted Penfield & Smith to complete a preliminary capacity evaluation in June 2005 and is looking to refine the analysis to develop a firm understanding of the pipeline capacity.
    c. The County and CCWA are expecting a thorough and detailed analysis, so that they can be very certain of capacity.
    d. The Coastal Branch pipeline is an import piece of infrastructure for the Central Coast and detailed information about its location and its operation needs to be protected. All information is to remain confidential among the project participants.
        i. WSC will tailor its reports and associated appendixes in coordination with the County of San Luis Obispo (County) and the CCWA to ensure that this information is not released as public record.

2. Roles, responsibilities, and lines of communication
    a. WSC
        i. Jeff Szytel – Project Manager for WSC. He is the engineer in responsible charge of the project and is the primary point of contact for the County and CCWA. He will ensure that Courtney and John are included on any communications related to the capacity assessment.
        ii. Dan Heimel – responsible for data acquisition and analysis, development of the GIS files and hydraulic model files, and supporting Jeroen in conducting the hydraulic analysis.
    b. HDR
        i. Jeroen Olthof – Project Engineer in charge of developing the model and performing the hydraulic analysis on the Coastal Branch pipeline

c. County
    i. Courtney Howard - Project Manager and the primary point of contact for County
    ii. Charlie Berna – Chorro Valley pipeline operations
    iii. Dean Benedix - Utilities Manager for the County, primarily interested in the interface between this project and the Lopez Pipeline capacity analysis
    iv. Kari Graton – assisting with development of delivery schedules and scenario development
d. CCWA
    i. John Brady – primary point of contact for CCWA
    ii. Andrew Dudley – overseeing development of GIS files for the Coastal Branch pipeline and associated pipeline data
    iii. Tom Peterson – operations manager of the Coastal Branch pipeline and will be involved in the execution of the flow test
    iv. Larry Seiford (sp?) is the superintendent for calibration and repair
e. CMC
    i. Katie McQuaid - Operations Manager, will coordinate data request(s)
    ii. Jason Meeks – Operator of CMC system and involved in flow testing
    iii. Rudolf Vargas – Supervisor
    iv. Josie Gastelo
    v. Bill Cook – resident "guru" will support project team
f. Morro Bay
    i. Dylan Wade – primary point of contact and will oversee flow testing

3. Scope and Schedule
    a. WSC presented a copy of the current project schedule (copy attached)
    b. The schedule for the capacity assessment may need to be adjusted to ensure that relevant flow data can be collected and a thorough hydraulic analysis of the pipeline can be completed. The capacity analysis will be an iterative process that may require additional flow testing after the development of the model in order to create the best possible hydraulic model of the pipeline. Dylan Wade stated that he would prefer that the project not be rushed to meet a deadline. Courtney Howard added that this project may not be limiting factor in pursuing additional state water deliveries on the Central Coast.
    c. The Coastal Branch pipeline is currently scheduled to be shutdown on November 1st for a 3 week period. This partially conflicts with the current schedule for this project and will require that flow testing be complete before the shutdown. None of the agencies at the meeting thought that this was an unobtainable goal, but there was consensus that the test should be conducted well in-advance of the shutdown to allow agencies time to recover.
    d. CCWA is currently performing leak repairs downstream of Tank 5, and there will not be any deliveries to Cachuma until October
    e. The Operation Criteria Development workshop could be pushed back to allow preliminary modeling work to be completed first.

4. Data Availability
    a. GIS data for the Coastal Branch pipeline is currently under development. Certain stretches of the pipeline are complete and ready for analysis. However, other sections do not have thorough construction drawings and are taking longer to develop. Alignment for the entire length of pipeline is currently available. Below is listed the status of the different pipeline sections.
        i. Polonio Pass to Tank 2 - complete
        ii. Lopez turnout (+/- STA 33+76) to Tank 5 – complete
        iii. Tank 2 to Lopez turnout - in progress
        iv. Devil's Den to Polonio Pass – to be completed next week
    b. Detailed flow data for the Coastal Branch pipeline is currently available through the CCWA's SCADA system. The SCADA system has an extensive amount of data from historical pipeline operations. WSC will provide the CCWA with criteria to query the database for relevant data. John Brady thought that data points at midnight might provide the best picture of steady state operations.
        i. Due to allocation restrictions, the previous water year encompassed a wide range of flows through the Coastal Branch pipeline. The flows ranged from 5 to 43 MGD (near capacity of the treatment plant) throughout the year. Due to the wide range of flows the data should be ideal for calibrating the model. The group discussed calibrating the model based on recent data, then comparing the predicted results with historical observations to observe how the capacity/condition of the pipeline has changed over time.
    c. To obtain pipeline and operational data for Reach 1 of the pipeline, the CCWA will draft a letter to Rick Sanchez (DWR). The DWR previously responded to data requests with a relatively quick turnaround time (2 weeks).
    d. WSC requested as-built construction drawings for the Morro Bay tank farm to enable the tanks to be modeled as fixed hydraulic grade reservoirs in the pipeline model. Dylan Wade stated that as-builts were available and provide them to WSC.
    e. Rick Meeks has best information for capacity of the Chorro Valley pipeline

5. Flow Testing
    a. The goals of the flow testing are to obtain flow and pressure data for the pipeline over a wide range of flows to calibrate pipeline friction factors. The historical data can provide adequate data for low and average flow rates, but may not be sufficient to characterize the operations of the pipeline at or near maximum capacity.
    b. Flow Test Preparation
        1. To ensure that the data obtained from the flow test is accurate, it would be beneficial for pressure transducers, pressure gages, and flow meters be calibrated prior to the flow test.
        2. The location of all flow meters and pressure gages should be established prior to the flow test to allow WSC to develop data sheets for field personnel.
        3. Santa Maria and the Lopez WTP and other involved agencies must be contacted prior to the flow test to ensure that sufficient water storage capacity is available for the flow test.

4. WSC will compile flow test ideas presented at the kickoff meeting and forward them onto the group for refinement.
5. John Brady described some basic questions for the flow test:
    a. Should the upstream tank elevations be held constant?
    b. How should the EDV be operated?
    c. Two EDVs or one?
6. WSC stressed the importance for the County and CCWA to consider valve opening and closing times to avoid dangerous pressure transients during the flow test

c. Due to the complexity of the Coastal Branch and associated pipelines, one of the strategies proposed was to perform flow test on individual sections of the pipeline at different times. The following sections have been proposed for individual flow tests.
    i. Tank 1 to Tank 2
        1. Flow test could be completed by raising the level in Tank 1 and dropping the level in Tank 2 to ensure a high rate of flow between the two tanks. The CCWA currently operates the tanks at constant water levels controlled by pressure reducing sleeve valves at the tank inlet(s). For the flow test the operations of the tanks may need to be modified to push additional water through the pipeline.
    ii. Tank 2 to Tank 5
        1. The energy dissipating valve (EDV) located between Tank 2 and Tank 5 will require special consideration for the development of the flow test through this section of pipeline.
            a. The EDV controls flow between Tank 2 and Tank 5 by maintaining tank elevation in Tank 5
            b. The EDV structure is comprised of 2 sleeve valves. Currently only one sleeve valve is operated at one time. If it is determined that the sleeve valves are limiting the capacity of the pipeline then SCADA changes would be required to allow both sleeve valves to be operated simultaneously. This may require further flow test.
            c. Operation of EDV must be performed carefully to ensure that the max operating pressure of the Coastal Branch pipeline is not exceeded.
            d. Additionally, the duration of the flow test must be sufficient to ensure that the opening and closing times of the EDV do not prevent the pipeline from reaching a steady state condition during the flow test.
        2. One proposed flow test procedure for this section of the pipeline would be to lower Tank 7 and flow as much water as possible through this section of pipeline and through Tank 5. This proposal would allow the sleeve valves to operate as normal.
        3. Lopez and Santa Maria would need to increase deliveries during the test.

4. Pressure data is available upstream and downstream of the EDV and thus the EDV could be modeled as a hydraulic brake if needed. Meaning that it could be modeled independently upstream and downstream of the valve.
5. The flow test for this section of pipeline is tentatively scheduled for 10/20/10. The CCWA and the County will contact the appropriate agencies to determine if this date is feasible.

iii. Chorro Valley Pipeline

1. A proposed flow testing procedure for this section of pipeline would be to lower the Morro Bay and CMC tanks water levels and the fill them from the Coastal Branch Tank 2. Tank 2 would be operated at a constant water level and a high HGL.
2. Morro Bay would prefer Chorro Valley pipeline flow test to be completed this year because they have excess water available.
3. Morro Bay currently operates their tanks in batch mode, but could change their operation mode for the flow test.
4. Water from CMC turnout flows directly to CMC Tank 5 (3 MG) and then to CMC Tank 1 if level in CMC Tank 5 reaches a certain level. For modeling the CMC Tank 5 HGL will be used as a fixed hydraulic grade to determine the flow capacity of the Chorro Valley pipeline.
5. The flow test for the Chorro Valley pipeline is tentatively scheduled for 10/13/10. Wednesdays are the best day to perform flow tests on the Chorro Valley pipeline.

6. Modeling Scenarios
   a. Courtney asked for input in developing the modeling scenarios for the capacity assessment. CMC and Morro Bay offered to provide her with several delivery scenarios for future increased SWP deliveries.

7. Action Items
   a. WSC
      i. Develop preliminary conceptual flow test plan for each pipeline section and distribute to the group for refinement
      ii. Provide CCWA with guidance for extracting historical flow data from the SCADA system
   b. County
      i. Prepare draft modeling scenarios based on data received from CMC and Morro Bay
      ii. Contact the Lopez WTP about the upcoming Coastal Branch flow test
   c. CCWA
      i. Develop a list of flow meters, pressure transducers, and pressure gages for the Coastal Branch pipeline and turnouts
      ii. Prepare letter to DWR requesting data for Reach 1of the Coastal Branch pipeline.
      iii. Contact Santa Maria about the upcoming Coastal Branch flow test

d. Morro Bay
    i. Provide WSC with as-built drawings and vertical datum for the Morro Bay tank farm and associated piping
    ii. Provide Courtney with peak delivery schedules for anticipated future SWP deliveries
e. CMC
    i. Provide Courtney with peak delivery schedules for anticipated future SWP deliveries
f. All Agencies
    i. Calibrate and/or replace all pressure transducers, pressure gages, and flow meters to be used during the upcoming flow tests

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Chorro Valley Flow Test Meeting

Date:	10/18/10
Time:	1:30 – 3:00 PM
Location:	County Offices

Discussion Topics

1. Flow Test Objectives
    a. To capture steady state flow and pressure data from the Chorro Valley pipeline over a wide range of flows for use in developing a calibrated model.
2. Flow Test Plan
    a. The Chorro Valley pipeline flow test will contain 4 different flow Test Groups (Table 1).
    b. Test Group #1 readings will be recorded prior to any adjustments to the pipeline FCVs. It will be assumed that the pipeline is at steady state at the time of the first recordings.
    c. All time sensitive actions will be performed on Verizon time. Those agencies without Verizon cell phones must synchronize their time to Verizon time.
    d. At the times listed in (Table 1), the Site 3 (CCWA) and Site 5a (County) FCVs will be adjusted to attempt to reach each Test Group's target flow rate.
        i. Site 3 will adjust its FCV first and will contact Site 5a once finished.
        ii. Site 5a will then adjust its FCV until the prescribed flow rates are reached.
        iii. If the flow rates listed in the flow test plan are unobtainable then Site 3 and Site 5a will coordinate and settle on an obtainable flow rate.
    e. Once the changes to the FCVs have been completed the pipeline flows will be allowed to stabilized.
    f. Flow and pressure readings will be recorded after each Test Group has run for a approximately 1 hr. Readings will be taken every minute for ten minutes.
3. Personnel and Site Locations
    a. Personnel will be stationed at the following locations
        i. Site 1 – Mark (County)
            1. Recording pressure upstream and downstream of the isolation valve.
        ii. Site 3 – CCWA Operator
            1. Recording pressure upstream and downstream of the FCV (sleeve).
        iii. Site 5a – County Operator
            1. Recording pressure upstream and downstream of the FCV (butterfly), flow meter, and globe valve.
        iv. Blow-off/Air Relief Valve near 12" to 10" contraction – Megan (County)
            1. Recording pipeline pressure.
        v. Site 6 – Morro Bay Operator
            1. Recording pressure upstream and downstream of the flow meter and globe valve, and collecting flow data.
        vi. County SCADA - Charlie (County)

            1. Recording Site 4 (CMC) and Site 5 (Morro Bay) flow rates.
        vii. CCWA SCADA – Tom (CCWA)
            1. Adjusting the Site 3 FCV and recording CCWA flow rates.
        viii. Roaming – Courtney (County)
            1. Providing assistance as needed during the flow test.

4. Action Items
    a. WSC
        i. Provide updated flow test plan and distribute it for review.
    b. County
        i. Investigation location for pressure gage near the 12” to 10” contraction.
        ii. Verify the accuracy of pressure gages located at Site 1 and 5a.
            1. Record pressure readings during steady state period to help establish criteria for steady state conditions.
    c. CCWA
        i. Verify the accuracy of the pressure gages located at Site 3.
            1. Record pressure readings during steady state period to help establish criteria for steady state conditions.
        ii. Synchronize SCADA time with Verizon time.
    d. Morro Bay
        i. Verify the accuracy of the pressure gages located at Site 6.
            1. Record pressure readings during steady state period to help establish criteria for steady state conditions.
    e. CMC
        i. Synchronize SCADA time with Verizon time and prepare to collect Tank #5 data for the duration of the flow test.

Table 1. Chorro Valley Flow Test Plan

Test Group	Activity	Start Time	End Time	Flow Rate Targets CCWA (gpm)	CMC (gpm)	MB (gpm)
1	Record 10 (1 minute interval) readings	8:50 AM	8:59 AM	1,425?	712?	712?
2	Adjust CCWA (Site 3) FCV	9:00 AM	9:10 AM	2,500	1,250	1,250
	Adjust County (Site 5a) FCV	9:10 AM	9:20 AM			
	Record 10 (1 minute interval) readings	9:50 AM	9:59 AM			
3	Adjust CCWA (Site 3) FCV	10:00 AM	10:10 AM	3,500	2,000	1,500
	Adjust County (Site 5a) FCV	10:10 AM	10:20 AM			
	Record 10 (1 minute interval) readings	10:50 AM	10:59 AM			
4	Adjust CCWA (Site 3) FCV	11:00 AM	11:10 AM	2,000	1,000	1,000
	Adjust County (Site 5a) FCV	11:10 AM	11:20 AM			
	Record 10 (1 minute interval) readings	11:50 AM	11:59 AM			

Capacity Required (gal)	622,050	343,992	277,992

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Data Review and Model Development Workshop

Date:	11/22/10
Time:	9:00 – 11:00 AM
Location:	WSC
Attendees:	Courtney Howard, John Brady, Jeff Szytel, Jeroen Olthof, Dan Heimel, Sasa Tomic, Charlie Berna

Discussion Topics

1. Project Schedule
    a. The capacity assessment is currently progressing on schedule. The critical path moving forward is the completion of the Coastal Branch pipeline preliminary calibration and the coordination of the Coastal Branch flow tests.
    b. Operational Criteria Questionnaires – CCWA will continue to complete questionnaire and attempt to return it to WSC by 12/3/10.
2. Scenario Development Workshop – Courtney said the Scenario Development workshop is tentatively scheduled for 12/7/10 at 1 PM and that has been confirmed.
    a. WSC will develop a preliminary agenda for the Scenario Development workshop and will distribute it to Courtney and John for review.
    b. Courtney and John will review their current delivery schedules and contracts to develop preliminary scenarios to be evaluated during the Scenario Development Workshop.
        i. The initial scenario will be to determine the highest percentage increase in deliveries that can be achieved with the existing infrastructure.
3. Chorro Valley Pipeline
    a. The initial calibration of the Chorro Valley pipeline has been completed using data from the flow test completed on 10/20/10. During the calibration process, it is theorized that some appurtenance is affecting the head losses within the pipeline downstream of Site 5a at different flow rates. This appurtenance is preventing the model from being calibrated for high and low flow rates. Currently, the model is calibrated for high flow rates and shows negative pressures at low flow rates.
        i. The County will investigate the altitude valve located at Site 6 to determine if it is opening and closing based on the flow rate in the pipeline. This could be the cause of the abnormal head losses seen at low flows during the flow test.
        ii. The County will provide WSC with cut sheets for the globe valves, inspection reports, and any valve position data from the SCADA.
4. Coastal Branch Pipeline
    a. The model of the Coastal Branch pipeline has been developed within WaterGEMS and is ready for preliminary calibration with historical data.
        i. 4 flow rates covering the full range of flows seen during historical data period will be selected for the preliminary calibration.

        ii. CCWA will provide WSC with a new download of Tank 2 historical data, resend Tank 1 data, and provide clarification on the elevation and operating height of the Tank 5 tanks.
    b. DWR data requests are still outstanding.
5. Coastal Branch Flow Test
    a. WSC and HDR will use the preliminary calibrated model to estimate pressures within the pipeline. These pressures will then be checked against the pipe pressure class to ensure they are within the design specifications.
        i. It is anticipated that overall the pressures will decrease within the pipeline at higher flow rates due to higher head losses. However, downstream of the EDV may see higher pressures as the head loss through the sleeve valve is decreased as the valve is opened.
    b. CCWA and the County will notify customers of a potential increase in turbidity within the pipeline during the flow test.
6. Capacity Assessment
    a. One approach for determining capacity assessment will be to calculate turnout HGLs and flow rates under the proposed scenarios. SWP customers may then need to modify their turnouts to receive these flow rates.
    b. The DWR pump stations were designed to pump off-peak and thus if allowed to pump on-peak should not be a limiting factor in the Coastal Branch pipeline.
7. Action Items
    a. WSC
        i. WSC will develop a preliminary agenda for the Scenario Development workshop and will distribute it to Courtney and John for review.
        ii. WSC and HDR will use the preliminary calibrated Coastal Branch pipeline model to estimate flow test pressures within the pipeline. These pressures will then be checked against the pipe pressure class to ensure they are within the design specifications.
    b. CCWA
        i. John will review CCWA's current delivery schedules and contracts to develop preliminary scenarios to be evaluated during the workshop.
        ii. CCWA will provide WSC with a new download of Tank 2 historical data, resend Tank 1 data, and provide clarification on the elevation and operating height of the Tank 5 tanks.
        iii. CCWA will continue to complete Operational Criteria Questionnaire and attempt to return it to WSC by 12/3/10.
    c. County
        i. Courtney will review the County's current delivery schedules and contracts to develop preliminary scenarios to be evaluated during the workshop.
        ii. The County will provide WSC with cut sheets, inspection reports, and any valve position data from the SCADA for the globe valves along the Chorro Valley pipeline.

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Scenario Development Workshop

Date:	12/7/10
Time:	1:00 – 3:00 PM
Location:	WSC's Office
Attendees:	Daniel Heimel, John Wallace, Peter Sevcik, Jason Meeks, Dean Benedix, Courtney Howard, Dwayne Chisam, Dan Migliazzo, Rick Koon, Jeff Szytel, Joe Rappa, Jerry Hartzell, Jim Garing, Dylan Wade, Michael Randall, John Brady

Discussion Topics

1. Project Goals
    a. The goal of the Coastal Branch Capacity Assessment project is to determine the water conveying capacity of the upper section of Coastal Branch pipeline, extending from the Devil's Den pumping plant to Tank #5. The capacity determination will be achieved through the development of a GIS-based hydraulic model for Coastal Branch, Chorro Valley, and Lopez pipelines.
2. Workshop Goals
    a. The goal of the Scenario Development Workshop is to develop different water delivery scenarios that will be used to assess the capacity of the Coastal Branch pipeline.
3. Existing SWP Contract Data
    a. The Courtney Howard, with the County of San Luis Obispo (County), provided a summary of existing State Water Project (SWP) sub-contractors allocations, for those agencies located within the County.
        i. Under the existing contracts, the maximum instantaneous delivery rate is the annual allocation divided over a 12 month time period.
        ii. There is a provision in the contract that allows for deliveries in excess of the contract delivery rates if extra conveyance capacity is available within the pipeline. This allows SWP sub-contractors to receive their full allocation, while accounting for the annual shutdowns of the Coastal Branch pipeline.
        iii. Over the past several years, the deliveries to San Luis Obispo County sub-contractors have been less than the allocation due the following reasons:
            1. Agencies choosing not to receive their full allocation (ie. Shandon, Avila Beach, Pismo Beach et al.)
            2. Department of Water Resources (DWR) allocations have been less than 100%.
            3. John Brady (CCWA) provided a summary of the San Luis Obispo sub-contractors flow rates for the previous 4 years.

Year	Chorro Deliveries (AF)	Lopez Deliveries (AF)	Total SLO County Deliveries (AF)
2010	1607	1709	3316
2009	2078	1723	3801
2008	2200	1204	3404
2007	2142	1634	3776

b. The CCWA provided a summary of historical flows and contract allotments for subcontractors located within Santa Barbara County. See meeting handouts.

4. Available SWP Supply
    a. The County has a contract with DWR for 25,000 AFY of SWP allocation (Table A). Currently, 4,830 AFY is allotted to sub-contractors with an additional 4,897 AFY reserved by sub-contractors as drought buffer. The remaining County allocation not currently allocated to sub-contractors is 15,273 AFY.
        i. Historically, the County's remaining ("excess") allocation has been used to allow County SWP sub-contractors to receive their full allocation in years when the DWR allocation is less than 100%.
            1. However, in 2008 and 2009 emergency "dry year" conditions were declared and the County was able to enter into an agreement to sell a portion of their excess allocation to the CCWA. Under this agreement, County sub-contractors were allowed the right of first refusal for the excess allocation.
5. Projected Demands for SWP supply
    a. Courtney Howard (County) provided a detailed summary of all of the requests that she has received for additional SWP allocation (attached).
6. Hydraulic Conditions
    a. WSC provided a preliminary summary of the hydraulic limitations within the Coastal Branch, Lopez, and Chorro Valley pipelines. This summary discussed findings from the Lopez pipeline capacity assessment and preliminary findings from the Chorro Valley pipeline flow test.
        i. Lopez Pipeline
            1. Previous hydraulic analysis indicates that the capacity of the Lopez pipeline is limited by the available head and that the maximum capacity is 707 AF/Month.
        ii. Chorro Valley Pipeline
            1. The flow tests completed on the Chorro Valley pipeline indicate that the maximum flow for the pipeline is ~3500 gpm. At this flow rate the pressure relief valve at Site 3 opened to relieve pressure downstream of the sleeve valve.
            2. The maximum flow rate that Morro Bay could achieve during the flow test was approximately ~1150 gpm.
        iii. Coastal Branch Pipeline
            1. Preliminary analysis indicates that there is ample pressure available within the pipeline and that the flow capacity will be restricted by the pipeline pressure and velocity ratings.

7. Capacity Assessment Delivery Scenarios
    a. Courtney Howard developed draft delivery scenarios designed to determine the maximum capacity of the Coastal Branch, Lopez, and Chorro Valley pipelines (attached).
    b. Table 1 provides a summary of the scenarios selected, during the workshop, to be included in the capacity assessment.

Table 1. Summary of Delivery Scenarios (AFY)

Delivery Scenario	Scenario Parameters	Chorro Valley Turnout (CVTO)	Lopez Turnout (LPTO)	Santa Barbara County Turnouts (SBC TO)
Existing	Existing Contract Flows	2338[1]	2492	43560
1	Maximum equal % increase	2338 + X%[2]	2492 + X%	43560 + X%
2	Max % increase at CVTO, Maintain equal % increase	2338 + Y%[3]	2492 + X%	43560 + X%
3	Max % increase at LPTO, Maintain equal % increase	2338 + X%	2492 + Y%	43560 + X%
4	Max % increase at SBC TO, Maintain equal % increase	2338 + X%	2492 + X%	43560 + Y%
5	Max % increase at LPTO w/CVTO Increase	2338 + Z%[4]	2492 + Y%	43560
6	Max % increase at SBC TO w/CVTO Increase	2338 + Z%	2492	43560 + Y%
7	Max % increase at LPTO and SBC TO w/ CVTO increase	2338 + Z%	2492 + Y%	43560 + Y%
8	Max % increase at Shandon, Maintain equal % increase	2338 + X%	2492 + X%	43560 + X%

    c. The guidelines for the capacity assessment will be to determine the maximum capacity of the Coastal Branch, Lopez, and Chorro Valley pipelines. This capacity will be for the pipeline and will not reflect the capacity of the individual turnouts. Therefore, the analysis will focus on the pipelines' ability to deliver the water and not the ability for each of the turnouts to receive the water. The modeling effort will identify bottlenecks, but will not include potential infrastructure improvements.

[1] All units are acre-foot per year (AFY)
[2] X% means equal increase from Scenario 1
[3] Y% means maximum increase
[4] Z% means highest remaining increase

8. Action Items
    a. WSC will use the scenarios selected in the Scenario Development Workshop to assess the capacity of the Coastal Branch, Chorro Valley, and Lopez pipelines.

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Progress Report Meeting #1

Date:	10/8/10
Time:	1:30 PM
Location:	WSC's Office
Attendees:	Courtney Howard, John Brady, Drew Dudley, Jeff Szytel, Dan Heimel

Discussion Topics

1. Project status update
   a. WSC
      i. The Chorro Valley pipeline layout has been developed in GIS and the hydraulic model developed in WaterGEMS. WSC and HDR will begin calibration of the pipeline once it can verify the appurtenances located in CCWA's Chorro Valley vault (Site 3). A tour of the vault and other local CCWA facilities is currently scheduled for Tuesday 10/12/10 at 7:00 AM.
      ii. The Coastal Branch pipeline GIS data has been obtained from the CCWA and is currently ready for review.
2. Planned activities
   a. The Chorro Valley pipeline flow test is currently scheduled for 10/20/10 with a pre-meeting is scheduled for 10/18/10 at 1:30.
3. Outstanding informational needs
   a. CCWA received notification that Don Kurasaka (GEI?) has requested data from DWR. WSC will reiterate to GEI that all DWR data requests should originate from the CCWA.
   b. CCWA provided an update on the status of their DWR request. They have received word from DWR (Terry Becker) that their request will be processed next week.
4. Operational Criteria/Scenario Development Workshop
   a. It was determined that the content of the Operation Criteria Workshop should include operating scenarios and involve the retail agencies. The workshop will not be limited to the development of engineering criteria for the operation of the pipeline. Courtney will provide WSC with input on when she feels that the County and its retailers are ready to participate in the Operational Criteria Workshop.
5. Velocity and Pressure Restrictions
   a. WSC and GEI will determine the maximum capacity for individual sections of the Coastal Branch and Chorro Valley pipelines by reviewing the design criteria reports and through interviews with operating agency staff. Velocity and pressure restrictions from the design criteria reports will be primary source for determining the maximum capacity of the pipeline sections.
   b. WSC and GEI will develop a list of questions relating to pipeline capacity analysis and distribute them to the operating agencies. Follow-up interviews will be performed if necessary.

c. If the design criteria reports do not provide velocity criteria, CCWA will assist in their development by using the original pipeline thrust equations for Reaches 5b and 6.
d. GEI will prepare a Pipeline Operation Technical Memorandum that will summarize the velocity and pressure restrictions, staff interviews, and thrust calculations.

6. WTP Analysis
   a. WSC will not perform a detailed analysis on the capacity of the Polonio Pass WTP. CCWA will provide WSC with a copy of the CDPH permit and a memo detailing potential expansion capability. This information will be used to determine if the treatment plant is a limiting factor in the Coastal Branch pipeline.
7. Chorro Valley Flow Test
   a. WSC will provide Courtney with flow test targets for the Chorro Valley Flow Test once a calibrated model and preliminary velocity and pressure restrictions have been developed.
      i. If the velocity and pressure restrictions are not available in the design materials for the Chorro Valley pipeline, then industry standard velocity and pressure criteria will be used.
8. Coastal Branch Flow Test
   a. CCWA has stated that it would prefer to perform the flow test from Tank 2 to Tank 5 by filling Tank 5. The flow test will used to evaluate the upper capacity of the pipeline as there is extensive data available for the existing flow rates.
      i. CCWA stated that changes to the pipeline flow rate are typically made between 7 and 10 AM. Any historical data used for the preliminary calibration should be utilized outside of this time window.
9. Action Items
   a. WSC
      i. WSC will provide Courtney with flow test targets once a calibrated model and preliminary pipeline operational criteria have been developed.
   b. GEI
      i. GEI will review design materials and interview operating agency staff to develop velocity and pressure restrictions for the Chorro Valley and Coastal Branch pipelines
      ii. GEI will prepare a Pipeline Operation Technical Memorandum that will summarize the findings from the design reports and staff interviews.
   c. County
      i. Courtney will provide input to WSC on when she would like to schedule the Operational Criteria/Scenario Development workshop.
   d. CCWA
      i. CCWA will provide WSC with a copy of the Polonio Pass WTP CDPH permit and a memo detailing potential expansion capability.
      ii. CCWA will provided WSC with photos of pertinent infrastructure along the Coastal Branch pipeline.

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Progress Report Meeting #2

Date:	11/9/10
Time:	10:00 AM
Location:	WSC's Office
Attendees:	Courtney Howard, John Brady, Jeff Szytel, Dan Heimel

Discussion Topics

1. Project status update
   a. WSC
      i. Chorro Valley pipeline flow test is complete and HDR is using the data to develop a calibrated model.
         1. Courtney to look for information on the County's meters at Site 4 and 5 and provide it to WSC.
      ii. GIS model of the Coastal Branch pipeline with elevation data is nearing completion. WSC is currently waiting on piping diagrams for the Polonio Pass WTP and information from DWR for the pumping plants.
         1. John will provide WSC with Polonio Pass drawings
2. Review Outstanding Data Needs
   a. John contacted Terry Becker (DWR) and received word that CCWA's data request will be processed shortly.
      i. DWR will scan the construction drawings for the pipeline and send them electronically.
      ii. Terry told John that the pumping plants were designed with 33% extra capacity to take advantage of off-peak electricity rates.
         1. Pumping stations were also designed with an additional 10% capacity to account for degradation and to allow catch-up pumping.
3. Engineering Operational Criteria Questionnaire
   a. WSC will finalize three versions of the questionnaire, one for each operating agency, and distribute them to CCWA and the County for completion.
   b. WSC requests that CCWA completes their portion of the questionnaire by 11/19/10 for use in developing the Coastal Branch flow test plan.
4. Data Review and Model Development workshop
   a. The workshop is scheduled for 11/22/10 and will be used to discuss model calibrations and any outstanding data gaps.
   b. WSC will provide CCWA and the County with a draft agenda prior to the workshop.
5. Scenario Development workshop
   a. WSC will send out proposed dates for the Scenario Development Workshop.
   b. The County and CCWA will work on developing draft scenarios that will be distributed to all parties prior to the workshop.
   c. WSC will provide CCWA and the County with a draft agenda for the workshop.
6. Action Items
   a. WSC

   i. WSC will send out proposed dates for the Scenario Development Workshop.
   ii. WSC will finalize three versions of the questionnaire, one for each operating agency, and distribute them to CCWA and the County.

b. County
   i. Courtney to look for information on the County's meters at Site 4 and 5 and provide it to WSC.
   ii. The County and CCWA will work on developing draft scenarios that will be distributed to all parties prior to the workshop.

c. CCWA
   i. John will provide WSC with Polonio Pass drawings.
   ii. The County and CCWA will work on developing draft scenarios that will be distributed to all parties prior to the workshop.

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Progress Report Meeting #3

Date:	12/14/10
Time:	10:00 AM
Location:	WSC's Office
Attendees:	Courtney Howard, John Brady, Jeff Szytel, Dan Heimel, Drew Dudley

Discussion Topics

1. Project status update
    a. WSC
        i. Preliminary calibration for the Coastal Branch pipeline has been completed. QA/QC on the pipeline calibration will be performed later this week by Sasa Tomic (HDR).
        ii. Chorro Valley Pipeline model cannot be calibrated due to the hydraulic anomaly observed in the section of pipeline from Site 5a to Site 6.
2. CCWA Flow Tests
    a. Coastal Branch pipeline flow tests-The Coastal Branch flow tests were scheduled for early December and are needed to perform the final calibration of the Coastal Branch pipeline model.
        i. CCWA stated that it would schedule the flow tests for the Coastal Branch pipeline for the week of December 20th.
            1. The CCWA will contact its sub-contractors to inform them of the flow test and the possibility of increased turbidity during the flow test.
            2. John Brady stated that the sleeve valve at Tank No. 2 has been fully opened in the past and it did not cause turbidity issues. However, the EDV has not previously been fully opened and the flow test from Tank No. 2 to Tank No. 5 may result in increased turbidity.
            3. CCWA will query its SCADA database to determine the highest flow rate that through the EDV and will provide WSC with one year of historical data (September 2009 to September 2010) for the operating position of the EDV sleeve valve.
        ii. WSC will develop HGL profiles for the following two flow scenarios to enable the CCWA to compare anticipated flow test pressures with pipeline pressure class.
            1. Rated capacity of the pipeline
            2. Maximum anticipated capacity of the pipeline
3. Chorro Valley pipeline model
    a. Chorro Valley pipeline calibration-The hydraulic anomaly detected during the Chorro Valley Pipeline flow test is preventing the model's final calibration.
        i. WSC is developing a memo for the County that details the results of the Chorro Valley pipeline hydraulic anomaly. The memo will contain the current calibration results and recommended action items to help determine the source of the anomaly.

1. John suggested that there is a point downstream of Site 5a in which there may be negative pressures within the pipeline. A malfunctioning air relief/vacuum release valve could be allowing air into the pipeline creating open channel flow conditions.
2. WSC will incorporate comments from the Progress Report Meeting #3 into the memo and will prioritize the memo's recommendations.
3. WSC will provide the County and Morro Bay with the hydraulic anomaly memo on Tuesday, December 14, 2010.

4. Coastal Branch pipeline model
    a. WSC and HDR have completed the preliminary calibration of the Coastal Branch pipeline from Tank No. 2 to Tank No. 5. It is expected that HDR will complete the calibration QA/QC later this week.
        i. John Brady pointed out that throttling of the sleeve valves to control tank levels may affect the preliminary calibration results
            1. John suggested that scatter plots showing observed pressure versus model pressure be developed to assist the model calibration.
    b. WSC will update the Coastal Branch model to fix the default (0 ft) elevations for newly added pipeline junctions.
5. Action Items
    a. WSC will develop HGL profiles for the following two flow scenarios to enable the CCWA to compare anticipated flow test pressures with pipeline pressure class.
        i. Rated capacity of the pipeline
        ii. Maximum anticipated capacity of the pipeline
    b. WSC will provide the County and Morro Bay with the hydraulic anomaly memo on Tuesday, December 14, 2010.
    c. WSC will update the Coastal Branch model to fix the default (0 ft) elevations for newly added pipeline junctions.

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Progress Report Meeting #4

Date:	1/11/11
Time:	10:00 AM
Location:	WSC's Office
Attendees:	Courtney Howard, John Brady, Jeff Szytel, Dan Heimel, Drew Dudley

Discussion Topics

1. Chorro Valley pipeline model status update
    a. WSC
        i. WSC & HDR have completed their analysis of the Chorro Valley pipeline and submitted a technical memorandum to the County summarizing the hydraulic anomaly in the downstream section of the pipeline.
            1. Courtney Howard reported that Charlie Berna (County) stated that the pipeline does not flow full under low flow conditions. Thus, the pipeline could be flowing under open channel conditions and could explain the abnormal head losses seen in this section of pipeline.
                a. WSC will investigate methods for modeling the downstream section of the Chorro Valley pipeline as an open channel under low flow conditions.
                b. Pressure below 5 psi within sections of the Chorro Valley pipeline presents a water quality hazard. This low pressure could be addressed by modifying the altitude valve at Site 6 to operate as a pressure-sustaining valve.
2. Coastal Branch pipeline flow test update
    a. The critical path item for the completion of the Coastal Branch Capacity Assessment is the completion of the Coastal Branch pipeline flow test.
        i. WSC will begin developing an outline and writing-up the background information for the technical memorandum to attempt to limit the impact that the delayed flow test will have on the project schedule.
        ii. CCWA is concerned that performing the planned flow test on the Coastal Branch pipeline will lead to increased water age within the pipeline. This increased water age could contribute to an existing nitrification problem and degrade the water quality within the pipeline.
            1. Analysis of historical flow rates showed that the maximum flow rate predicted by the model exceeded any historical flow rates within the Coastal Branch pipeline and thus performing the flow tests would provide new data that would be beneficial for model calibration.
            2. CCWA will also evaluate flow testing only the section of pipeline from Tank 2 to Tank 5 or limiting the maximum flow rate of the flow test as alternatives to the originally scheduled flow test.

a. It was determined that if the flow test was limited to one section of pipeline, the pipeline section from Tank 2 to Tank 5 was the highest priority.

3. CCWA will compare the model HGL data provided by WSC with the pipeline pressure class for the different sections of the pipeline to ensure that the pipe pressure does not exceed the pressure class during the flow test. Barlow's equation will be used to calculate the pressure rating for sections of pipeline without defined pressure class.
4. CCWA will to analyze the volume of water that would be required for the flow test and determine if it feasible given the concern over nitrification. The CCWA will send an e-mail to WSC and the County with the results of this analysis and the status of the flow tests.

3. Coastal Branch pipeline model status report
   a. The results of Sasa Tomic's (HDR) model calibration indicate that the model cannot accurately predict pipeline pressures at the Lopez turnout. Under high flow conditions the model over predicts the HGL at the Lopez turnout when compared to the observed values.
      1. CCWA will provide WSC with SCADA data for the EDV, Lopez turnout, Santa Maria turnout, and the Isolation Valve #1 from September 2008 to September 2010.
      2. WSC will analyze the historical data to ensure that the pressures used for model calibration are consistent with pressures seen at similar flow rates at other times of the year.
      3. CWWA will investigate the location and status of the pressure transducers and the flow meter at the Lopez turnout.
      4. The County will investigate the possibility of obtaining historical flow data from the County flow meter at the Lopez turnout.
   b. Several of the turnouts in the Coastal Branch pipeline model required elevation adjustment to provide better correlation between modeled and observed pressures. The most significant elevation change was 13 ft, which was seen between Tank 1 and Tank 2.
      i. WSC will verify that the elevations used in the model, obtained from the CCWA Coastal Branch Operations Manual match the as-built drawings for Tanks 1 and 2.
      ii. CCWA will review Sasa Tomic's e-mail and provide any comments on the proposed changes to the pipeline model.
4. DWR Data Request Status Update
   a. John Brady stated that he had not received complete responses to the data request that was submitted to DWR.
   b. CCWA will contact DWR about the status of the data request.
5. County request for Coastal Branch pipeline alignment GIS data
   a. CCWA will review its security policy and contact DWR to determine if it can distribute coastal branch pipeline alignment GIS data.
   b. WSC could modify the County's schematic to include the proper alignment of the Coastal Branch pipeline. This would enable the County's schematic to be updated without distributing the GIS files.

6. Action Items
   a. WSC
      i. WSC will analyze the historical data to ensure that the pressures used for model calibration are consistent with pressures seen at similar flow rates at other times of the year.
      ii. WSC will investigate methods for modeling the downstream section of the Chorro Valley pipeline as an open channel under low flow conditions.
      iii. WSC will verify that the elevations used in the model, obtained from the CCWA Coastal Branch Operations Manual, match the as-built drawings for Tanks 1 and 2.
      iv. WSC will begin developing an outline and writing-up the background information for the technical memorandum to attempt to limit the impact that the delayed flow test will have on the project schedule.
   b. CCWA
      i. CCWA will to analyze the volume of water that would be required for the flow test and determine if it feasible given the concern over nitrification. The CCWA will send an e-mail to WSC and the County with the results of this analysis and the status of the flow tests.
      ii. CCWA will compare the model HGL data provided by WSC with the pipeline pressure class for the different sections of the pipeline to ensure that the pipe pressure does not exceed the pressure class during the flow test.
      iii. CCWA will provide WSC with SCADA data for the EDV, Lopez turnout, Santa Maria turnout, and the Isolation Valve #1 from September 2008 to September 2010.
      iv. CWWA will investigate the location and status of the pressure transducers and the flow meter at the Lopez turnout.
      v. CCWA will contact DWR about the status of the data request.
      vi. CCWA will review Sasa Tomic's e-mail and provide any comments on the proposed changes to the pipeline model.
   c. County
      i. The County will investigate the possibility of obtaining historical flow data from the County flow meter at the Lopez turnout.

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Progress Report Meeting #5

Date:	2/08/11
Time:	10:00 AM
Location:	WSC's Office
Attendees:	Courtney Howard, John Brady, Jeff Szytel, Dan Heimel, Drew Dudley

Discussion Topics

1. Review of project schedule
    a. The project schedule was updated to reflect the completion of the Coastal Branch pipeline flow test. To accommodate Courtney's maternity leave the submission date for the Admin Draft Report was moved to 3/11/11. This allows for additional review time and the potential for presenting the Public Draft Technical Memorandum at the April WRAC Meeting.
        i. Whether or not the Draft TM is presented at the April WRAC meeting (4/6/11) is dependent upon the level of comments received from the County and the CCWA. If the Draft TM requires extensive edits then it will be presented at the June WRAC Meeting (6/11/11). The May WRAC meeting is not an option as Jeff is not available that week.
    b. WSC will tentatively schedule Review Meeting #1 for 3/30/11 to receive comments on the TM from the County and CCWA.
    c. John Brady will contact Bill Brennan (CCWA) to determine if a public presentation is necessary for San Barbara County (CCWA Ops Committee?).
    d. WSC will distribute the outline for the Technical Memorandum to the County and the CCWA for comments.
    e. At the next Progress Report Meeting, Courtney plans to introduce the County personnel that will assume the project manager roles during her maternity leave.
        i. Courtney anticipates that Tom Trott and Eric Laurie will take over in her absence.
2. Results of the Coastal Branch pipeline flow test
    a. The Coastal Branch pipeline was performed on 1/20/11 and flow rates up to 72.8 cfs were achieved through the EDV.
    b. The EDV flow control valve was opened to approximately 85% and held steady for 20 minutes to obtain accurate flow and pressure data at the peak flow rate.
        i. Pressure downstream of the EDV was the restricting factor during the flow test. The CCWA calculated that the pipeline downstream of the EDV was rated for 385 psi and this was used as the limiting factor for opening of the EDV sleeve valve.
            1. The 385 psi limit was calculated by CCWA based on the thickness of the steel pipe. It was calculated that 385 psi required a steel thickness of 0.5 in.

2. The EDV normally has a downstream high-pressure shutdown set point at 375 psi. This set point was disabled for the flow test to allow pressures up to 385 psi.

c. No vibration or turbidity issues were detected by any of the subcontractors or CCWA staff during the flow test.

3. Review of Chorro Valley and Coastal Branch pipeline calibrations
   a. Sasa Tomic (HDR) has completed the calibration of the Chorro Valley and Coastal Branch pipelines. The maximum discrepancies between the modeled and observed values were within approximately 5% for both pipelines. These errors will be applied to the capacity analysis to quantify uncertainty of the results.
      i. The Chorro Valley pipeline calibration was completed using the high flow data from the flow test. The low flow data was disregarded, as the pipeline does not flow full under low flow conditions. Thus, the model for the Chorro Valley pipeline will not be accurate for low flow conditions. This will not affect the outcome of the capacity analysis as the pipeline flows full under high flow conditions.
         1. The results of the Chorro Valley pipeline calibration are available in the meeting handouts.
      ii. Sasa Tomic completed Coastal Branch pipeline calibration on 2/3/11 and included data from the 1/20/11 flow test.
         1. There was an elevation discrepancy between Tank No.1 and Tank No.2 that required a 12.5 ft adjustment to the Tank No. 2 elevation. It is suspected that the pressure gage for Tank No. 2 may be located on a riser and could account for the elevation error.
            a. WSC will review the as-built drawings for Tank No. 2 to investigate the source of the elevation error.
            b. Elevation errors could also be related to differences in the vertical datums used during construction.
         2. The results of the Coastal Branch pipeline calibration are available in the meeting handouts.
4. Review Capacity Assessment Procedures
   a. The project team reviewed the proposed delivery scenarios to determine the desired procedure for the pipeline capacity analysis.
      i. It was determined that the Morro Bay and CMC turnouts will be analyzed as separate demand nodes.
      ii. The Lopez turnout will be treated as one demand node. The capacity of the Lopez pipeline will not be used to limit the potential flow through the Lopez turnout.
      iii. The Santa Barbara County demands will be separated into four demand nodes: Guadalupe; Santa Maria; Southern California Water Company; and Tank 5 (representing the remaining Santa Barbara County SWP sub-contractors). Each demand node will receive an equal percent flow increase until the pipeline capacity is reached.
5. Status of Data Requests and Operational Criteria Questionnaires
   a. The CCWA has received limited data from DWR related to Reach 1 of the Coastal Branch pipeline and the associated pump stations.

    i. John Brady will forward all information received from DWR to WSC.
    ii. John stated that a capacity analysis has been performed on Phase 1 of the Coastal Branch. He also stated that there are no flow meters on the Reach 1 pump stations.
        1. DWR has offered to perform flow tests on the pump stations, but at a significant cost to the County and the CCWA.
  b. John Brady will contact Bill Brennan to discuss how to proceed with the DWR data request and what information the CCWA wants to obtain from DWR on the Reach 1 of the Coastal Branch pipeline.
  c. WSC will re-distribute the Operation Criteria Questionnaires for Reach 1 and Reach 2-6 of the Coastal Branch pipeline.

6. Action Items
  a. WSC
    i. WSC will tentatively schedule Review Meeting #1 for 3/30/11 to receive comments on the TM from the County and CCWA.
    ii. WSC will distribute the outline for the Technical Memorandum to the County and the CCWA for comments
    iii. WSC will review the as-built drawings for Tank No. 2 to investigate the source of the elevation error.
    iv. WSC will re-distribute the Operation Criteria Questionnaires for Reach 1 and Reach 2-6 of the Coastal Branch pipeline.
  b. CCWA
    i. John Brady will contact Bill Brennan (CCWA) to determine if a public presentation is necessary for San Barbara County.
    ii. John Brady will forward all information received from DWR to WSC.
    iii. John Brady will contact Bill Brennan to discuss how to proceed with the DWR data request and what information the CCWA wants to obtain from DWR on the Reach 1 of the Coastal Branch pipeline.

Coastal Branch Capacity Assessment
County of San Luis Obispo

Notes – Progress Report Meeting #6

Date:	3/08/11
Time:	10:00 AM
Location:	WSC's Office
Attendees:	Courtney Howard, John Brady, Jeff Szytel, Dan Heimel, Tom Trott

Discussion Topics

1. Review of project schedule
   a. The project team reviewed the current schedule and made the following changes:
      i. The submission date for the administrative draft of the Coastal Branch Capacity Assessment Technical Memorandum (admin draft) was moved to 3/18/11. This will allow WSC and GEI to incorporate the results of CCWA's Operational Criteria Questionnaire in the admin draft.
      ii. The review period for the admin draft was shortened from 2 weeks to 1 week so that the remaining schedule would not be impacted by the modification of the admin draft submission date.
      iii. The current goal is to present the public draft technical memorandum (TM) at the April WRAC Meeting (4/6/2011). The estimated deadline for submission of items for the April WRAC Meeting is 3/31/11.
         1. Whether or not the draft TM is presented at the April WRAC meeting (4/6/11) is dependent upon the level of comments received from the County and the CCWA. If the draft TM requires extensive edits then it will be presented at the June WRAC Meeting (6/11/11). The May WRAC meeting is not an option as Jeff is not available that week.
      iv. John Brady and Bill Brennan (CCWA) will discuss the appropriate meeting for presentation of the capacity assessment results to the CCWA and Santa Barbara subcontractors.
         1. Including an additional presentation in the project scope may require a contract amendment with the County.
2. Data request status
   a. The CCWA completed the Operational Criteria Questionnaire and submitted it on 3/8/11.
      i. WSC and GEI will review the data provided by the CCWA and submit any additional data requests to the CCWA.
3. Contract flow rates
   a. WSC established the maximum contract flow rate for each of the turnouts by dividing the annual allocation by the 12 months.
      i. John commented that the annual allocation should be divided by 11 months to account for maintenance and emergency shutdowns.
         1. WSC will re-establish the contract flow rates based on an 11 month delivery schedule.

4. Modeling approach
    a. WSC presented the current modeling approach that was developed at the Scenario Development workshop and previous progress report meetings. This approach included the following steps:
        i. Flow control valves and tanks were placed downstream of each turnout.
        ii. The water level for each tank, placed at each turnout, was set to 12 ft to represent approximately 5 psi of pressure.
        iii. Flow rates to each turnout were then increased according to specifications of each of the scenarios until the operation criteria or the hydraulic capacity of the pipeline was exceeded.
    b. This modeling approach evaluated the capacity of the pipeline to deliver water and not the capacity of each turnout to receive the modeled flow rate.
        i. John commented that the modeling approach for the capacity assessment should account for turnout hydraulics as they can have an effect on each agency's ability to receive their contracted allocation.
        ii. The project team discussed potential modeling strategies for evaluating each agency's ability to receive their contract flow rates in each of the capacity assessment scenarios.
            1. Only the Santa Maria and Southern California Water Company turnouts would require additional analysis as all other turnouts discharge directly into storage tanks.
        iii. Three approaches were discussed to consider energy limitations on the pipeline, in addition to volumetric flow capacity:
            1. The first approach included reviewing historical turnout pressure and flow data to evaluate the capacity of each turnout.
                a. This approach may not provide a complete representation of the hydraulics of each agency's distribution system.
            2. The second approach would utilize each agency's distribution system HGL diagrams to estimate a minimum required HGL at the downstream side of the turnout to deliver contract flow rates.
                a. John stated that he would contact Santa Maria and the Southern California Water Company to obtain HGL diagrams for their distribution systems.
                b. This approach is an estimate only, and does not evaluate specific hydraulic characteristics and/or operational flexibility within the contractors' distribution systems
            3. The third approach would be to model the infrastructure between the Coastal Branch and the free surface within the contractor's distribution system to provide a dynamic representation of hydraulic performance under a range in flows.
                a. This approach would be the most accurate, however the effort required to conduct this analysis is outside of WSC's current scope.

iv. WSC proposed proceeding with the analysis as originally envisioned, without consideration for energy delivery.
1. HGL information provided by CCWA for each of the turnouts would be included as an appendix, and shown in a comparative table alongside modeled capacities and HGLs for each turnout under each scenario. These values could be used for comparative purposes, and could inform decision making relative to whether or not additional analysis is warranted.
2. The text of the report will explicitly state that the analysis is based on volumetric capacity only, and does not take into account hydraulic constraints of the turnouts and/or the distribution systems of the contractors.

c. Tank Levels - Coastal Branch Pipeline
i. The project team discussed the tank levels for the capacity assessment and determined that they should be set near maximum as that is how they are operated during periods of high flow through the Coastal Branch pipeline.
1. Tank levels are operated at low levels during periods of low demand to limit the pipeline hydraulic residence time and prevent nitrification.
2. For the capacity assessment, WSC will set the tank elevations in the model to the maximum operating level from the Coastal Branch Operations Manual.

5. Operation Criteria
a. Velocity Criteria
i. WSC noted that at high flow rates the velocities within the 24” sections of pipeline at the EDV exceed 20 ft/s. The AWWA standards for concrete mortar lined steel pipe recommend that the velocities not exceed 20 ft/s.
1. John stated that he would investigate to determine if the EDV piping was cement mortar or epoxy lined.

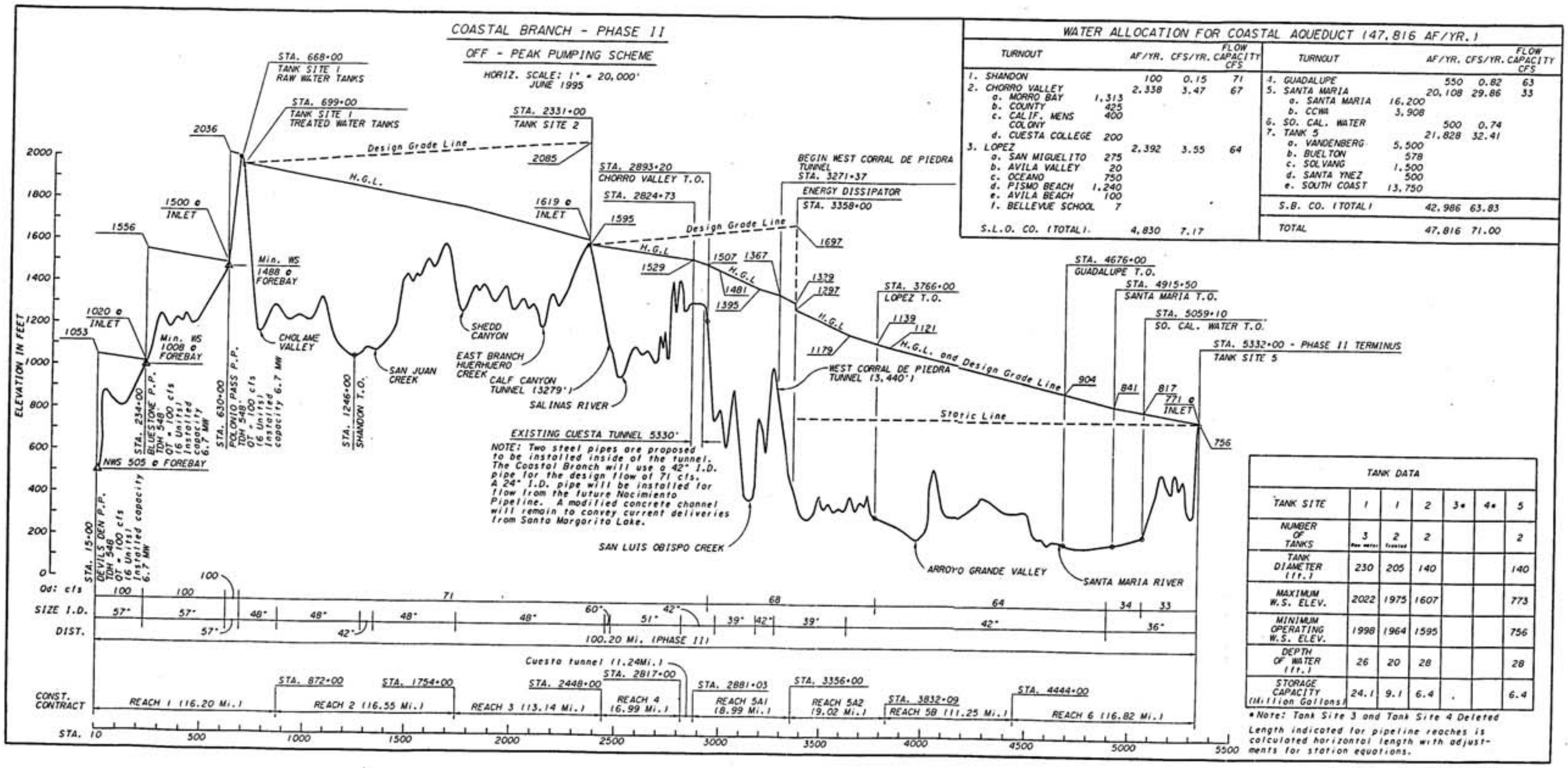
b. Low Pressure
i. To ensure that the pipeline maintains 5 psi of pressure in the pipeline at all flow rates, as mandated by CDPH. WSC proposed setting a low pressure limitation of 15 psi for all scenarios. Establishing a15 psi limitation versus a 5 psi limitation provides a safety factor to account for uncertainties in the model.
1. CDPH does allow the pressure to decrease below 5 psi at locations in close proximity to storage tanks. Therefore, nodes near Tanks 1, 2, and 5 would be allowed to decrease below 15 psi in each of the scenarios.
a. WSC will list all operations criteria used to determine the limits of each scenario in the admin draft, and the methodology used to establish them

6. Action Items
   a. WSC
      i. WSC and GEI will review the data provided by the CCWA and submit any additional data requests to the CCWA.
      ii. WSC will re-establish the contract flow rates based on an 11 month delivery schedule.
      iii. WSC will incorporate the distributions system HGL information into the admin draft to provide a point of comparison when considering turnout capacity limitations.
   b. CCWA
      i. John Brady and Bill Brennan (CCWA) will discuss the appropriate meeting for presentation of the capacity assessment results to the CCWA and Santa Barbara subcontractors.
      ii. John stated that he would contact Santa Maria and the Southern California Water Company to obtain HGL diagrams for their distribution systems.
      iii. John stated that he would investigate to determine if the EDV piping was cement mortar or epoxy lined.

APPENDIX D. DESIGN HYDRAULIC PROFILE-COASTAL BRANCH PIPELINE

ATTACHMENT C – HYDRAULIC GRADE LINE DIAGRAM

This hydraulic profile does not fully represent the constructed pipeline. The final pipeline was modified to allow for a 10% increase in capacity for the CCWA.



WATER ALLOCATION FOR COASTAL AQUEDUCT (47,816 AF/YR.)				
TURNOUT		AF/YR.	CFS/YR.	FLOW CAPACITY CFS
1. SHANDON		100	0.15	71
2. CHORRO VALLEY		2,338	3.47	67
a. MORRO BAY	1,313			
b. COUNTY	425			
c. CALIF. MENS COLONY	400			
d. CUESTA COLLEGE	200			
3. LOPEZ		2,392	3.55	64
a. SAN MIGUELITO	275			
b. AVILA VALLEY	20			
c. OCEANO	750			
d. PISMO BEACH	1,240			
e. AVILA BEACH	100			
f. BELLEVUE SCHOOL	7			
S.L.O. CO. (TOTAL)		4,830	7.17	
4. GUADALUPE		550	0.82	63
5. SANTA MARIA		20,108	29.86	33
a. SANTA MARIA	16,200			
b. CCWA	3,908			
6. SO. CAL. WATER		500	0.74	
7. TANK 5		21,828	32.41	
a. VANDENBERG	5,500			
b. BUELTON	578			
c. SOLVANG	1,500			
d. SANTA YNEZ	500			
e. SOUTH COAST	13,750			
S.B. CO. (TOTAL)		42,986	63.83	
TOTAL		47,816	71.00	

TANK DATA						
TANK SITE	1	1	2	3*	4*	5
NUMBER OF TANKS	3 (Raw water)	2 (Treated)	2			2
TANK DIAMETER (ft.)	230	205	140			140
MAXIMUM W.S. ELEV.	2022	1975	1607			773
MINIMUM OPERATING W.S. ELEV.	1998	1964	1595			756
DEPTH OF WATER (ft.)	26	20	28			28
STORAGE CAPACITY (Million Gallons)	24.1	9.1	6.4	.		6.4

*Note: Tank Site 3 and Tank Site 4 Deleted

Length indicated for pipeline reaches is calculated horizontal length with adjustments for station equations.

SOURCE:
FLOW CONTROL VALVE OPERATIONS AQUEDUCT FROM TANK NO. 2 TO TANK NO.5 CENTRAL COAST WATER AUTHORITY.

MONTGOMERY WATSON

HYDRAULIC PROFILE
SITE NO. 1 TO SITE NO. 5

FIGURE 1–2

APPENDIX E. LOPEZ PIPELINE CAPACITY RE-EVALUATION TECHNICAL MEMORANDUM

Technical Memorandum

WSC
WATER SYSTEMS CONSULTING, INC

Date: 8/15/2011

To: Tom Trott P.E.
County of San Luis Obispo
County Government Center, Room 207
San Luis Obispo, CA 93408

CC: Dean Benedix, Ron Coleman

Prepared by: Daniel Heimel, E.I.T.

Reviewed by: Jeffery Szytel, P.E.

Project: Lopez Pipeline Hydraulic Model

SUBJECT: LOPEZ PIPELINE CAPACITY RE-EVALUATION - FINAL

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1. Executive Summary

This memorandum summarizes an evaluation of the effectiveness of pigging the section of the Lopez pipeline from the Brisco turnout to the Vista Del Mar turnout. The pipeline pigging, performed in December 2010, was implemented to remove an approximate ¼" thick mineral deposit from the inner wall of the pipeline, and thus reduce the friction losses and increase pipeline capacity. To quantify the effectiveness of the pipeline pigging, an existing hydraulic model representing the pre pigging condition of the pipeline was updated using data collected during a flow test that was completed after the section was pigged (May 2011). The analysis shows that the pigging project decreased pipeline friction losses through the pigged section. The reduced friction losses can be expressed in three ways:

1. The hydraulic grade line (HGL), or pressure, at the turnouts along and downstream of the pigged section of pipeline increased by approximately 12 percent, when compared to the same flow scenario in the original model.
2. The overall pipeline capacity increased from 695.6 AF per month to 722.4 AF per month, or 4 percent.
3. The Hazen-Williams C-factor, a factor used to quantify interior pipeline friction, for the pigged section increased from 80 to 145 (higher values represent less friction), recovering the typical friction characteristics of a new pipeline.

Prior to pigging, the Grover turnout was the limiting factor for increasing the Lopez Pipeline capacity above its pre pigging capacity of 695.6 AF per month. Post pigging, the ability of the Oceano turnout and pipeline to deliver contract flows to the Oceano Community Services District is the limiting factor for increasing the Lopez Pipeline capacity above its post pigging capacity of 722.4 AF per month.

2. Purpose

This memorandum was prepared by Water Systems Consulting, Inc. (WSC) on behalf of the County of San Luis Obispo Flood Control and Water Conservation District (District), and provides a re-evaluation of the hydraulic capacity of the Lopez pipeline following the pigging of the 18" section of pipeline from the Brisco turnout to the Vista Del Mar turnout. The capacity re-evaluation included a full scale flow test, calibration of the existing hydraulic model to reflect the pigging of the 18" section of pipeline, and analysis of the improvement to pipeline HGL and capacity.

This memorandum includes the following sections: Executive Summary; Purpose; Background; Flow Test; Model Calibration; Modeling Approach; Model Results; Conclusions; and Recommendations

3. Background

WSC prepared a GIS-based hydraulic model using Bentley WaterGEMS® software and GIS data provided by the County under a previous contract with the Cities of Arroyo Grande, Grover Beach and Pismo Beach. WSC calibrated the model based on flow tests that were conducted on May 12, 2010, and used the calibrated model as the basis for the development of a capacity assessment. During the month of December in 2010, the District conducted a pigging project on the Lopez Pipeline from the Brisco Turnout, near the intersection of Brisco Rd and El Camino Real in Arroyo Grande, to the Vista Del Mar turnout near Vista Del Mar and Highway 101 in Pismo Beach, in an effort to remove accumulated sediment in the pipeline and improve hydraulic performance. Figure 1 shows the alignment of the Lopez Pipeline, and highlights the section that was pigged. The District is interested in evaluating the effects of this pigging operation on the hydraulic capacity of the pipeline.

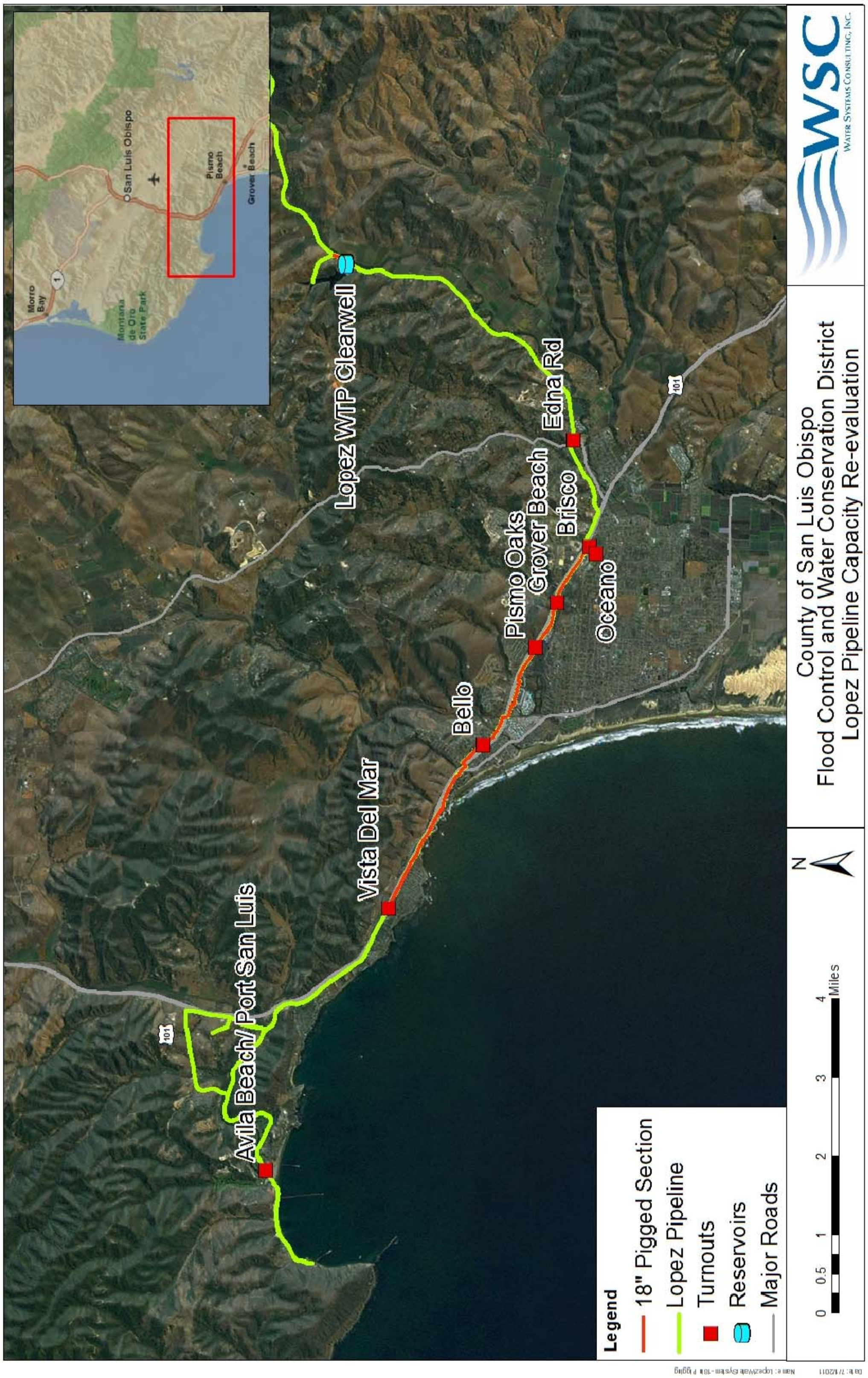

Figure 1. Lopez pipeline alignment

4. Flow Test

To obtain the flow and pressure data required to update the existing WaterGEMS® model of the Lopez pipeline, WSC assisted the District in planning and conducting a flow test of the Lopez pipeline. To facilitate comparison of results, the flow test mimicked the flow test completed on May 12, 2010 and utilized the same flow target flow rates and pumping schemes (1). WSC modified the 2011 flow test plan to allow for better steady state data collection. The modification involved changing the timing of the flow rate changes to increase the probability that the last reading in each test group represented steady state conditions and to reduce the influence of turnout flow control valve manipulation on system flow rates. The 2011 flow test plan and the 2011 flow test results are shown in Table 1 and Table 2 below.

Table 1. 2011 Flow Test Plan

Test Group	Test Start Time	Edna (gpm)	Brisco (gpm)	Oceano CSD WY (gpm)	Grover Beach (gpm)	Pismo Oaks (gpm)	Bello (gpm)	Vista Del Mar (gpm)	San Miguelito (gpm)	Avila Valley (gpm)	San Miguelito (gpm)	Avila Beach CSD (gpm)	Port San Luis (gpm)
1	Wide Open w/ Booster Stations On, 4.3 mgd SWP												
	9:00 AM	2,000	2,000		1,000		1,000	1,000	350		350		
2	Wide Open w/ Booster Stations Off, 4.3 mgd SWP												
	9:35 AM	2,000	2,000		1,000		1,000	1,000	350		350		
3	6.9 mgd Lopez + 2.0 mgd SWP												
	10:05 AM	1,053	1,053	930	736	0	1,000	855	238	28	238	150	92
4	6.0 mgd Lopez + 2.0 mgd SWP												
	10:35 AM	1,053	1,053	744	736	0	876	717	170	23	170	125	92
5	4.0 mgd Lopez + 2.0 mgd SWP												
	11:05 AM	710	710	653	496	0	729	596	170	20	170	104	62
6	4.0 mgd Lopez + 2.0 mgd SWP, PSLHD & AVMWC Boost On												
	11:35 AM	710	710	653	496	0	729	596	170	20	170	104	62

Table 2. 2011 Flow Test Results

Flow Testing Summary   Date: May 25, 2011

Test Start Time	Total Flow (GPM)	Flow SWP Turnout (GPM)	Flow Edna (GPM)	Pressure Lopez (PSI)	Flow Brisco (GPM)	Pressure Lopez (PSI)	Flow Oceano (GPM)	Pressure Lopez (PSI)	Oceano WY Pressure Lopez (PSI)	Flow Grover Beach (GPM)	Pressure Lopez (PSI)	Flow Pismo Oaks (GPM)	Pressure Lopez (PSI)
9:00 AM	6,069	1,303	0	54	1,608	58	613	58	0	0	82	1,800	-
9:10 AM	6,215	1,303	0	54	1,564	57	606	57	0	0	81	1,840	-
9:20 AM	6,278	1,303	0	54	1,570	57	598	56	0	0	80	1,830	-
9:30 AM	6,160	1,303	0	54	1,570	57	598	56	0	0	80	1,800	-
9:40 AM	5,222	1,303	174	57	0	64	613	62	0	105	82	1,850	-
9:50 AM	5,278	1,303	238	58	0	64	621	62	0	120	85	1,900	-
10:00 AM	5,306	1,303	236	58	0	64	621	62	0	120	85	1,900	-
10:10 AM	4,812	1,303	944	59	0	67	583	62	0	430	92	0	-
10:20 AM	4,809	1,303	979	59	0	68	568	66	0	430	92	0	-
10:30 AM	4,832	1,303	960	59	0	68	598	66	0	430	92	0	-
10:40 AM	4,653	1,303	1,155	60	397	69	583	67	0	505	97	0	-
10:50 AM	4,571	1,303	1,117	60	441	69	576	66	0	505	97	0	-
11:00 AM	4,610	1,303	1,058	60	510	69	576	67	0	500	96	0	-
11:10 AM	4,389	1,303	754	61	801	69	591	66	0	550	98	0	-
11:20 AM	4,256	1,303	706	61	727	70	576	67	0	550	98	0	-
11:30 AM	4,269	1,303	710	61	722	70	576	68	0	550	99	0	-
11:40 AM	4,244	1,303	704	61	690	70	583	68	0	550	99	0	-
11:50 AM	4,366	1,303	716	61	700	70	576	67	0	550	98	0	-
12:00 PM	4,526	1,303	758	60	722	70	576	67	0	550	99	0	-

Test Start Time	Flow Bello (GPM)	Pressure Lopez (PSI)	Flow Vista del Mar (GPM)	Pressure Lopez (PSI)	Flow Avila Valley (GPM)	Pressure Lopez (PSI)	Flow San Miguelito (GPM)	Pressure Lopez (PSI)	Flow Avila Beach (GPM)	Pressure Lopez (PSI)	Flow Port San Luis (GPM)	Pressure Lopez (PSI)	Flow Total (GPM)
9:00 AM	1,000	64	856	54	66	62	124	80	0	90	0	100	6,067
9:10 AM	1,000	63	832	53	61	60	217	72	0	95	0	90	6,120
9:20 AM	1,000	62	726	53	37	52	252	72	85	84	0	95	6,098
9:30 AM	1,000	62	737	53	41	52	255	70	90	78	0	82	6,091
9:40 AM	1,000	66	856	54	0	57	229	60	80	89	0	80	4,907
9:50 AM	1,000	66	856	55	0	60	279	80	0	90	0	90	5,014
10:00 AM	1,000	66	856	56	0	62	275	80	0	90	0	90	5,008
10:10 AM	1,000	74	856	62	0	67	276	84	0	90	0	90	4,089
10:20 AM	1,000	76	856	63	0	68	256	86	10	96	0	96	4,099
10:30 AM	1,000	74	856	63	0	72	239	88	20	98	0	100	4,103
10:40 AM	876	82	716	75	0	76	226	96	75	100	0	102	4,533
10:50 AM	876	82	725	76	0	78	191	98	90	104	0	104	4,521
11:00 AM	876	82	716	74	0	78	180	98	95	104	0	104	4,511
11:10 AM	729	85	591	77	0	80	177	100	105	106	0	107	4,298
11:20 AM	729	85	590	77	0	80	178	100	105	110	0	108	4,161
11:30 AM	729	84	591	78	0	80	181	100	105	107	0	107	4,164
11:40 AM	729	84	600	77	94	74	168	98	90	103	0	103	4,208
11:50 AM	729	84	593	77	94	74	164	96	90	103	0	104	4,212
12:00 PM	729	84	598	77	94	76	164	98	85	102	0	100	4,276

5. Model Calibration

WSC used the flow and pressure data obtained during the 2011 flow test to calibrate the 18" section of pipeline within the Lopez pipeline model. By manipulating Hazen-Williams roughness coefficients (C-factor) along this stretch of pipeline, WSC calibrated the model to mimic the pressures and flows observed during the flow test.

WSC developed profile and correlation plots to compare the modeled and observed HGL values. The plots from the final model calibration of the 18" section of pipeline are shown below in Figure 2 and Figure 3. For the profile plots, the modeled HGL should approximate the observed HGLs at each of the turnouts. With the correlation plots, the observed and modeled values create a 45 degree line to show correlation.

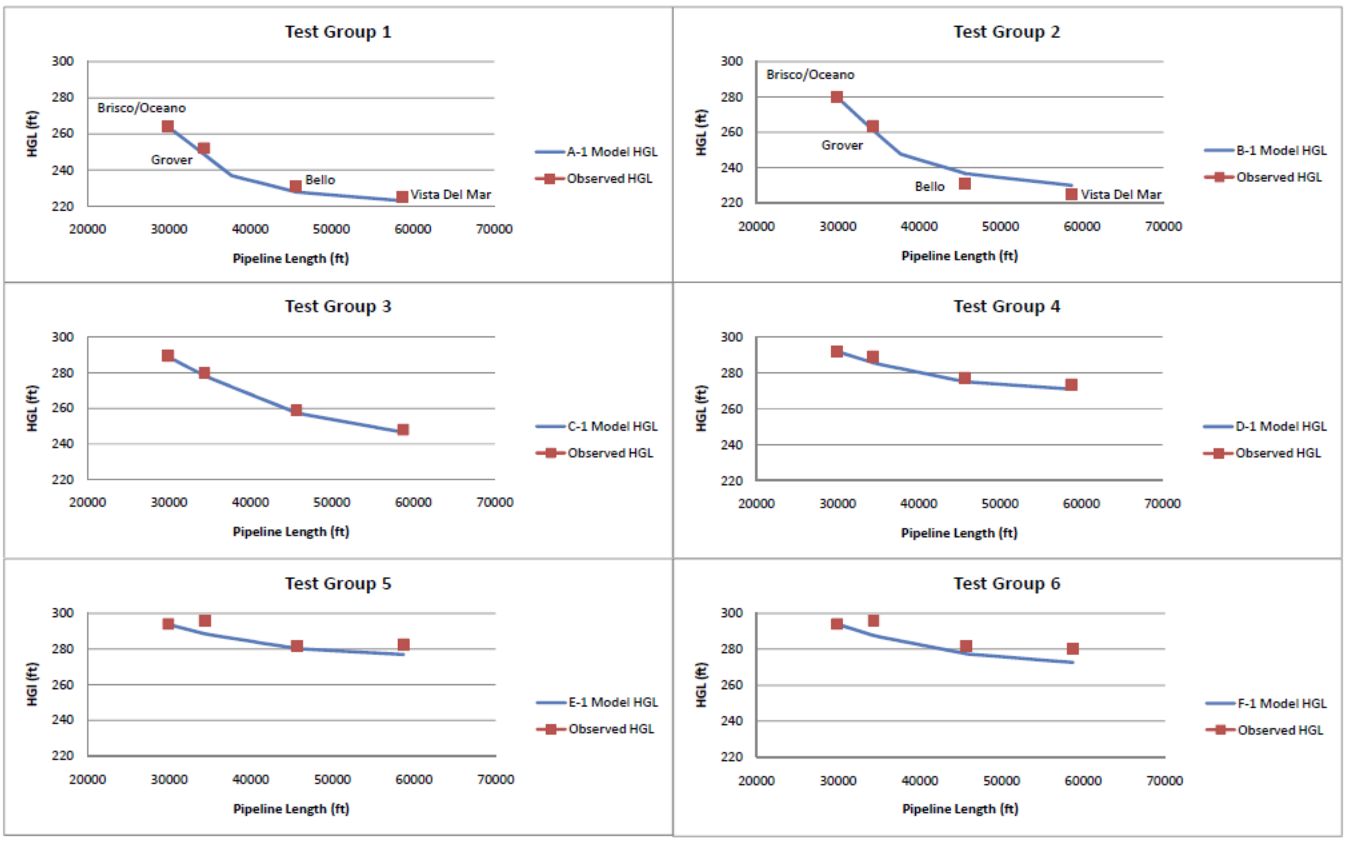

Figure 2. Lopez Pipeline Model - Calibration Profile Plots

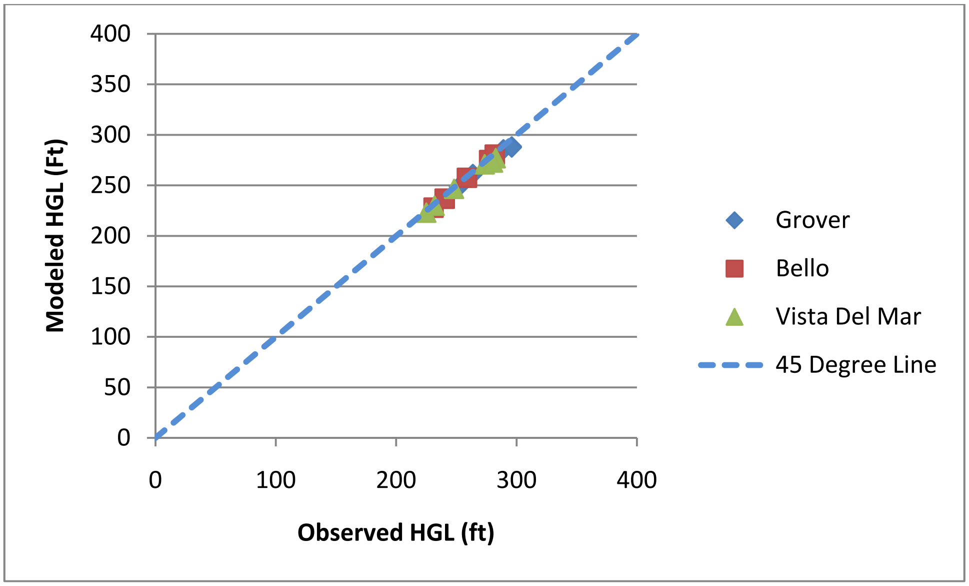

Figure 3. Lopez Pipeline Model – Calibration Correlation Plot

Additionally, the model calibration was analyzed numerically to determine the absolute and relative HGL error of the model calibration. Absolute and relative HGL error are defined below:

Absolute HGL error = (HGL observed – HGL modeled)

Relative HGL error = (HGL observed – HGL model) / (HGL observed – elevation)*100

Table 3 shows the absolute and relative HGL error for the final Lopez pipeline model calibration. Using the methods described above, the pipeline C-factors that created the lowest error between the observed and the modeled HGLs were selected for the final calibration.

Table 3. Lopez Pipeline Model Calibration – Absolute HGL Error and Relative HGL Error

Absolute HGL Error (ft) and Relative HGL Error (%)												
	Test Group 1		Test Group 2		Test Group 3		Test Group 4		Test Group 5		Test Group 6	
Observation Location	(ft)	(%)	(ft)	(%)	(ft)	(%)	(ft)	(%)	(ft)	(%)	(ft)	(%)
Grover	3.4	1.8	2.6	1.3	1.6	0.8	3.6	1.6	7.6	3.3	8.5	2.9
Bello	3.6	2.5	4.0	2.6	1.7	1.0	2.5	1.3	1.8	0.9	4.6	1.6
Vista_del_Mar	2.1	1.7	2.1	1.6	1.6	1.1	2.7	1.6	5.9	3.3	7.9	2.8

Using the calibration methods described above, the C-factors selected for the 18" section of pipeline are shown in Table 4 below. For the sake of comparison, Table 4 also shows the C-factors selected for the previous calibration (2010 pipeline model), as well as C-factors typically used for new concrete mortar lined steel pipe (2).

Table 4. Pipe physical characteristics

Hazen Williams Coefficients (C-factors)			
Pipe Group	2011	2010	Typical[1]
18" MCL Pipe	145	80	145
18" PVC Pipe	150	130	150
18" CEM Pipe	145	85	145

As seen in Table 4, the C-factors of the 18" section of pipeline following the pipeline pigging equaled those of new pipe and showed a significant improvement over the 2010 values.

6. Modeling Approach

To perform the pipeline modeling for the Lopez pipeline capacity re-evaluation, WSC developed two delivery scenarios: Scenario A; and Scenario B. Scenario A represents the total gravity flow achievable through the Lopez pipeline prior to the pigging and Scenario B represents the total gravity flow achievable through the pipeline following the pigging. In both scenarios, the flow rates through the Arroyo Grande, Pismo Beach, Grover Beach and the Oceano Community Service District (OCSD) turnouts were increased in the model until the total flow rate through the pipeline was maximized, while still maintaining contract flow rates at all other turnouts[2]. For the purposes of this analysis, the contract flow rates were set as the sum of each agency's Lopez Entitlement divided over a 12 month period[3] and State Water Project Table A Allocation divided over an 11 month period[4].

WSC set each of the turnouts in the model as either a fixed demand node or a fixed hydraulic grade reservoir. The turnouts that have pump stations on the customer side were set as fixed demand nodes. The flow rates for these nodes were set at each agency's contract flow rate. The exception to this was the Brisco Turnout which was set at the maximum flow rate observed during the 2010 and 2011 flow tests. The modeled pipeline HGL for the Brisco turnout was checked against the observed HGL during the flow test to ensure that the pump station had sufficient suction head to achieve the modeled flow rate.

The gravity flow turnouts were set as fixed hydraulic grade reservoirs. The hydraulic grades for the reservoirs represent the water level in the storage tanks that control the hydraulic grade for each of the individual agency distribution systems. However, these hydraulic grades do not account for the friction losses and minor losses from the turnout to the storage tanks or other point of demand within the distribution system. To account for the absence of these losses, the flow rates through each of the turnouts were restricted to flow rates observed during the 2010 and 2011 flow tests at the corresponding modeled pipeline HGLs.

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[1] C-factors values for coated steel piping (2)

[2] This scenario represents only one of the many possible delivery scenarios that could be achieved within the Lopez pipeline. Additional scenarios would need to be developed to evaluate the potential impact of the pipeline pigging on each individual turnout's capacity.

[3] The OCSD contract rate was reduced by 100 AF and the contract rate for Arroyo Grande was increased by 100 AF to reflect the water transfer agreement between the two agencies.

[4] The State Water Project Table A Allocation was divided over an 11 month period to account for an annual shutdown of the Coastal Branch of the State Water Project.

7. Model Results

To determine the effectiveness of the pipeline pigging, WSC evaluated the impact of the pigging on pipeline HGL and on the total gravity flow capacity of the pipeline.

Improvement in HGL – Constant Flow

The HGL for Scenario A (pre-pigging) was compared to the HGL for the same flow condition applied to the new model calibration to observe the improvements in HGL associated with the pigging. The HGL data for the pre and post pigging comparison are shown in Figure 4 and Table 5 below. Figure 4 shows that the post-pigging model run has a significantly higher HGL downstream of the Brisco turnout than the pre pigging scenario at the same flow rates[1].

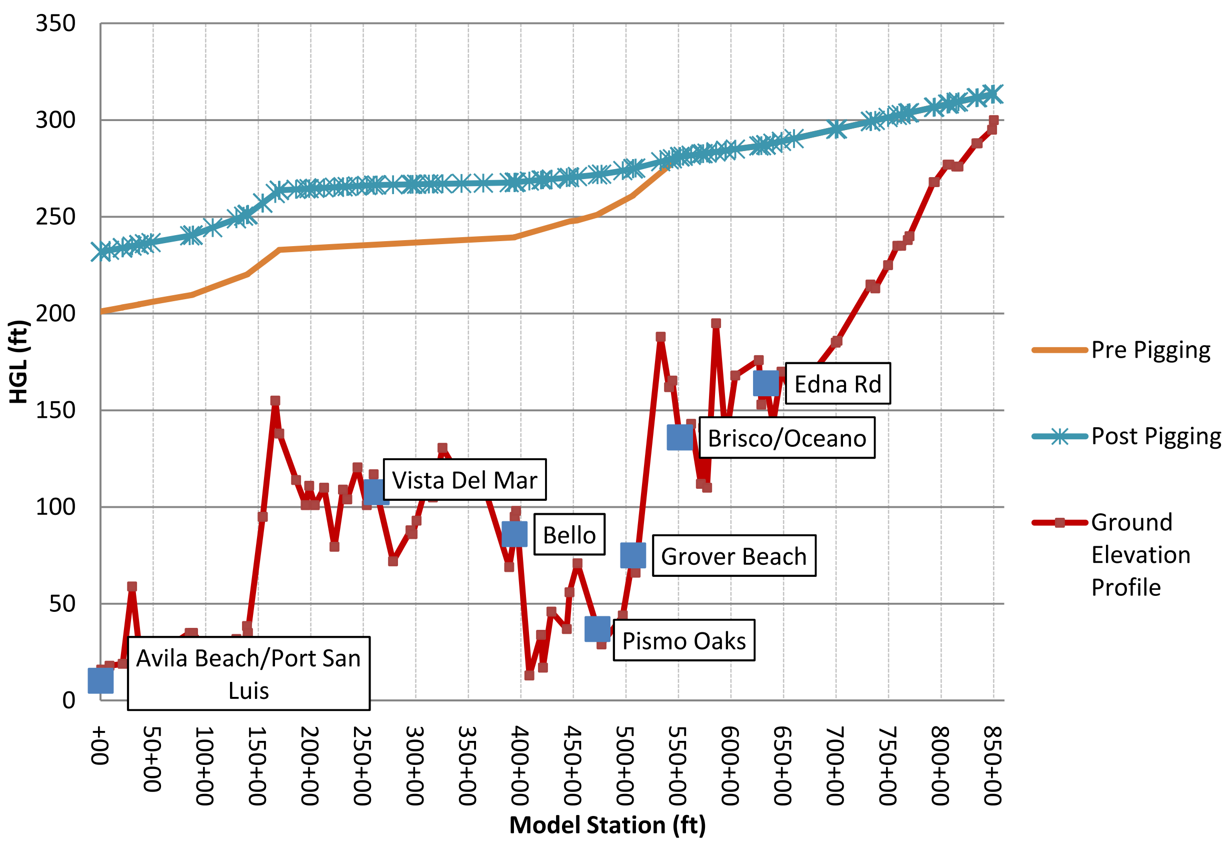


Figure 4. HGL Comparison (Pre/Post Pigging) at Scenario A flow rates

[1] For Scenario A flow rates see Table 6

Table 5. HGL Comparison Table (Pre and Post Pigging) at Scenario A flow rates

Turnout	Pre Pigging HGL	Post Pigging HGL	% Improvement
	(ft)	(ft)	(%)
Edna	287	287	0
Brisco	281	281	0
Oceano	281	281	0
Grover	261	275	5
Pismo Oaks	251	272	8
Bello	239	268	12
Vista del Mar	236	266	13
Avila Valley	216	247	14
San Miguelito	209	239	15
Avila Beach	201	232	15
Port San Luis	201	232	15

Improvement in Pipeline Capacity

To determine the improvement to pipeline capacity, WSC utilized the updated model to evaluate the current maximum gravity flow capacity of the pipeline (Scenario B). The capacity results for Scenario B were then compared to Scenario A to quantify the increase in pipeline capacity related to the pipeline pigging and are shown below in Table 6 and Table 7.

Table 6. Comparison of pipeline and turnout capacity (Pre and Post Pigging)[1]

Turnout	Scenario A Pre Pigging Flow Rate	Scenario A Pre Pigging Turnout HGL	Scenario B Post Pigging Flow Rate	Scenario B Post Pigging Turnout HGL	Capacity Improvement	% Improvement
	(gpm)	(ft)	(gpm)	(ft)	(gpm)	(%)
Edna	364	287	364[2]	285	0	0
Brisco	1733	280	1733	278	0	0
Oceano	635	274	635	271	0	0
Grover	500	261	599	272	99	20
Pismo Oaks	550	251	650	268	100	18
Bello	800	239	800	264	0	0
Vista del Mar	200	236	200	263	0	0
Avila Valley	21	216	21	244	0	0
San Miguelito	186	209	186	236	0	0
Avila Beach	110	201	110	228	0	0
Port San Luis	62	201	62	228	0	0
Total	**5160**		**5359**		**199**	

[1] There is sufficient head to manipulate the flow rates through each of the Pismo turnouts. However, the total flow rate to Pismo Beach is maximized and cannot be increased any further in this scenario without adversely impacting the ability to deliver the contract flow rate at the Oceano turnout.

[2] In Scenario B, the model did not show flow through the Edna turnout due to the assumed turnout fixed grade reservoir HGL being higher than the pipeline HGL. However, observed values from the 2010 flow showed the turnout flowing at 364 gpm at a pipeline HGL of 282 ft. Therefore, it was assumed that the turnout would transfer water under the modeled pipeline HGL. However, the 2011 flow test did not show flow through the Edna turnout at a pipeline HGL of 282 ft, which was attributed to higher tank levels in Arroyo Grande's distribution system. These two flow test results illustrate the impact of distribution system hydraulic conditions on turnout capacity and the need for the development of system curves for each turnout to better characterize the hydraulic performance of the system under a range of conditions.

Table 7. Comparison of pipeline delivery capacity (Pre and Post Pigging)

Agency	Contract Flow Rate	Scenario A Pre Pigging	Scenario B Post Pigging Flow Rate	Capacity Improvement	% Improvement
	AF/Month	(AF/Month)	(AF/Month)	(AF/Month)	(%)
Arroyo Grande	199.2	282.7	282.7	0.0	0
OCSD	85.1	85.6	85.6	0.0	0
Grover Beach	66.7	67.4	80.7	13.3	20
Pismo Beach	187.4	208.9	222.4	13.5	6
Port San Luis	8.3	8.4	8.4	0.0	0
Avila Valley MWC	2.8	2.8	2.8	0.0	0
Avila Beach CSD	14.8	14.8	14.8	0.0	0
San Miguelito MWC	25.0	25.1	25.1	0.0	0
Total	589.2	695.6	722.4	26.8	

8. Conclusions

The results of the 2011 flow test and the Lopez pipeline capacity re-evaluation showed that pigging of the Lopez pipeline significantly decreased the head losses within the 18" section of pipeline. The 2011 C-factors, derived from the 2011 flow test, are considerably higher than the 2010 C-factors. The reduction in friction losses improves the HGLs at the turnouts downstream of the Brisco turnout for equivalent flow rates.

By reducing pipeline friction losses, the pipeline pigging also improved pipeline and turnout capacity. The capacity re-evaluation showed that an additional 26.8 AF of water could be delivered per month through the Lopez pipeline, with increases to both the Grover Beach and Pismo Beach turnouts.

During the development of the capacity re-evaluation, WSC developed the following additional conclusions:

- Due to the dynamic nature of the Lopez pipeline delivery system and the many variables that affect turnout flows, steady state model results cannot be readily generalized to make operational recommendations, without due consideration of the system variables.
- Limiting the flow rates through the turnouts to observed flow and HGL conditions restricts the model's flexibility to predict the maximum capacity of the pipeline.
- Hydraulic conditions within each agency's distribution system significantly impact the flow rates that can be achieved through the turnouts.

9. Recommendations

WSC developed the following recommendations based on the results of Lopez capacity re-evaluation.

Perform Pipeline Pigging on the 33" section of the Lopez Pipeline

The District's current 8-Year Capital Outlay Plan includes pigging of the 33" section of the Lopez pipeline from the treatment plant clear well to the Edna turnout. Based on the results of the pigging of the 18" section of pipeline, it is recommended that the District continue to pursue this project. Reducing the friction factors and removing any accumulated deposits from this section of pipeline will improve the HGL for the entire pipeline and further increase pipeline capacity.

Upgrade the Oceano Meter and/or Modify the Oceano Pipeline

Obtaining contract flow rates through the Oceano turnout is one of the primary restricting factors for increasing the flow rates to other turnouts along the Lopez pipeline. There is the potential to increase capacity through the Oceano pipeline by upgrading the 3" meter to a larger size, removing of pipeline contractions and/or other modifications to the Oceano pipeline. Preparing a hydraulic model of the Oceano Pipeline would be a cost-effective way to evaluate the effectiveness of various pipeline improvement options.

Improve Utility of the Model by Developing System Curves for Each Turnout

WSC limited the flow rates through the turnouts in the capacity re-evaluation to the flow rates and HGLs observed during the 2010 and 2011 flow tests. Modeling the piping from the turnouts through the distribution system to each agency's storage facilities or developing system curves for each distribution system would allow the model to more accurately predict flow rates through the turnouts under varying hydraulic and operational conditions. Distribution system curves could be developed by collecting flow and pressure data over a wide range of flows at each of the turnouts. These system curves would provide the model more flexibility to maximize turnout and pipeline flow rates beyond those observed during the 2010 and 2011 flow tests and would allow the model to more accurately predict the potential flow rate increases to other turnouts along the Lopez pipeline.

10. Works Cited

1. **Water Systems Consulting, Inc.** *Lopez Pipeline Capacity Assessment Technical Memorandum.* 2010.

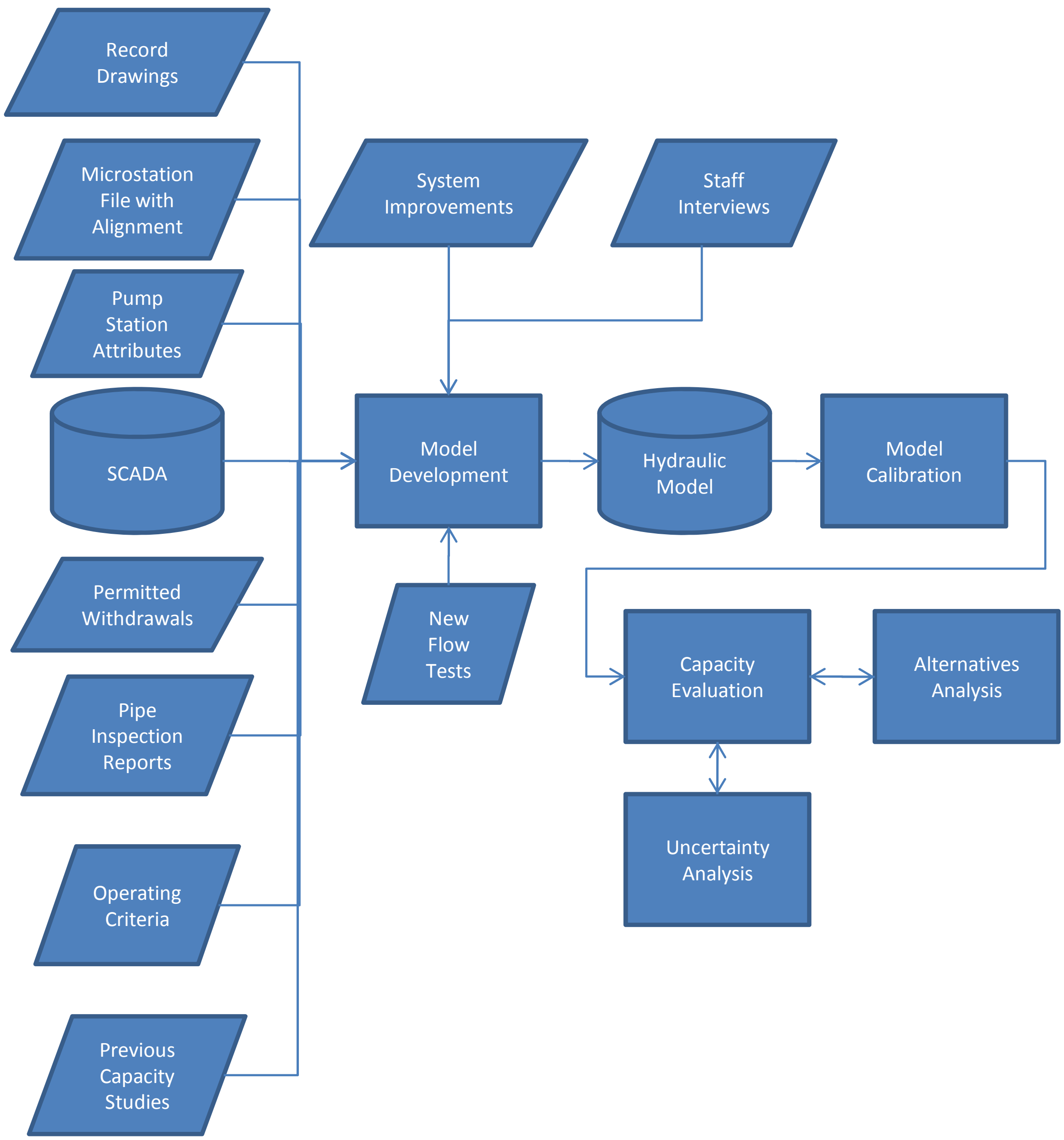
2. **Haestad Methods Water Solutions.** *Advanced Water Distribution Modeling and Management.* Exton : Bentley Institute Press, 2007.

APPENDIX F. HYDRAULIC MODELING APPROACH SELECTION PROCESS

Project Approach

The proposed approach of the WSC team is shown in the flowchart below and detailed in this section.

WSC uses the best available data and efficient, technically sound methods to deliver the highest quality results.



Defensible Results Depend on Complete, High Quality Data

The WSC team will identify and compile the best available information about the study area to form the basis for our analysis. This information is expected to include the sources shown below.

Information Source	Relevance to Project
Data from CCWA SCADA system	Historical data for recorded flows and pressures at various points in the system will provide data for model calibration
Electronic file of pipeline alignment	A computer hydraulic model of the infrastructure will be built using the plan view of the alignment in geographic coordinates
Record drawings of installed infrastructure	Record drawings will be used to add pipeline details to the model. Information including diameters and locations of isolation valves and blow-offs will be added to the model. The pressure class of each pipe reach will be added as a pipe attribute in the model to allow evaluation of potential strategies that increase pressures in the pipeline.
Information about improvement projects	Projects that may have modified or upgraded portions of the infrastructure since it was originally installed.
Information about installed infrastructure at three pumping plants	The pumps will be added to the hydraulic model. The piping and valves at each pump station will be added to the model based on the available information.
Pump tests	Actual pump test results showing flow, head, and energy use may be available from DWR and could be used to update the model.
2005 Hydraulic Capacity Assessment of main pipeline	This report describes a hydraulic model that was developed using the Hazen-Williams headloss formula and calibrated to observed pressures at turnouts. If they are available, the electronic files of the spreadsheets used for the 2005 study could provide useful reference information.
Pipeline inspection reports by CCWA	Reports could show information about the interior condition of the pipeline that can be used to adjust pipeline friction factors.
On-going capacity analysis of Lopez Pipeline	Modeling methodology, flow test procedures and coordination, and results of assessment
Interviews with CCWA operational staff	The strategy used to control flow through the pipeline, the set points for control valves, and energy dissipating valves.
Information about infrastructure in Guadalupe and Santa Maria	While these components are not part of the main pipeline, they do affect the ability to deliver water. Guadalupe has reported problems with low pressures in its pipeline from the CCWA pipeline to its tank.

CCWA is developing a GIS database of the infrastructure on the Coastal Branch, but this database will not be complete for the entire study area in time for this project. Because the design of the Coastal Branch was completed relatively recently, the pipeline design drawings are available electronically in Microstation format. These electronic files are believed to include a consolidated plan view alignment for the entire pipeline, which will be used to build the hydraulic model.

Selecting a Set of Equations to Model the Coastal Branch

The WSC team will develop a hydraulic model of the Coastal Branch infrastructure. The team proposes to use a state- of-the-art geography based hydraulic modeling software, Bentley's WaterGEMS. This software is currently being used for the Lopez Pipeline hydraulic assessment, and is widely used and respected in the industry. The WaterGEMS model will be built using the information compiled in the data collection task.

WaterGEMS allows the user to calculate friction losses using either the Darcy-Weisbach formula or the Hazen Williams formula. Because the flow through the treated water portion of the Coastal Branch is by gravity, friction losses will be the major factor determining how much water can be conveyed through the system. It will be important to use a defensible computational methodology for calculating friction losses.

One of the metrics used in analyzing the hydraulics of flow through pipelines is the Reynolds number. The Reynolds number is a dimensionless number that can be used to characterize the flow through a circular pipe. It is calculated as

Flow will be turbulent in the Coastal Branch when the velocity is greater than 0.007 feet per second.

$$\mathrm{R} = \frac{DV}{\nu}$$

where

$D = \text{diameter (ft)}$

$V = \text{mean velocity of the fluid (ft/s)}$

$\nu = \text{kinematic viscosity of water} = 1.0 * 10^{-5}\ ft^2 / s$

For normal cases of flow in a straight pipe of uniform diameter and usual roughness, the critical Reynolds number is 2000. If the Reynolds number is higher, the flow is turbulent; if the Reynolds number is lower, the flow is laminar. The smallest diameter on the main pipeline of the Coastal Branch is 36 inches, or 3 feet. Therefore the flow will be turbulent when the velocity is greater than 0.007 feet per second.

The general equation for head loss in a circular pipe flowing full is the Darcy-Weisbach equation, which is

$$h_l = f \frac{L}{D}\frac{V^2}{2g}$$

where

h_l = head loss due to friction (ft)

f = friction factor

L = pipe length (ft)

D = diameter (ft)

V = mean velocity of the fluid (ft/s)

g = acceleration of gravity = 32.2 ft/s^2

The Darcy-Weisbach equation shows that head loss varies directly with velocity head and pipe length, and inversely with pipe diameter. The friction factor "f" is a dimensionless number that is a function of the Reynolds Number.

The friction factor f is a dimensionless number and is a function of the Reynolds number. The roughness of a pipe surface can be characterized by *e*, the absolute roughness. This value is expressed in length (in this case, feet) and theoretically represents the extent that the roughness of the pipe protrudes into the flow path. The relative roughness, *e*/D, is calculated as the absolute roughness divided by the pipe diameter.

Laboratory tests have been performed by coating the inside of a pipe with a regular distribution of sand grains of a known size. In that case *e* would be the diameter of the sand grains. In a real pipe, the roughness is irregular in size and in distribution. The value of *e* is an indicator of the roughness, i.e. the diameter of sand grains that if uniformly coated on the pipe would produce the same friction as the actual pipe. Typically used values of *e* range from 0.00015 feet for welded steel pipe to 0.002 feet for rough concrete pipe. The value of *e* for this project will be determined through model calibration, and it may vary for different reaches of the pipe.

Two equations for determining the friction factor (f) are the Colebrook White equation and the Swamee Jain equation. The Colebrook White equation can be expressed as

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{e}{3.7D} + \frac{2.51}{R\sqrt{f}}\right)$$

where

f = friction factor

e = absolute roughness (ft)

D = pipe diameter (ft)

R = Reynolds number

The Swamee - Jain equation is a way to calculate f as a function of the Reynolds number. It can be expressed as

$$f = \frac{1.325}{\ln\left(\frac{e}{3.7D} + \frac{5.74}{R^{0.9}}\right)^2}$$

where

f = friction factor

e = absolute roughness (ft)

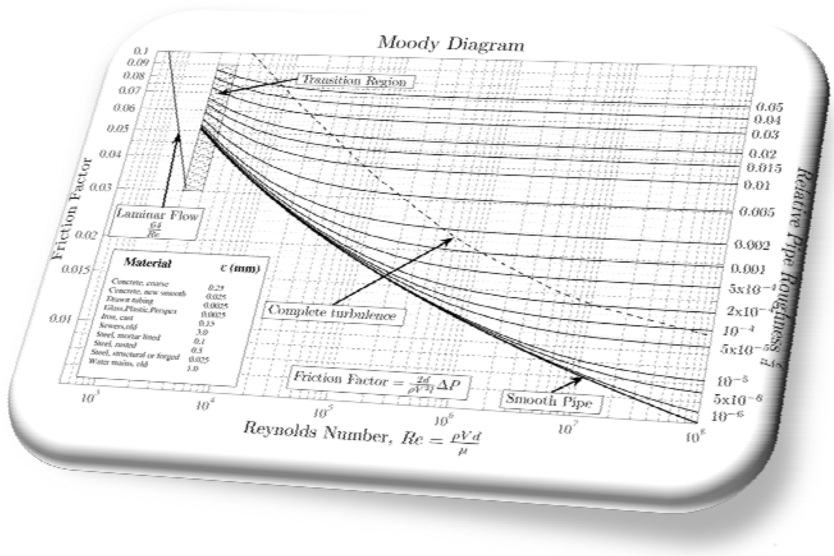
D = pipe diameter (ft)

R = Reynolds number

WaterGEMS solves the iterative set of equations without the need for the modeler to use a Moody Diagram. Elimination of this manual step leads to a more efficient analysis.

Both of these equations require an iterative solution, since the Reynolds number is a function of the velocity, which is a function of the friction factor, which is a function of the Reynolds number. The Swamee-Jain equation is used in the WaterGEMS software package.

Because these equations require an iterative solution, the Moody diagram is commonly used to estimate the friction factor. The Moody diagram allows the engineer to visually identify the appropriate friction factor, based on the Reynolds number and the relative roughness *e*/D. The disadvantage of the Moody diagram is that it requires visual review and manual selection of a friction factor for each scenario. Using a hydraulic modeling software packages such as WaterGEMS eliminates this manual step and leads to more efficient analysis.



Because the Darcy-Weisbach formula requires either an iterative solution or the manual use of the Moody diagram to determine a friction factor, simplifying empirical equations have been developed over time. The most commonly used is the Hazen Williams formula, expressed as

$$V = 1.32 C_{HW} R_h^{0.63} S^{0.54}$$

where

V = velocity (ft/s)

C_{HW} = Hazen Williams roughness coefficient

R_h = Hydraulic radius = D/4 (ft)

D = pipe diameter (ft)

S = energy gradient (ft/ft)

The Hazen Williams formula is an empirical simplification of the governing equations represented by the Darcy Weisbach formula.

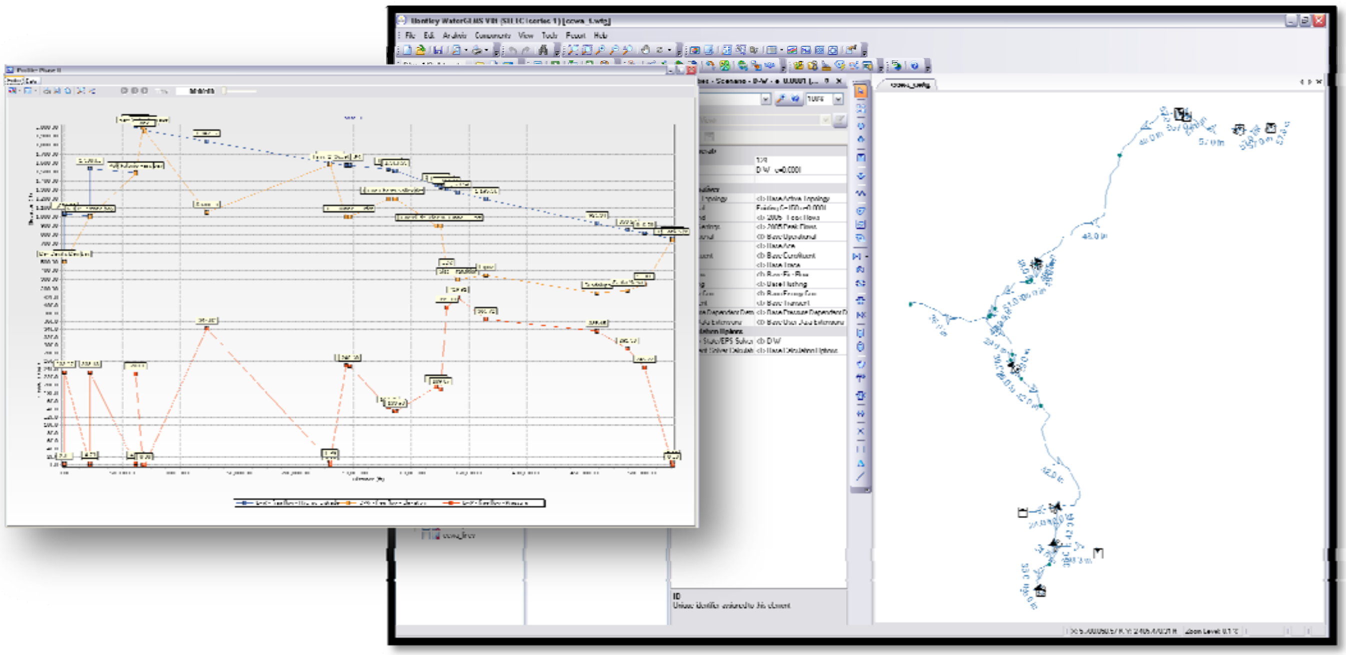
The Hazen-Williams formula is widely used in modeling water distribution systems. There are many references available that provide estimated Hazen Williams values for different pipe materials and different ages. However, the Hazen Williams formula is an empirical simplification of the governing equations represented by the Darcy Weisbach formula. The roughness factor in the Hazen Williams formula does not vary with velocity of flow through the pipe, and the Hazen Williams formula is only considered appropriate for some of the conditions that are covered by the more general Darcy-Weisbach formula.

For this project, most of the infrastructure is a consistent material and age. Therefore, the project team will not need to rely on comparison of Hazen Williams coefficients with other studies. It will be possible to select an absolute roughness value, or a set of values, that accurately reflect the existing condition of the pipeline.

The WSC team recommends developing the new model using the Darcy Weisbach headloss formula.

For the preliminary model developed for this proposal, the WSC team developed scenarios using both the Darcy Weisbach formula and the Hazen Williams formula. These model runs allowed the comparison of results with the results obtained during the 2005 Capacity Study.

For this proposal, WSC developed a preliminary model of the Coastal Branch using WaterGEMS to gain a better understanding of the system hydraulics.



The WSC team developed a preliminary model of the Coastal Branch and reviewed the results of the 2005 Capacity Study, which used the Hazen Williams formula. The 2005 Capacity Study cited a design Hazen Williams roughness value of 135. In the preliminary model, using a Darcy-Weisbach roughness of 0.0005 feet produced a calculated hydraulic grade line that approximated the results using Hazen Williams and a C value of 135. The actual values of pipe roughness used for this study will be selected during the model calibration phase.

The WSC team will review the SCADA data to identify where flow meters, pressure transducers, or other monitoring points are located. Nodes will be added to the model at these points so that model results can be compared directly to actual field data during the model calibration phase.

APPENDIX G. FLOW METER AND PRESSURE TRANSMITTER INVENTORY- COASTAL BRANCH PIPELINE

CCWA Flow Capacity Test Equipment					
Location	**Type**	**Calibration Date**	**Manufacturer**	**Model**	**Stated accuracy**
Tank 2	Inlet Pressure Transmitter	5/28/2010	ABB	2600T	0.075%
	Outlet Pressure Transmitter	5/28/2010	ABB	2600T	0.075%
	Ultrasonic flow meter	8/4/2010	Accusonic	7520	0.50%
Chorro TO	Inlet Pressure Transmitter	5/5/2010	Rosemount	1151GP	0.10%
	Outlet Pressure Transmitter	5/5/2010	Rosemount	1151GP	0.10%
	DP Flow transmitter flow meter	5/5/2010	Rosemount	1151GP	0.50%
EDV	Inlet Pressure Transmitter	5/19/2010	Rosemount	1151GP	0.10%
	Outlet Pressure Transmitter	5/19/2010	Rosemount	1151GP	0.10%
	Ultrasonic flow meter	11/5/2009	Accusonic	7520	0.50%
Lopez TO	Inlet Pressure Transmitter	4/16/2010	ABB	524TB	0.20%
	Outlet Pressure Transmitter	4/16/2010	ABB	524TB	0.20%
	DP Flow transmitter flow meter	4/16/2010	ABB	504TB	0.20%
Guadalupe TO	Inlet Pressure Transmitter	3/10/2010	ABB	524TB	0.20%
	Outlet Pressure Transmitter	3/10/2010	ABB	524TB	0.20%
	DP Flow transmitter flow meter	3/10/2010	ABB	600T	0.10%
Santa Maria TO	Inlet Pressure Transmitter	4/15/2010	ABB	2600T	0.075%
	Outlet Pressure Transmitter	4/15/2010	Wika	4215690	0.50%
	DP Flow transmitter flow meter	4/15/2010	ABB	600T	0.10%
Golde State TO	Inlet Pressure Transmitter	4/6/2010	ABB	524TB	0.20%
	Outlet Pressure Transmitter	4/6/2010	ABB	524TB	0.20%
	8" DP Flow transmitter flow meter	4/6/2010	ABB	600T	0.10%
	4" Mag Meter Transmitter	Not required	ABB	MagMaster	0.15%
Tank 5	Level Transmitters only	9/1/2010	Wika	LS 10	0.25%
ISO #1	Multi-mag insertion Flow Transmitter	Not required	Marsh Mc Birney	285	0.25%
ISO #2	None	Flow signal is transferred from ISO #1 for valve control			

APPENDIX H. CALIBRATION DATA-COASTAL BRANCH PIPELINE

Day	Observed Average HGL [ft]								Corrected Observed Average HGL [ft]								Model HGL [ft]								Model Error HGL [ft]							
	Tank_2_Inlet	CVTO_Inlet	EDV_Inlet	EDV_Outlet	Lopez_Inlet	Guadalupe_Inlet	Santa_Maria_Inlet	SCWC_Inlet	Tank_2_Inlet	CVTO_Inlet	EDV_Inlet	EDV_Outlet	Lopez_Inlet	Guadalupe_Inlet	Santa_Maria_Inlet	SCWC_Inlet	Tank_2_Inlet	CVTO_Inlet	EDV_Inlet	EDV_Outlet	Lopez_Inlet	Guadalupe_Inlet	Santa_Maria_Inlet	SCWC_Inlet	Tank_2_Inlet	CVTO_Inlet	EDV_Inlet	EDV_Outlet	Lopez_Inlet	Guadalupe_Inlet	Santa_Maria_Inlet	SCWC_Inlet
Station	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####	####																
Elevation	1579	546	366.5	366.5	297.2	158	188	175	1579	546	366.5	366.5	297.2	158	188	175	1579	546	366.5	366.5	297.2	158	188	175	1579	546	366.5	366.5	297.2	158	188	175
Correction									**-12.6**	**1.1**	**-0.9**	**-0.9**	**3.5**	**1.9**	**-1.1**	**1.5**																
2/8/10	1964	1584	1581	774	764	757	757	755	1952	1586	1580	773	767	759	756	756	1,952	1,586	1,580	773	767	759	756	756	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6/19/10	1877	1534	1494	915	851	784	762	760	1864	1535	1493	914	855	785	761	762	1,862	1,547	1,493	919	865	787	765	763	1.8	-11.3	-0.2	-4.6	-10.0	-1.1	-3.9	-0.9
7/17/10	1804	1523	1443	1036	925	817	779	777	1791	1524	1442	1035	929	819	778	779	1,787	1,533	1,440	1,044	952	821	784	780	3.8	-8.6	2.8	-9.0	-22.7	-1.2	-5.6	-1.1
9/16/10	1776	1517	1416	1098	974	832	786	782	1763	1518	1415	1097	978	834	785	783	1,760	1,520	1,411	1,098	991	834	790	785	3.0	-1.7	4.0	-0.9	-12.9	-0.2	-5.3	-1.4
1/20/11	1745	1493	1345	1256	1118	900	839	819	1732	1495	1344	1255	1121	902	838	820	1,733	1,483	1,343	1,243	1,104	894	834	817	-1.4	11.2	1.3	12.8	16.9	8.2	3.3	3.1
Max																									3.8	11.3	4.0	12.8	22.7	8.2	5.6	3.1

Day	Observed Healdoss Rate [ft/1,000ft]								Corrected Observed Healdoss Rate [ft/1,000ft]								Model Healdoss Rate [ft/1,000ft]								Model Healdoss Rate Error [ft/1,000ft]							
	Clearwell-Tank_2	Tank_2-CVTO	CVTO-EDV_Inlet	EDV_Outlet-Lopez	Lopez-Guadalupe	Guadalupe-SM	SM-SCWC	SCWC-Tank_5	Clearwell-Tank_2	Tank_2-CVTO	CVTO-EDV_Inlet	EDV_Outlet-Lopez	Lopez-Guadalupe	Guadalupe-SM	SM-SCWC	SCWC-Tank_5	Clearwell-Tank_2	Tank_2-CVTO	CVTO-EDV_Inlet	EDV_Outlet-Lopez	Lopez-Guadalupe	Guadalupe-SM	SM-SCWC	SCWC-Tank_5	Clearwell-Tank_2	Tank_2-CVTO	CVTO-EDV_Inlet	EDV_Outlet-Lopez	Lopez-Guadalupe	Guadalupe-SM	SM-SCWC	SCWC-Tank_5
2/8/10	(0.0)	0.1	0.1	0.2	0.1	(0.0)	0.3	(0.0)	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6/19/10	0.6	1.0	0.9	1.6	0.8	0.9	0.1	0.1	0.7	0.9	0.9	1.5	0.8	1.0	(0.1)	0.1	0.7	0.7	1.2	1.3	0.9	0.9	0.2	0.2	-0.01	0.20	-0.24	0.13	-0.10	0.11	-0.32	-0.04
7/17/10	1.1	1.4	1.7	2.7	1.2	1.5	0.2	0.3	1.1	1.4	1.8	2.6	1.2	1.7	(0.1)	0.4	1.2	1.2	2.0	2.3	1.5	1.5	0.4	0.4	-0.02	0.15	-0.24	0.33	-0.24	0.18	-0.49	-0.05
9/16/10	1.2	1.5	2.2	3.0	1.6	1.8	0.4	0.5	1.3	1.5	2.2	2.9	1.6	2.0	0.2	0.5	1.3	1.4	2.3	2.6	1.8	1.8	0.6	0.6	-0.02	0.03	-0.12	0.30	-0.14	0.21	-0.43	-0.06
1/20/11	1.4	1.6	3.2	3.4	2.5	2.4	2.1	1.8	1.5	1.6	3.2	3.3	2.5	2.6	1.8	1.9	1.5	1.8	3.0	3.4	2.4	2.4	1.8	1.8	0.01	-0.20	0.21	-0.10	0.10	0.20	0.03	0.06
																								Avg	0.02	0.20	0.24	0.33	0.24	0.21	0.49	0.06

	Model Error								Relative Model Error								Average Boundary Conditions									
	pressure [psi]								%								HGL [ft]			Flow [gpm]						
Day	Tank_2_Inlet	CVTO_Inlet	EDV_Inlet	EDV_Outlet	Lopez_Inlet	Guadalupe_Inlet	Santa_Maria_Inlet	SCWC_Inlet	Tank_2_Inlet	CVTO_Inlet	EDV_Inlet	EDV_Outlet	Lopez_Inlet	Guadalupe_Inlet	Santa_Maria_Inlet	SCWC_Inlet	Clearwell	Tank_2	Tank_5	WTP	CVTO	EDV	Lopez	Santa_Maria	SCWC_Mag	TO tank 5
Station																	0		#####							
Elevation	1579	546	367	367	297	158	188	175	1579	546	367	366.5	297.2	158	188	175	1955	1579	747.93							
Correction																										
2/8/10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1963.99	1589.75	756.12	6590.27	482.02	5800.73	326.17	4179.63	84.67	1210.27
6/19/10	0.8	-4.9	-0.1	-2.0	-4.3	-0.5	-1.7	-0.4	0.6%	-1.1%	0.0%	-0.8%	-1.8%	-0.2%	-0.7%	-0.2%	1974.46	1588.65	757.09	21141.16	1529.55	19615.39	1367.52	10451.51	137.14	7659.21
7/17/10	1.6	-3.7	1.2	-3.9	-9.8	-0.5	-2.4	-0.5	1.8%	-0.9%	0.3%	-1.4%	-3.6%	-0.2%	-1.0%	-0.2%	1974.05	1603.89	766.20	27596.19	1625.20	26142.39	1997.07	11841.52	132.54	12171.27
9/16/10	1.3	-0.7	1.7	-0.4	-5.6	-0.1	-2.3	-0.6	1.6%	-0.2%	0.4%	-0.1%	-1.9%	0.0%	-0.9%	-0.2%	1972.98	1600.85	765.82	29515.74	1472.13	28259.95	1698.32	11805.28	144.91	14611.45
1/20/11	-0.6	4.9	0.6	5.5	7.3	3.6	1.4	1.3	-0.9%	1.2%	0.1%	1.4%	2.0%	1.1%	0.5%	0.5%	1969.81	1584.36	759.33	31190.05	1011.57	32315.53	1089.11	4266.96	142.74	26816.72
Max	1.6	4.9	1.7	5.5	9.8	3.6	2.4	1.3	1.8%	1.2%	0.4%	1.4%	3.6%	1.1%	1.0%	0.5%										

Day
2/8/10
6/19/10
7/17/10
9/16/10
1/20/11

APPENDIX I. STEADY STATE FLOW TEST DATA-CHORRO VALLEY PIPELINE

Chorro Valley Pipeline Steady State Flow Test Data													
Location	Site 1 US	Site 2 US	Site 3 US_Contraction	Site 3 DS_Expansion	CMC Pipeline junction	Site 5a US	Site 5a DS	Site 6 US		Site 3 Flow	CMC Flow	Site 5 Flow	Site 6 Flow
Profile X	13	3,127	12,370	12,377	13,961	14,688	14,703	61,683					
Elevation (ft)	1,124	1,070	546	546	533	541	541	285					
Oct_2010_0900 Observed Pressure (psi)	190		443	51	55	52	12	11		1,490.00	730.00		760.00
Oct_2010_0900 Observed HGL (ft)	1,563		1,568	664	660	660	569	310					
Oct_2010_1000 Observed Pressure (psi)	194		426	62	64	60	22	14		2,482.00	*1,502.00*		980.00
Oct_2010_1000 Observed HGL (ft)	1,572		1,530	689	681	680	592	317					
Oct_2010_1100 Observed Pressure (psi)	187		408	80	80	76	66	17		3,477.00	*2,327.00*		1,150.00
Oct_2010_1100 Observed HGL (ft)	1,556		1,488	731	718	717	693	324					
Oct_2010_1200 Observed Pressure (psi)	195		434	62	64	62	8	9		2,000.00	*1,480.00*		520.00
Oct_2010_1200 Observed HGL (ft)	1,574		1,549	689	681	684	559	306					
								italic flows are calculated because CMC flow meter pegged out					

APPENDIX J. HYDRAULIC ANOMALY INVESTIGATION-CHORRO VALLEY PIPELINE

Technical Memorandum

Date: 12/14/2010

To: Courtney Howard- County of San Luis Obispo **Phone:** (805) 781-1016

CC: Dylan Wade-City of Morro Bay
Michael Randall-City of Morro Bay

Prepared by: Daniel Heimel, E.I.T.

Reviewed by: Jeffery Szytel, P.E.

Project: Coastal Branch Capacity Assessment

SUBJECT: **CHORRO VALLEY PIPELINE HYDRAULIC ANOMALY INVESTIGATION**

The purpose of this memorandum is to provide the County of San Luis Obispo with information to assist them in determining the source of the hydraulic anomaly found during the Chorro Valley pipeline flow test and subsequent model calibration.

Summary of Hydraulic Anomaly

The results obtained from the Chorro Valley pipeline flow test and the results of the model calibration point to the presence of a hydraulic anomaly in the section of pipeline from Site 5a and Site 6. Using the flow and pressure readings obtained during the flow test, WSC and HDR were unable to select a pipeline roughness height for this section of pipeline that provides the observed amount of head loss at both high and low flow rates. Initially, a roughness height was selected that allowed the model to mimic pipeline operations at high flow rates (980 & 1142 gpm) (Figure 2) and (Figure 3). However, this roughness height does not allow the model to accurately predict pressure values at low flow rates (760 & 520 gpm) (Figure 1) and (Figure 4).

Head Loss Rate Analysis

Additional analysis performed on the head loss per unit of pipeline length compared to flow rate provides further confirmation of the hydraulic anomaly in the downstream section of the Chorro Valley pipeline. When plotted on a log scale the head loss rates (ft head/100 ft) versus the flow rates (gpm) should be close to linear. However, the observed head loss rates in the section of pipeline from Site 5 to Site 6, shown as dark triangles, do not exhibit these characteristics and indicate that additional head loss is being contributed at low flow rates (Figure 5). The modeled head loss rates, shown as red stars, are provided as an example of how the relationship between head loss rate and flow rate should look on a log scale graph.

Recommendations

Based on the findings discussed above, WSC suggests that additional field investigation should be performed to determine the source of the anomaly. This investigation could involve the following activities.

1. Verify the accuracy of the pressure gages used during the flow test
    a. Service or replace all gages and confirm and document gage locations relative to existing appurtenances
    b. Investigate the stability of the pressure readings obtained at the Site 5a downstream location

2. Obtain additional flow and pressure data at the current flow rate or flow rates similar to the flow test under steady state conditions.
    a. Obtain pressure readings upstream and downstream of the altitude valve located at Site 6.
3. Investigate the operation of the air vacuum and air release valves (AVAR) located downstream of Site 5a. Specifically investigate the possibility that air is entering or exiting the pipeline at the AVAR at station 431+38.01.
4. Attempt to obtain additional pressure readings at locations between Site 5a and Site 6.

WSC cannot proceed with further hydraulic analysis of the Chorro Valley pipeline until this anomaly is resolved. Without resolution of this anomaly, our capacity analysis will fix the capacity of the Chorro Valley pipeline to the observed flow during the flow test. We are prepared to offer additional assistance if required to help the County and City of Morro Bay investigate and resolve this issue, however additional troubleshooting and/or field reconnaissance is outside of our current scope of services.

Reference Files

A complete list of the data obtained from the Chorro Valley pipeline flow test, on October 20, 2010, is presented in the excel spreadsheet titled *Flow Test Worksheet_Chorro Valley Pipeline*. The calibration analysis is presented in the excel spreadsheet titled *Chorro_Valley_calibration*.

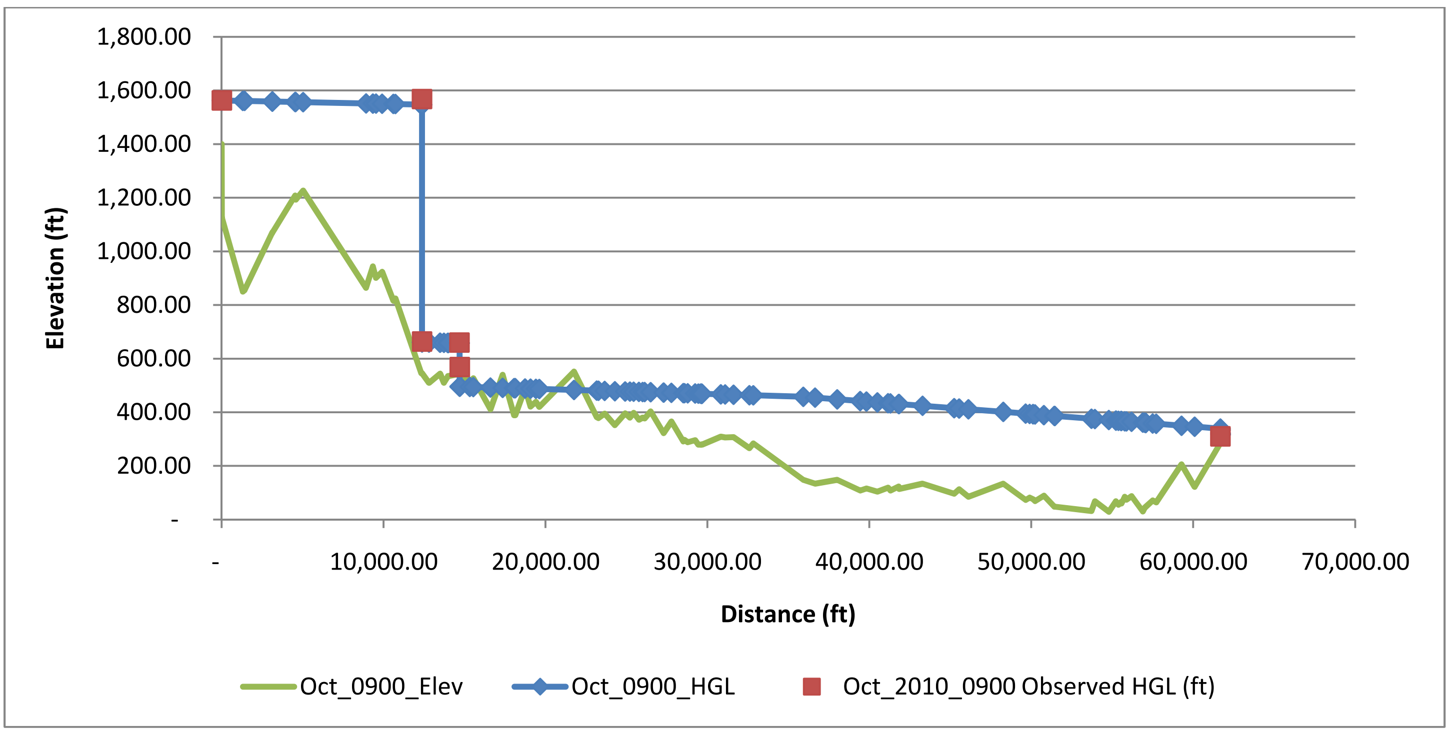


Figure 1. Chorro Valley pipeline hydraulic profile for a flow rate to Morro Bay of 760 gpm.

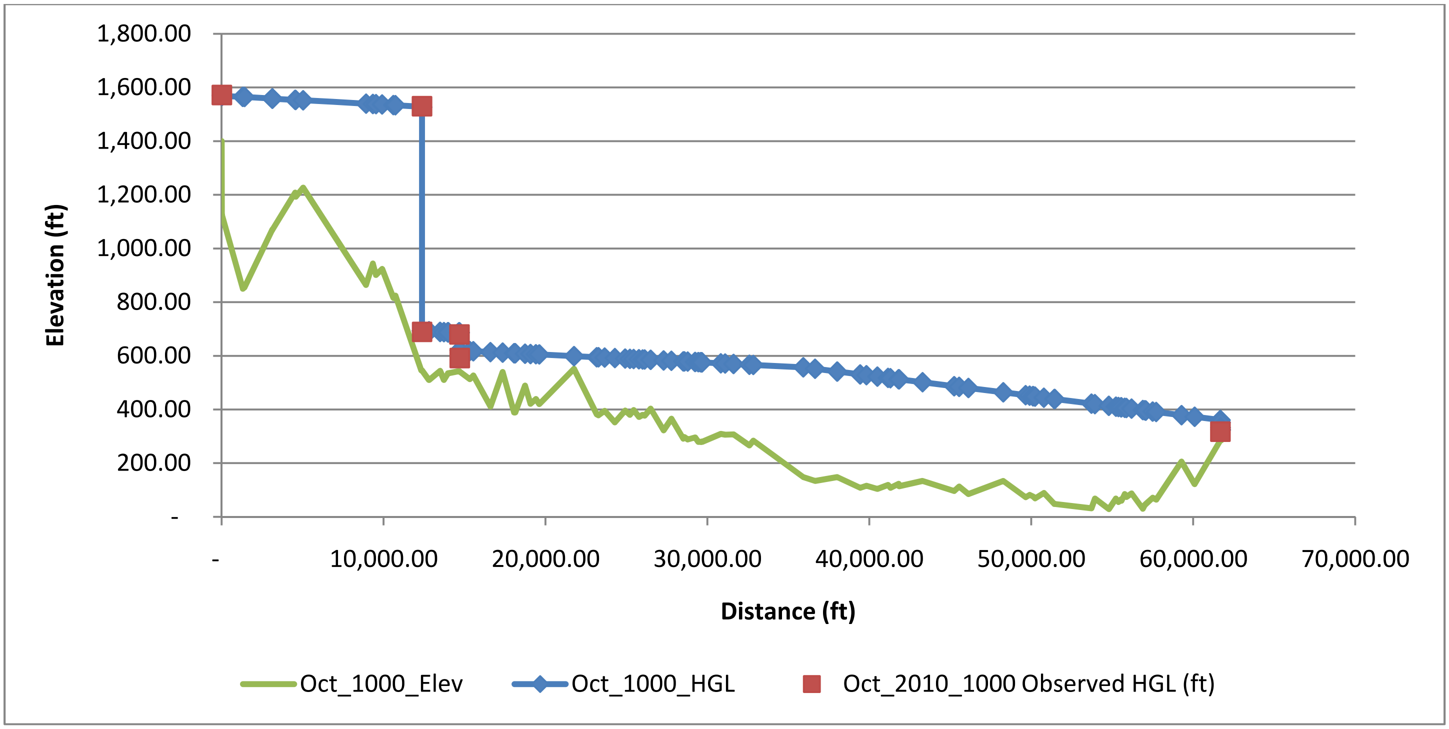


Figure 2. Chorro Valley pipeline hydraulic profile for a flow rate to Morro Bay of 980 gpm.

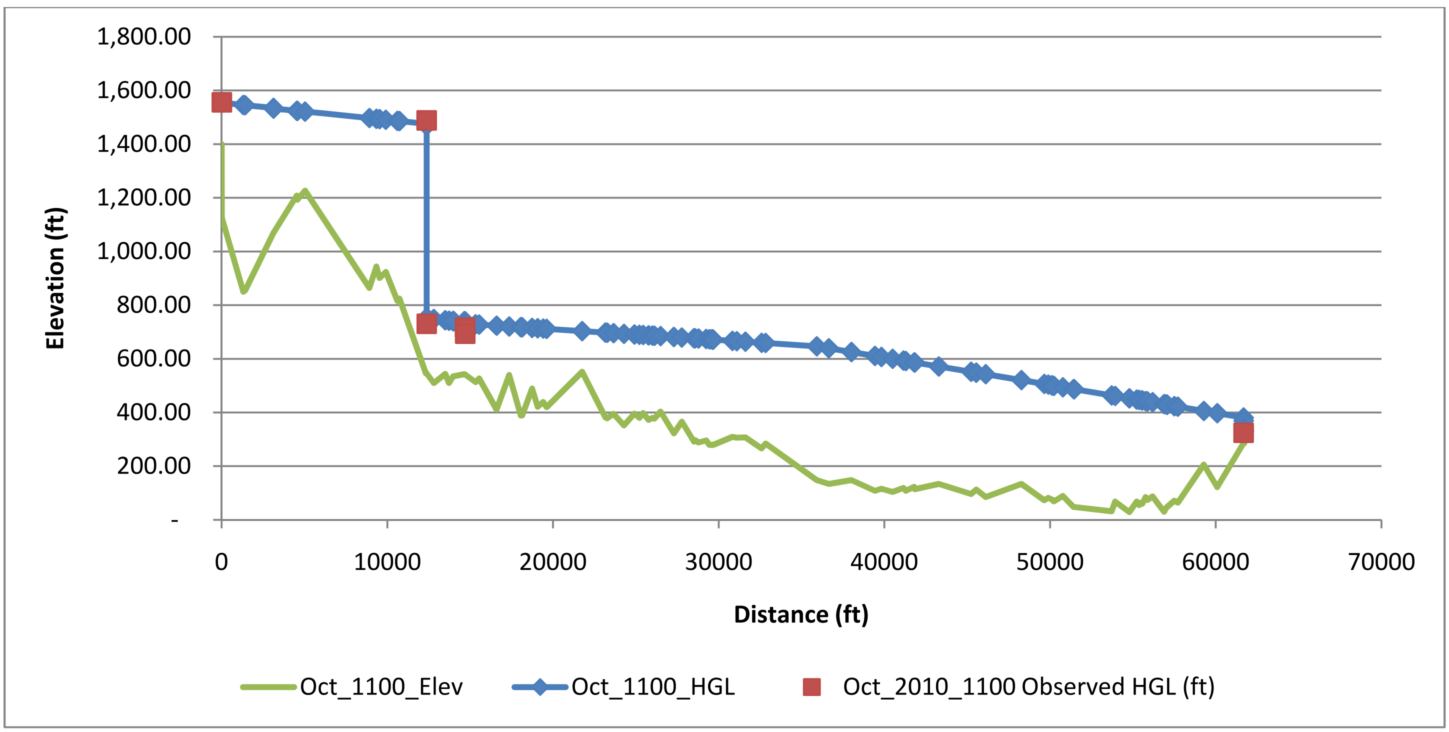


Figure 3. Chorro Valley pipeline hydraulic profile for a flow rate to Morro Bay of 1142 gpm.

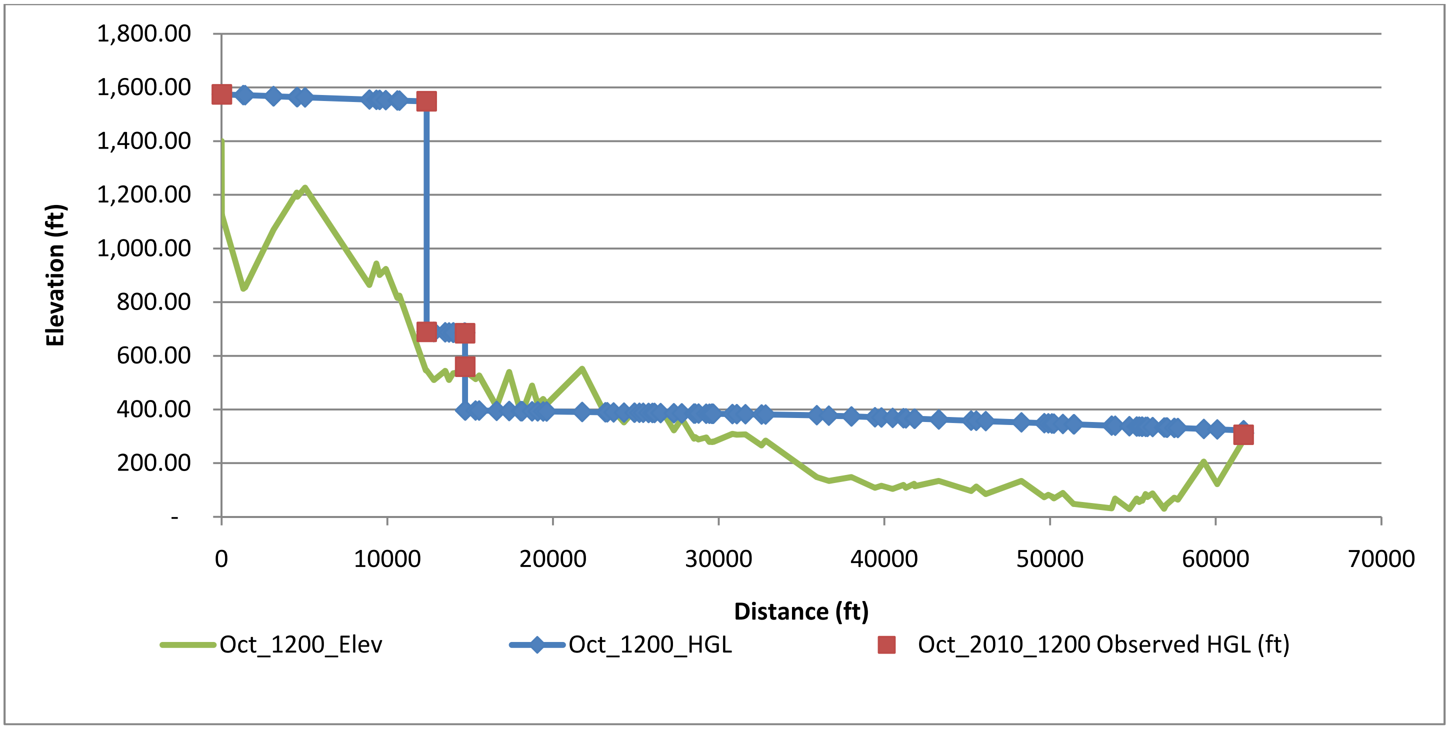


Figure 4. Chorro Valley pipeline hydraulic profile for a flow rate to Morro Bay of 479 gpm.

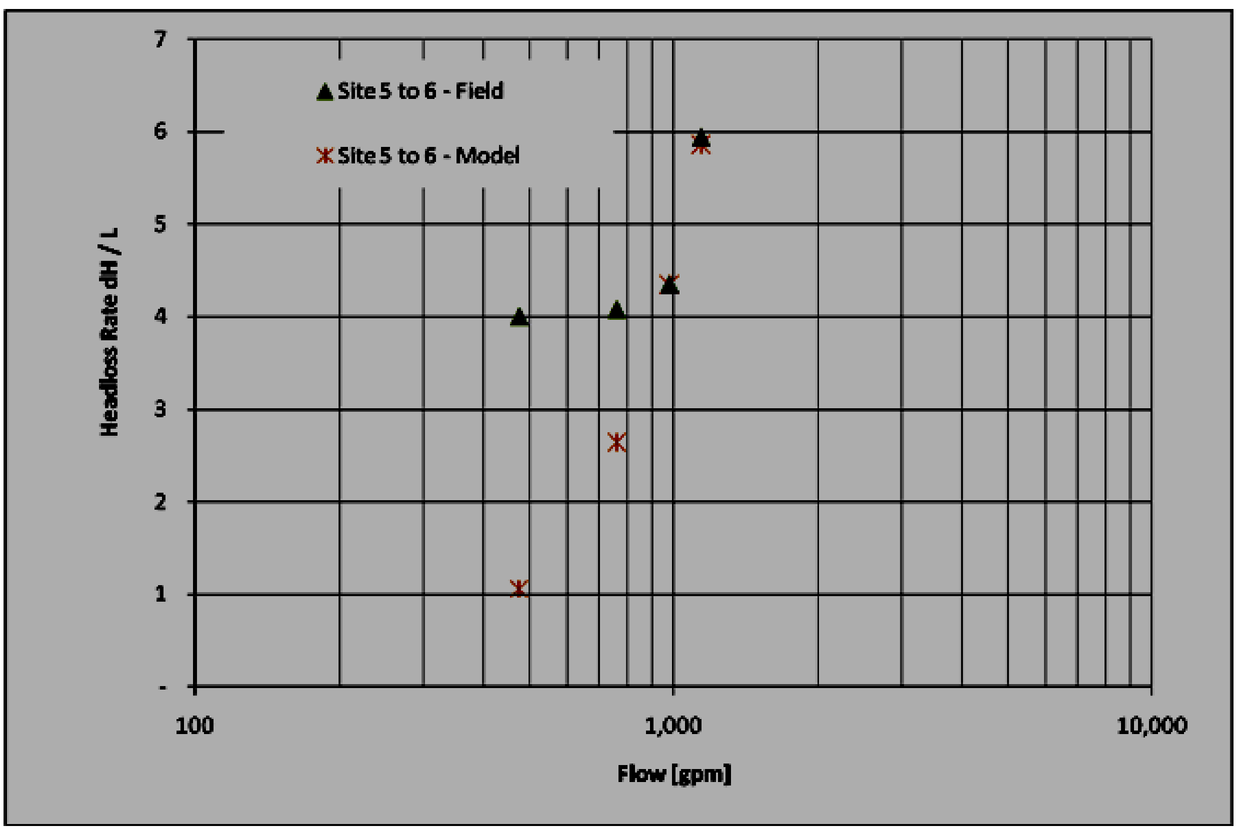


Figure 5. Head loss rate from Site 5 to Site 6 vs. flow rate plotted on a log scale

APPENDIX K. CALIBRATION DATA-CHORRO VALLEY PIPELINE

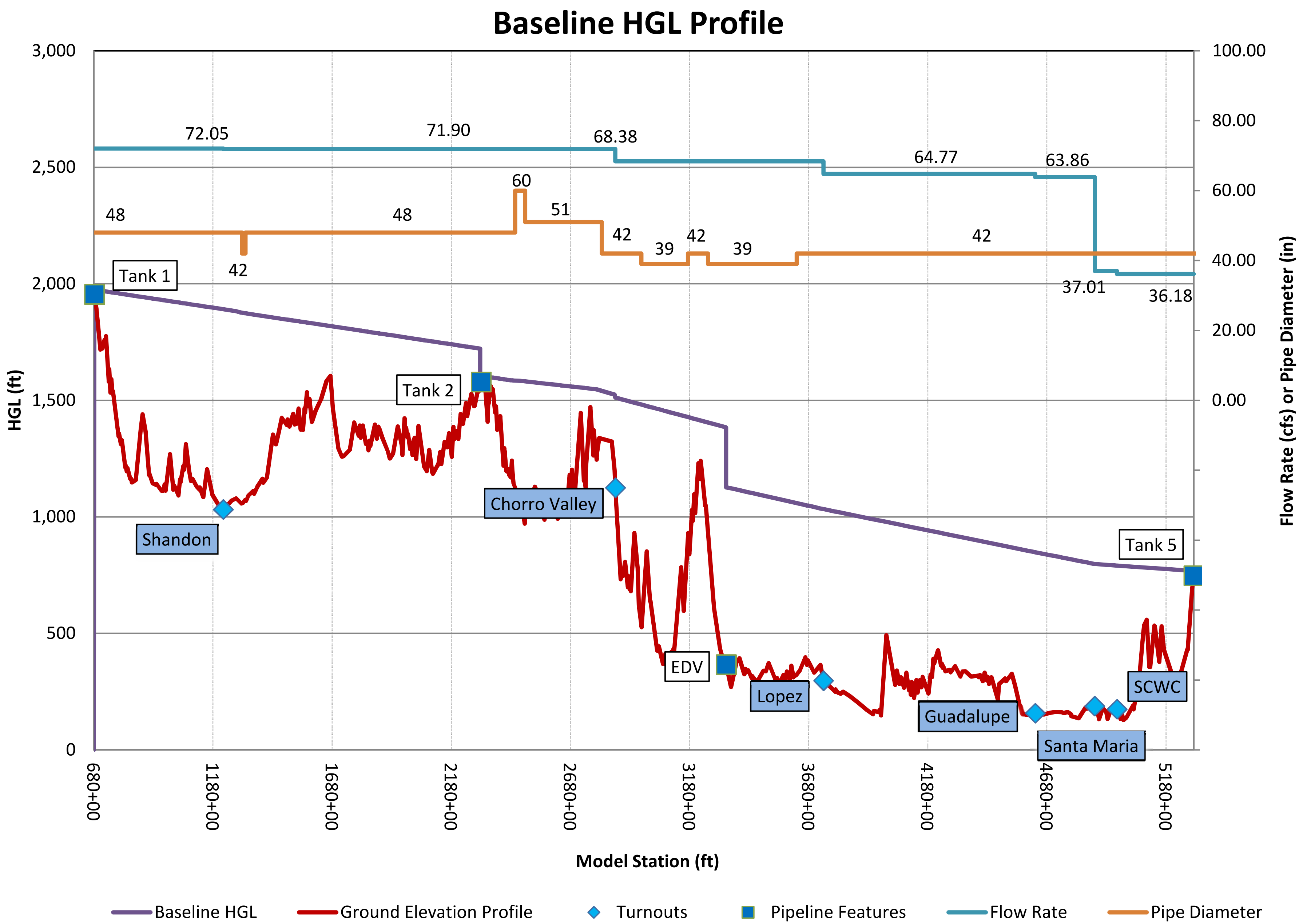
Test	Date	Time	Flow [gpm] (Site name / model element)								HGL [ft] (Site name / Model Element)								
			Site 3 - CCWA / FCV-1		CMC / CMC_Flow_Meter			Site 5 and 6 - MB / FCV - 2			Site 1 Upstream				Site 2 Upstream			
			Field	Model	Field	Adjusted	Model	Field	Model	Field p	Field HGL	Model	Error	Field p	Field HGL	Model	Error	% Error
Elevation [ft]											1,124				1,070			
Test 1	Oct-10	9AM	1,450	1,450	729	690	720	760	760	196	1,576	1,576	0.46				-	
Test 2	Oct-10	10AM	2,490	2,490		1,510	1,502	980	980	194	1,572	1,572	(0.15)				-	
Test 3	Oct-10	11AM	3,477	3,477		2,335	2,335	1,142	1,142	192	1,567	1,567	0.24				-	
Test 4	Oct-10	12AM	1,979	1,979		1,504	1,527	475	475	195	1,574	1,574	0.16				-	
Jan2010	Jan-10		1,090	1,105	620	605	612	500	493	201	1,588	1,588	(0.00)	222.00	1,582	1,586	(3.71)	-0.7%
Apr2010	Apr-10		1,393	1,405	619	608	614	797	791	195	1,574	1,574	0.16	215.00	1,566	1,570	(3.86)	-0.8%
Jun2010	Jun-11		1,532	1,551	744	725	735	826	816	188	1,558	1,558	0.01	206.00	1,545	1,554	(8.62)	-1.8%
Aug2010	Aug-11		1,662	1,683	755	734	746	949	937	184	1,549	1,549	(0.21)	202.00	1,536	1,544	(7.85)	-1.7%
							(79.60)						0.46				8.62	1.8%
PSI2FTH2O			2.31															

Test	Date	Time	HGL [ft] (Site name / Model Element)														
			Site 3 Upstream_Contraction					Site 3 Downstream					County SCADA Site 4 Upstream				
			Field p	Field HGL	Model	Error	% Error	Field p	Field HGL	Model	Error	% Error	Field p	Field HGL	Model	Error	% Error
				546			Rel.		546			Rel.		534			Rel.
Elevation [ft]			442.50	1,567	1,561	5.80	0.6%	51.50	665	658	6.89	5.8%	55	661	656	4.75	3.7%
Test 1	Oct-10	9AM	427.50	1,532	1,528	4.20	0.4%	62.90	691	686	5.19	3.6%	64	682	680	1.51	1.0%
Test 2	Oct-10	10AM	407.70	1,487	1,483	3.52	0.4%	79.50	729	734	(4.52)	-2.5%	80	718	721	(2.59)	-1.4%
Test 3	Oct-10	11AM	437.20	1,555	1,546	8.57	0.8%	61.40	688	684	3.73	2.6%	65	684	680	3.81	2.5%
Test 4	Oct-10	12AM	432.00					50.50	663	656	6.59	5.7%	54	658	655	3.44	2.8%
Jan2010	Jan-10		424.00					50.60	663	657	5.82	5.0%	54	658	655	3.44	2.8%
Apr2010	Apr-10		417.00					51.70	665	659	6.35	5.3%	55	661	657	3.75	3.0%
Jun2010	Jun-11		411.00					51.80	666	664	1.58	1.3%	55	661	661	(0.25)	-0.2%
Aug2010	Aug-11					8.57	0.8%				6.89	5.8%				4.75	3.7%

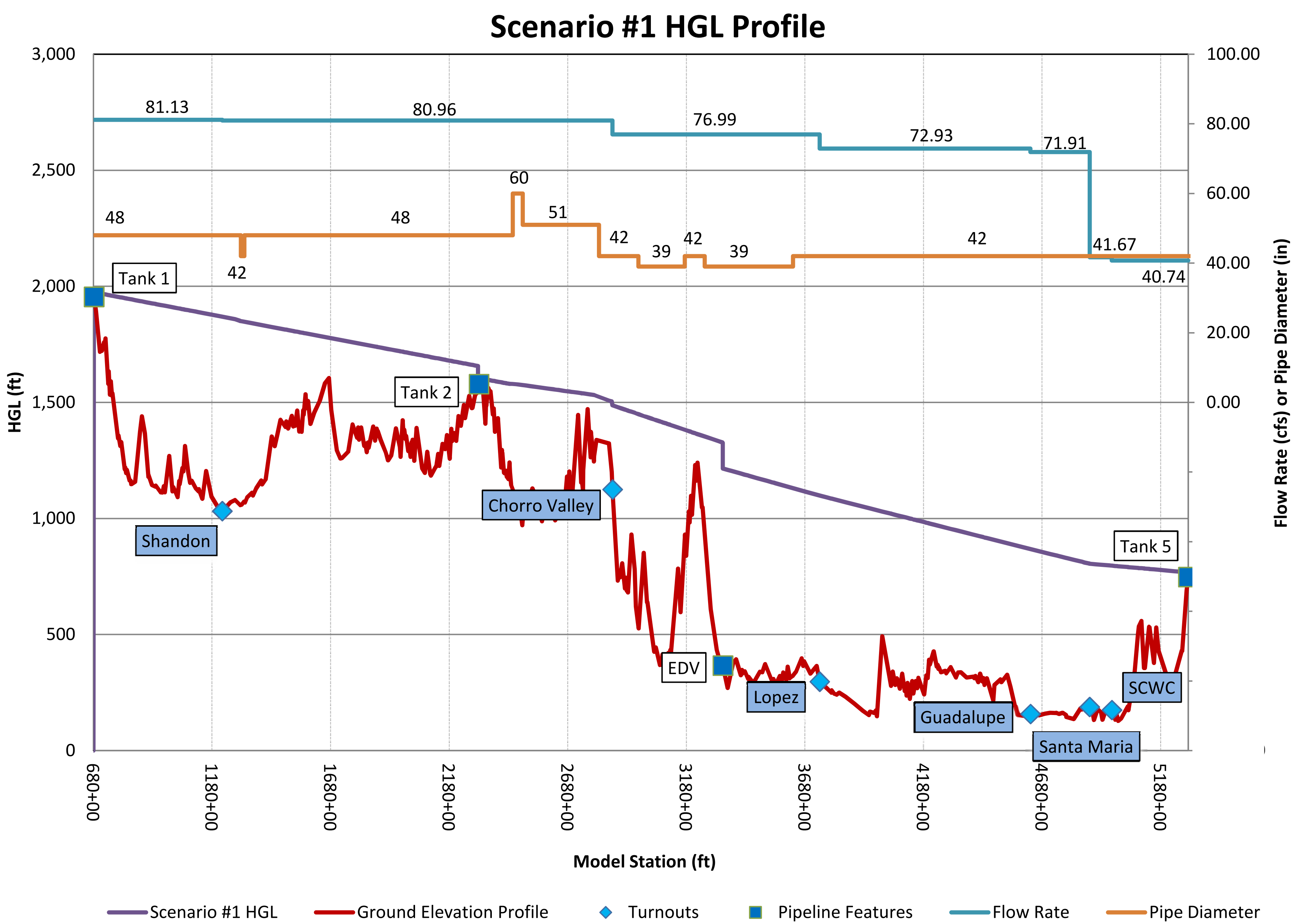
Test	Date	Time	HGL [ft] (Site name / Model Element)														
			Site 5a Upstream					Site 5a Downstream					Site 6 Upstream				
			Field p	Field HGL	Model	Error	% Error	Field p	Field HGL	Model	Error	% Error	Field p	Field HGL	Model	Error	% Error
Elevation [ft]				541			Rel.		541					301			
Test 1	Oct-10	9AM	52	661	656	4.73	3.9%	12	568	484	84.46	305%	11	327	327	(0.33)	-1.3%
Test 2	Oct-10	10AM	60	679	680	(0.82)	-0.6%	22	592	593	(1.47)	-2.9%	14	334	334	(0.41)	-1.3%
Test 3	Oct-10	11AM	76	716	722	(5.91)	-3.4%	66	693	691	2.02	1.3%	17	341	341	(0.49)	-1.2%
Test 4	Oct-10	12AM	62	684	680	3.79	2.7%	8	559	385	174.23	944%	9	322	322	0.06	0.3%
Jan2010	Jan-10												21	351	351	(0.34)	-0.7%
Apr2010	Apr-10												18	342	342	(0.10)	-0.3%
Jun2010	Jun-11												21	349	349	(0.41)	-0.9%
Aug2010	Aug-11												19	346	346	0.05	0.1%
						5.91	3.9%				174.23	944.2%				0.49	1.3%

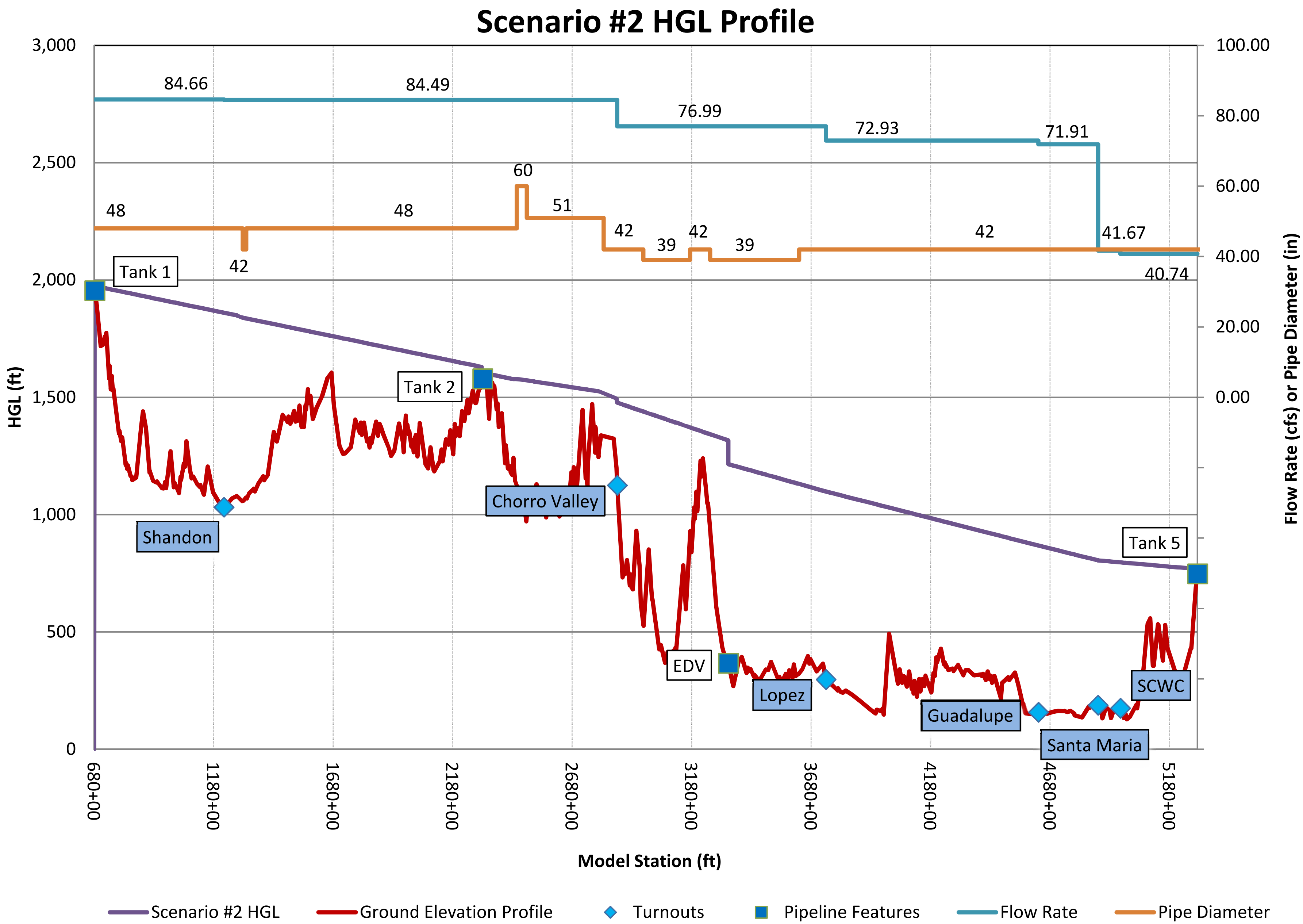
Test	Date	Time		Headloss Rate ft/1,000ft					
				Field			Model		
				Site 1 to 3	Site 3 to 5	Site 5 to 6	Site 1 to 3	Site 3 to 5	Site 5 to 6
Elevation [ft]			Station	12,380	2,328	59,357			
Test 1	Oct-10	9AM		0.78100	1.78123	4.07343	1.21163	0.85911	2.64501
Test 2	Oct-10	10AM		3.20318	4.15923	4.34546	3.55412	2.57732	4.36343
Test 3	Oct-10	11AM		6.51970	4.75372	5.93875	6.78514	5.58419	5.89652
Test 4	Oct-10	12AM		1.58218	1.68214	3.99571	2.26171	1.71821	1.06137
Jan2010	Jan-10				1.78123			0.42955	
Apr2010	Apr-10				1.88031			0.85911	
Jun2010	Jun-11				1.97939			0.85911	
Aug2010	Aug-11				2.07848			1.28866	

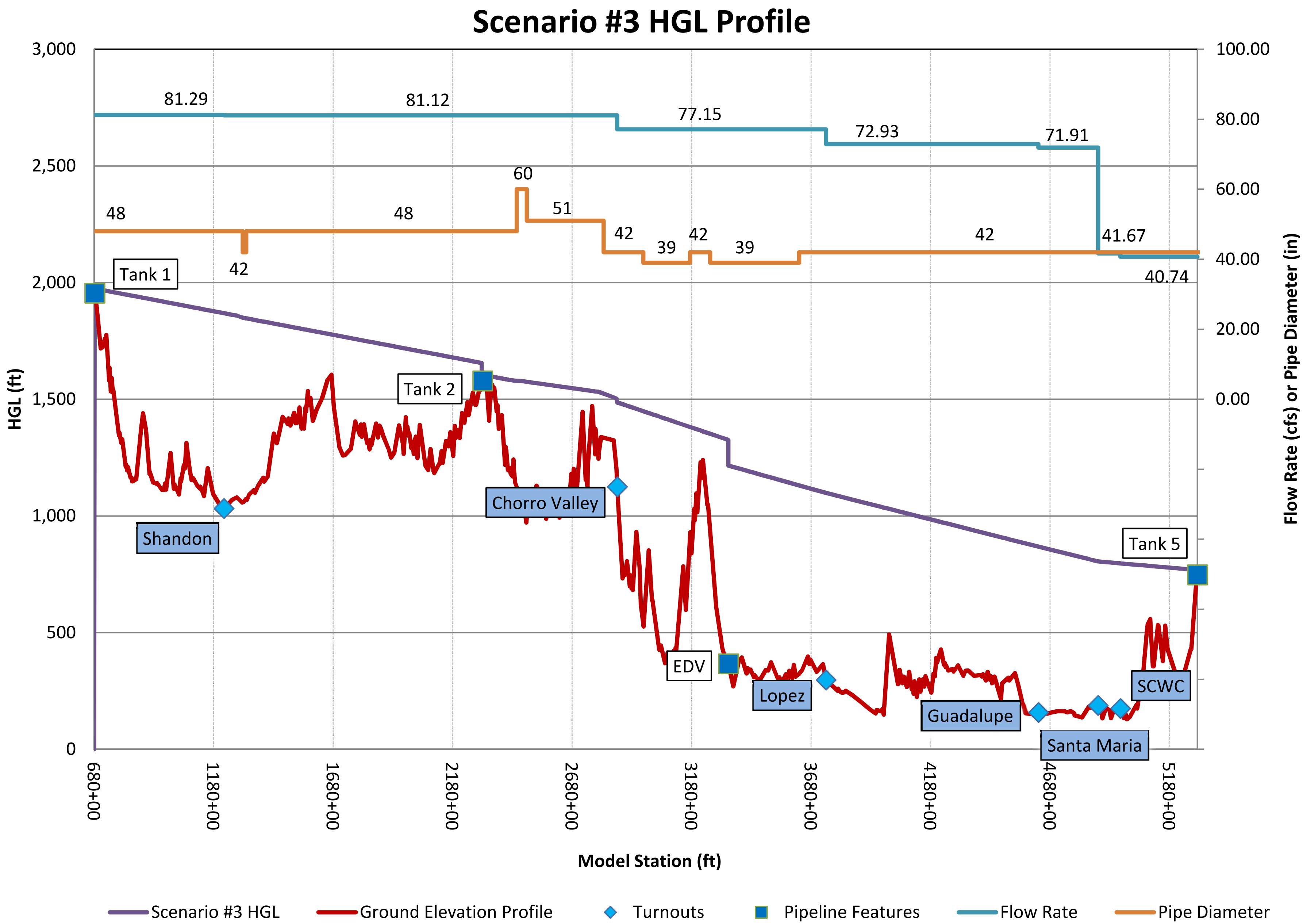
APPENDIX L. HGL PROFILES-COASTAL BRANCH PIPELINE



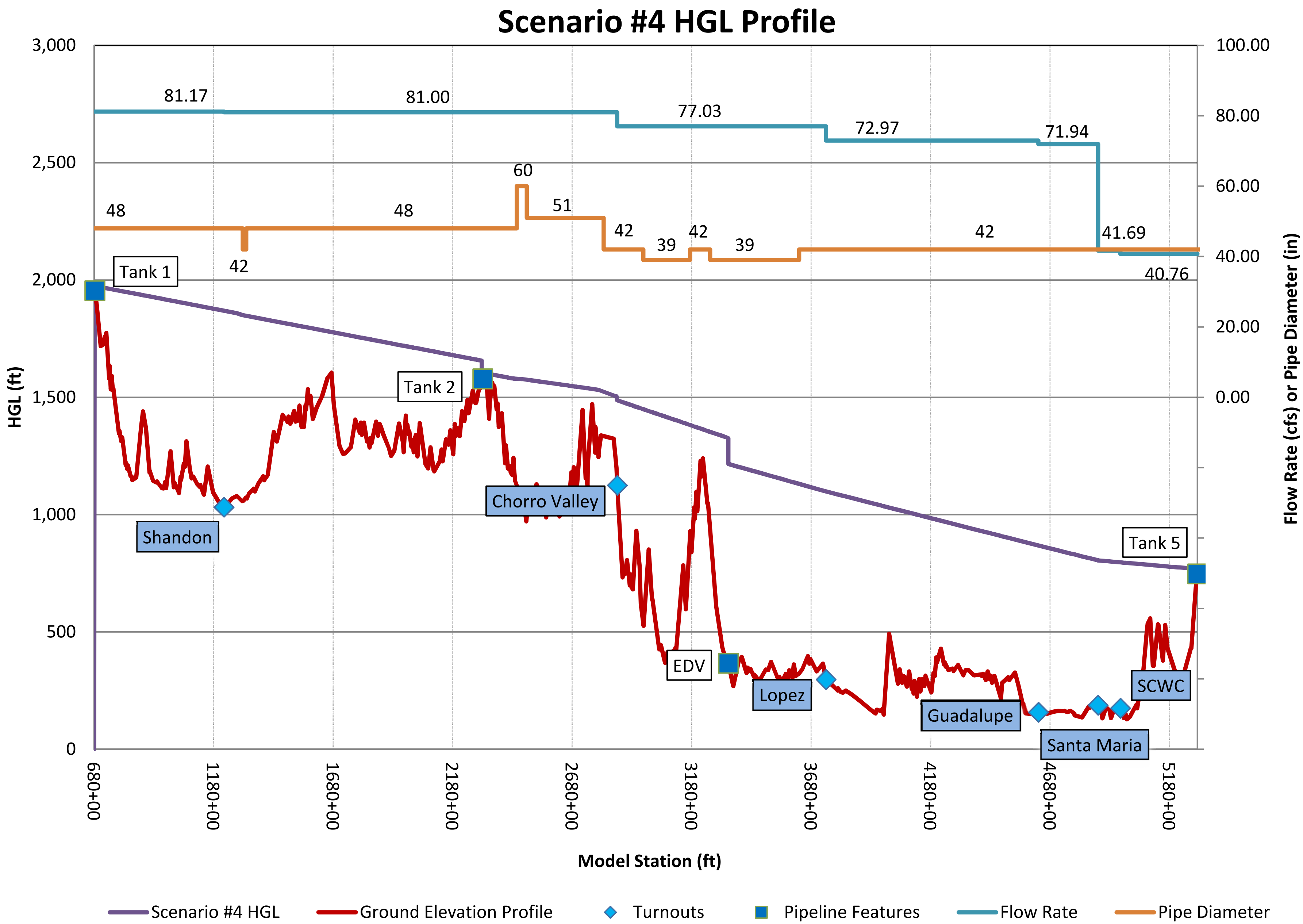
Baseline HGL Profile
HGL (ft)
Flow Rate (cfs) or Pipe Diameter (in)
Model Station (ft)
3,000
2,500
2,000
1,500
1,000
500
0
100.00
80.00
60.00
40.00
20.00
0.00
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
72.05
71.90
68.38
64.77
63.86
37.01
36.18
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
EDV
Shandon
Chorro Valley
Lopez
Guadalupe
Santa Maria
SCWC
Baseline HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter


Scenario #1 HGL Profile
HGL (ft)
Flow Rate (cfs) or Pipe Diameter (in)
Model Station (ft)
3,000
2,500
2,000
1,500
1,000
500
0
100.00
80.00
60.00
40.00
20.00
0.00
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
81.13
80.96
76.99
72.93
71.91
41.67
40.74
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
Shandon
Chorro Valley
EDV
Lopez
Guadalupe
Santa Maria
SCWC
Scenario #1 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter

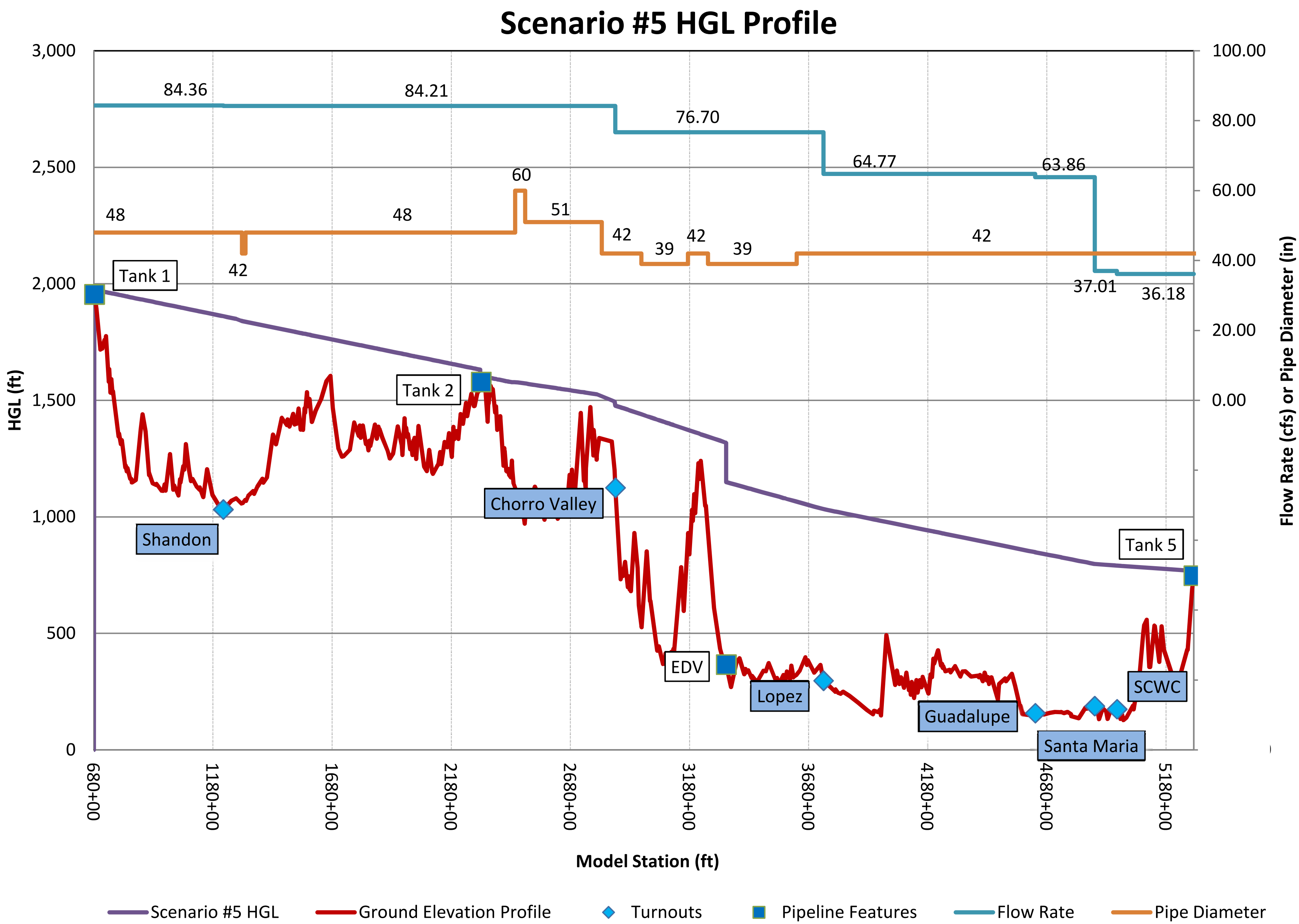

Scenario #2 HGL Profile
HGL (ft)
Flow Rate (cfs) or Pipe Diameter (in)
Model Station (ft)
3,000
2,500
2,000
1,500
1,000
500
0
100.00
80.00
60.00
40.00
20.00
0.00
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
84.66
84.49
76.99
72.93
71.91
41.67
40.74
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
Shandon
Chorro Valley
EDV
Lopez
Guadalupe
Santa Maria
SCWC
Scenario #2 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter



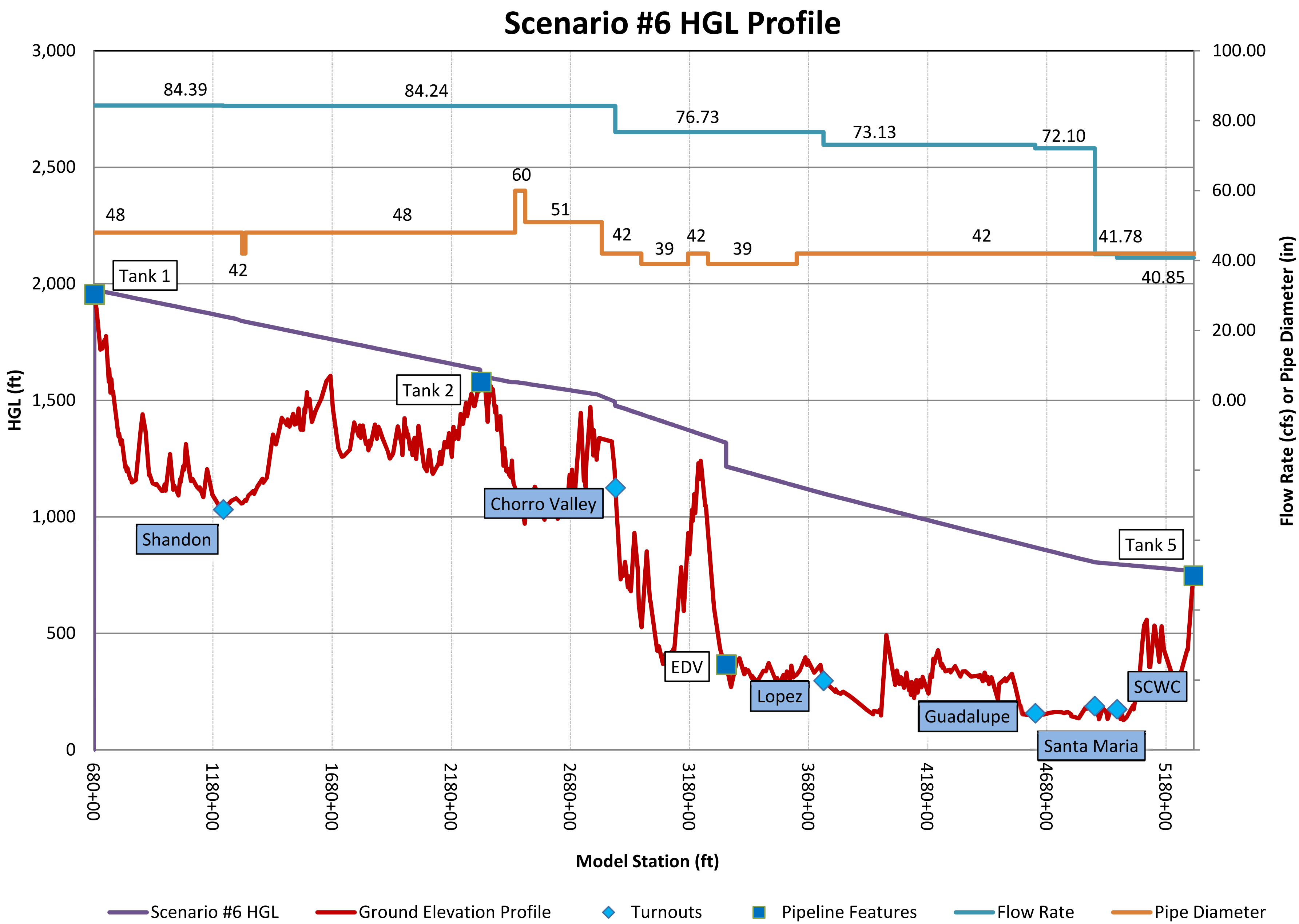
Scenario #3 HGL Profile
HGL (ft)
Flow Rate (cfs) or Pipe Diameter (in)
Model Station (ft)
3,000
2,500
2,000
1,500
1,000
500
0
100.00
80.00
60.00
40.00
20.00
0.00
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
81.29
81.12
77.15
72.93
71.91
41.67
40.74
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
Shandon
Chorro Valley
EDV
Lopez
Guadalupe
Santa Maria
SCWC
Scenario #3 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter

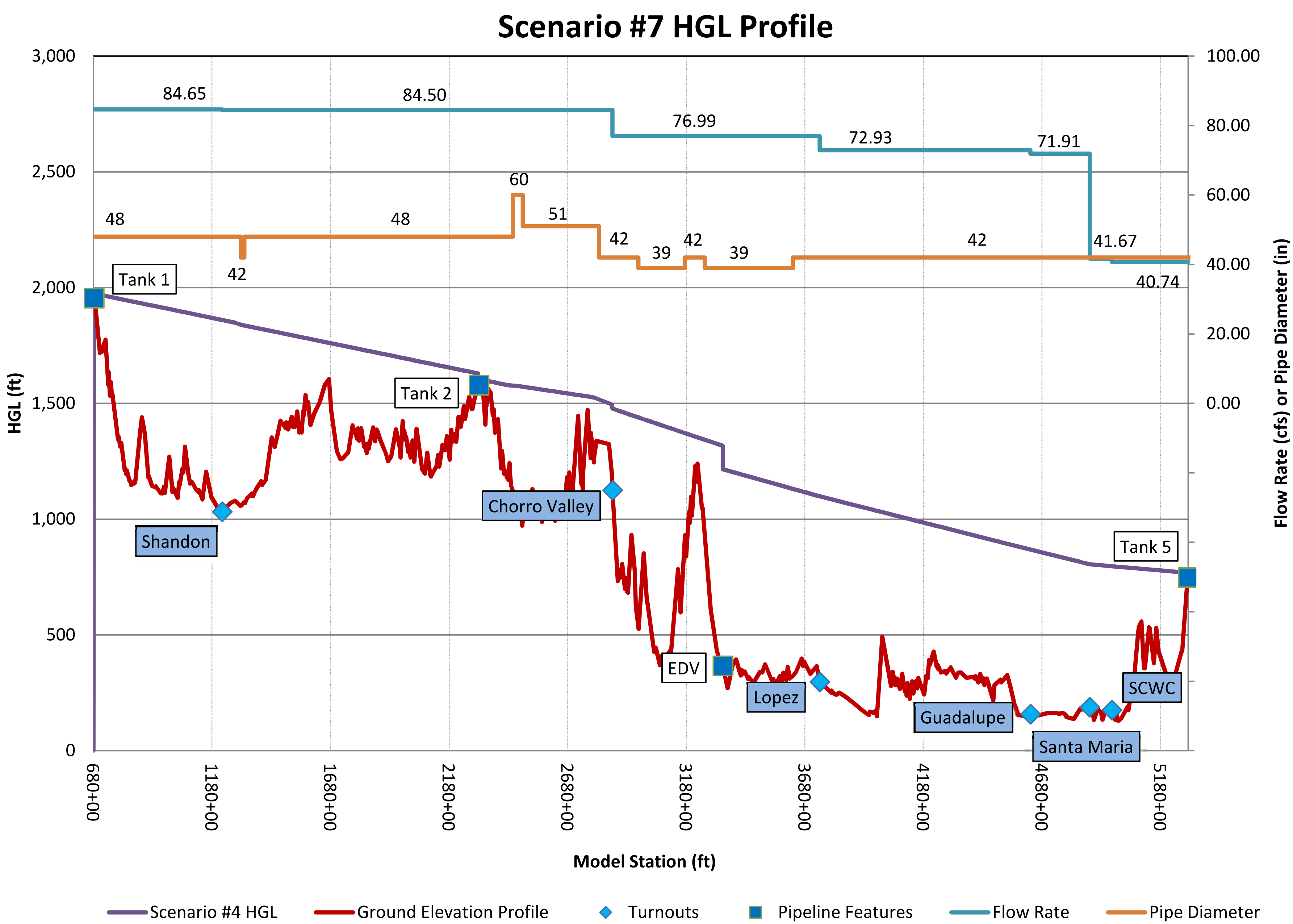


Scenario #4 HGL Profile
HGL (ft)
Flow Rate (cfs) or Pipe Diameter (in)
Model Station (ft)
3,000
2,500
2,000
1,500
1,000
500
0
100.00
80.00
60.00
40.00
20.00
0.00
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
81.17
81.00
77.03
72.97
71.94
41.69
40.76
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
EDV
Shandon
Chorro Valley
Lopez
Guadalupe
Santa Maria
SCWC
Scenario #4 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter

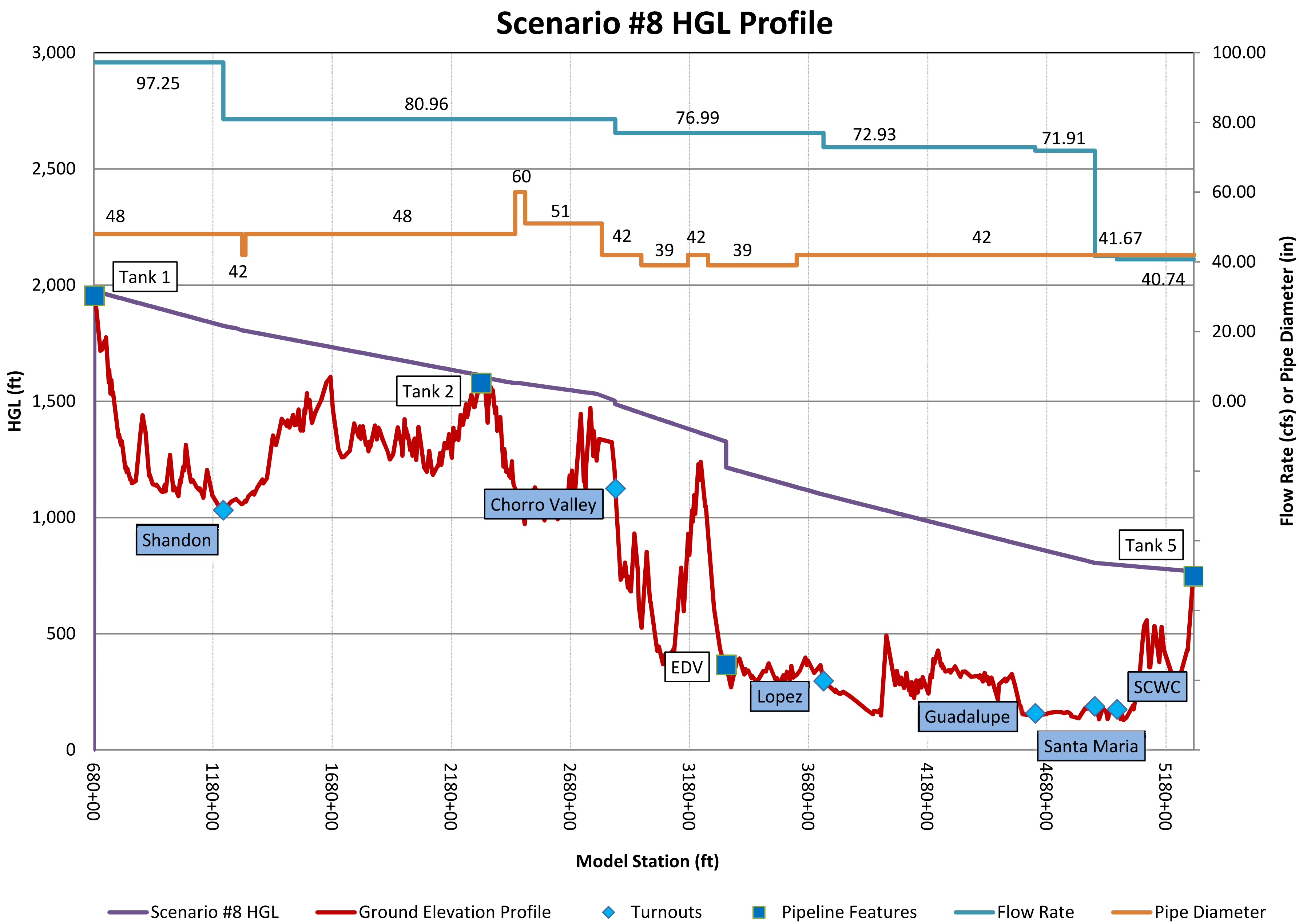


Scenario #5 HGL Profile
HGL (ft)
3,000
2,500
2,000
1,500
1,000
500
0
Flow Rate (cfs) or Pipe Diameter (in)
100.00
80.00
60.00
40.00
20.00
0.00
84.36
84.21
76.70
64.77
63.86
37.01
36.18
48
48
42
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
EDV
Shandon
Chorro Valley
Lopez
Guadalupe
Santa Maria
SCWC
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
Model Station (ft)
Scenario #5 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter


Scenario #6 HGL Profile
HGL (ft)
3,000
2,500
2,000
1,500
1,000
500
0
Flow Rate (cfs) or Pipe Diameter (in)
100.00
80.00
60.00
40.00
20.00
0.00
84.39
84.24
76.73
73.13
72.10
41.78
40.85
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
Shandon
Chorro Valley
EDV
Lopez
Guadalupe
Santa Maria
SCWC
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
Model Station (ft)
Scenario #6 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter



Scenario #7 HGL Profile
HGL (ft)
3,000
2,500
2,000
1,500
1,000
500
0
100.00
80.00
60.00
40.00
20.00
0.00
Flow Rate (cfs) or Pipe Diameter (in)
84.65
84.50
76.99
72.93
71.91
41.67
40.74
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Chorro Valley
Shandon
EDV
Lopez
Guadalupe
Santa Maria
SCWC
Tank 5
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
Model Station (ft)
Scenario #4 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter



Scenario #8 HGL Profile
HGL (ft)
Flow Rate (cfs) or Pipe Diameter (in)
Model Station (ft)
3,000
2,500
2,000
1,500
1,000
500
0
100.00
80.00
60.00
40.00
20.00
0.00
680+00
1180+00
1680+00
2180+00
2680+00
3180+00
3680+00
4180+00
4680+00
5180+00
97.25
80.96
76.99
72.93
71.91
41.67
40.74
48
42
48
60
51
42
39
42
39
42
Tank 1
Tank 2
Tank 5
EDV
Shandon
Chorro Valley
Lopez
Guadalupe
Santa Maria
SCWC
Scenario #8 HGL
Ground Elevation Profile
Turnouts
Pipeline Features
Flow Rate
Pipe Diameter

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