One of the most complex challenges facing many municipalities and wastewater utilities is cost-effectively managing urban wet weather discharges to meet evolving regulatory requirements and to protect water quality and public health. Carollo has provided a broad range of innovative services and solutions to help our clients meet this challenge.

Effective combined sewer overflow (CSO) and sanitary sewer overflow (SSO) control planning must consider a wide range of public policy issues and regulatory mandates, and requires an ability to evaluate alternatives and find creative solutions that fit within that framework. Carollo's wet weather include:

- Regulatory negotiations assistance.
- Development and implementation of flow data collection programs.
- Pilot testing of wet weather treatment schemes.
- Hydraulic and hydrologic modeling using a series of modeling platforms.
- Condition assessment of aging infrastructure.
- Detailed understanding of the benefits and tradeoffs of different wet weather control approaches.
- Collection system maintenance program evaluation and implementation planning.
- Storage facility planning and design.
- Wet weather pump station planning and design.
- Large interceptor and sewer design.
- Wet weather treatment facility design.
- Green solutions, such as best management practices (BMPs) and LID programs.

Carollo has been involved in the planning, permitting, design, and construction of some of the nation's largest and most innovative wet weather management programs.
Many wet weather management programs never move beyond the planning phase. Carollo has a proven track record of developing wet weather management solutions—and perhaps most importantly, getting them implemented.

Carollo has designed many innovative wet weather storage, conveyance, and treatment facilities to manage CSOs and SSOs. More recently, our focus has shifted to targeting the cause of high peak flows rather than treating the symptoms with a focus on improved collection system management, prioritization of replacement and repair of aging sewer systems, and reduction of the impacts of the built urban environment on wet weather flows using green and low impact development (LID). These solutions, often more difficult to evaluate and implement, provide our clients with greater long-term benefits and help keep them from reactive, more expensive solutions.

Representative CSO/SSO facility planning and design projects are highlighted in the table below and in the project profiles that follow.

### Representative Projects - Combined Sewer Overflow Facilities

<table>
<thead>
<tr>
<th>Client/Project</th>
<th>Project Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>City of Bellingham, WA - Comprehensive Sewer and CSO Control Planning</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>City of Kansas City, MO - Santa Fe Wastewater Pump Station CSO Improvements</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>King County Department of Natural Resources and Parks, Seattle, WA - Puget Sound Beaches CSO Planning/Predesign Services</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>City of Omaha, NE - CSO Control Program, Bridge Street Basin</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>City of Portland, OR - Columbia Boulevard Wastewater Treatment Plant Headworks Project</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>City of Portland, OR - Sewer System Rehabilitation Projects</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>City of Portland, OR - Sullivan/Stark/Holladay Basins Sewer Relief and Predesign</td>
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<tr>
<td>City of Portland, OR - Swan Island CSO Pump Station</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>City of Salem, OR - SSO Elimination Program</td>
<td>● ● ● ● ● ● ● ● ●</td>
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<tr>
<td>City and County of San Francisco, CA - Sewer Master Plan</td>
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# Wet Weather Management Services

## Representative Projects - Sanitary Sewer Overflow Facilities

<table>
<thead>
<tr>
<th>Client/Project</th>
<th>Project Elements</th>
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<tbody>
<tr>
<td>City of Albany, CA - Phase IV and V Replacement Projects</td>
<td>• • • •</td>
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<tr>
<td>City of Berkeley, CA - Sewer System Rehabilitation Project</td>
<td>• • • •</td>
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<tr>
<td>Central Marin Sanitation Agency, San Rafael, CA - Wet Weather Capacity Management Alternative Study</td>
<td>• • • • • • • •</td>
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<tr>
<td>City of Daly City, CA - Underground Flow Equalization and Wet Weather Treatment Facilities</td>
<td>• • • • • • • •</td>
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<tr>
<td>Diamondhead Water and Sewer District, MS - Wastewater Collection System Master Plan and Sewer System Rehabilitation</td>
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<tr>
<td>East Bay Municipal Utility District, Oakland, CA - Wet Weather Program Projects</td>
<td>• • • • • • • •</td>
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<tr>
<td>Johnson County Wastewater, Olathe, KS - Turkey Creek Pump Station and Force Main Replacement Project</td>
<td>• • • • • • • •</td>
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<tr>
<td>City of Lincoln, NE - Wastewater System Facilities Master Plan Update</td>
<td>• • • • • • • •</td>
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<tr>
<td>Livermore-Amador Valley Water Management Agency, Dublin, CA - Wet Weather Operations Model</td>
<td>• • • • • • • •</td>
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<tr>
<td>City of Manhattan, KS - SSO Elimination - Peak-Flow Holding Basin</td>
<td>• • • • • • • •</td>
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<tr>
<td>Metropolitan Sewer District of St. Louis, MO - SSO Elimination - Forestwood Lateral Sanitary Sewer Relief Project</td>
<td>• • • • • • • •</td>
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<tr>
<td>Metro Wastewater Reclamation District, Denver, CO - Service Area Utility Plan</td>
<td>• • • • • • • •</td>
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<tr>
<td>City of Piedmont, CA - Infiltration/Inflow Correction Projects</td>
<td>• • • • • • • •</td>
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<tr>
<td>City of Salem, OR - SSO Control Planning and Wet Weather Capacity Improvements Design</td>
<td>• • • • • • • •</td>
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<tr>
<td>City of San Bruno, CA - Sewer Master Plan and Infiltration/Inflow Study</td>
<td>• • • • • • • •</td>
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<tr>
<td>City of San José, CA - San José/Santa Clara Water Pollution Control Plant Wet Weather Reliability Improvements</td>
<td>• • • • • • • •</td>
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<tr>
<td>Sewer Authority Mid-Coastside, Half Moon Bay, CA - Wet Weather Management Program Facility Plan</td>
<td>• • • • • • • •</td>
</tr>
<tr>
<td>City of South San Francisco, CA - South San Francisco/San Bruno Water Quality Control Plant Wet Weather Improvements</td>
<td>• • • • • • • •</td>
</tr>
<tr>
<td>Union Sanitary District, Union City, CA - Irvington Wet Weather Equalization Storage Facilities Project</td>
<td>• • • • • • • •</td>
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<tr>
<td>Union Sanitary District, Union City, CA - Wastewater Treatment Plant Wet Weather Expansion</td>
<td>• • • • • • • •</td>
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<tr>
<td>Vallejo Sanitation and Flood Control District, Vallejo, CA - SSO Elimination Program</td>
<td>• • • • • • • •</td>
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<tr>
<td>Vallejo Sanitation and Flood Control District, Vallejo, CA - Wastewater Treatment Plant Wet Weather Expansion</td>
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<tr>
<td>West Valley Wastewater District, Campbell, CA - Los Gatos Sewer Collection System Analysis and Improvement Plan</td>
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Puget Sound Beaches CSO Planning/Predesign Services

King County has been working to control CSO overflows and come into compliance with state and federal regulations for CSO control. The County’s goal is to control overflows in the Barton, Murray, Magnolia, and North Beach basins by 2013. These four basins are the first Puget Sound CSO basins to be controlled and the County selected Carollo to complete planning and predesign.

Combined sewer overflow management and control requirements are established by state rules and the U.S. EPA CSO Control Policy. The CSO Control Policy was finalized in 1994 and establishes nine minimum controls for CSOs, as well as a presumptive level of control that is protective of water quality. The level of CSO control established by the State of Washington was adopted in 1987 prior to development of the U.S. EPA CSO Control Policy. The Washington policy is more restrictive, and it currently requires a level of control averaging one untreated discharge per year based on a five-year permit cycle.

Carollo and the County are developing comprehensive CSO facilities plans and predesigns of critical CSO control facilities within each basin. This includes evaluation of control alternatives, development of a preferred CSO alternative for each basin, preliminary design of the CSO facilities, environmental permitting services including SEPA documentation, public involvement with extensive neighborhood outreach, geotechnical evaluations, land surveys for easement or property acquisition, and development of the project costs for the preferred alternative.

King County’s previous CSO master planning focused on bottom of basin storage and increased conveyance capacity as preferred approaches to meeting control requirements. At the outset of this project, the County refined the basin hydraulic/hydrologic models based upon more recent flow data and found that much larger storage volumes and conveyance capacity would be required than was previously anticipated. As a result, achieving CSO control by using only bottom of basin storage and increased conveyance will be constrained by available sites, sensitive environmental issues, and downstream conveyance and treatment capacity.

A different approach to CSO control was clearly needed. Carollo developed and implemented a three-month flow monitoring program to collect subbasin flow data in each of the four basins. The flow data were used to calibrate detailed basin models Carollo developed using MIKE Urban software. The detailed hydrologic/hydraulic models allow evaluation of alternative approaches to CSO control such as end-of-pipe treatment facilities, distributed storage, impervious surface disconnection, sewer separation, and LID such as pervious pavement, bio-swales, and green streets.
Comprehensive Sewer and CSO Control Planning

The City of Bellingham selected Carollo to complete a comprehensive sewer plan for their collection system and wastewater treatment plant. Twenty percent of the City’s collection system is a combined sewer system. Base flows are 15 mgd and peak flows generated in the collection system are 81 mgd with approximately the 50 percent of the rainfall induced peak flows originating in the combined sewer area.

The total capacity of the conveyance system to the wastewater treatment plant is 72 mgd. Flows exceeding 72 mgd are discharged without treatment at a permitted CSO. The frequency of current discharges average greater than one event per year, based on long-term average. Washington State regulations require CSOs to be controlled to their baseline condition (frequency and volume), or to an average of less than one event per year, whichever is more stringent.

The City had a previously developed a collection system model that was used to evaluate hydraulic conditions in the collection system. The model was not suitable for long-term simulation of storm response and determination of overflow frequencies. To address this, Carollo developed a simplified collection system model using EPASWMM, calibrated the model to three significant storm events, and completed a long-term simulation using a 39-year rainfall record. The evaluation determined the potential risk of exceeding the regulatory requirement of “one overflow per year during the five-year permit cycle,” based on different storage volumes and conveyance capacities.

The analysis showed that peak-flow storage was a cost-effective control approach and that the "optimum" storage volume was 1.7 MG. Building additional storage greater than this volume, as suggested by the "design storm" approach, would have resulted in significantly higher cost and minimal reduction in the risk of exceeding the regulatory requirements.

Carollo assisted the City in resolving NPDES permitting and regulatory issues associated with establishing the appropriate CSO control and with developing permit language that would satisfy regulatory requirements at a reasonable cost to the City.

The City is moving forward with a plan to control CSOs based on building 1.7 MG of storage capacity. To add reliability and further reduce risk, the City will also target peak-flow reduction over time, focusing on I/I control in the leaky separated portions of the system and additional separation and disconnection in the combined sewer service area as the area becomes redeveloped.

Based on the success of the comprehensive sewer plan, Carollo was selected to complete a facilities plan for the identified necessary improvements to the City’s Post Point Wastewater Treatment Plant.
SSO Elimination Program

Carollo implemented a multi-phased Sanitary Sewer Overflow Elimination Program (SSOEP) for the Vallejo Sanitation and Flood Control District (VSFCD). This project began with an engineering feasibility study and planning program in 1999. As program manager, Carollo assisted VSFCD in completing this extensive program by the compliance date of 2006.

The SSOEP program, initially developed in 2000, included a master plan of the existing wastewater facilities, a water quality impacts assessment, and an Environmental Impact Report (EIR). The comprehensive master plan included an extensive analysis of the collection system and wastewater treatment plant to eliminate all unauthorized sewer overflows under a strict six-year time schedule. Tasks included:

- Rainfall, flow, and water quality monitoring.
- Hydrologic/hydraulic modeling of the collection system, treatment plant, urban storm water system, and Napa River watershed.
- A condition assessment of the existing system.
- Optimization/risk analysis for 1-, 5-, and 20-year storms storm events.
- Alternative development for storage, conveyance, and treatment.
- Comprehensive capital improvement program (CIP) development.
- State Revolving Fund (SRF) acquisition support.

Carollo completed a water quality assessment to project sewer overflow impacts on receiving water quality. This task included completing pollutant projections for the SSOs, urban storm water, and watershed flows. Work also involved a comprehensive EIR to document potential environmental impacts.

Following the completion of the SSOEP, Carollo further refined VSFCD’s CIP based on a cost-effective mix of alternatives that meet water quality objectives and protect public health. Phase I involved several immediate projects to remediate SSOs, including a wet weather expansion of VSFCD’s wastewater plant to 60 mgd, three million gallons of system storage, remediation of various conveyance system bottlenecks, and a collection system rehabilitation pilot program. Phase II recommended further conveyance improvements and Phase III involved project management of all the remaining projects necessary to reach compliance. The final program includes a blend of treatment plant storage, conveyance, and selective I/I rehabilitation to achieve VSFCD’s SSOEP goals.
DIAMONDHEAD WATER AND SEWER DISTRICT, MISSISSIPPI

Wastewater Collection System Master Plan and Sewer System Rehabilitation

The Diamondhead Water and Sewer District (DWSD) engaged Carollo to develop an immediate response to an U.S. EPA Region 4’s Cease and Desist Order. The present Diamondhead collection system commonly experiences peaking factors in excess of six times the dry weather flows and frequently experiences SSOs.

Carollo delivered a response package detailing DWSD’s programs for continuing sewer assessment, and collection system and pump station rehabilitation. Carollo also developed a draft comprehensive O&M manual for the entire collection system.

Coinciding with the Cease and Desist Order response effort, DWSD worked with Carollo and a subconsultant to plan and initiate a field assessment program to identify the location and degree of I/I in DWSD’s collection system. Flow monitoring identified the top 25 percent of the collection system experiencing excessive I/I. Work included investigating problem areas using smoke testing, manhole investigations, and closed circuit television.

Carollo completed a Phase 1 bid package to rehabilitate 15,000 feet of 8- to 24-inch sanitary sewers and 180 manholes. The bid package included bid items for the following sanitary sewer rehabilitation techniques: cured-in-place pipe (CIPP), air testing and grouting, point repairs, direct replacement of 140 feet of pipe, and manhole rehabilitation with epoxy lining.

Carollo has also completed a Phase 2 sewer system evaluation survey for a second 25 percent of the collection system experiencing excessive I/I. Based on this survey, Carollo prioritized additional rehabilitation projects for design and construction.

In conjunction with the pipeline and manhole evaluations, Carollo prepared a comprehensive evaluation of the system’s 34 lift stations in order to develop an upgrade and expansion plan. This plan outlines needed repairs, upgrades, and expansions to the system to accomplish I/I reduction goals ranging from 25 to 45 percent. The planning addressed immediate (two years), short-term (five years) and long-term (20 years) upgrades/expansion needs. Work also included preparation of a dynamic hydraulic model of the system that will provide documentation of the benefit for each improvement and upgrade to the system.
Wastewater System Facilities Master Plan Update

Carollo worked with the City of Lincoln Wastewater, Planning, and Public Works Departments to prepare the 2007 Wastewater Facilities Master Plan Update. The study area encompassed approximately 290 square miles, including 89 square miles presently served by Lincoln’s sanitary sewer system. Lincoln’s collection system currently comprises 13 drainage basins, with four additional basins planned for future growth. The master plan identified capital improvements for 25, 50, and 100-year planning periods for more than 970 miles of collection system piping, two existing wastewater treatment plants (combined capacity: 37.4 mgd), and 14 lift stations. The analysis also addressed the timing and size of a proposed third wastewater treatment plant.

Project elements included hydraulic modeling using XP SWMM dynamic modeling software, pipe material analysis, stream geomorphology, alternative alignment analysis, and figure preparation for the improvement projects. The XP SWMM model provided a realistic evaluation of how flows actually behave in the system, taking into account the time of travel and the physical conditions of the pipe. This is especially important in a large collection system. Population projections, along with treatment plant flows and flow-monitoring data, provided a basis for determining pipe sizes, storage basin and lift station capacity, and treatment improvements.

The overall methodology for developing improvements was to maximize the use of the existing infrastructure to the greatest extent possible in order to prevent SSOs. This included reviewing planned flows against actual flows and recommending peak-flow holding basins to maximize the use of existing sewer interceptors.

As part of this process, Carollo worked closely with Lincoln’s Finance and Planning Department staff to prepare a capital improvement plan for collection and treatment projects. Optimization techniques helped to minimize costs and maximize the benefit to the ratepayers. The team identified improvement costs by drainage basin and included them in a citywide cost summary to aid Lincoln in planning for future expenditures.
Sewer Master Plan

San Francisco is the only coastal city in California with a combined sewer system. This system is made up of a 1,000-mile-long collection system and three treatment facilities that discharge to San Francisco Bay or the Pacific Ocean.

This 30-year master plan is a joint venture of three firms addressing citywide wastewater collection and treatment. Carollo is providing the overall direction of work, coordinating the other joint venture members and subconsultants, preparing materials for presentations to the Public Utilities Commission and stakeholder groups, facilitating team brainstorming workshops, and developing evaluation criteria to screen and compare alternatives. Carollo is also taking the lead on determining existing and future regulatory requirements and compliance, evaluating storm water and receiving water quality, and identifying green technology, including low impact development (LID) options for reducing storm water flow and desynchronizing peak flows. Work also includes an analysis of sea level rise in order to evaluate the potential impacts to the City’s combined sewer system.

Key tasks include:

- Evaluating satellite treatment.
- Evaluating the condition of the three treatment facilities.
- Reviewing current and future regulations for effluent discharge, reuse, and biosolids.
- Identifying the future location, size, level, and type of treatment facilities.
- Identifying the future location and size of effluent outfalls.
- Integrating with the Water Reuse Master Plan.
- Developing costs, a CIP, and user rates and fees.
- Collaborating with an open public discourse involving various groups.
- Considering upgrading existing facilities and/or relocating treatment facilities at new sites.
- Modeling and planning for LID integration.
- Evaluating sustainability criteria.

San Francisco's Sewer Master Plan involves an analysis of sea level rise in order to evaluate the potential impacts to the City's combined sewer system.
Service Area Utility Plan

The Metro Wastewater Reclamation District (MWRD) retained Carollo to complete a Service Area Utility Plan. This plan addresses the current hydraulic capacity of the transmission system, including impacts of I/I, and examines its ability to provide adequate service in the future. The work effort determines demographic trends within MWRD’s service area so that wastewater flows conveyed to the MWRD’s Central Treatment Plant can be estimated. Part of this process includes estimating and examining long-range population and land use trends.

MWRD’s transmission system includes 43 gravity interceptor sewers, four lift stations, and four force mains. This system consists of approximately 236 miles of sewer pipe ranging in size from 8 inches to 90 inches in diameter, 65 primary metering facilities, 41 diversion structures, and approximately 3,750 manholes. Much of the transmission system was constructed within the last 15 to 20 years.

Work also included reviewed and recommended improvements to MWRD’s Transmission Division’s inspection and maintenance program. The plan includes the development of a real-time InfoWorks model of the distribution system, maintainable by MWRD staff. The model will have the following key features:

- A GIS-based land-use and population projection model.
- A flow and load-based model.
- A hydraulic model of the collection system.
- A predictive corrosion model.

The Carollo team will use the comprehensive model to evaluate the capacity and condition of the collection system to handle service area flows and loads. On-going project tasks have included the evaluation of several hydraulic models (with the final selection of InfoWorks) and development of a GIS-based data storage system using ArcView.

In addition, the team is evaluating the current inspection models and conducting a condition assessment of the entire collection system as part of an SSO elimination program with the Colorado Department of Public Health and Environment (CDPHE).

The review of inspection and system condition will ultimately be guided by the capacity, management, operations, and management (CMOM) regulations. Final products will include the utility plan report, a capital improvements plan (CIP), a comprehensive service area model with the four model components listed, and an inspection and condition evaluation.
SEWER AUTHORITY MID-COASTSIDE, HALF MOON BAY, CALIFORNIA

Wet Weather Management Program Facility Plan

Carollo prepared a Wet Weather Flow Management Program Facility Plan in 1999 for the Sewer Authority-Mid-Coastside (SAM) intertie pipeline system to abate SSOs. The intertie system, which has overflowed during heavy rainfall, conveys approximately 2 mgd of dry weather flow from SAM’s member agencies: the Montara Sanitary District, the Granada Sanitary District, and the City of Half Moon Bay. Wet weather flow was estimated at 15 mgd.

Carollo conducted the facility plan in three phases. Phase I included hydraulic modeling of the collection system with existing wet weather and dry weather flow data. The analysis included assessment of pump stations, force mains, and a gravity pipeline. This phase identified system bottlenecks and deficiencies to be upgraded as part of the overall facilities plan. Phase II consisted of measuring wet weather flows for the 1996 - 1997 wet weather season to calibrate the hydraulic model.

Carollo used these wet weather flows to develop flows associated with various recurrence interval design events and selected a five-year design storm as the system performance criterion. The final phase of the project consisted of hydraulically modeling the system using actual flow data to further identify deficiencies and develop a recommended improvement plan to manage up to the five-year design storm. Recommended improvements included pump station improvements, in-system storage basins, and a parallel force main.

Based on recommendations, SAM constructed a storage basin and the member agencies performed I/I rehabilitation. In 2003, SAM rehired Carollo to complete a new monitoring and modeling study and update the 1999 facility plan. The flow monitoring study included 10 flow meters and three rain gages. Carollo also used data from SAM’s SCADA system for the modeling effort. Carollo successfully calibrated the model to project new design flows for the five-year storm event. Because of implemented CIP recommendations and modeling efforts, the scope and cost improvements associated with the five-year event were reduced and optimized. The 2003 study will facilitate the design of the remaining wet weather facilities and bring SAM into compliance with sanitary sewer regulations in the Bay Area.
Wet weather operations and integrated flow management modeling.

Model aided in the design of wet weather infrastructure improvements.

Permitting assistance to allow discharge of excess wet weather flow to local water bodies, which lowered construction costs.

Wet Weather Operations Model

The Livermore-Amador Valley Water Management Agency (LAVWMA) engaged Carollo to develop a model of its wet weather operations and an integrated flow management program. LAVWMA is a joint powers agency responsible for the export and disposal of treated wastewater from the cities of Livermore and Pleasanton, and the Dublin San Ramon Services District. LAVWMA implemented the Export Pipeline Facilities Project to manage increased flows resulting from planned population growth and to mitigate wet weather flow in the dischargers' service areas. Carollo developed alternatives to increase export facility capacity from 21 mgd to 41.2 mgd. LAVWMA is contractually permitted to discharge 41.2 mgd of flow to a downstream discharge pipeline, but is limited to 19.7 mgd during extreme wet weather periods. Carollo also developed a cost-effective alternative to manage the remaining 20.2 mgd of wet weather flow.

LAVWMA’s 21-mgd export facilities included 16 miles of pipeline, a pump station, and reservoirs. Carollo provided hydraulic modeling of LAVWMA’s separate sewer systems, 50 million gallons of storage, and the existing export pipeline to optimize the system for wet weather flows. Carollo used a spreadsheet model to predict RDI/I and potential future overflows. Work included conducting a recurrence interval analysis for several design events. The modeling aided in the design of the improvements, which included 16 miles of new 21-mgd pipeline, relining the existing pipeline, a new LAVWMA export pump station, a new 12.4-mgd Livermore pump station, and the upgrade of 6.3 miles of existing Livermore Trunk Line.

Discharge options for the remaining 20.2 mgd of wet weather flow included storage, additional treatment and discharge, or discharge. Through water quality modeling efforts, Carollo assisted in obtaining permits from the RWQCB and Alameda County’s Zone 7 Water Agency for discharge of the excess wet weather flow to local water bodies, which significantly reduced construction costs.
Sewer Master Plan and Infiltration/Inflow Study

The City of San Bruno retained Carollo in 1996 to conduct a sewer master plan and infiltration/inflow study. Key project elements included:

- Preparing a sewer system hydraulic model, using HYDRA software, to identify sewer system deficiencies and improvements.
- Estimating wet weather flows that reach the sewer system for a five-year storm event.
- Evaluating the capacity and condition of all San Bruno pump stations.
- Developing a prioritized capital improvements plan.

The study recommended smoke testing and pipeline closed circuit television in order to pinpoint problem areas. Upon completion, San Bruno received the hydraulic model for use in planning future sewer additions and improvements.

A key aspect of the infiltration/inflow study included the collection of flow and rain data during the 1996/97 rainy season. Seven flow meters and three rain gages were installed and maintained by ADS Environmental Services to gather critical sewer flows and rainfall data within San Bruno’s collection system. Carollo used this information to calibrate the hydraulic model, identify system bottlenecks, segregate drainage basins, and quantify actual I/I volumes.

The project also included additional flow monitoring for the 1997/98 wet weather season.

Carollo provided San Bruno with a long-range, phased capital improvements program to rehabilitate their aging collection system.
Los Gatos Sanitary Sewer Collection System Analysis and Improvement Plan

The West Valley Wastewater District retained Carollo to prepare a Sanitary Sewer Collection System Analysis and Improvement Plan for the City of Los Gatos. This analysis included 40,000 feet of sanitary sewer in a 300-acre area. Engineering services included examining the existing information; hydraulic modeling and analysis of the system; evaluating system condition and performance; identifying system deficiencies; considering options for repair, rehabilitation and/or replacement; recommending cost-effective solutions; preliminary design for the best solutions; and developing a cost-benefit spreadsheet for each parcel within the proposed area of system improvements.

Carollo designed a phased infiltration/inflow reduction program to address overflow problems from the sewershed in the area around Los Gatos High School. CCTV inspections revealed that the sewer had a variety of cracks, joint off-sets, root intrusion and other defects. Carollo developed a program to rehabilitate the sewers in three phases, prepared contract documents, and provided bidding and construction period services. The construction cost of each rehabilitation phase ranged from $1 million to $1.5 million.

Carollo’s improvement plan for the West Valley Sanitation District resulted in cost-effective rehabilitation of sewers in city streets.
SSO Control Planning and Wet Weather Capacity Improvements Design

The City of Salem has a separated sewer system with high wet weather flows and resultant SSOs. Peak flows in the system increase to more than 10 times the average dry weather flow with peak flows projected to exceed 350 mgd at the end of the 20-year planning period. The State of Oregon issued a compliance order requiring that SSOs resulting from storms smaller than the 5-year, 24-hour storm be eliminated by December 2009.

The City of Salem selected Carollo, in partnership with another consultant, to provide facilities planning for improvements to the Willow Lake Water Pollution Control Facility (WLWPCF), major wastewater pump stations, and Salem’s interceptor system with the goal of eliminating SSOs and improving the reliability and treatment capacity of the WLWPCF.

To define process capacity, Carollo employed a holistic approach for modeling plant performance, rather than relying on historical rules-of-thumb. The team coupled bench-scale and laboratory testing with state-point analysis to identify ways to maximize the wet weather capacity of existing processes and give Salem the biggest "bang for its buck." Every effort was made to provide maximum use of existing facilities for process capacity without sacrificing plant reliability and redundancy. The recommendations reduced the capital improvement costs identified by a previous master plan by nearly $80 million.

A major component of the overall conveyance and treatment strategy included remote treatment of SSOs through high-rate processes. To provide a cost-effective combination of conveyance and treatment, the team suggested the use of innovative high-rate physical/chemical treatment processes. Carollo led the effort to evaluate these facilities, which included extensive pilot testing of coupled ballasted flocculation and UV disinfection processes on dilute wet weather flows.

Carollo worked with both the Oregon Department of Environmental Quality (DEQ) and the U.S. EPA to review the pilot testing methodology and results and to gain acceptance of the high-rate satellite wet weather treatment plant. Based upon the pilot testing and evaluations prepared by Carollo, Oregon DEQ accepted the high-rate ballasted flocculation as equivalent to secondary treatment for wet weather flows. After extensive review by Oregon DEQ and U.S. EPA, the satellite high-rate treatment facility was successfully permitted.

Based on the success of the facilities plan, Salem then selected Carollo to design the Phase I improvements to the City’s Willow Lake Water Pollution Control Facility, as well as provide engineering services during construction. The $95 million Phase I Improvements included increasing wet weather capacity to 155 mgd with the addition of a new 96-inch-diameter influent sewer, a new 155-mgd influent pumping facility and headworks complex eliminating hydraulic bottlenecks in the treatment plant, a new intermediate pump station, two new primary clarifiers, and chlorine contact basin capacity expansion.
Swan Island CSO Pump Station

The 220-mgd Swan Island Pump Station's performance and reliability is the linchpin to the success of Portland's CSO Program, and is the largest capital construction project in the City's history. The pump station serves as the terminus of the “Big Pipe” project, consisting of two gravity flow tunnels more 120 feet beneath the City, designed to collect and store combined sewage.

Significant cost savings resulted from the innovative design of the pumping systems to take advantage of wet well surcharge. As surcharging occurs under wet weather conditions, the static head that the pumps must overcome begins to decrease, increasing pump output. With enough surcharge, the total output from the pumping system can be achieved with the largest pump out of service. This eliminates the need to provide a fully redundant pump as a standby unit. Eliminating a fully redundant pump reduced the footprint of the pump station and lowered the construction cost of the shaft.

The wet well design features several special attributes that benefit pump station operation. The most distinguishing feature is its self-cleaning design, which reduces maintenance and risk to personnel. It is one of the deepest and largest self-cleaning pump stations in the world. Because of its uniqueness, Carollo utilized physical hydraulic modeling using a 1:7 scale to test for hydraulic inefficiencies, vortices, and other adverse flow phenomena to optimize wet well and pump performance.

The Phase 1 pumping system included two 16-mgd, 800-hp pumps used for low-flow (sewage) conditions and two, 42.7-mgd, 2,000-hp wet weather pumps for high-flow conditions.

In 2008, Portland selected the Carollo team to complete the civil, mechanical, structural, and electrical design for Phase 2. Phase 2 brings total pump station capacity to 220 mgd. Carollo's services included the selection of major equipment, layout of piping and appurtenances, and integration with the existing pumping system. This phase also includes three additional variable-speed, wet weather non-clog sewage pumps and associated systems and equipment, which, when operating together, will be capable of producing a combined flow of 120 mgd through a dedicated force main.
Santa Fe Wastewater Pump Station CSO Improvements

The Santa Fe Wastewater Pumping Station was constructed in 1963 and pumps combined raw sewage and storm water runoff from Kansas City’s central industrial district to the nearby Westside Wastewater Treatment Plant. The 22-mgd pump station includes three 150-hp dry-pit pumps each rated at 8,000 gpm, and two 35-hp dry pit submersible pumps each rated at 2,000 gpm. Kansas City retained Carollo to complete a pump station condition assessment and design improvements, which included an alternative for more effective influent grit removal.

Pumping System. The improvements included an alternative pump operation sequence to optimize performance, modifications to the pump discharge piping, and installation of a discharge flow meter to monitor pumping system efficiency. Under normal operating conditions, only the smaller pumps are used to pump the combined sewer flow to the treatment facility. These smaller pumps do not remove the accumulated grit from the wet well efficiently. An alternative strategy was to operate the larger pumps on a more frequent basis to aid in removing the deposited grit. In addition, the design included addition of an air release system to the discharge piping of the smaller pumps to alleviate air pockets.

Screenings Improvements. To address mechanical bar screen effectiveness and operability issues caused by large debris in the influent stream, pump station improvements also included two new heavy-duty mechanical climber screens along with two new screenings washer compactors.

Combined Sewer Improvements. The three main sewers that discharge into the pump station wet well include a 36-inch sanitary sewer, a 54-inch storm sewer, and a 120-inch combined sewer. The flow stream from these pipes to the pump station often carries rocks and large debris. This debris has created numerous problems and damage to the influent screens and raw sewage pumps at the pump station.

Two grit collecting manhole structures are being constructed on the two larger sewers that carry storm or combined flows to remove the large rocks and debris from the influent flow stream. A 19 foot by 17.5 foot concrete structure will be constructed on the existing 120-inch combined concrete sewer, and a 14-foot-square manhole structure will be constructed on the 54-inch storm sewer into the pump station. The manhole structures are designed with an invert lower than the respective sewer to capture larger, heavier solids in the flow stream by creating a “pocket” beneath the flow line for the debris to settle out. The settled solids will then be removed from the manhole structure with the use of a truck-mounted crane and clamshell system for transfer into a portable dumpster. The manhole concrete structures will be constructed within the trafficked roadway and were designed with a heavy-traffic rating.
Turkey Creek Pump Station and Force Main Replacement Project

Carollo worked with Johnson County Wastewater (JCW) during the design and construction of the Turkey Creek Pump Station upgrade and force main replacement project. These improvements increased capacity in JCW’s collection system and helped to minimize SSOs.

The Turkey Creek Pump Station is the primary source of wastewater for the Turkey Creek Wastewater Treatment Plant. It also receives solids from several satellite treatment facilities. The pump station upgrade replaced three pumps with new 300-hp solids handling wastewater pumps, each with a capacity of 6,250 gpm at a head of 106 feet, providing a firm wet weather capacity of 27 mgd.

The pump station upgrade completely renovated the power distribution system and the instrumentation and control system. Upstream from the pump wet well are two hydraulically driven mechanically cleaned bar screens, which were removed one at a time and sent to the manufacturer to be modified/rehabilitated to incorporate submersible electrical drives.

The design included replacing a 16-inch force main with a new 30-inch ductile iron force main. This was accomplished by routing the new force main over the top of the abandoned 16-inch force main, removing portions of the abandoned main that interfered with new construction and filling other portions with flowable fill.

The new force main works in unison with an existing 24-inch force main. Construction included one tunneled crossing of a major intersection, and the installation of several isolation valves to separate the two force mains.

Johnson County’s Turkey Creek Pump Station upgrade replaced three pumps with new 300-hp solids handling wastewater pumps, each with a capacity of 6,250 gpm at a head of 106 feet, providing a firm wet weather capacity of 27 mgd.
EAST BAY MUNICIPAL UTILITY DISTRICT, OAKLAND, CALIFORNIA

Wet Weather Program Projects

In order to protect San Francisco Bay from untreated sewage overflows, the East Bay Municipal Utility District (EBMUD) embarked on a $250 million wet weather program to provide transport, storage, and treatment of wastewater flows which average 10 to 20 times greater in wet weather than in dry weather. As part of this program, Carollo designed several wet weather facilities totaling nearly $70 million in construction costs. These included:

**Wet Weather Storage Basin.** Carollo provided design and construction-related services for this $25 million, 11-million-gallon storage basin to hold flows in excess of 320 mgd entering EBMUD’s main treatment plant. Once the incoming flows have subsided, the stored wastewater is returned to the plant for additional treatment.

**Point Isabel Wet Weather Treatment Plant.** Carollo provided preliminary and final design of this $28 million, 100-mgd remote wet weather treatment facility. Influent flow is pumped to 3 million gallons of storage until flows subside. Wastewater is then returned to the main plant for treatment. If rainfall continues and storage capacity is exceeded, the plant provides screening, grit removal, primary sedimentation, disinfection, and bay discharge of up to 100 mgd of wet weather flow.

**Wet Weather Interceptors.** Carollo provided design and construction services for two major wet weather interceptors. The Adeline Street Interceptor consists of two miles of 30-inch to 60-inch-diameter pipeline to carry flows from portions of Berkeley to the main treatment plant in Oakland. The South Foothill Interceptor consists of three miles of 48-inch to 60-inch-diameter pipeline to carry flows from Oakland to the Oakport remote wet weather treatment facility.

All projects successfully manage wet weather flows and were completed on time and within budget. The wet weather storage basin received a 1992 Design Honor Award from the California Consulting Engineers Council.
Underground Flow Equalization and Wet Weather Treatment Facilities

Carollo completed the design of an expansion to the oxygen activated sludge plant for the North San Mateo County Sanitation District in Daly City, California. This innovative $16 million plant expansion was required to accommodate increased annual as well as peak wet weather flows. The plant expansion increases the secondary treatment capacity from 8 mgd to 10.3 mgd. New facilities include a headworks, primary treatment modifications, and flow equalization and solids handling facilities. Primary treatment capacity was expanded from 8 mgd to 12 mgd.

Expansion of the secondary process was achieved by constructing 2.8 million gallons of underground equalization storage basins to maintain a constant flow rate to the secondary treatment process. Because of space constraints, the equalization basins and new primary clarifiers are constructed completely underground and covered with a baseball park. The equalization basins are fully ventilated and, because of the close proximity of residences and restaurants, exhaust air is scrubbed with an innovative activated carbon scrubber. Total air flow capacity is 80,000 cfm.

A unique three-story utility tunnel houses process equipment and piping. The design provides easy access to the underground facility from the existing plant. All pumping equipment is located at the lowest level, 50 feet below grade.

Nearby playing fields, homes, and businesses made odor control a prime concern. Burying the plant provided part of the solution. Today the treatment facilities and softball fields coexist without odor problems, even though the headworks and air scrubbers are within 20 feet of home plate. The reconstructed softball fields host teams throughout the San Francisco Bay Area.
Wet Weather Capacity Management Alternative Study

Carollo completed a Wet Weather Capacity Management Alternative Study for the Central Marin Sanitation Agency (CMSA) to address anticipated increased wet weather flows from its member agencies. The comprehensive study involved performing a hydraulic and process capacity of the CMSA treatment plant, estimating the wet weather flows to the treatment plant, and conducting an alternative analysis of various wet weather solutions to provide CMSA with a proven and cost-effective wet weather management program.

Because San Francisco Bay tide levels impact the gravity discharge capacity of the plant, Carollo modeled the entire plant's hydraulic capacity under a variety of flow scenarios and identified various alternatives to increase capacity during high tidal conditions. Effluent pumping was ultimately recommended to relieve bottlenecks and help mitigate flooding of upstream processes during peak wet weather flows.

Team members used Biotran™ for process modeling. Because the plant blends primary and secondary effluent during peak flows, this tool was valuable in determining the upper limit of the secondary treatment process' wet weather capacity. Alternatives to increase secondary capacity included operating the facility in a contact stabilization mode during wet weather periods. This strategy reduced the frequency and volume of primary effluent that otherwise would be diverted around the secondary process.

Carollo used SWMM to estimate wet weather flows, using both design storm and design flow event approaches to simulate the conditions within the collection system. The wet weather flow modeling provided a basis for comparing the costs of increasing treatment capacity versus providing storage to determine the optimum balance of components.

The study culminated in a comprehensive, multi-step analysis to generate, evaluate, screen, and refine available wet weather management alternatives. Ultimately a five-year design flow event at a hydraulic limit of 125 mgd offered the most cost-effective design conditions for public health protection. The recommended program included a combination of treatment plant process additions, a new storage basin, and a 10 percent reduction in collection system I/I. These improvements are currently being implemented by CMSA and its member agencies to mitigate sanitary sewer and treatment plant overflows.
Columbia Boulevard Wastewater Treatment Plant
Headworks Project

Carollo, in joint venture, completed the design of a 300-mgd headworks at the Columbia Boulevard Wastewater Treatment Plant. The $26 million headworks replacement is the cornerstone of a series of planned improvements to Portland's main wastewater facility to provide wet weather treatment. During dry weather, flows entering the plant average between 70 and 80 mgd. During periods of heavy rainfall, peak flows from Portland's combined sewer system have historically strained the plant's hydraulic capacity and overloaded its 40-year-old screening and grit removal systems. As Portland addresses combined sewer overflows, the volume of sewage conveyed to the treatment plant will continue to increase.

The project consisted of five phases including predesign, design, bidding services, construction services, and operator training and start-up. Key design features include: a new influent pumping station, modifications to existing screening and coarse and fine grit conveyance systems, a new truck loading facility, new odor control facilities, and an expansion capacity to 600 mgd.

The Carollo team worked with the Portland Bureau of Environmental Services to create a Citizens Advisory Group and establish a level of trust between the City and the neighbors. The team solicited citizen input into the design and was responsive to public concerns.

The resulting design incorporates rigid specifications for acoustical treatments, state-of-the-art odor control, and architectural treatments. Community amenity featuring water gardens, nature trails, and educational exhibits. State-of-the-art operator and public safety systems.

The new headworks has met its treatment objectives, providing pumping and improved preliminary treatment for increasing flows at the treatment plant. It is a focal point of the treatment plant and is viewed as an amenity to the neighborhood. The Citizens Advisory Group continues today and the public involvement approach established for the headworks project has been utilized for subsequent plant improvements.
San José/Santa Clara Water Pollution Control Plant Wet Weather Reliability Improvements

Carollo provided pre-design, design, and construction management services for a major project that will increase the wet weather reliability and capacity of San José/Santa Clara Water Pollution Control Plant. The wet weather reliability and hydraulic capacity improvements will enable the plant to treat a sustained flow of 300 mgd and a peak wet weather flow of 400 mgd. The project involves two major components:

**Wet Weather Facilities.** This component includes a new parallel headworks facility, a 160-mgd raw sewage pump station, supplemental filter influent pump station (SFIPS), and other associated junction structures and piping systems. The new headworks facility will consist of screening, grit removal, screenings conveyance and dewatering, and grit washing prior to influent pumping. The new headworks facilities will initially provide a treatment capacity of 160 mgd, but the design will ultimately set the master plan for a future 400-mgd headworks when the existing headworks is decommissioned in the future.

**Emergency Basin.** This component includes an 8.3-million-gallon raw sewage storage basin, return pump station, and associated structures and piping systems. The basin will be used when peak wet weather flows to the plant exceed 400 mgd and for power outages. Overflow captured in the basin will be pumped back to the new headworks facilities when capacity is available.

Facilities designed by Carollo as part of the San José WPCP Wet Weather Reliability Improvements project include a parallel headworks facility and a 160-mgd raw sewage pump station.
SSO Elimination - Peak-Flow Holding Basin

The City of Manhattan operates a wastewater treatment plant with a rated capacity of 8.7 mgd. This plant serves the population within Manhattan’s present City limits, as well as the immediate adjacent rural areas of Riley County and a small portion of Pottawatomie County.

The first phase of the project required the development of a facility plan. Based on the recommendations of the facility plan, Carollo developed detailed design plans and specifications for a new selector basin, new aeration basins, new mixed-liquor recycle pump station, new clarifiers, and related support facilities.

The design also addressed upgrades to the influent pumping system, replacement of the existing grit facility with a new grit and fine screenings handling facility, replacement of the existing UV disinfection system with a newer and more efficient UV disinfection system, and the addition of a peak-flow holding basin.

The existing peak-flow holding basin is a circular-settling basin with a maximum capacity of 860,000 gallons. When peak flows fill the basin, additional flow is directed to the UV system for disinfection and then discharged to the Kansas River. Because regulations do not permit water to be discharged without proper treatment, additional capacity is needed to temporarily store the influent during peak-flow events. The new capacity will allow the stored wastewater to be conveyed back to the headworks for processing through the WWTP.

Peak-flow storage was designed to store all flows above the maximum allowable flow of 16 mgd to biological treatment (based on the predicted firm pumping capacity). Using information from a 48-hour hydrograph based on a 10-year design storm event with a peak hourly rainfall of 2.5 inches, the total required peak-flow storage volume was estimated at approximately 1.98 MG. Based on an existing peak-flow storage capacity of 0.86 MG, an additional storage volume of 1.13 MG was required.

The new peak-flow holding basin will provide enough additional capacity to temporarily store two MG of water to be conveyed back to the headworks for processing through the WWTP.

Carollo designed a wastewater treatment plant upgrade for the City of Manhattan, Kansas, which included a 2-MG peak-flow holding basin.
CITY OF SOUTH SAN FRANCISCO, CALIFORNIA

South San Francisco/San Bruno Water Quality Control Plant Wet Weather Improvements

Carollo provided complete planning, permitting, design and construction support services for the $41 million South San Francisco/San Bruno Water Quality Control Plant Improvement Project. The project consisted of expanding the reliable dry weather capacity of the plant from 9 to 13 mgd and increasing the wet weather flow capacity to 62 mgd. As part of the initial planning effort, Carollo assessed the treatment capacity of the plant and developed interim improvements to bring the plant back into compliance with its permit requirements.

Carollo then developed projected flows and loads for the 13-mgd plant and identified long-term treatment plant expansion needs to accommodate this growth. In addition, Carollo evaluated existing collection system and rainfall data and developed a rainfall-derived infiltration and inflow (RDI/I) model for the plant for several design storm frequencies. The project also involved developing and evaluating various wet weather flow management alternatives and costs for each projected design storm flow. Carollo also used hydraulic and process modeling to project the level of treatment resulting from the different wet weather management alternatives. Permitting assistance efforts with the RWQCB resulted in the selection of a 5-year design wet weather flow of 62 mgd for final planning and design. The final wet weather flow management alternative selected by South San Francisco was to provide 62 mgd of preliminary and primary treatment capacity and 30 mgd of secondary treatment capacity. Primary effluent above 30 mgd would be routed around secondary treatment and blended with secondary effluent before disinfection to meet permit requirements.

The selected wet weather flow management alternative also required unique operation of the plant’s 62-mgd effluent pump station and outfall system jointly owned with three other agencies. Because the combined flow allocation of the other agencies’ pump station and outfall capacity is 30 mgd, plant flow in excess of 30 mgd can only be conveyed through the pump station if capacity is available. If this capacity is not available, the plant has to temporarily store the excess disinfected effluent in an adjacent storage basin. When wet weather flows subside, the stored flow is gradually returned to the effluent pump station and discharged to San Francisco Bay via the joint outfall.

Carollo completed design of the recommended dry weather and wet weather facilities in two phases: Phase 1 in 1998 and Phase 2 in 2002. The construction of all the dry weather facilities and construction of the wet weather facilities was completed in 2005.
VALLEJO SANITATION AND FLOOD CONTROL DISTRICT, CALIFORNIA

Wastewater Treatment Plant Wet Weather Expansion

As part of a program to eliminate sewage overflows and bypasses to surface waters entering San Francisco Bay, the Vallejo Sanitation and Flood Control District (VSFCD) selected Carollo to design a $19 million wet weather treatment facility. The project involved installing chlorination and dechlorination facilities for two discharge points. The plant’s National Pollutant Discharge Elimination System (NPDES) permit requires an effluent residual chlorine level of 0 mg/L and continuous recording of chlorine residual. The design included two chlorine contact basins, two new sulfonators, and chlorine residual analyzers to regulate sulfur dioxide feed rates.

Also included in the wet weather expansion project were the design and construction of a new, 60-mgd influent pumping facility. This facility includes six 12-mgd, variable speed drive raw sewage pumps. Carollo also designed a new 30-mgd effluent pumping facility that includes three 10-mgd vertical turbine pumps.

Recently, VSFCD retained Carollo to prepare contract documents to convert the existing gaseous chlorination and dechlorination facilities to ultraviolet (UV) disinfection. The project included design of modifications to existing systems to accommodate the installation of a UV system for flows up to 30 mgd and a sodium hypochlorite/sodium bisulfite system for wet weather flows from 30 mgd to 60 mgd. The fast-track project required the prepurchase of a Trojan UV 4000 disinfection system and incorporating the Trojan design into the plans and specifications.

Carollo completed design of Vallejo’s Wet Weather Treatment Plant, including a new 60-mgd headworks.
Carollo provided pre-design, preliminary design, and final design for this wet weather project for the Union Sanitary District. The project consisted of the expansion of the Irvington Pump Station to 44 mgd and the design of a first-phase 1.8-million-gallon equalization storage basin. The design also allows for an additional 1.8-million-gallon second-phase equalization storage basin. Key project features include: six Wemco hydrostatic dry pit submersible pumps with VFD drives, remote SCADA control, a 1,200-kW diesel standby power generator, an activated carbon basin odor control system, a 1.8-million gallon covered concrete storage basin, a passive overflow system for the storage basin, and a hypochlorite odor control system for the wet well. The design allowed for construction of the facilities while concurrently maintaining reliable pumping of wastewater from the cities of Newark and Fremont, California.

Significant engineering efforts included:

- Complex hydrostatic pumping and surge analysis of the existing dual 13-mile-long, 39-inch force mains.
- Seismic retrofit analysis of the existing pump station superstructure.
- Analysis and comparison of odor control technologies.
- State Revolving Fund financing.
- California Environmental Quality Act (CEQA) compliance documentation, including Bay Conservation Development Commission (BCDC) permitting, Bay Area Air Quality Management District (BAAQMD) air permitting, and State Water Resources Control Board (SWRCB) and National Pollutant Discharge Elimination System (NPDES) permitting.
- Value engineering eliminated $464,000 (approximately 4 percent) in capital costs.
CSO Control Program, Bridge Street Basin

The City of Omaha operates 51 square miles of combined sewers in its eastern service area. In 2006, in response to a federal mandate, Omaha began a CSO Control Program designed to prevent the release of untreated sewage into the Missouri River and Papio Creek during wet weather. The phased program, which encompasses several sewer basins, includes public input and the development of a Long-Term Control Plan (LTCP), followed by implementation and construction of the plan solutions. The goal of the program is to comply with regulatory requirements without imposing an excessive financial burden on the City.

Carollo is one of several engineering teams that are coordinating efforts to minimize CSOs and improve Omaha’s wastewater system. Carollo was responsible for modeling, preliminary sewer and lift station capacity analysis, and identification of collection system and lift station improvements within the Bridge Street Basin. The Bridge Street Basin comprises approximately 3,950 acres adjacent to the Missouri River in northeastern Omaha. Working with another consultant, Carollo developed an implementable CSO LTCP for the basin in accordance with the City’s goals.

Using InfoWorks CS, a GIS-based, highly sophisticated collection system modeling software, the team modeled approximately 13,000 feet of 24-inch sanitary sewer within the basin’s boundaries. Desktop modeling provided a basis to determine the existing and required system capacity/improvements needed when storm and sanitary sewer separations are completed.

Field work included flow monitoring to confirm model flow input parameters needed to generate flow curves, smoke testing, and condition assessments. The results of these efforts helped to confirm the model, identify CSO separation projects, and determine the existing and maximum capacity of the existing system.

The modeling, fieldwork, and evaluations resulted in infiltration/inflow reduction projects, and long-term capital improvement plans, including improvements to the Bridge Street Basin Lift Station.
SSO Elimination - Forestwood Lateral Sanitary Sewer Relief Project

Carollo provided the preliminary design report and system modeling for Forestwood Lateral Sanitary Relief Sewer for the Metropolitan Sewer District of St. Louis. The existing Forestwood lateral consists of 8-, 10-, and 12-inch-diameter, 1950s-era vitrified clay pipe (VCP), which is prone to backups and other problems. The basin drainage area is approximately 400 acres and includes parcels owned by more than 900 individual property owners. Land usage is primarily residential with some intermingled commercial land usage.

This reach of sewer included five SSOs. During high flows, these bypasses would allow sewage to flow into the storm sewer system. In addition, due to the condition of the pipe, maintenance issues, including soil cave-ins, were common during high-flow events.

The Carollo team used HYDRA software to model the sewer system. HYDRA offers full-featured analysis of municipal sewer systems for sanitary wastewater, storm water inflow, rainfall-dependent infiltration, and groundwater infiltration flows. Model results provided the necessary information to determine sewer capacity for current and future flows.

The analysis identified potential sewer overflows, surcharged pipes, street flooding, bottlenecks, and maintenance concerns. The recommended new Forestwood Relief Lateral replaces the existing VCP lateral with 6,650 linear feet of 12- to 30-inch-diameter sewer. When completed, the project will eliminate sewer surcharging, the five sanitary sewer bypasses, and will reduce maintenance concerns.
Sullivan/Stark/Holladay CSO Basins Sewer Relief and Predesign

The City of Portland Bureau of Environmental Services (BES) retained Carollo to prepare a detailed predesign for improvements to the collection system in a 7.4-square-mile area of east Portland. The combined sewers in this highly urban area, many of which are 100 years old, included segments in need of structural repair. Additionally, there were nearly 3,000 basements in the basins subject to basement flooding due to inadequate hydraulic capacity.

This three-year study identified improvements needed to provide hydraulic capacity and repair structurally failing pipe in the basins. The predesign was completed in parallel with citywide CSO control planning and implementation and was carefully integrated so as to reduce overflows and provide cost-effective CSO control city wide.

The predesign project included a detailed condition assessment involving closed-circuit TV inspection of 92,000 feet of sewer. The TV inspections were analyzed using the City’s procedures and criteria and were integrated into the City’s existing data management system.

The team used a PDXSWMM Runoff and Transport for analysis of basin response to the design storm and simulation of local controls. The collection system, and the effects of modifying pipe sizes were simulated using XPSWMM. Automated procedures used in the modeling process allowed a highly discrete representation of the subbasin down to single tax lots. Model inputs included data on each tax lot, such as roof area, parking area and pervious area to allow determination of the hydrological response of the tax lot to historical and design storms. The model includes more than 1,670 surface catchments and more than 19,000 direct connections from individual tax lots.

The recommended improvements included a combination of additional conveyance capacity, in-line storage facilities, and inflow reduction strategies. Inflow reduction strategies considered by the predesign included residential downspout disconnection, commercial on-site storm water controls, and street inlet controls.

The predesign package developed plan and profile drawings for a total of 226,000 feet of new or modified pipe, and totaled 287 drawing sheets. The total CIP for the recommended projects was approximately $110 million.

The project included an extensive community involvement program. Carollo worked with BES staff to inform the affected public and solicit their input for consideration in developing the final project plans.
Carollo assisted the Portland Bureau of Environmental Services with several projects related to a 20-year program to reduce CSOs to the Willamette River and Colombia Slough. Work included:

**Alder Basin Relief and Reconstruction.** This project consisted of three phases involving reconstruction and adding capacity to the upper reaches of the Alder Basin. The project included approximately 5,500 feet of sewer replacement ranging in size from 24 inches to 48 inches in diameter, plus house branch laterals. One element of the project was to calibrate and refine the existing Storm Water Management Model (SWMM) to eliminate the surcharges that appear in the recommended alternative. The recommended alternative eliminated the off-line storage in one area, upsized some of the existing trunk sewer, and included storage in other areas.

**Wheeler Basin Relief.** This project incorporated the design of combined sewer separation and capacity augmentation. The Wheeler Basin is an area of approximately 900 fully urbanized acres adjoining the northeast quadrant of Portland’s central city area. Constructed in phases, the project included 28,750 feet of sewer replacement, 103 groundwater recharge sumps, and miscellaneous improvements for a total construction cost of $5.5 million.

**St. Johns A Storm Sewer Separation.** This project included the design of a separate storm sewer to reduce the flow in the existing combined sewer and reduce CSO discharges. It included the approximately 30,000 feet of storm sewer ranging in size from 12 inches to 42 inches in diameter at a construction cost of $2.9 million. The project also involved hydrologic and hydraulic modeling of the basin to determine design flows and size the collection system.

Carollo uses models such as U.S. EPA’s SWMM to evaluate wastewater collection systems and recommend improvements for CSO control.
To facilitate sewer rehabilitation in the backyards of up-scale homes in the Oakland, California hills, Carollo specified highly specialized trenchless construction methods, including cured-in-place lining.

### Infiltration/Inflow Correction Projects

The City of Piedmont retained Carollo to provide design and construction management services for a series of I/I correction projects involving sewer replacement, rehabilitation and spot repairs. The initial project, completed in February 1988, involved the rehabilitation/replacement of approximately 5,200 linear feet of sewer pipe ranging in diameter from 10 inches to 24 inches in diameter and requiring construction on private lots of homes valued from $5 to $10 million.

Water, gas, storm, telephone, cable television, and sewer utility congestion were major concerns during design and construction in this exclusive residential community. A rigorous and proactive public relations program, including personal meetings, newsletters, and telephone contacts, successfully addressed community concerns and minimized impacts to surrounding residents and businesses.

A second Piedmont I/I sewer replacement project involved construction administration and inspection during installation of approximately 8,000 feet of 8-inch, 12-inch and 14-inch-diameter sewer pipelines, including laterals and sliplining of isolated sewer sections.

Carollo was also selected to provide engineering services on a third-phase project for Piedmont involving rehabilitation of deteriorated sewers in highly-sensitive residential and commercial areas. The project entailed both conventional open trench replacement of sewers in streets, as well as “in-place” lining and replacement of sewers located in areas where surface access for open trenching was not possible or desirable from a public acceptability standpoint. The project involved in-place sewer rehabilitation using trenchless or “no-dig” technology and included over 160 house laterals.
CITY OF ALBANY, CALIFORNIA

Phase IV and Phase V Replacement Projects

Most of Albany’s sewage collection system consists of six-inch clay pipe constructed around 1910. Faced with a Regional Water Quality Control Board Cease and Desist Order due sewer overflows and a history of emergency repairs due to plugging, Albany retained Carollo to investigate the problem and rehabilitate several large drainage basins.

An earlier sewer system evaluation survey identified several large sewage basins as cost effective to rehabilitate or replace. Carollo recommended that failing sewers in areas with deteriorating streets be targeted first. This way, pipeline rehabilitation could coincide with Albany’s pavement management objectives and reduce costs. The selected basins contained over 20,000 feet of sewer line and 700 residences. Adding to the challenge, 3,000 feet of sewer lay beneath backyards, buildings, and other structures, including the Albany High School Basketball courts.

Carollo specified trenchless technology in certain areas. At about half the cost of other construction methods, the contractor used a pipe bursting method that broke out the existing pipes and pulled new, larger thick-walled high density polyethylene (HDPE) pipe into place using a high-strength cable and winch system.

A comprehensive public relations program also helped to minimize disruption to the surrounding community. The public relations program consisted of sending initial notices to over 1,000 residences (approximately a quarter of the City) and holding public informational meetings.

“**The rapport we have developed and the partnership approach we have utilized in developing master plans and designing projects has, I believe, saved the public hundreds of thousands of dollars.**”

—Ron Lefler, Former Director, City of Albany

Carollo’s sewer rehabilitation design reduced Infiltration/Inflow in this Albany, California neighborhood.
Sewer System Rehabilitation Project

The City of Berkeley’s sanitary sewer system, constructed more than 70 years ago, suffered from excessive infiltration and inflow, as well as insufficient flow capacity, causing sewer overflows during wet weather conditions.

In 1995, Berkeley retained Carollo to provide design and support services for the preparation of plans and specifications for four sewer rehabilitation projects. These rehabilitation projects, located in a residential neighborhood in a steep, hilly area, required the installation of over 20,000 lineal feet of sewer line in backyards, side yards, and driveways, under garages, and in major arterial streets.

Services provided included:

- Project development.
- Obtaining and coordinating utility information from outside agencies and interfacing with appropriate agencies.
- Maintaining public relations with private property owners and businesses.
- Field and site investigations and manhole inspections.
- Closed circuit television sewer inspection.
- Ground surveying, aerial surveying, and mapping.
- Studying sewer alignments, analyzing flows and capacities, and assessing existing sewer conditions.
- Recommending rehabilitation methods, which included pipe replacement, pipe bursting and pipe lining, along with the preparation of plans and specifications.
- Additional support services.

Carollo’s sewer rehabilitation project for the City of Berkeley, California, included cured-in-place repair to sewers in city streets.