Appendix A

City of Oxnard Public Works Integrated Master Plan and Engineering Reports

CITY OF OXNARD CALIFORNIA

PUBLIC WORKS

Integrated Master Plan

Executive Summary

REVISED FINAL DRAFT • SEPTEMBER 2017

carollo®

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BRIEF HISTORY AND OVERVIEW OF THE CITY OF OXNARD PUBLIC WORKS DEPARTMENT'S INTEGRATED PLANNING EFFORTS: MAY 2014 – AUGUST 2017

In May 2014, the City of Oxnard (City) Public Works Department began developing the Public Works Integrated Master Plan (PWIMP, or Plan). The Plan unfolded to address future planning needs for all major utilities within the City's jurisdiction: water, wastewater, recycled water, and stormwater. The Plan uses a coordinated methodology to allow the City to take full advantage of potential linkages and synergies among its four major water utility systems.

The Final Draft Plan was published in December 2015 as a seven-volume set of notebooks containing more than forty master planning Project Memorandums. This was followed shortly after in early 2016 with the publication of the Final Draft Master Plan Summary Report (April 2016), and the Final Draft Executive Summary Report (May 2016).

As typical in master planning, these initial planning reports were published as first drafts. This practice recognizes that the initial planning findings and reports are not considered 'final' until further environmental and financial studies are completed.

Consequently, these Final Draft master-planning documents served as the basis for the City to proceed with cost of service studies to gain approval for the planned wastewater and water utility rate increases for the near-term capital projects, and to support a formal Proposition 218 process. The resulting Wastewater Cost of Service Study was approved in early 2017, and the Water Cost of Service Study was approved in summer 2017.

Between the time of publication of the Final Draft master-planning documents in December 2015 and the final adoption of the Cost of Service Studies/Rates in early 2017, the City continued to review and to optimize the final master planning recommended policies, projects, and programs. Therefore, certain projects included in the Final Draft planning documents have been refined and updated.

These refinements were made to incorporate the latest in recent findings from the advanced facilities planning conducted, in part, for the Cost of Service Studies, and as part of the preliminary designs proceeding concurrently for critically needed facilities. It should be noted that the refinements and optimizations were generally not related to capacity needs, but to achieve improved financial and implementation strategies, and to accommodate technology updates and global climate change strategies, as follows:

1. Project phasing and timing (but not for increased capacity), including: a phased primary treatment upgrade program, and a phased secondary treatment upgrade program.
2. Technology updates, including membrane bioreactors (MBR) to meet potential nutrient requirements, and to save costs related to advanced treatment for recycled water.
3. Global climate change, resiliency, and adaption projects to plan for increasing sea levels.

The Plan coordinates the need and timing of planned water utility facilities as related to the elements and projections in the City's 2030 General Plan, with a forward projection through the year 2040. The recommended master planning projects, timing, and phased implementation are noted in the Capital Improvement Plan (CIP) for both the near-term projects (the next several years) as defined in the Cost of Service Studies, and the longer-term projects (extending through 2040) as defined in the Plan.

Further, the time horizon for the near-term CIP serves as the basis for the newly adopted rates, and does not extend to the end of the long-term planning period (thru 2040). This is in recognition of the flexible design and adaptive nature of the recommended Plan.

In summary, the refined and updated near-term projects that were identified and developed as part of the Cost of Service Studies were subsequently incorporated into the recommended Final Draft CIP and Integrated Master Plan. Nevertheless, it is the near-term CIP that is the basis for the newly adopted rates. The overall CIP and Integrated Master Plan recommended herein was developed by merging the related planning efforts: the Water and Wastewater Cost of Service Studies, the Preliminary Design of critically needed facilities, and the long-term master planning recommendations.

The City of Oxnard's Public Works Integrated Master Plan consists of an Executive Summary, a Summary Report, and a seven-volume set of notebooks containing more than 40 Project Memorandums.

1. INTRODUCTION

The City of Oxnard's (City) Public Works Department is facing many challenges in managing its future water resources and utilities. These challenges include responding to immediate drought conditions while also planning for long-term water needs, reducing dependence upon costly imported water, addressing aging infrastructure and reliability concerns, pursuing aggressive goals for energy efficiency and sustainable solutions, maintaining compliance with changing regulatory requirements, and the on-going loss of seasoned staff and personnel. The City's opportunities in meeting these challenges are varied and range from institutional and non-structural approaches (policies and programs) to technical and structural approaches (capital projects). Because of its broad authority, the City is also keenly aware of its unique opportunity to realize the benefits of optimizing both capital and operations and maintenance investments for all water utilities, street improvements and other City infrastructure.

The City is located along the Pacific Ocean coastline in Southern California, just northwest of Los Angeles (see Figure 1). Oxnard is the largest city in Ventura County and is at the center of a regional agricultural industry with a growing business center.

The City has jurisdictional authority to provide potable water, wastewater, recycled water, and stormwater services to nearly 200,000 citizens and numerous commercial, industrial, and agricultural users. For example, the City provides potable water to users by blending groundwater and imported surface water (State Water Project) for its potable water supply.

The Public Works Integrated Master Plan (Integrated Master Plan or Plan) develops long-term recommendations for policies, programs, and projects that successfully address these challenges and opportunities in a holistic and integrated way. In carrying out the

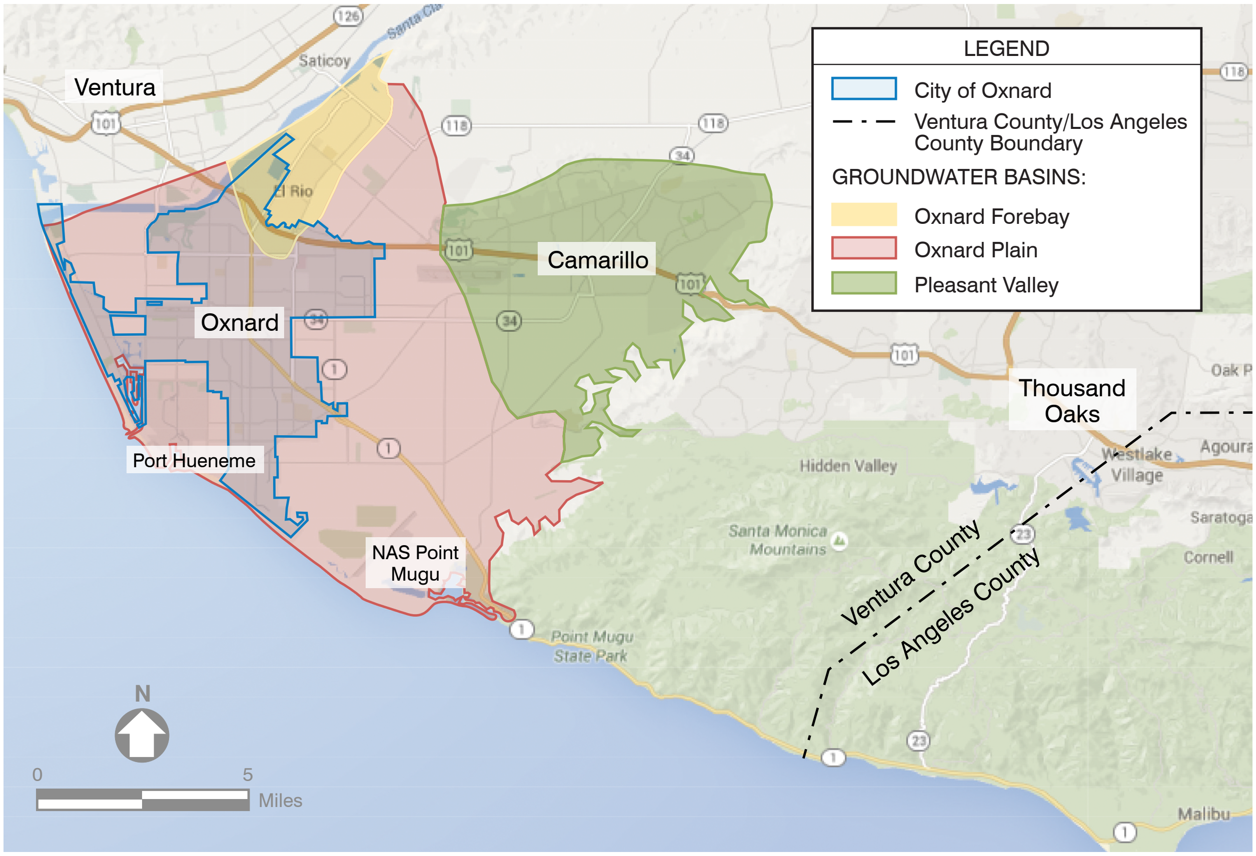

Figure 1. The City of Oxnard in relation to its surrounding communities and groundwater basins.

project goals, the Plan will help the City respond to planned population increases as well as challenges from new regulatory requirements, drought conditions, aging infrastructure, and reliability concerns.

> The Integrated Master Plan documents the policy decisions, goals, and objectives to help protect public health while balancing the environmental, social, and financial impacts of the City's water resource management.

Furthermore, the Integrated Master Plan documents the policy decisions, goals, and objectives to help protect public health while balancing the environmental, social, and financial impacts of the City's water resource management. This Plan also develops cost-effective strategies to address growth, regulatory compliance, environmental protection, and public and worker safety in ways that are consistent with the Plan's polices, goals, and objectives. While not covered in detail herein, the Integrated Master Plan also considered public works staffing, streets linkages to infrastructure, and security of public works facilities.

FACILITIES OVERVIEW

The City of Oxnard receives water by drawing it from the local Oxnard Plain groundwater basin and importing groundwater and surface water from the United Water Conservation District and State Water Project via Calleguas Municipal Water District, respectively. Before the water enters the potable water distribution system, the City uses six blending stations throughout city limits for hydraulic blending. One of the six blending station treats local groundwater for high levels of total dissolved solids.

The City also owns and operates its own wastewater collection and treatment system, the Oxnard Wastewater Treatment Plant (OWTP), located on Perkins Road. Since its inception, the plant has grown from a treatment capacity of approximately 5 million gallons per day (mgd) to its current permitted capacity of 31.7 mgd. The current OWTP facility includes raw sewage pumping, influent screening, primary sedimentation, an activated sludge secondary treatment process, effluent disinfection, and solids handling, including digestion. Final effluent is transported to an ocean outfall and discharged offshore to the Pacific Ocean or routed to the City's Advanced Water Purification Facility (AWPF).

In 2009, the City began planning for its Advanced Water Purification Facility, which provides full advanced treatment of secondary treatment wastewater effluent for recycled water use. This facility was dedicated in 2012 as part of the City's Groundwater Recovery Enhancement and Treatment (GREAT) program. Although its origins can be traced to two decades ago, the GREAT program was formally established in 2002 to address increasing concerns over the long-term sustainability of the City's groundwater supply.

GREAT Program Objectives

The objectives of the program as it was first established included the following:

- Increased water supply reliability during drought.
- Reduced water supply costs.
- Water supply security in meeting growing water demand.
- Enhanced local water supply stewardship through the reduction of groundwater pumping and recycling and reusing a substantial portion of the region's wastewater.
- Environmental benefits associated with the development and rehabilitation of local saltwater wetlands.

As the GREAT program evolved, the City shifted from using groundwater recharge as a seawater intrusion barrier to groundwater recharge as an Aquifer Storage and Recovery operation. Because indirect/direct potable reuse provides many benefits and is becoming more commonplace in the current regulatory climate, the City has renewed interest in it.

In addition to these water, wastewater, and recycled water processes, the City operates a network of stormwater facilities with collection piping and channels to convey stormwater to both the Santa Clara River and the ocean. Although Ventura County owns most of these facilities, the City maintains many of them.

INTEGRATED MASTER PLAN APPROACH

The Integrated Master Plan addresses future planning needs for all major water utilities within the City's jurisdiction, including water, wastewater, recycled water, and stormwater. Building on previous planning efforts, this Plan allows the City to take full advantage of potential linkages and efficiencies among the four water utility systems.

The Integrated Master Plan addresses the major water supply issues, including availability, quality, and cost, in a coordinated and integrated fashion across the entire City water utilities. For example, the Plan documents the relationship of the different City water utility policies, programs and projects in terms of physical, institutional, and financial linkages.

A key outcome of the plan was documenting the function of the Advanced Water Purification Facility (AWPF) as to its role in supplementing the community's water supply. It clarifies the AWPF physical linkages to the upstream OWTP, and to the downstream recycled water system. This is especially important in terms of defining the clear link between wastewater utility investments, and water supply and cost decisions, and extending to cost of service policy and water pricing.

Further, the Plan coordinates the need and timing of planned water utility infrastructure facilities as related to the infrastructure elements of the City's 2030 General Plan. This is an important consideration in establishing the priorities and rationale for investment decisions regarding water utility infrastructure to support the overall goals and objectives of the City.

The Plan also serves to integrate the many parallel planning and on-going water utility improvement efforts. This includes the development of industrial wastewater local limits, the permitting process for the indirect potable reuse program, the wastewater utility Report of Waste Discharge submittal, and the Salt and Nutrient Management Plan, among others.

To develop this Integrated Master Plan, six major steps (see Figure 2) were completed. These steps are described below.

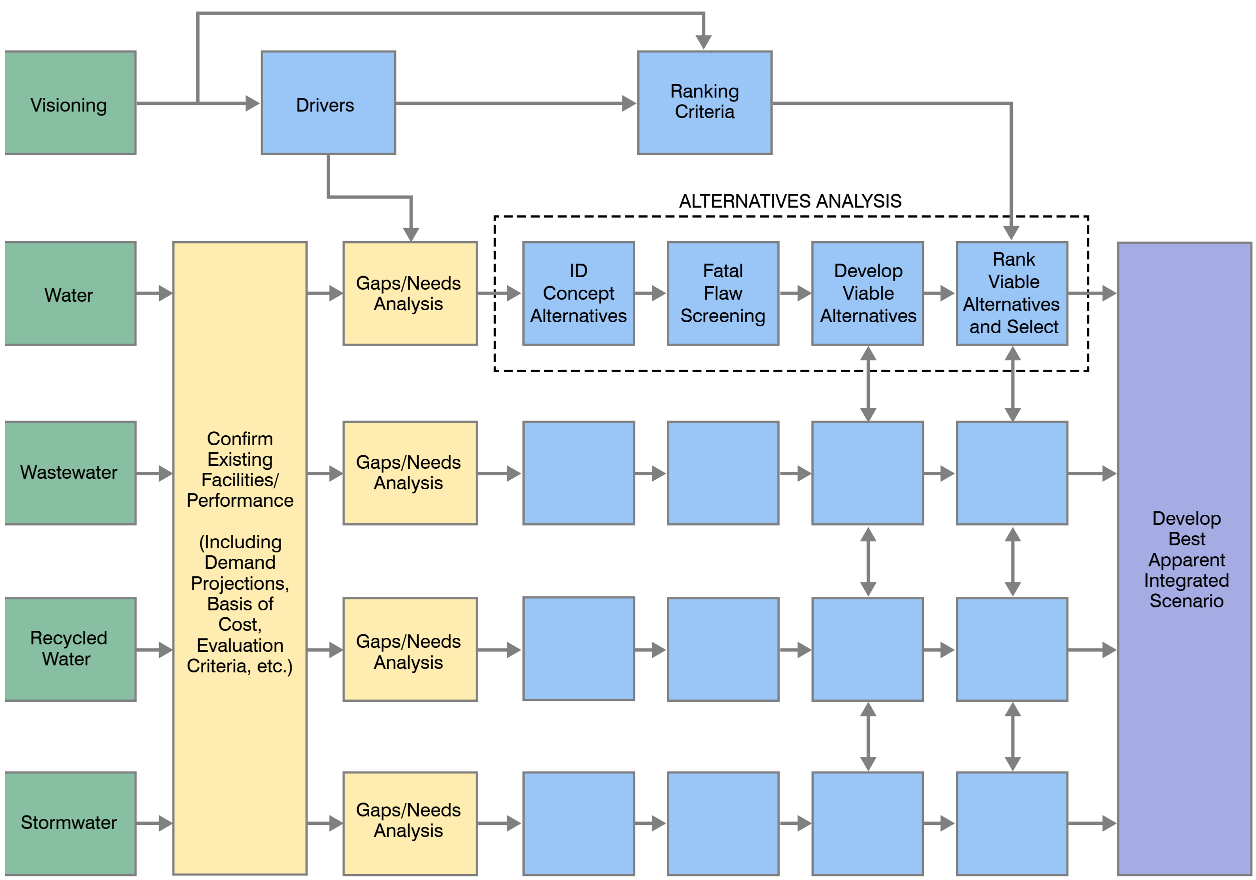

Figure 2. An overview of the Integrated Master Planning Process.

1. **Confirm Existing Facilities/Performance.** Findings and conclusions of past studies and reports were assimilated to confirm existing facilities and their performance. Asset condition assessments were completed to assess condition, criticality, and risk of failure of key assets.
2. **Identify Gaps/Needs Analysis.** Gaps in required performance and utility capacity were identified by comparing the existing facilities' condition, performance, and capacity with the anticipated needs for repair and replacement, capacity, regulatory compliance, and other planning drivers. Future needs were then determined based on anticipated regulatory requirements, planned capacity increases, repair and replacement, risk assessments, cost-effectiveness, and performance improvements that drive the need for future facility improvements.
3. **Analysis of Alternatives.** Viable alternatives were identified, evaluated, and developed to meet anticipated needs or to take advantage of new opportunities in resource recovery and/or technologies. A wide range of solutions were brainstormed, conceptual alternatives were identified, and screenings were conducted to select viable alternatives. The viable alternatives and their abilities were then selected to meet the overall goals and objectives.
4. **Identify Linkages/Evaluate Alternatives.** Various water system plans that support utilities were coordinated to identify key linkages and critical implementation issues, to quantify costs and benefits, and to rank alternatives.
5. **Develop Best Apparent Scenario.** The best combination of policies, projects, and ongoing programs across all water utilities were evaluated and determined, and the best apparent integrated scenario was developed.
6. **Develop Recommended Capital Improvement Plan.** Estimated capital, operations, and maintenance costs were developed to the 25-year planning horizon (through 2040), and a financial evaluation and rate analysis were developed. A phased Implementation Plan was also developed to integrate the recommended improvements for all utilities for greater efficiency and cost-effectiveness.

> Viable alternatives were identified, evaluated, and developed to meet anticipated needs or to take advantage of new opportunities in resource recovery and/or technologies.

This Integrated Master Plan is a high level study covering a multitude of areas within each infrastructure system. As such, this Plan will serve as the basis for future documentation and implementation steps, such as the environmental impact review, more detailed facilities planning, design, and implementation of planned projects, and financial planning.

2. MASTER PLAN DRIVERS AND OBJECTIVES

The main purpose of the Integrated Master Plan is to provide a phased program for constructing recommended facilities to accommodate planned growth while simultaneously maintaining treatment reliability, meeting future regulatory requirements, and optimizing costs.

Key planning drivers were identified that would direct the master planning efforts and be used to evaluate and recommend necessary facilities, policies, and programs within the Integrated Master Plan.

In the first stages of the planning process, key planning drivers were identified that would direct the master planning efforts and be used to evaluate and recommend necessary facilities, policies, and programs within the Integrated Master Plan. These drivers are described below.

- **Repair/Replacement (Condition).** A condition trigger was assigned when the process or facility had reached or was near the end of its economic useful life. This trigger is determined by the need for the facility to operate reliably and meet performance requirements related to the existing permit, worker and public safety, protection of the environment, and all other requirements.
- **Regulatory Requirement**. A regulatory trigger was assigned when local, state, or national regulatory requirements and deadlines established the need for additional treatment facilities. Determining when the new facilities would be put in service depends on the amount of lead-time needed to plan, design, and construct the facilities.
- **Economic Benefit.** An economic benefit trigger was assigned when life-cycle costs could be significantly reduced based on capital and operations and maintenance costs. For example, an economic benefit might be realized for an increase in initial capital investment that achieved an ongoing reduction in labor, energy, or chemical usage.
- **Improved Performance Benefit.** An improved performance benefit trigger was assigned when improved operations and maintenance performance led to more reliability and/or to reduced operational and safety-related risks. For example, an improved performance benefit can be seen in cases of improved process control or automation or to address an operational concern, such as flexibility, reliability, and the need for less complexity.
- **Growth Leading to Increased Demands/Flows/Loads.** A flow or pollutant load trigger was assigned when an increase in existing capacity is needed to accommodate future increases in demand or influent flows or loads to a facility. These increases are determined by population growth, industrial discharges, annexation, regionalization, or changes in wet weather or drought operations.
- **Resource Sustainability.** The resource sustainability trigger was assigned when there was a desire to meet energy initiatives, include resource recovery opportunities, and /or consider sustainable design alternatives.
- **Policy Decision.** The policy trigger was assigned when policy makers made management and/or political decisions.

Taking into account the Master Plan's main goal and key drivers, Carollo developed a set of specific goals and objectives, summarized in Table 1, to provide a framework and boundary conditions for the City's planning process. These goals and objectives guided the development of alternatives and strategies and help select alternatives based on established evaluation criteria.

Table 1. Integrated Master Planning Objectives

Specific Goals	Integrated Master Plan Objectives
Provide compliant, reliable resilient and flexible systems	• Improve system reliability consistent with industry standards. • Implement redundancy/backup systems for routine maintenance and repairs and to address security threats.
Integrate grey and green infrastructure with an emphasis on energy efficiency	• Optimize energy efficiency of systems. • Investigate green and grey infrastructure options such as low impact development techniques for stormwater and alternative energy sources.
Manage assets effectively (economic sustainability)	• Maximize cost/benefit ratio. • Spend public money wisely.
Integrate community interests and maximize public acceptance (social sustainability) and develop sustainable ongoing communication processes	• Minimize impacts to system due to potential climate change related events (i.e., sea level rise, changing rainfall patterns, etc.). • Minimize impacts to the public.
Mitigate and adapt to potential impacts of climate change	• Minimize impacts to systems due to potential climate change related events (i.e., sea level rise, changing rainfall patterns, etc.).
Protect environmental resources	• Maintain permit/regulatory compliance. • Position City for future regulatory changes.
Enhance environmental sustainability	• Maximize water conservation. • Maximize wastewater reclamation and reuse. • Maintain/minimize groundwater extraction levels. • Maximize beneficial reuse of biosolids.

3. MASTER PLANNING ASSUMPTIONS AND CONSIDERATIONS

A common set of planning considerations and assumptions was used to develop and evaluate the overall Integrated Master Plan and its many contributing elements. These planning considerations and assumptions support the City's positions and most current thinking, direction, and needs related to master planning drivers. However, as with any planning effort, changes in these assumptions and considerations could occur. This master planning process, however, includes flexibility to accommodate some variation in assumed planning forecasts.

POPULATION AND LAND USE

Population and land use projections help to determine the City's planned growth. With these projections, future water demands and wastewater flows can be calculated and used to determine additional water and wastewater infrastructure capacity required. For this Plan, the population and land use projections developed were based on the City's 2030 General Plan and on conversations with the City's Planning Department. The projections shown in Figure 3 were used for all water system planning. The future mix of residential, commercial, and industrial users is assumed to remain largely the same as the current mix, with the largest population increase anticipated to be from residential infill and mixed-use development.

The Integrated Master Plan is flexible and sensitive to changes in the timing of future water utility infrastructure capacity. This results in the "just-in-time" construction of additional capacity, as needed, which allows the Integrated Master Plan to establish the least-cost future Capital Improvement Plan.

CLIMATE CHANGE

Scientists predict that sea levels will rise and more frequent and intense storms will occur. Thus, this Integrated Master Plan focuses on how rising sea levels

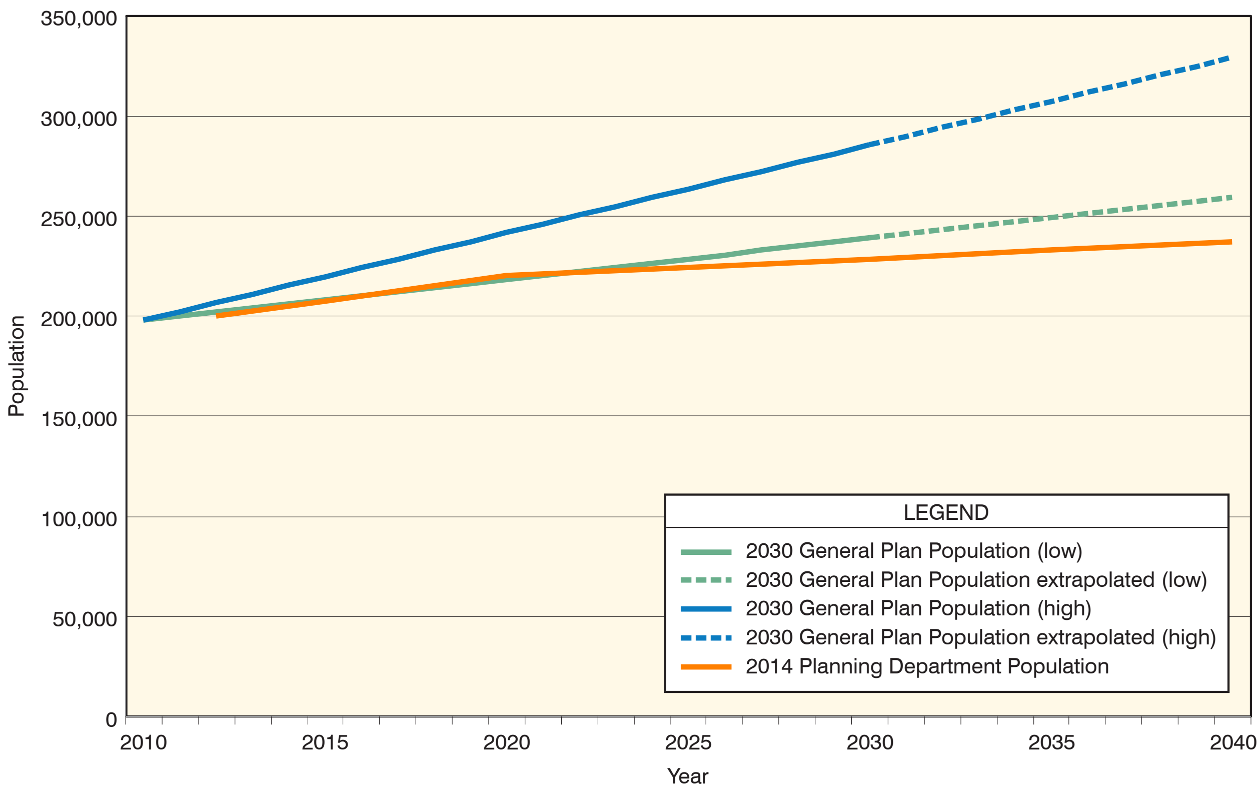

Figure 3. The City's historical and projected population through 2040, assuming population increase due to residential infill and mixed use development.

might affect the wastewater system, and how changes in precipitation patterns and the potential for drought might affect water supply and stormwater collection system capacity. For example, the Federal Emergency Management Agency (FEMA) predicts that portions of the wastewater treatment plant could experience significant flooding because of its low elevation.

REGULATORY

Regulations are constantly evolving. To determine the ability of the City's water systems to adapt to regulatory changes, a regulatory review was conducted for each system. This review analyzed the system's current regulatory performance and its ability to respond to pending shifts in regulations. In addition to this individual utility assessment, an integrated review was performed to understand how changes in one system might affect the regulatory compliance or performance of other systems and what mitigating requirements might be needed.

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Water System

The water treatment and supply facilities currently meet all state and federal water quality guidelines for both groundwater and surface water. The City is tracking several pending regulations, but none are expected to significantly affect the water system. In addition to following these regulations, the City is monitoring for several constituents (compounds found in water) that relate to public health and water quality. Specifically, the City seeks to limit total dissolved solids to less than 500 mg/L, hardness to less than 100 mg/L, and meet the permit limit of nitrates (as Nitrogen) to less than 10 mg/L. These goals apply to the quality of blended water and were included in the overall assessment of the water system's future needs.

Wastewater System

Regulations for the wastewater system can be divided into three major categories: water quality, air quality, and biosolids.

Water Quality. The City's ocean outfall wastewater discharge is governed by both federal and state requirements through the issuance of the National Pollutant Discharge Elimination Systems (NPDES) permit (CA0054097), which limits the amount of conventional constituents, nutrients, metals, and organic pollutants that can be discharged into US waters. The City's current permit was adopted by the Los Angeles Regional Water Quality Control Board (Regional Board) on July 26, 2013. For this permit, the City is consistently in compliance, but is rapidly approaching the limit of treatment reliability and redundancy.

Air Quality. At the local level, the Ventura County Air Pollution Control District is primarily responsible for controlling air pollution from the Oxnard Wastewater Treatment Plant, which holds operating permits for its gas and diesel engines and odor reduction and control systems. Improvements and changes to the wastewater process and discharge location are likely to require revised air quality permits.

Biosolids. Currently, the City disposes of its screenings, grit, and dewatered anaerobically digested solids (or biosolids) by hauling them to a nearby landfill. This complies with the EPA's 40 CFR 503 regulations, the main federal regulation for handling biosolids, as well as other regulatory requirements. However, using or disposing of biosolids is becoming increasingly difficult and costly in California, with fewer landfills accepting biosolids and many counties restricting the application of biosolids. Thus, several adopted and proposed regulations are expected to affect the City's ability to dispose of biosolids in landfills in the future.

Recycled Water

The City has served urban irrigation uses as of mid-2015 and agricultural uses as of early 2016. The City's long-term plan includes indirect potable reuse through aquifer storage and recovery as well as groundwater recharge. For these specific uses, the following regulations and policies apply:

- **Urban/Agricultural Reuse.** California Code of Regulations, Title 22, Division 4, Chapter 3, Section 60301 et seq. & the Recycled Water Policy (adopted by the State Board and administered through the Regional Board and Division of Drinking Water).

- **IPR/Groundwater Recharge**. Division of Drinking Water Groundwater Recharge Regulations and State Board Recycled Water Policy and Anti-Degradation Policy.

The recycled water regulations noted above are summarized in the following sections. In addition to these regulations, the City's GREAT program is currently permitted under Waste Discharge Permit, Order No. R4-2011-0079-A01, recently amended in July 2015. This permit covers non-potable reuse within the GREAT program.

Because the City will be starting to use recycled water for groundwater recharge through its Aquifer Storage and Recovery Demonstration Project, a Title 22 Engineer's Report and Report of Waste Discharge was submitted to the Regional Board and Division of Drinking Water. The City also developed a Salt and Nutrient Management Plan for the Oxnard Plain Groundwater Basin in accordance with requirements in the Recycled Water Policy and Anti-Degradation Policy.

Stormwater

The City's stormwater system is governed by a stormwater permit (termed a Municipal Separate Stormwater System Stormwater permit [MS4]) held by Ventura County Watershed Protection District and nine other surrounding communities. The Regional Board issued the current MS4 permit on July 8, 2010 (Permit CAS004002, Order No. R4-2010-0108). In addition, the City is a participating party in the Santa Clara River Bacteria TMDL and independently implements the Harbor Beaches TMDL.

GROUNDWATER MANAGEMENT CONDITIONS

One major constraint placed on the City's system is the safe yield of the Oxnard Plain Groundwater Basin, from which Oxnard draws its groundwater. The Fox Canyon Groundwater Management Agency protects the quantity and quality of the local groundwater by overseeing and managing all contractual withdrawals within the Oxnard Plain Groundwater Basin. For future groundwater allocation, this Plan made the following key assumptions:

- Groundwater pumping will be restricted to between 50 and 75 percent of historical allocation.
- Future additional and banked (i.e.: on the books) groundwater credits are not reliable and are therefore not included.
- Pump-back allocation for any recycled water supplied to agricultural users will be at a 1:1 ratio, with a maximum of 5,200 AFY available.

One major constraint placed on the City's system is the safe yield of the Oxnard Plain Groundwater Basin, from which Oxnard draws its groundwater.

An additional consideration is that the Sustainable Groundwater Management Act (SGMA) was passed through the California legislature in September 2014. The goal of this act is to have a sustainable management of groundwater by the year 2042. The full implications of SGMA are not known at the time of publication of this Plan.

SUSTAINABILITY

The City seeks to develop sustainable water solutions and infrastructure. As such, the Integrated Master Plan used the Envision® Sustainability Rating System to develop evaluation criteria and metrics for the strategies and alternatives. Each of the planning goals shown in Table 1 was assessed with the Envision® tool to produce measurable metrics for comparing alternatives.

Although the City has a broad interest in applying sustainable solutions, it specifically aims to reduce energy use and increase energy efficiency throughout the system. In April 2013, the City completed an Energy Action Plan (EAP). As part of this plan, the City committed to pursuing the "Gold Level" distinction in Southern California Edison's Energy Leadership Partnership Program, targeting a 10 percent reduction in energy use for its government facilities. Furthermore, Oxnard's Energy Action Plan expands this 10 percent reduction to the community at large, requiring a 10 percent citywide reduction in electricity and natural gas use.

AGREEMENTS/CONTRACTS

As part of the Integrated Master Plan, current agreements and contracts were organized into a database software program to provide the information for efficient City use. The database table structure was set up to be fully scalable for future buildout and also provide security preferences for different users. Some of the key information included in the database is start and expiration dates, dollar amount of original contract and description of contract scope.

4. KEY OPPORTUNITIES TO INTEGRATE BETWEEN SYSTEMS

The four water utility systems: water, wastewater, recycled water and stormwater, are integrally linked because of their positions in the water cycle. For this integrated planning effort, other potential integration opportunities and linkages were identified during the planning process through integration workshops. These workshops brought together key members from various consultant teams and city departments to provide input, coordination, and feedback on many planning elements. From these efforts, key integration linkages were identified, which are described below.

Planning parameters and tools, such as population and land use projections, the City GIS database, the planning cost basis, and levels of service, were coordinated among plans.

- **Basis of Planning.** Early on in the project, a common basis of design was identified to improve consistency among system plans. Planning parameters and tools, such as population and land use projections, the City GIS database, the planning cost basis, and levels of service, were coordinated among plans.
- **Water Supply Sustainability.** The City sought to secure a sustainable water supply for its community through the GREAT program. As such, the City proposed a relationship between recycled water and potable water. By planning the potable and recycled water systems together, the City was able to create combinations of alternatives that would have been more challenging to generate had the plans been evaluated separately.
- **AWPF and Outfall/Discharge.** The AWPF facility is an advanced treatment facility consisting of microfiltration (MF), reverse osmosis (RO), and advanced UV disinfection. This treatment process treats a portion of the final effluent from the OWTP secondary treatment process, and produces an excellent finished recycled water quality suitable for the widest range of end uses. It results in a concentrated "brine" waste stream, however, that is blended back into the remaining secondary effluent for discharge through the ocean outfall. As the percentage of secondary effluent that is diverted to the AWPF plant for treatment increases, so does the amount of the brine that is returned for blending and ocean discharge. There are several constituents that are concentrated in the brine that must be addressed to meet existing ocean outfall discharge requirements. There are two categories of concentration effects: 1) conventional NPDES permit limitations for secondary effluent (i.e. biochemical oxygen demand (BOD), and total suspended solids (TSS), and 2) ammonia limits with the Ocean Plan that need to be addressed as future AWPF capacity is increased. The two approaches to address these concentration effects are on-going, and include: 1) regulatory change involving the point of compliance, and 2) treatment of ammonia to reduce effluent concentrations.
- **Source Control.** It is critical to control the quality of wastewater entering the system and ultimately becoming the water source for advanced treatment systems. As part of this Integrated Master Plan, the City updated its local discharge limits from industrial dischargers through a Local Limits Study (Carollo, 2017). The City also developed best management practices for Centralized Waste Treatment facilities, which treat and discharge hazardous and nonhazardous materials. Plus the City began identifying and analyzing the possible users of a concentrate collection line to remove salts from the wastewater collection system.
- **Staffing.** Staff needs throughout the Public Works Department were reviewed and assessed to determine how staff could best facilitate all water-utility related systems.
- **Streets.** A key point of integration with the Integrated Master Plan is the City's Streets Master Plan. To minimize overall disruption to the entire community, the planned improvements recommended (e.g., pipeline replacement/addition) must be coordinated with any street upgrades (e.g., repaving, curb, and gutter addition).

5. EXISTING SYSTEM CAPACITY/CONDITION AND FUTURE NEEDS

A thorough assessment of the facilities associated with the City's four water systems was conducted, which included reviewing operation and monitoring data, conducting condition assessments, reviewing drawings, and completing collaborative discussions with staff. From this effort, Carollo drew several conclusions about the existing systems conditions and capacities, which are noted in the following sections.

Water System — At-a-Glance:

- 3 sources of supply:
  - Imported surface water (Calleguas Municipal Water District)
  - Imported groundwater (United Water Conservation District)
  - Locally controlled groundwater
- 6 blending stations throughout the City where supplies are blended to meet required water quantity/quality
- 9 local potable water wells
- 1 desalter that removes dissolved particles to acceptable levels
- Approximately 613 miles of distribution piping

WATER SYSTEM

The City's water system is a combination of water conveyance and treatment, drawing from the three main sources of water, which are all of unique quality. In general, groundwater sources are high in total dissolved salts and hardness, whereas surface water is softer and less salty.

The average annual water demand is approximately 25,000 acre-feet per year and comes from predominantly residential uses. Projecting out to 2040, the water demand is expected to rise to approximately 38,000 acre-feet per year due to in-fill and projected development.

The City's existing system, shown in Figure 4, is a combination of blending stations, potable drinking water wells, and desalter treatment. Depending on the asset, the overall condition of the existing system is fair to good. Currently, no facilities are in immediate risk of failure; however, a fair amount of facilities must be repaired and replaced to ensure that the City's potable infrastructure lasts well into the future. Regarding system maintenance, two of the highest priorities are to provide cathodic protection and to replace the Supervisory Control and Data Acquisition (SCADA). Regular maintenance needs to also be conducted routinely such as flushing the system, exercising the valves, and conducting an active leak detection program.

The system operates as a single pressure zone, which makes meeting pressure targets a challenge. As demands increase, these challenges are expected to worsen. To assess whether the City would benefit from splitting into two or more pressure zones, a pressure zone analysis was conducted using an updated and calibrated system hydraulic model.

The water system's biggest overall challenge will be to maintain a source of sustainable, high-quality supply.

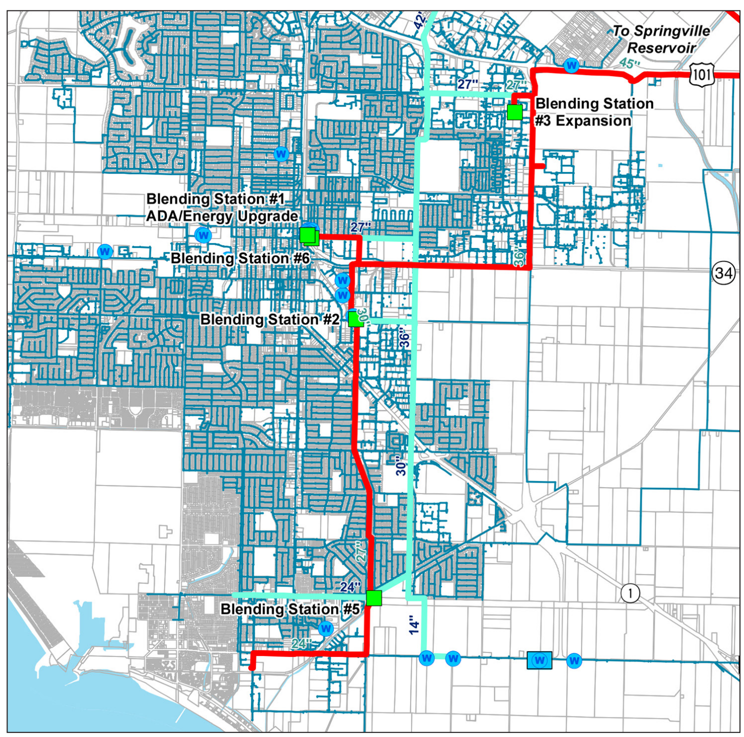

Figure 4. The City's water system is a combination of hydraulic blending stations, treatment, and distribution pipelines.

Though the City currently meets water demand requirements, projections made in the Integrated Master Plan indicate a potential supply gap throughout the planning period. This supply gap, which is based solely on quantity, is projected to be between 3,800 and 10,700 acre-feet per year (illustrated in Figure 5). These numbers depend on the groundwater pumping restrictions, which are expected to be between 50 and 75 percent less than current rates in the long-term.

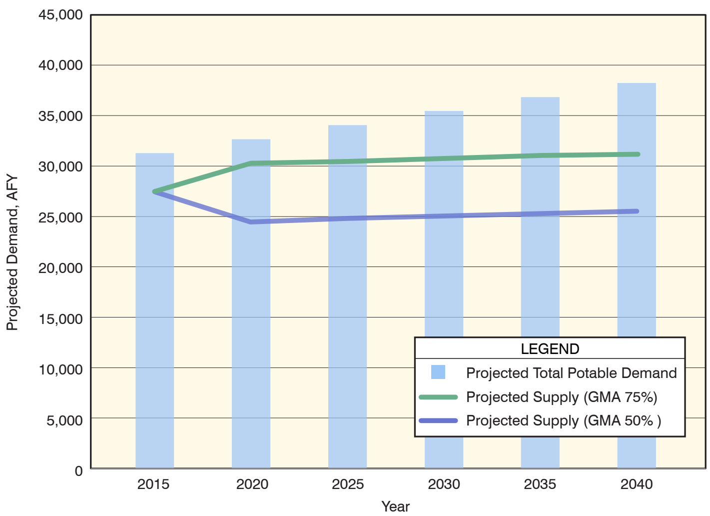

Figure 5. Due to an expected shortfall in supply, the Integrated Master Plan evaluated options for securing a sustainable water supply for the future.

From a water quality and regulatory standpoint, the system meets current regulations for drinking water quality. However, the City wishes to improve upon some taste and odor parameters. The hardness in the blended water is higher than acceptable for some customers, resulting in widespread use of point-of-use softeners throughout the City, which return salt to the wastewater system. Therefore, one of the City's goals is to reach a more acceptable level of hardness in the blended drinking water quality, which would reduce or even eliminate the need for point-of-use softeners. Because of the relatively high hardness of groundwater sources (both local and United Water), reducing the hardness will directly affect the water supply analysis. However, low hardness water could be supplied from the Advanced Water Purification Facility through indirect potable reuse.

WASTEWATER

The Oxnard Wastewater Treatment Plant has a permitted capacity of 31.7 million gallons per day and treats wastewater for discharge to the existing ocean outfall. The Wastewater Treatment Plant includes preliminary, primary, secondary, and disinfection treatment as well as solids handling (shown in Figures 6 and 7). Recent historic average dry weather flows are approximately 20 million gallons per day. If the same flow were projected out to 2040, it would be expected to increase to 27.5 million gallons per day. By 2040, the loading rates of total suspended solids and organics, which are measured by biological oxygen demand (BOD), are expected to increase at a minimum to moderate level.

Though the City consistently meets its discharge permit requirements, much of the wastewater treatment plant is in poor condition and reaching the end of its useful life. Because of this, major investment in repair and replacement is needed in the near future to improve the reliability and safety of plant operations.

Replacement is recommended for a number of process facilities, namely the primary clarifiers, dissolved air flotation thickeners, gravity thickeners, digesters, interstage pump station, effluent pump station, and cogeneration facility. Additionally, due to safety concerns, the biotowers should be demolished as soon as possible. Cathodic protection, SCADA, and electrical upgrades are also needed on key processes and buried facilities.

Wastewater System — At-A-Glance:

- Wastewater collection - Approximately 384 miles of gravity collection pipe, 5 miles of force main collection and 15 lift stations
- Preliminary Treatment - bar screens, screenings conveyance, grit removal, and grit conveyance
- Primary Treatment - 4 primary sedimentation basins with chemical addition
- Secondary Treatment - 2 biotowers, 2 activated sludge tanks, and 18 secondary sedimentation basins
- Equalization - 2 basins
- Disinfection - 2 chlorine contact tanks
- Solids Treatment - 2 gravity thickeners for primary sludge thickening, 2 dissolved air flotation thickeners for waste activated sludge thickening, 3 anaerobic digesters, and 4 belt filter presses for dewatering

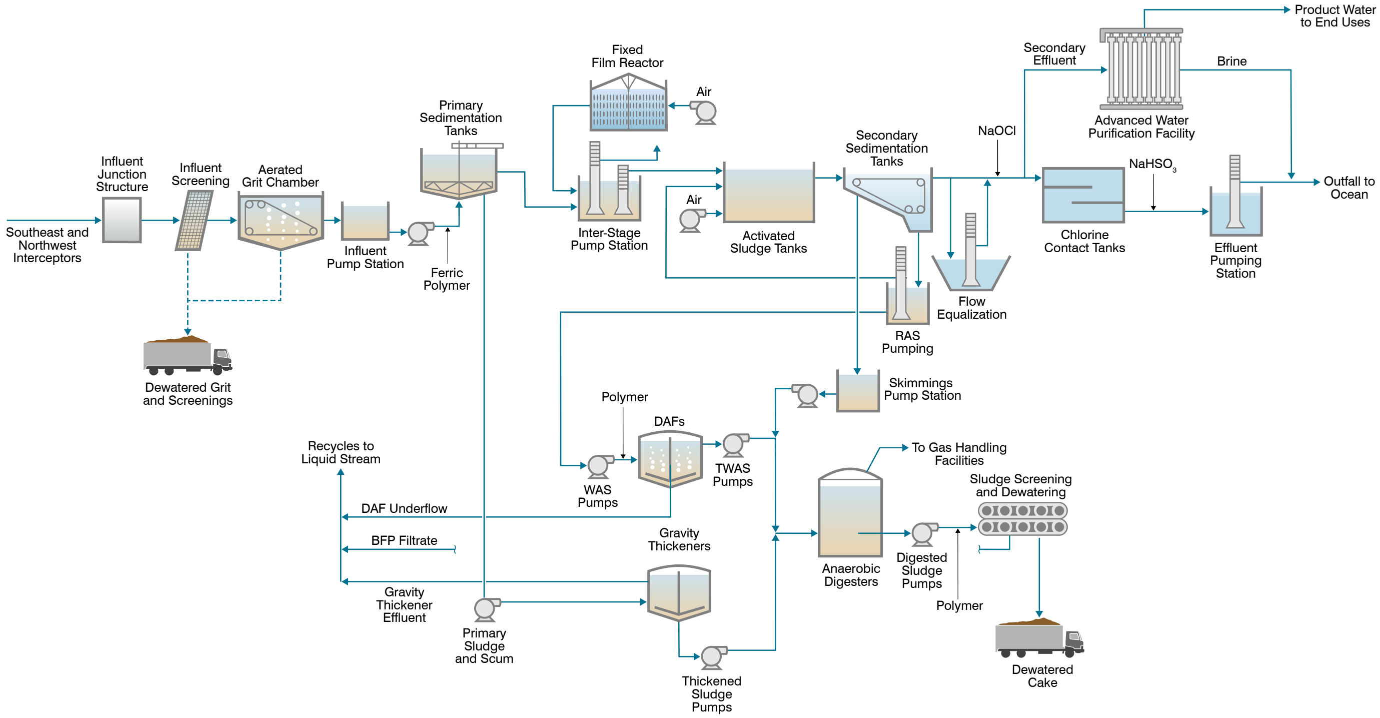

Figure 6. A schematic of the treatment processes currently in use at the Oxnard Wastewater Treatment Plant.

In general, the wastewater unit processes have operated at loading rates well within their original design values or typical operating ranges. In addition, performance has been adequate, and some of the unit processes do not operate with all units in service.

Though the liquid treatment process appears to have sufficient capacity for projected future flows, the solid process does not. In addition, the secondary process does not have the ability to nitrify or denitrify, both of which may be needed as more of the City's treated wastewater effluent is treated to become recycled water.

For the wastewater collection system, some sewers will need to be replaced to meet level-of-service criteria during peak dry weather flow conditions based on current and future growth estimates. In addition, the City will need to consider routine repair and replacement due to age, based on the City's understanding of project needs. The Central Trunk Sewer is also experiencing collapsing manholes that will need to be repaired and replaced.

RECYCLED WATER

The City's recycled water system is a product of the GREAT program, with most parts of the system only recently coming online for full-time operation in 2016. Currently, the recycled water system is used to provide unrestricted reuse water for urban irrigation to the River Ridge Golf Club as well as for agricultural irrigation to growers on the Oxnard Plain through Pleasant Valley County Water District's irrigation network and the Oxnard Recycled Water Pipeline in Hueneme Road. Figure 8 illustrates the location of existing recycled water lines.

Under the GREAT Program, the Advanced Water Purification Facility is planned to be constructed in four phases, resulting in capacities of 7,000, 14,000, 21,000, and 28,000 acre-feet per year. The first phase is complete (7,000 acre-feet per year or 6.25 million gallons per day of recycled water capacity) and is in

Recycled Water System — At-a-Glance:

- Source of Supply - City's secondary wastewater effluent
- Advanced Water Purification Facility (membrane treatment, advanced oxidation, and disinfection) capable of producing 6.25 mgd of recycled water effluent (Phase 1)
- Finished water pump station that pumps to the Recycled Water Backbone Pipeline for urban irrigation uses
- Ocean View pump station that is delivering recycled water to farmers through temporary use of the Salinity Management Pipeline until the Hueneme Pipeline is completed

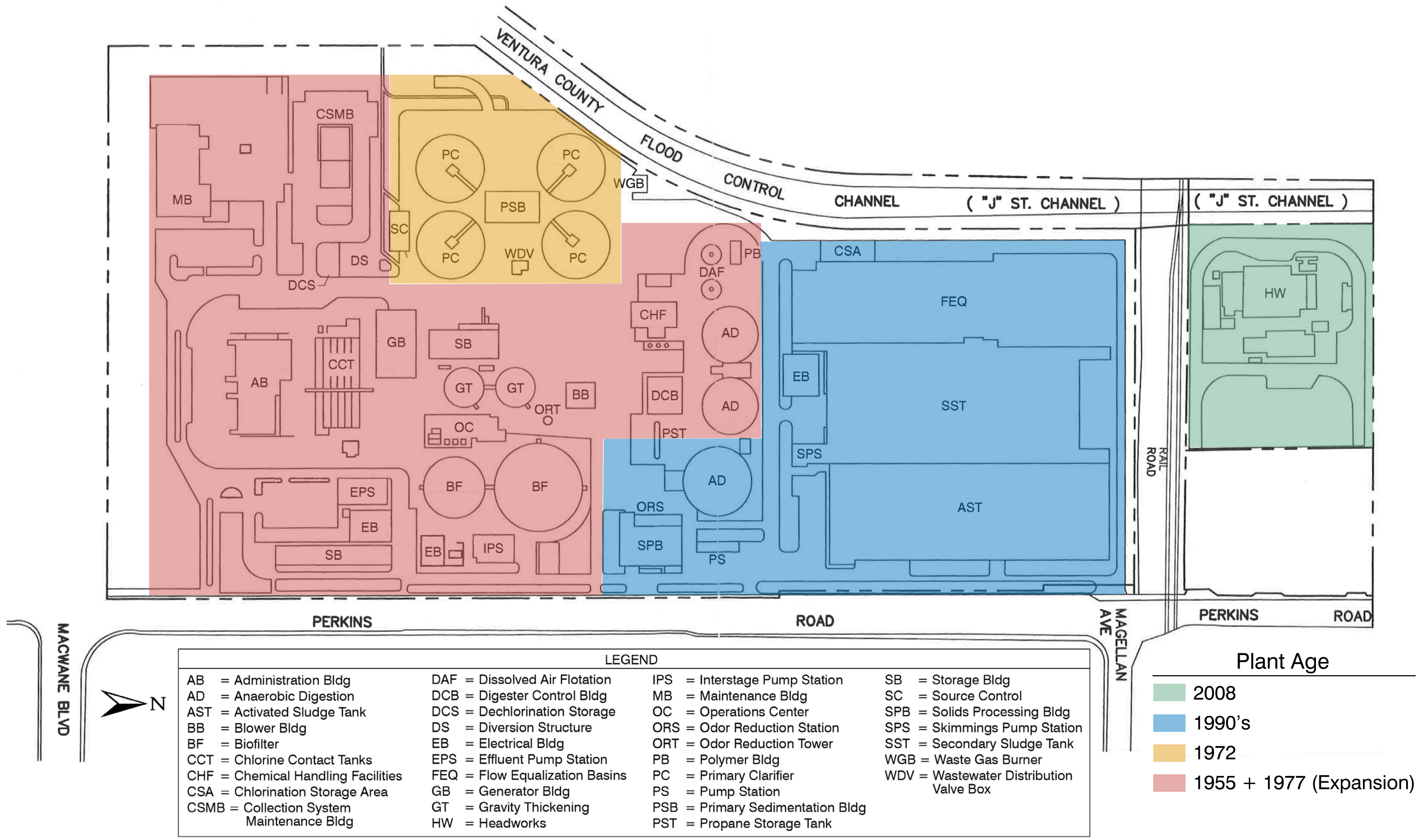

Figure 7. The Oxnard Wastewater Treatment Plant consists of preliminary, primary, and secondary treatment, effluent disinfection and solids handling facilities.

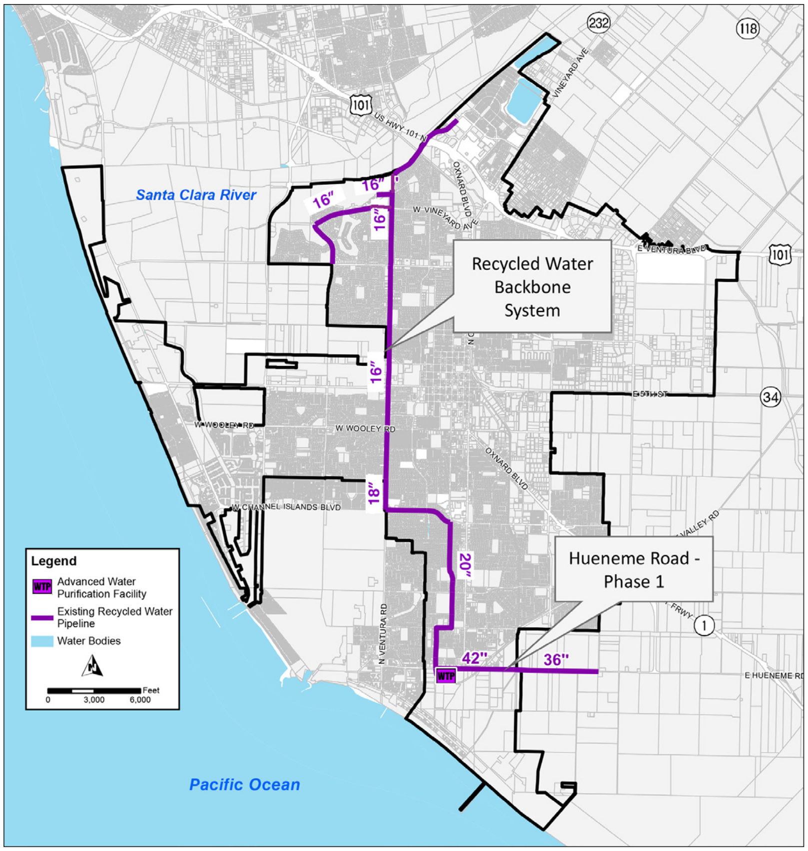

Figure 8. The City serves both urban and agricultural reuse customers with recycled water.

operation. Figure 9 provides a schematic of the treatment facility. For this phase, the current capacity is allocated to urban irrigation, industrial reuse, agricultural irrigation, and indirect potable reuse. As subsequent phases of the Advanced Water Purification Facility finish, the preferred schedule will be to first deliver recycled water to recycled water users currently under contract, second to indirect/direct potable reuse, and third to additional agricultural users, which could benefit the City groundwater due to pump-back credits.

The City is constructing an Aquifer Storage and Recovery Demonstration well (ASR Demo Well), which is expected to finish in 2018. The construction of this well is grant funded and will serve as a test well for understanding how indirect potable reuse will work moving forward. Initially, the ASR Demo Well will be used as an aquifer storage and recovery well for the recycled water system. In this case, recycled water from the Advanced Water Purification Facility will be injected into the ground and then extracted and returned to the City's recycled water system for irrigation use. Ultimately, once all of the required start-up testing and monitoring is complete, the well will switch

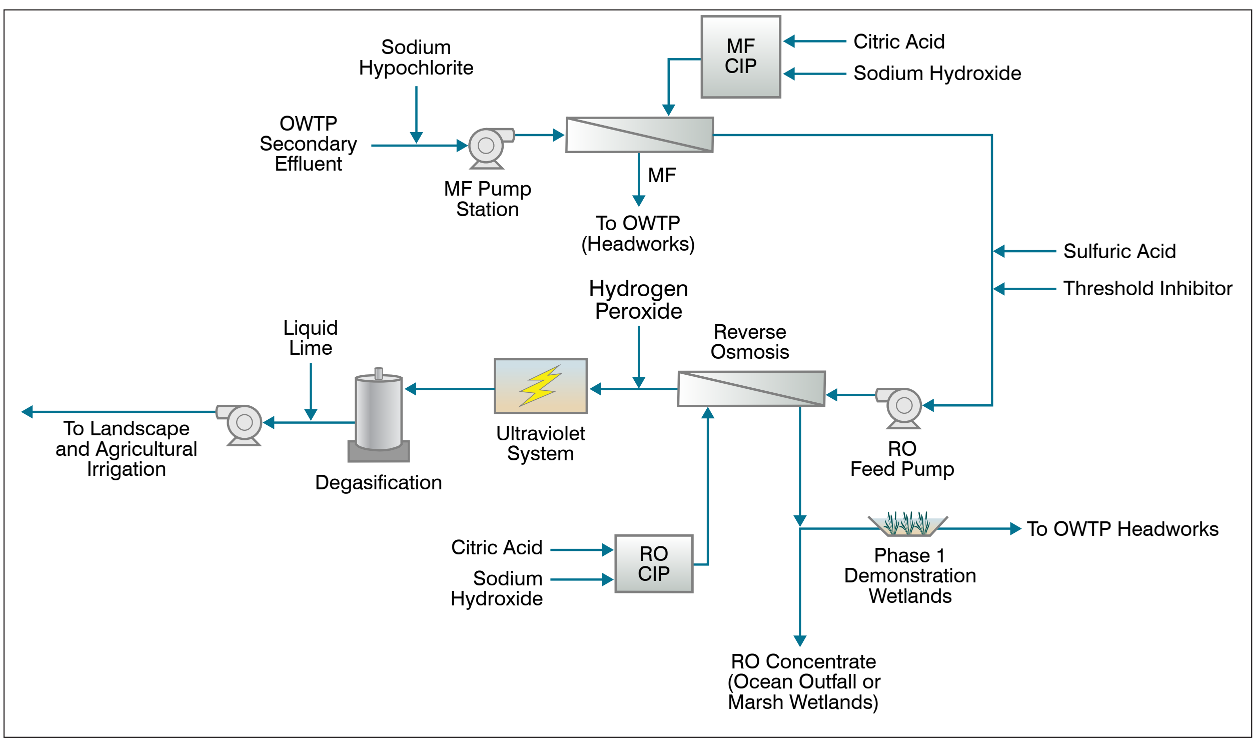

Figure 9. The Advanced Water Purification Facility includes microfiltration, reverse osmosis, and advanced disinfection.

to indirect potable reuse operation, and the extracted water will be conveyed to the nearby Water Campus (Blending Station No. 1) for disinfection and injection into the potable system.

STORMWATER

The City's stormwater system serves the City and surrounding lands that drain into Oxnard, an area that covers approximately 35 square miles. Drainage channels for this area are either partly or completely under the jurisdiction of the Ventura County Watershed Protection District and discharge directly into the ocean or into the Ventura County facilities before discharging to the ocean. The City's existing storm drainage system collects and conveys stormwater runoff from developed and undeveloped areas throughout the City.

During the condition assessment, the City's stormwater system was found to be in relatively good condition, with only 12 percent in poor or very poor condition. During the level-of-service analysis, significant surcharging was found for a 10-year, 24-hour storm event in the City's storm pipes located in the downtown core of the City. However, this surcharging is likely not related to the drainage pipe's capacity as much as it is to the Ventura County Channels' conveyance capacity. In similar locations, the existing storm drain system lacks sufficient capacity to convey the 100-year design runoff while meeting the flooding criteria.

Although major upgrades to the City's existing stormwater system are not needed, the City might benefit from adding a dry weather diversion into its system. Dry weather flows, including flow from irrigation runoff, pool draining, washdown water, construction work, and likely shallow groundwater infiltration, could be diverted to the wastewater plant for treatment and potential reuse at the Advanced Water Purification Facility.

Additionally, the City recently completed a Green Alleys Plan, the goal of which was to identify City alleys that are good candidates for green alley projects and to provide a framework to guide the future design and implementation of these projects. In reviewing the Green Alley program results, some of the high priority public alleys were noted to overlap with the observed areas of flooding. Figure 10 shows the areas of high priority for Green Alleys projects, along with the existing flooding areas.

Stormwater System — At-A-Glance:

- City owned - Approximately 162 miles of storm drains and open channels and 5 stormwater pump stations
- Ventura County owned - Approximately 28 miles of open channels

In addition to the structural needs addressed above, the City faces a total maximum daily load restriction for indicator bacteria in the Santa Clara River Estuary. This load limit will require participating agencies, including Oxnard, to prepare an implementation plan that outlines proposed activities to reduce the bacteria and trash loads to the Estuary.

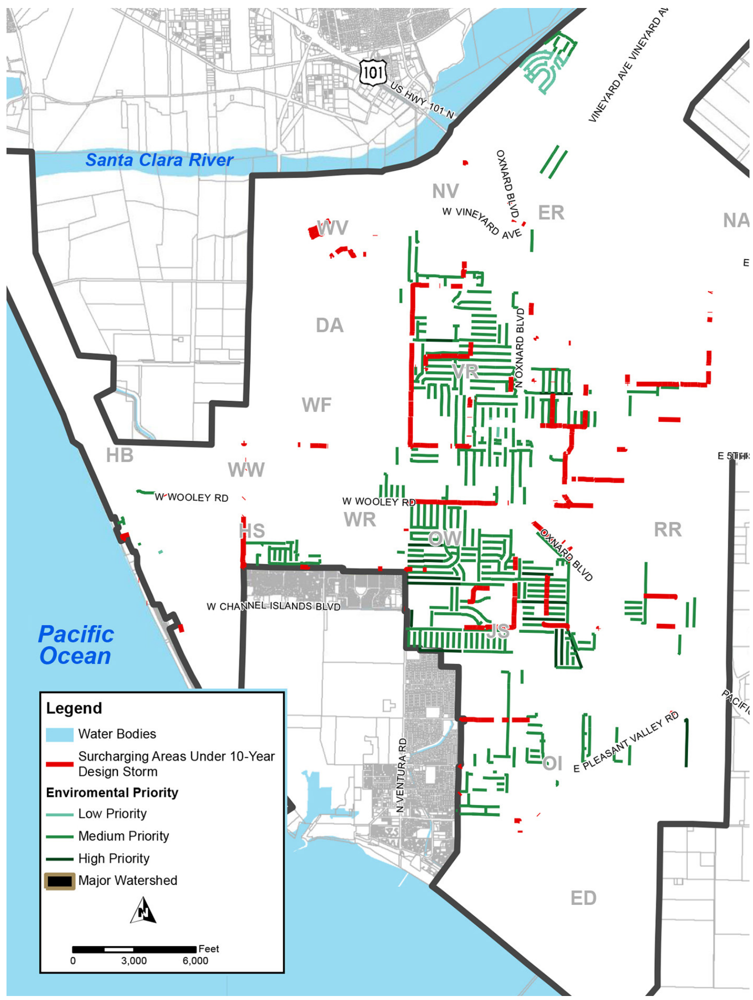

Figure 10. High Priority Green Alleys Environmental Improvements and Flooding Areas.

SUMMARY OF FUTURE NEEDS

When considering the future needs of each water system, categorizing them by their corresponding planning driver is helpful. Table 2 matches each future need with its planning driver.

Table 2. Summary of Future Needs Categorized by Planning Driver

Driver	Water	Wastewater	Recycled Water	Storm Water
Repair and Replacement (R&R)	• Cathodic protection • Select water main replacement due to age and fire flow needs • Routine maintenance on blend stations • Automatic Meter Reader Devices • Security needs	• Repair and/or replacement needed on almost every treatment plant process • Seismic/structural upgrades needed on several facilities • Cathodic protection of buried plant piping, clarifiers and digesters • Select sewer replacement due to age	• Minor improvements to the advanced water purification facility	• Select storm water pipeline/culvert replacement due to age and condition
Regulatory		• Potential addition of nitrification/ denitrification		• Infiltration basin to meet total maximum daily load allocation for indicator bacteria
Operational Optimization	• Electrical rehabilitation • Generator and ATS service • Turnout service	• Biotower removal • Interstage pumping reconfiguration(1)	• Addition of diurnal storage and booster pumping	
Growth/ Capacity/ Water Supply	• New potable wells • Upgraded pipelines to meet projected demand • Pressure zone separation	• Solids process expansion • Expansion of select sewer pipelines	• Expansion of advanced water purification facility • Addition of aquifer storage and recovery wells • Addition of recycled water distribution forcemains	
Resource Sustainability		• Blower and cogeneration replacement • Fats, oils and grease receiving station		• Dry weather stormwater diversion • Incentive program to encourage using stormwater as an offset to potable use
Improved LOS	• Additional desalting capacity to improve water quality • Pressure zone separation			

(1) Project satisfies driver for Resource Sustainability as well.

6. KEY FEATURES OF THE RECOMMENDED 25-YEAR PLAN

With future needs identified, recommended projects can be developed to meet those needs. This section presents the rationale for the City's Capital Improvement Plan (CIP). The complete CIP is presented at the end of the Executive Summary. For each system, the set of recommended projects uses the existing system's condition assessment, capacity, and performance needs in meeting projected future demands and the water quality objectives summarized below. Once the implementation timing was determined based on the technical aspects noted above, the CIP was then revised, as needed, to meet the City's near-term financial and budget limitations noted in the Cost of Service Studies. These projects cover the needs of the entire planning period for this Integrated Master Plan (through 2040). Though the overall Capital Improvement Plan was combined and integrated to account for potential linkage opportunities, each system plan is presented individually for added clarity and simplicity.

The complete CIP is presented at the end of the Executive Summary. These projects cover the needs of the entire planning period for this Integrated Master Plan (through 2040).

The lists presented in the CIP should be considered "draft" until the environmental review and assessment for the Integrated Master Plan are complete. Once the environmental review process is complete, the recommended project list will be reviewed and revised as necessary and made final.

The recommended projects are based on evaluations of conventional and advanced treatment requirements, the analysis of master plan alternatives and scenarios from the previous sections, numerous integration workshops and meetings with the City, and additional facilities planning conducted after the December 2015 publication of the project memos.

CAPITAL COSTS

The estimated capital (or project) costs presented are based on preliminary layouts and suggested unit process sizes. Construction costs have been estimated using information from estimating guides, equipment manufacturers, previous City construction projects, and construction costs of similar facilities designed by Carollo Engineers.

While the estimated construction costs represent the average bidding conditions for many projects, variation in bidding climate at the time the facilities are constructed could affect actual costs. The facilities' size may also be refined during preliminary and final design based on the most current operational information available. As a result, the actual construction costs may be lower or higher than estimated.

Although costs have been adjusted to cover special conditions known at this time, planning estimates are not as accurate as estimates prepared in conjunction with final design. The overall expected level of accuracy of the project cost estimates prepared for this Integrated Master Plan is +30 percent to -20 percent, which is consistent with the guidelines established by the American Association of Cost Engineers for planning studies.

Capital (or project) costs for the Capital Improvement Plan are based on a February 2015 20-City Engineering News Record Construction Cost Index of 9962 and were adjusted for City location as necessary. This date is used as the base level to which construction costs are adjusted, unless otherwise noted in the CIP. Therefore, all costs presented will reflect February 2015 cost levels. This means that actual costs may be higher than presented, depending on when the facilities are finally constructed. For the financial analysis, the estimated costs are escalated to the projected time of construction.

PROJECT PHASING

The projects presented in the Capital Improvement Plan were split into three projects timing phases:

- Immediate Needs (First 2 years)
- Near-Term Needs (Years 3 to 5)
- Long-Term Needs (beyond 5 years)

This project timing matches the Cost of Service Studies approved (Carollo, 2017).

While the estimated project costs and phasing presented are consistent with those developed for the Cost of Service Studies (Carollo, 2017), the timing implemented for those phases may differ.

While the estimated project costs and phasing presented are consistent with those developed for the Cost of Service Studies (Carollo, 2017), the actual timing implemented for those phases may differ. Some of this is because the timing and implementation of certain projects use assumptions with a range of uncertainty. These uncertainties include the rate of population growth, timing and performance standards for future regulatory requirements, the outstanding planning considerations mentioned above, and the development of new technologies and associated reliabilities. Thus, while the overall investment and total Capital Improvement Plan budget over the 25-year planning horizon is consistent with the Integrated Master Plan and the Cost of Service Studies, the implementation timing of some projects may differ with the variability in the underlying assumptions of Integrated Master Plan drivers.

Because Blending Station No. 1/6 and Blending Station No. 3 are the most favorable locations for potable groundwater pumping due to the significant existing infrastructure in both locations, these sites were selected for locating the new potable wells.

In general, most of the City's distribution system is capable of handling current and future demand flows, with the exception of some pipes in the immediate vicinity of the blending stations. As demands rise, the velocities in these pipes will likely exceed level-of-service criteria. Although the list of recommended projects includes replacing these pipes, the exact year for replacement needs to be determined after coordination with the Cost of Service Studies and the Project Memorandums contained in this Integrated Master Plan.

Also of note is a separate project indirectly related to water supply, which involves constructing a dedicated concentrate pipeline from Blending Station No. 1/6 to the Wastewater Treatment Plant's ocean outfall. This pipeline is especially needed since increasing the desalting capacity as local groundwater pumping increases is recommended. Furthermore, the City discharges brine from the existing desalter back to the Wastewater Treatment Plant, which, over time, could adversely affect the Advanced Water Purification Facility. Adding a dedicated concentrate pipeline could prevent this from occurring.

WATER SYSTEM

Figure 11 illustrates the location of the recommended water system improvements for securing and sustaining the City's water supply. Since the recommended projects work in concert with the recycled water improvements, both are shown together.

Water Supply

Securing a sustainable water supply for the City will come through a combination of additional potable water pumping and recycled water aquifer storage and recovery. As such, new potable water supply wells are needed to maintain the reliability of the City's local groundwater pumping operation and to add system reliability. These new wells will replace and bolster the City's current local groundwater pumping capacity.

Repair and Replacement

A number of projects related to repair and replacement for the water system were identified through the efforts of this Integrated Master Plan and City staff. These improvements are broken down into two broad categories: above-ground assets (blending station/treatment) and below-ground assets (distribution system piping).

Blending Station/Treatment. Replacing the cathodic protection systems is needed for the desalter and steel permeate storage tank. The water Supervisory Control and Data Acquisition (SCADA) system is also slated for complete replacement and upgrade.

Distribution. Distribution system piping improvements are needed for the replacement of aging pipes

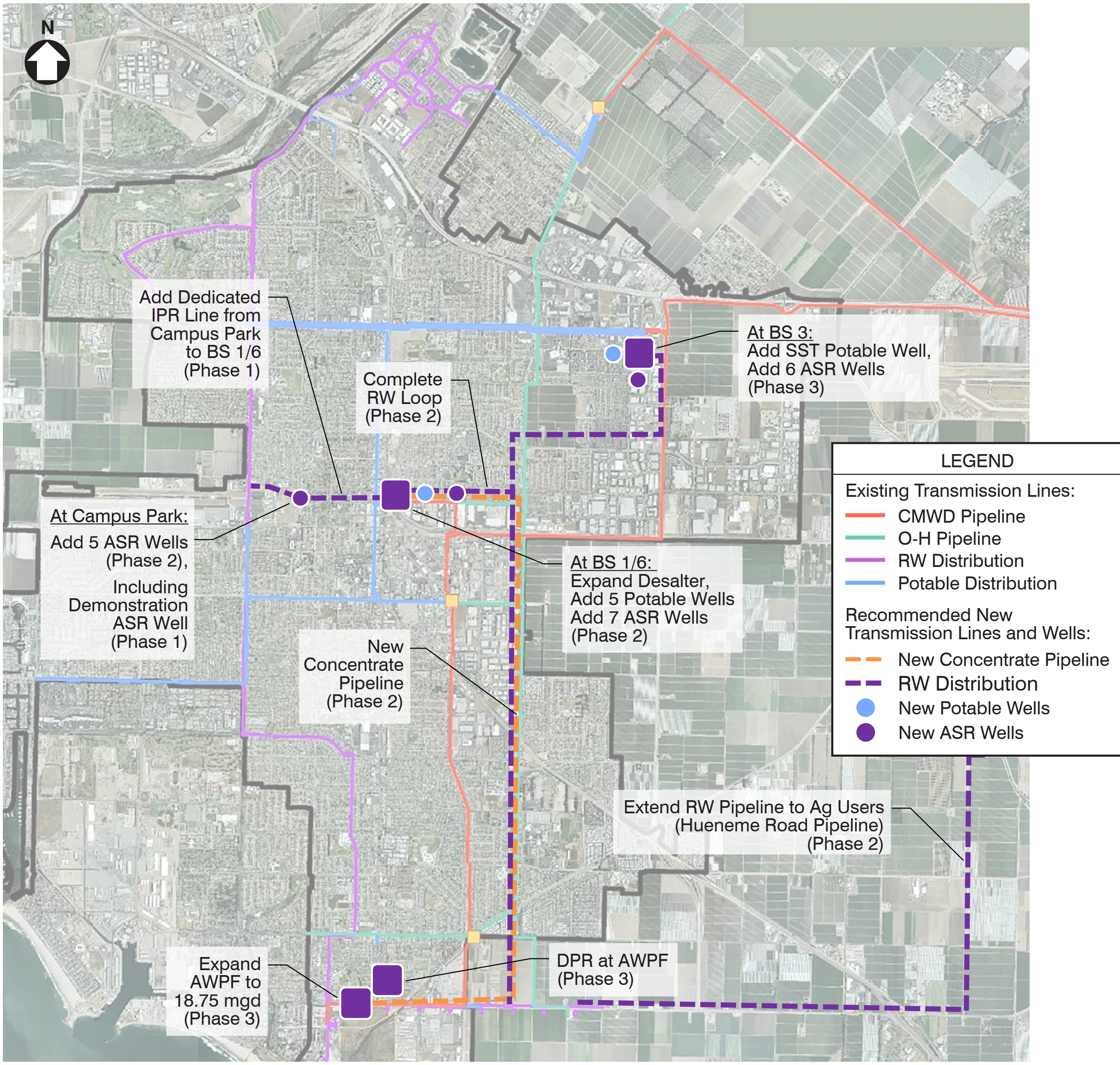

Figure 11. Recommended water/recycled water projects for water supply.

to meet reliability and redundancy requirements, and to protect public health. New piping is recommended to provide adequate fire flow water. Cathodic protection projects were identified for several key water force-mains throughout the City. Replacing the automatic meter reader devices is also imperative for accurate billings and water use data.

> For potable water customers, water quality and pressure are the two most readily perceived issues with water service.

Operations Optimization

The City is also working on several optimization projects for the City's water system operation. These projects were identified and included as recommended projects in the CIP.

Improved Level of Service

For potable water customers, water quality and pressure are the two most readily perceived issues with water service. If the City is to maintain and improve its high level of service to its customers, two main projects are recommended, and are described below.

Water Quality. Because of the groundwater supply's high level of hardness, the City operates a desalter to reduce the hardness level of blended water to approximately 350 mg/L. However, many customers still find the water dissatisfying and run their own softeners. These softeners increase the salt concentration, which adversely affects the Wastewater Treatment Plant and Advanced Water Purification Facility.

To improve the quality of the water supply, increasing the current and future supply's desalting capacity so it can meet a target hardness level of 100 mg/L is the most cost-effective option. To facilitate this project, the existing 7.5 million gallon per day desalter located at Blending Station No. 1/6 will be expanded to a total treated water capacity of 15 million gallons per day.

Water Pressure. Based on the pressure zone analysis, it is recommended to reduce service pressures outside of the established delivery pressure criteria by breaking its single pressure zone distribution system into four pressure zones: North, Coast, Central, and South. Figure 12 illustrates these pressure zone areas.

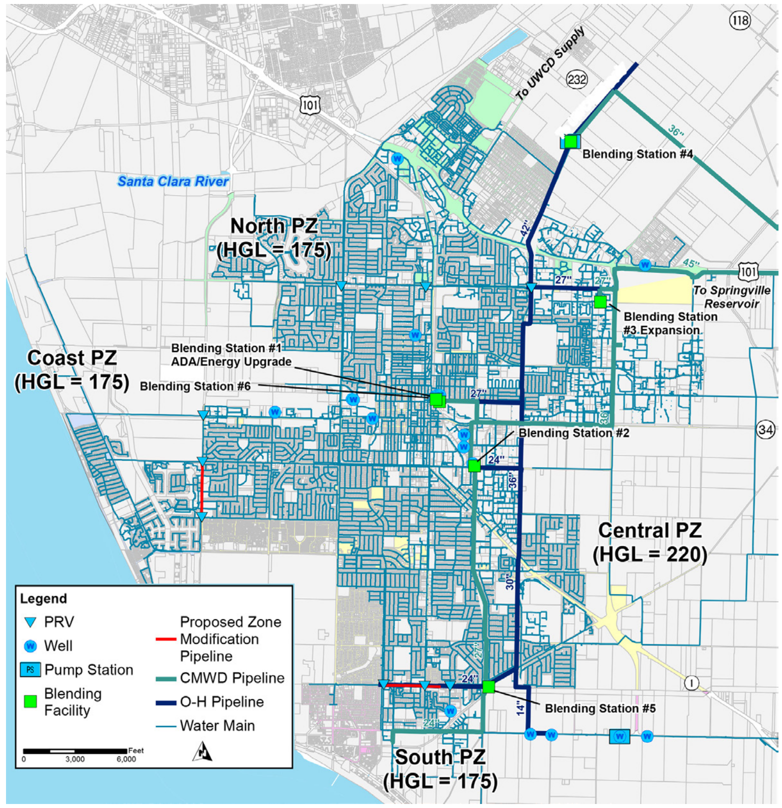

Figure 12. Proposed Pressure Zone Separation within the City's Water System.

WASTEWATER

Figure 13 shows the recommended projects for the wastewater treatment facility, which are categorized by implementation phase. The projects and phasing shown here represent one possible solution to upgrading the Oxnard Wastewater Treatment Plant. Between the time of original publication of the Final Draft Plan in 2015 and this Revised Final Draft publication in 2017, the City continued to review and optimize the recommended policies, projects and programs. Therefore, certain wastewater projects have been refined and updated. However the overall intent is the same, to upgrade the facilities that have served their useful life to achieve improved financial and implementation strategies, to accommodate technology updates, and address climate change strategies. It should be noted that these refinements and optimizations were generally not related to capacity needs.

Two overarching wastewater treatment locations were considered, namely, repair in place and relocate most of the wastewater treatment plant. Both are described in this section.

COLLECTION SYSTEM

Capacity

Projects related to increasing the wastewater system's capacity involve the collection system, and these projects are relatively few. Specifically, there are three main capacity projects, all of which are identified in the CIP.

Repair and Replacement/Improved Performance

Collection System. There are approximately a dozen identified repair and replacement and performance-based projects which are summarized in the CIP. These projects are located in various places throughout the City's collection system.

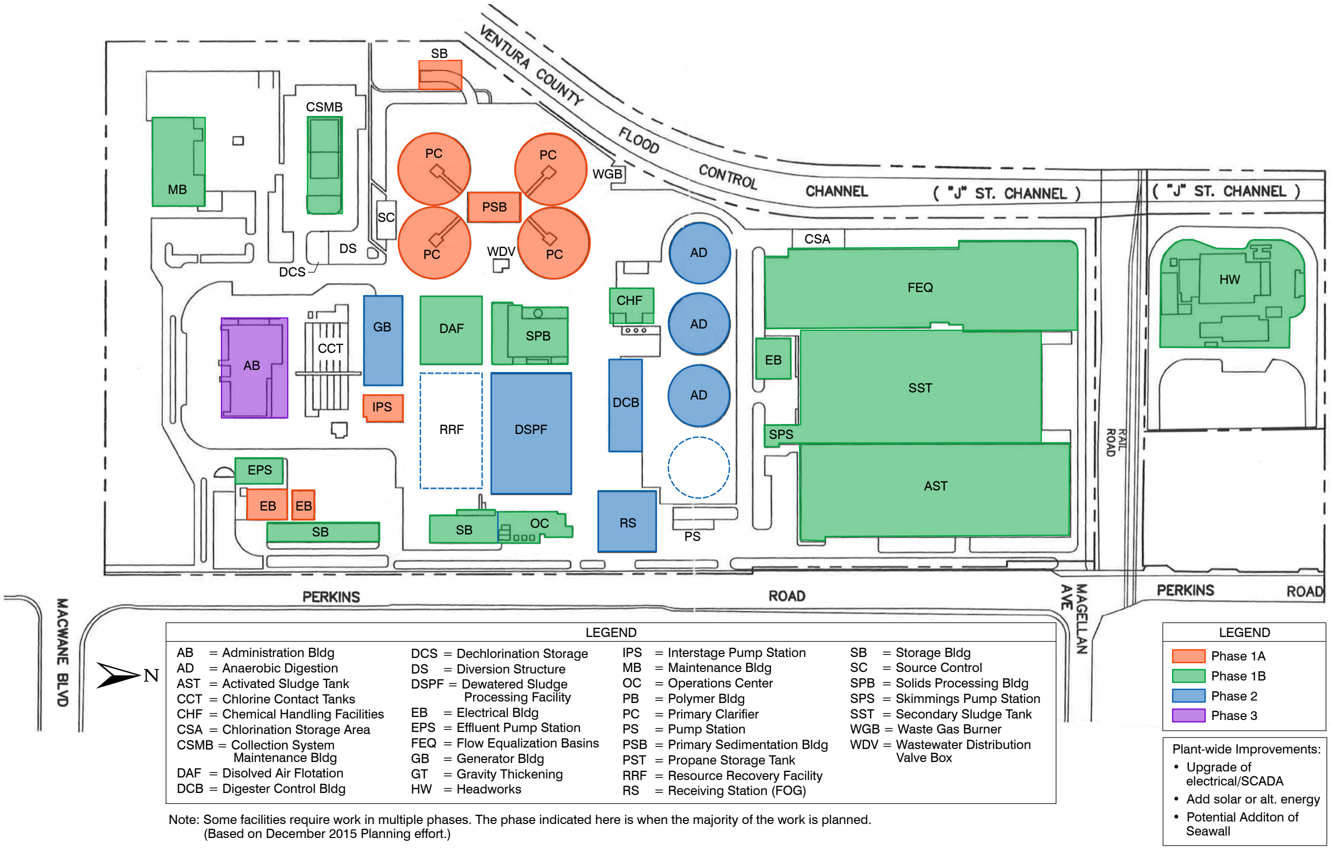

Figure 13. Recommended Wastewater Treatment Plant Projects by Implementation Phase.

TREATMENT SYSTEM

Repair and Replacement

Headworks. The proposed headworks improvement projects are to improve reliability and to help maintain a fully functioning and permit-compliant facility.

Primary Treatment. All four clarifiers and the associated primary clarifier building need to be replaced to increase the treatment plant's reliability and safety for plant operators due to seismic criteria and deteriorated condition. A new influent new splitter box is recommended to improve flow control.

Secondary Treatment. Based on the plant condition assessment and seismic evaluation, several improvements were identified in the secondary treatment process. Because the secondary process has sufficient capacity to meet future needs, the recommended projects are intended to address aging facilities and to improve operability and performance rather than increasing capacity.

Disinfection. For continued reliability of the disinfection system, concrete repairs and a new interior coating are recommended on the disinfection contact tank. Replacing the associated gates and operators as well as the sodium hypochlorite storage tanks and pumps is also recommended.

Effluent Pumping. The effluent pump station building and the associated effluent pump station equipment, all nearing the ends of their useful lives, should be replaced. These improvements will provide reliability for downstream users and will enhance safety for plant operators.

Solids Treatment. Based on the plant condition assessment and seismic evaluation, several improvements were identified in the solids treatment processes. Furthermore, the solids handling facilities do not have sufficient capacity for the expected increase in sludge production from removing the biotowers and adding an anaerobic selector in the activated sludge tanks. Because of these anticipated changes, additional solids handling units are needed.

Cogeneration. Because a seismic review found the cogeneration building to be nonconforming for the Immediate Occupancy performance level, replacing the building and the associated cogeneration equipment is recommended. However, because this project is not as critical as some of the others listed, it is slated for a later phase of the plan. An interim replacement for the building roof will be needed in the immediate future.

Electrical Systems. The majority of the existing electrical equipment at the treatment plant is in poor condition and needs to be replaced. All of the motor control centers (MCCs) throughout the plant are past or nearing the ends of their useful lives. In addition, the existing generators cannot be brought online quickly enough to meet new standards for emergency standby. Thus, new generators are recommended to supply the plant with emergency power. Furthermore, a new supervisory control and data acquisition (SCADA) system is needed for adequate plant process operation and control.

Non-Process Facilities. Various assessments for this Plan also identified several non-process facilities improvements. The major improvements are as follows:

> Various assessments for this Plan also identified several non-process facilities improvements.

- Cathodic protection of major treatment plant assets and annual cathodic protection maintenance
- Repaving the plant site once major improvements have been completed
- Adding a new Computerized Maintenance Management System (CMMS) for more uniformity and the ability to share data between divisions and departments
- Replacing various heat pumps and air conditioning condensing units with more efficient models

Resource Sustainability

Several projects focusing on resource sustainability were also identified. These projects were aimed at recovering resources onsite and decreasing waste sent offsite. Some of the projects also address issues with resiliency and reliability from potential climate change effects. These projects are described below.

> Some of the projects also address issues with resiliency and reliability from potential climate change effects.

- Add a **fats, oil, and grease receiving station** to provide flexibility in timing the addition of fats, oil, and grease to prevent slug loading, which can lead to digester upsets. Adding a receiving station will also allow fats, oil, and grease to be added when energy costs are high.
- Add **solar cells** to the rooftops and carports throughout the facility. Adding solar cells would increase the amount of energy produced onsite, thus helping the OWTP become energy self-sufficient.
- Add a **membrane bioreactor** (MBR) to address potential nutrient requirements placed on the outfall from increased levels of water reuse that concentrate ocean discharge. Adding membrane bioreactors is recommended as a "placeholder" technology to replace the secondary sludge tank. The bioreactors would treat all wastewater flow.
- Add **ultraviolet/advanced oxidation process** as a recommended additional step after installing the membrane bioreactors. This process would allow flows to be sent to the Advanced Water Purification Facility. One concern with a high reuse percentage is that the concentrate will not properly disinfect water. If this occurs, an additional disinfection process is recommended to address potential pathogen and toxics concerns.
- Allocate funds for the future **seawall** to protect the low-lying plant site from the potential effects of sea level rise. Predictions show that by 2040, the 100-year storm sea level could rise as much as seven feet, which would flood every major process unit.

Alternative Treatment Plant Location

Improvements to the treatment facilities on the existing plant site as previously described is considered the most viable short-term option. In the long-term, however, possibly relocating all or many of the treatment processes to a different location near the Advanced Water Purification Facility could be more attractive because of the extent of repair and replacement needed at the current site, and due to the potential flooding risk from rising sea levels.

To evaluate both sites, a preliminary master planning-level cost estimate was developed, which revealed little difference in the comparative cost of building wastewater treatment plant facilities in either location. It should be noted that for this high-level comparison, conventional secondary treatment was assumed for both options. However, further assessment is needed to confirm the selection of conventional secondary treatment and/or nutrient reduction, especially in light of the various regulatory and integration aspects of the water reuse program.

If the City chooses to relocate some or all of the processes to a new site, it would need to further consider the regulatory, timing, and financial feasibility. Specifically, planning work could take approximately five to ten years to complete. Because these efforts take time to finish and much of the Wastewater Treatment Facilities are in poor condition, a number of critical improvement projects must be completed before moving forward.

RECYCLED WATER

The location of the recommended recycled water system improvements was shown previously in Figure 11. These improvements are shown together because the water and recycled water improvements work in concert with one another to offer a new sustainable water supply.

Repair and Replacement

The Advanced Water Purification Facility was completed in 2012 and is now operating at full capacity. For this facility, only minor improvements are considered. Over time, the City is planning to retrofit the connection to approximately 40 urban irrigation customers for recycled water delivery.

Water Supply

A key component of providing a sustainable water supply is the use of indirect potable reuse with recycled water from the City's Advanced Water Purification Facility. For this reason, the recommended water supply projects for the recycled water system will involve expanding the system to operate as an indirect potable reuse system. These expansions are described below.

Treatment. Phase 2 will involve expanding the existing 6.25-million gallons per day Phase 1 Advanced Water Purification Facility. This facility of membrane and disinfection treatment trains can be modularly expanded without requiring additional ancillary equipment, such as cleaning and support systems. A Phase 3 expansion of the Advanced Water Purification Facility would require more treatment and ancillary equipment be added to meet the additional capacity, along with influent flow equalization.

Recycled Water Distribution. Current efforts to expand the recycled water distribution system have focused on delivering recycled water to urban and agricultural users east of the City, which will be accomplished with Phase 2 of the Hueneme Road Pipeline. The alignment of this pipeline will start at the terminus of the Hueneme Road Phase 1 Pipeline and terminate just before Lewis Road. The pipeline will also supply farmers with an agricultural demand of up to 5,200 acre-feet per year depending on the recycled water supply available.

> Adding these wells will correspond to the Phase 2 expansion of the Advanced Water Purification Facility and should help to meet potable water demands through approximately 2030.

Phase 2 includes construction of the recycled water loop, which will feed the various proposed aquifer storage and recovery locations at Campus Park and Blending Station No. 1/6. The recycled water loop starts at the existing Recycled Water Backbone pipeline and completes the remaining three sides of the loop with a combination of 20-, 24-, and 30-inch pipelines (see Figure 11). For Phase 3, a 24-inch pipeline should be installed that connects Blending Station No. 3 to the recycled water loop.

Indirect Potable Reuse. Implementing indirect potable reuse as a supplemental water supply within the City is planned to occur in phases, which are described below.

Phase 1 involves constructing the ASR Demo Well, as previously discussed. In adding this well, the City can assess the feasibility of the indirect potable reuse process in real-time and refine the assumptions for the aquifer capacity and the quality of extracted water.

For Phase 2, the majority of the aquifer storage and recovery wells would be installed for supplemental water supply use, which would also occur in phases. First, the Campus Park site would be "built out," adding four additional aquifer storage and recovery wells, each with its own set of monitoring wells (i.e., three monitoring wells per recovery well). Currently, a "built-out" aquifer storage and recovery site would also have operational storage sized to offset peak hour flows, booster pumping, and add conditioning facilities, such as disinfection and fluoride. However, because the Campus Park site is close to Blending Station No. 1/6, housing the ancillary equipment at Blending Station No. 1/6 makes more sense. Thus, extracted indirect potable reuse water would be conveyed from Campus Park to Blending Station No. 1/6 for storage and conditioning.

After the Campus Park aquifer storage and recovery wells are built out, four wells would be added near Blending Station No. 1/6 site and additional property near Blending Station No. 1/6 would need to be acquired, which the City has discussed with property owners. Adding these wells will correspond to the Phase 2 expansion of the Advanced Water Purification Facility and should help to meet potable water demands through approximately 2030.

To provide direct potable reuse at some future date would involve adding more aquifer storage and recovery wells, located at Blending Station No. 3, and/or additional facilities. Direct potable reuse circumvents injecting recycled water into the groundwater basin or extracting it, allowing the water to be discharged into above-ground storage tanks instead. After a period of monitoring and verification, the water can then be combined with the potable water system. These storage tanks could be located near the Advanced Water Purification Facility.

STORMWATER

Figure 14 shows the relative recommended project locations for the Stormwater System's necessary capacity upgrades.

Repair and Replacement

Approximately 12 percent of the stormwater collection assets evaluated need immediate attention or attention within the next five years. This percentage equates to approximately 20 projects related to repair and replacement, which should be addressed in Phase 1.

Capacity

Stormwater collection system improvements focused on the capacity needs determined from collection system modeling. The modeling identified over a dozen main capacity projects, which are summarized in the CIP to address the stormwater systems' capacity needs over the next 25 years. These projects include upgrading sections of culvert and/or piping to reduce surcharging and flooding in specific areas throughout the City.

Regulatory

In response to the total maximum daily load for indicator bacteria placed on the Santa Clara River Estuary, a draft Implementation Plan was developed in March 2015. Within the Implementation Plan, potential infiltration basins and subsurface infiltration basins for both dry and wet weather stormwater are recommended throughout the watershed, including one located at South Bank Park in Oxnard. The City will be expected to cover the cost of this infiltration basin, which helps mitigate the regulatory requirements.

Resource Sustainability

Two opportunities exist for making the City's stormwater system more sustainable for creating and conserving water for potable use. These opportunities are described below.

> Two opportunities exist for making the City's stormwater system more sustainable for creating and conserving water for potable use.

The first opportunity would be to divert dry weather stormwater channel flows to the Wastewater Treatment Plant for treatment and potential reuse at the Advanced Water Purification Facility. Typically, dry weather flows include flow from irrigation runoff, pool draining, washdown water, construction work, and other related activities. In Oxnard, dry weather flow is likely shallow groundwater infiltration. Diverting this dry weather flow could potentially create another water source, albeit a small one, for the City's reuse program.

The second opportunity is to create a citywide incentive program that targets capture stormwater to offset potable water use. This program would let interested residents retrofit their homes with rain barrels or rain cisterns to help decrease flooding and encourage residents and developers to be proactive in using stormwater. The cost for such an incentive program depends entirely on its size and the amount the City is willing to offset. It should be noted, however, that since the

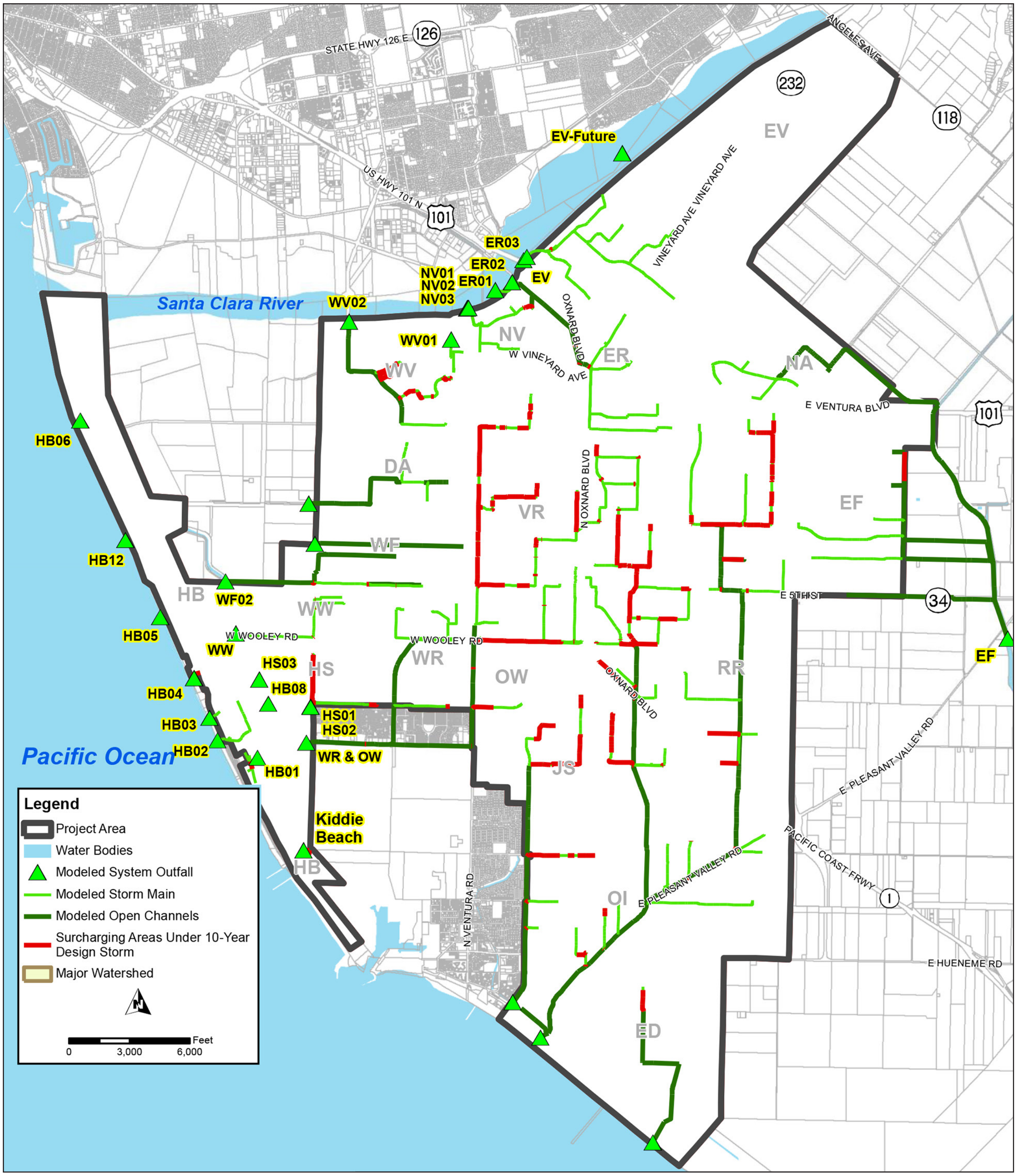

Figure 14. Capacity upgrades needed for 10-year design storm under 2040 conditions.

City of Oxnard is located on a shallow perched aquifer, this Integrated Master Plan recommends that any incentive program focus on onsite capture and irrigation use instead of infiltration to decrease customers' potable water use.

Integrated Overarching Systems

For this Integrated Master Planning effort, several overarching systems were reviewed and evaluated for upgrades. For instance, the planning effort included upgrades to the **Supervisory Control and Data Acquisition** (SCADA) systems for the water and wastewater systems to match the state-of-the art system currently installed in the Advanced Water Purification Facility. The City's **security systems** were reviewed and guidelines/recommendations were made to enhance security for the City's facilities.

In addition, the planning effort made several recommendations for updating the City's **data managements systems**. These recommendations included upgrades to the City's Geographical Information System database and Computerized Maintenance and Management System for accurate and timely tracking and managing of the City's water assets.

Several overarching systems were reviewed and evaluated for upgrades.

7. SUMMARY OF RECOMMENDED CAPITAL IMPROVEMENT PLAN COSTS AND IMPLEMENTATION SCHEDULE

In combining the water system utility plans to produce the Integrated Master Plan, the City developed a Capital Improvement Plan that provides a cost-effective, reliable, resilient, and highly functioning water infrastructure for the next 25 years. The exact timing of the CIP's phases depends on many factors, including the rate of population growth, the timing and performance standards of future regulatory requirements, the outstanding planning considerations mentioned previously, and the development of new technologies and associated reliabilities. This Integrated Master Plan has built-in flexibility to accommodate these anticipated changes.

Table 3 summarizes the Capital Improvement Plan project costs by implementation timing for the recommended projects. Timing for designing and constructing the Integrated Master Plan facilities can be seen in the CIP provided herein.

Table 3. Recommended Overall Capital Improvement Plan for the City's Integrated Master Plan

PLAN IMPLEMENTATION TIMING	Years 1 to 2 (FY 2017/18 - 2018/19)	Years 3 to 5 (FY 2019/20 - 2021/22)	Years 6 to 10 (FY 2022/23 - 2026/27)	Years 11-16 (FY 2027/28 - 2032/33)	Years 17-23 (FY 2033/34 - 2039/40)	Total(1)
Water	$3,175,000	$61,839,333	$62,527,333	$19,238,333	$80,600,000	$227,380,000
Wastewater(1)	$8,405,000	$68,425,064	$244,311,000	$58,908,334	$112,983,933	$493,033,330
Recycled Water	$11,166,667	$81,033,333	$57,500,000	$80,500,000	$22,200,000	$252,400,000
Stormwater	$8,363,333	$18,118,000	$2,936,667	$1,338,000	$1,930,000	$32,686,000
Total by Phase	**$31,110,000**	**$229,415,730**	**$367,275,000**	**$159,984,667**	**$217,713,933**	**$1,005,499,330**

(1) Project costs correspond to refinements and updates provided by City after Dec. 2015 publication date.

8. SUMMARY

The projects/programs/policies recommended in this Integrated Master Plan support the City's positions and most current thinking, direction, and needs related to the master planning drivers. However, these factors could change depending on the outcome of several key outstanding planning considerations. Carollo has noted four key outstanding planning considerations that could particularly affect the outcome, timing, and phasing of the policies, projects, and programs noted in this Integrated Master Plan. These key considerations are listed and described below.

Carollo has noted four key outstanding planning considerations that could particularly affect the outcome, timing, and phasing of the policies, projects, and programs noted in this Integrated Master Plan.

- **Eventual location of all or parts of the Wastewater Treatment Plant.** Two major options are being considered: 1) continue treatment in the same location by repairing and replacing most of the facilities, or 2) relocate treatment, all or parts of it, to a completely new site. Not only would continuing in the same location require most of the major processes to be repaired and replaced, but potential seawater intrusion from rising sea levels is also a concern. Conversely, relocating all or parts of the plant to a new site reduces site issues, but it also presents a challenge in implementation. Many of the existing Wastewater Treatment Plant facilities need to be upgraded immediately due to age and condition. Constructing new facilities at a new site would require a longer lead-time to acquire the land and plan, design, and implement the facilities.
- **Regulatory considerations for the existing Wastewater Treatment Plant/Advanced Water Purification Facility outfall based on overall water infrastructure operation.** As more water is proposed for reuse throughout the City and regional area instead of being discharged to the ocean, unintended consequences may arise from trying to meet the end-of-pipe requirements in the City's outfall. Impacts could include limits on the Advanced Water Purification Facility's ultimate capacity, the need to nitrify and denitrify the secondary effluent before discharge, and changes in local limits for industrial users. Although preliminary potential mitigation measures have been explored through this Integrated Master Plan, conversations with regulators must continue until an approach providing the most cost-effective and reliable benefit is determined.
- **The Fox Canyon Groundwater Management Agency and future groundwater allocations.** Developing a sustainable water supply for the City's future depends on the long-term yield of the existing groundwater basin and the allocation apportioned to the City, which are closely tied to the drought conditions and the availability of the natural supply. Thus, this Integrated Master Plan used certain assumptions about future allocations to consider the best- and worst-case conditions and to provide flexibility for working with these parameters. However, the future of groundwater is highly uncertain and must be monitored frequently to ensure the City's ability to plan for changes as they occur. It must also be noted that because of the 2015 Groundwater Management Act, changes are imminent but are not fully defined at this time.
- **Future of imported Calleguas and Metropolitan Water District (MWD) of Southern California water.** As the drought continues, regional water authorities have discussed the best ways to address the region's future water supply. For example, MWD is considering adding both indirect potable reuse and seawater desalination plants in its area. Therefore, the City continues to stay up-to-date on the possibilities of regional desalting and/or desalination facilities, which could provide an alternative supply of drinking water to the City. This would allow for some of the Advanced Water Purification Facility's capacity to be used for more potable offset or for groundwater replenishment.

Capital Improvement Plan

Table B1 Potable Water System Capital Improvements Program (CIP) Projects

Project ID 2017	Project ID 2015	Project Name	Project Description	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
			Production Total				**$47,590,000**	**$1,955,000**	**$13,705,000**	**$30,350,000**	**$1,580,000**	**$0**
W-1	W-P-35	Existing desalter upgrades	Membrane replacement, CIP automation, electric valve actuator replacements, discharge piping reconfiguration	R&R	2017	5	$5,000,000	$930,000	$4,070,000	$0	$0	$0
W-2	W-P-28 W-P-40	Desalter, piping and permeate tank cathodic protection	Investigate requirements for electrical isolation and CP of buried piping and RO finished water, and design and install capital project as warranted; Replacement of CP system at WTP and steel permeate tank	R&R	2020	2	$110,000	$0	$110,000	$0	$0	$0
W-3	W-P-62 W-P-65	Expand water treatment facility and storage (incl. booster pump station)	Expand disinfection system at Blending Station 1/6. Install new 1.5 MG storage reservoir for finished water. Install new booster pump station for new storage tank	Water Supply	2021	8	$6,600,000	$0	$500,000	$5,100,000	$1,000,000	$0
W-4	W-P-19	Blending Station #2 upgrade	R&R of mechanical, electrical, and AUX equipment	R&R	2028	1	$430,000	$0	$0	$0	$430,000	$0
W-5	W-P-20	Blending Stations #1 and #6 upgrade	R&R of wells, mechanical, electrical, and AUX equipment	R&R	2018	4	$3,400,000	$850,000	$2,550,000	$0	$0	$0
W-6	W-P-21	Water System CMMS	Water CMMS System (City Works)	R&R	2017	3	$300,000	$175,000	$125,000	$0	$0	$0
W-7	W-P-22	Water System SCADA Improvements	Perform water SCADA system improvements (design and implementation plan year 1)	R&R	2020	5	$5,000,000	$0	$2,000,000	$3,000,000	$0	$0
W-8		Security Improvements at Water Yard and Blending stations	Access Control, Cameras		2020	5	$500,000	$0	$250,000	$250,000	$0	$0
W-9		Chemical Tank Replacements	Replacement of chemical tanks (required every 10 years)	R&R	2025	3	$450,000	$0	$0	$300,000	$150,000	$0
W-10	W-P-32	Blending Station #3 Rehabilitation	R&R of wells, mechanical, electrical, and AUX equipment, VFD replacement	R&R	2019	2	$2,500,000	$0	$2,500,000	$0	$0	$0
W-11	W-P-33	Blending Station #4 Rehabilitation	Pumps, mechanical, electrical, and AUX equipment, VFD	R&R	2019	2	$400,000	$0	$400,000	$0	$0	$0
W-12	W-P-34	Blending Station #5 Rehabilitation	Mechanical, electrical, and AUX equipment	R&R	2019	2	$200,000	$0	$200,000	$0	$0	$0
W-13	W-P-61	Construct 3 new potable wells at BS 1/6	Add potable water wells, land management	Water Supply	2020	7	$11,000,000	$0	$1,000,000	$10,000,000	$0	$0
W-14	W-P-66	Construct 2 new potable wells (BS 1/6) and 1 new stainless steel well at BS 3	Add potable water wells	Water Supply	2023	4	$11,700,000	$0	$0	$11,700,000	$0	$0
			Transmission Total				**$2,405,000**	**$405,000**	**$1,620,000**	**$380,000**	**$0**	**$0**
W-15	W-P-23 W-P-36 W-P-37	Del Norte Transmission Main Cathodic Protection (CP)	Install 20 missing test stations; Replace rectifiers and anodes and resurvey; Locate and repair discontinuity near the east end of the Del Norte Pl	R&R	2019	2	$450,000	$0	$450,000	$0	$0	$0

Project ID 2017	Project ID 2015	Project Name	Project Description	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
W-16	W-P-26	Gonzalez 36-inch Pipeline CP	Replace the seized test traffic box lids; test the CP system	R&R	2018	1	$5,000	$5,000	$0	$0	$0	$0
W-17	W-P-27 W-P-10 W-P-5 W-P-6	Oxnard Conduit CP	Excavate & install new test stations at BFV near Del Norte connection, 9+10, 39+10, 57+45, 69+50, 111+50, 165+20; Install new test stations in ex manhole at 284+80; Corrosion engineer to conduct Close Interval Survey (CIS); Replace deep anode beds at Rectifiers #1 , #2, & #3; Locate, excavate, and bond across approximately three (3) points of electrical isolation	R&R	2017	4	$890,000	$400,000	$490,000	$0	$0	$0
W-18	W-P-38 W-P-39	Wooley Road / United CP	Replace 5 test stations and add 2 new stations; Replace rectifier and anode; resurvey	R&R	2020	1	$160,000	$0	$160,000	$0	$0	$0
W-19	W-P-7 W-P-24	3rd Street Lateral CP	Replace rectifer and anode bed; resurvey; Replace all test stations at an interval of 1,000-ft minimum and 2,000-ft maximum; Locate & repair discontinuity between 27+88 and South Hayes WTP; Provide electrical isolation at the main treatment plant	R&R	2020	3	$360,000	$0	$310,000	$50,000	$0	$0
W-20	W-P-25 W-P-8	Industrial Lateral CP	Replace all test stations; resurvey	R&R	2020	3	$130,000	$0	$100,000	$30,000	$0	$0
W-21	W-P-11	3rd St 27" UWCD CP	Bond UWCD pipeline to Oxnard Extension at rectifier	R&R	2020	2	$110,000	$0	$110,000	$0	$0	$0
W-22		Condition assessment program	Physical condition assessment of mains program	R&R	2022	5	$300,000	$0	$0	$300,000	$0	$0
			Distribution Total				**$58,965,000**	**$815,000**	**$24,551,000**	**$23,574,000**	**$10,025,000**	**$0**
W-23	W-P-9	Replacement of AMR Devices	Design and construct a new Advance Metering Infrastructure (AMI) system (Cost is possibly reduced by 1/2 if shared with wastewater division)	R&R	2017	7	$22,000,000	$200,000	$13,000,000	$8,800,000	$0	$0

Project ID 2017	Project ID 2015	Project Name	Project Description	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
W-24		Pipe Capacity Improvements	Pipe capacity improvements for 8-inch to 24-inch pipe	Water Supply	2019	9	$13,040,000	$0	$5,620,000	$6,870,000	$550,000	$0
	W-P-51 W-P-52 W-P-53 W-P-54 W-P-56 W-P-57 W-P-58 W-P-59 W-P-67 W-P-68 W-P-69 W-P-70 W-P-71 W-P-72		Upgrade 322 feet to 8" pipe Upgrade 238 feet to 12" pipe Upgrade 164 feet to 14" pipe Upgrade 3,804 feet to 30" pipe Upgrade 69 feet to 6" pipe Upgrade 391 feet to 8" pipe Upgrade 1,011 feet to 10" pipe Upgrade 2,447 feet to 12" pipe Upgrade 32 feet to 6" pipe Upgrade 233 feet to 8" pipe Upgrade 1,243 feet to 10" pipe Upgrade 997 feet to 12" pipe Upgrade 2,453 feet to 14" pipe Upgrade 937 feet to 24" pipe									
W-25	W-P-12 W-P-13 W-P-14 W-P-15	Neighborhood CIP Pipe Replacement*	Replace existing distribution pipes in La Colonia Neighborhood, Redwood Neighborhood, Fremont North Neighborhood, and Bryce Canyon South Neighborhood	R&R	2018	6	$10,500,000	$615,000	$5,931,000	$3,954,000	$0	$0
W-29		Large Valve Replacement Program	Replace valve 10-inch and larger	R&R	2022	10	$1,926,000	$0	$0	$926,000	$1,000,000	$0
W-30		Small Valve Replacement Program	Replace valves 8-inch and smaller	R&R	2022	10	$3,780,000	$0	$0	$1,780,000	$2,000,000	$0
W-31		Air / Vac Valve Replacement Program	Replace air and vacuum valves and covers	R&R	2022	10	$1,422,000	$0	$0	$672,000	$750,000	$0
W-32		Hydrant Replacement Program	Replace dry barrel hydrants to wet barrel	R&R	2022	10	$1,197,000	$0	$0	$572,000	$625,000	$0
W-33	W-P-74 W-P-75 W-P-76 W-P-77	North Zone Modifications	Install 1000 feet of 24-inch pipeline from BS#3 to the North Pressure Zone, Rehab 3 Pressure Reducing Stations (PRS), modify minor piping	Pressure Zone Separation	2027	4	$1,100,000	$0	$0	$0	$1,100,000	$0
W-34	W-P-78 W-P-79 W-P-80 W-P-81	Coast Zone Modifications	Install 3000 feet of 8-inch pipeline, construct 3 new Pressure Reducing Stations (PRS), modify minor piping	Pressure Zone Separation	2027	4	$1,600,000	$0	$0	$0	$1,600,000	$0
W-35	W-P-82 W-P-83 W-P-84 W-P-85	South Zone Modifications	Install 6000 feet of 8-inch pipeline, construct 3 new Pressure Reducing Stations (PRS), modify minor piping	Pressure Zone Separation	2027	3	$2,400,000	$0	$0	$0	$2,400,000	$0
				2017 Potable Water System CIP Subtotal			**$108,960,000**	**$3,175,000**	**$3,9876,000**	**$5,4304,000**	**$11,605,000**	**$0**

Project ID 2017	Project ID 2015	Project Name	Project Description	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
Additional 2015 Projects												
	W-P-1	Electrical Rehabilitation - Well Nos. 30, 32, 33 & 34		Operations Optimization	2026	1.5	$1,000,000	$0	$0	$666,667	$333,333	$0
	W-P-2	Sodium Hypochlorite Piping Replacement		Operations Optimization	2022	1.5	$30,000	$0	$0	$30,000	$0	$0
	W-P-4	Generator and ATS Service		Operations Optimization	2019	1.5	$20,000	$0	$20,000	$0	$0	$0
	W-P-16	Fire Flow Improvements - Install/Replace 18,500 feet of 8" pipe		R&R	2020	2	$4,600,000	$0	$4,600,000	$0	$0	$0
	W-P-17	Fire Flow Improvements - Install/Replace 13,500 feet of 12" pipe		R&R	2020	2	$4,400,000	$0	$4,400,000	$0	$0	$0
	W-P-18	Fire Flow Improvements - Install 250 feet of 14" pipe		R&R	2020	1	$100,000	$0	$100,000	$0	$0	$0
	W-P-64	Blend Station Tie-In (@ Blending Station 1/6)		Water Supply	2022	1	$250,000	$0	$0	$250,000	$0	$0
	W-P-60	Construct new concentrate line from Oxnard Wastewater Treatment Plant (OWTP) to Blending Station 1/6		Water Supply	2020	3	$18,800,000	$0	$12,533,333	$6,266,667	$0	$0
	W-P-28	Blending Station 1/6 - Install electrical isolation at all steel and cast iron water risers		R&R	2022	2	$30,000	$0	$0	$30,000	$0	$0
	W-P-30	Well 23 & 31 Rehabilitation		R&R	2022	1.5	$210,000	$0	$0	$210,000	$0	$0
	W-P-31	Wells Electrical & Variable Frequency Drive (VFD) Replacement		R&R	2022	1.5	$770,000	$0	$0	$770,000	$0	$0
	W-P-41	Age Replacement- 109,100 feet of 6" pipe		R&R	2033	2	$25,500,000	$0	$0	$0	$0	$25,500,000
	W-P-42	Age Replacement - 47,000 feet of 8" pipe		R&R	2034	2	$11,700,000	$0	$0	$0	$0	$11,700,000
	W-P-43	Age Replacement - 55,000 feet of 10" pipe		R&R	2035	2	$17,100,000	$0	$0	$0	$0	$17,100,000
	W-P-44	Age Replacement - 24,000 feet of 12" pipe		R&R	2036	2	$7,900,000	$0	$0	$0	$0	$7,900,000
	W-P-45	Age Replacement - 2,300 feet of 14" pipe		R&R	2037	1	$900,000	$0	$0	$0	$0	$900,000
	W-P-46	Age Replacement - 4,000 feet of 16" pipe		R&R	2037	1	$1,700,000	$0	$0	$0	$0	$1,700,000
	W-P-47	Age Replacement - 3,700 feet of 24" pipe		R&R	2037	2	$2,300,000	$0	$0	$0	$0	$2,300,000

Project ID 2017	Project ID 2015	Project Name	Project Description	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
	W-P-48	Age Replacement - 5,000 feet of 36" pipe		R&R	2038	2	$3,900,000	$0	$0	$0	$0	$3,900,000
	W-P-49**	Age Replacement - 5,300 feet of 42" pipe		R&R	2038	2	$5,500,000	$0	$0	$0	$0	$5,500,000
	W-P-50**	Age Replacement - 3,800 feet of 48" pipe		R&R	2038	2	$4,100,000	$0	$0	$0	$0	$4,100,000
	W-P-55	Connection to OH / United pipeline		Water Supply	2020	1.5	$310,000	$0	$310,000	$0	$0	$0
	W-P-73	Expand desalter at Blending Station 1/6 to 15 mgd (3.75 mgd expansion)		Water Supply	2028	3	$7,300,000	$0	$0	$0	$7,300,000	$0
				Unmatched 2015 Water Projects Subtotal			**$118,420,000**	**$0**	**$21,963,333**	**$8,223,333**	**$7,633,333**	**$80,600,000**
						Overall Total	**$227,380,000**	**$3,175,000**	**$61,839,333**	**$62,527,333**	**$19,238,333**	**$80,600,000**

Notes:
1. Projects W-25 through @-28 combined into single project ID'ed as W-25.
2. Project start years correspond to refinements and updates provided by City after December 2015 publication date.

Table B2 Wastewater Collection System and Treatment System Capital Improvements Program (CIP) Projects

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
Wastewater Collection System Projects													
C-1	WW-P-6		Central Trunk Manhole Rehabilitation Phase 1	Rehabilitate 47 existing manholes	R&R	2018	1	**$1,410,000**	$1,410,000	$0	$0	$0	$0
C-2	WW-P-13		Central Trunk Manhole Rehabilitation Phase 2[2]	Rehabilitate 27 existing manholes	R&R	2020	1	**$810,000**	$0	$810,000	$0	$0	$0
C-3	WW-P-8		Harbor Blvd Manhole Rehabilitation	Rehabilitate 12 existing manholes	R&R	2019	1	**$100,000**	$0	$100,000	$0	$0	$0
C-4			Pleasant Valley Manhole Rehabilitation	Rehabilitate 14 existing manholes	R&R	2019	1	**$200,000**	$0	$200,000	$0	$0	$0
C-5	WW-P-9		Redwood Tributary Manhole Rehabilitation	Rehabilitate 38 existing manholes	R&R	2019	1	**$300,000**	$0	$300,000	$0	$0	$0
C-6			Annual Existing Manhole Rehabilitation	Various locations throughout the City based on sewer inspection	R&R	2022	5	**$1,000,000**	$0	$0	$1,000,000	$0	$0
C-7	WW-P-16		Rice Avenue Sewer Improvement	Install new 24-inch sewer from Latigo to Camino Del Sol to replace existing 18-inch sewer line.	R&R	2020	2	**$1,300,000**	$0	$1,300,000	$0	$0	$0
C-8	WW-P-1		Existing Sewer Deficient Capacity Replacement	Ventura Road from Doris Avenue to Oxnard Airport	Capacity	2020	2	**$1,755,197**	$0	$1,755,197	$0	$0	$0
C-9	WW-P-2		Existing Sewer Deficient Capacity Replacement	Third Street & Navarro Street	Capacity	2021	1	**$364,869**	$0	$364,869	$0	$0	$0
C-10	WW-P-7		Existing asbestos concrete pipe (ACP) Replacement	Various locations throughout the City	R&R	2019	8	**$4,000,000**	$0	$1,500,000	$2,500,000	$0	$0
C-11			Annual Existing Pipe Repair	Various locations throughout the City based on sewer inspection	R&R	2019	8	**$1,600,000**	$0	$600,000	$1,000,000	$0	$0
C-12			Collection System Chemical Addition	Construct 3 new magnesium hydroxide addition facilities to reduce nuisance odors and protect sewer infrastructure	Performance	2019	2	**$4,400,000**	$0	$4,400,000	$0	$0	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
C-13	WW-P-10 WW-P-18		Devco Development Lift Station	Construct new lift station at Devco development & abandon existing lift station #23. The new lift station will accommodate sewer flows from existing lift station #23, Devco, Village (Wagon Wheel) developments. The lift station cost is $1,500,000 & the City cost is $500,000.	R&R, Performance	2019	1	**$500,000**	$0	$500,000	$0	$0	$0
C-14	WW-P-12		Existing Lift Station #4 (Mandalay & Wooley) Rehabilitation	Install new supervisory control and data acquisition (SCADA) & motor control center (MCC) panels. Install new valve vault door. Rehabilitate wet well coating.	R&R	2019	1	**$500,000**	$0	$500,000	$0	$0	$0
C-15	WW-P-11		Existing Lift Station #6 (Canal) Rehabilitation	Install new pumps. Replace MCC panel. Install new emergency standby generator.	R&R	2019	1	**$500,000**	$0	$500,000	$0	$0	$0
C-16			Existing Lift Station #20 (Beardsley) Rehabilitation	Install new MCC panel and concrete pad.	R&R	2019	1	**$300,000**	$0	$300,000	$0	$0	$0
C-17	WW-P-5		Meter Vault/Vortex Structure Coating Rehabilitation[2]	Rehabilitate coating in meter vault/vortex structure	R&R	2018	1	**$280,000**	$280,000	$0	$0	$0	$0
Additional Wastewater Collection System Projects from 2015 Capital Improvements Program													
	WW-P-3		Project 3: S Victoria Ave and W Hemlock St - Sewers in the Channel Islands Neighborhood		Capacity	2027*	2	**$1,112,267**	$0	$0	$0	$1,112,267	$0
	WW-P-14		Phase 1 Central Trunk replacement		R&R	2033**	2	**$36,500,000**	$0	$0	$0	$0	$36,500,000
	WW-P-15		Phase 2 Central Trunk Replacement		R&R	2036**	2	**$30,000,000**	$0	$0	$0	$0	$30,000,000
					Wastewater Collection System Total			**$86,932,333**	**$1,690,000**	**$13,130,066**	**$4,500,000**	**$1,112,267**	**$66,500,000**

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
Wastewater Treatment System Projects													
--			Accelerated design for renewal improvements (year 6-10)			2018	6	**$15,130,000**	$1,500,000	$86,360,000	$5,000,000		
			Preliminary Treatment/Headworks										
T-1	WW-P-83		Headworks Odor Control System[2]	Install new odor control dampers and fan. Repair existing foul air ductwork.	Small Equipment Replacement	2018	1	**$220,000**	$220,000	$0	$0	$0	$0
T-2	WW-P-67		Headworks Fiberglass Covers Replacement & Concrete Coating Repair[2]	Install new grit chamber & wet well fiberglass covers. Rehabilitate grit chamber & wet well concrete coating. Year 1 to 2: high foot traffic areas. Year 3 to 5: remaining areas.	R&R	2018	2	**$499,100**	$90,000	$409,100	$0	$0	$0
T-3	WW-P-66		Headworks Rehabilitation[2]	Install new odor control system. Enclose bar screen & conveyor areas to minimize odor complaints. Install screen wall along north and west property areas. In 2011, City settled $4.6M lawsuit related to Headworks construction and nuisance odor complaints.	R&R	2020	2	**$7,250,000**	$0	$7,250,000	$0	$0	$0
T-4	WW-P-41		Non-hazardous Waste Receiving Station	New non-hazardous waste receiving station with metering and screening systems	Performance	2026	1	**$2,100,000**	$0	$0	$ 2,100,000	$0	$0
			Primary Treatment										
T-5			Primary Clarifier Rehabilitation	Install new effluent launders. New primary clarifier #4 walkway. Install polymer addition system to improvement primary treatment efficiency.	R&R	2017	1	**$655,000**	$655,000	$0	$0	$0	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
T-6			Primary Clarifier Abandonment	Abandon existing primary clarifiers. Repurpose a portion existing secondary sedimentation tanks as primary clarifiers. Convert remaining secondary sedimentation tanks to membrane bioreactors (MBR).	R&R	N/A	0	**$0**	$0	$0	$0	$0	$0
T-7	WW-P-23		Primary Clarifiers, Old Headworks Structure and Primary Building Demolition[2]	Remove equipment, concrete, piping and electrical systems in old headworks and primary tanks area. Reroute piping and electrical systems	R&R	2025	1	**$7,300,000**	$0	$0	$7,300,000	$0	$0
			Secondary Treatment										
T-8			Biotowers Rehabilitation	Install wire wrap or mesh around biotowers to prevent block wall from falling.	R&R	2017	1	**$630,000**	$630,000	$0	$0	$0	$0
T-9	WW-P-20		Biotower Demolition[2]	Remove superstructure, remove concrete below ground, reroute piping and electrical; restore grade	R&R	2023	1	**$2,850,000**	$0	$0	$2,850,000	$0	$0
T-10	WW-P-69		Activated Sludge Tank (AST) Rehabilitation[2]	Install new air flow meters, air control valves, and dissolved oxygen meters.	R&R	2017	1	**$150,000**	$150,000	$0	$0	$0	$0
T-11	WW-P-72 WW-P-74 WW-P-76		Activated Sludge Tank (AST) Upgrades	Replace diffusers and add return sludge piping, aeration piping, gates and controls	R&R, Performance	2023	1	**$4,600,000**	$0	$0	$4,600,000	$0	$0
T-12	WW-P-72		Modify Activated Sludge Tank (AST) for MBR or other technology operation	Partition Tanks, add internal recycle system	Performance	2023	2	**$7,200,000**	$0	$0	$7,200,000	$0	$0
T-13	WW-P-68 WW-P-72		Convert Activated Sludge Tanks conversion to Flow Equalization Tank	Convert existing AST 4 to 8. Remove diffusers and add flow equalization pumps. Concrete repair and	R&R, Performance	2024	1	**$5,525,000**	$0	$0	$5,525,000	$0	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
				seismic retrofit - EQ Tank									
T-14	WW-P-70 WW-P-73		Convert Secondary Clarifiers to Primary Clarifiers	Convert existing secondary clarifiers 6 to 12. Install clarifier mechanisms, replace primary sludge pumps, isolation gates and scum systems. Replace collectors, skimmers, and drives. Concrete repair and re-painting - SSTs.	R&R	2025	1	**$8,300,000**	$0	$0	$8,300,000	$0	$0
T-15			Remove existing Secondary Clarifiers and prepare for new Membrane Bioreactor (MBR) or other Technology	Demolish existing secondary clarifiers 13 to 18. Remove equipment, re-route piping and electrical, reinforce walls of aeration basin, modify inlet and outlet channels	R&R	2023	2	**$7,150,000**	$0	$0	$7,150,000	$0	$0
T-16	WW-P-75 WW-P-97		New MBR or other technology Tanks	Construct new tanks, channels, membranes and piping, pump gallery, pumps, cranes, roof and ventilation systems, aeration blowers	R&R, Resource Sustainability	2023	2	**$57,200,000**	$0	$0	$57,200,000	$0	$0
T-17	WW-P-97		MBR or other Technology Building	New Chemical systems, electrical room, SCADA system, effluent pumps	Resource Sustainability	2023	2	**$12,350,000**	$0	$0	$12,350,000	$0	$0
T-18			Convert Existing Secondary Clarifier to Screening & Transfer Pump Station	Install screen channels for primary effluent, convert to flow equalization basin, add transfer pumping and pipes	R&R	2024	1	**$7,150,000**	$0	$0	$7,150,000	$0	$0
T-19	WW-P-96 WW-P-80 WW-P-81		Disinfection and Effluent Pumping	New Disinfection system, effluent wet well and pumps	Small Equipment Replacement, R&R	2024	1	**$7,215,000**	$0	$0	$7,215,000	$0	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
T-20			Relocate Existing Primary Influent Piping	Connect to main header and re-route to influent channel of clarifiers. Provide controls and valves	R&R	2024	1	**$3,510,000**	$0	$0	$3,510,000	$0	$0
Solids Treatment													
T-21	WW-P-44 WW-P-45 WW-P-51		Sludge Thickening Facility[2]	Demolish Dissolved Air Flotation Tank (DAFT) structures, gravity thickener tanks and chemical storage. New building with Rotating Drum Screens for primary sludge and Gravity Belt thickeners for waste secondary sludge	R&R, Performance	2026	1	**$24,700,000**	$0	$0	$24,700,000	$0	$0
T-22	WW-P-43		Digester 2 Cover Replacement and Clean Digesters 1 & 3[2]	Install digester 2 cover and clean digester 1 and 3.	R&R	2019	3	**$3,700,000**	$0	$3,700,000	$0	$0	$0
T-23	WW-P-87 WW-P-89		Digesters 1 and 3 Rehabilitation[2]	Replacement of mixing systems, roof and concrete walls repair; heat exchanger upgrades	R&R	2025	2	**$8,500,000**	$0	$0	$8,500,000	$0	$0
T-24	WW-P-40		Replace Belt Filter Presses & Conveyor	Year 1 to 2: Replace two existing belt filter presses. Year 3 to 5: Replace two existing belt filter presses and conveyor.	R&R	2017	4	**$2,610,000**	$1,180,000	$1,430,000	$0	$0	$0
T-25	WW-P-94		FOG Receiving Station[2]	Fats Oils Grease receiving station with tank heaters and pumps, for transfer to digesters	Resource Sustainability	2026	1	**$845,000**	$0	$0	$845,000	$0	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
Pump Station													
T-26	WW-P-22		Interstage Pump Station Rehabilitation[2]	Install new pumps, motors, variable frequency drives. Rehabilitate wet well concrete coating. Upgrade control facility to meet building seismic code.	R&R	2020	2	**$2,087,199**	$0	$2,087,199	$0	$0	$0
T-27			Effluent Pump Station Rehabilitation	Install new isolation valve, pumps, motors, variable frequency drives. Rehabilitate wet well concrete coating. Install bypass piping. Upgrade control facility to meet building seismic code.	R&R	2019	3	**$8,900,000**	$0	$8,900,000	$0	$0	$0
Electrical/Instrumentation													
T-28			Electrical Building ARC Flash Protection	Install temporary 25kV circuit breakers on each side of 16kV and 480 volt transformers.	Performance	2017	2	**$575,000**	$575,000	$0	$0	$0	$0
T-29	WW-P-93		Cogenerators Rehabilitation[2]	Year 1 to 2: Rebuild two existing cogenerators. Year 3 to 5: Rebuild one existing cogenerator.	R&R	2017	3	**$1,215,000**	$810,000	$405,000	$0	$0	$0
T-30	WW-P-32		Electrical/Instrumentation Manhole Rehabilitation	Rehabilitate seven existing electrical and instrumentation manholes.	R&R	2017	1	**$175,000**	$175,000	$0	$0	$0	$0
T-31	WW-P-33		Emergency Standby Generator Replacement[2]	Install new emergency standby generator	R&R	2020	2	**$5,000,000**	$0	$5,000,000	$0	$0	$0
T-32	WW-P-34		Plant Motor Control Center (MCC) Panel Replacement[2]	Install new MCC panels	R&R	2020	2	**$2,087,199**	$0	$2,087,199	$0	$0	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
T-33	WW-P-30 WW-P-31		New Main Electrical Building[2]	New Building; new transformers; reroute electrical duct banks and run new cabling; new Automatic transfer switches; demolish old electrical building and equipment, and restore grade.	R&R	2020	2	**$6,000,000**	$0	$6,000,000	$0	$0	$0
T-34	WW-P-59		New North Electrical Building	New Building; new Motor Control Centers	R&R	2024	2	**$4,400,000**	$0	$0	$4,400,000	$0	$0
T-35			Site Electrical Improvements	Install cables, duct banks, and wiring	R&R	2024	3	**$10,920,000**	$0	$0	$10,920,000	$0	$0
T-36	WW-P-39		Computerized Maintenance Management System (CMMS)	Install new CMMS system for plant maintenance record keeping, including work scheduling, equipment records keeping, labor hours, and costs.	R&R	2017	1	**$300,000**	$300,000	$0	$0	$0	$0
T-37	WW-P-35		Supervisory Control and Data Acquisition and (SCADA) System	Temporary convert existing fiber network to Ethernet to prevent SCADA drop-out.	R&R	2017	1	**$225,000**	$225,000	$0	$0	$0	$0
T-38	WW-P-35		New SCADA System	Install new SCADA system	R&R	2020	2	**$4,946,500**	$0	$4,946,500	$0	$0	$0
T-39	WW-P-35		New Supervisory Control and Data Acquisition (SCADA) system	Replace plant-wide SCADA systems and PLCs with current technology. Reprogram all processes for new Plant Control System	R&R	2024	2	**$9,620,000**	$0	$0	$9,620,000	$0	$0
			Site Work										
T-40	WW-P-42		Site Piping Replacements	Install new process water piping, buried valves, fire line.	R&R	2020	5	**$23,970,000**	$0	$1,350,000	$22,620,000	$0	$0
T-41			Site Security	Install site cameras, security fencing, building locks	R&R	2019	2	**$1,000,000**	$0	$1,000,000	$0	$0	$0
T-42			Storm water Site Improvements		R&R	2019	3	**$2,100,000**	$0	$2,100,000	$0	$0	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
Building													
T-43			Laboratory HVAC Unit	Install new 20-ton HVAC unit.		2017	1	**$205,000**	$205,000	$0	$0	$0	$0
T-44	WW-P-57		New Chemical Storage Building[2]	Demolish old structures, Centralized chemical storage, new storage tanks, pumps and piping to various processes	R&R	2026	1	**$2,730,000**	$0	$0	$2,730,000	$0	$0
T-45	WW-P-56		Collection System Maintenance Building Rehabilitation[2]	Rehabilitate existing building to meet building code requirements.	R&R	2026	1	**$500,000**	$0	$0	$500,000	$0	$0
T-46	WW-P-49		Administration Building and Laboratory Rehabilitation[2]	Rehabilitate existing building to meet building code requirements.	R&R	2025	1	**$850,000**	$0	$0	$850,000	$0	$0
T-47			Plant Control Center Building Rehabilitation	Rehabilitate existing building to meet building code requirements.	R&R	2025	1	**$850,000**	$0	$0	$850,000	$0	$0
T-48	WW-P-58		Maintenance Building Rehabilitation	Rehabilitate existing building to meet building code requirements.	R&R	2026	1	**$500,000**	$0	$0	$500,000	$0	$0
T-49	WW-P-27 WW-P-28		Storage Warehouse Building	New storage warehouse building	R&R	2026	1	**$1,500,000**	$0	$0	$1,500,000	$0	$0
Additional Wastewater Projects from 2015 Capital Improvements Program													
	WW-P-84	Preliminary Treatment	Small Equipment Replacement - Headworks 2		Small Equipment Replacement	2023*	3	**$6,306,000**	$0	$0	$6,306,000	$0	$0
	WW-P-21	Secondary Treatment	Add Baffle Walls in ASTs		R&R	2027*	1	**$380,000**	$0	$0	$0	$380,000	$0
	WW-P-95	Secondary Treatment	Coating Replacement on Chlorine Contact Tanks		R&R	2028*	2	**$1,359,000**	$0	$0	$0	$1,359,000	$0
	WW-P-79	Secondary Treatment	Small Equipment Replacement - wet weather storage 2		Small Equipment Replacement	2026*	3	**$527,000**	$0	$0	$175,667	$351,333	$0
	WW-P-98	Secondary Treatment	Add UV/AOP after MBR		Resource Sustainability	2026*	2	**$13,200,000**	$0	$0	$6,600,000	$6,600,000	$0
	WW-P-46	Solids Treatment	Demolish Operations Center and Vac Filter Building		R&R	2027*	1	**$448,000**	$0	$0	$0	$448,000	$0

Project ID 2017	Project ID 2015	Unit Operation	Project Name	Project Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY2017/18-2018/19)	Years 3 to 5 (FY2019/20-2021/22)-	Years 6 to 10 (FY2022/23-2026/27)	Years 11 to 16 (FY2027/28-2032/33	Years 17 to 23 (FY20363/34-2039/40)
	WW-P-88	Solids Treatment	New Digester 2		R&R	2030*	3	**$12,950,000**	$0	$0	$0	$12,950,000	$0
	WW-P-90	Solids Treatment	New Digester Control Building		R&R	2029*	5	**$1,543,000**	$0	$0	$0	$1,234,400	$308,600
	WW-P-47	Solids Treatment	Move Dewatering Facility and add New Centrifuges		Performance	2030*	3	**$23,370,000**	$0	$0	$0	$23,370,000	$0
	WW-P-48	Solids Treatment	Add Dewatering Capacity		Performance	2030*	3	**$2,160,000**	$0	$0	$0	$2,160,000	$0
	WW-P-50	Solids Treatment	Add Sludge Silos		Performance	2032*	3	**$6,370,000**	$0	$0	$0	$2,123,333	$4,246,667
	WW-P-91	Electrical / Instrumentation	New Cogen Building		R&R	2032*	3	**$4,630,000**	$0	$0	$0	$1,543,333	$3,086,667
	WW-P-36	Electrical / Instrumentation	Small Equipment Replacement - Electrical 1		Small Equipment Replacement	2028*	2	**$275,000**	$0	$0	$0	$275,000	$0
	WW-P-37	Electrical / Instrumentation	Small Equipment Replacement - Electrical 2		Small Equipment Replacement	2032*	2	**$626,000**	$0	$0	$0	$313,000	$313,000
	WW-P-38	Electrical / Instrumentation	Small Equipment Replacement - Electrical 3		Small Equipment Replacement	2036*	2	**$653,000**	$0	$0	$0	$0	$653,000
	WW-P-92	Electrical / Instrumentation	Small Equipment Replacement - Cogen		Small Equipment Replacement	2026*	3	**$2,233,000**	$0	$0	$744,333	$1,488,667	$0
	WW-P-60	Building	Rehab Grit Screening Building - Seismic Retrofit		R&R	2027*	2	**$1,866,000**	$0	$0	$0	$1,866,000	$0
	WW-P-65	Building	Plant Paving Resurfacing		R&R	2030*	3	**$410,000**	$0	$0	$0	$410,000	$0
	WW-P-99	Building	Solar or Alternative Energy Facility		Resource Sustainability	2027*	10	**$1,540,000**	$0	$0	$0	$924,000	$616,000
	WW-P-100		Seawall		Resource Sustainability	2033	5	**$37,260,000**		$0	$0	$0	$37,260,000
						Wastewater Treatment Total		**$406,100,998**	**$6,715,000**	**$55,294,998**	**$239,811,000**	**$57,796,067**	**$46,483,933**
						Wastewater Treatment System and Collection System Total		**$493,033,331**	**$8,405,000**	**$68,425,064**	**$244,311,000**	**$58,908,334**	**$112,983,933**

Notes:
1. 2017 Project ID's were arbitrarily assigned for Project ease. C = Collection System Project; T = Treatment System Project.
2. Projects and costs correspond to refinements and updates provided by City after December 2015 publication date. Costs may not correspond to project costs in PM 1.4 Basis of Cost.
3. Projects approved by Council in 2017 Cost of Service Rate studies.
4. Costs were equally split between years to implement.

*Projects start year correspond to refinements and updates provided by City after December 2015 publication date.
**Projects start year was adjusted by City at August 7, 2017 meeting, based on recent CCT inspection.

Table B3 Recycled Water Capital Improvements Program (CIP) Projects

Project ID	Project Name	Driver	Start Year[1]	Years to Implement	Total	Years 1 to 2 (FY2017/18-2018/19)[2]	Years 3 to 5 (FY2019/20-2021/22)[2]	Years 6 to 10 (FY2022/23-2026/27)[2]	Years 11 to 16 (FY2027/28-2032/33[2]	Years 17 to 23 (FY20363/34-2039/40)[2]
RW-P-1	Recycled Water Retrofits	R&R	2019	6	$4,000,000	$0	$2,000,000	$2,000,000	$0	$0
RW-P-2	Phase 1 Advanced Water Purification Facility (AWPF) Improvements (Disinfection conversion, security, A/V upgrade)	R&R	2020	2	$1.000,000	$0	$1,000,000	$0	$0	$0
RW-P-3	UV/Advanced Oxidation Process Brine Treatment	Water Supply	2023	3	$5,700,000	$0	$0	$5,700,000	$0	$0
RW-P-4	Construct Aquifer Storage and Recovery (ASR) Demonstration Well @ Campus Park Site (and associated monitoring wells)	Water Supply	2018	3	$4,400,000	$1,466,667	$2,933,333	$0	$0	$0
RW-P-5	Land Acquisition and Improvements - Near Blending Station 1/6 & 3	Water Supply	2020	2	$10,000,000	$0	$10,000,000	$0	$0	$0
RW-P-6	Recycled Water Pond for Off-Spec Water at Campus Park	Water Supply	2021	1.5	$1,600,000	$0	$1,066,667	$533,333	$0	$0
RW-P-7	Phase 2 - Expansion of AWPF to 12.5 mgd (including backup power)	Water Supply	2020	3	$27,500,000	$0	$18,333,333	$9,166,667	$0	$0
RW-P-8	Recycled Water Storage @ AWPF	Water Supply	2019	4	$8,000,000	$0	$6,000,000	$2,000,000	$0	$0
RW-P-9	Construct 1 duty + 1 standby ASR Wells @ Campus Park	Water Supply	2021	3	$7,800,000	$0	$2,600,000	$5,200,000	$0	$0
RW-P-10	Construct 1 duty + 1 standby ASR Wells @ Campus Park	Water Supply	2025	3	$7,800,000	$0	$0	$5,200,000	$2,600,000	$0
RW-P-11	Construct 1 duty + 1 standby ASR Wells @ Blending Station 1/6	Water Supply	2022	2	$7,800,000	$0	$0	$7,800,000	$0	$0
RW-P-12	Chemical Feed Expansion @ Blending Station 1/6	Water Supply	2022	2	$ 300,000	$0	$0	$300,000	$0	$0
RW-P-13	Operational Storage for ASR Wells @ Blending Station 1/6	Water Supply	2022	2	$2,100,000	$0	$0	$2,100,000	$0	$0
RW-P-14	Booster Pumping for ASR @ Blending Station 1/6	Water Supply	2022	2	$7,200,000	$0	$0	$7,200,000	$0	$0
RW-P-15	Construct 1 duty + 1 standby ASR Wells @ Blending Station 1/6	Water Supply	2024	1.5	$7,800,000	$0	$0	$7,800,000	$0	$0
RW-P-16	Rehabilitate Well 18 @ River Ridge Golf Course to Groundwater Recharge Well	Water Supply	2022	2	$2,500,000	$0	$0	$2,500,000	$0	$0
RW-P-17	Phase 3 - Expand AWPF to 18.75 mgd	Water Supply	2029	2.5	$28,100,000	$0	$0	$0	$28,100,000	$0
RW-P-18	Construct 2 duty + 1 standby ASR Wells @ Blending Station 1/6	Water Supply	2029	2	$11,500,000	$0	$0	$0	$11,500,000	$0
RW-P-19	Construct 2 duty + 1 standby ASR Wells @ Blending Station 3	Water Supply	2029	2.5	$11,500,000	$0	$0	$0	$11,500,000	$0
RW-P-20	Chemical Feed Expansion @ Blending Station 3	Water Supply	2029	2.5	$ 500,000	$0	$0	$0	$500,000	$0
RW-P-21	Operational Storage for ASR Wells @ Blending Station 3	Water Supply	2029	2.5	$2,100,000	$0	$0	$0	$2,100,000	$0
RW-P-22	Booster Pumping for ASR @ Blending Station 3	Water Supply	2029	2.5	$7,200,000	$0	$0	$0	$7,200,000	$0
RW-P-23	Construct 2 duty + 1 standby ASR Wells @ Blending Station 3	Water Supply	2031	1.5	$11,500,000	$0	$0	$0	$11,500,000	$0
RW-P-24	Connect Initial ASR Well at Campus Park to Recycled Water Backbone Line in Ventura Road - 2,000 feet of 20" pipe	Water Supply	2017	2	$700,000	$700,000	$0	$0	$0	$0
RW-P-25	Construct Dedicated Indirect Potable Reuse (IPR) Pipeline from Campus Park to Blending Station 1/6 - 4,000 feet of 24" pipe	Water Supply	2017	2	$2,500,000	$2,500,000	$0	$0	$0	$0
	Hueneme Road - Phase 2 Recycled Water Pipeline Expansion to Ag Users					$0	$0	$0	$0	$0
RW-P-26	Install 20,700 feet of 24" pipe	Water Supply	2019	2	$12,900,000	$0	$12,900,000	$0	$0	$0
RW-P-27	Install 16,000 feet of 36" pipe	Water Supply	2018	2	$13,000,000	$6,500,000	$6,500,000	$0	$0	$0
	Recycled Water Loop to ASR Sites					$0	$0	$0	$0	$0
RW-P-28	Install 9,000 feet of 24" pipe	Water Supply	2020	2	$7,500,000	$0	$7,500,000	$0	$0	$0
RW-P-29	Install 19,700 feet of 30" pipe	Water Supply	2020	2	$10,200,000	$0	$10,200,000	$0	$0	$0
RW-P-30	Direct Potable Reuse - 3, 3.1 million gallon Storage Tanks	Water Supply	2036	3	$22,200,000	$0	$0	$0	$0	$22,200,000
RW-P-31	Recycled Water Loop to Blending Station 3 Connection – Install 10,600 feet of 24" pipe	Water Supply	2029	1	$5,500,000	$0	$0	$0	$5,500,000	$0
	Recycled Water Capital Improvements Program Projects Total				$252,400,000	$11,166,667	$81,033,333	$57,500,000	80500000	$22,200,000

Notes:
1. Project start years adjusted with City input and do not correspond to December 2015 publication start years.
2. Costs were equally split between years to implement.

Table B4 Stormwater Capital Improvements Program (CIP) Projects

Project ID	Project Name	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY2017/18-2018/19)(1)	Years 3 to 5 (FY2019/20-2021/22)(1)	Years 6 to 10 (FY2022/23-2026/27)(1)	Years 11 to 16 (FY2027/28-2032/33)(1)	Years 17 to 23 (FY20363/34-2039/40)(1)
SW-P-1	Drainage Basin: WV - Length 444 ft	Capacity	2020(2)	2	$173,000	$0	$173,000	$0	$0	$0
SW-P-2	Drainage Basin: WV - Length 748 ft	Capacity	2038	2	$439,000	$0	$0	$0	$0	$439,000
SW-P-3	Drainage Basin: OI - Length 607 ft	Capacity	2020(2)	2	$237,000	$0	$237,000	$0	$0	$0
SW-P-4	Drainage Basin: RR - Length 2,436 ft	Capacity	2020(3)	2	$2,621,000	$0	$2,621,000	$0	$0	$0
SW-P-5	Drainage Basin: OI - Length 2,388 ft	Capacity	2038	2	$1,491,000	$0	$0	$0	$0	$1,491,000
SW-P-6	Drainage Basin: VR - Length 5,872 ft	Capacity	2018(2)	2	$5,768,000	$2,884,000	$2,884,000	$0	$0	$0
SW-P-7	Drainage Basin: JS - Length 1,421 ft	Capacity	2018(2)	2	$968,000	$484,000	$484,000	$0	$0	$0
SW-P-8	Drainage Basin: JS - Length 1,292 ft	Capacity	2020(2)	2	$885,000	$0	$885,000	$0	$0	$0
SW-P-9	Drainage Basin: JS - Length 426 ft	Capacity	2020(2)	2	$292,000	$0	$292,000	$0	$0	$0
SW-P-10	Drainage Basin: JS - Length 457 ft	Capacity	2020(2)	2	$313,000	$0	$313,000	$0	$0	$0
SW-P-11	Drainage Basin: JS - Length 655 ft	Capacity	2020(2)	2	$449,000	$0	$449,000	$0	$0	$0
SW-P-12	Drainage Basin: JS - Length 701 ft	Capacity	2020(2)	2	$480,000	$0	$480,000	$0	$0	$0
SW-P-13	Drainage Basin: HS - Length 1,552 ft	Capacity	2020(2)	2	$606,000	$0	$606,000	$0	$0	$0
SW-P-14	22 assets identified in the condition assessment	R&R	2018(2)	2	$3,324,000	$1,662,000	$1,662,000	$0	$0	$0
SW-P-15	Dry Weather Diversion Structure	Resource Sustainability	2021	3	$370,000	$0	$123,333	$246,667	$0	$0
SW-P-16	City-Wide Incentive Program	Resource Sustainability	2021	10	$2,420,000	$0	$242,000	$1,210,000	$968,000	$0
SW-P-17	Santa Clara River Total Maximum Daily Load (TMDL) Infiltration Basin	Resource Sustainability	2023	5	$1,850,000	$0	$0	$1,480,000	$370,000	$0
SW-P-18(4)	Mandalay Beach Areas	Capacity	2018	3	$10,000,000	$3,333,333	$6,666,667	$0	$0	$0
	Stormwater Capital Improvements Program Projects Total				**$32,686,000**	**$8,363,333**	**$18,118,000**	**$2,936,667**	**$1,338,000**	**$1,930,000**

Notes:
1. Costs were equally split between years to implement.
2. Project start year moved two years later compared to 2015 Capital Improvements Program.
3. Project start year adjusted with City input and do not correspond to December 2015.
4. Project added by City after December 2015 version.

CITY OF OXNARD

PUBLIC WORKS

Integrated Master Plan

Summary Report

REVISED FINAL DRAFT • SEPTEMBER 2017

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PUBLIC WORKS INTEGRATED MASTER PLAN

SUMMARY REPORT

City of Oxnard

REVISED FINAL DRAFT – September 2017

This document is released for the purpose of information exchange review and planning only under the authority of Tracy Anne Clinton, State of California PE No. 48199 September 2017.

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CITY OF OXNARD
PUBLIC WORKS INTEGRATED MASTER PLAN

SUMMARY REPORT

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LIST OF ABBREVIATIONS

AA	Average Annual
AACE	Association for the Advancement of Cost Engineering
AAD	average annual demand
ADD	average day demand
ADMM	Average Day Maximum Month
ADW	average dry weather
ADWF	average dry weather flow
AFY	acre feet per year
APCD	Air Pollution Control District
ASR	aquifer storage and recovery
AST	activated sludge tanks
AWPF	Advanced Water Purification Facility
BFP	belt filter press
BMP	best management practices
BOD_5	biochemical oxygen demand
BS	blending stations
CalRecycle	California Department of Resources Recycling and Recovery
CASA	California Association of Sanitation Agencies
CASQA	California Stormwater Quality Association
CCR	California Code of Regulations
CCT	chlorine contact tanks
CEC	compound of emerging concern
CEPT	Chemically Enhanced Primary Treatment
CIP	Capital Improvement Project

City	City of Oxnard
CMMS	Computerized Maintenance Management System
CMWD	Calleguas Municipal Water District
COS	Cost of Service
CP	cathodic protection
CWA	Clean Water Act
CWT	Centralized Waste Treatment
CWTF	Centralized Wastewater Treatment Facilities
DAFT	dissolved air flotation thickeners
DDW	Division of Drinking Water
DPR	direct potable reuse
EPA	Environmental Protection Agency
FCGMA	Fox Canyon Groundwater Management Agency
GIS	Geographic Information System
GPCD	gallons per day per capita
gpd	gallons per day
GREAT	Groundwater Recovery Enhancement and Treatment
GW	ground water
IPR	indirect potable reuse
LARWQCB	Los Angeles Regional Water Quality Control Board
LGS	Local Government Schema
LOS	level of service
MBR	membrane bioreactors
MC	measurable criterion
MDD	maximum day demand
MDD	Maximum Day

MG	million gallon
mgd	million gallon per day
MinHD	minimum hour demand
MT	million tons
MW	Maximum Week
NBVC	Naval Base Ventura County
NPDES	National Pollutant Discharge Elimination Systems
O&M	Operations and Maintenance
OP	overarching principle
OWTP	Oxnard Wastewater Treatment Plant
pcd	per capita daily
PHD	peak hour demand
PHWA	Port Hueneme Water Agency
PHWWF	peak hour wet weather flow
POTW	publicly owned treatment works
ppb	parts per billion
ppd	pounds per day
psi	pounds per square inch
R&R	repair and replacement
ROWD	report of waste discharge
ROWD	reverse osmosis
RW	recycled water
RWQCB	Regional Water Quality Control Board
SCADA	Supervisory Control And Data Acquisition
SMP	Salinity Management Pipeline
SST	secondary sedimentation basins

SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TMDL	Total Maximum Daily Load
TSS	total suspended solids
UV/AOP	ultraviolet/advanced oxidation process
UV/AOP	ultraviolet light
UWCD	United Water Conservation District
VCWPD	Ventura County Watershed Protection District
VFD	Variable Frequency Drive
WAS	waste activated sludge
WDR	Waste Discharge Requirements

BRIEF HISTORY AND OVERVIEW OF THE CITY OF OXNARD PUBLIC WORKS DEPARTMENT'S INTEGRATED PLANNING EFFORTS

In May 2014, the City of Oxnard (City) Public Works Department began developing the Public Works Integrated Master Plan (PWIMP, or Plan). The Plan unfolded to address future planning needs for all major utilities within the City's jurisdiction: water, wastewater, recycled water, and stormwater. The Plan uses a coordinated methodology to allow the City to take full advantage of potential linkages and synergies among its four major water utility systems.

The Final Draft Plan was published in December 2015 as a seven-volume set of notebooks containing more than forty master planning Project Memorandums. This was followed shortly after in early 2016 with the publication of the Final Draft Master Plan Summary Report (April 2016), and the Final Draft Executive Summary Report (May 2016).

As typical in master planning, these initial planning reports were published as first drafts. This practice recognizes that the initial planning findings and reports are not considered 'final' until further environmental and financial studies are completed.

Consequently, these Final Draft master-planning documents served as the basis for the City to proceed with a Cost of Service Study to gain approval for the planned wastewater and water utility rate increases for the near-term capital projects, and to support a formal Proposition 218 process. The resulting Wastewater Treatment and Collection Cost of Service Study was approved in early 2017, and the Water Division Cost of Service Study was approved in Summer 2017.

Between the time of publication of the Final Draft master-planning documents in December 2015 and the final adoption of the Cost of Service Studies/Rates in early 2017, the City continued to review and to optimize the final master planning recommended policies, projects, and programs. Therefore, certain projects included in the Final Draft planning documents for the Oxnard Wastewater Treatment Plant (OWTP) have been refined and updated.

These refinements were made to incorporate the latest in recent findings from the advanced facilities planning conducted, in part, for the Cost of Service Studies, and as part of the preliminary designs proceeding concurrently for critically needed facilities. It should be noted that the refinements and optimizations were generally not related to capacity needs, but to achieve improved financial and implementation strategies, and to accommodate technology updates and global climate change strategies, as follows:

1. Project phasing and timing (but not for increased capacity), including: a phased primary treatment upgrade program, and a phased secondary treatment upgrade program.

2. Technology updates, including membrane bioreactors (MBR) to meet potential nutrient requirements, and to save costs related to advanced treatment for recycled water.
3. Global climate change, resiliency, and adaption projects to plan for increasing sea levels.

The Plan coordinates the need and timing of planned water utility facilities as related to the elements in the City's 2030 General Plan (and projections through 2030) with a forward projection through the year 2040. The recommended master planning projects, timing, and phased implementation are noted in the Capital Improvement Plan (CIP) for both the near-term projects (the next several years) as defined in the Cost of Service Studies, and the longer-term projects (extending through 2040) as defined in the Plan.

Further, the time horizon for the near-term CIP serves as the basis for the newly adopted rates, and does not extend to the end of the long-term planning period (thru 2040). This is in recognition of the flexible design and adaptive nature of the recommended Plan.

In summary, the refined and updated near-term projects that were identified and developed as part of the Cost of Service Studies were subsequently incorporated into the recommended Final Draft CIP and Master Plan. Nevertheless, it is the near-term CIP that is the basis for the newly adopted rates. The overall CIP and Master Plan recommended herein was developed by merging the related planning efforts: the Cost of Service Studies, the Preliminary Design of critically needed facilities, and the long-term master planning recommendations.

Chapter 1

INTRODUCTION

1.1 PROLOGUE

The City of Oxnard's (City) Public Works Department faces many challenges in managing its future water resources and utilities. These challenges include identifying the best response to immediate drought conditions while planning for long-term water needs, reducing dependence on costly imported water, addressing aging infrastructure and reliability concerns, pursuing aggressive goals for energy efficiency and sustainable solutions, and managing the ongoing loss of seasoned staff and personnel.

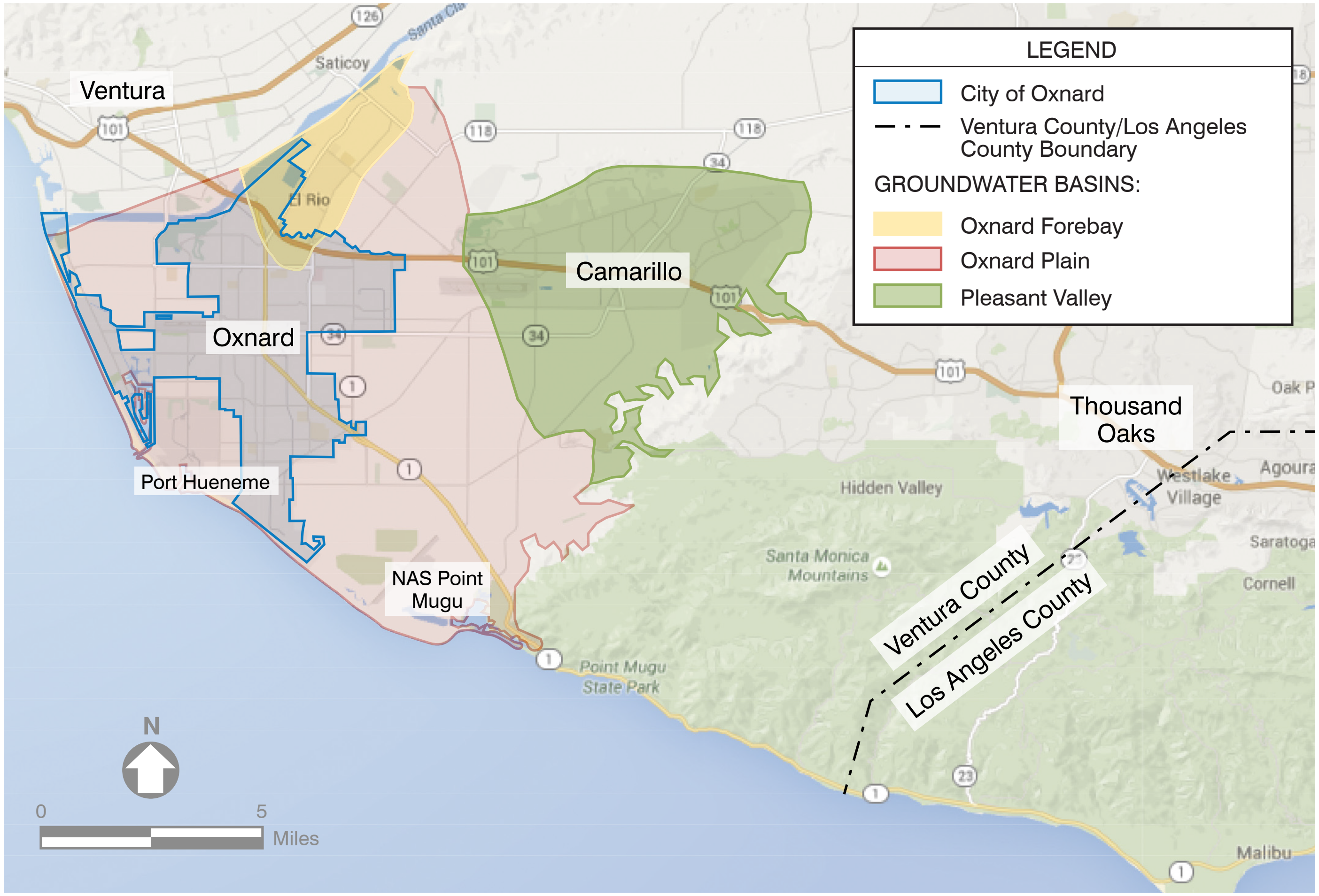
Opportunities to meet these challenges range from institutional and non-structural approaches (policies and programs) to technical and structural approaches (capital projects). Furthermore, because of the City's broad authority over utilities and streets, it has a unique opportunity to meet these challenges by optimizing both capital and operations and maintenance investments for all water utilities, street improvements, and other City infrastructure.

The City is located along the Pacific Ocean coastline in Southern California, just northwest of Los Angeles. Oxnard is the largest city in Ventura County and is at the center of a regional agricultural industry with a growing business center (see Figure 1.1). The City has jurisdictional authority to provide potable water, wastewater treatment, and stormwater services to its nearly 200,000 citizens and numerous industrial and commercial users.

To deliver these services, the City owns and operates the 31.7 million gallon per day (mgd) average dry weather (ADW) capacity Oxnard Wastewater Treatment Plant (OWTP), which discharges secondary treated effluent to the ocean. As part of the City's Groundwater Recovery Enhancement and Treatment (GREAT) program, the City also owns and operates a 6.25-mgd capacity Advanced Water Purification Facility (AWPF) that treats OWTP effluent for reuse throughout the City and region.

Given the City's challenges and opportunities to meet them, this Public Works Integrated Master Plan (Integrated Master Plan) develops long-term recommendations for policies, programs, and goals that successfully address the challenges and opportunities in a holistic and integrated way. In carrying out these goals, the Integrated Master Plan will help the City respond to planned population increase, challenges from new regulatory requirements, drought conditions, aging infrastructure, and reliability concerns.

In addition, the Integrated Master Plan documents the policy decisions, goals, and objectives to help protect public health while balancing the environmental, social, and financial impacts of the City's water resource management. This Plan also develops cost-effective strategies to address growth, regulatory compliance, environmental protection, and public and worker safety in ways that are consistent with the Plan's polices, goals, and objectives.



PROJECT AREA FOR INTEGRATED MASTER PLAN

FIGURE 1.1

CITY OF OXNARD
SUMMARY REPORT
PUBLIC WORKS INTEGRATED MASTER PLAN

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1.2 FACILITIES OVERVIEW

The City of Oxnard receives water by drawing it from the local Oxnard Plain groundwater basin and importing groundwater and surface water from United Water Conservation District (UWCD) and State Water Project via Calleguas Municipal Water District (CMWD), respectively. Before water enters the potable water distribution system, the City uses six blending stations throughout the City for hydraulic blending. One of these blending stations also treats the local groundwater for high levels of total dissolved solids (TDS).

In addition, the City owns and operates its own wastewater collection and treatment system, the OWTP, located on Perkins Road. Since its inception in the mid 1950’s, the OWTP has grown from a capacity of approximately 5 mgd to its current capacity of 31.7 mgd.

The OWTP includes raw sewage pumping, influent screening and grit removal, primary sedimentation, an activated sludge secondary treatment process, effluent disinfection, and solids handling consisting of thickening, anaerobic digestion, and dewatering. Final effluent is routed to the City's AWPF or conveyed to the Pacific Ocean and discharged offshore.

To produce recycled water, the City uses the AWPF facility, dedicated in 2012, as part of the City's GREAT program. The AWPF facility provides advanced treatment of secondary treated wastewater effluent for recycled water use.

At the GREAT program's inception in 2009, its objectives were to:

- Increase water supply reliability during drought.
- Reduce water supply costs.
- Protect the water supply while trying to meet a growing water demand.
- Enhance local water supply stewardship through recycling and reusing a substantial portion of the region’s wastewater.
- Maximize environmental benefits from developing and rehabilitating local saltwater wetlands.

Since the GREAT program's inception, the City shifted from its focus of using groundwater recharge as a sea water intrusion barrier to using the recycled water for an aquifer storage and recovery (ASR) operation. Because indirect potable reuse (IPR)/direct potable reuse (DPR) provides many benefits and is becoming more commonplace in the current regulatory climate, the City has renewed interest in it.

In addition to water, wastewater, and recycled water systems, the City operates a network of stormwater facilities consisting of collection piping and channels to convey stormwater to both the Santa Clara River and the ocean. Although Ventura County owns these facilities, the City maintains many of them.

1.3 MASTER PLAN PURPOSE AND DRIVERS

This Integrated Master Plan provides a phased program for constructing improvements to the City's infrastructure facilities that will accommodate planned growth while maintaining treatment reliability, meeting future regulatory requirements, and optimizing costs through the planning horizon (2040). Included with this document is the overall vision for the City's future infrastructure, the goals and objectives to achieve that vision, and an assessment of the City's existing facilities to meet those goals and objectives throughout the planning horizon.

In the first stages of the planning process, key planning drivers were identified that would direct the master planning efforts and evaluate and recommend necessary facilities, policies, and programs within the Integrated Master Plan. These drivers are described below.

- **Rehabilitation/Replacement (Condition)** – A condition trigger was assigned when the process or facility had reached the end of its economic useful life. This trigger is determined by the need to maintain a facility so it can operate reliably and meet performance requirements related to existing regulatory permits, worker and public safety, protection of the environment, and all other requirements.
- **Regulatory Requirement** – A regulatory trigger was assigned when local, state, or national regulatory requirements necessitated new facilities. Determining when the new facilities would be built depended on the amount of lead-time needed to plan, design, and construct the facilities according to the new requirements.
- **Economic Benefit** – An economic benefit trigger was assigned when life-cycle costs, consisting of capital costs and operations and maintenance costs, could be significantly reduced. For example, an economic benefit might be realized when an increase in initial capital investment achieves an ongoing reduction in labor, energy, or chemical usage.
- **Improved Performance Benefit** – An improved performance benefit trigger was assigned when improved operations and maintenance performance led to more reliability and/or reduced operational and safety-related risks. For example, this type of trigger would be applied when improving process control and automation or addressing an operational concern, such as adding flexibility/reliability or decreasing complexity, or reducing salts/ammonia going to the advanced facilities.
- **Growth Leading to Increased Demands/Flows/Loads** – A flow or pollutant load trigger was assigned when an increase in existing capacity was needed to accommodate future increases in demand or influent flows or loads to a facility. These increases are determined by population growth, industrial discharges, annexation, regionalization, or changes in wet weather operation.
- **Resource Sustainability** – A resource sustainability trigger was assigned when there was a desire to meet energy initiatives, include resource recovery opportunities, and / or consider sustainable design alternatives.

- **Policy Decision** – A policy trigger was assigned when policymakers made management and/or political decisions.

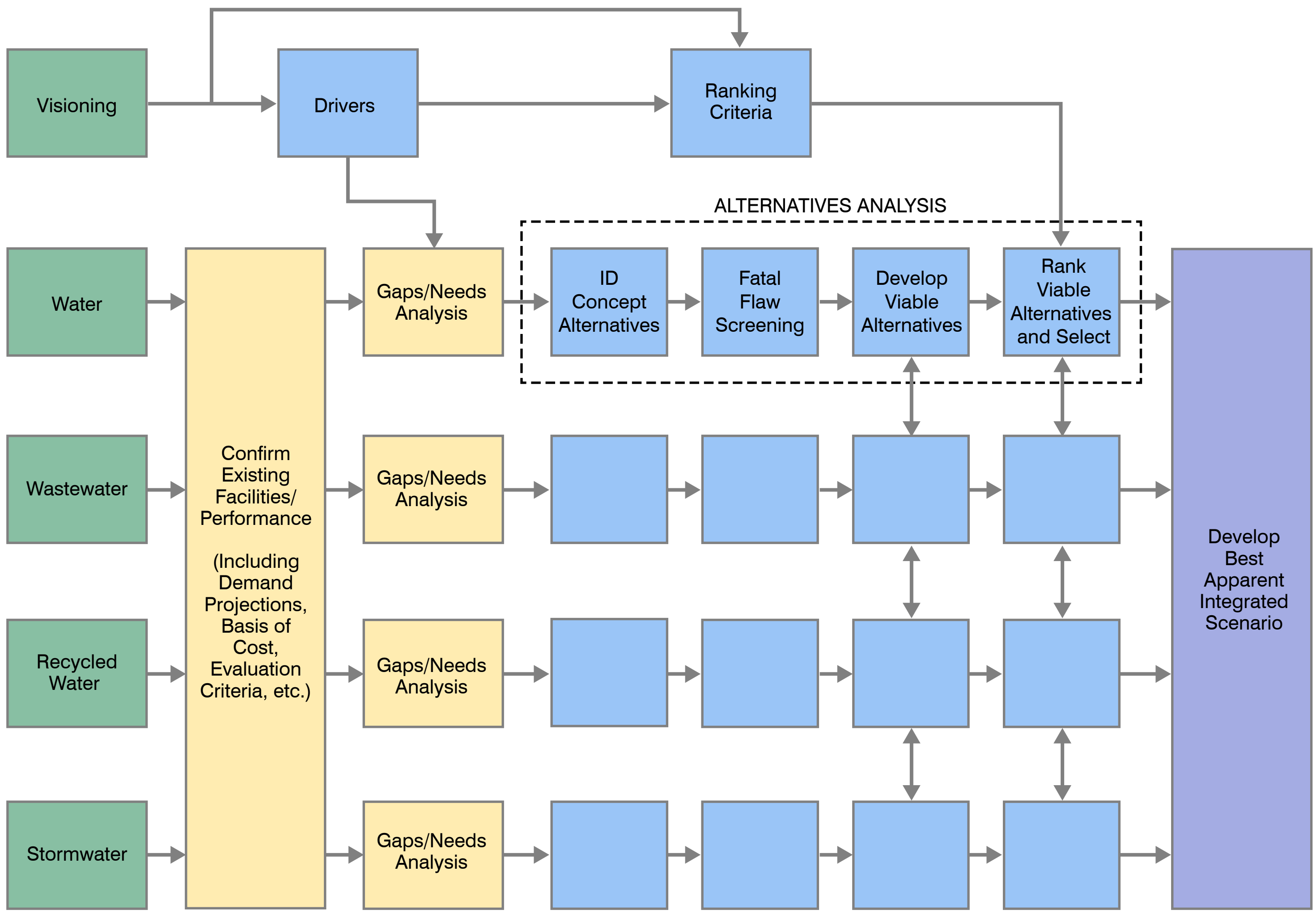
1.4 APPROACH TO THE INTEGRATED MASTER PLAN

The Integrated Master Plan addresses future planning needs for all major water utilities within the City's jurisdiction, which include water, wastewater, stormwater, and recycled water. The Plan builds on previous planning efforts using a coordinated methodology, allowing the City to take full advantage of potential linkages among the four water utility systems.

In addition, this Plan is coordinated with a Streets Master Plan to time future streets improvements with utility upgrades. This effort involved using the City's Geographic Information System (GIS) to identify large streets projects and upgrades to water infrastructure and then planning to complete these upgrades simultaneously to limit impacts on the City's streets. The City GIS staff/department will lead the effort to combine the Integrated Master Plan with the GIS planning system.

To develop this Integrated Master Plan, the following six major planning steps were completed. These steps are shown in Figure 1.2 and described below.

- **Confirm Existing Facilities/Performance.** Findings and conclusions of past studies and reports were assimilated to confirm existing facilities and their performance. Asset condition assessments were completed to assess facility's condition, criticality, and risk of failure.
- **Identify Gaps/Needs Analysis.** Gaps in required performance and utility capacity were identified by comparing the existing facilities' condition, performance, and capacity with the anticipated needs for repair and replacement (R&R), capacity, regulatory compliance, and other planning drivers. Future needs were identified based on pending regulatory requirements, planned capacity increases, R&R, cost-effectiveness, and performance improvements that drive the need for future facility improvements.
- **Analysis of Alternatives.** Viable alternatives were identified, evaluated, and developed to meet anticipated needs or to take advantage of new opportunities in resource recovery and/or technologies. A wide range of solutions were brainstormed, conceptual alternatives were identified, and screenings were conducted to select viable alternatives. The viable alternatives and their abilities were then selected to meet the overall goals and objectives.
- **Identify Linkages/Evaluate Alternatives.** Various water system plans that support utilities were coordinated to identify key linkages and critical implementation issues, to quantify costs and benefits, and to rank alternatives.



MASTER PLANNING PROCESS OVERVIEW

FIGURE 1.2

CITY OF OXNARD

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CITY OF OXNARD CALIFORNIA

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- **Develop the Best Apparent Scenario.** The best combination of policies, projects, and ongoing programs across all utilities were evaluated and determined, and the best apparent integrated scenario was developed.
- **Develop Recommended CIP.** Estimated capital, operations, and maintenance costs were developed to the 25-year planning horizon (through 2040), and a financial evaluation and rate analysis were developed. A phased Implementation Plan was also developed to integrate the recommended improvements for all utilities for greater efficiency and cost-effectiveness.

This Integrated Master Plan is a high-level study that covers several areas within each infrastructure system. As such, this Plan will serve as the basis for future documentation, such as the environmental impact review and more detailed facilities planning and design. It will also be the basis for implementation steps, such as the implementation of planned projects and financial planning.

INTEGRATED MASTER PLAN OBJECTIVES, ASSUMPTIONS, AND CRITERIA

2.1 INTRODUCTION

This chapter establishes the overall master planning process by determining planning objectives and strategies, documenting key planning considerations and assumptions, and describing current and proposed regulatory requirements that apply to the Integrated Master Plan.

2.2 OBJECTIVES AND STRATEGIES

For this Integrated Master Plan, specific goals and objectives were developed considering the broad drivers established in Chapter 1. These goals and objectives provide a framework and boundaries for the City's planning process and can guide the development of alternatives and strategies as projects progress. Table 2.1 summarizes the Integrated Master Plan goals with corresponding objectives.

2.2.1 Water and Recycled Water

In addition to the goals and objectives included in Table 2.1, specific water supply goals that provide a framework for alternatives development and comparison were identified. These water supply goals include:

- Provide reliable/resilient supply to meet future conditions (i.e., changes to demand, regulations, and water quality).
- Meet City's water quality objectives.
- Protect existing water rights by maximizing use of groundwater allocation.
- Minimize future reliance on imported water by maximizing use of AWPF Facility.
- Attract industry and jobs.
- Keep rates affordable.

The Oxnard Plain Groundwater Basin's safe yield is a major constraint placed on the City's system. The Fox Canyon Groundwater Management Agency (FCGMA) protects the quantity and quality of the local groundwater by overseeing and managing all contractual withdrawals within the Oxnard Plain Groundwater Basin.

Table 2.1 Integrated Master Plan Goals and Objectives Public Works Integrated Master Plan City of Oxnard		
Goal No	**Planning Goals**	**Integrated Master Plan Objectives**
1	Provide compliant, reliable resilient and flexible systems	• Improve system reliability consistent with industry standards. • Implement redundancy/backup systems for routine maintenance and repairs and for addressing security threats. • Implement innovative technology.
2	Integrate gray and green infrastructure with an emphasis on energy efficiency	• Optimize the systems' energy efficiency.(1) • Investigate green and gray infrastructure options, such as low impact development techniques for stormwater, or alternative energy sources.
3	Effectively manage assets (economic sustainability)	• Maximize the cost/benefit ratio. • Spend public money wisely.
	Integrate community interests and maximize public acceptance (social sustainability)	• Develop sustainable ongoing communication processes. • Minimize impacts to the public.
4	Mitigate and adapt to potential impacts of climate change	• Minimize potential climate change-related impacts to the system (e.g., sea level rise or changing rainfall patterns).
5	Protect environmental resources	• Maintain permit/regulatory compliance. • Position City for future regulatory changes.
	Enhance environmental sustainability	• Maximize water conservation. • Maximize wastewater reclamation and reuse. • Manage groundwater extraction. • Maximize the beneficial reuse of biosolids.

Notes:
(1) The City's Energy Action Plan sets a community-wide reduction in energy use of 10% by 2020, measured against a 2005 baseline.

2.2.2 Wastewater

While no goals specific to wastewater were identified, all projects proposed in this Integrated Master Plan are centered on the goals presented in Table 2.1. Key considerations for wastewater planning in Oxnard revolved around repairing and replacing (R&R) the existing system to maintain its reliability and safety as well as meeting or surpassing all regulatory requirements for wastewater effluent discharge.

2.2.3 Stormwater

In addition to the goals presented in Table 2.1, two stormwater specific objectives include maintaining the existing infrastructure and ensuring compliance with the Total Maximum Daily Load (TMDL). The Integrated Master Plan focuses on stormwater projects that will improve stormwater quality entering the environment and that can potentially harvest stormwater as an additional water supply. By including stormwater in the Integrated Master Plan, the integrated water utility system can become more robust, adaptable, and cost efficient.

2.3 KEY PLANNING CONSIDERATIONS AND ASSUMPTIONS

Although each utility (water, wastewater, recycled water, and stormwater) has its own set of specific design criteria based on each system's unique features, a common set of planning considerations and assumptions formed the basis for developing and evaluating each project. These key planning considerations are discussed in the following sections.

2.3.1 Population and Land Use

Population and land use projections help to determine the City's planned growth. With these projections, future water demands and wastewater flows can be calculated and used to determine additional water and wastewater infrastructure capacity required.

The Integrated Master Plan is flexible and sensitive to changes in the timing of future water utility infrastructure capacity. With this flexibility and sensitivity, constructing additional capacity can occur quickly when needed, providing for the least-cost future Capital Improvement Plan.

2.3.1.1 <u>Land Use Projections</u>

Land use projections were based on the City's 2030 General Plan and on conversations with the City's Planning Department. The future division between residential, commercial, and industrial users is assumed to remain largely the same as the current mix. As such, residential infill and mixed-use development are expected to form the largest population increase. Specific developments that will trigger significant growth include RiverPark, The Village, and potentially the South Shore and Teal Club Specific Plans.

2.3.1.2 <u>Population Projections</u>

A wide range of population projections were considered conceptually and three were evaluated in more detail. These three population projections are described below.

Two of the three projections were based on the City's 2030 General Plan, which was adopted in 2011 and extends through the year 2030. Using a variety of assumptions, this plan forecasted the 2030 population to be between 238,996 and 285,521. These two population forecasts are referred to as the low and high forecasts of the 2030 General Plan.

Because the 2030 General Plan population projections used data before the 2008 recession, the effects of the recession on population growth were not taken into account in these low and high forecasts. In response to this discrepancy, the City's Planning Department updated the 2030 General Plan population forecast in 2014 based on the 2010 Census and housing projections developed by Traffic Analysis Zone. The updated information formed the basis for the third projection, which projected a population below the low forecast of the 2030 General Plan.

As shown in Figure 2.1, the City's population forecasts vary significantly. The lowest population forecast (2014 Update) reflects an average growth rate of 0.5 percent per year, whereas the highest projection (2030 General Plan – High Forecast) reflects an average annual growth rate of 1.5 percent for the next 25 years.

The City’s population is currently trending toward the General Plan’s low forecast. Because of this, the Integrated Master Plan used the General Plan's low forecast to establish the planned needs and phasing of future capacity. These lower population projections were modified somewhat when combined with higher, more conservative per capita flows used to project water and wastewater flows.

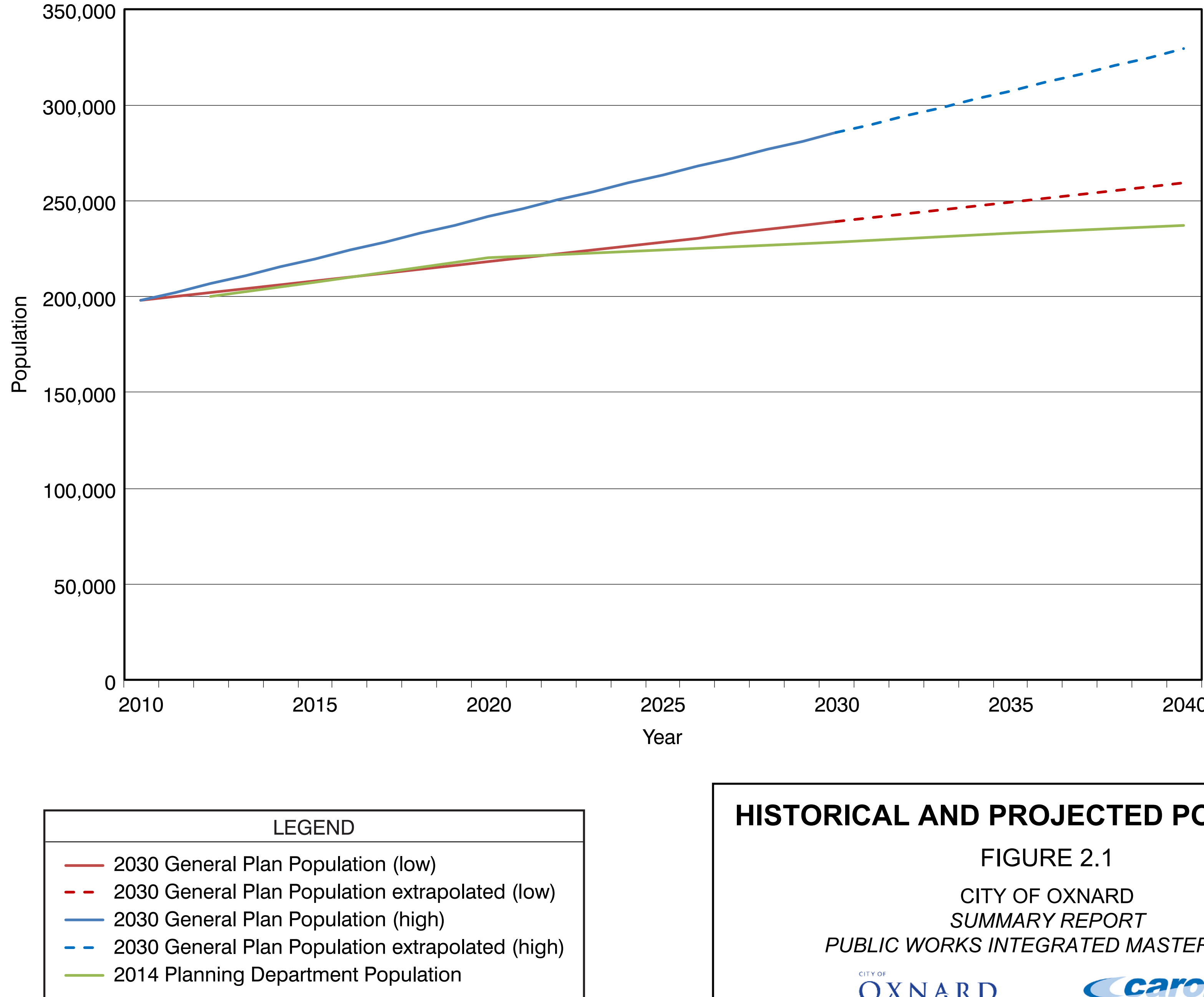
2.3.2 Climate Change

In addition to population, climate change can affect all utilities considered in the Integrated Master Plan. The chemistry and dynamics of atmospheric greenhouse gases, including water vapor, and carbon dioxide, hold heat in the atmosphere and create a natural greenhouse effect for the planet. Since the onset of the Industrial Revolution, data show that human-generated emissions of greenhouse gases, such as carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons, have been accumulating in the atmosphere and are intensifying Earth’s natural greenhouse effect more rapidly than expected (Rahmstorf, *et al.,* 2007).

Scientists predict that sea levels will rise and that more frequent and intense storms will occur. Thus, this Plan focuses on how rising sea levels might affect the wastewater system and how changes in precipitation patterns and the potential for drought might affect water supply and stormwater collection system capacity.

2.3.2.1 Sea Level Rise

Sea level is the ocean's elevation relative to a reference elevation. Data has shown that sea levels have increased over the last 100 years and are expected to accelerate at a faster rate in the future. Depending on the projection used, sea levels could rise anywhere from 7 to 18 feet by the year 2100. Since rising sea levels will affect the City's facilities, especially the OWTP, planning efforts incorporated these projections into the wastewater planning.



HISTORICAL AND PROJECTED POPULATION

FIGURE 2.1

CITY OF OXNARD
SUMMARY REPORT
PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

carollo Engineers...Working Wonders With Water®

ox1115f13-9587(SumRepFIG2-1).ai

2.3.2.2 Rainfall

The City has experienced an increase in extreme precipitation events consistent with climatologist's' projections of a changing, warming climate. Although the amount of annual rainfall has increased only slightly, rainfall events are likely occurring more frequently and becoming more intense, with distribution patterns changing as well. Until regional climate models can provide more accurate projections for the Oxnard area, long-term planning should assume that more frequent and intense precipitation events and changing weather patterns will continue.

2.3.2.3 Drought

The number of dry days during summer months is also expected to increase, extending California's already long dry season. As such, longer, drier, and more frequent periods of drought are anticipated, with up to 2.5 times the number of critically dry years by the end of the century. Until more accurate scientific information and regional model results indicate otherwise, the California Department of Water Resources recommends that local agencies assume a 20 percent increase in the frequency and duration of future dry conditions to prepare for future droughts (DWR 2008h).

2.3.3 Sustainability

The City seeks to develop sustainable water solutions and infrastructure. As such, the Integrated Master Plan used the Envision® Sustainability Rating System as a framework for developing the evaluation criteria and metrics for strategies and alternatives. Each of the five Integrated Master Plan goals (shown in Table 2.1) were assessed through the lens of the Envision® tool to help further define these goals in a way that produces measureable metrics for comparing alternatives.

2.3.3.1 Envision®

The Envision® Rating System was developed through a joint collaboration between the Zofnass Program for Sustainable Infrastructure at the Harvard University Graduate School of Design and the Institute for Sustainable Infrastructure[1]. It provides a holistic framework for evaluating and rating the community, environmental, and economic benefits of all types and sizes of infrastructure projects. The Envision® Rating System evaluates, grades, and recognizes infrastructure projects that use transformational and collaborative approaches to assess the sustainability indicators throughout a project's life cycle.

The Integrated Master Plan used Envision® to make an initial assessment of sustainability at the "big picture" level. This assessment was informed by the City's overarching values and goals for sustainability as much as it was by the goals and objectives of the Integrated

[1] The Institute for Sustainable Infrastructure (ISI) is a 501 (c) (3) not for profit organization, structured to develop and maintain a sustainability rating system for civil infrastructure in the United States. ISI was founded by the American Council of Engineering Companies (ACEC), the American Public Works Association (APWA), and the American Society of Civil Engineers (ASCE) and is governed by a nine-member Board of Directors appointed by the founding organizations.

Master Plan. With the assessment, a minimum performance level for reducing greenhouse gas emissions was identified and stretch goals were established to show the range of sustainable principles that could be implemented. This assessment also helped to develop criteria used to evaluate and compare alternatives.

From the initial assessment, two types of evaluation tests emerged. The first type was termed an overarching principle (OP), which is the minimum threshold every alternative must meet to be considered viable. The second type was termed a measurable criterion (MC), which is a result that can be measured, quantified, and assigned (a "metric") to determine the relative performance of alternatives.

Table 2.2 summarizes the OP and MC associated with each of the five major goals of the Integrated Master Plan.

Table 2.2 Evaluation Criteria Established for Integrated Master Plan
Public Works Integrated Master Plan
City of Oxnard

Goal	Objective	Type of Criteria	Metric	Unit of Measure	Associated Envision® Credit
#1	**Provide Compliant, Reliable, Resilient and Flexible Systems**				
	Improve system reliability consistent with industry standard.	OP	--	--	
	Implement redundancy/backup for routine maintenance and repairs and address threats to security.	OP	--	--	
	Provide flexibility to respond to changes in regulatory requirements, and reuse water demand or technological advances.	MC	Project Cost Differential	Incremental cost to change from current conditions.	CR2.2 Avoid traps and vulnerabilities CR2.3 Prepare for long-term hazards.
	Provide the ability to implement in a timely manner for a given need.	MC	Implementation Time	Years	

Table 2.2	Evaluation Criteria Established for Integrated Master Plan Public Works Integrated Master Plan City of Oxnard				
Goal	**Objective**	**Type of Criteria**	**Metric**	**Unit of Measure**	**Associated Envision® Credit**
#2	**Investigate Gray and Green Infrastructure with an Emphasis on Energy Efficiency**				
	Investigate gray and green infrastructure.	OP			NW2.1 Manage Stormwater (through LID).
	Maximize energy efficiency/sustainable energy use.	MC	Net non-renewable Energy Use (Energy use – Energy production – Renewable energy use/ purchase)	kWh/year	RA2.1 Reduce energy consumption. RA2.2 Use renewable energy.
#3	**Manage Assets Effectively (Economic Sustainability)**				
	Maximize cost/benefit ratio.	MC	Capital Costs O&M Costs Life-cycle Costs	Total Project Cost ($) Total O&M Cost ($/year) Annual Costs ($/year)	LD3.3 Extend Useful Life.
#4	**Mitigate and Adapt to Potential Impacts of Climate Change**				
	Minimize impacts to system due to events related to climate change.	OP			CR2.1 Assess climate threat. CR2.2 Avoid traps and vulnerabilities. CR2.3 Prepare for long-term adaptability.
	Minimize contribution to climate change factors through reducing/minimizing GHG emissions.	MC	Greenhouse Gas Emissions	Metric tons of CO2 equivalent emissions per year	RA1.1 Reduce net embodied energy. CR1.1 Reduce greenhouse gas emissions.
	Maintain regulatory/permit compliance.	OP			QL2.1 Protect public health.
	Maximize sustainable water use.	MC	Potable Water Offset	MG per year	RA3.1 Protect fresh water availability.

Table 2.2 Evaluation Criteria Established for Integrated Master Plan Public Works Integrated Master Plan City of Oxnard

Goal	Objective	Type of Criteria	Metric	Unit of Measure	Associated Envision® Credit
					RA3.2 Reduce potable water consumption.
		MC	Groundwater Replenishment	MG per year	RA3.1 Protect fresh water availability.
	Maximize beneficial reuse of solids.	MC	Solids Reused	Tons per year	RA1.5 Divert waste from landfills.

Notes:
OP = Overarching Principle
MC = Measured Criteria
QL = Quality of Life
RA = Resource Allocation
LD = Leadership
NW = Natural World
CR = Climate & Risk

2.3.3.2 Energy

Although the City has a broad interest in applying sustainable solutions, it specifically aims to reduce energy use and increase energy efficiency throughout the system. As part of this effort, the City completed an Energy Action Plan in April 2013 and committed to pursuing the “Gold Level” as defined in Southern California Edison’s Energy Leadership Partnership Program.

This goal targets a 10 percent reduction in energy use for City Government facilities. Oxnard’s Energy Plan expands this 10 percent reduction to the community at large, calling for a 10 percent citywide reduction in electricity and natural gas use. By implementing all recommended Energy Plan programs, State programs, and programs implemented since 2005, Oxnard is expected to decrease its greenhouse emissions by 114,000 million tons (MT) of CO_2 equivalent, which is an 8 percent reduction.

As part of the planning efforts for the Integrated Master Plan, the Energy Plan's recommendations were incorporated into the recommended CIP. The following three main recommendations were applicable:

- **Incorporate Greening Guidelines:** Incorporate green strategies by constructing new facilities that reduce energy consumption.
- **Increase Onsite Electricity Generation at City Wastewater Treatment and Materials Recovery Facility:** Investigate increasing the fats, oil, and grease collected for bio-gas electricity generation at the wastewater treatment plant.
- **Recycled Water Outreach and Education Program:** Expand use of the AWPF facility and educate the public on the energy savings associated with it.

2.3.4 Basis of Costs

Cost estimates were also coordinated across each utility to ensure comparable and consistent estimates. These estimates are described below.

The Association for the Advancement of Cost Engineering International (AACE International, formerly known as the American Association of Cost Engineers) has suggested levels of accuracy for five estimate classes. These five estimate classes are presented in the AACE International Recommended Practice No. 17R-97 (Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries). For projects in the Integrated Master Plan, cost estimates were developed following the AACE International Recommended Practice No. 17R-97 estimate Classes 4 and 5. Class 4 and 5 estimates are appropriate for master planning purposes and are derived from previous project costs and factored estimates where the former were not available.

Additionally, due to the differing nature of projects that occur within a treatment plant and for a collection or distribution system, two approaches were taken to estimate costs. The first approach, outlined in Table 2.32.3, is the method used for all projects recommended within the fence line of the OWTP and AWPF. The second approach, also outlined in Table 2.3, is the method used for all other capital improvement projects recommended for the Integrated Master Plan, including the water blending stations.

Table 2.3 Basis for Estimating Project Costs for the Integrated Master Plan
Public Works Integrated Master Plan
City of Oxnard

Item	Estimated Cost at OWTP and AWPF[1]	Estimated Cost for All Other Projects[2]
Base Construction Cost from Carollo Cost Curves and past projects (Bid Tabs)[3]:	"A"	"A"
• Adjust base construction cost for field piping[4]	15% of "A"	--
• Adjust base construction cost for electrical/instrumentation[4]	20% of "A"	--
• Adjust base construction cost for sheeting/shoring/piles and painting[4]	10% of "A"	--
Subtotal ("B")	**145%**	**100%**
Construction Contingency	15% of "B"	30% of "B"
Subtotal Construction Cost ("C")	**167%**	**130%**
Add 24% of Construction Cost to Cover Project Cost Factor[5]	24% of "C"	24% of "C"
Total Estimated Project Cost ("D")	**207%**	**161%**

Table 2.3	Basis for Estimating Project Costs for the Integrated Master Plan Public Works Integrated Master Plan City of Oxnard

Notes:

(1) Used to estimate all costs considered within the fence line of the treatment facilities.
(2) Used to estimate all costs considered outside the fence line (i.e., pipelines, well pumps, booster pumping, and storage).
(3) Adjust this cost to 20-City Index ENR CCI of 9962 (February 2015) and needed city location adjustment factors.
(4) Costs are adjusted based on site-specific conditions.
(5) Includes all "soft" costs: engineering, administration, legal, and construction management.

The main difference in these approaches is that the OWTP and AWPF projects use a construction contingency of 15 percent, whereas all other projects use a construction contingency of 30 percent. The different contingencies reflect the type of work being done and the more detailed nature of the OWTP and AWPF projects.

Table 2.4 presents the economic criteria used to estimate annual costs for all projects. When developing annual costs, these criteria are applied to capital and Operations and Maintenance (O&M) costs.

Table 2.4 Economic Criteria
Public Works Integrated Master Plan
City of Oxnard

Item	Assumption
Costs in Time and Place(1)	Costs are based on Oxnard costs in February 2015
Inflation Rate(2)	Annual inflation rate is assumed to be 3 percent
Interest Rate(2)	5 percent for amortization purpose
Amortization Period	20 years

Note:

(1) 20-City Average Index ENR CCI of 9,962 was used for February 2015. A R.S. Means Location Factor of 106.6 for Oxnard was used (ENR, 2015) (RSMeans, 2015).
(2) The inflation and interest rate are based on past experience with and an understanding of the economic climate of this industry.

2.4 REGULATORY REQUIREMENTS

2.4.1 Water

Water treatment and supply facilities must meet all state and federal water quality guidelines. The Environmental Protection Agency (EPA) establishes federal regulations in the form of the Safe Drinking Water Act, and the California Division of Drinking Water (DDW) administers state guidelines. Because the City's drinking water supply is a blend of surface water and groundwater, regulations apply to both.

2.4.1.1 <u>Current</u>

Local groundwater wells are a major source of the City's water, making groundwater regulations the most relevant. Since wholesalers providing surface water to the City must meet treatment regulations before the water enters the system, surface water regulations related to treatment are not summarized in this chapter. In this case, the CMWD is responsible for meeting all applicable surface water treatment regulations. The City, however, must meet any distribution-related regulation related to water quality. Table 2.5 summarizes current regulations focused on water quality within groundwater and distribution systems.

In addition to regulations related to groundwater quality, the quantity of groundwater use is managed by the FCGMA, an organization created by the California Legislature in 1982 to oversee Ventura County's vital groundwater resources. As an independent, special district separate from the County of Ventura or any city government, the FCGMA manages and protects both confined and unconfined aquifers within several groundwater basins beneath the southern portion of Ventura County.

The FCGMA establishes a set of ordinances directed at groundwater extraction. The most recent ordinance, Emergency Ordinance E, limits extractions from groundwater extraction facilities, including the City, due to the drought's impacts on underlying aquifers.

An additional consideration is that the Sustainable Groundwater Management Act (SGMA) was passed through the California state legislature in September 2014. The goal of this act is to have a sustainable management of groundwater by the year 2042. The full implications of SGMA are not known at the time of publication of this updated Plan but should be considered as projects move forward.

2.4.1.2 <u>Future Potential Regulations</u>

Future regulations that could potentially affect the City's system are also summarized in Table 2.5.

2.4.2 Wastewater

2.4.2.1 <u>Water Quality</u>

2.4.2.1.1 *Current*

Wastewater discharges are governed by both federal and state requirements. The primary laws regulating water quality are the Clean Water Act (CWA) and the California Water Code. Under the CWA, the EPA or a delegated State agency regulates discharging pollutants into waterways through the issuance of National Pollutant Discharge Elimination Systems (NPDES) permits. NPDES permits set limits on the amount of pollutants that can be discharged into the waters of the United States. Since the OWTP is located in the Los Angeles Region, the Los Angeles Regional Water Quality Control Board (LARWQCB) has authority to issue permits for wastewater discharge and waste discharge requirements for recycled water use.

Currently, the OWTP discharges to the Pacific Ocean under existing NPDES permit (CA0054097), which was adopted by the LARWQCB on July 26, 2013. This permit establishes discharge limits for conventional constituents, nutrients, metals, and organics. The aim of these limits is to protect aquatic life and other beneficial uses of the receiving water. Table 2.6 lists conventional constituents and metals with their permit limits.

2.4.2.1.2 *Future (Potential)*

As analytical techniques for detecting toxic compounds improve and detection limits drop, additional parameters might exceed California ocean plan objectives. As such, effluent limits might be added to the OWTP NPDES permit.

2.4.2.2 Air Quality

2.4.2.2.1 *Current*

At a local level, the Ventura County Air Pollution Control District (APCD) is primarily responsible for controlling air pollution from the OWTP. Beyond the local level, air quality permits are required by State and Federal laws as part of doing business in Ventura County. The OWTP currently holds permits from the District for the following sources:

- Two effluent pump natural gas engines.
- Three electrical generator waste gas engines.
- Two waste gas burners.
- One odor reduction tower.
- One odor control system (headworks).
- One odor reduction station (solids processing building).
- Six standby diesel engines for electricity generators.
- One emergency standby diesel engine for air compressor.

The APCD also regulates the emission of certain odorous substances, such as sulfur dioxide and hydrogen sulfide. Improvements and changes to the wastewater process and discharge location are likely to require revised air quality permits. Table 2.7 summarizes these concentration levels.

Table 2.5 Overview of Relevant Drinking Water Regulations
Public Works Integrated Master Plan
City of Oxnard

Regulation	Compliance Date	Requirements and Maximum Contaminant Level (MCL)
Current Applicable Regulations		
Safe Drinking Water Act and National Primary Drinking Water Regulations	Ongoing	Maximum contaminant levels (MCLs), maximum contaminant level goals (MCLGs), and/or treatment techniques set for 83 contaminants, including turbidity, seven microorganisms (two of which are indictors), four radionuclides, 16 inorganic contaminants, and 57 organic contaminants.
Stage 1 Disinfectants and Disinfection Byproducts Rule	1/1/01 – monitoring 1/1/02 – MCL compliance	Reduced total trihalomethanes (TTHM) limit from 0.1 to 0.080 milligrams per liter (mg/L); reduced haloacetic acids (HAA5) limit from 0.08 to 0.060 mg/L. Established an MCL for bromate of 0.010 mg/L; Established an MCL for chlorite of 1.0 mg/L Compliance for TTHMs & HAA5 based on a running annual average.
Stage 2 Disinfectants and Disinfection Byproducts Rule	10/1/06 – first provision 1/1/13 – all provisions	Perform Initial Distribution System Evaluation to identify new DBP compliance locations. Change compliance calculations from RAA to Locational Running Annual Averages.
Radionuclides Rule	12/31/07	Updated standards: Combined radium 226/228: 5 pCi/L. Total beta particles and photon emitters: 4 mrem/yr. Gross alpha particles (excluding U and Rn): 15 pCi/L. Uranium MCL: 30 µg/L.
Arsenic Rule	1/23/06	Arsenic MCL: 0.010 mg/L.
Secondary Drinking Water Regulations	Ongoing	Non-enforceable standards for aesthetic parameters.
Partnership for Safe Water	Ongoing	Voluntary standards and practices to minimize risk of microbial contamination of treated water.
Inorganic Chemicals	Various	Existing National Primary Drinking Water Regulations (NPDWRs) set standards for a number of different metals and other inorganic chemicals, including aluminum and nitrate.
Synthetic and volatile organic chemicals	Various	Existing NPDWRs for a number of different herbicides, pesticides, solvents, and other organic chemicals. Monitoring and reporting requirements.
Lead and Copper Rule and 2007 Revisions	1993 - 4/10/2008	Requires water suppliers to optimize their treatment system to control corrosion in a customer's plumbing. If lead action levels are exceeded, the suppliers are required to educate their customers about lead and suggest actions to reduce their exposure through public notices and public education programs.
Revisions Cr(VI)	CA MCL - 4/2014	DDW established MCL of 10 µg/L.

Table 2.5 Overview of Relevant Drinking Water Regulations
Public Works Integrated Master Plan
City of Oxnard

Regulation	Compliance Date	Requirements and Maximum Contaminant Level (MCL)
Future Regulations		
New "lead free" standard under the SDWA	1/4/14	Amends SDWA Section 1417 – Prohibition on Use and Introduction into Commerce of Lead Pipes, Solder, and Flux: Changes the definition of "lead-free" by reducing lead content from 8 percent to a weighted average of no more than 0.25 percent in the wetted surface material. This change primarily affects brass/bronze.
Combined Volatile Organic Compounds	Projected 10/14 proposal, 6/15 final	Efforts to define a VOC Rule are ongoing. The novel "group risk" approach focuses on total public health as opposed to each chemical. This may be combined using a common analytical method, treatment, or MCLG.
Revised trichloroethylene and tetrachloroethylene MALss	Unknown	These may be regulated separately from other VOCs.
Revised Lead and Copper Rule	Projected 2017	The EPA is evaluating all aspects of the current rule.
Nitrosamines	Unknown	The EPA is collecting data for possible future group MCL for nitrosamines (byproduct of chloramines). California Notification Level of 0.01 µg/L for NDMA.
Revised Total Coliform Rule	April 2016	Requires that MCL for Total Coliforms (including fecal coliform and E. coli) are no more than 5 percent of samples total coliform-positive.

Table 2.6 OWTP NPDES Permit Limits
Public Works Integrated Master Plan
City of Oxnard

Constituent	Units	Effluent Limitations[1]				
		Average Monthly	Average Weekly	Maximum Daily	Instantaneous Minimum	Instantaneous Maximum
Biochemical Oxygen Demand (BOD_5)	mg/L	30	45	--	--	--
	lbs/day	7,960	11,900	--	--	--
Total Suspended Solids (TSS)	mg/L	30	45	--	--	--
	lbs/day	7,960	11,900	--	--	--
pH	standard units	--	--	--	6.0	9.0
Oil and Grease	mg/L	25	40	--	--	75
	lbs/day	6,630	10,600	--	--	19,900
Settleable Solids	ml/L	1.0	1.5	--	--	3.0
Turbidity	NTU	75	100	--	--	225
Chronic Toxicity	TUc	--	--	99	--	--
Gross alpha	PCi/L	--	--	15	--	--
Gross beta	PCi/L	--	--	50	--	--
Combined Radium-226 & Radium-228	PCi/L	--	--	5.0	--	--
Tritium	PCi/L	--	--	20,000	--	--
Strontium-90	PCi/L	--	--	8.0	--	--
Uranium	PCi/L	--	--	20	--	--
Benzidine[2]	ug/L	0.0068	--	--	--	--
	lbs/day	0.0018	--	--	--	--
Heptachlor epoxide[2]	ug/L	0.002	--	--	--	--
	lbs/day	0.00053	--	--	--	--
Polychlorinated biphenyls (PCBs)[2]	ug/L	0.0019	--	--	--	--
	lbs/day	0.0005	--	--	--	--
Tetrachlorodibenzo-p-dioxin (TCDD) Equivalents[2]	ug/L	0.00000039	--	--	--	--
	lbs/day	0.0000001	--	--	--	--

Notes:
(1) From the 2013 NPDES Permit No. CA0054097.
(2) The reasonable potential analysis' result is inconclusive. Therefore, limitations are carried over from Order No. R4-2007-0029, as amended by Order No. R4-2010-0048, to avoid backsliding.

Table 2.7	Hydrogen Sulfide and Sulfur Dioxide Ground Level Concentrations - Emission Limits Public Works Integrated Master Plan City of Oxnard	
Substance	**Limit Ground Level Concentration (ppm)**	**Duration**
Hydrogen Sulfide[1]	0.06 or	Averaged over 3 consecutive minutes
	0.03	Averaged over 60 consecutive minutes
Sulfur Dioxide[1]	0.25 or	Averaged over 60 consecutive minutes
	0.04	Averaged over 24 hour period

Notes:
(1) Source: Ventura County Air Pollution Control District Regulation 4, Rule 54, (July 1994).
(2) http://www.vcapcd.org/Rulebook/Reg4/RULE%2054.pdf.

2.4.2.2.2 *Future (Potential)*

A recent amendment to the APCD's air quality regulations may affect the OWTP in the near future. This amendment, called Rule 54, was amended in January 2014 to limit sulfur dioxide emissions to 75 parts per billion (ppb) at or beyond the property line. Although existing sources do not need to demonstrate compliance, all sources must meet the combustion emission limit on a dry basis using a revised calculation to account for percent oxygen content.

In addition to this amendment, a draft amendment to Rule 74.15.1 regarding boilers, steam generators, and process heaters might also affect regulations. This rule would limit nitrogen oxide emissions for new or replacement units rated greater than 2 million BTU/hr and less than 5 million BTU/hr. These new limits would be based on similar standards adopted by the San Joaquin Valley in Rule 4307.

2.4.2.3 Biosolids

Currently, the OWTP disposes of its screenings, grit, and dewatered anaerobically digested solids (biosolids) by hauling it to a nearby landfill. To best use the energy and nutrient content, alternatives to landfilling biosolids were considered in the Integrated Master Plan.

2.4.2.3.1 *Current*

The EPA's 40 CFR 503 regulations are the main federal regulations of biosolids. The 40 CFR 503 regulations establish metal concentration limitations, pathogen density reduction requirements, vector attraction reduction requirements, and site management practices for the land application of biosolids. The 40 CFR 503 regulations also establish requirements for the surface disposal and incineration of biosolids.

In California, State regulations of biosolids land application are more stringent than federal regulations. The State Water Resources Control Board (SWRCB) has adopted General Waste Discharge Requirements for the Discharge of Biosolids to Land for use as a Soil

Amendment in Agricultural, Silvicultural, Horticultural, and Land Reclamation Activities (Biosolids General Order).

The Biosolids General Order goes beyond the requirements of 40 CFR 503 by requiring additional biosolids testing, soil testing, groundwater sampling, and wind and dryness limitations. Regulations for biosolids reuse and disposal in landfills in California are also more stringent and fall under the jurisdiction of the California Department of Resources Recycling and Recovery (CalRecycle). In addition to regulating the co-disposal of biosolids in landfills and the use of biosolids for alternative daily cover, CalRecycle also regulates facilities that compost biosolids.

2.4.2.3.2 *Future (Potential)*

Using or disposing of biosolids is becoming increasingly difficult in California. Many California utilities are restricting the land application of biosolids, and fewer landfills are accepting them. Furthermore, the State of California has passed several bills that directly affect the ability to send biosolids to landfills in the future.

Two bills in particular affect the land application of biosolids: Assembly Bill 341 and Assembly Bill 1594. In 2013, California passed Assembly Bill 341, which requires a 75 percent reduction of solid waste sent to landfills by 2020. (It is expected that by 2025, a 90 percent reduction of solid waste sent to landfills will be required.) In September 2014, Assembly Bill 1594 was passed, requiring that green waste no longer qualifies for diversion credit when used as alternative daily cover at a landfill. When this bill is fully implemented January 1, 2020, the diversion credits that utilities currently receive will be eliminated.

Approximately 30 percent of the solid waste stream sent to landfills is organic, which CalRecycle is working to eliminate from landfills in support of the Air Resources Board Assembly Bill 32 Scoping Plan's target to reduce greenhouse gas emissions to 1990 levels by 2020. Although the Assembly Bill 32 Scoping Plan does not explicitly state that organic waste streams are or will be prohibited from use as alternative daily cover, it does state that opportunities for phasing out landfilling organic material are being pursued, and that legislation could be developed as early as 2016.

2.4.3 Recycled Water

2.4.3.1 Current

The City has served urban irrigation uses since 2015 and agricultural uses since 2016. The City also plans to use recycled water for aquifer storage and recovery (ASR) and groundwater recharge for potable reuse. The permitting process for potable reuse occurs on a case-by-case basis.

Based on the uses of recycled water being considered by the City, the following regulations and policies apply:

- Urban/Agricultural Reuse – California Code of Regulations (CCR), Title 22, Division 4, Chapter 3, Section 60301 et seq. (Title 22) & the Recycled Water Policy (SWRCB Res No. 2009-0011, recycled water (RW) Policy).

- IPR/Groundwater Recharge – DDW's Groundwater Recharge Regulations and SWCRB's Recycled Water Policy and Anti-Degradation Policy.

The applicable recycled water regulations noted above are summarized in the following sections. In addition to the above regulations, the City's GREAT program is currently permitted under Waste Discharge Permit, Order No. R4-2011-0079-A01, which was recently amended in July 2015. This permit covers non-potable reuse within the GREAT program.

2.4.3.1.1 *Non-Potable*

The DDW is now California's primary agency responsible for protecting public health, regulating drinking water, and developing uniform water recycling criteria appropriate for particular water uses.

The DDW published the Title 22 recycled water regulations (CDPH, 2014a). Based on the level of treatment the AWPF will provide, per Title 22, non-potable uses of the City's recycled water include surface irrigation of food crops, parks, playgrounds, school yards, residential and freeway landscaping, unrestricted access golf courses, and some construction uses. The RW can also be used in industrial or commercial cooling or boiler operations as well as recreational impoundments.

2.4.3.1.2 *Indirect/Direct Potable Reuse*

The primary State agencies responsible for regulating an IPR project include DDW, LARWQCB, and the SWRCB. Because the purpose of IPR is to discharge to the existing Oxnard Plain Groundwater Basin and withdraw for potable reuse, several regulations apply. All of the applicable regulations that pertain to the installation and operation of IPR are summarized in Table 2.8.

2.4.3.2 Future (Potential)

For recycled water, endocrine-disrupting chemicals and other compounds of emerging concern (CECs) are most likely to be regulated. The RW Policy highlights CECs as a potential issue for recycled water.

While there are no current regulations for these constituents in recycled water, in accordance with the Recycled Water Policy, the State Water Board convened a science advisory panel (Panel) to guide the future monitoring of CECs in recycled water. The Panel developed a report that recommended ways to monitor for specific CECs in recycled water used for groundwater recharge reuse.

Table 2.8 Summary of All Applicable Regulatory Requirements for Recycled Water Systems Public Works Integrated Master Plan City of Oxnard		
Governing Agency	**Applicable Regulation/Policy**	**Regulatory Concept/Objective**
DDW	Title 22, Division 4, Chapter 3 of the California Code of Regulations	Stipulates criteria for both non-potable uses of recycled water and groundwater recharge for subsequent potable use, with the most recent version updated as of June 2014 (CDPH, 2014).
	60320.208	Requires that specific pathogen reduction targets must be met through multiple treatment processes. The log reduction requirements for viruses, *Giardia,* and *Cryptosporidium* are 12, 10, and 10, respectively.
	60320.210	Requires that a total nitrogen standard of ≤10 mg/L must be met at all times.
	60320.218	Requires a minimum TOC value of ≤0.5 mg/L is required.
	60320.226	Requires that, before operation, monitoring wells are placed in appropriate locations to monitor the movement and water quality of the injected water.
LARWQCB	Update WDRs Permit	Requires an amendment to the existing permit or a reissuance of a WDRs/WRR will be necessary prior to discharge.
SWRCB	Recycled Water Policy	Include Salt Nutrient Management Plans (SNMPs), Recycled Water Groundwater Recharge Projects (GRPs), anti-degradation, and monitoring constituents of emerging concern (CECs).
	SNMPs	Manages salts and nutrients from all sources "… on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses."
	GRPs	Requires compliance with regulations adopted by CDPH (now DDW) for groundwater recharge projects (CDPH, 2014).
	Anti-Degradation Policy (Resolution 68-16)	"… [Ensures that (a) pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."
	CEC Monitoring	Requires implementation of a monitoring program for CECs and priority pollutants, consistent with recommendations from DDW.

2.4.4 Stormwater

2.4.4.1 Water Quality

In cooperation with the federal EPA, the SWRCB has issued stormwater permits under the NPDES program. The City is a co-permittee, along with nine other cities and the Ventura County Watershed Protection District (VCWPD), for the MS4 NPDES permit issued by the California Regional Water Quality Control Board (RWQCB). The current MS4 permit was issued on July 8, 2010 (Permit CAS004002, Order No. R4-2010-0108). Pursuant to the permit, VCWPD has developed a countywide Stormwater Quality Management Plan that includes management measures/best management practices (BMPs).

Ventura County, through the use of a stormwater ordinance, also regulates stormwater quality in the County. The Ventura County Stormwater Ordinance (Ordinance No. 4142) prohibits non-stormwater discharges into County stormwater facilities and seeks to reduce pollutants in stormwater to the maximum extent practicable. Each co-permittee is responsible for adopting and enforcing stormwater pollution prevention ordinances, implementing self-monitoring programs and BMPs and conducting applicable inspections.

2.4.4.1.1 *Total Maximum Daily Load (TMDLs)*

Within Ventura County are a number of water bodies with TMDLs. The City of Oxnard is a participating party in the Santa Clara River Bacteria TMDL and implements the Harbor Beaches TMDL on its own.

Santa Clara River Bacteria TMDL went into effect in March 2012. The TMDL Implementation Plan is currently being developed through an agreement among the County of Ventura and the cities of Fillmore, Oxnard, Santa Paula, and Ventura (VCWPD, 2015). In addition, the same parties have developed the receiving water monitoring plan.

The Harbor Beaches TMDL went into effect in December 2008, and dry and wet weather implementation plans were submitted in 2009 and 2010. The City has implemented, and continues to implement, BMPs aimed at reducing sources and transporting bacteria into the receiving waters at Kiddie and Hobie Beaches.

2.4.4.1.2 *Water Quantity*

The Federal Emergency Management Agency administers the National Flood Insurance Program. To ensure compliance with the National Flood Insurance Program, communities must adopt a floodplain management ordinance addressing construction and habitation in flood zones. Ventura County adopted their Flood Plain Management Ordinance (Ordinance 3741) in 1985. Since then, several revisions have been made, with the latest ordinance adopted in 1990 (Ordinance 3954). The ordinance addresses the risks of development within the floodplain and includes a list of prohibited discharges, exemption procedures, and requirements for construction and permitting.

2.4.4.2 Future (Potential)

In January 2015, the VCWPD submitted their report of waste discharge (ROWD), which applies the renewal of waste discharge requirements set forth in the current order (Order No. R4-2010-0108). While the provisions of the next permit are unknown, the VCWPD is anticipating that it will be based on the MS4 Permit for Los Angeles County. The VCWPD ROWD includes proposed recommendations for changing or modifying specific provisions of the Los Angeles County Permit (VCWPD, 2015), and the justification for these recommendations for the purpose of the VCWPD permit renewal process.

At the statewide level, California Stormwater Quality Association (CASQA) (2015) outlined their strategic visions and goals for stormwater management to achieve the goals of the Clean Water Act. For future regulations, CASQA identified the need for stormwater to be considered a non-point source rather than a point source and for regulations related to stormwater capture and use as a resource.

INTEGRATION AND LINKAGE OPPORTUNITIES

3.1 INTRODUCTION

This Integrated Master Plan addresses future planning needs for all major water utilities under the City's jurisdiction, including water, wastewater, recycled water, and stormwater. Although these utility systems are integrally linked because of their positions in the water cycle, the City seeks to take full advantage of potential linkages and synergies among the systems. As such, this Plan builds on previous planning efforts by creating a single master plan that incorporates all planning efforts.

Through the planning process, additional opportunities for integration and linkages were identified. These opportunities are illustrated in Figure 3.1 and are described in this chapter.

3.1.1 Integration Workshops

Throughout the planning process, the project team met with the City for several integration workshops to review analyses and recommendations, identify common elements and linkages, coordinate project timing, and adjust the alignment of recommended projects and programs. While some of these workshops focused on specific systems and their connections to the broader plan, other workshops looked at the Master Plan's various projects and initiatives as a whole. The workshops allowed key team members from each utility to come together and provide input, coordination, and feedback on many elements of the Integrated Master Plan.

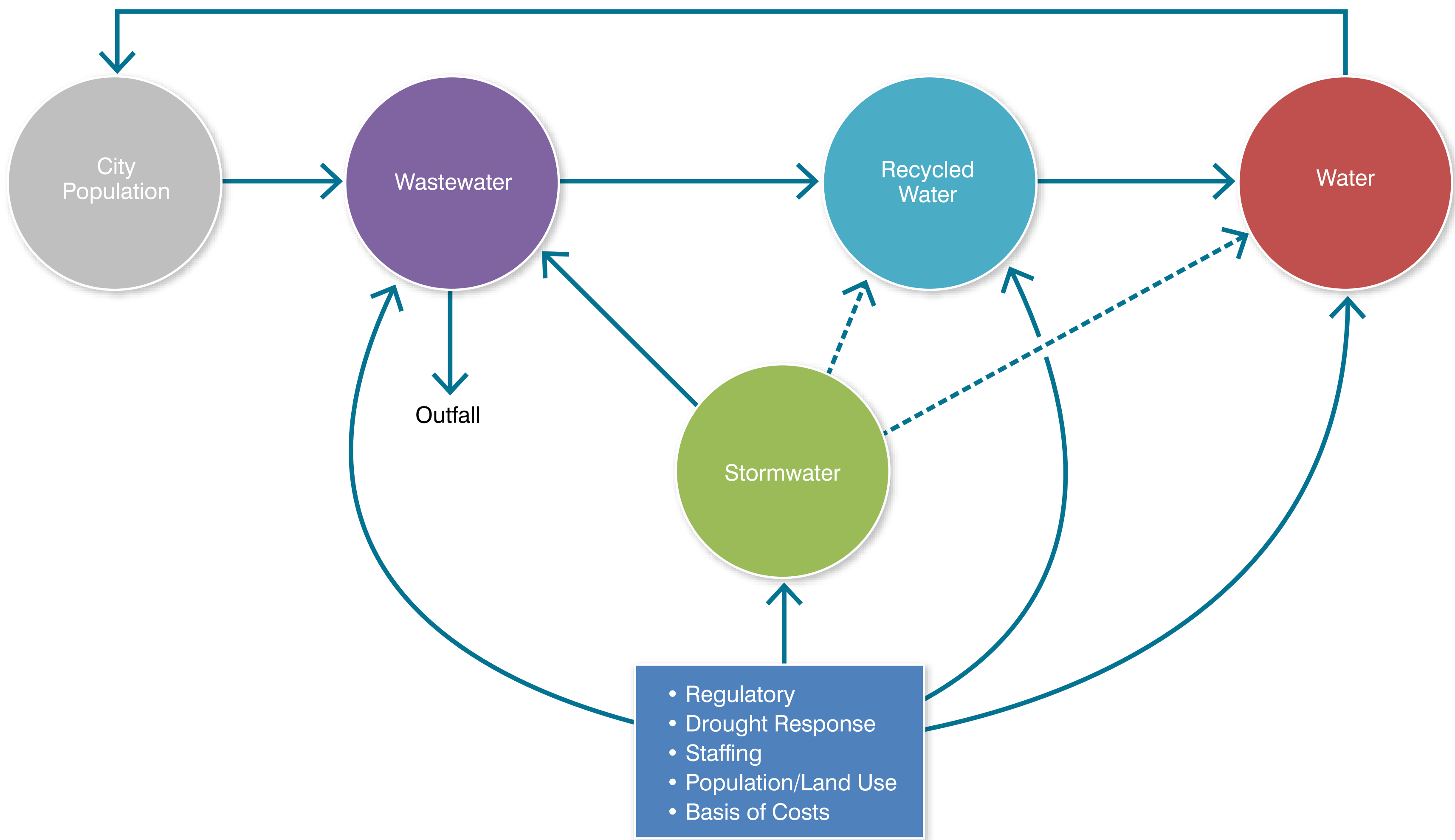
3.2 KEY LINKAGES AND INTEGRATION OPPORTUNITIES

Early on in the planning process, the project team identified several key issues, including the impact of population and land use projections on each system, the potential regulatory cross connections among systems, and the importance of using the same cost basis throughout the planning efforts. Below are brief summaries of the significance of each issue.

3.2.1 Population/Land Use

Population and land use direct the planning efforts for all water systems. For example, historical use and projected population can determine water demands and future wastewater flows, and land use can determine the amount of stormwater generated in an area. Thus, the ability to review population and land use data was an important part of this Master Plan.

Ideally, water system plans should be coordinated to keep system needs consistent. When water plans are performed separately, the basis for projected population differs, eliciting separate results for a system's demands, flows, and loads. Given the benefits of a coordinated plan, a significant part of the Integrated Master Plan involved coordinating the planning efforts for all four systems.



POTENTIAL INTEGRATION OPPORTUNITIES AND LINKAGES

FIGURE 3.1

CITY OF OXNARD
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PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

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ox1115f14-9587(SumRepFIG3-1).ai

3.2.2 Agreements and Contracts

As part of the Integrated Master Plan, Carollo was asked to organize the City's current contracts and agreements and provide recommendations and modifications at the City's request. To organize existing and future contracts and agreements, Carollo worked with City staff to form a Microsoft Access 2007 database that provided a comprehensive and convenient organizational structure that would be fully scalable for future build-out.

3.2.3 Basis of Costs

For the entire Integrated Master Plan, the recommended construction and project costs were based on the same cost-estimating levels and contingencies. This provided consistent cost estimates throughout the project, which rarely happens when plans are drafted separately. These cost estimates were then used in the City's Cost of Service (COS) Studies (Carollo, 2017) to explore and recommend future utility rates and rate increases as a whole. With this consistency, the City had a complete understanding of the water infrastructure needs and, more importantly, the costs and financial impacts of the projects recommended for all four systems.

3.2.4 Regulations

Not only did the project team review and summarize the impacts of regulations governing each specific water system, but it also looked at the ways regulations will affect all four water systems as a whole. For example, the Integrated Master Plan coordinated its recommendations with a Salt Nutrient Management Plan. Because the City plans on using recycled water for surface irrigation and sub-surface injection, this coordination is critical to ensuring that the increased use of recycled water doesn’t adversely affect the watershed.

In addition to the Salt Nutrient Management Plan (Carollo, 2016), a Title 22 Engineers Indirect Potable Reuse (IPR) Permit Report (Carollo, 2016) and Report of Waste Discharge (ROWD) (Carollo, 2016) were developed alongside the Integrated Master Plan so the City could obtain a permit to operate its Aquifer Storage and Recovery (ASR) Demonstration Well. The ASR Demonstration Well is an important project to determine the feasibility of conducting an IPR operation within the City, which is necessary to provide a future sustainable water supply.

3.2.5 Water Resources/Supply

The City of Oxnard seeks to secure a sustainable water supply for its community through the GREAT program. This program proposes using recycled water treated at the AWPF and through IPR operations as an additional water source as well as using recycled water conveyed to nearby agricultural users for pump-back allocation so the City can expand its groundwater pumping and treatment operations equally. By planning the potable and recycled water systems together in the Integrated Master Plan, several alternatives, including ASR of recycled water and additional groundwater pumping and treatment, could be combined in one integrated system.

3.2.6 Source Control

Source water for the OWTP and AWPF is directly affected by the Local Limits Study (Carollo, 2017) and the Best Management Practices (BMPs) for Centralized Waste Treatment (CWT) Facilities. Both are described in further detail below.

The Local Limits Study sets limits on the level of pollutants that industrial dischargers within the City's service area can discharge into the OWTP influent wastewater. Because these limits shape the quality of wastewater entering the OTWP, they also determine the treatment capacity and requirements for the water that leaves it. Thus, this particular Local Limits Study considered not only the information necessary for limits at the OWTP, but also the linkage between the OWTP and the AWPF. With this Study, the City can further understand the possible effects of discharging brine to the OWTP outfall under current and future flow scenarios. Ultimately, the study recommended 21 constituent limits.

Centralized Wastewater Treatment Facilities (CWTFs) treat hazardous and nonhazardous materials such as industrial tank residuals, called "tank bottoms," and oil field operations wastes. They are regulated under 40 CRF 437 and are mandated by publicly-owned treatment works (POTWs) through the POTWs' industrial pretreatment programs.

Because CWTFs can send harmful materials into the public drinking water, POTWs will not always accept discharge from CWTFs, especially Subcategory D facilities that accept multiple waste streams. To address this issue, Carollo designed BMPs that protect POTWs' waste treatment processes and conveyance systems, ensuring that the processes comply with regulations for treated effluent, water reuse, biosolids disposal/reuse, and air emissions. The BMPs also protect the environment and worker and public safety. Carollo's BMPs were endorsed by several major California POTWs that accept CWT waste discharges and were shared and endorsed by the California Association of Sanitation Agencies (CASA) and the WateReuse Association.

3.2.7 Outfall Considerations

Another key integration issue is the connection between the OWTP outfall and the AWPF capacity. As the AWPF capacity increases and more water is treated, less wastewater is discharged to the City's ocean outfall. With less water to dilute the effluent, the effluent becomes more concentrated.

To assess the impacts of increasing the AWPF's capacity, an analysis was conducted. This analysis revealed that the City might have difficulty meeting all of its NPDES permit limits with the increased capacity. As a result, potential linkages between the OWTP and the AWPF were explored to the fullest extent.

Possible mitigation measures include changing regulatory compliance points and/or dilution studies, changing treatment processes at the OWTP, and adding concentrate to the outfall to "dilute" the discharge. This potential impact on effluent was also considered when planning the recycled water and potable water supply alternatives. However, in this case, the project team considered how a reduction in AWPF capacity (less than the previously planned 25 mgd ultimate capacity) could be managed and put to best use.

3.2.8 Drought Considerations

As the severe drought continues in California and much of the West, the City faces many challenges, including reduced surface water import and local groundwater pumping (via the Fox Canyon Groundwater Management Agency) as well as mandatory reductions in potable water use. In response, the City has tried to find ways to deliver recycled water to its users.

Although the AWPF is operational and designed to produce 6.25 mgd of high quality advanced treated reverse osmosis (RO) recycled water, the City lacks the infrastructure required to deliver all of the recycled water it produces. Thus, the City has initiated plans to design and construct a distribution pipeline along Heuneme Road to deliver water to agricultural customers in the Oxnard Plain. However, it will take several years for this pipeline to be constructed and operational.

Since the CMWD Salinity Management Pipeline's route (SMP) runs parallel to the City’s planned pipeline and the SMP was underutilized at the time, the City saw an opportunity to use the CMWD SMP to temporarily deliver water to agricultural customers in the Oxnard Plain. In response, the Los Angeles Regional Water Quality Control Board (RWQCB) amended the City’s waste discharge requirements (WDRs), Order No. R4-2011-0079-A01 and Monitoring and Reporting Program R4-2008-A01, in July of 2015 to allow temporary use of the SMP to deliver AWPF water to farmers. Delivery of recycled water via the SMP began in early 2016.

Metropolitan Water District Conservation and Retrofit Grants:

The Metropolitan Water District offers recycled water retrofit grants to its retail customers. To take advantage of this program, the City applied for several grants, receiving one for its River Ridge golf courses. The City also plans to apply for grants for its other urban use customers as they show interest and in and commitment to utilizing recycled water and eventually use it as a water source.

Recycled Water Retrofits:

When the recycled water retrofit program began in 2010, emphasis was on retrofitting urban projects such as golf courses, parks, school yards, cemeteries, and other commercial facilities. Once the urban project began to identify and interview potential users for these retrofits, agricultural users' interest in and acceptance of recycled water grew. As a result, by 2012, the project emphasized urban reuse less and reuse for agricultural purposes more.

Currently, the City delivers recycled water to the two adjacent River Ridge golf courses and has made plans to deliver recycled water to the RiverPark development and the adjacent paper company. The City has also committed to serving the agricultural community, with user agreements already in place. In addition, in 2015, the City expanded an initiative to connect other urban irrigation users along the recycled water backbone pipeline. These projects help with the drought-mandated water use reductions and were coordinated with the long-term projects recommended in this Integrated Master Plan.

3.2.9 Staffing

Through these planning efforts, the City could review staffing needs throughout the Public Works Department. The City also conducted a salary survey from January 2015 through March 2015. For this survey, the following tasks were performed:

- Job descriptions for 92 total classifications were reviewed to understand each classification's duties and responsibilities; the survey's appropriate classification benchmarks for all classifications were then identified.
- Organization, classification, and salary data/material were gathered from ±18 comparable agencies relevant to the department’s competitive labor market.
- Job comparability analyses were conducted for the benchmark classes in each survey agency.
- Internal relationship analyses were conducted for department positions within the department and for classifications across other City departments to determine commonalities and linkages.
- The external market survey data and the results of an internal job content relationship analysis were used to develop specific salary range slotting recommendations within the City’s current salary grade/range structure for all Utilities & Engineering Department positions.

Through this analysis, the following five priority positions were deemed necessary for the City:

- Environmental Compliance and Water Supply Management Division Manager.
- Technical Services/Water Quality Manager.
- Wastewater Division Manager.
- Wastewater Operations Manager/Chief Operator.
- Water Division Manager.

For each position, a subconsultant for Carollo worked to evaluate staffing needs and helped the City develop and implement strategies for recruiting and advertising for the positions.

3.2.10 Streets

A final key point of integration for the Integrated Master Plan involves the City's Streets Master Plan. To minimize overall disruption to the community, planned improvements recommended for the Master Plan must be coordinated with street upgrades.

Existing documents that outline current and future street planning efforts were reviewed and summarized for the Integrated Master Plan. The specific planning documents reviewed include:

- Pavement Management Plan.
- Oxnard Bicycle and Pedestrian Facilities Master Plan.
- Intelligent Transportation Systems Master Plan.
- City of Oxnard Green Alleys Plan.
- Oxnard Transportation Demand Management Plan.
- Santa Clara River Trail Master Plan.
- Oxnard 2030 General Plan.

Based on the findings in these documents, a Streets Master Plan was developed. A large component of the Streets Master Plan involves integrating the Integrated Master Plan's recommended capital improvement projects across all disciplines into one living Geographic Information Systems (GIS) database that also houses existing infrastructure information. This database will provide the City with a dynamic management tool that explicitly optimizes the timing of water infrastructure related projects to minimize construction projects' impact on affected communities and coordinate such projects with street improvement projects and the projects recommended in the summarized reports.

WATER SYSTEM MASTER PLAN

4.1 INTRODUCTION

The City provides a blend of surface and groundwater through its water distribution system, which consists of six blending stations (BS) that take water from each of the City's water sources and combine it before distributing it throughout the City.

In addition to the overall Integrated Master Plan goals established in Chapter 2, planning efforts identified specific goals for the water supply. These goals are as follows:

- Goal 1: Provide reliable/resilient supply to meet future conditions (i.e., changes to demand, regulations, and water quality).
- Goal 2: Meet the City’s water quality objectives.
- Goal 3: Protect existing water rights by maximizing use of groundwater allocation.
- Goal 4: Minimize future reliance on imports by maximizing use of AWPF-produced water.
- Goal 5: Attract industry and jobs.
- Goal 6: Keep rates affordable.

This chapter will provide an overview of the existing water system and its strengths and vulnerabilities, as well as the regulatory requirements and climate change issues the system will face. This chapter also makes recommendations for meeting the defined goals.

The analysis and evaluations contained in this Summary Report are based on data and information available at the time of the original date of publication of the Project Memos (PMs), December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). The complete updated CIP based on the near-term and long-term projects is contained in Appendix B.

4.2 DESCRIPTION OF EXISTING FACILITIES

4.2.1 Source of Supply

To serve its constituents, the City of Oxnard gets water from the following sources:

- *Groundwater* from local wells that draw from the Oxnard Plain Groundwater Basin (some of which are treated through reverse osmosis).

- *Groundwater* from the United Water Conservation District (UWCD), which draws from the Oxnard Plain Forebay.
- *Surface Water* imported from the State Water Project via the Calleguas Municipal Water District (CMWD).
- *Recycled Water* from the Advanced Water Purification Facility (AWPF) (discussed in detail in Chapter 6 - Recycled Water System).

4.2.2 Treatment/Blending

Although the exact ratio of the blend at the City's blending stations varies, the City stated that future blending will be in a 1:1 (surface water to groundwater) ratio. This ratio produces water with a total dissolved solids (TDS) level between 600 and 700 mg/L, which meets the upper limit of the secondary drinking water standards (1,000 mg/L) at a fairly cost-effective unit rate.

Figure 4.1 is a schematic of the City's water system, showing how the six blending stations are linked together. Figure 4.2 is a map of the City's water system facilities, including the locations of the blending stations. Table 4.1 summarizes the major characteristics of each blending station. The City's individual facilities are all described in the following sections.

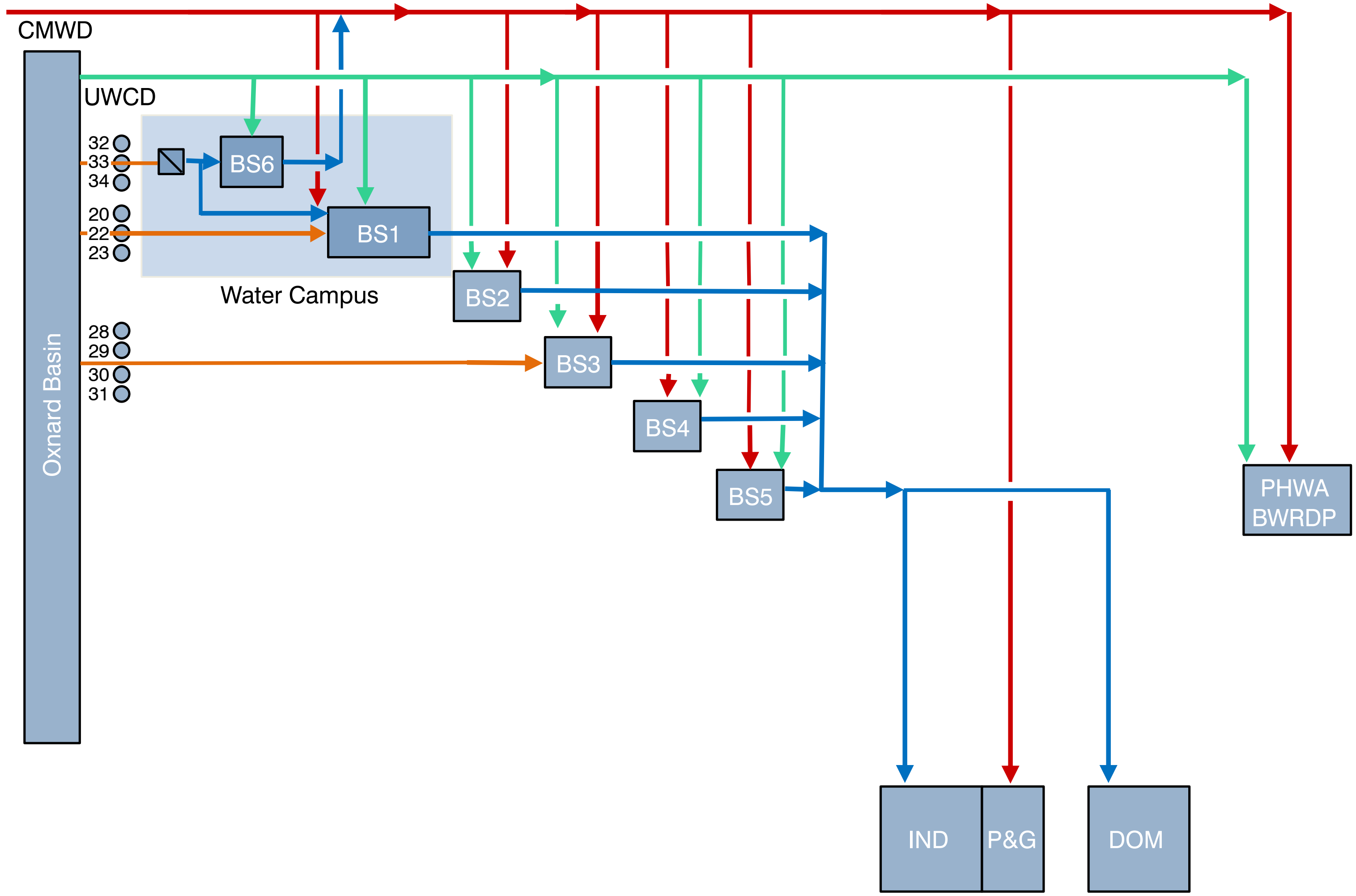
4.2.3 Distribution System

To reflect the system's ongoing growth, the City's transmission and distribution system consists of a variety of pipe types and sizes. To manage these pipes, the City has implemented an infrastructure management system (GIS database) that it continually populates with pipe attributes (diameter, material, year installed, etc.).

Based on the 2013 March GIS database, the distribution system includes nearly 613 miles, or 3.25 million linear feet, of pipe, the majority of which is between 6 to 12 inches in diameter. Figure 4.3 illustrates the City's existing water distribution system.

The City's water system currently operates in one pressure zone. However, some areas of the City have difficulties with pressures higher than the 80 pounds per square inch (psi) maximum pressure desired for the system while other areas need to be augmented to meet the minimum pressure targets.

The only above-ground engineered storage facilities within the system are the 600,000 gallons of permeate storage at Blending Stations (BS) No. 1 and No. 6, which are located adjacent to each other and referred to collectively as BS Nos. 1/6. The City also uses 70 percent of the 18.0 million gallon (MG) Springville Reservoir owned by CMWD. In total, the City has 12.5 MG of above-ground storage.



OVERALL WATER SYSTEM SCHEMATIC

FIGURE 4.1

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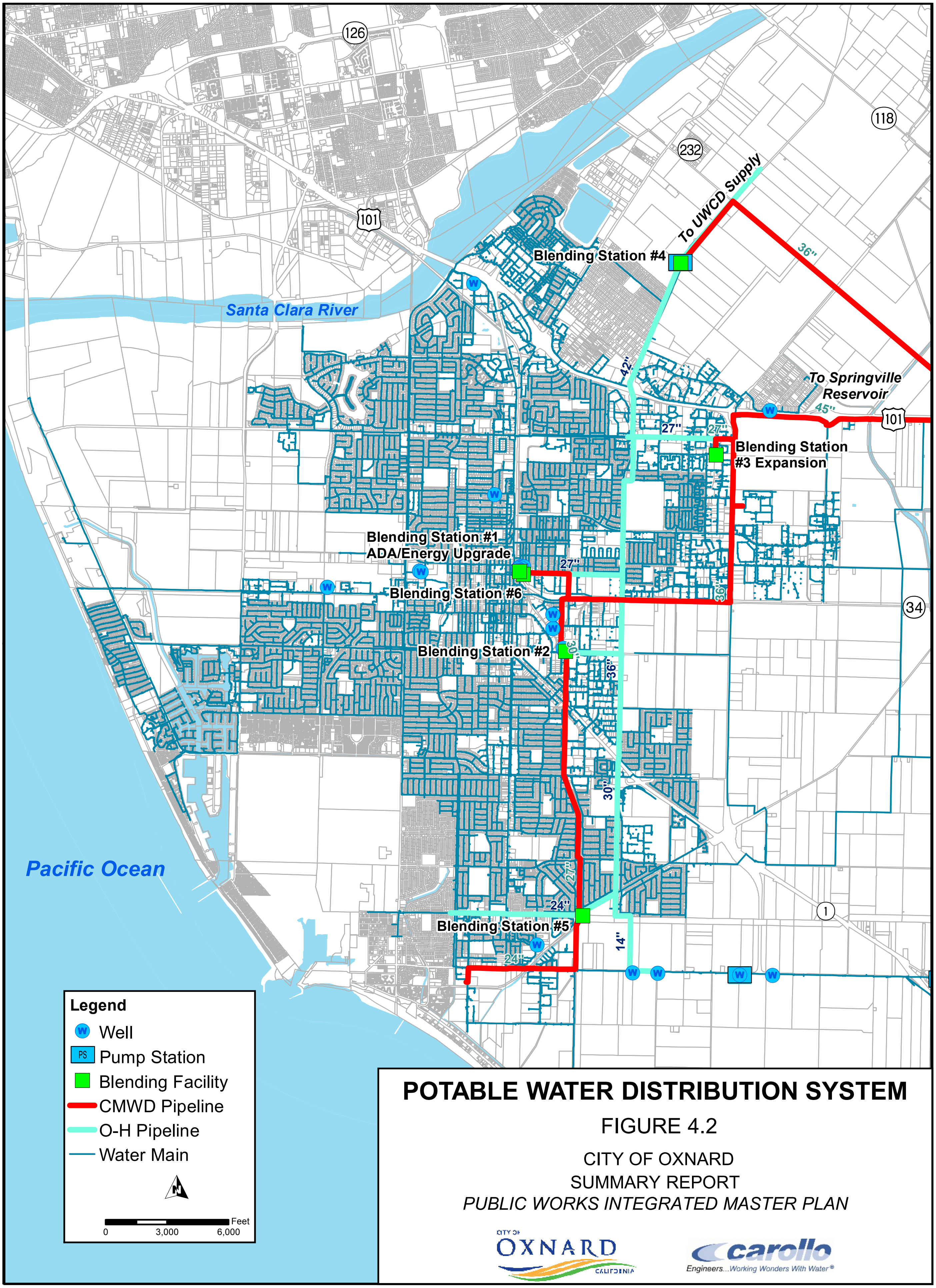

POTABLE WATER DISTRIBUTION SYSTEM

FIGURE 4.2

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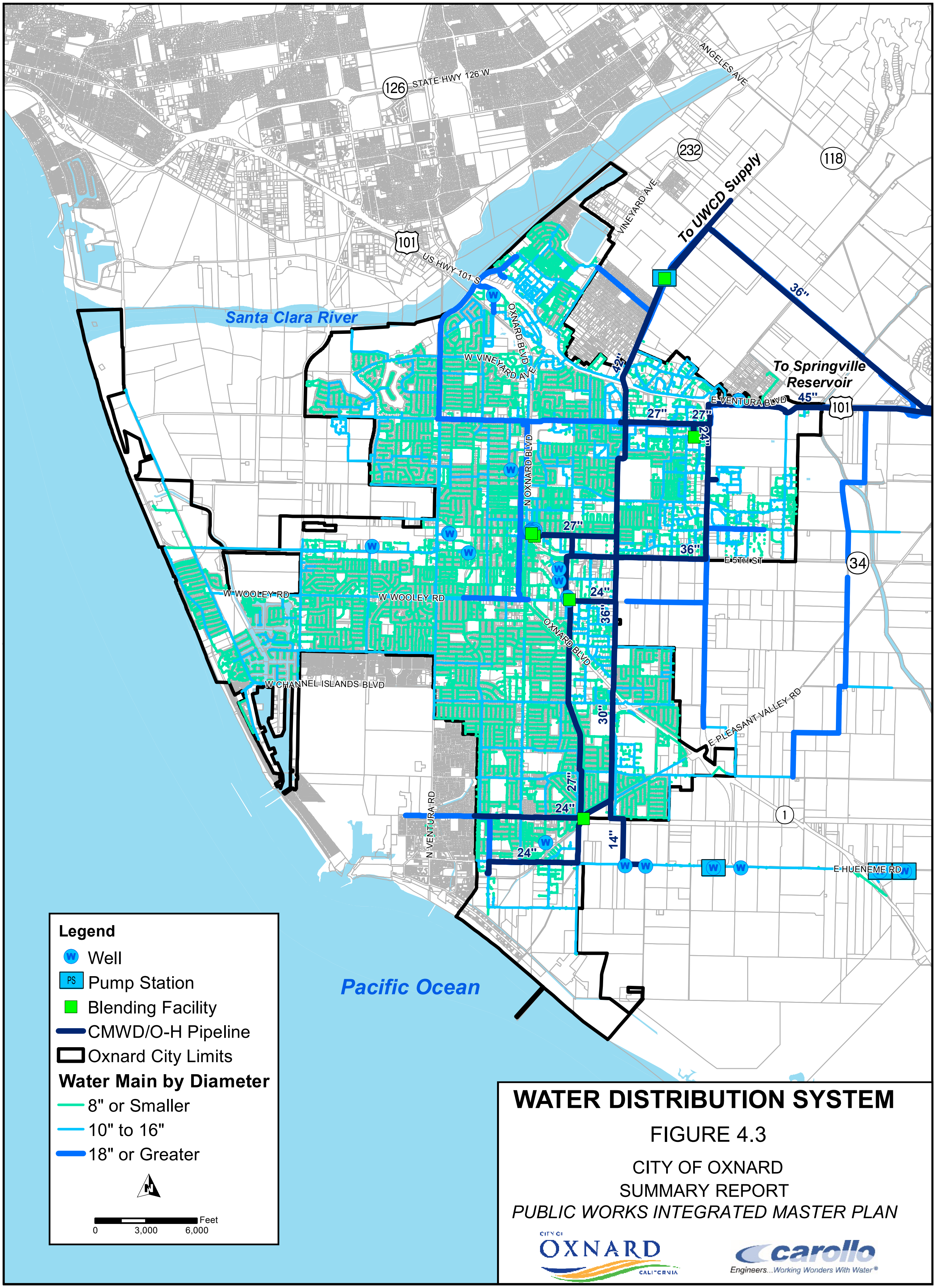
Table 4.1 Blending Station Facility Summary
Public Works Integrated Master Plan
City of Oxnard

	BS No. 1	**BS No. 2**	**BS No. 3**	**BS No. 4**	**BS No. 5**	**BS No. 6**
Location	Third Ave. & Hayes	E Wooley & Richmond Rd	Southwest of Gonzales Rd and Rice Ave.	N Rose Ave South of Central Ave.	Pleasant Valley Rd East of Saviers Rd.	Co-Located with BS No. 1
Status	Operational	Stand-By	Operational	Operational	Operational	Operational
Construction Date	1900 Updates in 1965, 1986, 2008	1971	1975 Update in 2006	1994	2007	2010
Local Wells Available	**Yes**	**No**	**Yes**	**No**	**No**	**Yes**
Well No. - Capacity gallons per minute (gpm)	20 – 2,900 22 – 3,000 23 – 2,800	--	28 – 2,000 29 – 3,000 30 – 2,000 31 – 2,000	--	--	32 – 2,000(1) 33 – 3,000(1) 34 – 2,500(1)
Total Well Capacity, mgd	12.5	--	13	--	--	10.8
Imported Water Available						
CMWD Capacity, mgd	29.5	18.7	42	27.8	8	--
UWCD Capacity, mgd	29.5	27.8	29.5	30.2	8	--
Treatment	**Yes**	**No**	**Yes**	**No**	**No**	**Yes**
Type	Desalting [reverse osmosis(RO)] & Chloramination	--	Chloramination	--	--	Desalting [reverse osmosis(RO)] & Chloramination
Capacity, mgd	--	--	--	--	--	7.5 (permeate)
Permeate Storage, gallons	--	--	--	--	--	600,000
Backup Generator	Yes 3 @ 750 kW	No --	Yes 1 @ 1,000 kW	Yes 1 @ 500 kW	No --	No --

Notes:

(1) These wells are fed directly to the desalter at BS No. 6. Due to water quality, the wells are not able to blend directly into the City's distribution system.



WATER DISTRIBUTION SYSTEM

FIGURE 4.3

CITY OF OXNARD
SUMMARY REPORT
PUBLIC WORKS INTEGRATED MASTER PLAN

4.2.4 Condition Assessment

A condition assessment was conducted to identify rehabilitation and replacement (R&R, or renewal) needs for the City's water system. For this effort, asset management methodology was used to identify existing water assets and to conduct a visual condition assessment of above-ground assets. The effort also included an evaluation of structures, a desktop evaluation of below-ground assets, and a cathodic protection system evaluation.

To prioritize the R&R needs, a risk assessment was also conducted that examined the vulnerability (likelihood of failure) and criticality (consequence of failure) for each asset. Consistent risk scoring methodology was applied to both above- and below-ground assets to prioritize each asset type.

4.2.4.1 Above Ground Assets

In total, 165 above-ground assets were assessed, including structures and equipment owned and operated by the City. Specifically, Carollo observed approximately 11 building structures, 41 pumps, 16 wells, and a variety of other assets, with the recorded age of each asset varying from 1965 to the present. Each asset was placed into an inventory and categorized according to its asset type and discipline.

Table 4.2 lists the assets with the highest above-ground risk, which was determined from the assessment. The results of the condition assessment analysis are as follows:

- Water Campus BS No. 1/6 – fair to good condition with a few exceptions noted in Table 2.
- BS No. 2 – fair to poor condition.
- BS No. 3 – fair to very good condition, with two wells (Well Nos. 30 and 31) in need of minor rehabilitation.
- BS No. 4 – fair to poor condition, with three Variable Frequency Drives (VFDs), two pumps, electrical equipment, and a central valve train in disrepair.
- BS No. 5 – fair to good condition.
- Wells – fair to good condition, except as noted in Table 4.2.

Table 4.2 Highest Above-Ground Risk Assets
Public Works Integrated Master Plan
City of Oxnard

Site/Asset	Risk[1]
Blend Station 2	
Supervisory Control and Data Acquisition (SCADA) System	2.01
Water Campus (BS1 and BS6)	
RO Building RO Filter (#1-3)	0.48
RO Building Cartridge Filter (#1-4)	0.48
Chemical Building Lab PLC	0.33

Table 4.2 Highest Above-Ground Risk Assets Public Works Integrated Master Plan City of Oxnard	
Site/Asset	**Risk(1)**
Well 18	
Motor Control Center (MCC) Single Box	0.40
Pump	0.36
Well 27	
MCC Cabinet	0.40
Pump	0.36
Blend Station 4	
Standby Generator	0.30
MCC	0.30
Switchboard	0.30

Note:

(1) Risk = Criticality x Vulnerability; Criticality = consequence of failure; Vulnerability = likelihood of asset failure.

4.2.4.2 Below-Ground Assets

Using GIS data of the Oxnard distribution system, a desktop evaluation was conducted on the City's below-ground water system assets. The dataset included information on the diameters and materials used for 30,632 of the 39,341 segments. The year of installation for each asset was available for 38,065 of the 39,341 segments.

A pipe's useful life will vary based on several factors, with pipe age and material the easiest to quantify. The majority (72 percent) of the City's distribution piping is of two types: asbestos cement pipe and polyvinyl chloride, which have relatively long useful lives of 65 and 85 years, respectively. However, approximately 87 percent of the asbestos cement pipe installed in the City is more than 30 years old. The polyvinyl chloride piping is relatively newer, with the majority installed within the last 20 years.

4.2.5 Cathodic Protection

A survey was conducted on the City's water infrastructure to assess the existing level of cathodic protection. From this assessment, the following improvements were identified:

- Several Key Pipelines: Install new test stations and replace rectifiers and anode-ground beds (Del Norte Pipeline, Oxnard Conduit, Wooley Road/United, 3rd Street Lateral, Industrial Lateral).
- Water Treatment Facility at BS No. 1/6: Investigate requirements of electrical isolation and cathodic protection (CP) of buried piping; design and install as needed.

- 600,000 Gallon Steel Water Tank at the Water Treatment Facility: Install internal CP system.

In addition to these projects, conducting an annual cathodic protection survey, providing a report for all City facilities, and bi-monthly rectifier monitoring is also recommended in the Integrated Master Plan.

4.2.6 Electrical Systems Protection

A study of the electrical systems for the existing six blending stations was performed. The study included a short circuit study, a protective device coordination evaluation, and an arc flash evaluation.

These evaluations were performed for distinct reasons. The short circuit study determined the short circuit current available at each piece of electrical equipment and identified underrated equipment. The protective device coordination evaluation identified protective devices (circuit breakers, fuses, etc.) that were not coordinated in the electrical system and might not minimize disruption of electrical power during a short circuit. The arc flash evaluation determined the maximum arc flash incident energy at each piece of electrical equipment and identified appropriate personnel protective equipment to be worn if work is performed on the equipment while it is being energized.

The results of the electrical systems investigation were then used to develop the electrical system study for each site. Study results identified pieces of existing electrical distribution equipment not sufficiently rated for the worst-case short circuit current and showed the arc flash incident energy at each piece of electrical equipment based on the existing protective device settings.

Concerns and code violations in the existing electrical equipment installations were observed and documented. Obsolete equipment and equipment nearing the end of its useful life were identified, as were equipment in need of repair and possible changes in the existing installation from code violations, such as equipment needing painting or relocation or incorrectly labeled equipment.

4.2.7 Operational Approach and Strategy of Existing System

Generally, the blending stations are operated to provide a target blended water quality and to meet system pressures. Table 4.3 shows the overall production breakdown by blending station as well as the approximate blend of the three major sources at each blending station.

Table 4.3 Operational Approach to Blend Station Source Breakdown[1] Public Works Integrated Master Plan City of Oxnard						
	BS No. 1	**BS No. 2**	**BS No. 3**	**BS No. 4**	**BS No. 5**	**Desalter Permeate Flow[2]**
Overall Annual Production[3]	23%	0.1%	30%	13%	3%	13%
Production by Source						
CMWD	22%	39%	47%	53%	46%	0%
UWCD	60%	61%	26%	47%	54%	0.5%
Local Wells	18%		27%			99.5%

Notes:

(1) Based on annual average production data provided by the City from 2009-2012.
(2) Based on permeate from the BS No. 6 desalter.
(3) For these to add up to 100 percent, contributions to industrial from UWCD (4 percent) and CMWD (13 percent) need to be added.

4.3 WATER SUPPLY

As noted, the City obtains drinking water from three primary sources: local groundwater, groundwater from the UWCD, and water imported from the CWMD. A thorough analysis of the City's water supply is included in the *2010 Urban Water Management Plan* (Kennedy/Jenks, 2012). Relevant information from that study was summarized and updated, as necessary, for use in this Plan.

4.3.1 Historical/Existing Supply

Table 4.4 summarizes the City's historical and current water supply allocations. This information was derived from the 2010 Urban Water Management Plan and was updated throughout the Integrated Master Plan development process with the most current information known at the time of development.

Table 4.5 presents the historical water production from 2002 through 2013 according to water supply source. As shown in the table, the City's total water supply has remained relatively constant between 2002 and 2013, fluctuating only between 26,919 and 28,826 acre feet per year (AFY). The annual water supply in 2013 was 28,443 AFY, or 25.4 mgd.

Table 4.4 Current Water Supply Allocations
Public Works Integrated Master Plan
City of Oxnard

Source	Type of Source	Transport Facility Details	Historical Source Allocation	Current Source Allocation
Local Wells	Groundwater	10 wells	• Baseline: 936 AFY(1) • Historical Pumping: 11,205 AFY(1) • One-Time Ferro Pit Credit: 11,000 AFY + 1,000 AFY per year (2012 – 2019)(1) • 700 AFY Transfer from Port Hueneme Water Agency (PHWA) (2002 Three-Party Agreement)(1)	• 7,186 AFY(2) • 700 AFY Transfer from (PHWA) (2002 Three-Party Agreement)
Calleguas Municipal Water District	Surface Water	Treated State Water Project water via Springville Reservoir and the Oxnard and Del Norte Conduits (36 inch)	Tier 1 Entitlement of 17,379 AFY(3)	Tier 1 Entitlement of 13,826 AFY(4)
United Water Conservation District	Groundwater	Oxnard-Hueneme Pipeline (42 inch)	• 9,378 AFY(5)	• 7,328 AFY(1)

Notes:

(1) Based on historical pumping.
(2) Groundwater pumping allocations have been reduced due to Emergency Ordinance E, Temporary Emergency Allocation.
(3) Tier 1 water (from Metropolitan Water District of Southern California) corresponds to the amount “contracted for” by the City. It is in essence a capacity reservation and includes the water being delivered to PHWA.
(4) Based upon current planning efforts for 2015 Urban Water Management Plan.
(5) Based upon "new" historical pumping (from Jan 1, 2003, to Dec 31, 2012) as noted in the Emergency Ordinance E.

According to Table 4.4 and Table 4.5, the City generally uses less water than allocated from the three main uses, with some exceptions. Historic use is factored into water supply availability in the future.

Table 4.5 Historical Annual Water Supply by Source
Public Works Integrated Master Plan
City of Oxnard

Year	Groundwater[(1)] (AFY)	UWCD Water (AFY)	CWMD Water (AFY)	System Total (AFY)
2002	6,971	7,067	13,170	**27,208**
2003	6,784	8,834	11,302	**26,919**
2004	12,743	3,820	11,717	**28,279**
2005	12,933	3,159	11,262	**27,354**
2006	14,056	4,001	9,964	**28,021**
2007	440	16,660	11,453	**28,552**
2008	4,245	9,863	13,573	**27,681**
2009	7,478	13,036	8,311	**28,826**
2010	7,172	10,852	9,769	**27,793**
2011	10,731	6,372	10,549	**27,652**
2012	5,174	9,828	12,538	**27,539**
2013	5,748	9,424	13,271	**28,443**

Note:
Source: Production data provided by the City.
(1) Includes water lost to brine from the City's desalter.

4.3.2 Historical/Existing Supply Quality

As noted in Section 4.2.7, the water quality of the blended sources dictates the amount of water drawn from each source, making it central to the water system's operation.

TDS is the primary driver for water quality. For TDS, the system produces a blended water quality of less than 700 mg/L. Although hardness is not currently a driver, it will likely be in the future. Table 4.6 summarizes the water quality of the various sources available to the City.

Table 4.6 Water Quality of Existing and Potential Sources of Water Public Works Integrated Master Plan City of Oxnard			
Source	**TDS, mg/L**	**Hardness, mg/L**	**Nitrate, mg/L**
CMWD[(1)]	350	120	10-60
UWCD[(2)]	1,000	530	22-50
Local Wells[(3)]	1,200	700	31
AWPF Effluent	50[(4)]	80[(5)]	--
Current Blended Distribution System[(6)]	700	350	<45

Notes:
(1) Based on CMWD's 2013 Annual Water Quality Report.
(2) Based on UWCD historical water quality data from 2009-2014.
(3) Based on local well water quality data from 2013-2104 and the City of Oxnard's 2013 Annual Water Quality Report.
(4) Based on AWPF 2015 monitoring data.
(5) Based on AWPF pilot performance.
(6) Based on the City of Oxnard's Annual Report Data.

4.3.3 Projected Supply

The City's available water supply was projected from 2015 to 2040, which is the end of the planning horizon. This projection was predicated on the following assumptions:

- Imported surface water from CMWD remains equal to the historical allocation.
- Groundwater pumping is restricted to between 50 and 75 percent of historical allocation by the Fox Canyon Groundwater Management Agency (FCGMA).
- Future additional groundwater credits are not reliable and are therefore not included.
- Pump-back allocation for any recycled water (RW) supplied to agricultural users will be at a 1:1 ratio, with a maximum of 5,200 AFY available.

Table 4.7 and Table 4.8 summarize the existing and projected available water supply for the two groundwater pumping restriction assumptions: low (75 percent) and high (50 percent), respectively.

Table 4.7 Summary of Projected Supply (assuming Low Groundwater Pumping Restriction[(1)])
Public Works Integrated Master Plan
City of Oxnard

Supply	Historical Allocation	Projected Supply/Demand (AFY)					
		2015	**2020**	**2025**	**2030**	**2035**	**2040**
Local Groundwater[(2)]	12,456	7,348[(11)]	9,581	9,581	9,581	9,581	9,581
Baseline	*954*	--	*954*	*954*	*954*	*954*	*954*
Historical Use	*11,502*	--	*8,627*	*8,627*	*8,627*	*8,627*	*8,627*
UWCD[(3)]	9,070	7,161[(11)]	6,803	6,803	6,803	6,803	6,803
CMWD[(4)]	12,500	13,826	13,826	13,826	13,826	13,826	13,826
Ag Development Re-Allocation[(5)]		0	149	376	603	830	1,057
Subtotal Supply		**28,335**	**30,359**	**30,586**	**30,813**	**31,040**	**31,267**
Recycled Water Offset[(6)]		--	1,475	1,475	1,475	1,475	1,475
Loss (Brine)[(7)]		(800)	(1,890)	(1,890)	(1,890)	(1,890)	(1,890)
Total Firm Supply		**27,535**	**29,944**	**30,171**	**30,398**	**30,625**	**30,852**
Other Potential Supplies							
PHWA Exchange[(8)]		700	700	700	700	700	
RW Pump Back Allocation[(9)]		--	3,620	3,620	3,620	3,620	3,620
Good Deeds Trust[(10)]		1,000					
Total Potential Supply		**29,235**	**34,264**	**34,491**	**34,718**	**34,945**	**34,472**

Notes:
(1) A restriction in the groundwater pumping of 75 percent of historical allocation (regulated by the FCGMA) is assumed on all groundwater sources, unless otherwise noted.
(2) The City's groundwater allocation is made up of a baseline and historical use allocation. The assumed FCGMA restriction on groundwater pumping is applied to the historical allocation only.
(3) The assumed FCGMA restriction is applied to the historical UWCD allocation.
(4) CMWD projection Tier 1 allocation as of Jan 1, 2015. It does not include 4,700 AFY allocated to PWHA.
(5) Estimate for ag reallocation is based on planned ag conversion acreage through 2040 and on using a reallocation factor of 1 AFY per acre converted.
(6) Based on contracts as of 2015; does not account for future urban or ag uses at this time. For details, see PM 4.2.
(7) Based on an existing (as of 2015) desalting capacity of 7.5 mgd (8,400 AFY).
(8) Annual transfer of FCGMA credits from PWHA, per 2002 Three Party Water Supply Agreement.
(9) Based on a 1:1 pump-back allocation ratio of RW supplied to ag users (Southland, Houweling, Reiter, and River Ridge Golf Course).
(10) Only through 2019. UWCD has not transferred the allocation since 2013, and the City has requested a refund for payments made.
(11) Based on Emergency Ordinance E, Temporary Allocations.

Table 4.8 Summary of Projected Supply (Assuming High Groundwater Pumping Restriction[1])
Public Works Integrated Master Plan
City of Oxnard

Supply	Historical Allocation	Projected Supply/Demand (AFY)					
		2015	2020	2025	2030	2035	2040
Local Groundwater[2]	12,456	7,348[11]	6,705	6,705	6,705	6,705	6,705
Baseline	*954*	--	*954*	*954*	*954*	*954*	*954*
Historical Use	*11,502*	--	*5,751*	*5,751*	*5,751*	*5,751*	*5,751*
UWCD[3]	9,070	7,161[11]	4,535	4,535	4,535	4,535	4,535
CMWD[4]	12,500	13,826	13,826	13,826	13,826	13,826	13,826
Ag Development Re-Allocation[5]		0	149	376	603	830	1,057
Subtotal Supply		**28,335**	**25,215**	**25,442**	**25,669**	**25,896**	**26,123**
Recycled Water Offset[6]		--	1,475	1,475	1,475	1,475	1,475
Loss (Brine)[7]		(800)	(1,890)	(1,890)	(1,890)	(1,890)	(1,890)
Total Firm Supply		**27,535**	**24,800**	**25,027**	**25,254**	**25,481**	**25,708**
Other Potential Supplies							
PHWA Exchange[8]		700	700	700	700	700	
RW Pump Back Allocation[9]		--	1,810	1,810	1,810	1,810	1,810
Good Deeds Trust[10]		1,000					
Total Potential Supply		**29,235**	**27,310**	**27,537**	**27,764**	**27,991**	**27,518**

Notes:
(1) A restriction in the groundwater pumping of 50 percent of historical allocation (regulated by the FCGMA) is assumed on all groundwater sources, unless otherwise noted.
(2) The City's groundwater allocation is made up of a baseline and historical use allocation. The assumed FCGMA restriction on groundwater pumping is applied to the historical allocation only.
(3) The assumed FCGMA restriction is applied to the historical UWCD allocation.
(4) CMWD projection is based on Tier 1 allocation as of Jan 1, 2015. It does not include 4,700 AFY allocated to PWHA.
(5) Estimate for ag re-allocation is based upon planned ag conversion acreage through 2040 and using a re-allocation factor of 1 AFY per acre converted.
(6) Based on contracts as of 2015; does not account for future urban or ag uses at this time. For details, see PM 4.2.
(7) Based on existing (as of 2015) desalting capacity of 7.5 mgd (8,400 AFY).
(8) Annual transfer of FCGMA credits from PWHA, per 2002 Three Party Water Supply Agreement.
(9) Only through 2019. UWCD has not transferred the allocation since 2013 and the City has requested a refund for payments made.
(10) Based on a 0.5:1 pump-back allocation ratio of RW supplied to ag users (Southland, Houweling, Reiter, and River Ridge Golf Course).
(11) Based on Emergency Ordinance E, Temporary Allocations.

4.4 WATER DEMANDS

Water demands represent water that leaves the distribution system through metered connections, unmetered connections, pipe joints (leaks), or breaks. Water demands occur throughout the distribution system and are based on the number and type of consumers in each location.

4.4.1 Historical Water Demands

The City has provided historical customer billing records per account for 2002 through 2012. These records are summarized in Table 4.9 and Figure 4.4.

As shown in Table 4.9, residential is the largest category of the City's demands, with the combined single- and multi-family water demand comprising 53 percent of the City's total demand. This percentage is relatively low because industrial users have high demands, with Proctor and Gamble alone generating 8.5 percent of demand. Other users make up 5.8 percent.

Figure 4.4 illustrates the seasonal demand categorized according to use type. Since most commercial and multi-family residential sites will also include a separate irrigation meter, commercial and multi-family residential demands are fairly consistent throughout the year. Seasonal peaking is most pronounced in the single family residential, industry (other than Proctor and Gamble) irrigation, and agricultural use types.

4.4.2 Projected Water Demands

Typically, water demand based on land use is projected from a combination of General Plan information, specific plans, vacant land information, aerial photography, and water demand factors. The City's projected water demands are made up of two main components:

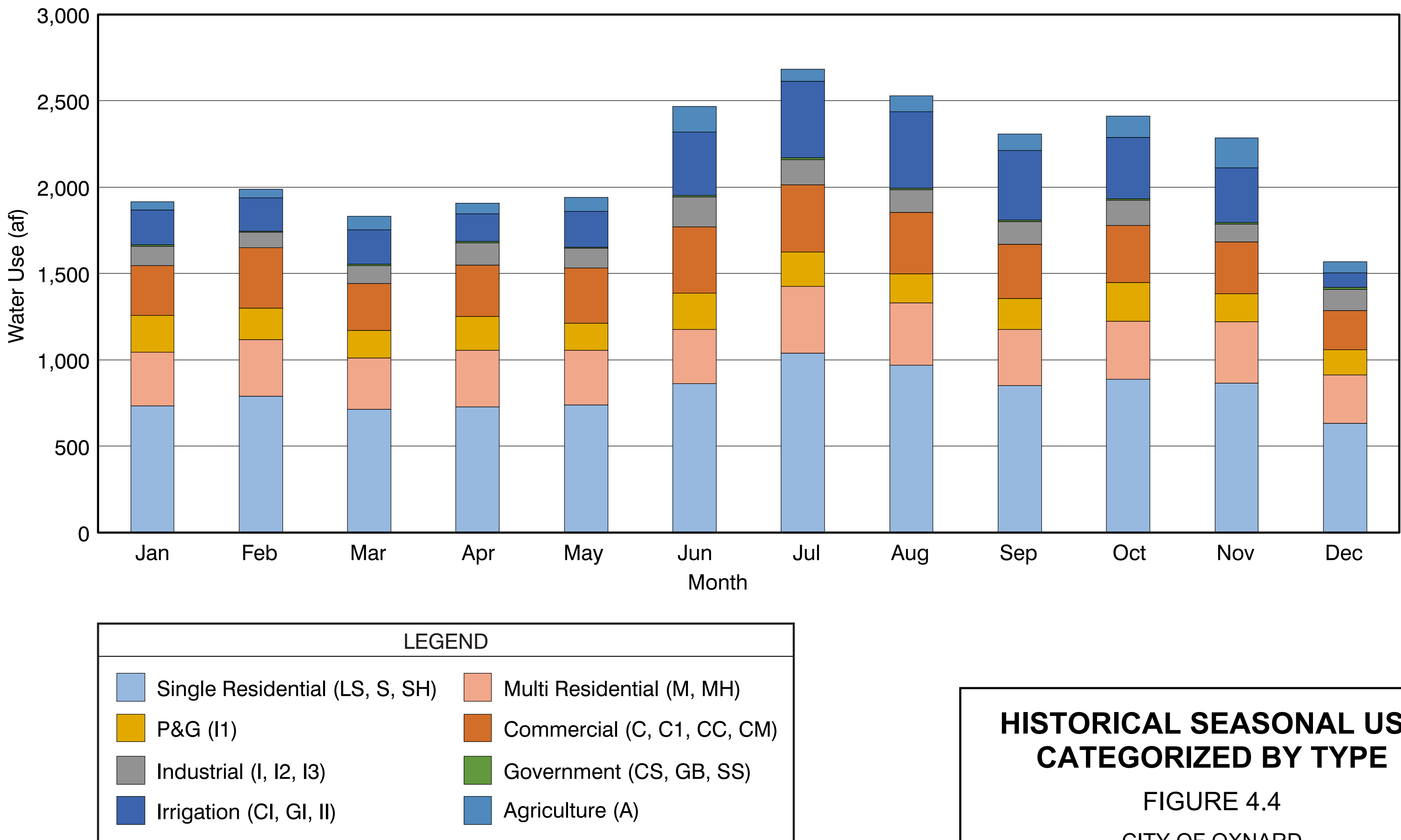
- Residential Development: Future demand estimated using three main factors: 1) projected population increase reported in number of new dwelling units, 2) the population density of the dwelling units (set at 4 persons per dwelling unit), and 3) the water use target (per person).
- Commercial/Industrial Development: Future demand estimated using the City's plans for near-term (through 2020) and long-term (through 2040) developments.

Though residential demand has steadily declined in recent years from drought conditions and a robust conservation program, a water usage target of 132.4 gallons per day per capita (gpcd) was used to estimate future demand. There are two reasons for this. First, the City may see water usage rebound since the recession has ended and the State has enacted mandatory use restrictions because of drought. Second, for the year 2020, the Water Conservation Act of 2009 (Senate Bill X7-7) target is 132.4 gpcd.

Table 4.9	Historical Annual Consumption by Customer Class Public Works Integrated Master Plan City of Oxnard								
Calendar Year	Annual Demand by Customer Class (AFY)								Total Annual Demand (AFY)
	Single Family Residential	Multi-Family Residential	Commercial	Industrial	Proctor & Gamble	Government	Irrigation	Agriculture	
2002	10,753	4,317	4,089	1,750	2,331	140	2,911	1	26,291
2003	10,694	4,274	3,904	1,791	2,370	152	2,712	1	25,898
2004	11,327	4,339	3,938	1,809	2,309	142	3,396	2	27,262
2005	10,886	4,212	4,040	1,704	2,386	141	3,003	2	26,373
2006	11,153	4,152	4,237	1,689	2,207	155	3,143	2	26,738
2007	11,478	4,114	4,216	1,708	1,618	146	3,529	2	26,811
2008	10,893	4,128	4,083	1,624	1,593	110	3,693	441	26,565
2009	10,608	4,097	3,654	1,225	1,481	88	3,458	1,155	25,766
2010	9,794	3,969	3,459	1,395	3,482	94	3,090	850	26,133
2011	9,679	3,918	3,582	1,319	2,142	95	3,037	1,069	24,842
2012	9,805	3,936	3,834	1,505	2,193	101	3,374	1,086	25,833
% of Total	**38.0%**	**15.2%**	**14.8%**	**5.8%**	**8.5%**	**0.4%**	**13.1%**	**4.2%**	

Note:

Source: Data for January 2002 through December 2012 provided by the City, excluding recycled water demand. Meters are read on a monthly basis. Customer classification was consolidated from the 21 billing classifications the City uses for its billing system.



HISTORICAL SEASONAL USE CATEGORIZED BY TYPE

FIGURE 4.4

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Population is another key variable in forecasting residential demand. As a result, a sensitivity analysis was developed for the City based on three population forecasts: a high and low population estimate from the City's 2030 General Plan and a 2014 estimate provided by the City's planning department. After discussions with the City, the 2030 General Plan low population estimate was chosen as the appropriate forecast for the water demand estimates, which resulted in a moderately conservative projected demand.

To determine the water usage for the proposed commercial/industrial developments, a water demand factor had to be assigned to each land use type, expressed in gallons per day (gpd)/acre. These were then summarized by near- and long-term developments and added to the residential demand estimates, which resulted in the average annual (AAD) and average day (ADD) water demand projections summarized in Table 4.10.

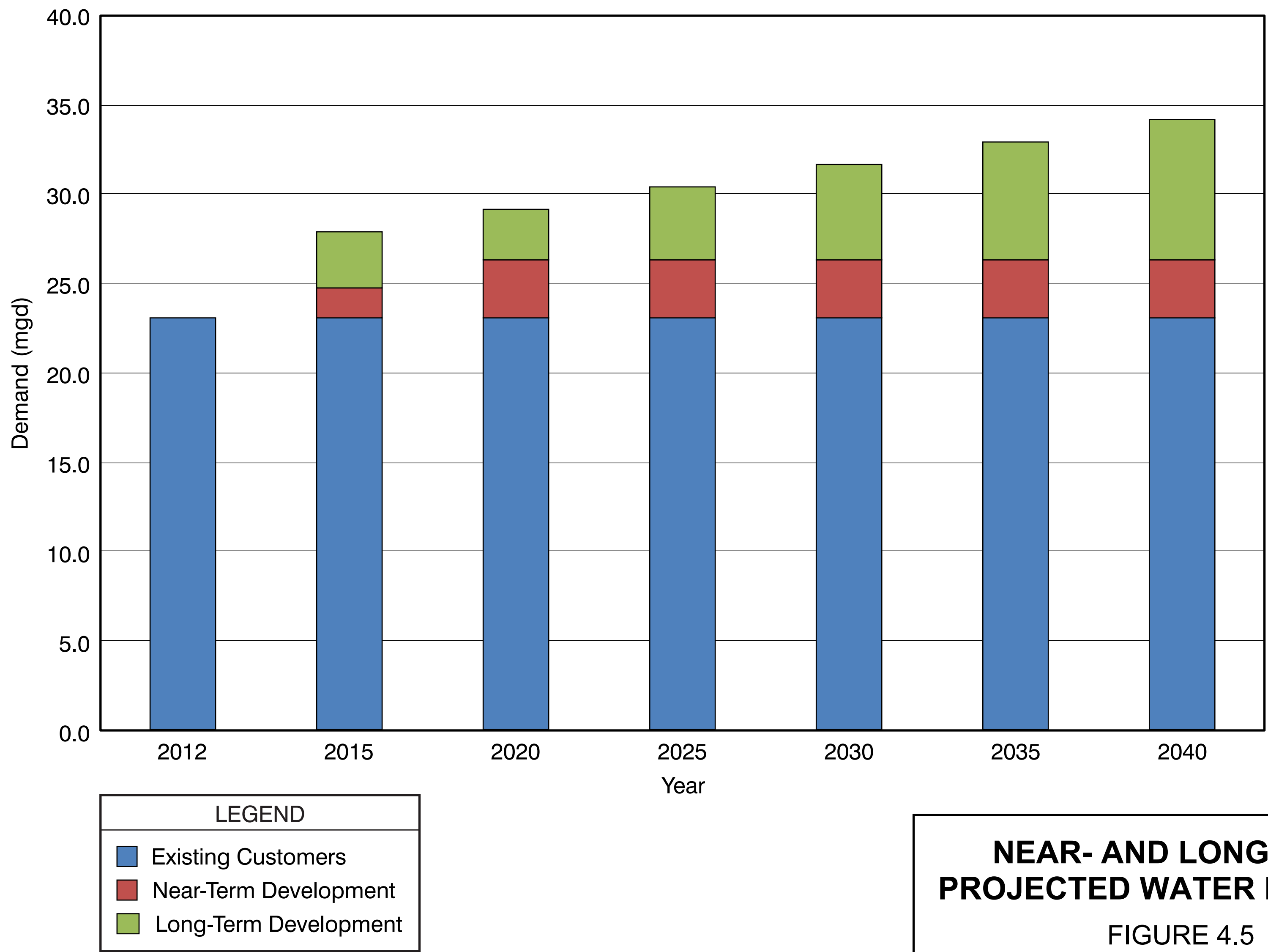
Table 4.10 Water Demand Projections
Public Works Integrated Master Plan
City of Oxnard

Year	2030 GP Population(1)	Per Capita Water Use (gpcd)	AAD(2) (AFY)	ADD (mgd)	MDD(3) (mgd)	PHD(4) (mgd)
2015	210,873	132	31,274	27.9	41.9	62.9
2020	220,248	132	32,664	29.2	43.7	65.6
2025	229,622	132	34,054	30.4	45.6	68.4
2030	238,996	132	35,445	31.6	47.5	71.2
2035	248,370	132	36,835	32.9	49.3	74.0
2040	257,744	132	38,225	34.1	51.2	76.8

Notes:
(1) This is the 2030 GP low population projection.
(2) Average annual demand forecast including residential, commercial, and industrial.
(3) Maximum Day Demand (MDD) estimated using an assumed MDD/ADD factor of 1.5.
(4) Peak Hour Demand (PHD) estimated using an assumed PHD/MDD factor of 1.5.

Peaking factors account for fluctuations in average water demand caused by seasonal or hourly conditions. The peaking factors defined for the Integrated Master Plan include maximum day demand (MDD) and peak hour demand (PHD) periods determined from the historical water system demand data for a select period and by dividing the quantity by the ADDs. Table 4.10 shows the resulting flows for MDD and PHD.

Figure 4.5 graphically shows the contributions of existing near- and long-term development customers to the total forecasted water demands. Approximately 11 mgd is associated with new developments, which equates to about 30 percent of the total 2040 demand.



NEAR- AND LONG-TERM PROJECTED WATER DEMANDS

FIGURE 4.5

CITY OF OXNARD

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CITY OF OXNARD CALIFORNIA

carollo Engineers...Working Wonders With Water®

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4.5 MASTER PLAN/DESIGN CRITERIA

Table 4.11 summarizes the key planning and design criteria used to evaluate the existing water system's ability to meet the future demand needs. These criteria were then used to evaluate alternatives and plan for future system improvements.

Table 4.11 Planning/Design Criteria for Water System
Public Works Integrated Master Plan
City of Oxnard

Description	Value	Units
Source Water Use Priority		
Local Groundwater	1	--
Recycled Water (AWPF Effluent)	2	--
UWCD	3	--
CMWD	4	--
Groundwater Allocation Assumptions		
FCGMA Pumping Allocation	50-75% of historical[(1)]	--
FCGMA Pump-Back Allocation	1:1	--
Groundwater credits	None	--
Blended Water Quality Objectives/Targets		
TDS	500	mg/L
Hardness	100	mg/L
Nitrate	45	mg/L
All Public Health Goals	Meet	--
Distribution System Pressure Criteria		
Max, without Service Lateral Pressure Regulator	80	psi
Max, Triggering Potential Improvements[(2)]	200	psi
Min, under PHD conditions	50	psi
Min, under MDD + Fire Flow conditions	20	psi
Pipeline Criteria		
Maximum Velocity at PHD	7	fps
Maximum Velocity at MDD + Fire Flow	10	fps
Design Velocity for New Pipelines	7	fps
Hazen-Williams C-factor	130	--
Minimum Size for Pipeline Replacement	8	inches

Table 4.11 Planning/Design Criteria for Water System Public Works Integrated Master Plan City of Oxnard		
Description	**Value**	**Units**
Fire Fighting Requirements		
Open Space / Single Family Residential / Multi-Family Residential	1,000/1,500/2,500	gpm for 2 hours
Commercial; Mixed Use	3,000	gpm for 4 hours
Industrial; Agricultural	4,500	gpm for 4 hours
Storage Volume Criteria		
Operational	25% of MDD	MG
Fire Fighting	Highest fire flow requirement of pressure zone	
Emergency	100% of MDD(3)	MG

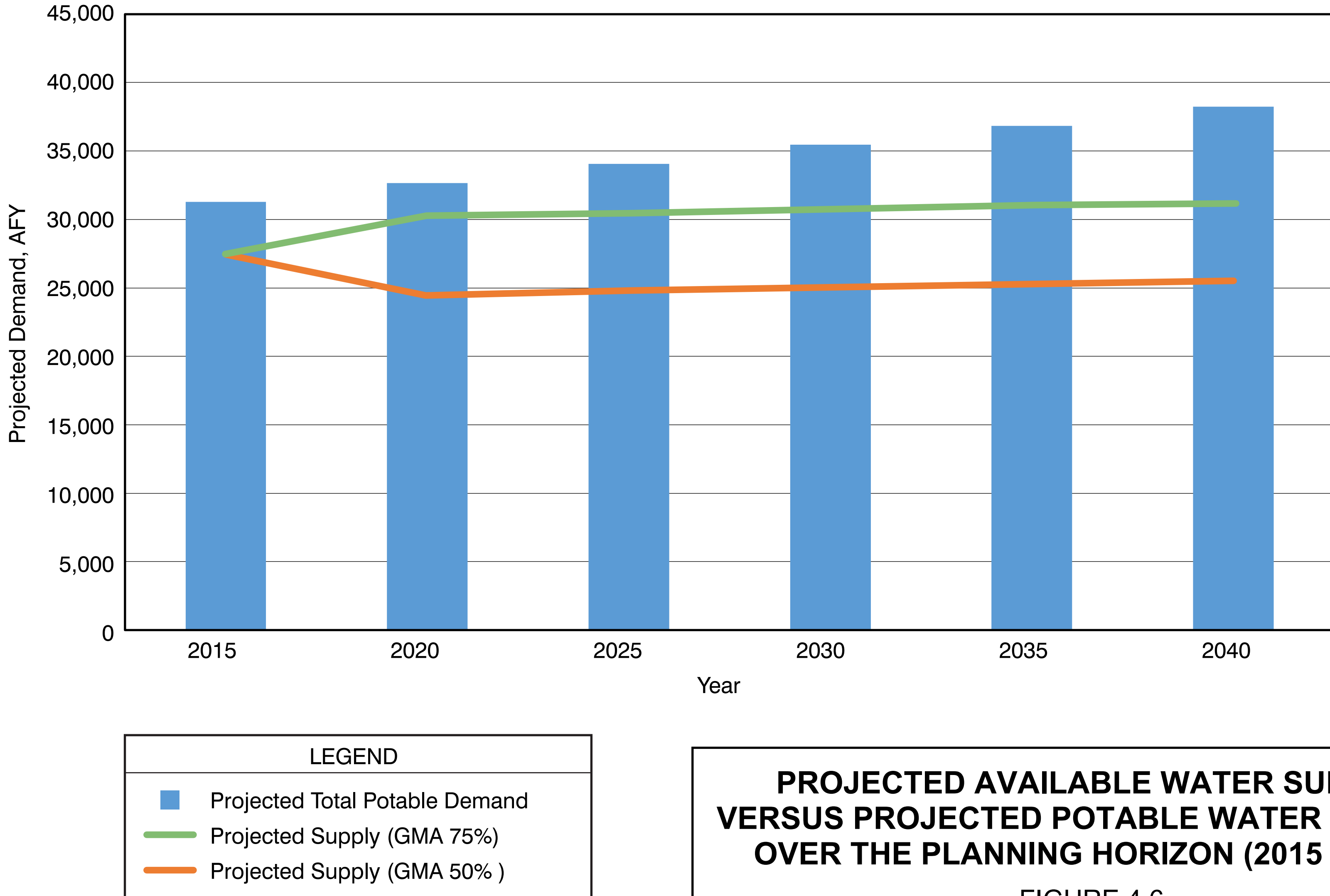
Notes:
(1) 75 percent of historical allocation was used for the alternative supply analysis; 50 percent was used to develop the recommended projects for water supply.
(2) Maximum pressures evaluated under ADD conditions.
(3) The emergency storage is assumed to be stored as groundwater.

4.6 FUTURE FACILITY NEEDS

The existing water system's capacity and performance were compared with the above criteria to identify existing shortfalls in the system. Although the system generally has adequate capacity to meet current demand conditions, it does so with little reliability. Thus, if key components, such as pumps, wells, and/or treatment processes, are in disrepair, meeting demand requirements would be a challenge.

4.6.1 Water Supply

Volume of Supply – Though the City currently meets water demand requirements, projections for the Integrated Master Plan show a potential supply gap of between 3,800 and 10,700 AFY. This gap is based on quantity and groundwater pumping restrictions, which are expected to be between 50 and 75 percent of historical in the long-term. Figure 4.6 graphically compares the projected available supply with demand over the planning horizon.



PROJECTED AVAILABLE WATER SUPPLY VERSUS PROJECTED POTABLE WATER DEMAND OVER THE PLANNING HORIZON (2015 - 2040)

FIGURE 4.6

CITY OF OXNARD
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Quality of Supply – From a water quality and regulatory standpoint, the system meets current regulations for drinking water quality. However, the City wishes to improve its taste and odor parameters.

Due to hardness in the water, many of the City's customers use point-of-use softeners that return salt to the wastewater system. As a result, the City aims for a more acceptable hardness level in the blended drinking water that would reduce or eliminate the need for point-of-use softeners.

Because the groundwater (both local and UWCD) sources have relatively high hardness levels, the City's desire for a more acceptable hardness level directly affects the water supply analysis. However, the City can use low hardness water from the AWPF through indirect potable reuse (IPR) / direct potable reuse (DPR), which has a hardness of approximately 10 mg/L.

4.6.2 Water Distribution

Although the above discussion focuses solely on water supply, the conveyance (distribution) system was also evaluated for its ability to meet future water demands, and assessing the system's capacity and performance. As with any water distribution system, conducting regular routine maintenance is imperative for maintaining a reliable system for the long term. Routine maintenance includes flushing the water lines, exercising the valves, and also conducting an active leak detection program. These actions along with other required maintenance help to routinely rehabilitate the pipelines thereby extending the useful life of the system. For this evaluation, four major areas were assessed in addition to the R&R needs identified. These areas are as follows:

Capacity Improvements – Pipeline capacity improvements are needed to meet level of service criteria (LOS) and to accommodate growth that requires additional demands to serve new customers. To estimate growth projections, the hydraulic model was run for existing conditions and the years 2020, 2030, and 2040. Pressure and velocity results were also investigated, and when either pressure or velocity exceeded LOS criteria (see Table 4.11), improvements were included to accommodate the demands.

Pressure Zone Separation – Meeting system pressure targets with a single pressure zone is a challenge and is expected to worsen with increased demands. As a result, a pressure zone analysis was conducted using the updated and calibrated system hydraulic model to assess whether the City would benefit from being split into two or three pressure zones.

Hydraulic modeling was conducted under two conditions: PHD conditions to identify minimum system pressures and minimum hour demand (MinHD) conditions to identify maximum system pressures. During PHD conditions, the modeling found pressures under 40 psi in the City's northeastern portion. However, during MinHD conditions, pressures in excess of 80 psi were seen in the City's southern portion. Thus, when considering the

City’s target minimum and maximum pressures, pressure zone separation seems warranted.

Fire Flow Requirements – The fire flow analysis tool was used in the system hydraulic model to calculate the available pressure and flow at each fire flow node on a case-by-case basis. Based on this analysis, when each respective fire flow demand was applied, 100 of the 980 fire flow nodes resulted in residual pressures of less than 20 psi. To correct the fire flow conditions for these 100 nodes, 39 projects were identified.

Storage Needs – The City currently has only 600,000 gallons of above-ground engineered storage reservoirs and in addition, relies on the Springville Reservoir (owned by CMWD) for its distribution system storage, with rights to 12.5 MG of the 18 MG reservoir's capacity. As such, an analysis was conducted to determine whether the existing storage is sufficient for operational, fire, and emergency needs. Although the storage requirements used for the analysis were based on MDD, they do vary based on the type of storage considered.

Based on the analysis, by 2040, an additional 1.5 MG of above-ground storage is recommended to meet fire and operational needs. It is assumed that groundwater pumping can provide water under emergency conditions as long as the appropriate redundancy for backup power and sufficient well capacity are provided.

4.6.3 Summary of Needs

Given the water system capacity and performance summary, future facility needs fell within four major categories:

- **Water Supply/Quality** – Includes system improvements needed to help the City maintain a sustainable water supply, meet projected demands, and sustain acceptable water quality through the planning period.
- **R&R** – Includes R&R of both the above- and below-ground assets deemed critical for reliable operation. Additional redundancy and reliability are also needed to provide a sustainable supply.
- **Operations Optimization** – Includes optimization projects that the City and AECOM identified for the City's water system operation.
- **Pressure Zone Separation** – Includes system improvements needed to separate the existing system into four distinct pressure zones.

4.7 ALTERNATIVES ANALYSIS

Although R&R and Operations Optimization are slightly more straightforward, providing a sustainable supply for the City over the planning period is more nuanced. As such, several alternatives were considered in concert with the City’s GREAT program, which began nearly a decade ago but was revised based on future needs and projections. These alternatives are briefly described in the following sections.

To reduce the supply gap, the same key sources of the GREAT program (recycled water and groundwater treatment) were the first primary sources considered for the Integrated Master Plan. Although desalination was also considered as another primary source, it was not cost effective at the time compared to other available sources. In addition, some secondary sources/offsets (e.g., conservation, recycled water for irrigation, stormwater, and intertie with Ventura) were considered. However, none were reliable as a primary source.

Given the layout of the City's current water system facilities, the locations of any new facilities, such as additional potable pumps, IPR wells and facilities, and blending stations, were also important to consider. As such, a fatal flaw analysis was conducted of viable locations throughout the City for either groundwater treatment (desalting) or IPR via ASR or groundwater recharge. Table 4.12 summarizes the results of this analysis.

Table 4.12 Priority Locations for Additional Water System Facilities
Public Works Integrated Master Plan
City of Oxnard

Site	Phase	Suitable For?	Reason
Water Campus (BS No. 1/6)	1	ASR and Desalting	Significant existing infrastructure Additional land nearby for purchase.
Campus Park	2	ASR Only	ASR Demonstration Well Site Close proximity to Water Campus.
BS No. 3	3	ASR and Desalting	Significant existing infrastructure Additional land nearby for purchase.
College Park	4	ASR Only	Relatively near to AWPF, less piping needed.
Community Park	4	ASR Only	Located along Recycled Water Backbone System pipeline.
AWPF	Alt.(1)	DPR	Ideally located next to AWPF and connection to potable system.

Notes:
(1) DPR could be an alternative to any of the first 4 sites.

Using the location priorities as a guide and considering the planning criteria established in Table 4.11, the following three main alternatives for a reliable water supply were considered:

- **Alternative 1: Groundwater Treatment Focused** – The premise of this alternative is to maximize groundwater pumping by distributing AWPF effluent to agricultural uses and then pumping an equivalent amount of local groundwater through pump-back allocations to meet potable demand. For this alternative, more potable wells would be needed to increase the overall local groundwater pumping capacity to meet potable demand, and additional desalting capacity would be needed to meet hardness objectives.
- **Alternative 2: Combination of Groundwater and ASR/IPR** – This alternative seeks to add flexibility and resiliency to Alternative 1 by combining the use of additional groundwater pumping and treatment with the use of recycled water by expanding the

IPR/ASR. As part of this alternative, facilities will be needed (in addition to groundwater pumping) to distribute recycled water to meet potable demands to IPR/ASR wellfields. These facilities will then send excess AWPF effluent to agricultural uses for irrigation.

Using AWPF effluent through IPR/DPR will dramatically improve the overall blended water quality related to TDS and hardness. However, because local groundwater pumping will increase, this alternative would also require adding desalting capacity to meet the hardness objectives.

- **Alternative 3: ASR/IPR Focused** – Alternative 3 seeks to maximize use of the AWPF by sending as much effluent to IPR/ASR wells and using the IPR to meet all additional potable water demands. For this alternative, groundwater pumping/treatment would still be utilized and expanded but not to the degree of the other alternatives. Water from the IPR/ASR wells would serve to meet additional potable demands and hardness objectives.

Each alternative was developed to include major conveyance and treatment facilities needed for complete operation and was projected to supply an equivalent blended water quality that would meet the target water quality objectives (shown in Table 4.11).

In addition, the three alternatives were evaluated for their lifecycle cost estimates, energy comparisons, water quality considerations, and other non-economic factors. Table 4.13 summarizes the lifecycle costs of the alternatives, and Table 4.14 contains the results of the overall alternative comparison, including non-economic considerations.

Table 4.13 Comparison of Water Supply Alternative Costs(1)
Public Works Integrated Master Plan
City of Oxnard

Cost ($ M)	Alt 1 – GW Treatment Focused	Alt 2 – Combined GW /IPR-ASR	Alt 3 – ASR-IPR Focused
Water System Improvements	$40	$23	$10
Recycled Water System Improvements	$74	$113	$158
Concentrate Conveyance	$20	$20	$20
Total Construction Cost	**$134**	**$156**	**$188**
Total Project Cost(2)	**$175**	**$201**	**$243**
Annual Costs ($ M/yr)			
Annualized Project Cost(3)	$14	$16	$20
Incremental O&M(4)	$19	$19	$19
Total Annual Cost	**$33**	**$35**	**$39**

Notes:
(1) Costs derived using the methodology outlined in Chapter 2.
(2) Project costs include project cost factor (as outlined in Chapter 2) as well as costs for land acquisition.
(3) Annualized at 5 percent over 20 years.
(4) O&M costs include energy, maintenance, and chemicals but do not include labor costs.

According to the economic comparison in Table 4.13, providing water supply through the recycled water system appears to be more costly than through groundwater alone. However, the costs do not necessarily reflect the risks involved with heavy reliance on the local groundwater supply, especially given the FCGMA's recent cutbacks on groundwater pumping. The relative energy use and blended water quality of the three alternatives was not estimated to be significantly different.

Given the overall comparison of alternatives shown in Table 4.14, Alternative 2: Combination of Groundwater (GW) and ASR / IPR might be an advantage. This alternative seems to offer the most reliability and resiliency for addressing future impacts from regulations or climate change while minimizing the risk to future supply. Alternative 2 also allows the City to maintain significant local control of the AWPF, its best water source, while still working with farmers to provide much needed water for irrigation.

Table 4.14 Overall Comparison of Water Supply Alternatives(1)
Public Works Integrated Master Plan
City of Oxnard

No.	Goal	Alt 1 – GW Treatment Focused	Alt 2 – Combined GW /ASR-IPR	Alt 3 – ASR/IPR Focused
PWIMP Overall Goals(2)				
#1	Reliability/Redundancy	+	+++	++
#3	Lifecycle Costs	+++	++	+
#2/4	Energy Use/GHGs	+	++	++
#5	Potable Water Offset	+++	++	+
#5	Groundwater Replenishment	+	++	+++
Water Supply Specific Goals				
	Water Quality	+++	+++	+++
	Maximize GW Pumping	+++	+++	+++
	Minimize Imported Water	++	++	++
	Local Control of Water Supply	+	++	+++
Total		**18+**	**21+**	**20+**

Notes:
(1) "+" = good, "++" = better, "+++" = best.
(2) As summarized in Chapter 2.

4.8 RECOMMENDED PROJECTS

After discussing the results of the above analysis with the City, Alternative 2: Combination of Groundwater and ASR / IPR was chosen as the recommended project for the water system plan. However, given the unknown future of groundwater pumping within the Oxnard Basin, a groundwater pumping allocation of 50 percent of historical was assumed over the long-term (rather than the 75 percent used in the alternative analysis).

This means that approximately 12,000 AFY of additional supply is needed to cover the supply gap projected by 2040. Furthermore, it was assumed that a cap of 5,200 AFY could be presented to farmers with the hope of receiving pump-back groundwater credit. This means that more ASR wells will be needed to take full advantage of the AWPF effluent for IPR use.

Summarized in the following sections are the recommended projects for the water system's Capital Improvement Plan (CIP), which are based on the existing system condition assessment and capacity as well as the performance needs for meeting projected future demands and water quality objectives. These projects cover the needs through the planning period (2015-2040) and are summarized in Table 4.15 according to the project type or driver. Figure 4.7 illustrates the locations of the recommended water supply projects.

The projects were split into phases that loosely follow the project timing: 1) Phase 1 – Immediate Needs (First 2 years); 2) Phase 2 – Near-Term Needs (Years 2 to 10); and 3) Phase 3 – Long-Term Needs (Beyond 10 years).

The phases presented here are what are recommended based upon the technical needs identified within this assessment. However, the actual timing of implementation may defer when compared and balanced against the financial considerations of total implementation of the Integrated Master Plan. Costs and timing for these projects is summarized under Chapter 9 as well as in the Cost of Service (COS) Rate Study (Carollo, 2015a).

Recycled water projects related to meeting water supply needs (e.g., AWPF expansion, ASR wells, etc.) are summarized in Chapter 6.

4.8.1 Water Supply/Quality

New potable water supply wells are needed to maintain the reliability of the City’s local groundwater pumping operation and to add system reliability. These new wells will replace and bolster the City’s current local groundwater pumping capacity. Because BS No. 1/6 and BS No. 3 are the most favorable locations for potable groundwater pumping and have significant infrastructure in place, these were the two sites identified to build new additional potable wells.

In general, most of the City's distribution system can handle current and future demand flows, with the exception of some pipes in the immediate vicinity of the blending stations where velocities exceeded LOS criteria. The list of recommended projects involves replacing these pipes; however, the exact year for replacement still needs to be determined after detailed year-by-year coordination with the other master plans included in the Integrated Master Plan.

Additional desalting of the groundwater will be needed in the future to meet the hardness objective of 100 mg/L. The existing 7.5 mgd desalter located at BS No. 1/6 is built to be expanded to a total permeate capacity of 15 mgd; therefore, expanding the desalter is more cost effective than building desalting capacity at another location.

Table 4.15 Recommended Projects to Meet Water Supply Needs through 2040
Public Works Integrated Master Plan
City of Oxnard

Facility/Location	Description	Phase	Quantity	Unit	Capacity
Water Supply/Quality - Treatment					
BS No. 1/6	Add potable water wells	2	5	wells	2,000 gpm (ea.)
BS No. 3	Add potable water well (stainless steel)	2	1	wells	2,000 gpm
BS No. 1/6	Expand existing desalter by 7.5 mgd (split into 2 phases at 3.75 mgd each)	2/3	1	--	Total: 15 mgd
BS No. 1/6	Construct a new permeate storage tank for operational storage	2	1	tank	2.0 MG
BS No. 1/6	Expand existing disinfection	2	1	--	--
BS No. 1/6	New connection to Oxnard-Hueneme (O-H)/UWCD Pipeline	2	--	--	--
Concentrate Conveyance	Construct brine line from OWTP to BS No. 1/6 (14 and 24 inch)	2	32,100	lf	--
Water Supply – Distribution System (Capacity Improvements)					
(Location Varies)	Replace 8" Pipeline	1	322	lf	--
	Replace 12" Pipeline	1	238	lf	--
	Replace 14" Pipeline	1	164	lf	--
	Replace 30" Pipeline	1	3,804	lf	--
	Replace 6" Pipeline	2	69	lf	--
	Replace 8" Pipeline	2	391	lf	--
	Replace 10" Pipeline	2	1,101	lf	--
	Replace 12" Pipeline	2	2,447	lf	--
	Replace 6" Pipeline	3	32	lf	--
	Replace 8" Pipeline	3	233	lf	--
	Replace 10" Pipeline	3	1,243	lf	--
	Replace 12" Pipeline	3	997	lf	--
	Replace 14" Pipeline	3	2,453	lf	--
	Replace 24" Pipeline	3	937	lf	--

Table 4.15 Recommended Projects to Meet Water Supply Needs through 2040
Public Works Integrated Master Plan
City of Oxnard

Facility/Location	Description	Phase	Quantity	Unit	Capacity
R&R – Blending Stations/Treatment					
BS No. 1/6	Replace Mechanical, Electrical, and AUX Equipment(1)	1	--	--	--
BS No. 2	Replace Mechanical, Electrical, and AUX Equipment(1)	1	--	--	--
Varies	Make Water SCADA System Improvements	1	--	--	--
BS No. 3	Replace Mechanical, Electrical, and AUX Equipment(1)	2	--	--	--
BS No. 4	Replace Mechanical, Electrical, and AUX Equipment(1)	2	--	--	--
BS No. 5	Replace Mechanical, Electrical, and AUX Equipment(1)	2	--	--	--
BS No. 1/6	Install electrical isolation at all steel and cast iron water risers (2)	2	--	--	--
BS No. 1/6	Add Cathodic Protection System for Steel Storage Tank(2)	2	--	--	--
R&R – Distribution System					
Varies	Replace Automatic Meter Reader (AMR) Devices	1	--	--	--
Del Norte Forced Main	Cathodic Protection - Install 20 missing test stations Replace rectifiers and anodes; resurvey(2)	1	--	--	--
Oxnard Conduit	Cathodic Protection - Replace deep anode beds and rectifiers #1, #2, and #3 (2)	1	--	--	--
Wooley Road/United	Cathodic Protection - Replace 5 test stations Replace rectifier and anode; resurvey(2)	1	--	--	--

Table 4.15 Recommended Projects to Meet Water Supply Needs through 2040
Public Works Integrated Master Plan
City of Oxnard

Facility/Location	Description	Phase	Quantity	Unit	Capacity
3rd Street Oxnard Extension	Cathodic Protection - Replace deep anode bed and rectifier; bond UWCD pipeline to Oxnard extension at rectifier [2]	1	--	--	--
Freemont North Neighborhood	GREAT Program Pipeline Replacements[3]	1	--	--	--
Bryce Canyon South Neighborhood	GREAT Program Pipeline Replacements[3]	1	--	--	--
Redwood Neighborhood	GREAT Program Pipeline Replacements[3]	1	--	--	--
La Colonia Neighborhood	GREAT Program Pipeline Replacements[3]	1	--	--	--
Well 23 & 31 Rehab	Rehabilitate Wells[4]	1	--	--	--
Varies	Electrical and VFD Replacement[4]	1	--	--	--
(Location varies)	Fire Flow Improvements	1			
	Add 8 inch-diameter pipeline		18,500	feet	--
	Add 12 inch-diameter pipeline		13,500	feet	--
	Add 14 inch-diameter pipeline		250	feet	--
Industrial Lateral	Cathodic Protection - Replace all test stations; resurvey[2]	2	--	--	--
Del Norte Force Main	Cathodic Protection - 48" & 36" CMCL PL - Locate and repair discontinuity near the ease end of Del Norte Pl[2]	2	--	--	--
3rd Street Oxnard Extension	Cathodic Protection - Locate and repair discontinuity near Chemical Building at BS No. 1/6[2]	2	--	--	--
Gonzales 36" Pipeline	Replace test station lids and test cathodic protection[2]	2	--	--	--

Table 4.15 Recommended Projects to Meet Water Supply Needs through 2040
Public Works Integrated Master Plan
City of Oxnard

Facility/Location	Description	Phase	Quantity	Unit	Capacity
Oxnard Conduit	Install new test stations, conduct CIS, and locate/excavate/bond across approx. Add 3 points of electrical isolation.[2]	2	--	--	--
Del Norte Force Main	Cathodic Protection - Replace rectifiers and anodes; resurvey[2]	3	--	--	--
Del Norte Force Main	Cathodic Protection - Install new test stations and leads[2]	3	--	--	--
Wooley Road/United	Cathodic Protection - Replace test stations and install 2 additional stations[2]	3	--	--	--
Wooley Road/United	Cathodic Protection - Replace rectifier and anode; resurvey[2]	3	--	--	--
(Location Varies)	Age-Based Pipeline Replacements	3			
	Replace 6" Pipeline		109,100	lf	--
	Replace 8" Pipeline		47,000	lf	--
	Replace 10" Pipeline		55,000	lf	--
	Replace 12" Pipeline		24,000	lf	--
	Replace 14" Pipeline		2,300	lf	--
	Replace 16" Pipeline		4,000	lf	--
	Replace 24" Pipeline		3,700	lf	--
	Replace 36" Pipeline		5,000	lf	--
	Replace 42" Pipeline		5,300	lf	--
	Replace 48" Pipeline		3,800	lf	--
Varies	Replace AMR Devices	1	--	--	--
Operations Optimization					
Well Nos. 30, 32, 33 & 34	Electrical Rehabilitation[4]	1	--	--	--
BS No. 1/6	Sodium Hypochlorite Piping Replacement[4]	1	--	--	--
BS No. 1/6	Emergency Turnouts Service[4]	1	--	--	--
BS No. 1/6	Generator and ATS Service[4]	1	--	--	--

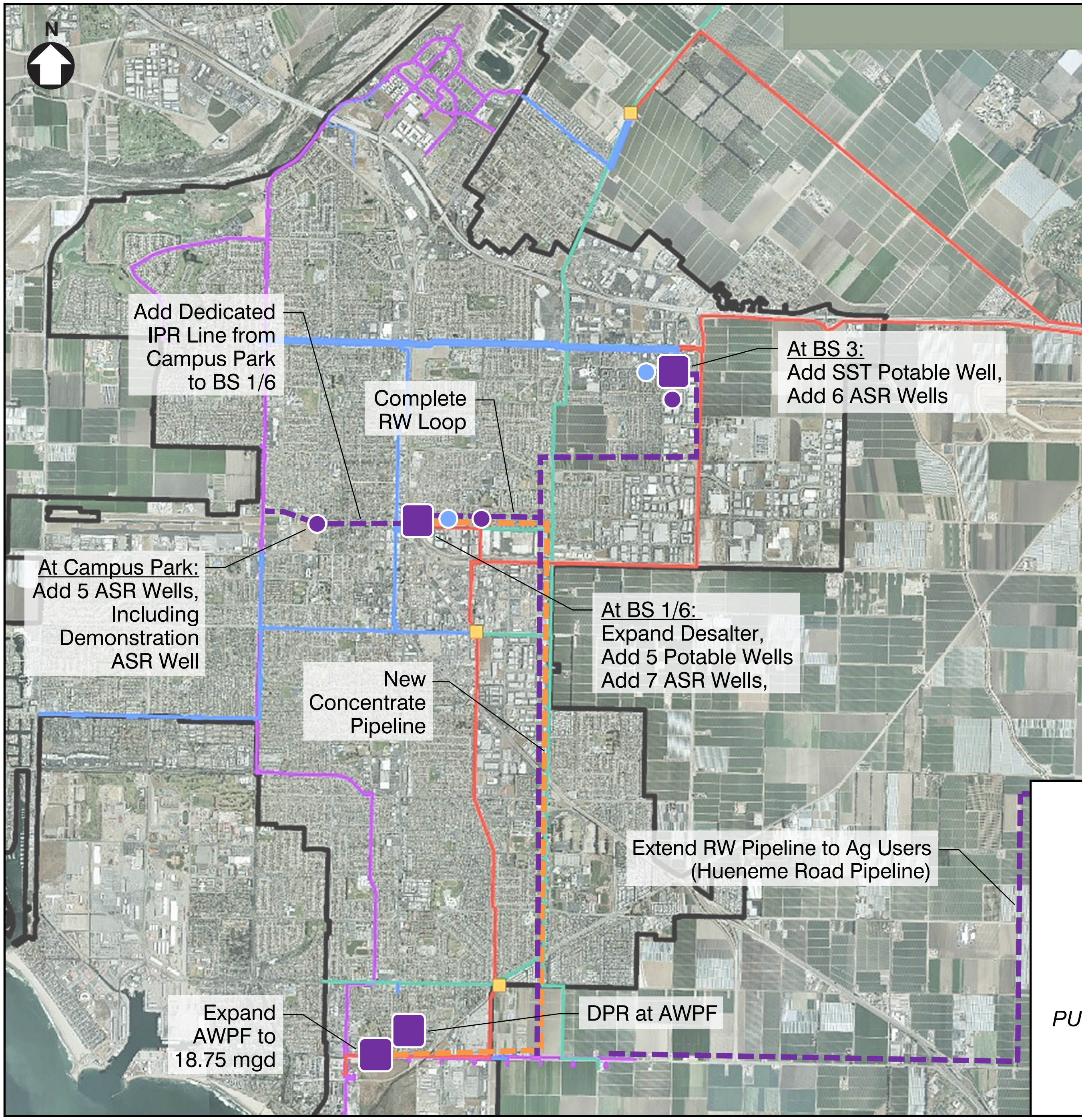
Table 4.15 Recommended Projects to Meet Water Supply Needs through 2040
Public Works Integrated Master Plan
City of Oxnard

Facility/Location	Description	Phase	Quantity	Unit	Capacity
Pressure Zone Separation					
North Zone Modification					
Three (3) locations on Gonzalez Road	Rehab 3 Pressure Reducing Station (PRS)	1	3	Valves	--
From BS#3 up Solar Road to Gonzalez Road	BS#3 Reconfigure 24" Pipeline to feed North Zone	1	--	--	--
Along Gonzalez Road	Make Minor Piping Modification	1	--	--	--
Coastal Zone Modification					
Three (3) locations on S. Victoria Avenue	Add 3 new PRS	1	3	Valves	--
S. Victoria Avenue	Add New 8" Parallel Pipeline	1	3,000	lf	--
Along S. Victoria Avenue	Make Minor Piping Modifications	1	--	--	--
South Zone Modifications					
Three (3) locations on E. Pleasant Valley Road	Add 3 new PRS	1	3	Valves	--
E. Pleasant Valley Road	Add New 8" Parallel Pipeline	1	6,000	lf	--
Along E. Pleasant Valley Road	Make Minor Piping Modification	1	--	--	--

Notes:

*General Note: For the pipeline replacement projects, see the hydraulic models developed as part of this integrated master plan to identify the exact pipeline locations. Project costs, schedules, and phasing are based on data and information available at the time of the original publication of the Project Memos (PMs) – December 2015.

(1) Projects based on R&R recommendations done through the Condition Assessment.
(2) Projects developed from the Cathodic Protection Assessments.
(3) As documented in the City's GREAT program CIP, February 18, 2015.
(4) Projects provided by AECOM.



RECOMMENDED WATER/RECYCLED WATER PROJECTS

FIGURE 4.7

CITY OF OXNARD
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ox1115f3-9587(SumRepFIG4-7).ai

To avoid taking brine from the desalter back to the OWTP, which would then affect the AWPF effluent and cost of operation, a dedicated concentrate line is recommended. This concentrate line could be routed from the Water Campus (BS No. 1/6) to the City's ocean outfall from the OWTP. However, the use of the City's outfall is predicated on the RWQCB's permit of policy. A possible option to the dedicated concentrate line is a connection to the Salinity Management Pipeline (SMP) and agreement with CMWD.

Figure 4.7 illustrates the locations of the water system improvements recommended for securing the City's water supply. These are also shown in conjunction with the recycled water improvements, since they work in concert with one another.

4.8.2 R&R

A number of R&R related projects were identified through the efforts of this Plan and City staff. These improvements are broken into the two broad categories: above-ground assets (blending station/treatment) and below-ground assets (distribution system piping).

The blending station/treatment R&R includes routine repair and replacement of elements identified through the condition assessment effort and staff input. Replacing the cathodic protection systems is needed for the desalter and steel permeate storage tank, and the water Supervisory Control and Data Acquisition (SCADA) system is slated for complete replacement and upgrade.

In addition, distribution system piping improvements are needed to meet reliability and redundancy and to protect public health. For these improvements, methodically replacing pipes by size and age is proposed. New piping is also recommended to provide adequate fire flow water, and cathodic protection was identified for several key water mains throughout the City. Also, conducting required routine maintenance such as flushing water lines, exercising valves, and leak detection is imperative to continually help to rehabilitate the system and extend its useful life.

4.8.3 Operations Optimization

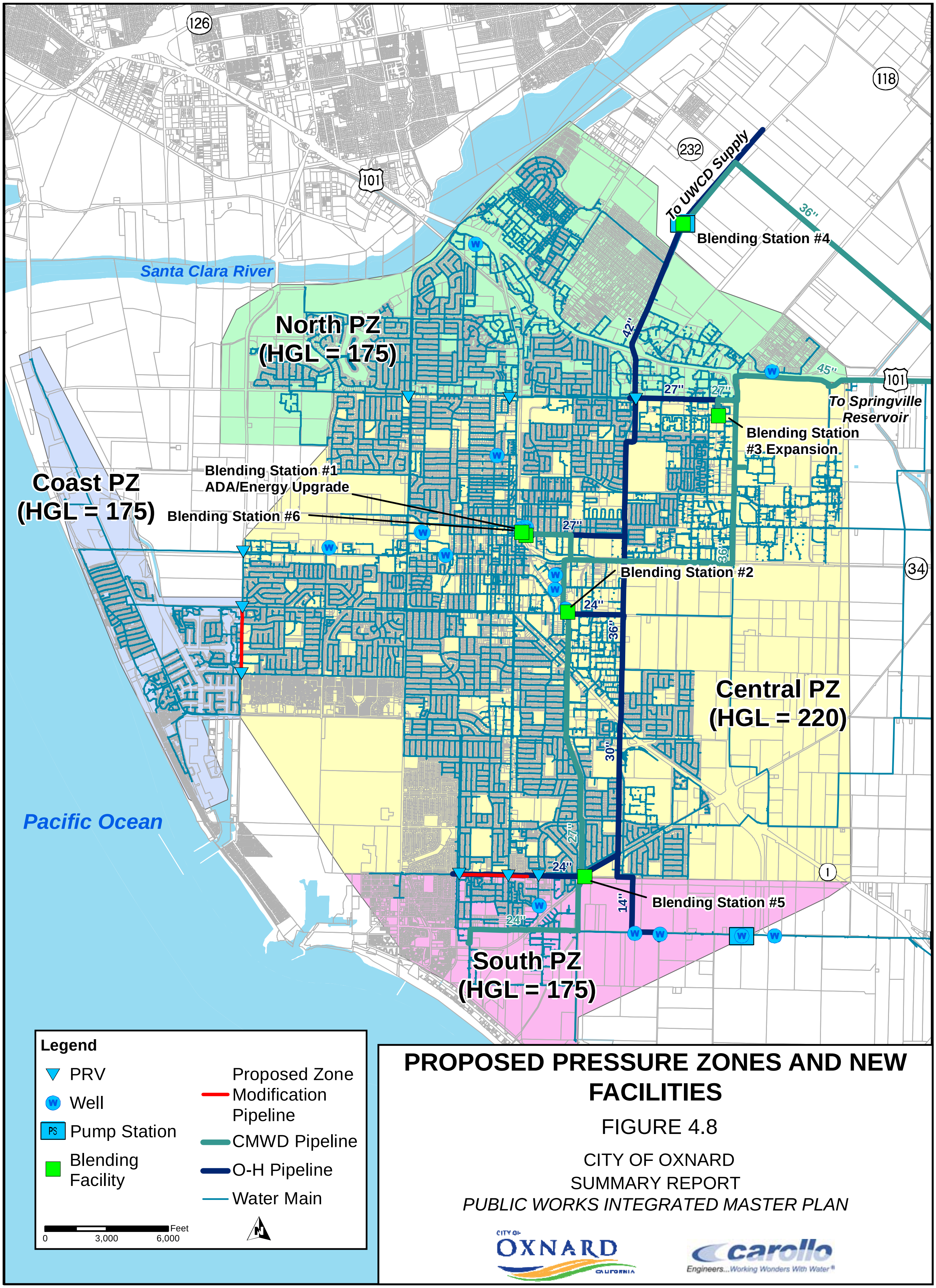
The City is working on several optimization projects for its water system operation. These projects were identified and included as recommended projects in the CIP.

4.8.4 Pressure Zone Separation

Based on the pressure zone analysis, it is recommended that the City reduce service pressures that exist outside of its established delivery pressure criteria by breaking the single pressure zone distribution system into four zones: the North, Coast, Central, and South. Figure 4.8 shows these pressure zone areas. The recommended improvements necessary for this conversion are summarized in Table 4.15.

4.8.5 Implementation Schedule

Figure 4.9 shows the implementation schedule for these water projects in the three phases previously described. Costs for the recommended water projects are summarized in Chapter 9.



PROPOSED PRESSURE ZONES AND NEW FACILITIES

FIGURE 4.8

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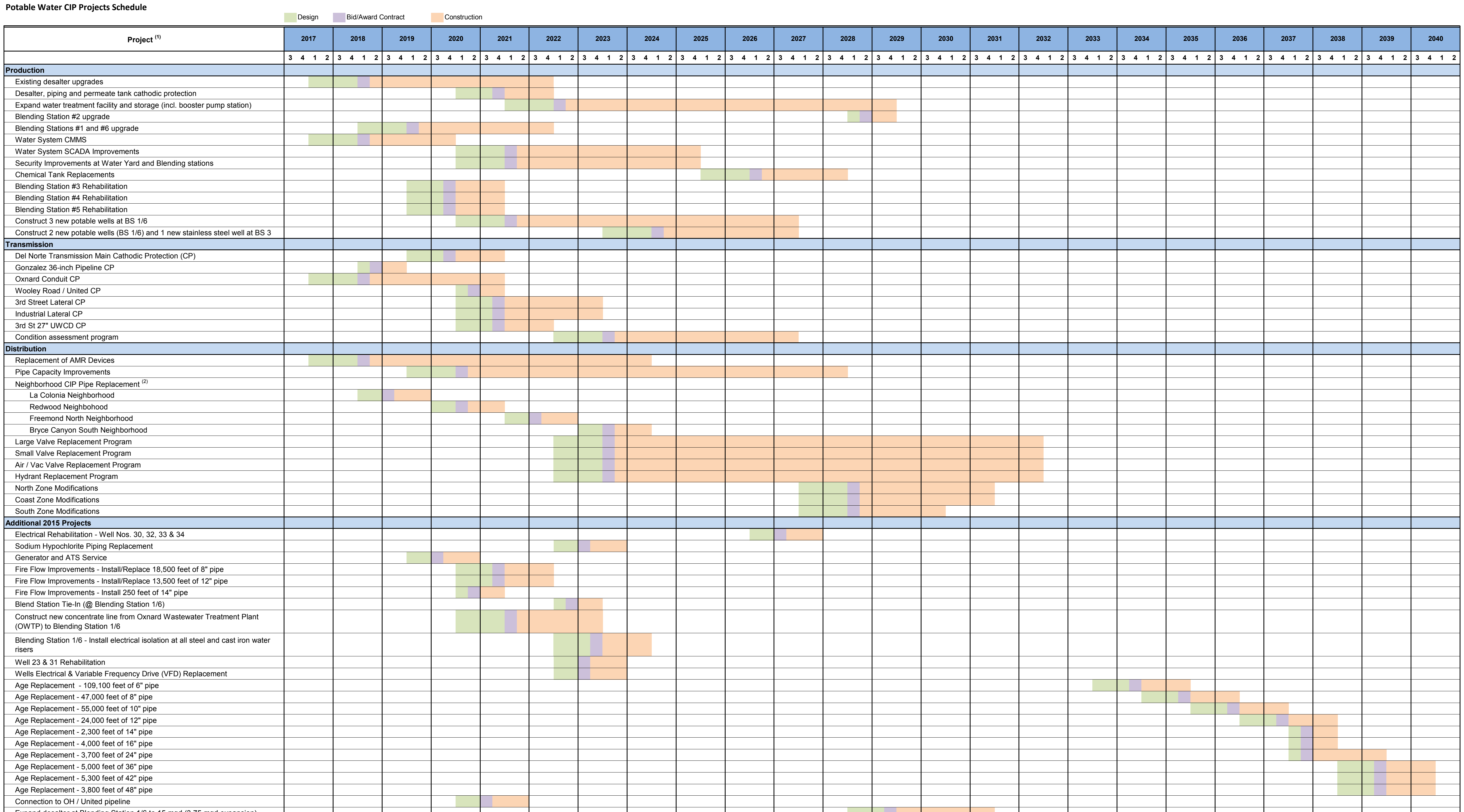


Notes:

(1) Project start years correspond to refinements and updates provided by City after Dec. 2015 publication date.

(2) Neighborhood CIP Replaement projects (La Colonia, Redwood, Freemont North, and Bryce Canyon South neighborhoods) combined into single project.

RECOMMENDED WATER PROJECTS SCHEDULE

FIGURE 4.9

CITY OF OXNARD

SUMMARY REPORT

PUBLIC WORKS INTEGRATED MASTER PLAN

WASTEWATER SYSTEM MASTER PLAN

5.1 INTRODUCTION

The City owns and operates the Oxnard Wastewater Treatment Plant (OWTP) and the associated wastewater collection system. Through the OWTP, the City provides wastewater treatment to Oxnard and several surrounding communities (the City of Port Hueneme, the Port Hueneme Water Agency, the Naval Base Ventura County facilities at Port Hueneme and Point Mugu, Ventura Regional Sanitation District, Crestview Mutual Water Company, Nyeland Acres, and Las Posas Estates) and is permitted to discharge treated wastewater to the Pacific Ocean. In addition, a portion of the treated wastewater is used as recycled water after additional treatment through the City's Advanced Water Purification Facility (AWPF).

While considering improvements to the OWTP, a number of goals were established to help develop possible improvement scenarios. Consistent with the overall Master Plan goals established in Chapter 1, the five main goals for the City's wastewater facilities are as follows:

- Goal 1: Provide a compliant, reliable, resilient, and flexible system.
- Goal 2: Manage assets effectively (economic sustainability).
- Goal 3: Mitigate and adapt to the potential impacts of climate change.
- Goal 4: Protect and enhance environmental and resource sustainability.
- Goal 5: Investigate green and gray infrastructure with an emphasis on energy efficiency.

This chapter will provide an overview of the existing wastewater system as well as its strengths and vulnerabilities and the regulatory requirements and climate change issues the system will face. This chapter also provides recommendations for ways to meet the defined goals.

The analysis and evaluations contained in this Summary Report are based on data and information available at the time of the original date of publication of the Project Memos (PMs), December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). The complete updated CIP based on the near-term and long-term projects is contained in Appendix B.

5.2 DESCRIPTION OF EXISTING FACILITIES

5.2.1 Wastewater Collection System

The City's existing sanitary sewer collection system is comprised of roughly 384 miles of gravity collection system pipe ranging from 4 to 60 inches in diameter. As is typical for a community this size, most of the sewers (67 percent) are 8 inches in diameter and most (70 percent) are made of vitrified clay pipe. The rest (22 percent) are made of polyvinyl chloride.

The City currently operates and maintains 15 lift stations located throughout the City. Except for the Patterson & Hemlock Wastewater Lift Station, which has a wet well configuration, all of the lift stations utilize a submersible pump configuration. All of the pump stations have a duty and a standby pump.

The force mains associated with the wastewater lift stations consist of approximately 4.7 miles of pressurized pipe ranging from 4 to 20 inches in diameter. The majority (67 percent) are 6 and 10 inches in diameter. Force main pipe are between 6 and 46 years old.

Figure 5.1 shows the existing wastewater collection system infrastructure.

5.2.2 Wastewater Treatment Plant

The City's existing OWTP has a permitted capacity of 31.7 mgd and treats wastewater for discharge to the existing ocean outfall. The OWTP provides preliminary, primary, and secondary treatment, which are described below.

Preliminary treatment includes bar screens, screenings conveyance, grit removal, and grit conveyance to remove solids that might damage downstream equipment. After preliminary treatment, flow is gravity fed to the influent pump station wet well, which includes six dry-pit submersible pumps. Three of the six pumps are on duty during normal operations.

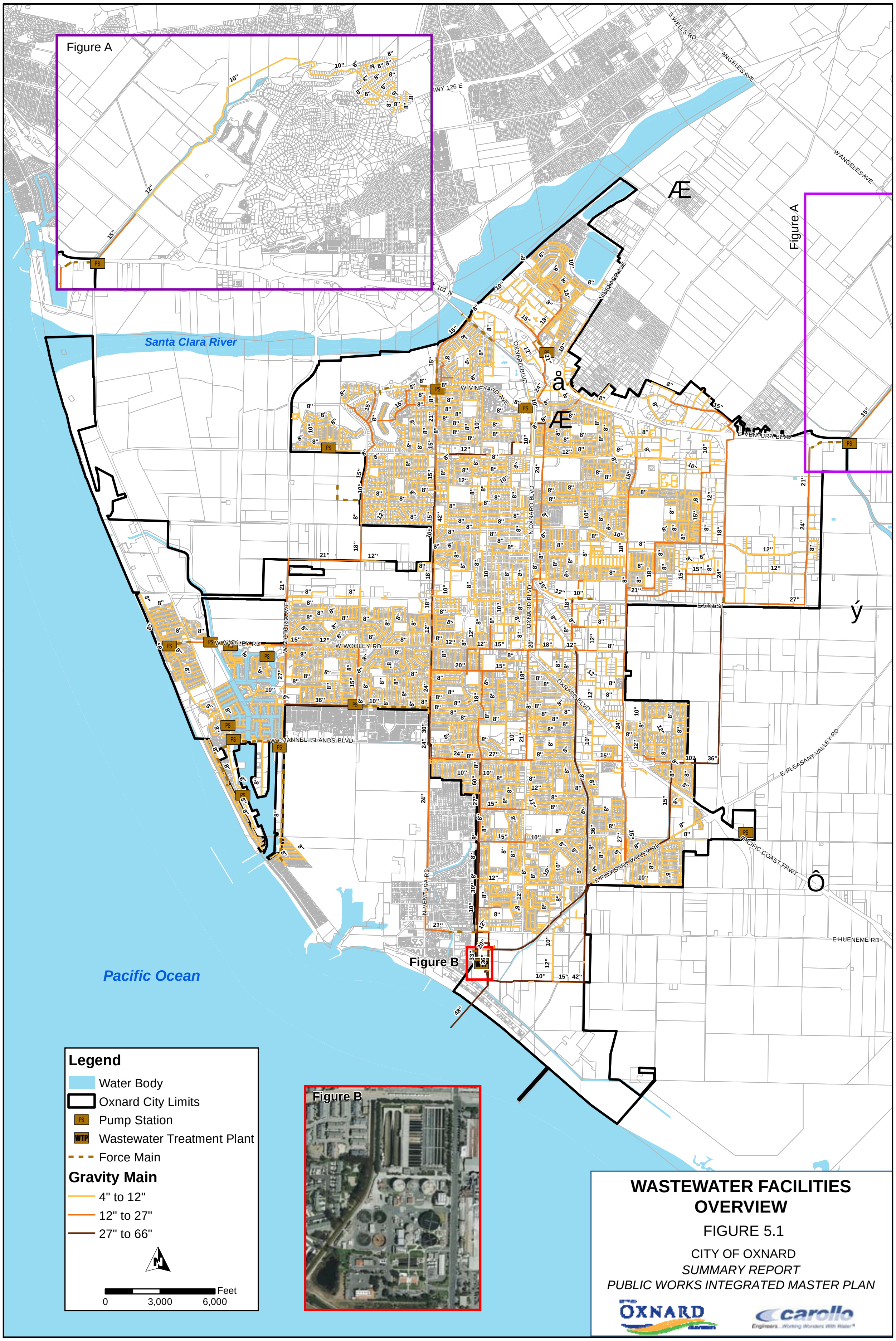
From the influent pump station wet well, raw wastewater flows to four primary sedimentation basins for primary treatment. The primary treatment process includes facilities in which ferric chloride are added to enhance sedimentation. A polymer storage and feed system is planned to further enhance primary treatment performance.

After primary treatment, flow enters the secondary treatment system, which uses a fixed-film secondary treatment process followed by an air-activated sludge process to remove organic material. The City's discharge permit for the facility does not currently require nitrogen or phosphorus removal.

The secondary treatment system is comprised of two biotowers, two three-pass activated sludge tanks (ASTs), and 18 secondary sedimentation basins (SSTs). A plant utility water pumping station is provided downstream of the secondary sedimentation basins.

The maximum hydraulic capacity of the ocean outfall is 50 mgd, so two 2.5-million gallon (MG) secondary effluent equalization basins (EQ Basins) were included as part of the activated sludge facilities to equalize the portion of secondary effluent flows greater than 50 mgd during wet weather events. (Currently, plant staff also operates the EQ Basins during the dry weather season to equalize secondary effluent during the peak power cost period of the day to minimize the cost of final effluent pumping to the ocean outfall.)

Secondary effluent leaving the SSTs and/or EQ Basin either flows by gravity or is pumped through a 48-inch secondary effluent line to two three-pass chlorine contact tanks (CCTs).



WASTEWATER FACILITIES OVERVIEW

FIGURE 5.1

CITY OF OXNARD

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PUBLIC WORKS INTEGRATED MASTER PLAN

Each pass is 145 feet long. Disinfected effluent is then pumped to the 6,800-linear feet (1.3 mile) ocean outfall from the effluent pump station, which has two engine-driven pumps, two electric motor variable frequency drive (VFD) pumps, and an additional motor-driven pump.

The solids handling facilities consist of 2 gravity thickeners for primary sludge thickening, two dissolved air flotation thickeners (DAFTs) for waste activated sludge (WAS) thickening, three anaerobic digesters, and 4 belt filter presses (BFPs) for dewatering.

Table 5.1 summarizes basic design criteria for the OWTP and Figure 5.2 provides a process flow schematic.

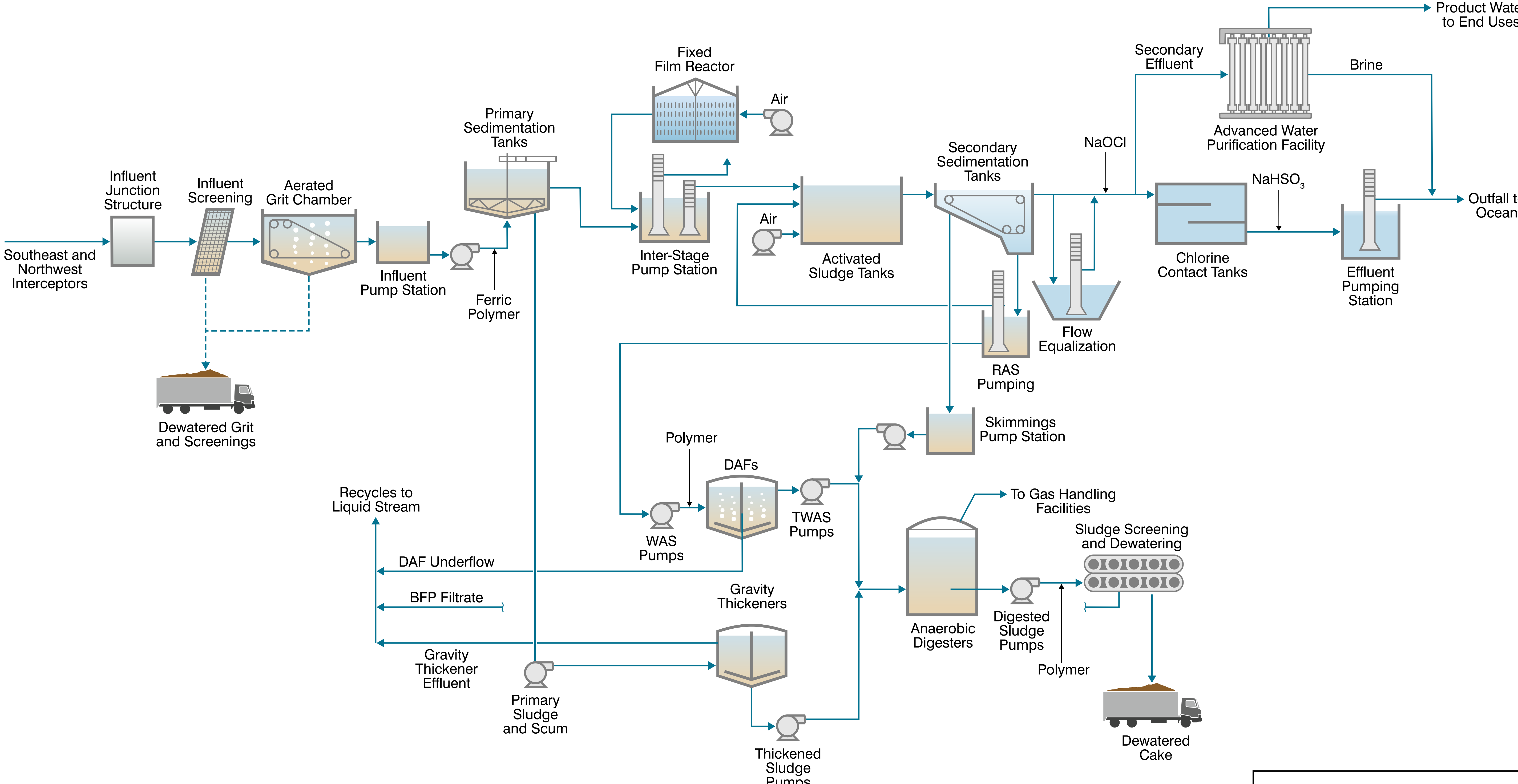
Table 5.1 Design Criteria for the Existing OWTP
Public Works Integrated Master Plan
City of Oxnard

Criteria	Main Equipment	Ancillary Equipment	Year Installed
Preliminary Treatment			
Bar Screens	4 mechanical screens (1/4-inch openings) 2 manual screens (1/2-inch opening)	Screenings Conveyor/Compactor	2008
Aerated Grit	2 chambers, each with 4 hoppers	4 Grit pumps / 3 separators	2008
Influent Pumps	6 – 18,000 gpm 450-hp pumps		2008
Primary Treatment			
Sedimentation	4 circular 105-foot diameter basins	Sludge scrapers, transfer pumps, scum ejector, optional polymer	4 basins – 1972
Interstage Pumping Station	3 variable-speed vertical mixed-flow pumps 2,800 – 21,500 gpm each 8 -21 ft TDH 250 HP each		1975
Secondary Treatment			
Biofiltration	2 – one 140-foot dia., and one 100-foot dia. Filters	4 feed and recirculation pumps, ventilation system 4 blowers, each tower	2 filters – 1975
Activated Sludge	2 tanks, each with 3 passes, 3 step-feed channels per pass. Fine air diffusers fixed on floor.	6 – single-stage blowers, return activated sludge pumps	1990

**Table 5.1 Design Criteria for the Existing OWTP
Public Works Integrated Master Plan
City of Oxnard**

Criteria	Main Equipment	Ancillary Equipment	Year Installed
Sedimentation	18 rectangular sedimentation basins	4 Return Activated Sludge (RAS) pumps 3 WAS pumps	1990
Flow Equalization	1 – 5-MG storage tank with 2 sections	Pump station and recirculation tubes	1990
3W Pumping Station	3 vertical turbine pumps 1,880 gpm each 185 ft TDH 125 HP each	Strainer	1988
Disinfection			
Chlorination/ Dechlorination	6 pass contact tank	Hypochlorite and bisulfite feed systems	6 passes – 1980
Effluent Pump Station	1 variable-speed mixed-flow pump 17,400 gpm @ 900 rpm 30 ft TDH		1975
	4 variable-speed engine driven mixed-flow pumps 12,000 gpm each @ 1,200 rpm 146 ft TDH		prior to 1975
Solids Handling			
Gravity Thickening (for primary solids)	2 – 59-foot diameter thickeners	Polymer and ferric chloride system for thickening, thickened primary sludge pump	2 GT – 1980
Dissolved Air Flotation (for secondary solids thickening)	2 – 25-foot diameter thickeners	Polymer system for thickening, thickened waste activated sludge pumps	2 units – 1990
Anaerobic Digestion	3 digesters, 2 at 90-foot diameter and 1 at 110-foot diameter	Heat exchanger, mixer, recirculation pumps, fixed cover, gas collection system, digested sludge pumping	90-foot dia.– 1980 110-foot dia. – 1990
Belt Filter Press (Dewatering)	4 – 2.2-m units	Polymer system for sludge conditioning	4 BFPs – 1990
Cogeneration	3 – 500-kW generators	Waste heat recovery system	1980

Note:
(1) Source: OWTP, Operation and Maintenance Manuals, and comments from Mark Moise.



OWTP PROCESS SCHEMATIC

FIGURE 5.2

CITY OF OXNARD

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5.2.3 Condition Assessment

To identify the City's wastewater system's R&R needs, a condition assessment was conducted. This effort involved using asset management methodology to identify existing water assets and conduct a visual condition assessment of above-ground assets, a seismic evaluation of structures, a desktop evaluation of below-ground assets, and a cathodic protection system evaluation.

To prioritize the R&R needs, a risk assessment was also conducted to examine the vulnerability, or likelihood of failure, and criticality, or consequence of failure, for each asset. Consistent risk scoring methodology was applied to both above- and below-ground assets to prioritize each asset type.

5.2.3.1 Above Ground Assets

Above-ground assets included structures and equipment owned and operated by the City. To assess and value all above-ground assets, a consistent approach was used regardless of whether they were in the treatment system or collection system. The above-ground asset inventory included approximately 26 structures, 160 pumps, 15 wet wells, and a variety of other assets across the OWTP and collection system. The recorded age of each asset varied from 1955 to the present.

Several tables summarize the results of the condition assessment analysis. Table 5.2 lists the OWTP's assets, including the highest above-ground risk determined from this assessment. Table 5.3 lists the assets at the collection system Lift Stations, including the highest above-ground risk determined from the assessment.

Below are the findings of the condition assessment for above-ground assets:

- Headworks – The headworks is in fair to good condition, with some concrete deterioration noted.
- Primary Clarification – Structurally, the primary sedimentation building and clarifier basins were found to be in fair to poor condition. Mechanical and electrical assets were in poor to very poor condition.
- Biofilters – The biofilters were in poor to very poor condition.
- Interstage Pumping Station – The pumps were found to be in fair to poor condition. The structure itself is in fair condition.
- Secondary Treatment – The structures were found to be in fair to poor condition. The equipment was found to be in very poor condition.
- Disinfection Facilities – These facilities are in fair condition; concrete repairs are needed.

- Effluent Pumping – Structurally, this facility is in poor condition. Mechanical assets were rated from fair to poor condition. Electrical assets were in very poor condition.
- Thickening – The facilities are in poor to very poor condition.
- Digestion – The facilities are in poor to very poor condition, and Digester 2 is currently non-operational.
- Dewatering – The facilities are in fair to poor condition.
- Cogeneration – The facilities are in fair to poor condition.
- Electrical Facilities – The facilities are in good to very poor condition. The emergency power facility is aging.

Table 5.2 High-Risk Assets at the OWTP
Public Works Integrated Master Plan
City of Oxnard

Process/Asset	Risk[1]
Primary Treatment	
Primary Clarifiers (1-4) Collector Drive, Walkways, and Launders	4.48
Sludge Pump Tanks (1-4)	3.85
MCCs-DPIA, DPIB, DP2B, EDPIA	3.85
Scum Ejectors	3.22
Primary Clarifiers (2 & 4)	1.7
Large Isolation Valves	1.04
Biofilters	
Recirculation Pumps Mag Drive 1 and 2	3.4
Distributors and Drives	2.17
Biofilter Tanks 1 and 2	1.7
Biofilter Media Tanks (1 & 2)	0.8
Secondary Treatment	
Collector, Skimmer, and Drives (17-18)	1.54
Effluent Pump Station	
MCCs	3.85
Gravity Thickening	
MCCs-DP3C, DP3D	3.85
Thickened Sludge Pumps (1-3)	0.51

Table 5.2 High-Risk Assets at the OWTP
Public Works Integrated Master Plan
City of Oxnard

Process/Asset	Risk(1)
Digestion	
Digester Heat Exchanger No. 2	3.22
Digester No. 2 Tank	1.52
Digested Sludge Pumps (1-3)	0.51
Digester Control Building	1.46
Digester Hot Water Pump 1	0.51
Digester Mixing Equipment and Draft Tubes Nos. 1-3	0.51
MCCs (DP2C, EDPIC, GF)	0.46
Dewatering	
Conveyors	2.8
Belt Filter Press 1-4	2.8
Dewatering Feed Pump 5	0.51
Washwater Booster Pumps (1-4)	0.51
Electrical	
Effluent Electrical Building Switchgear	5.11
Main Electrical Building Large Standby Generators	4.69
Effluent Electrical Building (DP2A, EBPIB)	3.85
Main Electrical 500 kW Generator	0.7
Older Transformers (1 & 2)	0.51
Main Electrical Building MCCs (DP4, DP4B, GB, GC, GD)	
Administration Building MCCs (DP2D, DP3A, EDPIE, HG)	
Buildings	
Main Switchgear Building	(1.46) Seismic(2)
Plant Control Center Building	(1.46) Seismic(2)
Vacuum Filter	(1.46) Seismic(2)
Blower Building	(1.1) Seismic(2)

Note:

(1) Risk = Criticality x Vulnerability; Criticality = consequence of failure; Vulnerability = likelihood of asset failure

(2) Indicates a seismic deficiency that requires concrete testing, further Tier 2 evaluation, or replacement.

Table 5.3 High Risk Assets at Lift Stations Public Works Integrated Master Plan City of Oxnard	
Site/Asset	**Risk[(1)]**
Lift Station 23 Wagon Wheel	
Submersible Pumps (1-2)	4.27
MCC	3.85
Wet Well Structure	2.56
SCADA Panel	2.25
Valve Vault	0.68
Lift Station 6 Canal	
Submersible Pumps (1-2)	0.51
MCC	0.46
Lift Station 04 Mandalay & Wooley	
SCADA Panel	0.51
MCC	0.46

Note:

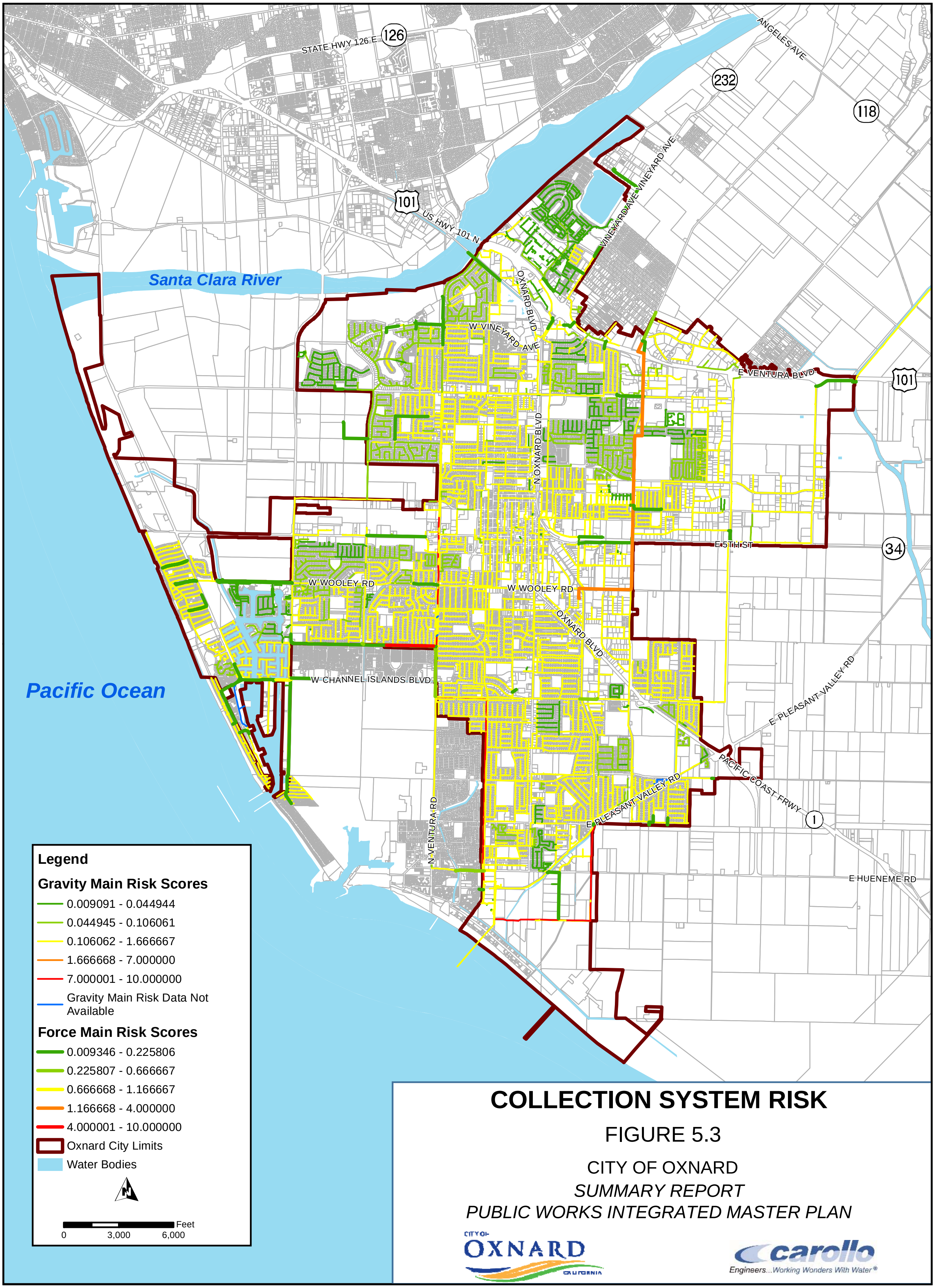
(1) Risk = Criticality x Vulnerability; Criticality = consequence of failure; Vulnerability = likelihood of asset failure.

5.2.3.1 Below Ground Assets

For the City's below-ground wastewater system assets, a desktop evaluation relying on GIS data from the Oxnard collection system was conducted. Collectively, only 18 percent of the collection system piping had a known installation year, with no year available for 206 of the 263 segments for sewer force mains and 7,123 of the 8,686 segments for sewer gravity mains. Because so few installation years were available, an installation year of 1965, which was based on a conservative estimate of development in the area, was assumed. Figure 5.3 shows the risk scores of the Oxnard collection system.

5.2.4 Seismic Assessment

Performing a seismic assessment of the OWTP structures established each structure's anticipated performance level during a seismic event and recommended retrofit strategies to meet established performance objectives for deficiencies identified. With Tier 1 screening, Tier 2 assessments of the buildings, and a seismic assessment of the water-retaining structures at the OWTP, structural and non-structural seismic vulnerabilities could be identified and evaluated. A seismic assessment was completed for a total of 18 buildings and eight water-retaining structures. The results of this analysis can be found in Table 5.4.



COLLECTION SYSTEM RISK

FIGURE 5.3

CITY OF OXNARD

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Table 5.4 Summary of Seismic Assessment and Preliminary Screening Public Works Integrated Master Plan City of Oxnard

Structure	Recommendations	
Tier 1 Evaluation		
Primary Sedimentation	Replace	
Main Electrical/Main Switchgear Building	Replace	
Digester Control Building	Replace	
Operations Center/Plant Control Center Building	Replace	
Effluent Pumping Station	Replace	
Generator/Co-Generation Building	Replace	
Storage-Vacuum Filter Building	Replace	
Storage-Butler Building	Replace	
Tier 2 Evaluation		
	Structural Components	**Non-Structural Components**
Headworks Building	No Deficiencies	Retrofit Needed
Grit Screenings Building	No Deficiencies	Retrofit Needed
Blower Building	No Deficiencies	Retrofit Needed
North Area Electrical Building	No Deficiencies	Retrofit Needed
Solids Processing Building	No Deficiencies	Retrofit Needed
Maintenance Building	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Needed
Collection System Maintenance Building	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Needed
Chemical Handling Facilities	Retrofit Recommended: wall-to-diaphragm connection	Retrofit Needed
16 kW Switchgear/Effluent Electrical Building	Replace structure based on condition assessment and plant considerations.	--
Administration Building	No Deficiencies	Retrofit Needed

Table 5.4	Summary of Seismic Assessment and Preliminary Screening Public Works Integrated Master Plan City of Oxnard
Structure	**Recommendations**
Concrete Testing and Assessment	
Activated Sludge Tanks/Aeration Basin	Repair/seal cracks
Secondary Sedimentation Basin	Repair/seal cracks
Flow Equalization Basin	Repair areas of damaged/cracked concrete; apply corrosion inhibitor to concrete surfaces
Primary Clarifier Tanks	Repair areas of damaged/cracked concrete; coat interior surfaces of tank with 100 percent epoxy or polyurethane coating
Gravity Thickeners	Replace
Digester Nos. 1, 2 and 3	Replace structure based on condition assessment and plant considerations.
DAF Tanks	Replace structure based on condition assessment and plant considerations.
Chlorine Contact Tank	Remove and replace existing coating in the next 10 years.

5.2.5 Cathodic Protection

A survey was conducted on the City's wastewater infrastructure to assess the existing level of cathodic protection. From this survey, the following needed improvements were identified:

- General Wastewater Treatment Plant: Almost all piping tested did not meet National Association of Corrosion Engineers Criteria for protection related to pipe-to-soil potentials. Thus, immediately replacing the entire cathodic protection system plantwide is recommended.
- Clarifiers and Digesters: Currently, no cathodic protection exists at these facilities. Thus, cathodic protection for the submerged surfaces of metallic components is recommended.

In addition to these projects, the project team recommends conducting an annual cathodic protection survey and report for all City facilities as well as bi-monthly rectifier monitoring.

5.2.6 Arc Flash Assessment

An electrical system study was also conducted for the existing OWTP. This study was comprised of a short-circuit study, a protective device coordination evaluation, and an arc flash evaluation.

Each analysis was performed for a particular reason. The short circuit study determined the available short circuit current at each piece of electrical equipment and identified underrated equipment. The protective device coordination evaluation identified protective devices (circuit breakers, fuses, etc.) not coordinated in the electrical system and not likely to minimize disruption of electrical power during a short circuit. The arc flash evaluation determined the maximum arc flash incident energy at each piece of electrical equipment and identified appropriate personnel protective equipment to be worn if working on the equipment while it is energized.

The results of the electrical systems investigation were used to develop the electrical system study for each site. With these results, pieces of existing electrical distribution equipment (e.g., the main breaker for PNL DP4) not sufficiently rated for the worst-case short circuit current could be identified. The results also showed the arc flash incident energy at each piece of electrical equipment based on the existing protective device settings.

Concerns (e.g., equipment that is damaged, scratched, rusty or not functioning, such as a broken indicator light) and code violations (e.g., insufficient working space around electrical equipment) in the existing electrical equipment installations were observed and documented in Section 5 of Project Memorandum 3.8. Obsolete equipment (approximately 40 percent) and equipment nearing the end of its useful life (approximately 30 percent) and in need of repair were identified, and possible changes in the existing installation from code violations were noted as well. For example, electrical equipment installed prior to 1989 was identified and recommended for replacement due to obsolescence and poor condition.

5.3 FLOW AND LOAD PROJECTIONS

5.3.1 Historical Wastewater Flows and Loads

Historical influent wastewater flows and loads were analyzed from 2009 through 2013, as shown in Tables 5.5 and 5.6. These influent flows and loads include residential and commercial users as well as industrial dischargers.

Table 5.5 Historical Wastewater Flows to OWTP (in mgd)
Public Works Integrated Master Plan
City of Oxnard

Flow Condition	Historical Data					
	2009	2010	2011	2012	2013	2009-2013 Average
Average Dry Weather Flow(1)	21.7	21.4	20.1	19.9	19.5	20.5
Average Annual(2)	22.4	22.2	21.6	20.5	19.7	21.3
Average Day Maximum Month(3)	24.2	24.1	24.3	21.4	20.3	22.9
Maximum Week(4)	24.6	26.9	26.0	21.9	20.7	24.0
Maximum Day(5)	26.9	30.5	31.6	25.5	23.5	27.6

Notes:
(1) Average Dry Weather (ADW) Flow = Lowest 90 day running average flow.
(2) Average Annual (AA) = Average for a 365 consecutive day period.
(3) Average Day Maximum Month (ADMM) = Highest 28 day running average flow.
(4) Maximum Week (MW) = Highest 7 day running average flow.
(5) Maximum Day (MD) = Highest observed daily flow.

Table 5.6 Historical Wastewater Loads to OWTP
Public Works Integrated Master Plan
City of Oxnard

Flow Condition	Historical Data					
	2009	2010	2011	2012	2013	2009-2013 Average
BOD_5(1)						
ADW, klb/d(2)	53.3	50.5	45.1	45.8	48.8	48.7
ADW, mg/L(3)	295	283	269	276	299	284
AA, klb/d	61.4	53.7	49.7	53.1	52.5	54.1
MM, klb/d	67.9	59.1	56.3	59.7	61.4	61.3
MW, klb/d	85.3	64.7	59.4	62.7	66.9	67.8
MD, klb/d	108	88.2	94.2	76.6	92.5	91.9
TSS						
ADW, klb/d	46.4	44.4	41.6	41.5	45.1	43.8
ADW, mg/L	257	249	248	250	277	256
AA, klb/d	49.5	49.2	48.7	46.0	47.8	48.2
ADMM, klb/d	60.5	59.5	65.5	53.1	56.5	59.0
MW, klb/d	89.8	76.5	81.8	64.5	70.7	76.7
MD, klb/d	142	211	190	104	173	164

Table 5.6	**Historical Wastewater Loads to OWTP Public Works Integrated Master Plan City of Oxnard**					
	Historical Data					
Flow Condition	**2009**	**2010**	**2011**	**2012**	**2013**	**2009-2013 Average**
NH3-N						
ADW, klb/d	6.53	6.26	5.97	6.22	6.30	6.26
ADW, mg/L	36.1	35.1	35.6	37.5	38.7	36.6
AA, klb/d	6.85	6.51	6.63	6.80	6.47	6.65
ADMM, klb/d	7.88	7.51	7.64	7.99	6.83	7.57
MW, klb/d	9.63	8.33	8.24	10.2	7.77	8.83
MD, klb/d	9.63	8.33	8.24	10.2	7.77	8.83

Notes:

**For flow condition definitions, see Table 5.5.

(1) These higher BOD_5 values are likely due to high soluble BOD_5 from the canning and food processing industry.
(2) ADW = Influent load during ADW flow period.
(3) ADW, mg/L calculated as ADW Load (lb/d)/average dry weather flow (ADWF) (mgd)/8.34.

5.3.2 Future Wastewater Flow and Load Projections

For domestic (residential and commercial) uses at the OWTP, flow and load projections were developed using a combined population-based per capita method. A land use-based projection method was used for industrial uses.

Residential and commercial wastewater flow and load projections were estimated using a per capita daily flow of 71.6 gallons per day (gpd)/capita, a per capita daily biochemical oxygen demand (BOD_5) load of 0.20 pounds per day (ppd)/capita, and a per capita daily (pcd) total suspended solids (TSS) load of 0.17 ppd/capita in conjunction with population projections outlined in Chapter 2.

Industrial flows and loads were projected for existing and new industries. Flows and loads for both industry types are described below.

For existing industries, the 30 significant industrial units that currently discharge at or above their permitted flow were assumed to continue discharging at 2013 flows and loadings through the planning horizon. It was assumed that the six remaining industries that currently discharge less than their permitted flow would discharge at their permitted flow through the planning horizon. The additional flow projected was assumed to have BOD_5 and TSS concentrations consistent with overall average industry concentrations. This approach was used for a conservative estimate of future flows and loads from existing industry.

New industry wastewater flow projections were estimated using projected industrial water demand projections. These demands were calculated using future land use, discussed in Chapter 2, and were allocated for 2020 and 2040. As a conservative estimate, it was assumed that the wastewater generation coefficient for the demand is 1.0, and that new industry would grow linearly from 0 to the 2020 water demand projections and then linearly again to the 2040 water demand projections.

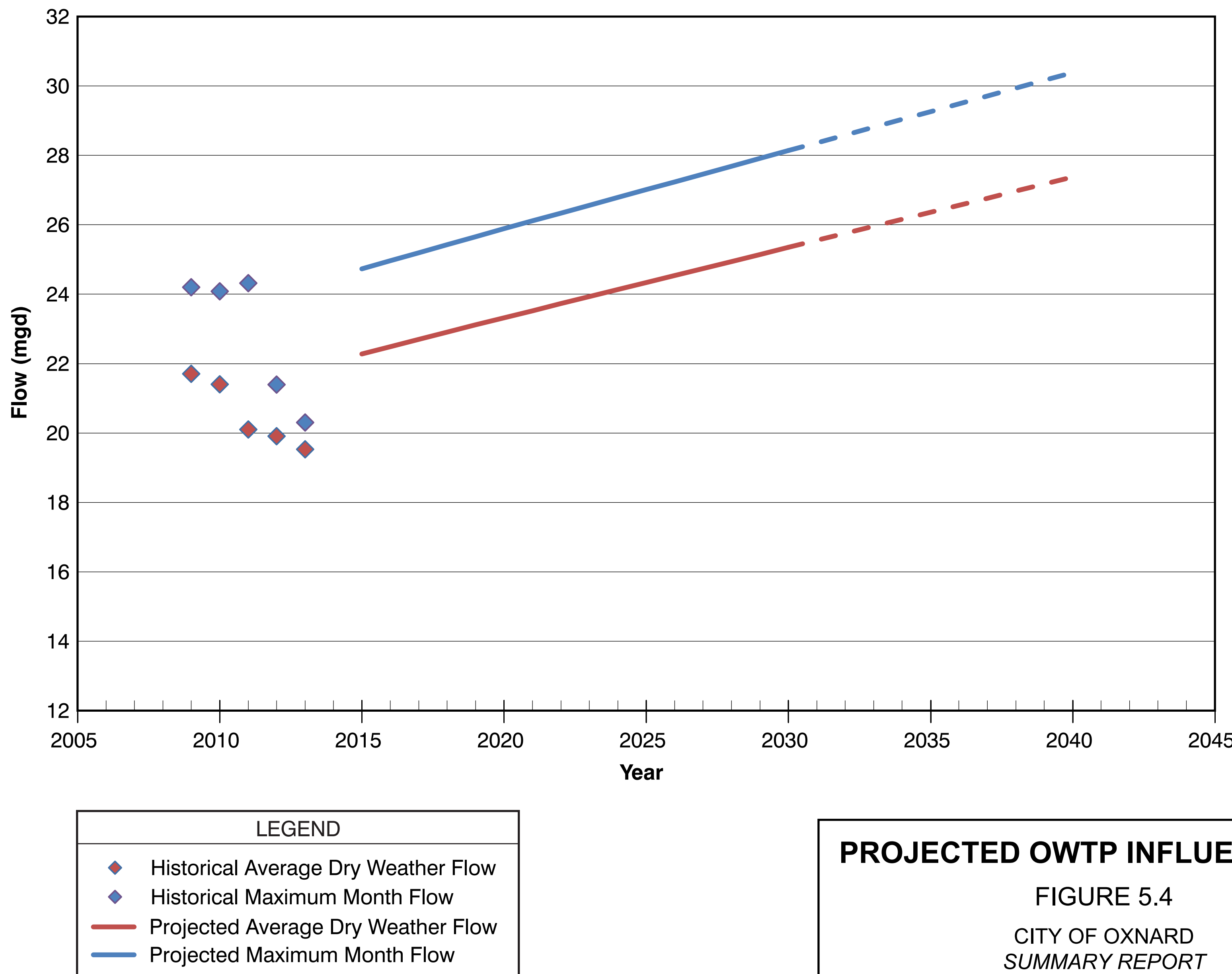
Similar to the industrial flow and load projections, both Naval Base Ventura County (NBVC) at Point Mugu and NBVC at Port Hueneme were assumed to discharge at their permitted limits throughout the planning period. It was also assumed that the incremental flow projected for these NBVCs - between their current and permitted flows - would have BOD_5 and TSS concentrations consistent with the average residential/commercial concentrations.

Projected desalter concentrate flows and loads from the Oxnard desalter and Port Hueneme Water Agency (PHWA) desalter were not included in the flow projections to the OWTP headworks. Concentrate flow from the PHWA desalter is planned to be discharged to the Calleguas Municipal Water District (CMWD) regional brine pipeline. In addition, in the future, the Oxnard desalter (located at Blending Station No. 1/6) concentrate will be discharged directly to the outfall through a separate concentrate line, bypassing the OWTP.

Flow, BOD_5, and TSS projections are shown in Figures 5.4, 5.5, and 5.6 respectively.

5.4 MASTER PLAN/DESIGN CRITERIA

Key planning and design criteria were used to evaluate the existing wastewater system's ability to meet the future needs. Table 5.7 shows the OWTP criteria, and Table 5.8 shows criteria for the collection system. The criteria were used for future system improvement planning.



PROJECTED OWTP INFLUENT FLOW

FIGURE 5.4

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CITY OF OXNARD CALIFORNIA

carollo Engineers...Working Wonders With Water®

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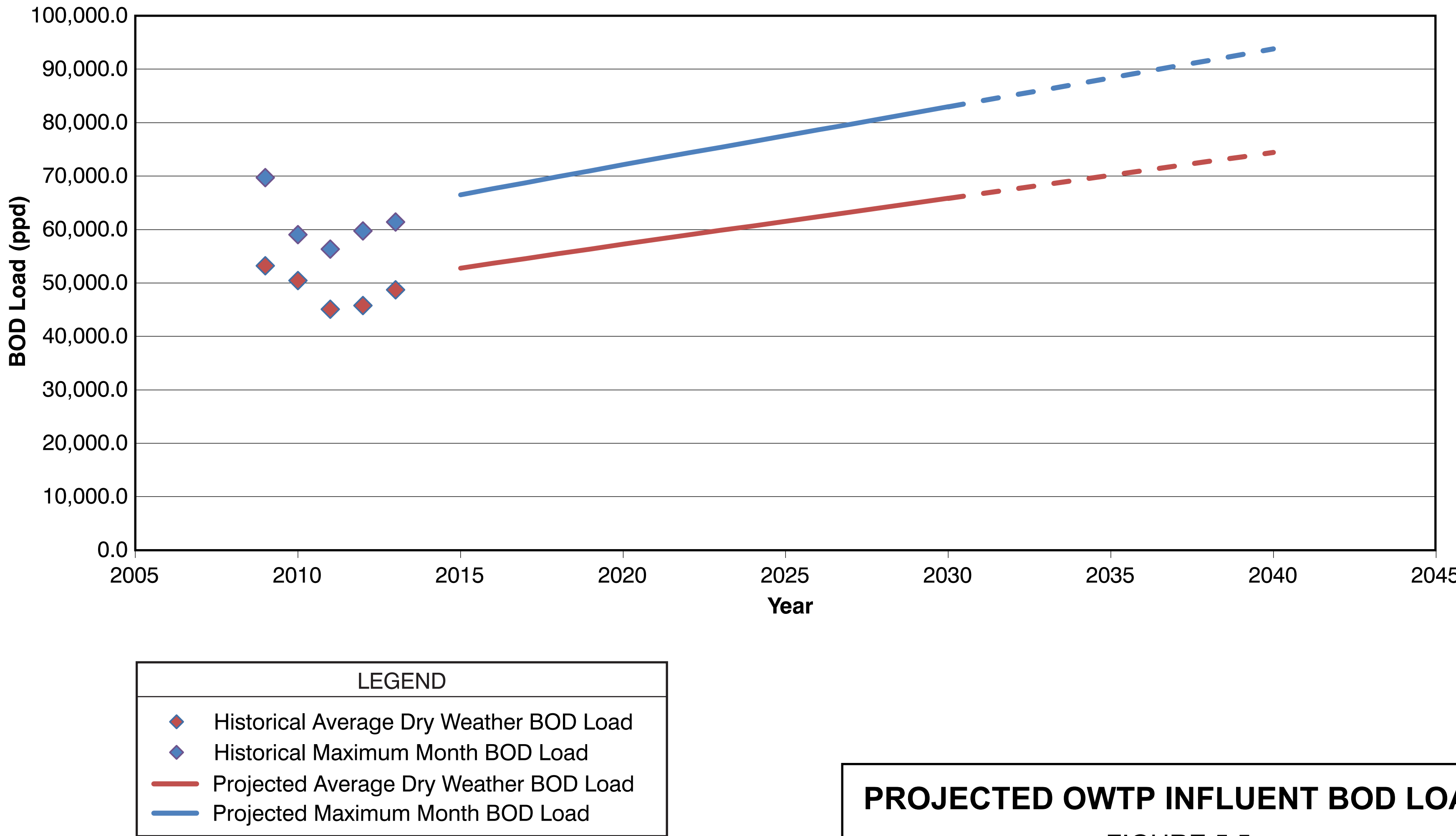

PROJECTED OWTP INFLUENT BOD LOAD

FIGURE 5.5

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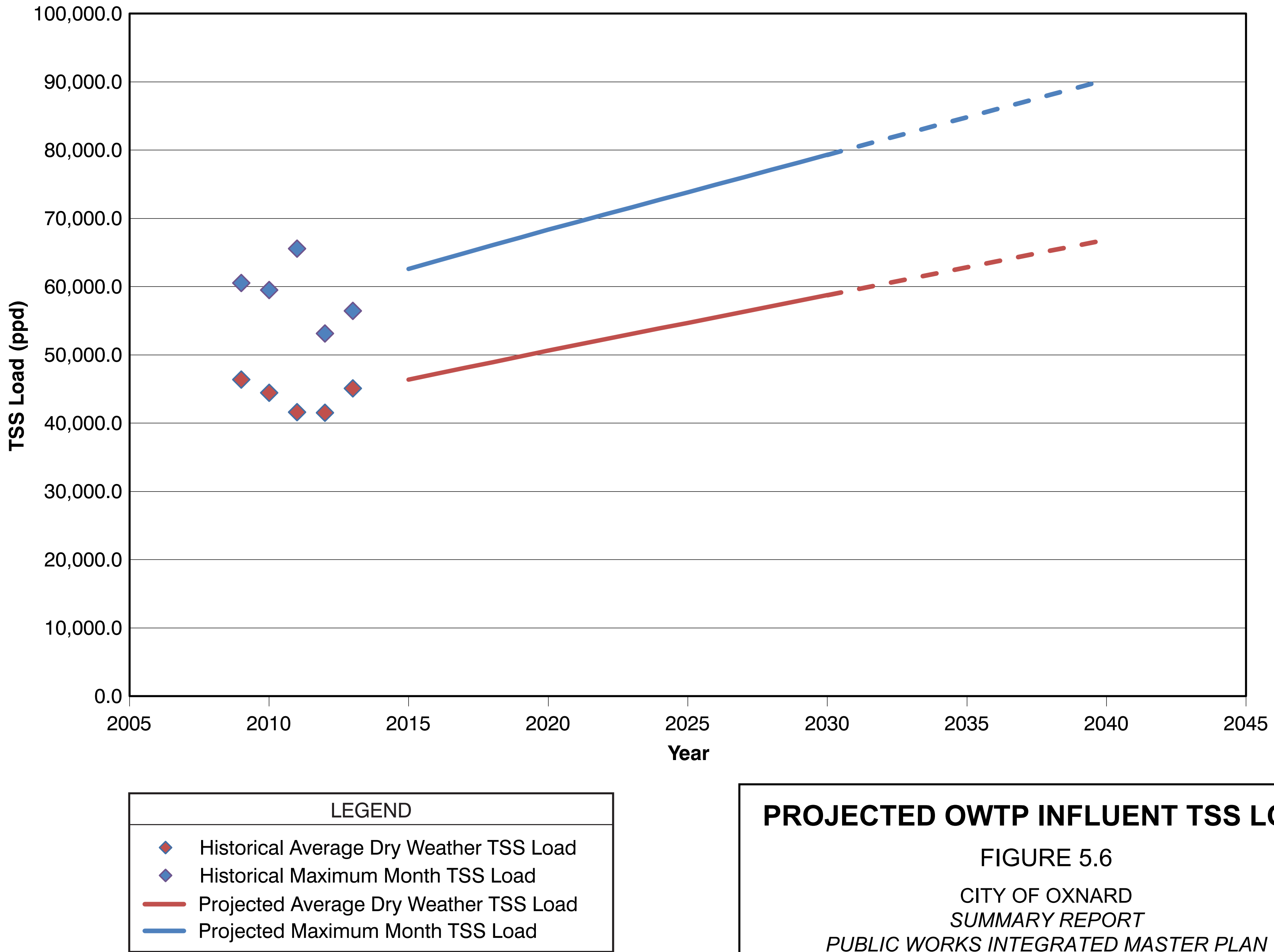

PROJECTED OWTP INFLUENT TSS LOAD

FIGURE 5.6

CITY OF OXNARD

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**Table 5.7 OWTP Process Performance and Criteria Summary
Public Works Integrated Master Plan
City of Oxnard**

Process/ Design Parameter	Design Parameter	Units	Original Design(1)	Historical Performance (2010 – 2013)	MOP-8(2) or Typical Values(3)	Recommended Criteria for Capacity Analysis
Grit Chambers	Overflow Rate at PWWF	gpd/sf	42,315	23,056	20,000 - 50,000	42,315
	Detention Time at PWWF	min	2.8	5.1	2 to 5(4)	2.8
Primary Sedimentation Tanks	Overflow Rate:	gpd/sf				
	ADWF		1,270	809(5)	800 - 1,200(2)	1,270
	PWWF		2,200	1,598(5)	2,000 - 3,000(2)	2,220
	% BOD_5 Removal	%	35	46	25 - 40(2)	35
	% TSS Removal	%	65	70	50 - 70(2)	65
Biofiltration Units	Hydraulic Load:					
	Average	gpm/sf	0.50	--	0.9(2)	1.00
	Peak		1.50	--	2.9(2)	1.50
	Volumetric Load at ADMML	lb BOD_5/ 1,000 ft^3/d	47(6)	55	100-220(2)	100
	% BOD_5 Removal	%	--	23	40-70(2)	24
	% Soluble BOD_5 Removal	%	--	63	40-70(2)	69
Aeration Basins	Solids Retention Time (SRT)	days	--	2.0 (7)	Variable	2.5
	Hydraulic Detention Time (HRT)	hrs	--	4.3 (7)	Variable	Variable
	MLSS	mg/L	--	1002	2,000 - 4,000(2)	Depends on Peak Week Load, SVI, and Sec Sed Basin Capacity
	Sludge Volume Index (SVI) 90 Percentile	mL/g	--	177	150(3)	150
	Temperature	°C	--	19 - 27	Variable	20 - 27

Table 5.7 OWTP Process Performance and Criteria Summary
Public Works Integrated Master Plan
City of Oxnard

Process/ Design Parameter	Design Parameter	Units	Original Design(1)	Historical Performance (2010 – 2013)	MOP-8(2) or Typical Values(3)	Recommended Criteria for Capacity Analysis
Secondary Sedimentation Tanks	Peak Solids Loading	lb/sf/day	--	28.7(8)	40 - 50(2)	28.7(9)
	Overflow Rate at ADWF	gpd/sf	600	341(10)	400 - 700(2)	Depends on SVI and MLSS concentration
	Overflow Rate at PWWF	gpd/sf	1,100	699(10)	1,000 - 1,600(3)	Depends on SVI and selected MLSS concentration
Chlorine Contact Basins	Detention Time: ADWF	min	20	46	30 - 60(2)	30
	PWWF		--	23	15 - 30(2)	15
Dissolved Air Floatation Thickeners	Solids Load (Peak 14-day Average)	lb/sf/hr	--	1.78(11)	0.4 - 1(2)	1.6
	Hydraulic Load (Peak 14-day Average)	gpm/sf	--	1.06(11)	0.5 - 2(2)	1.0
	Thickened Waste Activated Sludge (TWAS) Concentration	% TS	--	5.5	3.5 - 4(2)	--
Gravity Thickeners	Solids Load (Peak 14-day Average)	lb/sf/hr	1.0	1.5 (11)	1.2	1.2
	Hydraulic Load (Peak 14-day Average)	gpd/sf	700	842 (11)	700	700
	Percent Solids Capture	%	--	--	85 - 90	--
	Thickened Sludge Concentration	% TS	--	--	3.5 - 4.0	--

Table 5.7 OWTP Process Performance and Criteria Summary
Public Works Integrated Master Plan
City of Oxnard

Process/ Design Parameter	Design Parameter	Units	Original Design(1)	Historical Performance (2010 – 2013)	MOP-8(2) or Typical Values(3)	Recommended Criteria for Capacity Analysis
Anaerobic Digesters	Volatile Solids Load at ADMML	lbs VS/ CF/ day	0.1	0.10 (12)	0.1 - 0.4(2)	0.15
	HRT	days	25	25.4(12)	10 - 20(2)	15
	VS Reduction	%	55	55	50 - 65%(2)	55
	Volatile Acids	mg/L	50 - 500	194	< 300	< 300
	Alkalinity	mg/L as $CaCO_3$	2,000 - 4,000	3,378	> 1,000	> 1,000
	Volatile Acids/Alkalinity	--	0.03 - 0.13	0.06	< 0.10	< 0.10
	pH	-	6.8 - 7.4	--	6.8 - 7.4	6.8 - 7.4
Belt Filter Press	Solids Feed Rate per unit	lb/hr	820	984(13)	700 - 900	820
	Dewatered Sludge % Solids	%	18 - 22	19.6	15 - 25	20

Notes:
(1) From OWTP O&M Manuals (Brown and Caldwell, 1980) (Camp Dresser McKee Inc., 1991).
(2) Source: Water Environment Federation / American Society of Civil Engineers, 2010.
(3) Typical values based on Carollo experience.
(4) (Metcalf and Eddy, 2014).
(5) Calculated assuming 3 of 4 in service.
(6) Based on 1.73 lb BOD_5/d/sf media. 604 kcf of media at 27 sf/cf results in max BOD_5 load of 28,213 lb/d.
(7) Based on 1 of 2 in service.
(8) Peak flow rate of 74.5 mgd, return activated sludge (RAS) flow rate of 29.0 mgd, all secondary clarifiers in service, and an SVI of 150 mL/g.
(9) Given the shallow surface water depth of the OWTP primary clarifiers, a higher solids loading rate is not recommended.
(10) Assume all in service.
(11) Based on 1 of 2 in service.
(12) Digester 1 and 3 in service only.
(13) Based on all four in service for 16 hours per day.

Table 5.8	Collection System Level of Service Criteria Summary Public Works Integrated Master Plan City of Oxnard
Design Parameter	**Recommended Criteria for Analysis**
Wet Weather Level of Service Goals	
Hydraulic Grade Line	3 ft below manhole rim elevation
Peak Wet Weather Flow	Existing: 38.5 mgd 2040: 49.6 mgd
Design Storm	10-year 24-hour storm
Dry Weather Level of Service Goals	
Depth to Diameter (d/D)	less than 75% to 85%
Peak Dry Weather Flow	Existing: 22.9 mgd 2040: 34.8 mgd

5.5 FUTURE FACILITY NEEDS

The existing wastewater system's capacity and performance were compared with the above criteria (Table 5.7) to locate system shortfalls. In general, the system has adequate capacity to meet current demand conditions but with little reliability. Much of the existing OWTP is in need of major rehabilitation and repair and is reaching the end of its remaining useful life. This means that without substantial investment into the existing treatment system, the City has a high risk of treatment failure and regulatory fines.

5.5.1 Wastewater Collection System

5.5.1.1 Capacity

To determine the necessary collection system capacity, the existing collection system model was recalibrated with recent wastewater flow data and included both dry and wet weather flow monitoring. Dry weather flow monitoring occurred from August 2, 2014, to August 24, 2014, and wet weather flow monitoring occurred from December 9, 2014, to February 25, 2015.

The collection system capacity was assessed during existing and projected dry and wet weather flow conditions. According to this assessment, the existing system can adequately convey both peak dry and wet weather flow conditions using the level of service (LOS) criteria defined in Table 5.8. However, as flows increase over time, the system will require upgrades to meet capacity restrictions. By 2040, certain sewers are expected to surcharge during peak dry weather flow conditions, which is not acceptable per the LOS criteria. Therefore, pipelines in these areas that exhibited potential capacity deficiencies should be upsized to convey peak dry weather flow without surcharge.

The collection system was also evaluated under peak wet weather flow conditions. Using the LOS criteria in Table 5.8, the analysis indicated that no improvements are needed through 2040 based on the 10-year design storm event. Surcharging does occur throughout the system during these conditions. However, the peak hydraulic grade line is more than 3 feet above the manhole's rim elevation, meaning it does not violate the LOS criteria. Thus, since no sewers violated the peak wet weather flow criteria, no sewers require upgrades.

The pump stations within the system were also evaluated to determine if upgrades were necessary for projected flows. The City provided pump curves for the pump stations but could not provide the start and stop elevations within the wet wells for the pump operation. In general, the pump stations appear able to adequately convey future flows. However, without the actual stop and start elevations, it is difficult to definitively assess this.

5.5.1.2 R&R

Because of the limited information available on the existing condition and age of the collection system piping, a detailed system rehabilitation program could not be practically developed for the Integrated Master Plan. Instead, the CIP recommendations for rehabilitation projects are based on the City's understanding of project needs.

5.5.2 Wastewater Treatment Plant

5.5.2.1 R&R

As discussed in the condition assessment section, a large portion of the OWTP is in poor condition and reaching the end of its useful life. Because of this, major investment in R&R is needed in the near future for reliable plant operations and plant safety concerns.

Replacement is recommended for a number of process facilities, namely the primary clarifiers, DAFTs, digesters, interstage pump station, effluent pump station, and cogeneration facility. All of these facilities are nearing the ends of their useful lives. Additionally, due to safety concerns, demolishing the biotowers is recommended as soon as possible.

5.5.2.2 Process Performance

The performance assessment of the OWTP assessed the following:

- The plant's overall treatment performance for meeting discharge limits and other effluent requirements.
- Each unit process' historical loading and performance.

Approximately 1 to 3 years of daily operating data were reviewed to characterize the OWTP's overall performance. During the review period, the OWTP complied with all regulated conventional pollutants. However, while the OWTP met all the limits for conventional pollutants, there was one violation for benzidene cited in the fact sheet

(Attachment F) of the 2013 NPDES permit because the reported detection limit was greater than the discharge limit.

In general, the unit processes at the OWTP have operated at loading rates well within their original design values or typical operating ranges. In addition, performance has been adequate and there are a sufficient number of units in some of the unit processes to maintain a standby unit out of service for maintenance.

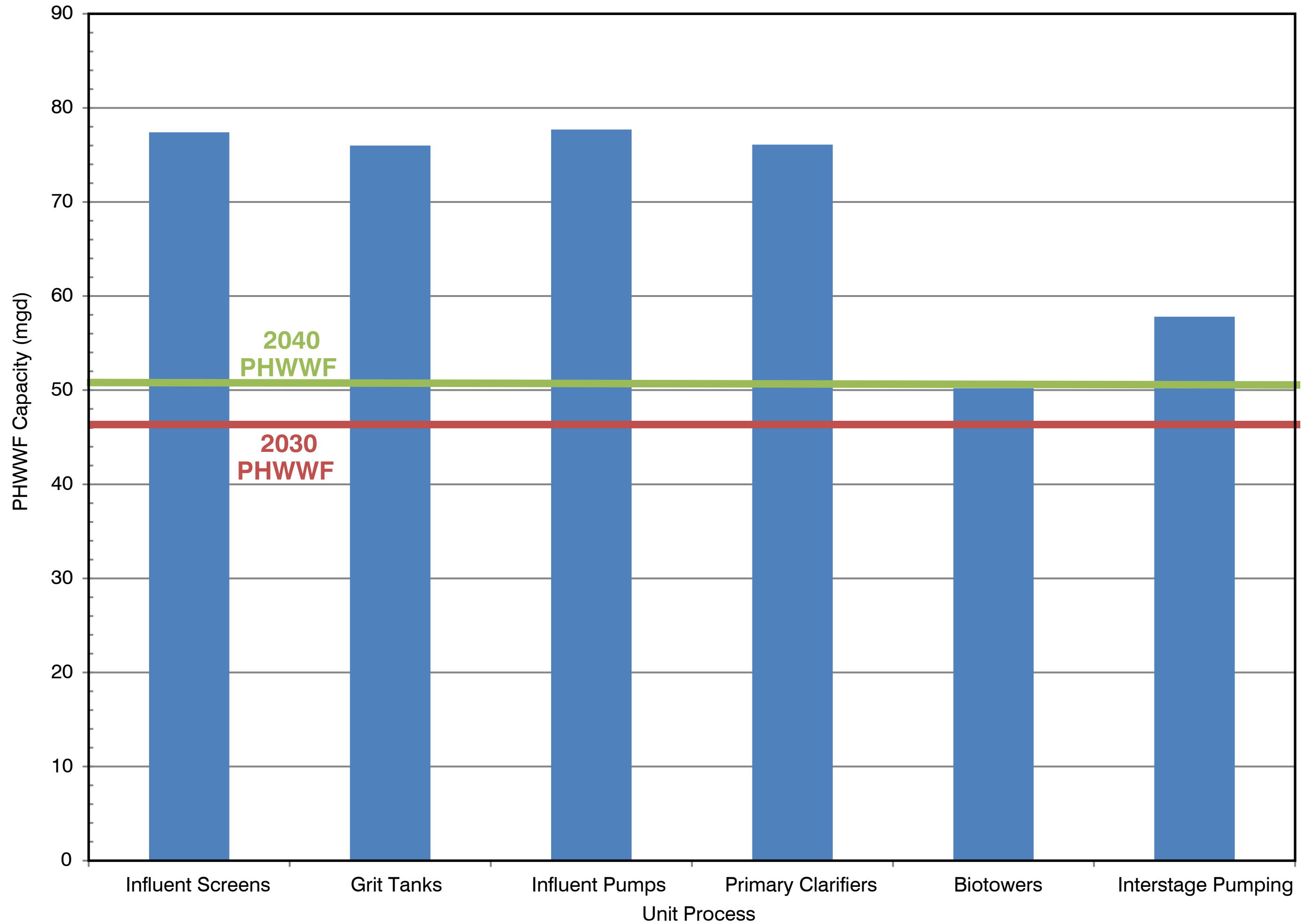
Removing the biotowers because they are a safety hazard will change the OWTP's treatment train configuration. The biotowers were originally designed to provide secondary treatment in the 1970s. In the 1980s, they were retained as part of the activated sludge system to reduce the organic load to the downstream aeration tanks. Currently, a significant portion of the biotower influent is untreated because of seal failures within the biotower itself. With the removal of the biotowers, the existing aeration tanks need to be modified to accommodate the incremental organic load. As most of the incremental organic load will be soluble BOD_5, it is recommended to add submerged baffle walls to create a biological selector zone in each aeration tank. The selector zone would be mechanically mixed, but unaerated, to maintain good sludge settling characteristics. Step feed capabilities, included as part of the original aeration basin design, can be used together with these recommended modifications to operate in a sludge reaeration (step feed) configuration to limit secondary clarifier sludge loading rates during periods of high wet weather flows and low sludge settleability. With these minor alterations, the aeration basins can treat higher loadings without expanding their footprint.

5.5.2.3 Capacity

As part of the Integrated Master Plan, the capacity of each unit process at the OWTP was assessed. This assessment considered a range of parameters, including flow, influent wastewater characteristics, treatment objectives, process configurations and limitations, and desired redundancy.

The peak hour wet weather flow (PHWWF) capacity was estimated for facilities that use peak flow to establish sizing. These facilities include the headworks, influent pumping, primary clarifiers, biotowers, and interstage pumping. Whereas pumping capacities are determined with the largest unit out of service, peak capacities for process units are determined with all units in service. Figure 5.7 summarizes the PHWWF capacity for each process.

Figure 5.8 illustrates the required EQ basin volume needed for the design storm based on flow rate treated at the OWTP. At the permitted capacity of 31.7 mgd, approximately 4.95 MG of storage will be needed in 2040, which is just under the available storage capacity. Historically, the EQ basins have never been filled to capacity. However, in 2040, the EQ basin capacity will approach its limit. Thus, determining whether additional capacity is needed will depend on how the EQ basins are operated as well as the needs of both the AWPF and the outfall.



OWTP PEAK HOUR WET WEATHER FLOW CAPACITY BAR GRAPH

FIGURE 5.7

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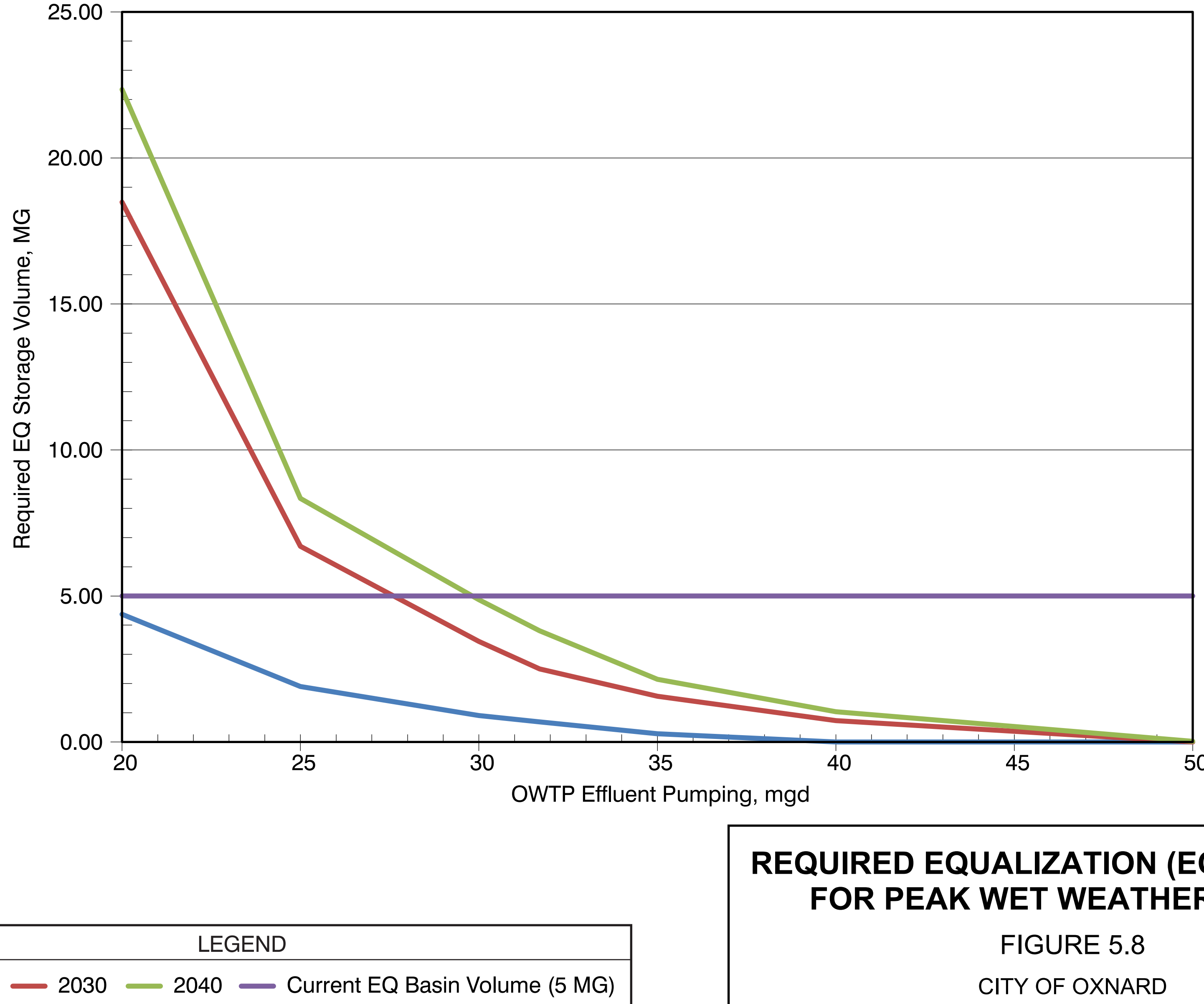

REQUIRED EQUALIZATION (EQ) STORAGE FOR PEAK WET WEATHER FLOWS

FIGURE 5.8

CITY OF OXNARD

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The ADWF capacity was estimated for facilities using average flows or influent BOD_5 and TSS loading to establish sizing. To estimate this capacity, a plant process model was developed and calibrated to historical operating data from 2013. Figure 5.9 summarizes the capacity for each process.

As shown in Figure 5.9, all of the liquid treatment processes have sufficient capacity for projected flows through 2040. However, although the existing secondary treatment process has sufficient treatment capacity to meet the City's NPDES BOD_5 limits through the planning horizon, it does not have sufficient capacity to nitrify with or without denitrification. The City's existing NPDES permit is not expected to require nitrification/denitrification in the near future, but increased recycled water production by the AWPF will increase constituent concentrations, particularly ammonia, above those in the secondary effluent.

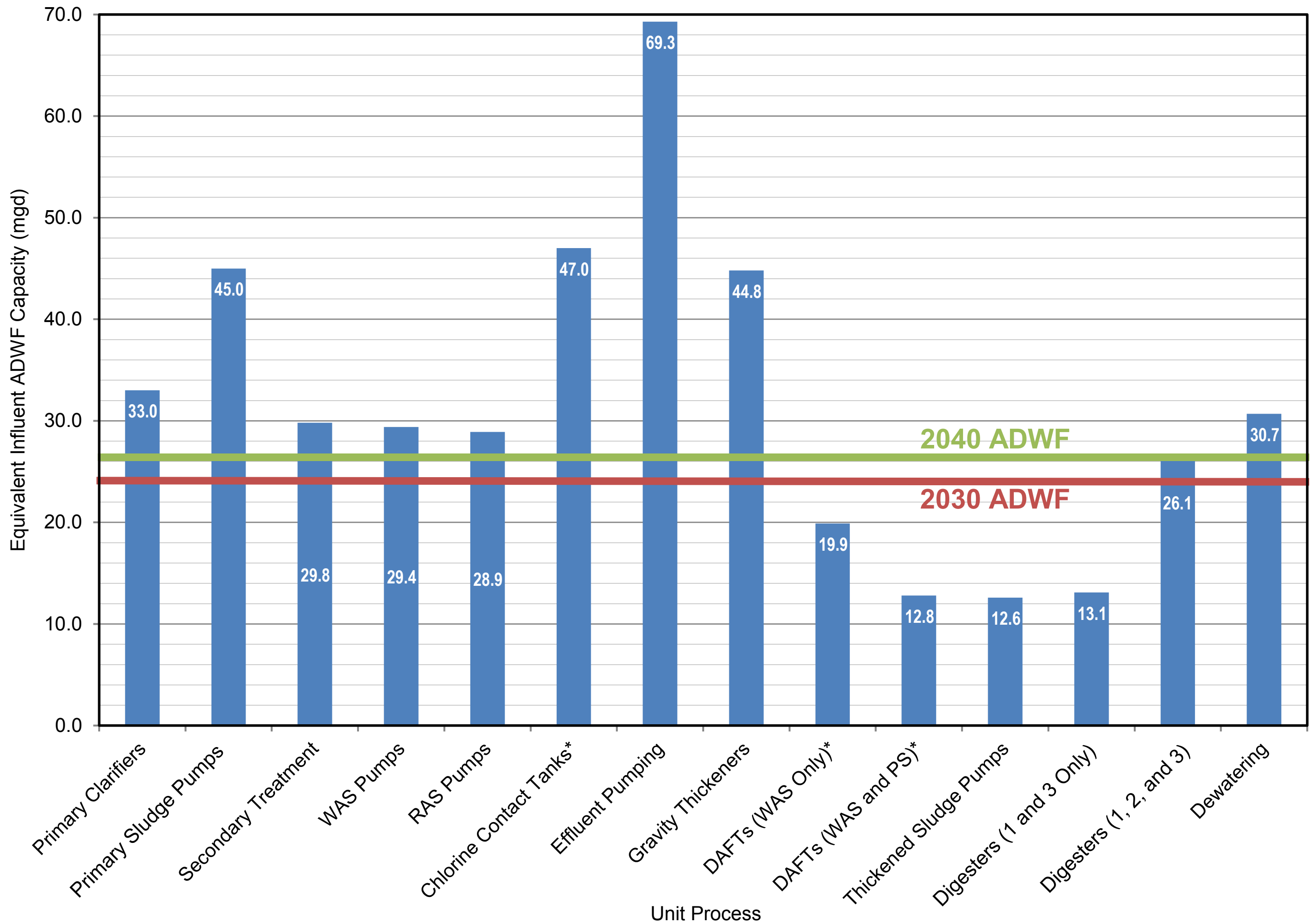
One way to address the insufficient capacity is to nitrify and denitrify in the secondary treatment process. To accommodate this, the OWTP may need to consider expanding the secondary treatment capacity or switching to an alternative process configuration such as membrane bioreactors (MBR), should the conversion be necessary with AWPF expansion.

According to Figure 5.9, the solids handing facilities do not have sufficient capacity. OWTP sludge production is expected to increase, in part because the biotowers will need to be removed and an anaerobic selector will need to be added in the ASTs. Because of the anticipated changes to sludge production, additional DAFT units, digesters, and dewatering units are needed.

5.6 ALTERNATIVES ANALYSIS

Based on the future facilities needs outlined, several alternative scenarios were considered for upgrading the OWTP facilities to meet future capacity and reliability needs. Of those scenarios, three were developed for the recommended CIP. Although each scenario has a different area of focus, it is important to recognize that these scenarios are not mutually exclusive and are instead compatible with one another, allowing for increasing levels of treatment to better address the overarching goals of this Master Plan. These three scenarios are further described below:

- **Scenario 1: Plant Reliability -** Scenario 1 includes all projects needed to meet existing and anticipated level of treatment requirements. Projects to optimize operations and maintenance as well as projects that adopt newer technologies in place of aging equipment are both included in this scenario. Because of the OWTP's age and state of repair, the majority of OWTP projects recommended in this Master Plan are related to repair and replacement required for continued plant operation. As a result, this baseline scenario includes a majority of the proposed projects.



**All unit processes assume the largest unit is out of service except for those starred.*

OWTP AVERAGE DRY WEATHER FLOW CAPACITY BAR GRAPH

FIGURE 5.9

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- **Scenario 2: Energy Efficiency -** Scenario 2 focuses on projects that promote energy efficiency at the OWTP. This scenario includes all projects discussed under Scenario 1. However, Scenario 2 also includes projects to reduce energy use at the OWTP.
- **Scenario 3: Resource Recovery -** Scenario 3 focuses on projects that maximize water reuse and nutrient mining. This scenario includes all projects discussed under Scenario 1 and Scenario 2. However, Scenario 3's focus is to protect and enhance resource sustainability.

A comparative evaluation of these three scenarios was conducted, which included lifecycle cost estimates, energy comparisons, water quality considerations, and other non-economic factors. Table 5.9 summarizes the lifecycle costs of the three alternatives considered, and Table 5.10 contains the results of the overall alternatives comparison, including non-economic considerations.

For each scenario, relative energy use was also compared. Although all scenarios include energy savings from recommended small equipment replacement projects, some larger CIP projects differentiate one scenario from another. Table 5.11 compares the energy use of the larger CIP projects.

After comparing each scenario, the City selected Scenario 2: Energy Efficiency. Although Scenario 1 provides the lowest overall cost, the non-economic comparison showed a slight advantage to Scenarios 2 and 3 because they indicate moderate to high goal achievement. Since Scenario 2 costs less than Scenario 3, Scenario 2 was chosen.

5.6.1 New OWTP Location

As part of the Integrated Master Plan, relocating most of the OWTP facilities to another location near the AWPF was considered, for several reasons:

- the inefficiency of the current plant layout,
- the need to replace/rehabilitate much of the existing site, and
- the need to address the potential for rising sea levels from climate change and the current facility's low elevation (relative to mean sea level).

Although considerable work would be needed to assess the feasibility of moving the OWTP, this option had no fatal flaws and was therefore considered at the City's request.

Table 5.9 Comparison of Scenario Costs[1]
Public Works Integrated Master Plan
City of Oxnard

Cost ($ M)	Scenario 1 Plant Reliability	Scenario 2 Energy Efficiency	Scenario 3 Resource Recovery
Headworks	$14.9	$14.9	$14.9
Primary Treatment	$20.9	$20.9	$20.9
Secondary Treatment	$100.3	$100.3	$100.3
Disinfection/Effluent Pumping/Outfall	$24.5	$24.5	$24.5
Sludge Thickening	$13.4	$13.4	$13.4
Digestion	$34.4	$34.4	$34.4
Dewatering and Sludge Post Processing	$27.6	$27.6	$88.1
Cogeneration/FOG	$13.8	$16.5	$16.5
Electrical	$18.3	$18.3	$18.3
Non-Process Buildings	$25.1	$25.1	$25.1
Other	$33.6	$34.8	$38.3
Total Construction Cost	**$327**	**$331**	**$395**
Total Project Cost[2]	**$405**	**$410**	**$489**
Annual Costs ($ M/yr)	$20.3	$20.5	$24.5
Annualized Project Cost[3]	$33	$33	$39
Incremental Annual O&M[4]	$5.0	$5.4	$6.5
Total Annual Cost	$37.5	$38.3	$45.8

Notes:
(1) Costs derived using the methodology outlined in Chapter 2.
(2) Project costs include project cost factor (as outlined in Chapter 2).
(3) Annualized at 5 percent over 20 years.
(4) O&M costs include only additional O&M costs from new capital improvement projects.

Table 5.10 Non-Economic Consideration of Water Supply Alternatives
Public Works Integrated Master Plan
City of Oxnard

	Scenario 1 - Plant Reliability	Scenario 2 - Energy Efficiency	Scenario 3 - Resource Recovery
Goal 1: Compliant, reliable, flexible system	Moderate	High	High
Goal 2: Economic sustainability	Moderate	High	Moderate
Goal 3: Mitigate/adapt to climate change	Moderate	Moderate	Moderate
Goal 4: Resource sustainability	Low	Moderate	High
Goal 5: Energy efficiency	Low	High	High
Benefits	• Has a lower overall cost • Focuses on rehabilitating the existing plant as the highest priority • Provides a seawall to protect against potential sea level rise from climate change	• Has a moderate cost • Has a more flexible system to address potential future changes in the cost of energy • Provides a seawall to protect against potential sea level rise from climate change	• Has more flexibility in sludge handling and resource recovery • Has a more flexible system to address potential future changes in the cost of energy • Provides a seawall to protect against potential sea level rise from climate change
Drawbacks	• Does not directly address goal 4 or goal 5 • Is less able to adapt to potential future increases in the cost of energy • Does little to take advantage of resources produced onsite	• Does not focus on recovering nutrients and sludge onsite	• Has a high cost

Table 5.11 Potential Energy Savings Public Works Integrated Master Plan City of Oxnard			
	Potential Relative Energy Savings		
Recommendation	**Scenario 1**	**Scenario 2**	**Scenario 3**
Biotower Removal and Interstage Pump Reconfiguration	Included in All Scenarios	Included in All Scenarios	Included in All Scenarios
AST Blower Replacement	Included in All Scenarios	Included in All Scenarios	Included in All Scenarios
Cogen Replacement	Included in All Scenarios	Included in All Scenarios	Included in All Scenarios
FOG Receiving Station	NA	+	+
Solar or Alternative Energy Facility	NA	+	+
Incineration	NA	NA	+
Total Potential Energy Savings	+	++	+++

Note:
(1) Only projects that could produce energy savings are included in this analysis.

One reason to move many of the OWTP facilities is that much of the existing infrastructure is nearing the end of its useful life and should be repaired or replaced within the next 15 years. Because of this, it would be beneficial to place the new facilities in an optimal location.

Another reason is that the current plant layout is inefficient and requires pumping between processes, which increases operation and maintenance costs. A new location would allow for a new efficient layout that would eliminate the need for pumping, which would lower costs.

Finally, Federal Emergency Management Agency predicts that portions of the OWTP could experience significant flooding within the next fifty years because of its low elevation. Moving most of the OWTP facilities to a new location at a higher elevation would reduce this risk.

To assess the costs of relocating the OWTP, a preliminary master planning-level cost estimate was developed. Based on the comparative cost of building OWTP facilities in the two locations discussed, there is no significant difference between the two options, assuming similar levels of treatment. Because space is theoretically not limited at a new site, conventional secondary treatment could be utilized and was thus assumed. Alternatively, a higher level of treatment could be implemented at additional cost. Table 5.12 shows the results of the cost comparison.

Table 5.12 Cost Comparison Between Upgrading the Existing Plant and Constructing a New Plant in a New Location
Public Works Integrated Master Plan
City of Oxnard

Components	Existing Plant ($ M)	New Plant ($ M)
Total Construction Cost	$331	$258
Total Project Cost	**$410(1)**	**$411(2)**
Constructability and Protection of electrical and major equipment from Sea Level Rise	$50	--
Additional O&M for Old Plant (15% of Construction Cost)	$77	--
Immediate Needs	--	$30
Additional civil/site work/inter-process piping needed with new plant (15% of Construction Cost)	--	$39(3)
Demolish and Reclaim old site	--	$10
Land Acquisition	--	$22
CEQA/Permitting (2% of Construction Cost)	--	$5
Total(4)	**$540**	**$520**

Notes:

(1) Engineering, legal, administration, and construction management (ELAC) is 24% of construction cost, consistent with other recommended projects in the Integrated Master Plan.
(2) ELAC is 35% of construction cost for those projects originally estimated for the existing site, but now moved to new site with this scenario, due to new site uncertainties; ELAC is 75% of construction cost for those projects based on cost curves.
(3) Spread over all the projects implemented at the new site.
(4) Totals are rounded up to the nearest $5 M.

5.7 RECOMMENDED PROJECTS

This section summarizes the recommended projects for the wastewater system. These projects are based on the existing system condition assessment, capacity, and performance needs for meeting projected future demands and discharge requirements through the Integrated Master Plan's planning period (2015-2040).

The projects were each assigned a phase that loosely follows when they will be implemented. These phases include Phase 1 – Immediate Needs; Phase 2 – Near-Term Needs; and Phase 3 – Long-Term Needs. The phases were recommended based on the technical needs identified from the condition assessment.

Note that the actual timing of implementation may differ when compared with and balanced against the financial considerations for the Integrated Master Plan's total implementation. For more detail on the costs and timing of these projects, consult Chapter 9 and the Cost of Service (COS) Studies (Carollo, 2017).

5.7.1 Wastewater Collection System

Collection system improvements focused on capacity needs were based on collection system modeling, R&R needs, and conversations with the City. Using the capacity, three main capacity projects and fifteen R&R and performance-based projects were identified. Each project is summarized in Table 5.13.

5.7.2 Wastewater Treatment Plant

The City has two options for implementing improvements needed at the OWTP. The first is to invest in the existing plant, and the second is to relocate most facilities. Both options require investing in a different set of wastewater treatment-related improvement projects. If the City chooses to invest in the existing plant, the recommended improvement projects will focus on rehabilitating aging infrastructure. If the City chooses to relocate the plant, the recommended improvement projects will focus on investing in new facilities. The recommended projects for each option are outlined below.

Table 5.13 Recommended Collection System Projects
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[(1)]	2015 Project ID	Project	Location	Driver	Start Year	Years to Implement
C-1	WW-P-6	Central Trunk Manhole Rehabilitation Phase 1	Rehabilitate 47 existing manholes	R&R	2018	1
C-17	WW-P-5	Headworks Meter Vault/Vortex Structure Coating Rehabilitation		R&R	2018	1
C-3	WW-P-8	Harbor Blvd Manhole Rehabilitation	Rehabilitate 12 existing manholes	R&R	2019	1
C-4		Pleasant Valley Manhole Rehabilitation	Rehabilitate 14 existing manholes	R&R	2019	1
C-5	WW-P-9	Redwood Tributary Manhole Rehabilitation	Rehabilitate 38 existing manholes	R&R	2019	1
C-10	WW-P-7	Existing asbestos concrete pipe (ACP) Replacement	Various locations throughout the collection system	R&R	2019	8
C-11		Annual Existing Pipe Repair	Various locations throughout the collection system based on sewer inspection	R&R	2019	8
C-12		Collection System Chemical Addition	Various locations throughout the collection system	Performance	2019	2
C-13	WW-P-10 WW-P-18	Devco Development Lift Station	Devco development, Village (Wagon Wheel) developments.	R&R, Performance	2019	1
C-14	WW-P-12	Existing Lift Station #4 (Mandalay & Wooley) Rehabilitation	Lift Station #4	R&R	2019	1
C-15	WW-P-11	Existing Lift Station #6 (Canal) Rehabilitation	Lift Station #6	R&R	2019	1
C-16		Existing Lift Station #20 (Beardsley) Rehabilitation	Lift Station #20	R&R	2019	1
C-2	WW-P-13	Central Trunk Manhole Rehabilitation Phase 2	Rehabilitate 27 existing manholes	R&R	2020	1

Table 5.13 Recommended Collection System Projects
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[(1)]	2015 Project ID	Project	Location	Driver	Start Year	Years to Implement
C-7	WW-P-16	Rice Avenue Sewer Improvement	Rice Avenue from Latigo to Camino Del Sol	R&R	2020	2
C-8	WW-P-1	Existing Sewer Deficient Capacity Replacement	Ventura Road Trunk Sewer from Doris Avenue to Oxnard Airport	Capacity	2020	2
			Conduit 4943	Capacity	2020	2
			Conduit 4956	Capacity	2020	2
			Conduit 1429	Capacity	2020	2
			Conduit 1431	Capacity	2020	2
			Conduit 1432	Capacity	2020	2
			Conduit 1443	Capacity	2020	2
			Conduit 4276	Capacity	2020	2
			Conduit 1460	Capacity	2020	2
			Conduit 1461	Capacity	2020	2
			Conduit 1462	Capacity	2020	2
			Conduit 1463	Capacity	2020	2
C-9	WW-P-2	Existing Sewer Deficient Capacity Replacement	Sewers in the La Colonia Neighborhood, Third Street & Navarro Street	Capacity	2021	1
			Conduit 2888	Capacity	2021	1
			Conduit 2889	Capacity	2021	1

Table 5.13 Recommended Collection System Projects
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID(1)	2015 Project ID	Project	Location	Driver	Start Year	Years to Implement
C-6		Annual Existing Manhole Rehabilitation	Various locations throughout the City based on sewer inspection	R&R	2022	5
	WW-P-3	Project 3: S Victoria Ave and W Hemlock St	Sewers in the Channel Islands Neighborhood	Capacity	2027(2)	2
			Conduit 501	Capacity	2027(2)	2
			Conduit {74B96752-98B2-4F5D-AF2A-21B06EE4909C}	Capacity	2027(2)	2
			Conduit P-2471	Capacity	2027(2)	2
	WW-P-14	Phase 1 Central Trunk Replacement		R&R	2033(3)	2
	WW-P-15	Phase 2 Central Trunk Replacement		R&R	2036(3)	2

Notes:

(1) 2017 Project ID's were arbitrarily assigned for Project ease. C = Collection System Project. These are the projects from the approved Cost of Service Studies (Carollo, 2017).
(2) Project start year corresponds to refinements and updates provided by City after December 2015 publication date.
(3) Project start year was adjusted by City at August 7, 2017 meeting, based on recent CCT Inspection.

General Note: For the pipeline replacement projects, see the hydraulic models developed as part of this integrated master plan to identify the exact pipeline locations.

5.7.2.1 Existing Site

Recommended projects to keep the existing OWTP operational include R&R projects for almost every unit process. This includes replacing equipment and making structural repairs. Facilities that are unsafe or are at the end of their useful lives, including the primary clarifiers, DAFTs, digesters, interstage pump station, effluent pump station, and cogeneration facility, will also need to be replaced. Presented herein is one process treatment option for replacing the OWTP aged facilities. Several options should be considered and screened during the facilities predesign phase.

In addition to these recommendations, a major electrical system overhaul is recommended to provide more reliable backup power and to replace many plant MCCs, SCADA, and electrical buildings. A new dewatering facility, a new operations center and administration building, a non-hazardous liquid receiving station, a FOG receiving station, and a water quality early warning system are also recommended. Furthermore, in the future, the City should consider switching to MBR, adding an ultraviolet/advanced oxidation process (UV/AOP), constructing a solar facility, and adding a sea wall as needed. Figure 5.10 illustrates a layout of the recommended projects color-coded by phase.

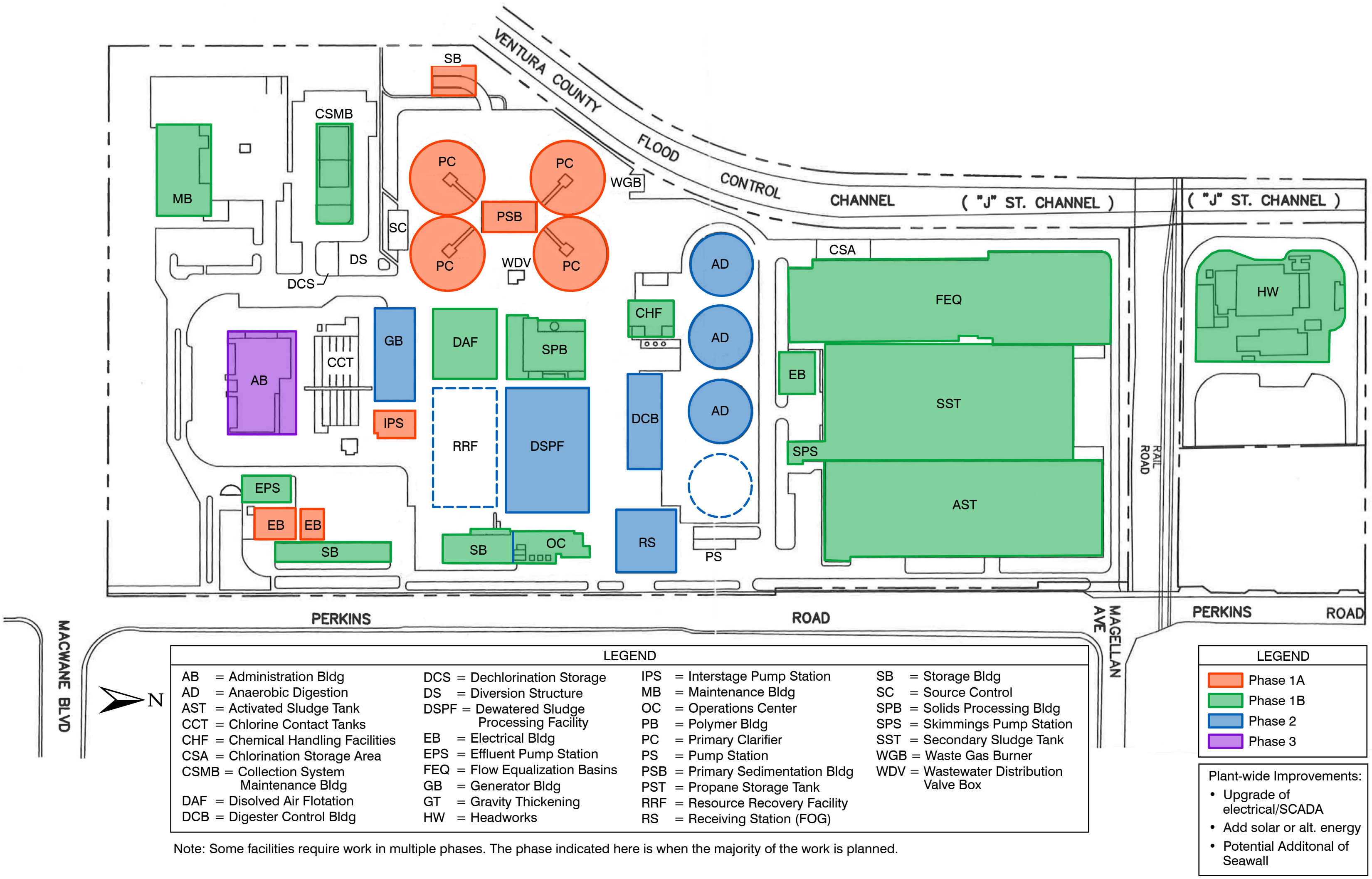
Table 5.14 lists the details of these projects. Figures 5.11A and 5.11B presents a schedule for the recommended projects.

5.7.2.2 New Location

To move many of the OWTP facilities to a new location, the City would need to consider the move's feasibility, taking into account the regulatory, timing, and financial needs. It is estimated that this upfront work could take approximately five to ten years to complete.

Given this timeframe and the condition of many of the existing OWTP facilities, a number of critical improvement projects at the OWTP will need to occur regardless of whether the OWTP will be relocated. Estimates are that these projects will cost around $20 million to $30 million. Table 5.15 shows a list of the projects requiring immediate attention.

For relocating the plant, a phased approach would be recommended. The City would start Phase 1 after implementing the projects with immediate needs. Phase 1 would involve moving all primary treatment, solids handling, and support facilities to the new site as well as rehabilitating facilities remaining in their existing location until Phase 2. These facilities include secondary treatment, disinfection, and effluent pumping facilities. The biotowers and gravity thickeners should also be demolished and the headworks rehabilitated. Assuming that the permitting and the environmental process takes five to ten years, Phase 1 could start around 2023, and Phase 2 could start around 2035.



Note: Some facilities require work in multiple phases. The phase indicated here is when the majority of the work is planned.

RECOMMENDED WASTEWATER TREATMENT PLANT PROJECTS BY PHASE

FIGURE 5.10

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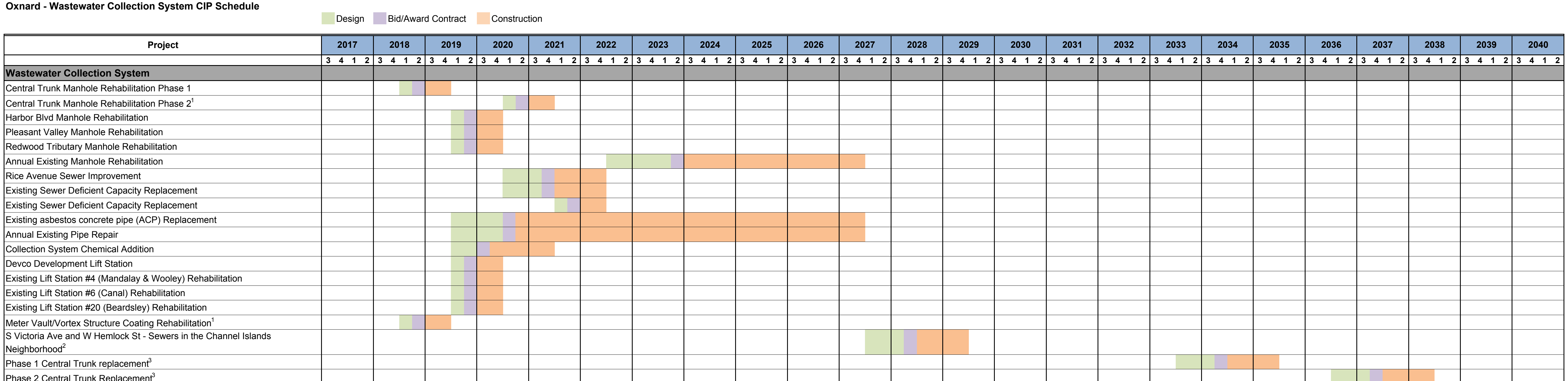
Oxnard - Wastewater Collection System CIP Schedule



Notes:
(1) Projects correspond to refinements and updates provided by City after Dec. 2015 publication date.
(2) Projects start year correspond to refinements and updates provided by City after Dec. 2015 publication date.
(3) Projects start year was adjusted by City at 8/7/17 meeting, based on recent CCT inspection.

RECOMMENDED COLLECTION SYSTEM PROJECTS SCHEDULE

FIGURE 5.11A

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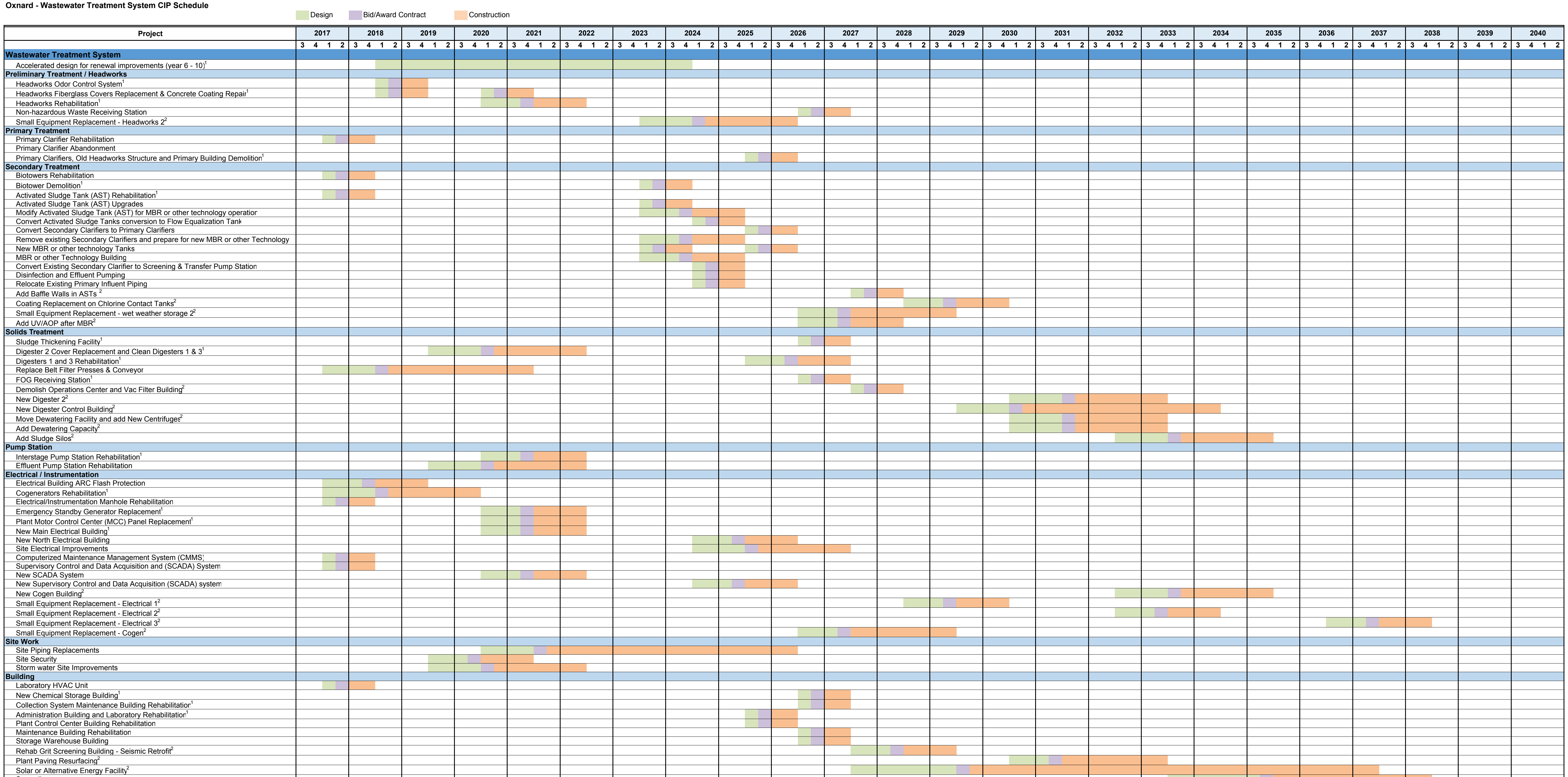
Oxnard - Wastewater Treatment System CIP Schedule



Notes:
(1) Projects correspond to refinements and updates provided by City after Dec. 2015 publication date.
(2) Projects start year correspond to refinements and updates provided by City after Dec. 2015 publication date

RECOMMENDED WASTEWATER SYSTEM PROJECTS SCHEDULE

FIGURE 5.11B

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Table 5.14 Recommended Projects for Within Fence-Line Wastewater System
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[(1)]	2015 Project ID	Project	Driver	Start Year	Years to Implement
--		Accelerated design for renewal improvements (year 6 - 10)[(2)]		2018	6
Preliminary Treatment/Headworks					
T-1	WW-P-83	Headworks Odor Control System[(3)]	Small Equipment Replacement	2018	1
T-2	WW-P-67	Headworks Fiberglass Covers Replacement & Concrete Coating Repair[(3)]	R&R	2018	2
T-3	WW-P-66	Headworks Rehabilitation[(3)]	R&R	2020	2
	WW-P-84	Small Equipment Replacement - Headworks[(2)]	Small Equipment Replacement	2023[(4)]	3
T-4	WW-P-41	Non-hazardous Waste Receiving Station	Performance	2026	1
Primary Treatment					
T-5		Primary Clarifier Rehabilitation	R&R	2017	1
T-6		Primary Clarifier Abandonment	R&R	N/A	0
T-7	WW-P-23	Primary Clarifiers, Old Headworks Structure and Primary Building Demolition[(3)]	R&R	2025	1
Secondary Treatment					
T-8		Biotowers Rehabilitation	R&R	2017	1
T-10	WW-P-69	Activated Sludge Tank (AST) Rehabilitation[(3)]	R&R	2017	1
T-9	WW-P-20	Biotower Demolition[(3)]	R&R	2023	1

Table 5.14 Recommended Projects for Within Fence-Line Wastewater System
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[1]	2015 Project ID	Project	Driver	Start Year	Years to Implement
T-11	WW-P-72 WW-P-74 WW-P-76	Activated Sludge Tank (AST) Upgrades	R&R, Performance	2023	1
T-12	WW-P-72	Modify Activated Sludge Tank (AST) for MBR or other technology operation	Performance	2023	2
T-15		Remove existing Secondary Clarifiers and prepare for new Membrane Bioreactor (MBR) or other Technology	R&R	2023	2
T-16	WW-P-75 WW-P-97	New MBR or other technology Tanks	R&R, Resource Sustainability	2023	2
T-17	WW-P-97	MBR or other Technology Building	Resource Sustainability	2023	2
T-13	WW-P-68 WW-P-72	Convert Activated Sludge Tanks conversion to Flow Equalization Tank	R&R, Performance	2024	1
T-18		Convert Existing Secondary Clarifier to Screening & Transfer Pump Station	R&R	2024	1
T-19	WW-P-96 WW-P-80 WW-P-81	Disinfection and Effluent Pumping	Small Equipment Replacement, R&R	2024	1
T-20		Relocate Existing Primary Influent Piping	R&R	2024	1
T-14	WW-P-70 WW-P-73	Convert Secondary Clarifiers to Primary Clarifiers	R&R	2025	1
	WW-P-79	Small Equipment Replacement - wet weather storage[2]	Small Equipment Replacement	2026[4]	3

Table 5.14 Recommended Projects for Within Fence-Line Wastewater System
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[1]	2015 Project ID	Project	Driver	Start Year	Years to Implement
	WW-P-98	Add UV/AOP after MBR	Resource Sustainability	2026[4]	2
	WW-P-21	Add Baffle Walls in ASTs	R&R	2027[4]	1
	WW-P-95	Coating Replacement on Chlorine Contact Tanks	R&R	2028[4]	2
Solids Treatment					
T-24	WW-P-40	Replace Belt Filter Presses & Conveyor	R&R	2017	4
T-22	WW-P-43	Digester 2 Cover Replacement and Clean Digesters 1 & 3[3]	R&R	2019	3
T-23	WW-P-87 WW-P-89	Digesters 1 and 3 Rehabilitation[3]	R&R	2025	2
T-21	WW-P-44 WW-P-45 WW-P-51	Sludge Thickening Facility[3]	R&R, Performance	2026	1
T-25	WW-P-94	FOG Receiving Station[3]	Resource Sustainability	2026	1
	WW-P-46	Demolish Operations Center and Vac Filter Bld	R&R	2027[4]	1
	WW-P-90	New Digester Control Building	R&R	2029[4]	5
	WW-P-88	New Digester 2	R&R	2030[4]	3
	WW-P-47	Move Dewatering Facility and add New Centrifuges	Performance	2030[4]	3
	WW-P-48	Add Dewatering Capacity	Performance	2030[4]	3
	WW-P-50	Add Sludge Silos	Performance	2032[4]	3

Table 5.14 Recommended Projects for Within Fence-Line Wastewater System
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID(1)	2015 Project ID	Project	Driver	Start Year	Years to Implement
Pump Station					
T-27		Effluent Pump Station Rehabilitation	R&R	2019	3
T-26	WW-P-22	Interstage Pump Station Rehabilitation(3)	R&R	2020	2
Electrical / Instrumentation					
T-28		Electrical Building ARC Flash Protection	Performance	2017	2
T-29	WW-P-93	Cogenerators Rehabilitation(3)	R&R	2017	3
T-30	WW-P-32	Electrical/Instrumentation Manhole Rehabilitation	R&R	2017	1
T-36	WW-P-39	Computerized Maintenance Management System (CMMS)	R&R	2017	1
T-37	WW-P-35	Supervisory Control and Data Acquisition and (SCADA) System	R&R	2017	1
T-31	WW-P-33	Emergency Standby Generator Replacement(3)	R&R	2020	2
T-32	WW-P-34	Plant Motor Control Center (MCC) Panel Replacement(3)	R&R	2020	2
T-33	WW-P-30 WW-P-31	New Main Electrical Building(3)	R&R	2020	2
T-38	WW-P-35	New SCADA System	R&R	2020	2
T-34	WW-P-59	New North Electrical Building	R&R	2024	2
T-35		Site Electrical Improvements	R&R	2024	3
T-39	WW-P-35	New Supervisory Control and Data Acquisition (SCADA) system	R&R	2024	2
	WW-P-92	Small Equipment Replacement - Cogen	Small Equipment Replacement	2026(4)	3

Table 5.14 Recommended Projects for Within Fence-Line Wastewater System
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[1]	2015 Project ID	Project	Driver	Start Year	Years to Implement
	WW-P-36	Small Equipment Replacement - Electrical 1	Small Equipment Replacement	2028[4]	2
	WW-P-91	New Cogen Building	R&R	2032[4]	3
	WW-P-37	Small Equipment Replacement - Electrical 2	Small Equipment Replacement	2032[4]	2
	WW-P-38	Small Equipment Replacement - Electrical 3	Small Equipment Replacement	2036[4]	2
Site Work					
T-41		Site Security	R&R	2019	2
T-42		Storm water Site Improvements	R&R	2019	3
T-40	WW-P-42	Site Piping Replacements	R&R	2020	5
Building					
T-43		Laboratory HVAC Unit		2017	1
T-46	WW-P-49	Administration Building and Laboratory Rehabilitation[3]	R&R	2025	1
T-47		Plant Control Center Building Rehabilitation	R&R	2025	1
T-44	WW-P-57	New Chemical Storage Building[3]	R&R	2026	1
T-45	WW-P-56	Collection System Maintenance Building Rehabilitation[3]	R&R	2026	1
T-48	WW-P-58	Maintenance Building Rehabilitation	R&R	2026	1
T-49	WW-P-27 WW-P-28	Storage Warehouse Building	R&R	2026	1
	WW-P-60	Rehab Grit Screening Building - Seismic Retrofit	R&R	2027[4]	2
	WW-P-99	Solar or Alternative Energy Facility	Resource Sustainability	2027[4]	10

Table 5.14 Recommended Projects for Within Fence-Line Wastewater System
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[1]	2015 Project ID	Project	Driver	Start Year	Years to Implement
	WW-P-65	Plant Paving Resurfacing	R&R	2030[4]	3
	WW-P-100	Seawall	Resource Sustainability	2033	5

Notes:
(1) 2017 Project ID's were arbitrarily assigned for Project ease. T = Treatment System Project. These are the projects from the approved Cost of Service Studies (Carollo, 2017).
(2) Cost added by City consultant after December 2015 publication during facilities pre-design/planning.
(3) Projects correspond to refinements and updates provided by City after December 2015 publication date.
(4) Project start year corresponds to refinements and updates provided by City after December 2015 publication date.

Table 5.15 Immediate CIP Projects Approved in Years 1 – 2[1]
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID[2]	2015 Project ID	Unit Operation	Project	Driver	Start Year	Years to Implement
C-1	WW-P-6	Collection System	Central Trunk Manhole Rehabilitation Phase 1	R&R	2018	1
C-17	WW-P-5	Collection System	Meter Vault/Vortex Structure Coating Rehabilitation[3]	R&R	2018	1
T-1	WW-P-83	Preliminary Treatment/Headworks	Headworks Odor Control System[3]	Small Equipment Replacement	2018	1
T-2	WW-P-67	Preliminary Treatment/Headworks	Headworks Fiberglass Covers Replacement & Concrete Coating Repair[3]	R&R	2018	2

Table 5.15 Immediate CIP Projects Approved in Years 1 – 2(1)
Public Works Integrated Master Plan
City of Oxnard

2017 Project ID(2)	2015 Project ID	Unit Operation	Project	Driver	Start Year	Years to Implement
T-5		Primary Treatment	Primary Clarifier Rehabilitation	R&R	2017	1
T-6		Primary Treatment	Primary Clarifier Abandonment	R&R	N/A	0
T-8		Secondary Treatment	Biotowers Rehabilitation	R&R	2017	1
T-10	WW-P-69	Secondary Treatment	Activated Sludge Tank (AST) Rehabilitation(3)	R&R	2017	1
T-24	WW-P-40	Solids Treatment	Replace Belt Filter Presses & Conveyor	R&R	2017	4
T-28		Electrical/Instrumentation	Electrical Building ARC Flash Protection	Performance	2017	2
T-29	WW-P-93	Electrical/Instrumentation	Cogenerators Rehabilitation(3)	R&R	2017	3
T-30	WW-P-32	Electrical/Instrumentation	Electrical/Instrumentation Manhole Rehabilitation	R&R	2017	1
T-36	WW-P-39	Electrical/Instrumentation	Computerized Maintenance Management System (CMMS)	R&R	2017	1
T-37	WW-P-35	Electrical/Instrumentation	Supervisory Control and Data Acquisition and (SCADA) System	R&R	2017	1
T-43		Building	Laboratory HVAC Unit		2017	1

Notes:
(1) Approved by City Council based on Wastewater Cost of Service Study (Carollo.2017).
(2) 2017 Project ID's were arbitrarily assigned for Project ease. C = Collection System Project: T = Treatment System Project. These are the projects from the approved Cost of Service Studies (Carollo, 2017).
(3) Project corresponds to refinements and updates provided by City after December 2015 publication date.

At this time, the new plant location is assumed to be less space-limited than the existing site. Thus, to reduce costs, conventional activated sludge treatment and chlorine disinfection could be installed for secondary treatment instead of MBR and ultraviolet light (UV) facilities. All other new facilities recommended for the existing plant option, such as a FOG receiving station and Chemically Enhanced Primary Treatment (CEPT), are still recommended with this option.

Table 5.16 lists the details of these projects.

Table 5.16 List of Projects Needed with Relocated Wastewater Treatment Plant Option
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement
Phase 1 Projects			
New Primary Clarifiers	R&R	2023	5
CEPT	Performance	2023	2
New Digesters	R&R	2023	5
New DAFTs	Performance	2023	3
New Chemical Handling Facilities	R&R	2023	2
New Primary Sedimentation Building	R&R	2023	5
New Chemical Handling Building	R&R	2023	3
New Non Hazardous Liquid Receiving Station	Performance	2023	2
New FOG Receiving Station	Resource Sustainability	2023	2
New Digester Control Building	R&R	2023	5
New Polymer Building	R&R	2023	3
New Solids Processing Facility	Performance	2023	3
New Sludge Silos	Performance	2023	3
New Cogeneration Facility	R&R	2023	3
New Operations Center and Lab Building	R&R	2023	4
New Collection System Maintenance Building	R&R	2023	2
New Storage/Warehouse	R&R	2023	2
New Effluent Electrical Building	R&R	2023	3
New North Area Electrical Building	R&R	2023	3
New Main Electrical Building	R&R	2023	3
Solar Facilities	Resource Sustainability	2023	10

Table 5.16 List of Projects Needed with Relocated Wastewater Treatment Plant Option
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	Years to Implement
SCADA System Upgrade	R&R	2023	5
AST Blower and Diffuser Replacement	R&R	2017	3
Secondary Small Equipment Replacement	Small Equipment Replacement	2017	3
Secondary Sedimentation Tanks Replace Skimmers, Collectors, Drives and RAS Pumps	R&R	2017	3
EQ Basin Small Equipment Replacement	Small Equipment Replacement	2019	3
AST Concrete Rehabilitation	R&R	2017	11
SST Concrete Rehabilitation	R&R	2017	11
EQ Concrete Rehabilitation	R&R	2017	3
Chlorine Contact Tanks Rehabilitation	Small Equipment Replacement	2023	3
Chlorine Contact Tanks Coating	R&R	2025	2
Effluent Pump Station Rehabilitation	R&R	2017	3
CMMS	R&R	2017	3
Phase 2 Projects			
New Activated Sludge Tanks	R&R	2035	5
New Secondary Sedimentation Tanks	R&R	2035	5
New EQ Basin	R&R	2035	5
New Chlorine Contact Tanks	R&R	2035	5
New Effluent Pump Station	R&R	2035	5
Headworks Rehabilitation	R&R	2035	5

RECYCLED WATER SYSTEM MASTER PLAN

6.1 INTRODUCTION

The City is committed to providing recycled water with its Groundwater Recovery Enhancement and Treatment (GREAT) Program, which gives the City access to a reliable and sustainable supply of high quality water, thus decreasing the City's reliance on imported water. Key components of the GREAT program include the following:

<u>Recycled Water (RW) System</u>
Treating and distributing wastewater to the most stringent levels [via the Advanced Water Purification Facility (AWPF)].

<u>Water Supply</u>
Treating groundwater for total dissolved solids (TDS) and nitrate reduction through a desalter.

<u>Indirect Potable Reuse (IPR) / Direct Potable Reuse (DPR) Through Groundwater Injection</u>
Adding wells that allow recycled water to be injected into and extracted from the local groundwater aquifer.

<u>Elements Related to the AWPF and Desalter:</u>
Collecting and treating concentrate (brine) from both AWPF and desalters.

A major part of the GREAT program is the use of recycled water, which the City has studied and made plans for over many years. This chapter outlines the portion of the system already used to provide tertiary-treated recycled water for irrigation. The remainder of the planned systems is summarized as well.

The analysis and evaluations contained in this Summary Report are based on data and information available at the time of the original date of publication of the Project Memos (PMs), December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). The complete updated CIP based on the near-term and long-term projects is contained in Appendix B.

6.1.1 GREAT Program Foundation & Evolution

When the GREAT program was formally established in 2002, its objectives were to:

- Increase the reliability of the water supply during drought.

- Reduce water supply costs.
- Secure the water supply's ability to meet a growing water demand.
- Enhance stewardship of the local water supply through recycling and reusing a substantial portion of the region’s wastewater.
- Increase environmental benefits associated with developing and rehabilitating local saltwater wetlands.

Although the program has evolved over the years, it has generally maintained its support of water recycling and reuse, groundwater injection, storage and recovery, and groundwater desalination. Thus, the goal of this Integrated Master Plan is to build on the foundation already in place.

To build on this foundation, it's helpful to analyze past reports to understand the program's evolution. Two reports are of particular importance: *The 2002 Advanced Planning Study* and *The 2012 GREAT Program Update*. These reports are summarized below.

- <u>2002 – Advanced Planning Study (K/J, 2002)</u> – This study recommended a series of projects aimed at providing a sustainable water supply for the City, including construction of tertiary and advanced recycled water treatment facilities, aquifer storage and recovery (both for IPR/DPR and seawater intrusion barrier), regional and local desalting to treat additional groundwater, and concentrate collection.
- <u>2012 – GREAT Program Update (City, 2012)</u> – This report provided additional details for many of the projects established in 2002, updated the progress to date, and estimated costs for the program elements.

Over the years, utilities have shifted from using groundwater recharge for seawater intrusion barriers to using it for ASR. This is largely due to the high cost of the wells. In addition, because of recent pumping cutbacks from the Fox Canyon Groundwater Management Agency (FCGMA), access to more local groundwater through pump-back credits is not guaranteed and is therefore of little direct benefit to the City.

At the same time, the City began to look at IPR/DPR with renewed interest because of its benefit to the City and the impending regulatory acceptance for it. As a result, the Integrated Master Plan focuses on recycled water for irrigation use as well as for IPR/DPR.

6.2 DESCRIPTION OF EXISTING FACILITIES

Wastewater from the Oxnard Wastewater Treatment Plant (OWTP) provides secondary treated wastewater to the AWPF for recycled water treatment. In general, the collected flow is residential. About 75 percent of all wastewater is domestic, with the remaining 25 percent from industrial users. Average secondary effluent flows (2009- 2013) from the wastewater facility are 20.5 mgd at average dry weather flow (ADWF) conditions and 22.9 mgd for an average day maximum month day flow (ADMMF). The OWTP is permitted at a capacity of 31.7 mgd ADWF.

6.2.1 AWPF

The recycled water system currently consists of an AWPF and distribution pumping and conveyance. The AWPF consists of microfiltration (MF), reverse osmosis (RO), and advanced oxidation processes (AOP), including ultraviolet light and hydrogen peroxide and the necessary ancillary equipment for a fully functional facility. Figure 6.1 illustrates a schematic of the AWPF process in its current configuration.

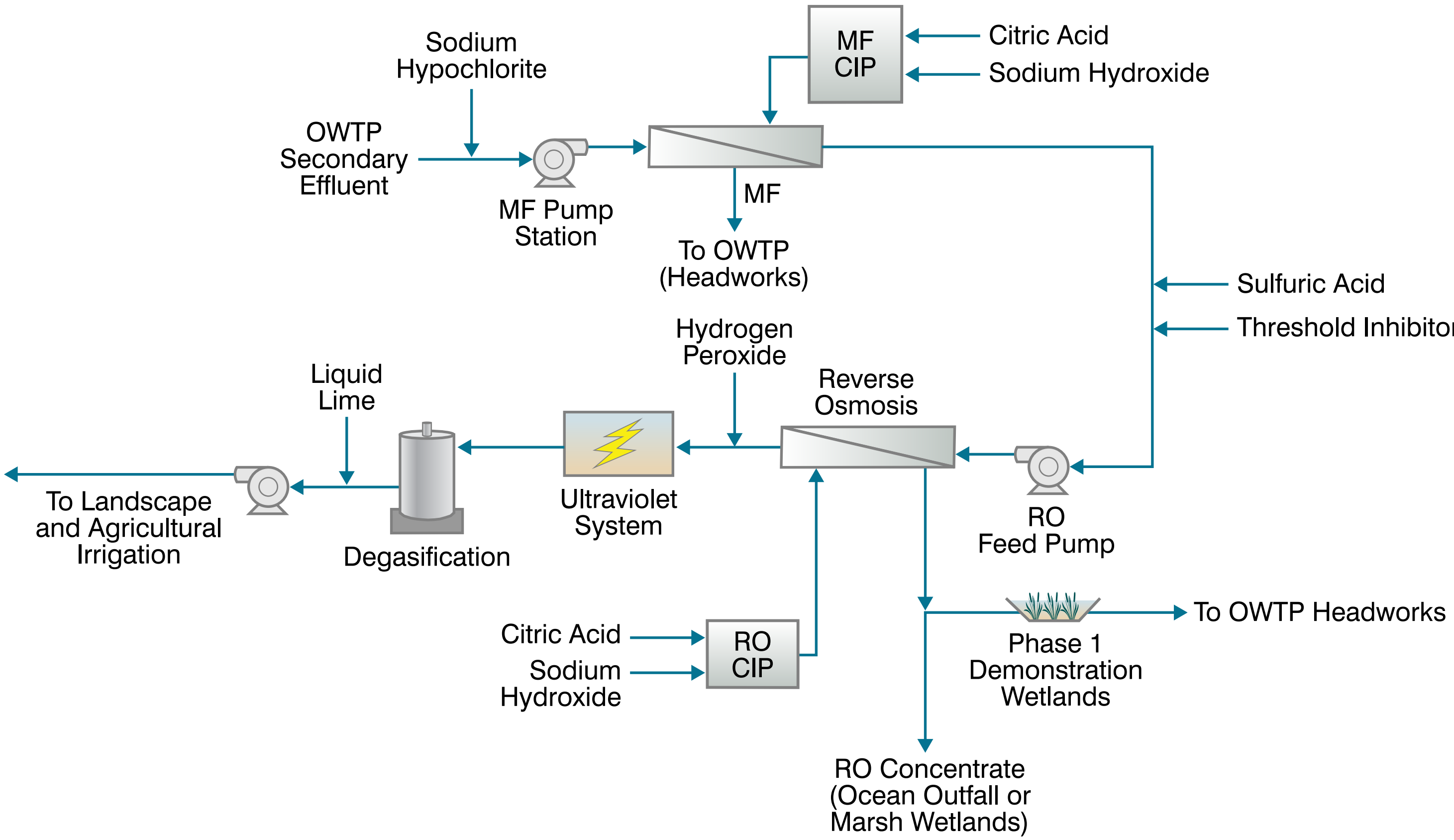
6.2.2 Recycled Water Distribution System

The main components of the existing recycled water distribution system include the following:

- Recycled Water Backbone System (RWBS)
  The constructed Phase 1 recycled water conveyance system is a combination of PVC and high-density polyethylene (HDPE) pipelines, with diameters ranging from 16 inches to 36 inches in the main transmission line and 6 to 8 inches in the distribution pipe to the River Park Development.
- Finished Recycled Water Pump Station
  The AWPF recycled water pump station contains two variable frequency drive (VFD) pumps, each with a design capacity of 4,000 gallons per minute (gpm) with an output pressure of about 150 psi.
- Hueneme Road – Phase 1

  A 42-inch diameter pipeline was recently installed from the existing 36-inch diameter connection to the AWPF at the intersection of Hueneme Road and Perkins Road. The 42-inch diameter section of this pipeline continues to the intersection of Hueneme Road and Edison Drive. From there, a 36-inch diameter recycled water pipeline continues down Hueneme Road until the intersection at Olds Road where it terminates. A Phase 2 Hueneme Road pipeline, beginning where Phase 1 left off, is in the planning stages.
- Temporary Salinity Management Pipeline (SMP) Line

  Because the Hueneme Road - Phase 2 pipeline will not be constructed and operational for several years, the City will temporarily deliver recycled water to the agricultural customers in the Oxnard Plain through the SMP. This is for two reasons: 1) the SMP's route runs parallel to the City's planned Hueneme Road pipeline, and 2) the SMP is underutilized at this time. For this to occur, the Los Angeles Regional Water Quality Control Board (LARWQCB) amended the City's Waste Discharge Requirements (WDRs), Order No. R4-2011-0079-A01 and Monitoring and Reporting Program, R4-2008-A01, in July of 2015 to allow the SMP to temporarily deliver AWPF effluent to farmers. Construction and planning for the temporary SMP connection are complete, with water delivery currently taking place.



AWPF SCHEMATIC

FIGURE 6.1

CITY OF OXNARD

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PUBLIC WORKS INTEGRATED MASTER PLAN

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- Ocean View Pump Station
  This Pump Station contains two VFD pumps, each with a design capacity of 2,210 gpm with an output pressure of about 50-psi. These pumps will be used to supply the SMP Line.

Currently, no storage tanks are in the distribution system, meaning peak demands must be met directly from the AWPF. A map of the existing recycled water distribution system is shown in Figure 6.2 along with major users.

6.2.3 ASR Demonstration Well (Under Construction)

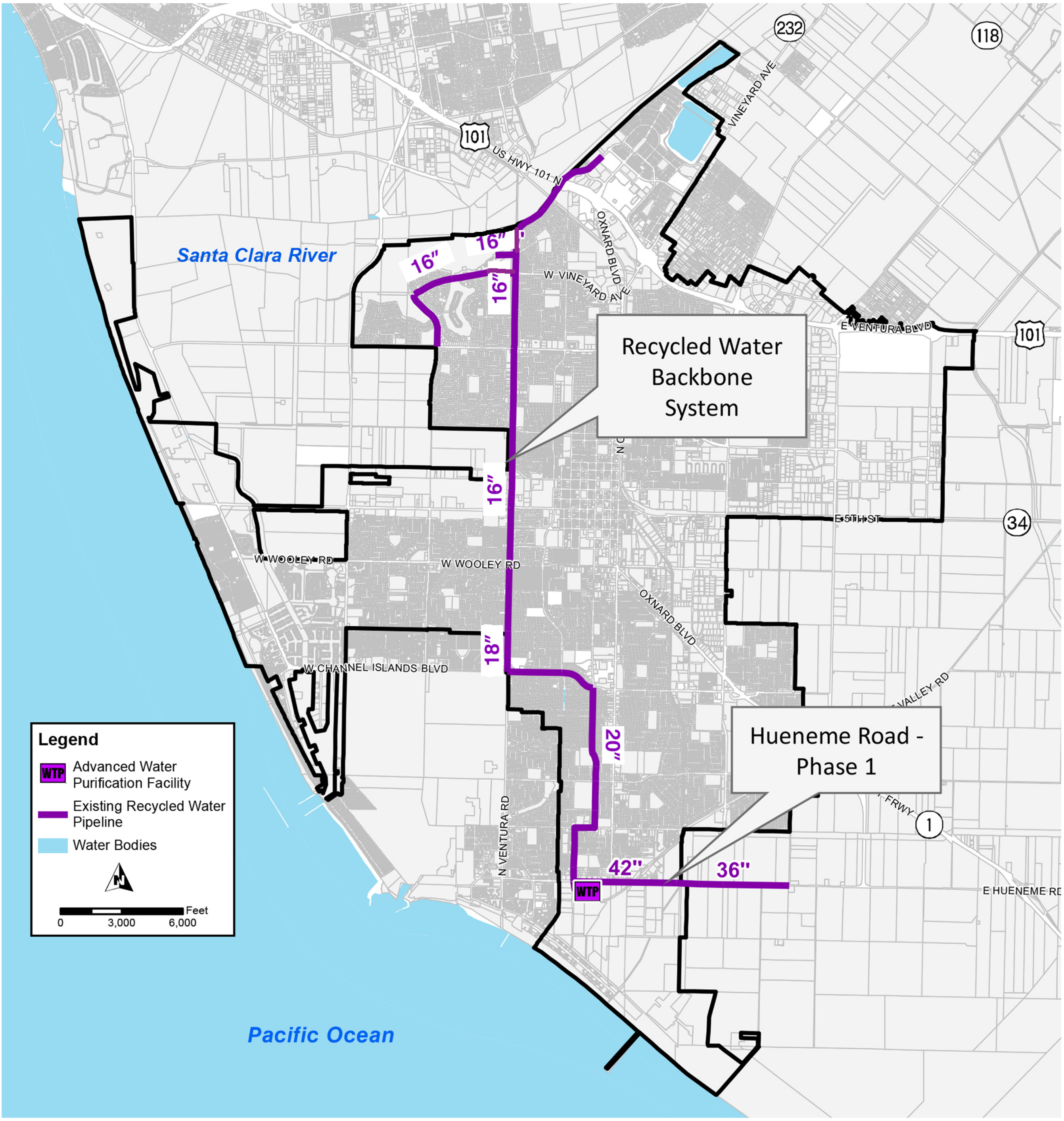
The City is currently constructing an ASR Demonstration well, which is expected to be completed in 2018. The construction of this well is grant funded and will serve as a test well for the City to understand how ASR/IPR will work moving forward.

Initially, the ASR Demonstration well will be used as an ASR well for the recycled water system. Recycled water from the AWPF will be injected into the ground and then extracted and put back into the City's RW system for irrigation use. Ultimately, once all of the required start-up testing and monitoring are complete, the well will switch to IPR operation, and the extracted water will be conveyed to the BS No. 1/6 nearby for disinfection and injection into the potable system.

Elements of this ASR Demonstration Well installation include the following:

- Constructing one IPR/ASR well at the Campus Park site.
- Constructing three monitoring wells (two shallow and one deep aquifer) for the one IPR/ASR well.
- Adding 2,000 linear feet (lf) of RW piping connecting the IPR/ASR well to the Recycled Water Backbone piping located in Ventura Road.
- Adding 4,000 lf of piping to convey IPR water from Campus Park to BS No. 1/6 for blending into the potable system, which will eventually be converted to a potable line when the IPR/ASR operation is fully approved.

A hydrogeological study was conducted (Hopkins, 2016) to assess the proposed location and capacity for this well at Campus Park. This study recommended an injection and extraction capacity of approximately 2,000 gpm and recommended operating the well on a 3-month rotation of recharge, retention, and recovery. Figure 6.3 illustrates the location of the proposed ASR well at Campus Park.



EXISTING RECYCLED WATER FACILITIES

FIGURE 6.2

CITY OF OXNARD
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N

250 125 0 250
Feet

LEGEND

Proposed ASR Well Location

Proposed Monitoring Well Locations

DEMONSTRATION ASR WELL PROPOSED LOCATION

FIGURE 6-3

CITY OF OXNARD
SUMMARY REPORT
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CITY OF OXNARD CALIFORNIA

carollo Engineers...Working Wonders With Water®

ox1115f30-9587(SumRepFIG6-3).ai

6.3 CURRENT RECYCLED WATER DEMANDS

The City projects that in the initial phases of the GREAT Program, approximately 7,000 AFY (acre-feet per year), or 6.25 mgd, of AWPF water will be produced. The City has an approved Full Advanced Treatment Recycled Water Management and Use Agreement, A-7651. Signatories to the Agreement include: United Water Conservation District (UWCD), Pleasant Valley County Water District (PVCWD), Houweling Nurseries Oxnard, Inc., Southland Sod, and Reiter Brothers, Inc. According to this agreement, the following significant demands are accounted for:

- The City has the right to the first 1,500 to 1,800 AFY, which will be delivered to existing customers in lieu of potable water and to the River Ridge Golf Club. In addition, the City will deliver RW water to River Park Development and New Indy Container Board for a total of approximately 2,800 AFY, or 2.5 mgd in Phase 1A. This RW will be used to offset potable water demand along the completed RWBS that would otherwise be served through the City's potable water system.
- For Phase 1B, an additional 2,000 AFY, or 1.8 mgd, of AWPF water is dedicated to agricultural users along the (future) Hueneme Road Pipeline.
- According to Agreement A-7651, using the remaining 7,000 AFY of RW available from the AWPF is to be determined by the City, UWCD, and PVCWD.

Table 6.1 summarizes the existing and future recycled water demands as they are currently known. The City is also planning to implement 40 to 50 small urban recycled water irrigation projects along the RWBS to offset further potable use. This implementation would be phased over several years. Figure 6.4 illustrates the locations of the existing and planned customers, as they are known that this time.

6.4 PROJECTED RECYCLED WATER DEMANDS

Under the GREAT Program, construction of the AWPF is planned in four phases that result in AWPF capacities of 7,000, 14,000, 21,000 and 28,000 AFY. As previously noted, the first phase of 7,000 AFY, which has been completed, is largely accounted for through urban and agricultural irrigation uses.

As subsequent phases of the AWPF come online, AWPF effluent will go first to recycled water users currently under contract, then to IPR/DPR, and then to additional agricultural users, which would benefit the City in the form of groundwater pump-back credits. Therefore, Phase 2 and 3 RW demands shown in Table 6.1 are shown as additional ASR capacity.

Table 6.1 **Existing and Future Recycled Water Demands**
Public Works Integrated Master Plan
City of Oxnard

Phase	Location	Recycled Water Use	Average Day Demand (gpm)	Delivery Pressure (psi)	Daily Demand Timing
1A	New Indy Paper Company	Irrigation	456	60	Constant
1A	River Park Development	Irrigation	651	60	10:00 a.m. - 6:00 p.m.
1A	River Ridge Golf Course	Irrigation	1,057	20(2)	Constant
1B	Houweling Nursery	Irrigation	1,000	60	6:00 p.m. - 6:00 a.m.
1B	Southland Sod	Irrigation	1,000	60	6:00 a.m. - 6:00 p.m.
1B	Reiter	Irrigation	1,400	60	6:00 a.m. - 6:00 p.m.
2	Blending Station (BS) 1/6	IPR	8,000(1)	20(3)	Constant
2	Campus Park	IPR	6,000(1)	20(3)	Constant
3	BS 3	IPR	8,000(1)	20(3)	Constant

Notes:
(1) There is no required amount for IPR; the required flow listed is equal to the maximum proposed capacity based on the recommended projects needed for water supply, per PM 2.5; IPR is to be maximized using excess flow after customer contracted flows are delivered.
(2) The customer pumps RW a lake onsite after delivery; therefore, lower delivery pressures are acceptable.
(3) RW is delivered for ASR; lower delivery pressures are acceptable.

6.5 RECYCLED WATER SUPPLY (SECONDARY EFFLUENT)

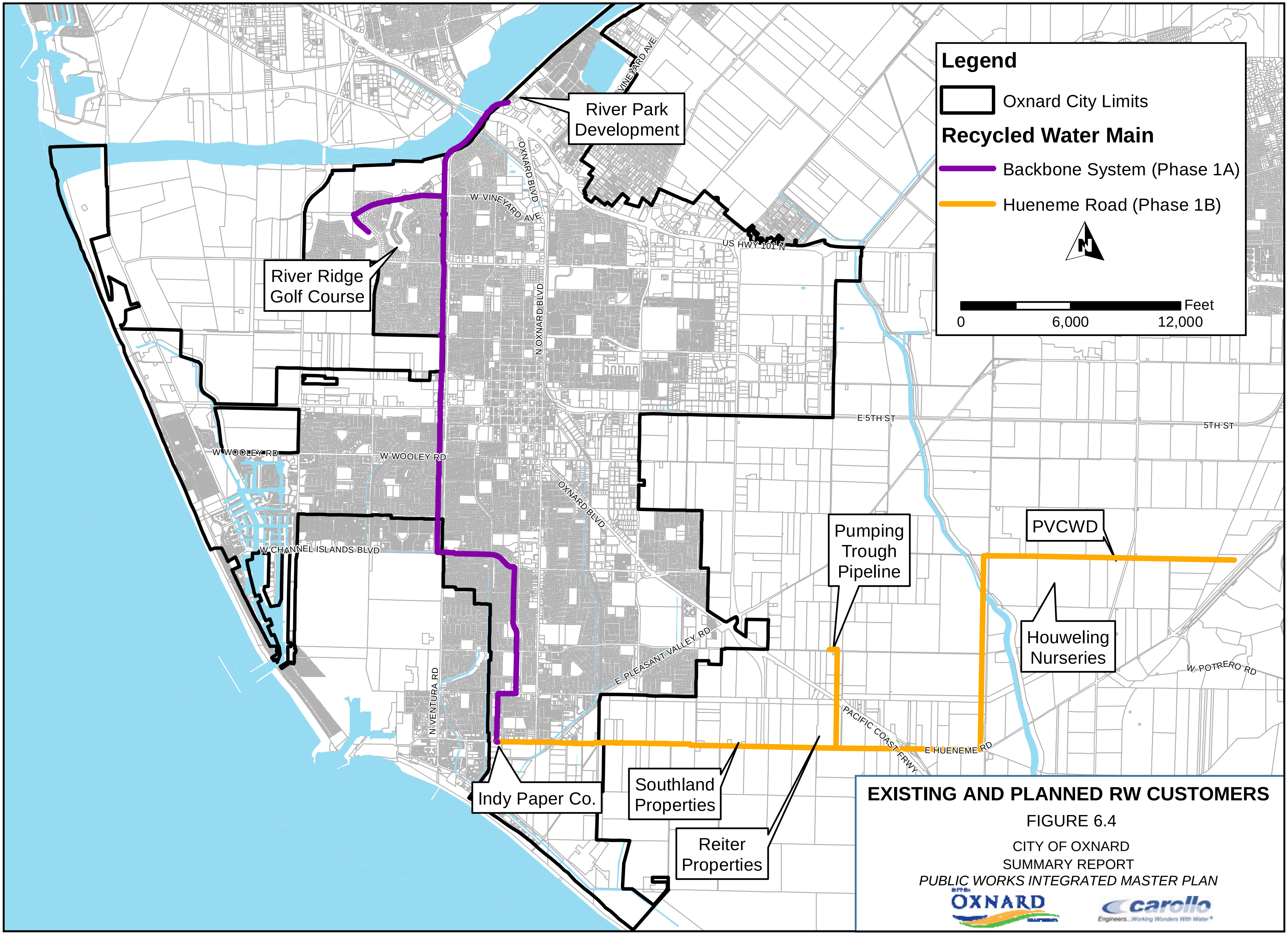
The AWPF's water supply source is secondary effluent from the OWTP. Therefore, it is necessary to assess whether enough OWTP effluent exists to feed into the AWPF as capacity increases. In general, the AWPF's capacity cannot be expanded beyond what the OWTP can supply.

Table 6.2 summarizes the amount of OWTP effluent needed for the planned capacity expansions at the AWPF. Based on the future wastewater flow projections outlined in Chapter 5, by 2040, ADWF to the OWTP is expected to reach only 27.4 mgd. Given this, it is unlikely that there would be sufficient supply to the AWPF for the Phase 4 expansion (see Table 6.2).

It is equally important to consider the diurnal variation of the average daily flow. While the AWPF is optimally operated at a constant (or relatively constant) flow, secondary effluent flow from the OWTP varies throughout the day. Therefore, storing secondary effluent may be required to allow the AWPF to draw a consistent supply. Table 6.2 summarizes the results of that analysis.

The OWTP currently has 5 MG of secondary effluent storage, which it uses for peak shaving of its effluent pumping. Based on the required storage noted in Table 6.2, it is believed that the existing secondary effluent storage will be sufficient to serve as both AWPF storage and peak shaving for effluent pumping.

AN1



EXISTING AND PLANNED RW CUSTOMERS

FIGURE 6.4

CITY OF OXNARD
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Table 6.2 Secondary Effluent Storage Needs Public Works Integrated Master Plan City of Oxnard			
AWPF Phase	**AWPF Capacity, mgd**	**Secondary Effluent Needed (Avg Day), mgd(1)**	**Secondary Effluent Storage Required, MG**
1	6.25	8.2	--
2	12.5	16.3	0.7
3	18.75	24.5	2.3
4	25	32.7	(2)

Notes:
(1) Estimated based on a MF recovery of 90% and RO recovery of 85%.
(2) Based upon wastewater flow projections for the PWIMP (by 2040, the average day flow is expected at 27.4 mgd), it is unlikely there will be enough secondary effluent flow to support an expansion of the AWPF up to 25 mgd.

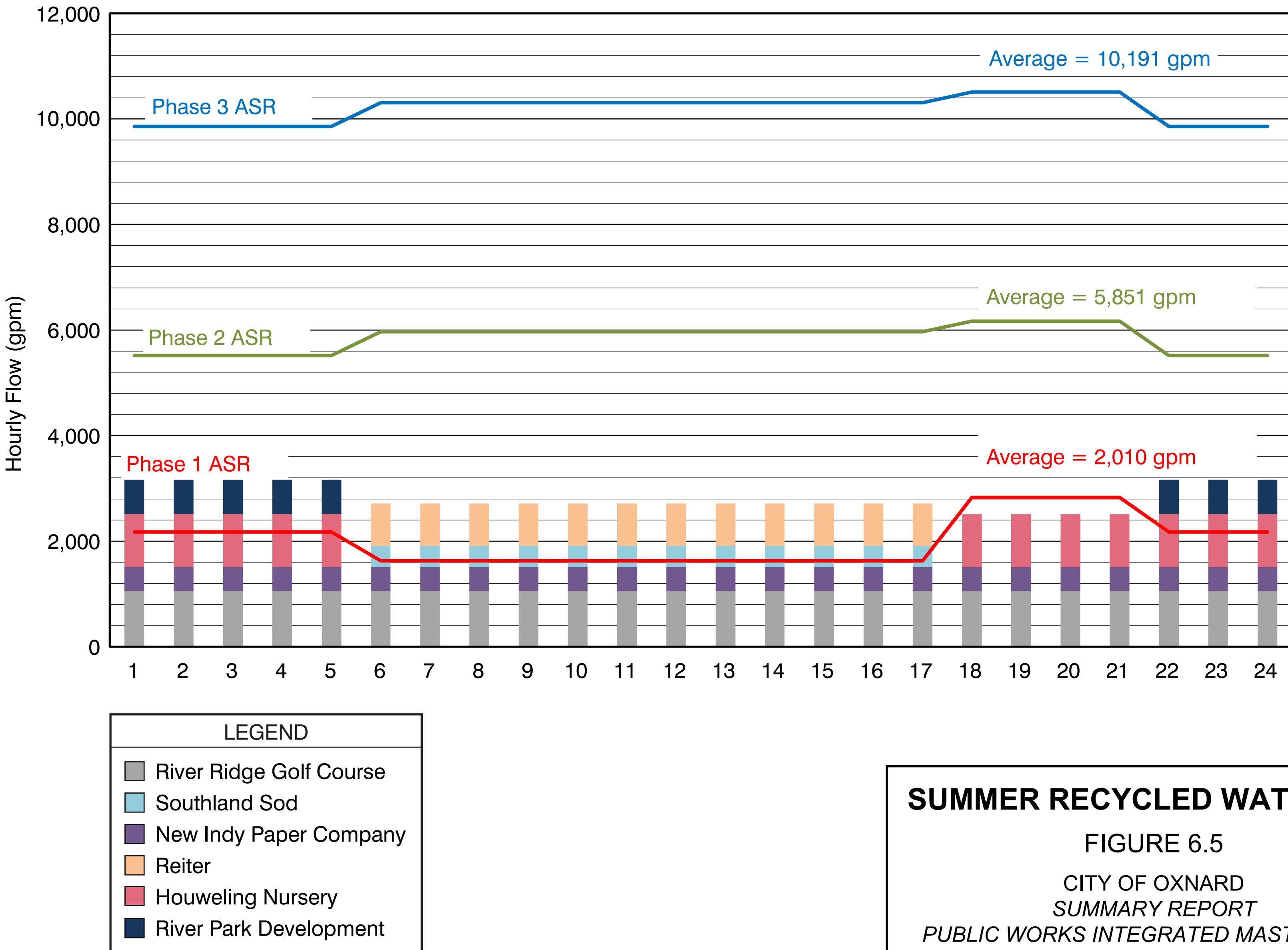
6.6 MASTER PLAN/DESIGN CRITERIA

Peaking conditions of particular importance to a hydraulic analysis of the distribution system include the following:

- Average Day Demand (ADD): the total annual production divided by number of days in the year.
- Maximum Day Demand (MDD): the greatest water demand during a 24-hour period of the year.
- Peak Hour Demand (PHD): the highest water demand during any 1-hour period of the year.

Recycled water demands are similar to water system demands in that water use above the ADD varies daily and seasonally. Irrigation demands vary from drinking water demands in that the peak use often occurs overnight so less irrigated water is lost from evapotranspiration.

For most of the customers shown in Table 6.1, water demand will be seasonal, peaking in the summer months. The only exceptions are the New Indy Paper Company, which has a year-round demand of 456 gpm, and the IPR operation, which is also expected to operate year-round. The RW customer demands are greater in the summer months but less in the winter, leaving more available water for IPR/ASR in the winter than in the summer. For Phases 1, 2 and 3, Figure 6.5 and Figure 6.6 display the projected diurnal demand curves for both the summer and winter demand conditions, respectively.



SUMMER RECYCLED WATER USE

FIGURE 6.5

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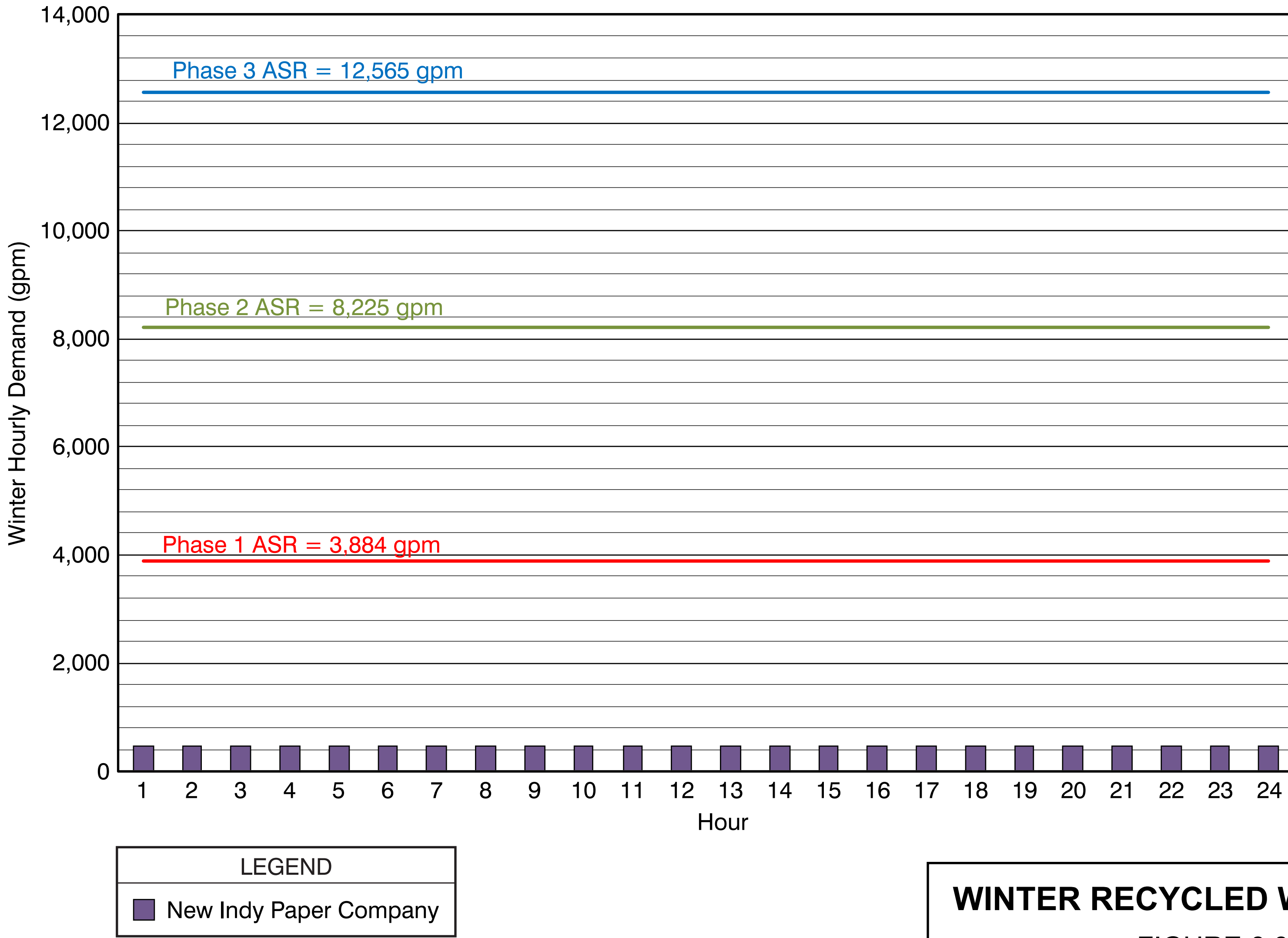

WINTER RECYCLED WATER USE

FIGURE 6.6

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6.6.1 Storage and Pumping

Currently, there are no operational storage tanks in the recycled water distribution system, although some small recycled water users maintain their own onsite storage, which reduces peak demand on the AWPF and the distribution system. Because of the lack of operational storage within the system, finished water storage was considered for the following RW operations:

- To provide operational storage for the IPR so the ASR well pumps can operate at a consistent rate while meeting peak demands out of storage.
- To provide a decoupling and monitoring step for future DPR, with each tank operating in one of three modes: filling, holding (for testing), or emptying.

If storage is installed, booster pumping capacity would be needed to pump from the distribution system's storage to meet PHD. For reliability, maintaining a firm pump station capacity equal to the PHD is desirable. Firm capacity is equal to the total capacity of the pump station minus the largest pump's capacity (in case one pump is out of service for maintenance).

In addition to the MDDs and PHDs discussed above, planning and design criteria were established for sizing the distribution system piping, storage, and pumping, and ASR operations. Table 6.3 summarizes all of the key planning criteria outlined for the RW system.

Table 6.3 RW System Master Planning/Design Criteria
Public Works Integrated Master Plan
City of Oxnard

Description	Value	Units
Design Capacity Criteria		
Treatment Facilities/Well Pumping	Max Day	--
Distribution System Piping/Pumping	Peak Hour	--
Aquifer Storage and Recovery Site		
Number of Wells per Site	6	--
Number of Monitoring Wells	3 per ASR Well	--
Well Capacity, each	2,000	gpm
Operational Storage(1)	1.0	MG
Booster Pumping(2)	500	HP
DPR Storage		
Number of Tanks	3	
Detention Time	12	hours
Tank Volume (per Tank)	3.1	MG

Table 6.3 RW System Master Planning/Design Criteria Public Works Integrated Master Plan City of Oxnard		
Description	**Value**	**Units**
Distribution System - Minimum Pressure		
Recycled Water Customers	60	psi
ASR Sites (Campus Park, BS No. 1/6, and BS No. 3)	20	psi
Customer Storage Tanks/Ponds	20	psi
Distribution System - Maximum Pressure		
Recycled Water Customers without Pressure Regulators	90	psi
Recycled Water Customers with Pressure Regulators	150	psi
Distribution Pipeline	150	psi
Distribution System - Pipeline Criteria		
Maximum Velocity at PHD	7	fps
Design Velocity for New Pipelines	5	fps
Hazen-Williams C-factor	130	n/a
Minimum Size for New Pipelines	8	inches
Head Loss for 1,000 feet of Pipeline	10	ft

Notes:

(1) Because the ASR wells are sized to supply a relatively constant supply (equal to the maximum day demand), operational storage provides additional capacity meet the peak demands (i.e., the difference between peak hour and maximum day demands) for the potable supply.

(2) Booster pumping designed to supply peak hour demands into the system for the potable supply.

6.7 FUTURE FACILITY NEEDS

The recycled water system's capacity and performance were compared with the above criteria to locate system shortfalls for both current and future conditions. In general, the existing system, which was newly constructed, will meet the demands of the current recycled water demands, as noted in Table 6.1, Phase 1A, and Phase 1B.

Since the AWPF was just completed and put online in 2015, the City is planning only minor adjustments for the facility, such as using sodium hypochlorite instead of hydrogen peroxide and modifying the A/V and security equipment. From a performance standpoint, the AWPF is operating as intended.

The WaterGems model was used to evaluate the existing water distribution system's performance for meeting current demands. The model was updated to reflect existing conditions of Oxnard’s recycled water system, including updated information on the AWPF, pump station, and pipelines. In general, under the established design criteria, the existing system was found to be adequately sized to meet the existing recycled water customer needs.

The treatment and distribution systems are currently sized to provide recycled water for the first phase of the GREAT program (up to 7,000 AFY) but not through the full 4 phases of the GREAT Program (up to 28,000 AFY). The WaterGems analysis was performed to reconfirm and refine the timing of those phases and the specific facilities needed to move recycled water throughout the City to provide a sustainable water supply for its customers. Since these two systems will work closely together moving forward, the analysis was done in close coordination with the potable water supply (summarized in Chapter 4).

6.8 APPROACH TO EXPANDING THE RECYCLED WATER SYSTEM AS A SUPPLEMENTAL WATER SUPPLY

Based on the alternatives analysis presented in Chapter 4, recycled water will be considered as a supplemental water supply to the City's current groundwater and imported water. Recycled water treated through the AWPF will be available for non-potable irrigation use (offsetting potable needs) for both agricultural and urban uses and for IPR and/or DPR. This approach adds flexibility and resiliency while maintaining significant local control of the water supply.

To implement this approach, the AWPF will need to be expanded (in the phases currently planned for with in the GREAT program) and facilities will need to be added to distribute recycled water to IPR/ASR wellfields. These facilities are in addition to already planned pipelines that will convey recycled water to agricultural uses for irrigation.

A review of the ultimate AWPF expansion capacity was presented in Chapter 4. Based solely on projected wastewater flows entering the OWTP, Phase 4 (up to 28,000 AFY) of the AWPF can be realized is uncertain. In addition, as discussed in Chapter 3, there are regulatory implications for the amount of secondary effluent that can be routed to the AWPF and not discharged to the outfall. At this time, based upon the data available (as noted in Chapter 3), it appears that Phase 3 (up to 21,000 AFY) may be the limit for AWPF expansion but further investigation of this implication will take place during subsequent phases of work.

To convey recycled water to various identified uses throughout the City, a closed recycled water loop will be built on the already constructed RWBS pipeline, which is intended to convey flows for the first phase (up to 6.25 mgd) along one north-south artery in the City (Ventura Road). The recycled water loop will provide access to a variety of geospatial points slated for IPR, including BS No. 1/6 and No. 3. Adding the loop will also eliminate any capacity issue the RWBS might have due to its size and construction.

In terms of the recycled water's end use/destination, irrigation uses make up the biggest component of Phase 1 capacity. For Phases 2 and 3, the largest use of the recycled water will be IPR/DPR. ASR wells will be used to inject recycled water into the underlying groundwater basin and to withdrawal the water for IPR use. Suitable sites for IPR operation are the Campus Park site, along with BS Nos. 1/6 and 3 because of the existing infrastructure already present.

Table 6.4 provides a high-level summary of the approach to expanding the recycled water system within the City.

Table 6.4 Recycled Water System Expansion Approach
Public Works Integrated Master Plan
City of Oxnard

Phase	AWPF Flow (mgd)	Recycled Water Distribution System[(1)]	ASR Well Capacity
Phase 1A	6.25	• Recycled Water Backbone System Pipeline (completed)	1 Demonstration Well
Phase 1B	6.25	• Hueneme Road Phase 2 Pipeline • Pipeline from RWBS to Campus Park • Pipeline from Campus Park to BS No. 1/6	1 Demonstration Well
Phase 2	12.50	• Complete Pipeline for RW Loop	4 duty + 4 standby
Phase 3	18.75	• N/A	6 duty + 3 standby

Note:
(1) Additions are to the existing recycled water described in Section 6.8; each additional phase includes the addition of previous phases.

6.9 RECOMMENDED PROJECTS

This section summarizes the recommended projects for the recycled water system based on the existing system capacity and performance needs for meeting projected future demands and water quality objectives. These projects cover needs through the Integrated Master Plan's planning period (2015-2040). The recommended projects are summarized in Table 6.5 and organized by project type. Figure 4.7 in Chapter 4 illustrates all of the water and recycled water projects recommended for water supply purposes. For further details, refer to that figure.

The projects were split into phases that loosely follow the projects' timing: Phase 1 – Immediate Needs (First 2 years), Phase 2 – Near-Term Needs (Years 2 to 10), and Phase 3 – Long-Term Needs (Beyond 10 years).

The phases presented here are what are recommended based upon the technical needs identified within this assessment. However, the actual timing of implementation may defer when compared and balanced against the financial considerations of total implementation of the Integrated Master Plan. Costs and timing for these projects is summarized under Chapter 9 as well as in the Cost of Service (COS) Rate Study (Carollo, 2015a).

Table 6.5 Recommended RW Projects to Meet Water Supply Needs through 2040
Public Works Integrated Master Plan
City of Oxnard

Facility/Location	Description	Phase	Quantity	Unit	Capacity
Recycled Water Treatment					
AWPF	Phase 1 Improvements (Disinfection conversion, security, A/V upgrade)[1]	1	--		
AWPF	UV/AOP Brine Treatment	1	1	Unit	--
AWPF	Phase 2 Expansion to 12.5 mgd (including backup power)	2	1	ea	6.25 mgd
AWPF	Phase 3 Expansion to 18.75 mgd	3	1	ea	6.25 mgd
Recycled Water Distribution					
Various	Recycled Water Distribution System Retrofits[2]	1	--	--	--
Campus Park to RWBS	Connect Initial ASR Well to RWBS Line in Ventura Road - 20: pipe[1]	1	2,000	Lf	--
Campus Park to BS No. 1/6	Construct Dedicated IPR Pipeline along 2nd Street - 24" pipe[1]	1	4,000	lf	--
AWPF	Ag RW Storage	2	1	--	--
Hueneme Road - Phase 2 (to Ag Users)	24" pipe – Along Wood Road from Hueneme Road to Laguna Road and east on Laguna terminating before Lewis Road	2	20,700	Lf	--
Hueneme - Phase 2 (to Ag Users)	36" pipe – Along Hueneme Road from Olds Road to Wood Road	2	16,000	Lf	--
Recycled Water Loop (to ASR Sites)	24" pipe – Along 2nd St to N Rose Ave	2	9,000	Lf	--
Recycled Water Loop (to ASR Sites)	30" pipe – Along N Rose Ave from 2nd St to Hueneme Road	2	19,700	Lf	--
AWPF	DPR Storage Tanks	3	3	MG	3.1
Recycled Water Loop (to ASR Sites)	24" pipe – North along N Rose Avenue from 2nd St. to Camino Del Sol; then east on Camino Del Sol to N Rice Ave; North along N Rice Ave to Wankel Way	3	10,600	LF	--

Table 6.5 Recommended RW Projects to Meet Water Supply Needs through 2040
Public Works Integrated Master Plan
City of Oxnard

Facility/Location	Description	Phase	Quantity	Unit	Capacity
IPR/DPR					
Campus Park	Demonstration ASR Well[3]	1	1	Ea	2,000 gpm
BS No. 1/6 & BS No. 3	Land Acquisition and Improvements	1	10	Ac.	--
Campus Park	RW Pond for Off-Spec Water	1	1	MG	1.9
Campus Park	2 duty + 2 standby ASR wells[3]	2	4	Ea	2,000 gpm
BS No. 1/6	2 duty + 2 standby ASR Wells[3]	2	4	Ea.	2,000 gpm
BS No. 1/6	Chemical Feed Expansion	2	1	Ea.	--
BS No. 1/6	Operational Storage	2	1	MG	1
BS No. 1/6	Booster Pumping	2	1	HP	500
Well 18 @ Golf Course	Rehab to Groundwater Recharge Well	2	1	Ea.	3,000 gpm
BS No. 1/6	2 duty + 1 standby ASR Wells[3]	3	3	Ea.	2,000 gpm
BS No. 3	4 duty + 2 standby ASR Wells[3]	3	6	Ea.	2,000 gpm
BS No. 3	Chemical Feed Expansion	3	1	Ea.	--
BS No. 3	Operational Storage	3	1	MG	1
BS No. 3	Booster Pumping	3	1	HP	500

Notes:
*General Notes: Project costs, schedules, and phasing are based on data and information available at the time of the original publication of the Project Memos (PMs) – December 2015.
(1) As documented in the City's GREAT program CIP, February 18, 2015.
(2) Assumed 10 retrofits per year for 4 years.
(3) Each ASR well installed will have 3 associated monitoring wells installed.

6.9.1 Treatment

Phase 1 of the AWPF is already completed, with only minor improvements slated as immediate needs. A UV/AOP treatment system for the RO concentrate from the AWPF is recommended to address water quality-related issues.

Phase 2 will involve expanding the existing Phase 1 AWPF facility by an additional 6.25 mgd. The existing 6.25 mgd facility was constructed to allow for modular expansion of the MF, RO, and UV/AOP treatment trains without adding ancillary equipment (i.e., cleaning and support systems). Phase 3 will require adding more treatment and ancillary equipment to reach the 18.75 mgd capacity.

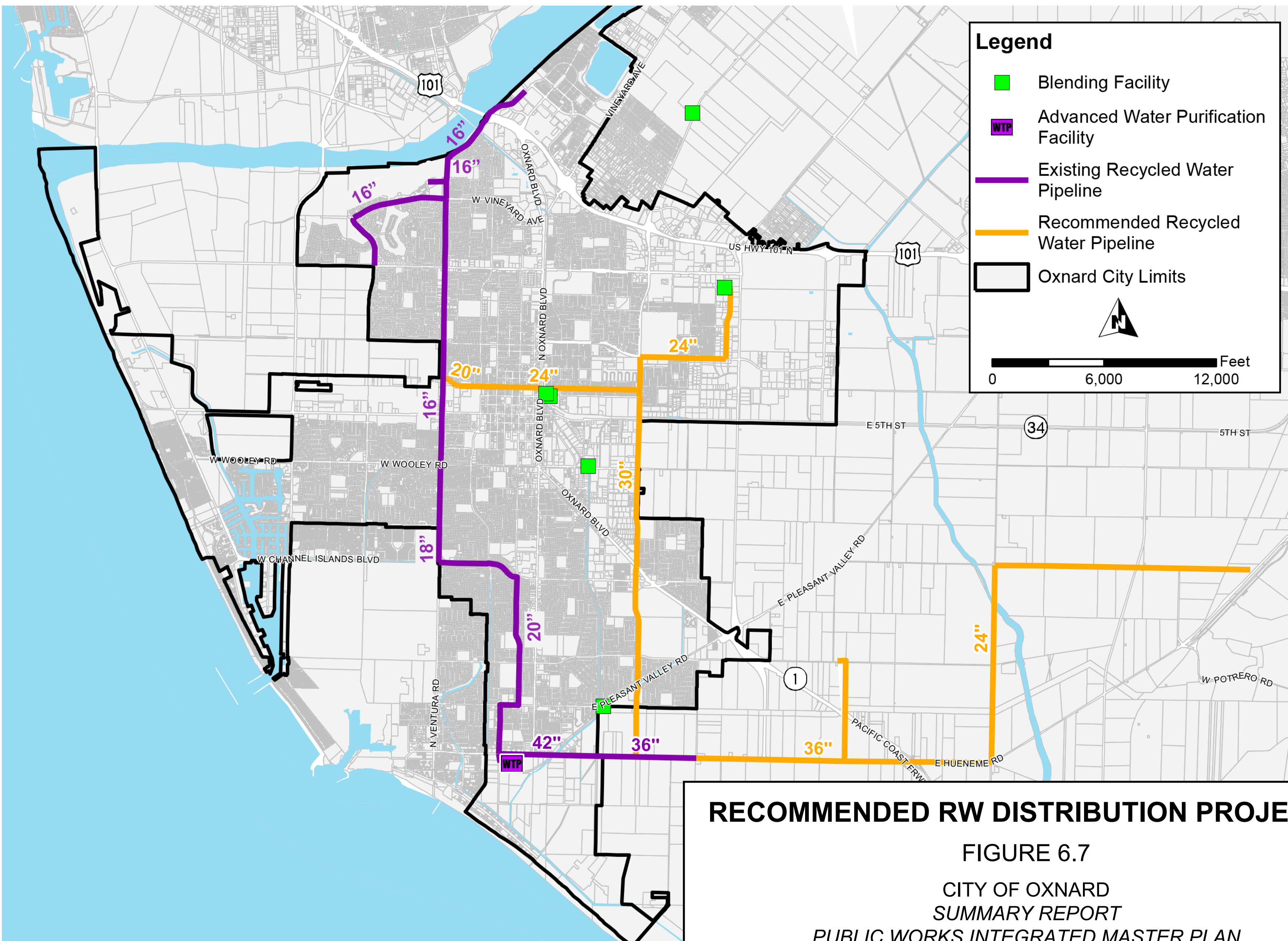
6.9.2 Distribution

Phase 1B of the recycled water distribution system expansion focuses on delivering recycled water to the agricultural users east of the City, which will be accomplished with Phase 2 of the Hueneme Road Pipeline. The pipeline's alignment will start at the end of the Hueneme Road Phase 1 Pipeline, at the intersection of Hueneme Road and Olds Road. The 36-inch diameter pipeline continues east down Hueneme Road to Wood Road and then transitions to a 24-inch pipeline, heading north on Wood Road until the intersection of Wood Road and Laguna Road. From there, it runs east on Laguna Road where it terminates just before Lewis Road. The Hueneme Road Phase 2 pipeline will supply an agricultural demand to the farmers of up to 5,200 AFY or 3,225 gpm depending on the RW supply available.

Phase 2 involves constructing the RW loop that will feed the proposed ASR locations at Campus Park and BS Nos. 1/6. The RW Loop tees off the existing 16-inch RWBS pipeline at the intersection of South Ventura Road and West Second Street. From this location, a 20-inch diameter pipeline continues east down West Second Street to the Campus Park ASR Facility where it increases to a 24-inch pipeline and continues past Campus Park and into BS No. 1/6. Once past BS No. 1/6, the 24-inch diameter pipeline continues east along East Second Street, intersecting at N Rose Avenue. There, it turns south on North Rose Ave, increasing to a 30-inch pipeline until it connects to the existing 36-inch Hueneme Road Pipeline.

Phase 3 involves constructing a 24-inch pipeline connecting BS No. 3 to the RW Loop. The pipeline starts from the RW Loop at the intersection of East Second Street and North Rose Avenue. This 24-inch pipeline continues north on N Rose Avenue, then east on Camino Del Sol, and then north on N Rice Avenue to Wankel Way where it terminates at BS No. 3.

Figure 6.7 shows the routings of these pipelines.



RECOMMENDED RW DISTRIBUTION PROJECTS

FIGURE 6.7

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6.9.3 IPR/DPR

Implementing IPR as a supplemental water supply will occur in steps. In Phase 1, the City will construct one demonstration ASR well (as noted in Section 6.2.3). With this demonstration well, the City can assess the feasibility of the IPR process in real time and refine the assumptions surrounding aquifer capacity and extracted water quality. In addition, the well will establish the process for regulatory approval for the IPR process. A Title 22 Engineer's Report (Carollo, 2016) and a Report of Waste Discharge (ROWD) (Carollo, 2016) were developed for this demonstration ASR well.

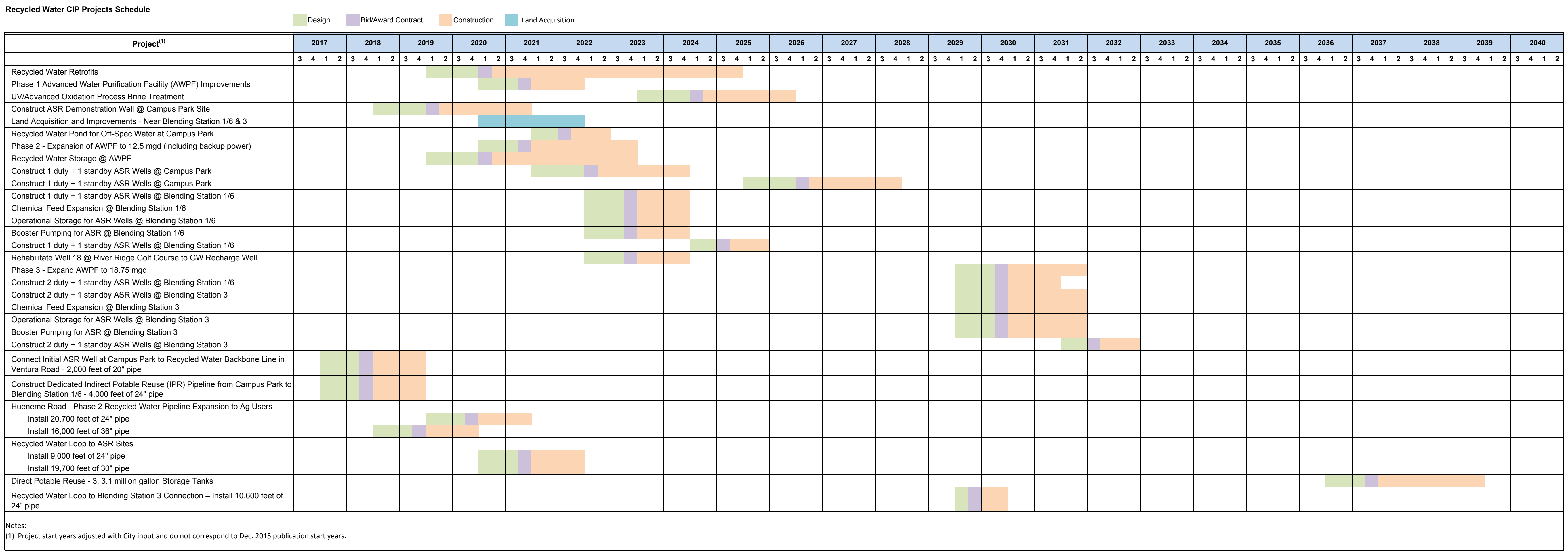
Phase 2 contains the majority of the ASR installations for supplemental water supply use, which will also happen in steps. First, the Campus Park site will be built-out. Four additional ASR wells will be added, each with their own set of monitoring wells (i.e., 3 per ASR well). Currently, a built-out ASR site will also consist of operational storage, sized to offset PHDs, booster pumping, and additional conditioning facilities (i.e., disinfection and fluoride addition). However, because the Campus Park site is near BS No. 1/6, it makes more sense to house the ancillary equipment at BS No. 1/6. Thus, extracted IPR water will be conveyed from Campus Park to BS No. 1/6 for storage and conditioning.

After build-out of the Campus Park ASR wells, four ASR wells will be added near the BS No. 1/6 site. Additional property near BS No. 1/6 will need to be acquired, which the City has already discussed with property owners. Adding these wells will correspond to the Phase 2 expansion of the AWPF and should help to meet potable water demands through approximately 2030.

Phase 3 will then continue to expand the City's ASR capacity and will correspond to expanding the AWPF to 18.75 mgd. Build-out of the BS No. 1/6 site with the addition of three ASR wells will occur next, followed by the construction of six ASR wells at BS No. 3. As with BS No. 1/6, additional property will need to be acquired near BS No. 3 to make this feasible. Operational storage, booster pumping, and conditioning facilities will need to be added to BS No. 3 as well.

6.9.4 Implementation Schedule

Implementing these recycled water projects will occur in conjunction with the water system master plan projects in Chapter 4. The proposed schedule for these improvements is included in **Error! Not a valid bookmark self-reference.**, and costs for the recommended recycled water projects are summarized in Chapter 9.



RECOMMENDED RECYCLED WATER SYSTEM PROJECTS SCHEDULE

FIGURE 6.8

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STORMWATER SYSTEM MASTER PLAN

7.1 INTRODUCTION

The City's stormwater system serves the City and surrounding areas that drain into Oxnard, approximately 35 square miles in drainage area. Within this system, the City maintains a network of storm drains comprised of gravity pipes, force mains, lift stations, and additional infrastructure associated with a stormwater drainage system.

The Ventura County Watershed Protection District (VCWPD) has either partial or complete jurisdiction over each of the City's drainage channels. As such, the City's drainage facilities discharge either directly into the ocean or into the VCWPD facilities first and then into the ocean.

When evaluating improvements to the stormwater collection system, a number of goals were established to help develop scenarios. Consistent with the overall goals established in Chapter 1, the five main goals for improvements are as follows:

- Goal 1: Provide a compliant, reliable, resilient, and flexible system.
- Goal 2: Manage assets in a way that maximizes economic sustainability.
- Goal 3: Mitigate and adapt to the potential impacts of climate change.
- Goal 4: Protect and enhance environmental and resource sustainability.
- Goal 5: Investigate green and gray infrastructure with an emphasis on energy efficiency.

As shown, these goals aim for more than simply maintaining the existing system. Instead, they seek to produce stormwater projects that can enhance the quality of stormwater entering the environment and potentially harvest some of it as an additional water supply. In doing this, the City aims for a more robust, adaptable, and cost-efficient system overall.

This chapter provides an overview of the existing stormwater system, including its strengths and vulnerabilities, as well as the regulatory requirements and climate change issues the system might face. This chapter also defines the recommendations for meeting the defined goals.

The analysis and evaluations contained in this Summary Report are based on data and information available at the time of the original date of publication of the Project Memos (PMs), December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). The complete updated CIP based on the near-term and long-term projects is contained in Appendix B.

7.2 DESCRIPTION OF EXISTING FACILITIES

7.2.1 Stormwater Collection System

The City's existing storm drainage system collects and conveys stormwater runoff from developed and undeveloped areas throughout the City. The system includes circular pipelines from 4 to 96 inches in diameter, rectangular pipes up to 264-by-96 inches wide, open channels, 5 stormwater pump stations and associated force mains, and various valves and diversion structures throughout the system. The majority (approximately 63 percent) of the pipes were built using reinforced concrete pipes (RCP).

Figure 7.1 shows the existing storm drainage system, including storm drain diameters, detention/retention ponds, pump stations, canals, and outfall locations. In total, the City owns approximately 162 miles of storm drains and open channels, and VCWPD has jurisdiction over 28 miles of open channels.

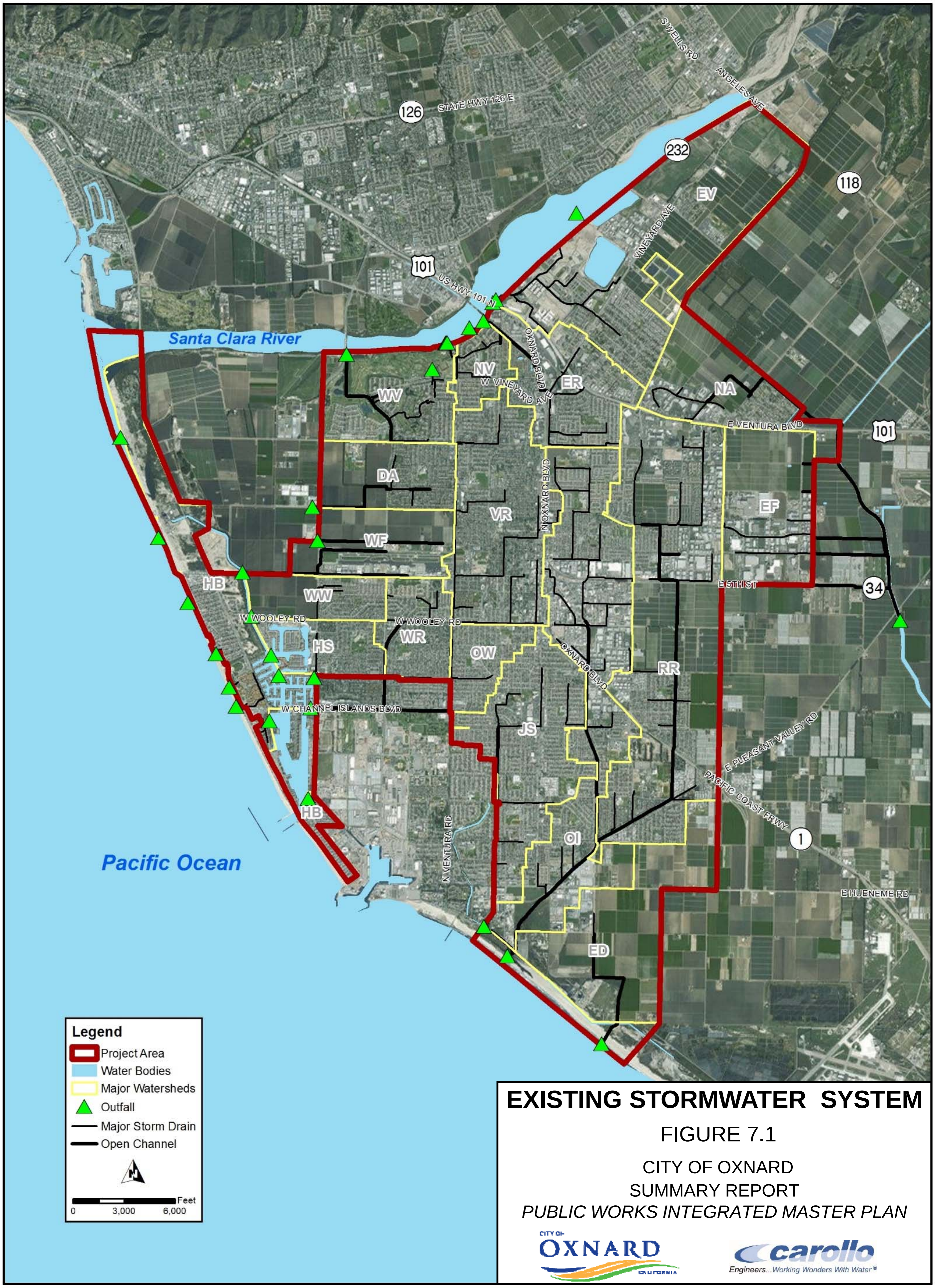
The VCWPD, previously called the Ventura County Flood Control District (VCFCD), was formed in 1944 to perform drainage services not readily performed by local agencies. The City resides in the VCWPD Flood Zone 2 and City drainage facilities discharge into the VCWPD channels whenever possible. Major drainage channels within Oxnard include Doris Avenue Drain, Fifth Street Drain, Wooley Road Drain, Oxnard West Drain, Ormond Lagoon Waterway, Rice Road Drain, Tsumas Creek, El Rio Drain, Camarillo Drain, and Nyeland Drain.

7.2.2 Condition Assessment

Between September 12, 2014, and September 18, 2014, a condition assessment was conducted of select storm drain facilities throughout the City. Assets for inspection were chosen based on age, slope, and proximity to areas prone to flooding. Groupings of old assets with small slopes located near flood-prone areas were assessed first.

This evaluation involved visually inspecting the topsides of 304 manholes, catch basins, pipes, channels, flood zones, and outfalls, as well as select areas that have flooded in the past. In total, 29 sites were assessed, representing 2 percent of the entire stormwater collection system.

Although the majority of the assets were in excellent condition, the assessment found that approximately 12 percent need immediate attention or attention within the next five years. Furthermore, although the majority of assets showed negligible amounts of sediment, sediment build-up is a concern in approximately 12 percent of the stormwater collection system assets. These assets had moderate to significant sediment buildup and should be cleaned within five years.



EXISTING STORMWATER SYSTEM

FIGURE 7.1

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Figure 7.2 illustrates the locations of assets in poor condition. Priority 4 assets in orange are in poor condition, and priority 5 assets in red require immediate attention.

7.3 MASTER PLAN/DESIGN CRITERIA

Key LOS criteria were used to evaluate the existing stormwater system's ability to meet the future needs summarized in Table 7.1. The criteria were used to evaluate the stormwater collection system and to plan for future system improvements.

Table 7.1 Level of Service Criteria
Public Works Integrated Master Plan
City of Oxnard

Design Storm	Facilities to be Evaluated	Maximum HGL Depth/Flooding Depth Criteria
10-year, 24-hour	Storm Conveyance Facilities and Basins	Surcharging allowed, but no flooding above surface elevation
100-year, 24-hour	Combined Capacity of Streets, Basins, and Pipes	Flooding allowed not higher than the building finish floor levels

7.4 FUTURE FACILITY NEEDS AND OPPORTUNITIES

The capacity and performance of the existing stormwater system were compared with the above LOS criteria to locate system shortfalls. In general, the system has adequate capacity to meet current and future demand conditions. However, some capacity deficits and R&R needs exist.

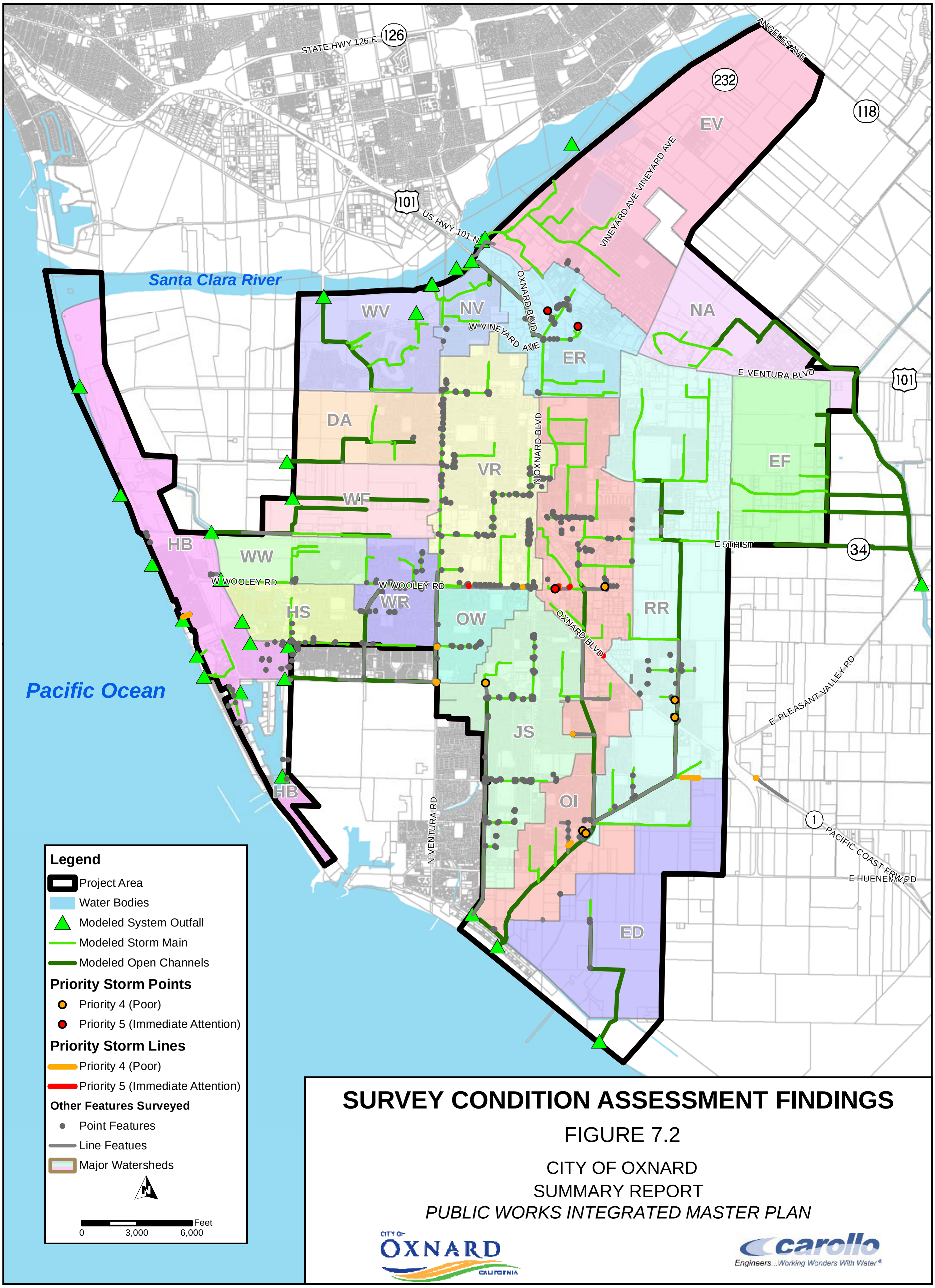
7.4.1 Stormwater Collection System

7.4.1.1 Capacity

As part of the planning effort, Carollo developed a storm drainage hydrologic and hydraulic model for the City in SewerGEMS. The model was used to identify existing system deficiencies, characterize infrastructure needs for future growth, and develop capital improvements to mitigate deficiencies and meet the City's planning criteria.

To develop the model, a capacity analysis was performed on pipelines 24 inches in diameter and larger as well as other critical facilities of all sizes. The first step in the capacity analysis was to divide the 22,709 acres within the service area into 418 individual subcatchments. In addition, appropriate outlet points (i.e., drainage inlets and catch basins in City Streets or nearby manholes) were defined. The resulting subcatchments range from 1.7 acres to 374.9 acres and average approximately 54.3 acres.

Rainfall data were used to generate the basis for stormwater evaluations. As shown in Figure 7.1, a 10-year 24-hour storm (total rainfall of 4 inches) and a 100-year 24-hour storm (total rainfall of 6.4 inches) were used for the capacity assessment.



SURVEY CONDITION ASSESSMENT FINDINGS

FIGURE 7.2

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Results from the modeling effort indicate that during the 10-year, 24-hour design storm, the hydraulic grade line (HGL) in the Ventura channels is elevated, which causes significant surcharging in the City's storm pipes that drain to the channels. However, because the Ventura channels have insufficient conveyance capacity and the City's pipes are not capacity deficient, no improvements to the City's drainage pipes are proposed. Instead, the recommendation is to improve the Ventura channel conveyance to lower the HGL and allow more stormwater to drain to the canals without being held upstream in the City's system.

The modeling effort also indicated that the majority of the surcharging and flooding problems under the 10-year design storm are located in Ventura Road, Tsumas Creek, Ormond Lagoon Waterway, and north of Rice Road Avenue watersheds, which correspond to the City's downtown core. The existing storm drain system also lacks sufficient capacity to convey the 100-year design runoff while meeting the flooding criteria. Figure 7.3 shows the location of this surcharging infrastructure.

The project team evaluated the reasonableness of the model results by comparing them with the City's observations. Based on staff observations during storm events, the model results confirmed areas around the City that typically experience flooding.

In addition to the sewerGEMS model, the City recently completed a Green Alleys Plan. This plan had two goals: to identify the City's alleys that are good candidates for green alley projects and to provide a framework for the future design and implementation of these projects.

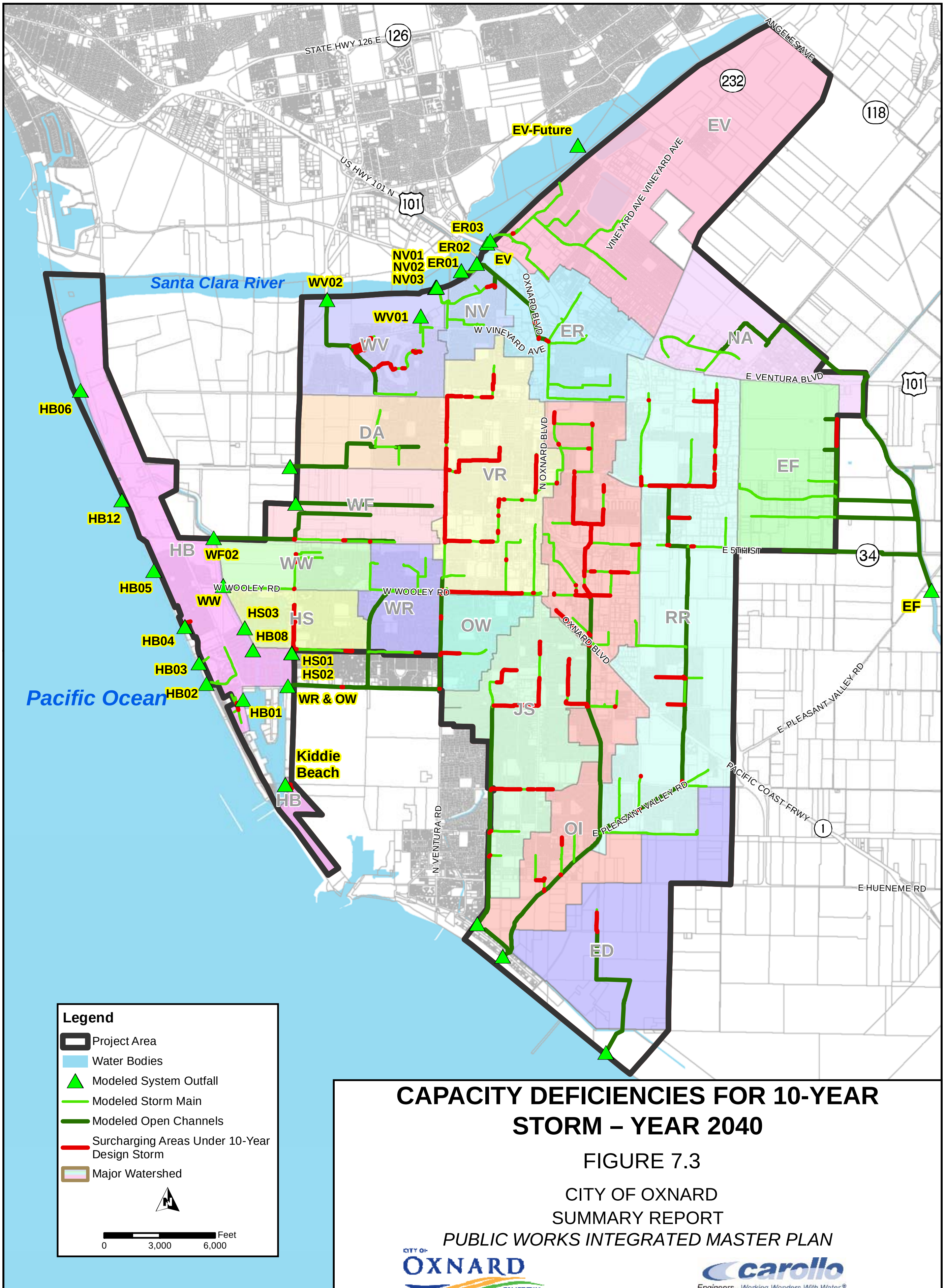
After comparing the environmental prioritization results performed in the Green Alley program, some of the high priority public alleys were noted to overlap with the observed areas of flooding. As a result, it is recommended, where appropriate, that the City incorporate bioswales, permeable paving, or rain barrels (for community gardens) to help decrease flooding in these locations. Figure 7.4 shows the areas of high priority for Green Alleys projects and the existing flooding areas.

7.4.1.2 R&R

As previously mentioned, approximately 12 percent of the assets need immediate attention or attention within the next five years. These assets are in poor or very poor condition. In addition, sediment build-up was a problem in approximately 12 percent of the assets.

7.4.2 New Stormwater Projects

A number of new stormwater projects were considered to achieve the goals outlined in the Integrated Master Plan. The goal of these projects is to improve stormwater quality so it can be harvested as an additional water source and meet regulatory requirements.



CAPACITY DEFICIENCIES FOR 10-YEAR STORM – YEAR 2040

FIGURE 7.3

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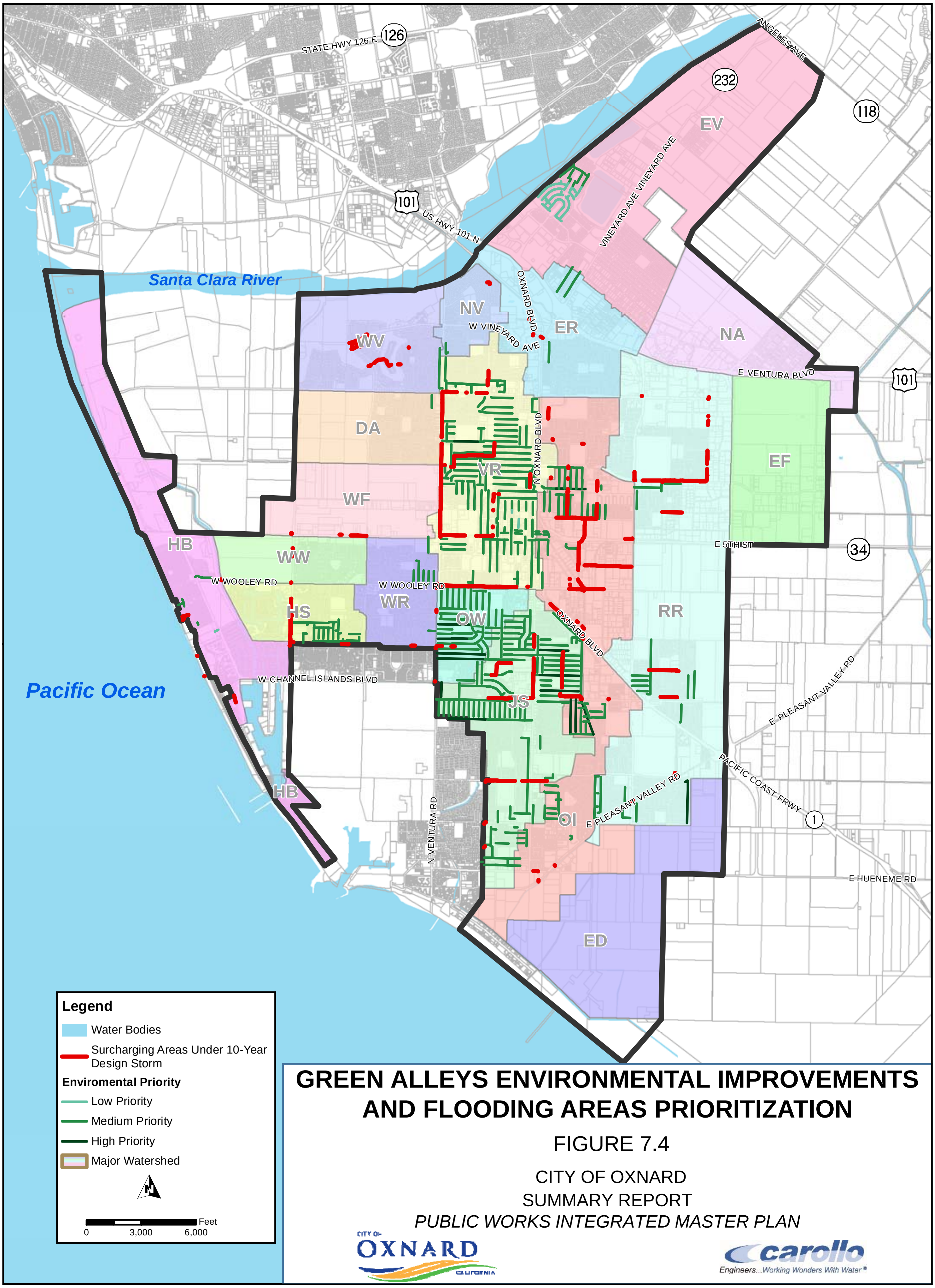

GREEN ALLEYS ENVIRONMENTAL IMPROVEMENTS AND FLOODING AREAS PRIORITIZATION

FIGURE 7.4

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Once an initial list of stormwater project options was identified, all options went through a fatal flaw screening to determine which were the most viable. From this screening, three new stormwater projects were selected: dry weather diversion, a citywide incentive program, and total maximum daily load (TMDL) compliance. Each project is described in the following sections.

7.4.2.1 Dry Weather Diversion

The first project would divert dry weather stormwater channel flows to the Oxnard Wastewater Treatment Plant (OWTP) to be treated and potentially reused at the Advanced Water Purification Facility (AWPF). Dry weather flows include flow from irrigation runoff, pool draining, washdown water, construction work, and other related activities. In Oxnard, shallow groundwater infiltration is likely another component of dry weather 'stormwater' flow.

Water could be diverted from the stormwater collection system in a number of ways. Typically, stormwater diversion structures in California are constructed by first screening water for trash and then pumping water from a stormwater pump station to a sanitary collection system. However, water can also be diverted in an open channel by installing an inflatable dam or mechanical gate. Water that builds up behind the dam or gate can then be pumped into the sanitary collection system. The diverted stormwater would be treated downstream at the OWTP and potentially the AWPF.

A dry weather diversion could be used only when the OWTP has excess capacity. In Oxnard's case, storage would not be required because dry weather flows in stormwater channels occur year-round. To prevent significant water quality degradation of OWTP influent, however, dry weather diversions should be kept small in proportion to OWTP influent.

Before this project could be implemented, the City should consider the effects removing this dry weather storm channel flow could have on downstream habitat. Additionally, water quality implications should be studied further.

7.4.2.2 Citywide Incentive Program

The second project is a citywide incentive program that would involve capturing stormwater to offset potable water use. A program like this would encourage new developers to invest in rainwater harvesting and onsite reuse. It would also give interested residents the opportunity to retrofit their homes with rain barrels or rain cisterns. These measures would lower the risk of flooding and would encourage residents and developers to take a proactive stance on stormwater.

The City could encourage such rainwater collection in several ways. It could provide discounted rain barrels and cisterns for purchase or offer a discount on water utilities bills. Such incentives could be provided for both existing land owners and developers. The cost for such an incentive program would depend entirely on its size and the amount the City is willing to offset.

Since the City is located on a shallow perched aquifer, the Integrated Master Plan recommends focusing any incentive program on onsite capture and use instead of infiltration. This focus will decrease customers' potable water use for landscape irrigation the most.

7.4.2.3 TMDL Compliance

The final project involves reaching a TMDL for indicator bacteria. The Los Angeles Regional Water Quality Control Board (LARWQCB) adopted a TMDL for indicator bacteria in the Santa Clara River Estuary. This TMDL requires participating agencies like the City to prepare an implementation plan outlining proposed activities to achieve a reduction in bacteria load.

In March 2015, a draft implementation plan was developed that located potential infiltration basins and subsurface infiltration basins for both dry and wet weather stormwater throughout the watershed. South Bank Park in Oxnard was one of the locations identified. This location, shown in Figure 7.5, is the proposed site for a subsurface infiltration basin.

This infiltration basin would be sized to treat the 85th percentile volume from the local drainage area and would require approximately 85,000 square feet. It would be approximately 2 feet deep and infiltrate at a rate of 0.5 inches per hour.

7.5 RECOMMENDED PROJECTS

7.5.1 Stormwater Collection System

Stormwater collection system improvements were focused on capacity and R&R needs and based on the capacity assessment and condition assessment, respectively. Through these assessments, 13 main capacity projects were identified. These projects are summarized in Table 7.2.

In addition, a total of 21 assets with a Level 4 rating were identified, as was an asset with a Level 5 rating that requires R&R. Costs for these R&R needs are also shown in Table 7.2, and an overall schedule can be found in Figure 7.6.

7.5.2 New Stormwater Projects

As outlined above, three new stormwater projects have been proposed for the Integrated Master Plan. The infiltration basin, recommended for TMDL compliance, should be implemented, since it is required to meet the Santa Clara River's indicator bacteria TMDL. The remaining two projects, a dry weather diversion and an incentive program, should be considered for future implementation. For more information about these projects, refer to Table 7.3. For an overall schedule, refer to Figure 7.6.

**Table 7.2 Recommended Collection System Projects
Public Works Integrated Master Plan
City of Oxnard**

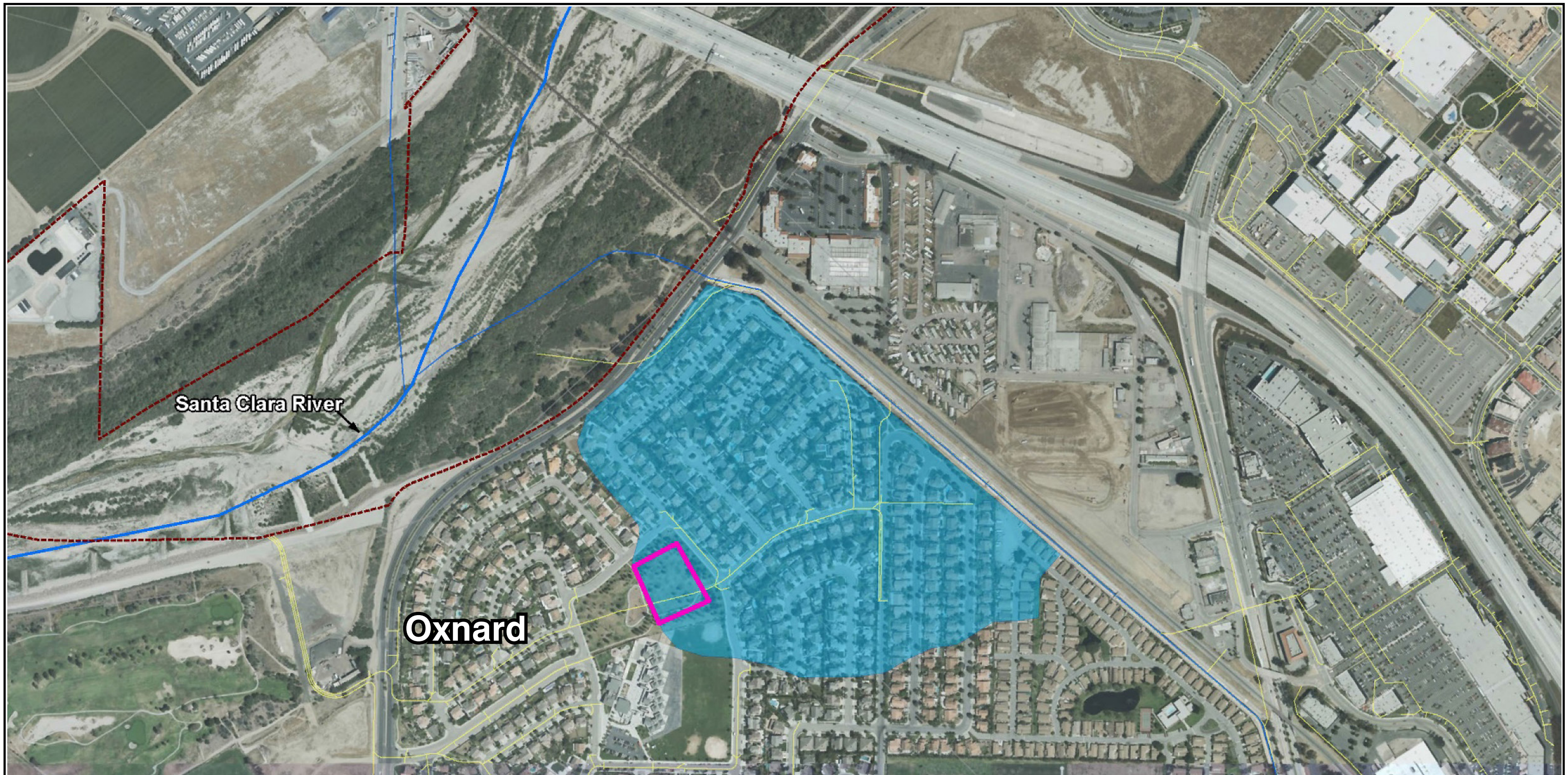
Project Name	Driver	Phase Ranking
Drainage Basin WV (444 ft)	Capacity	2
Drainage Basin WV (748 ft)	Capacity	4
Drainage Basin OI (607 ft)	Capacity	2
Drainage Basin RR (2,436 ft)	Capacity	3
Drainage Basin OI (2,388 ft)	Capacity	4
Drainage Basin VR (5,872 ft)	Capacity	1
Drainage Basin JS (1,421 ft)	Capacity	1
Drainage Basin JS (1,292 ft)	Capacity	2
Drainage Basin JS (426 ft)	Capacity	2
Drainage Basin JS (457 ft)	Capacity	2
Drainage Basin JS (655 ft)	Capacity	2
Drainage Basin JS (701 ft)	Capacity	2
Drainage Basin HS (1,552 ft)	Capacity	2
22 assets	R&R	1

General Note: For the pipeline replacement projects, see the hydraulic models developed as part of this integrated master plan to identify the exact pipeline locations. Project costs, schedule, and phasing are based on data and information available at the time of the original publication of the Project Memos (PMs) – December 2015.

**Table 7.3 Recommended New Stormwater Projects
Public Works Integrated Master Plan
City of Oxnard**

Project Name	Driver	Start Year	Phase Ranking
Dry Weather Diversion Structure	Resource Sustainability	2021	2
City-Wide Incentive Program	Resource Sustainability	2021	2
TMDL Infiltration Basin	Resource Sustainability	2023	2

General Note: Project costs, schedule, and phasing are based on data and information available at the time of the original publication of the Project Memos (PMs) – December 2015.



LEGEND

- Regional BMP Parcel
- BMP Drainage Area
- IP Area
- Santa Clara River
- Santa Clara River Watershed
- Tributaries to SCR
- Storm Drains

Source: "Draft Lower Santa Clara River TMDL Implementation Plan," Geosyntec, March 2015.

PROPOSED INFILTRATION BASIN FOR TMDL COMPLIANCE

FIGURE 7.5

CITY OF OXNARD
SUMMARY REPORT
PUBLIC WORKS INTEGRATED MASTER PLAN

City of OXNARD California

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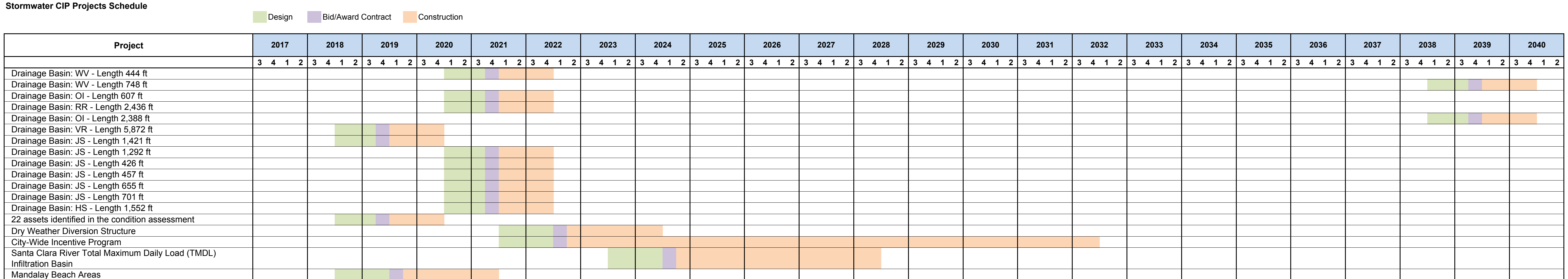
V:\Client23\Oxnard\9587\ox1115\SummaryReport\ox01115f24-9587(SumRepFIG7-5).ai

Stormwater CIP Projects Schedule



Notes:
(1) Project start year moved two years later compared to 2015 CIP.
(2) Project start year adjusted with City input and do not correspond to Dec. 2015 publication start year.
(3) Project added by City after December 2015 publication.

RECOMMENDED STORMWATER PROJECTS SCHEDULE

FIGURE 7.6

CITY OF OXNARD
SUMMARY REPORT
PUBLIC WORKS INTEGRATED MASTER PLAN

CITY OF OXNARD CALIFORNIA

carollo Engineers...Working Wonders With Water®

ox0817f4-9587(SumRepFIG7-6).ai

INTEGRATED AND COMMON SUPPORT ELEMENTS

8.1 INTRODUCTION

This chapter summarizes the studies conducted on common support elements (i.e., operation and data management systems, security, etc.) connecting the multiple utilities (water, wastewater, recycled water, and stormwater). An integrated approach was taken to analyze these support elements for greater efficiency and cost savings and to take a more a holistic approach to the overall system recommendations.

The analysis and evaluations contained in this Summary Report are based on data and information available at the time of the original date of publication of the Project Memos (PMs), December 2015. After development of the December 2015 Final Draft PMs, the City continued to move forward on two concurrent aspects: 1) advancing the facilities planning for the water, wastewater, recycled water, and stormwater facilities; and 2) developing Updated Cost of Service (COS) Studies (Carollo, 2017) for the wastewater/collection system and the water/distribution system. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). The complete updated CIP based on the near-term and long-term projects is contained in Appendix B.

8.2 COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM (CMMS)

The Computerized Maintenance Management System (CMMS) assessment evaluated the City's water treatment and distribution, wastewater collection and treatment, recycled water treatment and distribution, and stormwater assets, taking into account the Public Works' Enterprise Asset Management needs, existing capabilities and tools, and possible improvements. In the near-term, the focus will be on evaluating its CMMS needs, selecting a CMMS suitable to the City's daily needs, and implementing a CMMS to support maintenance and capital planning specifically for the Public Works Department.

In the next phase of work, Carollo recommends that the City start requesting proposals from the shortlisted CMMS vendors described in the Integrated Master Plan. Based on a review of the proposals received and preliminary reference checks, Carollo recommends narrowing down the shortlist to two or three preferred CMMS vendors that it can invite for software demonstrations.

The proposals, reference checks, and software demonstrations will serve as a basis for selecting a CMMS vendor. Table 8.1 includes summary costs for Year 1 and Year 2 activities. These cost estimates include software and implementation costs for both vendor and consultant services. These costs are included in the overall CIP.

Table 8.1 Compiled Summary of Vendor CMMS Software Cost Estimates
Public Works Integrated Master Plan
City of Oxnard

Cost Component	Cost Estimate[1]	Description	Basis/Assumptions
Year 1 Projects			
Software Licensing (Vendor)	$40,000 - $200,000	• Provides core functionality for assets, service requests, work orders, and Project Memorandums (PMs) • Provides basic inventory management functionality • Provides mobile functionality	• 55 named users or 20 concurrent users • 120 total users for service requests • Low estimate for enterprise license agreement • High estimate for user and module-based licensing • No add-on integration
Software Implementation Services (Vendor)	$50,000 - $300,000	• Implements core functionality for assets, service requests, work orders, and PMs • Implements GIS fleet management, inventory management, and mobile functionality	• Software installation • Software configuration for core modules • Limited data conversion and population for core functionality • Software testing • Basic training
Estimated Total Cost for Year 1	**$90,000 - $500,000**		
Year 2 Projects			
Annual Software Maintenance/Support (Vendor)	$15,000 - $150,000	• Provides vendor support and software upgrades and patches • Starts in Year 2 • Recurs each year of use	• Low estimate of 20 percent of licensing fee • High estimate for enterprise license agreement • Annual cost incurred indefinitely
Software Integration Services (Vendor)	$75,000 - $300,000	• Provides integration software and implementation services for SCADA and Enterprise Resource Planning • Provides additional business process implementation and training • Starts in Year 2	• Varies widely based on specific integration points, data flows, and selected software capabilities • May require multiple phases and years of implementation
Estimated Total Cost for Year 2	**$90,000 - $450,000**		

Note:

(1) Cost estimates are preliminary and subject to change based on detailed evaluation of requirements and negotiation of specific software licensing and services with selected vendor applicable to this specific Owner. Cost estimates are based on an approximate accuracy range of -15% to -30% on the low side to +20% to +50% on the high side.

8.3 GIS

The City is significantly invested in ArcGIS (ESRI). In 2015, the IT department started significantly updating the Public Works Geodatabase to ESRI's new "Local Government Schema" (LGS) configuration. By adopting the LGS, the ESRI could provide a significant number of free or low cost extensions to manage the Public Work Department's projects.

ESRI offers a *CIP Planning Tool* that allows users to define projects within the GIS by selecting assets. The tool then groups these assets into a project, allowing the user to enter unit costs and calculate the total cost by project. The user can also enter a schedule for starting and completing each project and for assigning a project manager.

Although the *CIP Planning Tool* is fairly simplistic, it allows users to easily manage individual CIP projects and compare multiple projects. The information can also be easily exported to MS Excel to complete additional calculations. Ultimately, the schedule can be imported to MS Project or a similar program to comprehensively manage project schedules.

This *CIP Planning Tool* has been briefly demonstrated to select individuals in the Public Works Department with a positive response. However, in discussing and understanding the Public Works Geodatabase setup further, there is the potential that the LGS may be changed in the future. If the LGS is changed, or "customized," then the extension tools in the *CIP Planning Tool* may not work with the new database structure, therefore rendering it less effective.

Therefore, Carollo recommends that the City maintain the LGS structure so these tools can be applied in the future. Carollo and the City should meet to further discuss the Public Works Geodatabase structure.

The *CIP Planning Tool* will also help in coordinating projects from multiple departments. For example, water and sewer projects can be overlaid with street improvement projects. With this, the City can adjust project schedules so streets are impacted only once and all infrastructure can be completed as a single project. This will significantly streamline project construction and minimize costs and disruptions to City stakeholders.

Using the *CIP Planning Tool* will also allow Carollo to deliver the CIP in GIS format, permitting continual update of the projects as time progresses and factors change. Since the City now uses tablets with GIS, this planning tool could ultimately become a "dynamic living CIP," so that Public Works Department employees can access the most current CIP projects and track which are completed and which are being deferred because of changing conditions.

8.4 SECURITY

Summers Associates, LLC, was contracted to develop a basis of design for physical and electronic security for the City's water resources facilities and to identify existing deficiencies in the facilities' security. A set of guidelines for enhancing security during their design and construction was also developed. Threats to the facilities include common crime, terrorist attacks, other manmade hazards, and some natural hazards.

Cost-effective recommendations are within the CIP to enhance safety throughout a facility's lifetime. These recommendations apply to new facilities as well as additions and modifications to the existing facilities.

8.5 SCADA

For this Integrated Master Plan, the existing supervisory control and data acquisition (SCADA) systems for the City's water and wastewater system were assessed and capital improvement projects were recommended. Planning efforts focused on these two systems in particular based on need and age of the existing SCADA systems. These projects, shown in Table 8.2 for water and Table 8.3 for wastewater, are included in the overall CIP recommendations.

Table 8.2 Recommended SCADA Projects for Water
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	Start Year	End Year	Un-escalated Project Cost ($)
Programmable Logic Controllers (PLC) Cabinet Replacements (6)	R&R	2015	2018	$2,050,000
SCADA Programming	Performance	2016	2021	$2,100,000
Asset Management Software Package Installation	Performance	2021	2022	$100,000
Network Upgrades (8)	Performance	2015	2022	$400,000
Control Room Upgrades	Performance	2016	2021	$300,000
			TOTAL:	**$5,000,000**

General Note: Project Costs, Schedules, and Phasing are based on data and information available at the time of the original publication of the Project Memos (PMs) - December 2015.

Table 8.3 Recommended SCADA Projects for Wastewater
Public Works Integrated Master Plan
City of Oxnard

Project Name	Driver	End Year	Start Year	Un-escalated Project Cost ($)
PLC Cabinet Replacements (12)	R&R	2018	2015	$4,601,000
SCADA Programming (12)	Performance	2021	2016	$4,989,000
Asset Management Software Package Installation	Performance	2022	2021	$104,000
Network Upgrades (12)	Performance	2022	2015	$776,000
Control Room Upgrades	Performance	2021	2016	$346,000
			TOTAL:	**$10,816,000**

General Note: Project Costs, Schedules, and Phasing are based on data and information available at the time of the original publication of the Project Memos (PMs) - December 2015.

RECOMMENDED CAPITAL IMPROVEMENT PLAN AND KEY OUTSTANDING PLANNING CONSIDERATIONS

9.1 INTRODUCTION

This chapter summarizes the key points of the four system master plans and presents a list of recommended projects for all water utilities. The Integrated Master Plan also integrated several other planning efforts such as data managements systems (e.g., SCADA, CMMS, GIS) and street planning efforts related to buried infrastructure and street upgrades such as repaving.

As with any planning effort, the Integrated Master Plan represents present and known conditions. Because of this, several key decisions and outcomes could dramatically affect the ultimate direction and phasing of implementation as the Plan progresses. Those key outstanding planning considerations and their potential impacts are summarized in this chapter.

Also summarized are the recommended costs for each project and an overall schedule for implementation. These recommended costs and schedules are based on a detailed evaluation of the existing water, wastewater, recycled water, and stormwater facilities, an assessment of likely future system needs, an analysis of master plan scenarios, and numerous meetings and workshops with City staff and management.

Until the environmental review and assessment for the Integrated Master Plan are complete, this Summary Report is considered a final draft. After those assessments are completed and approved by the City Council, the list of recommended projects may be revised based on a number of factors, such as the outcome of the environmental review process and the utility billing rates approved by the City Council.

9.2 APPROACH TO CIP DEVELOPMENT

As noted in Chapters 4 through 7, recommended projects were developed individually for each utility in 2014/2015. Also, as noted in the Brief History and Overview Section at the beginning of this report, the City continued to move forward with planning efforts and adoption of the Cost of Service (COS) studies (Carollo, 2017) from 2015 through 2017. Therefore, certain projects in these planning documents have been refined and updated since the original publication date in 2015/2016. It should be noted that the refinements were generally not capacity related, but instead related to improved financial strategies, technology updates, and climate change strategies. The updated 2017 COS studies contain the most recent near-term Capital Improvement Projects (CIP). The updated CIP list was combined with the December 2015 list to make a complete Integrated Master Plan CIP through 2040.

The costs and timing presented in this Integrated Master Plan represent Carollo's best professional judgment of the City's capital expenditure needs and timing to maintain a reliable and compliant system that can meet current and future water demands and wastewater generation needs.

Project timing was set to align with the seven master plan drivers, as noted earlier in Chapter 1: 1) repair & replacement (R&R), 2) regulatory requirements, 3) economic benefit, 4) performance benefit, 5) growth, 6) resource sustainability, and 7) policy decisions. Project timing is also based on input from City staff / management and the condition assessments performed as part of this planning project.

The projects were divided into three project timing phases: Immediate Needs (First 2 years); Near-Term Needs (years 3 to 5); and Long-Term Needs (Beyond 5 years).

9.3 SUMMARY OF THE PLANS

For each individual system, projects were developed based upon the system's most significant drivers and needs. For example, for water and wastewater systems, the facilities' ages and condition necessitate immediate R&R, whereas projects for the relatively new recycled water system involve maintaining and incorporating a reliable supply into the City's boundary. Given the complexity of each system and the systems' unique integration as a whole, a high-level summary of each of the four system plans is helpful. This summary is shown in Table 9.1.

9.4 OUTSTANDING PLANNING CONSIDERATIONS AFFECTING OVERALL CIP AND INDIVIDUAL PLANS

The projects/programs recommended within this Integrated Master Plan support the City's most current thinking, direction, and needs. However, the outcome, timing and phasing of the projects and programs could change depending on the outcome of several key outstanding planning considerations. Four key considerations include:

- The OWTP's eventual location – Two major options are being considered: continue treatment in the same location by repairing and replacing facilities, or relocate all or part of treatment to a completely new site.

  Continuing in the same location will require R&R of most of the major processes. Furthermore, future seawater intrusion due to rising sea levels is a concern and may require constructing a sea wall to mitigate and safeguard facilities.

  Conversely, relocating all of, or parts of, the OWTP to a new site reduces site issues, but implementation of the treatment plant can be challenging. Additionally, many of the existing OWTP facilities need to be upgraded immediately due to their age and condition. However, constructing them at a new site would require a longer lead time to acquire the land and to plan, design, and implement the facilities.

Table 9.1 Key Recommendations of Each Water System Plan
Public Works Integrated Master Plan
City of Oxnard

Timing	Water	Wastewater	Recycled Water	Stormwater
Years 1 - 2	R&R of pipelines and blending stations(1) Improve fire flow capability Separate system into 4 pressure zones for improved LOS Operations Optimization	Focus on R&R from minor to major projects on nearly every process within the OWTP R&R and Capacity improvements on several central trunk sewers	Minor R&R related to AWPF and conversion of recycled water customers	R&R of existing stormwater assets Limited capacity upgrades
Years 3 - 5	Add well and pipeline capacity to meet added demand Add desalter capacity to improve overall water quality of blended ground and surface water Add reliable water supply through ASR/IPR	Continued R&R on headworks and disinfection processes Energy efficiency improvements on digester / co-gen facilities	Add reliable water supply through AWPF Expansion and ASR/IPR	Capacity upgrades of existing assets Infiltration basin for TMDL compliance Dry weather diversion to capture dry weather flow in storm system Incentive program
Beyond 5 years	Continue to meet future demand through upgraded pipeline capacity Continue to bolster water supply through ASR/IPR integration	Focus on improved resource sustainability through process upgrades and alternative power	Continue to add reliable water supply, as needed, through AWPF Expansion and ASR/IPR facilities	Continues capacity upgrades (Phase 3 & 4)

Notes:
(1) Includes electrical and SCADA system upgrades and cathodic protection. Based on data and information available at the time of the original publication of the Project Memos (PMs) – December 2015.

- Regulatory considerations for the existing OWTP/AWPF outfall based on overall water infrastructure operation – Reusing water instead of discharging it to the ocean could have unintended consequences on the ocean outfall. Water reuse could limit the AWPF's ultimate capacity, require nitrification, and denitrification in the secondary effluent before discharge, and change local limits to industrial users. Preliminary mitigation measures have been explored through the Integrated Master Plan. However, conversations with regulators must continue until a cost-effective and reliable approach is determined.
- The FCGMA and future ground water allocations – Developing a sustainable water supply for the City's future depends on the long-term yield of the existing groundwater basin and the allocation apportioned to the City, which is closely tied to the drought conditions and the availability of natural supply. This Master Plan made certain assumptions about future allocations, trying to consider best- and worst-case conditions that provide flexibility for working within these parameters. However, at best, the future of FCGMA and groundwater are highly uncertain and must be monitored frequently to ensure that the City can plan for changes as they occur. Although changes are eminent, they are not fully defined at this time due to the recent passage of the 2015 Groundwater Management Act.
- Future of imported water from CMWD and Metropolitan Water District of Southern California – As the drought continues, regional authorities are exploring the best alternative water supplies to mitigate the drought's effects, including IPR and seawater desalination. In response, the City is staying abreast on the possibility of regional desalting and/or desalination facilities. These facilities could relieve some of the AWPF capacity for more potable offset or groundwater replenishment.

9.5 RECOMMENDED CIP/COST SUMMARY

An overall summary of the recommended CIP projects and their associated costs is presented in Table 9.2. The CIP costs are summarized for each system according to implementation phase. More detailed project costs and project drivers can be found in Appendix B.

The estimated near-term project costs shown in Table 9.2 and the associated operations and maintenance costs developed for the Integrated Master Plan are consistent with those developed for the Cost of Service (COS) Studies (Carollo, 2017). However, the timing of the costs presented may differ. This is partially because timing and implementing certain projects are based on assumptions with a range of uncertainty.

Uncertainties that can affect timing include the rate of population growth, the timing and performance standards of future regulatory requirements, the outstanding planning considerations mentioned above, and the development of new technologies and associated reliabilities. Therefore, while the overall investment and total CIP budget over the 25-year planning horizon are consistent between the Integrated Master Plan and the COS, timing the implementation of some projects may differ with the range of variability in the underlying assumptions of the Integrated Master Plan drivers.

Table 9.2 CIP Costs by Phase
Public Works Integrated Master Plan
City of Oxnard

Projects		Cost[(1)]
Water		
Years 1-2		$3,175,000
Years 3-5		$61,839,333
Years 6-10		$62,527,333
Years 11-16		$19,238,333
Years 17-23		$80,600,000
	Subtotal:	**$227,380,000**
Wastewater[(1)]		
Years 1-2		$8,405,000
Years 3-5		$68,425,064
Years 6-10		$244,311,000
Years 11-16		$58,908,334
Years 17-23		$112,983,933
	Subtotal:	**$493,033,330**
Recycled Water		
Years 1-2		$11,166,667
Years 3-5		$81,033,333
Years 6-10		$57,500,000
Years 11-16		$80,500,000
Years 17-23		$22,200,000
	Subtotal:	**$252,400,000**
Stormwater		
Years 1-2		$8,363,333
Years 3-5		$18,118,000
Years 6-10		$2,936,667
Years 11-16		$1,338,000
Years 17-23		$1,930,000
	Subtotal:	**$32,686,000**
	Total:	**$1,005,499,330**

Notes:
(1) Project costs correspond to refinements and updates provided by City after December 2015 publication date.

9.6 IMPLEMENTATION TIMING

Appendix B presents the timing for the recommended CIP projects.

APPENDIX A – LISTING OF THE PWIMP PROJECT MEMORANDUMS

CITY OF OXNARD

PUBLIC WORKS INTEGRATED MASTER PLAN

INDEX

Section No.	PM No.		PM Description
			Brief History and Overview
1			**General Overview**
	1.1		Master Planning Process Overview
	1.2		Public Works Maintenance and Optimization Plan
		1.2.1	Staffing
		1.2.2	Computerized Maintenance Management System (CMMS)
		1.2.3	Agreements/Contract Database Development Summary
	1.3		Population and Land Use Estimates
	1.4		Basis of Costs
	1.5		Security of Utilities Facilities
2			**Water System**
	2.1		Background Summary
	2.2		Flow Projections
	2.3		Infrastructure Modeling and Alternatives
	2.4		Condition Assessment
	2.5		Supply and Treatment Alternatives
	2.6		Arc Flash Assessment
	2.7		Cathodic Protection Assessment - Phases 1 and 2
	2.8		SCADA Assessment
3			**Wastewater System**
	3.1		Background Summary
	3.2		Flow and Load Projections
	3.3		Infrastructure Modeling and Alternatives
	3.4		Treatment Plant Performance and Capacity
	3.5		Condition Assessment
	3.6		Seismic Assessment
	3.7		Treatment Alternatives
		3.7.1	Traditional OWTP Assessment - Upgrade in Place
		3.7.2	Alternative OWTP Assessment - Relocate OWTP
	3.8		Arc Flash Assessment
	3.9		Cathodic Protection Assessment - Phase 1
	3.1		SCADA Assessment
	3.11		Flow Monitoring
	3.12		Biosolids Management

Section No.	PM No.	PM Description
4		**Recycled Water System**
	4.1	Background Summary
	4.2	Infrastructure Modeling and Alternatives
	4.3	AWPF/OWTP Outfall Regulatory Considerations
	4.4	Arc Flash Assessment
	4.5	Envision Documentation & Certification Summary Assessment
	4.6	Pathogen Analysis for Direct Potable Reuse (DPR) Summary
	4.7	Salt and Nutrient Management Plan (SNMP) Summary
5		**Stormwater System**
	5.1	Background Summary
	5.2	Infrastructure Modeling and Alternatives
	5.3	Condition Assessment
	5.4	Treatment Alternatives
6		**Streets**
		Integration of Streets with Planned Public Works Infrastructure and Summary of Current Street Planning Efforts

APPENDIX B – MASTER CIP TABLE

Project ID 2017	Project ID 2015	Project	Description	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY 2017/18 - 2018/19)	Years 3 to 5 (FY 2019/20 - 2021/22)	Years 6 to 10 (FY 2022/23 - 2026/27)	Years 11-16 (FY 2027/28 - 2032/33)	Years 17-23 (FY 2033/34 - 2039/40)
		Production Total					$47,590,000	$1,955,000	$13,705,000	$30,350,000	$1,580,000	$0
W-1	W-P-35	Existing desalter upgrades	Membrane replacement, CIP automation, electric valve actuator replacements, discharge piping reconfiguration	R&R	2017	5	$5,000,000	$930,000	$4,070,000	$0	$0	$0
W-2	W-P-28 W-P-40	Desalter, piping and permeate tank cathodic protection	Investigate requirements for electrical isolation and CP of buried piping and RO finished water, and design and install capital project as warranted; Replacement of CP system at WTP and steel permeate tank	R&R	2020	2	$110,000	$0	$110,000	$0	$0	$0
W-3	W-P-62 W-P-65	Expand water treatment facility and storage (incl. booster pump station)	Expand disinfection system at Blending Station 1/6. Install new 1.5 MG storage reservoir for finished water. Install new booster pump station for new storage tank	Water Supply	2021	8	$6,600,000	$0	$500,000	$5,100,000	$1,000,000	$0
W-4	W-P-19	Blending Station #2 upgrade	R&R of mechanical, electrical, and AUX equipment	R&R	2028	1	$430,000	$0	$0	$0	$430,000	$0
W-5	W-P-20	Blending Stations #1 and #6 upgrade	R&R of wells, mechanical, electrical, and AUX equipment	R&R	2018	4	$3,400,000	$850,000	$2,550,000	$0	$0	$0
W-6	W-P-21	Water System CMMS	Water CMMS System (City Works)	R&R	2017	3	$300,000	$175,000	$125,000	$0	$0	$0
W-7	W-P-22	Water System SCADA Improvements	Perform water SCADA system improvements (design and implementation plan year 1)	R&R	2020	5	$5,000,000	$0	$2,000,000	$3,000,000	$0	$0
W-8		Security Improvements at Water Yard and Blending stations	Access Control, Cameras		2020	5	$500,000	$0	$250,000	$250,000	$0	$0
W-9		Chemical Tank Replacements	Replacement of chemical tanks (required every 10 years)	R&R	2025	3	$450,000	$0	$0	$300,000	$150,000	$0
W-10	W-P-32	Blending Station #3 Rehabilitation	R&R of wells, mechanical, electrical, and AUX equipment, VFD replacement	R&R	2019	2	$2,500,000	$0	$2,500,000	$0	$0	$0
W-11	W-P-33	Blending Station #4 Rehabilitation	Pumps, mechanical, electrical, and AUX equipment, VFD	R&R	2019	2	$400,000	$0	$400,000	$0	$0	$0
W-12	W-P-34	Blending Station #5 Rehabilitation	Mechanical, electrical, and AUX equipment	R&R	2019	2	$200,000	$0	$200,000	$0	$0	$0
W-13	W-P-61	Construct 3 new potable wells at BS 1/6	Add potable water wells, land management	Water Supply	2020	7	$11,000,000	$0	$1,000,000	$10,000,000	$0	$0
W-14	W-P-66	Construct 2 new potable wells (BS 1/6) and 1 new stainless steel well at BS 3	Add potable water wells	Water Supply	2023	4	$11,700,000	$0	$0	$11,700,000	$0	$0
		Transmission Total					$2,405,000	$405,000	$1,620,000	$380,000	$0	$0
W-15	W-P-23 W-P-36 W-P-37	Del Norte Transmission Main Cathodic Protection (CP)	Install 20 missing test stations; Replace rectifiers and anodes and resurvey; Locate and repair discontinuity near the east end of the Del Norte Pl	R&R	2019	2	$450,000	$0	$450,000	$0	$0	$0
W-16	W-P-26	Gonzalez 36-inch Pipeline CP	Replace the seized test traffic box lids; test the CP system	R&R	2018	1	$5,000	$5,000	$0	$0	$0	$0
W-17	W-P-27 W-P-10 W-P-5 W-P-6	Oxnard Conduit CP	Excavate & install new test stations at BFV near Del Norte connection, 9+10, 39+10, 57+45, 69+50, 111+50, 165+20; Install new test stations in ex manhole at 284+80; Corrosion engineer to conduct Close Interval Survey (CIS); Replace deep anode beds at Rectifiers #1 , #2, & #3; Locate, excavate, and bond across approximately three (3) points of electrical isolation	R&R	2017	4	$890,000	$400,000	$490,000	$0	$0	$0
W-18	W-P-38 W-P-39	Wooley Road / United CP	Replace 5 test stations and add 2 new stations; Replace rectifier and anode; resurvey	R&R	2020	1	$160,000	$0	$160,000	$0	$0	$0
W-19	W-P-7 W-P-24	3rd Street Lateral CP	Replace rectifer and anode bed; resurvey; Replace all test stations at an interval of 1,000-ft minimum and 2,000-ft maximum; Locate & repair discontinuity between 27+88 and South Hayes WTP; Provide electrical isolation at the main treatment plant	R&R	2020	3	$360,000	$0	$310,000	$50,000	$0	$0
W-20	W-P-25 W-P-8	Industrial Lateral CP	Replace all test stations; resurvey	R&R	2020	3	$130,000	$0	$100,000	$30,000	$0	$0
W-21	W-P-11	3rd St 27" UWCD CP	Bond UWCD pipeline to Oxnard Extension at rectifier	R&R	2020	2	$110,000	$0	$110,000	$0	$0	$0
W-22		Condition assessment program	Physical condition assessment of mains program	R&R	2022	5	$300,000	$0	$0	$300,000	$0	$0
		Distribution Total					$58,965,000	$815,000	$24,551,000	$23,574,000	$10,025,000	$0
W-23	W-P-9	Replacement of AMR Devices	Design and construct a new Advance Metering Infrastructure (AMI) system (Cost is possibly reduced by 1/2 if shared with wastewater division)	R&R	2017	7	$22,000,000	$200,000	$13,000,000	$8,800,000	$0	$0
W-24		Pipe Capacity Improvements	Pipe capacity improvements for 8-inch to 24-inch pipe	Water Supply	2019	9	$13,040,000	$0	$5,620,000	$6,870,000	$550,000	$0
	W-P-51 W-P-52 W-P-53 W-P-54 W-P-56 W-P-57 W-P-58 W-P-59 W-P-67 W-P-68 W-P-69 W-P-70 W-P-71 W-P-72		Upgrade 322 feet to 8" pipe Upgrade 238 feet to 12" pipe Upgrade 164 feet to 14" pipe Upgrade 3,804 feet to 30" pipe Upgrade 69 feet to 6" pipe Upgrade 391 feet to 8" pipe Upgrade 1,011 feet to 10" pipe Upgrade 2,447 feet to 12" pipe Upgrade 32 feet to 6" pipe Upgrade 233 feet to 8" pipe Upgrade 1,243 feet to 10" pipe Upgrade 997 feet to 12" pipe Upgrade 2,453 feet to 14" pipe Upgrade 937 feet to 24" pipe									
W-25	W-P-12 W-P-13 W-P-14 W-P-15	Neighborhood CIP Pipe Replacement*	Replace existing distribution pipes in La Colonia Neighborhood, Redwood Neighborhood, Fremont North Neighborhood, and Bryce Canyon South Neighborhood	R&R	2018	6	$10,500,000	$615,000	$5,931,000	$3,954,000	$0	$0
W-29		Large Valve Replacement Program	Replace valve 10-inch and larger	R&R	2022	10	$1,926,000	$0	$0	$926,000	$1,000,000	$0
W-30		Small Valve Replacement Program	Replace valves 8-inch and smaller	R&R	2022	10	$3,780,000	$0	$0	$1,780,000	$2,000,000	$0
W-31		Air / Vac Valve Replacement Program	Replace air and vacuum valves and covers	R&R	2022	10	$1,422,000	$0	$0	$672,000	$750,000	$0
W-32		Hydrant Replacement Program	Replace dry barrel hydrants to wet barrel	R&R	2022	10	$1,197,000	$0	$0	$572,000	$625,000	$0
W-33	W-P-74 W-P-75 W-P-76 W-P-77	North Zone Modifications	Install 1000 feet of 24-inch pipeline from BS#3 to the North Pressure Zone, Rehab 3 Pressure Reducing Stations (PRS), modify minor piping	Pressure Zone Separation	2027	4	$1,100,000	$0	$0	$0	$1,100,000	$0
W-34	W-P-78 W-P-79 W-P-80 W-P-81	Coast Zone Modifications	Install 3000 feet of 8-inch pipeline, construct 3 new Pressure Reducing Stations (PRS), modify minor piping	Pressure Zone Separation	2027	4	$1,600,000	$0	$0	$0	$1,600,000	$0
W-35	W-P-82 W-P-83 W-P-84 W-P-85	South Zone Modifications	Install 6000 feet of 8-inch pipeline, construct 3 new Pressure Reducing Stations (PRS), modify minor piping	Pressure Zone Separation	2027	3	$2,400,000	$0	$0	$0	$2,400,000	$0
				2017 Potable Water System CIP Subtotal			**$108,960,000**	**$3,175,000**	**$39,876,000**	**$54,304,000**	**$11,605,000**	**$0**

Project ID 2017	Project ID 2015	Project	Description	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY 2017/18 - 2018/19)	Years 3 to 5 (FY 2019/20 - 2021/22)	Years 6 to 10 (FY 2022/23 - 2026/27)	Years 11-16 (FY 2027/28 - 2032/33)	Years 17-23 (FY 2033/34 - 2039/40)
Additional 2015 Projects												
	W-P-1	Electrical Rehabilitation - Well Nos. 30, 32, 33 & 34		Operations Optimization	2026	1.5	$1,000,000	$0	$0	$666,667	$333,333	$0
	W-P-2	Sodium Hypochlorite Piping Replacement		Operations Optimization	2022	1.5	$30,000	$0	$0	$30,000	$0	$0
	W-P-4	Generator and ATS Service		Operations Optimization	2019	1.5	$20,000	$0	$20,000	$0	$0	$0
	W-P-16	Fire Flow Improvements - Install/Replace 18,500 feet of 8" pipe		R&R	2020	2	$4,600,000	$0	$4,600,000	$0	$0	$0
	W-P-17	Fire Flow Improvements - Install/Replace 13,500 feet of 12" pipe		R&R	2020	2	$4,400,000	$0	$4,400,000	$0	$0	$0
	W-P-18	Fire Flow Improvements - Install 250 feet of 14" pipe		R&R	2020	1	$100,000	$0	$100,000	$0	$0	$0
	W-P-64	Blend Station Tie-In (@ Blending Station 1/6)		Water Supply	2022	1	$250,000	$0	$0	$250,000	$0	$0
	W-P-60	Construct new concentrate line from Oxnard Wastewater Treatment Plant (OWTP) to Blending Station 1/6		Water Supply	2020	3	$18,800,000	$0	$12,533,333	$6,266,667	$0	$0
	W-P-28	Blending Station 1/6 - Install electrical isolation at all steel and cast iron water risers		R&R	2022	2	$30,000	$0	$0	$30,000	$0	$0
	W-P-30	Well 23 & 31 Rehabilitation		R&R	2022	1.5	$210,000	$0	$0	$210,000	$0	$0
	W-P-31	Wells Electrical & Variable Frequency Drive (VFD) Replacement		R&R	2022	1.5	$770,000	$0	$0	$770,000	$0	$0
	W-P-41	Age Replacement - 109,100 feet of 6" pipe		R&R	2033	2	$25,500,000	$0	$0	$0	$0	$25,500,000
	W-P-42	Age Replacement - 47,000 feet of 8" pipe		R&R	2034	2	$11,700,000	$0	$0	$0	$0	$11,700,000
	W-P-43	Age Replacement - 55,000 feet of 10" pipe		R&R	2035	2	$17,100,000	$0	$0	$0	$0	$17,100,000
	W-P-44	Age Replacement - 24,000 feet of 12" pipe		R&R	2036	2	$7,900,000	$0	$0	$0	$0	$7,900,000
	W-P-45	Age Replacement - 2,300 feet of 14" pipe		R&R	2037	1	$900,000	$0	$0	$0	$0	$900,000
	W-P-46	Age Replacement - 4,000 feet of 16" pipe		R&R	2037	1	$1,700,000	$0	$0	$0	$0	$1,700,000
	W-P-47	Age Replacement - 3,700 feet of 24" pipe		R&R	2037	2	$2,300,000	$0	$0	$0	$0	$2,300,000
	W-P-48	Age Replacement - 5,000 feet of 36" pipe		R&R	2038	2	$3,900,000	$0	$0	$0	$0	$3,900,000
	W-P-49**	Age Replacement - 5,300 feet of 42" pipe		R&R	2038	2	$5,500,000	$0	$0	$0	$0	$5,500,000
	W-P-50**	Age Replacement - 3,800 feet of 48" pipe		R&R	2038	2	$4,100,000	$0	$0	$0	$0	$4,100,000
	W-P-55	Connection to OH / United pipeline		Water Supply	2020	1.5	$310,000	$0	$310,000	$0	$0	$0
	W-P-73	Expand desalter at Blending Station 1/6 to 15 mgd (3.75 mgd expansion)		Water Supply	2028	3	$7,300,000	$0	$0	$0	$7,300,000	$0
						Unmatched 2015 Water Projects Subtotal	**$118,420,000**	**$0**	**$21,963,333**	**$8,223,333**	**$7,633,333**	**$80,600,000**
						Overall Total	**$227,380,000**	**$3,175,000**	**$61,839,333**	**$62,527,333**	**$19,238,333**	**$80,600,000**

Note: * Projects W-25 through W-28 combined into single project ID'ed as W-25.
** Project start years correspond to refinements and updates provided by CIty after Dec. 2015 publication date.

2017 Project ID[1]	2015 Project ID	Unit Operation	Project	Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY 2017/18 - 2018/19)[3]	Years 3 to 5 (FY 2019/20 - 2021/22)[3]	Years 6 to 10 (FY 2022/23 - 2026/27)[4]	Years 11-16 (FY 2027/28 - 2032/33)[4]	Years 17-23 (FY 2033/34 - 2039/40)[4]
Wastewater Collection System Projects													
C-1	**WW-P-6**		Central Trunk Manhole Rehabilitation Phase 1	Rehabilitate 47 existing manholes	R&R	2018	1	**$ 1,410,000**	$ 1,410,000	$ -	$ -	$ -	$ -
C-2	**WW-P-13**		Central Trunk Manhole Rehabilitation Phase 2[2]	Rehabilitate 27 existing manholes	R&R	2020	1	**$ 810,000**	$ -	$ 810,000	$ -	$ -	$ -
C-3	**WW-P-8**		Harbor Blvd Manhole Rehabilitation	Rehabilitate 12 existing manholes	R&R	2019	1	**$ 100,000**	$ -	$ 100,000	$ -	$ -	$ -
C-4			Pleasant Valley Manhole Rehabilitation	Rehabilitate 14 existing manholes	R&R	2019	1	**$ 200,000**	$ -	$ 200,000	$ -	$ -	$ -
C-5	**WW-P-9**		Redwood Tributary Manhole Rehabilitation	Rehabilitate 38 existing manholes	R&R	2019	1	**$ 300,000**	$ -	$ 300,000	$ -	$ -	$ -
C-6			Annual Existing Manhole Rehabilitation	Various locations throughout the City based on sewer inspection	R&R	2022	5	**$ 1,000,000**	$ -	$ -	$ 1,000,000	$ -	$ -
C-7	**WW-P-16**		Rice Avenue Sewer Improvement	Install new 24-inch sewer from Latigo to Camino Del Sol to replace existing 18-inch sewer line.	R&R	2020	2	**$ 1,300,000**	$ -	$ 1,300,000	$ -	$ -	$ -
C-8	**WW-P-1**		Existing Sewer Deficient Capacity Replacement	Ventura Road from Doris Avenue to Oxnard Airport	Capacity	2020	2	**$ 1,755,197**	$ -	$ 1,755,197	$ -	$ -	$ -
C-9	**WW-P-2**		Existing Sewer Deficient Capacity Replacement	Third Street & Navarro Street	Capacity	2021	1	**$ 364,869**	$ -	$ 364,869	$ -	$ -	$ -
C-10	**WW-P-7**		Existing asbestos concrete pipe (ACP) Replacement	Various locations throughout the City	R&R	2019	8	**$ 4,000,000**	$ -	$ 1,500,000	$ 2,500,000	$ -	$ -
C-11			Annual Existing Pipe Repair	Various locations throughout the City based on sewer inspection	R&R	2019	8	**$ 1,600,000**	$ -	$ 600,000	$ 1,000,000	$ -	$ -
C-12			Collection System Chemical Addition	Construct 3 new magnesium hydroxide addition facilities to reduce nuisance odors and protect sewer infrastructure	Performance	2019	2	**$ 4,400,000**	$ -	$ 4,400,000	$ -	$ -	$ -
C-13	**WW-P-10** **WW-P-18**		Devco Development Lift Station	Construct new lift station at Devco development & abandon existing lift station #23. The new lift station will accommodate sewer flows from existing lift station #23, Devco, Village (Wagon Wheel) developments. The lift station cost is $1,500,000 & the City cost is $500,000.	R&R, Performance	2019	1	**$ 500,000**	$ -	$ 500,000	$ -	$ -	$ -
C-14	**WW-P-12**		Existing Lift Station #4 (Mandalay & Wooley) Rehabilitation	Install new supervisory control and data acquisition (SCADA) & motor control center (MCC) panels. Install new valve vault door. Rehabilitate wet well coating.	R&R	2019	1	**$ 500,000**	$ -	$ 500,000	$ -	$ -	$ -
C-15	**WW-P-11**		Existing Lift Station #6 (Canal) Rehabilitation	Install new pumps. Replace MCC panel. Install new emergency standby generator.	R&R	2019	1	**$ 500,000**	$ -	$ 500,000	$ -	$ -	$ -
C-16			Existing Lift Station #20 (Beardsley) Rehabilitation	Install new MCC panel and concrete pad.	R&R	2019	1	**$ 300,000**	$ -	$ 300,000	$ -	$ -	$ -
C-17	**WW-P-5**		Meter Vault/Vortex Structure Coating Rehabilitation[2]	Rehabilitate coating in meter vault/vortex structure	R&R	2018	1	**$ 280,000**	$ 280,000	$ -	$ -	$ -	$ -
Additional Wastewater Collection System Projects from 2015 CIP									$ -	$ -	$ -	$ -	$ -
	WW-P-3		Project 3: S Victoria Ave and W Hemlock St - Sewers in the Channel Islands Neighborhood		Capacity	2027*	2	**$ 1,112,267**	$ -	$ -	$ -	$ 1,112,267	$ -
	WW-P-14		Phase 1 Central Trunk replacement		R&R	2033**	2	**$ 36,500,000**	$ -	$ -	$ -	$ -	$ 36,500,000
	WW-P-15		Phase 2 Central Trunk Replacement		R&R	2036**	2	**$ 30,000,000**	$ -	$ -	$ -	$ -	$ 30,000,000
Wastewater Collection System Total								**$ 86,932,333**	**$ 1,690,000**	**$ 13,130,066**	**$ 4,500,000**	**$ 1,112,267**	**$ 66,500,000**
Wastewater Treatment System Projects													
--			Accelerated design for renewal improvements (year 6 - 10)			2018	6	**$ 15,130,000**	**$ 1,500,000**	**$ 8,630,000**	**$ 5,000,000**		
		Preliminary Treatment / Headworks											
T-1	**WW-P-83**		Headworks Odor Control System[2]	Install new odor control dampers and fan. Repair existing foul air ductwork.	Small Equipment Replacement	2018	1	**$ 220,000**	$ 220,000	$ -	$ -	$ -	$ -
T-2	**WW-P-67**		Headworks Fiberglass Covers Replacement & Concrete Coating Repair[2]	Install new grit chamber & wet well fiberglass covers. Rehabilitate grit chamber & wet well concrete coating. Year 1 to 2: high foot traffic areas. Year 3 to 5: remaining areas.	R&R	2018	2	**$ 499,100**	$ 90,000	$ 409,100	$ -	$ -	$ -
T-3	**WW-P-66**		Headworks Rehabilitation[2]	Install new odor control system. Enclose bar screen & conveyor areas to minimize odor complaints. Install screen wall along north and west property areas. In 2011, City settled $4.6M lawsuit related to Headworks construction and nuisance odor complaints.	R&R	2020	2	**$ 7,250,000**	$ -	$ 7,250,000	$ -	$ -	$ -
T-4	**WW-P-41**		Non-hazardous Waste Receiving Station	New non-hazardous waste receiving station with metering and screening systems	Performance	2026	1	**$ 2,100,000**	$ -	$ -	$ 2,100,000	$ -	$ -
		Primary Treatment										$ -	$ -
T-5			Primary Clarifier Rehabilitation	Install new effluent launders. New primary clarifier #4 walkway. Install polymer addition system to improvement primary treatment efficiency.	R&R	2017	1	**$ 655,000**	$ 655,000	$ -	$ -	$ -	$ -
T-6			Primary Clarifier Abandonment	Abandon existing primary clarifiers. Repurpose a portion existing secondary sedimentation tanks as primary clarifiers. Convert remaining secondary sedimentation tanks to membrane bioreactors (MBR).	R&R	N/A	0	**$ -**	$ -	$ -	$ -	$ -	$ -
T-7	**WW-P-23**		Primary Clarifiers, Old Headworks Structure and Primary Building Demolition[2]	Remove equipment, concrete, piping and electrical systems in old headworks and primary tanks area. Reroute piping and electrical systems	R&R	2025	1	**$ 7,300,000**	$ -	$ -	$ 7,300,000	$ -	$ -
		Secondary Treatment										$ -	$ -
T-8			Biotowers Rehabilitation	Install wire wrap or mesh around biotowers to prevent block wall from falling.	R&R	2017	1	**$ 630,000**	$ 630,000	$ -	$ -	$ -	$ -

2017 Project ID[1]	2015 Project ID	Unit Operation	Project	Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY 2017/18 - 2018/19)[3]	Years 3 to 5 (FY 2019/20 - 2021/22)[3]	Years 6 to 10 (FY 2022/23 - 2026/27)[4]	Years 11-16 (FY 2027/28 - 2032/33)[4]	Years 17-23 (FY 2033/34 - 2039/40)[4]
T-9	WW-P-20		Biotower Demolition[2]	Remove superstructure, remove concrete below ground, reroute piping and electrical; restore grade	R&R	2023	1	$ 2,850,000	$ -	$ -	$ 2,850,000	$ -	$ -
T-10	WW-P-69		Activated Sludge Tank (AST) Rehabilitation[2]	Install new air flow meters, air control valves, and dissolved oxygen meters.	R&R	2017	1	$ 150,000	$ 150,000	$ -	$ -	$ -	$ -
T-11	WW-P-72 WW-P-74 WW-P-76		Activated Sludge Tank (AST) Upgrades	Replace diffusers and add return sludge piping, aeration piping, gates and controls	R&R, Performance	2023	1	$ 4,600,000	$ -	$ -	$ 4,600,000	$ -	$ -
T-12	WW-P-72		Modify Activated Sludge Tank (AST) for MBR or other technology operation	Partition Tanks, add internal recycle system	Performance	2023	2	$ 7,200,000	$ -	$ -	$ 7,200,000	$ -	$ -
T-13	WW-P-68 WW-P-72		Convert Activated Sludge Tanks conversion to Flow Equalization Tank	Convert existing AST 4 to 8. Remove diffusers and add flow equalization pumps. Concrete repair and seismic retrofit - EQ Tank	R&R, Performance	2024	1	$ 5,525,000	$ -	$ -	$ 5,525,000	$ -	$ -
T-14	WW-P-70 WW-P-73		Convert Secondary Clarifiers to Primary Clarifiers	Convert existing secondary clarifiers 6 to 12. Install clarifier mechanisms, replace primary sludge pumps, isolation gates and scum systems. Replace collectors, skimmers, and drives. Concrete repair and re-painting - SSTs.	R&R	2025	1	$ 8,300,000	$ -	$ -	$ 8,300,000	$ -	$ -
T-15			Remove existing Secondary Clarifiers and prepare for new Membrane Bioreactor (MBR) or other Technology	Demolish existing secondary clarifiers 13 to 18. Remove equipment, re-route piping and electrical, reinforce walls of aeration basin, modify inlet and outlet channels	R&R	2023	2	$ 7,150,000	$ -	$ -	$ 7,150,000	$ -	$ -
T-16	WW-P-75 WW-P-97		New MBR or other technology Tanks	Construct new tanks, channels, membranes and piping, pump gallery, pumps, cranes, roof and ventilation systems, aeration blowers	R&R, Resource Sustainability	2023	2	$ 57,200,000	$ -	$ -	$ 57,200,000	$ -	$ -
T-17	WW-P-97		MBR or other Technology Building	New Chemical systems, electrical room, SCADA system, effluent pumps	Resource Sustainability	2023	2	$ 12,350,000	$ -	$ -	$ 12,350,000	$ -	$ -
T-18			Convert Existing Secondary Clarifier to Screening & Transfer Pump Station	Install screen channels for primary effluent, convert to flow equalization basin, add transfer pumping and pipes	R&R	2024	1	$ 7,150,000	$ -	$ -	$ 7,150,000	$ -	$ -
T-19	WW-P-96 WW-P-80 WW-P-81		Disinfection and Effluent Pumping	New Disinfection system, effluent wet well and pumps	Small Equipment Replacement, R&R	2024	1	$ 7,215,000	$ -	$ -	$ 7,215,000	$ -	$ -
T-20			Relocate Existing Primary Influent Piping	Connect to main header and re-route to influent channel of clarifiers. Provide controls and valves	R&R	2024	1	$ 3,510,000	$ -	$ -	$ 3,510,000	$ -	$ -
		Solids Treatment										$ -	$ -
T-21	WW-P-44 WW-P-45 WW-P-51		Sludge Thickening Facility[2]	Demolish Dissolved Air Flotation Tank (DAFT) structures, gravity thickener tanks and chemical storage. New building with Rotating Drum Screens for primary sludge and Gravity Belt thickeners for waste secondary sludge	R&R, Performance	2026	1	$ 24,700,000	$ -	$ -	$ 24,700,000	$ -	$ -
T-22	WW-P-43		Digester 2 Cover Replacement and Clean Digesters 1 & 3[2]	Install digester 2 cover and clean digester 1 and 3.	R&R	2019	3	$ 3,700,000	$ -	$ 3,700,000	$ -	$ -	$ -
T-23	WW-P-87 WW-P-89		Digesters 1 and 3 Rehabilitation[2]	Replacement of mixing systems, roof and concrete walls repair; heat exchanger upgrades	R&R	2025	2	$ 8,500,000	$ -	$ -	$ 8,500,000	$ -	$ -
T-24	WW-P-40		Replace Belt Filter Presses & Conveyor	Year 1 to 2: Replace two existing belt filter presses. Year 3 to 5: Replace two existing belt filter presses and conveyor.	R&R	2017	4	$ 2,610,000	$ 1,180,000	$ 1,430,000	$ -	$ -	$ -
T-25	WW-P-94		FOG Receiving Station[2]	Fats Oils Grease receiving station with tank heaters and pumps, for transfer to digesters	Resource Sustainability	2026	1	$ 845,000	$ -	$ -	$ 845,000	$ -	$ -
		Pump Station										$ -	$ -
T-26	WW-P-22		Interstage Pump Station Rehabilitation[2]	Install new pumps, motors, variable frequency drives. Rehabilitate wet well concrete coating. Upgrade control facility to meet building seismic code.	R&R	2020	2	$ 2,087,199	$ -	$ 2,087,199	$ -	$ -	$ -
T-27			Effluent Pump Station Rehabilitation	Install new isolation valve, pumps, motors, variable frequency drives. Rehabilitate wet well concrete coating. Install bypass piping. Upgrade control facility to meet building seismic code.	R&R	2019	3	$ 8,900,000	$ -	$ 8,900,000	$ -	$ -	$ -
		Electrical / Instrumentation										$ -	$ -
T-28			Electrical Building ARC Flash Protection	Install temporary 25kV circuit breakers on each side of 16kV and 480 volt transformers.	Performance	2017	2	$ 575,000	$ 575,000	$ -	$ -	$ -	$ -
T-29	WW-P-93		Cogenerators Rehabilitation[2]	Year 1 to 2: Rebuild two existing cogenerators. Year 3 to 5: Rebuild one existing cogenerator.	R&R	2017	3	$ 1,215,000	$ 810,000	$ 405,000	$ -	$ -	$ -
T-30	WW-P-32		Electrical/Instrumentation Manhole Rehabilitation	Rehabilitate seven existing electrical and instrumentation manholes.	R&R	2017	1	$ 175,000	$ 175,000	$ -	$ -	$ -	$ -
T-31	WW-P-33		Emergency Standby Generator Replacement[2]	Install new emergency standby generator	R&R	2020	2	$ 5,000,000	$ -	$ 5,000,000	$ -	$ -	$ -
T-32	WW-P-34		Plant Motor Control Center (MCC) Panel Replacement[2]	Install new MCC panels	R&R	2020	2	$ 2,087,199	$ -	$ 2,087,199	$ -	$ -	$ -
T-33	WW-P-30 WW-P-31		New Main Electrical Building[2]	New Building; new transformers; reroute electrical duct banks and run new cabling; new Automatic transfer switches; demolish old electrical building and equipment, and restore grade.	R&R	2020	2	$ 6,000,000	$ -	$ 6,000,000	$ -	$ -	$ -
T-34	WW-P-59		New North Electrical Building	New Building; new Motor Control Centers	R&R	2024	2	$ 4,400,000	$ -	$ -	$ 4,400,000	$ -	$ -
T-35			Site Electrical Improvements	Install cables, duct banks, and wiring	R&R	2024	3	$ 10,920,000	$ -	$ -	$ 10,920,000	$ -	$ -
T-36	WW-P-39		Computerized Maintenance Management System (CMMS)	Install new CMMS system for plant maintenance record keeping, including work scheduling, equipment records keeping, labor hours, and costs.	R&R	2017	1	$ 300,000	$ 300,000	$ -	$ -	$ -	$ -

2017 Project ID[1]	2015 Project ID	Unit Operation	Project	Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY 2017/18 - 2018/19)[3]	Years 3 to 5 (FY 2019/20 - 2021/22)[3]	Years 6 to 10 (FY 2022/23 - 2026/27)[4]	Years 11-16 (FY 2027/28 - 2032/33)[4]	Years 17-23 (FY 2033/34 - 2039/40)[4]
T-37	WW-P-35		Supervisory Control and Data Acquisition and (SCADA) System	Temporary convert existing fiber network to Ethernet to prevent SCADA drop-out.	R&R	2017	1	$ 225,000	$ 225,000	$ -	$ -	$ -	$ -
T-38	WW-P-35		New SCADA System	Install new SCADA system	R&R	2020	2	$ 4,946,500	$ -	$ 4,946,500	$ -	$ -	$ -
T-39	WW-P-35		New Supervisory Control and Data Acquisition (SCADA) system	Replace plant-wide SCADA systems and PLCs with current technology. Reprogram all processes for new Plant Control System	R&R	2024	2	$ 9,620,000	$ -	$ -	$ 9,620,000	$ -	$ -
		Site Work										$ -	$ -
T-40	WW-P-42		Site Piping Replacements	Install new process water piping, buried valves, fire line.	R&R	2020	5	$ 23,970,000	$ -	$ 1,350,000	$ 22,620,000	$ -	$ -
T-41			Site Security	Install site cameras, security fencing, building locks	R&R	2019	2	$ 1,000,000	$ -	$ 1,000,000	$ -	$ -	$ -
T-42			Storm water Site Improvements		R&R	2019	3	$ 2,100,000	$ -	$ 2,100,000	$ -	$ -	$ -
		Building										$ -	$ -
T-43			Laboratory HVAC Unit	Install new 20-ton HVAC unit.		2017	1	$ 205,000	$ 205,000	$ -	$ -	$ -	$ -
T-44	WW-P-57		New Chemical Storage Building[2]	Demolish old structures, Centralized chemical storage, new storage tanks, pumps and piping to various processes	R&R	2026	1	$ 2,730,000	$ -	$ -	$ 2,730,000	$ -	$ -
T-45	WW-P-56		Collection System Maintenance Building Rehabilitation[2]	Rehabilitate existing building to meet building code requirements.	R&R	2026	1	$ 500,000	$ -	$ -	$ 500,000	$ -	$ -
T-46	WW-P-49		Administration Building and Laboratory Rehabilitation[2]	Rehabilitate existing building to meet building code requirements.	R&R	2025	1	$ 850,000	$ -	$ -	$ 850,000	$ -	$ -
T-47			Plant Control Center Building Rehabilitation	Rehabilitate existing building to meet building code requirements.	R&R	2025	1	$ 850,000	$ -	$ -	$ 850,000	$ -	$ -
T-48	WW-P-58		Maintenance Building Rehabilitation	Rehabilitate existing building to meet building code requirements.	R&R	2026	1	$ 500,000	$ -	$ -	$ 500,000	$ -	$ -
T-49	WW-P-27 WW-P-28		Storage Warehouse Building	New storage warehouse building	R&R	2026	1	$ 1,500,000	$ -	$ -	$ 1,500,000	$ -	$ -
Additional Wastewater Projects from 2015 CIP									$ -	$ -	$ -	$ -	$ -
	WW-P-84	Preliminary Treatment	Small Equipment Replacement - Headworks 2		Small Equipment Replacement	2023*	3	$ 6,306,000	$ -	$ -	$ 6,306,000	$ -	$ -
	WW-P-21	Secondary Treatment	Add Baffle Walls in ASTs		R&R	2027*	1	$ 380,000	$ -	$ -	$ -	$ 380,000	$ -
	WW-P-95	Secondary Treatment	Coating Replacement on Chlorine Contact Tanks		R&R	2028*	2	$ 1,359,000	$ -	$ -	$ -	$ 1,359,000	$ -
	WW-P-79	Secondary Treatment	Small Equipment Replacement - wet weather storage 2		Small Equipment Replacement	2026*	3	$ 527,000	$ -	$ -	$ 175,667	$ 351,333	$ -
	WW-P-98	Secondary Treatment	Add UV/AOP after MBR		Resource Sustainability	2026*	2	$ 13,200,000	$ -	$ -	$ 6,600,000	$ 6,600,000	$ -
	WW-P-46	Solids Treatment	Demolish Operations Center and Vac Filter Building		R&R	2027*	1	$ 448,000	$ -	$ -	$ -	$ 448,000	$ -
	WW-P-88	Solids Treatment	New Digester 2		R&R	2030*	3	$ 12,950,000	$ -	$ -	$ -	$ 12,950,000	$ -
	WW-P-90	Solids Treatment	New Digester Control Building		R&R	2029*	5	$ 1,543,000	$ -	$ -	$ -	$ 1,234,400	$ 308,600
	WW-P-47	Solids Treatment	Move Dewatering Facility and add New Centrifuges		Performance	2030*	3	$ 23,370,000	$ -	$ -	$ -	$ 23,370,000	$ -
	WW-P-48	Solids Treatment	Add Dewatering Capacity		Performance	2030*	3	$ 2,160,000	$ -	$ -	$ -	$ 2,160,000	$ -
	WW-P-50	Solids Treatment	Add Sludge Silos		Performance	2032*	3	$ 6,370,000	$ -	$ -	$ -	$ 2,123,333	$ 4,246,667
	WW-P-91	Electrical / Instrumentation	New Cogen Building		R&R	2032*	3	$ 4,630,000	$ -	$ -	$ -	$ 1,543,333	$ 3,086,667
	WW-P-36	Electrical / Instrumentation	Small Equipment Replacement - Electrical 1		Small Equipment Replacement	2028*	2	$ 275,000	$ -	$ -	$ -	$ 275,000	$ -
	WW-P-37	Electrical / Instrumentation	Small Equipment Replacement - Electrical 2		Small Equipment Replacement	2032*	2	$ 626,000	$ -	$ -	$ -	$ 313,000	$ 313,000
	WW-P-38	Electrical / Instrumentation	Small Equipment Replacement - Electrical 3		Small Equipment Replacement	2036*	2	$ 653,000	$ -	$ -	$ -	$ -	$ 653,000
	WW-P-92	Electrical / Instrumentation	Small Equipment Replacement - Cogen		Small Equipment Replacement	2026*	3	$ 2,233,000	$ -	$ -	$ 744,333	$ 1,488,667	$ -
	WW-P-60	Building	Rehab Grit Screening Building - Seismic Retrofit		R&R	2027*	2	$ 1,866,000	$ -	$ -	$ -	$ 1,866,000	$ -
	WW-P-65	Building	Plant Paving Resurfacing		R&R	2030*	3	$ 410,000	$ -	$ -	$ -	$ 410,000	$ -
	WW-P-99	Building	Solar or Alternative Energy Facility		Resource Sustainability	2027*	10	$ 1,540,000	$ -	$ -	$ -	$ 924,000	$ 616,000
	WW-P-100		Seawall		Resource Sustainability	2033	5	$ 37,260,000		$ -	$ -	$ -	$ 37,260,000
Wastewater Treatment Total								$ 406,100,998	$ 6,715,000	$ 55,294,998	$ 239,811,000	$ 57,796,067	$ 46,483,933
Wastewater Treatment System and Collection System Total								$ 493,033,331	$ 8,405,000	$ 68,425,064	$ 244,311,000	$ 58,908,334	$ 112,983,933

Notes:
(1) 2017 Project ID's were arbitrarily assigned for Project ease. C = Collection system project; T = Treatment system project
(2) Projects and costs correspond to refinements and updates provided by City after Dec. 2015 publication date. Costs may not correspond to project costs in PM 1.4 Basis of Cost.
(3) Projects approved by Council in 2017 Cost of Service/Rate studies

2017 Project ID[1]	2015 Project ID	Unit Operation	Project	Description	Driver	Start Year	Years to Implement	Total Un-escalated Project Cost	Years 1 to 2 (FY 2017/18 - 2018/19)[3]	Years 3 to 5 (FY 2019/20 - 2021/22)[3]	Years 6 to 10 (FY 2022/23 - 2026/27)[4]	Years 11-16 (FY 2027/28 - 2032/33)[4]	Years 17-23 (FY 2033/34 - 2039/40)[4]
(4) Costs were equally split between years to implement.													
* Projects start year correspond to refinements and updates provided by City after Dec. 2015 publication date.													
** Projects start year was adjusted by City at 8/7/17 meeting, based on recent CCT inspection.													

Project ID	Project	Driver	Start Year[1]	Years to Implement	Total	Years 1 to 2 (FY 2017/18 - 2018/19) [2]	Years 3 to 5 (FY 2019/20 - 2021/22) [2]	Years 6 to 10 (FY 2022/23 - 2026/27) [2]	Years 11-16 (FY 2027/28 - 2032/33) [2]	Years 17-23 (FY 2033/34 - 2039/40) [2]
RW-P-1	Recycled Water Retrofits	R&R	2019	6	$ 4,000,000	$0	$2,000,000	$2,000,000	$0	$0
RW-P-2	Phase 1 Advanced Water Purification Facility (AWPF) Improvements (Disinfection conversion, security, A/V upgrade)	R&R	2020	2	$ 1,000,000	$0	$1,000,000	$0	$0	$0
RW-P-3	UV/Advanced Oxidation Process Brine Treatment	Water Supply	2023	3	$ 5,700,000	$0	$0	$5,700,000	$0	$0
RW-P-4	Construct Aquifer Storage and Recovery (ASR) Demonstration Well @ Campus Park Site (and associated monitoring wells)	Water Supply	2018	3	$ 4,400,000	$1,466,667	$2,933,333	$0	$0	$0
RW-P-5	Land Acquisition and Improvements - Near Blending Station 1/6 & 3	Water Supply	2020	2	$ 10,000,000	$0	$10,000,000	$0	$0	$0
RW-P-6	Recycled Water Pond for Off-Spec Water at Campus Park	Water Supply	2021	1.5	$ 1,600,000	$0	$1,066,667	$533,333	$0	$0
RW-P-7	Phase 2 - Expansion of AWPF to 12.5 mgd (including backup power)	Water Supply	2020	3	$ 27,500,000	$0	$18,333,333	$9,166,667	$0	$0
RW-P-8	Recycled Water Storage @ AWPF	Water Supply	2019	4	$ 8,000,000	$0	$6,000,000	$2,000,000	$0	$0
RW-P-9	Construct 1 duty + 1 standby ASR Wells @ Campus Park	Water Supply	2021	3	$ 7,800,000	$0	$2,600,000	$5,200,000	$0	$0
RW-P-10	Construct 1 duty + 1 standby ASR Wells @ Campus Park	Water Supply	2025	3	$ 7,800,000	$0	$0	$5,200,000	$2,600,000	$0
RW-P-11	Construct 1 duty + 1 standby ASR Wells @ Blending Station 1/6	Water Supply	2022	2	$ 7,800,000	$0	$0	$7,800,000	$0	$0
RW-P-12	Chemical Feed Expansion @ Blending Station 1/6	Water Supply	2022	2	$ 300,000	$0	$0	$300,000	$0	$0
RW-P-13	Operational Storage for ASR Wells @ Blending Station 1/6	Water Supply	2022	2	$ 2,100,000	$0	$0	$2,100,000	$0	$0
RW-P-14	Booster Pumping for ASR @ Blending Station 1/6	Water Supply	2022	2	$ 7,200,000	$0	$0	$7,200,000	$0	$0
RW-P-15	Construct 1 duty + 1 standby ASR Wells @ Blending Station 1/6	Water Supply	2024	1.5	$ 7,800,000	$0	$0	$7,800,000	$0	$0
RW-P-16	Rehabilitate Well 18 @ River Ridge Golf Course to Groundwater Recharge Well	Water Supply	2022	2	$ 2,500,000	$0	$0	$2,500,000	$0	$0
RW-P-17	Phase 3 - Expand AWPF to 18.75 mgd	Water Supply	2029	2.5	$ 28,100,000	$0	$0	$0	$28,100,000	$0
RW-P-18	Construct 2 duty + 1 standby ASR Wells @ Blending Station 1/6	Water Supply	2029	2	$ 11,500,000	$0	$0	$0	$11,500,000	$0
RW-P-19	Construct 2 duty + 1 standby ASR Wells @ Blending Station 3	Water Supply	2029	2.5	$ 11,500,000	$0	$0	$0	$11,500,000	$0
RW-P-20	Chemical Feed Expansion @ Blending Station 3	Water Supply	2029	2.5	$ 500,000	$0	$0	$0	$500,000	$0
RW-P-21	Operational Storage for ASR Wells @ Blending Station 3	Water Supply	2029	2.5	$ 2,100,000	$0	$0	$0	$2,100,000	$0
RW-P-22	Booster Pumping for ASR @ Blending Station 3	Water Supply	2029	2.5	$ 7,200,000	$0	$0	$0	$7,200,000	$0
RW-P-23	Construct 2 duty + 1 standby ASR Wells @ Blending Station 3	Water Supply	2031	1.5	$ 11,500,000	$0	$0	$0	$11,500,000	$0
RW-P-24	Connect Initial ASR Well at Campus Park to Recycled Water Backbone Line in Ventura Road - 2,000 feet of 20" pipe	Water Supply	2017	2	$ 700,000	$700,000	$0	$0	$0	$0
RW-P-25	Construct Dedicated Indirect Potable Reuse (IPR) Pipeline from Campus Park to Blending Station 1/6 - 4,000 feet of 24" pipe	Water Supply	2017	2	$ 2,500,000	$2,500,000	$0	$0	$0	$0
	Hueneme Road - Phase 2 Recycled Water Pipeline Expansion to Ag Users					$0	$0	$0	$0	$0
RW-P-26	Install 20,700 feet of 24" pipe	Water Supply	2019	2	$ 12,900,000	$0	$12,900,000	$0	$0	$0
RW-P-27	Install 16,000 feet of 36" pipe	Water Supply	2018	2	$ 13,000,000	$6,500,000	$6,500,000	$0	$0	$0
	Recycled Water Loop to ASR Sites					$0	$0	$0	$0	$0
RW-P-28	Install 9,000 feet of 24" pipe	Water Supply	2020	2	$ 7,500,000	$0	$7,500,000	$0	$0	$0
RW-P-29	Install 19,700 feet of 30" pipe	Water Supply	2020	2	$ 10,200,000	$0	$10,200,000	$0	$0	$0
RW-P-30	Direct Potable Reuse - 3, 3.1 million gallon Storage Tanks	Water Supply	2036	3	$ 22,200,000	$0	$0	$0	$0	$22,200,000
RW-P-31	Recycled Water Loop to Blending Station 3 Connection – Install 10,600 feet of 24" pipe	Water Supply	2029	1	$ 5,500,000	$0	$0	$0	$5,500,000	$0
	Recycled Water CIP Projects Total				**$ 252,400,000**	$11,166,667	$81,033,333	$57,500,000	$80,500,000	$22,200,000

Notes:

(1) Project start years adjusted with City input and do not correspond to Dec. 2015 publication start years.

(2) Costs were equally split between years to implement.

Project ID	Project	Driver	Start Year	Years to Implement	Total	Years 1 to 2 (FY 2017/18 - 2018/19)(1)	Years 3 to 5 (FY 2019/20 - 2021/22)(1)	Years 6 to 10 (FY 2022/23 - 2026/27)(1)	Years 11-16 (FY 2027/28 - 2032/33)(1)	Years 17-23 (FY 2033/34 - 2039/40)(1)
SW-P-1	Drainage Basin: WV - Length 444 ft	Capacity	2020(2)	2	$ 173,000	$0	$173,000	$0	$0	$0
SW-P-2	Drainage Basin: WV - Length 748 ft	Capacity	2038	2	$ 439,000	$0	$0	$0	$0	$439,000
SW-P-3	Drainage Basin: OI - Length 607 ft	Capacity	2020(2)	2	$ 237,000	$0	$237,000	$0	$0	$0
SW-P-4	Drainage Basin: RR - Length 2,436 ft	Capacity	2020(3)	2	$ 2,621,000	$0	$2,621,000	$0	$0	$0
SW-P-5	Drainage Basin: OI - Length 2,388 ft	Capacity	2038	2	$ 1,491,000	$0	$0	$0	$0	$1,491,000
SW-P-6	Drainage Basin: VR - Length 5,872 ft	Capacity	2018(2)	2	$ 5,768,000	$2,884,000	$2,884,000	$0	$0	$0
SW-P-7	Drainage Basin: JS - Length 1,421 ft	Capacity	2018(2)	2	$ 968,000	$484,000	$484,000	$0	$0	$0
SW-P-8	Drainage Basin: JS - Length 1,292 ft	Capacity	2020(2)	2	$ 885,000	$0	$885,000	$0	$0	$0
SW-P-9	Drainage Basin: JS - Length 426 ft	Capacity	2020(2)	2	$ 292,000	$0	$292,000	$0	$0	$0
SW-P-10	Drainage Basin: JS - Length 457 ft	Capacity	2020(2)	2	$ 313,000	$0	$313,000	$0	$0	$0
SW-P-11	Drainage Basin: JS - Length 655 ft	Capacity	2020(2)	2	$ 449,000	$0	$449,000	$0	$0	$0
SW-P-12	Drainage Basin: JS - Length 701 ft	Capacity	2020(2)	2	$ 480,000	$0	$480,000	$0	$0	$0
SW-P-13	Drainage Basin: HS - Length 1,552 ft	Capacity	2020(2)	2	$ 606,000	$0	$606,000	$0	$0	$0
SW-P-14	22 assets identified in the condition assessment	R&R	2018(2)	2	$ 3,324,000	$1,662,000	$1,662,000	$0	$0	$0
SW-P-15	Dry Weather Diversion Structure	Resource Sustainability	2021	3	$ 370,000	$0	$123,333	$246,667	$0	$0
SW-P-16	City-Wide Incentive Program	Resource Sustainability	2021	10	$ 2,420,000	$0	$242,000	$1,210,000	$968,000	$0
SW-P-17	Santa Clara River Total Maximum Daily Load (TMDL) Infiltration Basin	Resource Sustainability	2023	5	$ 1,850,000	$0	$0	$1,480,000	$370,000	$0
SW-P-18	Mandalay Beach Areas	Capacity	2018	3	$ 10,000,000	$3,333,333	$6,666,667	$0	$0	$0
	Storm Water CIP Projects Total				**$ 32,686,000**	**$8,363,333**	**$18,118,000**	**$2,936,667**	**$1,338,000**	**$1,930,000**

(1) Costs were equally split between years to implement.
(2) Project start year moved two years later compared to 2015 CIP.
(3) Project start year adjusted with City input and do not correspond to Dec. 2015 publication start

CITY OF
OXNARD
CALIFORNIA

DECEMBER 2018

Engineering Report

Groundwater Replenishment Reuse Project

VOLUME 1 OF 2

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City of Oxnard

ENGINEERING REPORT

GROUNDWATER REPLENISHMENT REUSE PROJECT

December 2018

Contents

Appendices

Tables

Figures

Abbreviations

-A-	
ASR	Aquifer Storage and Recovery
AWPF	Advanced Water Purification Facility
-B-	
bgs	below ground surface
BOD	Biological Oxygen Demand
-C-	
CEC	Constituents of Emerging Concern
CEQA	California Environmental Quality Act
City	The City of Oxnard
CIUs	Categorical Industrial Users
CMWD	Calleguas Municipal Water District
CWC	California Water Code
-D-	
DDW	Division of Drinking Water
DIT	Direct Integrity Test
-E-	
EC	Electrical Conductivity
EDCs	Endocrine Disrupting Compounds
ELAP	Environmental Laboratory Accreditation Program
-F-	
FCGMA	Fox Canyon Groundwater Management Authority
-G-	
GRPs	Groundwater Recharge Projects
GRRP	Groundwater Replenishment Reuse Project
GWRS	Groundwater Replenishment System
-H-	
H_2O_2	Hydrogen Peroxide
-I-	
IPR	Indirect Potable Reuse
-L-	
LARWQCB	Los Angeles RWQCB
LAS	Lower Aquifer System
LASAN	LA Sanitation
LPHO	Low-Pressure High-Output
-M-	

MCLs	Maximum Contaminant Levels
MDL	Method Detection Limit
MF	Microfiltration
MRP	Monitoring and Reporting Program
MWDSC	Metropolitan Water District of Southern California
-N-	
ND	Non-Detected
NLs	Notification Levels
NOV	Notice of Violation
NWRI	National Water Research Institute
-O-	
OMMP	Operations, Maintenance, and Monitoring Plan
OOP	Operations Optimization Plan
ORP	Oxidation Reduction Potential
OVMWD	Ocean View Municipal Water District
OWTP	Oxnard Wastewater Treatment Plant
-P-	
PDT	Pressure Decay Test
PEIR	Program Environmental Impact Report
PHWA	Port Hueneme Water Authority
POTW	Publicly-Owned Treatment Works
PPCP(s)	Pharmaceuticals and Personal Care Products
-Q-	
QAPP	Quality Assurance Project Plan
-R-	
RO	Reverse Osmosis
ROP	RO Permeate
ROSA	Reverse Osmosis System Analysis
ROWD	Report of Waste Discharge
RRT	Response Retention Time
RWC	Recycled Water Contribution
RWQCB	Regional Water Quality Control Board
-S-	
SCVWD	Santa Clara Valley Water District
SIU(s)	Significant Industrial User(s)
SNMP(s)	Salt Nutrient Management Plan(s)
SWP	State Water Project
SWRCB	State Water Resources Control Board

-T-	
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TSP-SC	Technical Services Program – Source Control
TTO	Total Toxic Organics
-U-	
UAS	Upper Aquifer System
UV AOP	Ultraviolet Light and Hydrogen Peroxide
UVT	UV Transmittance
UWCD	United Water Conservation District's
-W-	
WDR(s)	Waste Discharge Requirement(s)
WRD	Water Replenishment District
WRR	Water Recycling Requirement

EXECUTIVE SUMMARY

Notes regarding revisions of prior versions of this report

This version of the Engineering Report reflects comments received from the State Water Resources Control Board Division of Drinking Water as follows:

- From letters dated December 5, 2016 and February 17, 2017. The letters were prepared in response to an October (2016) draft of this Engineering Report
- From a meeting in person in San Diego on December 22, 2017. The in-person meeting was held to clarify the UV advanced oxidation performance and recommended monitoring approach
- From a phone meeting dated May 29, 2018. The phone meeting was conducted to provide DDW a better understanding of ASR well operation.

This version of the report also reflects comments received from the State Water Resources Control Board Division of Drinking water, letter dated April 21, 2016. That letter was prepared in response to an October (2015) draft of this Engineering Report.

Included in this submittal are the results from extensive startup testing on the AWPF, demonstrating water quality in accordance with regulatory objectives, with the results presented within this report. Last, no public comments were submitted regarding this Engineer's Report, though substantial opportunity and time was provided for such public comments.

Section 1

PROJECT OVERVIEW

The City of Oxnard (City) owns and operates a regional publicly-owned treatment works (POTW) that serves the City, City of Port Hueneme, Naval Base Ventura County and several surrounding unincorporated communities. It is comprised of the Oxnard Wastewater Treatment Plant (OWTP) and its associated wastewater collection system and outfall line. The OWTP is a secondary treatment facility with a design flow of 31.7 million gallons per day (mgd) and an average daily flow of 20 to 22 mgd.

The City's Advanced Water Purification Facility (AWPF) can divert 8 to 9 mgd of biologically-treated secondary effluent for purification using three advanced treatment steps: microfiltration (MF), reverse osmosis (RO), and advanced oxidation with ultraviolet light and hydrogen peroxide (UV AOP). Because of reject streams, the 8 to 9 mgd of influent flow to the AWPF results in 6.25 mgd of advanced treated recycled water. For such an operation, the MF reject and backwash wastewater produced at the AWPF will be returned to the OWTP headworks. The RO concentrate waste produced at the AWPF will be commingled with the OWTP secondary treated effluent and discharged to the Pacific Ocean via an ocean outfall pipeline.

This Engineering Report is submitted to the State Water Resources Control Board Division of Drinking Water (DDW) for review and approval. This Report is intended to provide the necessary information to permit indirect potable reuse (IPR) of up to 6.25 mgd of purified AWPF-treated product water. For the complete use of 6.25 mgd of new water, there will be a number of aquifer storage and recovery (ASR) wells needed for implementation. The initial injection project is for a portion of the 6.25 mgd of water (2,000 gpm = 2.9 mgd), referred to as Phase 1[1]. Phase 1 will be IPR through Aquifer Storage and Recovery (ASR) with a well (and future wells) screened in the Lower Aquifer System (LAS). All subsequent phases are also anticipated to be ASR with water injected into the LAS. For Phase 1, the City plans to inject the AWPF-treated recycled water into specific wells at the Campus Park location (at the corner of 5th and H Street in Oxnard), keep the water underground for a set period of time, then extract the water (from the same wells into which the water was injected) for potable and non-potable use.

This Engineer's Report focuses upon, and requests approval for, the ability to purify and use 6.25 mgd of new water for groundwater recharge, with initial injection of up to 2.9 mgd and expandable to the full plant capacity in the future. Table 1.1 summarizes the groundwater recharge and ASR wells identified in the Public Works Integrated Master Plan (PWIMP) for Phases 1, 2, and 3.

Table 1.1 Planned GRRP Wells

Project ID (from the PWIMP)	Project Phase	Well Type	No of Wells	Well Location[1]	Planned Implementation Year
RW-P-4	1	ASR Demonstration Well (Phase 1 well)	1	Campus Park	2018
RW-P-9	2	ASR Well	1 duty + 1 Standby	Campus Park	2021
RW-P-10	2	ASR Well	1 duty + 1 Standby	Campus Park	2025
RW-P-11	2	ASR Well	1 duty + 1 Standby	Blending Station 1/6	2022
RW-P-15	2	ASR Well	1 duty + 1 Standby	Blending Station 1/6	2024
RW-P-16	2	Recharge Well (rehab & convert existing City Well 18)	1	River Ridge Golf Course	2022
RW-P-18	3	ASR Well	2 Duty + 1 Standby	Blending Station 1/6	2029
RW-P-19	3	ASR Well	2 Duty + 1 Standby	Blending Station 3	2029
RW-P-23	3	ASR Well	2 Duty + 1 Standby	Blending Station 3	2031

Notes:
(1) Well locations include the required associated monitoring wells.

[1] It is worth noting that for an ASR operation with one well at 2,000 gpm, the amount of recharged water with one well in operation is less than 2,000 gpm averaged over a year. For example, if water is recharged for 4 months, then held for 4 months, then extracted for 4 months, only 667 gpm is recharged on an annual basis. Hence, the future need for a number of additional wells.

1.1 Water in Oxnard

The City's current water supply comes from surface and groundwater sources. Fifty percent of the City's water supply is from northern California rainfall and snowmelt pumped through the Sacramento–San Joaquin Delta and imported to southern California via the State Water Project (SWP). This water is delivered by the Calleguas Municipal Water District (CMWD). Twenty-five percent of the City's water is regional groundwater supplied by the United Water Conservation District's (UWCD) spreading and pumping operations on the Santa Clara River and Oxnard Plain. Local, City owned and operated wells account for the remaining twenty-five percent of the City's water.

1.1.1 CMWD

The City receives SWP water from CMWD's Springville Reservoir (supplied by Metropolitan Water District of Southern California [MWDSC]) through the City's Oxnard and Del Norte conduits that feed five of the City's six water blending stations. Existing agreements between the City and CMWD do not guarantee the quantity of water the City may purchase. The City has a current MWDSC Tier 1 entitlement. Tier 1 water corresponds to the amount "contracted for" by the City. It is in essence a capacity reservation and includes the water being delivered to the Port Hueneme Water Authority (PHWA). MWDSC Tier 2 water is normally available to the City; however, the cost per acre-foot is higher. There is less availability and reliability of Tier 2 water in periods of drought.

1.1.2 Fox Canyon Groundwater Management Authority (FCGMA)

The FCGMA was created at the direction of the State Water Resources Control Board (SWRCB) to address ongoing overdraft and seawater intrusion into the Oxnard Plain Pressure Basin. The purpose of the FCGMA is to manage the region's groundwater supply by protecting the quantity and quality of local groundwater resources and by balancing the supply and demand for groundwater resources.

The FCGMA governs all extractions from the groundwater basin and, thus, the City's use of UWCD water and its own local wells is governed by the "safe yield" extraction volumes set by FCGMA.

In 2016, the FCGMA issued a permit for the installation of the proposed Campus Park ASR well (letter dated June 24, 2016).

1.1.3 UWCD

UWCD currently provides a portion of the City's groundwater supply. This arrangement has been in place since 1954, and was formalized in the 1996 Water Supply Agreement for Delivery of Water through the O-H Pipeline. UWCD holds a pumping sub-allocation for all users of the O-H Pipeline, which includes the City, PHWA, and a number of small mutual water companies.

1.1.4 2002 Three-Party Agreement

The City, CMWD, and PHWA entered into a Three-Party Agreement in 2002, which provides PHWA with CMWD water through Oxnard's O-H pipeline. The City also supplied water to the Ocean View Municipal Water District (OVMWD) until 2008, when the OVMWD was dissolved and has since been managed and operated by the City. The OVMWD's distribution system is now referred to as the Ocean View System and the demand of the Ocean View customers is accounted for as part of the City's total demand, with much of the demand categorized as agricultural water use.

The City does not sell water to any other agencies. However, with the completion of Blending Station Number 6 in 2011, the City can provide desalted groundwater to PHWA in the case that PHWA's O-H pipeline supply becomes temporarily unavailable.

1.1.5 Recycled Water Management and Use Agreement

Agreement No. A-7651, Full Advanced Treatment Recycled Water Management and Use Agreement was entered into on January 13, 2014 by the City of Oxnard, Pleasant Valley County Water District, Houweling Nurseries Oxnard Incorporated, Southland Sod, Reiter Brothers Incorporated, Southern Pacific Farming Incorporated, and Southern Pacific Farming II, LLC. United Water Conservation District entered into the Agreement on August 18, 2016 by their separate signatory page. They are collectively referred to as the Parties. In recognition of the need to protect, conserve, and replenish the underground water supplies of the region, the Parties desire to enter into this Agreement providing for the delivery of advanced treated recycled water to the Parties and other future customers located within the groundwater sub-basins in Ventura County, commonly known as the Oxnard Plain, Forebay, and Pleasant Valley.

1.2 GREAT Program

To ensure a future reliable and affordable supply of high-quality water, the City has developed the Groundwater Recharge Enhancement and Treatment or GREAT program to be implemented and operated in two phases. Phase 1 (6.25 mgd, or 7,000 AFY) treatment facilities are now in operation for non-potable water reuse, whereas additional treatment will be constructed in the near future to 12.5 mgd, with a future final capacity of 18.75 mgd. The objectives of the GREAT program are as follows:

- Increased reliability of water supply.
- Reduced cost of water supply.
- Improved dependability of water supply in accommodating existing needs and meeting planned growth and associated water demand.
- Enhanced stewardship of local water supply through recycling and reusing a substantial portion of the region's wastewater.

The GREAT program includes treating effluent from the OWTP and providing state-of-the-art MF, RO, and advanced oxidation with UV/H_2O_2 at the AWPF, schematically shown in Figure 1.1.

Elements of the GREAT program are summarized as follows:

- Recycled Water Delivery System - Distributes recycled water to agricultural users, golf courses, and an industrial customer.
- Aquifer Storage and Recovery - Intended to help alleviate groundwater overdraft conditions and associated water quality problems, including coastal seawater intrusion. Will allow seasonal storage of potable water supplies to maximize use of the existing potable water distribution system.

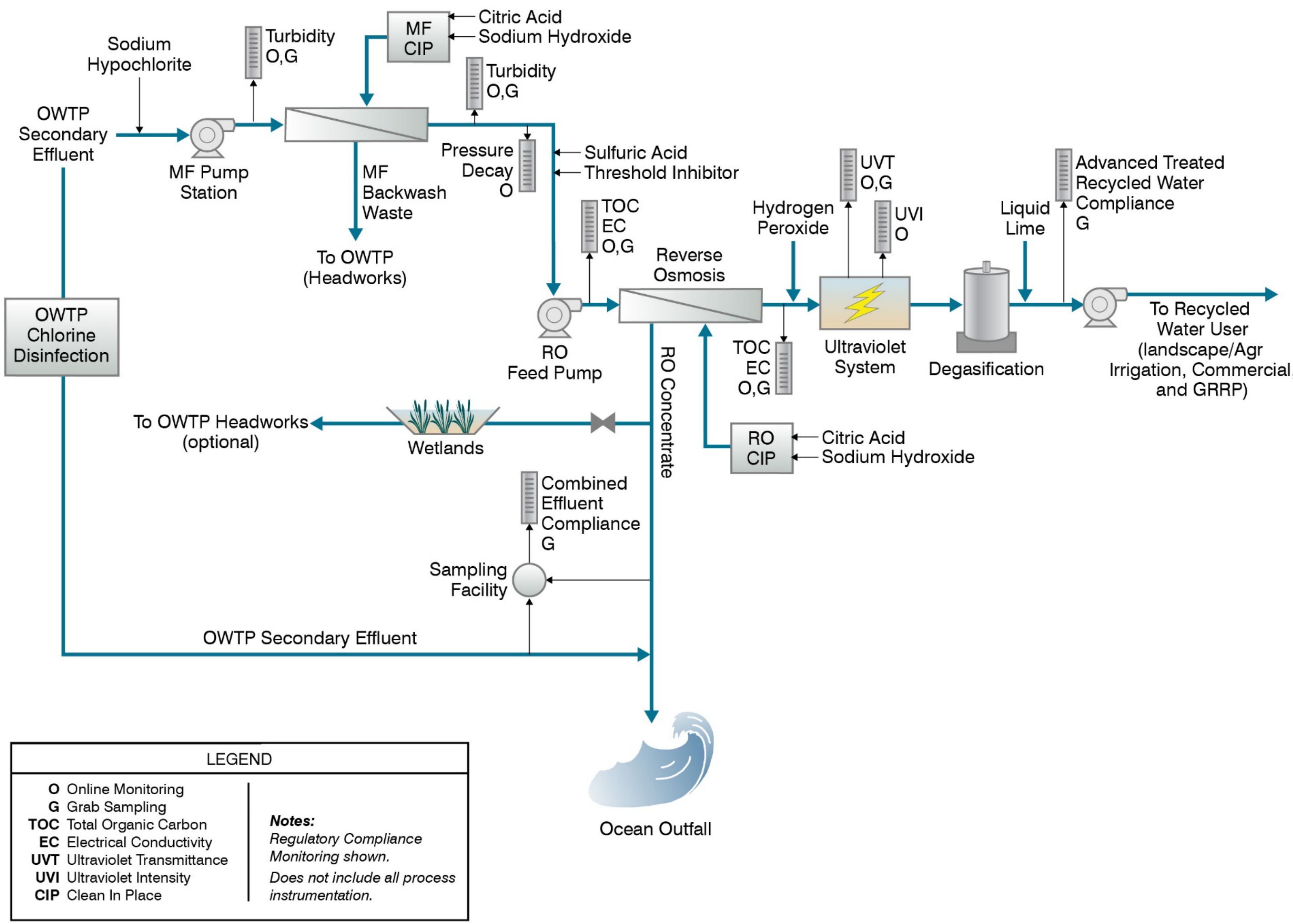

Figure 1.1 AWPF Process Schematic

- Regional Desalter - Membrane filter systems to remove dissolved minerals from groundwater, in order to reduce the levels of nitrates and total dissolved solids (TDS) in the groundwater basin.
- Blending Station No. 5 - Provides improved water supply infrastructure reliability, water quality, and hydraulic efficiencies. It also assists in meeting peak-hour and fire-flow water supply demands.
- Concentrate collection system from regional brine dischargers - Avoid discharge of high-salinity concentrate into City sanitary sewer system and Oxnard WWTP.
- Permeate Delivery System - Permeate delivery from regional desalter to industrial users.

All of the end uses (agricultural irrigation, landscape irrigation, injection into the aquifer, and industrial) will be served with a common water quality that meets the groundwater recharge (groundwater recharge) criteria for injection of purified recycled water. In exchange for the delivery of recycled water, agricultural customers would transfer their groundwater pumping allocations to the City on a one-for-one basis. The additional pumping by the City would be from the poor-quality Oxnard Aquifer, which would require additional treatment prior to delivery to the City's distribution system. The GREAT desalter constructed in 2007/2008 would provide this treatment. It does not increase the total water supply. It does, however, allow full use of the City's groundwater resources.

1.2.1 Project Site

The project site is Oxnard, California. The location of the AWPF and the Initial ASR location are shown in Figure 1.2.

1.2.2 Existing Facilities

The OWTP liquid processes include preliminary treatment, primary clarification, secondary treatment (biofiltration (trickling filters) followed by activated sludge), and chlorine disinfection in order to achieve an acceptable level of water quality for ocean discharge. The solids-handling processes include gravity thickening of primary sludge, dissolved air flotation thickening of secondary sludge, anaerobic digestion, and belt filter press dewatering.

The AWPF is a standard MF/RO/UV AOP system to purify secondary effluent. It includes the following processes: automatic strainers, MF system (detailed below), equalization tank, RO transfer pumps, Cartridge filter, High pressure RO feed pump, Two-stage RO train (detailed below), UV disinfection system (detailed below), Decarbonator, lime stabilization, product water pumps, and chemical storage. The AWPF is located adjacent to the OWTP (Figure 1.3).

The three primary advanced treatment processes (MF, RO, and UV AOP) are designed to meet DDW performance criteria for indirect potable water reuse. A summary of each process is provided in Table 1.2.

Figure 1.2 Project Location

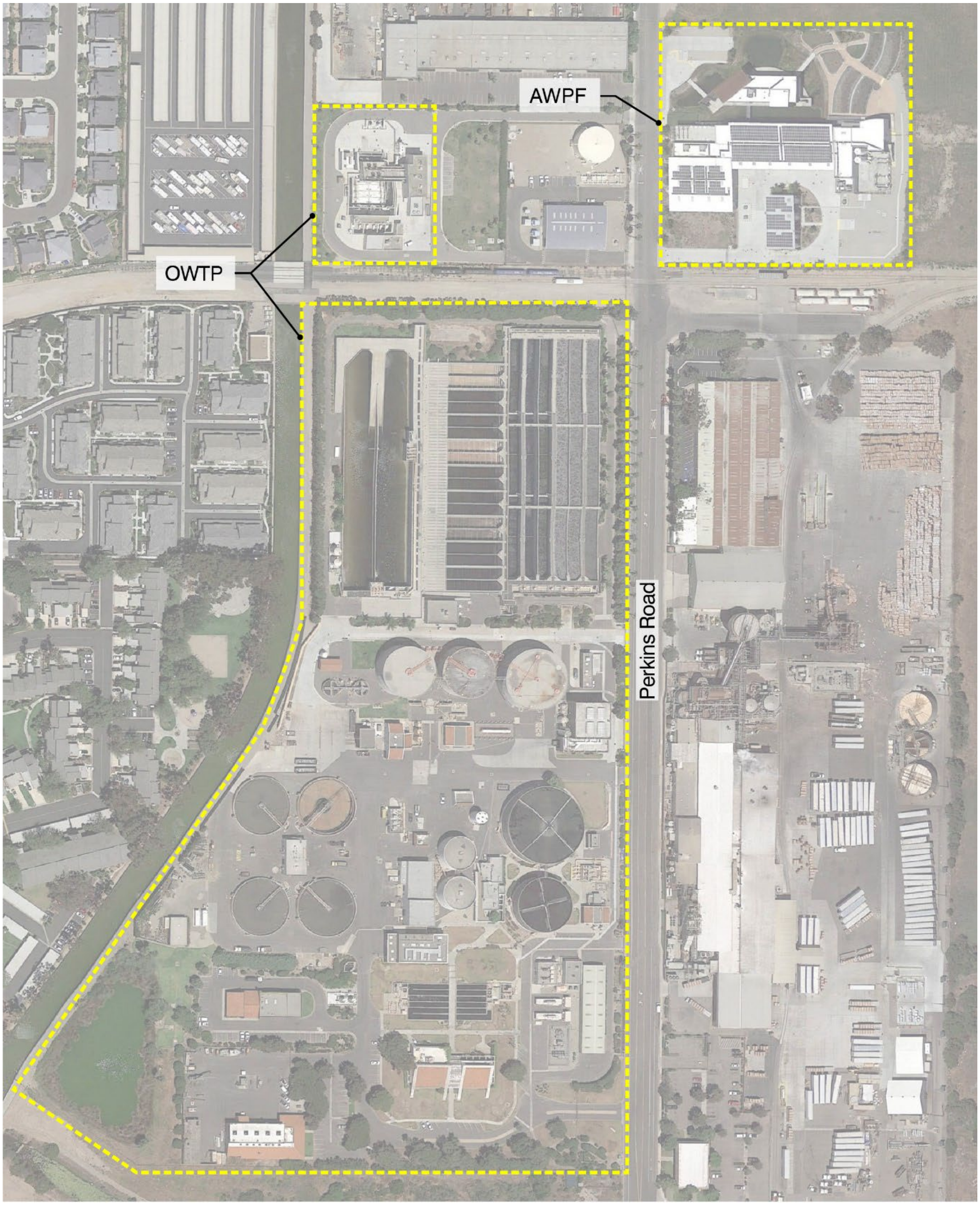

Figure 1.3 OWTP and AWPF

Table 1.2 Advanced Treatment Design Criteria

Process	Performance Goal	Performance Monitoring
MF	Filtrate Nephelometric Turbidity Unit (NTU)<0.2 NTU.	Maintaining turbidity values of <0.2 NTU indicates no gross membrane failure. However, insufficient research exists to correlate MF filtrate turbidity with pathogen removal.
	Pressure Decay Test (PDT, also called membrane integrity test (MIT)) <0.3 pounds per square inch per 5 minutes (psi/5min).	Daily testing demonstrates MF integrity, allowing for 4-log protozoa credit.
RO	Each membrane element must achieve ≥99% rejection of sodium chloride, and average rejection of ≥ 99.2% sodium chloride.	Track and trend electrical conductivity (EC) reduction through the RO membrane. Pathogen reduction credits for RO based upon this measured value.
	RO permeate must have a total organic carbon (TOC) ≤ 0.25 mg/L greater than 95% of the time at startup and through 20 weeks of operation. Subsequently, RO permeate TOC must be ≤0.5 mg/L.	No online TOC metering is currently installed, but online TOC metering will be installed prior to IPR operation. It remains to be determined TOC will be installed just after RO, or before and after RO.
UV AOP	≥0.5-log reduction of 1,4-dioxane; at least one continuously monitored surrogate or operational parameter shall be established to reflect that the minimum 1,4-dioxane criterion is being met.	Startup testing documents 1,4-dioxane removal and correlates such removal with an online surrogate (UVI/Q).
	6-log reduction of adenovirus.	UVI/Q values correlate with N-Nitrosodimethylamine (NDMA) destruction, which maintains continuous documentation of a UV dose well in excess of 235 mJ/cm^2; which is the dose for 6-log adenovirus. This minimum dose will be maintained at all times.

1.2.2.1 MF System

The MF system (Figure 1.4) is an outside-in MF system (PALL Microza) and consists of MF feed strainers, MF feed water ORP, pH, turbidity, and total chlorine residual analyzers. The MF is used to remove particulate and microbial contaminants, including turbidity, *Giardia*, and *Cryptosporidium* using a low-pressure filtration system. Upstream of RO, this system mitigates RO membrane fouling by reducing the level of particulates and larger colloids. MF also reduces the concentration of bacteria – particularly those that are particulate-associated. There are six treatment trains in parallel in the MF room with capacity for an additional six trains to be built if needed. One of the six trains can be out of service and the MF system will still maintain production of sufficient flow to result in 6.25 mgd of RO permeate.

Figure 1.4 MF Photos at the AWPF

1.2.2.2 RO System

RO units are furnished by H2O Innovation (Figure 1.5), and installed with Hydranautics ESPA2 membrane elements. The RO units are housed in their own room, with two identical skids running in parallel with individual production capacities of 3.125 mgd. Space for three additional RO skids of 6.25 mgd each is built into the room in for possible future needs. The RO system is monitored using online EC at the MF filtrate (RO feed) and several places on the RO. discharge; Stage 1, 2, and 3, total flow, and concentrate. These EC locations are at both trains. Currently there is no online TOC metering of this MF filtrate or RO permeate, though the City intends to install TOC monitors on the RO feed and RO permeate prior to operation.

1.2.2.3 UVOX System

Three Trojan UVPhox D72AL75 reactors are installed to provide additional treatment of the RO permeate (ROP) via AOP. These reactors operate with low-pressure high-output (LPHO) lamps and with dosed hydrogen peroxide (H_2O_2); based upon a target EEO sufficient for 0.5 log reduction of 1,4-dioxane. Startup testing, documented further on, demonstrates the dose capacity of this system and effective monitoring using a UVI/Q process. These three reactors each have two banks, for a total of six banks of UV lamps. Five of those banks are duty, and the sixth bank is redundant. Similar to the MF and RO systems, there is room to expand this UV system to meet future needs (Figure 1.6).

1.3 Public Outreach and Coordination Effort

The City has gone through the required notification processes for this project with the public and stakeholders.

Figure 1.5 RO Photos at the AWPF

Figure 1.6 Photo of Similar UV Phox

1.3.1 Stakeholders

Key regional stakeholders are aware of this IPR project. These stakeholders include the CMWD, the UWCD, the FCGMA, and the City of Ventura. CMWD, UWCD, and FCGMA are directly involved in water supply to the City. Other regional stakeholders include various regulatory and governmental bodies, and several environmental organizations. The Program Environmental Impact Report (PEIR), completed in 2004, included the required public notice and engagement regarding the various aspects of the GREAT program, including potable reuse (CH2MHill, 2004).

Once this Engineer's Report is approved by DDW and the Regional Water Quality Control Board (RWQCB), the City will further engage with project stakeholders.

1.3.2 System Startup Information

As outlined in subsequent sections of this Engineer's Report, extensive testing of the purification system has been completed to demonstrate compliance with DDW's groundwater recharge regulations. This testing was done during the normal operation of the GREAT system for non-potable reuse applications. These tests are detailed in the following Chapter 17.

After the construction of the proposed IPR ASR well, a series of tests will be done on the background groundwater quality. This information, once it is thoroughly reviewed, will be presented to the various stakeholders and for regulatory review.

1.3.3 Public Hearing and Notifications

The City has followed the public hearing requirements specified in the DDW groundwater recharge regulations (SWRCB, 2018a). Section 60320.202 includes a review of the necessary public and regulatory notice requirements of the proposed project. The City has completed the public hearing process, as follows:

- The technical aspects of the Engineer's Report have been reviewed and conceptually approved by DDW. Subsequent to that review, the City posted the Engineer's Report on its website and made it available at the City's office for at least 30-days prior to a public hearing. The report was posted on 12/21/2017.
- The City provided DDW and the RWQCB the information it intended to present at the public hearing regarding this IPR project in advance of the public hearing. Feedback from DDW and the RWQCB was obtained and used to modify the presentation material.
- The City notified the public about the availability of the information and the public hearing on May 17, 2018. The posting was done on the City's website and in the town newspaper. The posting included what the project was, where the Draft Engineering Report could be found, information on the Public Hearing, and how to provide comments to the City.
- The City held a public hearing regarding this project on 6/14/2018, six months after posting the Draft Engineer's Report on their City website. Presentations were made by the City, by Carollo Engineers, Inc., and by DDW. The RWQCB was invited by declined to attend due to other commitments.
- The City allowed 60 days of public comment on the presentation. Ending on 8/15/2018. The City received no public comments.
- As required, the City has notified the first downgradient potable water well owner and well, which happens to be the City of Oxnard.
- Further outreach will also occur once the draft tentative permit is issued. In accordance with California Water Code (CWC) Section 13167.5, the Los Angeles RWQCB (LARWQCB) must

provide notice and a period of at least 30 days for public comment prior to adoption of a Waste Discharge Requirement (WDR) and/or Water Recycling Requirement (WRR). This is accomplished by providing a draft of the amendment to anyone who has requested a copy or by posting the draft on the LARWQCB website and providing an electronic notice to interested parties. After posting on the consent calendar, the LARWQCB will hold a public hearing that provides opportunity for further public comment.

1.3.4 California Environmental Quality Act (CEQA)

The CEQA compliance is summarized below under the "Environmental Compliance" section.

1.4 Environmental Compliance

The CEQA process for the GREAT treatment facilities has already been completed (CH2MHill, 2004). This process provided an open forum for public comment on the project at the time of that work (2004).

An addendum to that EIR was completed in January of 2015 by Hollee King to address the ASR well and monitoring wells (King, 2015). In a letter dated January 21, 2016, the Governor's Office of Planning and Research State Clearinghouse and Planning Unit issued a letter of compliance to Oxnard for the ASR project, stating "that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act" (State of California, 2016).

1.5 Project Goal

The goal of the GREAT program is to ensure a future reliable and affordable supply of high-quality water. Phase 1 (6.25 mgd, or 7000 AFY) treatment facilities have been constructed and is now producing water for non-potable use. The City has plans to expand the production capability of this facility, and will provide details of this expansion at a future date.

1.6 Purpose of This Report

The purpose of this Title 22 Engineering Report is to provide detailed information on the design of the City's AWPF, describe the water reuse goals for the City, clearly indicate the means for compliance with DDW's groundwater recharge regulations and any other features specified by the RWQCB, and in total, gain approval for the City to implement an IPR groundwater recharge replenishment project (GRRP).

This Engineering Report is in compliance with the State of California Water Recycling Criteria (SWRCB. 2018a) that requires the submission of an Engineer's Report to the RWQCB and DDW prior to any modification to an existing project or implementation of a new project.

Section 2

PROJECT PARTICIPANTS

The City intends to recharge groundwater and extract groundwater from the same location, an ASR project. This operation, under the current plan, will not impact other utilities or entities. With that said, there are a number of key participants outside of the City that have had, and will have, a role in the successful implementation of IPR. The project participants, their role, and their contact information are listed below in Table 2.1.

Table 2.1 List of Key Project Participants

Organization	Name	Contact Information	Project Role
City of Oxnard	Jan Hauser, WW Division Manager	Desk: 805-271-2205 Cell: 805-844-5501 jan.hauser@oxnard.org	Responsible for Daily Production of Advanced treated recycled water and Operation of the IPR System.
City of Oxnard	Thien Ng, Assistant Public Works Director	(805) 432-3575 Thien.Ng@oxnard.ca.us	Oversee water and wastewater divisions.
City of Oxnard	Hoon Hahn, Project Manager	Hoon.hahn@oxnard.org	Assistant project manager for this potable reuse project
RWQCB	Elizabeth Erickson	(213)576-6665 Elizabeth.Erickson@waterboards.ca.gov	Lead RWQCB permitting authority for this project.
DDW	Jeff Densmore, District Engineer	(805)566-1326 Jeff.densmore@waterboards.ca.gov	Lead DDW permitting authority for this project.
DDW	Kurt Souza, Assistant Deputy Director	(805)566-1326 Kurt.souza@waterboards.ca.gov	Regional oversight and perspective on potable reuse.
DDW	Saeed Hafeznezami Water Resource Control Engineer	Saeedreza.Hafeznezami@Waterboards.ca.gov (818)551-2972	Technical specialist
DDW	Brian Bernados	brian.bernados@waterboards.ca.gov (619)525-4497)	Technical specialist
DDW	Randy Barnard, Recycled Water Unit Chief	Randy.Barnard@waterboards.ca.gov (619)525-4022	Project review
CalMWD	Kristine McCaffrey, Manager of Engineering	(805)579-7173	Regional Stakeholder.
UWCD	Tony Emmert, Deputy GM	(805)525-0621 (805)317-8961	Regional Stakeholder.
FCGWMA	Gerhardt Hubner	(805)654-5051	Regional Stakeholder.
City of Ventura	Gina Dorrington, Wastewater Utility Manager	(805)677-4131 gdorrington@venturawater.net	Adjacent City dealing with similar water supply concerns and potable reuse considerations.

Table 2.1 List of Key Project Participants (continued)

Organization	Name	Contact Information	Project Role
Consultant Team			**Project Role**
Carollo Engineers	Tracy Warriner, Project Manager	(925)932-1710 twarriner@carollo.com	Project Manager for Water Reuse Permitting and Implementation, working for the City.
Carollo Engineers	Andrew Salveson, Project Engineer	(925)932-1710 asalveson@carollo.com	Engineer of Record for this Engineer's Report.
Hopkins Groundwater Consultants	Curtis Hopkins, Principal Hydrogeologist	(805)653-5306 chopkins.hgc@sbcglobal.net	Groundwater hydrogeologist of record for this Engineer's Report & Well Monitoring Plan
HLK Planning	Hollee L. King	(805)901- 2261 hollee@hlkplanning.com	CEQA Permitting Lead.
MV Engineering LLC	Mary Vorissis	(805) 217-8494 mary.vorissis@gmail.com	Operations Optimization Plan (OOP) and ROWD report coordination

Section 3

REGULATORY REQUIREMENTS

The overarching regulatory requirements are summarized in this section. The specific parameters for monitoring and permit compliance are documented in Sections 9 and 15.

3.1 California Water Code (CWC)

The CWC stipulates that each RWQCB formulate and adopt Water Quality Control Plans (Basin Plans) for all areas governed by the board. These plans must contain water quality objectives for surface water and groundwater within the regions that provide reasonable protection of the beneficial uses of the waters. During the process of formulating such plans the RWQCBs must consult with and consider recommendations of affected state and local agencies. Such plans shall be periodically reviewed and may be revised (Section 13240).

In accordance with CWC Section 13260, all persons discharging waste within the region must file with the appropriate board, and provide information pertaining to their discharge. Within the region, it is not permitted for a person to construct, maintain, or use any waste well that interferes with a source for domestic water supply without proper permitting or exceptions (CWC Section 13540). "Recycling criteria" are the levels of constituents of recycled water, and means for assurance of reliability under the design concept which will result in recycled water safe from the standpoint of public health, for the uses to be made (CWC Section 13520). Section 13521 of the CWC states that the State Department of Public Health (now DDW) shall establish uniform statewide recycling criteria for each varying type of use of recycled water where the use involves the protection of public health.

Section 13522 stipulates that if a contamination occurs as a result of recycled water, then procedures for abating this contaminant must be followed in accordance with the Health and Safety Code. The use of recycled water must not cause, constitute, or contribute to, any form of contamination. In order to comply with contamination prevention with recycled water use, any person recycling or proposing to recycle water must file for appropriate permitting with the regional board (Section 13522.5).

If a master recycling permit is granted, it must include at a minimum (Section 13523.1): waste discharge requirements(WDRs), a permittee statewide recycling criteria compliance requirement, recycled water producer end user rule enforcement requirement, requirement for a recycled water use quarterly report, periodic facility inspection requirement, and additional requirements given by the regional board in permit. Recycled water may only be used for the permitted purpose, as specified by the regional board (Section 13524).

3.2 DDW Requirements

DDW (formerly CDPH) has developed criteria for both non-potable uses of recycled water and groundwater recharge for subsequent potable use, with the most recent version updated as of October 2018 (SWRCB. 2018a). This Engineering Report deals specifically groundwater recharge for potable reuse.

This project will meet the requirements specified in the Water Recycling Criteria (SWRCB. 2018a). Key items related to groundwater recharge are summarized in Table 3.1, a table that could be set aside for quick reference for the life of the project.

3.3 RWQCB Requirements

The OWTP discharges to the Pacific Ocean under NPDES permit (CA0054097) which was adopted by the RWQCB on October 11, 2018. The City's current discharge of RW from the AWPF is regulated under Water Recycling Requirements and Waste Discharge Requirements (WRR/WDR) Order No. R4-2011-0079, R4-2011-0079-A01, and R4-2011-0079-A02 (WRR/WDRs).

Table 3.1 List of Key Potable Reuse Regulatory Issues and Information for Groundwater Recharge

Issue	Value/Details	Location in This Report
Contact List of Key Personnel	Quick response related to water quality and permit compliance	Section 2, Table 3
Raw Wastewater Source Control for Potable Reuse	Details the industrial discharges, the City's Local Limits program, and the Enhanced Source Control Program for potable water reuse	Section 4 and Appendix A
Pathogen Removal for Potable Reuse	Defines the log reduction of pathogens across all treatment processes, resulting in compliance with the 12/10/10 standard	Section 5
Chemical Pollutant Removal by Advanced Treatment	Summarizes chemical water quality criteria for potable water reuse and the results of performance testing of the installed purification system	Section 5 (pertaining to NDMA and 1,4-dioxane) Section 9
Groundwater Recharge for Aquifer Storage and Recovery	Describes the use of Aquifer Storage and Recovery for recharge and subsequent recovery of purified water. Includes a description of groundwater modeling results.	Section 6
Water Quality Failure Decision Protocol	Details the actions to be taken in the event of a water quality failure	Section 7
Monitoring and Reporting Program	Details the required treatment process and water quality monitoring program for chemical constituents. Includes testing of finished water quality and water quality within the groundwater basin.	Section 15

This potable reuse project will require a reissuance of the WDR/WRR Order No. R4-2008-0083, including the Monitoring and Reporting Program No. 9456. A Report of Waste Discharge (ROWD) is required to initiate the permit application process. That ROWD is submitted under separate cover to the RWQCB (Oxnard, 2018).

The LARWQCB regulates groundwater recharge projects under numerous state laws and regulations, including the Water Quality Control Plan, Los Angeles Region (hereinafter, the Basin Plan) and SWRCB policies. The Basin Plan requirements include groundwater objectives for minerals and drinking water Maximum Contaminant Levels (MCLs). The Basin Plan also applies the state's Anti-degradation Policy, which has been further interpreted pursuant to the 2013 SWRCB Recycled Water Policy (SWRCB, 2013).

3.4 SWRCB Requirements

The SWRCB has two policies related to this proposed IPR project. They are the Anti-Degradation Policy and the Recycled Water Policy. While the full expectation for this IPR project is to improve groundwater quality through the injection of advanced-treated recycled water, the specific provisions of these two policies must be identified and met.

3.4.1 Anti-degradation Policy

Resolution 68-16 is the state's Anti-degradation policy, titled "Statement of Policy with Respect to Maintaining High Water Quality in California." The key components of this Resolution, listed here verbatim, are:

- "Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality water will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies."
- "Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to ensure that (a) pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."

3.4.2 Recycled Water Policy

The Recycled Water Policy was adopted by the SWRCB in 2009 and revised in 2013 (SWRCB, 2013). Relevant components of the Policy include Salt Nutrient Management Plans (SNMPs), Recycled Water Groundwater Recharge Projects (GRPs), anti-degradation, and monitoring constituents of emerging concern (CEC). Each of these is summarized below.

3.4.2.1 SNMPs

This element of the Recycled Water Policy requires SNMPs to be developed for every groundwater basin/sub-basin in California within five years of the Recycled Water Policy adoption (seven years with approved extensions). The objective of the SNMP is to manage salts and nutrients from all sources" on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses." The SNMP includes the following tasks:

- Identify the SNMP work group and develop the SNMP work plan.
- Establish and manage a stakeholder process.
- Summarize/Characterize Water Management and Salt/Nutrient Management Goals and Objectives.
- Characterize Groundwater Basin Geology, Hydrology, and Hydrogeology.
- Summarize Existing Groundwater and Surface Water Monitoring Programs and Water Quality.
- Develop Salt and Nutrient Source Identification.
- Estimate Assimilative Capacity for Each Sub-Basin.

The City of Oxnard developed a preliminary draft SNMP for the Oxnard Plain (inclusive of the Oxnard Forebay) and Pleasant Valley groundwater basins (Carollo, 2016). The preliminary draft was submitted to the LARWQCB and other stakeholders in July 22, 2016 for review and comment. The LARWQCB provided comments (email from Ginachi Amah, September 1, 2016). The United Water Conservation District provided comments regarding including potential use of advanced treated recycled water from the AWPF for recharge at UWCD facilities (personal communication, Dan Detmer UWCD). The City of Oxnard sent a response to comments to the LARWQCB in September 2016. The response to comments included the following request, related to allowing the City of Oxnard to obtain recycled water permits.

> *"The City of Oxnard respectfully requests that the RWQCB accept the Preliminary Draft Oxnard SNMP, as a draft document (with minor changes to accommodate TAG comments), with the understanding that the SNMP process is well underway, and that obtaining recycled water permits for the proposed projects identified in the Preliminary Draft Oxnard SNMP will not be impacted by delaying the development of a Final Oxnard SNMP. The City of Oxnard requests that the Final Oxnard SNMP be delayed to be coincident with the development of the Groundwater Sustainability Plan (GSP). It is envisioned that at that time, the involved stakeholders will determine the need for additional modeling and analysis based on the findings of the GSP."*

The Oxnard SNMP includes all of the required elements in the SNMP evaluation. Critical to the evaluation is the assessment of assimilative capacity and the evaluation of proposed projects.

The SNMP includes evaluation of existing groundwater quality and calculation of area weighted average TDS, chloride, and nitrate concentrations, by basin. Assimilative capacity for each constituent, which is a comparison of the existing groundwater quality with the target groundwater quality, summarized here. Note two things. First, the proposed ASR project is in the Oxnard Plain, which has assimilative capacity for chloride, TDS, and nitrate. Second, the advanced treated recycled water that will be used for groundwater recharge, will result in improved groundwater quality for all conditions.

- Oxnard Plain Excluding Coastal Saline Zone UAS (upper aquifer system)
  - Chloride Assimilative Capacity - YES
  - TDS Assimilative Capacity - YES
  - Nitrate Assimilative Capacity - YES
- Oxnard Plain Excluding Coastal Saline Zone LAS (lower aquifer system)
  - Chloride Assimilative Capacity - YES
  - TDS Assimilative Capacity - YES
  - Nitrate Assimilative Capacity - YES
- Oxnard Forebay
  - Chloride Assimilative Capacity - YES
  - TDS Assimilative Capacity - YES
  - Nitrate Assimilative Capacity - YES
- Pleasant Valley
  - Chloride Assimilative Capacity - YES - LIMITED
  - TDS Assimilative Capacity - NO
  - Nitrate Assimilative Capacity - YES

The City of Oxnard is planning to implement ASR in the Oxnard Plain. The purpose of the proposed ASR projects is to provide potable water supply. It is conservatively assumed that the proposed ASR project(s) would not necessarily lead to a reduction in groundwater pumping (via offsetting use of existing wells) or use of imported water, both of which would have potential groundwater quality benefits. The intent of the ASR project is to inject recycled water into a groundwater aquifer, allow it to remain within the aquifer for a specified retention time, and then extract the water for potable use.

Agricultural irrigation with recycled water from the AWPF may be delivered directly to agricultural areas east of the City of Oxnard and/or delivered to PVCWD. Use of recycled water would likely offset existing water supplies for agricultural irrigation (groundwater or other). Recycled water delivered directly to agricultural areas east of the City of Oxnard would recharge the Oxnard Plain. If recycled water from the AWPF is sold to PVCWD, then it would be comingled with PVCWD existing water supplies and delivered for agricultural irrigation within the PVCWD service area. Recycled water delivered to PVCWD would recharge the Oxnard Plain and the Pleasant Valley Basin.

The AWPF treatment facility will produce purified recycled water and includes MF, RO, and UV AOP. It is anticipated that lime will be added to restore the alkalinity and calcium to the water to minimize the corrosivity of the recycled water. Prior estimates for TDS and chloride of the reverse osmosis permeate was projected as 201 mg/L and 70 mg/L, respectively (Jensen Design and Survey 2015). Approximately 30 m/L of additional TDS was attributed to lime addition. Therefore, the predicted TDS, chloride and nitrate concentrations were 230 mg/L, 70 mg/L, and 0.7 mg/L as N, respectively. More recent numbers for the AWPF reverse osmosis permeate water suggest values of approximately 51 mg/L TDS, 14 mg/L chloride, and 0.11 mg/L as N of nitrate. Accounting for the additional TDS of lime addition, and adding in conservatism (factor of 2) to the estimates, it is assumed for this analysis that the recycled water from the AWPF has 160 mg/L TDS, 30 mg/L chloride, and 0.2 mg/L nitrate as N. The predicted water AWPF recycled water quality is well below the objectives and existing water quality in all systems of all basins within the study area.

As discussed, the City of Oxnard's proposed recycled water projects include potable reuse via ASR. In an ASR configuration, the recycled water is injected into an aquifer and extracted for use after some specified residence time. The purpose of the ASR projects is to provide water to meet increasing demands, and it is conservatively assumed that the water from the ASR project(s) will not offset existing groundwater pumping.

Relative to the time scales that are important in groundwater fate and transport, the residence time in an ASR configuration is relatively short. ASR effectively provides a relatively small and temporary additional load to the basin. There may be localized mixing of the injected water (desalted) and the groundwater aquifer during the residence time in the aquifer. However, any mixing that would occur would provide a diluting effect on existing groundwater, due to the superior quality of the AWPF recycled water as compared to existing groundwater quality. Therefore, if there is any effect of the temporary injection of AWPF water into aquifers in the Oxnard Plain, then it would be a beneficial effect of dilution. From a salt and nutrient loading perspective, ASR generates a no-net change to the existing system. Since ASR will effectively provide no change to groundwater quality (or possibly a benefit to groundwater quality) then it is reasonable to conclude that the proposed ASR project(s) are allowable under the SNMP framework and should proceed, provided that other regulatory requirements are met.

The SNMP evaluation of the City's proposed recycled water projects concluded that these projects can be implemented provided that all other regulatory requirements are met. It should be noted, that the SNMP includes management measures and a monitoring plan, and that the City will likely share the responsibility for implementing management measures and monitoring as part of future management and evaluation of groundwater quality in the Oxnard Plain and Pleasant Valley Basins.

3.4.2.2 Recycled Water Groundwater Recharge Replenishment Projects

As listed in the Recycled Water Policy, approved GRRPs must meet the following criteria:

- Compliance with regulations adopted by DDW for groundwater recharge projects (SWRCB. 2018a).
- Implementation of a monitoring program for CECs and priority pollutants, consistent with recommendations from DDW.

Additionally, the Recycled Water Policy states that the "Regional Water Board" can implement "additional requirements for a proposed recharge project that has a substantial adverse effect on the fate and transport of a contaminant plume or changes the geochemistry of an aquifer thereby causing the dissolution of constituents, such as arsenic, from the geologic formation into groundwater."

3.4.2.3 Anti-degradation

As stated in the Recycled Water Policy, "the proponent of a groundwater recharge project must demonstrate compliance with Resolution No. 68-16. Until such time as the City's SNMP is completed, such compliance may be demonstrated as follows:

- A project that utilizes less than 10 percent of the available assimilative capacity in a basin/sub-basin (or multiple projects utilizing less than 20 percent of the available assimilative capacity in a basin/sub-basin) need only conduct an antidegradation analysis verifying the use of the assimilative capacity. For those basins/sub-basins where the Regional Water Boards have not determined the baseline assimilative capacity, the baseline assimilative capacity shall be calculated by the initial project proponent, with review and approval by the Regional Water Board, until such time as the salt/nutrient plan is approved by the Regional Water Board and is in effect. For compliance with this subparagraph, the available assimilative capacity shall be calculated by comparing the mineral water quality objective with the average concentration of the basin/sub-basin, either over the most recent five years of data available or using a data set approved by the Regional Water Board Executive Officer. In determining whether the available assimilative capacity will be exceeded by the project or projects, the Regional Water Board shall calculate the impacts of the project or projects over at least a ten-year time frame.
- In the event a project or multiple projects utilize more than the fraction of the assimilative capacity designated in subparagraph (1), then a Regional Water Board-deemed acceptable antidegradation analysis shall be performed to comply with Resolution No. 68-16. The project proponent shall provide sufficient information for the Regional Water Board to make this determination. An example of an approved method is the method used by the State Water Board in connection with Resolution No. 2004-0060 and the Regional Water Board in connection with Resolution No. R8-2004-0001. An integrated approach (using surface water, groundwater, recycled water, stormwater, pollution prevention, water conservation, etc.) to the implementation of Resolution No. 68-16 is encouraged."

The regional groundwater quality is presented in Section 12 of this report. A review of anti-degradation and assimilative capacity is included in Section 14 of this report.

3.4.2.4 CEC Monitoring

The Recycled Water Policy addresses CECs and acknowledges that the state of knowledge on CECs is incomplete. CEC concentrations in advanced treated recycled water should be minimized through effective source control and treatment programs. The monitoring of specific CECs is required for

GRRPs, and the CEC requirements for injection projects are reviewed in Section 9 of this Engineer's Report.

3.5 Recycled Water Conveyance Pipeline

The advanced treated recycled water is pumped from the AWPF north in an existing recycled water backbone line and to the east to serve farmers. These lines are feeding recycled water to several non-potable applications. Spurs from this line will be constructed to carry the recycled water to the West for the ASR application and to the North for future spreading operations.

3.6 Spreading Facilities

In addition to the proposed ASR application, the City has investigated potential potable reuse spreading applications at other locations within the City (Woolsey Pits, Ferro Pits). At this time, the City does not intend to pursue these alternatives.

3.7 ASR Facilities

3.7.1 ASR Well Head Operation

This ASR application will be operated to eliminate cross connections between injected water and extracted water, maintaining the minimum proposed RRT of 3.1 months at all times (unless a shorter time is approved in writing by the SWRCB). The cross connection control is best described graphically in Figure 3.1.

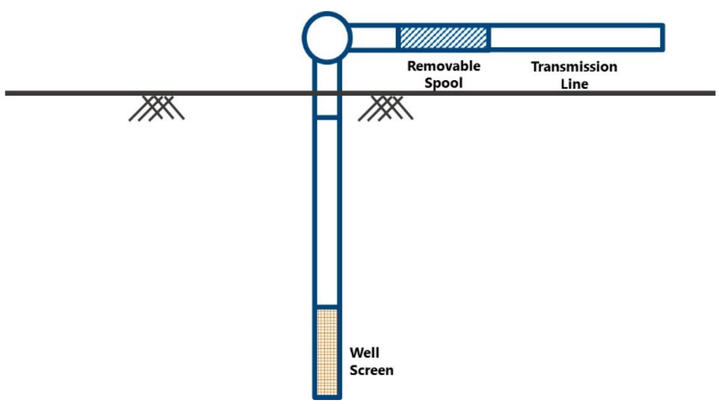

Figure 3.1a ASR Cross Connection Control (Side View)

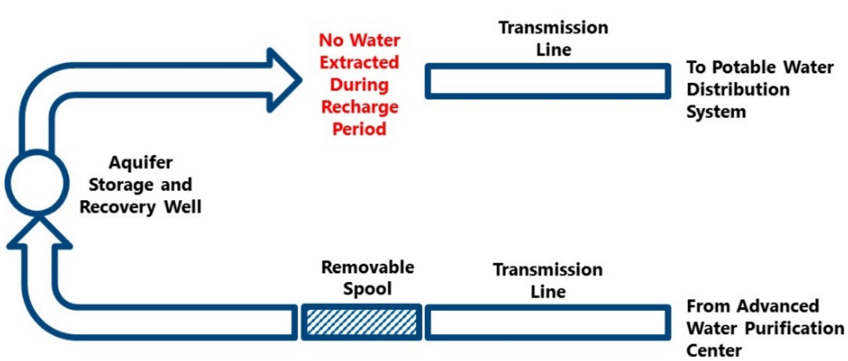

Figure 3.1b ASR Cross Connection Control (Plan View, Recharge with Purified Water Shown)

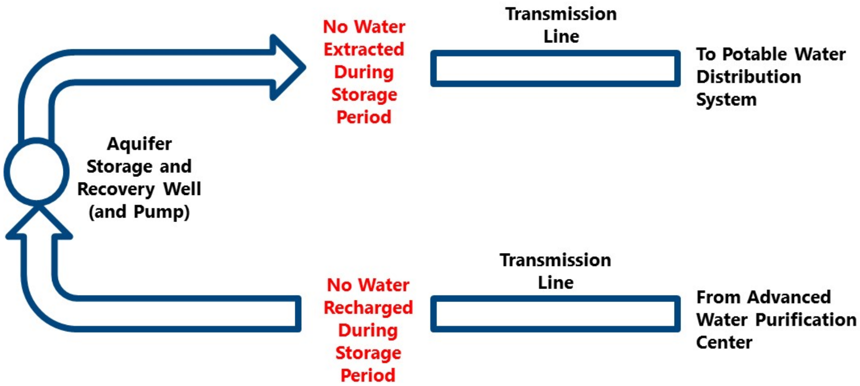

Figure 3.1c ASR Cross Connection Control (Plan View, No Recharge or Extraction during RRT Period)

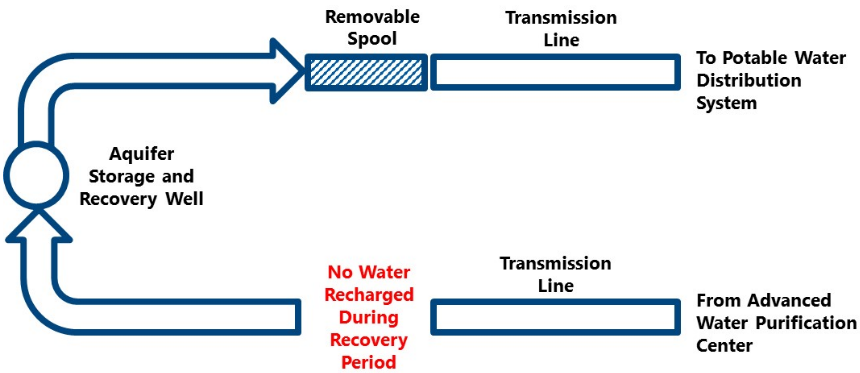

Figure 3.1d ASR Cross Connection Control (Plan View, Extraction of Groundwater Shown)

3.7.2 Injection and Monitoring

The injection and monitoring facilities must meet the criteria of DDW (SWRCB, 2018a), including section 60320.226. This section specifies:

- Prior to operating a GRRP, a project sponsor shall site and construct at least two monitoring wells downgradient of the GRRP such that:
  - At least one monitoring well is located no less than two weeks but no more than six months of travel time from the GRRP, and at least 30 days upgradient of the nearest drinking water well.
  - At least one monitoring well is located between the GRRP and the nearest drinking water well.

For this project, sufficient monitoring wells are proposed that meet DDW regulations (SWRCB, 2018a), as detailed in Section 11.

3.7.3 Chloramination

Extraced water from the ASR well will be pumped to Blending Station No. 1/6 (combined at the same location) where the supply will blend with other potable supplies and be chloraminated.

Section 4

SOURCE WATER FOR POTABLE REUSE

The production of advanced treated recycled water starts with an effective source control program and is followed by reliable primary and secondary treatment. Source water, and an Enhanced Source water Control Program (ESCP), are detailed in the following report, which is intended as a stand-alone document, but also vital to this Engineering Report: *Indirect Potable Reuse Enhanced Source Water Control and Collection System Monitoring Program* (Carollo, 2018); also attached here as Appendix A. Sections from that report are briefly summarized here.

The OWTP is permitted under Waste Discharge Requirements Order No. R4-2013-0094 (NPDES No. CA0054097), which was issued to the City in June 2013, and operates an EPA-approved industrial pretreatment program. That program is operating based upon an approved Local Limits program (from 1999). Oxnard is now updating that Local Limits program and has a Final Draft dated May 2018.

The regulatory requirements for wastewater source control are defined in Section 60320.206 of the regulations for groundwater recharge with recycled water (SWRCB. 2018a). For this project, the City must administer an industrial pretreatment and pollutant source control program that includes, at a minimum:

1. An assessment of the fate of Department-specified and RWQCB-specified chemicals and contaminants through the wastewater and recycled municipal wastewater treatment systems.
2. Chemical and contaminant source investigations and monitoring that focuses on Department-specified and RWQCB-specified chemicals and contaminants.
3. An outreach program to industrial, commercial, and residential communities within the portions of the sewage collection agency's service area that flows into the water reclamation plant subsequently supplying the GRRP, for the purpose of managing and minimizing the discharge of chemicals and contaminants at the source.
4. A current inventory of chemicals and contaminants identified pursuant to this section, including new chemicals and contaminants resulting from new sources or changes to existing sources, that may be discharged into the wastewater collection system.
5. Is compliant with the effluent limits established in the wastewater management agency's RWQCB permit.

The referenced report (*Indirect Potable Reuse Enhanced Source Water Control and Collection System Monitoring Program)*, included as Appendix A, is intended to address each of these items to the satisfaction of the Division of Drinking Water (DDW).

The Enhanced Source Control Monitoring Program (ESCMP) builds on the existing source control program already in place at the City of Oxnard; including:

- A source control program manager overseeing all data collection and regulatory issues relating to discharge from the first user to groundwater wells.
- More frequent sampling than required in the secondary effluent and AWPF advanced treated recycled water, including regulated, unregulated and industry-specific constituents.
- Use of historical and operationally collected online monitoring data required for operation to create baselines and predict trends in process performance.

- Heavily involved industrial outreach programs and residential outreach programs for potable reuse education and discharge initiatives.
- Mapping strategies for fast-acting collection system tracing of detected contaminants of health concern.
- Optional additions to discharge mapping, including hospitals.
- Ensure all SIUs report monthly and annual TTO monitoring results.
- Annual review of slug discharge control plans from SIUs.

Section 5

PATHOGEN MICROORGANISM CONTROL

DDW (SWRCB, 2018a) requires that potable reuse projects for groundwater recharge provide a combined level of treatment resulting in 12-log virus reduction, 10-log *Giardia* reduction, and 10-log *Cryptosporidium* reduction (12/10/10-log removal). No single process can receive more than 6-log reduction credit. DDW regulations (SWRCB, 2018a) also states that at least three processes must provide at least 1-log reduction. Beyond those three key processes, processes which provide <1-log reduction can be included within the analysis.

The step-by-step removal of pathogens, from raw wastewater to the production of potable water is reviewed below.

5.1 Primary and Secondary Treatment

Table 2-3 of USEPA (1986) lists less than 10 percent removal of total coliforms, 35 percent removal of fecal coliforms, and less than 10 percent removal of virus through primary treatment. Protozoa removal through primary treatment is not listed. The same Table (2-3) includes bacteria and virus removal percentages for secondary treatment (not including disinfection), indicating 90 to 99 percent removal of both total and fecal coliforms, and 76 to 99 percent removal of virus.

Francy *et al.* (2012) indicates 99 to 99.98 percent removal of bacteria and 88 to 99.9995 percent removal of various virus and coliphage. The single data set with any data below 90 percent removal, which was for adenovirus, showed removal ranging from 88 to 99.93 percent with a median removal of 99.8 percent.

One of the most recent DDW approval of pathogen removal credits for combined primary and secondary treatment, was obtained by the Water Replenishment District (WRD) (2013). That document relied upon risk analysis data presented in Olivieri *et al.* (2007) which was developed based upon Rose *et al.* (2004). Within Rose *et al.* (2004), the research team defined the range of bacteria, enterovirus, *Cryptosporidium*, and *Giardia* removal through six different full-scale wastewater treatment plants. The raw data from that work is reported in Olivieri *et al.* (2007). For WRD (2013), the pathogen removal credits for their secondary process were based upon the data from two of the six tested secondary process configurations. Specifically, two of the secondary process trains (Facilities C and D, with SRTs of 1.6-2.7 days and 3-5 days, respectively) had SRT values less than the secondary process feeding the WRD advanced treatment system (>9 days), and thus are presumed to be conservative estimates of performance. Per DDW request, WRD (2013) used the lower 10th percentile values calculated for each pathogen, resulting in 2.06-log reduction of enterovirus, 1.42-log reduction of *Cryptosporidium*, and 2.42-log reduction of *Giardia.* Note that analysis of the same data set by Carollo Engineers found one data translation error, but the overall impact on the log reduction credits is minimal.

Interpretations of the data set (Rose *et al.*, 2004) suggest that longer SRT values result in increased pathogen removal. While this may be the case, the raw data from Rose *et al.* (2004) does not show this clearly (Table 5.1). For example, Facility F from that research with the longer SRT has reduced protozoa reduction than most of the other facilities, but also shows the best virus removal compared to the other facilities. The lowest virus removal occurs at Facility A, which has an SRT of 6 to 8 days, similar to the TIWRP. This data set is limited and making projections based upon SRT is speculative. Without site-specific data, our team recommends using the lower 10th percentile of the entire data set in Table 5.1, which results in 1.9-log reduction of virus, 1.2-log reduction of *Cryptosporidium*, and 0.8-log reduction of *Giardia*.

Table 5.1 Pathogen Reduction Values through Primary and Secondary Treatment (from Rose *et al.*, 2004)

Lower 10th Percentile Values		Log Reduction		
SRT	Facility	Enterovirus	*Giardia*	Crypto
1.6-2.7	C	1.8	2.6	1.25
3-5	D	2.05	1.35	1.4
3.5-6	B	1.95	2.45	1.6
6-8	A	1.65	0.8	0.7
8.7-13.3	E	1.75	2.6	1.9
8-16	F	2.6	0.9	0.25
1.6-16	**ALL**	**1.85**	**0.8**	**1.2**
7-8	***Projected for OWTP***	***1.9***	***0.8***	***1.2***
50th Percentile Values		Log Reduction		
SRT	Facility	Enterovirus	*Giardia*	Crypto
1.6-2.7	C	2.05	3.05	1.65
3-5	D	2.5	1.9	2.6
3.5-6	B	2.25	2.6	1.9
6-8	A	2.1	1.6	1.1
8.7-13.3	E	2.2	2.8	2.1
8-16	F	2.75	1.1	0.95
1.6-16	**ALL**	**2.3**	**2.6**	**1.6**
7-8	***Projected for OWTP***	***2.3***	***2.6***	***1.6***

As part of WateReuse Research Foundation Project 14-16, Oxnard has been researching the pathogen removal by the OWTP, in an effort to supplement, and potentially better understand, pathogen removal through the primary and secondary processes. The work, as of yet unpublished, examines a range of pathogens (*Giardia*, *Cryptosporidium*, norovirus, total culturable virus, *E. coli*), biological surrogates (enterococci, total coliform, male specific coliphage, somatic coliphage), chemical surrogates (UV Absorbance, TOC, DOC, BOD), and innovative monitoring (fluorescence). The laboratory work was done by Southern Nevada Water Authority (chemistry) and BioVir (biology). Spanning nearly 12 months, with sampling over 6 dates (four data sets are currently complete), the project team is developing an understanding of pathogen concentrations and removal (Figures 5.1, 5.2, and 5.3).

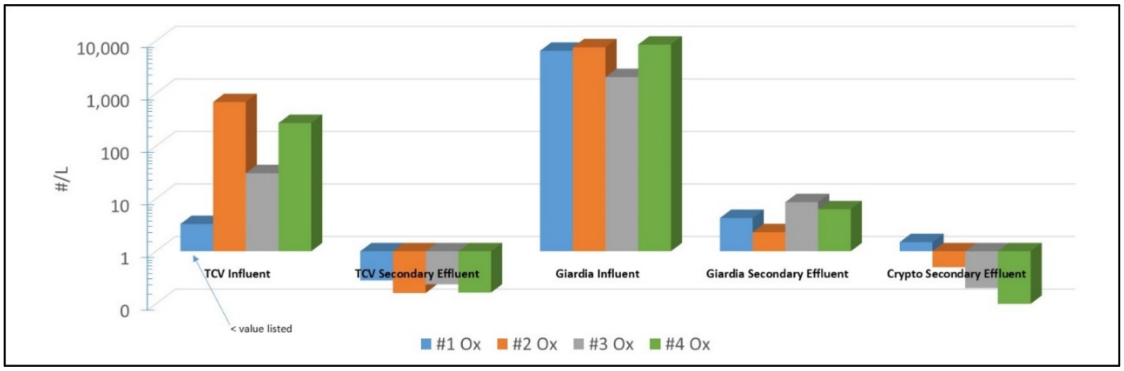

Figure 5.1 Total Culturable Virus, Giardia, and Cryptosporidium Concentrations in Raw Wastewater and Secondary Effluent for Oxnard

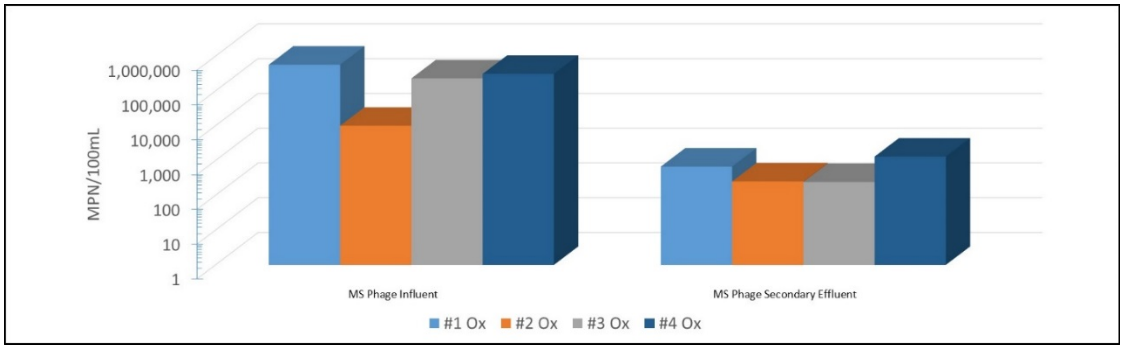

Figure 5.2 Male Specific Phage Concentrations in Raw Wastewater and Secondary Effluent for Oxnard

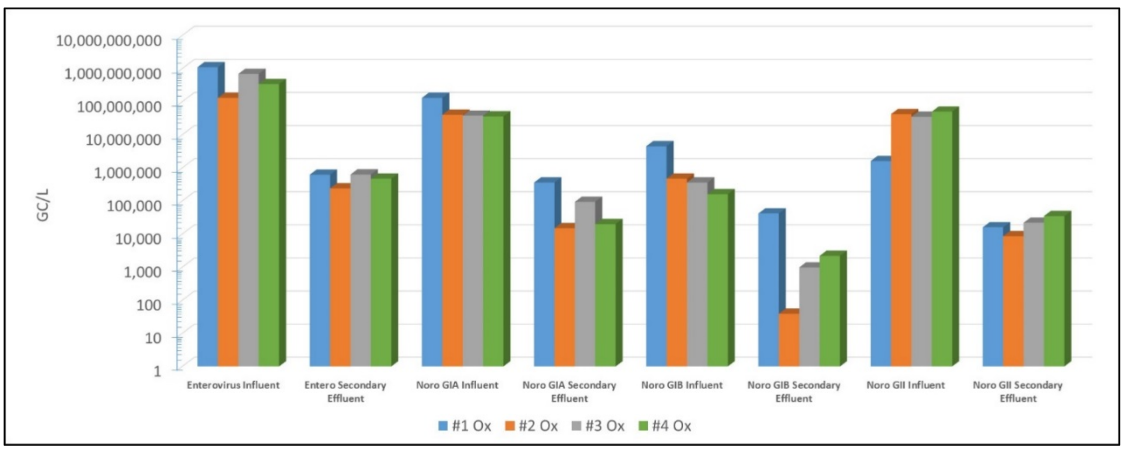

Figure 5.3 Enterovirus and Norovirus Concentrations in Raw Wastewater and Secondary Effluent for Oxnard

Analytical difficulty with *Cryptosporidium* enumeration inhibited calculation of log reduction for this organism. Log removal values (LRVs) for all other organisms were:

- Male Specific Phage - 1.6 to 2.98 LRV, with an average value of 2.47 LRV.
- Giardia - 2.38 to 3.52 LRV, with an average value of 3.05 LRV.

- Enterovirus - 2.7 to 3.2 LRV, with an average value of 2.97 LRV.
- Total Culturable Virus - 2.1 to 3.6 LRV, with an average value of 2.99 LRV.
- Norovirus Type GIA - 2.6 to 3.4 LRV, with an average value of 2.96 LRV.
- Norovirus Type GIB - 1.9 to 4.1 LRV, with an average value of 2.63 LRV.
- Norovirus Type GII - 2.0 to 3.7 LRV, with an average value of 3.01 LRV.

While raw wastewater and secondary effluent were sampled on the same day, the samples were not time-coupled, meaning that they do not necessarily represent the same drop of water and thus the average log reductions are likely more representative of performance compared to individual numbers. Using the lowest average value from all the virus data and the average for Giardia removal, reasonable LRVs for protozoa and virus are 3-log and 2.5 log, respectively. **If we were to assume accuracy in the individual sample events and use the lowest measured reductions for protozoa and virus (not coliphage), we would result in 2.4-log and 1.9-log, respectively.** DDW, in a letter dated December 5, 2016, acknowledged the value of this new research to the industry, but raises important concerns regarding the lack of a surrogate to monitor log removal performance. As a result, DDW has stated that they will only approve the lower log removal values from Rose et al (2004); 1.9-log reduction of virus, 1.2-log reduction of *Cryptosporidium*, and 0.8-log reduction of *Giardia*. It is Oxnard's position that these numbers from Rose et al (2004) are conservative. Oxnard intends to initiate a more detailed pathogen sampling and analysis plan and to submit that information to DDW at part of the future 5-Year Engineer's Report.

The concentrations of the organisms in the secondary effluent also allow for an analysis of risk. Water treatment regulations for pathogens are predicated on reducing the risk of infection to minimal levels. For this project, the team has targeted the concentration end goals for pathogens that correspond to a modeled, annual risk of infection of 1 in 10,000 or less (Trussell *et al.*, 2013). DDW used this risk level to develop their pathogen criteria (SWRCB, 2018a) and NWRI used this risk level to develop their pathogen criteria (NWRI, 2013). This risk level corresponds to the following potable water concentrations:

- *Giardia* - 6.80E-06 cysts/L.
- Cryptosporidium - 3.00E-05 oocysts/L.
- Enteric virus - 2.22E-07 MPN/L.

Giardia and *Cryptosporidium* results varied from 2.3 to 8.6 #/L and <0.1 to 1.5 #/L, respectively. Taking the highest count for each *Giardia* and *Cryptosporidium* results in a need for 6.1-log and 4.7-log of additional treatment following the secondary process to meet the risk-based levels above. Considering that subsequent MF treatment will provide 4-log protozoa removal, the subsequent RO will provide 1 to 2-log protozoa removal, and subsequent UV will provide 6-log protozoa removal, protozoa in the advanced treated recycled water does not represent a health concern.

For virus, there are many more data sets to evaluate. Total culturable virus concentrations in secondary effluent were 0.16 to 0.28 MPN/L. Taking the highest count results in a need for 6.1-log of additional treatment following the secondary process to meet the risk-based levels above. Considering that subsequent RO will provide 1 to 2-log virus removal and subsequent UV will provide 6-log virus removal, total culturable virus concentrations in the advanced treated recycled water does not represent a health concern.

Enterovirus, norovirus GIA, norovirus GIB, and norovirus GII had concentrations of 240,000 to 630,000, 15,000 to 360,000, 39 to 42,000, and 8,600 to 35,000 GC/L, respectively. ***An important difference*** between the total culturable virus test and the other tests is the use of a culture to measure viable organisms in the former, while the measurement of gene copies in the latter. Gene copy numbers do not necessarily correlate to viable pathogens and this is a current topic of research within our industry. A highly conservative approach would be to assume all gene copies to be viable pathogens. Following that approach and using the highest GC/L counts, an additional 11 to 12-log removal of virus would be needed through subsequent processes. Considering that subsequent RO will provide 1 to 2-log virus removal, subsequent UV will provide 6-log virus removal, and groundwater recharge can provide up to 6-log virus removal (depending upon travel/storage time), the advanced treated recycled water does not represent a health concern.

5.2 MF

Reardon *et al.* (2005) reported numerous studies showing bacteria rejection of 3 to 9 logs, protozoa rejection of 4 to 7 logs, and unreliable rejection of virus. The AWPF utilizes Pall Microza MF membranes, which are credited by DDW for 4-log protozoa removal and 0.5-log virus removal (95 percent of the time), as documented by DDW (CDPH, 2011). According to the Supplier's documentation, which cites USEPA (2003) and Sethi (2002) to calculate a maximum allowable pressure decay test (PDT) result that correlates to a specific protozoa log reduction.

Pall's approach is to use the maximum allowable TMP, the minimum feed water temperature, the maximum filtrate flow (27.2 gfd based upon the maximum flux in the Pall Operating Protocol and as measured in their 2011 Initial Performance Test), and a default VCF of 1.08. The result is that a PDT of 0.16 psi/min equates to a protozoa LRV of 4, which equates to a PDT of 0.80 psi/5min. Details on Pall's approach can be found in Appendix C.

Extensive SCADA data exists demonstrating compliance with this maximum PDT. As part of start-up demonstration testing of Oxnard's purification processes in April, May, and June of 2016, Carollo staff recorded a handful of PDTs and turbidity values, as shown below.

- **4/27/2016:** Rack 2 - 0.2, Rack 3 - 0.2, Rack 4 - 0.18, Rack 5 - 0.18, Rack 6 - 0.20
- **5/2/2016:** Rack 1 - 0.31, Rack 2 - 0.2, Rack 3 - 0.17
- **5/3/2016:** Rack 1 - 0.26, Rack 4 - 0.17, Rack 5 - 0.15, Rack 6 - 0.16
- **6/3/2016:** Rack 1 - 0.25, Rack 2 - 0.20, Rack 3 - 0.18, Rack 4 - 0.18, Rack 5 - 0.16, Rack 6 - 0.22
- **Influent Turbidity:** 3.48 to 5.09
- **Effluent Turbidity:** 0.04 to 0.10

During the May site visit and inspection, MF influent and effluent samples were also collected to analyze the particle size distribution (PSD). The analysis was done with Carollo's optical particle sizer/counter (PSS AccuSizer 780/SIS), with a sensitivity down to approximately 1 micron (Figure 5.4). The goal of the PSD testing was to set a baseline of performance for particle removal, focusing on the size range of protozoa (4 to 15 microns). The results demonstrate >3-log removal of particles in the 4 and 5 micron range, affirming the PDT performance shown above.

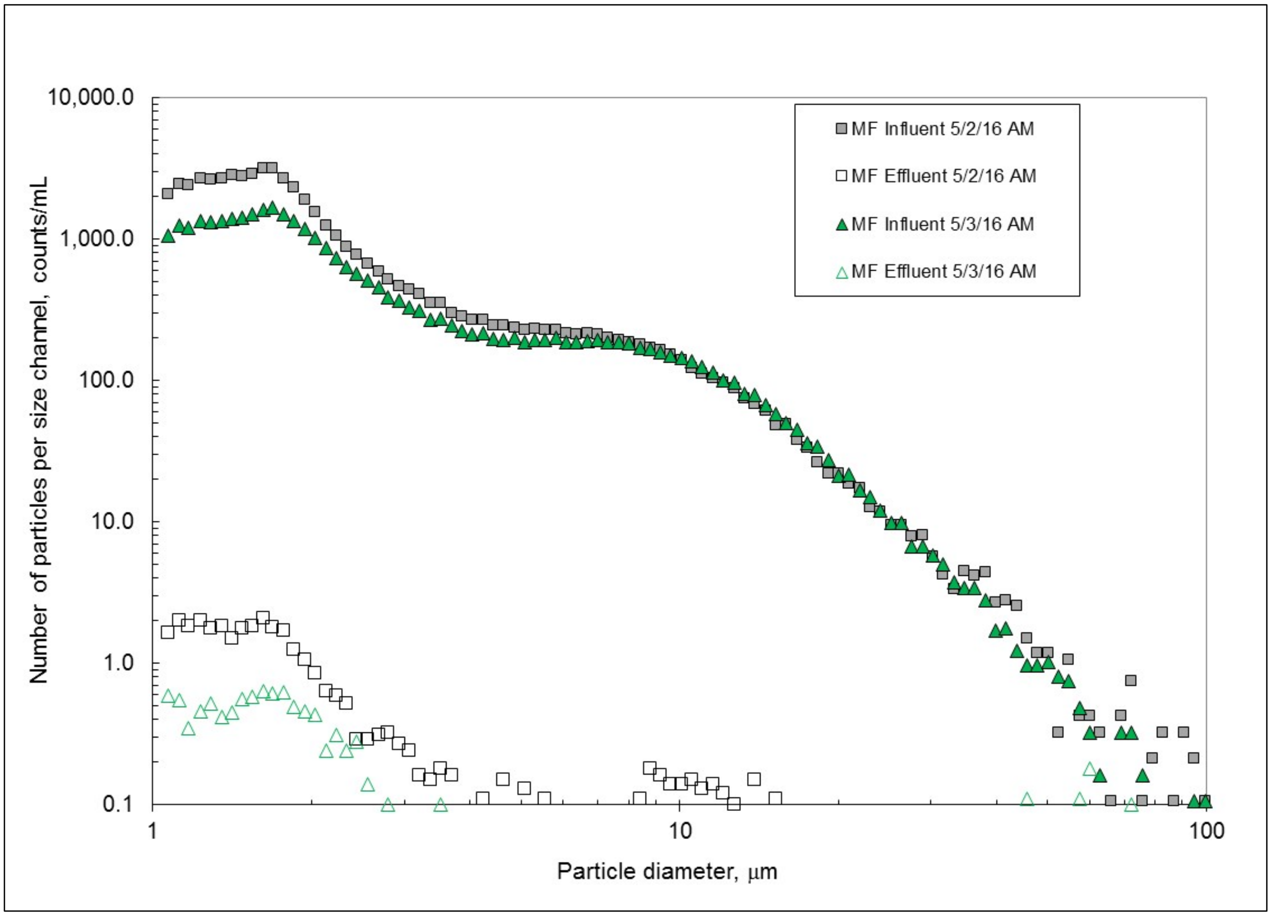

Figure 5.4 Particle Size Distribution for MF Influent and Effluent (5/2/16 and 5/3/16)

Online turbidity and PDT measurements for December 2014 through June 2016 are shown as Figures 5.5 and 5.6, respectively. The online results back demonstration results previously presented, showing the MF in normal operation at Oxnard is able to consistently achieve the PDT target. Online microfiltration filtrate turbidity measurements confirm a required effluent turbidity limit of <0.2 NTU is consistently met. Exceedances of 0.2 NTU in the MF filtrate were seen when 1) the online turbidimeter requires cleaning and calibration or 2) when the plant is cycling through a startup period and flow has not yet stabilized. Influent turbidity concentrations from secondary effluent, typically range between 1 - 6 NTU. Benchtop and online turbidimeter measurements during testing showed consistency when compared.

Overall, the City proposes to use 0-log virus reduction credit and 4-log protozoa reduction credit for this Pall membrane. No virus credit is sought because PDTs do not have sufficient resolution to measure virus removal performance.

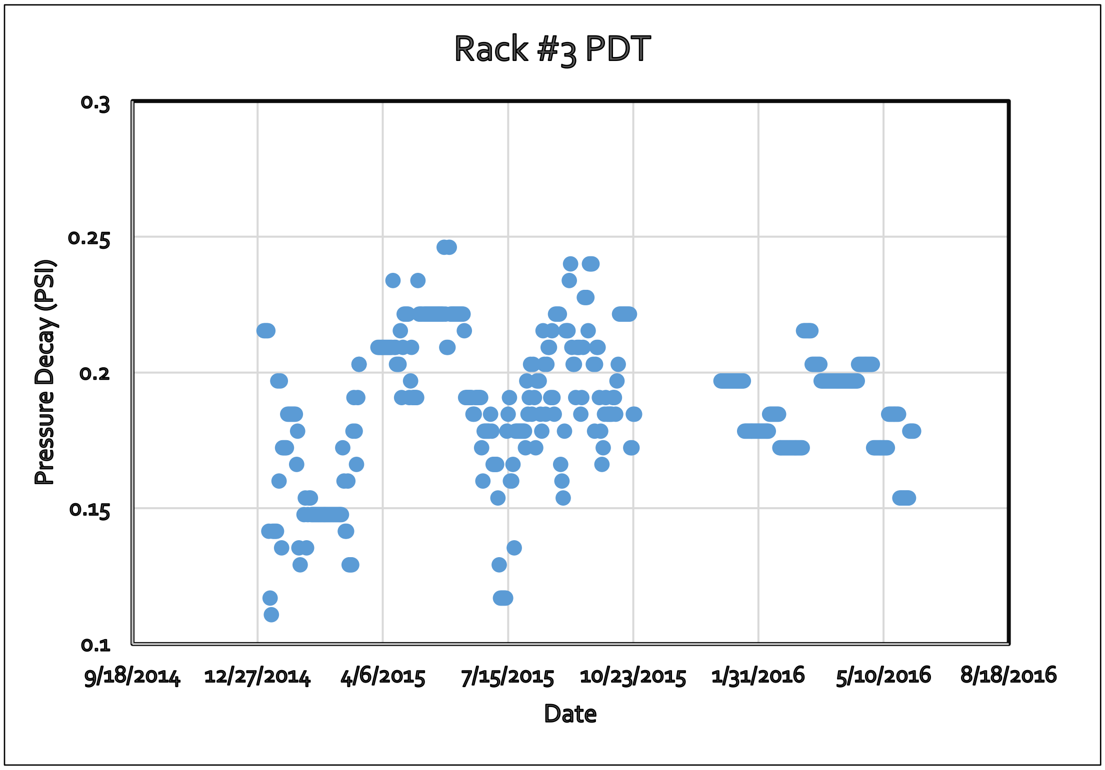

Figure 5.5 MF Online PDT Results for December 2014 through June 2016

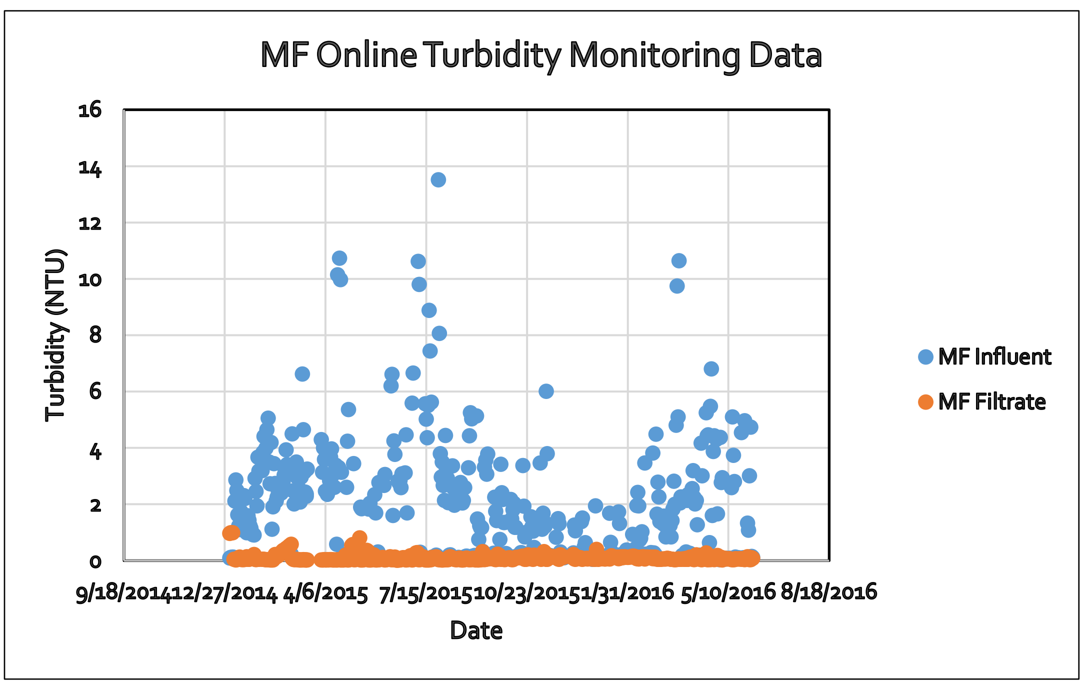

Figure 5.6 MF Influent and Filtrate Online Turbidity Data for December 2014 through June 2016

5.3 Reverse Osmosis

RO process performance for pathogen rejection is not governed by the ability of an intact membrane to reject pathogens but by the ability to monitor process integrity (Reardon *et al.* (2005) and Schäfer *et al.* (2005)). The monitoring tools currently used, electrical conductivity meters and total organic carbon (TOC) meters, can measure 99 percent or less removal of both parameters through the RO process. Recently, the DDW granted 1.5-log reduction credit for all pathogens (i.e., virus, *Giardia*, and *Cryptosporidium*) for RO (WRD, 2013), based upon a requirement to continuously monitor TOC reduction across RO.

Currently, the City only measures EC across the RO membranes. During the Carollo performance demonstration testing and site audit, our team collected EC data.

- **5/2/2016:** Influent EC 2693 to 2787 µS/cm, Effluent EC 107 to 134 µS/cm.
- **EC LRV is 1.3 to 1.4.**

Monitoring and performance data showing online EC measurements of the RO system from March - May 2016 are displayed in Figure 5.7, with the average, minimum and maximum LRV results by train shown in Table 5.2 and Figure 5.8. The online data confirms the site inspection results from Carollo, showing an average of 1.47 LRV from a 3 month period, with a minimum LRV of ~1.29. These online results indicate consistent and reliable LRV of EC that can be confidently correlated to pathogen removal credits.

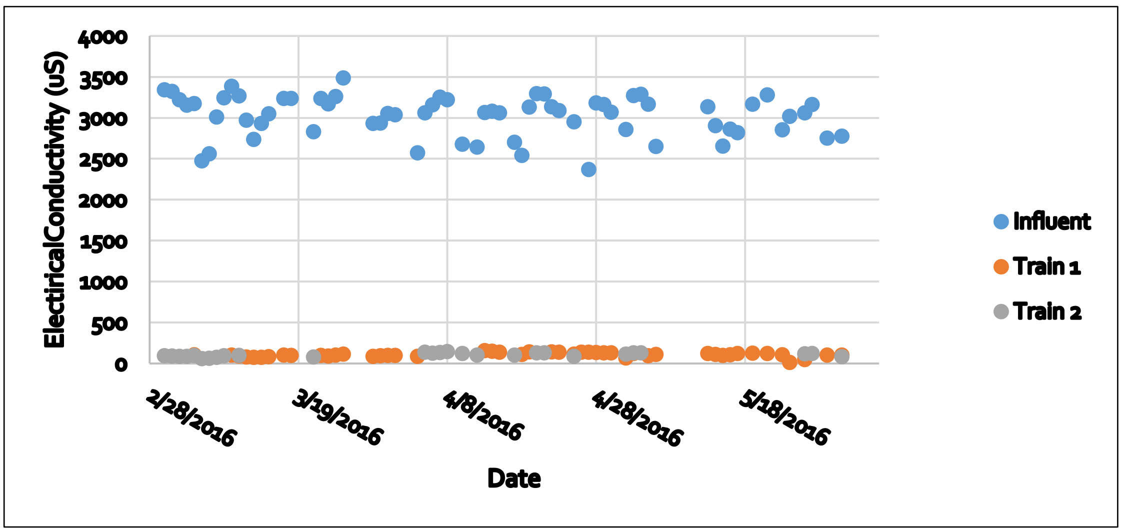

Figure 5.7 MF Influent and Filtrate Online Turbidity Data for December 2014 through June 2016

Table 5.2 Average, Minimum, and Maximum EC LRV through RO treatment (March 2016-May 2016)

	Train 1 LRV	Train 2 LRV	Total Perm LRV
Average	1.47	1.47	1.47
Min	1.23	1.34	1.29
Max	2.44	1.62	2.03

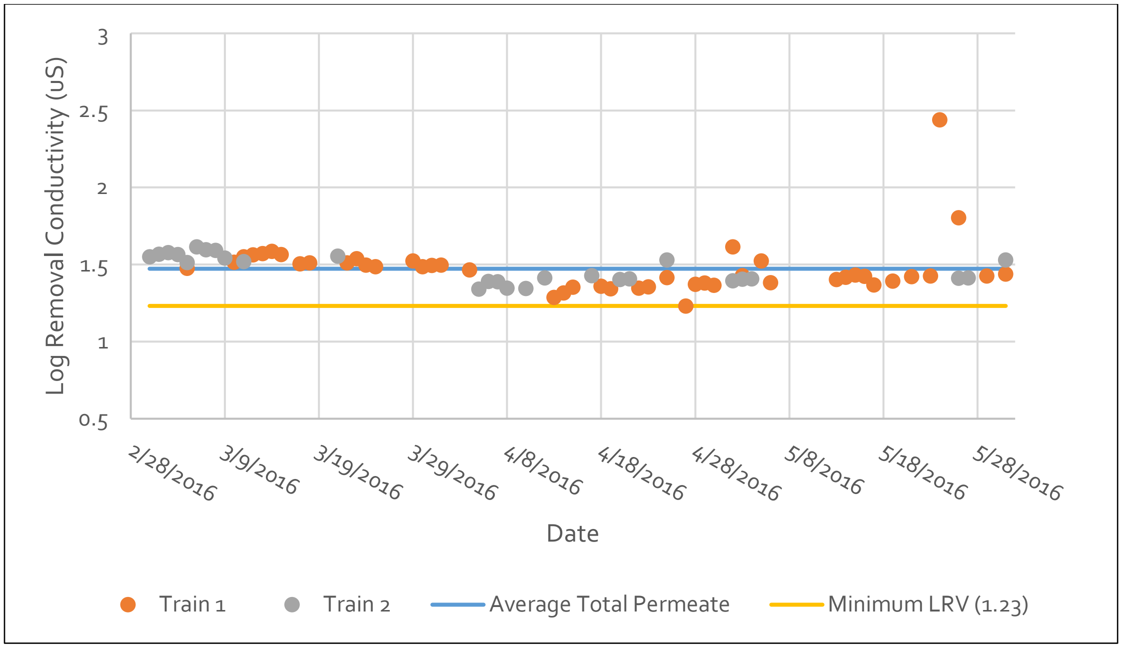

Figure 5.8 EC LRV Online Monitoring Data March 2016 - May 2016

The AWPF does not have online TOC meters, though intends to install them in the near future prior to operation. Grab samples were taken during the May Carollo inspection to document TOC removal across the RO process. TOC concentrations in the RO feed was 16 mg/L (on both 5/2 and 5/3), whereas RO permeate TOC concentrations were at the detection limit of 0.3 mg/L or below detection (again on 5/2 and 5/3). The LRV for this limited TOC data set is 1.7, suggesting that TOC reduction may be a more sensitive monitoring tool for RO performance and RO LRV credits.

In the April 2016 letter from DDW to the City, DDW stated that "online EC can show log reduction value (LRV) of approximately 0.5 to 1.0". The data collected here demonstrates a higher level of performance monitoring, with a minimum of 1.3 LRV. The City proposed to use the 1.3-log reduction value for all pathogens for RO at this time and use EC to monitor the performance of the system. DDW, in a letter dated December 5, 2016, approved a credit of 1-log based upon EC monitoring. *In the future, the AWPF intends to install TOC meters and potentially demonstrate higher LRV credits using this or other advanced monitoring (such as online fluorescence) resulting higher pathogen removal credit.*

5.4 UV Advanced Oxidation

The UV advanced oxidation process (AOP) provides three primary values:

- Disinfection.
- NDMA Destruction by Photolysis.
- Trace Chemical Destruction Through Advanced Oxidation (1,4-dioxane).

Following RO treatment, advanced oxidation is accomplished through the use of UV and hydrogen peroxide (H_2O_2), with an H_2O_2 dose of up to 6 mg/L. The UV system is the D72AL75, which has gone through extensive validation for non-potable water reuse applications and is the same reactor as the ones used at the OCWD for the Groundwater Replenishment System. For the AWPF, there are three D72AL75 reactors in series (stacked). The "D" in "D72AL75 means "dual", as each reactor actually has two banks of 72 lamps within it. This system is designed with redundancy, with five banks of lamps required for operation and the sixth bank of lamps for redundancy.

Note: The discussion here, which is in the disinfection section of this report, focuses upon all three components of performance, disinfection, NDMA destruction, and 1,4-dioxane destruction; as each of the three data sets are necessary to fully understand UV AOP performance and the recommended controls.

5.4.1 Current UV System Controls

Historically, UV AOP systems have been controlled to provide a target EEO, or electrical energy use per order of magnitude destruction of a target pollutant. UVI and a pure "dose" based control has yet to be implemented for the various installed UV AOP systems for potable water reuse in California (e.g., OCWD, WBMWD, WRD), but will soon be operational for the City of Los Angeles' Terminal Island facility (early 2018).

The target of the City's UV AOP control system is to provide sufficient power to achieve a required level of treatment (removal) of the target chemical, NDMA. The control system calculates the target power for a UV system via the EE/O metric. EE/O as a function of flow rate and UVT is computed by the system, and adjusted for a Lamp Efficiency Factor (LEF), based on the target contaminant removal setpoint. The power modulation can be described as:

Power = a x f(flow, UVT, LEF*), where

a = Trojan-specific empirical factor, and

LEF = f(lamp age, temperature, power level efficiency)

The actual total power (summation of all power output by the system at any timepoint) is then compared to the target power (based on a LRV contaminant setpoint), to allow for power reduction in times of low flow or high UVT.

The current target NDMA LRV setpoint for Oxnard is 1.0. As part of startup testing, the Carollo/Oxnard team obtained SCADA data to document the performance of the existing control system to meet the 1.0 NDMA LRV metric. System NDMA LRV and UVT values are recorded by plant staff directly from the UV system monitoring screen every 4 hours. Data provided by plant staff from 9/27/16 and 9/28/16 show the system's response to changes in UVT in terms of LRV achieved (Figure 5.9).

Additional data was collected showing the system's response to UVT and flow for the same 9/27/16 - 9/28/2016 dates, Figure 5.10. This result confirms the system's control philosophy is functioning as intended. All LRV values were above the setpoint of 1.0, showing the system was meeting the target setpoint at all times during the two days analyzed.

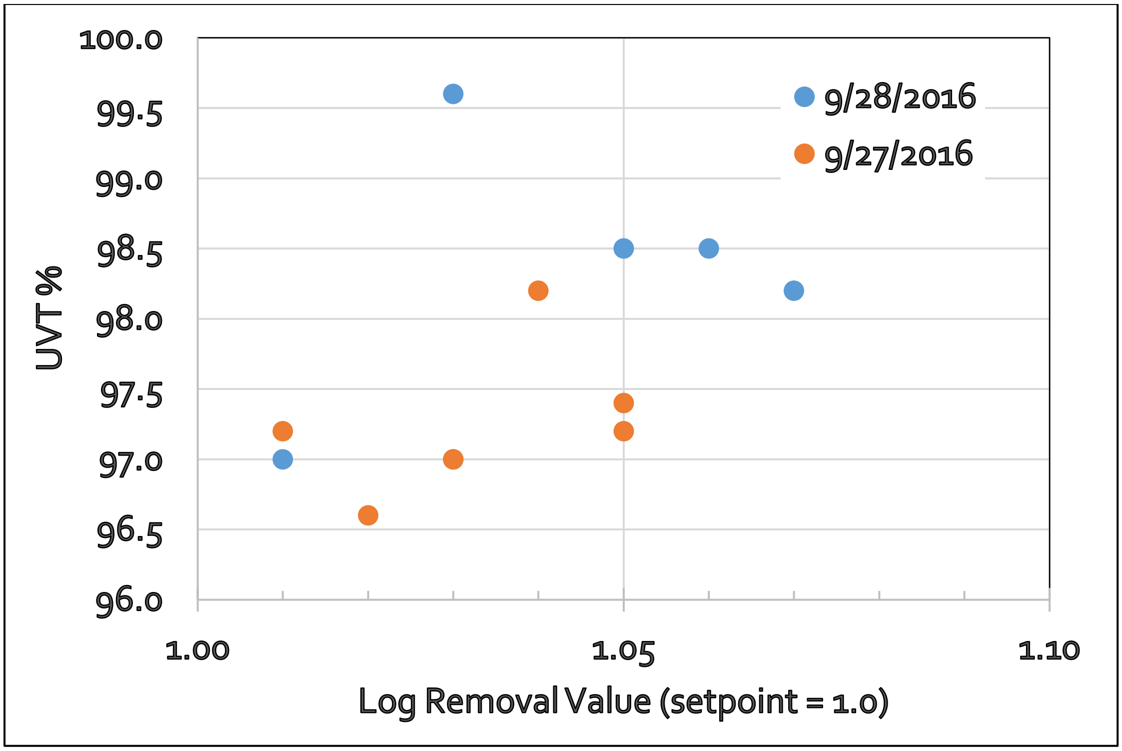

Figure 5.9 Percent UVT and corresponding Log Removal Values for 9/27 and 9/28/2016

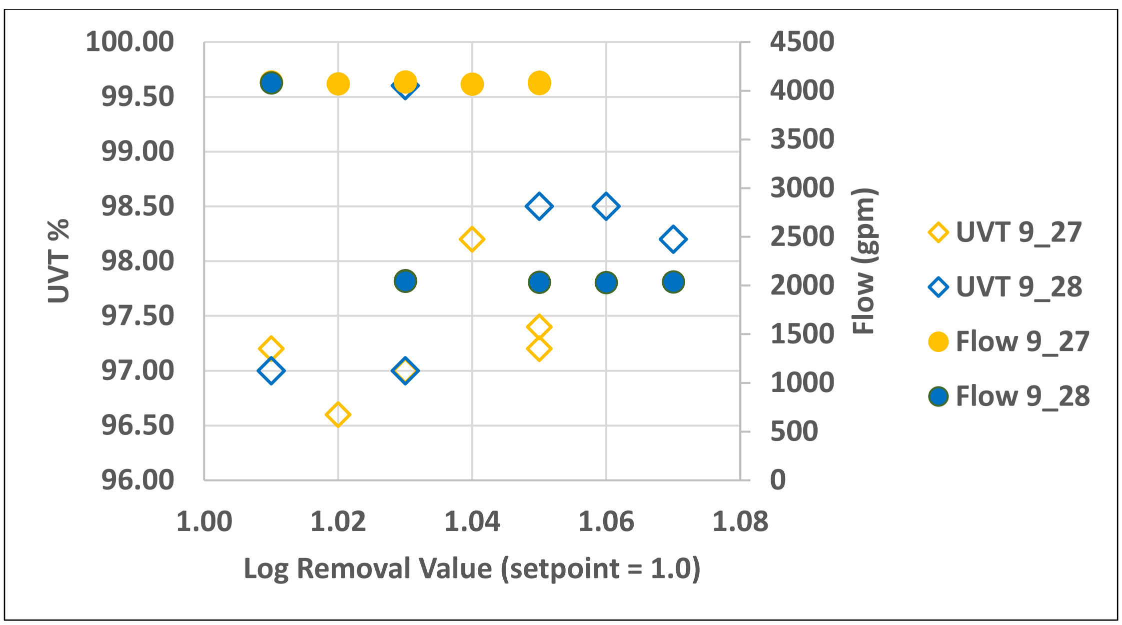

Figure 5.10 UV Log Removal Value as a Function of UVT and Flow

Power modulation is the final step in the UV AOP control strategy. The apparent power and target power across the UV system was analyzed for consistency across 9/27/16 and 9/28/16 operation (Figure 5.11). This consistency shows the UV system's ability to modulate the power to limit the energy input to the system to only what is necessary to meet the target power at any given time based on the UVT and flow.

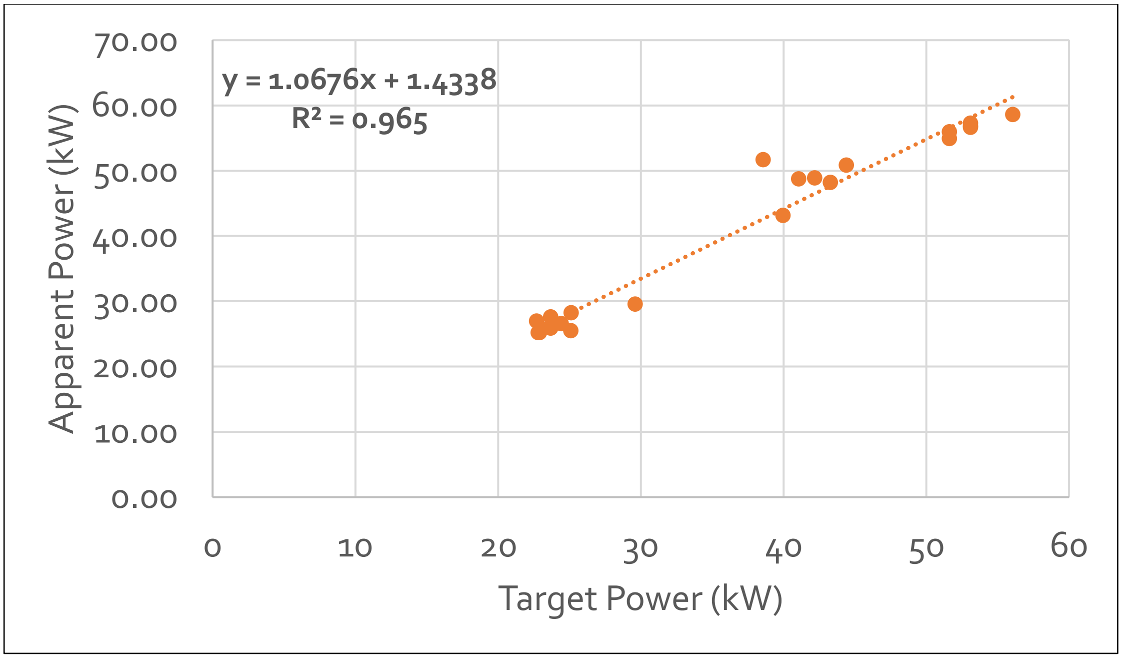

Figure 5.11 Apparent Power vs. Target Power (data collected 9/25/16 - 9/28/16)

The sections and analysis that follows evaluates the capacity of the installed UV AOP to destroy NDMA, pathogens, and 1,4-dioxane; then determines if the existing control system (as defined above) is sufficient or if it needs some level of adjustment.

5.4.2 UV Sensor Performance

Though UVI is not an active control within the UV system (at this time), the Carollo project team did a preliminary analysis of sensors for the installed 6-bank UV system. The orientation of the reactor sets the naming of the reactors and the corresponding UVI sensors, as shown in Figure 5.12 below; LWR LFT (lower left), MID RHT (middle right), and HGH LFT (high left) are three naming examples. Note that in the figure below, the terms "left" and "right" refer to the direction of flow (with flow going from left to right), not the visual location of the banks.

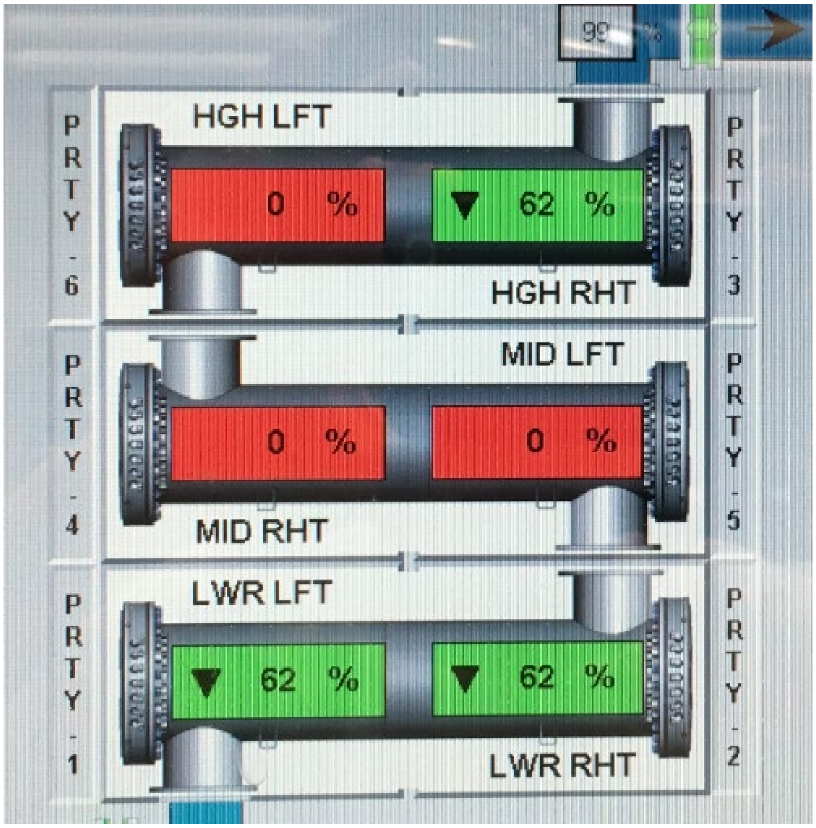

Figure 5.12 Screenshot of Trojan HMI at Oxnard

Through twenty-two different tests, different flow, different UVT, different # of reactors, and different reactor power settings were used. UVT transmittance readings were taken from an online meter, from a calibrated bench-top meter, and with laboratory grab sampling with subsequent analysis. Samples were taken before and after UV. For this analysis, only samples from the influent side of the UV were used, and only the results from the calibrated bench-top meter were used. The logic of this approach is based upon our team's confidence in the accuracy of the bench-top meter coupled with the future method of system monitoring, which is UVT on the influent to the UV system.

The sensor results are shown in Figure 5.13. Substantial sensor variability was shown. At a basic level, the sensors did track changes in UVT and power.

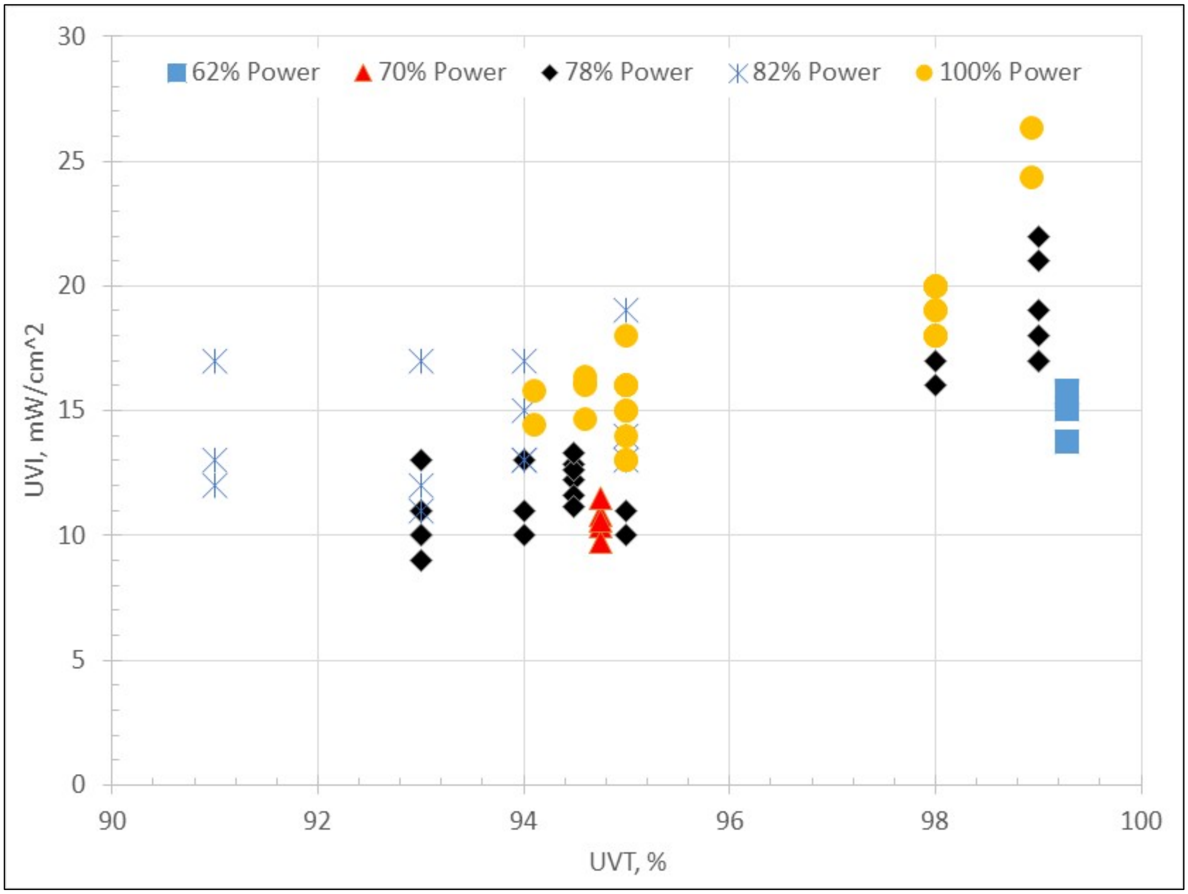

Figure 5.13 Sensor Values for Different UVT and Power Values

Using the sensor data points, a predictive formula was developed for the sensors. Sensor intensity is a function of UV absorbance (UVA) and ballast power (BP), as follows:

$$S = 10^{A} \times UVA^{B} \times BP^{C}$$

Where:

A = -1.27979

B = -0.25179

C = 1.02881

This formula results in an R^2 value of 0.92, which indicates a good measure of data variability. The prediction residuals are shown in Figure 5.14, demonstrating the accuracy of the predictive formula to be plus or minus 20 percent, and the general ability of the UV sensors to track UV intensity.

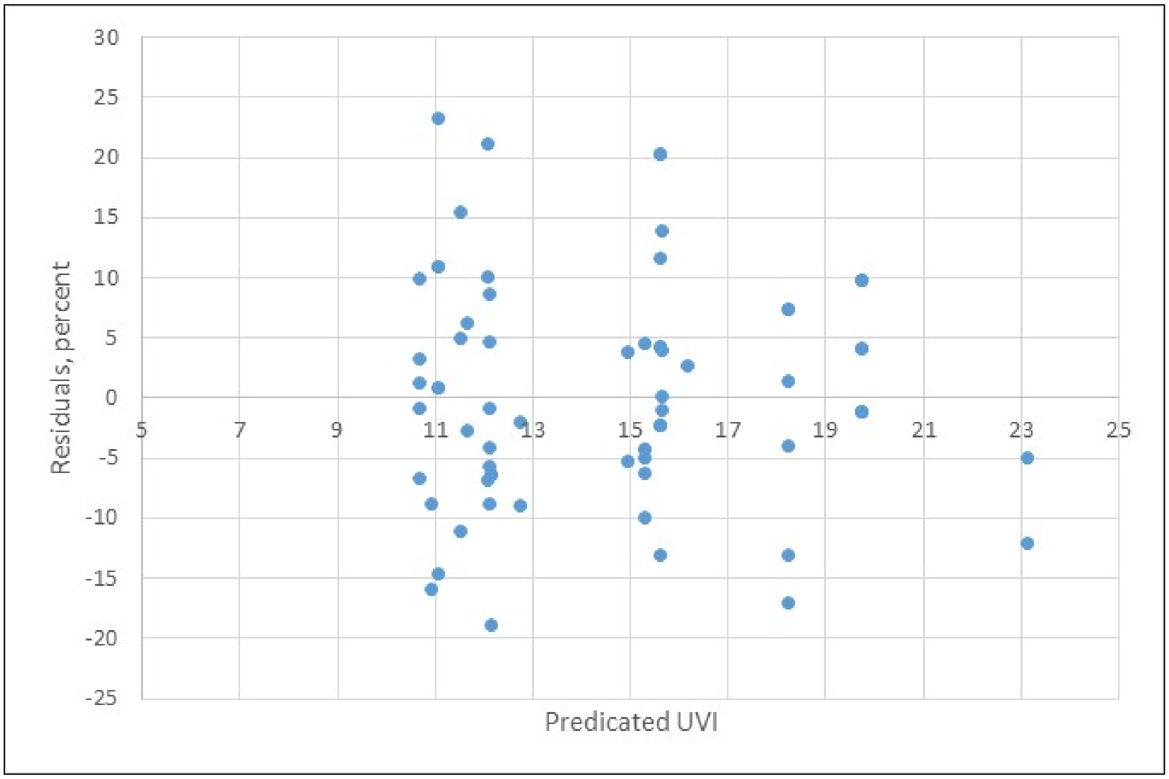

Figure 5.14 Sensor Residuals

5.4.3 Disinfection Performance

The D72AL75 validation is documented in Carollo (2009). That work documented reactor performance over a range of flow (1.05 to 7.3 mgd) and over a range of UV transmittance (UVT) (41.4 to 80.8 percent), with the data analyzed in accordance with National Water Research Institute Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (NWRI, 2003) but not NWRI (2012). The validation of the D72AL75 is based upon the dose delivery per reactor, recognizing that there are two 72 lamp banks within each reactor. Note that the Oxnard UV AOP system is controlled based upon the use of each bank, so three reactors results in a total of 6 banks of UV light. For this application at the AWPF, the flow per reactor is 6.25 mgd (as all three reactors are in series). As the UVT in ROP is greater than 95 percent, the validation formula from Carollo (2009) is conservative. Using the maximum validated UVT of 80.8 percent the dose of five banks of lamps from the three D72AL75 reactors (leaving one bank in standby) is >250 mJ/cm^2.

As this is a potable reuse application, disinfection credit for UV should be based upon adenovirus disinfection. Adenoviruses comprise a large group of serologically different viruses that can cause a broad spectrum of diseases with varying severity (USEPA, 2010). Research on the dose-response relationship of Adenoviruses, using Low Pressure (LP) UV radiation on a bench-scale collimated beam setup, is mainly limited to Adenovirus types 2, 40, and 41. The dose response relationship at high UV doses (>200 mJ/cm^2) is more widely published for Adenovirus type 2 (Ad2), and shows that 6-log reduction of Ad2 may be obtained at a dose of 235 mJ/cm^2 (Gerba *et al.*, 2002). The dose response relationship of Ad2 as well as other viruses is shown in Figure 5.15, demonstrating that Ad2 is a conservative surrogate for a wider range of virus.

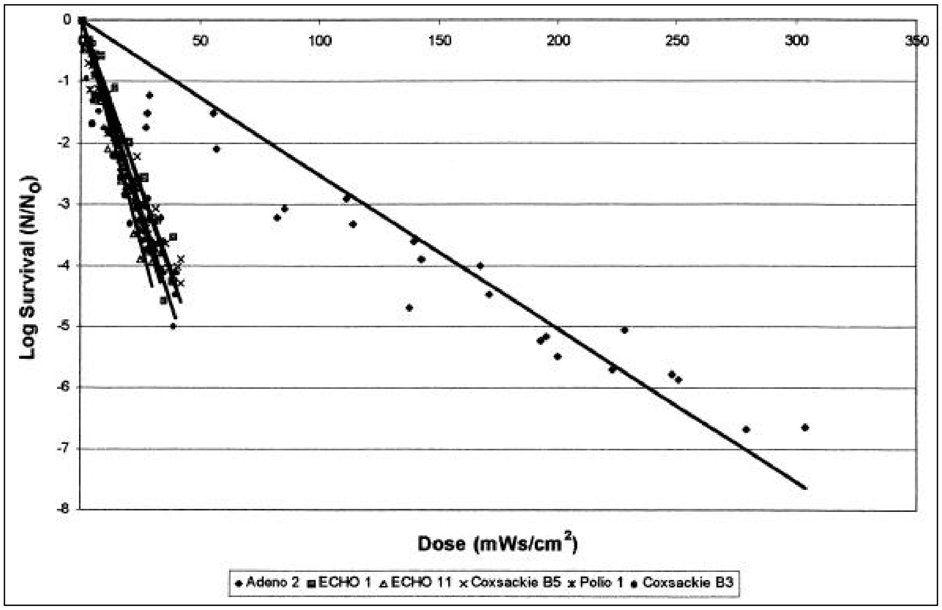

Figure 5.15 LP UV Dose Response Relationship of Ad2

USEPA (2010) published a dose-response equation for Ad2 of:

$$\text{Log Reduction} = 0.0262 * \text{UV Dose} + 0.2774$$

This dose response relationship is based on a dose range between 20 and 160 mJ/cm^2 (USEPA, 2010). Other studies have shown similar dose responses, consistently indicating that a 6-log reduction of Ad2 is met with a LP UV dose of up to 235 mJ/cm^2.

Pertaining directly to Oxnard and their Trojan D72AL75, the following can be said:

- The system, with five banks in series, results in a predicted UV dose of >250 mJ/cm^2 at a UVT of 80.8 percent. For a UVT of 95 percent or higher, as is the case for potable reuse projects using RO permeate, the UV dose will be substantially higher.
- 6-log adenovirus can be obtained based upon a UV dose of 235 mJ/cm2. Because MS2 is more sensitive to UV light than adenovirus, using an MS2-based validation conservatively estimates dose for adenovirus. The underlying concept for this conclusion is found in the discussion of RED bias in USEPA (2006).
- USEPA (2006) (Table 5.3 below) provides data on the dose required for up to 4-log reduction, but did not go further as such higher reductions are not required for drinking water disinfection applications.
- In total, the UV system, operating at a UV dose in excess of 250 mJ/cm^2, installed at the AWPF is sufficient to provide 6-log reduction of both virus and protozoa.

Table 5.3 UV Dose Targets for Log Inactivation Credit, mJ/cm^2 (USEPA, 2006)

Target	0.5-log	1.0-log	1.5-log	2.0-log	2.5-log	3.0-log	3.5-log	4.0-log
Crypto	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3	5.2	7.7	11	15	22
Adenovirus	39	58	79	100	121	143	163	186

5.4.4 NDMA Destruction Performance and Correlation to Disinfection Performance

While this section of the report is focused on disinfection credits, the destruction of NDMA provides a clear documentation of high UV dose delivery, and thus a high level of disinfection.

NDMA destruction is required to reduce RO permeate NDMA concentrations to below the DDW notification level of 10 ng/L (ppt). NDMA destruction has a proven correlation with UV dose, as shown in Figure 5.16, below. Using the information below, 1-log reduction of NDMA correlates to a UV dose in the range of ~700 to ~1100 mJ/cm^2. Such a wide variation does require further refinement by the industry. However, remembering that our disinfection target dose is 235 mJ/cm^2, there is a margin of comfort that dose sufficient to meet NDMA targets will also be sufficient to provide disinfection. Using the NDMA destruction dose/response from Sharpless and Linden (2003), the results of 22 NDMA destruction test runs at Oxnard can be evaluated for dose delivery and accuracy of system control, as shown in Figures 5.17 and 5.18, below.

Note: The NDMA data was collected over four different days, and the influent concentrations to the UV AOP system was consistent on each specific day, but varied from one day to the next. Thus, the NDMA destruction analysis utilized the average of influent NDMA concentrations for each day. Daily influent numbers, in ng/L, are shown below:

- 5/4/2016 - 32, 23, 29, 25, 23, 28.
- 6/20/2016 - 28, 32.
- 6/21/2016 - 24, 22, 19, 23, 20.
- 6/22/2016 - 11, 12, 13, 12.

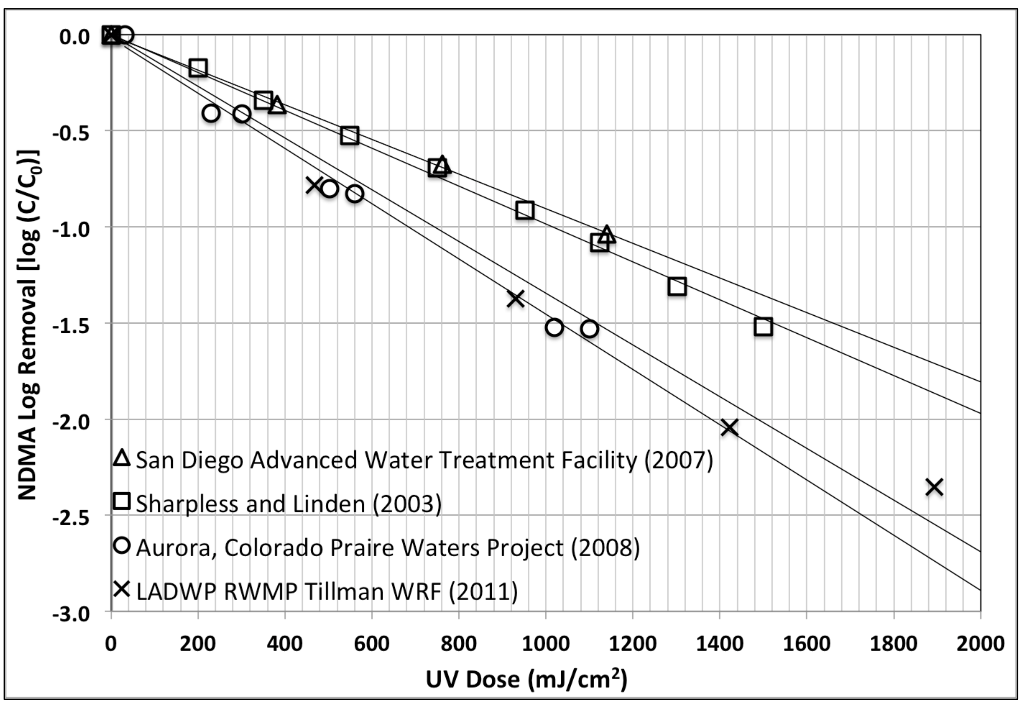

Figure 5.16 Collimated Beam Bench Testing Results for NDMA Collected in different Studies

(Sources of Data: City of San Diego, 2007; Sharpless and Linden, 2003; Swaim et al., 2008; Hokanson et al., 2011). The Colorado Prairie Waters Project in Aurora, Colorado is the only reference study that used hydrogen peroxide (5 mg/L). The results shown for the other three studies used UV photolysis (graphic credit: Trussell Technologies).

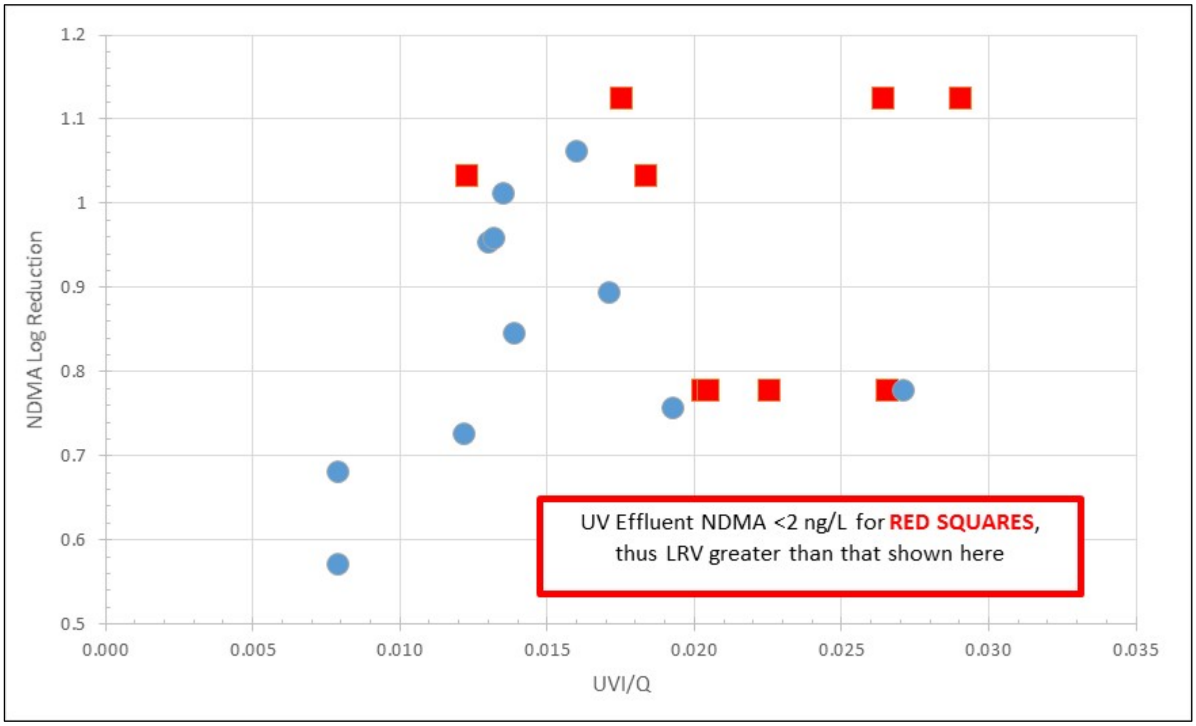

Figure 5.17 NDMA Destruction as a Function of UVI/Q

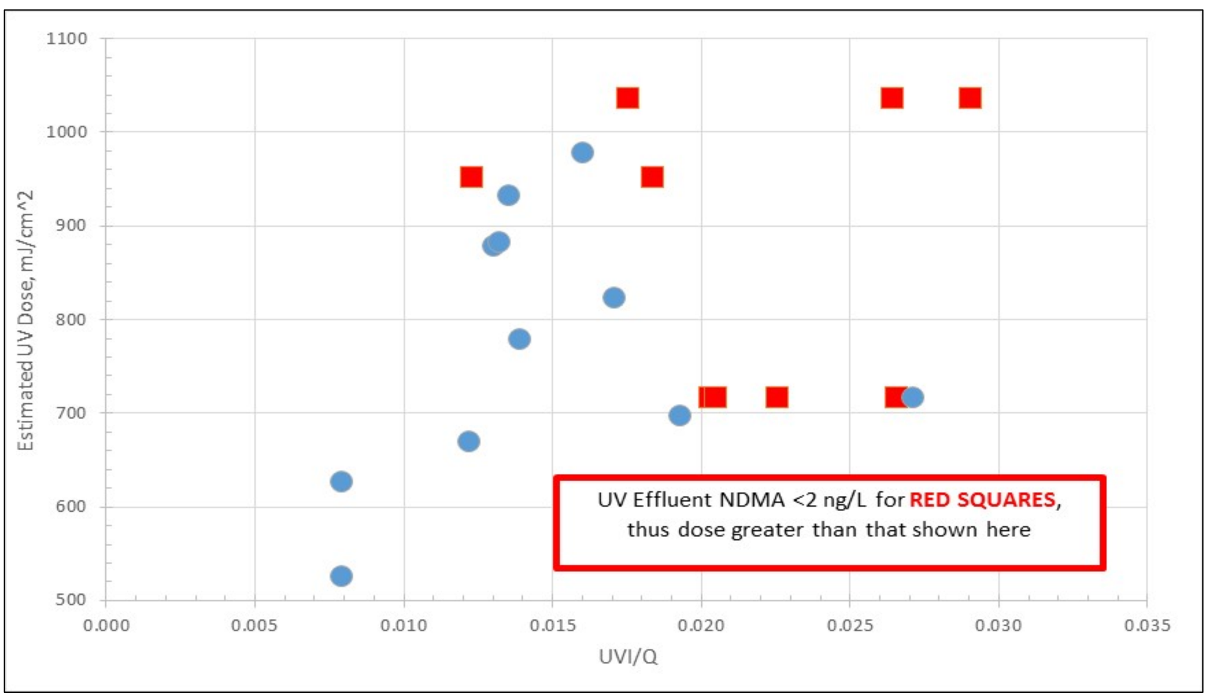

Figure 5.18 UV Dose as a Function of UVI/Q

The data in the figure above cannot be trended because a large number of the test events had NDMA below detection (<2 ng/L) in the UV effluent. However, this information can be used as a set-point control or alarm system for both disinfection and NDMA destruction based upon the following approach:

- NDMA concentrations in the RO permeate, through limited testing, have been in the range of 11 to 32 ng/L. Using the highest measured influent concentration (32 ng/L), and targeting the NDMA notification level of 10 ng/L, a minimum NDMA destruction of 0.5 is appropriate.
  - Assuming that NDMA levels in the RO permeate will vary from the measured numbers, and understanding that some level of operational safety factor is warranted to meet the 10 ng/L target, an advanced treated recycled water NDMA target of 5 ng/L is recommended, resulting in a need for an NDMA reduction target of 0.8-log.
  - 0.8-log NDMA destruction, based upon the collected data, can be obtained at a UVI/Q of 0.014 (with UVI being the sum of all UVI for operational reactors and Q being the total flow to the system in gpm).
- Regarding UV dose, the UVI/Q of 0.014 correlates to a UV dose of >800 mJ/cm2, well in excess of the dose needed for 6-log reduction of all known pathogens.

An important question thus exists on the capacity of the UV system under reduced UVT conditions, as detailed in Table 5.4 below, which predicts the UVI based upon the sensor equation and data detailed previously. As shown, even at a much reduced UVT of 95 percent, the UV system is projected to attain a UVI/Q of 0.018, which is greater than the minimum desired value of 0.014.

Table 5.4 UV Capacity to Meet NDMA Target of 5 ng/L

UVT	Q, mgd (gpm)	UVI for One Bank, mW/cm^2	# Banks in Operation at 100% Power	Combined UVI, mW/cm^2	UVI/Q
Ambient (~99%)	6.25 (4,340)	23.6	5	118	0.027
Reduced (95%)	6.25 (4,340)	15.6	5	78	0.018

5.4.5 1,4-Dioxane Destruction Performance

The UV AOP system, per DDW regulations (SWRCB, 2018a) must demonstrate 0.5-log reduction of 1,4-dioxane, or demonstrate destruction of a wider range of trace pollutants. Similar to ongoing and recently completed work for the City of LA (LA Sanitation, LASAN) and the Santa Clara Valley Water District (SCVWD), Seeding and destruction of 1,4-dioxane is the most precise method for such performance demonstration. Testing was completed over a range of H_2O_2 (hydrogen peroxide, peroxide) doses to demonstration 0.5-log reduction of 1,4-dioxane. Values for UVT, UV intensity, and UV reactor power were recorded. Testing was performed in triplicate, with all seeding and sampling done over a two-day period, with results shown in Figures 5.19 and 5.20.

Figure 5.19 indicates that a minimum Peroxide Weighted Dose (peroxide dose * UVI/Q) should be in the range of 0.072 to 0.088. Assuming the more conservative peroxide weighted dose of 0.088, the following target UVI/Q values are recommended:

- Peroxide dose of 3 mg/L - *Minimum* UVI/Q = 0.029;
- Peroxide dose of 4 mg/L - *Minimum* UVI/Q = 0.022;
- Peroxide dose of 5 mg/L - *Minimum* UVI/Q = 0.018.

Understanding that the installed system is controlled based upon an NDMA LRV and not a UVI based control, the recommended approach is to adjust the NDMA LRV setpoint to attain, on average, a UVI/Q value of 0.018 or higher, then provide for a constant peroxide dose of 6 mg/L, thus consistently providing for a Peroxide Weighted Dose of 0.108 (greater than the conservative value of 0.088 documented above).

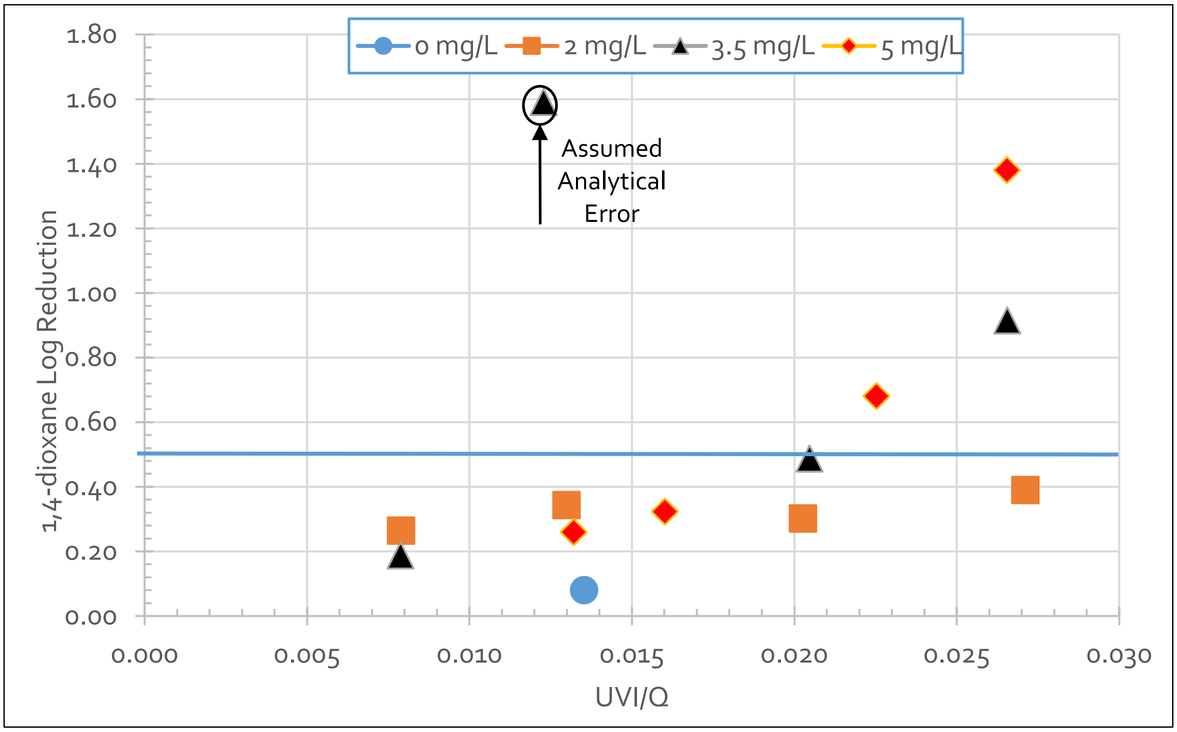

Figure 5.19 1,4-dioxane Destruction as a Function of UVI/Q and Peroxide Dose

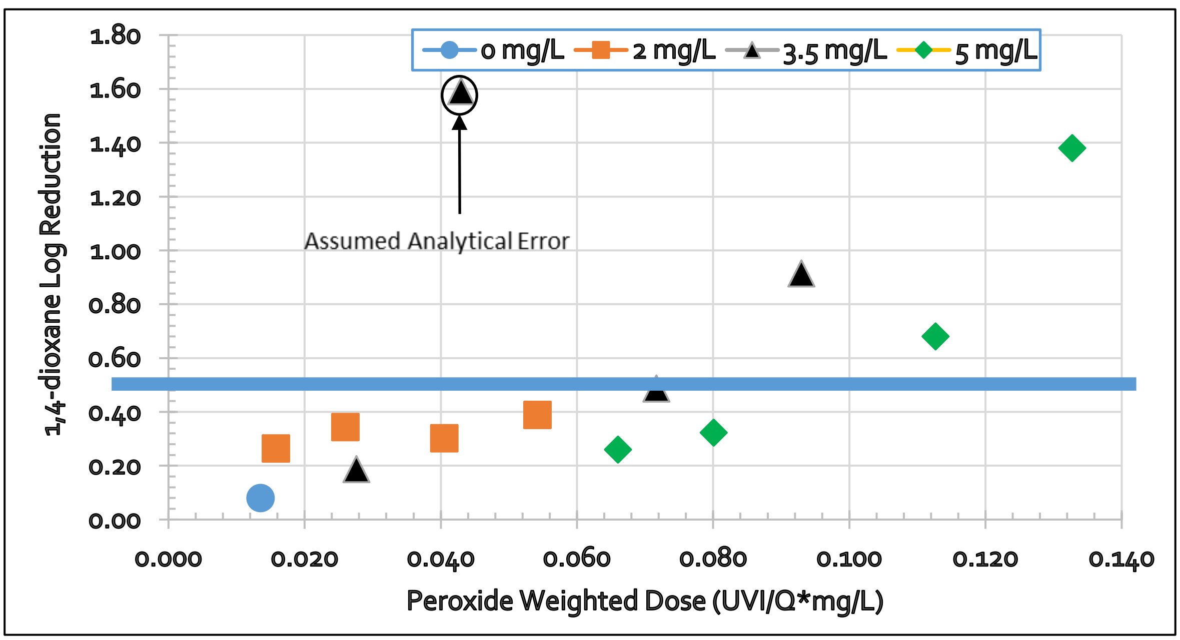

Figure 5.20 1,4-dioxane Destruction as a Function of Peroxide Weighted Dose

5.4.6 UV AOP Setpoint and Control for Disinfection, NDMA Reduction, and 1,4-Dioxane Reduction

The following conclusions can be made regarding system setpoints, control, and monitoring to meet disinfection, NDMA destruction, and 1,4-dioxane destruction for potable water reuse:

- The recommended UVI/Q to reliably below the 10 ng/L NDMA notification level is 0.014. This correlates to a minimum NDMA log reduction of 0.8, which also correlates to a UV dose well in excess of 235 mJ/cm^2 (the minimum UV dose for 6-log adenovirus disinfection).
- The use of 6 mg/L peroxide allows for the use of a minimum UVI/Q of 0.018 for 1,4-dioxane destruction.
- As shown in Table 8 (above), at a UVT of 95 percent, with 5 of 6 reactors in service, the installed system is projected to be able to attain the target 0.018 UVI/Q value; while still allowing for maintaining one UV reactor as redundant.
- **Thus, the key conclusion is that the installed system has sufficient capacity to meet disinfection, NDMA destruction, and 1,4-dioxane destruction at peak flow (6.25 mgd) and at a reduced UVT (95 percent).**

The remaining focus is the determination of what NDMA LRV setpoint is necessary to maintain the target UVI/Q of 0.018, and what level of additional monitoring is necessary to provide confidence in the maintenance of UVI readings over the lifetime of operation; as follows:

- As part of startup testing, the project team collected the necessary data to compare UVI/Q with the NDMA LRV setpoint, as shown in Figure 5.21. With one exception, the existing control system maintained a UVI/Q at or above ~0.013, which is noticeably below the recommended target of 0.018. **Accordingly, our recommendation is to adjust the NDMA LRV setpoint from 1.0 to 1.0*0.018/0.013, which results in a NDMA LRV setpoint of 1.4.**
- UVI/Q is not within the existing control system. On a daily basis at a minimum, AWPF staff shall hand record the UVI readings of all operational UV reactors, the flow through the UV reactors, the predicted NDMA LRV value, and calculate the UVI/Q. Should the UVI/Q value drop below 0.018 on a 30-day running average, the NDMA LRV setpoint shall be increased as needed to bring the 30-day running average above 0.018.
- On a quarterly basis, a reference set (6) of calibrated UVI sensors will be installed into the entire UV reactor and UVI readings will be compared to readings with the duty UVI sensors[2]. Readings for both the duty and reference sensors will be compared under similar operational conditions (hand control, all banks on at full power). Should the reference and duty UVI values be roughly equivalent (~20 percent), the reference sensors will be removed and replaced with the duty sensors. Any duty sensor that varies by more than 20 percent from the reference sensor will be replaced by the reference sensor and the duty sensor will be sent back to Trojan for calibration.

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[2] The sensors are located under the end cover, which will de-energize the system when removed (a safety feature). Therefore the reference sensor check would involve recording the sensor value, shutting down and swapping sensors, and then starting/warming up the system again to check the second sensor response. The sensor is held in a quartz sensor sleeve so the reactor would not have to be drained.

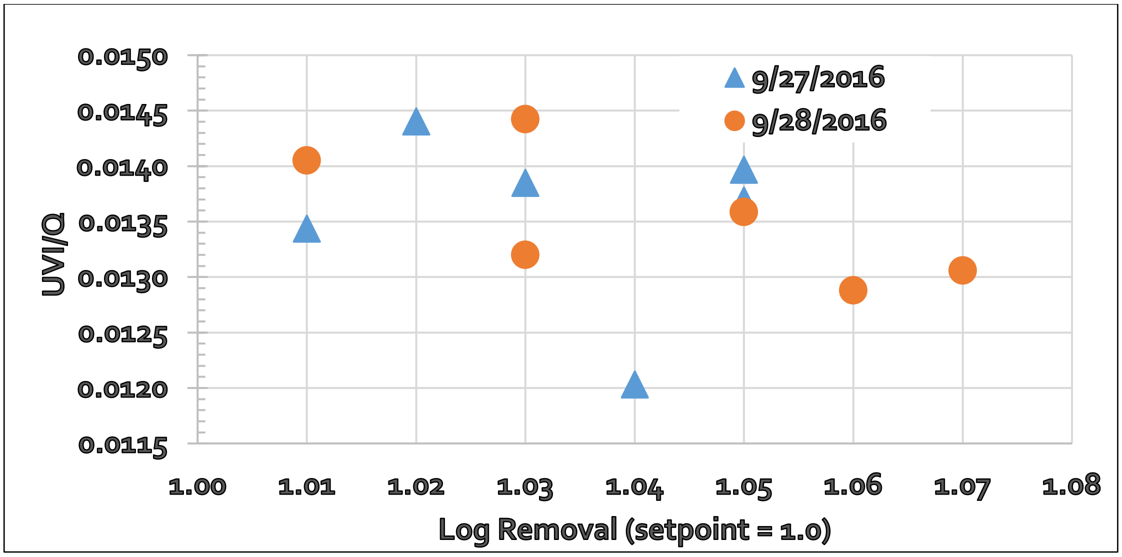

Figure 5.21 UVI/Q and NDMA LRV Control System Comparison

As a final point of comparison, DDW has become accustomed to the EEO concept for system control and permitting. Figure 5.22 plots the calculated EEO as a function of UVI/Q, presented here for information only. This data suggests that an EEO target would be in excess of 0.230 for Oxnard's particular application.

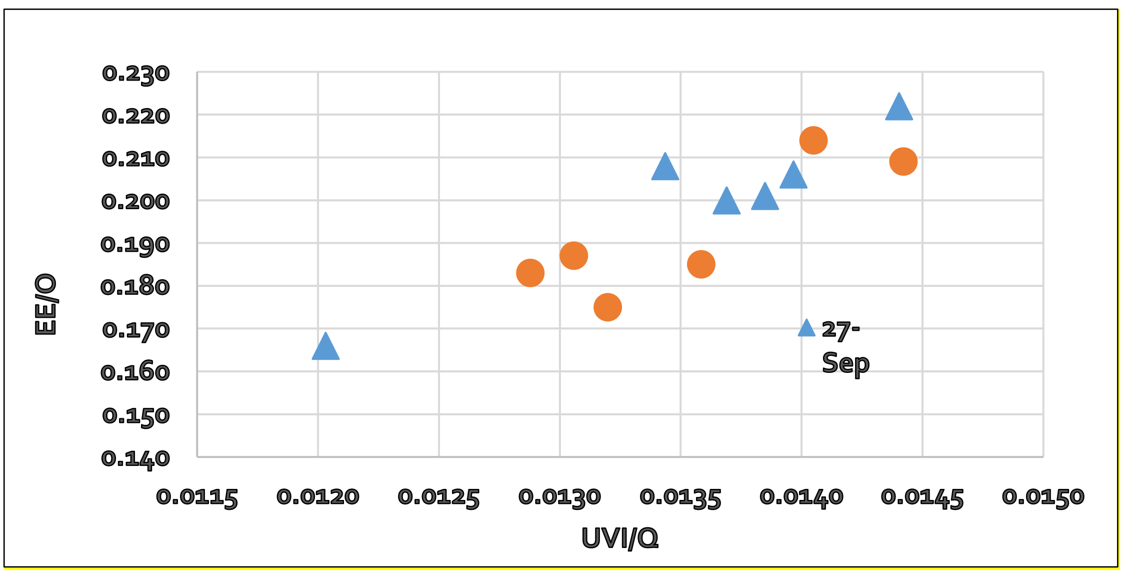

Figure 5.22 UVI/Q and EEO Comparisons

5.5 Subsurface Pathogen Removal Credit

Per DDW regulations (SWRCB, 2018a), utilities employing groundwater injection are granted 1-log virus removal credit per month of subsurface travel time, but are currently not granted credit for protozoa removal. Recent work by the WateReuse Research Foundation (led by Jorg Drewes) has documented the subsurface die-off rate of *Cryptosporidium* at 0.025 to 0.072-log reduction per day, with a mean of 0.039-log reduction per day (Drewes *et al.*, 2014). For 6-months of underground storage, the work by Drewes suggests 7-logs of die-off. Peng *et al.* (2008) reported 85 to 268 days of time to result in 1-log die-off of *Cryptosporidium* in sterile water at 4 degrees C. For 6-months of underground storage, the work by Peng suggests 0.7 to 2.1-log die-off. Per the April 2016 letter from DDW to the City, the DDW is not ready to allow protozoa removal credits based upon the referenced literature.

For the proposed groundwater recharge projects the water will be in the subsurface for a minimum subsurface retention time of 2 months, though longer periods may be required to attain the full 12-log virus credit requirement. Based upon current virus credits documented in Table 5.5, the minimum subsurface time is 3.1 months.

Table 5.5 Total Pathogen Log Reduction Credits

Process	Virus	*Giardia*	*Crypto*
Primary/Secondary Treatment	1.9	0.8	1.2
MF	0.0	4.0	4.0
RO	1.0	1.0	1.0
UV Advanced Oxidation	6	6	6
Groundwater Retention Time	3.1	0.0	0.0
Totals	***12.0***	***11.8***	***12.2***
DDW Requirements	***12***	***10***	***10***

5.6 Findings for Disinfection Credit

When taken together, the treatment processes discussed in Section 5.1 have the ability to meet (and exceed) the 12/10/10 pathogen log reduction requirements specified in the groundwater recharge regulations, as shown in Table 9. The total pathogen log reduction credits are 12.0/11.8/12.2 for a groundwater recharge project with 3.1 months of subsurface storage time.

Oxnard will be installing online TOC meters before and after RO, which is anticipated to provide greater pathogen credit through RO. Oxnard also intends to conduct a more detailed pathogen removal study through primary and secondary treatment. These results are, based upon the limited work already done, result in higher pathogen log removal through primary and secondary treatment. The anticipated most important result of the greater pathogen removal by RO and by primary and secondary treatment is greater virus reduction, which will allow for less reliance on groundwater time for virus credit. As such, **Oxnard requests flexibility from DDW and the RWQCB to adjust the time underground of the purified water, the RRT, based upon the collection of the aforementioned new data and the submittal of that new data to DDW and the RWQCB as part of monthly reporting.**

Section 6

GROUNDWATER RECHARGE OPERATIONAL STRATEGY

As mentioned previously, the City proposes one groundwater recharge operation (one ASR well) at this time with a capacity of ~2.9 mgd, and with future addition of wells to maximize the use of up to 6.25 mgd of water from the AWPF. This operation is proposed with 100 percent recycled water (i.e., no blending with diluent water). The City plans to inject the advanced treated recycled water into specific wells at the Campus Park location into aquifer zones within the Lower Aquifer System (LAS), keep the water underground for a minimum of 3.1 months (or the required response retention time [RRT]), then extract the water from the same ASR well for potable and non-potable use. In the future, should the City implement more advanced monitoring for the RO system and gain greater credits, the minimum time of 3.1 months may be reduced to 2 months.

This summary is based upon Hopkins (2016) study, which is included as Appendix B – Hydrogeological Study Report. The Hopkins report is provided to comply with regulations pursuant to section 60320.200(h), with a short summary provided here. **The first single ASR well has been installed at the Campus Park location, with an anticipated capacity of 2,000 gpm (2.9 mgd), with future wells and capacity to be added at Campus Park and other locations, as summarized in Table 1.** A pair of wells is anticipated to be necessary to fully utilize the operational capacity of each aquifer zone available for replenishment and reuse at the Campus Park site. This first well (and future wells) will inject advanced treated recycled water into a discrete aquifer zone(s) in the LAS and subsequently facilitate groundwater extraction after the required RRT is achieved and regulatory approval is granted.

The Campus Park location is ideal, as the ASR wells and monitoring wells can all be placed on City property, thus firmly controlling the use of groundwater in this area. Further, the proposed injection is into the LAS, whereas nearby potable wells are all in the Upper Aquifer System (UAS), and thus hydraulically isolated from the LAS. The closest well to the ASR location that is constructed within the LAS is located nearly 1 mile to the east and is owned and operated by the City.

The construction of ASR well facilities in discrete aquifer zones uses the isolation of natural clay layers to allow simultaneous operation of replenishment, retention, and reuse without mutual interference. Wells located in Aquifer 1 are by design isolated from wells located in Aquifer 2 and 3. Utilization of the confined aquifer system in this manner will allow optimization of a continual ASR operation and full utilization of the wellfield location. Utilization of discrete aquifer zones also serves to preservation of the replenished water quality and minimizes mixing with native groundwater. This type of operation will require validation that the minimum time requirement is in compliance prior to the distribution of recycled water.

The ASR operation, upon full execution, will involve recharge of some wells concurrent with extraction of water from other wells. This process is intended to be flexible to allow the City to maximize recharge of the groundwater. One potential example of operation is as follows:

- Recharge ASR Well No. 1 in confined Aquifer 1 at flows up to 2,000 gpm. The period of recharge time must be sufficient so that recharged water does not migrate to off-site potable water wells. The duration of injection may range from 3.1 months to 6 months or greater.
- After the allocated time, stop recharge of ASR Well No. 1. Hold water in Aquifer 1 for a minimum of 3.1 months or the required RRT starting from the time the last drop of water entered the ASR well.
- Extract Water from ASR Well 1 at a rate of up to 3,000 gpm.
- Repeat the three steps described above in rotation for all operational ASR wells to allow a continual IPR operation.
- Methods to prevent a cross connection during injection, during the necessary 3.1 months of hold time (RRT), and during extraction are presented previously in Chapter 3.

Though this operation is fully intended as an ASR operation, in the event that some recharged water is not extracted and migrates toward drinking water wells, the time to the nearest downstream potable water supply well must be determined and documented to be more than 3.1 months of time for this project, though regulations allow for as little as 2 months of travel time as long as all pathogen reduction criteria are met.

Utilizing a conservative estimation of soil porosity (15 percent), an average hydraulic conductivity value of (125 feet /day), and the range of groundwater gradients calculated from available data, Hopkins (2016) used the average linear flow velocity equation to predict the subsurface travel time caused by the seasonal gradients in the aquifer system.

During normal to wet years, the groundwater gradient is toward the southwest away from the Oxnard Forebay, the primary area of aquifer recharge (Hopkins, 2016). During dry years, the groundwater gradient is predominantly westward toward the area of greatest agricultural use (Hopkins, 2016). During a drought with repeated dry years where the groundwater levels in the aquifer system fall below sea level, the groundwater gradient migrates to the north toward inland pumping and away from the ocean where offshore storage is located in the aquifer system. The movement of groundwater caused by the regional gradient is slow and results in very little movement of the injected advanced treated recycled water plume, with an estimated travel time of between 0.17 and 0.92 feet per day.

The injection of advanced treated recycled water at 2,000 gpm results in a purified plume at a ~1,000 foot radius and ~1,500 foot radius after 3 months and 6 months of continuous injection, respectively (Hopkins, 2016). Using the 0.17 to 0.92 ft/day travel time, the advanced treated recycled water will move 30 to 165 feet in the direction of groundwater flow (to the Southwest or to the North) over a period of six months (during 3 months of injection and 3 months of retention). DDW regulations (SWRCB. 2018a) require a safety factor of 4 times the distance for groundwater calculations using Darcy's law methods (0.25 log credit for virus and 0.25-month response time credit per month of transport using Darcy's law methods). This results in a projected movement of 120 to 660 feet after the completion of a 180-day injection and retention period. This distance is significantly short of the distance to the nearest potable wells, both municipal and private wells.

After the 2-year injection period at 2,000 gpm, the area of the displaced volume is predicted by Hopkins (2016) to not reach the nearest potable supply well (City Well No. 20, located in the LAS). **Note: until tracer studies document otherwise, the maximum proposed injection period is 90 days.**

The proposed monitoring well locations and related hydrogeology are also documented by Hopkins (2016). These well locations are intended to track the travel time of the injected water (greater than 2 weeks and less than 6 months, in accordance with DDW regulations (SWRCB, 2018a). As proposed, the three monitoring wells will sufficiently define the groundwater gradient in Aquifer 1. The location of Monitoring Well No. 2 is between the proposed ASR well and the City municipal supply Well No. 20. The differential well spacing will generate data through tracer testing to confirm the displacement rate of native groundwater. As detailed by Hopkins (2016), Monitoring Well No. 1 is anticipated to see the recharge bubble within 2 weeks while Monitoring Well No. 2 should see the recharge bubble at around 60 days. If our estimates are accurate, Monitoring Well No. 3 will not see the recharge bubble prior to the end of 90 days of recharge.

Section 7

MONITORING AND RESPONSE RETENTION TIME

Over time, detection of trace pollutants in the monitoring wells and reduced treatment performance may occur. Depending upon the issue, the City may handle the issue internally, or, in the event of a regulatory exceedance, the City must provide the appropriate notification to DDW and RWQCB staff. These meetings and discussions will determine if the produced water remains protective of public health or if some form of mitigation is required. The need for and magnitude of response from the City will be based upon the following analysis:

- **Analytical detection of a pollutant above a regulated value.** The City will resample the groundwater and concurrently evaluate the AWPF performance. Should resampling still demonstrate non-compliance, appropriate remediation measures will be taken, which may include shutting down production wells or installation of well-head treatment for wells that may extract inadequately treated water. For the ASR operation, the ASR wells can be put into extraction mode and water can be pumped and used for non-potable applications.
- **Analytical detection of a pollutant below a regulated value.** The City will evaluate the occurrence, cause, and significance of the trace pollutant at the AWPF and may take corrective measures to reduce the concentration of the pollutant, either through source control or through treatment process modification.
- **Process failures or online metering/process monitoring failures above regulated values.** The City will evaluate the potential impact on treatment performance, both in terms of pathogen reduction and trace pollutant reduction.
- Included in the analysis by City and regulatory staff is the potential impact of dilution and attenuation of the pollutant of concern in the groundwater basin. Because the ASR operation is intended to be a fill and draw operation with minimal loss of injected water, dilution is not anticipated to be significant.

For the purpose of the RRT, the City anticipates a time period of 4 to 6 weeks for resampling, analysis of treatment processes, and regulatory consultation, as detailed below. This time value is less than the proposed minimum RRT of 3.1 months, as reviewed below.

7.1 Proposed Response retention Time (RRT) Concept

The ASR operations will follow the requirements of DDW regulations (SWRCB, 2018a), Sections 60320.200(b) and 60320.224. For the ASR project, the RRT is based entirely upon City operation of the well. The minimum time of storage for this ASR operation will be 3.1 months to meet the pathogen credits for potable reuse. In the event of a stoppage in ASR operation, the travel distance to the nearest potable water well (City Well #20) is ~4,000 feet. As shown by Hopkins (2016), two years of continuous recharge does not reach City Well #20. As only a 3-month to 6-month recharge period is originally proposed, and as DDW requires a 4X safety factor for Darcy's Law estimations, a 6-month RRT is readily achieved without having the advanced treated recycled water reach a potable well.

For this project, a RRT of three months is more than sufficient to:

- Gain 3-log virus credit through subsurface storage time.
- Identify a treatment failure or detect an inadequately-treated constituent.
- Consider appropriate actions to protect public health.
- Implement corrective measures.

7.1.1 Online Process Control Monitoring

The AWPF controls are designed to maintain water quality that is protective of public health. The AWPF will have both continuous online monitoring and periodic monitoring of treatment performance. Production of water for IPR applications may cease based upon the process monitoring approaches listed in Table 7.1. The RRT for each of these monitoring approaches is also included within Table 7.1.

The original Operations and Maintenance Management Plant (OMMP, KEH, 2015)[3], has been updated based upon the work documented herein into the Draft Operations Optimization Plan (OOP, MV Engineering, 2018). The Draft OOP provides further details on the operations and control concepts for the production of water for non-potable and potable reuse.

7.1.2 Offline Analytical Monitoring

Details on the required water quality monitoring and the proposed sampling plan are included in Sections 9 and 17, respectively. This section provides information on the RRT for sampling, analytical monitoring, and response.

The monitoring and control of the MF, RO, and UV AOP systems focuses on process performance to maximize pathogen reduction, plus additional monitoring of trace constituent removal or destruction. The offline monitoring program focuses on chemicals that could present a chronic risk. Most of the monitored constituents are regulated based on conservative estimates of the lifetime health risk associated with chronic exposure. Accordingly, the RRT must be sufficient to respond to acute health concerns such as pathogens as well as several specific chemicals (e.g., nitrate, nitrite), but need not necessarily account for the response time for constituents with long term chronic concerns.

With the above context, the project team examined the RRT for different analytical parameters that represent a chronic concern (Table 7.2). Because the groundwater storage time for this ASR project is at least 3.1 months, there is more than sufficient RRT to address any potential issues related to regulated and non-regulated constituents.

[3] This document, which has previously been reviewed by DDW, can be provided upon request.

Table 7.1 RRT Values for Online and Periodic Treatment Process Control

Process	Monitoring	Regulatory Requirement	Issue	Evaluation Approach	Operational Response	RRT
MF	Online filtrate turbidity	0.2 NTU.	A properly functioning MF should produce a filtrate with a turbidity of <0.2 NTU.	• Calibrate online meter using bench-scale results. • Examine trend turbidity with time, watch for increasing filtrate turbidity with time, indicative of loss of membrane performance.	• Shut down out of compliance train. Bring on redundant MF train if turbidity continues to exceed 0.2 NTU. • Reduce or shut down water production if insufficient MF capacity to meet turbidity standards. • Perform DIT and repair membranes.	Minutes to Hours
MF	Daily pressure decay testing (also called DIT)	Performance requirement of <0.8 psi/5min.	DIT failure suggests breach in MF, resulting in reduced a removal of particulates (including protozoa) by MF.	No evaluation, see Operational Response.	• Shut down out of compliance train. Bring on redundant train. • Reduce or shut down water production if insufficient MF capacity exists. • Repair membranes.	One day if DIT done daily. Shorter RRTs if DITs done more frequently.
RO	Online EC	• Either EC or TOC online monitoring required to document performance. • Log reduction of EC across RO can be used to prove pathogen credits.	Log reduction of EC across RO is trending down, indicating RO membrane decay or some other leak.	• Verify/calibrate online EC meters with bench-scale testing. • Profile RO vessels to find damaged membrane or seal.	Replace damaged RO membranes or seals.	Hours to Days
RO	Online or periodic TOC	• For the first 20 weeks of operation, ROP TOC must be ≤0.25 mg/L 95% of the time based upon weekly or more frequent sampling. • Subsequent to 20 weeks, ROP TOC must be ≤0.5 mg/L. • Log reduction of TOC can be used to continuously measure RO performance.	• High TOC in ROP suggests either a breach in the RO membrane or the existence of low molecular weight compounds that can pass through RO. • Log reduction of TOC across RO is trending down, indicating RO membrane decay or some other leak.	• Verify/calibrate online TOC meters with bench-scale testing. • Sample RO influent and ROP for analysis of a wide range of trace organic and regulated compounds. • Profile RO vessels to find damaged membrane or seal. Profile to be done using EC, as above.	Depending upon the results of the evaluation: • Replace damaged RO membranes or seals. • Implement a source control solution.	Days to Weeks
UV AOP	Online F	No set value. ROP typically has a UVT of 98 to 99%. The UV system is designed to provide a target dose based upon an assumed UVT value of 95%.	• Trending of UVT down suggests either the passage of low molecular weight organics through the RO or suggests damage to the RO process. • Reduced UVT will impact the ability of the existing UV system to deliver the proper UV dose.	• Verify/calibrate online UVT meter with bench-scale testing. • Sample RO influent and ROP for analysis of a wide range of trace organic and regulated compounds. • Profile RO vessels to find damaged membrane or seal. Profile to be done using EC, as above.	Depending upon the results of the evaluation: • Replace damaged RO membranes or seals. • Implement a source control solution.	Days to Weeks
UV AOP	NDMA LRV Based Upon a Target UVI/Q	UV intensity is used to measure the combined impact of lamp output decay and sleeve fouling. UV intensity can also be used as part of UV reactor dose control. For this project, the UVI/Q is recommended as a daily verification of performance to support the NDMA LRV-based operation.	Reduced UV intensity suggests one of several issues: • Aged lamps that must be replaced. • Fouled sleeves that must be cleaned. • Reduced UVT.	• Verify accuracy of online UVT meter (above). • Verify that UV intensity sensor is properly seated in sensor port. • Check UV intensity sensor accuracy with reference sensor(s). • Remove and replace UV intensity sensor with a standby sensor. • Pull representative quartz sleeve, clean, and replace. Alternatively, clean all sleeves. Recheck sensor intensity.	Depending upon the results of the evaluation: • Replace sensor. • Clean all sleeves. • Replace lamp(s). • Calibrate UVT meter.	Hours to Days

Table 7.2 RRT Examples for Analytical Monitoring of AWPF and Monitoring Wells

Location	Parameter	Frequency	Performance Requirement	Issue	Evaluation Approach	Operational Response	RRT
Monitoring Wells	Primary MCLs	Quarterly	Varies	Primary MCLs are typically met in secondary effluent. Detection of pollutants near, at, or above the MCLs suggests a high pollutant load at the OWTP and a lack of performance through the AWPF.	• Resample compliance point in question. • If detection was at the monitoring well, sample advanced treated recycled water at the AWPF. • Profile OWTP and AWPF systems as needed.	• Repair process components. • Evaluate other sources of pollutant that may be contributing to the pollutant at the monitoring well.	Sampling is quarterly. Response time, including repeat samples and analysis is a minimum of two weeks. Reasonable RRT is 16 weeks.
Monitoring Wells	Total Coliform	Quarterly (wells)	≤2 MPN/100mL	Total coliform detection at the AWPF is likely sample contamination or sampling from a line with regrowth. Legitimate breakthrough of total coliform suggests a large performance failure.	• Resample compliance point in question. • Concurrently sampling for fecal coliform. • Evaluate treatment processes for compliance with various operating criteria.	• Repair process components. • Evaluate other sources of pollutant that may be contributing to the pollutant at the monitoring well.	Sampling is quarterly for the monitoring wells. Response time, including repeat samples and analysis is a few days. Reasonable RRT is 13 weeks.
AWPF Advanced treated recycled water	NDMA	Quarterly	≤10 ng/L	Values in excess of 10 ng/L suggest either reduced UV performance or increased levels of NDMA in the secondary effluent.	• Sample advanced treated recycled water at the AWPF. • Sample RO influent and RO permeate. • Determine if the problem is UV performance or increased NDMA at the OWTP.	Depending upon the results of the evaluation: • Shut down water production or bring redundant treatment processes online. • Evaluate NDMA formation in the OWTP or increased NDMA loadings in the collection system.	Sampling is quarterly. Response time, including repeat samples and analysis is a minimum of two weeks. Reasonable RRT is 16 weeks.
AWPF Advanced treated recycled water	Total Coliform	Daily	ND-≤2.2 MPN/100mL	Total coliform should be removed after RO and after UV AOP. Existence of total coliform at the monitoring well suggests sample contamination or a much larger treatment process failure.	• Resample monitoring well. • Sample advanced treated recycled water at the AWPF. • Sample RO influent and RO permeate. • Concurrently sampling for fecal coliform.	Depending upon the results of the evaluation: • Shut down water production or bring redundant treatment processes online. • Evaluate other methods for total coliform contamination of the monitoring well.	Days
AWPF Advanced treated recycled water	Total Nitrogen	Weekly	<10 mg/L	Maintaining TN <10 mg/L assures that nitrate levels are also <10 mg/L. Nitrate is an acute health concern.	• Resample monitoring well. • Sample advanced treated recycled water at the AWPF. • Sample RO influent and RO permeate.	• Shut down water production until TN<10 mg/L.	Sampling is twice weekly, no more than 3 days between sampling events. Response time, including repeat samples and analysis is a minimum of three weeks. Reasonable RRT is four weeks.

7.2 Water Quality Failure Decision Protocol

This water quality failure decision protocol is intended to address a suspected water quality failure detected either at the AWPF (e.g., a process failure or an unknown chemical pollutant that passes through the AWPF) or within the groundwater monitoring system. For treatment plant failures that are detected at the AWPF, the advanced treated recycled water would be diverted to effluent discharge and not sent into the distribution system for water reuse applications.

For this analysis, two scenarios are assumed. First, a control system and/or alarm system failure is assumed at the AWPF, resulting in the noncompliant water being continuously produced and recharged into the groundwater basin. Second, non-compliant water quality is detected in the groundwater monitoring wells. In either of these cases, City staff will follow a detailed decision protocol to evaluate the situation and determine if the advanced treated recycled water quality presents a risk to public health.

The objectives of the decision protocol are as follows:

- Provide a mechanism to verify water quality in a rigorous and measured way. Effort also will minimize questions and concerns from City stakeholders and interested parties through effective communication of the sampling results and their implications.
- Have the City openly communicate water quality information with a single voice to deliver a clear and consistent message.
- Provide an organized process for data evaluation and reporting.

The first step in such a water quality situation is to shut down all water production for potable reuse (non-potable reuse would remain in operation as long as non-potable water quality standards are met). Figure 30 illustrates an example protocol that would follow cessation of production for potable water reuse[4]. Central to this protocol are two teams:

- The "Engineering/Operations Staff."
- The "Decision Committee."

Once a water quality problem is verified, non-compliant water will be extracted from the system and used for non-potable water reuse applications. As shown in Figure 7.1, proper notifications (e.g., public, regulators) will be completed, detailing the water quality challenge(s) and the implemented solution(s). Regulatory notifications will be done in accordance with Order No. 2011-0079-A02 (VII)(10) from the RWQCB. ***This protocol will be adopted by the City prior for the production of recycled water for potable reuse***.

7.3 Proposed RRT

The proposed RRT here is based upon responding to acute concerns, which are those associated with pathogens and a few chemical constituents (e.g., nitrate, nitrite). Thus, the proposed RRT can be calculated as follows:

RRT = Sample Collection (daily to twice per week[5]), Analysis and Regulatory Consultation Time (4 weeks) + Time to Provide Relief Measure or Alternative Source of Water (4 weeks) = 9 weeks.

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[4] Modeled after the Santa Clara Valley Water District's (SCVWD's) Water Quality Response Protocol. The City and Carollo appreciates the use of this information.

[5] DDW requirements for TN (which provides a conservative measure for nitrate) is twice per week.

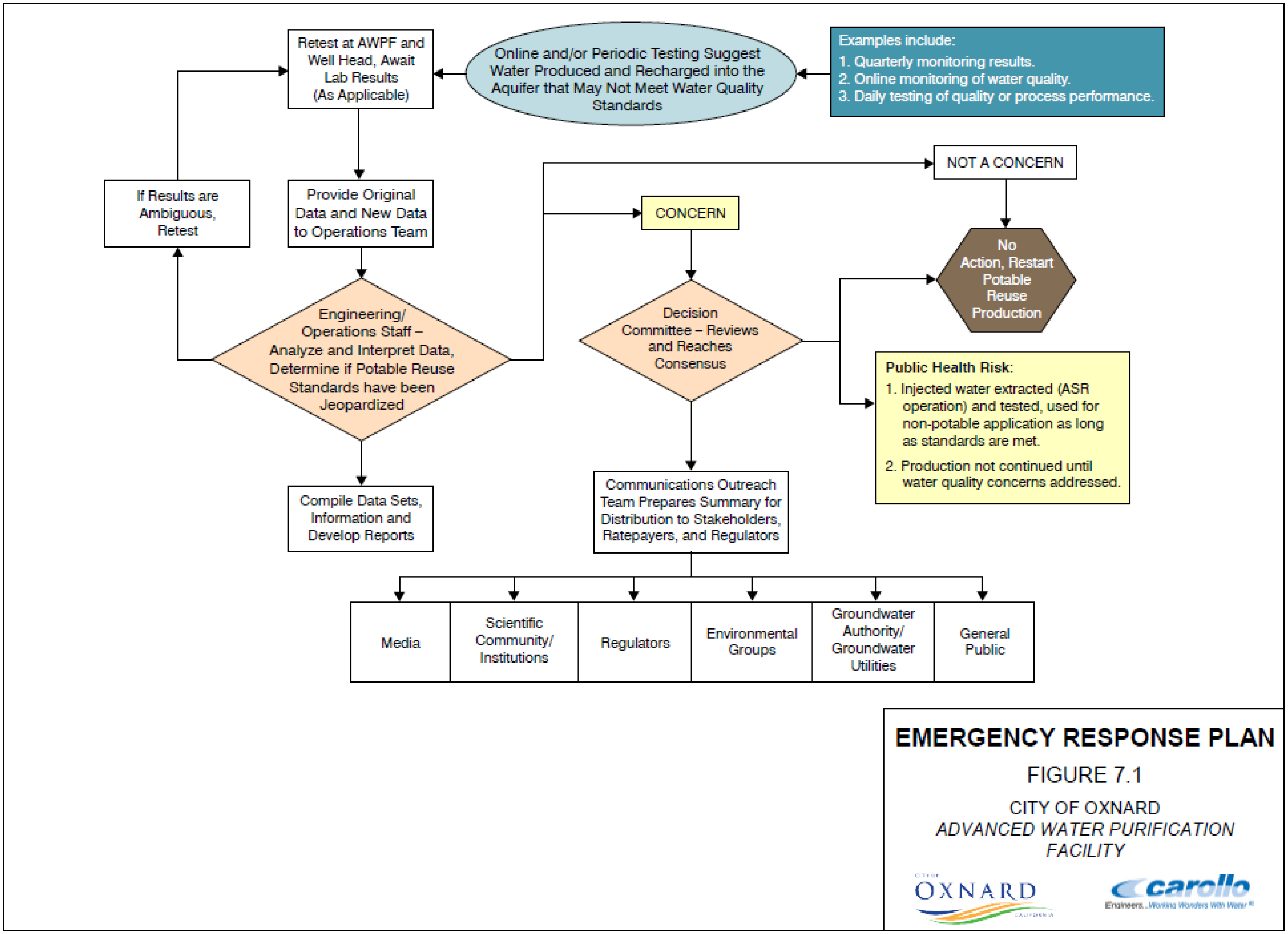

Figure 7.1 Emergency Response Plan

As detailed in Hopkins (2016) and in accordance with DDW regulations (SWRCB, 2018a) Section 60320.224, groundwater residence/travel times to the nearest potable well are estimated at more than 2 years for the ASR application. As the ASR fill and draw times are controlled, and the proposed project will leave the water in the ground for a minimum of 3.1 months, the RRT of 9 weeks will be reliably met.

Upon commencement of the project, these travel and residence times will be demonstrated through the use of intrinsic or added tracers, potentially TDS, chloride, and sulfate. Further details on startup testing, which includes the groundwater residence time demonstrations, is included in Section 17 of this report.

Section 8

NEED FOR ALTERNATIVE SOURCES OF WATER

Long-term sustainable capture and reuse of water supplies is the goal of the City. However, the City's short term water supply remains reliable and interruptions in the production of water from potable reuse do not constitute an emergency or short term problem. Thus, for failures in monitoring or process performance, or detection of pollutants in the groundwater monitoring network, the AWPF can be simply shut down and not produce water.

For ASR operations, if improperly treated water is injected into the aquifer, or if groundwater monitoring results do not meet regulatory limits, the water will be extracted from the ASR location, and one of the following will occur.

- If the water quality meets the requirements for non-potable reuse, the water will be sent off-site for non-potable reuse operations.
- If the water quality does not meet the requirements for non-potable reuse, well-head treatment will be employed to bring the non-compliant water to non-potable water reuse standards.

As the ASR wells are intended to extract the majority of injected water, and as the current groundwater analysis shows limited groundwater migration at the proposed ASR site, migration of injected water to off-site potable wells is not anticipated. With that said, DDW has requested that this report address such off-site migration. As illustrated in Hopkins (2016), the nearest potable water well to the proposed ASR location is City Well No. 20. In the event of contamination of that well, well-head treatment would be initiated, with the treatment based upon the type of contaminant. For pathogens, installation of a UV system and/or free chlorination could be employed. For trace pollutants, the use of activated carbon or advanced oxidation (which could be a UV-based process) could be employed. For nitrate contamination, ion exchange treatment would be employed.

Section 9

POTABLE REUSE WATER QUALITY

There are no federal regulations pertaining to water reuse, and water reuse regulations are developed at the state level. The main regulatory agency for water reuse in the State of California is the SWRCB. The SWRCB is separated into nine different RWQCBs that regulate water reuse projects in conformance with the regulations adopted by the DDW. The City is located within the jurisdiction of the LARWQCB.

The water quality limits for groundwater recharge with recycled water and the projected water quality for the AWPF are reviewed below. ***The proposed monitoring and reporting program, based upon the regulatory requirements, is detailed in Chapter 15.***

9.1 Water Quality Requirements

Tables 9.1 through 9.6 constitute the required water quality performance, consistent with DDW regulations (SWRCB, 2017). Within each table is a specific reference to the table within the regulation (e.g., Primary MCLs are listed in a table below and also found in Table 64431-A of SWRCB (2018b)). In addition to the DDW (SWRCB, 2017) water quality requirements provided in the following tables, the advanced treated recycled water from the AWPF facility will be required to satisfy the discharge limits included in the revised GREAT permit (R4-2011-0079-A01 and R4-2008-0083-A01) prior to injection.

Table 9.1 Inorganics with Primary MCLs(1)

Constituents	Primary MCL (in mg/L)	Constituents	Primary MCL (in mg/L)
Aluminum	1.0	Fluoride	2
Antimony	0.2	Lead	0.015(4)
Arsenic	0.006	Mercury	0.002
Asbestos	7 (MFL)(2)	Nickel	0.1
Barium	1	Nitrate (as NO_3)	45
Beryllium	0.004	Nitrite (as N)	1
Cadmium	0.005	Total Nitrate/Nitrite (as N)	10
Hexavalent Chromium	0.010	Selenium	0.05
Copper	1.3(3)	Thallium	0.02
Cyanide	0.15		

Notes:
(1) Based on Table 64431-A.
(2) MFL = Million fibers per liter, with fiber lengths > 10 microns.
(3) Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.
(4) The MCL for lead was rescinded with the adoption of the regulatory action level. The action level is like a MCL except it also requires additional testing. If more than 10 percent of samples collected at the point of delivery exceed the action level, the water distributor must take steps to reduce the corrosivity and/or lead concentrations of the delivered water and notify the public about steps they should take to protect their health.

Table 9.2 Constituents/Parameters with Secondary MCLs

Constituents(1)	MCL (in mg/L)	Constituents(2)	MCL (in mg/L)
Aluminum	0.2	TDS	500
Color	15 (units)	Specific Conductance	900 uS/cm
Copper	1	Chloride	250
Foaming Agents (MBAS)	0.5	Sulfate	250
Iron	0.3		
Manganese	0.05		
Methyl-tert-butyl-ether (MBTE)	0.005		
Odor Threshold	3 (units)		
Silver	0.1		
Thiobencarb	0.001		
Turbidity	5 (NTU)		
Zinc	5		

Notes:
(1) Based on Table 64449-A.
(2) Based on **Table 6449-B**

Table 9.3 Radioactivity(1)

Constituents	MCL (in pCi/L)	Constituents	MCL (in pCi/L)
Uranium	20	Gross Beta particle activity	50(2)
Combined radium-226 & 228	5	Strontium-90	8(2)
Gross alpha particle activity	15	Tritium	20,000(2)

Notes:
(1) Based on Tables 64442 and 64443.
(2) 50 pCi/L is used for regulatory purposes to ensure that exposure above 4 millirem/yr does not occur. If 50 pCi/L is exceeded, than the water is deemed "vulnerable" and in need of potential future monitoring of specific radionuclides.

Table 9.4 Regulated Organics[1]

Constituents	MCL (in mg/L)	Constituents	MCL (in mg/L)
Volatile Organic Compounds			
Benzene	0.001	Monochlorobenzene	0.07
Carbon Tetrachloride	0.0005	Styrene	0.1
1,2-Dichlorobenzene	0.6	1,1,2,2-Tetrachloroethane	0.001
1,4-Dichlorobenzene	0.005	Tetrachloroethylene	0.005
1,1-Dichloroethane	0.005	Toluene	0.15
1,2-Dichloroethane	0.0005	1,2,4 Trichlorobenzene	0.005
1,1-Dichloroethylene	0.006	1,1,1-Trichloroethane	0.2
cis-1,2-Dichloroethylene	0.006	1,1,2-Trichloroethane	0.005
trans-1,2-Dichloroethylene	0.01	Trichloroethylene	0.005
Dichloromethane	0.005	Trichlorofluoromethane	0.15
1,3-Dichloropropene	0.0005	1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
1,2-Dichloropropane	0.005	Vinyl chloride	0.0005
Ethylbenzene	0.3	Xylenes	1.75
Methyl-tert-butyl ether (MTBE)	0.013		
SVOCs			
Alachlor	0.002	Hexachlorobenzene	0.001
Atrazine	0.001	Hexachlorocyclopentadiene	0.05
Bentazon	0.018	Lindane	0.0002
Benzo(a) Pyrene	0.0002	Methoxychlor	0.03
Carbofuran	0.018	Molinate	0.02
Chlordane	0.0001	Oxamyl	0.05
Dalapon	0.2	Pentachlorophenol	0.001
Dibromochloropropane	0.0002	Picloram	0.5
Di(2-ethylhexyl)adipate	0.4	Polychlorinated Biphenyls	0.0005
Di(2-ethylhexyl)phthalate	0.004	Pentachlorophenol	0.001
2,4-D	0.07	Picloram	0.5
Dinoseb	0.007	Polychlorinated Biphenyls	0.0005
Diquat	0.02	Simazine	0.004
Endothall	0.1	Thiobencarb	0.07/0.001[2]
Endrin	0.002	Toxaphene	0.003
Ethylene Dibromide	0.00005	2,3,7.8-TCDD (Dioxin)	$3x10^{-8}$
Glyphosate	0.7	2,4,5-TP (Silvex)	0.05
Heptachlor	0.00001		

Notes:
(1) Based on **Table 64444-A.**
(2) Second value is listed as a Secondary MCL.

Table 9.5 Disinfection By-Products(1)

Constituents	MCL (in mg/L)	Constituents	MCL (in mg/L)
Total Trihalomethanes	0.080	Bromate	0.010
Total haloacetic acids	0.060	Chlorite	1.0

Notes:
(1) Based on **Table 64533-A.**

Table 9.6 Constituents with Notification Levels (1,2)

Constituents	NL (in µg/L)	Constituents	NL (in µg/L)
Boron	1000	Manganese	500
n-Butylbenzene	260	Methyl isobutyl ketone (MIBK)	120
sec-Butylbenzene	260	Naphthalene	17
tert-Butylbenzene	260	N-Nitrosodiethylamine (NDEA)	0.01
Carbon disulfide	160	N-Nitrosodimethylamine (NDMA)	0.01
Chlorate	800	N-Nitrosodi-n-propylamine (NDPA)	0.01
2-Chlorotoluene	140	Propachlor**	90
4-Chlorotoluene	140	n-Propylbenzene	260
Diazinon	1.2	RDX	0.3
Dichlorodifluoromethane (Freon 12)	1000	Tertiary butyl alcohol (TBA)	12
1,4-Dioxane	1	1,2,3-Trichloropropane (1,2,3-TCP)	0.005
Ethylene glycol	14000	1,2,4-Trimethylbenzene	330
Formaldehyde	100	1,3,5-Trimethylbenzene	330
HMX	350	2,4,6-Trinitrotoluene (TNT)	1
Isopropylbenzene	770	Vanadium	50
Perfluorooctanoic acid (PFOA)	**0.014**	**Perfluorooctanesulfonic acid (PFOS)**	**0.013**

Notes:
(1) The Oxnard facility analysis within this Engineering Report was based upon a prior version of the State's Notification Levels, as found on: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf. The web link above also contains the levels of the pollutants in this table that must result in a removal of the water source from service.
(2) As this Engineer's Report was being finalized, the State of California released a new Notification Level document (2018), adding PFOA and PFOS, which are shown in red within this table and found on: *https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notification_levels_response_levels_overview.pdf*

9.2 CEC Monitoring

The Recycled Water Policy (SWRCB, 2013) lists specific compounds for monitoring for groundwater injection projects (Table 9.7). In 2018 a scientific advisory panel funded by the State of California published recommendations regarding CECs (SCCWRP, 2018), with recommendations entirely in-line with Table 9.7.

Table 9.7 Monitoring Trigger Levels for Groundwater Recharge, as Listed in SCCWRP (2018)

Constituents	Relevance/ Indicator Type/ Surrogate	Monitoring Trigger Level (in µg/L)	Removal Percentages (%)
17B-estradiol(1)	Health	0.0009	--
Caffeine(1)	Health & Performance	0.35	>90
NDMA(1)	Health & Performance	0.01	25-50, >80(3)
Triclosan(1)	Health	0.35	--
DEET(1)	Performance	--	>90
Sucralose(1)	Performance	--	>90
Electrical Conductivity(1)	Surrogate	--	>90
TOC(2)	Surrogate	--	>90

Notes:
(1) Monitored quarterly, per SCCWRP (2018).
(2) Continuously monitored.
(3) 25 to 50 percent removal by RO, >80 percent removal by RO followed by UV, depending upon the UV dose.

The LARWQCB requires specific monitoring for CECs. In communication with Elizabeth Erickson to the project team on 10/29/2014, the following CECs for monitoring: 17-alpha-estradiol, caffeine, DEET, Iodinated Contrast Media (Iopromide), Triclosan, NDMA, and Sucralose. There is overlap with the list in Table 9.7, essentially adding Iopromide and 17-alpha-estradiol to the sampling list for this project.

9.3 Basin Plan

The Basin Plan Objectives for ground water quality for the LA region are divided into five groups: bacteria, chemical constituents and radionuclides, minerals, nitrogen, and taste and odor. Excluding the chemical constituents and radionuclides, the objectives are summarized as follows:

- **Bacteria -** Concentration of coliform organisms shall be < 1.1/100 mL over any 7-day period.
- **Minerals:** TDS - (1200 mg/L (confined aquifers), 3000 mg/L (unconfined aquifers), Sulfate (600 mg/L (confined aquifers), 1000 mg/L (unconfined aquifers), Chloride (150 mg/L (confined aquifers), 500 mg/l (unconfined aquifers), Boron (1 mg/L).
- **Nitrogen –** 10 mg/L (NO_3-N + NO_2-N), 45 mg/L (NO_3), 10 mg/L (NO_3-N), 1 mg/L (NO_2-N).
- **Taste and Odor -** Ground waters shall not contain taste or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.

Additionally, the Basin Plan specifies compliance with Table 64431-A, Table 6444-A, and Tables 64442 and 64443 of DDW regulations (SWRCB, 2018b). The constituents in these tables are provided in the regulatory tables shown previously in this report.

9.4 Current Water Quality

The City's AWPF is now in operation, producing high quality water for non-potable reuse. Detailed water quality and performance testing has been completed and is documented here. Secondary Effluent, RO permeate, and UV AOP final effluent were sampled for MCLs, NLs, Secondary MCLs and CECs, results are show in Tables 9.8 through 9.15. Consistent contaminant removal was seen throughout the MF/RO/UVAOP process, with the AWPF treatment train advanced treated recycled water meeting all health goals (MCLs, secondary MCLs, and NLs). CEC concentrations were either ND or below the recommended health levels according to literature sources. ***Of important note, only 8 chemicals tested for were detected above the health-based goal/limit in the secondary effluent.*** All 8 constituents were fully removed to below the detection level or health target/limit in the advanced treated recycled water, and most were removed prior to UV AOP treatment, as demonstrated both by the RO effluent sampling, and the RO concentrate contaminant concentrations.

9.4.1 TOC

The DDW regulatory (SWRCB, 2018a) requirement for total organic carbon (TOC) is a maximum of 0.5 mg/L, and new membranes are required to meet a value of 0.25 mg/L. Grab samples taken as part of the startup testing all resulted in RO permeate TOC levels below detection at <0.3 mg/L. Prior to operation, online TOC meters will be installed before and after RO for continuous monitoring.

9.4.2 Total Nitrogen

The DDW groundwater recharge requirement for total nitrogen (TN) is ≤10 mg/L. As listed in the tables below, the advanced treated recycled water has low nitrate + nitrite (as N) of <0.2 mg/L. Recent (6/22/2016) ammonia concentrations (RO feed = 33 mg/L, UV AOP feed = 2.8 mg/L, Advanced treated recycled water = 2.1 mg/L) coupled with the low nitrate and nitrite numbers indicate a low TN result of ~3 mg/L.

Table 9.8 MF/RO/UV AOP Advanced treated recycled water Quality for MCLs- Inorganic Chemicals per Table 64431-A and Table 64432-A (SWRCB, 2018b)

Constituent	Unit	RO INF	RO CONC	UV INF	Advanced treated recycled water	MCL/Action Level	MRL (units shown at far left)
		5/2/16	5/2/16	6/20/16	6/20/16		
Aluminum	ug/L	ND	87	ND	ND	200	20
Antimony	ug/L	ND	3.9	ND	ND	6	1
Arsenic	ug/L	1	8.1	ND	ND	10	1
Asbestos	MFL[(2)]	ND	ND	ND	ND	7	0.2
Barium	ug/L	18	120	ND	ND	1,000	2
Beryllium	ug/L	ND	ND	ND	ND	4	1
Cadmium	ug/L	ND	ND	ND	ND	5	0.5
Chromium	ug/L	1.2	5.9	ND	ND	50	1
Copper	ug/L	5.4	36	ND	ND	1,300 *(Action Level)*	2
Cyanide	mg/L	0.04	0.18	ND	ND	150	0.025
Fluoride	mg/L	0.78	3.6	ND	ND	2	0.05
Hexavalent Chromium[(1)]	ug/L	--	--	--	--	10	0.5
Lead	ug/L	ND	ND	ND	ND	15 *(Action Level)*	0.5
Mercury	ug/L	ND	ND	ND	ND	2	0.2
Nickel	ug/L	6.2	46	ND	ND	100	5
Nitrate (as NO_3)	mg/L	ND	ND	ND	0.12	45	0.013
Nitrite (as N)	mg/L	ND	ND	ND	0.072	1	0.013
Perchlorate	ug/L	32	200	ND	ND	6	2
Nitrate + Nitrite (as N)	mg/L	ND	ND	ND	0.192	10	0.055
Selenium	ug/L	5.7	28	ND	ND	50	5
Thallium	ug/L	ND	ND	ND	ND	2	1

Notes:
(1) Laboratory error, hexavalent chromium not analyzed for.
(2) MFL = million fibers per liter longer than 10 um.
(3) Hexavalent chromium was not tested due to a sampling error, however, total chromium was analyzed.

Table 9.9 MF/RO/UV AOP Advanced treated recycled water Quality for MCLs- Radionuclides per Table 64442 AND 64443 (SWRCB, 2018B)

Constituent	Unit	RO INF 5/2/16	RO CONC 5/2/16	UV INF 6/20/16	Advanced treated recycled water 6/20/16	MCL/Action Level	MRL (units shown at far left)
Gross Alpha (including Radium-226 but not Radon and Uranium)	pCi/L	5.7	29.1		ND	15	1.5
Radium-226	pCi/L	<0.889	0.354	<0.733	ND	-	0.889
Radium-228	pCi/L	<0.661	<0.593	<0.804	ND	-	0.661
Combined Radium-226 and Radium-228 (*226 + 228*)	pCi/L	ND	0.354	ND	ND	5	
Strontium-90	pCi/L	<0.968	<1.92	<0.908	<0.654	8	0.968
Uranium	pCi/L	5.2	37	ND	ND	20	0.7
Tritium	pCi/L	<267	<265	<264	<279	20,000	267
Beta/Photon emitters (gross beta tested)	pCi/L	38	210	5.3	<1.80	50(1)	2.42

Notes:
(1) 50 pCi/L is used for regulatory purposes to ensure that exposure above 4 millirem/yr does not occur. If 50 pCi/L is exceeded, than the water is deemed "vulnerable" and in need of potential future monitoring of specific radionuclides.

Table 9.10 MF/RO/UV AOP Advanced treated recycled water Quality for MCLs- Synthetic Organic Chemicals - SVOCS per Table 64444-A (SWRCB, 2018B)

		RO INF	RO CONC	UV INF	Advanced treated recycled water		
Constituent	Unit	5/2/16	5/2/16	6/20/16	6/20/16	MCL/Action Level	MRL (units shown at far left)
Alachlor	ug/L	ND	ND	ND	ND	2	0.05
Atrazine	ng/L	ND	9.3	ND	ND	1	5
Benzo(a)pyrene	ug/L	ND	ND	ND	ND	0.2	0.02
Carbofuran	ug/L	ND	ND	ND	ND	40	0.5
Chlordane	ug/L	ND	ND	ND	ND	2	0.1
Dalapon	ug/L	ND	1.1	ND	ND	200	1
Dibromochloropropane	ug/L	ND	ND	ND	ND	0.2	0.01
Dinoseb	ug/L	ND	ND	ND	ND	7	0.2
Dioxin(2,3,7,8-TCDD)	pg/L	ND	ND	ND	ND	3.00E-08	5
Diquat	ug/L	ND	0.65	ND	ND	20	0.4
Di(2-ethylhexyl) adipate	ug/L	ND	ND	ND	ND	400	0.6
Di(2-ethylhexyl) phthalate	ug/L	ND	ND	ND	ND	6	0.6
Endothall	ug/L	ND	ND	ND	ND	100	5
Endrin	ug/L	ND	ND	ND	ND	2	0.2
Ethylene Dibromide	ug/L	ND	ND	ND	ND	0.05	0.01
Glyphosate	ug/L	ND	ND	ND	ND	700	6
Heptachlor	ug/L	ND	0.033	ND	ND	0.04	0.01
Heptachlor epoxide	ug/L	ND	ND	ND	ND	0.02	0.01
Hexachlorobenzene	ug/L	ND	ND	ND	ND	1	0.05
Hexachlorocyclopentadiene	ug/L	ND	ND	ND	ND	50	0.05
Lindane	ug/L	ND	ND	ND	ND	0.2	0.04
Methoxychlor	ug/L	ND	ND	ND	ND	40	0.1
Oxamyl(Vydate)	ug/L	ND	ND	ND	ND	200	0.5
Picloram	ug/L	ND	ND	ND	ND	500	0.1

Table 9.10 MF/RO/UV AOP Advanced treated recycled water Quality for MCLs- Synthetic Organic Chemicals - SVOCS per Table 64444-A (SWRCB, 2018B) (continued)

Constituent	Unit	RO INF 5/2/16	RO CONC 5/2/16	UV INF 6/20/16	Advanced treated recycled water 6/20/16	MCL/Action Level	MRL (units shown at far left)
Polychlorinated Biphenyls (TOTAL)(1)	ug/L	ND	ND	ND	ND	0.5	0.0005
Pentachlorophenol	ug/L	ND	ND	ND	ND	1	0.04
Simazine	ng/L	20	76	ND	ND	4	5
Toxaphene	ug/L	ND	ND	ND	ND	3	0.5
2,4-D	ug/L	0.25	2.3	ND	ND	70	0.1
2,4,5-TP Silvex	ug/L	ND	ND	ND	ND	50	0.2
Bentazon	ug/L	ND	0.78	ND	ND	18	0.5
Molinate	ug/L	ND	ND	ND	ND	20	0.1
Thiobencarb	ug/L	ND	ND	ND	ND	1	0.2

Notes:
(1) Polychlorinated Biphenyls (TOTAL) includes: PCB 1016, PCB 1221, PCB 1232, PCB 1242, PCB 1248, PCB 1254 and PCB 1260.

Table 9.11 MF/RO/UV AOP Advanced treated recycled water Quality for MCLs- Volatile Organic Chemicals - VOCS per Table 64444-A (SWRCB, 2018B)

Constituent	Unit	RO INF 5/2/16	RO CONC 5/2/16	UV INF 6/20/16	Advanced treated recycled water 6/20/16	MCL/Action Level	MRL (units shown at far left)
Benzene	ug/L	ND	ND	ND	ND	1	0.5
Carbon tetrachloride	ug/L	ND	ND	ND	ND	0.5	0.5
cis-1,2-Dichloroethylene	ug/L	ND	ND	ND	ND	6	0.5
Dichloromethane	ug/L	ND	ND	ND	ND	5	0.5
Ethylbenzene	ug/L	ND	ND	ND	ND	300	0.5
Monochlorobenzene (Chlorobenzene)	ug/L	ND	ND	ND	ND	70	0.5

Table 9.11 MF/RO/UV AOP Advanced treated recycled water Quality for MCLs- Volatile Organic Chemicals - VOCS per Table 64444-A (SWRCB, 2018B) (continued)

Constituent	Unit	RO INF	RO CONC	UV INF	Advanced treated recycled water	MCL/Action Level	MRL (units shown at far left)
		5/2/16	5/2/16	6/20/16	6/20/16		
o-Dichlorobenzene	ug/L	ND	ND	ND	ND	600	0.5
p-Dichlorobenzene	ug/L	ND	ND	ND	ND	5	0.5
Styrene	ug/L	ND	ND	ND	ND	100	0.5
Tetrachloroethylene(PCE)	ug/L	ND	ND	ND	ND	5	0.5
Toluene	ug/L	ND	ND	ND	ND	150	0.5
trans-1,2-Dichloroethylene	ug/L	ND	ND	ND	ND	10	0.5
Trichloroethylene (TCE)	ug/L	ND	ND	ND	ND	5	0.5
Vinyl chloride	ug/L	ND	ND	ND	ND	0.5	0.3
Xylenes (total)	ug/L	ND	ND	ND	ND	1,750	0.5
1,1-Dichloroethylene	ug/L	ND	ND	ND	ND	6	0.5
1,1,1-Trichloroethane	ug/L	ND	ND	ND	ND	200	0.5
1,1,2-Trichloroethane	ug/L	ND	ND	ND	ND	5	0.5
1,2-Dichloroethane	ug/L	ND	ND	ND	ND	0.5	0.5
1,2-Dichloropropane	ug/L	ND	ND	ND	ND	5	0.5
1,2,4-Trichlorobenzene	ug/L	ND	ND	ND	ND	5	0.5
1,1-Dichloroethane	ug/L	ND	ND	ND	ND	5	0.5
1,3-Dichloropropene	ug/L	ND	ND	ND	ND	0.5	0.5
Methyl-tert-butyl ether (MTBE)	ug/L	ND	ND	ND	ND	135 (Secondary MCL)	0.5
1,1,2,2-Tetrachloroethane	ug/L	ND	ND	ND	ND	1,200	0.5
Trichlorofluoromethane	ug/L	ND	ND	ND	ND	150	0.5
1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L	ND	ND	ND	ND	1,200	0.5

Table 9.12 MF/RO/UV AOP Advanced treated recycled water Quality for MCLs- Disinfection Byproducts per Table 64533-A (SWRCB, 2018B)

Disinfection Byproduct	Unit	RO INF	RO CONC	UV INF	Advanced treated recycled water	MCL/Action Level	MRL (units shown at far left)
		5/2/16	5/2/16	6/20/16	6/20/16		
Total Trihalomethanes (TTHM)	ug/L	2.3	11	1.5	0.89	80	0.5
Haloacetic acids (five) (HAA5)(1)	ug/L	20	85	ND	ND	60	2
Bromate	ug/L	ND	1.8	ND	ND	10	1
Chlorite	mg/L	ND	ND	ND	ND	1.0	0.01
Chlorate	ug/L	350	1600	16	ND	800	10

Notes:
(1) Haloacetic acids (five) includes: Bromoacetic Acid, Chloroacetic Acid, Dibromoacetic Acid, Dichloroacetic Acid and Trichloroacetic Acid.

Table 9.13 MF/RO/UV AOP Advanced treated recycled water Quality for Secondary MCLs per Tables 64449-A and 64449-B (SWRCB, 2018B)

Secondary Constituent	Unit	RO INF	RO CONC	UV INF	Advanced treated recycled water	MCL/Action Level	MRL (units shown at far left)
		5/2/16	5/2/16	6/20/16	6/20/16		
Color	ACU	40	300	ND	5	15 color units	3
Corrosivity (below)*:						Non-corrosive	
Langelier Index - 20 degrees C	-	-3	-4.9	-2.4	5.4	Non-corrosive	-
Langelier Index at 60 degrees C	-	NA	NA	NA	NA	Non-corrosive	-
Aggressiveness Index-Calculated	-	8.7	6.8	9.3	7.4	Non-corrosive	-
pH of CaCO3 saturation(25C)	Units	6.6	5	10	10	Non-corrosive	0.1

Table 9.13 MF/RO/UV AOP Advanced treated recycled water Quality for Secondary MCLs per Tables 64449-A and 64449-B (SWRCB, 2018B) (continued)

Secondary Constituent	Unit	RO INF 5/2/16	RO CONC 5/2/16	UV INF 6/20/16	Advanced treated recycled water 6/20/16	MCL/Action Level	MRL (units shown at far left)
pH of CaCO3 saturation(60C)	Units	6.2	4.6	9.9	9.9	Non-corrosive	0.1
Bicarb. Alkalinity as HCO3, calc	mg/L	650	4200	ND	ND	Non-corrosive	3
Foaming agents (Surfactants)	mg/L	0.2	0.89	ND	ND	0.5	0.1
pH	Units	8	7.8	6.7	6.5	6.5-8.5	0.1
Hardness (as CaCO3)	mg/L	650	4,200	ND	ND	250	3
Odor (SM 2150B - Odor at 60 C (TON))	TON	200	200	3	ND	3 (Threshold Odor Number)	1
Total dissolved solids(TDS)	mg/L	2,000	11,000	68	64	500	10
Aluminum	ug/L	ND	87	ND	ND	50-200	20
Chloride	mg/L	610	3,700	26	17	250	1
Copper	ug/L	5.4	36	ND	ND	1,000	2
Fluoride	mg/L	0.78	3.6	ND	ND	2	0.05
Iron	mg/L	0.13	0.87	ND	ND	0.3	0.02
Manganese	ug/L	95	680	ND	ND	50	2
Silver	ug/L	ND	ND	ND	ND	100	0.5
Sulfate	mg/L	510	3400	ND	0.55	250	0.5
Turbidity	NTU	0.17	0.5	ND	0.14	5	0.1
Specific Conductance	umho/cm	3400	18,000	140	110	900	2
Zinc	ug/L	21	140	ND	ND	5,000	20

Table 9.14 MF/RO/UV AOP Advanced treated recycled water Quality for Drinking Water NLs per DDW (2017) [(1)]

Secondary Constituent	Unit	RO INF 5/2/16	RO CONC 5/2/16	UV INF 6/20/16	Advanced treated recycled water 6/20/16	MCL/Action Level	MRL (units shown at far left)
Boron	mg/L	1.1	2.1	0.82	0.77	1	0.05
n-Butylbenzene	ug/L	ND	ND	ND	ND	260	0.5
sec-Butylbenzene	ug/L	ND	ND	ND	ND	260	0.5
tert-Butylbenzene	ug/L	ND	ND	ND	ND	206	0.5
Carbon disulfide	ug/L	ND	ND	ND	ND	160	0.5
Chlorate	ug/L	350	1,600	16	ND	800	10
2-Chlorotoluene	ug/L	ND	ND	ND	ND	140	0.5
4-Chlorotoluene	ug/L	ND	ND	ND	ND	140	0.5
Diazinon	ug/L	ND	ND	ND	ND	1.2	0.1
Dichlorodifluoromethane (Freon 12)	ug/L	ND	ND	ND	ND	1,000	0.5
1,4-Dioxane	ug/L	1.4	7	ND	ND	1	1
Ethylene glycol	mg/L	ND	ND	ND	ND	14	10
Formaldehyde	ug/L	36	100	20	17	100	5
HMX	ug/L	ND	ND	ND	ND	350	0.1
Isopropylbenzene	ug/L	ND	ND	ND	ND	770	0.5
Manganese	ug/L	95	680	ND	ND	500	2
Methyl isobutyl ketone (MIBK)	ug/L	ND	ND	ND	ND	120	5
Naphthalene	ug/L	ND	ND	ND	ND	17	0.5
N-Nitrosodiethylamine (NDEA)	ng/L	2.9	25	ND	ND	10	2
N-Nitrosodimethylamine (NDMA)	ng/L	33	90	32	5	10	2

Table 9.14 MF/RO/UV AOP Advanced treated recycled water Quality for Drinking Water NLs per DDW (2017) [1] (Continued)

Secondary Constituent	Unit	RO INF 5/2/16	RO CONC 5/2/16	UV INF 6/20/16	Advanced treated recycled water 6/20/16	MCL/Action Level	MRL (units shown at far left)
N-Nitrosodi-n-propylamine (NDPA)	ng/L	ND	ND	ND	ND	10	2
Propachlor**	ug/L	ND	ND	ND	ND	90	0.05
n-Propylbenzene 0.26	ug/L	ND	ND	ND	ND	260	0.5
RDX	ug/L	ND	ND	ND	ND	0.3	0.1
Tertiary butyl alcohol (TBA)	ug/L	2.1	19	ND	ND	12	2
1,2,3-Trichloropropane (1,2,3-TCP)	ug/L	ND	0.017	ND	ND	0.005	0.005
1,2,4-Trimethylbenzene	ug/L	ND	ND	ND	ND	330	0.5
1,3,5-Trimethylbenzene	ug/L	ND	ND	ND	ND	330	0.5
2,4,6-Trinitrotoluene (TNT)	ug/L	ND	ND	ND	ND	1	0.1
Vanadium	ug/L	ND	11	ND	ND	50	3

Table 9.15 MF/RO/UV AOP Advanced treated recycled water Quality for CECs

		RO INF	RO CONC	UV INF	Advanced treated recycled water		
Secondary Constituent	Unit	5/2/16	5/2/16	6/20/16	6/20/16	MCL/Action Level	MRL (units shown at far left)
Gemfibrozil	ng/L	1200	16000	ND	ND	5	Gemfibrozil
Naproxen	ng/L	130	230	ND	ND	10	Naproxen
Triclosan	ng/L	230	2000	12	ND	10	Triclosan
Ibuprofen	ng/L	ND	5200	ND	ND	10	Ibuprofen
Acetaminophen	ng/L	150	240	45	ND	5	Acetaminophen
Sucralose	ng/L	47,000	310,000	ND	ND	100	Sucralose
Triclocarban	ng/L	ND	ND	ND	ND	5	Triclocarban
Sulfamethoxazole	ng/L	1,600	15,000	ND	ND	5	Sulfamethoxazole
Atenolol	ng/L	320	3700	5.5	ND	5	Atenolol
Trimethoprim	ng/L	320	3500	ND	ND	5	Trimethoprim
Caffeine	ng/L	3500	31000	23	21	5	Caffeine
Fluoxetine	ng/L	35	220	ND	ND	10	Fluoxetine
Meprobamate	ng/L	ND	930	ND	ND	5	Meprobamate
Carbamazepine	ng/L	140	1000	ND	ND	5	Carbamazepine
Primidone	ng/L	94	260	ND	ND	5	Primidone
DEET	ng/L	94	260	ND	ND	5	DEET
TCEP	ng/L	200	1100	ND	ND	10	TCEP
PFOA	ug/L	0.0057	0.035	ND	0.0051	0.0025	PFOA
PFOS	ug/L	0.0042	0.035	ND	ND	0.0025	PFOS
Estrone	ng/L	9.4	51	ND	ND	0.002	Estrone
Estradiol	ng/L	ND	ND	ND	ND	5	Estradiol
Ethynylestradiol	ug/L	ND	0.0052	ND	ND	0.0009	Ethynylestradiol
Testosterone	ug/L	0.0019	0.0090	ND	ND	0.0001	Testosterone
Progesterone	ng/L	ND	ND	ND	ND	5	Progesterone

Section 10
DILUENT WATER

No diluent water is proposed for the ASR project. The water that will be used for recharge will be 100 percent recycled water that has received advanced treatment (MF/RO/UV AOP). Any dilution in the subsurface (due to groundwater underflow) will not be counted toward TOC credits or for meeting pollutant or pathogen levels.

Section 11
ASR FACILITIES

The proposed ASR concept is to inject highly-treated recycled water for a minimum period of 3.1 months and possibly for up to 6 months, hold the water in the designated aquifer for 3.1 months, and then withdraw the water from the same wells into which the water was injected for potable and/or non-potable use. The proposed ASR operation is summarized in Section 6 and detailed by Hopkins (2016).

Section 12

GROUNDWATER BASINS

12.1 Existing Water Quality

The project team has extensive groundwater data provided by the UWCD for the "Lower Aquifer System," or LAS (shown in Figure 12.1). The LAS extends throughout the area and groundwater quality is anticipated to be similar underneath the proposed ASR location. Table 12.1 is lists local groundwater quality data obtained from UWCD.

Table 12.1 List of UWCD Groundwater Quality

Constituent (mg/L unless otherwise stated)	Comparative Groundwater Quality Well IDs			Nearest Well to Proposed ASR Location
	01N22W03F05S	02N22W30F03S	02N22W20L03S	(1N22W04F04)(1
Alk as CaCO3	213	484	608	520
Temperature (C)				
pH	7.38	7.40	7.46	7.6
TDS	996			958
Turbidity (NTUs)	0.04		0.42	
Nitrate-N				4.3
Potassium	5	7	5	6
Sodium	102	93	140	93
Magnesium	47	37	54	44
Calcium	141	135	155	135
Bicarbonate	239	255	286	249
Sulfate	470	435	594	418
Boron (µg/L)	700	600	620	600
Chloride	50	54	66	49
Fluoride	0.62	0.50	0.60	0.7

Notes:
(1) Data from 1960 to 1989.

12.2 Groundwater Model

No groundwater model exists for the project area.

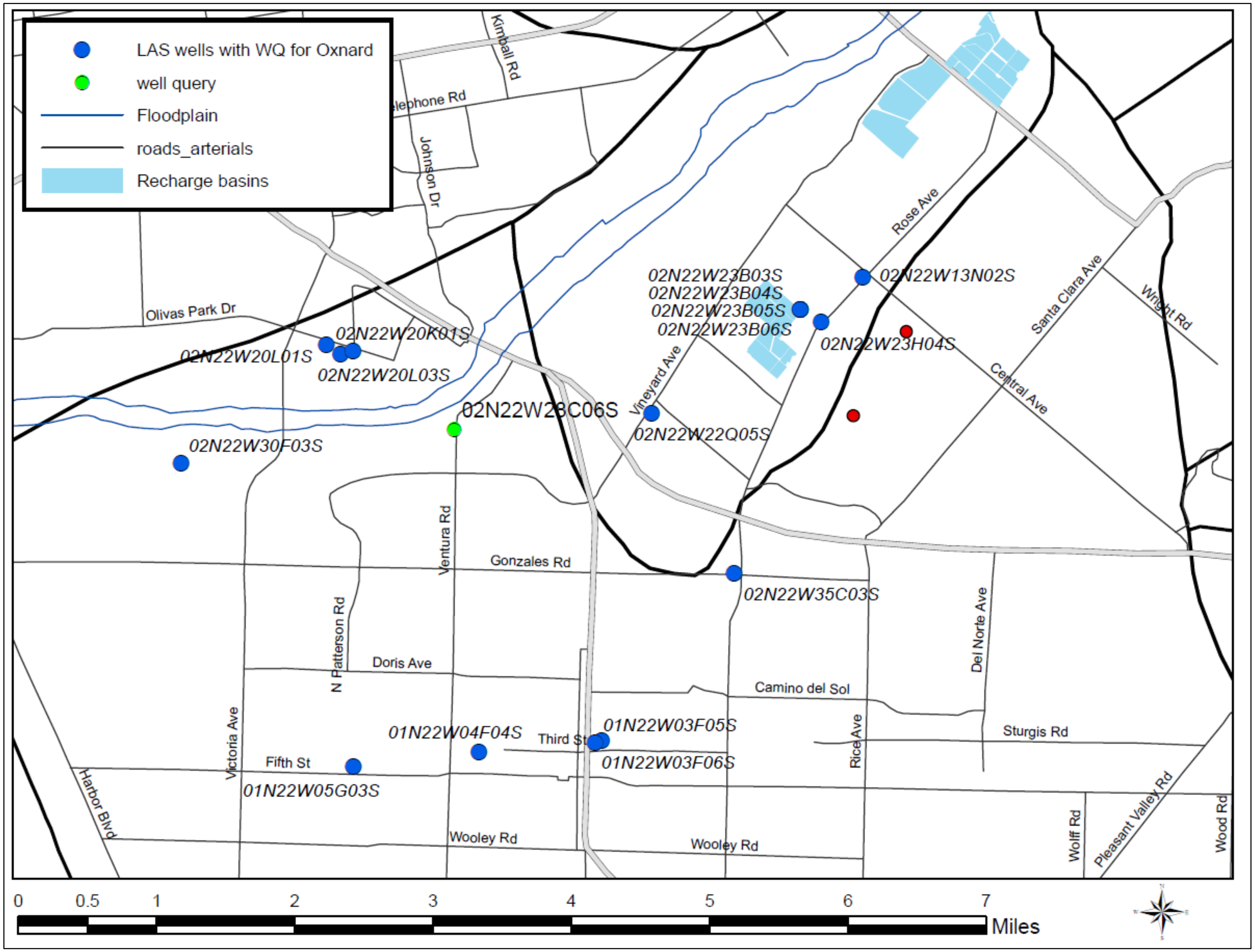

Figure 12.1 Oxnard Map of UWCD Well Locations (provided by UWCD)

Section 13
DOMESTIC WATER SUPPLY PRODUCTION WELLS

13.1 Production Wells Near the Project

The Campus Park site is located within the City where all potable water is provided by the City municipal supply system. The nearest production well to the project is a domestic well located southeast of the site that is used for off-site irrigation. The next closest production wells are domestic wells located to the northwest of the site in the County. These wells, ***all in the UAS***, supply residential uses, noting that this ASR project with purified water will be into the LAS not the UAS. The next closest wells are located to the east at City Blending Station No. 1. See Hopkins (2016) for more details. The City of Oxnard potable water system will provide a backup supply if or when needed.

13.2 Closest Domestic Supply Well

The closest existing domestic supply wells are located over 2,000 feet northwest of the site and are constructed in the Oxnard Aquifer, the uppermost member of the upper aquifer system. See Hopkins (2016) for more details.

13.3 Domestic Water Supply Production Wells – Water Quality

The water quality in regional water supply wells is summarized in Section 12.

Section 14

GROUNDWATER RECHARGE IMPACTS

14.1 Regional Geologic and Hydrogeologic Framework

The subsurface geology that controls groundwater flow in the study area is differentiated into two primary geologic units that include; the Holocene and late Pleistocene alluvium, and the San Pedro Formation. The first unit is comprised largely of unconsolidated sedimentary deposits and includes all older and recent alluvial deposits. These shallower units are coarse-grained sand and gravel layers that form the Oxnard and Mugu Aquifers and comprise the UAS in the Oxnard Plain Basin (see Hopkins (2016), Appendix B, Plates 3, and 4). The San Pedro Formation consists of consolidated marine and nonmarine clay, silt, sand, and gravel deposits that comprise the Hueneme and Fox Canyon Aquifers that are designated as the LAS. The low permeability geologic formations underlying the San Pedro Formation are generally considered to be non-water-bearing and effectively define the base of fresh water.

The groundwater in the Oxnard Plain Basin LAS is isolated from overlying land uses by the laterally extensive aquitard (silt and clay) layers that separate and confine the Hueneme and Fox Canyon Aquifer zones. The conceptual subsurface profile uses the geophysical survey (electric log) from the proximate (destroyed) City Well No. 13 to show the anticipated geology and aquifer zones beneath the Campus Park GRRP site. The aquifer zones are discretely separated by clay layers that are laterally continuous and appear as marker beds in other well logs shown by Hopkins (2016) in Appendix B, Plates 3 and 4. The significance of the highly confined condition that results from the discretely layered aquifer system is that wells located in close proximity (50 feet apart) but producing from different aquifer layers, do not have hydraulic connectivity with each other (no interference).

Recharge into the LAS will store water in aquifer zones that receive significantly less groundwater recharge than the UAS because of the regional confined aquifer conditions. The UAS readily receives groundwater recharge derived from natural percolation of rainwater and Santa Clara River flows in the Oxnard Forebay Basin, as well as from river flow diversions into the engineered recharge facilities operated by UWCD.

14.1.1 Other Existing or Proposed GWRS Project that Could Impact the ASR

There are no other planned groundwater recharge projects in the vicinity.

14.1.2 Cumulative Impact on Water Quantity and Quality With and Without the Proposed GWRS Project

The water quality in the aquifer zones that will be used for replenishment in the LAS was previously described in Chapter 12. The groundwater is typically a calcium sulfate-barcarbonate chemical character with a TDS concentration of approximately 1,000 mg/l. Water quality degradation has been occurring in the overdrafted basin and results from poorer quality groundwater seeping out of the fine-grained silt and clay layers that are interbedded with the sand and gravel aquifer zones along with seawater intrusion. Without the project, regional groundwater quality will continue to degrade largely as a result of these 2 mechanisms.

With the project, the regional and local water quality impacts are beneficial. The regional benefit occurs when the aquifer is replenished and the groundwater levels rise. The rising water levels lessen any landward gradient and effectively slow the rate of seawater intrusion in the aquifer zones used for storage. This regional benefit remains until the stored volume is entirely removed. After removal there is no impact, in that the groundwater levels return to pre-recharge conditions.

The localized benefit to water quality will occur from flushing and mixing with the superior water quality of the advanced treated recycled water. Any water left behind will blend with the local native groundwater and improve its quality for downgradient users.

14.2 Predicted Recycled Water Retention Time

As detailed previously, the retention time is fully controlled by the City because of the ASR operation. The minimum retention time will be 3.1 months but can vary specifically as chosen by the City as long as all pathogen credit requirements are met.

14.3 Recycled Water Contribution

As there is no proposed dilution, the recycled water contribution (RWC) is 1.0, or 100 percent.

14.4 Antidegradation Assessment – Predicted Groundwater Quality Post Recharge and Utilization of Available Assimilative Capacity of Basin

14.4.1 MCLs, Secondary MCLs, NLs, and CECs

As detailed in WRD (2013), the purified recycled water from an AWPF is expected to improve groundwater quality and thus improve the assimilative capacity. Demonstration of such improved water quality, comparing the water quality at the proposed recharge locations with the water quality of the advanced treated recycled water from the AWPF, has not yet been done. Such work will be done as detailed in Section 17.

14.4.2 Recharge of Advanced treated recycled water and Groundwater Chemistry Concerns

The LARWQCB has requested more information regarding the change in groundwater chemistry that can result from injection of an advanced treated recycled water. The following perspective comes from OCWD (2014).

- The advanced treated recycled water from Groundwater Replenishment System (GWRS) is stabilized prior to injection via decarbonation and lime addition. Initially the target pH was set at 9.0, but this has been progressively reduced to 8.0 in an effort to mitigate arsenic mobilization while also maintaining pipeline integrity. Ambient groundwater pH is approximately 7.5, and previous literature indicates elevated pH in laboratory experiments can mobilize certain arsenic species. More recent laboratory experiments conducted by Stanford University on behalf of OCWD have shown pH to be a secondary factor in mobilization behavior, with the relatively poorly-buffered finished GWRS water rapidly taking on the pH of the soil column. The effect of reducing the GWRS advanced treated recycled water pH on field-observed arsenic mobilization has been inconclusive to date.

- The literature indicates that low alkalinity and low ionic strength of the advanced treated recycled water may alter the surface charge of aquifer mineral surfaces, affecting arsenic sorption. However, recent laboratory experiments conducted by Stanford University on behalf of OCWD have indicated that neither of these parameters is of significant importance in shallow unconfined aquifer sediments collected near OCWDs recharge area; instead the concentration of divalent cations, primarily magnesium and secondarily calcium, have been the most important inorganic controls on arsenic desorption.
- The high oxidation reduction potential (ORP) of the advanced treated recycled water may affect the oxidation state of arsenic and increase its solubility or release it via the oxidation of host minerals (e.g., iron sulfides) in the aquifer. This phenomena has been observed at some ASR project sites. In a second phase of work, Stanford University is currently conducting laboratory experiments on the addition of GWRS advanced treated recycled water to deep aquifer sediments collected from a geochemically reducing environment targeted for potential future injection.
- Field observations indicate a complex, non-linear relationship between the proportional GWRS water in the subsurface and resulting arsenic mobilization, governed by significant spatial and temporal variability. The majority of monitoring wells showing GWRS arrival demonstrate little or no mobilization of arsenic. A majority of those wells showing mobilization behavior have resulting arsenic concentrations below levels of regulatory concern (i.e., the 10 ug/L MCL) and/or have shown declining trends after an initial increase.

As part of this project, it is proposed to pilot test the ASR system and measure the impacts. The pilot test would include detailed monitoring of intrinsic tracers (dissolved minerals) as summarized in Section 17.

Because of the ASR operation, injected water will be extracted for both potable and non-potable reuse applications. If there are groundwater chemistry changes that are of public health significance for drinking water, the extracted water can be used exclusively for non-potable applications.

14.5 Impact of Groundwater Recharge Project on Contaminant Plumes

Groundwater recharge projects that utilize surface water spreading or injection in an unconfined groundwater basin can potentially effect the movement or cause movement of existing groundwater contamination. A preliminary search of the State operated GeoTracker web site indicated that there are 4 leaky underground storage tank sites located within 2,000 feet of the Campus Park site. The contamination was either contained in the soil or found in the shallow semi-perched aquifer zone which is isolated from the underlying Oxnard Aquifer by an extensive clay layer. The aquifer zones targeted by the ASR recharge project are isolated by multiple clay layers and aquifer zones beneath the semi-perched aquifer and prevent the project from having a potential impact on shallow groundwater contamination. Furthermore, all 4 sites have been remediated and are closed.

Section 15
MONITORING AND REPORTING

This proposed monitoring and reporting program (MRP) was developed to conform to the DDW groundwater recharge regulations (SWRCB. 2018a).

15.1 General Monitoring Provisions

The following are general monitoring provisions:

- The City proposes to monitor the following according to the manner and frequency specified in this MRP:
  - Influent flow rate and quality to the AWPF.
  - AWPF advanced treated recycled water flow rate and quality.
  - Receiving groundwater quality, both background monitoring and monitoring after start of recharge project.
  - Production well (ASR wells) flow rate and quality.
- Compliance with the requirements of the LARWQCB WDRs will be evaluated based on the analytical monitoring data. Monitoring reports will include, but not be limited to, the following:
  - Analytical results.
  - Location of each sampling station where representative samples can be obtained, including a map that clearly identifies the locations of all injection wells, monitoring wells, and production wells (detailed in Hopkins, 2016).
  - Analytical test methods used and the corresponding method reporting limits (MRLs).
  - Name(s) of the laboratory that conducted the analyses.
  - Copy of the laboratory certifications by the DDW's Environmental Laboratory Accreditation Program (ELAP).
  - Quality assurance and control information.

15.1.1 Sampling and Analytical Protocols

Though not required to be included in the monitoring reports unless specifically requested by DDW or the LARWQCB, the City will have in place sampling protocols including procedures for handling, storing, testing, and disposing of purge and decontamination waters generated from sampling events.

For groundwater monitoring, the sampling protocols will outline the methods and procedures for: measuring water levels; purging wells; collecting samples; decontaminating equipment; containing, preserving, and shipping samples; and maintaining appropriate documentation.

The samples will be analyzed using analytical methods described in 40 CFR Part 141; or where no methods are specified for a given pollutant, by methods approved by the DDW, LARWQCB, and/or SWRCB. The City will select the analytical methods that provide MRLs lower than the limits prescribed in the WDR or as low as possible that will provide reliable data.

The City will instruct its contract laboratories to establish calibration standards so that the MRLs (or its equivalent if there is a different treatment of samples relative to the calibration standards) are the lowest calibration standard. At no time will analytical data derived from extrapolation beyond the lowest point of the calibration curve be used.

For all bacterial analyses, sample dilutions will be performed so the range of values extends from 1 to 800. The detection methods used for each analysis will be reported with the results of the analyses.

15.1.2 QA/QC Procedures

The LARWCB, DDW and the SWRCB Quality Assurance Program, may establish MRLs in any of the following situations:

- When the pollutant has no established method under 40 CFR 141.
- When the method under 40 CFR 141 for the pollutant has a MRL higher than the limit specified in the WDR.
- When the City proposes to use a test method that is more sensitive than those specified in 40 CFR Part 141.

For regulated constituents, the laboratory conducting the analyses will be certified by ELAP or approved by the DDW, LARWQCB, and/or SWRCB for a particular pollutant or parameter.

Samples will be analyzed within allowable holding time limits as specified in 40 CFR Part 141. All QA/QC analyses will be run on the same dates that samples are actually analyzed. The City will retain the QA/QC documentation in its files and make those files available for inspection and/or submit them when requested by the LARWQCB or the DDW. Proper chain of custody procedures will be followed and a copy of this documentation will be submitted with the quarterly report.

15.1.3 Unregulated Chemical Procedures

For unregulated chemical analyses, the City will select methods according to the following approach:

- Use drinking water methods, if available.
- Use DDW-recommended methods for unregulated chemicals, if available.
- If there is no DDW-recommended drinking water method for a chemical, then City staff will utilize the method that results in the lowest MRL for that chemical.
- If there is more than a single USEPA-approved method available, use the most sensitive of the USEPA-approved methods.
- If there is no USEPA-approved method for a chemical, and more than one method is available from the scientific literature and commercial laboratory, after consultation with DDW, use the most sensitive method.
- If no approved method is available for a specific chemical, the City's laboratory (or contract laboratory) may develop methods or use its own methods and will provide the analytical methods to DDW for review. Those methods may be used until DDW-recommended or USEPA-approved methods are available.

15.2 AWPF Influent Monitoring Requirements

OWTP effluent is the feed to the AWPF. Monitoring of OWTP quality allows for a better understanding of AWPF performance. OWTP effluent will be monitored in accordance with the current NPDES permit and based upon the Enhanced Source Control Program (Appendix A).

For this potable reuse project, recommended additional monitoring of OWTP effluent is shown below in Table 15.1.

Table 15.1 OWTF Effluent Monitoring Requirements

Constituents	Units	Type of Sample	Minimum Frequency of Analysis
Total Flow	mgd	Online Recorder	Continuous(1)
pH	--	Online Recorder	Continuous(1)
Turbidity	NTU	Online Recorder	Continuous(1,2)
TSS	mg/L	24-hour comp	Daily
TDS	mg/L	24-hour comp	Daily
BOD_5, 20°C	mg/L	24-hour comp	Weekly
TOC	mg/L	24-hour comp	Continuous(1,2)
EC	µS/cm	Online Recorder	Continuous(1,2)
NDMA	ng/L	Grab	Monthly

Notes:
(1) For those constituents that are continuously monitored, the City will report the monthly minimum, maximum, and daily average values.
(2) Turbidity values will be monitored in the feed to MF. EC and TOC values will be monitored in the feed to RO, which is MF effluent.

15.3 RO Permeate and AWPF Advanced Treated Recycled Water Monitoring Requirements

DDW (SWRCB, 2018a) outlines a number of monitoring requirements for various process parameters and constituents that can determine performance of the system and compliance of the AWPF advanced treated recycled water in relation to the WDR. Section 60320.201 of DDW regulations (SWRCB, 2018a) states the following general requirements by process:

RO:

- On-going performance monitoring (EC or TOC) that indicates when the process has been compromised.
  - Online monitoring of EC in the RO feed and the RO permeate is currently in operation and will be used to measure RO performance at the AWPF.
  - DDW has requested that TOC monitoring also be used to determine TOC reduction across RO. Oxnard will install TOC metering upstream and downstream of the RO process and will be used to monitor RO performance at the AWPF.
- Minimum of one (1) form of continuous monitoring as well as associated surrogate and/or operational parameter limits and alarm settings that indicate when the integrity has been compromised.
  - As listed above, the RO feed and permeate EC and log removal of EC across RO will be continuously monitored. The log removal of EC is a conservative surrogate for pathogen removal. Once the initial background log reduction of EC is established, a level below the background noise will be alarmed to indicate a reduction in RO performance. DDW, in a letter dated 12/5/2016, recommended setting alarm points similar to OCWD, with a blended EC target of 95 uS/cm and an individual train EC

  target of 110 uS/cm. As noted above, the baseline EC in the RO permeate will first be monitored before settling on specific EC targets.
  - As listed above, DDW has recommended the use of TOC as an additional monitoring method for RO performance. TOC meter(s) will be installed by the City.

Advanced Oxidation:

- Perform an occurrence study on municipal wastewater that includes indicator compounds and select a total of at least nine indicator compounds, with at least one from each of the functional groups. Or, as an alternative, demonstrate 0.5-log reduction of 1,4-dioxane by the AOP (in this case, UV AOP).
  - Demonstration testing of 1,4-dioxane destruction by AOP was performed at startup and was documented previously in this report.
- Occurrence study protocol, as well as subsequent results and chosen indicator compounds should be submitted for DDW review and approval.
  - 1,4-dioxane demonstration work was done in lieu of this requirement.
- During full-scale operation, the surrogate and or/operational parameter identified should be continuously monitored.
  - As detailed here, demonstration testing was done to show a correlation between the existing control philosophy (NDMA LRV) and 1,4-dioxane destruction.
  - The existing EEO-based control system would be modified based upon an NDMA LRV setpoint of 1.4 (instead of 1.0). The result of this modification would be to increase the UVI/Q to a minimum value of 0.018. Because UVI/Q is not part of the proposed system control, the UVI/Q values would be recorded daily and reported on a quarterly basis, with a requirement for the running average 30-day UVI/Q value to be 0.018 or higher. Should the UVI/Q value average be below this target, the NDMA LRV setpoint would need to be increased to a value greater than 1.4.
- Monthly (grab or composite) samples representative of the advanced treated recycled water of the advanced treatment process will be analyzed for contaminants having MCLs and notification levels (NLs). After 12-consecutive months with no results exceeding MCL or NL, a reduction in monitoring frequency can be applied for (minimum quarterly). Monitoring conducted in this subsection can be used in lieu of monitoring (for the same contaminants) in DDW regulations (SWRCB, 2018a), Sections 60320.212 and 60320.220.

Table 15.2 provides more detail on the key analytical monitoring requirements specified in the DDW regulations (SWRCB. 2015a) as they pertain to the direct injection of advanced treated recycled water. This summary will serve as the basis for the monitoring and testing recommendations set forth within this MRP.

Table 15.2 Master Table for Analytical Monitoring Requirements Required by DDW (SWRCB, 2018a)

Sample Location	Parameter	Monitoring Requirements				
		Frequency	Results	Future Performance	Maintenance Plan	DDW (SWRCB 2018a) Reference
RO	Electrical Conductivity	Continuous monitoring pre and post RO	>1 Log Removal Value (LRV).	Stable performance or a gradual increase in effluent EC and decrease in LRV	Calibrate online probes, replace membranes, inspect seals and o-rings as needed to maintain LRV performance	60320.201 (b)
	Total Organic Carbon	Continuous monitoring pre and post RO (once installed)	>1 Log Removal Value (LRV). RO permeate TOC <0.5 mg/L, based upon a 20 week running average	Stable performance or a gradual increase in effluent TOC and decrease in LRV	Calibrate online probes, replace membranes, inspect seals and o-rings as needed to maintain LRV performance	60320.218 (a)
After UV AOP	1,4-dioxane	One-Time. Work completed. No further work needed.	0.5 LRV proven during startup testing	No further performance demonstration needed	≥ 0.5-log proven based upon recommended setpoints for NDMA LRV, UVI/Q, and peroxide dose.	60320.201 (d)
	NDMA LRV control with UVI/Q inspections	Continuous control based upon NDMA LRV setpoint of 1.4, supported by daily UVI/Q calculation (reported quarterly)	Proven during startup	The NDMA LRV based control must be set to achieve a 30-day running average UVI/Q of 0.018. The proposed NDMA LRV setpoint of 1.4 is anticipated to be sufficient	A reference set (6) of calibrated UVI sensors will be installed into the entire UV reactor and UVI readings will be compared to readings with the duty UVI sensors[6]. Readings for both the duty and reference sensors will be compared under similar operational conditions (hand control, all banks on at full power). Should the reference and duty UVI values be roughly equivalent (~20%), the reference sensors will be removed and replaced with the duty sensors. Any duty sensor that varies by more than 20% from the reference sensor will be replaced by the reference sensor and the duty sensor will be sent back to Trojan for calibration.	60320.201 (e)
	MCLs & NLs (Inorganics, Radionuclides, Organics, Disinfection By-Products, Lead and Copper). See Chapter 9, Tables 9.1, 9.3, 9.4, 9.5, 9.6	Monthly for 12 months, then transition to Quarterly	Initial results meet all standards, see Chapter 9.	Continued compliance anticipated.	Exceedance of MCLs and NLs suggest a source control issue coupled with process performance failures. Detailed source control and process audit required to define the extent and magnitude of the problem.	60320.201 (i) / 60320.212 (a) / 60320.220 (b)
						Moni
	Secondary MCLs, See Chapter 9 Table 9.2	Yearly(2,3)	Initial results meet all standards, see Chapter 9.	Continued compliance anticipated.	Exceedance of Secondary MCLs suggest a source control issue coupled with process performance failures. Detailed source control and process audit required to define the extent and magnitude of the problem.	60320.212 (c)
	CECs, See Chapter 9 Table 9.7 (caffeine, NDMA, triclosan, DEET, sucralose, plus 17-alpha-estradiol and iopromide)	Annually	Robust CEC reduction demonstrated in Chapter 9 of this report.	Removal of the vast majority of CECs to below or near the detection level anticipated for the life of the project.	Increased levels of CECs in the finished water suggest a breach or degradation in the RO system.	60320.220 (d)

[6] The sensors are located under the end cover, which will de-energize the system when removed (a safety feature). Therefore the reference sensor check would involve recording the sensor value, shutting down and swapping sensors, and then starting/warming up the system again to check the second sensor response. The sensor is held in a quartz sensor sleeve so the reactor would not have to be drained.

Table 15.2 Master Table for Analytical Monitoring Requirements Required by DDW (SWRCB, 2018a) (continued)

Sample Location	Parameter	Monitoring Requirements				
		Frequency	Results	Future Performance	Maintenance Plan	DDW (SWRCB 2018a) Reference
	Nitrogen Compounds (total nitrogen)	2 x week, 3 days apart	Initial results meet all standards, see Chapter 9.	Continued removal of TN to below 10 mg/L	Monitor ammonia, nitrite, nitrate, and TN. Gradual rise or trends should be examined in the context of OWTF performance and RO performance. Sampling can be reduced after 12 months of low level TN. Ammonia sampling (not regulated), along with nitrite, nitrate, and TN, will assist in troubleshooting.	60320.210 (a)
	Priority Toxic Pollutants, see Table 15.3 below	Quarterly for two years, transition to annual pending results			Chemicals listed in 40 CFR Part 131.38.	60320.220 (a)
	Chemicals analyzed as part of Source Control	Annually			See Appendix A for the ESCP and related recommended sampling.	60320.206
Monitoring Wells, all wells as defined by 60320.226 (a)(1) and (a)(2)	Priority Toxic Pollutants, see Table 15.3 below	Quarterly for two years, reduction to annual pending results	TBD, background sampling not performed	Purified water will be stabilized. Compliance anticipated.		60320.220 (a)
	Additional chemicals named by DDW	Quarterly for two years, reduction to annual pending results	TBD, background sampling not performed	Purified water will be stabilized. Compliance anticipated.		60320.220 (a)
	Secondary MCLs, See Chapter 9 Table 9.2	2 background samples before operation followed by quarterly samples	TBD, background sampling not performed	Purified water will be stabilized. Compliance anticipated.		60320.226 (b)
	Nitrogen (Total nitrogen, nitrate, nitrite)	2 background samples before operation followed by quarterly samples	TBD, background sampling not performed	Purified water will be stabilized. Compliance anticipated.		60320.226 (b)

15.4 Groundwater Monitoring

The proposed ASR Well Monitoring and Reporting Plan defined briefly herein is for the Phase 1 ASR well. See the Report of Waste Discharge (2018) for this project to get greater detail. The proposed monitoring well locations and related hydrogeology are shown in Hopkins (2016). These well locations are intended to track the travel time and water quality of the injected water (greater than 2 weeks and less than 6 months, in accordance with DDW (2016)). Additionally, the locations of the monitoring wells are designed to accomplish three things:

- Be far enough apart to collect water levels that will define the site specific groundwater gradient.
- Be close enough to comply with DDW regulated monitoring well requirements including a travel time of greater than 2 weeks and less than 6 months.
- Utilize the City owned parcel and minimize impacts to airport operations and future park development to be planned.

As proposed, the three monitoring wells will sufficiently define the groundwater gradient in Aquifer 1 of the LAS. The location of the Phase 1 Monitoring Well No. 1 is between the proposed ASR well and the City Well No. 20, which is a municipal supply well. The differential well spacing will generate data through tracer testing to confirm the displacement rate of native groundwater. The Phase 1 Monitoring Well No. 2 is anticipated to see the recharge bubble within 2 weeks while Monitoring Well No. 1 should see the recharge bubble at around 60 days. If estimates are accurate, the Phase 1 Monitoring Well No. 3 will not see the recharge bubble at all.

15.5 Advanced Treatment Online Monitoring

Online monitoring of process performance is critical to maintain the proper barrier to pathogens and trace pollutants. Table 9.1, presented earlier in this report provides information on the proposed monitoring and response procedures to produce high quality water and the necessary response retention time.

15.6 Reporting Requirements

The reporting requirements included in this section are proposed requirements and not the final requirements. The final reporting requirements for IPR will be specified in the revised Order.

Priority Toxic Pollutants from the California Toxics Rule (CTR) are required to be monitored and reported (SWRCB, 2015), but are not regulated on a concentration basis. Thus, the important issue for Oxnard is to properly define the full list of PTPs for monitoring and to clearly note which of these PTPs are not listed in previous tables of regulated chemical pollutants. Thus, Oxnard can readily add in the additional chemical constituents for sampling.

Table 15.3 Priority Toxic Pollutants from California Toxics Rule

Monitored PTPs(1)	Add Chemical to Other Monitoring Efforts?
Antimony	
Copper	
Mercury	
Nickel	
Thallium	

Table 15.3 Priority Toxic Pollutants from California Toxics Rule (continued)

Monitored PTPs(1)	Add Chemical to Other Monitoring Efforts?
Cyanide	
Asbestos	
2,3,7,8-TCDD (Dioxin)	
Acrolein	YES
Acrylonitrile	YES
Benzene	
Bromoform	YES
Carbon Tetrachloride	
Chlorobenzene	YES
Chlorodibromomethane	YES
Dichlorobromomethane	YES
1,2-Dichloroethane	
1,1-Dichloroethylene	
1,2-Dichloropropane	
1,3-Dichloropropylene	YES
Ethylbenzene	
Methyl Bromide	YES
Methylene Chloride	YES
1,1,2,2-Tetrachloroethane	
Tetrachloroethylene	
Toluene	
1,2-Trans-Dichloroethylene	
1,1,2-Trichloroethane	
Trichloroethylene	
Vinyl Chloride	
2-Chlorophenol	YES
2,4-Dichlorophenol	YES
2,4-Dimethylphenol	YES
2-Methyl-4,6-Dinitrophenol	YES
2,4-Dinitrophenol	YES
Pentachlorophenol	
Phenol	YES
2,4,6-Trichlorophenol	YES
Acenaphthene	YES
Anthracene	YES
Benzidine	YES
Benzo(a)Anthracene	YES

Table 15.3 Priority Toxic Pollutants from California Toxics Rule (continued)

Monitored PTPs(1)	Add Chemical to Other Monitoring Efforts?
Benzo(a)Pyrene	
Benzo(a)Fluoranthene	YES
Benzo(k)Fluoranthene	YES
Bis(2-Chloroethly)Ether	YES
Bis(2-Chloroisopropyl)Ether	YES
Bis(2-Ethylhexyl)Phthalate	YES
Butylbenzyl Phthalate	YES
2-Chloronaphthalene	YES
Chrysene	YES
Dibenzo(a,h)Anthracene	YES
1,2 Dichlorobenzene	
1,3 Dichlorobenzene	YES
1,4 Dichlorobenzene	
3,3'-Dichlorobenzidine	YES
Diethyl Phthalate	YES
Dimethyl Phthalate	YES
Di-n-Butyl Phthalate	YES
2,4-Dinitrotoluene	YES
1,2-Diphenylhydrazine	YES
Fluoranthene	YES
Fluorene	YES
Hexachlorobenzene	YES
Hexachlorobutadiene	YES
1,1,2,2-Tetrachloroethane	
Tetrachloroethylene	
Toluene	
1,2-Trans-Dichloroethylene	
1,1,2-Trichloroethane	
Trichloroethylene	
Vinyl Chloride	
2-Chlorophenol	YES
2,4-Dichlorophenol	YES
2,4-Dimethylphenol	YES
2-Methyl-4,6-Dinitrophenol	YES
2,4-Dinitrophenol	YES
Pentachlorophenol	
Phenol	YES

Table 15.3 Priority Toxic Pollutants from California Toxics Rule (continued)

Monitored PTPs(1)	Add Chemical to Other Monitoring Efforts?
2,4,6-Trichlorophenol	YES
Acenaphthene	YES
Anthracene	YES
Benzidine	YES
Benzo(a)Anthracene	YES
Benzo(a)Pyrene	
Benzo(a)Fluoranthene	YES
Benzo(k)Fluoranthene	YES
Bis(2-Chloroethly)Ether	YES
Bis(2-Chloroisopropyl)Ether	YES
Bis(2-Ethylhexyl)Phthalate	YES
Butylbenzyl Phthalate	YES
2-Chloronaphthalene	YES
Chrysene	YES
Dibenzo(a,h)Anthracene	YES
1,2 Dichlorobenzene	
1,3 Dichlorobenzene	YES
1,4 Dichlorobenzene	
3,3'-Dichlorobenzidine	YES
Diethyl Phthalate	YES
Dimethyl Phthalate	YES
Di-n-Butyl Phthalate	YES
2,4-Dinitrotoluene	YES
1,2-Diphenylhydrazine	YES
Fluoranthene	YES
Fluorene	YES
Hexachlorobenzene	YES
Hexachlorobutadiene	YES
Hexachlorocyclopentadiene	
Hexachloroethane	YES
Indeneo(1,2,3-cd) Pyrene	YES
Isophorone	YES
Nitrobenzene	YES
N-Nitrosodimethylamine	
N-Nitrosodi-n-Propylamine	
N-Nitrosodiphenylamine	
Pyrene	YES

Table 15.3 Priority Toxic Pollutants from California Toxics Rule (continued)

Monitored PTPs(1)	Add Chemical to Other Monitoring Efforts?
Aldrin	YES
alpha-BHC	YES
beta-BHC	YES
gamma-BHC (lindane)	
Chlordane	
4,4'-DDT	YES
4,4'-DDE	YES
4,4'-DDD	YES
Dieldrin	YES
alpha-Endosulfan	YES
beta-Endosulfan	YES
Endosulfan Sulfate	YES
Endrin	
Endrin Aldehyde	YES
Heptachlor	
Heptachlor Epoxide	
Polychlorinated biphenyls (PCBs)	
Toxaphene	

Notes:
(1) California Toxics Rule (CTR) as defined by: https://www.gpo.gov/fdsys/pkg/FR-2000-05-18/pdf/00-11106.pdf & https://www.gpo.gov/fdsys/pkg/FR-2001-02-13/pdf/01-3617.pdf.

15.6.1 Report Submittals

The City will submit the required compliance monitoring reports, as outlined in the following paragraphs to the SWRCB's GeoTracker database and to the DDW by the dates listed in Table 15.4.

Table 15.4 Summary of Compliance Report Submittals and their Due Dates

Report	Description	Due
Occurrence / Surrogate Study Report	Provide summary of occurrence study and subsequent surrogate monitoring effectiveness.	60 days after initial 12-months of monitoring during full-scale operation.
Quarterly Monitoring Reports	Provide discussion of previous quarter's analytical results and graphical and tabular summaries of monitoring data (see detailed description below).	May 15 (for Jan – Mar) Aug 15 (for Apr – Jun) Nov 15 (for Jul – Sep) Feb 15 (for Oct – Dec)
Annual Summary Report	Provide discussion of previous year's analytical results and graphical and tabular summaries of monitoring data (see detailed description below).	April 15 (for previous year).
Operations, Maintenance and Monitoring Plan	Description of operation, maintenance, and monitoring activities related to the AWPF.	Initial prior to operation Amended: After 6 months of operation.
Five-year Engineering Report	Provide and update to the Engineer's Report.	Every 5th year from date of approval of this Engineer's Report.

Notes:
(1) All reports will be submitted to SWRCB's GeoTracker as well as to the DDW.

15.6.2 Requirements for Reports

15.6.2.1 Analytical Reporting Details

For the purposes of reporting compliance with numerical limitations, analytical data will be reported using the following reporting protocols:

- Sample results greater than or equal to the MRL must be reported 'as measured' by the laboratory (i.e., the measured chemical concentration in the sample).
- Sample results less than the MRL, but greater than or equal to the laboratory's method detection limit (MDL), will be reported as "Detected, but not Quantified", "DNQ", or "J". The laboratory will write the estimated chemical concentration of the sample next to "DNQ" or "J."
- Sample results less than the laboratory's MDL will be reported as "Non-Detected," or ND.

If the City (or their consultants/contractors) samples and performs analyses (other than for process/operational control, startup, research or equipment testing) on any sample more frequently than required in this MRP using approved analytical methods, the results of those analyses will be included in the report. The results will be reflected in the calculation of the average used in the demonstrating compliance with average effluent limitations.

The quarterly report will be prepared by an engineer licensed in the State of California and experienced in the fields of wastewater treatment and public water supply.

The LARWQCB may request supporting documentation, such as daily logs of operations.

15.6.2.2 Occurrence / Surrogate Study Report

As detailed in Section 17, the performance of the system will be documented at startup, including the use of online surrogates for performance monitoring.

Within 60-days after completing the initial 12-months of monitoring during the full-scale operation, the City will submit a report to the DDW and LARWQCB that includes:

- The results of combined chlorine destruction monitoring across the UV AOP.
- The results on online EC reduction across RO.
- The results on online measurements of UV intensity and UVT.
- The results of MF DIT results and turbidity compliance.
- A description of actions taken, or those that would be taken, if the indicator compound removal did not meet the associated design criteria, the continuous surrogate monitoring failed to correspond to the indicator compound removal percentage, or the surrogate and/or operation parameter established was not met.

15.6.2.3 Quarterly Report

The quarterly compliance monitoring reports will, at a minimum, include the following information:

- The volume of recycled water used for non-potable and potable reuse applications. If no recycled water was used/spread/injected, the report shall so state.
- The date and time of all sampling and analyses.
- All analytical results of samples collected during the monitoring period, as listed in previously in this Section.
- UVI/Q values (max, min, and average).
- Records of any operational problems, plant upset, and equipment breakdowns or malfunctions and any diversion(s) of off-specification recycled water and the location(s) of final disposal.
- Discussion of compliance, non-compliance, or violation of requirements.
- All corrective or preventative action(s) taken or planned with schedule of implementation, if any.
- Certification by the City that no groundwater for drinking water purposes has been pumped from wells within the boundary representing the greatest of the horizontal and vertical distances reflecting 3.1 months of RRT.
- Verification of compliance with the 20-week running average TOC in numerical graphic formats.
- Monitoring results associated with the evaluation of pathogenic microorganism removal as described in Section 5 of this Engineering Report.

15.6.2.4 Annual Report

The annual compliance monitoring reports will, at a minimum, include the following information:

- The volume of advanced treated recycled water used for non-potable and potable reuse applications. If no recycled water was used/spread/injected, the report shall so state.
- Tabular and graphical summaries of the monitoring data (influent, recycled water, and groundwater) obtained during the previous calendar year.

- A summary of compliance status, and for any non-compliance, a description of:
  - The date, duration, and nature of the violation.
  - A summary of any corrective actions and/or suspensions of surface and sub-surface application of recycled water resulting from a violation.
  - If uncorrected, a schedule for and summary of all remedial actions.
- Information pertaining to the vertical and horizontal migration of the recharge water plume.
- Observed trends in the monitoring wells.
- DDW drinking water quality data for the nearest domestic water supply well.
- A description of any changes in the operation of any unit processes or facilities.
- A description of any anticipated changes, along with an evaluation of the expected impacts of those changes on subsequent unit processes or facilities.
- A list of the analytical methods used for each test and associated laboratory quality assurance/quality control procedures; the report will identify the laboratories used by the City to monitor compliance with the WDR, their status of certification and provide a summary of proficiency test.
- A summary of measures taken by the City to comply with wastewater source control program and the effectiveness of the implementation measures.
- Evaluation of the ability of the City to comply with all regulations and provisions.
- List of current operating personnel, their responsibilities, and their corresponding grade of certification.

The annual report will be prepared by an engineer licensed in the State of California and experienced in the fields of wastewater treatment and public water supply.

15.6.2.5 Operation Optimization Plan

The operation and maintenance requirements of the AWPF and its initial recycled water uses were addressed in the *Operations Maintenance Management Plan (OMMP)*, KEH and Associates, Inc., 2015 (OMMP). This OMMP has been updated as an *Operation Optimization Plan (OOP)* in accordance with the California Code of Regulations (CCR), Title 22 for groundwater Replenishment Reuse Projects (GRRPs). The Draft OOP, prepared under separate cover by MV Engineering (2018), describes:

- Operation and control methodologies of the facility.
- Routine maintenance procedures.
- The monitoring and reporting plan (as included herein).
- Analytical methods for constituent analysis.

The Draft OOP will be submitted separately. Looking forward, after 6-months of optimizing treatment processes during actual operation, the OOP may be further updated and amended and will be submitted to the SWRCB's GeoTracker.

15.6.2.6 Five-Year Report

A five-year Engineering Report update will address any project changes and will include, but not be limited to:

- Evidence that the requirements associated with retention time in Section 60320.108, if applicable, and Section 60320.124 of DDW regulations (SWRCB, 2018a) have been met.

- A detailed analysis of pathogen removal through primary and secondary treatment. This work will better develop the already completed four rounds of pathogen information with another 16 to 20 data points. The type of pathogens and analytical methods are to be determined.
- A description of any inconsistencies between previous groundwater model predictions and the observed and/or measured values. For this requirement, the City will summarize the groundwater flow and transport including injection and extraction operations for the project during the previous five calendar years. This summary will also use the most current data for the evaluation of the transport of recycled water; such evaluations will include, at a minimum, the following information:
  - Total quantity of water injected into each major aquifer.
  - Estimates of the rate and path of flow of the injected water within each major aquifer.
  - Projections of the arrival time of the recycled water at the closest extraction well and the percent of recycled water at the wellheads.
  - Clear presentation on any assumptions and/or calculations used for determining the rates of flow and for projecting arrival times.
  - A discussion of the underground retention time of recycled water, a numerical model, or other methods used to determine the recycled water contribution to each aquifer.
  - A revised flow and transport model to match actual flow patterns observed within the aquifer if the flow paths have significantly changed.
  - Revised estimates, if applicable, on hydrogeologic conditions including the retention time and the amount of the recycled water in the aquifers and at the production well field at the end of that calendar year. The revised estimates will be based upon actual data collected during that year on recharge rates (including recycled water, native water, and potable water), hydrostatic head values, groundwater production rates, basin storage changes and any other data needed to revise the estimates of the retention time and the amount of the recycled water in the aquifers and at the production well field. Significant differences, and the reasons for such differences, between the original estimates presented in the Engineer's Report, and the revised estimates, will be clearly presented. Additionally, the City will use the most recently available data to predict the retention time of recycled water in the substance.

The 5-year report will be prepared by an engineer licensed in the State of California and experienced in the fields of wastewater treatment and public water supply.

Section 16

GENERAL OPERATIONS PLAN

Details of the AWPF operation, including chemical use and complimentary process details are provided in the Draft OOP (MV Engineering, 2018).

The DDW commented on the OMMP on February 19, 2015 (SWRCB, 2015); providing the following important comments, followed by responses from the City on April 14, 2015 (Oxnard, 2015). Prior to operational for potable water reuse, the OMMP (now the Draft OOP) has been updated to reflect these comments and recommended changes to system operation and monitoring (e.g., TOC implementation as one example) have been incorporated in the Draft OOP.

- **DDW Comment (General)** - DDW "strongly encourages OWD to train additional staff on the operation of the AWPF to allow more flexibility in staffing...OWD shall not put an unnecessary strain on existing drinking water operations staffing...DDW requests more detail on the recycled water distribution staffing." **City Response:** The City is cross-training OWTP staff to assist the two current AWPF operators. The City also intends to limit AWPF operation, at this time, "to daytime hours when dedicated operators are manning the facility." The City intends to "add another position for a dedicated AWPF operator as well as increase Water Quality and Cross Connection staffing, by two."
- **DDW Comment (on IPR) -** "Conductivity will have a water quality trigger level at greater than 60 umho/cm. Will there be an alarm triggered instantly if this level is sustained for a period of time? What is the response time for the confirmation sample? Are operators able to respond afterhours quickly? What would their response time be?" **City Response:** "The SCADA system will be programmed to have a water quality conductivity levels above 60 umho/cm trigger an alarm after a sustained period of 10 minutes. If the AWPF is unmanned when an alarm is triggered, operators at the OWTP would respond. The OWTP has operates 24-hours per day that will be trained to respond to AWPF alarms. The response times would be less than 30 minutes. **Additional Comments based upon this Engineer's Report:** The recommended approach has been incorporated into the Draft OOP.
- **DDW Comment -** "The UV system is expected to achieve 0.9-log NDMA destruction. DDW comments on previous studies which show this corresponds to an EEO of approximately 0.20 kWhr/kgal." **City Response: Comment Noted. Additional Comments based upon this Engineer's Report:** Extensive startup work has been performed and documented in this report which illustrate the proper UV system control to meet NDMA targets with a high degree of reliability. The recommended approach has been incorporated into the Draft OOP. In particular, the NDMA LRV setpoint needs to be adjusted to 1.4 and daily UVI/Q calculations must be done. UVI/Q is not within the existing control system. On a daily basis at a minimum, AWPF staff shall hand record the UVI readings of all operational UV reactors, the flow through the UV reactors, the predicted NDMA LRV value, and calculate the UVI/Q. Should the UVI/Q value drop below 0.018 on a 30-day running average, the NDMA LRV setpoint shall be increased as needed to bring the 30-day running average above 0.018.

Further, on a quarterly basis, a reference set (6) of calibrated UVI sensors will be installed into the entire UV reactor and UVI readings will be compared to readings with the duty UVI sensors[7]. Readings for both the duty and reference sensors will be compared under similar operational conditions (hand control, all banks on at full power). Should the reference and duty UVI values be roughly equivalent (~20 percent), the reference sensors will be removed and replaced with the duty sensors. Any duty sensor that varies by more than 20 percent from the reference sensor will be replaced by the reference sensor and the duty sensor will be sent back to Trojan for calibration.

- **DDW Comment -** "Number four on the list of parameters monitored by SCADA is conductivity monitoring of the RO permeate. For IPR applications, DDW strongly encourages OWD to use an online TOC analyzer." **City Response:** "An online TOC analyzer will be added to the AWPF." **Additional Comments based upon this Engineer's Report:** At this time, no TOC analyzer has been added to the AWPF. The City intends to install TOC meter(s), and the Draft OOP has been amended to include TOC monitoring and calibration.
- **DDW Comment -** "Please explain what is meant by dose and how this set point is calculated. OMWD should propose a minimum EED." **City Response:** "A minimum EED will be identified..." **Additional Comments based upon this Engineer's Report:** See comment above regarding startup testing of the UV system. The recommended approach has been incorporated into the Draft OOP.
- **DDW Comment -** "The set point for the UV system should be...set [to] a level to always achieve 0.9-log NDMA destruction, which in previous studies corresponds to an EED of approximately 0.2 kWhr/kgal." **City Response:** Comment Noted. **Additional Comments based upon this Engineer's Report:** See comment above regarding startup testing of the UV system. The recommended approach has been incorporated into the Draft OOP.
- **DDW Comment** - OWD shall submit more details on tracer studies, monitoring wells, etc. as they become available. Additionally, please propose a detailed procedure for monitoring leakage between aquifers." **City Response:** Comment noted, the City will provide requested information to DDW. **Additional Comments based upon this Engineer's Report:** No further information in this Engineer's Report.

In the event of a process failure that impacts water quality (potentially or confirmed), the decision making process for protection of public health, detailed in Section 7, will be followed.

[7] The sensors are located under the end cover, which will de-energize the system when removed (a safety feature). Therefore the reference sensor check would involve recording the sensor value, shutting down and swapping sensors, and then starting/warming up the system again to check the second sensor response. The sensor is held in a quartz sensor sleeve so the reactor would not have to be drained.

Section 17
STARTUP TESTING

17.1 DDW Testing Requirements

In discussions with DDW, the City's engineering team reviewed how this project will not use dilution water and will use 100 percent recycled water for recharge. Additionally, the groundwater hydrogeology analyzed within this report is basic, with no tracer work yet performed. Extensive testing has been done on the AWPF, as detailed in Sections 5 and 9. These results demonstrate the ability of the AWPF to meet all regulated water quality standards, including for chemical pollutants and for pathogen log reduction. As such, the City proposes to use purified water for demonstrating the groundwater transport characteristics of the groundwater basin.

The critical missing information that still must be gathered is the travel time of injected water as it pertains to nearby drinking water wells (detailed in Hopkins, 2016). While the analysis methods are conservative, demonstration of groundwater movement (speed and direction) is required. For the ASR project, the ASR well will be put into temporary operation to track the movement of the injected water. Advanced treated recycled water and water from all monitoring wells will be sampled weekly (at a minimum) for TDS, chloride, and sulfate. The time of transport with these intrinsic tracers will be compared to the estimated values and the necessary RRT documented within this report.

The results from the testing above will be submitted to DDW and the RWQCB for review and approval prior to IPR operation.

17.2 LARWQCB Testing Requirements

Several key items must be demonstrated in advance of potable reuse:

- **Background Groundwater Quality –** Upon completion of the monitoring wells, the City will perform sampling required for regulated drinking water projects and the requirements in the Basin Plan for bacteria, minerals, nitrogen, and taste and odor. This testing will be done twice for each groundwater monitoring location. Results will be compared to the AWPF advanced treated recycled water quality detailed in Section 9.
- **Groundwater Chemistry Impacts –** The LARWQCB is concerned about changes in groundwater chemistry that may occur due to the addition of advanced treated recycled water into the groundwater basin. The primary example of this concern is the release of bound arsenic as a result of changes in groundwater chemistry (as reviewed in Section 14 of this report). Upon completion of the initial recharge demonstration period and the response retention, the groundwater will be recovered and placed into the recycled water system for irrigation uses. Groundwater will be sampled weekly for laboratory testing for potential contaminants of concern including for pH, alkalinity, arsenic, magnesium, calcium, and iron sulfides. In addition, water analyses for general minerals, metals, and radionuclides will be conducted on the recovered groundwater toward the beginning, the middle, and the end of the recovery period to assess its suitability as a potable supply.

Section 18

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Groundwater Replenishment Reuse Project

Supplemental Report

INDIRECT POTABLE REUSE ENHANCED SOURCE CONTROL AND COLLECTION SYSTEM MONITORING PROGRAM

December 2018

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CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
PENNY ALBRIGHT CARLO
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CIVIL
STATE OF CALIFORNIA

Contents

Tables

Figures

Abbreviations

-A-	
ASR	Aquifer Storage and Recovery
AWPF	Advanced Water Purification Facility
-B-	
bgs	below ground surface
BOD	Biological Oxygen Demand
-C-	
CEC	Constituents of Emerging Concern
CEQA	California Environmental Quality Act
City	The City of Oxnard
CIUs	Categorical Industrial Users
CMWD	Calleguas Municipal Water District
CWC	California Water Code
-D-	
DDW	Division of Drinking Water
DIT	Direct Integrity Test
-E-	
EC	Electrical Conductivity
EDCs	Endocrine Disrupting Compounds
ELAP	Environmental Laboratory Accreditation Program
-F-	
FCGMA	Fox Canyon Groundwater Management Authority
-G-	
GRPs	Groundwater Recharge Projects
GRRP	Groundwater Replenishment Reuse Project
GWRS	Groundwater Replenishment System
-H-	
H_2O_2	Hydrogen Peroxide
-I-	
IPR	Indirect Potable Reuse
-L-	
LARWQCB	Los Angeles RWQCB
LAS	Lower Aquifer System
LASAN	LA Sanitation
LPHO	Low-Pressure High-Output
LRV	Log-Removal Value

-M-	
MCLs	Maximum Contaminant Levels
MDL	Method Detection Limit
MF	Microfiltration
MRP	Monitoring and Reporting Program
MWDSC	Metropolitan Water District of Southern California
-N-	
ND	Non-Detected
NLs	Notification Levels
NOV	Notice of Violation
NWRI	National Water Research Institute
-O-	
OMMP	Operations, Maintenance, and Monitoring Plan
ORP	Oxidation Reduction Potential
OVMWD	Ocean View Municipal Water District
OWTP	Oxnard Wastewater Treatment Plant
-P-	
PDT	Pressure Decay Test
PEIR	Program Environmental Impact Report
PHWA	Port Hueneme Water Authority
POTW	Publicly-Owned Treatment Works
PPCP(s)	Pharmaceuticals and Personal Care Products
-Q-	
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
-R-	
RO	Reverse Osmosis
ROP	RO Permeate
ROSA	Reverse Osmosis System Analysis
ROWD	Report of Waste Discharge
RRT	Response Retention Time
RWC	Recycled Water Contribution
RWQCB	Regional Water Quality Control Board
-S-	
SCPM	Source Control Program Manager
SCVWD	Santa Clara Valley Water District
SIU(s)	Significant Industrial User(s)
SNMP(s)	Salt Nutrient Management Plan(s)

SWP	State Water Project
SWRCB	State Water Resources Control Board
-T-	
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TSP-SC	Technical Services Program – Source Control
TTO	Total Toxic Organics
-U-	
UAS	Upper Aquifer System
UV AOP	Ultraviolet Light and Hydrogen Peroxide
UVT	UV Transmittance
UWCD	United Water Conservation District's
-W-	
WDR(s)	Waste Discharge Requirement(s)
WRD	Water Replenishment District
WRR	Water Recycling Requirement

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Appendix A

INDIRECT POTABLE REUSE ENHANCED SOURCE WATER CONTROL AND COLLECTION SYSTEM MONITORING PROGRAM

City of Oxnard

Groundwater Replenishment Reuse Project

Supplemental Report

INDIRECT POTABLE REUSE
ENHANCED SOURCE CONTROL AND COLLECTION SYSTEM MONITORING PROGRAM

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QAPP	Quality Assurance Project Plan
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Acknowledgements: At the onset of this effort, Carollo and City of Oxnard staff reached out to the Orange County Sanitation District and the Los Angeles County Sanitation Districts for initial guidance on source control for potable water reuse. Their assistance was substantial and is appreciated.

Section 1

INTRODUCTION

The City of Oxnard (Oxnard, City) is in the process of permitting an Advanced Water Purification Facility (AWPF) for the purposes of implementing potable reuse. The production of purified water starts with an effective enhanced source control program (ESCP), which goes beyond the existing approved source control program for the City. This ESCP details the planned program to effectively monitor the industrial and municipal contributions to the Oxnard Wastewater Treatment Plant (OWTP) as it pertains to the forthcoming potable water reuse project. This document is intended as guidance to the City with proposed methods to monitor in numerous locations and proposed methods to trace pollutants to their source. Some changes to the monitoring and response recommendations will occur as the City gains more experience and moves forward with their forthcoming project.

Much of this ESCP details sampling efforts currently employed as part of the existing source control program and sampling efforts that are already required by State of California Division of Drinking Water (DDW) for finished water quality monitoring for potable reuse. This document is not recommending duplication of those efforts, but instead presents the overall collection and use of data to optimize source control.

Section 2
BACKGROUND

This section includes an overview the National Pretreatment program, an overview of enhanced source control, and the DDW regulatory requirements for groundwater recharge with recycled water.

2.1 National Pretreatment Program

The National Pretreatment Program was established as part of the Clean Water Act to control and regulate the discharge of pollutants from commercial and industrial dischargers of wastewater to publicly owned treatment works (POTWs).

The National Pretreatment Program affords agencies implementing potable reuse the foundational elements needed to implement enhanced source control. The program was promulgated by the United States Environmental Protection Agency (USEPA) in 1983 to control the discharge of pollutants to POTWs. The General Pretreatment Regulations are contained in the Code of Federal Regulations, 40 CFR 403. They establish responsibilities of federal, state, and local government, as well as industrial dischargers, to implement pretreatment standards to control pollutants discharged from nondomestic sources. Since its inception, the National Pretreatment Program has been notably successful in reducing the discharge of pollutants into POTWs nationwide. The objectives of the program are to:

- Prevent the introduction of pollutants into a POTW that will interfere with the operation of the POTW, including interference with its use or disposal of municipal biosolids.
- Prevent the introduction of pollutants into a POTW that will pass through the treatment facility and exit the POTW and cause effluent or biosolids permit violations.
- Improve opportunities to recycle and reclaim municipal and industrial wastewaters and biosolids.

The City operates a USEPA-approved industrial pretreatment program in accordance with 40 CFR 403. Permitted industrial dischargers are subject to national pretreatment standards, which are prohibited discharge standards, categorical pretreatment standards, and local limits. Industrial dischargers are also required to follow permit requirements for discharge monitoring and reporting.

While not designed for potable reuse, Oxnard's pretreatment program can be leveraged with other enhancements to create an enhanced source control program tailored towards potable reuse. The six main elements of the National Pretreatment Program are listed below.

EPA's Six Main Pretreatment Program Elements

1. Legal Authority

The POTW must operate pursuant to legal authority enforceable in federal, state, or local courts, which authorizes or enables the POTW to apply and enforce any pretreatment requirements developed pursuant to the Clean Water Act (CWA) and implementing regulations.

2. **Enforcement Response Plan (ERP)**

The POTW must develop and implement an ERP that contains detailed procedures indicating how the POTW will investigate and respond to instances of IU noncompliance.

3. **Local Limits**

The POTW must develop local limits in defined circumstances or demonstrate why these limits are not necessary. They are custom-designed by each POTW for site-specific protection.

4. **Industrial Waste Survey**

The POTW must prepare, update, and submit to the Approval Authority a list of all Significant Industrial Users (SIUs).

5. **Procedures**

The POTW must develop and implement procedures to ensure compliance with pretreatment requirements, including identifying industrial users, sampling, monitoring, reporting, investigating instances of noncompliance, and public notification.

6. **Funding and Other Resources**

The POTW must demonstrate that they have sufficient resources and qualified personnel to carry out the authorities and procedures specified in its pretreatment program.

Pollutant monitoring is one of the foundations of the National Pretreatment Program, and proper use of the requirements and procedures provide defensible characterization of wastewater. Sampling is regularly conducted at the industrial user discharge points to verify compliance with pretreatment standards and local limits. Sampling is conducted at the POTW for local limits development.

2.2 Role of Enhanced Source Control

The latest research and information regarding enhanced source control was reviewed to determine the proposed ESCP strategies described in this document. Enhanced source control builds upon the existing source control and pre-treatment program already implemented by the City, with potable reuse in mind. The goals of an ESCP for potable reuse include (Tchobanoglous, 2015):

- Minimize the discharge of potentially harmful or difficult-to-treat chemical constituents to the wastewater collection system from industries, health care facilities, commercial businesses, and homes.
- Improve wastewater effluent quality and advanced water treatment performance.
- Provide the public with confidence that the wastewater collection system is being managed with potable reuse in mind.

The principal elements of enhanced source control for potable reuse are listed below (NRWI 2016). The elements build on the foundational pretreatment program elements described in Section 2.

- Regulatory authority.
- Monitoring and assessment of the sewershed.
- Source investigations.

- Updated inventory of chemicals and constituents.
- Public outreach.
- Response plan.

An ESCP is not designed to remove all unwanted constituents but rather to reduce the likelihood that problematic constituents will be introduced into the influent to the advanced water purification facility (AWPF). A risk-based approach to source control is recommended by the Australian Sewage Quality Management Guidelines (WSAA 2012) and encompasses an understanding of baseline sewage quality, the identification of hazardous events, and the control/mitigation of hazards based on risk level.

2.3 DDW Regulations

The regulatory requirements for wastewater source control are defined in the California Code of Regulations Section 60320.206 of the regulations for groundwater recharge with recycled water (California Division of Drinking Water (DDW), 2018b). For this project, the City must administer an industrial pretreatment and pollutant source control program. The City must implement and maintain a program that includes, at a minimum:

1. An assessment of the fate of chemicals and contaminants that are specified by the Department of Drinking Water (Department) and Regional Water Quality Control Board, Los Angeles Region (RWQCB) through the wastewater and recycled municipal wastewater treatment systems (addressed in Section 8).
2. Chemical and contaminant source investigations and monitoring that focuses on Department-specified and RWQCB-specified chemicals and contaminants (addressed in Sections 4 – 6).
3. An outreach program to industrial, commercial, and residential communities within the portions of the sewage collection agency's service area that flows into the water reclamation plant subsequently supplying the groundwater replenishment reuse project (GRRP), for the purpose of managing and minimizing the discharge of chemicals and contaminants at the source (addressed in Sections 6 and 7).
4. A current inventory of chemicals and contaminants identified pursuant to this section, including new chemicals and contaminants resulting from new sources or changes to existing sources, that may be discharged into the wastewater collection system (addressed in Section 6).
5. Is compliant with the effluent limits established in the wastewater management agency's Regional Water Quality Control Board (RWQCB) permit (addressed in Sections 5 and 8).

This document is intended to address each of these items to the satisfaction of DDW.

Section 3

COLLECTION SYSTEM AND SECONDARY EFFLUENT SOURCE MONITORING PROGRAMS

While collection system pre-treatment programs and monitoring are important, secondary effluent is the source water to be used for potable reuse. The proposed ESCP includes a specific contaminant inventory to be monitored in the secondary effluent as well as in the purified water. An action plan detailing when and how to trace contaminants back through the wastewater treatment plant (WWTP) and potentially into the collection system can be found in Section 6.

A generic example of how to trace industrial discharges from their source to the AWPF, based upon different constituent groups, is shown in Figure 3.1. Monitoring parameters vary by location, with more constituents being tested in the secondary effluent and purified water.

An effective enhanced source control program will have a monitoring and data analysis plan that starts with the first discharge of wastewater into the collection system all the way through to the final purification step at the AWPF. Key to this success is having a dedicated staff member heading up the program as the Source Control Program Manager (SCPM). A further job description for the SCPM is provided later in this document.

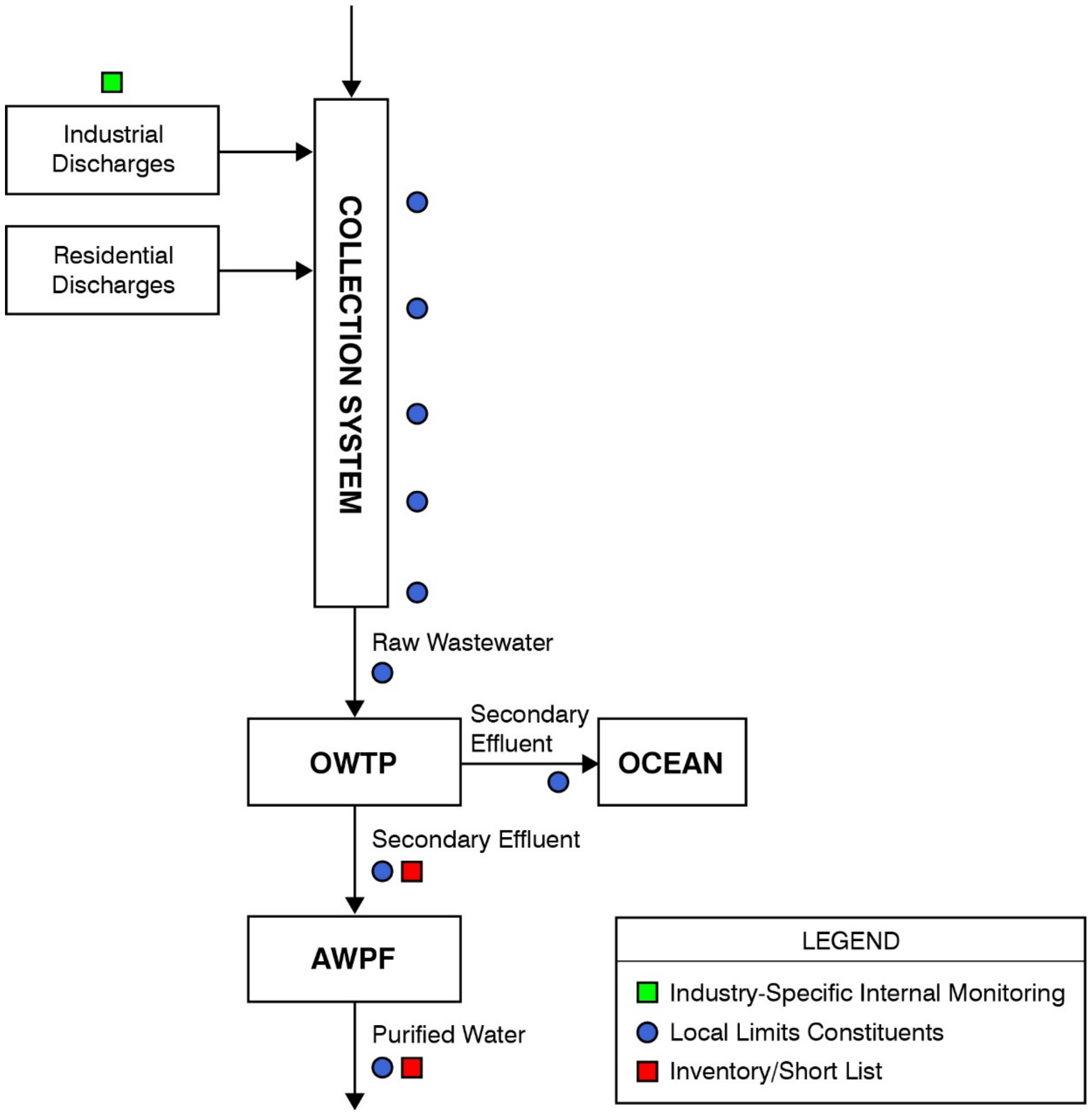

Figure 3.1 Dischargers, Sampling Locations and Monitoring Constituents across the Collection and Treatment System

Section 4

EXISTING INDUSTRIAL PRETREATMENT AND COLLECTION SYSTEM SOURCE CONTROL PROGRAM OVERVIEW

The OWTP is permitted under National Pollutant Discharge Elimination System [NPDES] No. CA0054097, issued to the City on October 11, 2018, and operates an Environmental Protection Agency (EPA)-approved industrial pretreatment program. That program is operating based upon an approved Local Limits program (from 1999).

Oxnard is currently updating that Local Limits program. The City is undertaking such an effort in accordance with the permit, and will submit the proposed limits to the Los Angeles office of the RWQCB for approval. As part of this new Local Limits effort, the City and its contractors have performed detailed sampling efforts of the various industrial users and across the OWTP and the AWPF. The sampling plan included different sewer sampling sites for residential sampling, as well as additional sites for industrial and commercial business sampling. A draft local limits report is now under evaluation by the City. The City continues to conduct public outreach to the industries.

Elements of, and updates to, the City’s current source control program are provided below.

4.1 Description of Industrial Users

The OWTP treats wastewater from the City and Port Hueneme as well as the Point Mugu Naval Base, Ventura County. Approximately 75 percent of this collected flow is residential. The remaining 25 percent is from commercial and industrial users.

Categorical Industrial Users (CIUs) are defined by the federal government and subject to categorical pretreatment standards established in the Code of Federal Regulations. Their discharge requirements are applicable nationwide and are based on best available technology. CIUs, by definition, are also defined as Significant Industrial Users (SIUs). There are typically other SIUs which may not be CIUs.

An industrial user is classified as a SIU if it meets any of the following:

- Is subject to categorical pretreatment standards under 40 CFR 403.6 and 40 CFR Section I, Subsection N.
- Discharges an average of 25,000 gpd or more of process wastewater to the POTW (excluding sanitary, noncontact cooling, and boiler blowdown wastewater).
- Contributes a process waste stream that makes up 5 percent or more of the average dry-weather hydraulic or organic capacity of the POTW treatment plant.
- Is designated as such by the POTW on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement [in accordance with 40 CFR 403.8(f)(6)].

There are thirty-five industries in the service area identified as SIUs discharging into the OWTP collection system, as shown in Table 4.1. Included in Table 4.2 are several dischargers that are not defined as SIUs, but are regulated under the Oxnard Local Limits program. For each discharger shown in the table below, pertinent details are included, such as Regulatory Classification, Wastewater Type, Type of Pretreatment, Potential Contaminants, Average Daily Flow (ADF), Location, and Oxnard permit number. Figure 4.1 shows the location of these customers within the Oxnard wastewater collection system.-

Table 4.1 Industrial Dischargers to OWTP

	Regulatory Classification	Categorical Standard(1)	Wastewater Type	Type of Pretreatment	Potential Contaminants(2)	ADF, kgal (Permit)	Address	Permit #
Aluminum Precision	SIU with Local Limits	Aluminum Forming	Aluminum Forming for Aerospace Automotive and Military Industries	Metals Precipitation, Filter Press, Ultra-Filtration and pH Adjustment	Cd, Cr, Cu, CN, Pb, Ni, O&G, pH, TTO, Zn, Flow	7	1001 McWayne Blvd.	74162
Arcturus	SIU with Local Limits	Aluminum Forming	Ferrous & Non-Ferrous Metals Forming	Settling Pond, Oil Skimming, pH Adjustment with H2SO4	Cd, Cr, Cu, CN, Pb, Ni, O&G, pH, TTO, Zn, Flow	25	6001 Arcturus Ave.	308
Boskovich Farms, Inc.	SIU with Local Limits	N/A	Food Processor; wash, cool, package	Screenings & Filtration	BOD, H2S, O&G, TSS, Flow	250	711 Diaz Ave.	23035
Cal Sun	SIU with Local Limits	N/A	Strawberry Food Processor	Activated Sludge	BOD, H2S, pH, TSS, Flow	32	511 Mountain View Ave.	87549
City of Oxnard Desalter	SIU with Local Limits	N/A	Water Treatment	None	TDS, pH, TSS, Flow	1,500	251 S. Hayes Ave.	23233
Coastal Green Vegetables	SIU with Local Limits	N/A	Food Processor; wash, cool, package, freeze	Activated Sludge	BOD, H2S, O&G, pH, TSS, Flow	220	605 Buena Vista Ave.	94108
Coastal Metal Finishing *(now owned by Limons Metal Finishing)*	Local Limits Only	Metal Finishing	Metal Finishing	Batch Treatment: pH Adjustment, Filtration, Ion Exchange, Evaporation, Solids Dewatering	Ag, CN, Cr, Cu, Pb, Ni, pH, TTO, Zn	4	1160 Mercantile St.	86037
Consolidated Precision Products	SIU with Local Limits	Metal Molding and Casting (Foundries)	Metal Molding & Casting	pH Adjustment	Cd, Cr, Cu, Pb, Ni, Ag, Zn, O&G, pH, TSS, TTO, Flow	30	705 Industrial Ave.	OC-25
Crestview Municipal Water Company	SIU with Local Limits	N/A	Filter Backwash	None	BOD, TSS, pH	Not Operating	602 Valley Vista	OC-5
Deardorf Farms	SIU with Local Limits	N/A	Food Processor; wash, cool, package	Clarifier	BOD, H2S, O&G, TSS, pH, Flow	10	400 N. Lombard	24330
Duda Farms	SIU with Local Limits	N/A	Food Processor	Screening	BOD, H2S, TSS, pH, Flow	37	860 Pacific Ave.	87287
EF Oxnard	SIU with Local Limits	Steam Electric Power Generating	Steam Electric Power Generation; cooling tower blowdown, reverse osmosis reject	None	Cd, Cr, Cu, Pb, Ni, O&G, pH, TTO, Zn, Flow	15	550 Diaz	85723
Elite	SIU with Local Limits	Metal Finishing	Metal Finishing	Batch Treatment: pH Adjustment, Filtration, Ion Exchange, Evaporation, Solids Dewatering	Ag, CN, Cr, Cd, Cu, Pb, Ni, pH, TTO, Zn	14	540 Spectrum Circle	69418
Frozsun Foods, Inc. *(Sunrise Growers 3rd St.)*	SIU with Local Limits	N/A	Food Processor	Rotating Hydrosieve, Biological	BOD, H2S, pH, TSS, O&G, Flow	350	808 E. Third St.	60905
Frozsun, Inc. *(Sunrise Growers Sturgis)*	SIU with Local Limits	N/A	Food Processor; wash, cook, pack	Bio Reactors, Clarification, pH Adjustment	BOD, H2S, TSS, pH, Flow	40	2640 Sturgis Rd.	103247

Table 4.1 Industrial Dischargers to OWTP (continued)

	Regulatory Classification	Categorical Standard(1)	Wastewater Type	Type of Pretreatment	Potential Contaminants(2)	ADF, kgal (Permit)	Address	Permit #
Gills Onions	SIU with Local Limits	N/A	Food Processor; onion washing, cutting and packaging	Screening, Biological Treatment, Settling/Clarification	BOD, H2S, O&G, TSS, pH, Flow	250	901 Pacific Ave.	57277
Harris Water Conditioning	SIU with Local Limits	N/A	Water Softener Regenerator	Gravity Separator, Settling Tanks	BOD, H2S, O&G, pH, TSS, TDS, Flow	138	1025 S. Rose	2072
Herzog	SIU with Local Limits	N/A	Winery	Gravity Separator, pH Adjustment	BOD, H2S, pH, TSS, Flow	11	3201 Camino Del Sol	84360
J.M. Smuckers Co.	SIU with Local Limits	N/A	Food Processor; wash, process, package	Activated Sludge	BOD, H2S, pH, TSS, Flow	148	800 Commercial Ave.	88262
Limons Metal Finishing, Inc.	SIU with Local Limits	Metal Finishing	Metal Finishing	Batch Treatment: pH Adjustment, Filtration, Ion Exchange, Evaporation, Solids Dewatering	Ag, CN, Cr, Cu, Pb, Ni, pH, TTO, Zn	4	1160 Mercantile St.	26531
Mission Linen	SIU with Local Limits	N/A	Commercial Laundry	pH Adjustment, Gravity Separation, DAF and Filtration	BOD, O&G, pH, TSS, Flow, H2S, Temperature	39	505 Maulhardt	533
Naval Base Ventura Cty - Point Mugu Facility	SIU with Local Limits	N/A	Domestic/Commercial	Settling	BOD, Cd, Cu, Pb, O&G, H2S, pH, TSS, TTO, Zn, Flow	382	Bldg. 64, Point Mugu	OC-2
Naval Base Ventura Cty - Port Hueneme Facility	SIU with Local Limits	N/A	Domestic/Commercial	None	BOD, Cd, Cr, Ag, Cu, Pb, Ni, O&G, H2S, pH, TSS, TTO Zn, Flow	650	Mills Road Bldg. 1430, Port Hueneme	OC-04
New Indy	SIU with Local Limits	Pulp, Paper and Paperboard	Pulp, Paper, and Paperboard Processing	Activated Sludge	BOD, H2S, O&G, pH, TSS, TTO, Flow, PCP, TCP	309	5936 Perkins Rd.	100024
Oxnard Lemon Co.	SIU with Local Limits	N/A	Food Processor; wash, process, package	Activated Sludge, Clarification	BOD, H2S, O&G, pH, TSS, Flow	35	2001 Sunkist Circle	13266
Pacific Ridge Farms *(now owned by Frozsun)*	Local Limits Only	N/A	Food Processor; wash, cool, pack	Bio Reactors, Clarification, pH Adjustment	BOD, H2S, TSS, pH, Flow	30	2640 Sturgis Rd.	96073
Parker Hannafin	SIU with Local Limits	N/A	Membrane and Filter Manufacturing	Reverse Osmosis, Vacuum Distillation and UV Advanced Oxidation	BOD, TTO, O&G, pH, TSS, Zn	26	2340 Eastman	88211
Port Hueneme Water Agenc	SIU with Local Limits	N/A	Water Treatment	None	TDS, pH, TSS, Flow	650	5751 Perkins Rd.	56788
Proctor and Gamble	SIU with Local Limits	Pulp, Paper and Paperboard	Pulp, Paper and Paperboard Processing	Gravity Separation, Filtration, Dewatering, Equalization, Neutralization	BOD, H2S, O&G, pH, TSS, TTO, Flow, PCP, TCP	1,376	800 N. Rice	4438
Puretec Industrial	SIU with Local Limits	N/A	Water Softener Regenerator	pH Adjustment	BOD, H2S, O&G, pH, TSS, Flow	100	3151 Sturgis Rd.	56690
Raypak	SIU with Local Limits	Metal Finishing	Metal Finishing	Chemical Precipitation, Neutralization, Settling/Clarification, Filter Press, Filtration	O&G, Cd, Cr, Cu, CN, Pb, pH, Ni, Ag, TTO, Zn	11	2151 Eastman	64517

Table 4.1 Industrial Dischargers to OWTP (continued)

	Regulatory Classification	Categorical Standard(1)	Wastewater Type	Type of Pretreatment	Potential Contaminants(2)	ADF, kgal (Permit)	Address	Permit #
Saticoy Lemon	SIU with Local Limits	N/A	Food Processor; wash lemons, box and package	Biological Control, Clarification, Aeration, Screening	BOD, H2S, O&G, TSS, pH, Flow	50	600 E. Third St.	1345
Scarborough Farms, Inc.	SIU with Local Limits	N/A	Food Processor; vegetable washing, packaging	None	BOD, H2S, pH, TSS, Flow	17	731 Pacific Ave.	57313
Seaboard Produce	SIU with Local Limits	N/A	Food Processor	Settling, Clarification	BOD, H2S, O&G, TSS, Flow	6	601 Mountain View	9866
Seminis	SIU with Local Limits	N/A	Seed Processing	Batch Treatment, Precipitation, Clarification, pH Adjustment, Solids Removal, Ozone	BOD, H2S, TSS, pH, Flow, Zn, TTO, COD, O&G	19	2700 Camino Del Sol	47449
Simba Cal	SIU with Local Limits	Metal Finishing	Metal Finishing	None	Cd, Cr, Cu, Pb, Ni, Ag, Zn, CN, TTO, pH	0.75	1680 Universe Circle	32321
Terminal Freezers (Del Mar, Sun Coast, Tree Top)	SIU with Local Limits	N/A	Food Processor	Activated Sludge, Hydrosieve	BOD, H2S, pH, TSS, O&G, Flow	730	1300 E. Third St.	98242
Ventura Pacific	SIU with Local Limits	N/A	Food Processor; (processing & packaging of lemons)	Activated Sludge, Screening and Clarification	BOD, H2S, O&G, TSS, pH, Flow	70	245 E. Colonia Rd.	26979

Notes:
(1) N/A indicates the industry is not federally regulated.
(2) All TTOs required for monitoring are included in Table 4.3, with corresponding federal categorical standards, where applicable. TTO requirements for non-federally regulated industries are determined by the POTW and will be updated with the Local Limits study.

Table 4.2 Industrial Discharge Customer and Corresponding Numbers to Figure 4.1

INDUSTRIAL CUSTOMERS	
No.	Name
1	Aluminum Precision Products
2	Arcturus Manufacturing
3	Automobile Racing Products
4	Boskovich Farms
5	Cal Sun Produce
6	City of Oxnard Blending Station 3
7	City of Oxnard Desalter
8	Coastal Green Vegetable Company
9	Coastal Metal Finishing
10	Consolidated Precision Products
11	Crestview Municipal Water Company
12	Deardorf Farms
13	Duda Farm Fresh Foods
14	EF Oxnard
15	Elite Metal Finishing
16	Frozsun Foods
17	Frozsun Inc
18	Gill's Onions
19	Harris Water Conditioning
20	Herzog Wine Cellars
21	J.M. Smucker Co.
22	Limons Metal Finishing, Inc.
23	Mission Linen Supply
24	Naval Base Ventura County - Point Mugu Facility
25	Naval Base Ventura County - Port Hueneme Facility
26	New Indy
27	Oxnard Lemon Co.
28	Pacific Ridge Farms
29	Parker Hannifin
30	Port Hueneme Water Agency
31	Proctor and Gamble
32	Puretec Industrial Water

Table 4.2 Industrial Discharge Customer and Corresponding Numbers to Figure 4.1 (continued)

INDUSTRIAL CUSTOMERS	
No.	Name
33	Raypak
34	Santa Clara Waste Water Co.(1)
35	Saticoy Lemon #4
36	Scarborough Farms
37	Seaboard Produce Distributors
38	Seminis
39	Simba Cal
40	Terminal Freezer
41	Ventura Pacific Co.

Notes:
(1) Santa Clara Waste Water Co.'s permit is suspended.

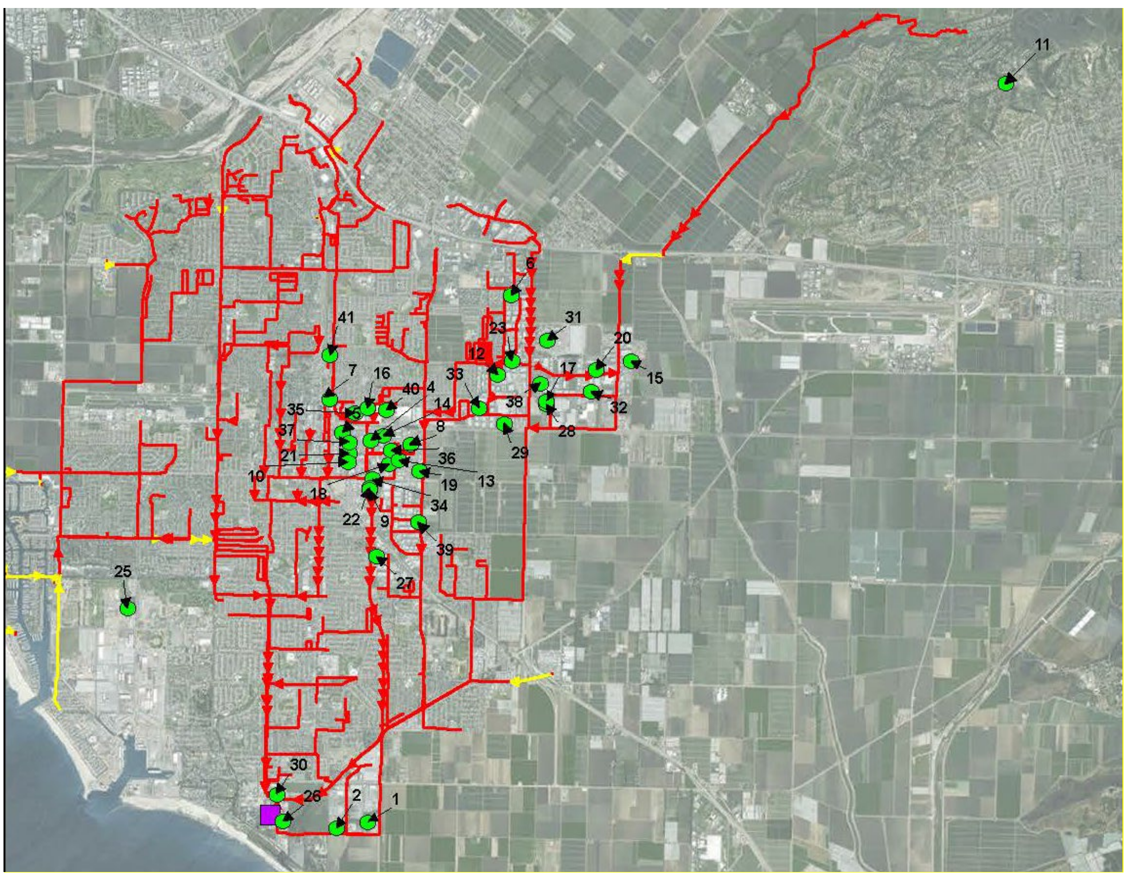

Figure 4.1 Oxnard Collection System with SIUs

4.2 Source Control Program Description

Oxnard's Source Control Program was established as part of the City's industrial pretreatment program, to prevent contaminants from entering the sewer system that could negatively impact the wastewater treatment process or reclaimed water quality. The source control program was also designed to protect the public and environment as well as OWTP personnel from harmful industrial waste. To achieve these goals, the City adopted a Sewer Ordinance within Section 19, Article 1 of the Oxnard Code of Ordinances. *Although not specifically designed to address potable water reuse, Oxnard's existing source control program is intended to protect OWTP effluent, which is the source to the AWPF.* The proposed source control program specifically tailored to potable water reuse is detailed further on in this document.

4.2.1 Local Limits Evaluation

A Local Limits Evaluation Report was produced in 1999 that determined allowable contaminant concentrations in industrial wastewater. The Local Limits Evaluation Report is now being updated (October 2017 Draft).

4.2.2 Permitting of Industrial Users

All SIUs are required to obtain an Industrial Wastewater Discharge Permit from the Oxnard City Manager. Permits are issued for up to five-year periods and contain both effluent limits and sampling requirements. These limits can be both local and federal. SIUs are required to submit their permit application at least 90 days before any proposed discharge. Table 4.2, above, includes all industrial dischargers permitted by the City.

4.2.3 Industrial Waste Monitoring

Oxnard's monitoring program provides necessary information for evaluating industry compliance, assessing OWTP loading and operation, and determining illicit discharges. SIUs are monitored via three mechanisms: self-monitoring, monitoring by the City, and surveillance sampling.

Self-monitoring is required for each SIU. The Industrial Wastewater Discharge Permits mandate daily flow monitoring as well as bi-monthly contaminant sampling. Each month the SIU must submit a Surveillance Monitoring Report to the City. Typical parameters for which dischargers must sample include: Biological Oxygen Demand (BOD), TSS, Total Toxic Organics (TTO), Oil and Grease, and pH. Industry specific metal monitoring is often also mandated. Monthly TTO monitoring may not be required if TTO samples contain less than 1.0 mg/L, and in this case, only yearly samples are necessary. The following Table 4.3 contains a list of all TTOs and the corresponding industry category that requires monitoring.

Table 4.3 Industrial Discharge Monitoring Requirements for TTOs

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
1,1,1-trichloroethane		X	X	X		
1,1,2,2-Tetrachloroethane		X		X		
1,1,2-trichloroethane		X		X		
1,12-benzoperylene (benzo(ghi) perylene)		X		X		
1,1-dichloroethane		X		X		
1,1-dichloroethylene		X		X		
1,2,4-trichlorobenzene		X		X		
1,2,5,6-dibenzanthracene (dibenzo(a,h)anthracene)	X		X			
1,2-benzanthracene (benzo(a) anthracene)		X		X		
1,2-dichlorobenzene		X		X		
1,2-dichloroethane		X		X		
1,2-dichloropropane		X		X		
1,2-dichloropropylene (1,3-dichloropropene)				X		
1,2-diphenylhydrazine	X	X		X		
1,2-trans-dichloroethylene		X		X		
1,3-dichlorobenzene		X		X		
1,3-Dichloropropylene (1,3-dichloropropene)		X				
1,4-dichlorobenzene		X		X		
11,12-benzofluoranthene (benzo(b) fluoranthene)				X		
11,12-Benzofluoranthene (benzo(k)fluoranthene)		X				
2,3,4,6-tetrachlorophenol					X	

Table 4.3 Industrial Discharge Monitoring Requirements for TTOs (continued)

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)		X		X		
2,4,5-trichlorophenol					X	
2,4,6-trichlorophenol		X	X	X	X	X
2,4-dichlorophenol		X		X		
2,4-dimethylphenol		X	X	X		
2,4-dinitrophenol		X		X		
2,4-dinitrotoluene	X	X		X		
2,6-dinitrotoluene		X		X		
2-chloroethyl vinyl ether (mixed)		X		X		
2-chloronaphthalene		X		X		
2-chlorophenol	X	X		X		
2-nitrophenol		X		X		
3,3-dichlorobenzidine		X		X		
3,4,5-trichlorocatechol					X	
3,4,5-trichloroguaiacol					X	
3,4,6-trichlorocatechol					X	
3,4,6-trichloroguaiacol					X	
3,4-Benzofluoranthene (benzo(b) fluoranthene)	X	X		X		
4,4-DDD (p,p-TDE)		X		X		
4,4-DDE (p,p-DDX)		X		X		
4,4-DDT		X		X		
4,5,6-trichloroguaiacol					X	
4,6-dinitro-o-cresol		X		X		
4-bromophenyl phenyl ether		X		X		

Table 4.3 Industrial Discharge Monitoring Requirements for TTOs (continued)

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
4-chlorophenyl phenyl ether		X		X		
4-nitrophenol		X		X		
Acenaphthene	X	X	X	X		
Acenaphthylene	X	X		X		
Acrolein		X		X		
Acrylonitrile		X		X		
Aldrin		X		X		
Alpha-BHC		X		X		
Alpha-endosulfan		X		X		
Anthracene	X	X	X	X		
Antimony				X		
Arsenic				X		
Asbestos				X		
Benzene		X	X	X		
Benzidine		X		X		
benzo (a)anthracene (1,2-benzanthracene)			X			
Benzo(a)pyrene (3,4-benzo-pyrene)	X	X	X	X		
benzo(ghi)perylene	X					
Benzo(k)fluoranthene	X					
Beryllium				X		
Beta-BHC		X		X		
Beta-endosulfan		X		X		
Bis (2-chloroethoxy) methane		X		X		
Bis (2-chloroethyl) ether		X		X		

Table 4.3 Industrial Discharge Monitoring Requirements for TTOs (continued)

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
Bis (2-chloroisopropyl) ether		X		X		
Bis (2-ethylhexyl) phthalate	X	X	X	X		X
Bromoform (tribromomethane)		X		X		
Butyl benzyl phthalate		X	X	X		
Cadmium				X		
Carbazole						X
Carbon tetrachloride (tetrachloromethane)		X		X		
Chlordane (technical mixture and metabolites)		X		X		
Chlorobenzene		X	X	X		
Chlorodibromomethane		X		X		
Chloroethane		X		X		
Chloroform (trichloromethane)		X	X	X		
Chromium				X		
Chrysene	X	X	X	X		
Copper				X		
Cyanide, Total				X		
Delta-BHC (PCB-polychlorinated biphenyls)		X		X		
dibenzo(a,h)	X					
Dichlorobromomethane		X		X		
Dieldrin		X		X		
Diethyl Phthalate	X	X	X	X		
Dimethyl phthalate		X		X		

Table 4.3 Industrial Discharge Monitoring Requirements for TTOs (continued)

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
Di-N-Butyl Phthalate	X	X	X	X		
Di-n-octyl phthalate		X		X		
Endosulfan sulfate	X	X		X		
Endrin	X	X		X		
Endrin aldehyde	X	X		X		
Ethylbenzene	X	X		X		
Fluoranthene	X	X	X	X		X
Fluorene	X	X	X	X		
Gamma-BHC (lindane)		X		X		
Heptachlor		X		X		
Heptachlor epoxide (BHC-hexachlorocyclohexane)		X		X		
Hexachlorobenzene		X		X		
Hexachlorobutadiene		X		X		
Hexachlorocyclopentadiene		X				
Hexachloroethane		X		X		
Hexachloromyclopentadiene				X		
Indeno (,1,2,3-cd) pyrene (2,3-o-pheynylene pyrene)	X			X		
Indeno(1,2,3-cd) pyrene (2,3-o-phenlene pyrene)		X				
Isophorone	X	X		X		
Lead				X		
Mercury				X		
Methyl bromide (bromomethane)		X		X		

Table 4.3 Industrial Discharge Monitoring Requirements for TTOs (continued)

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
Methyl chloride (chloromethane)		X				
Methyl chloride (dichloromethane)				X		
Methylene chloride (dichloromethane)		X	X	X		
Naphthalene	X	X	X	X		
n-Decane						X
Nickel				X		
Nitrobenzene		X		X		
N-nitro sodi phenyl amine	X					
N-nitrosodimethylamine		X		X		
N-nitrosodi-n-propylamine		X		X		
N-nitrosodiphenylamine		X		X		
n-Octadecane						X
o-Cresol						X
Para-chloro meta-cresol (p-chloro-m-cresol)	X	X	X	X		
PCB-1016 (Arochlor 1016)	X	X		X		
PCB-1221 (Arochlor 1221)	X	X		X		
PCB-1232 (Arochlor 1232)	X	X		X		
PCB-1242 (Arochlor 1242)	X	X		X		
PCB-1248 (Arochlor 1248)	X	X		X		
PCB-1254 (Arochlor 1254)	X	X		X		
PCB-1260 (Arochlor 1260)	X	X		X		
p-Cresol						X
Pentachlorophenol		X		X	X	

Table 4.3 Industrial Discharge Monitoring Requirements for TTOs (continued)

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
Phenanthrene	X	X	X	X		
Phenol	X	X	X	X		
Pyrene	X	X	X	X		
Selenium				X		
Silver				X		
TCDD					X	
TCDF					X	
Tetrachlorocatechol					X	
Tetrachloroethylene	X	X	X	X		
Tetrachloroguaiacol					X	
Thallium				X		
Toluene	X	X	X	X		
Toxaphene		X		X		
Trichloroethylene	X	X	X	X		
Trichlorophenol					X	
Trichlorosyringol					X	
Vinyl chloride (chloroethylene)		X		X		
Zinc				X		

To help ensure the validity of self-monitoring results, sampling and analyses for required chemicals must be performed by a California state-certified laboratory, acceptable to the City's Technical Services Program – Source Control (TSP-SC), in accordance with 40 CFR, Part 136.

In addition to industry self-monitoring, the City conducts facility sampling twice per year. The sampling location is outlined in each SIU's permit.

To facilitate detection of illegal discharges of prohibited materials into the collection system, surveillance monitoring is also conducted. Such monitoring is performed if the City suspects illegal dumping or if there are complaints.

4.2.4 Slug Control

A slug load or slug discharge is defined as any discharge which would cause a violation of the industrial pretreatment program, either by a flow violation or an exceedance of contaminant concentration limit. Slug loads can be caused by accidental spills or batch discharges of irregular nature, causing a drastic increase in contaminant concentration ("slug") to occur in the collection system. Slug loads by definition are not routine or predictable. If an event occurs that may cause a slug discharge, the industrial user must notify the city manager immediately. The City Manager is then responsible for assessing the severity of the load and once identified, taking appropriate measures to ensure public safety and optimal operations. This may involve diverting the wastewater treatment plant effluent flow or purified water flow until the slug load has been processed appropriately.

It is recommended that the City should require all SIUs to develop and submit a Slug Discharge Control (SDC) Plan. The slug control plan would be reviewed and updated by the source control program manager as needed.

4.2.5 Inspection of Industries

Annual SIU inspections are conducted by City staff. Such inspections allow for the investigation of SIU permit compliance. These inspections also help identify if a SIU is responsible for treatment plant upsets. Additionally, the inspections act as industrial outreach efforts and help disseminate information on technical issues such as permit requirements and pollution prevention opportunities.

4.2.6 Centralized Waste Treatment

Oxnard has one of the largest centralized waste treatment (CWT) facilities in California within their service area, Santa Clara Wastewater (SCWW). CWTs treat hazardous and nonhazardous wastes (e.g. industrial tank residuals called "tank bottoms", oil field operations wastes, etc.). They are regulated under 40 CRF 437, and are managed by POTWs through their industrial pretreatment programs. The major issue surrounding the acceptance by POTWs of the discharge from CWT facilities, especially Subcategory D facilities that accept multiple wastestreams, is their potential impact on water reuse programs. An explosion occurred at the SCWW facility, a CWT that receives hauled waste from many sources, treats those wastes, then discharges them into the Oxnard collection system. The cause of the accident has been attributed to the unsafe mixture of specific chemicals with domestic sewage. Currently, the SCWW facility is not approved to discharge to the OWTP.

In response to the explosion event, Carollo prepared Best Management Practices (BMP) policy for CWTs on behalf of the City, which, were then endorsed by the California Association of

Sanitation Agencies (CASA). Carollo surveyed six POTWs regarding CWTs in their service areas. Carollo contacted and received help from POTWs that have CWTs; including OCSD, LACSD, City of LA, the City of San Jose, and Oxnard. The BMP for CWTs is attached as Appendix A to this document. Oxnard has implemented this BMP for any CWT within its collection system. Key elements of the BMP are:

- Waste Receiving Requirements - including manifests for haulers, testing of hauled waste before disposal, prohibition of specific activities, and allowance for random sampling.
- Treatment Requirements - treatment meeting EPA standards under 40 CFR 437, emergency shutoff, treatment reliability and redundancy, prohibition of holding tanks for dilution, and recording of treatment system operations details.
- Effluent Discharge and Sampling/Testing Requirements - continuous discharge prohibited, batch tanks continuously mixed, sampling and analysis before discharge required, reprocessing if necessary.
- Recommended Certification and Documentation Requirements - requirements for certifications, plans, procedures, O&M, treatment system details, documentation of all waste haulers, and testing and monitoring requirements.

4.2.7 Enforcement

Enforcement procedures for industrial dischargers are in place to ensure that out-of-compliance industries can be brought into compliance, or their service terminated. Sections 19, Article 1, Divisions 8 through 10 of Oxnard's Municipal Code outline all the allowable enforcement actions that can be taken by the City. If an SIU violates its permit, a written Notice of Violation (NOV) is sent to the SIU. The SIU then has 10 days to submit an explanation of violation and a plan for correction. For biological oxygen demand (BOD) and total suspended solids (TSS) limit violations, the SIU is surcharged based on a predetermined formula. For other exceedances, increasing enforcement action is taken as necessary. Such actions can include discontinuing sewer or water service, a cease and desist order, issuance of a fine, or termination of permission to discharge to the system.

The 2013 OWTP Annual Pretreatment Report identified 42 total industrial dischargers having 49 total violations (with zero penalties or legal action required), and 3 industrial dischargers with significant non-compliance necessitating public notification.

Section 5

COLLECTION SYSTEM AND OWTP WATER QUALITY RESULTS

5.1 Industrial Sampling Program

As a requirement of their local limits update, the City conducted an extensive wastewater sampling program to characterize pollutant loadings and process removals to develop scientifically-based local limits in the fall of 2015. In addition to this study, the City performed routine monitoring for NPDES permit requirements as well as industrial discharge constituents. OWTP's routine influent monitoring is conducted at the headworks of the plant, which is downstream of plant recycled flows.

5.1.1 Prior Incident of Pass-Through with Gross Beta Radioactivity

On September 4th, 2014 analytical results showed an exceedance of the OWTPs gross-beta NPDES defined permit limit. The gross-beta sample concentration was 94 pCi/L and the permit requirement was 50 pCi/L. The sample was taken one month prior on August 5th during a routine semiannual sampling event at the OWTP. Oxnard's Technical Services Program found hydraulic fracturing fluids to be a potential source of gross-beta contaminant. Wastewater staff then collected wastewater samples at City Water Yard and SCWW (both known to discharge this type of contaminants) on Wooley Road. Following analytical results reported on October 14, 2014, monitoring staff were informed that the SCWW sample port had a gross-beta concentration of 4400 pCi/L. The next day on October 15, 2014, the staff convened a meeting to determine an action plan.

On October 16, 2014 additional samples were taken upstream of the SCWW site to track the source of the gross-beta discharge into the Santa Clara collection system. Green Compass, the parent company of SCWW, was identified as the responsible discharger, stating that Vintage Productions, an industrial customer of SCWW, was the point source into their facility. A Cease and Desist order was issued to Green Compass, who immediately complied with the order. Continuous gross-beta monitoring was conducted near the sampling site for the following months, and a NOV was issued to SCWW for violations on sample dates 9/24, 10/16, 10/22 and subsequently 10/28, 11/6, and 11/13.

Shortly thereafter (11/2014), the aforementioned accident at the SCWW occurred and the Oxnard City Manager issued a suspension of discharge permit and prohibited SCWW from discharging any wastewater into the Oxnard Collection System.

5.2 Industry Water Quality Results

Industrial pretreatment programs are in place, and additional pretreatment and auditing programs are recommended as part of this enhanced source control program as detailed in Section 5. Table 5.1 contains a list of detected industrial discharge contaminants from 2013-2014. The permit limits for these industries are being updated (Local Limits Report), and for some more stringent limits are to follow. All collection system monitoring samples are tested for the constituents listed, however, many of the industries do not produce or use these contaminants in their processes as shown by the blank cells. Internal monitoring program data is also available in the Local Limits study and internal auditing can take place by the SCPM when collection system monitoring data does not align.

5.3 Residential (only) Water Quality Results

The domestic/residential sectors of the service area had not been sampled in over 15 years prior to the recent Local Limits study. Four sampling locations were chosen for the study, based on collection system discharges and trunk lines (Figure 5.1). Concentrations from residential dischargers for a limited set of constituents tested are shown in Table 5.2. These results provide baseline concentrations for OWTP influent monitoring, allowing the isolation of industrial and domestic discharge inputs.

Table 5.1 Industry Water Quality Data 2013-2014 for all Industrial Dischargers to the City of Oxnard WWTP

	2013 ADF	Avg BOD	Avg pH	Avg TSS	Avg H2S	Avg O&G	TDS	TTO	Cd	Cr	Cu	Pb	Zn	Ni	Ag	CN-	As	Sb	Ar	Co	Hg	Sn	Ti	V
Industry Name	gpd	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Industries																								
Alliance Finishing & Manufacturing	--																							
Aluminum Precision Products	7,000	N/A	7.8	9	NA	4	2,063		0.0023	0.007	0.021	0.0075	0.21	0.0118		0.004								
Arcturus Manufacturing	25,000	N/A	8.3	NA	NA	14	N/A		0.004	0.01	0.04	0.009	0.008	0.065		0.004								
Automotive Racing Products*																								
Boskovich Farms	250,000	364	N/A	176	0.10	6	N/A																	
Cal Sun Produce	32,000	171	7.3	135	0.1	7	N/A																	
Coastal Green Vegetable Co.	220,000	219	7.2	300	0.02	5	N/A																	
Coastal Metal Finishing/Limons Metal Finishing	1,000	N/A	7.8	N/A			N/A	1	0.0200	0.2000	0.5000	0.0800	0.6000	1.3000	0.0200	0.0050	0.1000							
Consolidated Precision Products	11,907																							
Deardorff Family Farms	10,000	31	7.9	46	0.1	6	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Duda Farm Fresh Foods	37,000	507	7.3	156	0.02	9	N/A																	
EF Oxnard	15,000	N/A	7.7	N/A	0.20	4	2,842		0.0103	0.0403	0.0245	0.0528	0.1841	0.0263										
Elite Metal Finishing	14,000	N/A	8.1	N/A	NA	NA	N/A		0.01	0.06	0.1	0.03	0.14	0.15	0.01	0.03								
Frozsun Foods	350,000	371	7.2	119	0.10	N/A	N/A																	
Gill's Onions	250,000	185	7.5	53	0.38	5	N/A																	
Harris Water Conditioning	138,000	2	6.9-8.5	19	0.10	3	20,883	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Herzog Wine Cellars	10,000	2,187	7.2	190	0.5	6	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
J.M. Smucker Co.	148,000	139	7.7	224	0.12	4	N/A	na																
Mission Linen Supply	39,000	217	7.4	134	0.02	41	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na

Table 5.1 Industry Water Quality Data 2013-2014 for all Industrial Dischargers to the City of Oxnard WWTP (continued)

	2013 ADF	Avg BOD	Avg pH	Avg TSS	Avg H2S	Avg O&G	TDS	TTO	Cd	Cr	Cu	Pb	Zn	Ni	Ag	CN-	As	Sb	Ar	Co	Hg	Sn	Ti	V
Industry Name	gpd	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
New Indy	300,000	28	7.4	26	0.04	5	3,390	0.67	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Oxnard Lemon Co.	35,000																							
Pacific Ridge Farms	30,000	559	6.9	322	0.25	6	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Parker Hannifin	26,000	995	6.8	8	NA	5	N/A	0.037					0.05											
Proctor and Gamble	1,400,000	112	6.2-9.3	214	0.02	23	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Puretec Industrial Water	100,000	14	6.3-9.3	43	0.02	5	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Raypak	11,000	N/A	6.8-9.9	N/A	NA	6	N/A	0.03	0.02	0.06	0.02	0.05	0.12	0.04		0.031								
Saticoy Lemon #4	50,000	131	8.3	214	0.1	15	N/A																	
Scarborough Farms	17,000	25	7.2	432	0.1	NA	N/A																	
Schlumberger Technology																								
Seaboard Produce Distributors	25000																							
Seminis	19,000	156	8.1	455	0.1	17	N/A	0.46					0.29											
Industries																								
Alliance Finishing & Manufacturing	--																							
Simba Cal	750	N/A	9.3	N/A	NA	NA	N/A	<1 mg/l	0.01	0.052	0.67	0.05	0.21	0.027	0.013	0.005								
Terminal Freezer (Del Mar, Suncoast, Tree Top)	730,000	84	8.0	102	N/A		N/A																	
Ventura Pacific Co.	70,000	408	7.6	88	0.12	13																		
Other Agencies																								
City of Oxnard Desalter	1,500,000	N/A	7.2	5	N/A	N/A	1,580																	
Crestview Municipal Water Co.	0																							
NBVC Point Mugu	223,722																							
NBVC Port Hueneme	452,807																							
Port Hueneme Water Agency	347,947																							
Santa Clara Waste Water Co.	150,000	185	7.7	26	0.02	5	N/A	0.34	<0.01	0.01	0.02	0.03	0.06	0.01	0.01			<0.05	<0.01	<0.005	<0.005	0.01	0.01	0.03

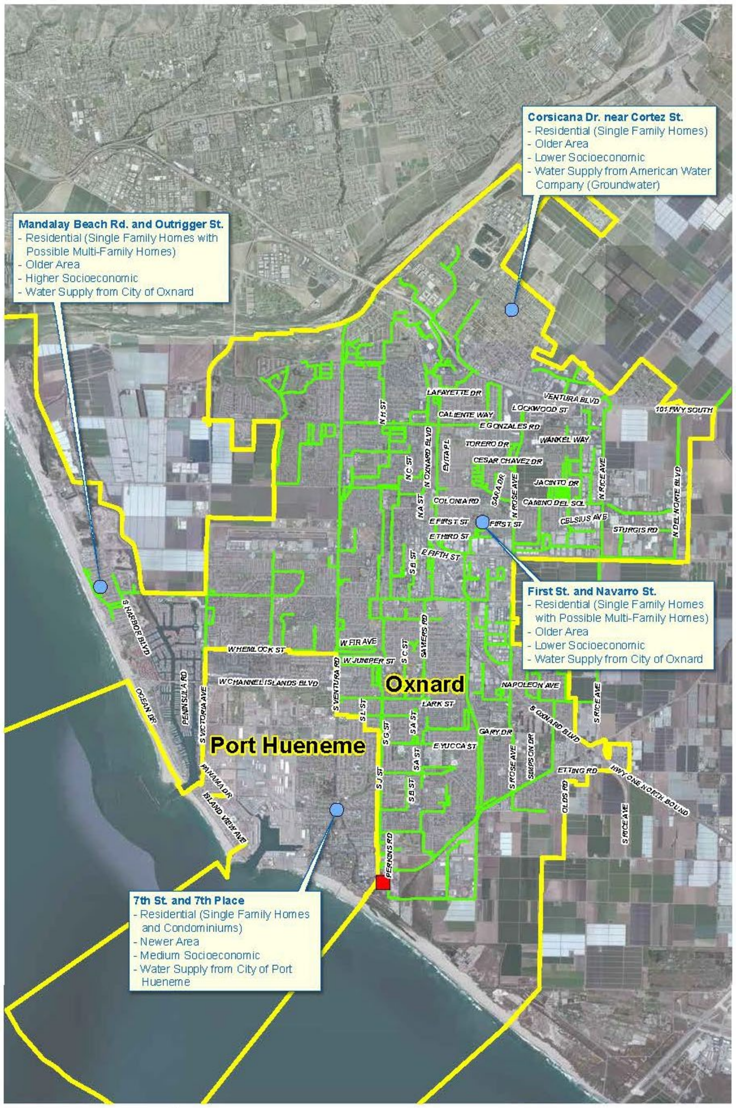

Figure 5.1 Four Residential Sampling Locations Included in the Local Limits Study

Table 5.2 Residential Wastewater Concentrations from 4 Sampling Locations Listed in Figure 5.1

Constituent	Units	Average	Geometric Mean
Ammonia Nitrogen	mg/L	39	38
Antimony Total	ug/L	1.011	1.009
Arsenic Total	ug/L	2.31	2.09
Barium Total	ug/L	45.46	40.1
Beta, Gross	pCi/L	21.96	21.04
Biochemical Oxygen Demand	mg/L	258	248
Boron Total	mg/L	0.77	0.76
Cadmium Total	ug/L	0.505	0.504

Table 5.2 Residential Wastewater Concentrations from 4 Sampling Locations Listed in Figure 5.1 (continued)

Constituent	Units	Average	Geometric Mean
Calcium Total	mg/L	98	88
Chloride	mg/L	123.1	116.8
Chromium Total	ug/L	1.39	1.24
Copper Total	ug/L	89.04	75.48
Fixed Dissolved Solids	mg/L	839	776
Fluoride	mg/L	0.54	0.53
Gross Alpha	pCi/L	3.55	3.44
Iron Total	mg/L	0.93	0.56
Lead Total	ug/L	1.81	1.54
Magnesium Total	mg/L	34.1	30.4
Manganese Total	mg/L	0.043	0.037
Mercury	ng/L	23.43	6.08
Molybdenum Total	ug/L	10.53	9.45
Nickel Total	ug/L	6.99	6.68
Potassium Total	mg/L	21.7	21.3
Selenium Total	ug/L	5.4	5.35
Silica	mg/L	27.8	26.5
Silver Total	ug/L	0.508	0.507
Sodium Total	mg/L	151.4	148.5
Specific Conductance	umho/cm	1689	1659
Strontium	mg/L	0.91	0.81
Sulfate	mg/L	325.4	284.7
Total Dissolved Solids	mg/L	1252	1187
Total Kjeldahl Nitrogen	mg/L	61	59
Total phosphorus as P	mg/L	7.3	7
Total Suspended Solids	mg/L	241	211
Uranium	ug/L	5.07	4.3
Zinc Total	ug/L	177.46	161.77
Strontium	mg/L	0.91	0.81
Sulfate	mg/L	325.4	284.7
Total Dissolved Solids	mg/L	1252	1187
Total Kjeldahl Nitrogen	mg/L	61	59
Total phosphorus as P	mg/L	7.3	7

Table 5.2 Residential Wastewater Concentrations from 4 Sampling Locations Listed in Figure 5.1 (continued)

Constituent	Units	Average	Geometric Mean
Total Suspended Solids	mg/L	241	211
Uranium	ug/L	5.07	4.3
Zinc Total	ug/L	177.46	161.77

Notes:
Concentrations were averaged for all five sampling locations for all dates tested.

5.4 Raw Wastewater Water Quality Results

As part of the Local Limits discharge update study, raw wastewater was tested for regulated, industrial and NPDES constituents. Results are included in the Local Limits study. It is important to note that although many constituents were tested for, few were found at detectable concentrations in the raw wastewater. This provides a further level of confidence for downstream treatment and secondary effluent source protection.

Section 6
PROPOSED ENHANCED SOURCE CONTROL PROGRAM FOR POTABLE REUSE

Title 22 Regulations require a source control program to be in place prior to operating an indirect potable reuse (IPR) facility. As previously discussed, Oxnard's current source control program meets all of the requirements; however, an enhanced source control program (ESCP) is recommended as an additional barrier for producing purified water from IPR. An ESCP would build on the existing source control program in place, with increased monitoring frequency and additional monitoring locations. The following section provides a framework for an ESCP, which could be implemented in Oxnard.

6.1 Source Control Program Manager

The current structure of the source control program at the City of Oxnard includes multiple points of contact covering the collection system, wastewater treatment plant, drinking water treatment plant and groundwater injection. In order to ensure all data is reported, logged and analyzed, a Source Control Program Manager (SCPM), acting as a single point of contact should be hired into a full-time position and charged with the following tasks:

- Collect and log all data from the collection system, OWTP, AWPF and groundwater monitoring program.
- Analyze online data for trends indicating potential upsets in the treatment process.
- Report any concerns, issues, and violations to City management. Any finished water violations would be reported by other City staff to the RWQCB.
- Plan and facilitate all industrial stakeholder workshops.
- Plan and oversee all residential outreach efforts.
- Ensure staffing needs are met for industrial audits, collection system sampling and outreach efforts.
- Update any new industrial dischargers or housing developments to source control program.
- Ensure all SIUs report monthly and annual TTO monitoring results.
- Annual review of slug discharge control plans from SIUs.

Data collected and provided to the SCPM will be analyzed by this person to create baseline trends and identify outliers, events, or a constituent that is slowly increasing through the collection system or through the OWTP. Analysis of pollutants through the AWPF and the groundwater system will be handled by the SCPM manager as it applies to raw wastewater source control. The same water quality data from the AWPF and groundwater system, pertaining to potable water reuse regulatory compliance, will be handled by other City management. The SCPM should have a second in command who is knowledgeable about the status of the source control program in the event the SCPM is not available.

6.2 Recommended Parameters, Detection Levels, and Methods

Monitoring wastewater influent, secondary treated wastewater, RO concentrate and AWPF water in one program can pose challenges due to analytical methods. The same contents could be monitored in each water type, but will likely require at least 2 different methods, if not 4. Methods for detecting all Title 22 monitored constituents in RO concentrate (very low water quality) and purified water (very high water quality) exist, but prove to be challenging due to their unique water qualities. Current analytical monitoring practices are described in detail below.

6.2.1 General Monitoring Provisions

General monitoring provisions proposed by the City include flow rate and water quality of the secondary effluent, AWPF finished water, receiving groundwater supply and production (ASR) wells. This enhanced source control document focuses on secondary effluent and AWPF finished water quality.

Compliance with RWQCB waste discharge requirements (WDRs) will be evaluated based on the analytical monitoring data. Monitoring reports produced by the SCPM will include at a minimum:

- Analytical results across the collection system through AWPF finished water (see Section 6.2).
- A clear map identifying the location of each sampling station, including groundwater monitoring and production wells (details following permit approval)
- Analytical test methods used and corresponding method report limits (MRLs).
- Name(s) and copies of laboratory certifications granted by the DDW's Environmental Laboratory Accreditation Program (ELAP).
- Quality assurance and control information.

Brief details about analytical testing methods and reporting are included in subsequent sections.

6.2.2 Sampling and Analytical Protocols

Though not required to be included in the monitoring reports unless specifically requested by DDW or the RWQCB, the City will have in place sampling protocols including procedures for handling, storing, testing, and disposing of purge and decontamination waters generated from sampling events. For groundwater monitoring, the sampling protocols will outline the methods and procedures for: measuring water levels; purging wells; collecting samples; decontaminating equipment; containing, preserving, and shipping samples; and maintaining appropriate documentation such as Chain of Custody (COC).

All wastewater samples and industrial wastewater samples will use the methods and QA/QC procedures contained in 40 CFR Part 136. All purified water samples will be analyzed and use the QA/QC procedures included in 40 CFR Part 141.

Where no methods are specified for a given pollutant, by methods approved by the DDW, RWQCB, and/or SWRCB. The City will select the analytical methods that provide MRLs lower than the limits prescribed in the WDR or as low as possible that will provide reliable data.

The City will instruct outside contract laboratories to establish calibration standards so that the MRLs (or its equivalent if there is a different treatment of samples relative to the calibration standards) are the lowest calibration standard. At no time will analytical data extrapolated from below the calibration curve be used.

6.2.3 QA/QC Procedures

The RWQCB, DDW and the SWRCB Quality Assurance Program may specify maximum MRLs in any of the following situations:

- When the pollutant has no established method under 40 CFR 141.
- When the method under 40 CFR 141 for the pollutant has a MRL higher than the limit specified in the WDR.
- When the City proposes to use a test method that is more sensitive than those specified in 40 CFR Part 141.

For regulated constituents, the laboratory conducting the analyses will be certified by ELAP or approved by the DDW, LARWQCB, and/or SWRCB for a particular pollutant or parameter.

Samples will be collected with method specific containers and preservatives and analyzed within defined holding time limits as specified in 40 CFR Part 141. All QA/QC analyses will be run simultaneously with collected samples. The City SCPM will retain the QA/QC documentation in its files and make those files available for inspection and/or submit them when requested by the RWQCB or the DDW. Proper chain of custody procedures will be followed and a copy of this documentation will be submitted with the quarterly report.

6.2.4 Unregulated Chemical Procedures

For unregulated chemical analyses, the City will select methods according to the following approach:

- Use drinking water methods, if available and matrix appropriate.
- Use DDW-recommended methods for unregulated chemicals, if available and matrix appropriate.
- If there is no DDW-recommended or approved drinking water method for a chemical, then City staff will use the method that results in the lowest MRL for that chemical in the applicable matrix.
- If there is more than a single USEPA-approved method available, the most sensitive of the USEPA-approved methods for the applicable matrix will be used.
- If there is no USEPA-approved method for a chemical in the applicable matrix, and more than one method is available from the scientific literature and commercial laboratory, after consultation with DDW, use the most sensitive method.
- If no approved method is available for a specific chemical, the City's laboratory (or contract laboratory) may develop methods or use its own methods and will provide the analytical methods to DDW for review. Those methods may be used until DDW-recommended or USEPA-approved methods are available. This option is likely to be used when an unregulated contaminant needs to be traced back through the collection system and no raw wastewater matrix method exists or when sampling RO concentrate for the unregulated contaminant.

6.2.5 Online and Benchtop Constituent Monitoring

Online monitoring data from the OWTP and the AWPF will be reported to the SCPM and analyzed to create a baseline for nominal concentrations and process performance. Total

Organic Carbon (TOC), Electrical Conductivity (EC), BOD, Turbidity, and UV Transmittance (UVT) are all relevant monitoring parameters and will be continuously collected to award pathogen log removal (LRV) credits across the OWTP and AWPF. The online data trends used for LRV information will be directly applied to contaminant removal correlations. If a new contaminant or a slug load is detected, a process upset or unusual online data trend is observed, an intervention into the responsible process can be identified and responded to promptly to prevent further contaminant loading.

Accuracy and confidence in monitoring tools is important. Benchtop measurements are not necessarily more accurate that online monitors, however they provide an independent measure of the parameters being tracked. Therefore, benchtop measurements should be conducted frequently to compare online meter measurements and discrepancies should be evaluated, and calibrations on either benchtop or online meters should be performed immediately. Benchtop measurements as well as calibration dates and times should be well-documented and reported to the SCPM weekly. Online sampling parameters and benchtop verification frequencies are shown in Table 6.1 (to be coordinated with the latest NPDES Permit at the time).

Table 6.1 Online Sampling Parameters and Benchtop Verification Frequencies for the Potable Reuse Enhanced Source Control Program

Online Monitoring Parameters	Location and Frequency of Sampling				
	OWTP	Secondary Effluent	RO Influent	RO Permeate	Purified Water
TOC			Online	Online	
Bench			Bi-weekly	Bi-weekly	Bi-weekly
EC	Online	Online	Online	Online	Online
Bench	2 X daily	2 X daily	2 X daily	2 X daily	2 X daily
BOD					
Bench	Daily	Daily			
Turbidity	Online	Online	Online		
Bench	Daily	Daily	Daily		
UVT		Online	Online	Online	Online
Bench	Daily	Daily	4 X Daily	4 X Daily	4 X Daily

6.2.6 Regulated and Unregulated Constituents

Tables 6.2 through 6.6 constitute the required water quality performance, consistent with DDW (2018a). Within each table is a specific reference to the table within the regulation (e.g., Primary MCLs are listed in Table 6.2 below and also found in Table 64431-A).

Table 6.7 includes constituents with notification levels, which are health-based advisory levels for constituents that lack MCLs.

Tables 6.8-6.10 are related to constituents of emerging concern (CECs). The requirements for CECs are in flux. The SWRCB first adopted its recycled water policy (RWP) in 2009 and amended it in 2013 to specify monitoring requirements for CECs in recycled water based on the recommendations of an advisory panel, SWRCB (2010). The RWP contains a provision to reconvene a Science Advisory Panel every five years to update the recommendations for CEC monitoring in recycled water. In April 2018, the reconvened science advisory panel published Monitoring Strategies for CECs in Recycled water, Recommendations of a Science Advisory Panel (SCCWRP, 2018). Based on the recommendations therein, the RWP is in the process of being updated. Therefore, this section contains monitoring recommendations in both the 2013 RWP (SWRCB 2013) and the 11/15/2018 Draft Amendment to the RWP (SWRCB, 2018 (draft)).

CECs are defined by SWRCB (2018, draft) as constituents in personal care products; pharmaceuticals; antimicrobials; industrial, agricultural, and household products; naturally-occurring hormones; food additives; transformation products; inorganic constituents; microplastics; and nanomaterials. CECs with health-based significance are assigned health based-screening levels, MTLs, which are designated for different types of potable reuse.

SWRCB 2013 CEC monitoring includes CECs with health-based significance, CECs that serve as performance indicators, and non-CECs that serve as performance surrogates. SWRCB (2018, draft) includes revised recommendations for CECs in all three aforementioned categories, as well as the addition of a new category for monitoring – bioanalytical screening tools. Monitoring requirements for CECs per SWRCB 2013 are provided in Table 6.8 Additional monitoring required by the Los Angeles RWQCB provided to our team by Elizabeth Erickson on 10/29/2014 are provided in Table 14. Monitoring requirements per SWRCB (2018, draft) are included in Table 6.10 Per SWRCB (2018, draft), RWQCB would not issue additional monitoring requirements for CECs beyond those in the RWP unless recommended by the SWRCB. The monitoring requirements in SWRCB (2018, draft) would replace those in SWRCB 2013, if the draft RWP amendment is accepted.

Table 6.2 Inorganics with Primary MCLs or ALs[(1)]

Constituents	Primary MCL or AL (in mg/L)	Constituents	Primary MCL or AL (in mg/L)
Aluminum	1.0	Fluoride	2
Antimony	0.006	Lead	0.015[(4)]
Arsenic	0.010	Mercury	0.002
Asbestos	7 (MFL)[(2)]	Nickel	0.1
Barium	1	Nitrate (as NO_3)	45
Beryllium	0.004	Nitrite (as N)	1
Cadmium	0.005	Total Nitrate/Nitrite (as N)	10
Hexavalent Chromium	0.010	Perchlorate	0.006
Copper	1.3[(3)]	Selenium	0.05
Cyanide	0.15	Thallium	0.002

Notes:
(1) Based on Table 64431-A.
(2) MFL = Million fibers per liter, with fiber lengths > 10 microns.
(3) Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.
(4) The MCL for lead was rescinded with the adoption of the regulatory action level described in footnote '3'.

Table 6.3 Radioactivity[1]

Constituents	MCL (in pCi/L)	Constituents	MCL (in pCi/L)
Uranium	20	Gross Beta particle activity	50[2]
Combined radium-226 & 228	5	Strontium-90	8[2]
Gross alpha particle activity	15	Tritium	20,000[2]

Notes:
(1) Based on Tables 64442 and 64443.
(2) MCLs are intended to ensure that exposure above 4 millirem/yr does not occur.

Table 6.4 Regulated Organics[1]

Constituents	MCL (in mg/L)	Constituents	MCL (in mg/L)
Volatile Organic Compounds			
Benzene	0.001	Monochlorobenzene	0.07
Carbon Tetrachloride	0.0005	Styrene	0.1
1,2-Dichlorobenzene	0.6	1,1,2,2-Tetrachloroethane	0.001
1,4-Dichlorobenzene	0.005	Tetrachloroethylene	0.005
1,1-Dichloroethane	0.005	Toluene	0.15
1,2-Dichloroethane	0.0005	1,2,4 Trichlorobenzene	0.005
1,1-Dichloroethylene	0.006	1,1,1-Trichloroethane	0.2
cis-1,2-Dichloroethylene	0.006	1,1,2-Trichloroethane	0.005
trans-1,2-Dichloroethylene	0.01	Trichloroethylene	0.005
Dichloromethane	0.005	Trichlorofluoromethane	0.15
1,3-Dichloropropene	0.0005	1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
1,2-Dichloropropane	0.005	Vinyl chloride	0.0005
Ethylbenzene	0.3	Xylenes	1.75
Methyl-tert-butyl ether (MTBE)	0.013		
SVOCs			
Alachlor	0.002	Heptachlor	0.00001
Atrazine	0.001	Heptachlor Epoxide	0.00001
Bentazon	0.018	Hexachlorobenzene	0.001
Benzo(a) Pyrene	0.0002	Hexachlorocyclopentadiene	0.05
Carbofuran	0.018	Lindane	0.0002
Chlordane	0.0001	Methoxychlor	0.03
Dalapon	0.2	Molinate	0.02

Table 6.4 Regulated Organics[1] (continued)

Constituents	MCL (in mg/L)	Constituents	MCL (in mg/L)
Dibromochloropropane	0.0002	Oxamyl	0.05
Di(2-ethylhexyl)adipate	0.4	Pentachlorophenol	0.001
Di(2-ethylhexyl)phthalate	0.004	Picloram	0.5
2,4-D	0.07	Polychlorinated Biphenyls	0.0005
Dinoseb	0.007	Simazine	0.004
Diquat	0.02	Thiobencarb	0.07/0.001[2]
Endothall	0.1	Toxaphene	0.003
Endrin	0.002	1,2,3-Trichloropropane	$5x10^{-9}$
Ethylene Dibromide	0.00005	2,3,7.8-TCDD (Dioxin)	$3x10^{-8}$
Glyphosate	0.7	2,4,5-TP (Silvex)	0.05

Notes:
(1) Based on Table 64444-A.
(2) Second value is listed as a Secondary MCL.

Table 6.5 Disinfection By-Products[1]

Constituents	MCL (in mg/L)	Constituents	MCL (in mg/L)
Total Trihalomethanes	0.080	Bromate	0.010
Total haloacetic acids	0.060	Chlorite	1.0

Notes:
(1) Based on **Table 64533-A.**

Table 6.6 Constituents/Parameters with Secondary MCLs

Constituents[1]	MCL (in mg/L)	Constituents[2]	MCL (in mg/L)
Aluminum	0.2	TDS	500
Color	15 (units)	Specific Conductance	900 uS/cm
Copper	1	Chloride	250
Foaming Agents (MBAS)	0.5	Sulfate	250
Iron	0.3		
Manganese	0.05		
Methyl-tert-butyl-ether (MBTE)	0.005		
Odor Threshold	3 (units)		
Silver	0.1		
Thiobencarb	0.001		
Turbidity	5 (NTU)		
Zinc	5		

Notes:
(1) Based on Table 64449-A.
(2) Based on Table 64449-B.

Table 6.7 Constituents with Notification Levels[1,2]

Constituents	NL (in µg/L)	Constituents	NL (in µg/L)
Boron	1,000	Methyl isobutyl ketone (MIBK)	120
n-Butylbenzene	260	Naphthalene	17
sec-Butylbenzene	260	N-Nitrosodiethylamine (NDEA)	0.01
tert-Butylbenzene	260	N-Nitrosodimethylamine (NDMA)	0.01
Carbon disulfide	160	N-Nitrosodi-n-propylamine (NDPA)	0.01
Chlorate	800	Perfluorooctanoic acid (PFOA)	0.014
2-Chlorotoluene	140	Perfluorooctanesulfonic acid (PFOS)	0.013
4-Chlorotoluene	140	Propachlor	90
Diazinon	1.2	n-Propylbenzene	260
Dichlorodifluoromethane (Freon 12)	1,000	RDX	0.3
1,4-Dioxane	1	Tertiary butyl alcohol (TBA)	12
Ethylene glycol	14,000	1,2,4-Trimethylbenzene	330
Formaldehyde	100	1,3,5-Trimethylbenzene	330
HMX	350	2,4,6-Trinitrotoluene (TNT)	1
Isopropylbenzene	770	Vanadium	50
Manganese	500[2]		

Notes:
(1) Based on http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf
(2) The web link above also contains the levels of the pollutants in this table that must result in a removal of the water source from service.

Table 6.8 Monitoring Requirements for CECs per SWRCB, 2013. Advanced Water Purification Facility

Constituents	Relevance/ Indicator Type/ Surrogate	Monitoring Trigger Level (in μg/L)	Removal Percentages (%)
17B-estradiol(1)	Health	0.0009	--
Caffeine(1)	Health & Performance	0.35	>90
NDMA(1)	Health & Performance	0.01	25-50, >80(3)
Triclosan(1)	Health	0.35	--
DEET(1)	Performance	--	>90
Sucralose(1)	Performance	--	>90
Electrical Conductivity(1)	Performance Surrogate	--	>90
4-Chlorotoluene	140	Propachlor	90
TOC(2)	Performance Surrogate	--	>90

Notes:
(1) Monitored quarterly, per SWRCB 2013.
(2) Continuously monitored.
(3) 25 to 50 percent removal by RO, >80 percent removal by RO followed by UV, depending upon the UV dose.

Table 6.9 CECs Required for Monitoring by LARWQCB(1)

Constituent	Sample Type	Reporting Level, ng/L
17-alpha-estradiol	Composite	0.5
Caffeine	Composite	10
DEET	Composite	10
Iodinated Contrast Media (Iopromide)	Composite	10
Triclosan	Composite	10
NDMA	Composite	10
Sucralose	Composite	100

Notes:
(1) Information provided by Elizabeth Erickson to the project team on 10/29/2014.

Table 6.10 Monitoring Requirements for CECs per SWRCB (2018, draft)

Constituent	Relevance	MTL (µg/L)
1,4-dioxane	Health	1
NDMA(1)	Health and Performance Indicator	0.010
NMOR(2)	Health	0.012
PFOS	Health	0.013
PFOA	Health	0.014
Sulfamethoxazole(2)	Performance Indicator	-
Sucralose(2)	Performance Indicator	-
Dissolved Organic Carbon(2)	Performance Surrogate	-
UV Absorbance(2)	Performance Surrogate	-
EC(2)	Performance Surrogate	-
Estrogen receptor-alpha bioassay(2)	Bioanalytical Screening	-
Aryl hydrocarbon bioassay(2)	Bioanalytical Screening	-

Notes:
(1) Health-based CECs and Bioanalytical Screening to be monitored following treatment.
(2) Performance indicator CECs and surrogates to be monitored before RO and after treatment.

6.3 Monitoring and Enforcement Programs

As part of this enhanced source control monitoring plan for potable reuse, regulated and unregulated constituents will be monitored with the same frequency (for the first year of operation) and given equal scrutiny for detection and available health criteria in the source water (OWTP secondary effluent) and the purified effluent of the AWPF.

Each monitoring location, class of constituent (regulated, CECs, etc) and proposed monitoring frequency are summarized in Table 6.11. Following acceptable monitoring performance during the first year of operation, the sampling frequency in some monitoring locations will decrease for select classes of constituents. Monitoring and enforcement is described in further detail in the following sections.

Table 6.11 Class of Constituents, Location and Frequency Monitoring Plan

Constituent	Monitoring Plan				
	Industries	Collection System	Raw Wastewater Influent	Secondary Effluent	Purified Water
Industry-Specific	As specified in permit	2X annually			
Local Limits	2X annually	2X annually	Monhtly (first 6 months), TBD thereafter	Monthly (first 6 months), 2X annually thereafter	Monthly (year 1), quarterly thereafter
NPDES Permit		2X annually	As specified by NPDES permit	As specified by NPDES permit	
Regulated (MCLs)		2X annually (year 1), TBD thereafter	Monhtly (first 6 months), TBD thereafter	Monthly (first 6 months), 2X annually thereafter	Monthly (year 1), quarterly thereafter
Secondary Treatment Goals MCLs		2X annually (year 1), TBD thereafter	Monhtly (first 6 months), TBD thereafter	Monthly (first 6 months), annually thereafter	Monthly (year 1), annually thereafter
Notification Levels		2X annually (year 1), TBD thereafter	Monhtly (first 6 months), TBD thereafter	Monthly (first 6 months), 2X annually thereafter	Monthly (year 1), quarterly thereafter
Constituents of Emerging Concern (CECs)		2X annually (year 1), TBD thereafter	Monhtly (first 6 months), TBD thereafter	Monthly (first 6 months), annually thereafter	Monthly (year 1), 2X annually thereafter

Notes:
(1) Monitoring frequency for industrial dischargers will be determined by flow, as outlined in each industry permit.

6.3.1 Finished Water Monitoring and Enforcement

At a minimum, pursuant to Section 60320.201 of Title 22 (DDW 2018), the AWPF purified water effluent must be analyzed for all constituents with MCLs and NLs monthly for the first year. For subsequent years, Oxnard can apply for a reduced monitoring frequency of quarterly if no constituent exceeds its MCL or NL. Secondary MCLs must be monitored for annually.

CEC monitoring will be conducted according to the finalized 2018 RWP. Per SWRCB 2018 (draft) Appendix A, health-based CECs are to be monitored for in purified water quarterly for one year (initial assessment phase), and semi-annually for an additional three years (baseline monitoring phase). After the first four years, monitoring for health-based CECs may be eliminated based on results of the first two phases. Bioanalytical screening tools are also to be used for monitoring purified water quarterly for the first four years. Monitoring using bioanalytical screening tools can be eliminated or reduced to semi-annually based on the results of the first two phases. SWRCB (2018, draft) lists additional monitoring requirements (surrogates and indicators) not described herein.

The monitoring and enforcement plans currently required by Title 22 and the RWP for purified water are shown as Figure 6.1 through Figure 6.8. This sampling pertains to finished water quality for potable water reuse; and is not an added sampling effort for the ESCP. However, the data obtained as part of this required sampling is a useful component of the ESCP.

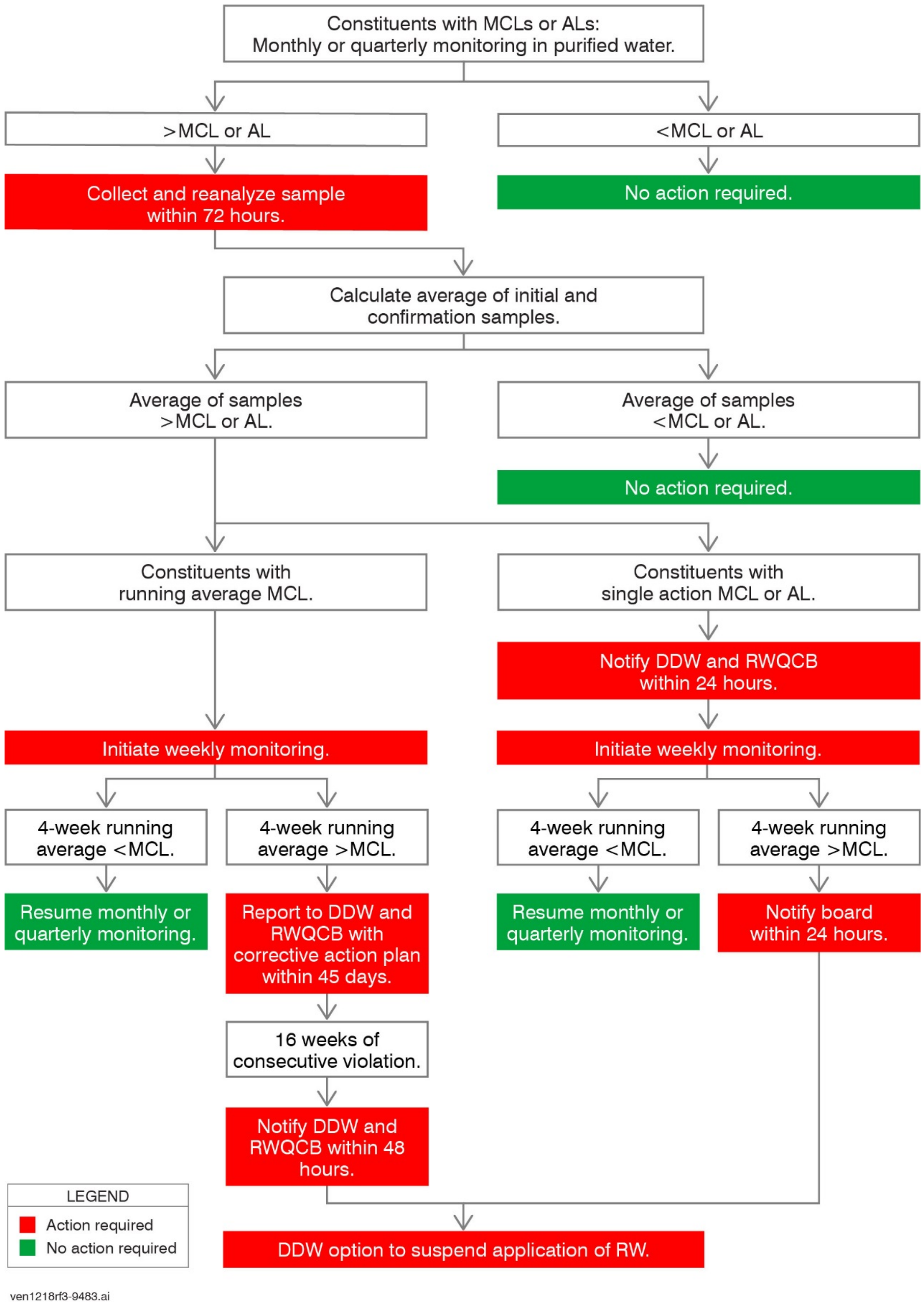

Figure 6.1 Title 22 MCL and AL Monitoring Requirements and Action Plan for Purified Water, per DDW 2018, Section 60320.212. List of Constituents in Tables 6.2-6.5.

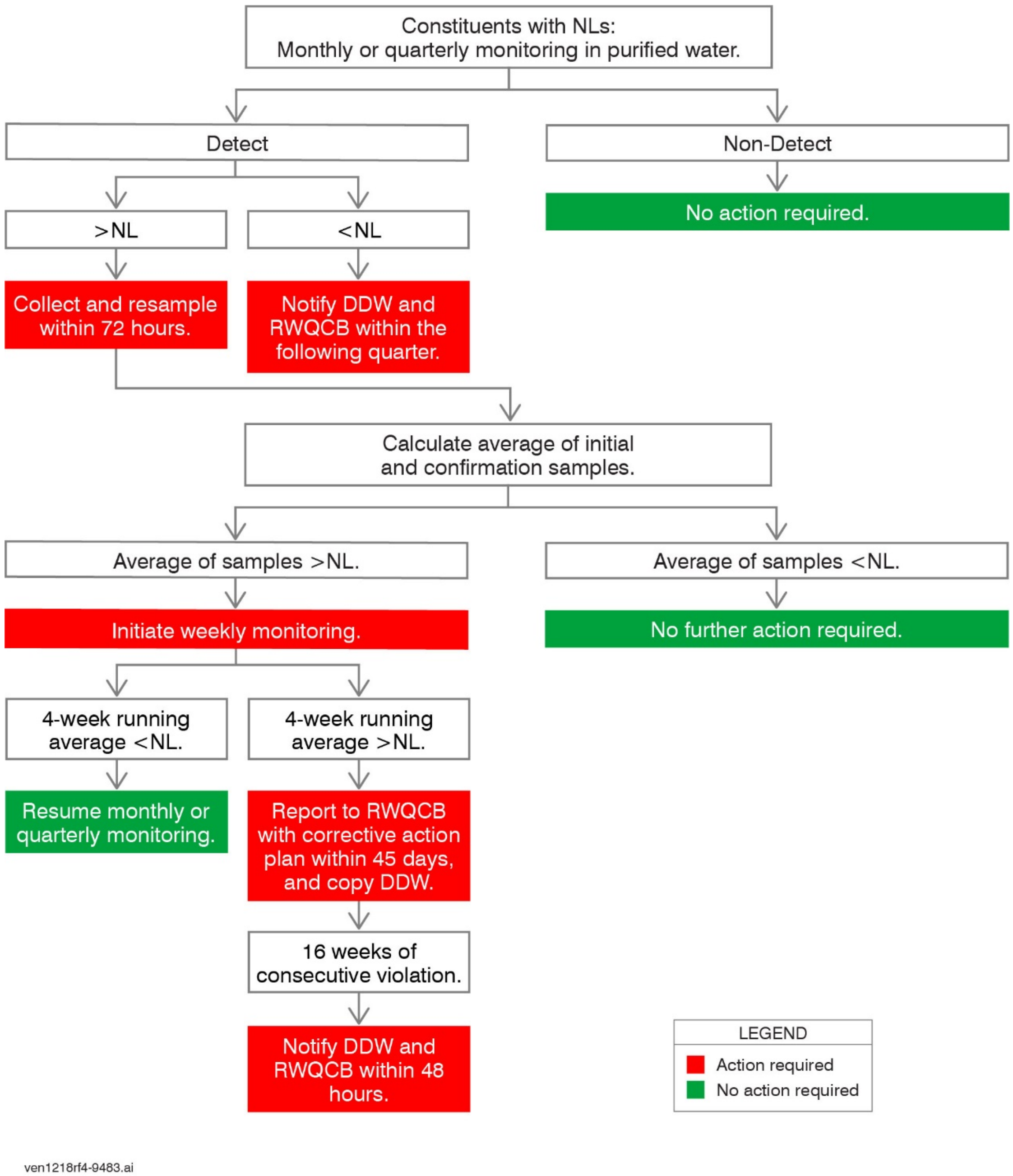

Figure 6.2 Title 22 NL Monitoring Requirements and Action Plan for Purified Water, per DDW 2018 Section 60320.220. List of Constituents Corresponds to Tables 6.7

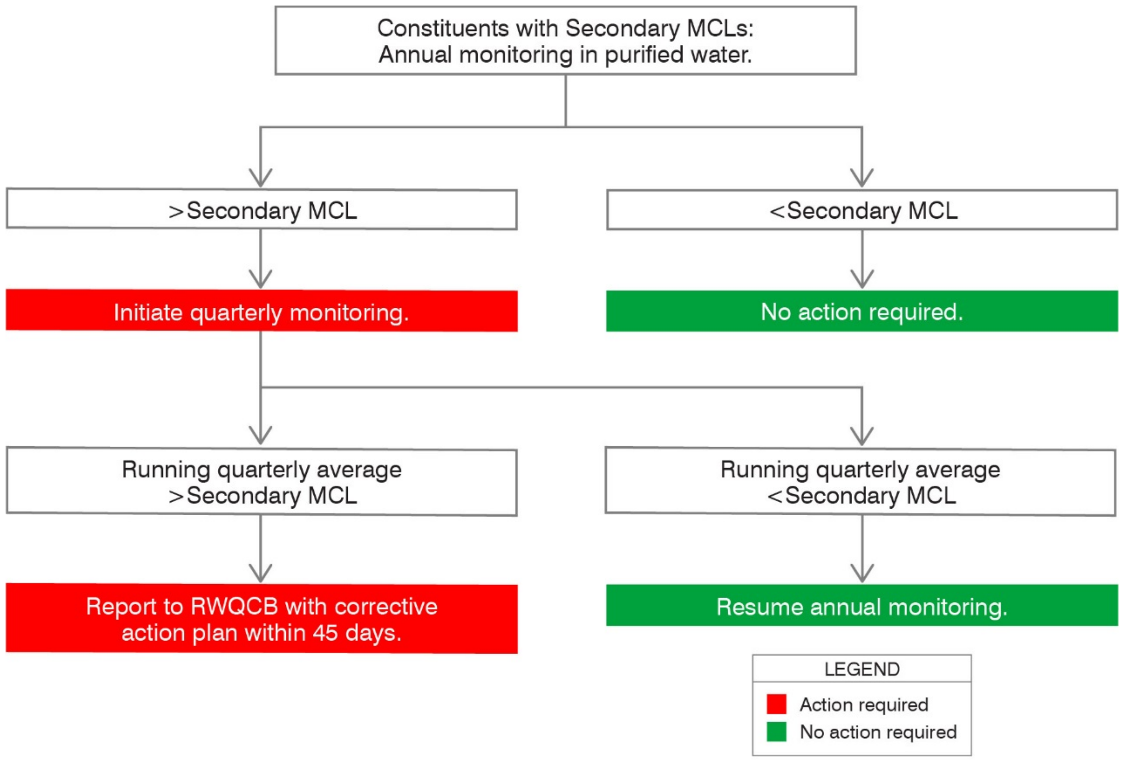

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Figure 6.3 Title 22 Secondary MCL Monitoring Requirements and Action Plan for Purified Water, per DDW 2018 Section 60320.212. List of Constituents Corresponds to Table 6.6

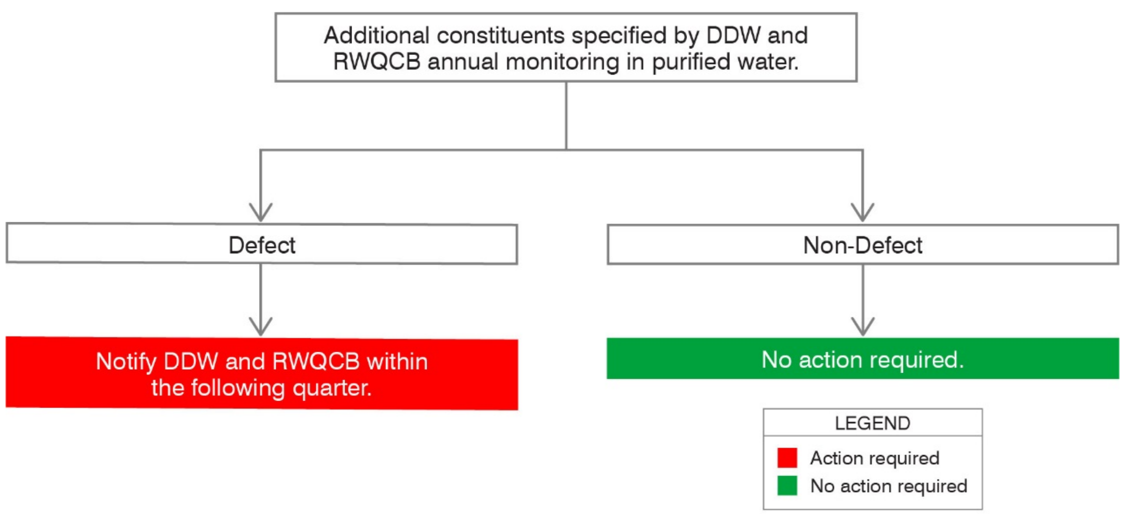

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Figure 6.4 Title 22 Additional Monitoring and Action Plan for Purified Water, per DDW 2018, Section 60320.220 (d) & (e)

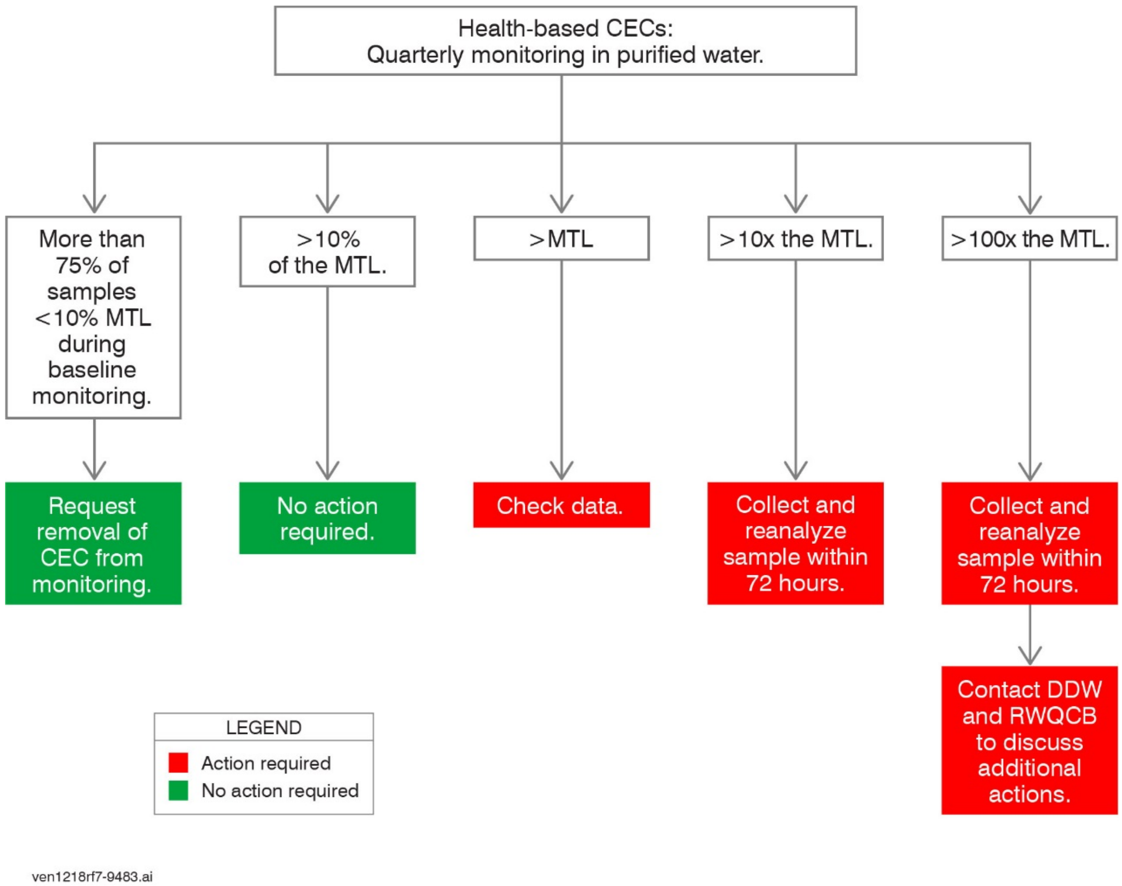

Figure 6.5 Title 22 CEC Monitoring and Action Plan for Purified Water, per SWRCB 2013, Appendix A. List of constituents corresponds to Tables 6.8 and 6.9, and/or Table 6.10

All constituents with MCLs, ALs, NLs, sMCLs, and health-based CECs (Tables 7-12 and 15 of this report) will be included in the "Inventory List"[1]. All constituents on the Inventory List will be monitored for on a monthly basis in purified water for the first year. After the first year, the monitoring frequency will be based on Title 22 requirements as shown in Figures 4 – 8.

Purified water quality data will trigger actions for enhanced source control. A response will be triggered if a constituent is detected in purified water at a level higher than 10% of its applicable level (MCL, sMCL, AL, NL, or MTL). Lengthy sampling efforts and tracing activities can be avoided with positive industrial relationships and close communication. Therefore, the first response will include direct outreach from the SCPM to potentially responsible industries, as well as discussion of the constituent at the next quarterly industry meeting. The discussion will include possible BMPs.

In parallel with industrial outreach, increased monitoring will be triggered for the problematic constituent. Similar to Title 22 requirements, a confirmation sample will be collected within 10 days of notification of the result. The initial and confirmation samples will be averaged. If the average of the two samples exceeds 10 percent of the applicable limit, and outreach efforts have not yet identified a culpable industry, samples will be collected in the purified effluent, secondary

[1] The inventory list does not include constituents with local limits, because all constituents with local limits also have an associated drinking water-related levels, except for FDS, H2S, and grease/oils/fats.

wastewater effluent, raw wastewater, and at the monitoring nodes within the collection system designated in the Source Mapping Strategy. These samples will be collected within 10 days of notification of the result of the confirmation sample. If loading of the problematic constituent is attributable to one of the four sewersheds, the constituent will be traced through the collection system per the Source Mapping Strategy.

If a new industry is determined to be discharging a problematic constituent, the industry will be included in the industrial discharge program through either voluntary means, or through the issuance of a new local limit and industrial discharger permit.

A constituent detected at greater than 10% of the applicable level in purified water will also be included on the "short list" and will be monitored on a monthly basis in both purified water, and secondary effluent until the average of six consecutive months of sampling is lower than 10 percent of the applicable level in purified water. Duplicate sampling for constituents on the short list as part of inventory list monitoring in either purified water or secondary effluent.

The purified water action and enforcement plan for ESCP is shown in Figure 6.6. All constituents on the short list will be closely monitored for changes during the subsequent sampling periods and the detections will be noted during the Industrial Source Control Workshops held quarterly by the SCPM.

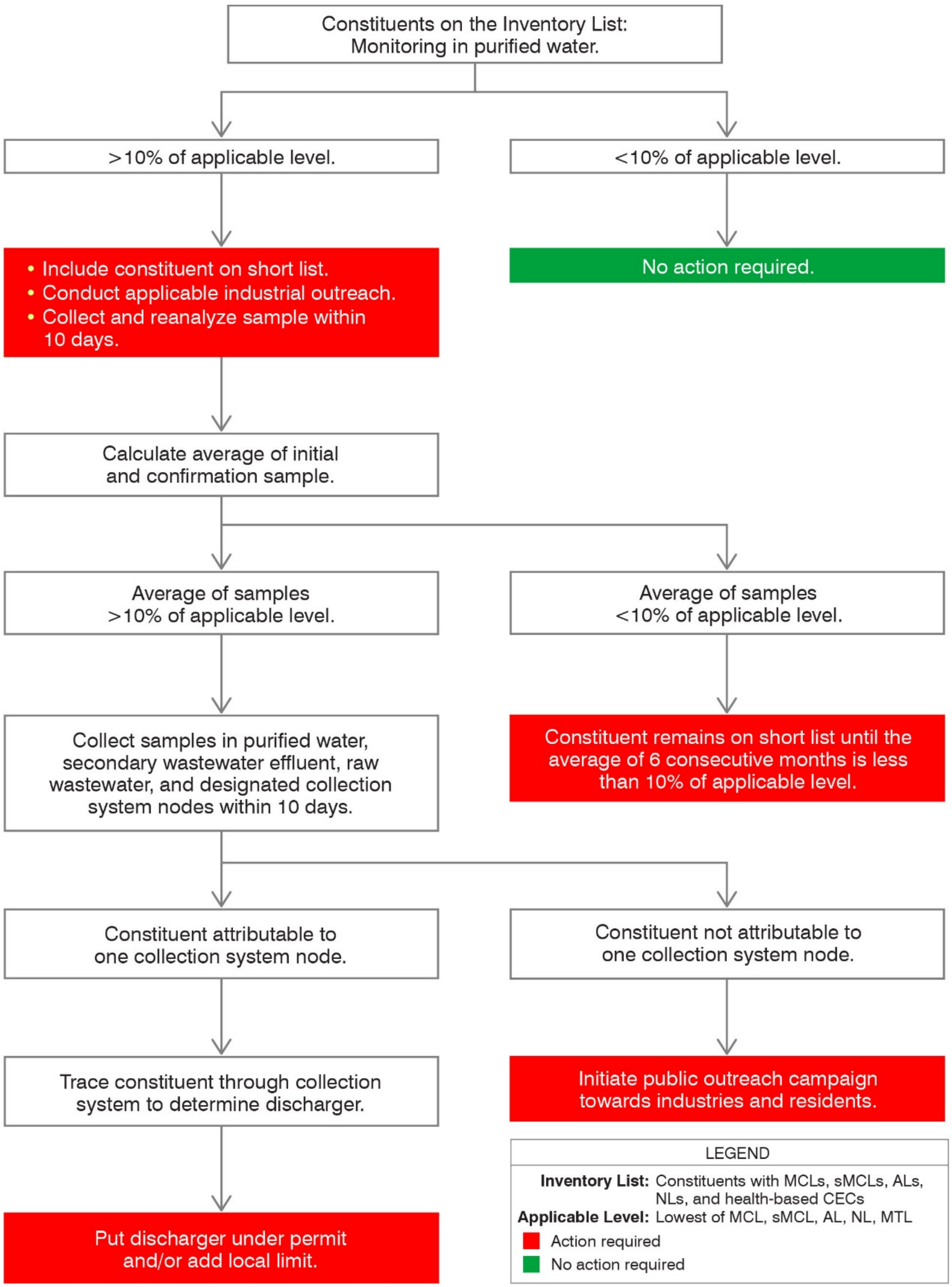

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Figure 6.6 Purified Water Monitoring Response Plan for Proposed ESCP

6.3.2 Secondary Water Monitoring and Enforcement

This proposed ESCP includes monitoring of the secondary effluent source water. The recommended grab sample and online monitoring is detailed previously in this report and not repeated here.

All constituents on the Inventory List and all constituents with local limits will be monitored in the secondary effluent on a monthly basis for the first six months of AWPF operations. Following the first six months of operations, the monitoring frequency of constituents on the Inventory List in secondary effluent will be reduced to semi-annually for most constituents, except as described below.

As described above, if a constituent is detected at greater than 10% of the applicable level in purified water, the constituent will be included on the Short List and monitored monthly in both purified water and secondary effluent until the average of six consecutive months of testing shows the level to be lower than 10 percent of the applicable level in purified water.

Similarly, if a constituent is detected at a level higher than 10 percent of the applicable level *in the secondary effluent*, the constituent will also be included on the Short List. The constituent will remain on the Short List until the average of six consecutive months of testing shows the level to be lower than 10% of the applicable level in *purified* water. These constituents will be taken off of the Short List and added to the No-Trigger List, even if levels remain high in secondary effluent samples, because the constituent is sufficiently reduced through the AWPF. For these constituents, the only driver for inclusion in the Short List for a second time would be levels in purified water, not levels in secondary effluent. Three constituents with proven engineering solutions will start out on the No-Trigger List – NDMA, TDS, and Specific Conductance – meaning that elevated levels in secondary effluent will not trigger inclusion on the short list for increased monitoring frequencies.

All chemicals on the Short List will be closely monitored for changes during the subsequent sampling periods and the detections will be noted during the Industrial Source Control Workshops held quarterly by the SCPM.

Monitoring action plans tailored to secondary effluent sampling are included on Figure 6.7.

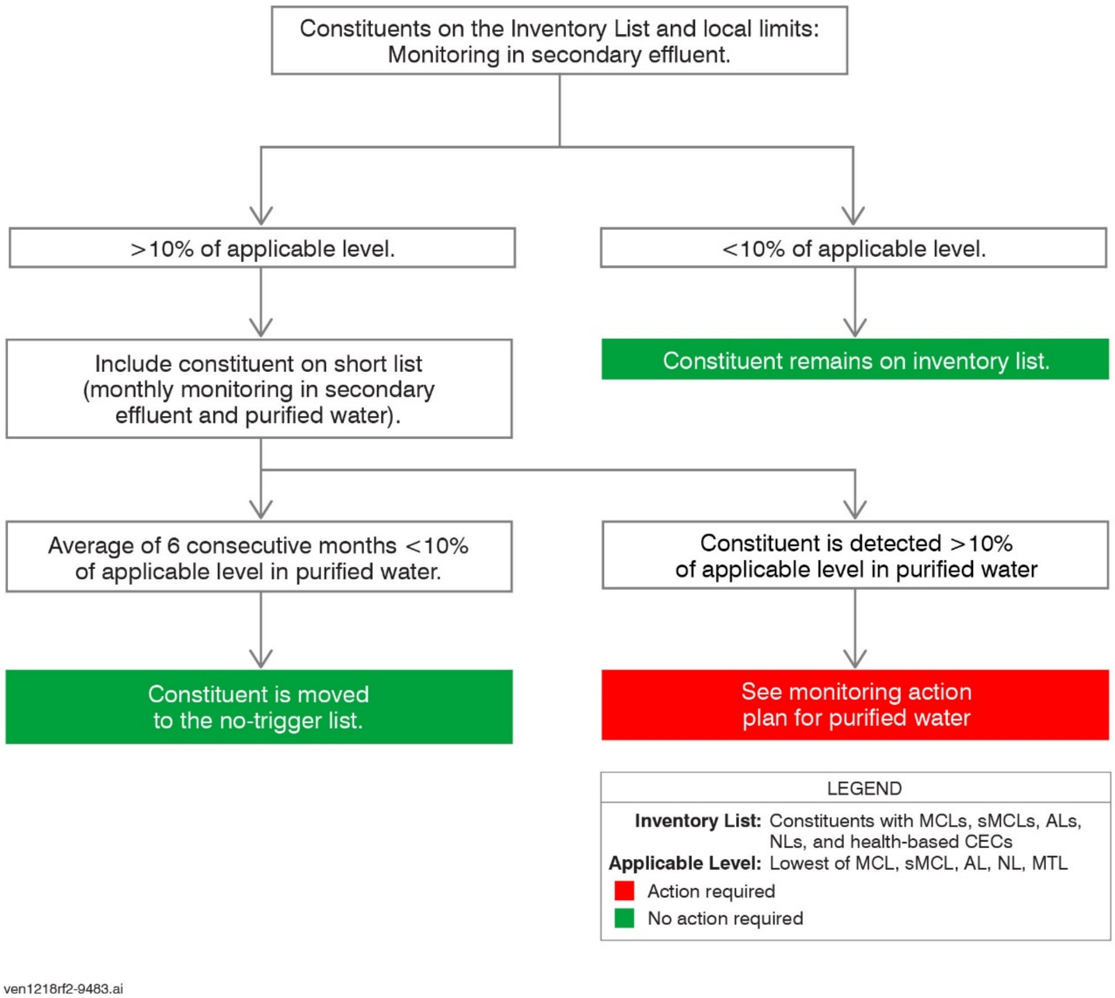

Figure 6.7 Secondary Effluent Source Monitoring Action Plan for Proposed ESCP

6.4 Source Mapping Strategy

The City currently has a collection system tracing strategy that has proven effective by the "gross-beta" incident. For enhanced source control monitoring, a defined area strategy is proposed. This strategy includes defining areas of the collection system from which all major trunks meet and allows for increased isolation between domestic and industrial dischargers. Example mapping areas are shown below in Figure 6.8 as (M1 - M6). Each area will be monitored at the major junctions with the frequency and breadth defined previously in Table 6.11, and as needed for priority events where mapping contaminants through the system is necessary.

The initial discharge area in M4 will be monitored as a "baseline" for collection system contaminant accumulation. This will provide information about loading rates through each sampling event. Industry measured contaminant discharge data and flow rates will be used to create a mass balance for industry-specific loading rates. If these loading rates remain within a +/- (TBD by City)% margin, the loading rates will be acceptable. If out of this range, all industrial dischargers known to discharge this specific contaminant will be contacted. Household dischargers could also be responsible for contributing to this difference in industrial contaminant discharge. This approach is not meant to replace downstream monitoring of industrial discharge by the City for confirmation of each industry, only to provide a larger data set for long-term monitoring and a first look at monthly data trending for increasing dischargers in the service area. This will also provide confirmation of residential input, not only industry input.

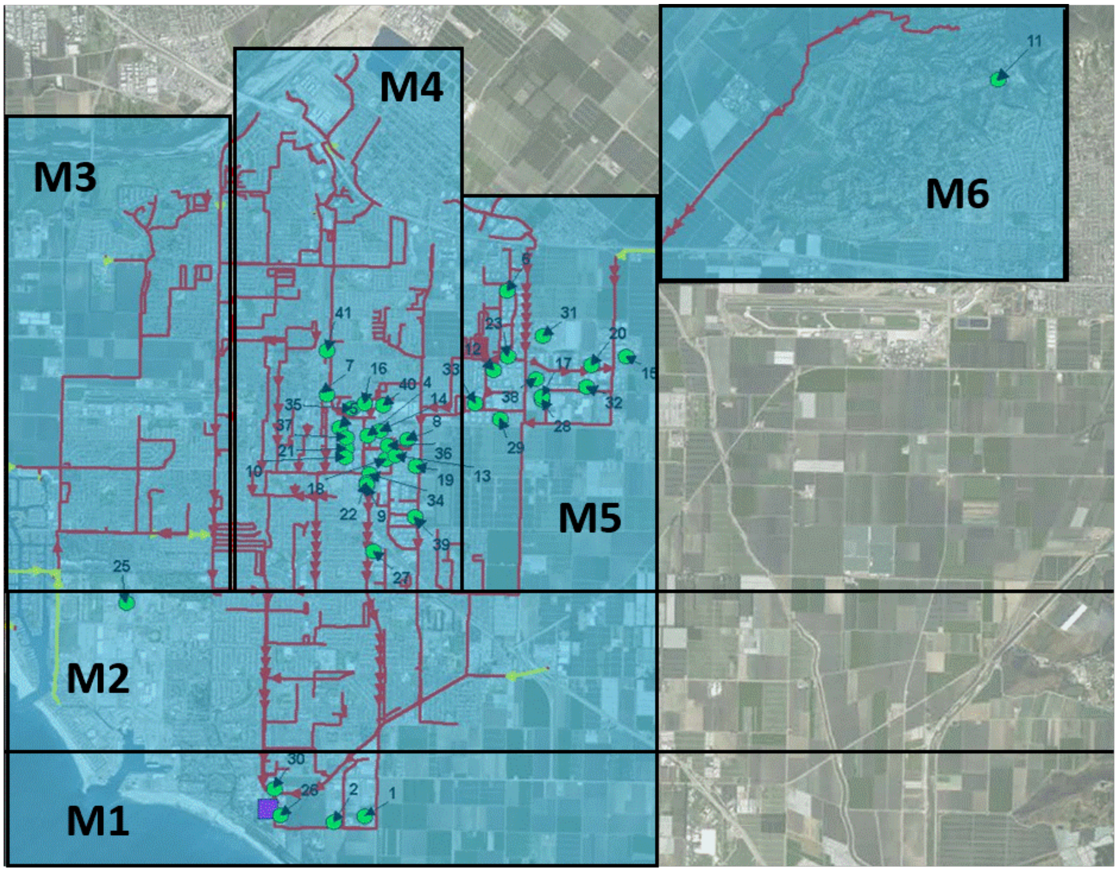

Figure 6.8 Proposed Collection System Strategic Monitoring Strategy for Both Routine Monitoring and Action Plan Response

To reduce the likelihood that harmful pollutants enter the OWTP, a monitoring and enforcement response plan similar to the SCWW "gross-beta incident" must be implemented. Monitoring and sampling effluent wastewater on a semiannual basis (to analyze for radioactivity) allows for early detection of contaminants. If a contaminant is found, research should be conducted to locate the source. Once locations are identified, samples should be taken from several locations - upstream, downstream, onsite and adjacent to suspected violators. If unacceptable concentrations of contaminants are found, proper action by the City should be taken to control the problem. This can include an order to Cease-and-Desist discharge, a Notice of Violation, and/or suspension of Industrial Waste Discharge Permit that would prohibit the discharge of any wastewater by the violators to the Oxnard Collection System.

The City of Oxnard has a mostly residential section of town and another section that contains significant numbers of industrial dischargers. If a household is discharging a contaminant of concern, it will be difficult to pinpoint which house is causing the violations. In order to minimize painstaking contaminant tracking through the sewage discharge lines, a heavy emphasis will be put on household outreach and education. Additionally, the City will provide a hazardous waste disposal program where the public can bring medications, pesticides, and other hazardous waste items to the landfill for treatment, recovery, or burial. The plans for public outreach can be found in Section 7.3.

6.5 Hospital Discharge Program

Hospital waste discharge monitoring is not currently required in source control programs. The City of Oxnard has several hospitals, including animal hospitals, shown in Figure 6.9. SWRCB (2018 draft) produces the recommended constituents for monitoring in potable reuse projects among the pharmaceuticals and personal care products of emerging concern. The recommended constituents for monitoring are included in the Inventory List of contaminants and if an unexplained detection of these contaminants is found in the secondary effluent or purified water when tested, the compound will move to the Short List. If the action plan indicates a pharmaceutical contaminant should be traced back into the collection system (Figure 6.9), previously determined sampling locations downstream of the hospital dischargers will be utilized. Facilities with the highest discharge flow will be targeted first.

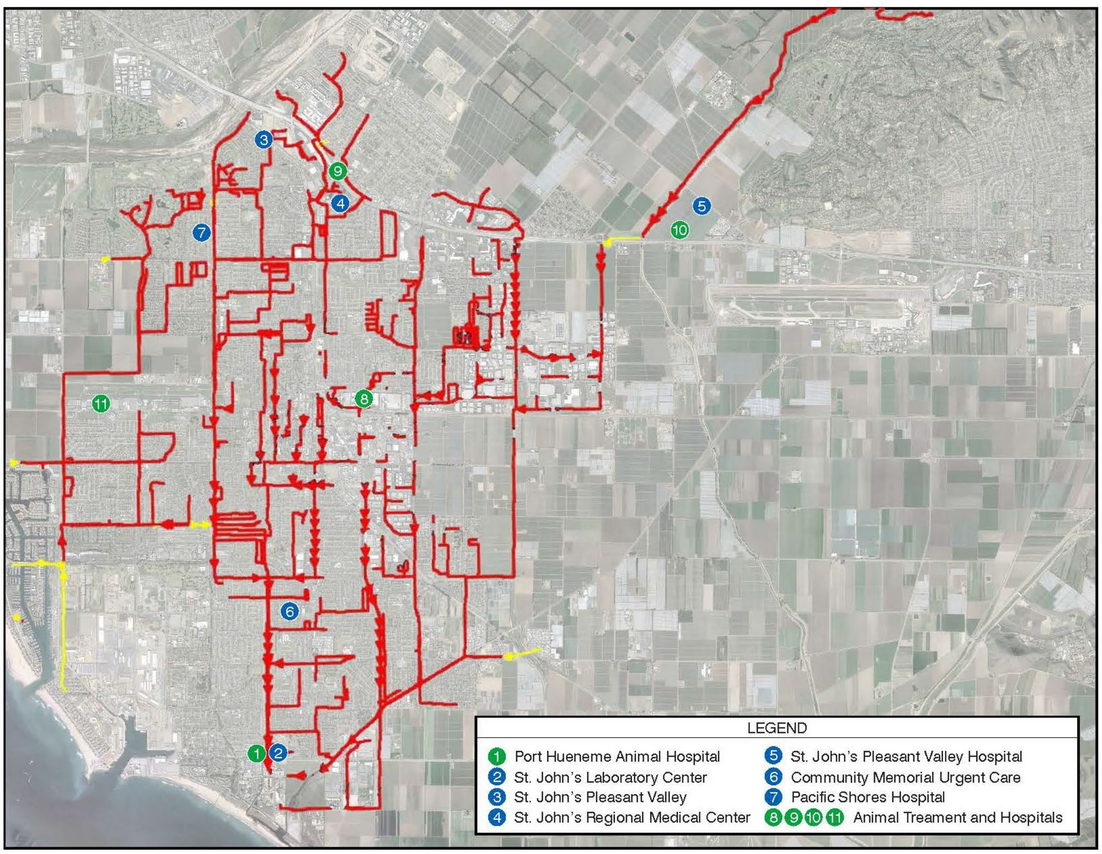

Figure 6.9 Short List of Human and Animal Hospitals Discharging to OWTP

6.5.1 Iohexol Hospital Discharge Indicator

Distinguishing hospital discharge versus residential discharge can prove challenging. Iohexol can be used as a potential indicator with which to identify hospital discharge locations and determine their contributions to the total flow. Iohexol is introduced into the wastewater collection system almost exclusively through the urine of patients in hospitals that have undergone medical imaging. Iohexol acts as a contrasting agent for medical imaging, and is designed to have no impact on human or animal health. Advanced oxidation processes efficiently remove Iohexol, and the compound is typically completely degraded in secondary treated wastewater. If incorporating a hospital discharge program into the ESCP becomes necessary, Iohexol should be used to help track medical dischargers.

Section 7
OUTREACH PROGRAMS

7.1 Industrial Outreach

Meetings with all dischargers in groups will take place as described in the Local Limits Study. During these meetings, each discharger will be given their new discharge limits for all registered constituents. The rollout of the industrial discharge outreach program will be included in these meetings, where a clear plan will be made with each industrial discharger for what to do in the event of any constituent release changes. Changes could include a slug discharge event, a new contaminant introduced into production and needing to be added to the inventory list, removing a contaminant from a discharge list, and others.

Industrial dischargers will be reminded of the changes taking place downstream of them, and the effects discharging waste in violation of their permit could have on downstream potable reuse treatment and subsequent public consumption. The outreach plan will include 30 minutes to 1 hour monthly webinars to provide updates on their discharge statuses to each other and the City can provide the latest monitoring data and any updates or changes to the source control program. Monthly webinars will include information on any program updates, questions asked and answered by other dischargers during that time period and potable reuse monitoring information.

Quarterly 3-hour meetings will take place with all industries to send 1 representative to an update meeting in lieu of the monthly webinar. An example agenda for this meeting is shown as Figure 7.1. These meetings will be led by the SCPM with support from Oxnard staff. All industrial dischargers should participate with a short update on their recent monitoring and discharge information.

To encourage further engagement by industries, a yearly award will be given to those companies who have not had a discharge violation during audits or routine collection system monitoring. The "Enhanced Source Control Responsible Partner Award" is a yearly reminder to all industries that public health protection is a partnership with the community and water treatment system operations Figure 7.2.

7.2 Periodic Industry Reviews

In addition to educational outreach and coordinated industry discharger meetings, site audits currently run through the City's pre-treatment program will continue. The auditors will submit all data, reports, and meeting summaries directly to the SWPM immediately following site visits. The SWPM will then compile the data and files to ensure each industry is being properly monitored.

City of Oxnard Quarterly Source Control Dischargers Meeting

Meeting Month Day, Year

8:00 AM - 11:00 AM

Meeting Location

Welcome and Introductions (SCPM)	8:00 - 8:20
Source Control Program Updates (SCPM)	8:20 - 8:45
OWTP Monitoring Trends from Quarter (Oxnard Staff)	8:45 - 9:15
Individual Discharger Updates (Industry Representative)	9:15 - 10:30
Discussion and Q&A (Everyone)	10:30 - 10:50
Set Next Meeting Date and Agenda Items (SCPM)	10:50 - 11:00

Figure 7.1 Example Quarterly Industrial Dischargers Source Control Meeting Agenda

Figure 7.2 ESCP Responsible Partner Award Certificate (Example)

If a violation is found during a site audit, the current enforcement plan for pre-treatment violations will apply, unless a more stringent enforcement plan is needed during audits in the future. Any violations reported or recorded will be discussed during the quarterly and monthly industry outreach meetings that include representatives from each industry.

In the event of a new discharge license being issued by the City, a source control review will be triggered. This review will be discussed and integrated into the industry discharger partnership attending monthly and quarterly meetings. All business licenses for dischargers will be reviewed annually by the industry's assigned auditor. The licenses are required to be within expiration date, show proper fees have been paid to the City for the annual time period, and no new constituents or major changes have been made to the discharge matrices.

7.3 Residential Outreach

Household outreach and education is the major residential source control strategy for most communities. Due to the increased risk involved in potable reuse, the residents should be strongly educated as to where their waste is going and the potential impacts to the communities drinking water supply. An outreach plan for public acceptance purposes is already planned for this project, and the discharge information could be rolled out along with this initiative upfront. Providing a proactive awareness program for household discharges prior to the operation of IPR in the community can provide increased confidence to the City in their residential source water control strategy.

Contaminant discharges causing unwanted impact to the water supply cannot be tracked easily in residual areas due to the quantity of individual dischargers with low-volume inputs. In order to prevent unwanted discharges from households in the sewer line, educational tools and disposal centers will be used for the public to have options for disposing of unwanted items.

Discharge information will address a list of household items that would potentially be detrimental to the wastewater and water purification process, and alternative disposal options for the residents provided by the City or otherwise available. Educational materials will include a website developed to address safe disposal practices. For example, the public would be educated that flushing leftover antibiotics or pharmaceuticals is unsafe, however, household cleaners are acceptable. A detailed list with brand examples will be made available to ensure public understanding of the issue. An example of a public outreach website for residential discharge was developed by the San Francisco Public Utilities Commission (SFPUC). The website offers top things not to flush, and a flyer you can print with the title "Think Before You Flush". The website can be accessed here: http://sfwater.org/index.aspx?page=151

The majority of households in Oxnard primarily speak Spanish, therefore it is imperative that bilingual educational materials are developed alongside of materials in English. The SFPUC in the above example provides 4 language options (English, Spanish, Mandarin and Tagalog) to cater to that city's demographics. To direct residents to the informational website, a link and description will be highly visible on their monthly water bills mailed, or in their water bills provided online. Provided internet is not available in the household, annual residential source control program meetings will be organized by the SWPM to provide another educational option for City residents.

Section 8

OWTP AND AWPF WATER QUALITY RESULTS

8.1 Secondary Effluent Water Quality Standards and Results

In order for AWPF effluent to be used for indirect potable reuse, the water must first meet the existing NPDES OWTP effluent regulations and Los Angeles Region Basin Plan (Basin Plan) objectives. Since secondary effluent is the influent source for AWPF treated water, the higher the secondary effluent water quality, the higher our source water quality is for IPR.

8.1.1 NPDES Permit Regulations

The NPDES Permit for the OWTP includes regulations for major wastewater constituents such as 5-day biological oxygen demand (BOD_5) and total suspended solids (TSS), marine aquatic life contaminants, and contaminants relevant to human health (both carcinogens and non-carcinogens).

Per the NPDES permit, Oxnard already does periodic monitoring (quarterly) of the plant influent.

- Flow - continuous.
- pH, TSS, BOD - daily.
- Oil & Grease - weekly.
- Benzedrine, Heptachlor epoxide, PCBs, TCDD equivalents - quarterly.
- Everything else - semiannually.

8.1.2 Relevant Basin Plan Objectives

The Basin Plan was adopted in 1994 and outlines water quality requirements for waters in the Los Angeles region of which Oxnard is a part. All Basin Plan objectives pertaining to water designated for human consumption, are consistent with DDW requirements.

8.2 OWTP and AWPF Wastewater Quality

The OWTP has been in full compliance with its NPDES permit. Historical effluent data for BOD, TSS, turbidity, residual chlorine, pH, ammonia, oil and grease, and settleable solids are continuously measured in the OWTP effluent. Historical values for these parameters are provided in Tables 8.1 through 8.3. A summary of data for metals and trace pollutants in the OWTP effluent is shown in Table 8.2, including new data collected as part of the 2015 Local limits evaluation. The data provided in Tables 8.1 and 8.2 indicate that the OWTP provides high quality secondary-treated effluent suitable for advanced treatment and potable reuse. Further, the high beta radioactivity has been addressed through the source control program with the cease of all discharge from Santa Clara Wastewater, as demonstrated with the low beta radioactivity shown in Table 8.2.

Table 8.1 Effluent Regulatory Limits and OWTP Data - Typical Wastewater Constituents

Parameter	Units	NPDES Permit Limit		OWTP Data(1)
		Discharge Limit	Criteria	
BOD_5	mg/l	30	Monthly Average	14 - 22
		45	Weekly Average	11 - 28
	lbs/day	7,900	Monthly Average	2,326 - 3,621
		12,000	Weekly Average	1,880 - 4,403
TSS	mg/l	30	Monthly Average	5.8 - 10.4
		45	Weekly Average	4.6 - 19.1
	lbs/day	7,900	Monthly Average	965 - 1,696
		12,000	Weekly Average	760 - 3,063
Turbidity	NTU	75	Monthly Average	2.9 - 6.8
		100	Weekly Average	2.7 - 12.9
		225	Daily Maximum	20.7
Total Residual Chlorine	mg/L	0.085	Monthly Performance Goal	0.01 - 0.04
	lbs/day	23		1.4 - 7.2
pH		6.0 - 9.0	Instantaneous Minimum to Maximum	7 - 7.9(2)
Ammonia Nitrogen	mg/L	25	Monthly Performance Goal	25 - 34
	lbs/day	6,600		4,259 - 5,781
Oil and Grease	mg/L	25	Monthly Average	4.9 - 4.9
		40	Weekly Average	4.9 - 5.1
	lbs/day	6,630	Monthly Average	782 - 827
		10,600	Weekly Average	769 - 850
Settleale Solids	ml/L	1	Monthly Average	0.01 - 0.016
		1.5	Weekly Average	0.01 - 0.036
		3	Daily Maximum	0.10

Notes:
(1) Based on 2013 Data.
(2) From daily grab samples

Table 8.2 Effluent Regulatory Limits and OWTP Data – Other Pollutants

Contaminant	Units	Effluent Limitations		Title 22 Contaminant Action Levels(1) and OWTP Discharge Goals	OWTP Data(2)
		Average Monthly	Maximum Daily	Annual Average or Single Action	
Marine Aquatic Life Toxicants					
Arsenic	ug/L	-	-	10	0.7
Cadmium	ug/L	-	-	5	<0.5
Chromium VI	ug/L	-	-	10	<0.3
Copper	ug/L	-	-	1300	28
Lead	ug/L	-	-	15	<5
Mercury	ug/L	-	-	2	<0.2
Nickel	ug/L	-	-	100	5
Selenium	ug/L	-	-	50	2.4
Silver	ug/L	-	-	100	1
Zinc	ug/L	-	-	5000	19
Cyanide	ug/L	-	-	0.15	-
Phenolic Compounds (non-chlorinated)(3)	ug/L	-	-	5(4)	<23
Phenolic Compounds (chlorinated) (3)	ug/L	-	-	0.42(4)	<5
Endosulfan(3)	ug/L	-	-	0.05(4)	<0.03
HCH(3)	ug/L	-	-	0.1(4)	-
Endrin	ug/L	-	-	2	<0.01
Chronic Toxicity(3)	Tuc	-	99	-	-
Radioactivity					
Alpha Radioactivity	Pci/L	-	15	15	1.67 ± 0.24
Beta Radioactivity	Pci/L	-	50	50	94 ± 3.939(5,6)
Combined Radium-226 & Radium-228	Pci/L	-	5	5	-
Tritium	Pci/L	-	20000	20000	-
Strontium-90	Pci/L	-	8	8	-
Uranium	Pci/L	-	20	20	-
Human Health Toxicants – Non Carcinogens					

Table 8.2 Effluent Regulatory Limits and OWTP Data – Other Pollutants (continued)

Contaminant	Units	Effluent Limitations		Title 22 Contaminant Action Levels(1) and OWTP Discharge Goals	OWTP Data(2)
		Average Monthly	Maximum Daily	Annual Average or Single Action	
Acrolein(3)	ug/L	-	-	10(4)	<5
Antimony	ug/L	-	-	6	<2
Bis (2-chloroethoxy) methane(3)	ug/L	-	-	25(4)	<1
bis (2-Chloroisopropyl) ether(3)	ug/L	-	-	10(4)	<1
Chlorobenzene(3)	ug/L	-	-	2.5(4)	<1
Chromium (III)	ug/L	-	-	50	<5
Di-N-Butyl phthalate(3)	ug/L	-	-	0.19(4)	<1
Dichlorobenzenes	ug/L	-	-	260	<3
Diethyl phthalate	ug/L	-	-	63	<1
Dimethyl phthalate(3)	ug/L	-	-	10(4)	<1
2-Methyl-4,6-dinitrophenol(3)	ug/L	-	-	25(4)	<5
2,4-Dinitrophenol(3)	ug/L	-	-	25(4)	<10
EthylBenzene	ug/L	-	-	600	<1
Fluoranthene(3)	ug/L	-	-	0.039(4)	<1
Hexachlorocyclopentadiene	ug/L	-	-	5	<1
Nitrobenzene(3)	ug/L	-	-	5(4)	<1
Thallium	ug/L	-	-	2	<2
Toluene	ug/L	-	-	150	<1
Tributyltin(3)	ug/L	-	-	0.0263(4)	<0.005
1,1,1-Trichloroethane	ug/L	-	-	200	<1
Human Health Toxicants - Carcinogens					
Acrylonitrile(3)	ug/L	-	-	10(4)	<2
Aldrin(3)	ug/L	-	-	0.025(4)	<0.005
Benzene	ug/L	-	-	1	<1
Benzedrine	ug/L	0.0068	-	-	<10
Beryllium	ug/L	-	-	4	<0.5
Bis (2-chloroethyl) ether(3)	ug/L	-	-	5(4)	<1

Table 8.2 Effluent Regulatory Limits and OWTP Data – Other Pollutants (continued)

Contaminant	Units	Effluent Limitations		Title 22 Contaminant Action Levels[1] and OWTP Discharge Goals	OWTP Data[2]
		Average Monthly	Maximum Daily	Annual Average or Single Action	
Bis (2-ethylhexyl) phthalate[3]	ug/L	-	-	50[4]	10
Carbon Tetrachloride	ug/L	-	-	0.5	<1
Chlordane	ug/L	-	-	2	<0.01
Chlorodibromomethane[3]	ug/L	-	-	0.61[4]	<.001
Chloroform[3]	ug/L	-	-	1.2[4]	<1
DDT[3]	ug/L	-	-	0.25[4]	<0.01
1,4-Dichlorobenzene[3]	ug/L	-	-	0.041[4]	<1
3,3-Dichlorobenzidine[3]	ug/L	-	-	25[4]	<5
1,2-Dichloroethane	ug/L	-	-	5	<1
1,1-Dichloroethylene	ug/L	-	-	6	<1
Bromodichloromethane[3]	ug/L	-	-	2.5(4)	<1
Dichloromethane	ug/L	-	-	5	<1
1,3-Dichloropropene	ug/L	-	-	0.5	<2
Dieldrin[3]	ug/L	-	-	0.05[4]	<0.01
2,4-Dinitrotoluene[3]	ug/L	-	-	25[4]	<1
Azobenzene (1,2-Diphenylhydrazine)[3]	ug/L	-	-	5[4]	<1
Halomethanes	ug/L	-	-	80	<4
Heptachlor	ug/L	-	-	0.04	<0.01
Heptachlor epoxide	ug/L	0.002	-	0.02	<0.01
Hexachlorobenzene	ug/L	-	-	1	<1
Hexachlorobutadiene[3]	ug/L	-	-	5[4]	<1
Hexachloroethane[3]	ug/L	-	-	5[4]	<1
Isophorone[3]	ug/L	-	-	5[4]	<1
N-Nitrosodimethylamine (NDMA)	ug/L	-	-	10	<1
N-Nitrosodi-N-propylamine (NDPA)	ug/L	-	-	10	<1
PAHs[3]	ug/L	-	-	0.097[4]	<19
PCBs	ug/L	0.0019	-	0.5	<17.5

Table 8.2 Effluent Regulatory Limits and OWTP Data – Other Pollutants (continued)

Contaminant	Units	Effluent Limitations		Title 22 Contaminant Action Levels[(1)] and OWTP Discharge Goals	OWTP Data[(2)]
		Average Monthly	Maximum Daily	Annual Average or Single Action	
Total 2,3,7,8-TCDD Equivalence[(3)]	ug/L	0.00000039	-	-	<0.00001
1,1,2,2-Tetrachloroethane	ug/L	-	-	1200	<1
Tetrachloroethylene	ug/L	-	-	5	<1
Toxaphene	ug/L	-	-	3	<2.5
Trichloroethylene	ug/L	-	-	5	<1
1,1,2-Trichloroethane	ug/L	-	-	5	<1
2,4,6-Trichlorophenol[(3)]	ug/L	-	-	0.35[(4)]	<1
Vinyl chloride	ug/L	-	-	0.5	<1

The OWTP data collected to date was intended to demonstrate compliance with the existing NPDES permit and to address the local limits evaluation, and was not intended to address future potable reuse water quality standards. However, the OWTP secondary effluent data (Table 8.3) shows for any contaminant monitored under Title 22, the measured secondary effluent data meets or exceeds Title 22 maximum contaminant concentrations, with the exception of one event, where subsequent sampling consistently showed a much lower concentration. As discussed in the subsequent section, additional analytical testing of secondary effluent, ROP, and UV AOP effluent will be done during the startup of the AWPF and the production of non-potable recycled water, which will be done in the summer of 2016.

Table 8.3 AWPF Removal Efficiencies (Local Limits Constituents)

Constituent	Units	Secondary Effluent	Finished Water	Removal Efficiency[(1)]
Ammonia	mg/L	33.9	1.67	95.1%
Antimony	ug/L	0.84[(2)]	<1	40.5%
Arsenic	ug/L	2.09[(2)]	<1	76.0%
Barium Tot	ug/L	23.0	<2	95.7%
Beta, Gross	pCi/L	5.96[(2)]	<3	74.8%
Biochemical Oxygen Demand, total	mg/L	6.91[(3)]	2.31[(3)]	66.6%
Boron	mg/L	1.09	0.74	31.9%
Cadmium	ug/L	<0.5	<0.5	--
Calcium	mg/L	164	7.52	95.4%

Table 8.3 AWPF Removal Efficiencies (Local Limits Constituents) (continued)

Constituent	Units	Secondary Effluent	Finished Water	Removal Efficiency(1)
Chloride	mg/L	548	18.7	96.6%
Chromium	ug/L	0.52(4)	<1	4.2%
Copper	ug/L	7.16	<2	86.0%
Fixed Dissolved Solids	mg/L	1,603	1.14(4)	99.9%
Fluoride	mg/L	0.70	0.02	96.4%
Gross Alpha	pCi/L	26.5	<3	94.3%
Iron Total	mg/L	0.30	0.01(4)	96.2%
Lead Total	ug/L	<0.5	<0.5	--
Magnesium	mg/L	67.8	0.23	99.7%
Manganese	mg/L	0.11	<0.002	99.1%
Mercury	ng/L	6.01(2)	1.52	74.7%
Molybdenum	ug/L	16.4	<2	93.9%
Nickel	ug/L	6.57(2)	<5	62.0%
Potassium	mg/L	35.1	1.43	95.9%
Selenium	ug/L	8.05(2)	<5	69.0%
Silica	mg/L	30.8	1.01	96.7%
Silver Total	ug/L	<0.5	<0.5	--
Sodium	mg/L	397	17.4	95.6%
Specific Conductance	umho/cm	3,346	141	95.8%
Strontium	mg/L	1.55	0.01(4)	99.6%
Sulfate	mg/L	543	1.27	99.8%
Total Dissolved Solids	mg/L	1,869	69.9	96.3%
Total Kjeldahl Nitrogen	mg/L	34.3	1.70	95.0%
Total phosphorus as P	mg/L	1.45	0.03	97.8%
Total Suspended Solids	mg/L	5.32(2)	<10	6.1%
Uranium	ug/L	8.49	<1	94.1%
Zinc Total	ug/L	17.3(2)	<20	42.2%

Notes:

(1) Where the reported value is < reporting limit, the removal efficiency was calculated assuming the reported value equaled one half of the reporting limit.

(2) Some data points in this dataset were extrapolated below reporting limit based on other reported data at the sampling location. These datasets had three or more data points above the reporting limit to allow regression analysis for extrapolating concentrations below the level of detection.

(3) BOD data were collected on 9 days from 6/11/15 through 8/30/15.

(4) These datasets had less than three data points above the reporting limit which makes a regression analysis inaccurate. Thus, a geometric mean of all data points was used. Data reported below the reporting limit were assumed to be one half the reporting limit for calculating the geometric mean.

Section 9

SUMMARY

An ESCM Program framework has been proposed in this document, building on the existing source control program already in place at the City of Oxnard. The proposed ESCM for the City of Oxnard will include:

- A source control program manager overseeing all data collection and regulatory issues relating to discharge from the first user to groundwater wells.
- More frequent sampling than currently required of the secondary effluent and AWPF finished water, including for regulated, unregulated and industry-specific constituents.
- Use of historical and online monitoring data currently required for operation to create baselines and predict trends in process performance.
- Substantial industrial and residential outreach programs for potable reuse education and discharge initiatives.
- Mapping strategies for fast-acting collection system tracing of detected contaminants of health concern.
- Optional additions to discharge mapping, including hospitals.

Section 10

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Appendix A

BEST MANAGEMENT PRACTICES (BMPS) FOR CENTRALIZED WASTE TREATMENT (CWT)

CALIFORNIA ASSOCIATION OF SANITATION AGENCIES (CASA)

BEST MANAGEMENT PRACTICES

FOR

CENTRALIZED WASTE TREATMENT (CWT) FACILITIES

(SUBCATEGORY D MULTIPLE WASTESTREAM)

October 12, 2015

Purpose

These Best Management Practices (BMPs) have been endorsed by several major POTW's in California that currently accept CWT waste discharges. These major California POTWs have developed and adopted these BMPs to serve as guidance, and to help assure uniform compliance among POTWs in California with their mandates under the U.S. EPA pretreatment program requirements.

These requirements are designed to protect POTW wastewater treatment processes and conveyance systems; to assure compliance with the regulations governing discharge of treated effluent, water reuse, biosolids disposal/reuse, and air emissions; and to protect worker and public safety and the environment.

Acknowledgement

The following agencies participated in the development and review of this BMP.

- City of Oxnard
- County Sanitation District of Los Angeles
- City of San Jose (SJ/SC Water Pollution Control Plant)
- City of Los Angeles
- Orange County Sanitation District

Background

Centralized Waste Treatment (CWT) facilities are defined in Rule 40 CFR 437 as those that accept hazardous or non-hazardous industrial metal-bearing wastes, oily wastes and organic-bearing wastes received from off-site for pretreatment processing before discharge to a water of the U.S., or to a Publically Owned Wastewater Treatment (POTW) facility. Specifically, CWT Subcategory D dischargers are those that receive for treatment a combination of two of more any of the following three major categorical waste streams: metal-bearing wastes, oily wastes, and organic-bearing wastes.

CWTs are required to be permitted and to comply with all federal and local rules and regulations set by Rule 40 CFR 437. They are also required to meet those rules and regulations set by the local agency that owns and operates the POTW facility and administers the POTWs pretreatment program, if the CWT discharges to a POTW.

The EPA's guidance document labeled "Small Entity Compliance Guide, Centralized Waste Treatment (CWT) Effluent Limitations and Guidelines and Pretreatment Standards (40 CFR 437) (EPA 821-B-01-003; June 2001; Version 3.0) "sets guidance for businesses that are subject to the

Rule in complying with the national regulations and limitations set forth in the Rule." A Subcategory D discharger must establish that its facility provides "equivalent treatment" in terms of comparable pollutant removals to the applicable treatment technologies used as the basis for the federal limitations and pretreatment standards (40 CFR 437.2).

Best Management Practices

The following summarizes the recommended Best Management Practices (BMPs) for CWT facilities discharging to California POTWs. These recommended BMPs are organized based on the following topical headings:

- Waste Receiving Requirements
- Treatment Requirements
- Effluent Discharge and Sampling/Testing Requirements
- Recommended Certification and Documentation Requirements.

1. **Waste Receiving Requirements**
    a. The waste hauler bringing waste to a CWT shall submit a Waste Manifest to the CWT upon arrival at the CWT processing facility. The Waste Manifest shall include the following minimum information:
        i. Information as defined in Chapter 5 of Small Entity Compliance Guide, Centralized Waste Treatment (CWT) Effluent Limitations and Guidelines and Pretreatment Standards (40 CFR 437) (EPA 821-B-01-003; June 2001; Version 3.0). This shall include a date and time stamp.
    b. The following mandatory tests shall be performed for confirmation of the Waste Manifest in accordance with 40 CFR 403 General Pretreatment Regulations and the analytical methods and sampling techniques stipulated in 40 CFR 136:
        i. Heavy Metals
        ii. Cyanides
        iii. Total Phenol
        iv. Sulfides
        v. Volatile Organic Compounds
        vi. Oil and Grease
        vii. Total Toxic Organics (TTOs)
        viii. BOD and TSS
    c. Combining waste from multiple location into one tank truck (i.e. "Milk Runs") is prohibited.
    d. Additional random sampling of waste haulers by the CWT may be requested by the POTW to confirm the waste characteristics are as described in the Waste Manifest.
2. **Treatment Requirements**
    a. The minimum required treatment shall be as specified in 40 CFR 437, and as described in the Small Entity Compliance Guide, Centralized Waste Treatment (CWT) Effluent Limitations and Guidelines and Pretreatment Standards (40 CFR 437) (EPA 821-B-01-003; June 2001; Version 3.0).
    b. Emergency shutoff and re-routing procedures must be in place.
    c. Treatment reliability and redundancy requirements must meet. As a minimum, those that are established by the most recent version of the 'Ten-State Standards'

(Board of State and Provincial Public Health and Environmental Managers, Health Research, Inc., Health Education Services Division).

d. Holding tanks for the purpose of dilution will not be allowed.
e. A logbook shall be maintained of the operating parameters of the treatment process.

3. **Effluent discharge and sampling/testing requirements.**
   a. Batch discharge will be required. Continuous discharge is not permitted.
   b. The batch tanks will be continuously mixed.
   c. A representative sample will be taken and analyzed by a POTW approved, State certified laboratory, before a decision is made to discharge to the POTW sewer system. Testing shall, as a minimum, be for the following:
      i. Local Limits as established by the POTW.
      ii. Applicable 40 CFR 437 Categorical Limits, adjusted by the combined waste stream formula if non-regulated waste streams are discharged at the compliance point.
      iii. Toxicity as determined by Specific Oxygen Uptake Rate (SOUR), Method 1683, EPA-821-R-01-014.
      iv. Any other limits imposed by the POTW.
   d. The batch discharge will only be allowed if the above test results meet the applicable discharge limits.
   e. Adequate emergency shut-off/rerouting procedures must be established. Incoming wastes must be halted or diverted to storage if an emergency shutdown of the treatment system is required.
   f. If the federal or local discharge limitations are not met for a parameter other than pH, then the tank contents shall to be returned to the beginning of the treatment process train for reprocessing. If the federal or local pH limits are not met based on pH only, then the CWT Facility can add an acid or base to bring the pH into the allowable range before discharge. The POTW may have restrictions on the acid or base chemical that can be used for pH adjustment.
   g. Installation of flow metering of the discharge to the POTW is required and must be maintained and calibrated routinely by a qualified professional.

4. **Recommended General Certification and Documentation Requirements**

   Documents must be developed and submitted to the POTW, and be available for the POTW to review at the CWT site all times.

   Note that all documents, forms, and other submittals must be certified and stamped by a registered professional engineer in California with expertise in industrial treatment. This list includes, but is not limited to the following.

5. **Initial Certification Statement.**
   a. Submit initial Certification Statement to the POTW in accordance with 40 CFR 437.41.
   b. The initial Certification Statement must be reviewed and approved by the POTW before a Permit to Discharge is granted to the CWT by the POTW.

6. **Plans/Procedures**
   a. Monitoring, Sampling and Testing Plan (MSTP). The MSTP shall specify: location, frequency, and methodology for all monitoring/sampling of waste received,

treatment processes and performance, and treated effluent discharged to the POTW.

b. Monitoring Plan Reporting: Monthly and annual reports shall be submitted summarizing all mandatory and self-monitoring data results.
c. Slug Discharge Control Plan.
d. Spill Containment plan.
e. Flow Metering Plan.
f. Rainwater and Stormwater Management Plan (Note: stormwater cannot be commingled with received and/or treated CWT wastes).
g. Solvent Management Plan.
h. Waste Minimization Plan.

7. **Treatment Process/Facility Information.**
   a. O&M Manual
      i. Routine O&M Procedures
      ii. Emergency Response, Bypass, and Storage O&M Procedures
      iii. O&M Logbook
   b. Unit process sizing and design criteria. Information shall be sufficient for independently assessing the rated treatment capacity of all unit operations, including physical dimensions, and process design criteria (e.g. hydraulic detention times, overflow rates, pollutant removals, etc.).
   c. Engineering Design Drawings (100% Design Drawings/As-built).
   d. Process and Instrumentation diagram. This shall show the following information:
      i. Process flows for all major unit operations (routine and emergency conditions). This shall include identification of all flow and recycle streams for each treatment process
      ii. Process monitoring parameters (location and metrics). As a minimum these shall include:
         1) Flow rates
         2) pH
         3) Temperature
         4) Others as recommended by the POTW.
   e. Wastewater Treatment Operator Requirements.
   f. Water Usage. Copies of historical water bills and/or local well records showing water usage for a five-year (5) period.
   g. Operating Records. All plant operating and performance records relating to wastewater discharge and waste manifests for up to five (5) years, including all monitoring, testing, and analytical results (See Testing and Monitoring Information, below).
8. **Received Waste Documentation**
   a. Comprehensive list of all generators accepted by the CWT.
   b. Waste Hauler Reports.
   c. Logbook of all prequalification for each of the CWTs clients, this includes;
      i. Generator information
      ii. Initial Sample information
      iii. Requalification tests
   d. d. Customer Laboratory Treatability Information.

9. **Testing and Monitoring Information**
    a. All sampling, testing and laboratory analyses must be performed by an independent testing laboratory that is licensed and certified in California.
    b. All laboratory analytical results, including QA/QC information, shall be submitted monthly, and records maintained for a five-year period.
    c. Effluent pH recordings from the previous 180 days
    d. Flow Meter Calibration and Maintenance Reports (Note: must be signed and stamped by a registered professional engineer in California).
        i. Flow meter locations
        ii. Flow meter descriptions
        iii. Flow meter system details
        iv. Calibration methods/results
        v. Corrective measures
        vi. Discharge log (with signature(s) from responsible party at time of release from CWT facility to the POTW system.)
        vii. Time, date, and volume of when the contents from the tank are discharged to the sewer
        viii. Signature from responsible operator
        ix. Other observations
    e. Chain of custody forms for monitoring samples with signatures.
    f. All other sampling reports.
10. **Compliance Paperwork**
    a. On-site Compliance Paperwork, as required by 40 CFR Part 437.47(a)(4)
    b. Periodic Certification of equivalent treatment statement in the Self-Monitoring Report 40 CFR Part 437.41(b)
    c. Facility shall continue to submit application information on a five-year cycle, with all applicable documentation and any information pertaining to changes planned for the future years. The information provided must include changes in the nature or volume of the discharge, or anticipated customers.

Appendix B

PRELIMINARY HYDROGEOLOGICAL STUDY REPORT, CITY OF OXNARD GREAT PROGRAM, CAMPUS PARK GROUNDWATER REPLENISHMENT AND REUSE PROJECT

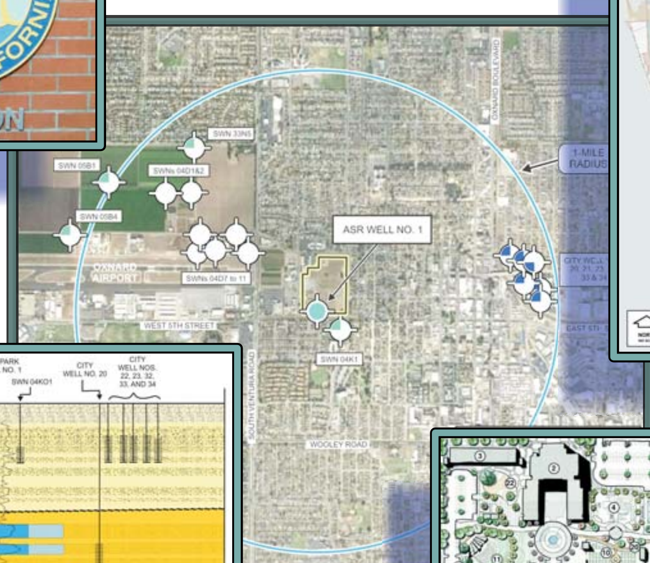
HOPKINS GROUNDWATER CONSULTANTS, INC.

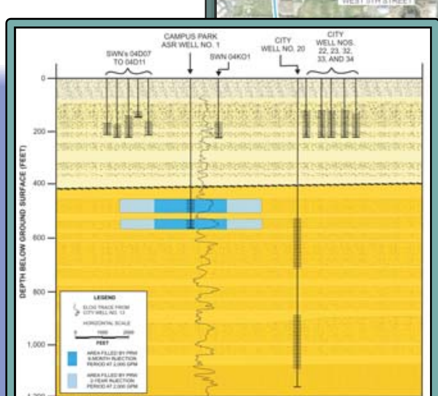
PRELIMINARY HYDROGEOLOGICAL STUDY

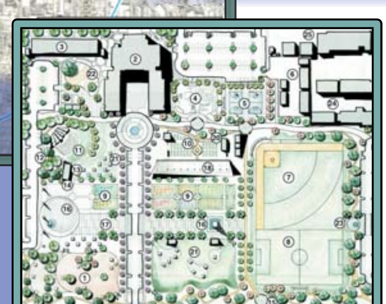
CITY OF OXNARD GREAT PROGRAM
CAMPUS PARK GROUNDWATER
REPLENISHMENT AND REUSE PROJECT
OXNARD, CALIFORNIA

Prepared for:
City of Oxnard

July 2016







HOPKINS
GROUNDWATER
CONSULTANTS, INC.
THE WATER RESOURCE SPECIALISTS

July 26, 2016
Project No. 01-011-09E

City of Oxnard
305 West Third Street, Second Floor, East Wing
Oxnard, California 93030

Attention: Mr. Daniel Rydberg
Public Works Director

Subject: Preliminary Hydrogeological Study, City of Oxnard Great Program, Campus Park Groundwater Replenishment Reuse Project, Oxnard, California.

Dear Mr. Rydberg:

Hopkins Groundwater Consultants, Inc. (Hopkins) is pleased to submit this final report summarizing the findings, conclusions, and recommendations developed from a preliminary study evaluating the feasibility of a Groundwater Replenishment Reuse Project (GRRP) that is proposed as part of the City of Oxnard Groundwater Recovery Enhancement and Treatment (GREAT) Program. The study findings indicate that the Campus Park GRRP site proposed for Indirect Potable Reuse is a feasible location and that the replenishment and recovery of groundwater with an improved quality could be achieved by the project for Indirect Potable Reuse. The study provides detailed hydrogeological findings in compliance with Groundwater Replenishment Using Recycled Water regulations designated DPH-14-003E, dated June 18, 2014, to augment the Indirect Potable Reuse engineering report required for the project, and to facilitate discussion with State regulatory agencies, local groundwater management agencies, and stakeholder groups that may have a direct interest in the project.

As always, Hopkins is pleased to be of service. If you have questions or need additional information, please give us a call.

Sincerely,

HOPKINS GROUNDWATER CONSULTANTS, INC.

Curtis J. Hopkins
Principal Hydrogeologist
Professional Geologist PG 5695
Certified Hydrogeologist HG 114
Certified Engineering Geologist EG 1800

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P.O. Box 3596, Ventura, California 93006 Phone: (805) 653-5306 e-mail: chop4@earthlink.net

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ACRONYM LIST

AFY – Acre-Feet Per Year

ASR – Aquifer Storage and Recovery

AWPF – Advanced Water Purification Facility

BGS – Below Ground Surface

BS-1 – Blending Station No. 1

BS-3 – Blending Station No. 3

CDPH – California Department of Public Health

CRWQCB – California Regional Water Quality Control Board

DDW – California Department of Drinking Water

FCGMA – Fox Canyon Groundwater Management Agency

GPM – Gallons Per Minute

GREAT – Groundwater Recovery Enhancement and Treatment

GRRP – Groundwater Replenishment Reuse Project

GRURW – Groundwater Replenishment Using Recycled Water

IPR – Indirect Potable Reuse

LAS – Lower Aquifer System

MSL – Mean Sea Level

MG/L – Milligrams Per Liter

PRW – Purified Recycled Water

PSI – Pounds Per Square Inch

TDS – Total Dissolved Solids

UAS – Upper Aquifer System

UWCD – United Water Conservation District

VCWPD – Ventura County Watershed Protection District

CITY OF OXNARD GREAT PROGRAM
CAMPUS PARK GROUNDWATER
REPLENISHMENT AND REUSE PROJECT

INTRODUCTION

GENERAL STATEMENT

Presented in this report are the findings, conclusions, and recommendations developed from a preliminary hydrogeological study conducted by Hopkins Groundwater Consultants, Inc. (Hopkins) to assist the City of Oxnard (City) in evaluating the feasibility of a Groundwater Replenishment Reuse Project (GRRP) using purified recycled water (PRW). This hydrogeological study was conducted to support the City's Groundwater Recovery Enhancement and Treatment (GREAT) Program by developing an aquifer storage and recovery (ASR) project that will provide Indirect Potable Reuse (IPR) of the PRW produced at the City's Advanced Water Purification Facility (AWPF).

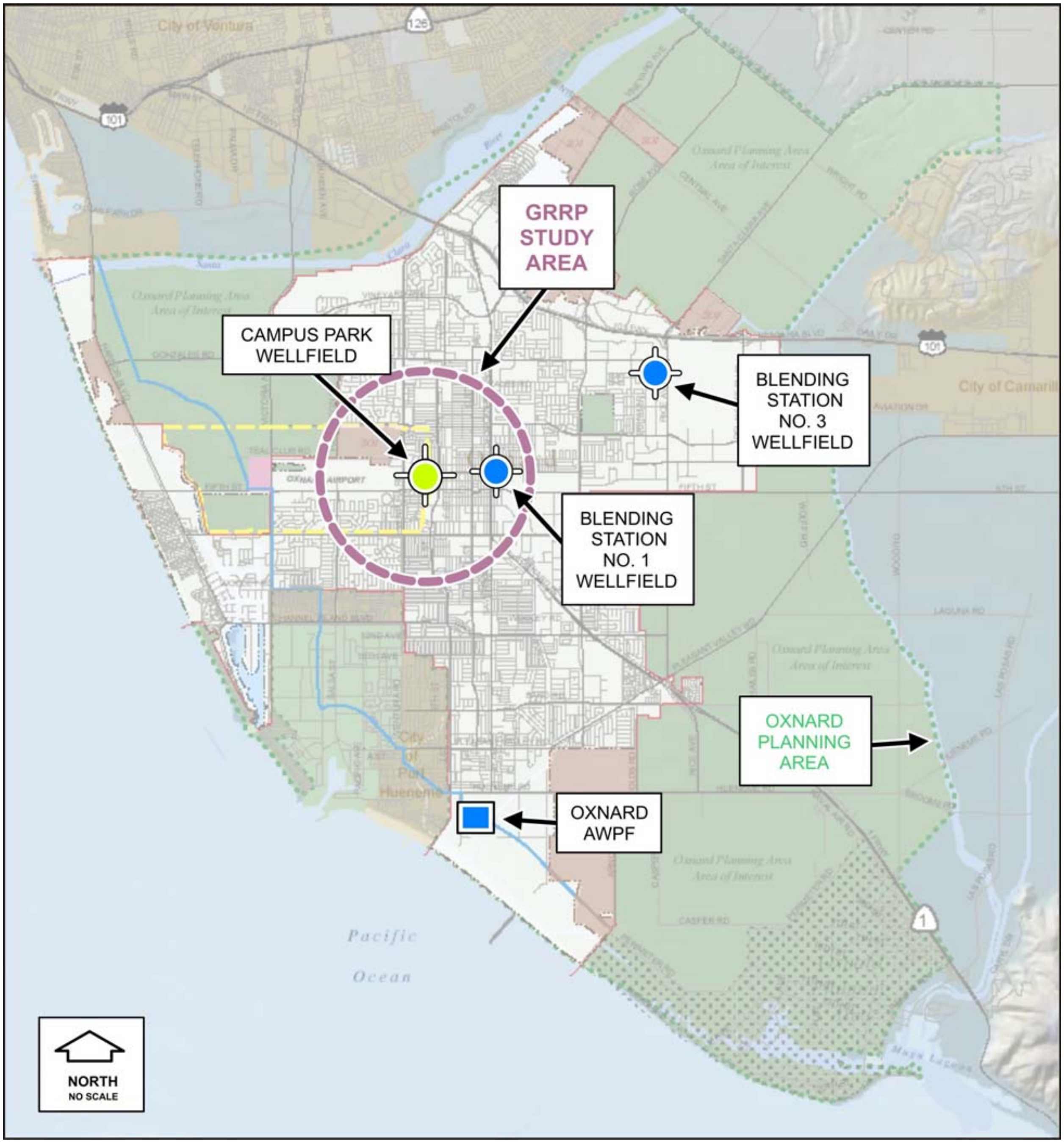
The proposed City GRRP includes developing a sustainable program for groundwater replenishment and IPR of PRW using aquifer units located in the Oxnard Plain Groundwater Basin. The proposed GRRP is intended to augment the City's potable water system by; 1) improving the delivered water quality, 2) increasing the available supply, and 3) providing greater reliability through source redundancy. The GRRP study area is indicated on Figure 1 – Study Area Location Map.

BACKGROUND

The present City water supply is a combination of sources including; a) imported water from the State Water Project, b) groundwater produced by the United Water Conservation District (UWCD), and c) groundwater produced by the City wellfields at Blending Station Nos. 1 and 3 (BS-1 and BS-3). Historically, the City has improved the quality of its municipal supply by blending the higher quality imported water with its local groundwater supplies. The recent construction of the brackish groundwater desalter facilities located at BS-1 has provided the City with the means to further improve its water quality through the desalination of poor quality groundwater. During the desalination process, approximately 20 percent of the produced groundwater feeding the desalter is lost as brine reject that is discharged to the sewer ocean outfall.

The present operation of the City's groundwater desalter has allowed the City to shift groundwater production from the higher quality aquifer zones in the Lower Aquifer System (LAS) to the poorer quality aquifer zones in the Upper Aquifer System (UAS). This shift of pumping was designed to comply with the most recent groundwater management strategies of the Fox Canyon Groundwater Management Agency (FCGMA).

Figure 1 – Study Area Location Map



The GREAT Program was originally developed at a time when recycled water regulations treated all recycled water in the same manner. State regulations required onerous project development studies, monitoring and reporting programs, and dilution requirements utilizing another potable supply. Soil and aquifer treatment criteria could require extended retention times and travel distances through an aquifer to provide additional treatment prior to beneficial potable reuse. With these regulations, the City believed the best approach was to inject the PRW into the local aquifer system at a location that optimized basin management strategies, and extract a like amount of native groundwater from another area of the basin for municipal use. Consistent with this approach, the City proposed the direct use of the PRW for permissible agricultural purposes. Subsequently, a transfer of the unused groundwater would be provided to the City for municipal uses. Both of these strategies would provide the City with a source of potable groundwater in exchange for its recycled water.

This original approach required that the City purify a greater portion of the groundwater with a desalter and resulted in additional treatment costs and a loss of approximately 20 percent of the produced groundwater supply. The present approach for IPR would eliminate the additional step of desalting groundwater by allowing the indirect reuse of the high quality PRW. This will conserve energy and prevent wasting 20 percent of the supply as part of the redundant treatment process. The stored and recovered PRW by the GRRP can be blended with lower quality groundwater to achieve the City's water quality objectives.

Since construction of the GREAT Program AWPF, Federal and State recycled water regulations have been updated to the present Groundwater Replenishment Using Recycled Water (GRURW) regulations designated DPH-14-003E, dated June 18, 2014. These regulations accommodate the use of highly treated effluent produced by the PRW process by reducing or eliminating the requirement for soil/aquifer treatment. The State has recognized that the threat to public health is significantly lower after municipal wastewater receives advanced purification and disinfection using reverse osmosis, advanced oxidation, and ultraviolet radiation treatment processes. Because of the PRW extreme high quality, the new GRURW regulations significantly reduce the requirements for IPR compared to wastewater treated to secondary or tertiary standards.

PURPOSE

The purpose of this hydrogeological assessment of the proposed GRRP is to provide specific information to comply with the GRURW regulations pursuant to section 60320.200(h) and permit the preliminary investigation to develop site specific information that is required for the GRRP Title 22 engineering report. The findings of this study are also intended to further define the conceptual components of the ASR program that will be necessary to implement the IPR of PRW as a municipal supply in accordance with regulation provisions.

As part of the GRRP, the City proposes a project that:

1) utilizes (to the extent practicable) existing pipelines and facilities to control potential costs,

2) recharges aquifer zones that preserve the water quality during underground storage,

3) minimizes the risk to other potable well facilities,

4) is consistent with the FCGMA and UWCD groundwater management strategies,

5) has operational flexibility to adapt to changing system demands and aquifer conditions,

6) demonstrates the ASR capacity of the Oxnard Plain LAS,

7) can be increased to facilitate future AWPF expansion, and

8) can simplify monitoring and reporting to UWCD, the FCGMA, the California State Water Resources Control Board Division of Drinking Water (DDW), and the California Regional Water Quality Control Board (CRWQCB).

This hydrogeological study utilizes the City GREAT Program Update, dated June 25, 2012, as the guide for the anticipated capacity of the AWPF and the initial availability of PRW. This study is intended to provide the mandatory hydrogeological assessment to accompany the engineering report required pursuant to section 60323 of the Title 22, California Code of Regulations, GRURW regulations for a new GRRP.

Additionally, this hydrogeological assessment is intended to provide operational criteria based on aquifer parameters estimated from historical well data, which will define the range of ASR capacity that can be reasonably anticipated from the underlying aquifer system. Subsequently, a conceptual GRRP operational schedule can be developed for the ASR operations to comply with the response retention time requirements of the GRURW regulations for IPR that is based on reasonable expectations of the natural aquifer system constraints.

Sources of available data and published information that were used for the study include; a) City data and reports, b) UWCD data and reports, c) United States Geological Survey, and d) Ventura County Watershed Protection District (VCWPD) databases.

HYDROGEOLOGICAL CONDITIONS

The City recognizes that the threat of seawater intrusion is a regional issue. The City has historically complied with FCGMA regulations and participated in UWCD groundwater supply management programs. Implementation of the GREAT Program is intended to continue this cooperative management effort and the beneficial use of the local groundwater resources in the vicinity of the City. The proposed GRRP using PRW includes ASR wells constructed in aquifer zones that comprise the LAS. Recharge into the LAS will store water in aquifer zones that receive significantly less groundwater recharge than the UAS because of the regional confined aquifer conditions. The UAS readily receives groundwater recharge derived from natural percolation of rainwater and Santa Clara River flows in the Oxnard Forebay Basin, as well as from river flow diversions into the engineered recharge facilities operated by UWCD.

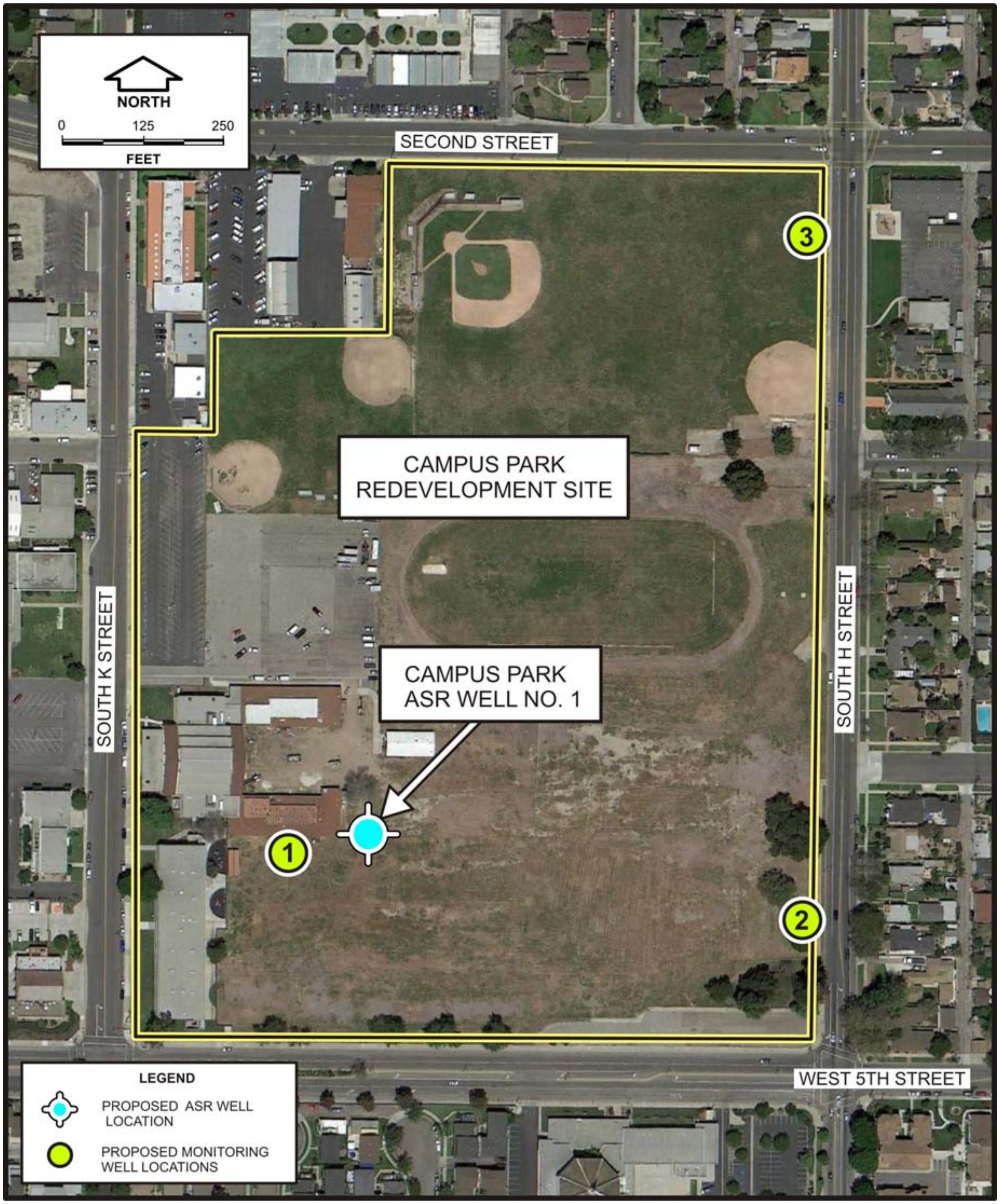
The GRRP ASR Well will be designed to inject PRW into discrete aquifer zones in the LAS and subsequently facilitate groundwater extraction after the response retention time is achieved and regulatory approval is granted. The proposed ASR Well No. 1 is anticipated to be constructed with a completion depth of about 580 feet below ground surface (bgs) and with a screened interval limited to a discrete aquifer zone(s) in the LAS. The well will be designed for an injection capacity of up to 2,000 gallons per minute (gpm). Plate 1 – Preliminary ASR Well No. 1 Design Drawing provides preliminary design details that reflect the anticipated hydrogeology and comply with the VCWPD sealing zone requirements.

Water to be injected during initial testing is proposed to be 100 percent PRW. Initially, the water may be conveyed to the ASR well from the City recycled water system using temporary piping. The initial phase of aquifer testing will determine the percentage of recovery that occurs prior to evidence of native groundwater mixing with the PRW along with any change in the PRW chemistry that could occur as it travels through the aquifer matrix. During the test period, PRW that is extracted from the ASR well will be discharged back into the recycled water transmission main and subsequently used for irrigation.

The ASR demonstration program, as developed, will comply with GRURW regulations and last for an anticipated period of between 2 and 4 months. During the initial demonstration period, monitoring well data and water quality samples will be collected and analyzed to verify the preliminary estimations of aquifer parameters, groundwater storage volumes, and groundwater travel times effectuated by PRW recharge. These data will be utilized to finalize the permit application required for full-scale project operation using the PRW generated by the AWPF.

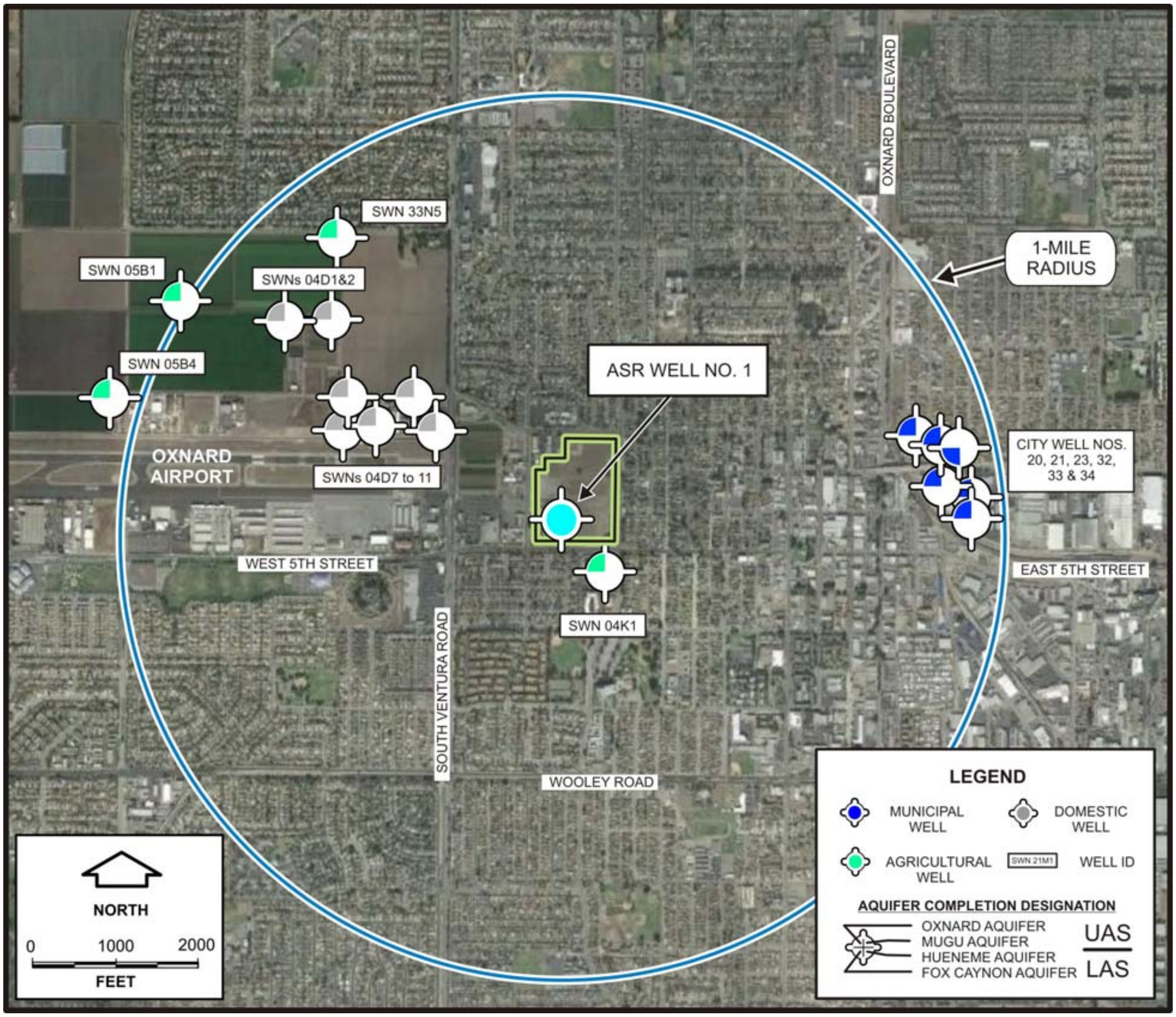
The proposed GRRP would ultimately be sized to accommodate the first phase of the AWPF, providing the ability to store and reuse up to 1,500 acre-feet per year (AFY). The GRRP location identified for groundwater recharge wells is indicated in Figure 2 – Proposed GRRP ASR Well Site Location Map. This location serves to isolate City groundwater facilities within the City boundaries where it has control of surrounding land uses and future groundwater development.

Figure 2 – Proposed GRRP ASR Well Site Location Map



The property selected for installation and operation of the GRRP ASR Well is owned by the City and had an existing City well proximately located and constructed in the LAS (City Well No. 13). While the old City well has since been destroyed, several smaller wells are presently active in the unincorporated area north of the Oxnard Airport along the western City limit. Figure 3 – Existing Well Location Map shows all the active wells within a 1-mile-radius of the GRRP ASR well location.

Figure 3 – Existing Well Location Map



As shown, many proximate wells are constructed in the UAS and as such will not be hydraulically connected with the LAS aquifer zones proposed for use by the GRRP. Review of available data indicates that the nearest well constructed in the LAS is almost 1 mile away and is a municipal supply well owned by the City. The closest existing LAS well is City Well No. 20 located at BS-1. As such, the City ASR well location appears to provide more than a sufficient distance from existing LAS wells to allow GRRP operations without interference.

HYDROGEOLOGY AND AQUIFER DELINEATION

Geology

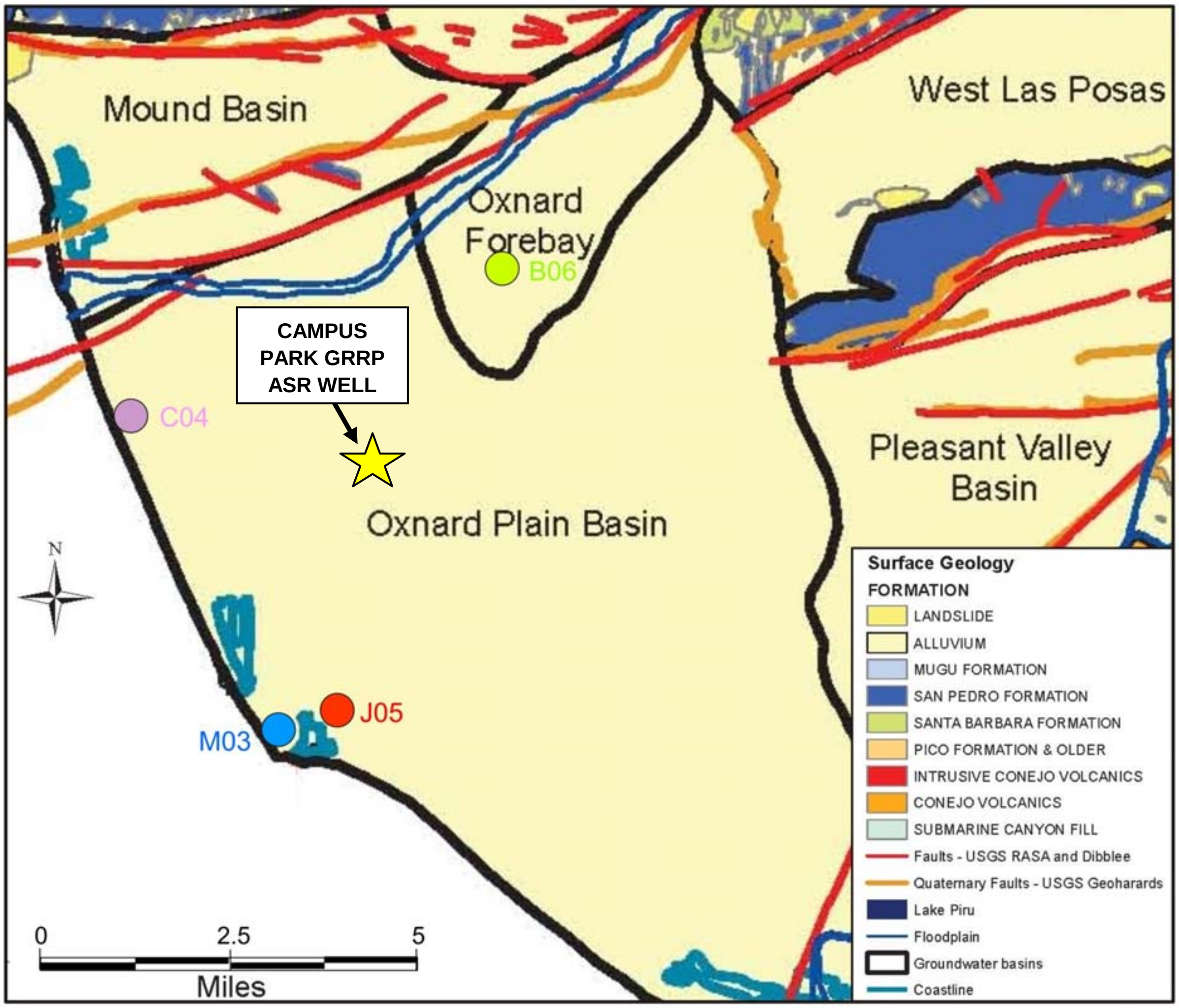
The proposed City project is located in the Oxnard Plain Groundwater Basin, which is part of the Transverse Ranges geologic/geomorphic province and defined by a number of geologic structures and features that separate it from the adjacent groundwater basins. The geology of the Oxnard Plain Basin has been described in detail by several authors including the California State Water Resources Board (SWRB, 1953), Turner (1975), and UWCD (2012). Figure 4 – Generalized Geologic Map and Oxnard Plain Basin Boundaries shows the project location in relation to the adjacent boundaries of the Oxnard Plain Basin with the Mound, Oxnard Forebay, West Las Posas, and Pleasant Valley Basins.

Plate 2 – Hydrogeological Cross-Section Location Map shows the location of cross-sections constructed from available well data to illustrate the subsurface profiles of the geological formations that comprise the underlying aquifer systems. Plate 2 also shows the location of wells that provided geophysical data near the Campus Park GRRP site. Plates 3 and 4 – Hydrogeological Cross-Section A-A’ and B-B’, respectively, provide an interpretation of the hydrostratigraphy in the study area. This conceptual understanding of the confined Oxnard Plain Basin aquifer system is key to the understanding of how the GRRP potential impacts are limited by natural conditions. It also illustrates how the GRRP was developed to utilize discrete aquifer zones that will allow rotation of the three phases of project operations; 1) injection/recharge of the PRW produced from the AWPF, 2) storage/response retention time, and 3) recovery and reuse/IPR.

Aquifer Zone Designation

The subsurface geology that controls groundwater flow in the study area is differentiated into two primary geologic units that include; the Holocene and late Pleistocene alluvium, and the San Pedro Formation. The first unit is comprised largely of unconsolidated sedimentary deposits and includes all older and Recent alluvial deposits. These shallower units are coarse-grained sand and gravel layers that form the Oxnard and Mugu Aquifers and comprise the UAS in the Oxnard Plain Basin (see Plates 3 and 4). The San Pedro Formation consists of consolidated marine and nonmarine clay, silt, sand, and gravel deposits that comprise the Hueneme and Fox Canyon Aquifers that are designated as the LAS. The low permeability geologic formations underlying the San Pedro Formation are generally considered to be non-water-bearing and effectively define the base of fresh water.

Figure 4 – Generalized Geologic Map and Oxnard Plain Basin Boundaries

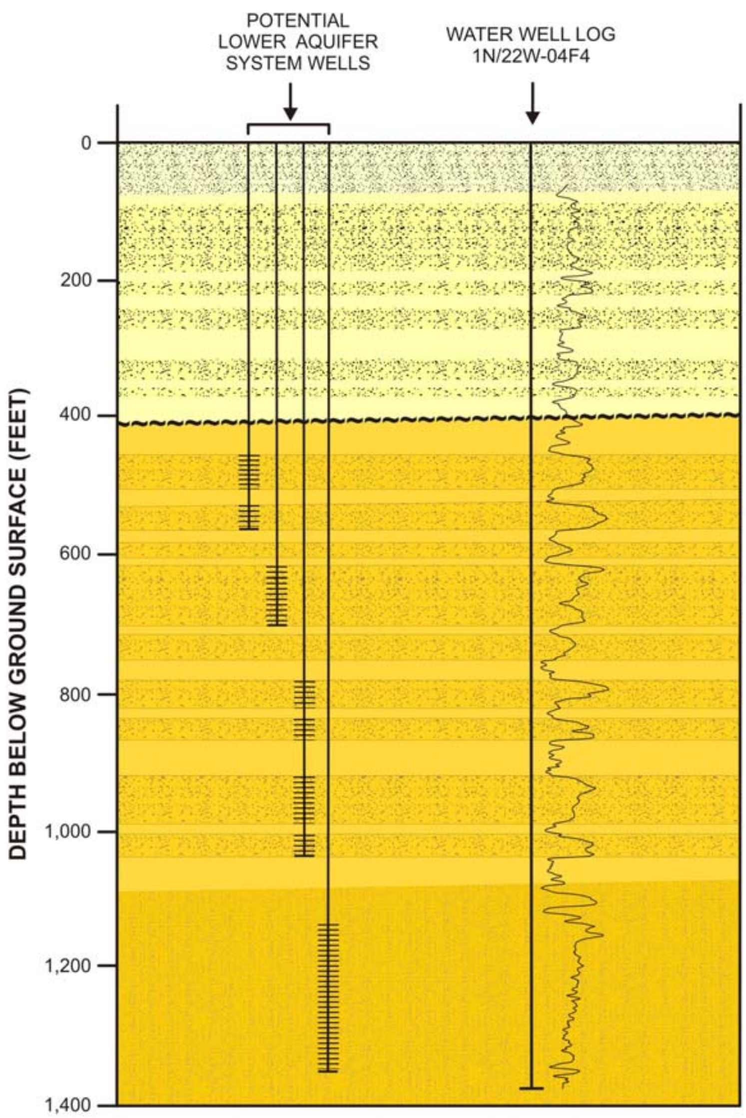


FROM UWCD, 2012

The groundwater in the Oxnard Plain Basin LAS is isolated from overlying land uses by the laterally extensive aquitard (silt and clay) layers that separate and confine the Hueneme and Fox Canyon Aquifer zones. The conceptual subsurface profile shown in Figure 5 – Discrete Aquifer Zone Delineation uses the geophysical survey (electric log) from the proximate City Well No. 13 to show the anticipated geology and aquifer zones beneath the Campus Park GRRP site. The aquifer zones shown in Figure 5 are discretely separated by clay layers that are laterally continuous and appear as marker beds in other well logs shown in Plates 3 and 4. The significance of the highly confined condition that results from the discretely layered aquifer system is that wells located in close proximity (50 feet apart) but producing from different aquifer layers, do not have hydraulic connectivity with each other.

Figure 5 shows a series of proposed wells that could be designed to utilize the storage capacity of discrete aquifer units while being effectively isolated from each other by the natural confining clay layers. This concept can allow the design and use of discrete aquifer zones as individual storage units, as demonstrated by Well Nos. 28, 29, 30, and 31 located at City BS-3. One aquifer zone can be filled without affecting wells that are competently constructed in other aquifer zones. The benefit of this natural condition to the GRRP is that multiple wells can be operated on the same site with a rotating schedule which allows discrete recharge, storage (response retention time), and recovery from separate aquifer zones.

Figure 5 – Discrete Aquifer Zone Delineation

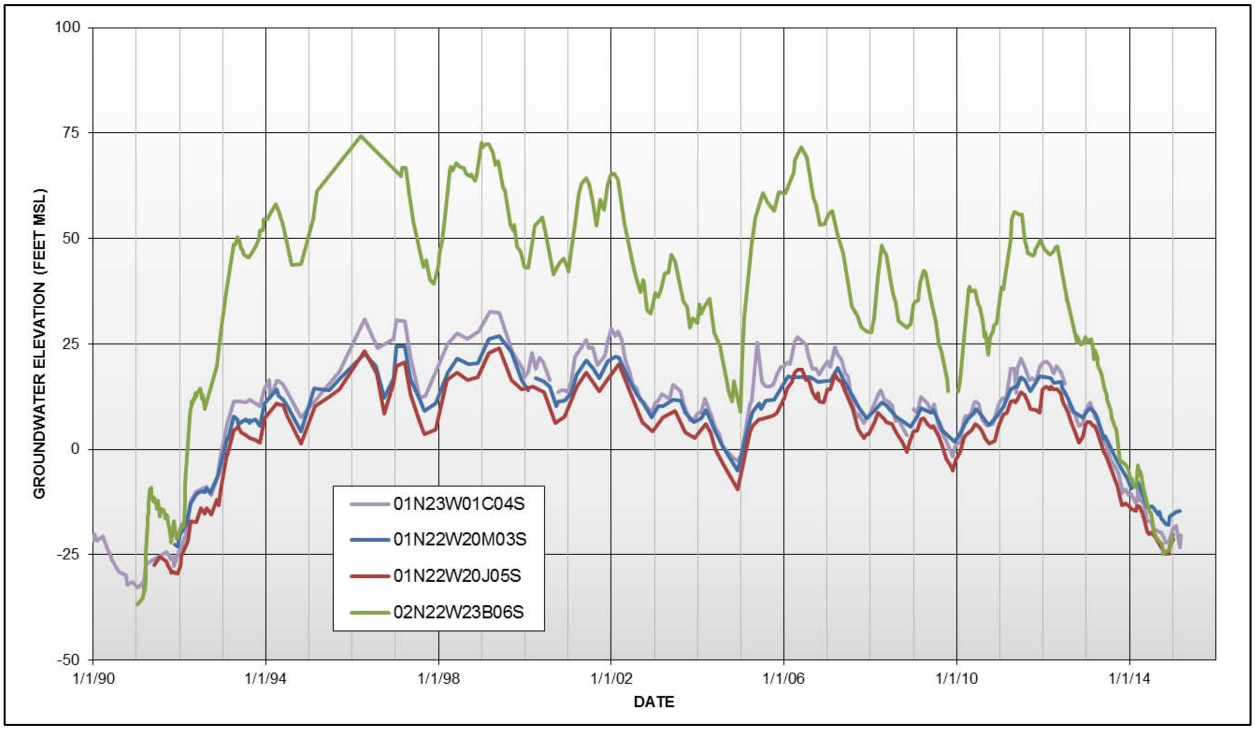


The proposed GRRP utilizes this natural confined aquifer condition to develop an operational scenario that is unique in its application. It can satisfy the GRURW regulations that require a minimum 2-month retention response time, while optimizing the proposed ASR well facilities at a single site. It can operate independent of groundwater flow direction and serve to minimizing the potential risk and consequence of PRW treatment violations (to be explained in following sections).

Groundwater Levels

Groundwater elevations in the Oxnard Plain Basin vary over time. Figure 6 – Groundwater Elevation Hydrograph shows the fluctuation of water levels in the upper Hueneme Aquifer zones in LAS. These data are from discretely screened monitoring wells in aquifer zones that correlate to the aquifer zones proposed for use by ASR Well No. 1. The location of the wells is shown on Figure 4 using the same color for the well symbols as is used for the water levels in the Figure 6 graph. Three of the wells are coastal monitoring wells, and one is located in the Oxnard Forebay where the upper Hueneme Aquifer zones lie unconformably beneath the overlying alluvium of the UAS. The Oxnard Forebay Basin is the primary source of recharge to the LAS.

Figure 6 – Groundwater Elevation Hydrograph



The groundwater elevation in the LAS proximate to the GRRP study area has dropped to approximately 25 feet below mean sea level (msl) during the 1986 to 1990 drought and has risen as high as 20 to 25 feet above msl in wet years. These available data indicate that seasonal fluctuations in the Oxnard Plain Basin groundwater levels are typically around 5 to 10 feet. Dry climatic conditions result in consecutive annual declines in the coastal water levels of up to 45 feet (see Figure 6). These same dry climatic conditions result in water level declines in the Oxnard Forebay Basin on the order of 100 feet. These groundwater level conditions indicate that ASR well operation may require the ability to operate/inject under pressure during high water level conditions while gravity-flow injection operations may be sustained during dry climatic periods.

Combining these water level conditions with the depth to the top of the proposed aquifer units, an injection pressure of 20 pounds per square inch (psi) should be allowable without adverse consequences. The deeper the aquifer zone(s), the greater the operational pressure that is allowable for recharge without creating the potential for adverse effects.

Groundwater Gradient and Flow Velocity

Utilizing data provided by the UWCD, the groundwater elevations in the vicinity of the GRRP were contoured quarterly for 2011 and 2013. These years are believed representative of normal to wet groundwater conditions (2011) and dry year groundwater conditions (2013). Water level data from August 2014 were also contoured and represent groundwater flow conditions after multiple dry years. A series of quarterly groundwater elevation contour maps for the years selected are provided in Appendix A – Groundwater Elevation Contour Maps. Table 1 – Groundwater Gradient and Flow Direction summarizes the results of groundwater gradient estimations using the maps in Appendix A.

For the purpose of the Campus Park GRRP study, the use of the groundwater gradients provided by these data are believed sufficient for understanding the seasonal and climatic changes that occur to the groundwater gradient and the approximate prevailing flow directions in the upper Hueneme Aquifer zones of the LAS.

Table 1 – Groundwater Gradient and Flow Direction

OBSERVATION PERIOD	ASR WELL NO. 1	
	FLOW DIRECTION	GRADIENT
JANUARY 2011	S 43º W	0.0008
APRIL 2011	S 41º W	0.0011
JULY 2011	S 44º W	0.0011
OCTOBER 2011	S 43º W	0.0009
JANUARY 2013	S 44º W	0.0004
APRIL 2013	S 47º W	0.0004
JULY 2013	S 67º W	0.0003
OCTOBER 2013	N 74º W	0.0002
AUGUST 2014	N 04º E	0.0002

TABLE DATA DISPLAYED GRAPHICALLY ON PLATES IN APPENDIX A

As shown, during normal and wet years, recharge in the Oxnard Forebay Basin is significant and establishes a predominant southwesterly groundwater flow direction in the Oxnard Plain Basin (see Appendix A). During the Spring of 2011, the upper Hueneme Aquifer groundwater gradient was generally 0.0011 (dimensionless) and the flow direction was S 41º W as shown on Figure 7 - LAS Groundwater Elevation Contour Map April 2011. The fall gradient in October 2011 was observed to flatten out to a value of 0.0009 (see Table 1).

During dry years like 2013, the groundwater flow direction was observed to be roughly the same as 2011 but the gradient continued to flatten out and the groundwater elevations were closer to sea level. This prevailing flow pattern continues until inland pumping causes water levels to fall below sea level. The lack of recharge during repeated dry years can result in inland groundwater elevations that are substantially below sea level. Figure 8 – LAS Groundwater Elevation Contour Map August 2014 shows the groundwater elevations and flow direction that developed under a 3-year-drought condition.

**Figure 7 – LAS Groundwater Elevation
Contour Map April 2011**

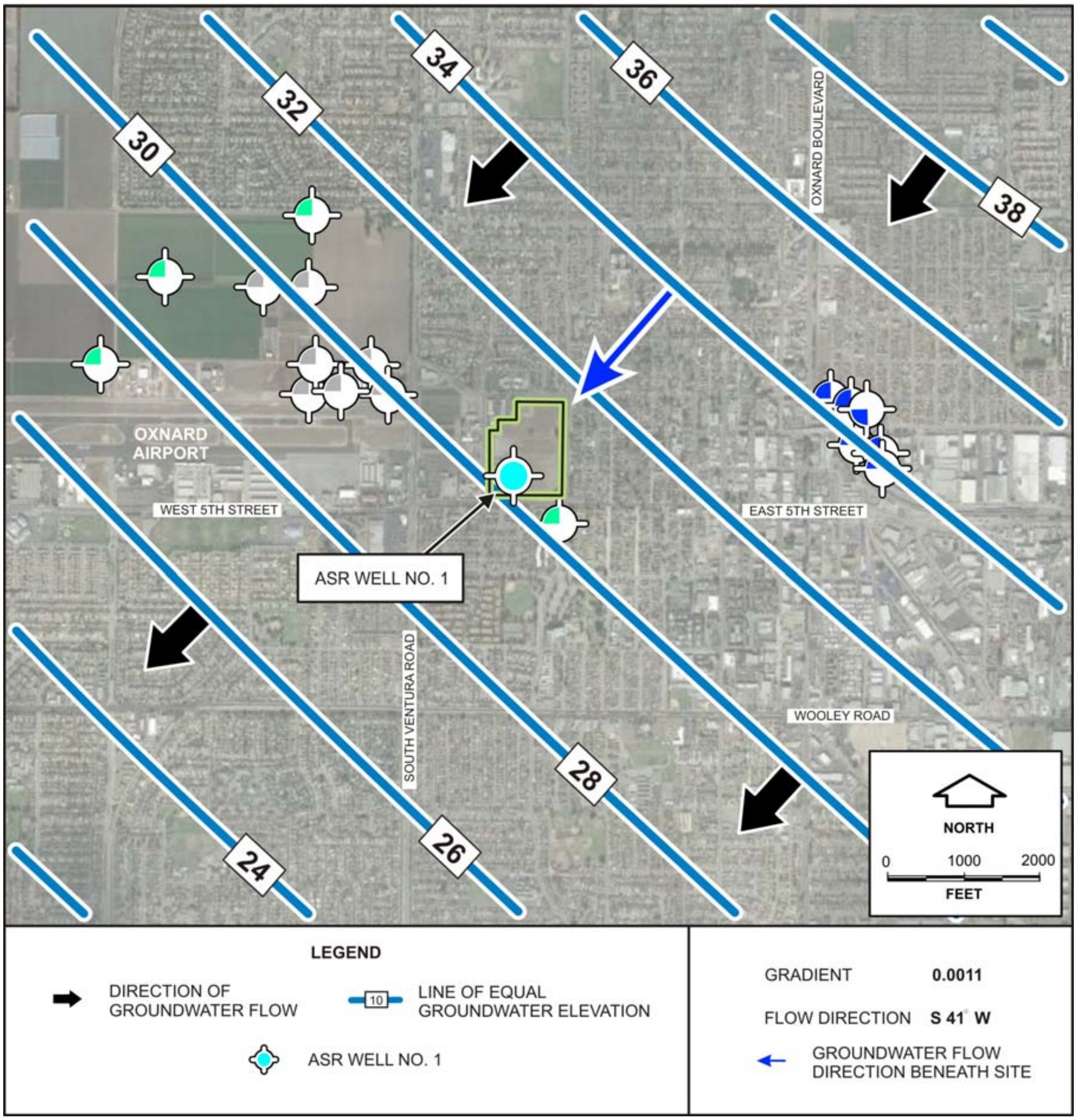
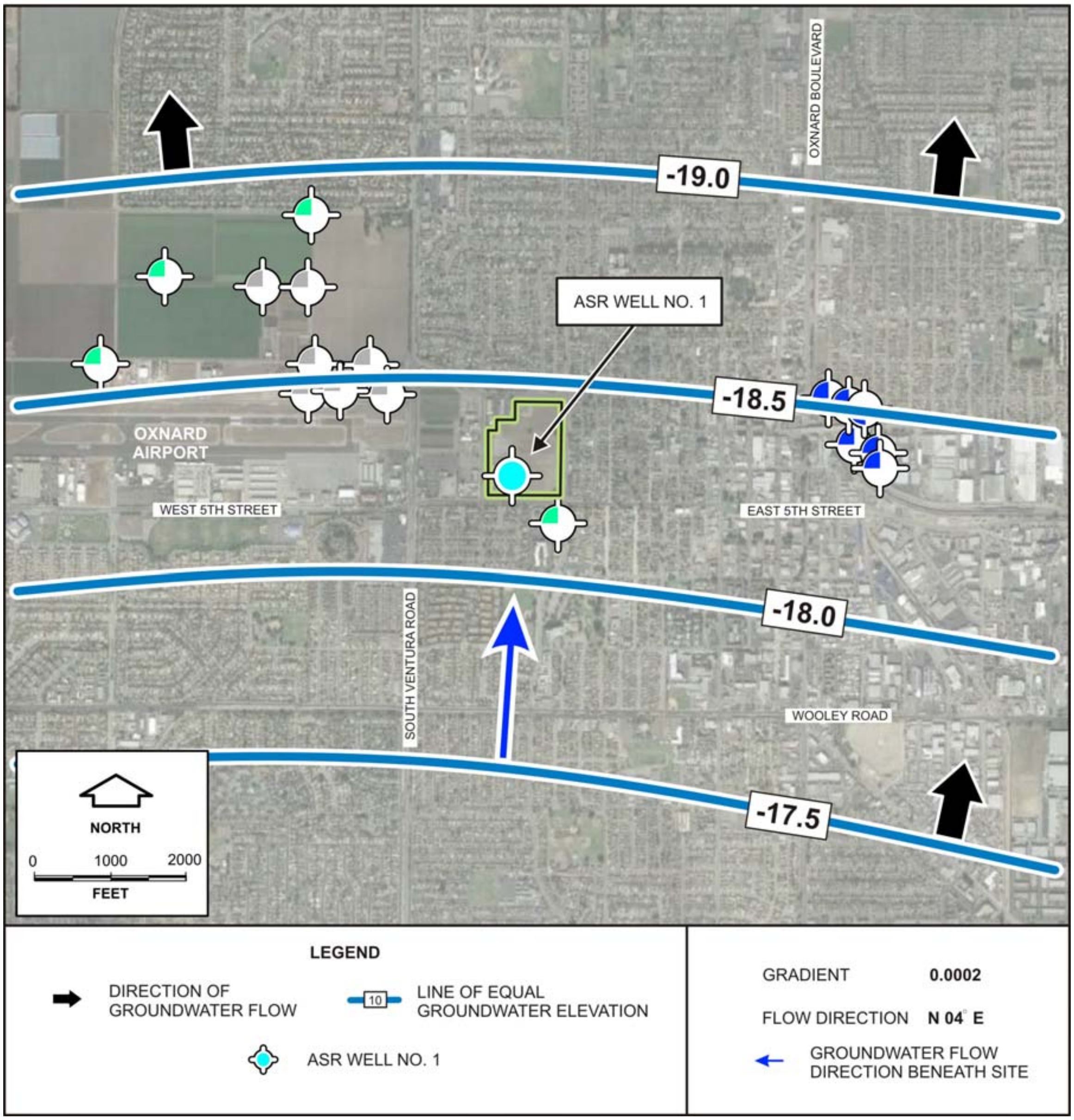


Figure 8 – LAS Groundwater Elevation Contour Map August 2014



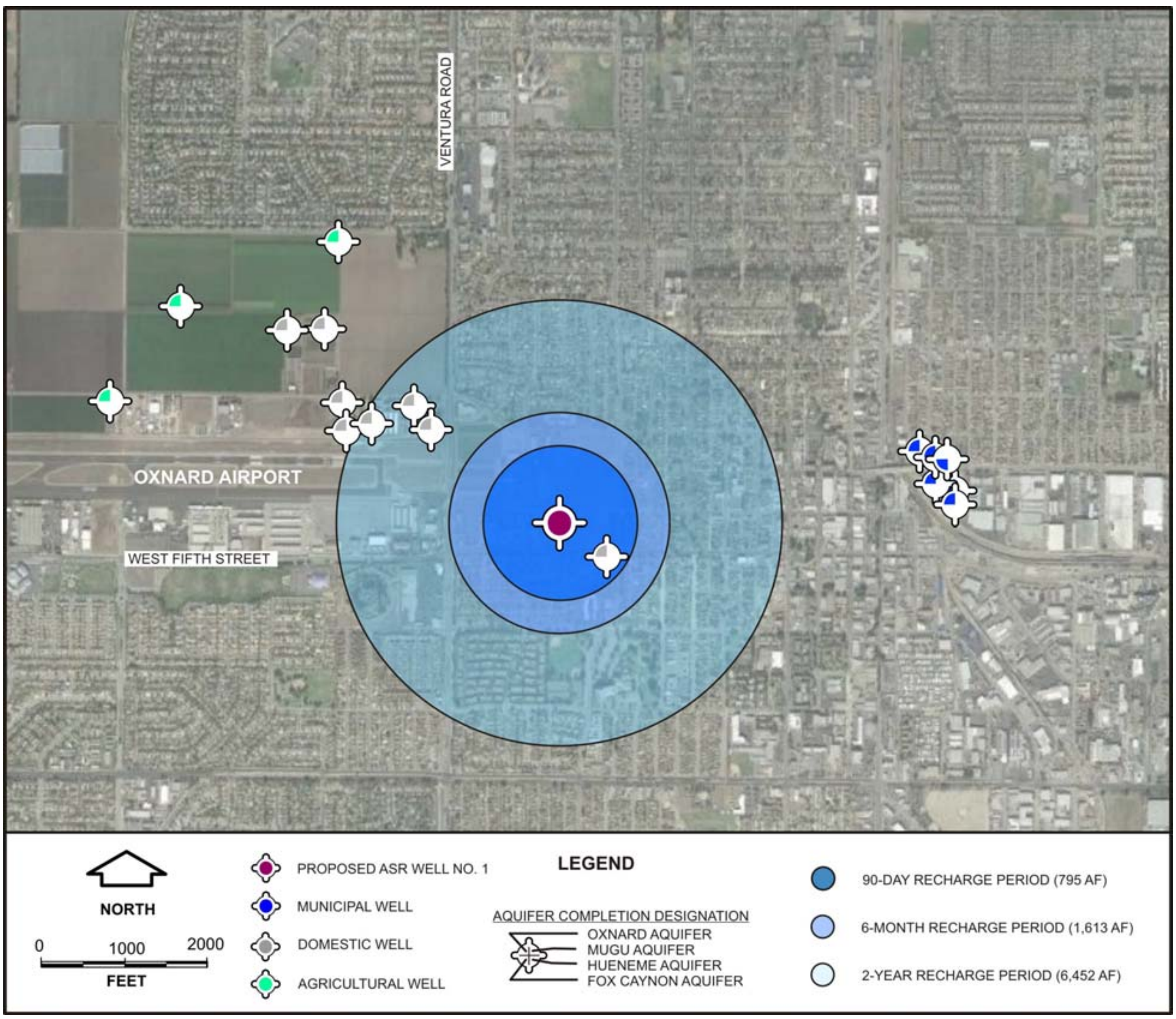
Aquifer Recharge and Retention

The area potentially influenced by recycled water recharge in the vicinity of the ASR well is determined by the aquifer area filled with the PRW during injection and the rate and direction of groundwater flow while it is in storage. The aquifer area filled by PRW replenishment was estimated by using;

- a discrete aquifer thickness of 85 feet,
- radial flow in the aquifer away from the center of recharge, and
- an average aquifer porosity of 15 percent (to be conservative).

The resulting aquifer area filled after injection of PRW at a rate of 2,000 gpm for a period of; 90 days (795 AF), 6 months (1,613 AF) and a period of 2 years (6,452 AF) is shown in Figure 9 – Aquifer Area Filled With Purified Recycled Water.

Figure 9 – Aquifer Area Filled With Purified Recycled Water



The aquifer area filled by these injection volumes would be proportionally less than those shown in Figure 9 as the porosity of the aquifer increases. Table 2 – Radial Distance Calculations shows the magnitude of change in the size of the recharge bubble within a range of typical aquifer porosity values.

Table 2 – Radial Distance Calculations

POROSITY	30-DAY RADIAL DISTANCE (FEET)	60-DAY RADIAL DISTANCE (FEET)	90-DAY RADIAL DISTANCE (FEET)	6-MONTH RADIAL DISTANCE (FEET)	2-YEAR RADIAL DISTANCE (FEET)
15 %	537	759	930	1,324	2,649
20%	465	658	806	1,147	2,294
25%	416	588	720	1,026	2,052
30%	380	537	658	937	1,873

AQUIFER THICKNESS IS 85 FEET AND THE INJECTION RATE IS 2,000 GPM

While the proposed City ASR operation will recharge the aquifer for a period of up to 3-months, a 6-month and 2-year-period of recharge were provided for comparison of potential project impacts. The estimated aquifer area filled with PRW in Figure 9 is believed conservative because a larger porosity value is highly likely. As shown, the nearest drinking water supply well (municipal well) constructed in the LAS is the City's and is beyond the 2-year aquifer replenishment area.

To approximate the area potentially influenced by PRW as it flows away from the point of recharge under the local groundwater gradient, the linear groundwater flow velocity was estimated by using;

- an average hydraulic conductivity value estimated from City Well No. 13 production test data (125 feet/day),
- the groundwater gradient at representative points in time (see Table 1),
- an average aquifer porosity of 15 percent (to be conservative), and
- the average linear flow velocity equation:

$$V = K\, I/\eta$$

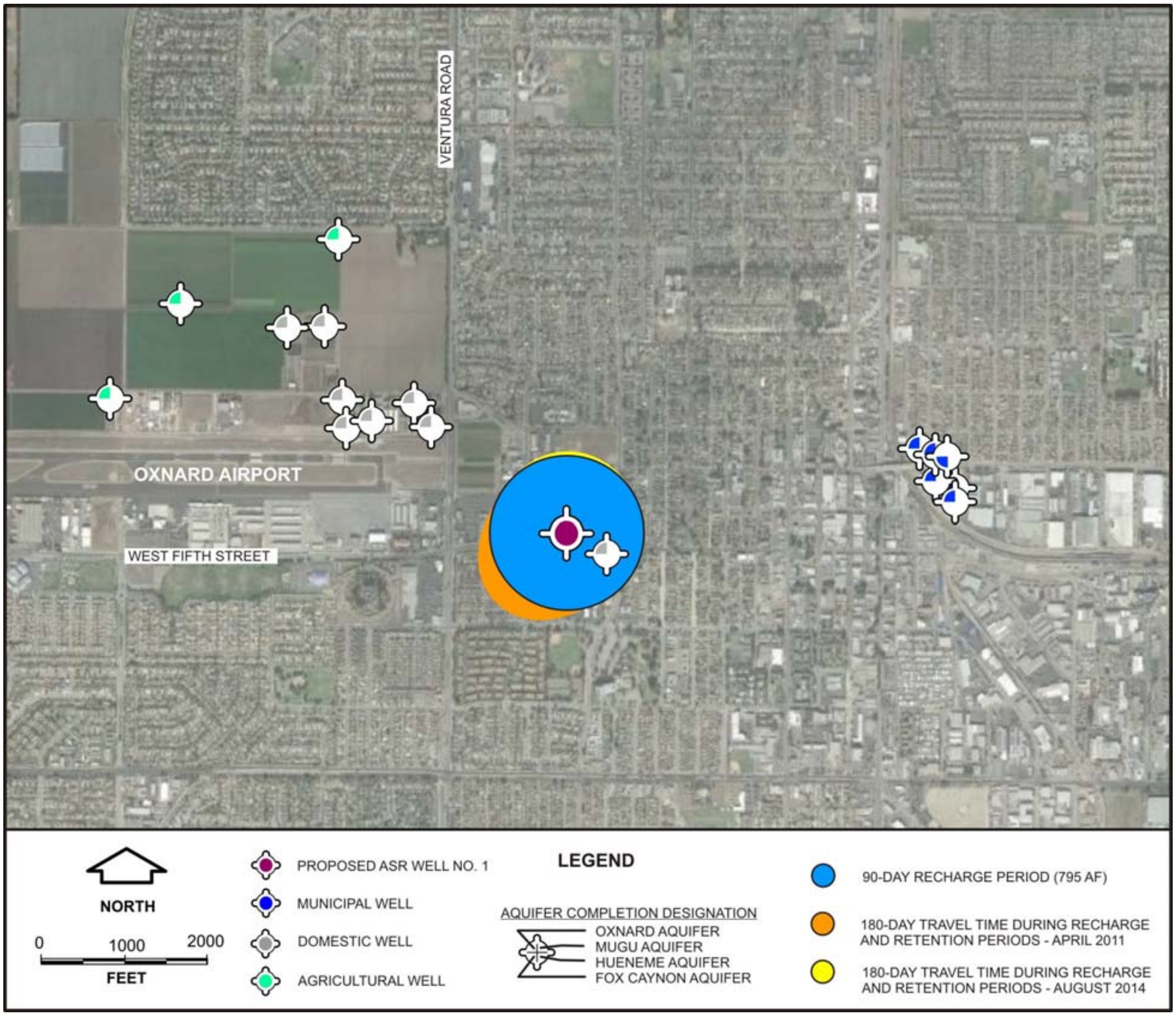
V	=	GROUNDWATER FLOW VELOCITY
K	=	AQUIFER HYDRAULIC CONDUCTIVITY
I	=	GROUNDWATER GRADIENT
η	=	AQUIFER POROSITY

The hydraulic conductivity of the upper Hueneme Aquifer zones was estimated from well production test data provided from City Well No. 13 combined with our experience and knowledge of wells in the Oxnard Plain Basin. The hydraulic conductivity of the aquifer zones that are proposed for ASR Well No. 1 was estimated to be 125 feet per day (ft/d). Using this hydraulic conductivity value and the range of groundwater gradients that are shown in Table 1, results in groundwater flow velocity estimates that range between 0.17 ft/d and 0.92 ft/d. Applying these two linear groundwater flow velocities over a 6-month period that includes the 3-month recharge period and the 3-month retention time, results in groundwater movement of a total distance between 30 feet and 165 feet.

The relative movement of the PRW from the ASR well during these 2 extreme conditions (April 2011 and August 2014) is shown in Figure 10 – Range of Purified Recycled Water Movement From ASR Well Location. These extremes are believed to bracket the actual anticipated movement of the recharge bubble in these aquifer zones. Because the quarterly groundwater measurements indicate a gradient of less than approximately 0.0011 exists a majority of the time (see Table 1), the transient groundwater gradient and flow direction will likely result in a cumulative movement that is between the two extremes indicated in Figure 10.

The result of this analysis indicates that the volume of water proposed for cyclical storage in the upper Hueneme Aquifer zone(s) of the LAS at the Campus Park GRRP well site will not have an adverse effect on any existing wells. Because of the assumptions stated above, these estimates are believed to be conservative and the area filled by PRW would likely be smaller. Based on the proposed cyclical recovery of the PRW for IPR, the distance of movement from the ASR well location could be significantly shorter. These factors indicate that the potential area of impact from the proposed GRRP presents little risk to existing well facilities.

Figure 10 – Range of Purified Recycled Water Movement From ASR Well Location



Water Quality

Review of historical water quality data indicate that groundwater in the LAS is generally a calcium sulfate chemical character of fair to poor quality with total dissolved solids (TDS) concentrations in the range of 900 to 1,300 milligrams per liter (mg/l) and sulfate concentrations that range from 400 to 650 mg/l. These historical data indicate that the storage of the proposed recycled water will improve the general mineral quality of groundwater in the LAS (a beneficial impact) and that injection water chemistry can likely be controlled (buffered) to be compatible with native groundwater and avoid degradation.

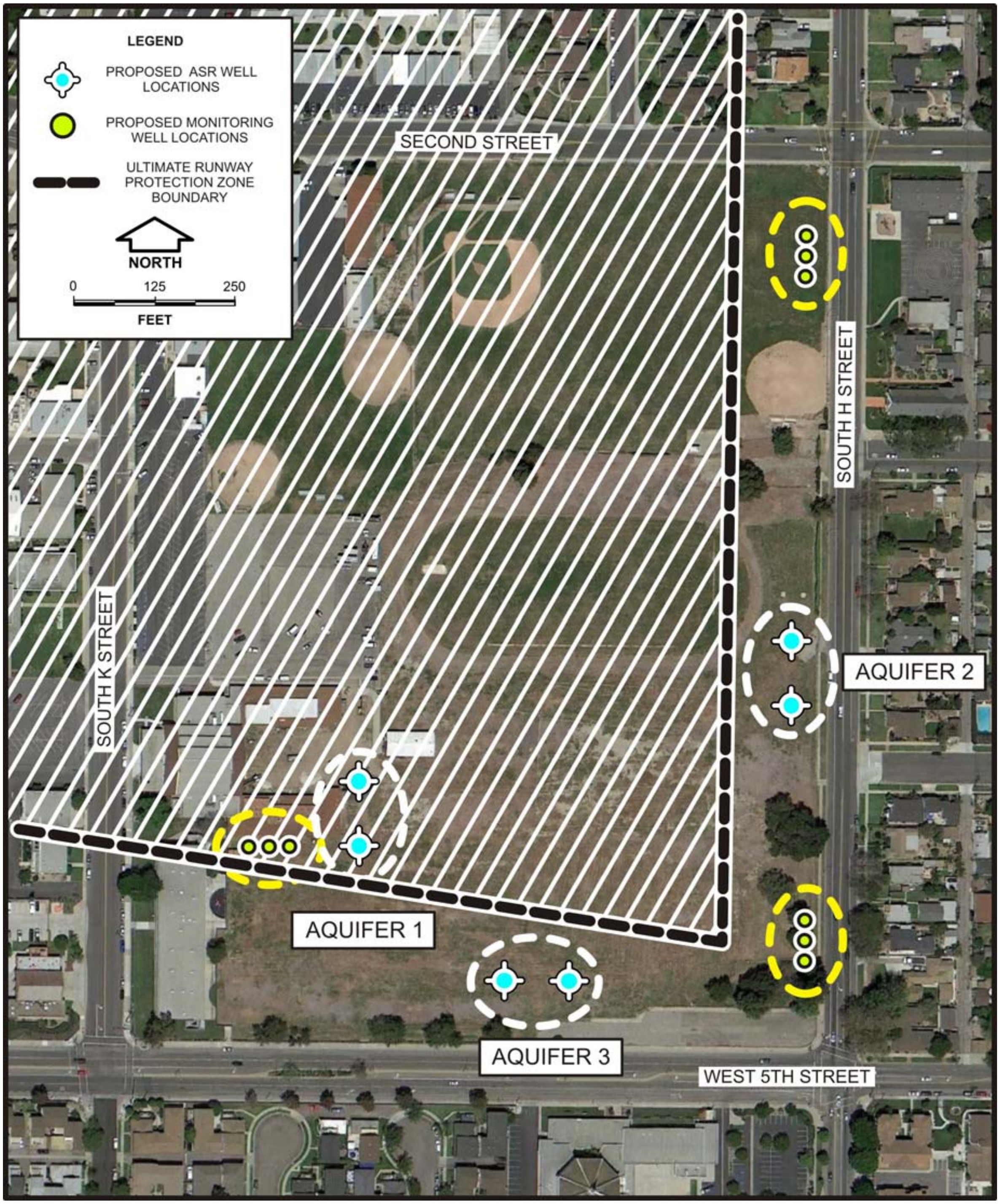
SITE LAYOUT AND FACILITIES DESIGN

To fully develop the Campus Park GRRP location, the City will utilize ASR well facilities that are constructed in discrete aquifer zones. These facilities will be used to conduct the demonstration testing required for final permitting of the IPR GRRP. The site specific groundwater data generated will further define the groundwater gradient, the aquifer materials, the site specific hydrogeology available for GRRP operations, local water quality, and ultimately the aquifer replenishment potential at the ASR well location. Initially, the proposed upper Hueneme Aquifer zone ASR well will be constructed along with 3 monitoring wells to develop information that establishes site specific data. Figure 11 – Proposed Campus Park ASR Wellfield Location Map shows the approximate location of the proposed ASR Wells and Monitoring Wells as they are positioned in the proposed City park development plan.

The proposed well locations were selected to construct facilities that will accomplish wellfield construction and data collection that complies with GRURW regulations and still be within the City property on the Campus Park site. As shown on Figure 11, the well locations are designed to be outside the ultimate runway protection zone boundary proposed by the County of Ventura Department of Airports for Federal Aviation Administration approval. This wellfield layout is designed to accommodate present and future conditions that may restrict the use of the Campus Park Property where drilling equipment of up to 60 feet high may be allowed to operate.

As shown, it is ultimately anticipated that a minimum of two wells will be required in each discrete aquifer zone(s) to achieve the full recharge and extraction capacities desired by the City. ASR Well No. 1 is located in the group labeled Aquifer 1 (see Figure 11). Aquifer 2 is the designated site for the wells that will utilize an aquifer(s) immediately below the Aquifer 1 wells. Accordingly, Aquifer 3 will utilize a deeper aquifer(s) to provide the final ASR capacity required for the recharge, retention, and recovery cycle to support continuous utilization of PRW produced from the AWPF. The initial demonstration ASR well location (see Figure 2) is within the Aquifer 1 area and the 3 monitoring wells are located within each of the monitoring well locations at variable distances from the ASR well.

Figure 11 – Proposed Campus Park ASR Wellfield Location Map



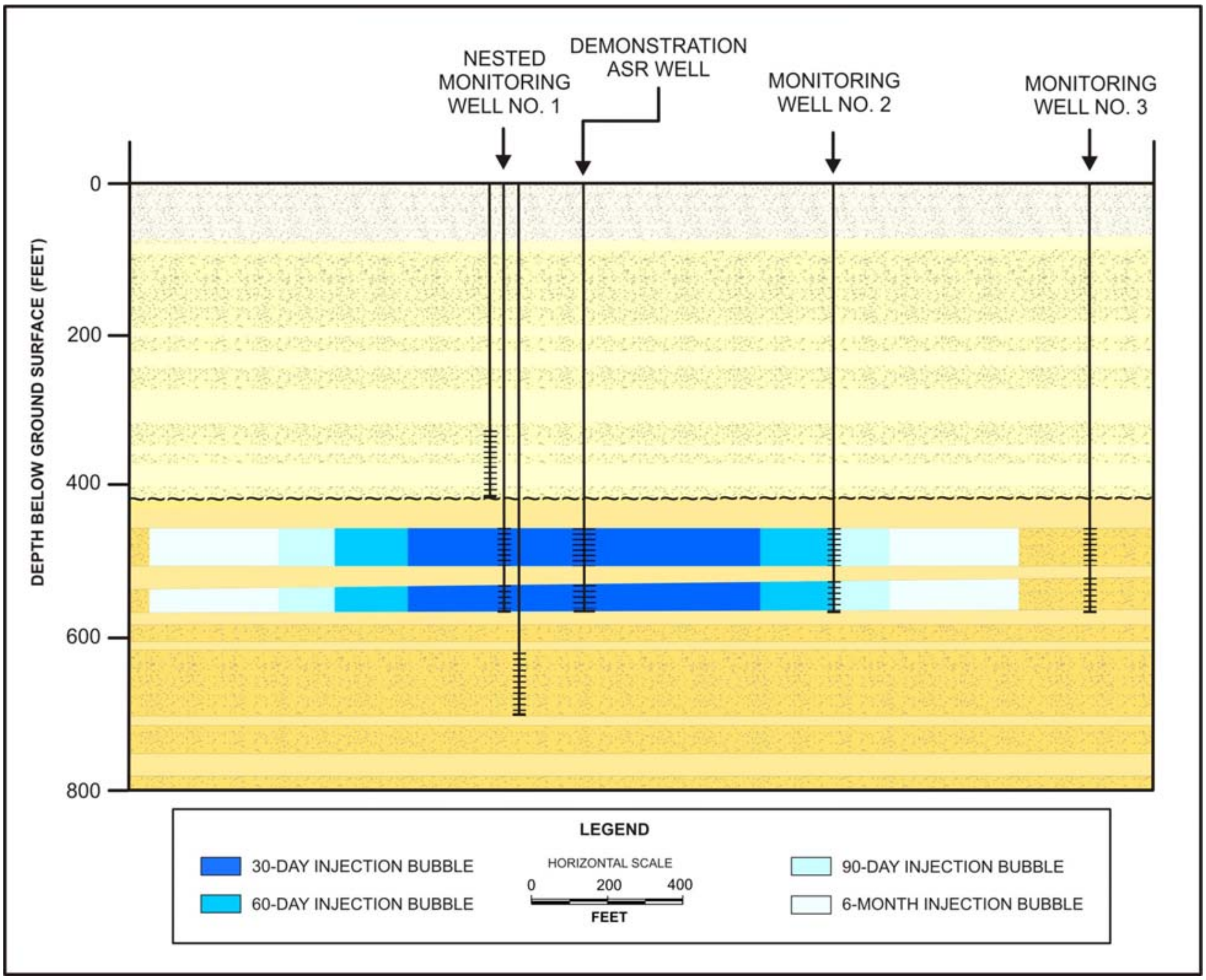
Well construction will be conducted by drilling and logging a pilot hole to select the aquifer(s) to be utilized by the ASR well(s). Based on these data, the final design of the demonstration ASR well and monitoring wells will be provided in the uppermost aquifer unit. The monitoring well locations selected are designed to test the aquifer properties and confirm groundwater travel time estimates at the Campus Park site in compliance with the GRURW regulations. Upon completion of well construction, groundwater tracer testing using an intrinsic tracer will be conducted to satisfy regulation provisions and obtain a CRWQCB permit for operation of the GRRP. Additional analyses to be conducted during the site investigation will include evaluating the geochemical compatibility of the PRW with the native groundwater and with the lithology of aquifer materials through direct sample analysis of the PRW during the recovery phase of the initial recharge cycle.

The locations of the monitoring wells are designed to; a) be far enough apart to collect water levels that will define the site specific groundwater gradient, b) be close enough to comply with GRURW regulation monitoring well requirements for GRRP permitting including a travel time of greater than 2 weeks and less than 6 months, and c) utilize the City owned parcel and minimize impacts to airport operations and future park development to be planned. The location of the demonstration ASR well is presently on the periphery of the future park property and positioned to allow the additional ASR wells to be constructed on the site.

Figure 12 – Subsurface Profile of PRW Travel Time Estimates shows the radial distances estimated that will be filled with PRW during replenishment in the discrete aquifer zones identified for storage using Campus Park ASR Well No. 1. These estimations were calculated using an aquifer porosity of 20 percent (which is believed a reasonable value for this purpose) and a test injection rate of 2,000 gpm. Variations in aquifer porosities will either decrease or increase the estimated travel time proportionally as shown in Table 2. As shown, the displacement volume from ASR Well No. 1 replenishment is anticipated to fill the aquifer at radial distances that will reach Monitoring Well No. 1 within approximately 2 weeks and Monitoring Well No. 2 in approximately 60 days. The estimated displacement volume from the proposed injection rate is not anticipated to reach Monitoring Well No. 3 for over 6 months and would likely be on the order of 9 months.

Based on the regional groundwater gradient, the travel time of PRW will be primarily dominated by the rate of injection and the displacement of native groundwater in the aquifer and not by the background flow of groundwater through Aquifer No. 1. Because the GRRP Wellfield is located within an area of the City where it has control over water well permitting, a prohibition of private wells constructed in the LAS can be implemented and prevent potential impacts to private well owners during the lifetime of the project. This condition effectively establishes the required isolation zone for future well construction.

Figure 12 – Subsurface Profile of PRW Travel Time Estimates

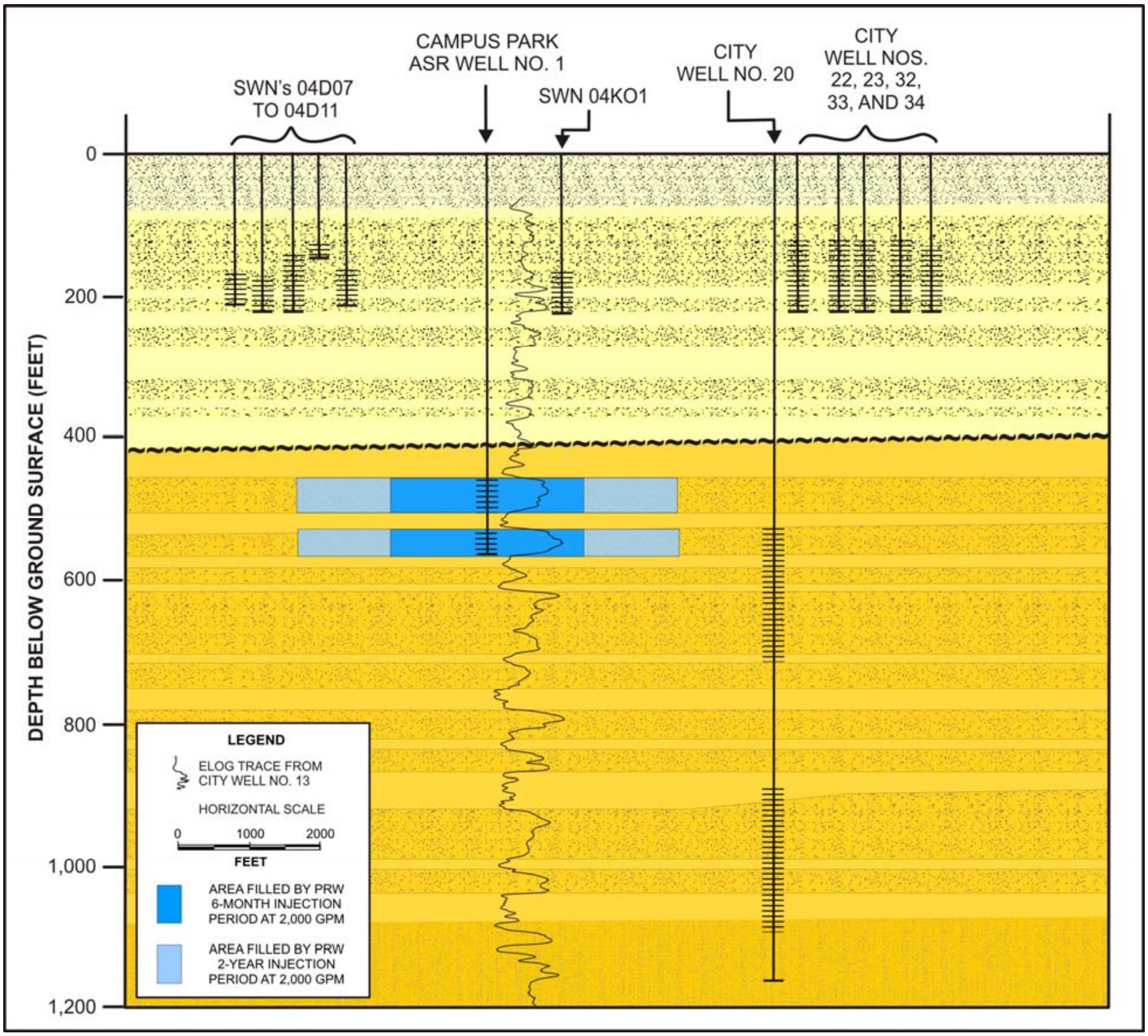


GRRP OPERATION AND VIOLATION MITIGATION

GRRP OPERATIONS

The conceptual design of the GRRP includes the cyclical recharge and storage of PRW in the discrete aquifer zones utilized by each ASR well. While it is anticipated that the majority of the recycled water produced by the AWPF during the first phase of production will be sold for in-City uses or for agricultural purposes, winter season demand will likely require injection and storage of the PRW to prevent plant shutdown or discharge to the ocean. The proposed use of the well is cyclical in nature, however, the actual amount that will be required for storage under full plant capacity is unknown and operational flexibility is always desirable. This study evaluated the merit of a 6-month and 2-year recharge/storage cycle (see Figure 9). The results indicated that these volumes can be accommodated if required, without adverse impacts to proximal well facilities. Figure 13 – Profile of Existing Wells shows the closest wells to the Campus Park site along with their approximate distance and completed depth. As indicated, City Well No. 20 is the only well within a mile of the site that is constructed in the LAS.

Figure 13 – Profile of Existing Wells



The injection volumes shown on the scaled drawing represent the radii of a 6-month and 2-year recharge period. This clearly indicates the low risk of the 3-month ASR cycle proposed. In addition, it illustrates the multiple confining layers and aquifer zones between the proposed ASR well constructed in the upper Hueneme Aquifer and the existing shallow 200- to 230-foot-deep wells constructed in the Oxnard Aquifer.

Preliminary analysis of the GRURW regulation requirements for treatment credits was performed by the City to understand the ability of the designed AWPF treatment process to satisfy the minimum 12-log reduction of enteric virus, 10-log reduction of Giardia cyst, and 10-log reduction of Cryptosporidium oocyst. The findings of that review indicated that the treatment process is capable of achieving the credits required for an IPR project for Giardia and Cryptosporidium, but is approximately 3-log reduction short of the requirement for enteric virus. Because of this finding, the aquifer used for storage may also be used for soil aquifer treatment to obtain the additional credit required for virus removal to achieve the IPR requirement (if no other treatment process is added to obtain additional credit). Based on the information in Table 60320.208 in the GRURW regulations, the necessary retention time will be approximately 3 months. The primary assessment of this hydrogeological study was to accommodate planned ASR operations on a 3-month cycle until treatment process improvements are implemented.

For initial GRRP operations, the City proposes to recharge the well for approximately 3 months with PRW. Upon completion of the recharge cycle, the City will allow a 3-month retention time (or less if additional treatment is provided) where the PRW will continue to move through the aquifer under the influence of the regional groundwater gradient (whichever direction that may be) and receive soil aquifer treatment throughout the retention time. Upon completion of the retention time necessary to achieve the required 3-log reduction credit, the stored water will be produced over an approximate 2- to 3-month recovery period. During recovery of the PRW, the well will discharge into the recycled water system and the recovered groundwater will be utilized for irrigation. Upon approval of use for IPR purposes, the groundwater will be recovered and conveyed to BS-1 for blending and use in the City municipal system.

Additional wells can be added to accommodate greater recharge and storage volumes or achieve higher retention time, as desired.

WATER QUALITY VIOLATION MITIGATION

The proposed GRRP is designed to allow rapid response and mitigation in the event of a AWPF treatment failure resulting in a water quality violation. Because the GRRP is designed to recapture the stored PRW at the point of replenishment, the ability for recapture of all of the water has a high level of certainty regardless of changes in the groundwater gradient direction. The steps toward mitigation at the time of violation detection would include the following components:

1. Stop aquifer recharge into the specific well(s) receiving the unsuitable water upon immediate discovery of a violation.

2. Address the treatment plant problem and supplement the recycled system, if necessary, with a potable supply.

3. Immediately begin removal/recapture of the tainted groundwater (if necessary) and discharge to a location other than the municipal water supply system until all the water has been removed from the aquifer system. The recovered water would be discharged either back into the recycled water system and used for irrigation (if suitable) or discharged to the sewer for disposal.

4. Initiate injection into another ASR well after the AWPF treatment problem has been solved and until the tainted groundwater in the previously active well has been remediated.

5. Allow the stored volume of water to remain in the aquifer for a greater response/retention time to receive additional soil aquifer treatment for the required time necessary based on the specific violation prior to subsequent removal and reuse.

Well discharge can be conducted until the affected aquifer zone is completely purged. Discharge from the affected well(s) can be directed to the most beneficial use allowable for its determined quality. City facilities provide multiple locations for discharge of the inadequately treated water, which include the City:

- sanitary sewer
- recycled water system for permitted irrigation reuse
- IPR after additional response retention time or aquifer travel time (soil aquifer treatment) has been achieved to mitigate the violation.

CONCLUSIONS AND RECOMMENDATIONS

In June 2014, the DDW released the final GRURW regulations that reflect its current thinking on the regulation for replenishing groundwater with PRW and the subsequent reuse as a potable supply. Based on the findings of this study, we conclude that available data indicate the proposed GRRP is feasible and that replenishment and recovery of groundwater with an improved quality could be accomplished in this portion of the Oxnard Plain Basin that would be consistent with the current GRURW regulations.

It is anticipated that properly designed and constructed ASR wells located at the proposed Campus Park GRRP site will provide operational well capacities beneficial for the proposed IPR program. Injection into the LAS in the Oxnard Plain Basin will require multiple wells that will likely be capable of sustained injection rates between 1,500 to 2,000 gpm. While the initial proposed demonstration project includes a single ASR well to achieve permitting, and a total of 3 ASR wells to achieve cycling for continual operation, additional wells can be added to facilitate a higher capacity GRRP operation in each of the aquifer storage units.

The City's review of the DDW regulations indicates that IPR operations may require a response retention time that achieves a 3-log removal credit for enteric virus and that the retention time of the PRW in the aquifer will likely be 3 months prior to reuse until additional treatment at the AWPF is provided. We conclude that it is feasible to inject PRW over a 3 to 6-month period into any discrete aquifer zone(s) and expect a high percentage of recovery after a 3-month retention period that allows full compliance with permit conditions. The proposed GRRP has direct control over the response retention time in that the ASR well facility that replenishes the aquifer(s) will remain off until the specified retention time has been achieved. Recovery of the final portion of the PRW will likely produce a component of groundwater with a reduced quality as a result of mixing with the native groundwater. Recovery percentages can be improved with the establishment of a buffer zone around the recharge bubble by originally using a greater quantity of the PRW than planned for recovery.

We conclude that while zone specific water level data from the Campus Park site are not available, the prevailing groundwater conditions indicated by available data in the Oxnard Plain Basin support the ability for effective capture and reuse of the higher quality recharge water from the Campus Park ASR Wellfield. As designed, the project does not rely on horizontal movement through an aquifer in any specific direction to allow capture at some distance away from the point of recharge. The point of capture is anticipated to be near the center of the PRW recharge bubble. We also conclude that in the event of a water quality violation where non-compliant water is injected in the aquifer system, the GRRP design will allow immediate mitigation and, as necessary, recapture of the non-compliant volume of PRW. There are no drinking water wells constructed in the LAS within ¾ of a mile of the proposed GRRP location. The only potable well in the LAS within a mile of the Campus Park is City Well No. 20.

Anticipated travel time to the nearest potable water supply well is greater than 2 years, if the PRW is not recovered for IPR. Because the City is the permitting agency and can control well construction within its limits, the proposed IPR operation has an effectively established isolation zone from future well construction.

We recommend the City drill a pilot borehole to a depth of 580 feet to define the site specific aquifer zone depths for use in final design of the GRRP ASR Well No. 1 in the upper Hueneme Aquifer zones (see Plate 1). We also recommend the City construct 3 monitoring wells at the designated locations which are preliminarily identified on Figures 2 and 11 to allow collection of groundwater data in compliance with the GRURW regulation pursuant to section 60320.200(h)(4). We recommend Monitoring Well No. 1 be constructed as a nested monitoring well to allow monitoring of the aquifer zones above and below the depths of Aquifer Storage Unit No. 1 during the operation of ASR Well No. 1.

PERSONNEL QUALIFICATIONS

The assessment of hydrogeological conditions for the proposed GRRP was conducted by and under the direction of Mr. Curtis J. Hopkins, Principal Hydrogeologist with Hopkins Groundwater Consultants, Inc. Mr. Hopkins is the company's president and is certified as a Professional Geologist (PG 5695), Certified Engineering Geologist (EG 1800) and Certified Hydrogeologist (HG 114) in the State of California. Mr. Hopkins has over 27 years of work experience on groundwater development projects performed throughout the Southern and Central California area and specifically, the Oxnard Plain Basin. Mr. Hopkins has extensive experience with water supply studies to establish municipal wellfields and with design and management of well construction projects.

CLOSURE

This report has been prepared for the exclusive use of the City of Oxnard and its agents for specific application to the City of Oxnard GREAT Program utilization of PRW treated at the AWPF and properly applied at the proposed Campus Park GRRP site for IPR. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeological planning and engineering practices. No other warranty, express or implied is made.

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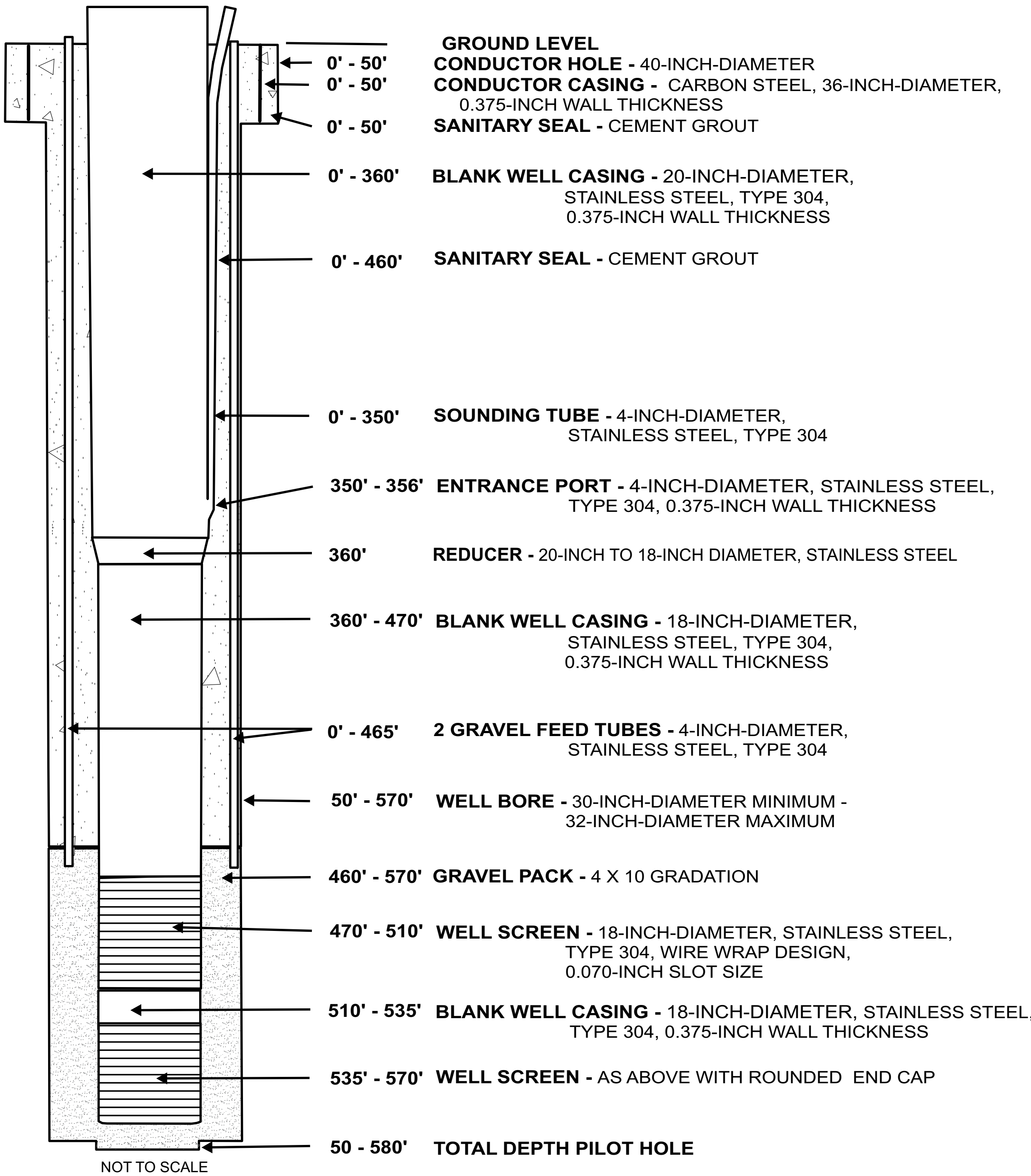
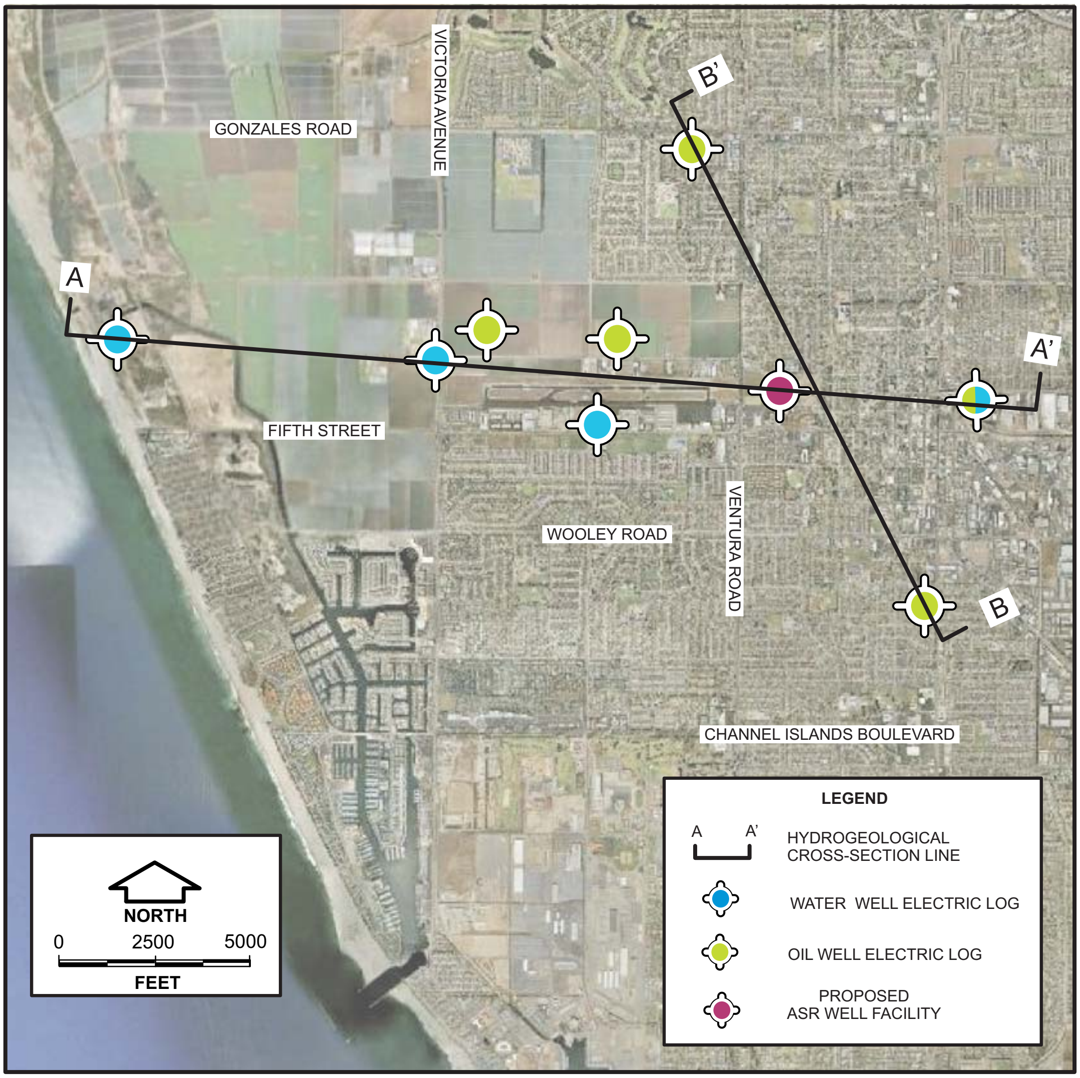
PLATES

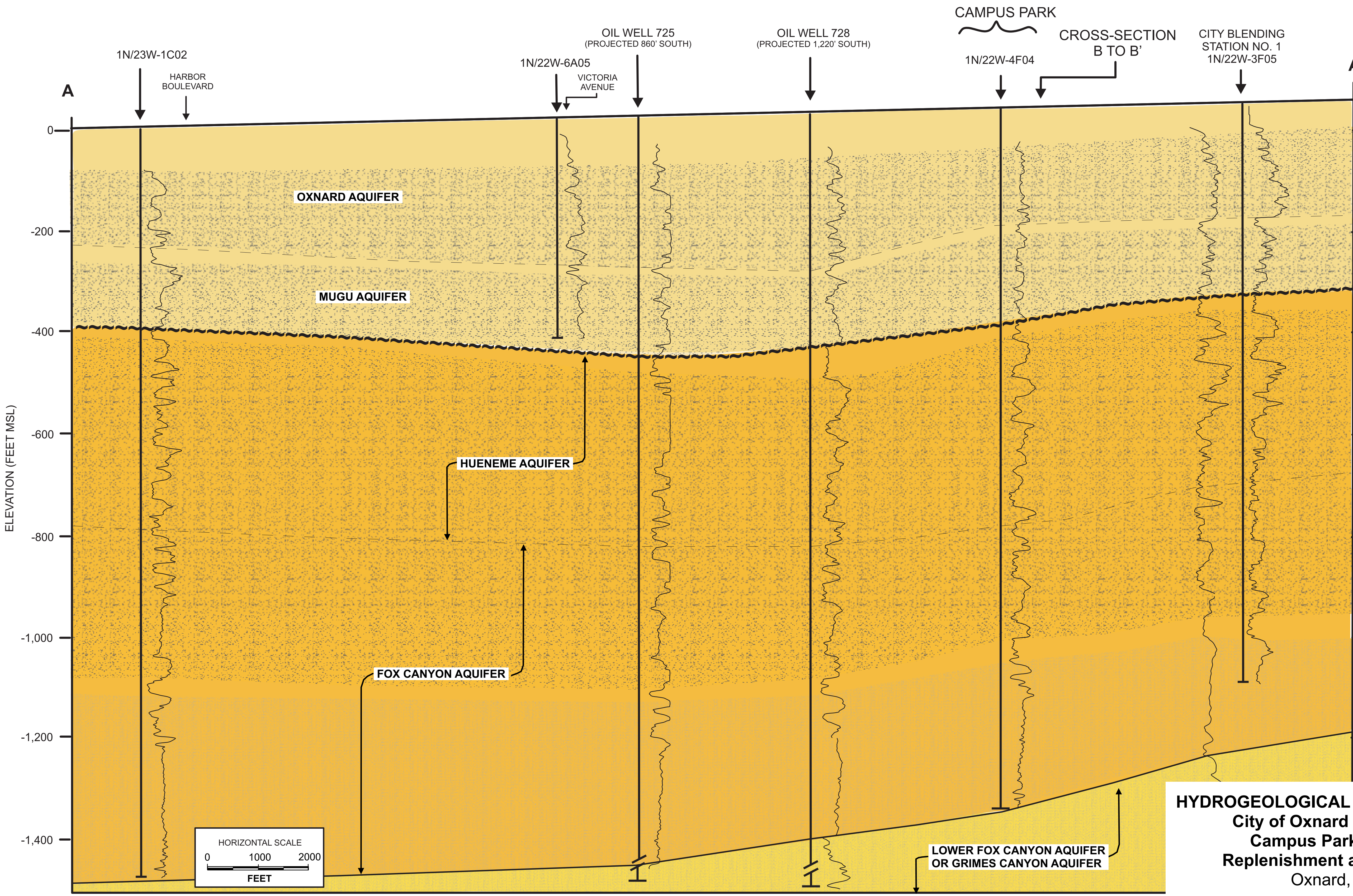


PRELIMINARY ASR WELL NO. 1 DESIGN DRAWING
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California

PLATE 1

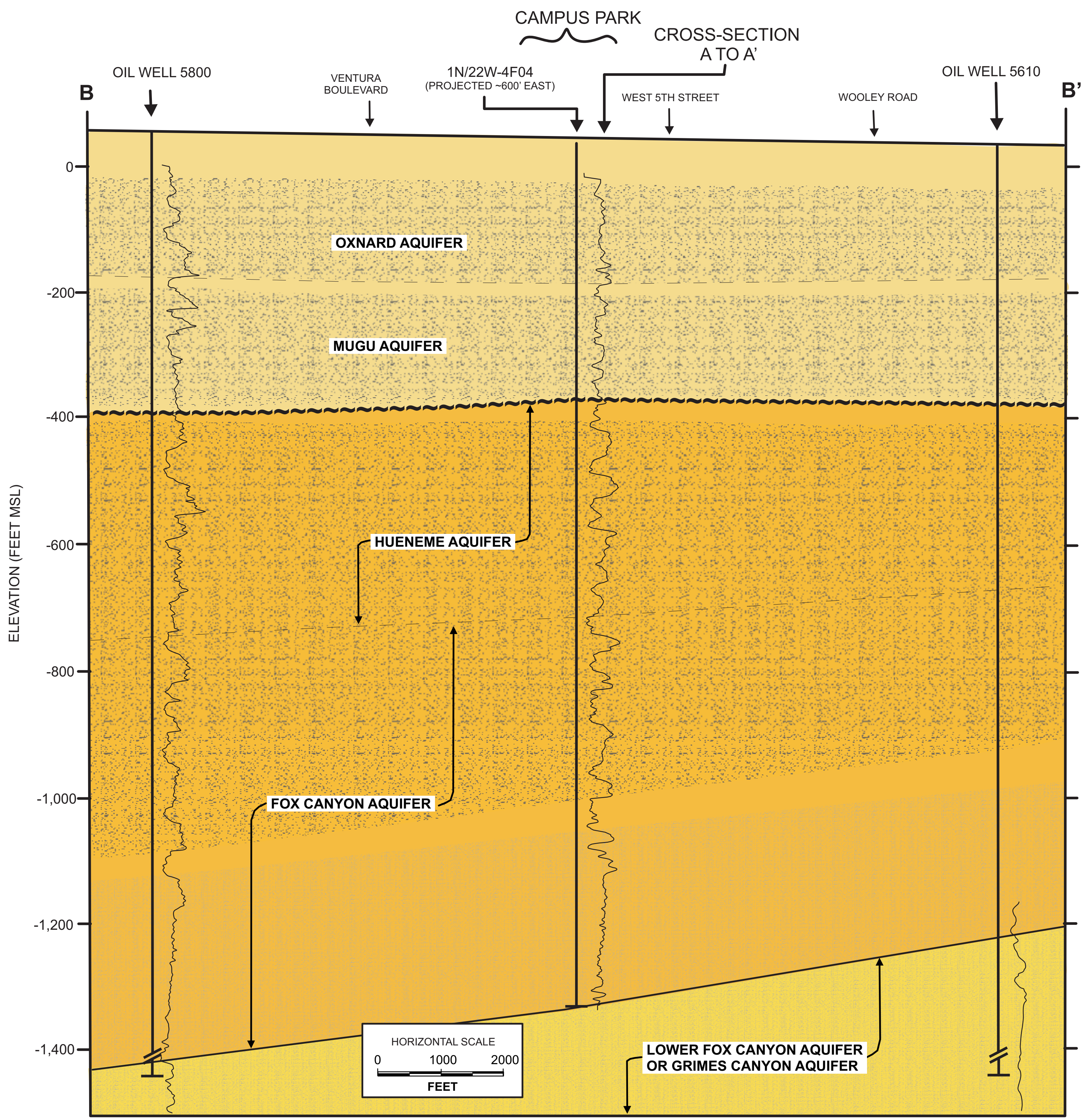


HYDROGEOLOGICAL CROSS-SECTION LOCATION MAP
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California



HYDROGEOLOGICAL CROSS-SECTION A - A'
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California

PLATE 3



LEGEND

QUATERNARY — HOLOCENE / PLEISTOCENE

Qoa — **UN-DIFFERENTIATED OLDER AND YOUNGER ALLUVIUM -** older alluvial gravel, and silt/clay

QTs — **SAUGUS FORMATION -** weakly consolidated alluvial deposits, light gray to light brown gravel composed of pebbles and small cobbles mostly of white to light gray granitic rocks, in coarse sandy matrix; weakly indurated sand, and fossiliferous sand, silt, and clay

Qtlp / Qsb — **LAS POSAS SAND OR SANTA BARBARA FORMATION -** weakly indurated, fine to medium grained sand, in Las Posas Hills contains thin lenses of calcareous fossiliferous pebbly sandstone; unconformity at base

SYMBOLS

Formation contact - dashed where inferred or indefinite

Unconformable formation contact

Electric Log Trace of Resistivity Curve

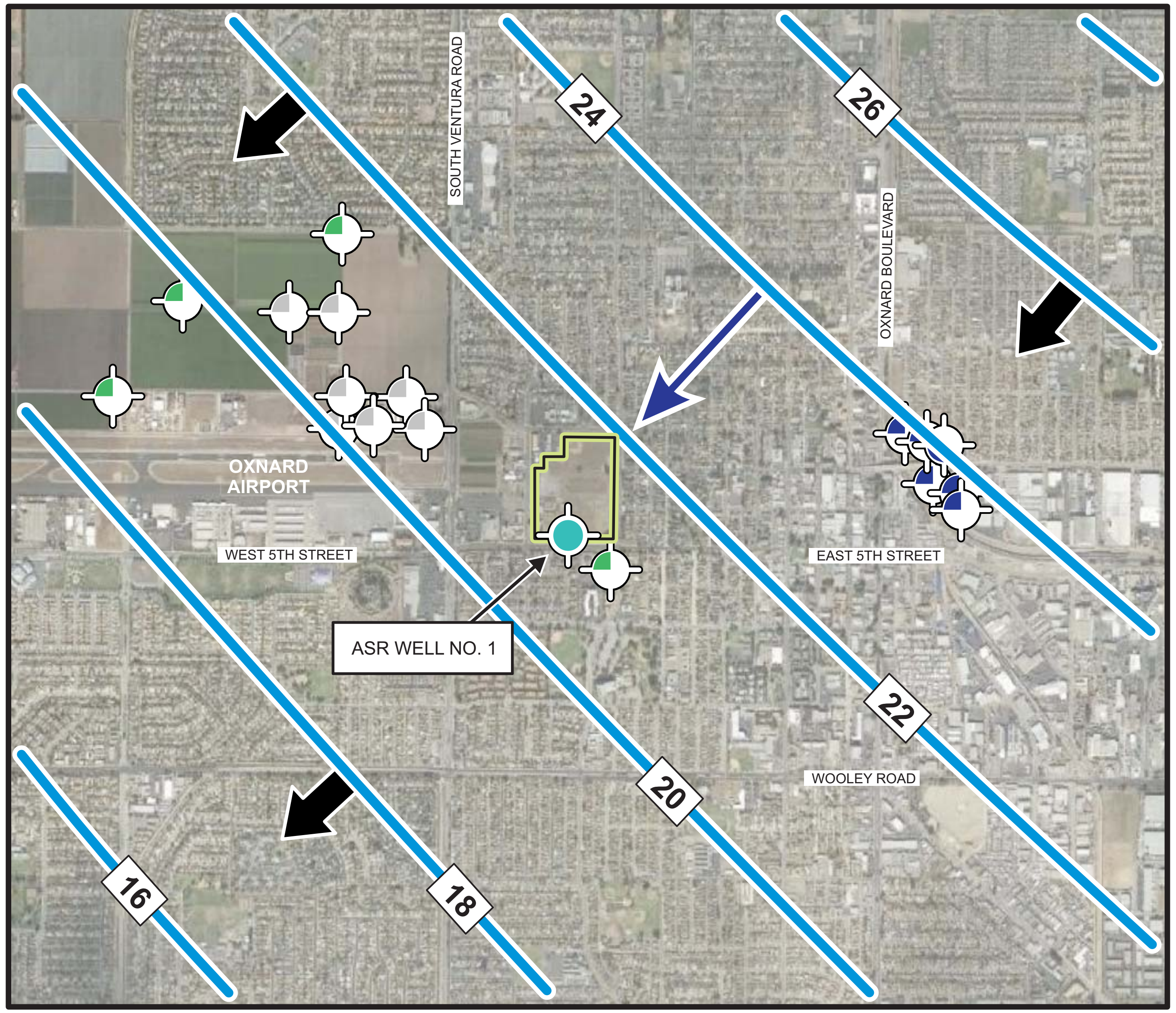
Location of Historical Water or Oil Well

Geology from: THOMAS W. DIBBLEE

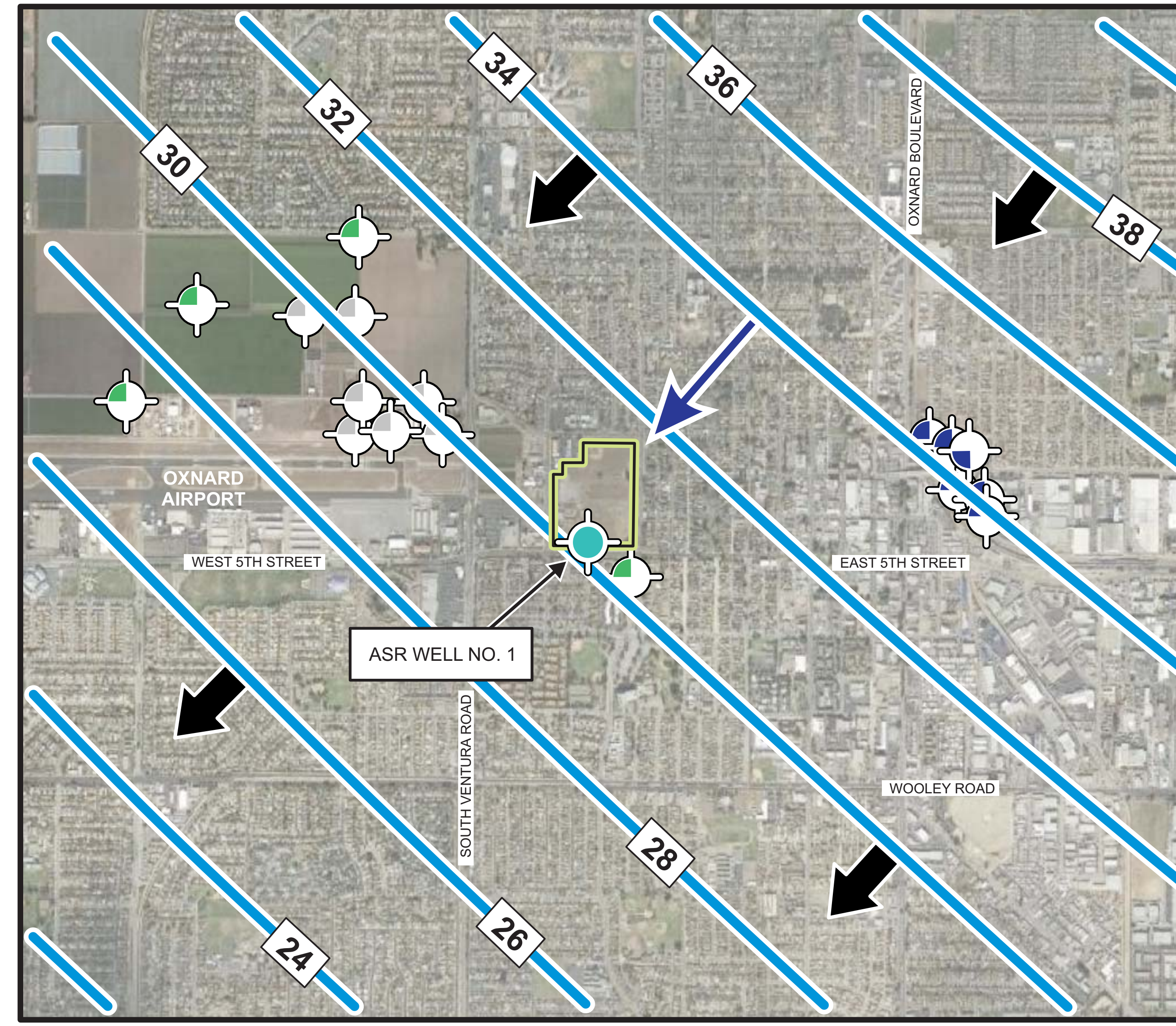
HYDROGEOLOGICAL CROSS-SECTION B - B'
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California

PLATE 4

APPENDIX A
GROUNDWATER ELEVATION
CONTOUR MAPS



JANUARY 2011



APRIL 2011

GROUNDWATER LEGEND

10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0008**

FLOW DIRECTION **S 43° W**

NORTH

0 1000 2000

FEET

WELL LEGEND

MUNICIPAL WELL — DOMESTIC WELL

AGRICULTURAL WELL — SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER — UAS
HUENEME AQUIFER
FOX CAYNON AQUIFER — LAS

GROUNDWATER LEGEND

10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

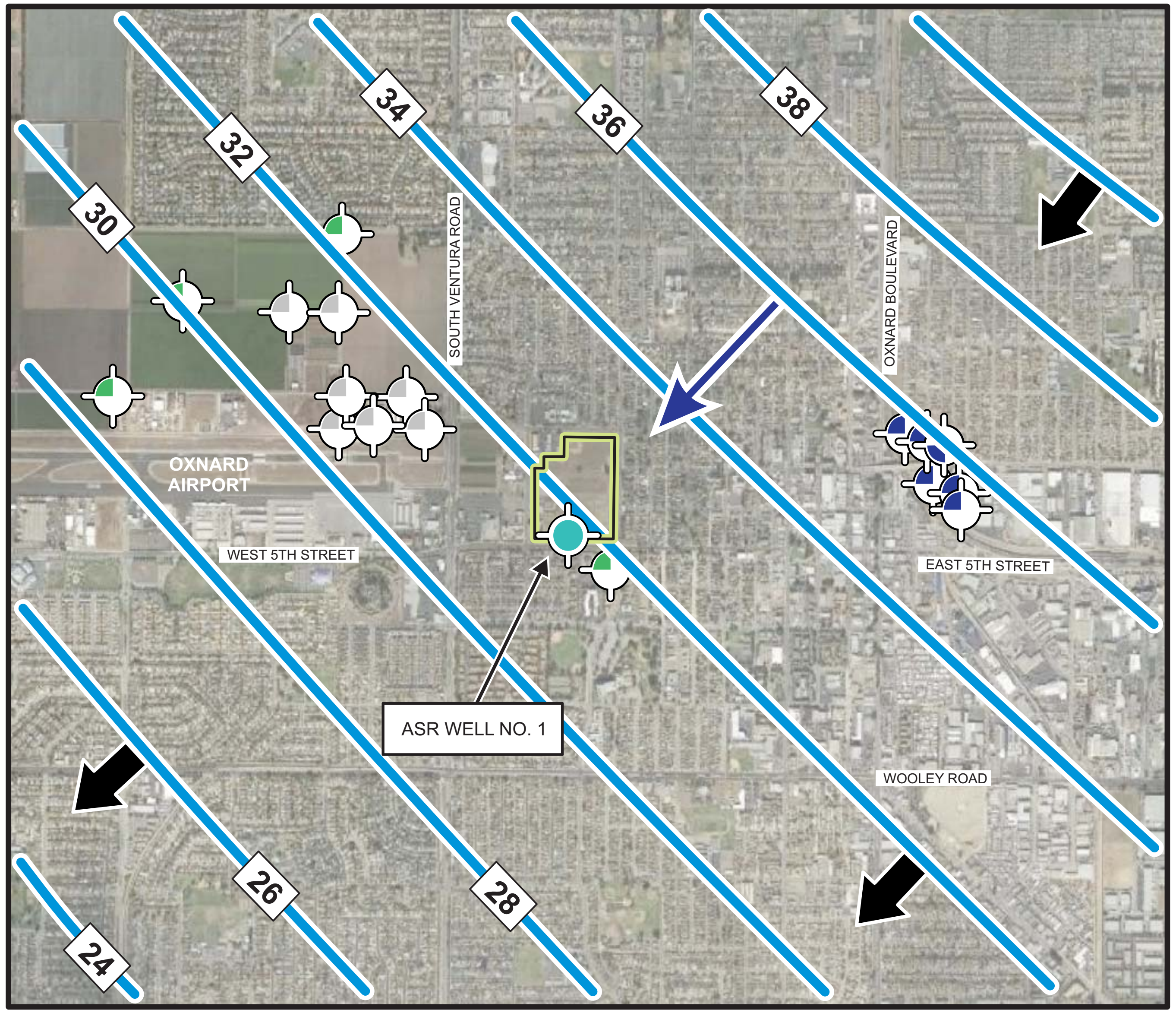
GRADIENT **0.0011**

FLOW DIRECTION **S 41° W**

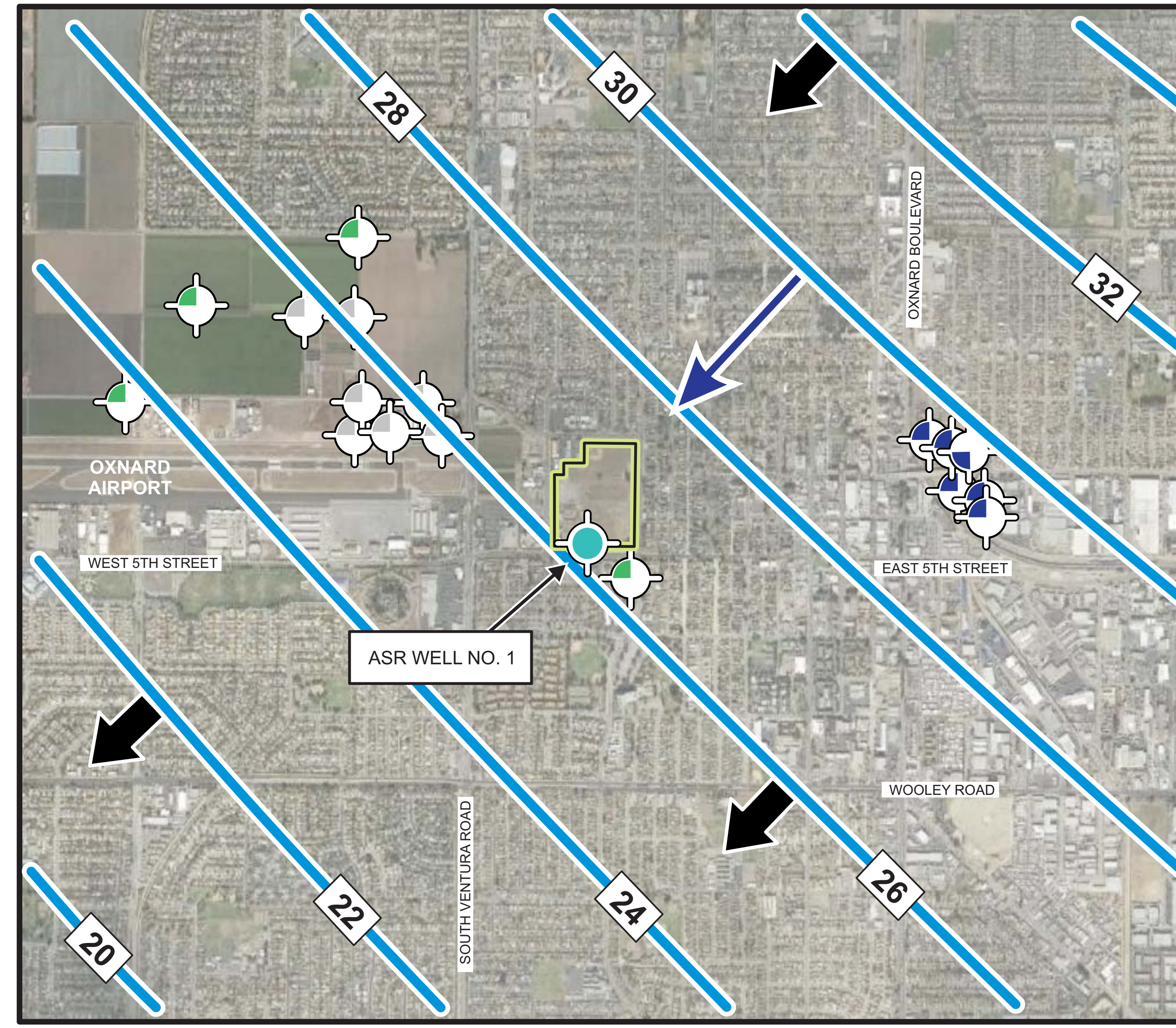
GROUNDWATER ELEVATION
CONTOUR MAPS
JANUARY AND APRIL 2011
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California

PLATE A1

HOPKINS
GROUNDWATER CONSULTANTS



JULY 2011



OCTOBER 2011

GROUNDWATER LEGEND

- 10 LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0011**

FLOW DIRECTION **S 44° W**

NORTH

0 1000 2000

FEET

WELL LEGEND

MUNICIPAL WELL — DOMESTIC WELL

AGRICULTURAL WELL — SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER / MUGU AQUIFER — UAS

HUENEME AQUIFER / FOX CAYNON AQUIFER — LAS

GROUNDWATER LEGEND

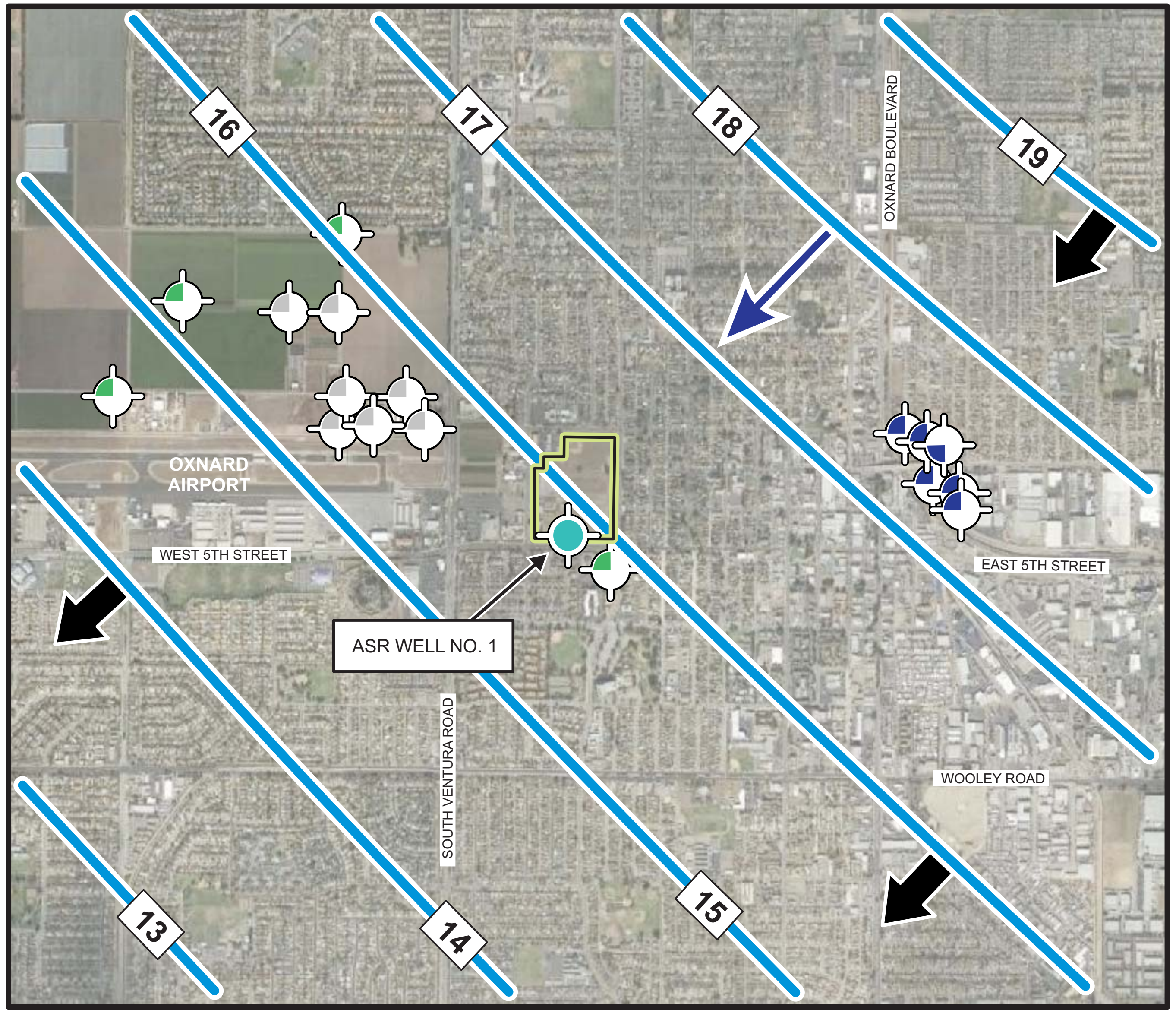
- 10 LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0009**

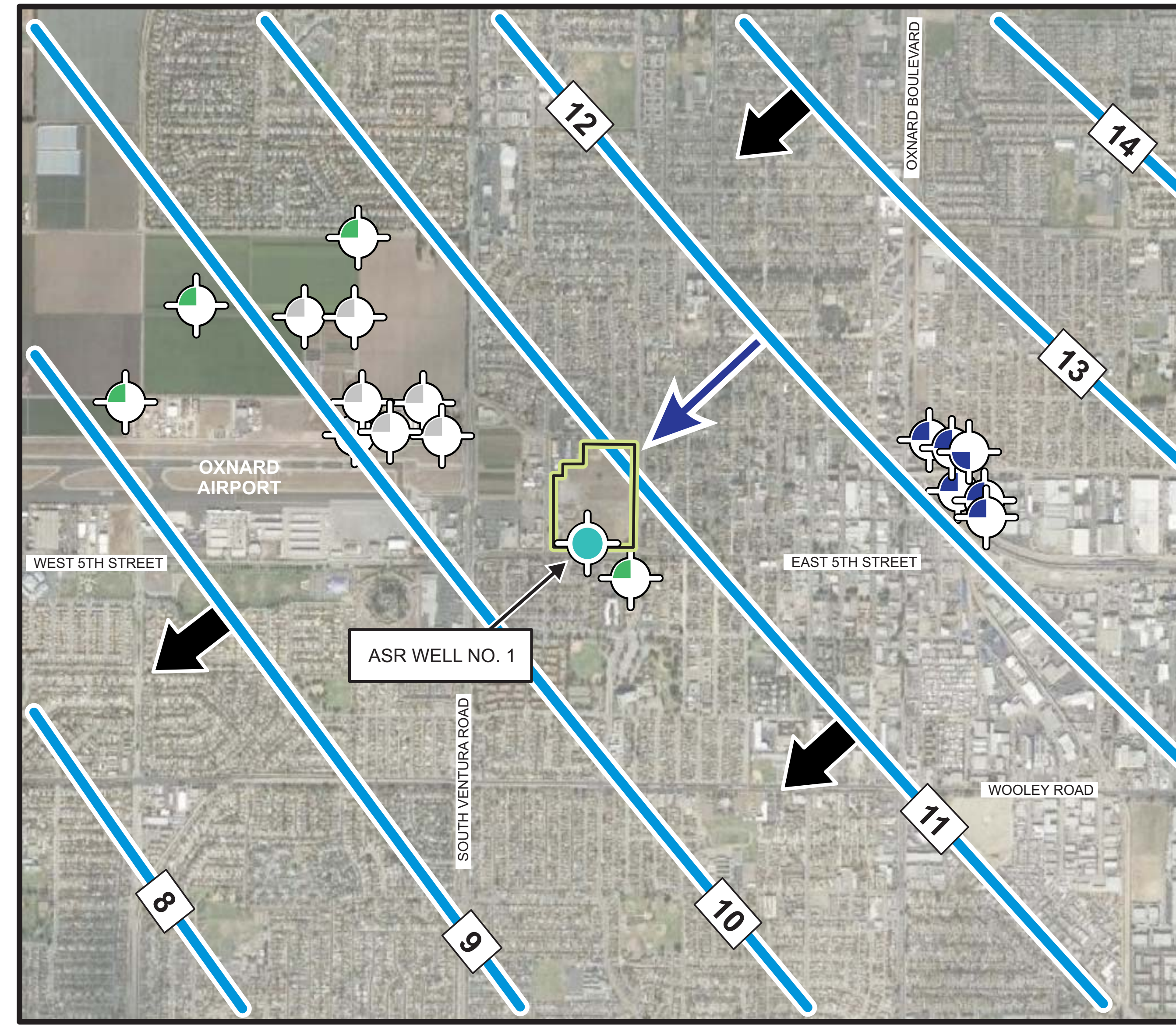
FLOW DIRECTION **S 43° W**

GROUNDWATER ELEVATION CONTOUR MAPS
JULY AND OCTOBER 2011
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California

PLATE A2



JANUARY 2013



APRIL 2013

GROUNDWATER LEGEND

- 10 LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT 0.0004

FLOW DIRECTION S 44° W

NORTH

0 1000 2000

FEET

WELL LEGEND

- MUNICIPAL WELL
- DOMESTIC WELL
- AGRICULTURAL WELL
- SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER
HUENEME AQUIFER
FOX CAYNON AQUIFER

UAS
LAS

GROUNDWATER LEGEND

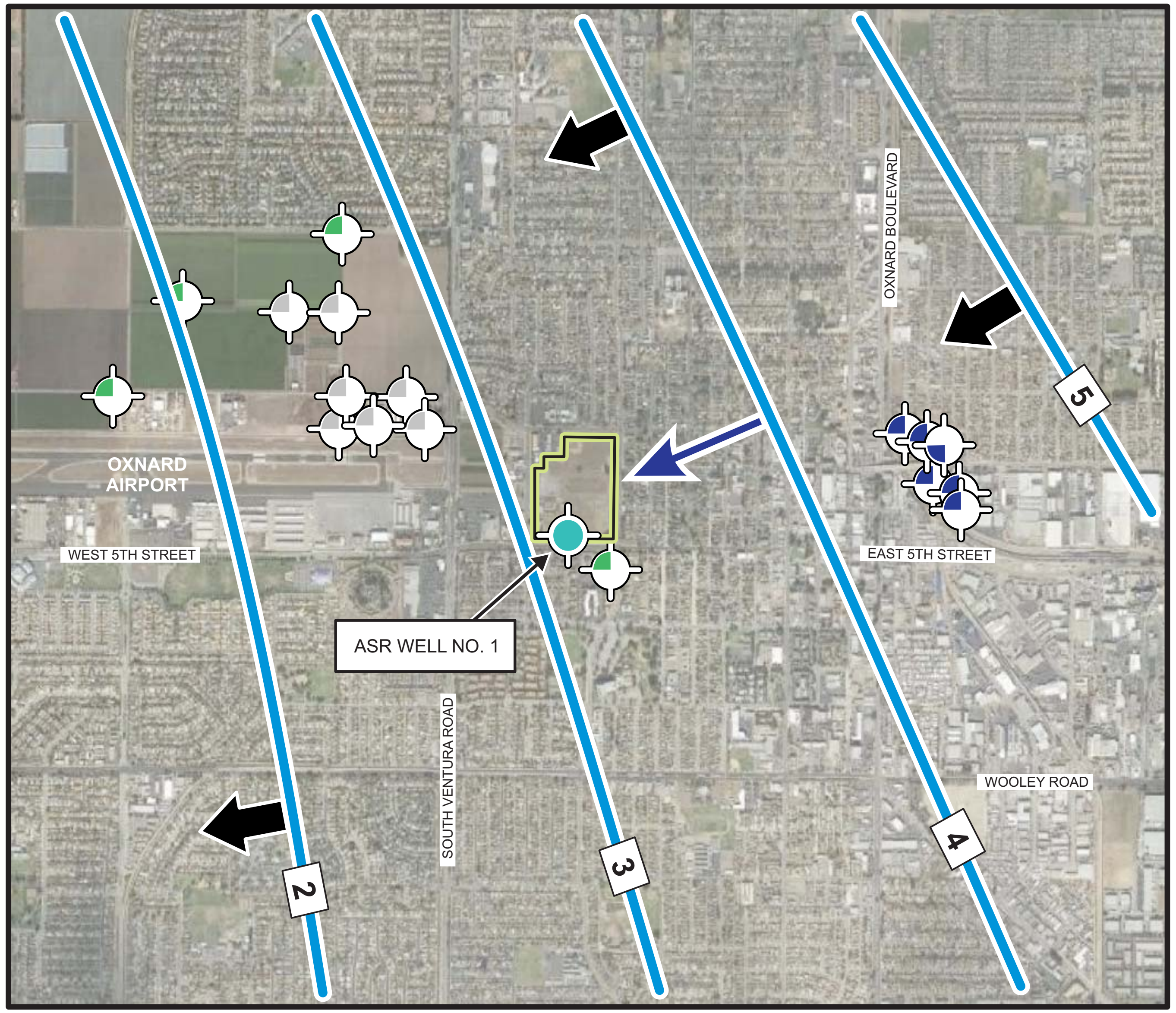
- 10 LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT 0.0004

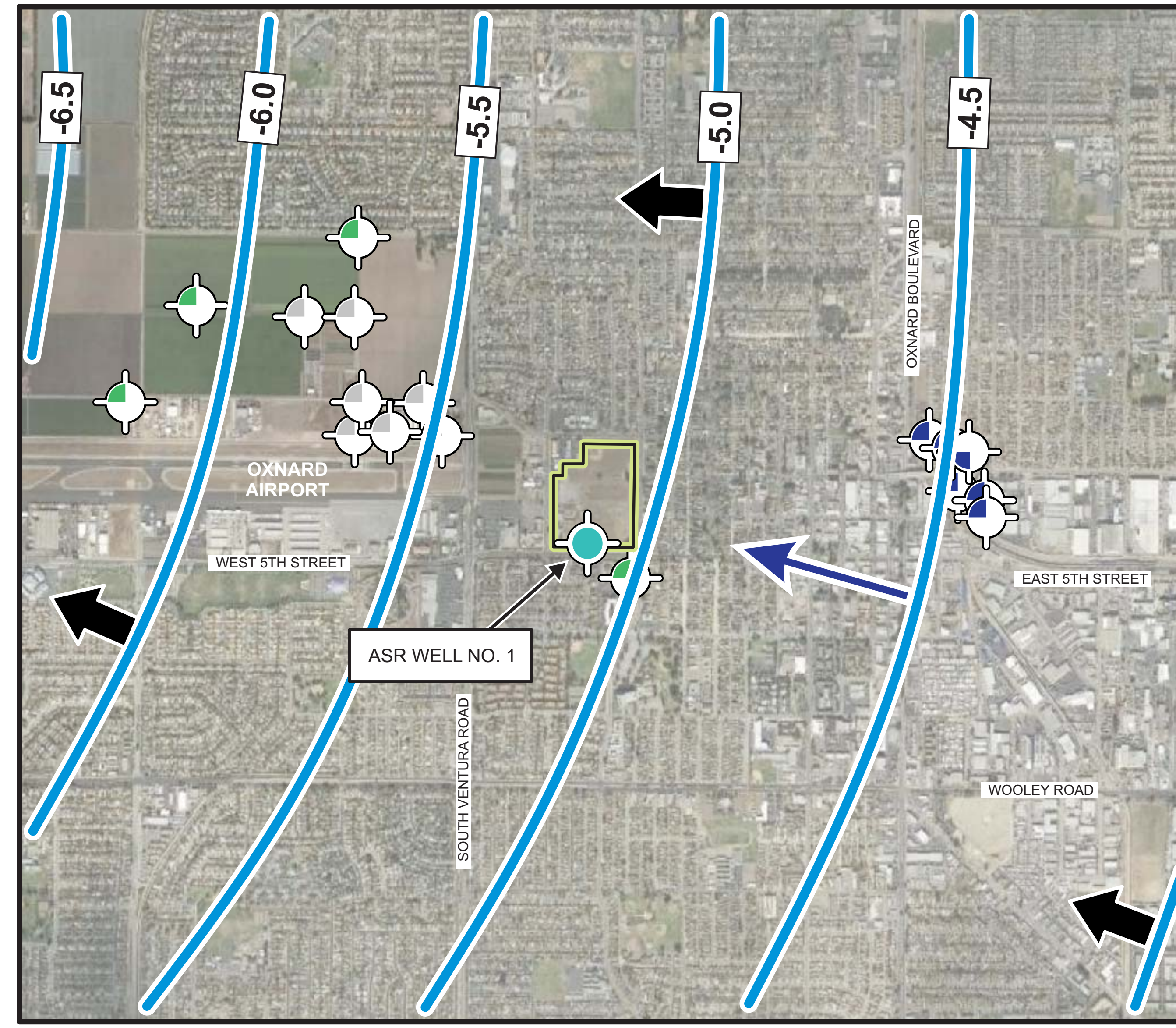
FLOW DIRECTION S 47° W

GROUNDWATER ELEVATION CONTOUR MAPS
JANUARY AND APRIL 2013
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California

PLATE A3



JULY 2013



OCTOBER 2013

GROUNDWATER LEGEND

- LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0003**

FLOW DIRECTION **S 67° W**

NORTH

0 1000 2000

FEET

WELL LEGEND

- MUNICIPAL WELL
- DOMESTIC WELL
- AGRICULTURAL WELL
- SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER
HUENEME AQUIFER
FOX CAYNON AQUIFER

UAS
LAS

GROUNDWATER LEGEND

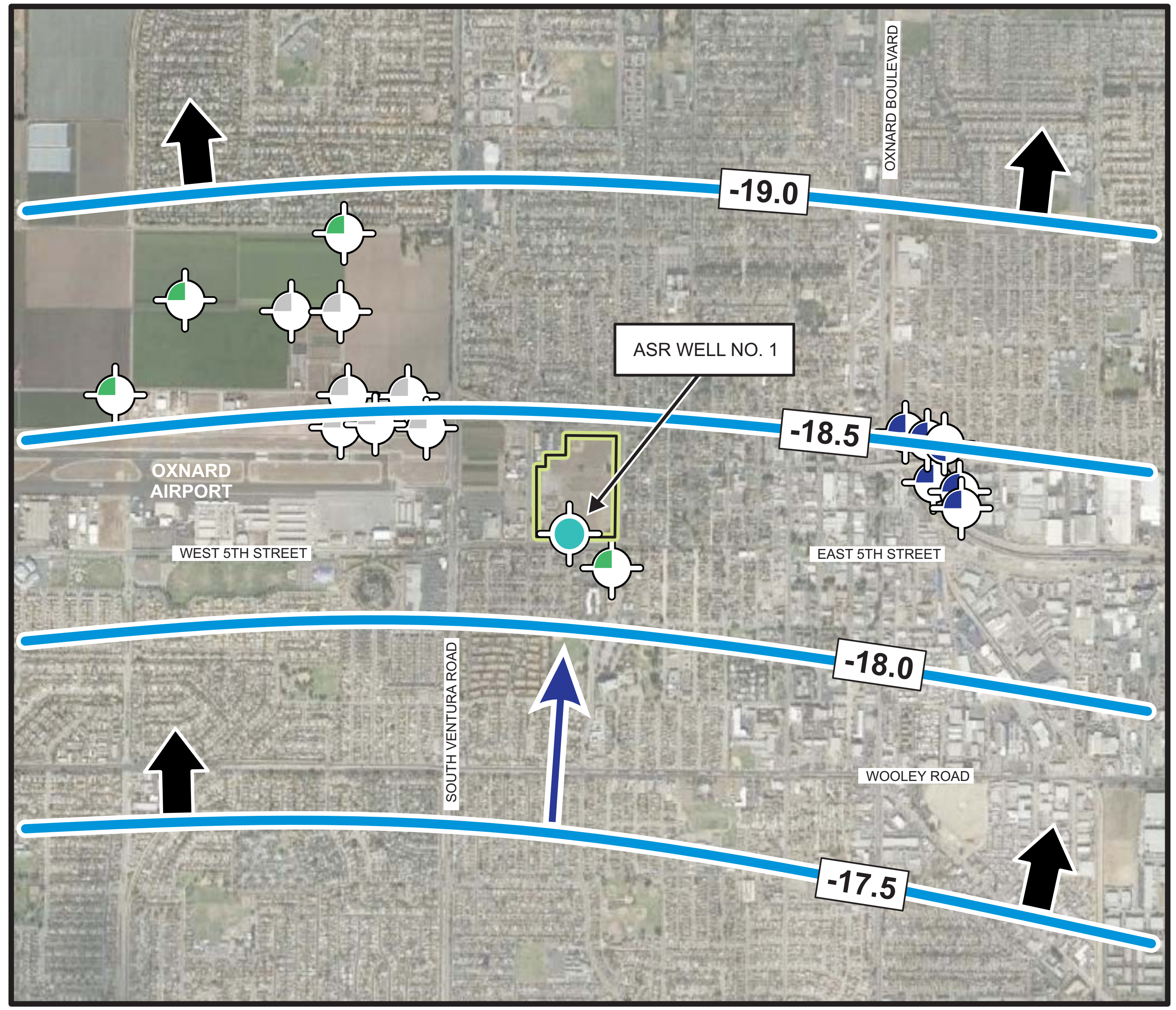
- LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0002**

FLOW DIRECTION **N 74° W**

GROUNDWATER ELEVATION CONTOUR MAPS
JULY AND OCTOBER 2013
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California

PLATE A4



AUGUST 2014

GROUNDWATER LEGEND

LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0002**

FLOW DIRECTION **N 04° E**

NORTH

0 1000 2000

FEET

WELL LEGEND

MUNICIPAL WELL

DOMESTIC WELL

AGRICULTURAL WELL

SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER
HUENEME AQUIFER
FOX CAYNON AQUIFER

UAS
LAS

GROUNDWATER ELEVATION CONTOUR MAPS
AUGUST 2014
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California

Appendix C

PALL MF PDT/LRV ANALYSIS

Pall Corporation

Resolution and LRV Calculations for Direct Integrity Testing Using the MFGM Method for Water Treatment Plant at 01.00106 Oxnard, CA

Objectives

The objective is to determine (1) the testing pressure required to meet the resolution criterion of 3 μm or less as specified in the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), (2) the pressure decay value (PDR) corresponding to required Log Reduction Value (LRV) for particles with the size of 3 μm at plant design conditions.

Calculation for Resolution and Sensitivity of the Membrane System

1. Determining Testing Pressure for Required Resolution (≤3 μm)

The testing pressure can be calculated per Equation (4.1)

$$P_{test} = (0.193 * \kappa * \sigma * \cos\theta) + BP_{\max} \qquad \text{Equation (4.1)}$$

Table 1. Calculation Variables (P_{test})

Item	Description	Unit	Value
P_{test}	Test pressure for required resolution	psi	17.47
k	Shape correction factor	dimensionless	1
σ	Surface tension of water @ 5 °C	dynes/cm	74.97
θ	Water contact angle of membrane medium	degree	0.00
BP_{max}	Sum of backpressure and static head	psid	3

Since the testing pressure to be used is 25 psi or above and the pressure decay is anticipated lower than 1 psi during the duration of the test for Pall MF system, the resolution criterion is satisfied.

2. Calculating Sensitivity (LRV_{DIT})

The LRV calculation is performed by using Equation (4.9) in USEPA's Membrane Filtration Guidance Manual (USEPA, 2005):

$$LRV_{DIT} = \log\left(\frac{Q_p * ALCR * P_{atm}}{\Delta P_{test} * V_{sys} * VCF}\right)$$ Equation (4.9)

The air-liquid conversion ration (ALCR) is calculated using Darcy Equation by assuming that the hollow fiber breaks completely at the interface of potting layer, which results in a shortest flow path for bypass flow. The calculation also uses the highest trans-membrane pressure (TMP) during a filtration cycle. This results in a conservative result that has a low LRV.

Air-to-liquid-conversion ratio (ALCR):

$$ALCR = 170 * Y * \sqrt{\frac{(P_{test} - BP)(P_{test} + P_{atm})}{(460 + T) * TMP}}$$ Equation (C.4)

$$Y \propto \left[\frac{1}{\frac{(P_{test} - BP)}{(P_{test} + P_{atm})}}, K\right]$$ Equation (C.5)

K: resistant coefficient

$$K = f * \frac{L}{d_{fiber}}$$ Equation (C.6)

The parameters used in the LRV calculation are presented in Table 2.

Table 2. Parameters Used for LRV Calculation

Item	Description	Unit	Value
Q_p	design (instantaneous) flow per rack	gpm	1,554
VCF [a]	volumetric concentration factor	dimensionless	1.00
ΔP_{test}	The smallest pressure decay rate associated w/ a breach	psi/min.	0.06
V_{sys} [b]	system hold-up volume	ft^3	44.17
P_{atm}	Atmospheric pressure	psi	14.7
BP [b,c]	back-pressure during pressure decay test	psi	0
T [b]	Temperature	^oF	80.6
TMP [b]	terminal trans-membrane pressure during filtration	psi	40
f	friction factor	dimensionless	0.025
L [c]	the length of flow path for breach	M	0.06
D	diameter of hollow fiber lumen	M	0.00064
P_{test} [b]	testing pressure for pressure decay test	psi	25.0

Note: a - *Dead-end filtration*
b - *Based on the design data*
c - *Assume worst-case fiber breakage (at the top potting layer)*

Find K:

$$K = f * \frac{L}{d_{fiber}} \qquad \text{Equation (C.6)}$$

f: friction factor
L: the length of flow path of the breach (equal to the potting thickness)
d_{fiber} lumen diameter of the fiber.

$$K = 0.025 * \frac{0.06}{0.00064}$$

Find Y value using the chart on page A-22 from Crane:

$$Y \propto \left[\frac{1}{\frac{(P_{test} - BP)}{(P_{test} + P_{atm})}}, K \right]$$

Substitute Y into Equation (C.4):

Substitute ALCR into Equation (4.9):

Table 3. Additional Parameters Used for LRV Calculation

Item	Description	Unit	Value
K	Resistant coefficient	dimensionless	2.34
Y	Net expansion factor	dimensionless	0.63
ALCR	Air to liquid conversion ratio	dimensionless	22.84
LRV_{dit}	Sensitivity of direct integrity test	log	4.4

Therefore, the sensitivity of direct integrity testing is = LRV_{dit} in Table 3.

1. Calculate Upper Control Limit (UCL) and Alert Level (AL) for Direct Integrity Testing. The UCL for direct integrity testing, the pressure decay rate corresponding to the required LRV, is determined by rearranging Equation (4.9):

$$UCL = \frac{Q_p \bullet ALCR \bullet P_{atm}}{10^{LRC*} \bullet V_{sys} \bullet VCF} \qquad \text{Equation (4.17)}$$

Where: UCL - upper control limit for pressure decay rate, psi/min.
$LRC*$ - required LRV for the membrane system

If the required LRV for the membrane system is 4-logs, substitute $LRC*$ = 4 and the same parameters in Table 2:

The plot of LRV as a function of pressure decay rate is presented in Figure 1 in which the UCL is marked with red dotted line.

Table 4. Results of UCL Calculation

Item	Description	Unit	Value
UCL	Upper control limit	dimensionless	0.16

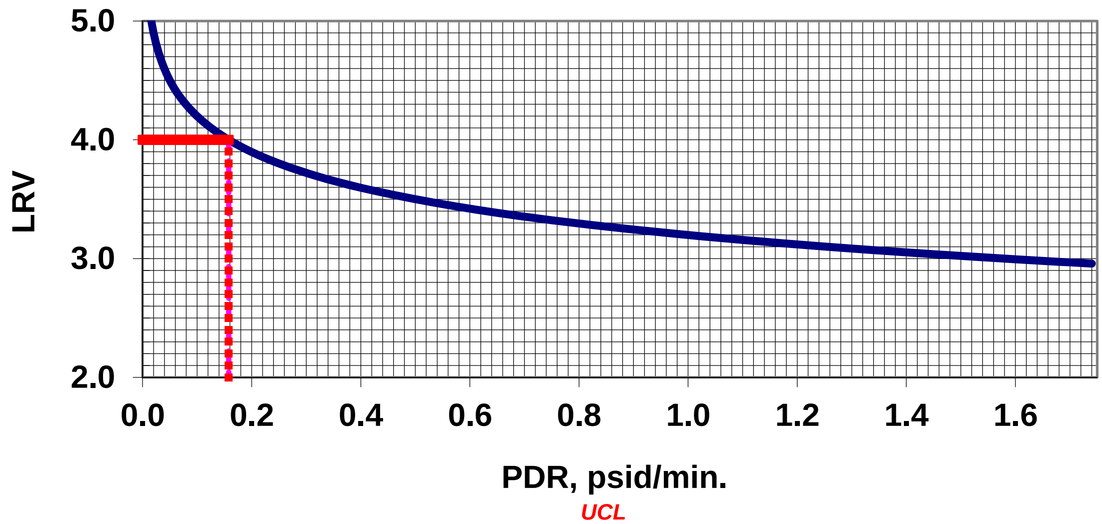


Figure 1: LRV as a function of pressure-decay rate (PDR)

UCL is indicated on the graph corresponding to LRV of 4-logs.

References

Sethi, S., G. Crozes, D. Hugaboom, B., Mi, J. M. Curl, and B. J. Mariñas (2004): *Assessment and Development of Low-Pressure Membrane Integrity Monitoring Tools* , AwwaRF Report No. 91032, Denvor, CO.

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OXNARD
CALIFORNIA

MARCH 2017

Advanced Water Purification Facility

Indirect Potable Reuse Engineering Report

VOLUME 1 OF 2

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CITY OF OXNARD

ADVANCED WATER PURIFICATION FACILITY

INDIRECT POTABLE REUSE
POTABLE REUSE ENGINEERING REPORT

FINAL
VOLUME 1 OF 2

March 2017

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CITY OF OXNARD
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INDIRECT POTABLE REUSE
POTABLE REUSE ENGINEERING REPORT

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LIST OF FIGURES

VOLUME 2 OF 2

INDIRECT POTABLE REUSE POTABLE REUSE ENGINEERING REPORT

Note: *This version of the Engineering Report reflects comments received from the State Water Resources Control Board Division of Drinking Water, letter dated December 5, 2016 and a letter dated February 17, 2017. These letters were prepared in response to an October (2016) draft of this Engineering Report. This version of the report also reflects comments received from the State Water Resources Control Board Division of Drinking water, letter dated April 21, 2016. That letter was prepared in response to an October (2015) draft of this Engineering Report. Since the last submittal, extensive startup testing has been completed on the AWPF, demonstrating water quality in accordance with regulatory objectives, with the results presented within this report. Further, an Enhanced Source Control Program (ESCP) has been developed for Oxnard as they move into potable water reuse. That ESCP is also presented within this report.*

1.0 PROJECT OVERVIEW

The City of Oxnard (City) owns and operates a regional publicly-owned treatment works (POTW) that serves the City, City of Port Hueneme, Naval Base Ventura County and several surrounding unincorporated communities. It is comprised of the Oxnard Wastewater Treatment Plant (OWTP) and its associated wastewater collection system and outfall line. The OWTP is a secondary treatment facility with a design flow of 31.7 million gallons per day (mgd) and an average daily flow of 20 to 22 mgd.

The City's Advanced Water Purification Facility (AWPF) which, when placed into operation, will divert 8 to 9 mgd of biologically-treated secondary effluent for purification using three advanced treatment steps: microfiltration (MF), reverse osmosis (RO), and advanced oxidation with ultraviolet light and hydrogen peroxide (UV AOP). Because of reject streams, the 8 to 9 mgd of influent flow to the AWPF will result in 6.25 mgd of purified water. The MF reject and backwash wastewater produced at the AWPF will be returned to the OWTP headworks. The RO concentrate waste produced at the AWPF will be commingled with the OWTP secondary treated effluent and discharged to the Pacific Ocean.

This Engineering Report is submitted to the State Water Resources Control Board Division of Drinking Water (DDW) for review and approval. This Report is intended to provide the necessary information to permit indirect potable reuse (IPR) of up to 6.25 mgd of purified AWPF-treated product water. This first phase (Phase 1) will be IPR through Aquifer Storage and Recovery (ASR) in the Lower Aquifer System (LAS). For the ASR project, the City plans to inject the AWPF-treated recycled water into specific wells at the Campus Park location (at the corner of 5th and H Street in Oxnard), keep the water underground for a set period of time, then extract the water (from the same wells into which the water was injected) for potable and non-potable use.

1.1 Water in Oxnard

The City's current water supply comes from surface and groundwater sources. Fifty percent of the City's water supply is from northern California rainfall and snowmelt pumped through the Sacramento–San Joaquin Delta and imported to southern California via the State Water Project (SWP). This water is delivered by the Calleguas Municipal Water District (CMWD). Twenty-five percent of the City's water is regional groundwater supplied by the United Water Conservation District's (UWCD) spreading and pumping operations on the Santa Clara River and Oxnard Plain. Local, City owned and operated wells account for the remaining twenty-five percent of the City's water.

1.1.1 CMWD

The City receives SWP water from CMWD's Springville Reservoir (supplied by Metropolitan Water District of Southern California [MWDSC]) through the City's Oxnard and Del Norte conduits that feed five of the City's six water blending stations. Existing agreements between the City and CMWD do not guarantee the quantity of water the City may purchase. The City has a current MWDSC Tier 1 entitlement. Tier 1 water corresponds to the amount "contracted for" by the City. It is in essence a capacity reservation and includes the water being delivered to the Port Hueneme Water Authority (PHWA). MWDSC Tier 2 water is normally available to the City; however, the cost per acre-foot is higher. There is less availability and reliability of Tier 2 water in periods of drought.

1.1.2 Fox Canyon Groundwater Management Authority (FCGMA)

The FCGMA was created at the direction of the State Water Resources Control Board (SWRCB) to address ongoing overdraft and seawater intrusion into the Oxnard Plain Pressure Basin. The purpose of the FCGMA is to manage the region's groundwater supply by protecting the quantity and quality of local groundwater resources and by balancing the supply and demand for groundwater resources.

The FCGMA governs all extractions from the groundwater basin and, thus, the City's use of UWCD water and its own local wells is governed by the "safe yield" extraction volumes set by FCGMA.

In 2009 the City participated in the Ferro Pit Program, in which the City helped UWCD purchase an additional recharge basin, known as the Ferro Pit.

In 2016, the FCGMA issued a permit for the installation of the proposed Campus Park ASR well (letter dated June 24, 2016).

1.1.3 UWCD

UWCD currently provides a portion of the City's groundwater supply. This arrangement has been in place since 1954, and was formalized in the 1996 Water Supply Agreement for Delivery of Water through the O-H Pipeline. UWCD holds a pumping sub-allocation for all users of the O-H Pipeline, which includes the City, PHWA, and a number of small mutual water companies.

1.1.4 2002 Three-Party Agreement

The City, CMWD, and PHWA entered into a Three-Party Agreement in 2002, which provides PHWA with CMWD water through Oxnard's O-H pipeline. The City also supplied water to the Ocean View Municipal Water District (OVMWD) until 2008, when the OVMWD was dissolved and has since been managed and operated by the City. The OVMWD's distribution system is now referred to as the Ocean View System and the demand of the Ocean View customers is accounted for as part of the City's total demand, with much of the demand categorized as agricultural water use.

The City does not sell water to any other agencies. However, with the completion of Blending Station Number 6 in 2011, the City can provide desalted groundwater to PHWA in the case that PHWA's O-H pipeline supply becomes temporarily unavailable.

1.2 GREAT Program

To ensure a future reliable and affordable supply of high-quality water, the City has developed the Groundwater Recharge Enhancement and Treatment or GREAT program to be implemented and operated in two phases. Phase 1 (6.25 mgd, or 7,000 AFY) treatment facilities are now in operation for non-potable water reuse, whereas additional treatment will be constructed in the near future to 12.5 mgd, with a future final capacity of 25 mgd. At this time, regulatory approval is only sought for the 6.25 mgd flow. The objectives of the GREAT program are as follows:

- Increased reliability of water supply.
- Reduced cost of water supply.
- Improved dependability of water supply in accommodating existing needs and meeting planned growth and associated water demand.
- Enhanced stewardship of local water supply through recycling and reusing a substantial portion of the region's wastewater.

The GREAT program includes treating effluent from the OWTP and providing state-of-the-art MF, RO, and advanced oxidation with UV/H_2O_2 at the AWPF, schematically shown in Figure 1.

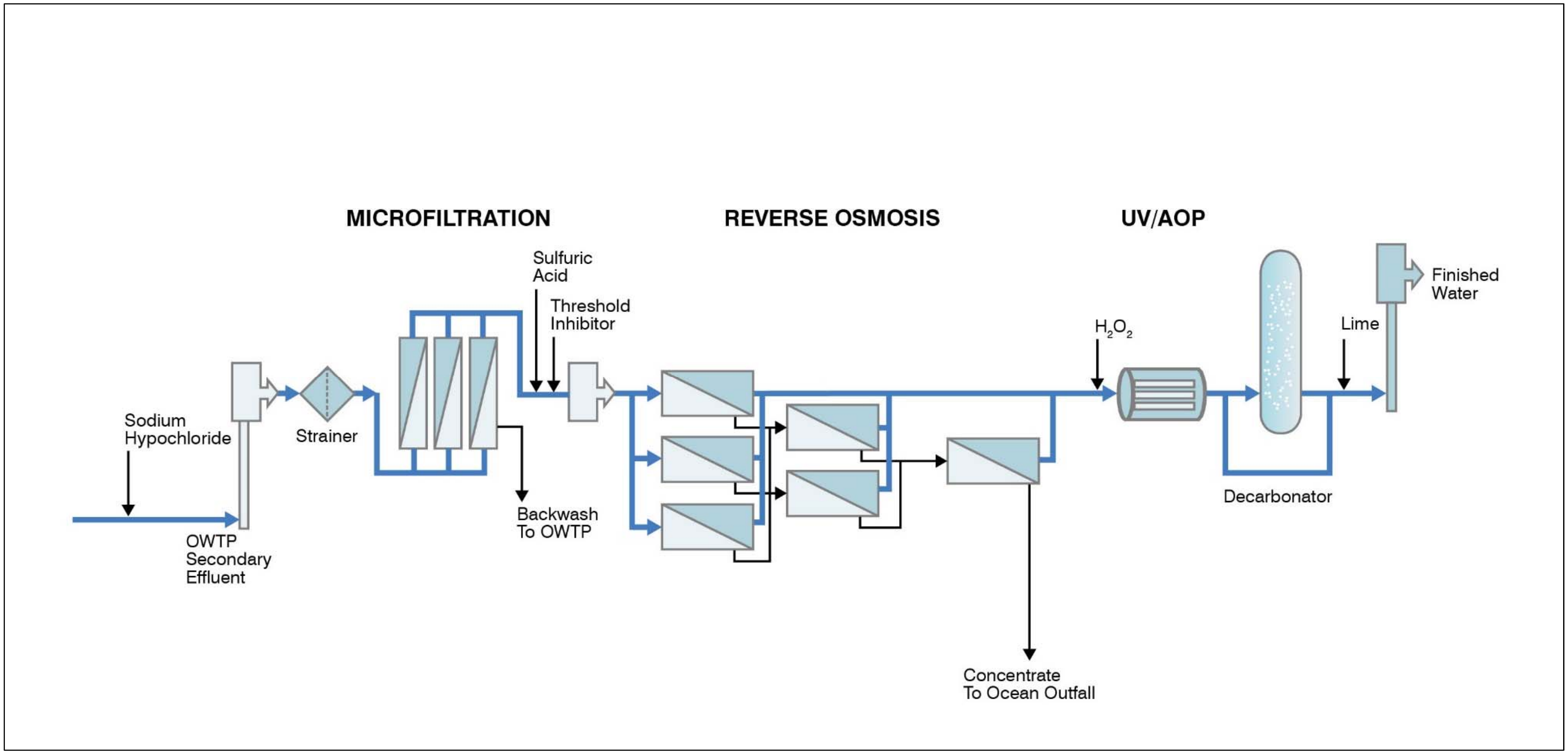

Figure 1 Advanced Treatment Schematic

Elements of the GREAT program are summarized as follows:

- Recycled Water Delivery System - Distributes recycled water for irrigation to agricultural users.
- Aquifer Storage and Recovery - Intended to help alleviate groundwater overdraft conditions and associated water quality problems, including coastal seawater intrusion. Will allow seasonal storage of potable water supplies to maximize use of the existing potable water distribution system.
- Regional Desalter - Membrane filter systems to remove dissolved minerals from groundwater, in order to reduce the levels of nitrates and total dissolved solids (TDS) in the groundwater basin.
- Blending Station No. 5 - Provides improved water supply infrastructure reliability, water quality, and hydraulic efficiencies. It also assists in meeting peak-hour and fire-flow water supply demands.
- Concentrate collection system from regional brine dischargers - Avoid discharge of high-salinity concentrate into City sanitary sewer system and Oxnard WWTP.
- Permeate Delivery System - Permeate delivery from regional desalter to industrial users.

All of the end uses (agricultural irrigation, landscape irrigation, injection into the aquifer, and industrial) will be served with a common water quality that meets the groundwater recharge (groundwater recharge) criteria for injection of purified recycled water. In exchange for the delivery of recycled water, agricultural customers would transfer their groundwater pumping allocations to the City on a one-for-one basis. The additional pumping by the City would be from the poor-quality Oxnard Aquifer, which would require additional treatment prior to delivery to the City's distribution system. The GREAT desalter constructed in 2007/2008 would provide this treatment. It does not increase the total water supply. It does, however, allow full use of the City's groundwater resources.

1.2.1 Project Site

The project site is Oxnard, California. The location of the AWPF and the ASR location are shown in Figure 2.

1.2.2 Existing Facilities and OMMP

The OWTP liquid processes include preliminary treatment, primary clarification, secondary treatment (biofiltration (trickling filters) followed by activated sludge), and chlorine disinfection in order to achieve an acceptable level of water quality for ocean discharge. The solids-handling processes include gravity thickening of primary sludge, dissolved air flotation thickening of secondary sludge, anaerobic digestion, and belt filter press dewatering.

Figure 2 Project Location

The AWPF is a standard MF/RO/UV AOP system to purify secondary effluent. It includes the following processes: automatic strainers, MF system (detailed below), equalization tank, RO transfer pumps, Cartridge filter, High pressure RO feed pump, Two-stage RO train (detailed below), UV disinfection system (detailed below), Decarbonator, lime stabilization, product water pumps, and chemical storage. The AWPF is located adjacent to the OWTP (Figure 3).

The three primary advanced treatment processes (MF, RO, and UV AOP) are designed to meet DDW performance criteria for indirect potable water reuse. A summary of each process is provided in Table 1.

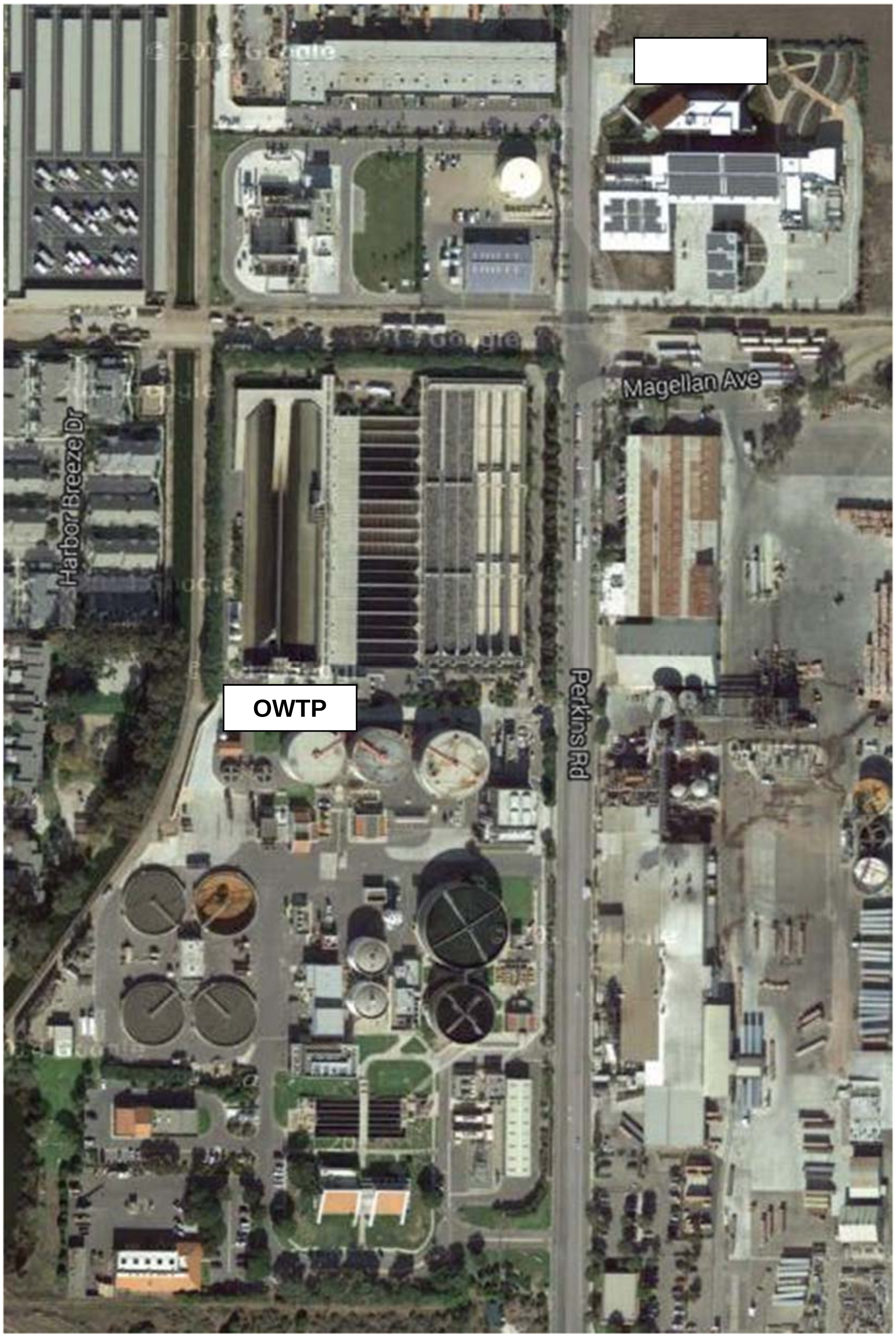

Figure 3 OWTP and AWPF

Table 1	Advanced Treatment Design Criteria Advanced Water Purification Facility City of Oxnard	
Process	**Performance Goal**	**Performance Monitoring**
MF	Filtrate Nephelometric Turbidity Unit (NTU)<0.2 NTU.	Maintaining turbidity values of <0.2 NTU indicates no gross membrane failure. However, insufficient research exists to correlate MF filtrate turbidity with pathogen removal.
	Pressure Decay Test (PDT, also called membrane integrity test (MIT)) <0.3 pounds per square inch per 5 minutes (psi/5min).	Daily testing demonstrates MF integrity, allowing for 4-log protozoa credit.
RO	Each membrane element must achieve ≥99% rejection of sodium chloride, and average rejection of ≥ 99.2% sodium chloride.	Track and trend electrical conductivity (EC) reduction through the RO membrane. Pathogen reduction credits for RO based upon this measured value.
	RO permeate must have a total organic carbon (TOC) ≤ 0.25 mg/L greater than 95% of the time at startup and through 20 weeks of operation. Subsequently, RO permeate TOC must be ≤0.5 mg/L.	No online TOC metering is currently installed, but online TOC metering will be installed prior to IPR operation. It remains to be determined TOC will be installed just after RO, or before and after RO.
UV AOP	≥0.5-log reduction of 1,4-dioxane; at least one continuously monitored surrogate or operational parameter shall be established to reflect that the minimum 1,4-dioxane criterion is being met.	Startup testing documents 1,4-dioxane removal and correlates such removal with an online surrogate (UVI/Q).
	6-log reduction of adenovirus.	UVI/Q values correlate with N-Nitrosodimethylamine (NDMA) destruction, which maintains continuous documentation of a UV dose well in excess of 235 mJ/cm^2; which is the dose for 6-log adenovirus. This minimum dose will be maintained at all times.

1.2.2.1 MF System

The MF system (Figure 4) is an outside-in MF system (PALL Microza) and consists of MF feed strainers, MF feed water ORP, pH, turbidity, and total chlorine residual analyzers. The

MF is used to remove particulate and microbial contaminants, including turbidity, *Giardia,* and *Cryptosporidium* using a low-pressure filtration system. Upstream of RO, this system mitigates RO membrane fouling by reducing the level of particulates and larger colloids. MF also reduces the concentration of bacteria – particularly those that are particulate-associated. There are six treatment trains in parallel in the MF room with capacity for an additional six trains to be built if needed. One of the six trains can be out of service and the MF system will still maintain production of sufficient flow to result in 6.25 mgd of RO permeate.

Figure 4 MF Photos at the AWPF

1.2.2.2 RO System

RO units are furnished by H2O Innovation (Figure 5), and installed with Hydranautics ESPA2 membrane elements. The RO units are housed in their own room, with two identical skids running in parallel with individual production capacities of 3.125 mgd. Space for three additional RO skids of 6.25 mgd each is built into the room in for possible future needs. The RO system is monitored using online EC at the MF filtrate (RO feed) and several places on the RO. discharge; Stage 1, 2 and 3, total flow, and concentrate. These EC locations are at both trains. Currently there is no online TOC metering of this MF filtrate or RO permeate, though the City intends to install TOC monitors on the RO feed and RO permeate prior to operation.

Figure 5 RO Photos at the AWPF

1.2.2.3 UVOX System

Three Trojan UVPhox D72AL75 reactors are installed to provide additional treatment of the RO permeate (ROP) via AOP. These reactors operate with low-pressure high-output (LPHO) lamps and with dosed hydrogen peroxide (H_2O_2); based upon a target EEO sufficient for 0.5 log reduction of 1,4-dioxane. Startup testing, documented further on, demonstrates the dose capacity of this system and effective monitoring using a UVI/Q process. These three reactors each have two banks, for a total of six banks of UV lamps. Five of those banks are duty, and the sixth bank is redundant. Similar to the MF and RO systems, there is room to expand this UV system to meet future needs (Figure 6).

1.3 Public Outreach and Coordination Effort

The City has yet to initiate a formal outreach effort to the general public to discuss this IPR project. Stakeholders, however, are aware of this project and will be further informed as detailed below.

Figure 6 Photo of Similar UV Phox

1.3.1 Stakeholders

Key regional stakeholders are aware of this IPR project. These stakeholders include the CMWD, the UWCD, the FCGMA, and the City of Ventura. CMWD, UWCD, and FCGMA are directly involved in water supply to the City. Other regional stakeholders include various regulatory and governmental bodies, and several environmental organizations. The Program Environmental Impact Report (PEIR), completed in 2004, included the required public notice and engagement regarding the various aspects of the GREAT program, including potable reuse (CH2MHill, 2004).

Once this Engineer's Report is submitted for review and approval by DDW and the Regional Water Quality Control Board (RWQCB), the City will re-engage with project stakeholders.

1.3.2 System Startup

As outlined in subsequent sections of this Engineer's Report, extensive testing of the purification system has been completed to demonstrate compliance with DDW's groundwater recharge regulations. This testing was done during the normal operation of the GREAT system for non-potable reuse applications. These tests are detailed in the following Chapter 17.

After the construction of the proposed IPR ASR well, a series of tests will be done on the background groundwater quality. This information, once it is thoroughly reviewed, will be presented to the various stakeholders and for regulatory review.

1.3.3 Public Hearing and Notifications

The City will follow the public hearing requirements specified in the DDW groundwater recharge regulations, which were adopted in June 2014 and are now included in the Division of Drinking Water (DDW) Water Recycling Criteria (CDPH, 2014). Section 60320.202 includes a review of the necessary public and regulatory notice requirements of the proposed project. In general, the following approach will be followed:

- The City will provide DDW and the RWQCB the information it intends to present at the hearing regarding this IPR project.
- After the Engineering Report has been approved, the City will post the Report on its website and make it available at the City's office at least 30-days prior to the hearing.
- The City will notify the public about the availability of the information and the public hearing, including how the public can provide comments and attend the hearing. This can be done through several media channels.
- The City will notify the first downgradient potable water well owner and well, which is the City of Oxnard.
- Further outreach will also occur once the draft tentative permit is issued. In accordance with California Water Code (CWC) Section 13167.5, the Los Angeles RWQCB (LARWQCB) must provide notice and a period of at least 30 days for public comment prior to adoption of a Waste Discharge Requirement (WDR) and/or Water Recycling Requirement (WRR). This is accomplished by providing a draft of the amendment to anyone who has requested a copy or by posting the draft on the LARWQCB website and providing an electronic notice to interested parties. After posting on the consent calendar, the LARWQCB will hold a public hearing that provides opportunity for further public comment.

1.3.4 California Environmental Quality Act (CEQA)

The CEQA compliance is summarized below under the "Environmental Compliance" section.

1.4 Environmental Compliance

The CEQA process for the GREAT treatment facilities has already been completed (CH2MHill, 2004). This process provided an open forum for public comment on the project at the time of that work (2004).

An addendum to that EIR was completed in January of 2015 by Hollee King to address the ASR well and monitoring wells (King, 2015). In a letter dated January 21, 2016, the Governor's Office of Planning and Research State Clearinghouse and Planning Unit issued a letter of compliance to Oxnard for the ASR project, stating "that you have complied with the State Clearinghouse review requirements for draft environmental documents, pursuant to the California Environmental Quality Act" (State of California, 2016).

1.5 Project Goal

The goal of the GREAT program is to ensure a future reliable and affordable supply of high-quality water. Phase 1 (6.25 mgd, or 7000 AFY) treatment facilities have been constructed and is now producing water for non-potable use. The City has plans to expand the production capability of this facility, and will provide details of this expansion at a future date.

1.6 Purpose of This Report

The purpose of this Title 22 Engineering Report is to provide detailed information on the design of the City's AWPF, describe the water reuse goals for the City, clearly indicate the means for compliance with DDW's groundwater recharge regulations and any other features specified by the RWQCB, and in total, gain approval for the City to implement an IPR groundwater recharge project.

This Engineering Report is in compliance with the State of California Water Recycling Criteria (CDPH, 2014) that requires the submission of an Engineer's Report to the RWQCB and DDW prior to any modification to an existing project or implementation of a new project.

2.0 PROJECT PARTICIPANTS

The City intends to recharge groundwater and extract groundwater from the same location. This operation, under the current plan, will not impact other utilities or entities. With that said, there are a number of key participants outside of the City that have had, and will have, a role in the successful implementation of IPR. The project participants, their role, and their contact information are listed below in Table 2.

3.0 REGULATORY REQUIREMENTS

The overarching regulatory requirements are summarized in this section. The specific parameters for monitoring and permit compliance are documented in Sections 9 and 15.

3.1 California Water Code (CWC)

The CWC stipulates that each RWQCB formulate and adopt Water Quality Control Plans (Basin Plans) for all areas governed by the board. These plans must contain water quality objectives for surface water and groundwater within the regions that provide reasonable protection of the beneficial uses of the waters. During the process of formulating such plans the RWQCBs must consult with and consider recommendations of affected state and local agencies. Such plans shall be periodically reviewed and may be revised (Section 13240).

Table 2 List of Key Project Participants
Advanced Water Purification Facility
City of Oxnard

Organization	Name	Contact Information	Project Role
City of Oxnard	David Lutz, AWPF Plant Manager	Desk: (805) 271-2203 Cell: (760) 415-2496 david.lutz@oxnard.org	Responsible for Daily Production of Purified Water and Operation of the ASR System.
City of Oxnard	Dan Rydberg, Director of Public Works	(805) 385-8055. Daniel.Rydberg@ci.oxnard.ca.us	Overall potable reuse program manager for the City.
City of Oxnard	Thien Ng, Wastewater Division Manager	(805) 432-3575 Thien.Ng@ci.oxnard.ca.us	Project Manager for this potable reuse project.
RWQCB	Elizabeth Erickson	(213)576-6665 Elizabeth.Erickson@waterboards.ca.gov	Lead RWQCB permitting authority for this project.
DDW	Jeff Densmore, District Engineer	(805)566-1326 Jeff.densmore@waterboards.ca.gov	Lead DDW permitting authority for this project.
DDW	Kurt Souza, South Field Branch Chief	(805)566-1326 Kurt.souza@waterboards.ca.gov	Regional oversight and perspective on potable reuse.
CalMWD	Kristine McCaffrey, Manager of Engineering	805-579-7173	Regional Stakeholder.
UWCD	Tony Morgan, GW Dept Manager Tony Emmert, Deputy GM	805-525-0621 805-317-8961	Regional Stakeholder.
FCGWMA	Gerhardt Hubner	805-654-5051	Regional Stakeholder.
City of Ventura	Shana Epstein, General Manager	805.652.4518 sepstein@venturawater.net	Adjacent City dealing with similar water supply concerns and potable reuse considerations.
Consultant Team			**Project Role**
Carollo Engineers	Tracy Clinton, Project Manager	(925)932-1710 tclinton@carollo.com	Project Manager for Water Reuse Permitting and Implementation, working for the City.
Carollo Engineers	Andrew Salveson, Project Engineer	(925)932-1710 asalveson@carollo.com	Engineer of Record for this Engineer's Report.
Hopkins Groundwater Consultants	Curtis Hopkins, Principal Hydrogeologist	(805)653-5306 chopkins.hgc@sbcglobal.net	Groundwater hydrogeologist of record for this Engineer's Report & Well Monitoring Plan
HLK Planning	Hollee L. King	(805)901- 2261 hollee@hlkplanning.com	CEQA Permitting Lead.
MV Engineering LLC	Mary Vorissis	(805) 217-8494 mary.vorissis@gmail.com	Operations and Maintenance Management Plan (OMMP)

In accordance with CWC Section 13260, all persons discharging waste within the region must file with the appropriate board, and provide information pertaining to their discharge. Within the region, it is not permitted for a person to construct, maintain, or use any waste well that interferes with a source for domestic water supply without proper permitting or exceptions (CWC Section 13540). "Recycling criteria" are the levels of constituents of recycled water, and means for assurance of reliability under the design concept which will result in recycled water safe from the standpoint of public health, for the uses to be made (CWC Section 13520). Section 13521 of the CWC states that the State Department of Public Health (now DDW) shall establish uniform statewide recycling criteria for each varying type of use of recycled water where the use involves the protection of public health.

Section 13522 stipulates that if a contamination occurs as a result of recycled water, then procedures for abating this contaminant must be followed in accordance with the Health and Safety Code. The use of recycled water must not cause, constitute, or contribute to, any form of contamination. In order to comply with contamination prevention with recycled water use, any person recycling or proposing to recycle water must file for appropriate permitting with the regional board (Section 13522.5).

If a master recycling permit is granted, it must include at a minimum (Section 13523.1): waste discharge requirements(WDRs), a permittee statewide recycling criteria compliance requirement, recycled water producer end user rule enforcement requirement, requirement for a recycled water use quarterly report, periodic facility inspection requirement, and additional requirements given by the regional board in permit. Recycled water may only be used for the permitted purpose, as specified by the regional board (Section 13524).

3.2 DDW Requirements

DDW (formerly CDPH) has developed criteria for both non-potable uses of recycled water and groundwater recharge for subsequent potable use, with the most recent version updated as of June 2014 (CDPH, 2014). This Engineering Report deals specifically groundwater recharge for potable reuse.

This project will meet the requirements specified in the Water Recycling Criteria (CDPH, 2014). Key regulatory requirements related to groundwater recharge are summarized in Table 3.

3.3 RWQCB Requirements

The OWTP currently discharges to the Pacific Ocean under existing NPDES permit (CA0054097) Order No. R4-2013-0094 which was adopted on June 6, 2013 and became effective on July 26, 2013 (WW-16). The City also operates an AWPF under its GREAT Program, to produce non-potable water for reuse. The GREAT Program operates under a separate WRR and WDR Order No. R4-2008-99-0083 (WW-17), as amended by Order No. R4-2011-0079 and R4-2008-0083-A01.

Table 3	List of Key Potable Reuse Regulatory Requirements for Groundwater Recharge Advanced Water Purification Facility City of Oxnard		
Issue	**Regulation Citation**	**Regulatory Concept**	**Section in This Report**
Alternate Source of Supply	60320.200(b)	The project proponent must have a plan for an alternative water supply in the event of a treatment process failure or unforeseen water quality event.	8
Background Groundwater Quality Sampling	60320.200(c)	Background groundwater quality must be documented to allow for a comparison with the recycled water.	12
Underground Retention Time for Recharged Water	60320.200(d)	The recycled water must be stored for a specific time prior to potable use to allow for monitoring of water quality and response in the event of water quality concerns.	6,7
Groundwater Flow Maps and Hydrogeology	60320.200(e, h)	The groundwater transport must be sufficiently and conservatively documented to provide confidence that a minimum specified travel time is obtained.	6
Treatment Process Performance	60320.200(f,g)	The proponent must demonstrate its ability to produce a high quality water protective of public health.	5,9
Advanced Treatment Criteria, RO	60320.201 (a,b)	The RO membranes must meet specific EC and TOC performance criteria and be monitored by a proven method to demonstrate continuous performance.	5
Advanced Treatment Criteria, Advanced Oxidation	60320.201 (d,e)	The advanced oxidation system must be sufficiently robust to provide specific log reduction of one or more trace pollutants and have a proven method for monitoring performance online.	5
Public Hearing	60320.202	The project proponent must provide notice to the public and stakeholders regarding the intent and implementation of the potable reuse project.	1
Wastewater Source Control	60320.206	A rigorous wastewater source control is required to minimize impacts to potable reuse water quality.	4
Pathogenic Microorganism Control	60320.208	Specific pathogen reduction targets must be met through a series of multiple treatment processes. The log reduction requirements for virus, *Giardia,* and *Cryptosporidium* are 12, 10, and 10, respectively.	5
Nitrogen Compounds Control	60320.210	A total nitrogen standard of ≤10 mg/L must be met at all times.	9
Regulated Contaminants and Physical Characteristics Control	60320.212	The recycled water must meet DDW drinking water regulations for MCLs and action levels for lead and copper.	9

Table 3	List of Key Potable Reuse Regulatory Requirements for Groundwater Recharge Advanced Water Purification Facility City of Oxnard		
Issue	**Regulation Citation**	**Regulatory Concept**	**Section in This Report**
Diluent Water	60320.214	No diluent water is being proposed for this project.	10
Recycled Water Contribution (RWC)	60320.216	The RWC is the relative amount of recycled water compared to the total water being recharged. For this project, the RWC is 100 percent.	10
Total Organic Carbon	60320.218	TOC is used as a bulk surrogate for organics in the purified water. A maximum TOC value of 0.5 mg/L is required.	9
Additional Chemical and Contaminant Monitoring	60320.220	Monitoring of recycled water and groundwater is required for priority toxic pollutants, chemicals with notification levels, and other chemicals specified by DDW.	15
Operation Optimization and Plan	60320.222	Prior to operation, a detailed Operation Optimization Plan approved by DDW is required to operate, maintain, and monitor the project.	16
Response Retention Time	60320.224	The response retention time (RRT) is the time to monitor and respond to treatment process failures. The RRT must be less than the underground retention time of the stored purified water.	7
Monitoring Well Requirements	60320.226	Prior to operation, monitoring wells must be placed in appropriate locations to monitor the movement and water quality of the injected water.	6,11

This potable reuse project will require a reissuance of the WDR/WRR Order No. R4-2008-0083, including the Monitoring and Reporting Program No. 9456. A Report of Waste Discharge (ROWD) is required to initiate the permit application process.

The LARWQCB regulates groundwater recharge projects under numerous state laws and regulations, including the Water Quality Control Plan, Los Angeles Region (hereinafter, the Basin Plan) and SWRCB policies. The Basin Plan requirements include groundwater objectives for minerals and drinking water Maximum Contaminant Levels (MCLs). The Basin Plan also applies the state's Anti-degradation Policy, which has been further interpreted pursuant to the 2013 SWRCB Recycled Water Policy (SWRCB, 2013).

3.4 SWRCB Requirements

The SWRCB has two policies related to this proposed IPR project. They are the Anti-Degradation Policy and the Recycled Water Policy. While the full expectation for this IPR project is to improve groundwater quality through the injection of advanced-treated recycled water, the specific provisions of these two policies must be identified and met.

3.4.1 Anti-degradation Policy

Resolution 68-16 is the state's Anti-degradation policy, titled "Statement of Policy with Respect to Maintaining High Water Quality in California." The key components of this Resolution, listed here verbatim, are:

- "Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality water will be maintained until it has been demonstrated to the state that any change will be consistent with maximum benefit to the people of the state, will not unreasonably affect present and anticipated beneficial use of such water, and will not result in water quality less than that prescribed in the policies."
- "Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to ensure that (a) pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."

3.4.2 Recycled Water Policy

The Recycled Water Policy was adopted by the SWRCB in 2009 and revised in 2013 (SWRCB, 2013). Relevant components of the Policy include Salt Nutrient Management Plans (SNMPs), Recycled Water Groundwater Recharge Projects (GRPs), anti-degradation, and monitoring constituents of emerging concern (CEC). Each of these is summarized below.

3.4.2.1 SNMPs

This element of the Recycled Water Policy requires SNMPs to be developed for every groundwater basin/sub-basin in California within five years of the Recycled Water Policy adoption (seven years with approved extensions). The objective of the SNMP is to manage salts and nutrients from all sources" on a basin-wide or watershed-wide basis in a manner that ensures attainment of water quality objectives and protection of beneficial uses." The SNMP includes the following tasks:

- Identify the SNMP work group and develop the SNMP work plan.
- Establish and manage a stakeholder process.
- Summarize/Characterize Water Management and Salt/Nutrient Management Goals and Objectives.
- Characterize Groundwater Basin Geology, Hydrology, and Hydrogeology.

- Summarize Existing Groundwater and Surface Water Monitoring Programs and Water Quality.
- Develop Salt and Nutrient Source Identification.
- Estimate Assimilative Capacity for Each Sub-Basin.

The City of Oxnard developed a preliminary draft SNMP for the Oxnard Plain (inclusive of the Oxnard Forebay) and Pleasant Valley groundwater basins (Carollo, 2016b). The preliminary draft was submitted to the LARWQCB and other stakeholders in July 22, 2016 for review and comment. The LARWQCB provided comments (email from Ginachi Amah, September 1, 2016). The United Water Conservation District provided comments regarding including potential use of purified water from the AWPF for recharge at UWCD facilities (personal communication, Dan Detmer UWCD). The City of Oxnard sent a response to comments to the LARWQCB in September 2016. The response to comments included the following request, related to allowing the City of Oxnard to obtain recycled water permits.

> *"The City of Oxnard respectfully requests that the RWQCB accept the Preliminary Draft Oxnard SNMP, as a draft document (with minor changes to accommodate TAG comments), with the understanding that the SNMP process is well underway, and that obtaining recycled water permits for the proposed projects identified in the Preliminary Draft Oxnard SNMP will not be impacted by delaying the development of a Final Oxnard SNMP. The City of Oxnard requests that the Final Oxnard SNMP be delayed to be coincident with the development of the Groundwater Sustainability Plan (GSP). It is envisioned that at that time, the involved stakeholders will determine the need for additional modeling and analysis based on the findings of the GSP."*

The Oxnard SNMP includes all of the required elements in the SNMP evaluation. Critical to the evaluation is the assessment of assimilative capacity and the evaluation of proposed projects.

The SNMP includes evaluation of existing groundwater quality and calculation of area weighted average TDS, chloride, and nitrate concentrations, by basin. Assimilative capacity for each constituent, which is a comparison of the existing groundwater quality with the target groundwater quality, summarized here. Note two things. First, the proposed ASR project is in the Oxnard Plain, which has assimilative capacity for chloride, TDS, and nitrate. Second, the purified water that will be used for groundwater recharge, will result in improved groundwater quality for all conditions.

- Oxnard Plain Excluding Coastal Saline Zone UAS (upper aquifer system)
  - Chloride Assimilative Capacity - YES
  - TDS Assimilative Capacity - YES
  - Nitrate Assimilative Capacity - YES

- Oxnard Plain Excluding Coastal Saline Zone LAS (lower aquifer system)
  - Chloride Assimilative Capacity - YES
  - TDS Assimilative Capacity - YES
  - Nitrate Assimilative Capacity - YES
- Oxnard Forebay
  - Chloride Assimilative Capacity - YES
  - TDS Assimilative Capacity - YES
  - Nitrate Assimilative Capacity - YES
- Pleasant Valley
  - Chloride Assimilative Capacity - YES - LIMITED
  - TDS Assimilative Capacity - NO
  - Nitrate Assimilative Capacity - YES

The City of Oxnard is planning to implement ASR in the Oxnard Plain. The purpose of the proposed ASR projects is to provide potable water supply. It is conservatively assumed that the proposed ASR project(s) would not necessarily lead to a reduction in groundwater pumping (via offsetting use of existing wells) or use of imported water, both of which would have potential groundwater quality benefits. The intent of the ASR project is to inject recycled water into a groundwater aquifer, allow it to remain within the aquifer for a specified retention time, and then extract the water for potable use.

Agricultural irrigation with recycled water from the AWPF may be delivered directly to agricultural areas east of the City of Oxnard and/or delivered to PVCWD. Use of recycled water would likely offset existing water supplies for agricultural irrigation (groundwater or other). Recycled water delivered directly to agricultural areas east of the City of Oxnard would recharge the Oxnard Plain. If recycled water from the AWPF is sold to PVCWD, then it would be comingled with PVCWD existing water supplies and delivered for agricultural irrigation within the PVCWD service area. Recycled water delivered to PVCWD would recharge the Oxnard Plain and the Pleasant Valley Basin.

The AWPF treatment facility will produce purified recycled water and includes MF, RO, and UV AOP. It is anticipated that lime will be added to restore the alkalinity and calcium to the water to minimize the corrosivity of the recycled water. Prior estimates for TDS and chloride of the reverse osmosis permeate was projected as 201 mg/L and 70 mg/L, respectively (Jensen Design and Survey 2015). Approximately 30 m/L of additional TDS was attributed to lime addition. Therefore, the predicted TDS, chloride and nitrate concentrations were 230 mg/L, 70 mg/L, and 0.7 mg/L as N, respectively. More recent numbers for the AWPF reverse osmosis permeate water suggest values of approximately 51 mg/L TDS, 14 mg/L chloride, and 0.11 mg/L as N of nitrate. Accounting for the additional TDS of lime addition, and adding in conservatism (factor of 2) to the estimates, it is assumed for this analysis that the recycled water from the AWPF has 160 mg/L TDS, 30 mg/L chloride, and 0.2 mg/L nitrate as N. The predicted water AWPF recycled water quality is well below the objectives and existing water quality in all systems of all basins within the study area.

As discussed, the City of Oxnard's proposed recycled water projects include potable reuse via ASR. In an ASR configuration, the recycled water is injected into an aquifer and extracted for use after some specified residence time. The purpose of the ASR projects is to provide water to meet increasing demands, and it is conservatively assumed that the water from the ASR project(s) will not offset existing groundwater pumping.

Relative to the time scales that are important in groundwater fate and transport, the residence time in an ASR configuration is relatively short. ASR effectively provides a relatively small and temporary additional load to the basin. There may be localized mixing of the injected water (desalted) and the groundwater aquifer during the residence time in the aquifer. However, any mixing that would occur would provide a diluting effect on existing groundwater, due to the superior quality of the AWPF recycled water as compared to existing groundwater quality. Therefore, if there is any effect of the temporary injection of AWPF water into aquifers in the Oxnard Plain, then it would be a beneficial effect of dilution. From a salt and nutrient loading perspective, ASR generates a no-net change to the existing system. Since ASR will effectively provide no change to groundwater quality (or possibly a benefit to groundwater quality) then it is reasonable to conclude that the proposed ASR project(s) are allowable under the SNMP framework and should proceed, provided that other regulatory requirements are met.

The SNMP evaluation of the City's proposed recycled water projects concluded that these projects can be implemented provided that all other regulatory requirements are met. It should be noted, that the SNMP includes management measures and a monitoring plan, and that the City will likely share the responsibility for implementing management measures and monitoring as part of future management and evaluation of groundwater quality in the Oxnard Plain and Pleasant Valley Basins.

3.4.2.2 Recycled Water Groundwater Recharge Projects

As listed in the Recycled Water Policy, approved GRPs must meet the following criteria:

- Compliance with regulations adopted by CDPH for groundwater recharge projects (CDPH, 2014).
- Implementation of a monitoring program for CECs and priority pollutants, consistent with recommendations from DDW.

Additionally, the Recycled Water Policy states that the “Regional Water Board” can implement “additional requirements for a proposed recharge project that has a substantial adverse effect on the fate and transport of a contaminant plume or changes the geochemistry of an aquifer thereby causing the dissolution of constituents, such as arsenic, from the geologic formation into groundwater.”

3.4.2.3 Anti-degradation

As stated in the Recycled Water Policy, "the proponent of a groundwater recharge project must demonstrate compliance with Resolution No. 68-16. Until such time as the City's SNMP is completed, such compliance may be demonstrated as follows:

- A project that utilizes less than 10 percent of the available assimilative capacity in a basin/sub-basin (or multiple projects utilizing less than 20 percent of the available assimilative capacity in a basin/sub-basin) need only conduct an antidegradation analysis verifying the use of the assimilative capacity. For those basins/sub-basins where the Regional Water Boards have not determined the baseline assimilative capacity, the baseline assimilative capacity shall be calculated by the initial project proponent, with review and approval by the Regional Water Board, until such time as the salt/nutrient plan is approved by the Regional Water Board and is in effect. For compliance with this subparagraph, the available assimilative capacity shall be calculated by comparing the mineral water quality objective with the average concentration of the basin/sub-basin, either over the most recent five years of data available or using a data set approved by the Regional Water Board Executive Officer. In determining whether the available assimilative capacity will be exceeded by the project or projects, the Regional Water Board shall calculate the impacts of the project or projects over at least a ten-year time frame.
- In the event a project or multiple projects utilize more than the fraction of the assimilative capacity designated in subparagraph (1), then a Regional Water Board-deemed acceptable antidegradation analysis shall be performed to comply with Resolution No. 68-16. The project proponent shall provide sufficient information for the Regional Water Board to make this determination. An example of an approved method is the method used by the State Water Board in connection with Resolution No. 2004-0060 and the Regional Water Board in connection with Resolution No. R8-2004-0001. An integrated approach (using surface water, groundwater, recycled water, stormwater, pollution prevention, water conservation, etc.) to the implementation of Resolution No. 68-16 is encouraged."

The regional groundwater quality is presented in Section 12 of this report. A review of anti-degradation and assimilative capacity is included in Section 14 of this report.

3.4.2.4 CEC Monitoring

The Recycled Water Policy addresses CECs and acknowledges that the state of knowledge on CECs is incomplete. CEC concentrations in finished water should be minimized through effective source control and treatment programs. The monitoring of specific CECs is required for groundwater recharge projects, and the CEC requirements for injection projects are reviewed in Section 9 of this Engineer's Report.

3.5 Recycled Water Conveyance Pipeline

The advanced treated recycled water is pumped from the AWPF north in an existing recycled water backbone line and to the east to serve farmers. These lines are feeding recycled water to several non-potable applications. The line currently terminates near the River Park Development. Spurs from this line will be constructed to carry the recycled water to the West for the ASR application and to the North for future spreading operations.

3.6 Spreading Facilities

In addition to the proposed ASR application, the City has investigated potential potable reuse spreading applications at other locations within the City (Woolsey Pits, Ferro Pits). At this time, the City does not intend to pursue these alternatives.

3.7 Injection Facilities

The injection and monitoring facilities must meet the criteria of CDPH (2014), including section 60320.226. This section specifies:

- Prior to operating a Groundwater Replenishment Reuse Project (GRRP), a project sponsor shall site and construct at least two monitoring wells downgradient of the GRRP such that:
    - At least one monitoring well is located no less than two weeks but no more than six months of travel time from the GRRP, and at least 30 days upgradient of the nearest drinking water well.
    - At least one monitoring well is located between the GRRP and the nearest drinking water well.

For this project, sufficient monitoring wells are proposed that meet CDPH (2014), as detailed in Section 11.

4.0 SOURCE WATER FOR POTABLE REUSE

The production of purified water starts with an effective source control program and is followed by reliable primary and secondary treatment. Source water, and an enhanced source water control program, are detailed in the following report, which is intended as a stand-alone document, but also vital to this Engineering Report: *Indirect Potable Reuse Enhanced Source Water Control and Collection System Monitoring Program* (Carollo, 2016a); also attached here as Appendix A. Sections from that report are briefly summarized here.

The OWTP is permitted under Waste Discharge Requirements Order No. R4-2013-0094 (NPDES No. CA0054097), which was issued to the City in June 2013, and operates an EPA-approved industrial pretreatment program. That program is operating based upon an approved Local Limits program (from 1999). Oxnard is now updating that Local Limits program.

The regulatory requirements for wastewater source control are defined in Section 60320.206 of the regulations for groundwater recharge with recycled water (CDPH, 2014). For this project, the City must administer an industrial pretreatment and pollutant source control program that includes, at a minimum:

A. An assessment of the fate of Department-specified and RWQCB-specified chemicals and contaminants through the wastewater and recycled municipal wastewater treatment systems.

B. Chemical and contaminant source investigations and monitoring that focuses on Department-specified and RWQCB-specified chemicals and contaminants.

C. An outreach program to industrial, commercial, and residential communities within the portions of the sewage collection agency's service area that flows into the water reclamation plant subsequently supplying the GRRP, for the purpose of managing and minimizing the discharge of chemicals and contaminants at the source.

D. A current inventory of chemicals and contaminants identified pursuant to this section, including new chemicals and contaminants resulting from new sources or changes to existing sources, that may be discharged into the wastewater collection system.

E. Is compliant with the effluent limits established in the wastewater management agency's RWQCB permit.

The referenced report (*Indirect Potable Reuse Enhanced Source Water Control and Collection System Monitoring Program)*, included as Appendix A, is intended to address each of these items to the satisfaction of the Division of Drinking Water (DDW).

The Enhanced Source Control Monitoring Program (ESCMP) builds on the existing source control program already in place at the City of Oxnard; including:

- A source control program manager overseeing all data collection and regulatory issues relating to discharge from the first user to groundwater wells.
- More frequent sampling than required in the secondary effluent and AWPF finished water, including regulated, unregulated and industry-specific constituents.
- Use of historical and operationally collected online monitoring data required for operation to create baselines and predict trends in process performance.
- Heavily involved industrial outreach programs and residential outreach programs for potable reuse education and discharge initiatives.
- Mapping strategies for fast-acting collection system tracing of detected contaminants of health concern.

- Optional additions to discharge mapping, including hospitals.
- Ensure all SIUs report monthly and annual TTO monitoring results.
- Annual review of slug discharge control plans from SIUs.

5.0 PATHOGEN MICROORGANISM CONTROL

CDPH (2014) requires that potable reuse projects for groundwater recharge provide a combined level of treatment resulting in 12-log virus reduction, 10-log *Giardia* reduction, and 10-log *Cryptosporidium* reduction (12/10/10-log removal). No single process can receive more than 6-log reduction credit. CDPH (2014) also states that at least three processes must provide at least 1-log reduction. Beyond those three key processes, processes which provide <1-log reduction can be included within the analysis.

The step-by-step removal of pathogens, from raw wastewater to the production of potable water is reviewed below.

5.1 Primary and Secondary Treatment

Table 2-3 of USEPA (1986) lists less than 10 percent removal of total coliforms, 35 percent removal of fecal coliforms, and less than 10 percent removal of virus through primary treatment. Protozoa removal through primary treatment is not listed. The same Table (2-3) includes bacteria and virus removal percentages for secondary treatment (not including disinfection), indicating 90 to 99 percent removal of both total and fecal coliforms, and 76 to 99 percent removal of virus.

Francy *et al.* (2012) indicates 99 to 99.98 percent removal of bacteria and 88 to 99.9995 percent removal of various virus and coliphage. The single data set with any data below 90 percent removal, which was for adenovirus, showed removal ranging from 88 to 99.93 percent with a median removal of 99.8 percent.

One of the most recent DDW approval of pathogen removal credits for combined primary and secondary treatment, was obtained by the Water Replenishment District (WRD) (2013). That document relied upon risk analysis data presented in Olivieri *et al.* (2007) which was developed based upon Rose *et al.* (2004). Within Rose *et al.* (2004), the research team defined the range of bacteria, enterovirus, *Cryptosporidium*, and *Giardia* removal through six different full-scale wastewater treatment plants. The raw data from that work is reported in Olivieri *et al.* (2007). For WRD (2013), the pathogen removal credits for their secondary process were based upon the data from two of the six tested secondary process configurations. Specifically, two of the secondary process trains (Facilities C and D, with SRTs of 1.6-2.7 days and 3-5 days, respectively) had SRT values less than the secondary process feeding the WRD advanced treatment system (>9 days), and thus are presumed to be conservative estimates of performance. Per CDPH request, WRD (2013) used the lower 10th percentile values calculated for each pathogen, resulting in 2.06-log reduction of enterovirus, 1.42-log reduction of *Cryptosporidium*, and 2.42-log reduction of *Giardia.* Note that analysis of the same data set by Carollo Engineers found one data translation error, but the overall impact on the log reduction credits is minimal.

Interpretations of the data set (Rose *et al.,* 2004) suggest that longer SRT values result in increased pathogen removal. While this may be the case, the raw data from Rose *et al.* (2004) does not show this clearly (Table 4). For example, Facility F from that research with the longer SRT has reduced protozoa reduction than most of the other facilities, but also shows the best virus removal compared to the other facilities. The lowest virus removal occurs at Facility A, which has an SRT of 6 to 8 days, similar to the TIWRP. This data set is limited and making projections based upon SRT is speculative. Without site-specific data, our team recommends using the lower 10th percentile of the entire data set in Table 4, which results in 1.9-log reduction of virus, 1.2-log reduction of *Cryptosporidium*, and 0.8-log reduction of *Giardia*.

Table 4 Pathogen Reduction Values Through Primary and Secondary Treatment (from Rose *et al.*, 2004)
Advanced Water Purification Facility
City of Oxnard

Lower 10th Percentile Values		**Log Reduction**		
SRT	**Facility**	**Enterovirus**	***Giardia***	**Crypto**
1.6-2.7	C	1.8	2.6	1.25
3-5	D	2.05	1.35	1.4
3.5-6	B	1.95	2.45	1.6
6-8	A	1.65	0.8	0.7
8.7-13.3	E	1.75	2.6	1.9
8-16	F	2.6	0.9	0.25
1.6-16	**ALL**	**1.85**	**0.8**	**1.2**
7-8	***Projected for OWTP***	***1.9***	***0.8***	***1.2***
50th Percentile Values		**Log Reduction**		
SRT	**Facility**	**Enterovirus**	***Giardia***	**Crypto**
1.6-2.7	C	2.05	3.05	1.65
3-5	D	2.5	1.9	2.6
3.5-6	B	2.25	2.6	1.9
6-8	A	2.1	1.6	1.1
8.7-13.3	E	2.2	2.8	2.1
8-16	F	2.75	1.1	0.95
1.6-16	**ALL**	**2.3**	**2.6**	**1.6**
7-8	***Projected for OWTP***	***2.3***	***2.6***	***1.6***

As part of WateReuse Research Foundation Project 14-16, Oxnard has been researching the pathogen removal by the OWTP, in an effort to supplement, and potentially better understand, pathogen removal through the primary and secondary processes. The work, as of yet unpublished, examines a range of pathogens (*Giardia, Cryptosporidium*, norovirus, total culturable virus, *E. coli*), biological surrogates (enterococci, total coliform, male specific coliphage, somatic coliphage), chemical surrogates (UV Absorbance, TOC, DOC, BOD), and innovative monitoring (fluorescence). The laboratory work was done by Southern Nevada Water Authority (chemistry) and BioVir (biology). Spanning nearly 12 months, with sampling over 6 dates (four data sets are currently complete), the project team is developing an understanding of pathogen concentrations and removal (Figures 7, 8, and 9).

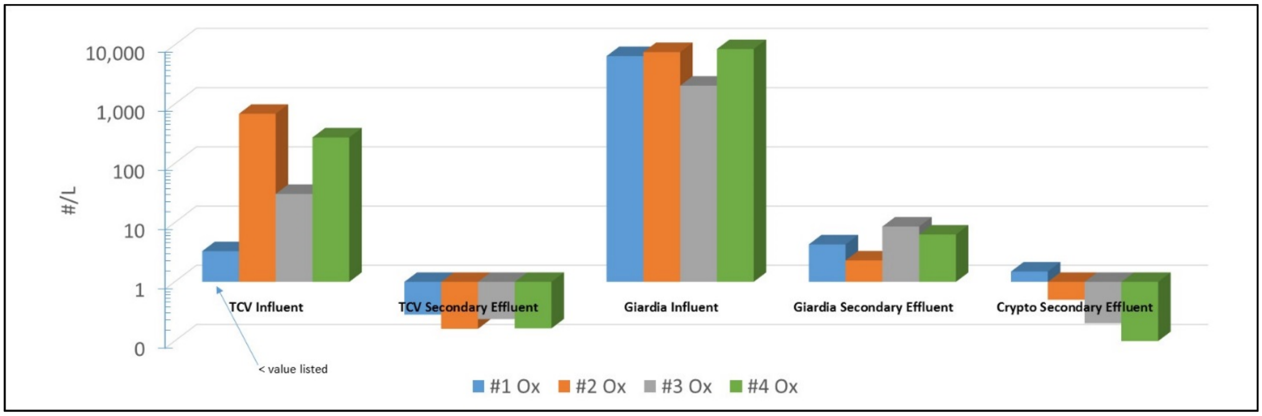

Figure 7 Total Culturable Virus, *Giardia*, and *Cryptosporidium* Concentrations in Raw Wastewater and Secondary Effluent for Oxnard

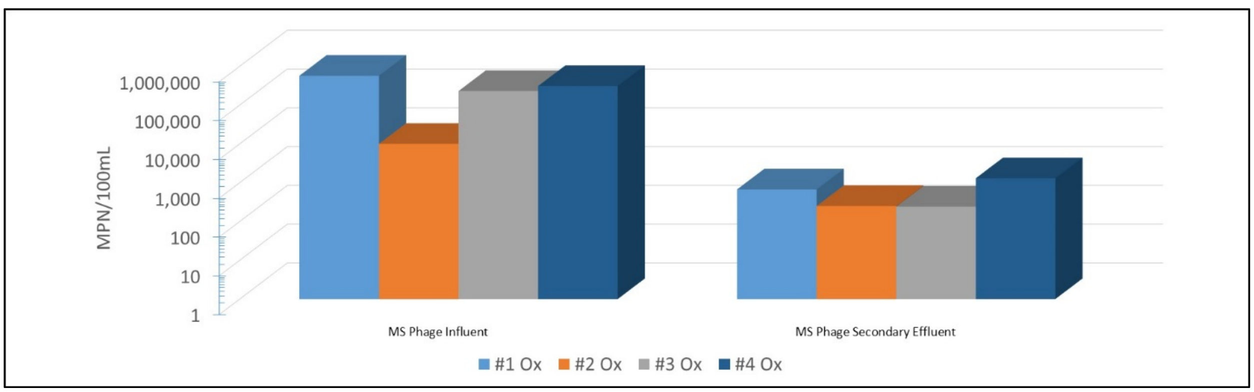

Figure 8 Male Specific Phage Concentrations in Raw Wastewater and Secondary Effluent for Oxnard

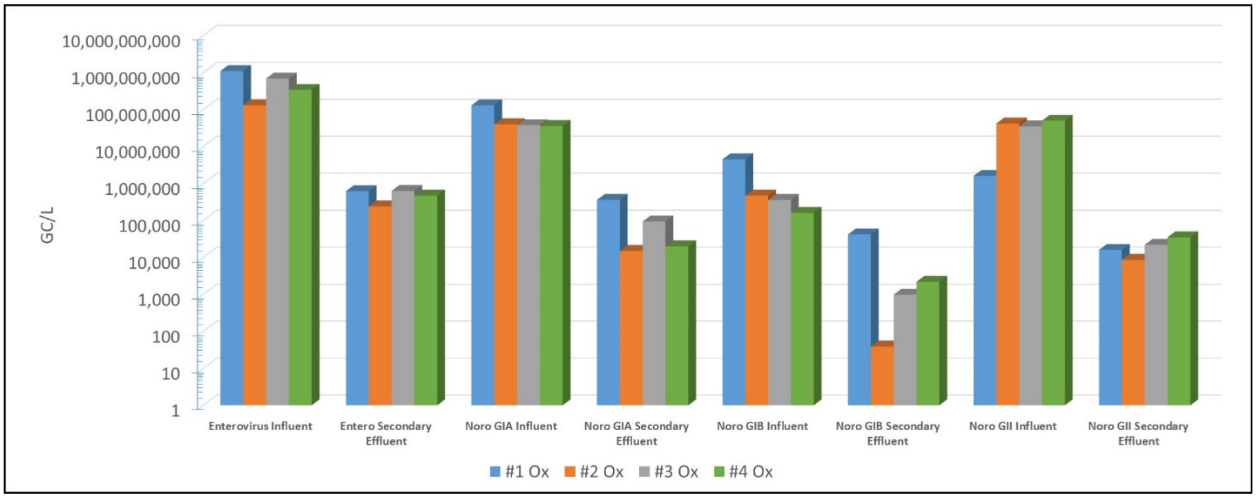

Figure 9 Enterovirus and Norovirus Concentrations in Raw Wastewater and Secondary Effluent for Oxnard

Analytical difficulty with *Cryptosporidium* enumeration inhibited calculation of log reduction for this organism. Log removal values (LRVs) for all other organisms were:

- Male Specific Phage - 1.6 to 2.98 LRV, with an average value of 2.47 LRV.
- Giardia - 2.38 to 3.52 LRV, with an average value of 3.05 LRV.
- Enterovirus - 2.7 to 3.2 LRV, with an average value of 2.97 LRV.
- Total Culturable Virus - 2.1 to 3.6 LRV, with an average value of 2.99 LRV.
- Norovirus Type GIA - 2.6 to 3.4 LRV, with an average value of 2.96 LRV.
- Norovirus Type GIB - 1.9 to 4.1 LRV, with an average value of 2.63 LRV.
- Norovirus Type GII - 2.0 to 3.7 LRV, with an average value of 3.01 LRV.

While raw wastewater and secondary effluent were sampled on the same day, the samples were not time-coupled, meaning that they do not necessarily represent the same drop of water and thus the average log reductions are likely more representative of performance compared to individual numbers. Using the lowest average for all virus removal and the average for Giardia removal, reasonable LRVs for protozoa and virus are 3-log and 2.5 log, respectively. **If we were to assume accuracy in the individual sample events and use the lowest measured reductions for protozoa and virus (not coliphage), we would result in 2.4-log and 1.9-log, respectively.** DDW, in a letter dated December 5, 2016, acknowledged the value of this new research to the industry, but raises important concerns regarding the lack of a surrogate to monitor log removal performance. As a result, DDW has stated that they will only approve the lower log removal values from Rose et al (2004); 1.9-log reduction of virus, 1.2-log reduction of *Cryptosporidium*, and 0.8-log reduction of *Giardia*.

The concentrations of the organisms in the secondary effluent also allow for an analysis of risk. Water treatment regulations for pathogens are predicated on reducing the risk of infection to minimal levels. For this project, the team has targeted the concentration end goals for pathogens that correspond to a modeled, annual risk of infection of 1 in 10,000 or less (Trussell *et al.*, 2013). DDW used this risk level to develop their pathogen criteria (CDPH, 2014a) and NWRI used this risk level to develop their pathogen criteria (NWRI, 2013). This risk level corresponds to the following potable water concentrations:

- *Giardia* - 6.80E-06 cysts/L.
- Cryptosporidium - 3.00E-05 oocysts/L.
- Enteric virus - 2.22E-07 MPN/L.

Giardia and *Cryptosporidium* results varied from 2.3 to 8.6 #/L and <0.1 to 1.5 #/L, respectively. Taking the highest count for each *Giardia* and *Cryptosporidium* results in a need for 6.1-log and 4.7-log of additional treatment following the secondary process to meet the risk-based levels above. Considering that subsequent MF treatment will provide 4-log protozoa removal, the subsequent RO will provide 1 to 2-log protozoa removal, and subsequent UV will provide 6-log protozoa removal, protozoa in the finished water does not represent a health concern.

For virus, there are many more data sets to evaluate. Total culturable virus concentrations in secondary effluent were 0.16 to 0.28 MPN/L. Taking the highest count results in a need for 6.1-log of additional treatment following the secondary process to meet the risk-based levels above. Considering that subsequent RO will provide 1 to 2-log virus removal and subsequent UV will provide 6-log virus removal, total culturable virus concentrations in the finished water does not represent a health concern.

Enterovirus, norovirus GIA, norovirus GIB, and norovirus GII had concentrations of 240,000 to 630,000, 15,000 to 360,000, 39 to 42,000, and 8,600 to 35,000 GC/L, respectively. ***An important difference*** between the total culturable virus test and the other tests is the use of a culture to measure viable organisms in the former, while the measurement of gene copies in the latter. Gene copy numbers do not necessarily correlate to viable pathogens and this is a current topic of research within our industry. A highly conservative approach would be to assume all gene copies to be viable pathogens. Following that approach and using the highest GC/L counts, an additional 11 to 12-log removal of virus would be needed through subsequent processes. Considering that subsequent RO will provide 1 to 2-log virus removal, subsequent UV will provide 6-log virus removal, and groundwater recharge can provide up to 6-log virus removal (depending upon travel/storage time), the finished water does not represent a health concern.

5.2 MF

Reardon *et al.* (2005) reported numerous studies showing bacteria rejection of 3 to 9 logs, protozoa rejection of 4 to 7 logs, and unreliable rejection of virus. The AWPF utilizes Pall Microza MF membranes, which are credited by CDPH for 4-log protozoa removal and 0.5-log virus removal (95 percent of the time), as documented by CDPH (2011). According to the Supplier's documentation, which cites USEPA (2003) and Sethi (2002) to calculate a maximum allowable pressure decay test (PDT) result that correlates to a specific protozoa log reduction.

Pall's approach is to use the maximum allowable TMP, the minimum feed water temperature, the maximum filtrate flow (27.2 gfd based upon the maximum flux in the Pall Operating Protocol and as measured in their 2011 Initial Performance Test), and a default VCF of 1.08. The result is that a PDT of 0.16 psi/min equates to a protozoa LRV of 4, which equates to a PDT of 0.80 psi/5min. Details on Pall's approach can be found in Appendix C.

Extensive SCADA data exists demonstrating compliance with this maximum PDT. As part of start-up demonstration testing of Oxnard's purification processes in April, May, and June of 2016, Carollo staff recorded a handful of PDTs and turbidity values, as shown below.

- **4/27/2016:** Rack 2 - 0.2, Rack 3 - 0.2, Rack 4 - 0.18, Rack 5 - 0.18, Rack 6 - 0.20
- **5/2/2016:** Rack 1 - 0.31, Rack 2 - 0.2, Rack 3 - 0.17
- **5/3/2016:** Rack 1 - 0.26, Rack 4 - 0.17, Rack 5 - 0.15, Rack 6 - 0.16
- **6/3/2016:** Rack 1 - 0.25, Rack 2 - 0.20, Rack 3 - 0.18, Rack 4 - 0.18, Rack 5 - 0.16, Rack 6 - 0.22
- **Influent Turbidity:** 3.48 to 5.09
- **Effluent Turbidity:** 0.04 to 0.10

During the May site visit and inspection, MF influent and effluent samples were also collected to analyze the particle size distribution (PSD). The analysis was done with Carollo’s optical particle sizer/counter (PSS AccuSizer 780/SIS), with a sensitivity down to approximately 1 micron (Figure 10). The goal of the PSD testing was to set a baseline of performance for particle removal, focusing on the size range of protozoa (4 to 15 microns). The results demonstrate >3-log removal of particles in the 4 and 5 micron range, affirming the PDT performance shown above.

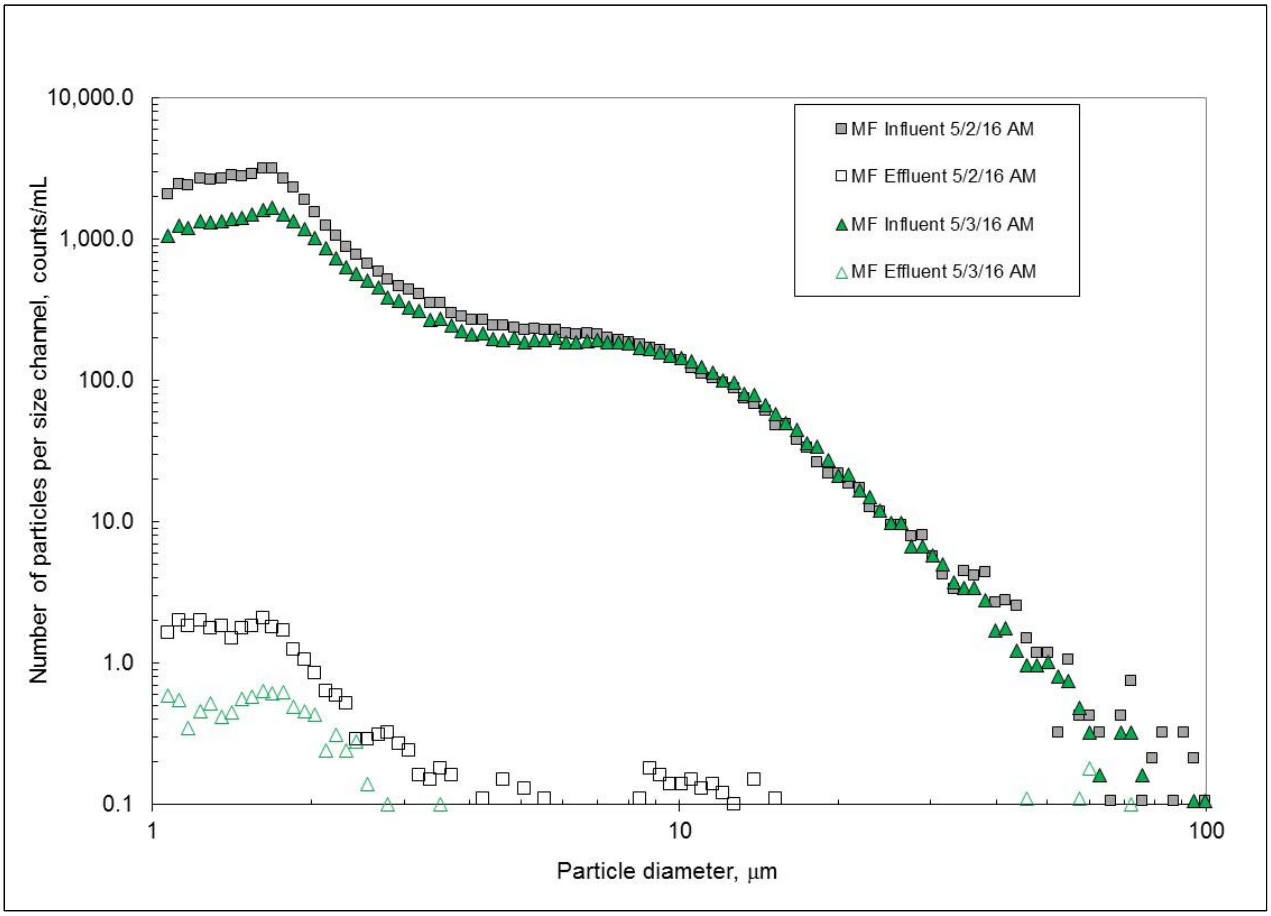

Figure 10 Particle Size Distribution for MF Influent and Effluent (5/2/16 and 5/3/16)

Online turbidity and PDT measurements for December 2014 through June 2016 are shown as Figures 11 and 12, respectively. The online results back demonstration results previously presented, showing the MF in normal operation at Oxnard is able to consistently achieve the PDT target. Online microfiltration filtrate turbidity measurements confirm a required effluent turbidity limit of <0.2 NTU is consistently met. Exceedances of 0.2 NTU in the MF filtrate were seen when 1) the online turbidimeter requires cleaning and calibration or 2) when the plant is cycling through a startup period and flow has not yet stabilized. Influent turbidity concentrations from secondary effluent, typically range between 1 - 6 NTU. Benchtop and online turbidimeter measurements during testing showed consistency when compared.

Overall, the City proposes to use 0-log virus reduction credit and 4-log protozoa reduction credit for this Pall membrane. No virus credit is sought because PDTs do not have sufficient resolution to measure virus removal performance.

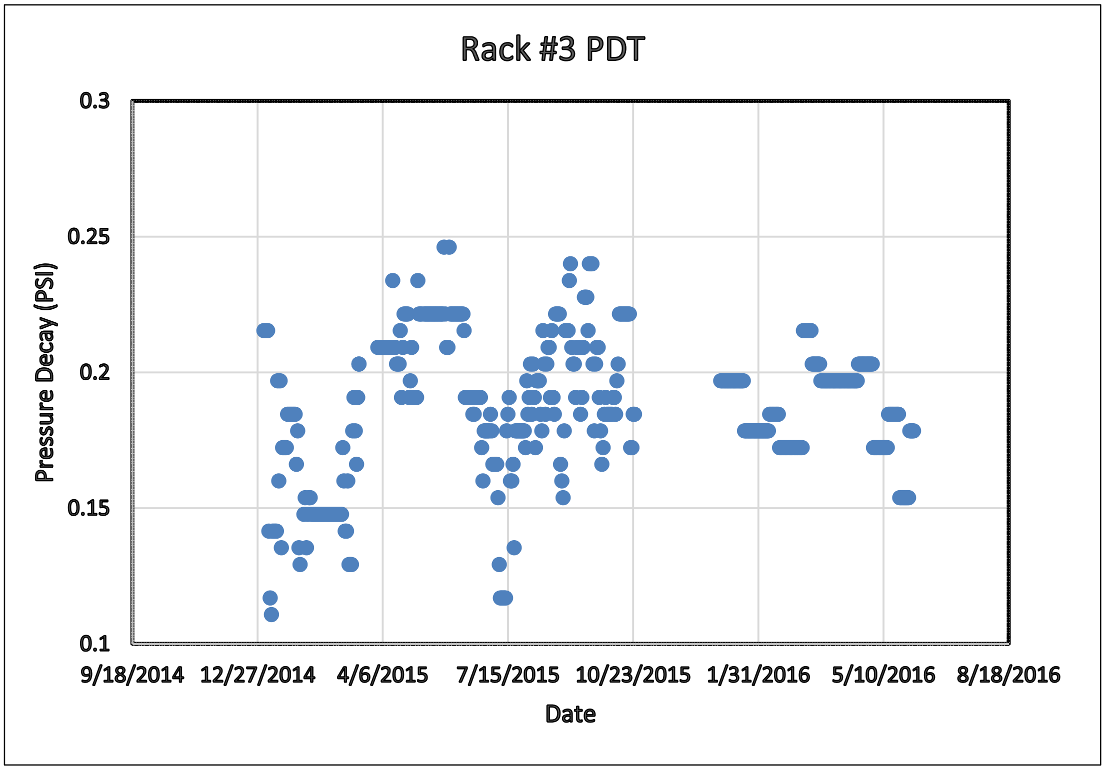

Figure 11 MF Online PDT Results for December 2014 through June 2016

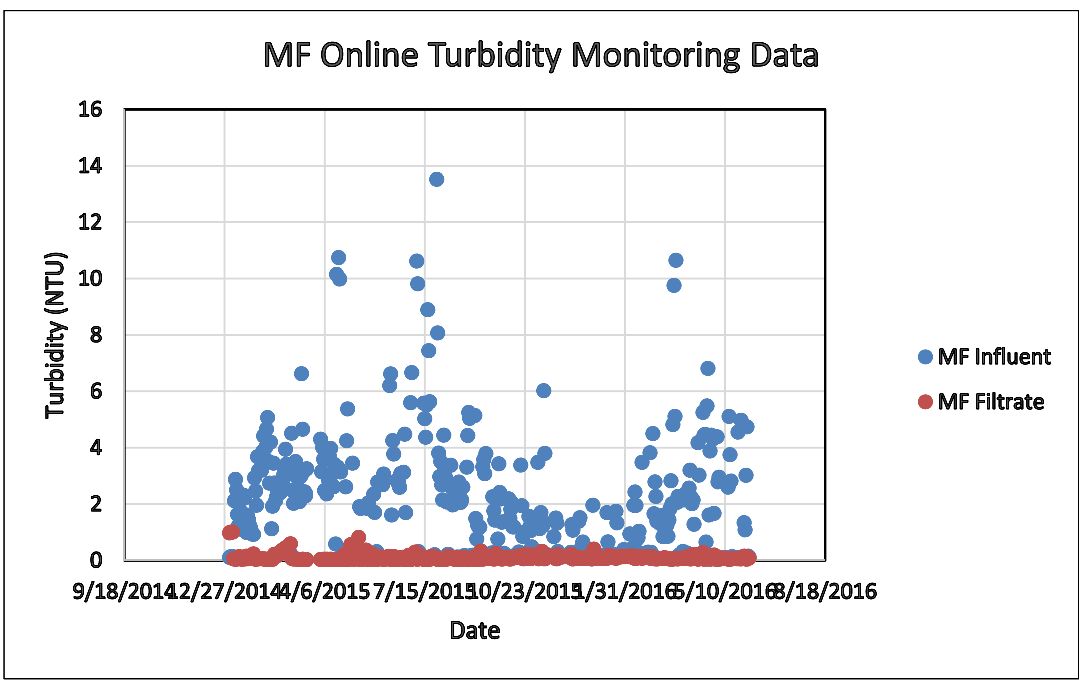

Figure 12 MF Influent and Filtrate Online Turbidity Data for December 2014 through June 2016

5.3 Reverse Osmosis

RO process performance for pathogen rejection is not governed by the ability of an intact membrane to reject pathogens but by the ability to monitor process integrity (Reardon *et al.* (2005) and Schäfer *et al.* (2005)). The monitoring tools currently used, electrical conductivity meters and total organic carbon (TOC) meters, can measure 99 percent or less removal of both parameters through the RO process. Recently, the CDPH granted 1.5-log reduction credit for all pathogens (i.e., virus, *Giardia*, and *Cryptosporidium*) for RO (WRD, 2013), based upon a requirement to continuously monitor TOC reduction across RO.

Currently, the City only measures EC across the RO membranes. During the Carollo performance demonstration testing and site audit, our team collected EC data.

- **5/2/2016:** Influent EC 2693 to 2787 µS/cm, Effluent EC 107 to 134 µS/cm.
- **EC LRV is 1.3 to 1.4.**

Monitoring and performance data showing online EC measurements of the RO system from March - May 2016 are displayed in Figure 13, with the average, minimum and maximum LRV results by train shown in Table 5 and Figure 14. The online data confirms The site inspection results from Carollo, showing an average of 1.47 LRV from a 3 month period, with a minimum LRV of ~1.29. These online results indicate consistent and reliable LRV of EC, that can be confidently correlated to pathogen removal credits.

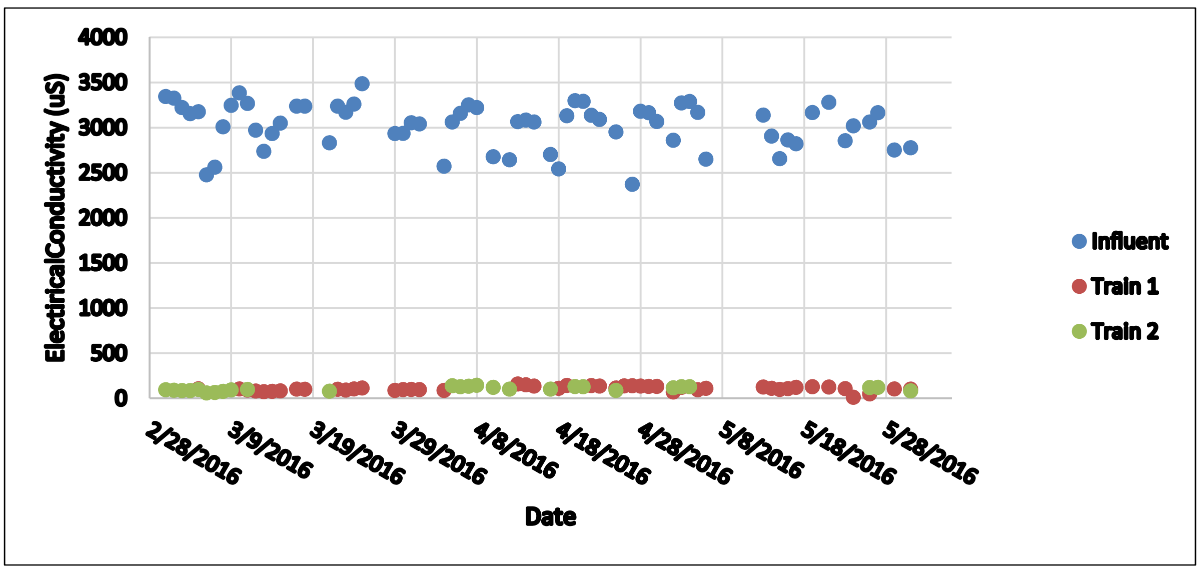

Figure 13 Influent and Effluent Historical (March 2016 - May 2016) Electrical Conductivity Online Data

Table 5	Average, Minimum and Maximum EC LRV through RO treatment March 2016 - May 2016 Advanced Water Purification Facility City of Oxnard		
	Train 1 LRV	**Train 2 LRV**	**Total Perm LRV**
Average	1.47	1.47	1.47
Min	1.23	1.34	1.29
Max	2.44	1.62	2.03

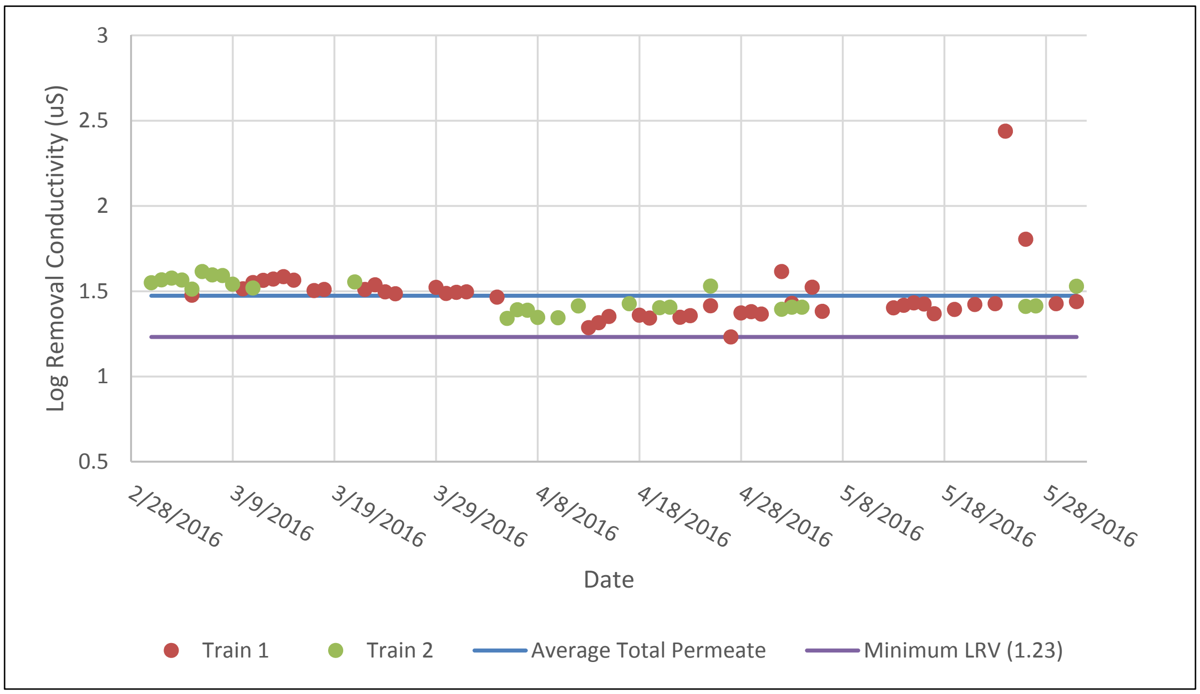

Figure 14 EC LRV Online Monitoring Data March 2016 - May 2016

The AWPF does not have online TOC meters, though intends to install them in the near future prior to operation. Grab samples were taken during the May Carollo inspection to document TOC removal across the RO process. TOC concentrations in the RO feed was 16 mg/L (on both 5/2 and 5/3), whereas RO permeate TOC concentrations were at the detection limit of 0.3 mg/L or below detection (again on 5/2 and 5/3). The LRV for this limited TOC data set is 1.7, suggesting that TOC reduction may be a more sensitive monitoring tool for RO performance and RO LRV credits.

In the April 2016 letter from DDW to the City, DDW stated that "online EC can show log reduction value (LRV) of approximately 0.5 to 1.0". The data collected here demonstrates a higher level of performance monitoring, with a minimum of 1.3 LRV. The City proposed to use the 1.3-log reduction value for all pathogens for RO at this time and use EC to monitor the performance of the system. DDW, in a letter dated December 5, 2016, approved a credit of 1-log based upon EC monitoring. *In the future, the AWPF intends to install TOC meters and potentially demonstrate higher LRV credits using this or other advanced monitoring (such as online fluorescence) resulting higher pathogen removal credit.*

5.4 UV Advanced Oxidation

The UV advanced oxidation process (AOP) provides three primary values:

- Disinfection.
- NDMA Destruction by Photolysis.
- Trace Chemical Destruction Through Advanced Oxidation (1,4-dioxane).

Following RO treatment, advanced oxidation is accomplished through the use of UV and hydrogen peroxide (H_2O_2), with an H_2O_2 dose of up to 6 mg/L. The UV system is the D72AL75, which has gone through extensive validation for non-potable water reuse applications and is the same reactor as the ones used at the OCWD for the Groundwater Replenishment System. For the AWPF, there are three D72AL75 reactors in series (stacked). The “D” in “D72AL75 means “dual”, as each reactor actually has two banks of lamps within it. This system is designed with redundancy, with five banks of lamps required for operation and the sixth bank of lamps for redundancy.

Note: The discussion here, which is in the disinfection section of this report, focuses upon all three components of performance, disinfection, NDMA destruction, and 1,4-dioxane destruction; as each of the three data sets are necessary to fully understand UV AOP performance and the recommended controls.

5.4.1 Current UV System Controls

Historically, UV AOP systems have been controlled to provide a target EEO, or electrical energy use per order of magnitude destruction of a target pollutant. UVI and a pure "dose" based control has yet to be implemented for the various installed UV AOP systems for potable water reuse in California (e.g., OCWD, WBMWD, WRD), but will soon be implemented for the City of Los Angeles' Terminal Island facility.

The target of the City's UV AOP control system is to provide sufficient power to achieve a required level of treatment (removal) of the target compound, NDMA. The control system calculates the target power for a UV system via the EE/O metric. EE/O as a function of flow rate and UVT is computed by the system, and adjusted for a Lamp Efficiency Factor (LEF), based on the target contaminant removal setpoint. The power modulation can be described as:

Power = a x f(flow, UVT, LEF*), where

a = Trojan-specific empirical factor, and

LEF = f(lamp age, temperature, power level efficiency)

The present power (summation of all power output by the system at any timepoint) is then compared to the target power (based on a LRV contaminant setpoint), to allow for power reduction in times of low flow or high UVT as the present power should be greater than the target power.

The current target NDMA LRV setpoint for Oxnard is 1.0. As part of startup testing, the Carollo/Oxnard team obtained SCADA data to document the performance of the existing control system to meet the 1.0 NDMA LRV metric. Actual system LRV outputs and UVT values are recorded by plant staff directly from the UV system monitoring screen every 4 hours. Data provided by plant staff from 9/27 and 9/28/16 show the system's response to changes in UVT in terms of LRV achieved (Figure 15). All LRV values were above the setpoint of 1.0, showing the system was meeting the target setpoint at all times during the two days analyzed.

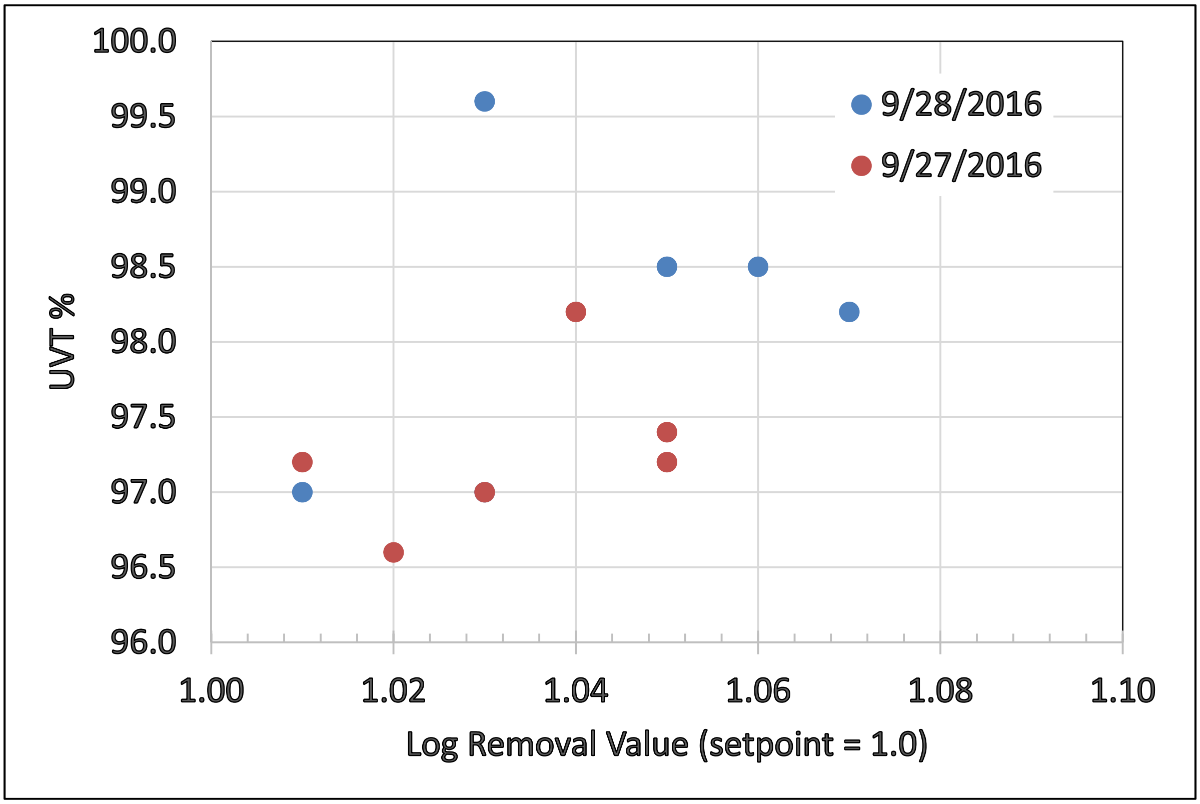

Figure 15 Percent UVT and corresponding Log Removal Values for 9/27 and 9/28/2016

The LRV-based control takes into account changes in flow rate and UVT. Additional data was collected showing the system's response to UVT and flow for the same 9/27 - 9/28/2016 dates, Figure 16. This result confirms the system's control philosophy is functioning as intended.

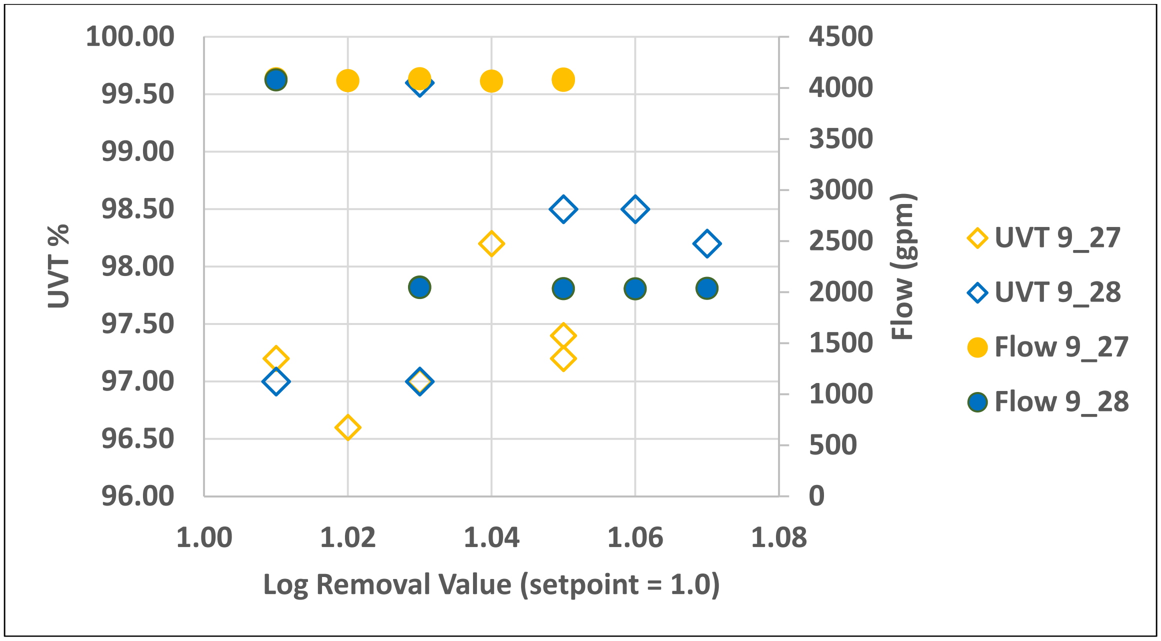

Figure 16 UV Log Removal Value as a Function of UVT and Flow

Power modulation is the final step in the UV AOP control strategy. The apparent power and target power across the UV system was analyzed for consistency across 9/27 and 9/28 operation (Figure 17). This consistency shows the UV system's ability to modulate the power to limit the energy input to the system to only what is necessary to meet the target power at any given time based on the UVT and flow.

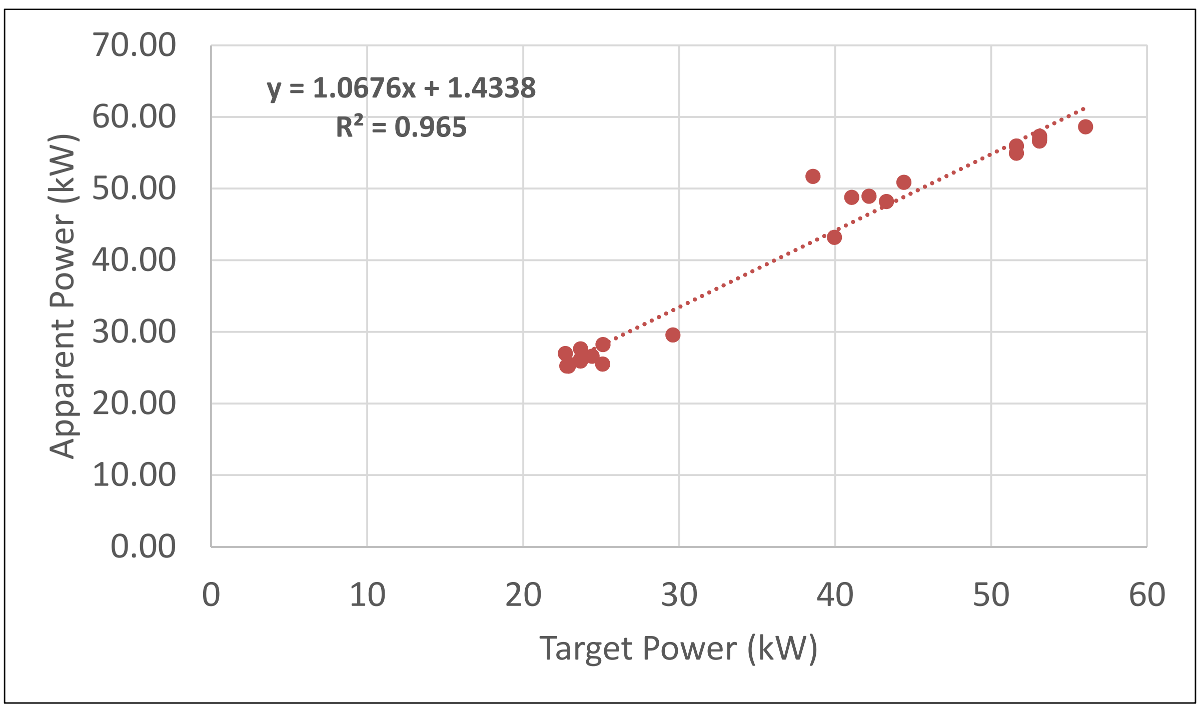

Figure 17 Apparent Power vs. Target Power (data collected 9/25 - 9/28/16)

The sections and analysis that follows evaluates the capacity of the installed UV AOP to destroy NDMA, pathogens, and 1,4-dioxane; then determine if the existing control system (as defined above) is sufficient or if it needs some level of adjustment.

5.4.2 UV Sensor Performance

Though UVI is not an active control within the UV system (at this time), the Carollo project team did a preliminary analysis of sensors for the installed 6-bank UV system. The orientation of the reactor sets the naming of the reactors and the corresponding UVI sensors, as shown in Figure 18 below; LWR LFT (lower left), MID RHT (middle right), and HGH LFT (high left) are three naming examples. Note that in the figure below, the terms "left" and "right" refer to the direction of flow (with flow going from left to right), not the visual location of the banks.

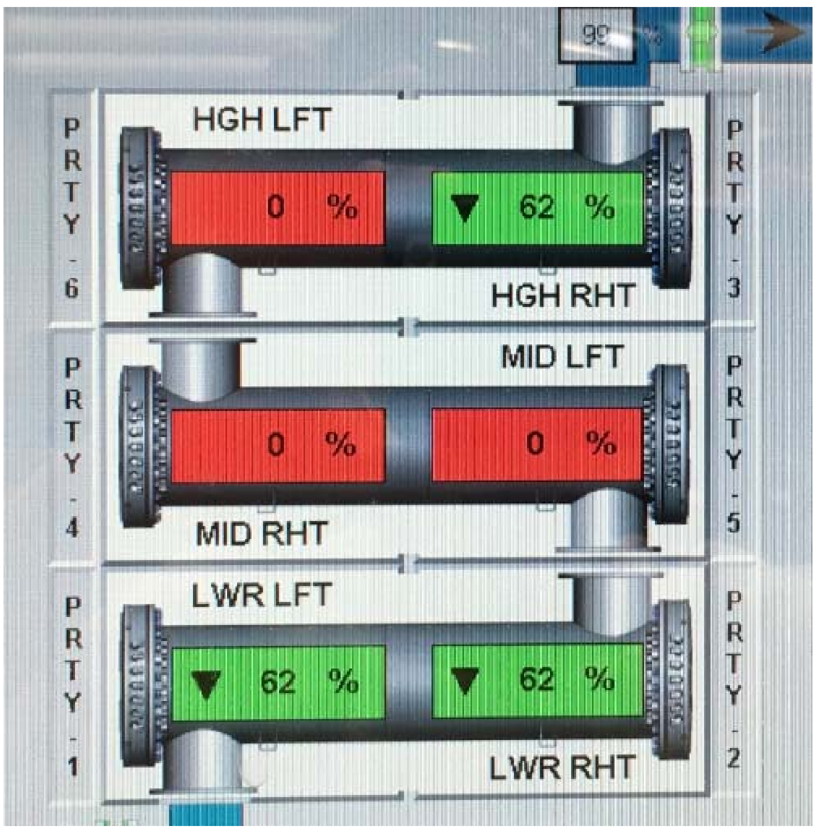

Figure 18 Screenshot of Trojan HMI at Oxnard

Through twenty-two different tests, different flow, different UVT, different # of reactors, and different reactor power settings were used. UVT transmittance readings were taken from an online meter, from a calibrated bench-top meter, and with laboratory grab sampling with subsequent analysis. Samples were taken before and after UV. For this analysis, only samples from the influent side of the UV were used, and only the results from the calibrated bench-top meter were used. The logic of this approach is based upon our team's confidence in the accuracy of the bench-top meter coupled with the future method of system monitoring, which is UVT on the influent to the UV system.

The sensor results are shown in Figure 19 below. Substantial sensor variability was shown. At a basic level, the sensors did track changes in UVT and power.

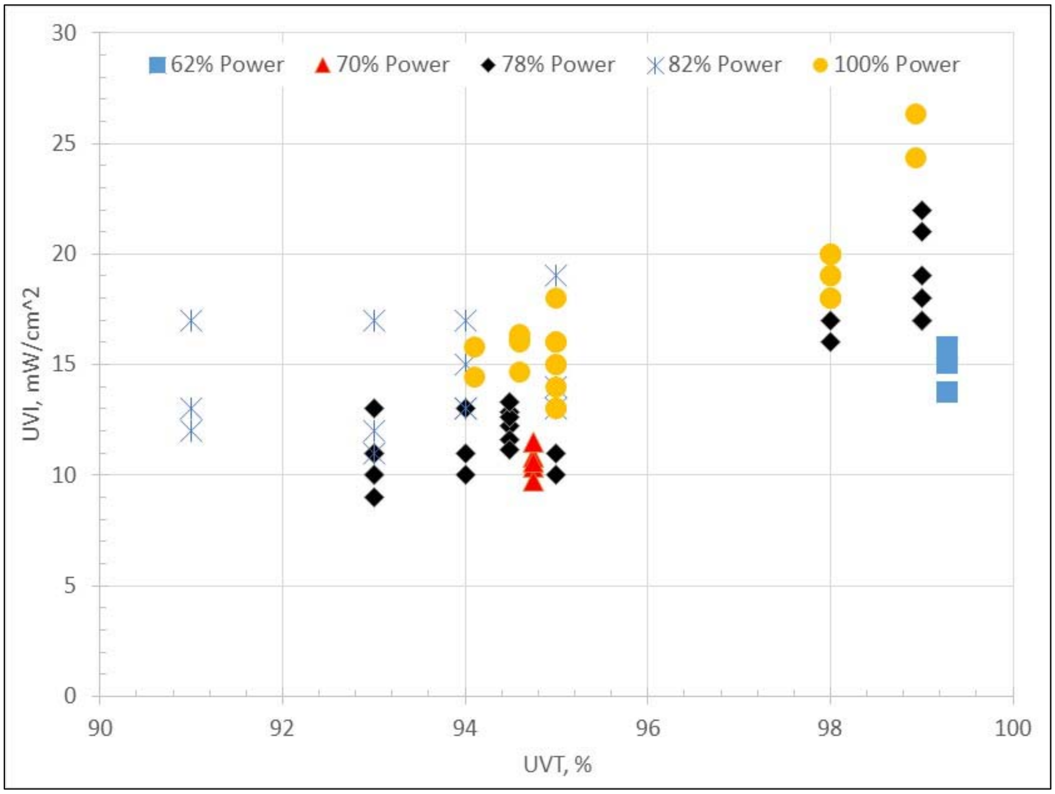

Figure 19 Sensor Values for Different UVT and Power Values

Using the sensor data points, a predictive formula was developed for the sensors. Sensor intensity is a function of UV absorbance (UVA) and ballast power (BP), as follows:

$$S = 10^{A} \times UVA^{B} \times BP^{C}$$

Where:

A = -1.27979

B = -0.25179

C = 1.02881

This formula results in an R^2 value of 0.92, which indicates a good measure of data variability. The prediction residuals are shown in Figure 20, demonstrating the accuracy of the predictive formula to be plus or minus 20 percent.

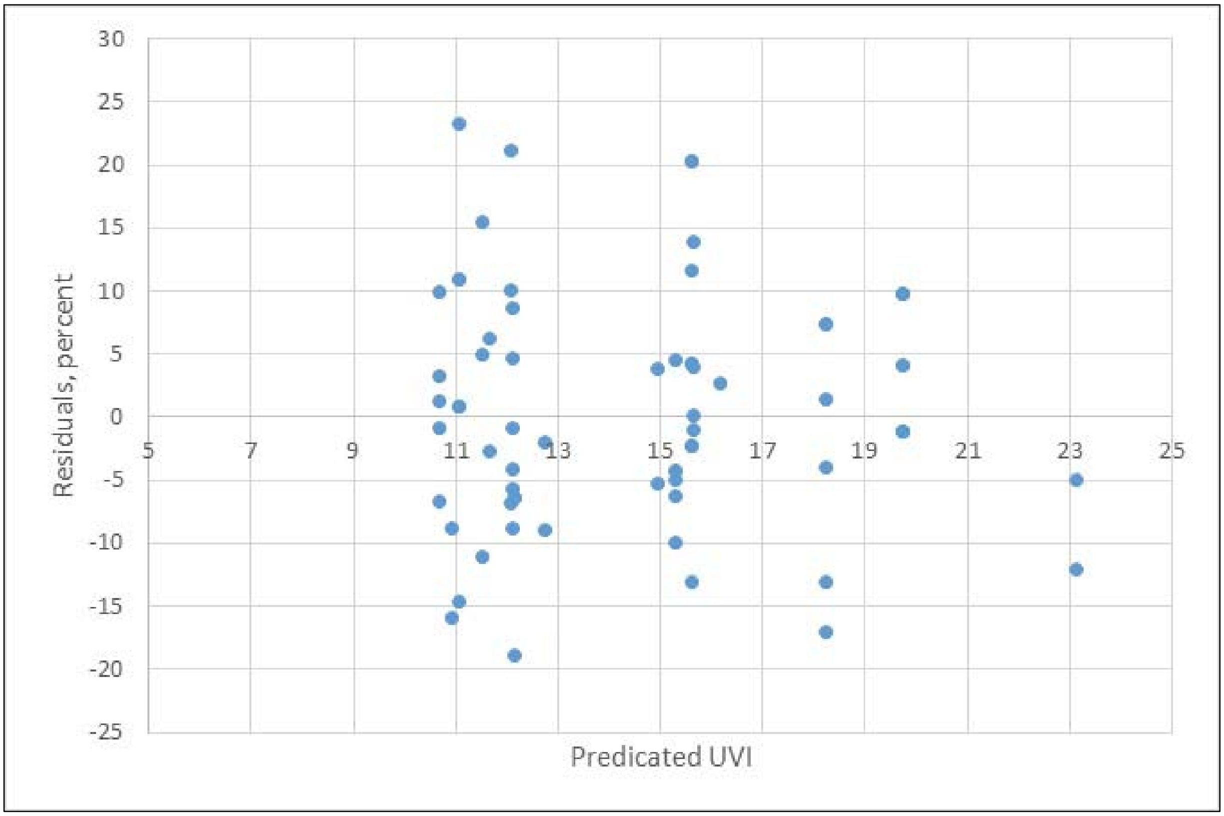

Figure 20 Sensor Residuals

5.4.3 <u>Disinfection Performance</u>

The D72AL75 validation is documented in Carollo (2009). That work documented reactor performance over a range of flow (1.05 to 7.3 mgd) and over a range of UV transmittance (UVT) (41.4 to 80.8 percent), with the data analyzed in accordance with National Water Research Institute Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (NWRI, 2003) but not NWRI (2012). The validation of the D72AL75 is based upon the dose delivery per reactor, recognizing that there are two 72 lamp banks within each reactor. Note that the Oxnard UV AOP system is controlled based upon the use of each bank, so three reactors results in a total of 6 banks of UV light. For this application at the AWPF, the flow per reactor is 6.25 mgd (as all three reactors are in series). As the UVT in ROP is greater than 95 percent, the validation formula from Carollo (2009) is conservative. Using the maximum validated UVT of 80.8 percent the dose of five banks of lamps from the three D72AL75 reactors (leaving one bank in standby) is >250 mJ/cm^2.

As this is a potable reuse application, disinfection credit for UV should be based upon adenovirus disinfection. Adenoviruses comprise a large group of serologically different viruses that can cause a broad spectrum of diseases with varying severity (USEPA, 2010). Research on the dose-response relationship of Adenoviruses, using Low Pressure (LP) UV radiation on a bench-scale collimated beam setup, is mainly limited to Adenovirus types 2, 40, and 41. The dose response relationship at high UV doses (>200 mJ/cm^2) is more widely published for Adenovirus type 2 (Ad2), and shows that 6-log reduction of Ad2 may be obtained at a dose of 235 mJ/cm^2 (Gerba *et al.*, 2002). The dose response relationship of Ad2 as well as other viruses is shown in Figure 21, demonstrating that Ad2 is a conservative surrogate for a wider range of virus.

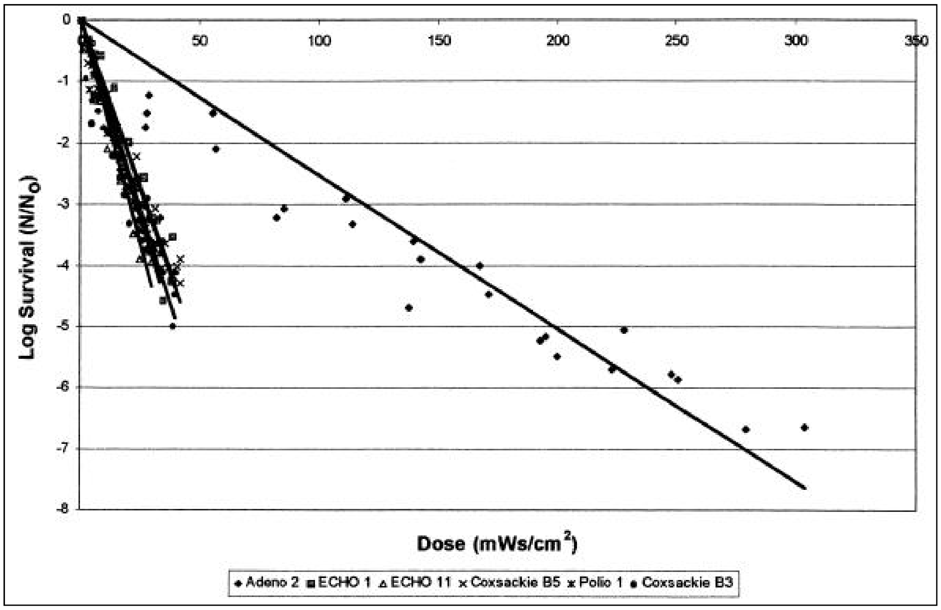

Figure 21 LP UV Dose Response Relationship of Ad2

USEPA (2010) published a dose-response equation for Ad2 of:

$$\text{Log Reduction} = 0.0262*\text{UV Dose} + 0.2774$$

This dose response relationship is based on a dose range between 20 and 160 mJ/cm^2 (USEPA, 2010). Other studies have shown similar dose responses, consistently indicating that a 6-log reduction of Ad2 is met with a LP UV dose of up to 235 mJ/cm^2.

Pertaining directly to Oxnard and their Trojan D72AL75, the following can be said:

- The system, with five banks in series, results in a predicted UV dose of >250 mJ/cm^2 at a UVT of 80.8 percent. For a UVT of 95 percent or higher, as is the case for potable reuse projects using RO permeate, the UV dose will be substantially higher.
- 6-log adenovirus can be obtained based upon a UV dose of 235 mJ/cm^2. Because MS2 is more sensitive to UV light than adenovirus, using an MS2-based validation conservatively estimates dose for adenovirus. The underlying concept for this conclusion is found in the discussion of RED bias in USEPA (2006).
- USEPA (2006) (Table 6 below) provides data on the dose required for up to 4-log reduction, but did not go further as such higher reductions are not required for drinking water disinfection applications.

- In total, the UV system, operating at a UV dose in excess of 250 mJ/cm^2, installed at the AWPF is sufficient to provide 6-log reduction of both virus and protozoa.

Table 6 UV Dose Targets for Log Inactivation Credit, mJ/cm^2 (USEPA, 2006)
Advanced Water Purification Facility
City of Oxnard

Target	0.5-log	1.0-log	1.5-log	2.0-log	2.5-log	3.0-log	3.5-log	4.0-log
Crypto	1.6	2.5	3.9	5.8	8.5	12	15	22
Giardia	1.5	2.1	3	5.2	7.7	11	15	22
Adenovirus	39	58	79	100	121	143	163	186

5.4.4 NDMA Destruction Performance and Correlation to Disinfection Performance

While this section of the report is focused on disinfection credits, the destruction of NDMA provides a clear documentation of high UV dose delivery, and thus a high level of disinfection.

NDMA destruction is required to reduce RO permeate NDMA concentrations to below the DDW notification level of 10 ng/L (ppt). NDMA destruction has a proven correlation with UV dose, as shown in Figure 22, below. Using the information below, 1-log reduction of NDMA correlates to a UV dose in the range of ~700 to ~1100 mJ/cm^2. Such a wide variation does require further refinement by the industry. However, remembering that our disinfection target dose is 235 mJ/cm^2, there is a margin of comfort that dose sufficient to meet NDMA targets will also be sufficient to provide disinfection. Using the NDMA destruction dose/response from Sharpless and Linden (2003), the results of 22 NDMA destruction test runs at Oxnard can be evaluated for dose delivery and accuracy of system control, as shown in Figures 23 and 24, below.

Note: The NDMA data was collected over four different days, and the influent concentrations to the UV AOP system was consistent on each specific day, but varied from one day to the next. Thus, the NDMA destruction analysis utilized the average of influent NDMA concentrations for each day. Daily influent numbers are shown below:

- 5/4/2016 - 32, 23, 29, 25, 23, 28.
- 6/20/2016 - 28, 32.
- 6/21/2016 - 24, 22, 19, 23, 20.
- 6/22/2016 - 11, 12, 13, 12.

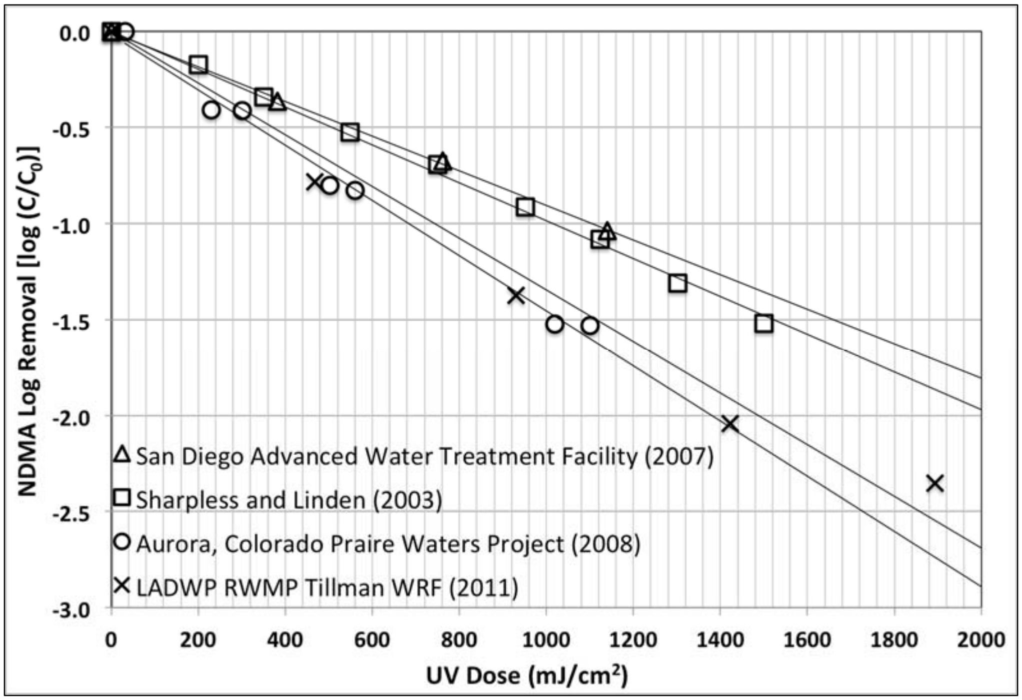

Figure 22 Collimated Beam Bench Testing Results for NDMA Collected in different Studies (Sources of Data: City of San Diego, 2007; Sharpless and Linden, 2003; Swaim et al., 2008; Hokanson et al., 2011). The Colorado Prairie Waters Project in Aurora, Colorado is the only reference study that used hydrogen peroxide (5 mg/L). The results shown for the other three studies used UV photolysis (graphic credit: Trussell Technologies).

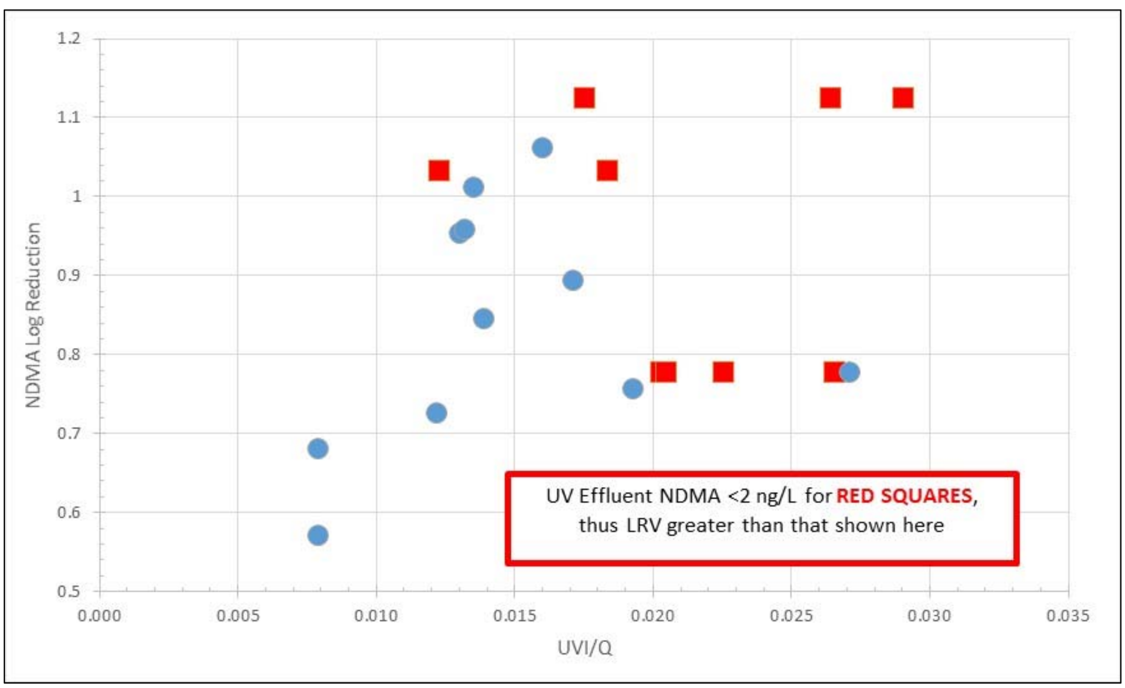

Figure 23 NDMA Destruction as a Function of UVI/Q

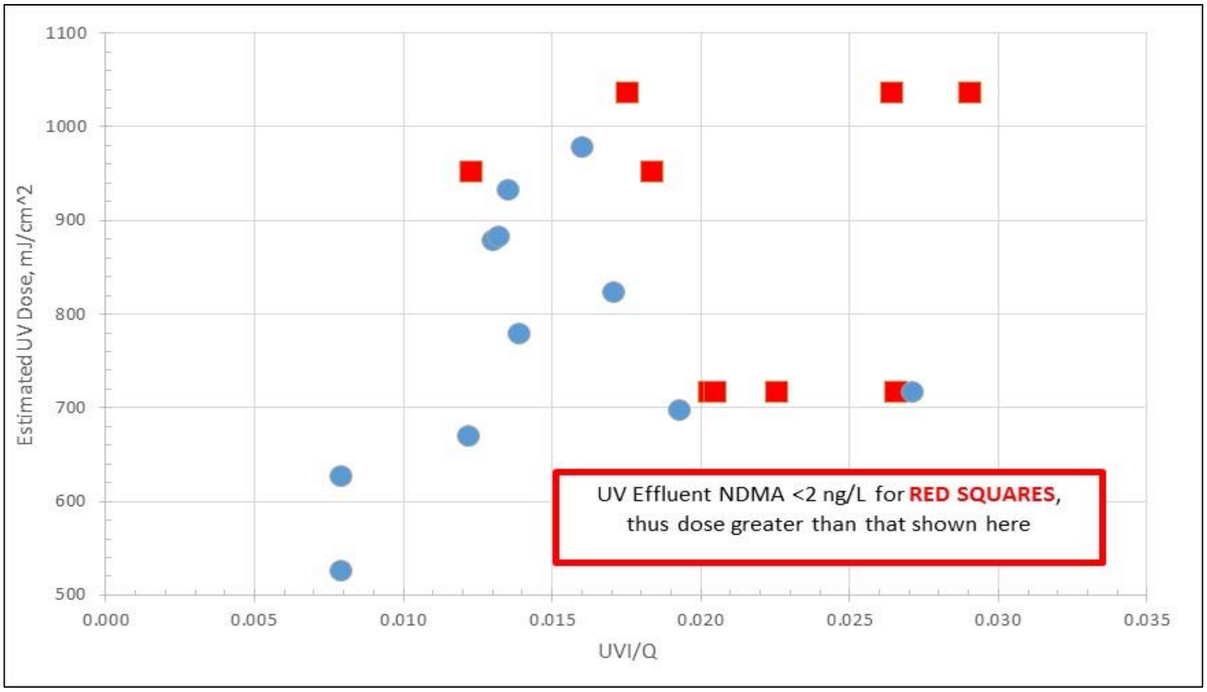

Figure 24 UV Dose as a Function of UVI/Q

The data in the figure above cannot be trended because a large number of the test events had NDMA below detection (<2 ng/L) in the UV effluent. However, this information can be used as a set-point control or alarm system for both disinfection and NDMA destruction based upon the following approach:

- NDMA concentrations in the RO permeate, through limited testing, have been in the range of 11 to 32 ng/L. Using the highest measured influent concentration (32 ng/L), and targeting the NDMA notification level of 10 ng/L, a minimum NDMA destruction of 0.5 could be required.
  - Assuming that NDMA levels in the RO permeate will vary from the measured numbers, and understanding that some level of operational safety factor is warranted to meet the 10 ng/L target, a finished water NDMA target of 5 ng/L is recommended, resulting in a need for an NDMA reduction target of 0.8-log.
  - 0.8-log NDMA destruction, based upon the collected data, can be obtained at a UVI/Q of 0.014 (with UVI being the sum of all UVI for operational reactors and Q being the total flow to the system in gpm).
- Regarding UV dose, the UVI/Q of 0.014 correlates to a UV dose of >800 mJ/cm^2, well in excess of the dose needed for 6-log reduction of all known pathogens.

An important question thus exists on the capacity of the UV system under reduced UVT conditions, as detailed in Table 7 below, which predicts the UVI based upon the sensor equation and data detailed previously. As shown, even at a much reduced UVT of

95 percent, the UV system is projected to attain a UVI/Q of 0.018, which is greater than the minimum desired value of 0.014.

Table 7 UV Capacity to Meet NDMA Target of 5 ng/L
Advanced Water Purification Facility
City of Oxnard

UVT	Q, mgd (gpm)	UVI for One Bank, mW/cm^2	# Banks in Operation at 100% Power	Combined UVI, mW/cm^2	UVI/Q
Ambient (~99%)	6.25 (4,340)	23.6	5	118	0.027
Reduced (95%)	6.25 (4,340)	15.6	5	78	0.018

5.4.5 1,4-Dioxane Destruction Performance

The UV AOP system, per CDPH (2014) must demonstrate 0.5-log reduction of 1,4-dioxane, or demonstrate destruction of a wider range of trace pollutants. Similar to ongoing and recently completed work for the City of LA (LA Sanitation, LASAN) and the Santa Clara Valley Water District (SCVWD), Seeding and destruction of 1,4-dioxane is the most precise method for such performance demonstration. Testing was completed over a range of H_2O_2 (hydrogen peroxide, peroxide) doses to demonstration 0.5-log reduction of 1,4-dioxane. Values for UVT, UV intensity, and UV reactor power were recorded. Testing was performed in triplicate, with all seeding and sampling done over a two-day period, with results shown in Figures 25 and 26.

Recognizing that analytical and sampling variability may account for some data variability, the analysis of the data using the Peroxide Weighted Dose concept, then back-calculating the minimum UVI/Q, may be more appropriate. Figure 26 indicates that a minimum UVI/Q should be in the range of 0.072 to 0.088; resulting in a tapered peroxide dose based upon the target UVI/Q. Assuming the more conservative peroxide weighted dose of 0.088, the following target UVI/Q values are recommended:

- Peroxide dose of 3 mg/L - *Minimum* UVI/Q = 0.029;
- Peroxide dose of 4 mg/L - *Minimum* UVI/Q = 0.022;
- Peroxide dose of 5 mg/L - *Minimum* UVI/Q = 0.018.

Understanding that the installed system has a set UV system capacity, the recommended approach is to utilize a peroxide dose of 6 mg/L and maintain a minimum UVI/Q of 0.018 to meet the required 0.5-log reduction of 1,5-dioxane.

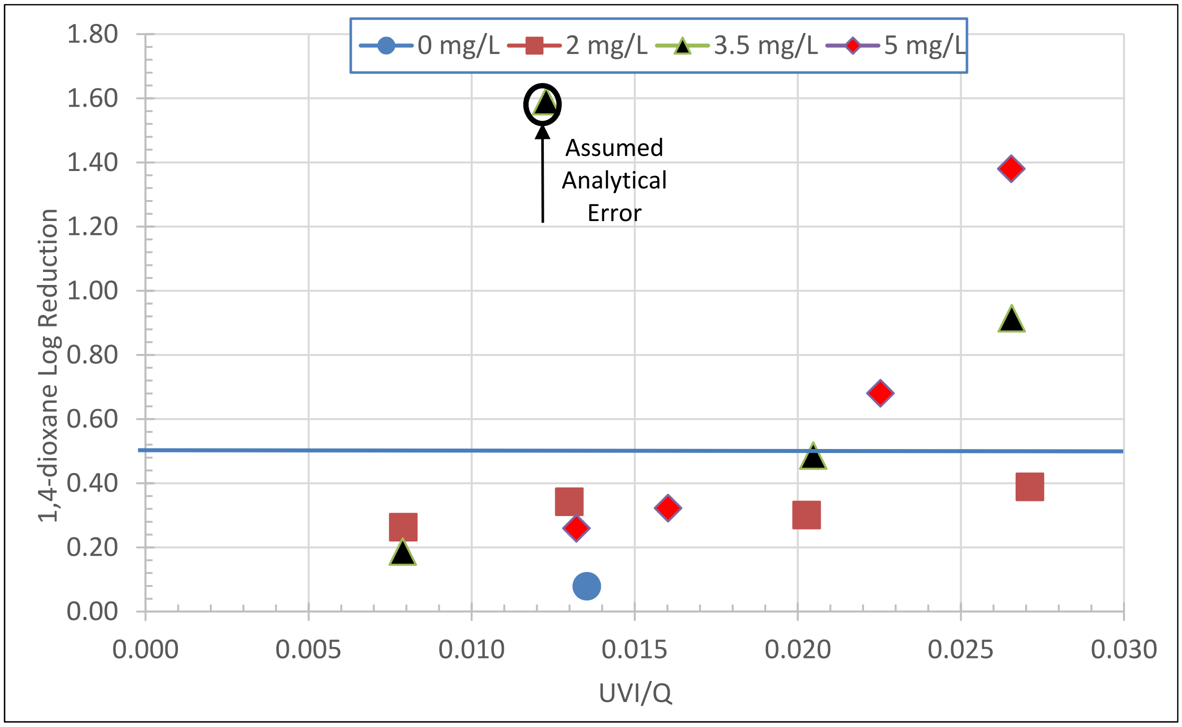

Figure 25 1,4-dioxane Destruction as a Function of UVI/Q and peroxide dose

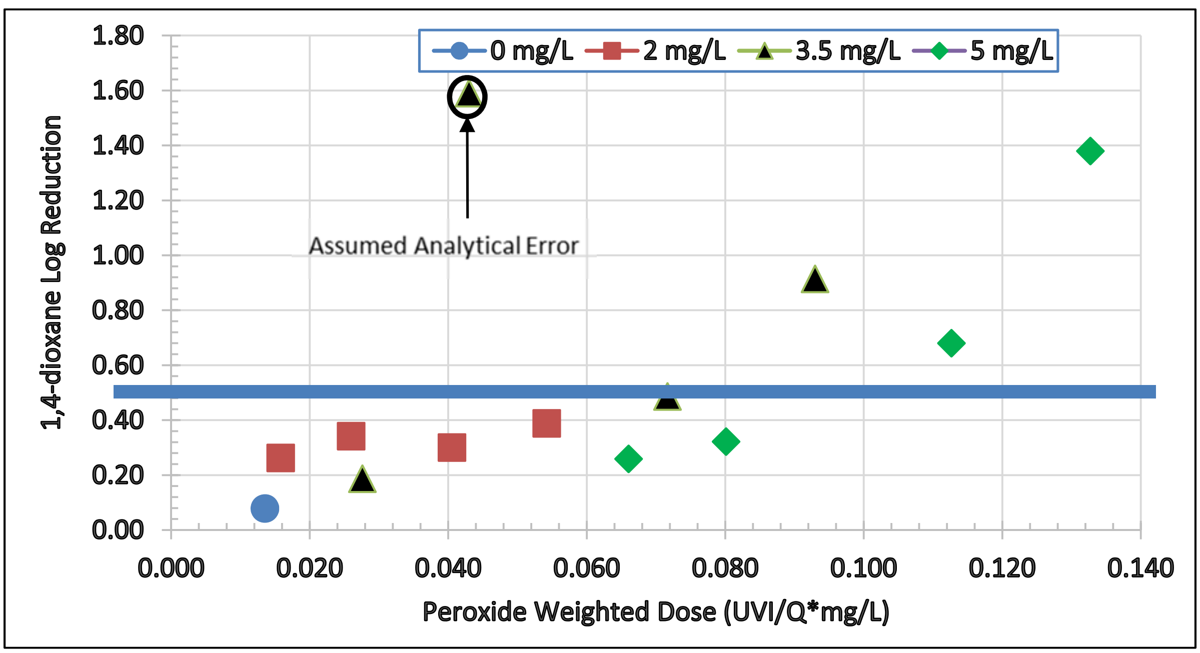

Figure 26 1,4-dioxane Destruction as a Function of Peroxide Weighted Dose

Based upon Figure 25, for a peroxide dose of 3.5 mg/L, the minimum UVI/Q should be 0.021; whereas for a peroxide dose of 5 mg/L the minimum UVI/Q should be 0.020. Recommendations on UV AOP Control Based Upon Disinfection, NDMA, and 1,4-Dioxane Performance Targets

The recommended UVI/Q to reliably below the 10 ng/L NDMA notification level is 0.014. This correlates to a minimum NDMA log reduction of 0.8, which also correlates to a UV dose well in excess of 235 mJ/cm^2 (the minimum UV dose for 6-log adenovirus disinfection). The use of 6 mg/L peroxide allows for the use of a minimum UVI/Q of 0.018 for 1,4-dioxane destruction. As shown in Table 7 (above), at a UVT of 95 percent, with 5 of 6 reactors in service, the installed system is projected to be able to attain the target 0.018 UVI/Q value; while still allowing for maintaining one UV reactor as redundant. **Thus, the key conclusion is that the installed system has sufficient capacity to meet disinfection, NDMA destruction, and 1,4-dioxane destruction at peak flow (6.25 mgd) and at a reduced UVT (95%).**

The remaining focus is the determination of what NDMA LRV setpoint is necessary to maintain the target UVI/Q of 0.018. As part of startup testing, the project team collected the necessary data to compare UVI/Q with the NDMA LRV setpoint, as shown in Figure 27. With one exception, the existing control system maintained a UVI/Q at or above ~0.013, which is noticeably below the recommended target of 0.018. **Accordingly, our recommendation is to adjust the NDMA LRV setpoint from 1.0 to 1.0*0.018/0.013, which results in a NDMA LRV setpoint of 1.4.**

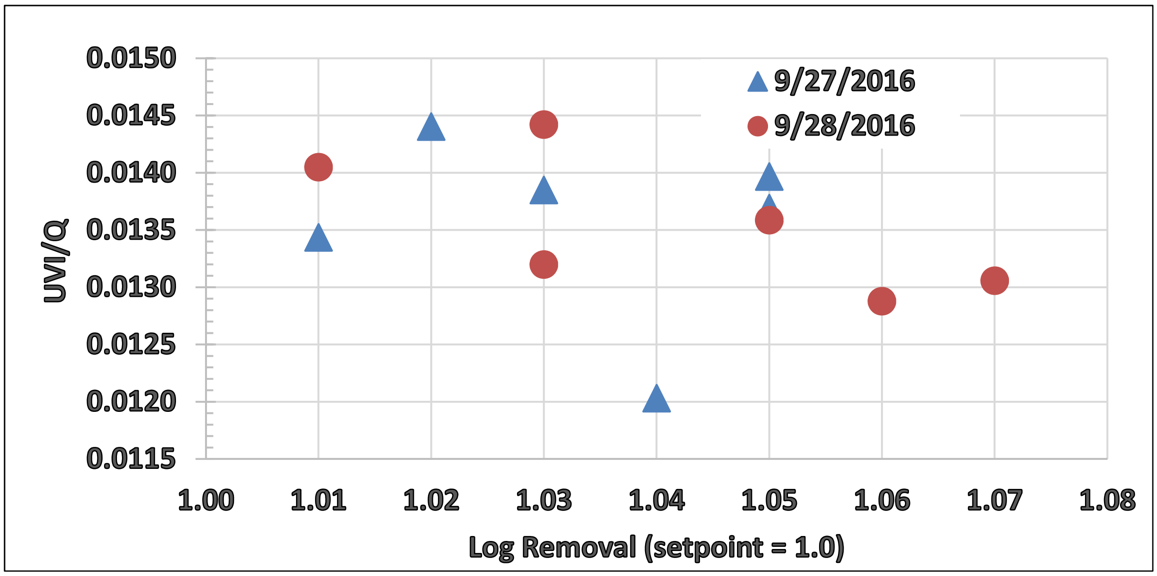

Figure 27 UVI/Q and NDMA LRV Control System Comparison

As a final point of comparison, DDW has become accustomed to the EEO concept for system control and permitting. Figure 28, below, plots the calculated EEO as a function of UVI/Q, presented here for information only. This data suggests that an EEO target would be in excess of 0.230 for Oxnard's particular application.

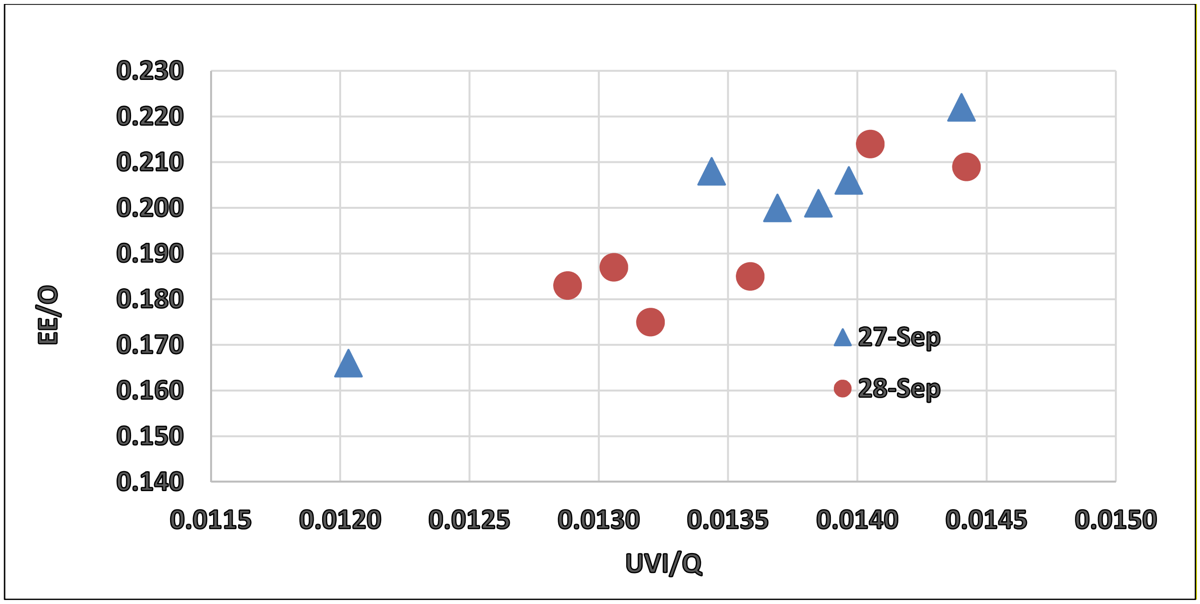

Figure 28 UVI/Q and EEO Comparisons

5.5 Subsurface Pathogen Removal Credit

Per CDPH (2014), utilities employing groundwater injection are granted 1-log virus removal credit per month of subsurface travel time, but are currently not granted credit for protozoa removal. Recent work by the WateReuse Research Foundation (led by Jorg Drewes) has documented the subsurface die-off rate of *Cryptosporidium* at 0.025 to 0.072-log reduction per day, with a mean of 0.039-log reduction per day (Drewes *et al.*, 2014). For 6-months of underground storage, the work by Drewes suggests 7-logs of die-off. Peng *et al.* (2008) reported 85 to 268 days of time to result in 1-log die-off of *Cryptosporidium* in sterile water at 4 degrees C. For 6-months of underground storage, the work by Peng suggests 0.7 to 2.1-log die-off. Per the April 2016 letter from DDW to the City, the DDW is not ready to allow protozoa removal credits based upon the referenced literature.

For the proposed groundwater recharge projects (Phase 1 – ASR and Phase 2 – conventional injection and Downgradient extraction) the water will be in the subsurface for a minimum subsurface retention time of 2 months, though longer periods may be required to attain the full 12-log virus credit requirement. Based upon current virus credits documented in Table 8, below, the minimum subsurface time is 3.1 months.

5.6 Findings for Disinfection Credit

When taken together, the treatment processes discussed in Section 5.1 have the ability to meet (and exceed) the 12/10/10 pathogen log reduction requirements specified in the groundwater recharge regulations, as shown in Table 8. The total pathogen log reduction credits are 12.0/11.8/12.2 for a groundwater recharge project with 3.1 months of subsurface storage time.

Table 8 Total Pathogen Log Reduction Credits Advanced Water Purification Facility City of Oxnard			
Process	**Virus**	***Giardia***	***Crypto***
Primary/Secondary Treatment	1.9	0.8	1.2
MF	0.0	4.0	4.0
RO	1.0	1.0	1.0
UV Advanced Oxidation	6	6	6
Groundwater Retention Time	3.1	0.0	0.0
Totals	***12.0***	***11.8***	***12.2***
DDW Requirements	***12***	***10***	***10***

6.0 GROUNDWATER RECHARGE OPERATIONAL STRATEGY

As mentioned previously, the City proposes one groundwater recharge operation at this time. This operation is proposed with 100 percent recycled water (i.e., no blending with diluent water). The City plans to inject the purified water into specific wells at the Campus Park location into aquifer zones within the Lower Aquifer System (LAS), keep the water underground for a minimum of 3.1 months (or the required response retention time [RRT]), then extract the water from the same ASR well for potable and non-potable use. In the future, should the City implement more advanced monitoring for the RO system and gain greater credits, the minimum time of 3.1 months may be reduced to 2 months.

This summary is based upon Hopkins (2016) study, which is included as Appendix B – Hydrogeological Study Report. The Hopkins report is provided to comply with regulations pursuant to section 60320.200(h), with a short summary provided here.

The City's long-term plan is to inject up to 6.5 mgd (4,500 gpm) of recycled water into several wells at the Campus Park location. The first ASR well location is proposed to ultimately include two adjacent wells (3 if necessary), each with an injection capacity of up to 2,000 gpm (totaling 4,000 gpm for this first application). This first pair of wells will inject purified water into a discrete aquifer zone(s) in the LAS and subsequently facilitate groundwater extraction after the required RRT is achieved and regulatory approval is granted.

The Campus Park location is ideal, as the ASR wells and monitoring wells can all be placed on City property, thus firmly controlling the use of groundwater in this area. Further, the proposed injection is into the LAS, whereas nearby potable wells are all in the Upper Aquifer System (UAS), and thus hydraulically isolated from the LAS. The closest well to the proposed ASR location that is constructed within the LAS is located nearly 1 mile to the east and is owned and operated by the City.

For the fully expanded ASR project, the Campus Park location would host several pairs of ASR wells, with each pair recharging discrete aquifers. A pair of wells is anticipated to be necessary to fully utilize the operational capacity of each aquifer zone available for replenishment and reuse at the Campus Park site. This concept is described in detail by Hopkins (2016).

The construction of ASR well facilities in discrete aquifer zones uses the isolation of natural clay layers to allow simultaneous operation of replenishment, retention, and reuse without mutual interference. Wells located in Aquifer 1 are by design isolated from wells located in Aquifer 2 and 3. Utilization of the confined aquifer system in this manner will allow optimization of a continual ASR operation and full utilization of the wellfield location. Utilization of discrete aquifer zones also serves to preservation of the replenished water quality and minimizes mixing with native groundwater. This type of operation will require validation that the minimum time requirement is in compliance prior to the distribution of recycled water.

The ASR operation, upon full execution, will involve recharge of some wells concurrent with extraction of water from other wells. This process is intended to be flexible to allow the City to maximize recharge of the groundwater. One potential example of operation is as follows:

- Recharge ASR Well No. 1 in confined Aquifer 1 at flows up to 2,000 gpm. The period of recharge time must be sufficient so that recharged water does not migrate to off-site potable water wells. The duration of injection may range from 3.1 months to 6 months or greater.
- After the allocated time, stop recharge of ASR Well No. 1. Hold water in Aquifer 1 for a minimum of 3.1 months or the required RRT starting from the time the last drop of water entered the ASR well.
- Extract Water from ASR Well 1 at a rate of up to 3,000 gpm.
- Repeat the three steps described above in rotation for all operational ASR wells to allow a continual IPR operation.

Though this operation is fully intended as an ASR operation, in the event that some recharged water is not extracted and migrates toward drinking water wells, the time to the nearest downstream potable water supply well must be determined and documented to be more than 3.1 months of time for this project, though regulations allow for as little as 2 months of travel time as long as all pathogen reduction criteria are met.

Utilizing a conservative estimation of soil porosity (15 percent), an average hydraulic conductivity value of (125 feet /day), and the range of groundwater gradients calculated from available data, Hopkins (2016) used the average linear flow velocity equation to predict the subsurface travel time caused by the seasonal gradients in the aquifer system.

During normal to wet years, the groundwater gradient is toward the southwest away from the Oxnard Forebay, the primary area of aquifer recharge (Hopkins, 2016). During dry years, the groundwater gradient is predominantly westward toward the area of greatest agricultural use (Hopkins, 2016). During a drought with repeated dry years where the groundwater levels in the aquifer system fall below sea level, the groundwater gradient migrates to the north toward inland pumping and away from the ocean where offshore storage is located in the aquifer system. The movement of groundwater caused by the regional gradient is slow and results in very little movement of the injected purified water plume, with an estimated travel time of between 0.17 and 0.92 feet per day.

The injection of purified water at 2,000 gpm results in a purified plume at a ~1,000 foot radius and ~1,500 foot radius after 3 months and 6 months of continuous injection, respectively (Hopkins, 2016). Using the 0.17 to 0.92 ft/day travel time, the purified water will move 30 to 165 feet in the direction of groundwater flow (to the Southwest or to the North) over a period of six months (during 3 months of injection and 3 months of retention). DDW regulations (CDPH, 2014) require a safety factor of 4 times the distance for groundwater calculations using Darcy's law methods (0.25 log credit for virus and 0.25-month response time credit per month of transport using Darcy's law methods). This results in a projected movement of 120 to 660 feet after the completion of a 180-day injection and retention period. This distance is significantly short of the distance to the nearest potable wells, both municipal and private wells.

After the 2-year injection period at 2,000 gpm, the area of the displaced volume is predicted by Hopkins (2016) to not reach the nearest potable supply well (City Well No. 20, located in the LAS). **Note: until tracer studies document otherwise, the maximum proposed injection period is 90 days.**

The proposed monitoring well locations and related hydrogeology are also documented by Hopkins (2016). These well locations are intended to track the travel time of the injected water (greater than 2 weeks and less than 6 months, in accordance with CDPH (2014)). As proposed, the three monitoring wells will sufficiently define the groundwater gradient in Aquifer 1. The location of Monitoring Well No. 2 is between the proposed ASR well and the City municipal supply Well No. 20. The differential well spacing will generate data through tracer testing to confirm the displacement rate of native groundwater. As detailed by Hopkins (2016), Monitoring Well No. 1 is anticipated to see the recharge bubble within 2 weeks while Monitoring Well No. 2 should see the recharge bubble at around 60 days. If our estimates are accurate, Monitoring Well No. 3 will not see the recharge bubble prior to the end of 90 days of recharge.

7.0 MONITORING AND RESPONSE RETENTION TIME

Over time, detection of trace pollutants in the monitoring wells and reduced treatment performance may occur. Depending upon the issue, the City may handle the issue internally, or, in the event of a regulatory exceedance, the City must provide the appropriate notification to DDW and RWQCB staff. These meetings and discussions will determine if the produced water remains protective of public health or if some form of mitigation is required. The need for and magnitude of response from the City will be based upon the following analysis:

- **Analytical detection of a pollutant above a regulated value.** The City will resample the groundwater and concurrently evaluate the AWPF performance. Should resampling still demonstrate non-compliance, appropriate remediation measures will be taken, which may include shutting down production wells or installation of well-head treatment for wells that may extract inadequately treated water. For the ASR operation, the ASR wells can be put into extraction mode and water can be pumped and used for non-potable applications.
- **Analytical detection of a pollutant below a regulated value.** The City will evaluate the occurrence, cause, and significance of the trace pollutant at the AWPF and may take corrective measures to reduce the concentration of the pollutant, either through source control or through treatment process modification.
- **Process failures or online metering/process monitoring failures above regulated values.** The City will evaluate the potential impact on treatment performance, both in terms of pathogen reduction and trace pollutant reduction.
- Included in the analysis by City and regulatory staff is the potential impact of dilution and attenuation of the pollutant of concern in the groundwater basin. Because the ASR operation is intended to be a fill and draw operation with minimal loss of injected water, dilution is not anticipated to be significant.

For the purpose of the RRT, the City anticipates a time period of 4 to 6 weeks for resampling, analysis of treatment processes, and regulatory consultation, as detailed below. This time value is less than the proposed minimum RRT of 3.1 months, as reviewed below.

7.1 Proposed RRT Concept

The ASR operations will follow the requirements of CDPH (2014), Sections 60320.200(b) and 60320.224. For the ASR project, the RRT is based entirely upon City operation of the well. The minimum time of storage for this ASR operation will be 3.1 months to meet the pathogen credits for potable reuse. In the event of a stoppage in ASR operation, the travel distance to the nearest potable water well (City Well #20) is ~4,000 feet. As shown by Hopkins (2016), two years of continuous recharge does not reach City Well #20. As only a 3-month to 6-month recharge period is originally proposed, and as DDW requires a 4X safety factor for Darcy's Law estimations, a 6-month RRT is readily achieved without having the purified water reach a potable well.

For this project, a RRT of three months is more than sufficient to:

- Gain 3-log virus credit through subsurface storage time.
- Identify a treatment failure or detect an inadequately-treated constituent.
- Consider appropriate actions to protect public health.
- Implement corrective measures.

7.1.1 Online Process Control Monitoring

The AWPF controls are designed to maintain water quality that is protective of public health. The AWPF will have both continuous online monitoring and periodic monitoring of treatment performance. Production of water for IPR applications may cease based upon the process monitoring approaches listed in Table 9 below. The RRT for each of these monitoring approaches is also included within Table 9.

The OMMP (OMMP, KEH, 2015)[1] provides further details on the operations and control concepts for the production of water for non-potable and potable reuse.

7.1.2 Offline Analytical Monitoring

Details on the required water quality monitoring and the proposed sampling plan are included in Sections 9 and 17, respectively. This section provides information on the RRT for sampling, analytical monitoring, and response.

The monitoring and control of the MF, RO, and UV AOP systems focuses on process performance to maximize pathogen reduction, plus additional monitoring of trace constituent removal or destruction. The offline monitoring program focuses on chemicals that could present a chronic risk. Most of the monitored constituents are regulated based on conservative estimates of the lifetime health risk associated with chronic exposure. Accordingly, the RRT must be sufficient to respond to acute health concerns such as pathogens as well as several specific chemicals (e.g., nitrate, nitrite), but need not necessarily account for the response time for constituents with long term chronic concerns.

With the above context, the project team examined the RRT for different analytical parameters that represent a chronic concern (Table 10). Because the groundwater storage time for this ASR project is at least 3.1 months, there is more than sufficient RRT to address any potential issues related to regulated and non-regulated constituents.

[1] This document, which has previously been reviewed by DDW, can be provided upon request.

Table 9	RRT Values for Online and Periodic Treatment Process Control Advanced Water Purification Facility City of Oxnard					
Process	**Monitoring**	**Regulatory Requirement**	**Issue**	**Evaluation Approach**	**Operational Response**	***RRT***
MF	Online filtrate turbidity	0.2 NTU.	A properly functioning MF should produce a filtrate with a turbidity of <0.2 NTU.	• Calibrate online meter using bench-scale results. • Examine trend turbidity with time, watch for increasing filtrate turbidity with time, indicative of loss of membrane performance.	• Shut down out of compliance train. Bring on redundant MF train if turbidity continues to exceed 0.2 NTU. • Reduce or shut down water production if insufficient MF capacity to meet turbidity standards. • Perform DIT and repair membranes.	Minutes to Hours
MF	Daily pressure decay testing (also called DIT)	Performance requirement of <0.8 psi/5min.	DIT failure suggests breach in MF, resulting in reduced a removal of particulates (including protozoa) by MF.	No evaluation, see Operational Response.	• Shut down out of compliance train. Bring on redundant train. • Reduce or shut down water production if insufficient MF capacity exists. • Repair membranes.	One day if DIT done daily. Shorter RRTs if DITs done more frequently.
RO	Online EC	• Either EC or TOC online monitoring required to document performance. • Log reduction of EC across RO can be used to prove pathogen credits.	Log reduction of EC across RO is trending down, indicating RO membrane decay or some other leak.	• Verify/calibrate online EC meters with bench-scale testing. • Profile RO vessels to find damaged membrane or seal.	Replace damaged RO membranes or seals.	Hours to Days
RO	Online or periodic TOC	• For the first 20 weeks of operation, ROP TOC must be ≤0.25 mg/L 95% of the time based upon weekly or more frequent sampling. • Subsequent to 20 weeks, ROP TOC must be ≤0.5 mg/L. • Log reduction of TOC can be used to continuously measure RO performance.	• High TOC in ROP suggests either a breach in the RO membrane or the existence of low molecular weight compounds that can pass through RO. • Log reduction of TOC across RO is trending down, indicating RO membrane decay or some other leak.	• Verify/calibrate online TOC meters with bench-scale testing. • Sample RO influent and ROP for analysis of a wide range of trace organic and regulated compounds. • Profile RO vessels to find damaged membrane or seal. Profile to be done using EC, as above.	Depending upon the results of the evaluation: • Replace damaged RO membranes or seals. • Implement a source control solution.	Days to Weeks
UV AOP	Online UVT	No set value. ROP typically has a UVT of 98 to 99%. The UV system is designed to provide a target dose based upon an assumed UVT value of 95%.	• Trending of UVT down suggests either the passage of low molecular weight organics through the RO or suggests damage to the RO process. • Reduced UVT will impact the ability of the existing UV system to deliver the proper UV dose.	• Verify/calibrate online UVT meter with bench-scale testing. • Sample RO influent and ROP for analysis of a wide range of trace organic and regulated compounds. • Profile RO vessels to find damaged membrane or seal. Profile to be done using EC, as above.	Depending upon the results of the evaluation: • Replace damaged RO membranes or seals. • Implement a source control solution.	Days to Weeks
UV AOP	NDMA LRV Based Upon a Target UVI/Q	UV intensity is used to measure the combined impact of lamp output decay and sleeve fouling. UV intensity can also be used as part of UV reactor dose control. For this project, the UVI/Q is recommended as a daily verification of performance to support the NDMA LRV-based operation.	Reduced UV intensity suggests one of several issues: • Aged lamps that must be replaced. • Fouled sleeves that must be cleaned. • Reduced UVT.	• Verify accuracy of online UVT meter (above). • Verify that UV intensity sensor is properly seated in sensor port. • Check UV intensity sensor accuracy with reference sensor(s). • Remove and replace UV intensity sensor with a standby sensor. • Pull representative quartz sleeve, clean, and replace. Alternatively, clean all sleeves. Recheck sensor intensity.	• Depending upon the results of the evaluation: • Replace sensor. • Clean all sleeves. • Replace lamp(s). • Calibrate UVT meter.	Hours to Days

Table 10 RRT Examples for Analytical Monitoring of AWPF and Monitoring Wells
Advanced Water Purification Facility
City of Oxnard

Location	Parameter	Frequency	Performance Requirement	Issue	Evaluation Approach	Operational Response	RRT
Monitoring Wells	Primary MCLs	Quarterly	Varies	Primary MCLs are typically met in secondary effluent. Detection of pollutants near, at, or above the MCLs suggests a high pollutant load at the OWTP and a lack of performance through the AWPF.	• Resample compliance point in question. • If detection was at the monitoring well, sample finished water at the AWPF. • Profile OWTP and AWPF systems as needed.	• Repair process components. • Evaluate other sources of pollutant that may be contributing to the pollutant at the monitoring well.	Sampling is quarterly. Response time, including repeat samples and analysis is a minimum of two weeks. Reasonable RRT is 16 weeks.
Monitoring Wells	Total Coliform	Quarterly (wells)	≤2 MPN/100mL	Total coliform detection at the AWPF is likely sample contamination or sampling from a line with regrowth. Legitimate breakthrough of total coliform suggests a large performance failure.	• Resample compliance point in question. • Concurrently sampling for fecal coliform. • Evaluate treatment processes for compliance with various operating criteria.	• Repair process components. • Evaluate other sources of pollutant that may be contributing to the pollutant at the monitoring well.	Sampling is quarterly for the monitoring wells. Response time, including repeat samples and analysis is a few days. Reasonable RRT is 13 weeks.
AWPF Finished Water	NDMA	Quarterly	≤10 ng/L	Values in excess of 10 ng/L suggest either reduced UV performance or increased levels of NDMA in the secondary effluent.	• Sample finished water at the AWPF. • Sample RO influent and RO permeate. • Determine if the problem is UV performance or increased NDMA at the OWTP.	Depending upon the results of the evaluation: • Shut down water production or bring redundant treatment processes online. • Evaluate NDMA formation in the OWTP or increased NDMA loadings in the collection system.	Sampling is quarterly. Response time, including repeat samples and analysis is a minimum of two weeks. Reasonable RRT is 16 weeks.
AWPF Finished Water	Total Coliform	Daily	ND-≤2.2 MPN/100mL	Total coliform should be removed after RO and after UV AOP. Existence of total coliform at the monitoring well suggests sample contamination or a much larger treatment process failure.	• Resample monitoring well. • Sample finished water at the AWPF. • Sample RO influent and RO permeate. • Concurrently sampling for fecal coliform.	Depending upon the results of the evaluation: • Shut down water production or bring redundant treatment processes online. • Evaluate other methods for total coliform contamination of the monitoring well.	Days
AWPF Finished Water	Total Nitrogen	Weekly	<10 mg/L	Maintaining TN <10 mg/L assures that nitrate levels are also <10 mg/L. Nitrate is an acute health concern.	• Resample monitoring well. • Sample finished water at the AWPF. • Sample RO influent and RO permeate.	• Shut down water production until TN<10 mg/L.	Sampling is twice weekly, no more than 3 days between sampling events. Response time, including repeat samples and analysis is a minimum of three weeks. Reasonable RRT is four weeks.

7.2 Water Quality Failure Decision Protocol

In the event of a suspected water quality failure, in which water was continuously produced and recharged into the groundwater basin that was suspected to be non-compliant (e.g., control system failure, alarm failure), or in the case of detections of pollutants in the groundwater monitoring wells, City staff will follow a detailed decision protocol to evaluate the situation and determine if the finished water quality presents a risk to public health.

The objectives of the decision protocol are as follows:

- Provide a mechanism to verify water quality in a rigorous and measured way. Effort also will minimize questions and concerns from City stakeholders and interested parties through effective communication of the sampling results and their implications.
- Have the City communicate with a single voice to deliver a clear and consistent message.
- Insure that the City is openly communicating water quality information.
- Provide an organized process for data evaluation and follow-up activities.

The first step in such a water quality situation is to shut down all water production for potable reuse (non-potable reuse would remain in operation as long as non-potable water quality standards are met). Figure 29 illustrates an example protocol that would follow cessation of production for potable water reuse[2]. Central to this protocol are two teams:

- The "Engineering/Operations Staff."
- The "Decision Committee."

This protocol will be adopted by the City prior for the production of recycled water for potable reuse.

7.3 Proposed RRT

The proposed RRT here is based upon responding to acute concerns, which are those associated with pathogens and a few chemical constituents (e.g., nitrate, nitrite). Thus, the proposed RRT can be calculated as follows:

> RRT = *Sample Collection (daily to twice per week[3]), Analysis and Regulatory Consultation Time (4 weeks) + Time to Provide Relief Measure or Alternative Source of Water (4 weeks) = 9 weeks.*

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[2] Modeled after the SCVWD's Water Quality Response Protocol. The City and Carollo appreciates the use of this information.

[3] DDW requirements for TN (which provides a conservative measure for nitrate) is twice per week.

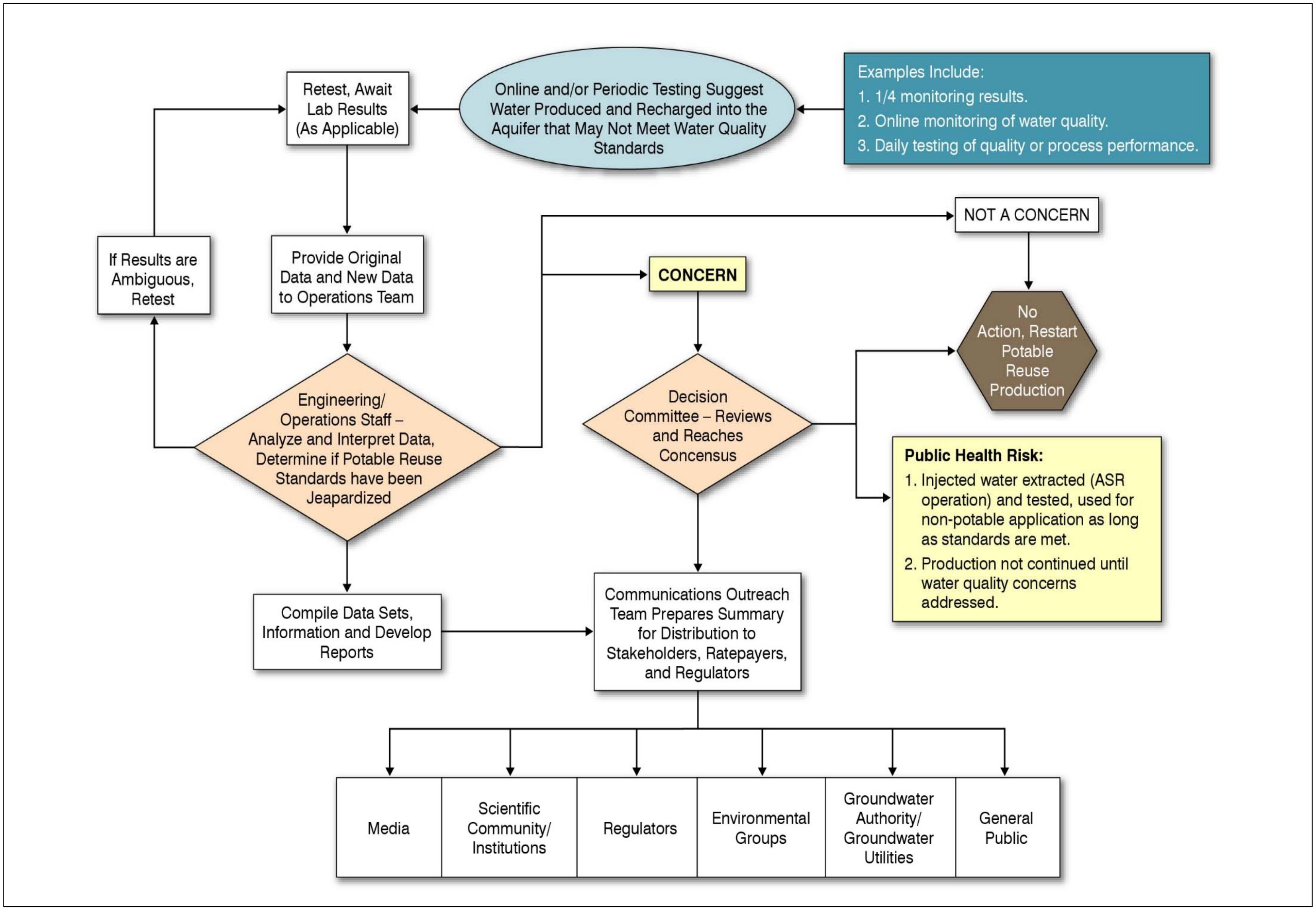

Figure 29 Emergency Response Schematic

As detailed in Hopkins (2016) and in accordance with CDPH (2014) Section 60320.224, groundwater residence/travel times to the nearest potable well are estimated at more than 2 years for the ASR application. As the ASR fill and draw times are controlled, and the proposed project will leave the water in the ground for a minimum of 3.1 months, the RRT of 9 weeks will be reliably met.

Upon commencement of the project, these travel and residence times will be demonstrated through the use of intrinsic or added tracers, potentially TDS, chloride, and sulfate. Further details on startup testing, which includes the groundwater residence time demonstrations, is included in Section 17 of this report.

8.0 NEED FOR ALTERNATIVE SOURCES OF WATER

Long-term sustainable capture and reuse of water supplies is the goal of the City. However, the City’s short term water supply remains reliable and interruptions in the production of water from potable reuse do not constitute an emergency or short term problem. Thus, for failures in monitoring or process performance, or detection of pollutants in the groundwater monitoring network, the AWPF can be simply shut down and not produce water.

For ASR operations, if improperly treated water is injected into the aquifer, or if groundwater monitoring results do not meet regulatory limits, the water will be extracted from the ASR location, and one of the following will occur.

- If the water quality meets the requirements for non-potable reuse, the water will be sent off-site for non-potable reuse operations.
- If the water quality does not meet the requirements for non-potable reuse, well-head treatment will be employed to bring the non-compliant water to non-potable water reuse standards.

As the ASR wells are intended to extract the majority of injected water, and as the current groundwater analysis shows limited groundwater migration at the proposed ASR site, migration of injected water to off-site potable wells is not anticipated. With that said, DDW has requested that this report address such off-site migration. As illustrated in Hopkins (2016), the nearest potable water well to the proposed ASR location is City Well No. 20. In the event of contamination of that well, well-head treatment would be initiated, with the treatment based upon the type of contaminant. For pathogens, installation of a UV system and/or free chlorination could be employed. For trace pollutants, the use of activated carbon or advanced oxidation (which could be a UV-based process) could be employed. For nitrate contamination, ion exchange treatment would be employed.

9.0 POTABLE REUSE WATER QUALITY

There are no federal regulations pertaining to water reuse, and water reuse regulations are developed at the state level. The main regulatory agency for water reuse in the State of California is the SWRCB. The SWRCB is separated into nine different RWQCBs that regulate water reuse projects in conformance with the regulations adopted by the CDPH, which is now part of the SWRCB as the Division of Drinking Water (DDW). The City is located within the LARWQCB.

The water quality limits for groundwater recharge with recycled water and the projected water quality for the AWPF are reviewed below.

9.1 Water Quality Requirements

Tables 11 through 16 constitute the required water quality performance, consistent with CDPH (2014). The tables of constituents referenced in CDPH (2014) are found in CDPH (2014a). Within each table is a specific reference to the table within the regulation (e.g., Primary MCLs are listed in a table below and also found in Table 64431-A). In addition to the CDPH (2014) water quality requirements provided in the following tables, the advanced treated recycled water from the AWPF facility will be required to satisfy the discharge limits included in the revised GREAT permit (R4-2011-0079-A01 and R4-2008-0083-A01) prior to injection.

Table 11 Inorganics with Primary MCLs(1)
Advanced Water Purification Facility
City of Oxnard

Constituents	Primary MCL (in mg/L)	Constituents	Primary MCL (in mg/L)
Aluminum	1.0	Fluoride	2
Antimony	0.2	Lead	0.015(4)
Arsenic	0.006	Mercury	0.002
Asbestos	7 (MFL)(2)	Nickel	0.1
Barium	1	Nitrate (as NO_3)	45
Beryllium	0.004	Nitrite (as N)	1
Cadmium	0.005	Total Nitrate/Nitrite (as N)	10
Hexavalent Chromium	0.010	Selenium	0.05
Copper	1.3(3)	Thallium	0.02
Cyanide	0.15		

Table 11	**Inorganics with Primary MCLs[1]** **Advanced Water Purification Facility** **City of Oxnard**		
Constituents	**Primary MCL (in mg/L)**	**Constituents**	**Primary MCL (in mg/L)**

Notes:

(1) Based on **Table 64431-A.**
(2) MFL = Million fibers per liter, with fiber lengths > 10 microns.
(3) Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.
(4) The MCL for lead was rescinded with the adoption of the regulatory action level. The action level is like a MCL except it also requires additional testing. If more than 10% of samples collected at the point of delivery exceed the action level, the water distributor must take steps to reduce the corrosivity and/or lead concentrations of the delivered water and notify the public about steps they should take to protect their health.

Table 12 Constituents/Parameters with Secondary MCLs
Advanced Water Purification Facility
City of Oxnard

Constituents[1]	**MCL (in mg/L)**	**Constituents[2]**	**MCL (in mg/L)**
Aluminum	0.2	TDS	500
Color	15 (units)	Specific Conductance	900 *u*S/cm
Copper	1	Chloride	250
Foaming Agents (MBAS)	0.5	Sulfate	250
Iron	0.3		
Manganese	0.05		
Methyl-tert-butyl-ether (MBTE)	0.005		
Odor Threshold	3 (units)		
Silver	0.1		
Thiobencarb	0.001		
Turbidity	5 (NTU)		
Zinc	5		

Notes:

(1) Based on **Table 64449-A.**
(2) Based on **Table 6449-B.**

Table 13 Radioactivity[1]
Advanced Water Purification Facility
City of Oxnard

Constituents	MCL (in pCi/L)	Constituents	MCL (in pCi/L)
Uranium	20	Gross Beta particle activity	50[2]
Combined radium-226 & 228	5	Strontium-90	8[2]
Gross alpha particle activity	15	Tritium	20,000[2]

Notes:
(1) Based on **Tables 64442 and 64443**.
(2) MCLs are intended to ensure that exposure above 4 millirem/yr does not occur.

Table 14 Regulated Organics[1]
Advanced Water Purification Facility
City of Oxnard

Constituents	MCL (in mg/L)	Constituents	MCL (in mg/L)
Volatile Organic Compounds			
Benzene	0.001	Monochlorobenzene	0.07
Carbon Tetrachloride	0.0005	Styrene	0.1
1,2-Dichlorobenzene	0.6	1,1,2,2-Tetrachloroethane	0.001
1,4-Dichlorobenzene	0.005	Tetrachloroethylene	0.005
1,1-Dichloroethane	0.005	Toluene	0.15
1,2-Dichloroethane	0.0005	1,2,4 Trichlorobenzene	0.005
1,1-Dichloroethylene	0.006	1,1,1-Trichloroethane	0.2
cis-1,2-Dichloroethylene	0.006	1,1,2-Trichloroethane	0.005
trans-1,2-Dichloroethylene	0.01	Trichloroethylene	0.005
Dichloromethane	0.005	Trichlorofluoromethane	0.15
1,3-Dichloropropene	0.0005	1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
1,2-Dichloropropane	0.005	Vinyl chloride	0.0005
Ethylbenzene	0.3	Xylenes	1.75
Methyl-tert-butyl ether (MTBE)	0.013		
SVOCs			
Alachlor	0.002	Hexachlorobenzene	0.001

Table 14	Regulated Organics[1] Advanced Water Purification Facility City of Oxnard		
Constituents	**MCL (in mg/L)**	**Constituents**	**MCL (in mg/L)**
Atrazine	0.001	Hexachlorocyclopentadiene	0.05
Bentazon	0.018	Lindane	0.0002
Benzo(a) Pyrene	0.0002	Methoxychlor	0.03
Carbofuran	0.018	Molinate	0.02
Chlordane	0.0001	Oxamyl	0.05
Dalapon	0.2	Pentachlorophenol	0.001
Dibromochloropropane	0.0002	Picloram	0.5
Di(2-ethylhexyl)adipate	0.4	Polychlorinated Biphenyls	0.0005
Di(2-ethylhexyl)phthalate	0.004	Pentachlorophenol	0.001
2,4-D	0.07	Picloram	0.5
Dinoseb	0.007	Polychlorinated Biphenyls	0.0005
Diquat	0.02	Simazine	0.004
Endothall	0.1	Thiobencarb	0.07/0.001[2]
Endrin	0.002	Toxaphene	0.003
Ethylene Dibromide	0.00005	2,3,7.8-TCDD (Dioxin)	$3x10^{-8}$
Glyphosate	0.7	2,4,5-TP (Silvex)	0.05
Heptachlor	0.00001		
Heptachlor Epoxide	0.00001		

Notes:
(1) Based on Table 64444-A.
(2) Second value is listed as a Secondary MCL.

Table 15	Disinfection By-Products[1] Advanced Water Purification Facility City of Oxnard		
Constituents	**MCL (in mg/L)**	**Constituents**	**MCL (in mg/L)**
Total Trihalomethanes	0.080	Bromate	0.010
Total haloacetic acids	0.060	Chlorite	1.0

Notes:
(1) Based on **Table 64533-A.**

**Table 16 Constituents with Notification Levels(1)
Advanced Water Purification Facility
City of Oxnard**

Constituents	NL (in μg/L)	Constituents	NL (in μg/L)
Boron	1000	Manganese	500
n-Butylbenzene	260	Methyl isobutyl ketone (MIBK)	120
sec-Butylbenzene	260	Naphthalene	17
tert-Butylbenzene	260	N-Nitrosodiethylamine (NDEA)	0.01
Carbon disulfide	160	N-Nitrosodimethylamine (NDMA)	0.01
Chlorate	800	N-Nitrosodi-n-propylamine (NDPA)	0.01
2-Chlorotoluene	140	Propachlor**	90
4-Chlorotoluene	140	n-Propylbenzene	260
Diazinon	1.2	RDX	3
Dichlorodifluoromethane (Freon 12)	1000	Tertiary butyl alcohol (TBA)	12
1,4-Dioxane	1	1,2,3-Trichloropropane (1,2,3-TCP)	0.005
Ethylene glycol	14000	1,2,4-Trimethylbenzene	330
Formaldehyde	100	1,3,5-Trimethylbenzene	330
HMX	350	2,4,6-Trinitrotoluene (TNT)	1
Isopropylbenzene	770	Vanadium	50

Notes:
(1) Based on http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf.
The web link above also contains the levels of the pollutants in this table that must result in a removal of the water source from service.

9.2 CEC Monitoring

SWRCB (2013) lists specific compounds for monitoring for groundwater injection projects (Table 17). The initial monitoring program is intended to be quarterly, followed by semi-annual monitoring for the duration of the project.

Table 17 Monitoring Trigger Levels for Groundwater Recharge, as Listed in SWRCB (2013) Advanced Water Purification Facility City of Oxnard			
Constituents	**Relevance/ Indicator Type/ Surrogate**	**Monitoring Trigger Level (in μg/L)**	**Removal Percentages (%)**
17B-estradiol	Health	0.0009	--
Caffeine	Health & Performance	0.35	>90
NDMA	Health & Performance	0.01	25-50, >80(1)
Triclosan	Health	0.35	--
DEET	Performance	--	>90
Sucralose	Performance	--	>90
Electrical Conductivity	Surrogate	--	>90
TOC	Surrogate	--	>90

Notes:

(1) 25 to 50 % removal by RO, >80% removal by RO followed by UV, depending upon the UV dose.

The LARWQCB requires specific monitoring for CECs. The Monitoring and Reporting Program of the revised GREAT permit will specify the monitoring program for this project.

9.3 Basin Plan

The Basin Plan Objectives for ground water quality for the LA region are divided into five groups: bacteria, chemical constituents and radionuclides, minerals, nitrogen, and taste and odor. Excluding the chemical constituents and radionuclides, the objectives are summarized as follows:

- **Bacteria -** Concentration of coliform organisms shall be < 1.1/100 mL over any 7-day period.
- **Minerals:** TDS - (1200 mg/L (confined aquifers), 3000 mg/L (unconfined aquifers), Sulfate (600 mg/L (confined aquifers), 1000 mg/L (unconfined aquifers), Chloride (150 mg/L (confined aquifers), 500 mg/l (unconfined aquifers), Boron (1 mg/L).
- **Nitrogen –** 10 mg/L (NO_3-N + NO_2-N), 45 mg/L (NO_3), 10 mg/L (NO_3-N), 1 mg/L (NO_2-N).
- **Taste and Odor -** Ground waters shall not contain taste or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.

Additionally, the Basin Plan specifies compliance with Table 64431-A, Table 6444-A, and Tables 64442 and 64443 of CDPH (2014a). The constituents in these tables are provided in Tables 12, 14, and 15 of this report.

9.4 Current Water Quality

The City's AWPF is now in operation, producing high quality water for non-potable reuse. Detailed water quality and performance testing has been completed and is documented here. Secondary Effluent, RO permeate, and UV AOP final effluent were sampled for MCLs, NLs, Secondary MCLs and CECs, results are show in Tables 18 through 25. Consistent contaminant removal was seen throughout the MF/RO/UVAOP process, with the AWPF treatment train finished water meeting all health goals (MCLs, secondary MCLs, and NLs). CEC concentrations were either ND or below the recommended health levels according to literature sources. ***Of important note, only 8 contaminants tested for were detected above the health-based goal/limit in the secondary effluent (as highlighted in yellow in the tables below).*** All 8 constituents were fully removed to below the detection level or health target/limit in the finished water, and most were removed prior to UV AOP treatment, as demonstrated both by the RO effluent sampling, and the RO concentrate contaminant concentrations.

9.4.1.1 TOC

The CDPH (2014) requirement for total organic carbon (TOC) is a maximum of 0.5 mg/L, and new membranes are required to meet a value of 0.25 mg/L. Grab samples taken as part of the startup testing all resulted in RO permeate TOC levels below detection at <0.3 mg/L.

9.4.1.2 Total Nitrogen

The CDPH groundwater recharge requirement for total nitrogen (TN) is ≤10 mg/L. As listed in the tables above, the finished water has low nitrate + nitrite (as N) of <0.2 mg/L. Recent (6/22/2016) ammonia concentrations (RO feed = 33 mg/L, UV AOP feed = 2.8 mg/L, Finished water = 2.1 mg/L) coupled with the low nitrate and nitrite numbers indicate a low TN result of ~3 mg/L.

10.0 DILUENT WATER

No diluent water is proposed for the ASR project. The water that will be used for recharge will be 100 percent recycled water that has received advanced treatment (MF/RO/UV AOP). Any dilution in the subsurface (due to groundwater underflow) will not be counted toward TOC credits or for meeting pollutant or pathogen levels.

Table 18 MF/RO/UV AOP Finished Water Quality for MCLs- Inorganic Chemicals per Table 64431-A and Table 64432-A (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF	RO CONC	UV INF	Finished Water	MCL/Action Level	MRL (units shown at far left)
		5/2/16	5/2/16	11/12/15	5/20/16		
Aluminum	ug/L	ND	87	ND	ND	200	20
Antimony	ug/L	ND	3.9	ND	ND	6	1
Arsenic	ug/L	1	8.1	ND	ND	10	1
Asbestos	MFL[(2)]	ND	ND	ND	ND	7	0.2
Barium	ug/L	18	120	ND	ND	1,000	2
Beryllium	ug/L	ND	ND	ND	ND	4	1
Cadmium	ug/L	ND	ND	ND	ND	5	0.5
Chromium	ug/L	1.2	5.9	ND	ND	50	1
Copper	ug/L	5.4	36	ND	ND	1,300 *(Action Level)*	2
Cyanide	mg/L	0.04	0.18	ND	ND	150	0.025
Fluoride	mg/L	0.78	3.6	ND	ND	2	0.05
Hexavalent Chromium[(1)]	ug/L	--	--	--	--	10	0.5
Lead	ug/L	ND	ND	ND	ND	15 *(Action Level)*	0.5
Mercury	ug/L	ND	ND	ND	ND	2	0.2
Nickel	ug/L	6.2	46	ND	ND	100	5
Nitrate (as NO_3)	mg/L	ND	ND	ND	0.12	45	0.013
Nitrite (as N)	mg/L	ND	ND	ND	0.072	1	0.013
Perchlorate	ug/L	32	200	ND	ND	6	2
Nitrate + Nitrite (as N)	mg/L	ND	ND	ND	0.192	10	0.055

Table 18 MF/RO/UV AOP Finished Water Quality for MCLs- Inorganic Chemicals per Table 64431-A and Table 64432-A (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF 5/2/16	RO CONC 5/2/16	UV INF 11/12/15	Finished Water 5/20/16	MCL/Action Level	MRL (units shown at far left)
Selenium	ug/L	5.7	28	ND	ND	50	5
Thallium	ug/L	ND	ND	ND	ND	2	1

Notes:
(1) Laboratory error, hexavalent chromium not analyzed for.
(2) MFL = million fibers per liter longer than 10 *u*m.
(3) Hexavalent chromium was not tested due to a sampling error, however, total chromium was analyzed.

Table 19 MF/RO/UV AOP Finished Water Quality for MCLs- Radionuclides per Table 64442 AND 64443 (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF 5/02/16	RO CONC 5/02/16	UV INF 5/02/16	Finished Water 5/20/16	MCL	MRL (units shown at far left)
Gross Alpha (including Radium-226 but not Radon and Uranium)	pCi/L	5.7	29.1		ND	15	1.5
Radium-226	pCi/L	<0.889	0.354	<0.733	ND	-	0.889
Radium-228	pCi/L	<0.661	<0.593	<0.804	ND	-	0.661
Combined Radium-226 and Radium-228 (*226 + 228*)	pCi/L	ND	0.354	ND	ND	5	
Strontium 90	pCi/L	<0.968	<1.92	<0.908	<0.654	8	0.968
Uranium	pCi/L	5.2	37	ND	ND	20	0.7
Tritium	pCi/L	<267	<265	<264	<279	20,000	267
Beta/Photon emitters (gross beta tested)	pCi/L	38	210	5.3	<1.80	4	2.42

Table 20 MF/RO/UV AOP Finished Water Quality for MCLs- Synthetic Organic Chemicals - SVOCS per Table 64444-A (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF 5/02/16	RO CONC 5/02/16	UV INF 5/0216	Finished Water 5/20/16	MCL/Action Level	MRL(units shown at far left)
Alachlor	ug/L	ND	ND	ND	ND	2	0.05
Atrazine	ng/L	ND	9.3	ND	ND	1	5
Benzo(a)pyrene	ug/L	ND	ND	ND	ND	0.2	0.02
Carbofuran	ug/L	ND	ND	ND	ND	40	0.5
Chlordane	ug/L	ND	ND	ND	ND	2	0.1
Dalapon	ug/L	ND	1.1	ND	ND	200	1
Dibromochloropropane	ug/L	ND	ND	ND	ND	0.2	0.01
Dinoseb	ug/L	ND	ND	ND	ND	7	0.2
Dioxin(2,3,7,8-TCDD)	pg/L	ND	ND	ND	ND	3.00E-08	5
Diquat	ug/L	ND	0.65	ND	ND	20	0.4
Di(2-ethylhexyl) adipate	ug/L	ND	ND	ND	ND	400	0.6
Di(2-ethylhexyl) phthalate	ug/L	ND	ND	ND	ND	6	0.6
Endothall	ug/L	ND	ND	ND	ND	100	5
Endrin	ug/L	ND	ND	ND	ND	2	0.2
Ethylene Dibromide	ug/L	ND	ND	ND	ND	0.05	0.01
Glyphosate	ug/L	ND	ND	ND	ND	700	6
Heptachlor	ug/L	ND	0.033	ND	ND	0.04	0.01
Heptachlor epoxide	ug/L	ND	ND	ND	ND	0.02	0.01
Hexachlorobenzene	ug/L	ND	ND	ND	ND	1	0.05
Hexachlorocyclopentadiene	ug/L	ND	ND	ND	ND	50	0.05
Lindane	ug/L	ND	ND	ND	ND	0.2	0.04

Table 20 MF/RO/UV AOP Finished Water Quality for MCLs- Synthetic Organic Chemicals - SVOCS per Table 64444-A (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF 5/02/16	RO CONC 5/02/16	UV INF 5/0216	Finished Water 5/20/16	MCL/Action Level	MRL(units shown at far left)
Methoxychlor	ug/L	ND	ND	ND	ND	40	0.1
Oxamyl(Vydate)	ug/L	ND	ND	ND	ND	200	0.5
Picloram	ug/L	ND	ND	ND	ND	500	0.1
Polychlorinated Biphenyls (TOTAL)(1)	ug/L	ND	ND	ND	ND	0.5	0.0005
Pentachlorophenol	ug/L	ND	ND	ND	ND	1	0.04
Simazine	ng/L	20	76	ND	ND	4	5
Toxaphene	ug/L	ND	ND	ND	ND	3	0.5
2,4-D	ug/L	0.25	2.3	ND	ND	70	0.1
2,4,5-TP Silvex	ug/L	ND	ND	ND	ND	50	0.2
Bentazon	ug/L	ND	0.78	ND	ND	18	0.5
Molinate	ug/L	ND	ND	ND	ND	20	0.1
Thiobencarb	ug/L	ND	ND	ND	ND	1	0.2

Notes:
(1) Polychlorinated Biphenyls (TOTAL) includes: PCB 1016, PCB 1221, PCB 1232, PCB 1242, PCB 1248, PCB 1254 and PCB 1260."

Table 21 MF/RO/UV AOP Finished Water Quality for MCLs- Volatile Organic Chemicals - VOCS per Table 64444-A (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF	RO CONC	UV INF	Finished Water	MCL/Action Level	MRL
		5/02/16	5/02/16	5-02-16	5/2016		
Benzene	ug/L	ND	ND	ND	ND	1	0.5
Carbon tetrachloride	ug/L	ND	ND	ND	ND	0.5	0.5
cis-1,2-Dichloroethylene	ug/L	ND	ND	ND	ND	6	0.5
Dichloromethane	ug/L	ND	ND	ND	ND	5	0.5
Ethylbenzene	ug/L	ND	ND	ND	ND	300	0.5
Monochlorobenzene (Chlorobenzene)	ug/L	ND	ND	ND	ND	70	0.5
o-Dichlorobenzene	ug/L	ND	ND	ND	ND	600	0.5
p-Dichlorobenzene	ug/L	ND	ND	ND	ND	5	0.5
Styrene	ug/L	ND	ND	ND	ND	100	0.5
Tetrachloroethylene(PCE)	ug/L	ND	ND	ND	ND	5	0.5
Toluene	ug/L	ND	ND	ND	ND	150	0.5
trans-1,2-Dichloroethylene	ug/L	ND	ND	ND	ND	10	0.5
Trichloroethylene (TCE)	ug/L	ND	ND	ND	ND	5	0.5
Vinyl chloride	ug/L	ND	ND	ND	ND	0.5	0.3
Xylenes (total)	ug/L	ND	ND	ND	ND	1,750	0.5
1,1-Dichloroethylene	ug/L	ND	ND	ND	ND	6	0.5
1,1,1-Trichloroethane	ug/L	ND	ND	ND	ND	200	0.5
1,1,2-Trichloroethane	ug/L	ND	ND	ND	ND	5	0.5
1,2-Dichloroethane	ug/L	ND	ND	ND	ND	0.5	0.5

Table 21 MF/RO/UV AOP Finished Water Quality for MCLs- Volatile Organic Chemicals - VOCS per Table 64444-A (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF	RO CONC	UV INF	Finished Water	MCL/Action Level	MRL
		5/02/16	5/02/16	5-02-16	5/2016		
1,2-Dichloropropane	ug/L	ND	ND	ND	ND	5	0.5
1,2,4-Trichlorobenzene	ug/L	ND	ND	ND	ND	5	0.5
1,1-Dichloroethane	ug/L	ND	ND	ND	ND	5	0.5
1,3-Dichloropropene	ug/L	ND	ND	ND	ND	0.5	0.5
Methyl-tert-butyl ether (MTBE)	ug/L	ND	ND	ND	ND	135 (Secondary MCL)	0.5
1,1,2,2-Tetrachloroethane	ug/L	ND	ND	ND	ND	1,200	0.5
Trichlorofluoromethane	ug/L	ND	ND	ND	ND	150	0.5
1,1,2-Trichloro-1,2,2-Trifluoroethane	ug/L	ND	ND	ND	ND	1,200	0.5

Table 22 MUF/RO/UV AOP Finished Water Quality for MCLs- Disinfection Byproducts per Table 64533-A (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Disinfection Byproduct	Unit	RO INF	RO CONC	UV INF	Finished Water	MCL/Action Level	MRL
		5/02/16	5/02/16	5/02/16	5/20/16		
Total Trihalomethanes (TTHM)	ug/L	2.3	11	1.5	0.89	80	0.5
Haloacetic acids (five) (HAA5)(1)	ug/L	20	85	ND	ND	60	2
Bromate	ug/L	ND	1.8	ND	ND	10	1
Chlorite	mg/L	ND	ND	ND	ND	1.0	0.01
Chlorate	ug/L	350	1600	16	ND	800	10

Note:
(1) Haloacetic acids (five) includes: Bromoacetic Acid, Chloroacetic Acid, Dibromoacetic Acid, Dichloroacetic Acid and Trichloroacetic Acid.

Table 23 MF/RO/UV AOP Finished Water Quality for Secondary MCLs per Tables 64449-A and 64449-B (DDW, 2015)
Advanced Water Purification Facility
City of Oxnard

Secondary Constituent	Unit	RO INF 5/02/16	RO CONC 5/02/16	UV INF 5/02/16	Finished Water 5/20/16	MCL/Action Level (units shown at far left)	MRL (units shown at far left)
Color	ACU	40	300	ND	5	15 color units	3
Corrosivity (below)*:						Non-corrosive	
Langelier Index - 20 degrees C	-	-3	-4.9	-2.4	5.4	Non-corrosive	-
Langelier Index at 60 degrees C	-	NA	NA	NA	NA	Non-corrosive	-
Aggressiveness Index-Calculated	-	8.7	6.8	9.3	7.4	Non-corrosive	-
pH of CaCO3 saturation(25C)	Units	6.6	5	10	10	Non-corrosive	0.1
pH of CaCO3 saturation(60C)	Units	6.2	4.6	9.9	9.9	Non-corrosive	0.1
Bicarb. Alkalinity as HCO3, calc	mg/L	650	4200	ND	ND	Non-corrosive	3
Foaming agents (Surfactants)	mg/L	0.2	0.89	ND	ND	0.5	0.1
pH	Units	8	7.8	6.7	6.5	6.5-8.5	0.1
Hardness (as CaCO3)	mg/L	650	4,200	ND	ND	250	3
Odor (SM 2150B - Odor at 60 C (TON))	TON	200	200	3	ND	3 (Threshold Odor Number)	1
Total dissolved solids(TDS)	mg/L	2,000	11,000	68	64	500	10
Aluminum	ug/L	ND	87	ND	ND	50-200	20
Chloride	mg/L	610	3,700	26	17	250	1
Copper	ug/L	5.4	36	ND	ND	1,000	2
Fluoride	mg/L	0.78	3.6	ND	ND	2	0.05
Iron	mg/L	0.13	0.87	ND	ND	0.3	0.02
Manganese	ug/L	95	680	ND	ND	50	2
Silver	ug/L	ND	ND	ND	ND	100	0.5
Sulfate	mg/L	510	3400	ND	0.55	250	0.5
Turbidity	NTU	0.17	0.5	ND	0.14	5	0.1
Specific Conductance	umho/cm	3400	18,000	140	110	900	2
Zinc	ug/L	21	140	ND	ND	5,000	20

Table 24 MF/RO/UV AOP Finished Water Quality for Drinking Water NLs per DDW, 2015a
Advanced Water Purification Facility
City of Oxnard

Secondary Constituent	Unit	RO INF	RO CONC	UV INF	Finished Water	MCL/Action Level (units shown at far left)	MRL (units shown at far left)
		5/02/16	5/02/16	5/02/16	5/20/16		
Boron	mg/L	1.1	2.1	0.82	0.77	1	0.05
n-Butylbenzene	ug/L	ND	ND	ND	ND	260	0.5
sec-Butylbenzene	ug/L	ND	ND	ND	ND	260	0.5
tert-Butylbenzene	ug/L	ND	ND	ND	ND	206	0.5
Carbon disulfide	ug/L	ND	ND	ND	ND	160	0.5
Chlorate	ug/L	350	1,600	16	ND	800	10
2-Chlorotoluene	ug/L	ND	ND	ND	ND	140	0.5
4-Chlorotoluene	ug/L	ND	ND	ND	ND	140	0.5
Diazinon	ug/L	ND	ND	ND	ND	1.2	0.1
Dichlorodifluoromethane (Freon 12)	ug/L	ND	ND	ND	ND	1,000	0.5
1,4-Dioxane	ug/L	1.4	7	ND	ND	1	1
Ethylene glycol	mg/L	ND	ND	ND	ND	14	10
Formaldehyde	ug/L	36	100	20	17	100	5
HMX	ug/L	ND	ND	ND	ND	350	0.1
Isopropylbenzene	ug/L	ND	ND	ND	ND	770	0.5
Manganese	ug/L	95	680	ND	ND	500	2
Methyl isobutyl ketone (MIBK)	ug/L	ND	ND	ND	ND	120	5
Naphthalene	ug/L	ND	ND	ND	ND	17	0.5
N-Nitrosodiethylamine (NDEA)	ng/L	2.9	25	ND	ND	10	2
N-Nitrosodimethylamine (NDMA)	ng/L	33	90	32	5	10	2

Table 24 MF/RO/UV AOP Finished Water Quality for Drinking Water NLs per DDW, 2015a
Advanced Water Purification Facility
City of Oxnard

Secondary Constituent	Unit	RO INF	RO CONC	UV INF	Finished Water	MCL/Action Level (units shown at far left)	MRL (units shown at far left)
		5/02/16	5/02/16	5/02/16	5/20/16		
N-Nitrosodi-n-propylamine (NDPA)	ng/L	ND	ND	ND	ND	10	2
Propachlor**	ug/L	ND	ND	ND	ND	90	0.05
n-Propylbenzene 0.26	ug/L	ND	ND	ND	ND	260	0.5
RDX	ug/L	ND	ND	ND	ND	0.3	0.1
Tertiary butyl alcohol (TBA)	ug/L	2.1	19	ND	ND	12	2
1,2,3-Trichloropropane (1,2,3-TCP)	ug/L	ND	0.017	ND	ND	0.005	0.005
1,2,4-Trimethylbenzene	ug/L	ND	ND	ND	ND	330	0.5
1,3,5-Trimethylbenzene	ug/L	ND	ND	ND	ND	330	0.5
2,4,6-Trinitrotoluene (TNT)	ug/L	ND	ND	ND	ND	1	0.1
Vanadium	ug/L	ND	11	ND	ND	50	3

Table 25 MF/RO/UV AOP Finished Water Quality for CECs
Advanced Water Purification Facility
City of Oxnard

Constituent	Unit	RO INF 5/02/16	RO CONC 5/02/16	UV INF 5/02/16	Finished Water 5/2016	MRL
Gemfibrozil	ng/L	1200	16000	ND	ND	5
Naproxen	ng/L	130	230	ND	ND	10
Triclosan	ng/L	230	2000	12	ND	10
Ibuprofen	ng/L	ND	5200	ND	ND	10
Acetaminophen	ng/L	150	240	45	ND	5
Sucralose	ng/L	47,000	310,000	ND	ND	100
Triclocarban	ng/L	ND	ND	ND	ND	5
Sulfamethoxazole	ng/L	1,600	15,000	ND	ND	5
Atenolol	ng/L	320	3700	5.5	ND	5
Trimethoprim	ng/L	320	3500	ND	ND	5
Caffeine	ng/L	3500	31000	23	21	5
Fluoxetine	ng/L	35	220	ND	ND	10
Meprobamate	ng/L	ND	930	ND	ND	5
Carbamazepine	ng/L	140	1000	ND	ND	5
Primidone	ng/L	94	260	ND	ND	5
DEET	ng/L	94	260	ND	ND	5
TCEP	ng/L	200	1100	ND	ND	10
PFOA	ug/L	0.0057	0.035	ND	0.0051	0.0025
PFOS	ug/L	0.0042	0.035	ND	ND	0.0025
Estrone	ng/L	9.4	51	ND	ND	0.002
Estradiol	ng/L	ND	ND	ND	ND	5
Ethynylestradiol	ug/L	ND	0.0052	ND	ND	0.0009
Testosterone	ug/L	0.0019	0.0090	ND	ND	0.0001
Progesterone	ng/L	ND	ND	ND	ND	5

11.0 ASR FACILITIES

The proposed ASR concept is to inject highly-treated recycled water for a minimum period of 3.1 months and possibly for up to 6 months, hold the water in the designated aquifer for 3.1 months, and then withdraw the water from the same wells into which the water was injected for potable and/or non-potable use. The proposed ASR operation is summarized in Section 6 and detailed by Hopkins (2016).

12.0 GROUNDWATER BASINS

12.1 Existing Water Quality

At this time, the project team has extensive groundwater data provided by the UWCD for the "Lower Aquifer System," or LAS (shown in Figure 30 below). The LAS extends throughout the area and groundwater quality is anticipated to be similar underneath the proposed ASR location. Table 26 is lists local groundwater quality data obtained from UWCD.

Table 26 List of UWCD Groundwater Quality
Advanced Water Purification Facility
City of Oxnard

Constituent (mg/L unless otherwise stated)	Comparative Groundwater Quality Well IDs			Nearest Well to Proposed ASR Location
	01N22W03F05S	02N22W30F03S	02N22W20L03S	(1N22W04F04)[(1)]
Alk as CaCO3	213	484	608	520
Temperature (C)				
pH	7.38	7.40	7.46	7.6
TDS	996			958
Turbidity (NTUs)	0.04		0.42	
Nitrate-N				4.3
Potassium	5	7	5	6
Sodium	102	93	140	93
Magnesium	47	37	54	44
Calcium	141	135	155	135
Bicarbonate	239	255	286	249
Sulfate	470	435	594	418
Boron (µg/L)	700	600	620	600
Chloride	50	54	66	49
Fluoride	0.62	0.50	0.60	0.7

Notes:
(1) Data from 1960 to 1989.

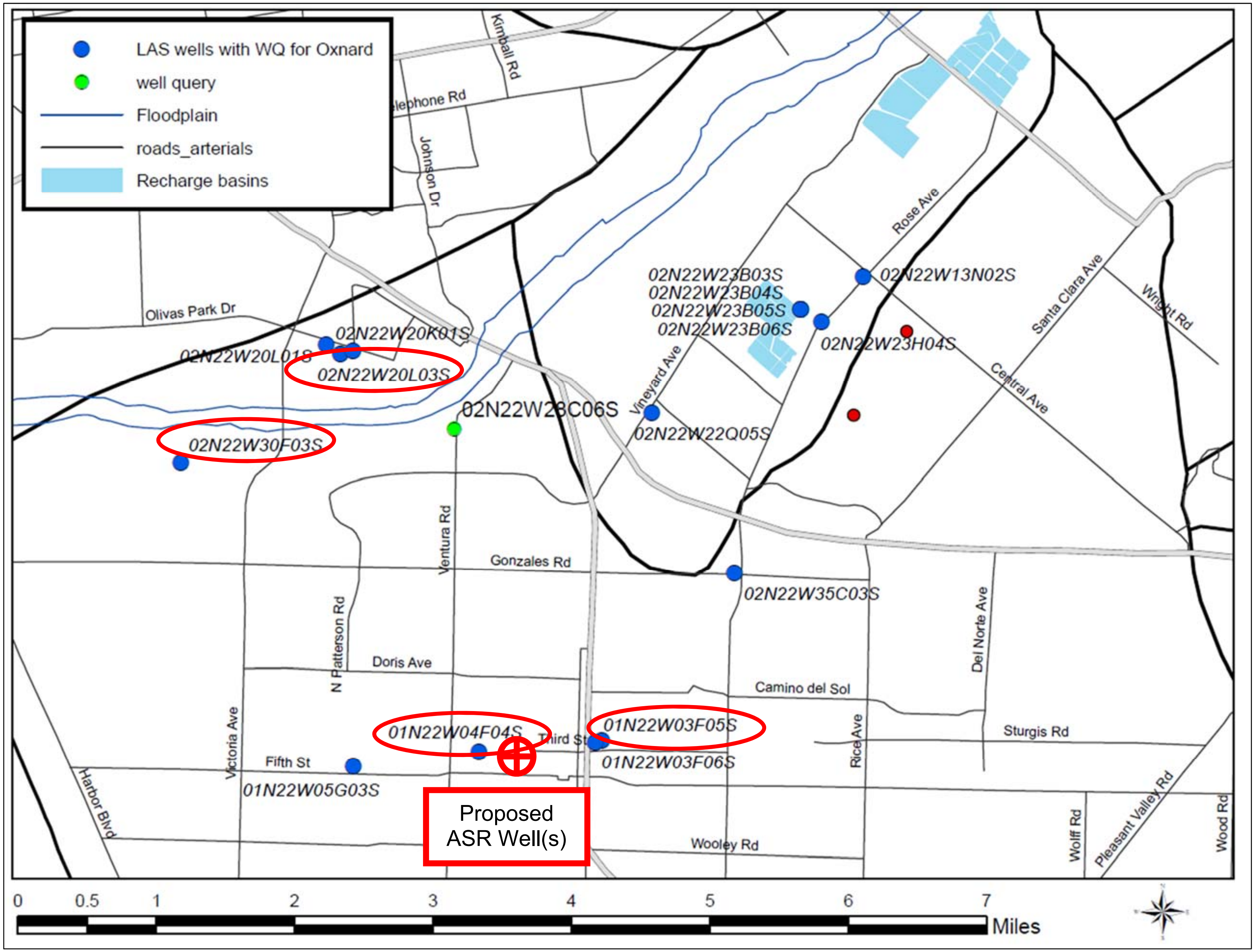

Figure 30 Oxnard Map of UWCD Well Locations (provided by UWCD)

12.2 Groundwater Model

No groundwater model exists for the project area.

13.0 DOMESTIC WATER SUPPLY PRODUCTION WELLS

13.1 Production Wells Near the Project

The Campus Park site is located within the City where all potable water is provided by the City municipal supply system. The nearest production well to the project is a domestic well located southeast of the site that is used for off-site irrigation. The next closest production wells are domestic wells located to the northwest of the site in the County. These wells, ***all in the UAS***, supply residential uses. The next closest wells are located to the east at City Blending Station No. 1. See Hopkins (2016) for more details.

13.2 Closest Domestic Supply Well

The closest existing domestic supply wells are located over 2,000 feet northwest of the site and are constructed in the Oxnard Aquifer, the uppermost member of the upper aquifer system. See Hopkins (2016) for more details.

13.3 Domestic Water Supply Production Wells – Water Quality

The water quality in regional water supply wells is summarized in Section 12.

14.0 GROUNDWATER RECHARGE IMPACTS

14.1 Regional Geologic and Hydrogeologic Framework

The subsurface geology that controls groundwater flow in the study area is differentiated into two primary geologic units that include; the Holocene and late Pleistocene alluvium, and the San Pedro Formation. The first unit is comprised largely of unconsolidated sedimentary deposits and includes all older and recent alluvial deposits. These shallower units are coarse-grained sand and gravel layers that form the Oxnard and Mugu Aquifers and comprise the UAS in the Oxnard Plain Basin (see Hopkins (2016), Appendix D, Plates 3, and 4). The San Pedro Formation consists of consolidated marine and nonmarine clay, silt, sand, and gravel deposits that comprise the Hueneme and Fox Canyon Aquifers that are designated as the LAS. The low permeability geologic formations underlying the San Pedro Formation are generally considered to be non-water-bearing and effectively define the base of fresh water.

The groundwater in the Oxnard Plain Basin LAS is isolated from overlying land uses by the laterally extensive aquitard (silt and clay) layers that separate and confine the Hueneme and Fox Canyon Aquifer zones. The conceptual subsurface profile (shown in Figure 11) uses the geophysical survey (electric log) from the proximate (destroyed) City Well No. 13 to show the anticipated geology and aquifer zones beneath the Campus Park GRRP site. The aquifer zones shown in Figure 11 are discretely separated by clay layers that are laterally continuous and appear as marker beds in other well logs shown by Hopkins (2016) in Appendix D, Plates 3 and 4. The significance of the highly confined condition that results from the discretely layered aquifer system is that wells located in close proximity (50 feet apart) but producing from different aquifer layers, do not have hydraulic connectivity with each other (no interference).

Recharge into the LAS will store water in aquifer zones that receive significantly less groundwater recharge than the UAS because of the regional confined aquifer conditions. The UAS readily receives groundwater recharge derived from natural percolation of rainwater and Santa Clara River flows in the Oxnard Forebay Basin, as well as from river flow diversions into the engineered recharge facilities operated by UWCD.

14.1.1 Other Existing or Proposed GWRS Project that Could Impact the ASR

There are no other planned groundwater recharge projects in the vicinity.

14.1.2 Cumulative Impact on Water Quantity and Quality With and Without the Proposed GWRS Project

The water quality in the aquifer zones that will be used for replenishment in the LAS was previously described in Chapter 12. The groundwater is typically a calcium sulfate-barcarbonate chemical character with a TDS concentration of approximately 1,000 mg/l. Water quality degradation has been occurring in the overdrafted basin and results from poorer quality groundwater seeping out of the fine-grained silt and clay layers that are interbedded with the sand and gravel aquifer zones along with seawater intrusion. Without the project, regional groundwater quality will continue to degrade largely as a result of these 2 mechanisms.

With the project, the regional and local water quality impacts are beneficial. The regional benefit occurs when the aquifer is replenished and the groundwater levels rise. The rising water levels lessen any landward gradient and effectively slow the rate of seawater intrusion in the aquifer zones used for storage. This regional benefit remains until the stored volume is entirely removed. After removal there is no impact, in that the groundwater levels return to pre-recharge conditions.

The localized benefit to water quality will occur from flushing and mixing with the superior water quality of the purified water. Any water left behind will blend with the local native groundwater and improve its quality for downgradient users.

14.2 Predicted Recycled Water Retention Time

As detailed previously, the retention time is fully controlled by the City because of the ASR operation. The minimum retention time will be 3.1 months but can vary specifically as chosen by the City as long as all pathogen credit requirements are met.

14.3 Recycled Water Contribution

As there is no proposed dilution, the recycled water contribution (RWC) is 1.0, or 100 percent.

14.4 Antidegradation Assessment – Predicted Groundwater Quality Post Recharge and Utilization of Available Assimilative Capacity of Basin

14.4.1 MCLs, Secondary MCLs, NLs, and CECs

As detailed in WRD (2013), the purified recycled water from an AWPF is expected to improve groundwater quality and thus improve the assimilative capacity. Demonstration of such improved water quality, comparing the water quality at the proposed recharge locations with the water quality of the finished water from the AWPF, has not yet been done. Such work will be done as detailed in Section 17.

14.4.2 Recharge of Purified Water and Groundwater Chemistry Concerns

The LARWQCB has requested more information regarding the change in groundwater chemistry that can result from injection of a purified water. The following perspective comes from OCWD (2014).

- The finished water from Groundwater Replenishment System (GWRS) is stabilized prior to injection via decarbonation and lime addition. Initially the target pH was set at 9.0, but this has been progressively reduced to 8.0 in an effort to mitigate arsenic mobilization while also maintaining pipeline integrity. Ambient groundwater pH is approximately 7.5, and previous literature indicates elevated pH in laboratory experiments can mobilize certain arsenic species. More recent laboratory experiments conducted by Stanford University on behalf of OCWD have shown pH to be a secondary factor in mobilization behavior, with the relatively poorly-buffered finished GWRS water rapidly taking on the pH of the soil column. The effect of reducing the GWRS finished water pH on field-observed arsenic mobilization has been inconclusive to date.

- The literature indicates that low alkalinity and low ionic strength of the finished water may alter the surface charge of aquifer mineral surfaces, affecting arsenic sorption. However, recent laboratory experiments conducted by Stanford University on behalf of OCWD have indicated that neither of these parameters is of significant importance in shallow unconfined aquifer sediments collected near OCWDs recharge area;

instead the concentration of divalent cations, primarily magnesium and secondarily calcium, have been the most important inorganic controls on arsenic desorption.

- The high oxidation reduction potential (ORP) of the finished water may affect the oxidation state of arsenic and increase its solubility or release it via the oxidation of host minerals (e.g., iron sulfides) in the aquifer. This phenomena has been observed at some ASR project sites. In a second phase of work, Stanford University is currently conducting laboratory experiments on the addition of GWRS finished water to deep aquifer sediments collected from a geochemically reducing environment targeted for potential future injection.

- Field observations indicate a complex, non-linear relationship between the proportional GWRS water in the subsurface and resulting arsenic mobilization, governed by significant spatial and temporal variability. The majority of monitoring wells showing GWRS arrival demonstrate little or no mobilization of arsenic. A majority of those wells showing mobilization behavior have resulting arsenic concentrations below levels of regulatory concern (i.e., the 10 ug/L MCL) and/or have shown declining trends after an initial increase.

As part of this project, it is proposed to pilot test the ASR system and measure the impacts. The pilot test would include detailed monitoring of intrinsic tracers (dissolved minerals) as summarized in Section 17.

Because of the ASR operation, injected water will be extracted for both potable and non-potable reuse applications. If there are groundwater chemistry changes that are of public health significance for drinking water, the extracted water can be used exclusively for non-potable applications.

14.5 Impact of Groundwater Recharge Project on Contaminant Plumes

Groundwater recharge projects that utilize surface water spreading or injection in an unconfined groundwater basin can potentially effect the movement or cause movement of existing groundwater contamination. A preliminary search of the State operated GeoTracker web site indicated that there are 4 leaky underground storage tank sites located within 2,000 feet of the Campus Park site. The contamination was either contained in the soil or found in the shallow semi-perched aquifer zone which is isolated from the underlying Oxnard Aquifer by an extensive clay layer. The aquifer zones targeted by the ASR recharge project are isolated by multiple clay layers and aquifer zones beneath the semi-perched aquifer and prevent the project from having a potential impact on shallow groundwater contamination. Furthermore, all 4 sites have been remediated and are closed.

15.0 PROPOSED MONITORING AND REPORTING PROGRAM

This proposed monitoring and reporting program (MRP) was developed to conform to the DDW groundwater recharge regulations (CDPH, 2014).

15.1 General Monitoring Provisions

The following are general monitoring provisions:

- The City proposes to monitor the following according to the manner and frequency specified in this MRP:
  - Influent flow rate and quality to the AWPF.
  - AWPF finished water flow rate and quality.
  - Receiving groundwater quality, both background monitoring and monitoring after start of recharge project.
  - Production well (ASR wells) flow rate and quality.
- Compliance with the requirements of the LARWQCB WDRs will be evaluated based on the analytical monitoring data. Monitoring reports will include, but not be limited to, the following:
  - Analytical results.
  - Location of each sampling station where representative samples can be obtained, including a map that clearly identifies the locations of all injection wells, monitoring wells, and production wells (detailed in Hopkins, 2016).
  - Analytical test methods used and the corresponding method reporting limits (MRLs).
  - Name(s) of the laboratory that conducted the analyses.
  - Copy of the laboratory certifications by the DDW's Environmental Laboratory Accreditation Program (ELAP).
  - Quality assurance and control information.

15.1.1 Sampling and Analytical Protocols

Though not required to be included in the monitoring reports unless specifically requested by DDW or the LARWQCB, the City will have in place sampling protocols including procedures for handling, storing, testing, and disposing of purge and decontamination waters generated from sampling events.

For groundwater monitoring, the sampling protocols will outline the methods and procedures for: measuring water levels; purging wells; collecting samples; decontaminating equipment; containing, preserving, and shipping samples; and maintaining appropriate documentation.

The samples will be analyzed using analytical methods described in 40 CFR Part 141; or where no methods are specified for a given pollutant, by methods approved by the DDW, LARWQCB, and/or SWRCB. The City will select the analytical methods that provide MRLs lower than the limits prescribed in the WDR or as low as possible that will provide reliable data.

The City will instruct its contract laboratories to establish calibration standards so that the MRLs (or its equivalent if there is a different treatment of samples relative to the calibration standards) are the lowest calibration standard. At no time will analytical data derived from extrapolation beyond the lowest point of the calibration curve be used.

For all bacterial analyses, sample dilutions will be performed so the range of values extends from 1 to 800. The detection methods used for each analysis will be reported with the results of the analyses.

15.1.2 QA/QC Procedures

The LARWCB, DDW and the SWRCB Quality Assurance Program, may establish MRLs in any of the following situations:

- When the pollutant has no established method under 40 CFR 141.
- When the method under 40 CFR 141 for the pollutant has a MRL higher than the limit specified in the WDR.
- When the City proposes to use a test method that is more sensitive than those specified in 40 CFR Part 141.

For regulated constituents, the laboratory conducting the analyses will be certified by ELAP or approved by the DDW, LARWQCB, and/or SWRCB for a particular pollutant or parameter.

Samples will be analyzed within allowable holding time limits as specified in 40 CFR Part 141. All QA/QC analyses will be run on the same dates that samples are actually analyzed. The City will retain the QA/QC documentation in its files and make those files available for inspection and/or submit them when requested by the LARWQCB or the DDW. Proper chain of custody procedures will be followed and a copy of this documentation will be submitted with the quarterly report.

15.1.3 Unregulated Chemical Procedures

For unregulated chemical analyses, the City will select methods according to the following approach:

- Use drinking water methods, if available.
- Use DDW-recommended methods for unregulated chemicals, if available.
- If there is no DDW-recommended drinking water method for a chemical, then City staff will utilize the method that results in the lowest MRL for that chemical.
- If there is more than a single USEPA-approved method available, use the most sensitive of the USEPA-approved methods.
- If there is no USEPA-approved method for a chemical, and more than one method is available from the scientific literature and commercial laboratory, after consultation with DDW, use the most sensitive method.

- If no approved method is available for a specific chemical, the City's laboratory (or contract laboratory) may develop methods or use its own methods and will provide the analytical methods to DDW for review. Those methods may be used until DDW-recommended or USEPA-approved methods are available.

15.2 RO Permeate and AWPF Finished Water Monitoring Requirements

CDPH (2014) outlines a number of monitoring requirements for various process parameters and constituents that can determine performance of the system and compliance of the AWPF finished water in relation to the WDR. Section 60320.201 of CDPH (2014) states the following general requirements by process:

RO:

- On-going performance monitoring (EC or TOC) that indicates when the process has been compromised.
  – Online monitoring of EC in the RO permeate is proposed for this project, and the measurement of EC removal across RO will be determined at the AWPF.
  – DDW has requested that TOC monitoring also be used to determine TOC reduction across RO. Oxnard will install TOC metering upstream and downstream of the RO process.
- Minimum of one (1) form of continuous monitoring as well as associated surrogate and/or operational parameter limits and alarm settings that indicate when the integrity has been compromised.
  – As listed above, the RO permeate EC and log removal of EC across RO will be continuously monitored. The log removal of EC is a conservative surrogate for pathogen removal. Once the initial background log reduction of EC is established, a level below the background noise will be alarmed to indicate a reduction in RO performance. DDW, in a letter dated 12/5/2016, recommended setting alarm points similar to OCWD, with a blended EC target of 95 uS/cm and an individual train EC target of 110 uS/cm. As noted above, the baseline EC in the RO permeate will first be monitored before settling on specific EC targets.
  – As listed above, DDW has recommended the use of TOC as an additional monitoring method for RO performance. TOC meter(s) will be installed by the City.

Advanced Oxidation:

- Perform an occurrence study on municipal wastewater that includes indicator compounds and select a total of at least nine indicator compounds, with at least one from each of the functional groups. Or, as an alternative, demonstrate 0.5-log reduction of 1,4-dioxane by the AOP (in this case, UV AOP).
  – Demonstration testing of 1,4-dioxane destruction by AOP was performed at startup and was documented previously in this report.

- Occurrence study protocol, as well as subsequent results and chosen indicator compounds should be submitted for DDW review and approval.
  - 1,4-dioxane demonstration work was done in lieu of this requirement.
- During full-scale operation, the surrogate and or/operational parameter identified should be continuously monitored.
  - As detailed here, demonstration testing was done to show a correlation between the existing control philosophy (NDMA LRV) and 1,4-dioxane destruction.
- Monthly (grab or composite) samples representative of the finished water of the advanced treatment process will be analyzed for contaminants having MCLs and notification levels (NLs). After 12-consecutive months with no results exceeding MCL or NL, a reduction in monitoring frequency can be applied for (minimum quarterly). Monitoring conducted in this subsection can be used in lieu of monitoring (for the same contaminants) in CDPH (2014), Sections 60320.212 and 60320.220.

Table 27 provides more detail on the key analytical monitoring requirements specified in the DDW regulations (CDPH, 2014) as they pertain to the direct injection of purified water. This summary will serve as the basis for the monitoring and testing recommendations set forth within this MRP.

15.3 AWPF Influent Monitoring Requirements

OWTP effluent is the feed to the AWPF. Monitoring of OWTP quality allows for a better understanding of AWPF performance. OWTP effluent will be monitored in accordance with the current NPDES permit and based upon the Enhanced Source Control Program (Appendix A).

For this potable reuse project, recommended minimum monitoring of OWTP effluent is shown below in Table 28.

15.4 Advanced Treatment Online Monitoring

Online monitoring of process performance is critical to maintain the proper barrier to pathogens and trace pollutants. Table 9, presented earlier in this report provides information on the proposed monitoring and response procedures to produce high quality water and the necessary response retention time.

15.5 Reporting Requirements

The reporting requirements included in this section are proposed requirements and not the final requirements. The final reporting requirements for IPR will be specified in the revised Order.

Table 27	Master Table for Analytical Monitoring Requirements Required by CDPH (2014) Advanced Water Purification Facility City of Oxnard					
		Location				
Treatment Process	**Parameter**	**Influent to Process**	**Effluent from Process**	**Frequency**	**Further Information**	**CDPH (2014) Reference**
RO	Electrical Conductivity	X	X	Continuous	Effluent concentration and log reduction.	60320.201 (b)
	Total Organic Carbon	X	X	Weekly (24-hour composite)	Effluent concentration only. TOC<0.25 mg/L 95% of the time for first 20 weeks. TOC<0.5 mg/L thereafter. City will be installing online TOC meters influent and effluent to RO.	60320.201 (b) / 320.218 (a)
UV AOP	1,4-dioxane	X		One-Time	Seeding and destruction of 1,4-dioxane, $\geq$ 0.5-log.	60320.201 (d)
	NDMA LRV control with UVI/Q inspections		X	Continuous	NDMA LRV based control system correlates well with 1,4-dioxane destruction, NDMA destruction, and pathogen disinfection	60320.201 (e)
	MCLs, NLs (Inorganics, Radionuclides, Organics, Disinfection By-Products, Lead and Copper)		X	Monthly for 12 months, then transition to Quarterly	Contaminants with MCLs and NLs.	60320.201 (i) / 60320.212 (a)
	Secondary MCLs		X	Yearly(2,3)	Secondary DW MCLs defined in Table 13.	60320.212 (c)
	CECs		X	Annually	CECs defined in Table 19.	60320.220 (d)
	Nitrogen Compounds		X	2 x week, 3 days apart	TN<10 in RO finished water.	60320.210 (a)
	Priority Toxic Pollutants		X	Quarterly	Chemicals listed in 40 CFR Part 131.38.	60320.220
	Chemicals analyzed as part of Source Control		X	Annually	Appendix A	60320.220 & 60320.206
Monitoring Wells		All Monitoring Wells		2 background samples before operation followed by Quarterly Samples	Chemicals listed in 40 CFR Part 131.38. Secondary DW MCLs. Total Nitrogen, nitrate, nitrite. Additional contaminants named by the Department.	60320.220 / 60320.226

Table 28	Influent Monitoring Requirements Advanced Water Purification Facility City of Oxnard		
Constituents	**Units**	**Type of Sample**	**Minimum Frequency of Analysis**
Total Flow	mgd	Online Recorder	Continuous(1)
pH	--	Online Recorder	Continuous(1)
Turbidity	NTU	Online Recorder	Continuous(1)
TSS	mg/L	24-hour comp	Daily
TDS	mg/L	24-hour comp	Daily
BOD_5, 20^oC	mg/L	24-hour comp	Weekly
TOC	mg/L	24-hour comp	Weekly
EC	µS/cm	Online Recorder	Continuous(1)
NDMA	ng/L	Grab	Monthly

Notes:

(1) For those constituents that are continuously monitored, the City will report the monthly minimum, maximum, and daily average values.

15.5.1 Report Submittals

The City will submit the required compliance monitoring reports, as outlined in the following paragraphs to the SWRCB's GeoTracker database and to the DDW by the dates listed in Table 29.

Table 29	Summary of Compliance Report Submittals and their Due Dates Advanced Water Purification Facility City of Oxnard	
Report	**Description**	**Due**
Occurrence / Surrogate Study Report	Provide summary of occurrence study and subsequent surrogate monitoring effectiveness.	60 days after initial 12-months of monitoring during full-scale operation.
Quarterly Monitoring Reports	Provide discussion of previous quarter's analytical results and graphical and tabular summaries of monitoring data (see detailed description below).	May 15 (for Jan – Mar) Aug 15 (for Apr – Jun) Nov 15 (for Jul – Sep) Feb 15 (for Oct – Dec)
Annual Summary Report	Provide discussion of previous year's analytical results and graphical and tabular summaries of monitoring data (see detailed description below).	April 15 (for previous year).

Table 29 Summary of Compliance Report Submittals and their Due Dates Advanced Water Purification Facility City of Oxnard		
Report	**Description**	**Due**
Operations, Maintenance and Monitoring Plan	Description of operation, maintenance, and monitoring activities related to the AWPF.	Initial prior to operation Amended: After 6 months of operation.
Five-year Engineering Report	Provide and update to the Engineer's Report.	Every 5th year from date of approval of this Engineer's Report.
Notes: (1) All reports will be submitted to SWRCB's GeoTracker as well as to the DDW.		

15.5.2 <u>Requirements for Reports</u>

15.5.2.1 Analytical Reporting Details

For the purposes of reporting compliance with numerical limitations, analytical data will be reported using the following reporting protocols:

- Sample results greater than or equal to the MRL must be reported 'as measured' by the laboratory (i.e., the measured chemical concentration in the sample).
- Sample results less than the MRL, but greater than or equal to the laboratory's method detection limit (MDL), will be reported as "Detected, but not Quantified", "DNQ", or "J". The laboratory will write the estimated chemical concentration of the sample next to "DNQ" or "J."
- Sample results less than the laboratory's MDL will be reported as "Non-Detected," or ND.

If the City (or their consultants/contractors) samples and performs analyses (other than for process/operational control, startup, research or equipment testing) on any sample more frequently than required in this MRP using approved analytical methods, the results of those analyses will be included in the report. The results will be reflected in the calculation of the average used in the demonstrating compliance with average effluent limitations.

The quarterly report will be prepared by an engineer licensed in the State of California and experienced in the fields of wastewater treatment and public water supply.

The LARWQCB may request supporting documentation, such as daily logs of operations.

15.5.2.2 Occurrence / Surrogate Study Report

As detailed in Section 17, the performance of the system will be documented at startup, including the use of online surrogates for performance monitoring.

Within 60-days after completing the initial 12-months of monitoring during the full-scale operation, the City will submit a report to the DDW and LARWQCB that includes:

- The results of combined chlorine destruction monitoring across the UV AOP.
- The results on online EC reduction across RO.
- The results on online measurements of UV intensity and UVT.
- The results of MF DIT results and turbidity compliance.
- A description of actions taken, or those that would be taken, if the indicator compound removal did not meet the associated design criteria, the continuous surrogate monitoring failed to correspond to the indicator compound removal percentage, or the surrogate and/or operation parameter established was not met.

15.5.2.3 Quarterly Report

The quarterly compliance monitoring reports will, at a minimum, include the following information:

- The volume of recycled water used for non-potable and potable reuse applications. If no recycled water was used/spread/injected, the report shall so state.
- The date and time of all sampling and analyses.
- All analytical results of samples collected during the monitoring period, as listed in previously in this Section.
- Records of any operational problems, plant upset, and equipment breakdowns or malfunctions and any diversion(s) of off-specification recycled water and the location(s) of final disposal.
- Discussion of compliance, non-compliance, or violation of requirements.
- All corrective or preventative action(s) taken or planned with schedule of implementation, if any.
- Certification by the City that no groundwater for drinking water purposes has been pumped from wells within the boundary representing the greatest of the horizontal and vertical distances reflecting 3.1 months of RRT.
- Verification of compliance with the 20-week running average TOC in numerical graphic formats.
- Monitoring results associated with the evaluation of pathogenic microorganism removal as described in Section 5 of this Engineering Report.

15.5.2.4 Annual Report

The annual compliance monitoring reports will, at a minimum, include the following information:

- The volume of purified water used for non-potable and potable reuse applications. If no recycled water was used/spread/injected, the report shall so state.
- Tabular and graphical summaries of the monitoring data (influent, recycled water, and groundwater) obtained during the previous calendar year.
- A summary of compliance status, and for any non-compliance, a description of:
  - The date, duration, and nature of the violation.
  - A summary of any corrective actions and/or suspensions of surface and sub-surface application of recycled water resulting from a violation.
  - If uncorrected, a schedule for and summary of all remedial actions.
- Information pertaining to the vertical and horizontal migration of the recharge water plume.
- Observed trends in the monitoring wells.
- DDW drinking water quality data for the nearest domestic water supply well.
- A description of any changes in the operation of any unit processes or facilities.
- A description of any anticipated changes, along with an evaluation of the expected impacts of those changes on subsequent unit processes or facilities.
- A list of the analytical methods used for each test and associated laboratory quality assurance/quality control procedures; the report will identify the laboratories used by the City to monitor compliance with the WDR, their status of certification and provide a summary of proficiency test.
- A summary of measures taken by the City to comply with wastewater source control program and the effectiveness of the implementation measures.
- Evaluation of the ability of the City to comply with all regulations and provisions.
- List of current operating personnel, their responsibilities, and their corresponding grade of certification.

The annual report will be prepared by an engineer licensed in the State of California and experienced in the fields of wastewater treatment and public water supply.

15.5.2.5 Operations, Maintenance and Monitoring Plan

The Operations, Maintenance, and Monitoring Plan (OMMP) has been prepared under separate cover (KEH (2015)). The OMMP describes:

- Operation and control methodologies of the facility.
- Routine maintenance procedures.

- The monitoring and reporting plan (as included herein).
- Analytical methods for constituent analysis.

As detailed in Section 16, the OMMP needs to be updated prior to operation for potable water reuse. Looking forward, after 6-months of optimizing treatment processes during actual operation, the OMMP will be further updated and amended and will be submitted to the SWRCB's GeoTracker.

15.5.2.6 Five-Year Report

A five-year Engineering Report update will address any project changes and will include, but not be limited to:

- Evidence that the requirements associated with retention time in Section 60320.108, if applicable, and Section 60320.124 of CDPH (2014) have been met.
- A description of any inconsistencies between previous groundwater model predictions and the observed and/or measured values. For this requirement, the City will summarize the groundwater flow and transport including injection and extraction operations for the project during the previous five calendar years. This summary will also use the most current data for the evaluation of the transport of recycled water; such evaluations will include, at a minimum, the following information:
  - Total quantity of water injected into each major aquifer.
  - Estimates of the rate and path of flow of the injected water within each major aquifer.
  - Projections of the arrival time of the recycled water at the closest extraction well and the percent of recycled water at the wellheads.
  - Clear presentation on any assumptions and/or calculations used for determining the rates of flow and for projecting arrival times.
  - A discussion of the underground retention time of recycled water, a numerical model, or other methods used to determine the recycled water contribution to each aquifer.
  - A revised flow and transport model to match actual flow patterns observed within the aquifer if the flow paths have significantly changed.
  - Revised estimates, if applicable, on hydrogeologic conditions including the retention time and the amount of the recycled water in the aquifers and at the production well field at the end of that calendar year. The revised estimates will be based upon actual data collected during that year on recharge rates (including recycled water, native water, and potable water), hydrostatic head values, groundwater production rates, basin storage changes and any other data needed to revise the estimates of the retention time and the amount of the recycled water in the aquifers and at the production well field. Significant differences, and the reasons for such differences, between the original

estimates presented in the Engineer's Report, and the revised estimates, will be clearly presented. Additionally, the City will use the most recently available data to predict the retention time of recycled water in the substance.

The 5-year report will be prepared by an engineer licensed in the State of California and experienced in the fields of wastewater treatment and public water supply.

16.0 GENERAL OPERATIONS PLAN

Details of the AWPF operation, including chemical use and complimentary process details are provided in the Operations and Maintenance Management Plan (OMMP, KEH, 2015).

The DDW commented on this OMMP on February 19, 2015 (DDW, 2015); providing the following important comments, followed by responses from the City on April 14, 2015 (Oxnard, 2015). Prior to operational for potable water reuse, the OMMP needs to be updated to reflect these comments and recommended changes to system operation and monitoring (e.g., TOC implementation as one example).

- **DDW Comment (General)-** DDW "strongly encourages OWD to train additional staff on the operation of the AWPF to allow more flexibility in staffing…OWD shall not put an unnecessary strain on existing drinking water operations staffing…DDW requests more detail on the recycled water distribution staffing." **City Response:** The City is cross-training OWTP staff to assist the two current AWPF operators. The City also intends to limit AWPF operation, at this time, "to daytime hours when dedicated operators are manning the facility." The City intends to "add another position for a dedicated AWPF operator as well as increase Water Quality and Cross Connection staffing, by two."
- **DDW Comment (on IPR) -** "Conductivity will have a water quality trigger level at greater than 60 umho/cm. Will there be an alarm triggered instantly if this level is sustained for a period of time? What is the response time for the confirmation sample? Are operators able to respond afterhours quickly? What would their response time be?" **City Response:** "The SCADA system will be programmed to have a water quality conductivity levels above 60 umho/cm trigger an alarm after a sustained period of 10 minutes. If the AWPF is unmanned when an alarm is triggered, operators at the OWTP would respond. The OWTP has operates 24-hours per day that will be trained to respond to AWPF alarms. The response times would be less than 30 minutes. **Additional Comments based upon this Engineer's Report:** The recommended approach needs to be incorporated into the OMMP.
- **DDW Comment -** "The UV system is expected to achieve 0.9-log NDMA destruction. DDW comments on previous studies which show this corresponds to an EEO of approximately 0.20 kWhr/kgal." **City Response:** Comment Noted. **Additional Comments based upon this Engineer's Report:** Extensive startup work has been performed and documented in this report which illustrate the proper UV system

control to meet NDMA targets with a high degree of reliability. The recommended approach needs to be incorporated into the OMMP.

- **DDW Comment -** "Number four on the list of parameters monitored by SCADA is conductivity monitoring of the RO permeate. For IPR applications, DDW strongly encourages OWD to use an online TOC analyzer." **City Response:** "An online TOC analyzer will be added to the AWPF." **Additional Comments based upon this Engineer's Report:** At this time, no TOC analyzer has been added to the AWPF. The City intends to install a TOC meter, and the OMMP must then be amended to include TOC monitoring and calibration.
- **DDW Comment -** "Please explain what is meant by dose and how this set point is calculated. OMWD should propose a minimum EED." **City Response:** "A minimum EED will be identified…". **Additional Comments based upon this Engineer's Report:** See comment above regarding startup testing of the UV system. The recommended approach needs to be incorporated into the OMMP.
- **DDW Comment -** "The set point for the UV system should be…set [to] a level to always achieve 0.9-log NDMA destruction, which in previous studies corresponds to an EED of approximately 0.2 kWhr/kgal." **City Response:** Comment Noted. **Additional Comments based upon this Engineer's Report:** See comment above regarding startup testing of the UV system. The recommended approach needs to be incorporated into the OMMP.
- **DDW Comment -** OWD shall submit more details on tracer studies, monitoring wells, etc. as they become available. Additionally, please propose a detailed procedure for monitoring leakage between aquifers." **City Response:** Comment noted, the City will provide requested information to DDW. **Additional Comments based upon this Engineer's Report:** No further information in this Engineer's Report.

In the event of a process failure that impacts water quality (potentially or confirmed), the decision making process for protection of public health, detailed in Section 7, will be followed.

17.0 STARTUP TESTING

17.1 DDW Testing Requirements

In discussions with DDW, the City's engineering team reviewed how this project will not use dilution water and will use 100 percent recycled water for recharge. Additionally, the groundwater hydrogeology analyzed within this report is basic, with no tracer work yet performed. As such, extensive testing has been done on the AWPF, as detailed in Sections 5 and 9. These results demonstrate the ability of the AWPF to meet all regulated water quality standards, including for chemical pollutants and for pathogen log reduction.

The single missing information that still must be gathered is the travel time of injected water as it pertains to nearby drinking water wells (detailed in Hopkins, 2016). The analysis within this report of groundwater movement is simplistic. While the analysis methods are conservative, demonstration of groundwater movement (speed and direction) is required. For the ASR project, the ASR well will be put into temporary operation to track the movement of the injected water. Finished water and water from all monitoring wells will be sampled weekly (at a minimum) for TDS, chloride, and sulfate. The time of transport with these intrinsic tracers will be compared to the estimated values and the necessary RRT documented within this report.

The results from the testing above will be submitted to DDW and the RWQCB for review and approval prior to IPR operation.

17.2 LARWQCB Testing Requirements

Several key items must be demonstrated in advance of potable reuse:

- **Background Groundwater Quality –** Upon completion of the monitoring wells, the City will perform sampling required for regulated drinking water projects and the requirements in the Basin Plan for bacteria, minerals, nitrogen, and taste and odor. This testing will be done twice for each groundwater monitoring location. Results will be compared to the AWPF finished water quality detailed in Section 9.
- **Groundwater Chemistry Impacts –** The LARWQCB is concerned about changes in groundwater chemistry that may occur due to the addition of purified water into the groundwater basin. The primary example of this concern is the release of bound arsenic as a result of changes in groundwater chemistry (as reviewed in Section 14 of this report). Upon completion of the initial recharge demonstration period and the response retention, the groundwater will be recovered and placed into the recycled water system for irrigation uses. Groundwater will be sampled weekly for laboratory testing for potential contaminants of concern including for pH, alkalinity, arsenic, magnesium, calcium, and iron sulfides. In addition, water analyses for general minerals, metals, and radionuclides will be conducted on the recovered groundwater toward the beginning, the middle, and the end of the recovery period to assess its suitability as a potable supply.

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LIST OF ACRONYMS

-A-	
ASR	Aquifer Storage and Recovery
AWPF	Advanced Water Purification Facility
-B-	
bgs	below ground surface
BOD	Biological Oxygen Demand
-C-	
CEC	Constituents of Emerging Concern
CEQA	California Environmental Quality Act
City	The City of Oxnard
CIUs	Categorical Industrial Users
CMWD	Calleguas Municipal Water District
CWC	California Water Code
-D-	
DDW	Division of Drinking Water
DIT	Direct Integrity Test
-E-	
EC	Electrical Conductivity
EDCs	Endocrine Disrupting Compounds
ELAP	Environmental Laboratory Accreditation Program
-F-	
FCGMA	Fox Canyon Groundwater Management Authority
-G-	
GRPs	Groundwater Recharge Projects
GRRP	Groundwater Replenishment Reuse Project
GWRS	Groundwater Replenishment System
-H-	
H_2O_2	Hydrogen Peroxide
-I-	
IPR	Indirect Potable Reuse
-L-	
LARWQCB	Los Angeles RWQCB
LAS	Lower Aquifer System
LASAN	LA Sanitation
LPHO	Low-Pressure High-Output
-M-	
MCLs	Maximum Contaminant Levels
MDL	Method Detection Limit
MF	Microfiltration
MRP	Monitoring and Reporting Program

MWDSC	Metropolitan Water District of Southern California
-N-	
ND	Non-Detected
NLs	Notification Levels
NOV	Notice of Violation
NWRI	National Water Research Institute
-O-	
OMMP	Operations, Maintenance, and Monitoring Plan
ORP	Oxidation Reduction Potential
OVMWD	Ocean View Municipal Water District
OWTP	Oxnard Wastewater Treatment Plant
-P-	
PDT	Pressure Decay Test
PEIR	Program Environmental Impact Report
PHWA	Port Hueneme Water Authority
POTW	Publicly-Owned Treatment Works
PPCP(s)	Pharmaceuticals and Personal Care Products
-Q-	
QAPP	Quality Assurance Project Plan
-R-	
RO	Reverse Osmosis
ROP	RO Permeate
ROSA	Reverse Osmosis System Analysis
ROWD	Report of Waste Discharge
RRT	Response Retention Time
RWC	Recycled Water Contribution
RWQCB	Regional Water Quality Control Board
-S-	
SCVWD	Santa Clara Valley Water District
SIU(s)	Significant Industrial User(s)
SNMP(s)	Salt Nutrient Management Plan(s)
SWP	State Water Project
SWRCB	State Water Resources Control Board
-T-	
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TSP-SC	Technical Services Program – Source Control
TTO	Total Toxic Organics
-U-	
UAS	Upper Aquifer System
UV AOP	Ultraviolet Light and Hydrogen Peroxide

UVT	UV Transmittance
UWCD	United Water Conservation District’s
-W-	
WDR(s)	Waste Discharge Requirement(s)
WRD	Water Replenishment District
WRR	Water Recycling Requirement

APPENDIX A – INDIRECT POTABLE REUSE ENHANCED SOURCE WATER CONTROL AND COLLECTION SYSTEM MONITORING PROGRAM

APPENDIX A - LOCATED IN VOLUME 2

APPENDIX B – PRELIMINARY HYDROGEOLOGICAL STUDY REPORT, CITY OF OXNARD GREAT PROGRAM, CAMPUS PARK GROUNDWATER REPLENISHMENT AND REUSE PROJECT

APPENDIX B - LOCATED IN VOLUME 2

APPENDIX C - LOCATED IN VOLUME 2

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CITY OF
OXNARD
CALIFORNIA

MARCH 2017

Advanced Water Purification Facility

Indirect Potable Reuse Engineering Report Appendices

VOLUME 2 OF 2

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CITY OF OXNARD

ADVANCED WATER PURIFICATION FACILITY

INDIRECT POTABLE REUSE POTABLE REUSE ENGINEERING REPORT

FINAL
VOLUME 2 OF 2
March 2017

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CITY OF OXNARD
ADVANCED WATER PURIFICATION FACILITY

INDIRECT POTABLE REUSE
POTABLE REUSE ENGINEERING REPORT

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APPENDIX A – INDIRECT POTABLE REUSE ENHANCED SOURCE WATER CONTROL AND COLLECTION SYSTEM MONITORING PROGRAM

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CITY OF OXNARD

ADVANCED WATER PURIFICATION FACILITY

INDIRECT POTABLE REUSE
ENHANCED SOURCE CONTROL AND COLLECTION SYSTEM MONITORING PROGRAM

SUPPLEMENTAL REPORT

DRAFT

March 2017

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CITY OF OXNARD

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INDIRECT POTABLE REUSE ENHANCED SOURCE WATER CONTROL AND COLLECTION SYSTEM MONITORING PROGRAM

Acknowledgements: At the onset of this effort, Carollo and Oxnard staff reached out to the Orange County Sanitation District and the Los Angeles County Sanitation Districts for initial guidance on source control for potable water reuse. Their assistance was substantial and is appreciated.

The production of purified water starts with an effective source control program. This supplement goes beyond the existing approved source control program for Oxnard, hence the use of "Enhanced" in the title of this document. This Enhanced Source Control Program (ESCP) details the planned program to effectively monitor the industrial and municipal contributions to the Oxnard Wastewater Treatment Plant (OWTP) as it pertains to the forthcoming potable water reuse project. This document is intended as guidance to the City with proposed methods to monitor in numerous locations and proposed methods to trace pollutants to their source. Some changes to the monitoring and response recommendations will occur as the City gains more experience and moves forward with their forthcoming project.

Much of this ESCP details sampling efforts currently employed as part of the existing source control program and sampling efforts that are already required by DDW for finished water quality monitoring. This document is not recommending duplication of those efforts, but instead presents the overall collection and use of data to optimize source control.

1.0 DDW REGULATIONS

The regulatory requirements for wastewater source control are defined in the California Code of Regulations Section 60320.206 of the regulations for groundwater recharge with recycled water (DDW2014). For this project, the City must administer an industrial pretreatment and pollutant source control program. The City must implement and maintain a program that includes, at a minimum:

A. An assessment of the fate of chemicals and contaminants that are specified by the Department of Drinking Water (Department) and Regional Water Quality Control Board, Los Angeles Region (RWQCB) through the wastewater and recycled municipal wastewater treatment systems (addressed in Section 7).

B. Chemical and contaminant source investigations and monitoring that focuses on Department-specified and RWQCB-specified chemicals and contaminants (addressed in Sections 3 and 4).

C. An outreach program to industrial, commercial, and residential communities within the portions of the sewage collection agency's service area that flows into the water reclamation plant subsequently supplying the groundwater replenishment reuse project (GRRP), for the purpose of managing and minimizing the discharge of chemicals and contaminants at the source (addressed in Sections 5 and 6).

D. A current inventory of chemicals and contaminants identified pursuant to this section, including new chemicals and contaminants resulting from new sources or changes to existing sources, that may be discharged into the wastewater collection system (addressed in Section 5).

E. Is compliant with the effluent limits established in the wastewater management agency's RWQCB permit (addressed in Section 4).

This document is intended to address each of these items to the satisfaction of the Division of Drinking Water (DDW).

2.0 COLLECTION SYSTEM AND SECONDARY EFFLUENT SOURCE MONITORING PROGRAMS

The main purpose of any source control monitoring program is to protect public health. With potable reuse systems, it is even more imperative that all steps used to protect public health are taken. Title 22 requires a source monitoring and control program be implemented upstream of potable reuse systems. The City's current source water control program has been recently upgraded to include more stringent discharge limits and monitoring in the collection system. Suggestions to enhance the current collection system monitoring plan are included in this document.

While collection system pre-treatment programs and monitoring are important, secondary effluent is the source water to be used for IPR. The proposed enhanced source control program includes a specific contaminant inventory to be monitored in the secondary effluent as well as in the purified water. An action plan detailing when and how to trace contaminants back through the wastewater treatment plant and potentially into the collection system can be found in Section 5.

A generic example of how to trace industrial discharges from their source to the AWPF, based upon different constituent groups, is shown in Figure 1. Monitoring parameters vary by location, with more constituents being tested in the secondary effluent and purified water.

An effective enhanced source control program will have a monitoring and data analysis plan that starts with the first discharge of wastewater into the collection system all the way through to the final purification step at the AWPF. Key to this success is having a dedicated staff member heading up the program as the Source Control Program Manager (SCPM). A further job description for the SCPM is provided later in this document.

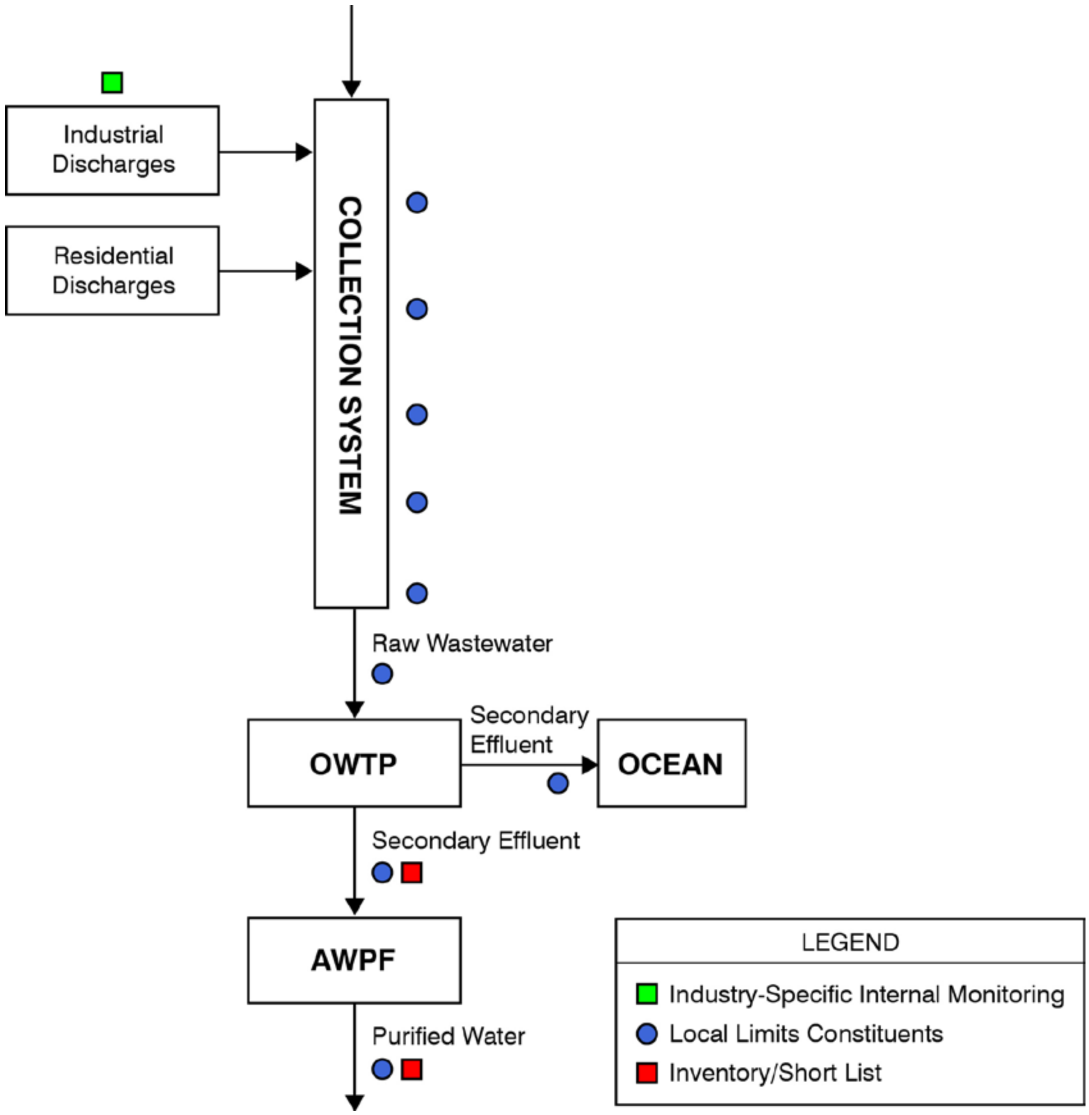

Figure 1 Dischargers, Sampling Locations and Monitoring Constituents Across the Collection and Treatment System.

3.0 EXISTING INDUSTRIAL PRETREATMENT AND COLLECTION SYSTEM SOURCE CONTROL PROGRAM OVERVIEW

The OWTP is permitted under Waste Discharge Requirements Order No. R4-2013-0094 (National Pollutant Discharge Elimination System [NPDES] No. CA0054097), issued to the City in June 2013, and operates an Environmental Protection Agency (EPA)-approved industrial pretreatment program. That program is operating based upon an approved Local Limits program (from 1999). Oxnard is now updating that Local Limits program. The City is undertaking such an effort in accordance with the permit, and will submit the proposed limits to the Los Angeles office of the RWQCB for approval. As part of this new Local Limits effort, the City and their contractors have performed detailed sampling efforts of the various industrial users and across the OWTP and the AWPF. The sampling plan included different sewer sampling sites for residential sampling as well as additional sites for industrial and commercial business sampling. A draft local limits report is now under evaluation by the City.

Elements of, and updates to, the City's current source control program are provided below.

3.1 Description of Industrial Users

The OWTP treats wastewater from the City and Port Hueneme as well as the Point Mugu Naval Base, Ventura County. Approximately 75 percent of this collected flow is residential. The remaining 25 percent is from industrial users.

Categorical Industrial Users (CIUs) are defined by the federal government and subject to categorical pretreatment standards established in the Code of Federal Regulations. Their discharge requirements are applicable nationwide and are based on best available technology. CIUs, by definition, are also defined as Significant Industrial Users (SIUs). There are typically other SIUs which may not be CIUs.

An industrial user is classified as a SIU if it meets any of the following:

- Is subject to categorical pretreatment standards under 40 CFR 403.6 and 40 CFR Section I, Subsection N.
- Discharges an average of 25,000 gpd or more of process wastewater to the POTW (excluding sanitary, noncontact cooling, and boiler blowdown wastewater).
- Contributes a process waste stream that makes up 5 percent or more of the average dry-weather hydraulic or organic capacity of the POTW treatment plant.
- Is designated as such by the POTW on the basis that the industrial user has a reasonable potential for adversely affecting the POTW's operation or for violating any pretreatment standard or requirement [in accordance with 40 CFR 403.8(f)(6)].

There are thirty-five industries in the service area identified as SIUs discharging into the OWTP collection system, as shown in Table 1. Included in Table 2 are several dischargers not defined as SIUs, but are regulated under the Oxnard Local Limits program. For each discharger shown in the table below, pertinent details are included, such as Regulatory Classification, Wastewater Type, Type of Pretreatment, Potential Contaminants, Average Daily Flow (ADF), Location, and Oxnard permit number. Figure 2 shows the location of these customers within the Oxnard wastewater collection system.

Table 1 Industrial Dischargers to OWTP
Advanced Water Purification Facility
City of Oxnard

	Regulatory Classification	Categorical Standard[1]	Wastewater Type	Type of Pretreatment	Potential Contaminants[2]	ADF, kgal (Permit)	Address	Permit #
Aluminum Precision	SIU with Local Limits	Aluminum Forming	Aluminum Forming for Aerospace Automotive and Military Industries	Metals Precipitation, Filter Press, Ultra-Filtration and pH Adjustment	Cd, Cr, Cu, CN, Pb, Ni, O&G, pH, TTO, Zn, Flow	7	1001 McWayne Blvd.	74162
Arcturus	SIU with Local Limits	Aluminum Forming	Ferrous & Non-Ferrous Metals Forming	Settling Pond, Oil Skimming, pH Adjustment with H2SO4	Cd, Cr, Cu, CN, Pb, Ni, O&G, pH, TTO, Zn, Flow	25	6001 Arcturus Ave.	308
Boskovich Farms, Inc.	SIU with Local Limits	N/A	Food Processor; wash, cool, package	Screenings & Filtration	BOD, H2S, O&G, TSS, Flow	250	711 Diaz Ave.	23035
Cal Sun	SIU with Local Limits	N/A	Strawberry Food Processor	Activated Sludge	BOD, H2S, pH, TSS, Flow	32	511 Mountain View Ave.	87549
City of Oxnard Desalter	SIU with Local Limits	N/A	Water Treatment	None	TDS, pH, TSS, Flow	1,500	251 S. Hayes Ave.	23233
Coastal Green Vegetables	SIU with Local Limits	N/A	Food Processor; wash, cool, package, freeze	Activated Sludge	BOD, H2S, O&G, pH, TSS, Flow	220	605 Buena Vista Ave.	94108
Coastal Metal Finishing *(now owned by Limons Metal Finishing)*	Local Limits Only	Metal Finishing	Metal Finishing	Batch Treatment: pH Adjustment, Filtration, Ion Exchange, Evaporation, Solids Dewatering	Ag, CN, Cr, Cu, Pb, Ni, pH, TTO, Zn	4	1160 Mercantile St.	86037
Consolidated Precision Products	SIU with Local Limits	Metal Molding and Casting (Foundries)	Metal Molding & Casting	pH Adjustment	Cd, Cr, Cu, Pb, Ni, Ag, Zn, O&G, pH, TSS, TTO, Flow	30	705 Industrial Ave.	OC-25
Crestview Municipal Water Company	SIU with Local Limits	N/A	Filter Backwash	None	BOD, TSS, pH	Not Operating	602 Valley Vista	OC-5
Deardorf Farms	SIU with Local Limits	N/A	Food Processor; wash, cool, package	Clarifier	BOD, H2S, O&G, TSS, pH, Flow	10	400 N. Lombard	24330
Duda Farms	SIU with Local Limits	N/A	Food Processor	Screening	BOD, H2S, TSS, pH, Flow	37	860 Pacific Ave.	87287
EF Oxnard	SIU with Local Limits	Steam Electric Power Generating	Steam Electric Power Generation; cooling tower blowdown, reverse osmosis reject	None	Cd, Cr, Cu, Pb, Ni, O&G, pH, TTO, Zn, Flow	15	550 Diaz	85723
Elite	SIU with Local Limits	Metal Finishing	Metal Finishing	Batch Treatment: pH Adjustment, Filtration, Ion Exchange, Evaporation, Solids Dewatering	Ag, CN, Cr, Cd, Cu, Pb, Ni, pH, TTO, Zn	14	540 Spectrum Circle	69418
Frozsun Foods, Inc. *(Sunrise Growers 3rd St.)*	SIU with Local Limits	N/A	Food Processor	Rotating Hydrosieve, Biological	BOD, H2S, pH, TSS, O&G, Flow	350	808 E. Third St.	60905
Frozsun, Inc. *(Sunrise Growers Sturgis)*	SIU with Local Limits	N/A	Food Processor; wash, cook, pack	Bio Reactors, Clarification, pH Adjustment	BOD, H2S, TSS, pH, Flow	40	2640 Sturgis Rd.	103247
Gills Onions	SIU with Local Limits	N/A	Food Processor; onion washing, cutting and packaging	Screening, Biological Treatment, Settling/Clarification	BOD, H2S, O&G, TSS, pH, Flow	250	901 Pacific Ave.	57277
Harris Water Conditioning	SIU with Local Limits	N/A	Water Softener Regenerator	Gravity Separator, Settling Tanks	BOD, H2S, O&G, pH, TSS, TDS, Flow	138	1025 S. Rose	2072
Herzog	SIU with Local Limits	N/A	Winery	Gravity Separator, pH Adjustment	BOD, H2S, pH, TSS, Flow	11	3201 Camino Del Sol	84360
J.M. Smuckers Co.	SIU with Local Limits	N/A	Food Processor; wash, process, package	Activated Sludge	BOD, H2S, pH, TSS, Flow	148	800 Commercial Ave.	88262
Limons Metal Finishing, Inc.	SIU with Local Limits	Metal Finishing	Metal Finishing	Batch Treatment: pH Adjustment, Filtration, Ion Exchange, Evaporation, Solids Dewatering	Ag, CN, Cr, Cu, Pb, Ni, pH, TTO, Zn	4	1160 Mercantile St.	26531
Mission Linen	SIU with Local Limits	N/A	Commercial Laundry	pH Adjustment, Gravity Separation, DAF and Filtration	BOD, O&G, pH, TSS, Flow, H2S, Temperature	39	505 Maulhardt	533
Naval Base Ventura Cty - Point Mugu Facility	SIU with Local Limits	N/A	Domestic/Commercial	Settling	BOD, Cd, Cu, Pb, O&G, H2S, pH, TSS, TTO, Zn, Flow	382	Bldg. 64, Point Mugu	OC-2
Naval Base Ventura Cty - Port Hueneme Facility	SIU with Local Limits	N/A	Domestic/Commercial	None	BOD, Cd, Cr, Ag, Cu, Pb, Ni, O&G, H2S, pH, TSS, TTO Zn, Flow	650	Mills Road Bldg. 1430, Port Hueneme	OC-04
New Indy	SIU with Local Limits	Pulp, Paper and Paperboard	Pulp, Paper, and Paperboard Processing	Activated Sludge	BOD, H2S, O&G, pH, TSS, TTO, Flow, PCP, TCP	309	5936 Perkins Rd.	100024
Oxnard Lemon Co.	SIU with Local Limits	N/A	Food Processor; wash, process, package	Activated Sludge, Clarification	BOD, H2S, O&G, pH, TSS, Flow	35	2001 Sunkist Circle	13266
Pacific Ridge Farms *(now owned by Frozsun)*	Local Limits Only	N/A	Food Processor; wash, cool, pack	Bio Reactors, Clarification, pH Adjustment	BOD, H2S, TSS, pH, Flow	30	2640 Sturgis Rd.	96073
Parker Hannafin	SIU with Local Limits	N/A	Membrane and Filter Manufacturing	Reverse Osmosis, Vacuum Distillation and UV Advanced Oxidation	BOD, TTO, O&G, pH, TSS, Zn	26	2340 Eastman	88211

Table 1 Industrial Dischargers to OWTP
Advanced Water Purification Facility
City of Oxnard

	Regulatory Classification	Categorical Standard[1]	Wastewater Type	Type of Pretreatment	Potential Contaminants[2]	ADF, kgal (Permit)	Address	Permit #
Port Hueneme Water Agency	SIU with Local Limits	N/A	Water Treatment	None	TDS, pH, TSS, Flow	650	5751 Perkins Rd.	56788
Proctor and Gamble	SIU with Local Limits	Pulp, Paper and Paperboard	Pulp, Paper and Paperboard Processing	Gravity Separation, Filtration, Dewatering, Equalization, Neutralization	BOD, H2S, O&G, pH, TSS, TTO, Flow, PCP, TCP	1,376	800 N. Rice	4438
Puretec Industrial	SIU with Local Limits	N/A	Water Softener Regenerator	pH Adjustment	BOD, H2S, O&G, pH, TSS, Flow	100	3151 Sturgis Rd.	56690
Raypak	SIU with Local Limits	Metal Finishing	Metal Finishing	Chemical Precipitation, Neutralization, Settling/Clarification, Filter Press, Filtration	O&G, Cd, Cr, Cu, CN, Pb, pH, Ni, Ag, TTO, Zn	11	2151 Eastman	64517
Saticoy Lemon	SIU with Local Limits	N/A	Food Processor; wash lemons, box and package	Biological Control, Clarification, Aeration, Screening	BOD, H2S, O&G, TSS, pH, Flow	50	600 E. Third St.	1345
Scarborough Farms, Inc.	SIU with Local Limits	N/A	Food Processor; vegetable washing, packaging	None	BOD, H2S, pH, TSS, Flow	17	731 Pacific Ave.	57313
Seaboard Produce	SIU with Local Limits	N/A	Food Processor	Settling, Clarification	BOD, H2S, O&G, TSS, Flow	6	601 Mountain View	9866
Seminis	SIU with Local Limits	N/A	Seed Processing	Batch Treatment, Precipitation, Clarification, pH Adjustment, Solids Removal, Ozone	BOD, H2S, TSS, pH, Flow, Zn, TTO, COD, O&G	19	2700 Camino Del Sol	47449
Simba Cal	SIU with Local Limits	Metal Finishing	Metal Finishing	None	Cd, Cr, Cu, Pb, Ni, Ag, Zn, CN, TTO, pH	0.75	1680 Universe Circle	32321
Terminal Freezers (Del Mar, Sun Coast, Tree Top)	SIU with Local Limits	N/A	Food Processor	Activated Sludge, Hydrosieve	BOD, H2S, pH, TSS, O&G, Flow	730	1300 E. Third St.	98242
Ventura Pacific	SIU with Local Limits	N/A	Food Processor; (processing & packaging of lemons)	Activated Sludge, Screening and Clarification	BOD, H2S, O&G, TSS, pH, Flow	70	245 E. Colonia Rd.	26979

Notes:
(1) N/A indicates the industry is not federally regulated.
(2) All TTOs required for monitoring are included in Table 3, with corresponding federal categorical standards, where applicable. TTO requirements for non-federally regulated industries are determined by the POTW and will be updated with the Local Limits study.

Table 2 Industrial Discharge Customers and Corresponding Numbers to Figure 2
Advanced Water Purification Facility
City of Oxnard

INDUSTRIAL CUSTOMERS	
No.	Name
1	Aluminum Precision Products
2	Arcturus Manufacturing
3	Automobile Racing Products
4	Boskovich Farms
5	Cal Sun Produce
6	City of Oxnard Blending Station 3
7	City of Oxnard Desalter
8	Coastal Green Vegetable Company
9	Coastal Metal Finishing
10	Consolidated Precision Products
11	Crestview Municipal Water Company
12	Deardorf Farms
13	Duda Farm Fresh Foods
14	EF Oxnard
15	Elite Metal Finishing
16	Frozsun Foods
17	Frozsun Inc
18	Gill's Onions
19	Harris Water Conditioning
20	Herzog Wine Cellars
21	J.M. Smucker Co.
22	Limons Metal Finishing, Inc.
23	Mission Linen Supply
24	Naval Base Ventura County - Point Mugu Facility
25	Naval Base Ventura County - Port Hueneme Facility
26	New Indy
27	Oxnard Lemon Co.
28	Pacific Ridge Farms
29	Parker Hannifin
30	Port Hueneme Water Agency
31	Proctor and Gamble
32	Puretec Industrial Water
33	Raypak

Table 2 Industrial Discharge Customers and Corresponding Numbers to Figure 2 Advanced Water Purification Facility City of Oxnard	
INDUSTRIAL CUSTOMERS	
No.	Name
34	Santa Clara Waste Water Co.(1)
35	Saticoy Lemon #4
36	Scarborough Farms
37	Seaboard Produce Distributors
38	Seminis
39	Simba Cal
40	Terminal Freezer
41	Ventura Pacific Co.

Notes:
(1) Santa Clara Waste Water Co.'s permit is suspended.

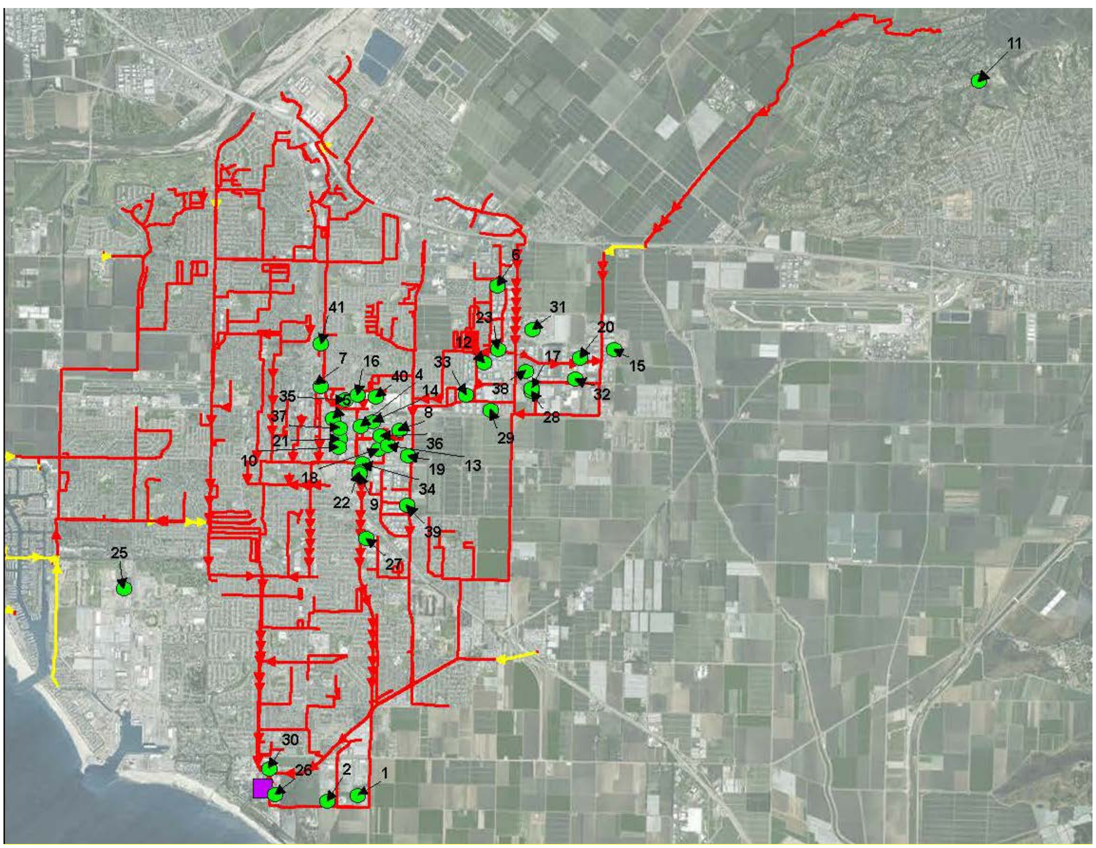

Figure 2 Oxnard Collection System with SIUs

3.2 Source Control Program Description

Oxnard's Source Control Program was established as part of the City's industrial pretreatment program, to prevent contaminants from entering the sewer system that could negatively impact the wastewater treatment process or reclaimed water quality. The source control program was also designed to protect the public and environment as well as OWTP personnel from harmful industrial waste. To achieve these goals, the City adopted a Sewer Ordinance within Section 19, Article 1 of the Oxnard Code of Ordinances. *Although not specifically designed to address potable water reuse, Oxnard's existing source control program is intended to protect OWTP effluent, which is the source to the AWPF.* The proposed source control program specifically tailored to potable water reuse is detailed further on in this document.

3.2.1 Local Limits Evaluation

A Local Limits Evaluation Report was created in 1999 to determine allowable contaminant concentrations in industrial wastewater. The Local Limits Evaluation Report is now being updated (September 2015 Draft).

3.2.2 Permitting of Industrial Users

All SIUs are required to obtain an Industrial Wastewater Discharge Permit from the Oxnard City Manager. Permits are issued for up to five-year periods and contain both effluent limits and sampling requirements. These limits can be both local and federal. SIUs are required to submit their permit application at least 90 days before any proposed discharge. Table 2, above, includes all industrial dischargers permitted by the City.

3.2.3 Industrial Waste Monitoring

Oxnard's monitoring program provides necessary information for evaluating industry compliance, assessing OWTP loading and operation, and determining illicit discharges. SIUs are monitored via three mechanisms: self-monitoring, monitoring by the City, and surveillance sampling.

Self-monitoring is required for each SIU. The Industrial Wastewater Discharge Permits mandate daily flow monitoring as well as bi-monthly contaminant sampling. Each month the SIU must submit a Surveillance Monitoring Report to the City. Typical parameters for which dischargers must sample include: Biological Oxygen Demand (BOD), TSS, Total Toxic Organics (TTO), Oil and Grease, and pH. Industry specific metal monitoring is often also mandated. Monthly TTO monitoring may not be required if TTO samples contain less than 1.0 mg/L, and in this case, only yearly samples are necessary. The following Table 3 contains a list of all TTOs and the corresponding industry category that requires monitoring.

Table 3 Industrial Discharge Monitoring Requirements for TTOs
Advanced Water Purification Facility
City of Oxnard

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
1,1,1-trichloroethane		X	X	X		
1,1,2,2-Tetrachloroethane		X		X		
1,1,2-trichloroethane		X		X		
1,12-benzoperylene (benzo(ghi) perylene)		X		X		
1,1-dichloroethane		X		X		
1,1-dichloroethylene		X		X		
1,2,4-trichlorobenzene		X		X		
1,2,5,6-dibenzanthracene (dibenzo(a,h)anthracene)		X		X		
1,2-benzanthracene (benzo(a) anthracene)		X		X		
1,2-dichlorobenzene		X		X		
1,2-dichloroethane		X		X		
1,2-dichloropropane		X		X		
1,2-dichloropropylene (1,3-dichloropropene)				X		
1,2-diphenylhydrazine	X	X		X		
1,2-trans-dichloroethylene		X		X		
1,3-dichlorobenzene		X		X		
1,3-Dichloropropylene (1,3-dichloropropene)		X				
1,4-dichlorobenzene		X		X		
11,12-benzofluoranthene (benzo(b) fluoranthene)				X		
11,12-Benzofluoranthene (benzo(k)fluoranthene)		X				
2,3,4,6-tetrachlorophenol					X	
2,3,7,8-tetrachloro-dibenzo-p-dioxin (TCDD)		X		X		
2,4,5-trichlorophenol					X	
2,4,6-trichlorophenol		X	X	X	X	X
2,4-dichlorophenol		X		X		
2,4-dimethylphenol		X	X	X		
2,4-dinitrophenol		X		X		
2,4-dinitrotoluene	X	X		X		
2,6-dinitrotoluene		X		X		
2-chloroethyl vinyl ether (mixed)		X		X		
2-chloronaphthalene		X		X		
2-chlorophenol	X	X		X		
2-nitrophenol		X		X		
3,3-dichlorobenzidine		X		X		
3,4,5-trichlorocatechol					X	
3,4,5-trichloroguaiacol					X	
3,4,6-trichlorocatechol					X	
3,4,6-trichloroguaiacol					X	
3,4-Benzofluoranthene (benzo(b) fluoranthene)	X	X		X		

Table 3 Industrial Discharge Monitoring Requirements for TTOs
Advanced Water Purification Facility
City of Oxnard

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
4,4-DDD (p,p-TDE)		X		X		
4,4-DDE (p,p-DDX)		X		X		
4,4-DDT		X		X		
4,5,6-trichloroguaiacol					X	
4,6-dinitro-o-cresol		X		X		
4-bromophenyl phenyl ether		X		X		
4-chlorophenyl phenyl ether		X		X		
4-nitrophenol		X		X		
Acenaphthene	X	X	X	X		
Acenaphthylene	X	X		X		
Acrolein		X		X		
Acrylonitrile		X		X		
Aldrin		X		X		
Alpha-BHC		X		X		
Alpha-endosulfan		X		X		
Anthracene	X	X	X	X		
Antimony				X		
Arsenic				X		
Asbestos				X		
Benzene		X	X	X		
Benzidine		X		X		
benzo (a)anthracene (1,2-benzanthracene)			X			
Benzo(a)pyrene (3,4-benzo-pyrene)	X	X	X	X		
benzo(ghi)perylene	X					
Benzo(k)fluoranthene	X					
Beryllium				X		
Beta-BHC		X		X		
Beta-endosulfan		X		X		
Bis (2-chloroethoxy) methane		X		X		
Bis (2-chloroethyl) ether		X		X		
Bis (2-chloroisopropyl) ether		X		X		
Bis (2-ethylhexyl) phthalate	X	X	X	X		X
Bromoform (tribromomethane)		X		X		
Butyl benzyl phthalate		X	X	X		
Cadmium				X		
Carbazole						X
Carbon tetrachloride (tetrachloromethane)		X		X		
Chlordane (technical mixture and metabolites)		X		X		
Chlorobenzene		X	X	X		

Table 3 Industrial Discharge Monitoring Requirements for TTOs
Advanced Water Purification Facility
City of Oxnard

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
Chlorodibromomethane		X		X		
Chloroethane		X		X		
Chloroform (trichloromethane)		X	X	X		
Chromium				X		
Chrysene	X	X	X	X		
Copper				X		
Cyanide, Total				X		
Delta-BHC (PCB-polychlorinated biphenyls)		X		X		
dibenzo(a,h)	X					
Dichlorobromomethane		X		X		
Dieldrin		X		X		
Diethyl Phthalate	X	X	X	X		
Dimethyl phthalate		X		X		
Di-N-Butyl Phthalate	X	X	X	X		
Di-n-octyl phthalate		X		X		
Endosulfan sulfate	X	X		X		
Endrin	X	X		X		
Endrin aldehyde	X	X		X		
Ethylbenzene	X	X		X		
Fluoranthene	X	X	X	X		X
Fluorene	X	X	X	X		
Gamma-BHC (lindane)		X		X		
Heptachlor		X		X		
Heptachlor epoxide (BHC-hexachlorocyclohexane)		X		X		
Hexachlorobenzene		X		X		
Hexachlorobutadiene		X		X		
Hexachlorocyclopentadiene		X				
Hexachloroethane		X		X		
Hexachloromyclopentadiene				X		
Indeno (,1,2,3-cd) pyrene (2,3-o-pheynylene pyrene)	X			X		
Indeno(1,2,3-cd) pyrene (2,3-o-phenlene pyrene)		X				
Isophorone	X	X		X		
Lead				X		
Mercury				X		
Methyl bromide (bromomethane)		X		X		
Methyl chloride (chloromethane)		X				
Methyl chloride (dichloromethane)				X		
Methylene chloride (dichloromethane)		X	X	X		
Naphthalene	X	X	X	X		

Table 3 Industrial Discharge Monitoring Requirements for TTOs
Advanced Water Purification Facility
City of Oxnard

Total Toxic Organics (TTOs)	Aluminum Forming	Metal Finishing	Metal Molding and Casting (Foundries)	Steam Electric Power Generating	Pulp, Paper and Paperboard	Centralized Waste Treatment
n-Decane						X
Nickel				X		
Nitrobenzene		X		X		
N-nitro sodi phenyl amine	X					
N-nitrosodimethylamine		X		X		
N-nitrosodi-n-propylamine		X		X		
N-nitrosodiphenylamine		X		X		
n-Octadecane						X
o-Cresol						X
Para-chloro meta-cresol (p-chloro-m-cresol)	X	X	X	X		
PCB-1016 (Arochlor 1016)	X	X		X		
PCB-1221 (Arochlor 1221)	X	X		X		
PCB-1232 (Arochlor 1232)	X	X		X		
PCB-1242 (Arochlor 1242)	X	X		X		
PCB-1248 (Arochlor 1248)	X	X		X		
PCB-1254 (Arochlor 1254)	X	X		X		
PCB-1260 (Arochlor 1260)	X	X		X		
p-Cresol						X
Pentachlorophenol		X		X	X	
Phenanthrene	X	X	X	X		
Phenol	X	X	X	X		
Pyrene	X	X	X	X		
Selenium				X		
Silver				X		
TCDD					X	
TCDF					X	
Tetrachlorocatechol					X	
Tetrachloroethylene	X	X	X	X		
Tetrachloroguaiacol					X	
Thallium				X		
Toluene	X	X	X	X		
Toxaphene		X		X		
Trichloroethylene	X	X	X	X		
Trichlorophenol					X	
Trichlorosyringol					X	
Vinyl chloride (chloroethylene)		X		X		
Zinc				X		

To help ensure the validity of self-monitoring results, sampling and analyses for required chemicals must be performed by a California state-certified laboratory, acceptable to the City's Technical Services Program – Source Control (TSP-SC), in accordance with 40 CFR, Part 136.

In addition to industry self-monitoring, the City conducts facility sampling twice per year. The sampling location is outlined in each SIU's permit.

To facilitate detection of illegal discharges of prohibited materials into the collection system, surveillance monitoring is also conducted. Such monitoring is performed if the City suspects illegal dumping or if there are complaints.

3.2.4 Slug Control

A slug load or slug discharge is defined as any discharge which would cause a violation of the industrial pretreatment program, either by a flow violation or an exceedance of contaminant concentration limit. Slug loads can be caused by accidental spills or batch discharges of irregular nature, causing a drastic increase in contaminant concentration (slug) to occur in the collection system. Slug loads by definition are not routine or predictable. If an event occurs that may cause a slug discharge, the industrial user must notify the city manager immediately. The City Manager is then responsible for assessing the severity of the load and once identified, taking appropriate measures to ensure public safety and optimal operations. This may involve diverting the wastewater treatment plant effluent flow or purified water flow until the slug load has been processed appropriately.

It is recommended that the City should require all SIUs to develop and submit a Slug Discharge Control (SDC) Plan. The slug control plan would be reviewed and updated by the source control program manager as needed.

3.2.5 Inspection of Industries

Annual SIU inspections are conducted by City staff. Such inspections allow for the investigation of SIU permit compliance. These inspections also help identify if a SIU is responsible for treatment plant upsets. Additionally, the inspections act as industrial outreach efforts and help disseminate information on technical issues such as permit requirements and pollution prevention opportunities.

3.2.6 Centralized Waste Treatment

Oxnard has one of the largest centralized waste treatment (CWT) facilities in California within their service area (Santa Clara Wastewater). CWTs treat hazardous and nonhazardous wastes (e.g. industrial tank residuals called "tank bottoms", oil field operations wastes, etc.). They are regulated under 40 CRF 437, and are managed by POTWs through their industrial pretreatment programs. The major issue surrounding the acceptance by POTWs of the discharge from CWT facilities, especially Subcategory D facilities that accept multiple wastestreams, is their potential impact on water reuse programs. An explosion occurred at the Santa Clara Wastewater facility, a CWT that receives hauled waste from many sources, treats those wastes, then discharges them into the Oxnard collection system. The cause of the accident has been attributed to the unsafe mixture of specific chemicals with domestic sewage.

In response to the explosion event, Carollo prepared Best Management Practices (BMP) policy for CWTs on behalf of the City, which, were then endorsed by the California Association of Sanitation Agencies (CASA). Carollo surveyed six POTWs regarding CWTs in their service areas. Carollo contacted and received help from POTWs that have CWTs; including OCSD, LACSD, City of LA, the City of San Jose, and Oxnard. The BMP for CWTs is attached as Appendix A to this document. Oxnard has implemented this BMP for any CWT within its collection system. Key elements of the BMP are:

- Waste Receiving Requirements - including manifests for haulers, testing of hauled waste before disposal, prohibition of specific activities, and allowance for random sampling.
- Treatment Requirements - treatment meeting EPA standards under 40 CFR 437, emergency shutoff, treatment reliability and redundancy, prohibition of holding tanks for dilution, and recording of treatment system operations details.
- Effluent Discharge and Sampling/Testing Requirements - continuous discharge prohibited, batch tanks continuously mixed, sampling and analysis before discharge required, reprocessing if necessary.
- Recommended Certification and Documentation Requirements - requirements for certifications, plans, procedures, O&M, treatment system details, documentation of all waste haulers, and testing and monitoring requirements.

3.2.7 Enforcement

The 2013 OWTP Annual Pretreatment Report identified 42 total industrial dischargers having 49 total violations (with zero penalties or legal action required), and 3 industrial dischargers with significant non-compliance necessitating public notification. If an SIU violated its permit, a written Notice of Violation (NOV) is sent to the SIU. The SIU then has 10 days to submit an explanation of violation and a plan for correction. For BOD and TSS limit violations, the SIU is surcharged based on a predetermined formula. For other exceedances, increasing enforcement action is taken as necessary. Such actions can include discontinuing sewer or water service, a cease and desist order, issuance of a fine, or termination of permission to discharge to the system. Sections 19, Article 1, Divisions 8 through 10 of Oxnard's Municipal Code outline all the allowable enforcement actions.

4.0 COLLECTION SYSTEM AND OWTP WATER QUALITY RESULTS

4.1 Industrial Sampling Program

As a requirement of their local limits update, the City conducted an extensive wastewater sampling program to characterize pollutant loadings and process removals to develop scientifically-based local limits in Fall 2015. In addition to this study, the City performed routine monitoring for NPDES permit requirements as well as industrial discharge constituents. OWTP's routine influent monitoring is conducted at the headworks of the plant, which is downstream of plant recycled flows.

4.1.1 Prior Incident of Pass-Through with Gross Beta Radioactivity

On September 4th, 2014 analytical results showed an exceedance of the OWTPs gross-beta NPDES defined permit limit. The gross-beta sample concentration was 94 pCi/L and the permit requirement was 50 pCi/L. The sample was taken one month prior on August 5th during a routine semiannual sampling event at the OWTP. Oxnard's Technical Services Program found hydraulic fracturing fluids to be a potential source of gross-beta contaminant. Wastewater staff then collected wastewater samples at City Water Yard and SCWW (both known to discharge this type of contaminants) on Wooley Road. Following analytical results reported on October 14, 2014, monitoring staff were informed that the Santa Clara Wastewater (SCWW) sample port had a gross-beta concentration of 4400 pCi/L. The next day on October 15, 2014, the staff convened a meeting to determine an action plan.

On October 16, 2014 additional samples were taken upstream of the SCWW site to track the source of the gross-beta discharge into the Santa Clara collection system. Green Compass, the parent company of SCWW, was identified as the responsible discharger, stating that Vintage Productions, an industrial customer of SCWW, was the point source into their facility. A Cease and Desist order was issued to Green Compass, who immediately complied with the order. Continuous gross-beta monitoring was conducted near the sampling site for the following months, and a NOV was issued to SCWW for violations on sample dates 9/24, 10/16, 10/22 and subsequently 10/28, 11/6, and 11/13.

Shortly thereafter (11/2014), the aforementioned accident at the SCWW occurred and the Oxnard City Manager issued a suspension of discharge permit and prohibited SCWW from discharging any wastewater into the Oxnard Collection System.

4.2 Industry Water Quality Results

Industrial pretreatment programs are in place and additional pretreatment and auditing programs are recommended as part of this enhanced source control program as detailed in Section 5. Table 4 contains a list of detected industrial discharge contaminants from 2013-2014. The permit limits for these industries are being updated (Local Limits Report),

Table 4 Industry Water Quality Data 2013-2014 for all Industrial Dischargers to the City of Oxnard WWTP
Advanced Water Purification Facility
City of Oxnard

	2013 ADF	Avg BOD	Avg pH	Avg TSS	Avg H2S	Avg O&G	TDS	TTO	Cd	Cr	Cu	Pb	Zn	Ni	Ag	CN-	As	Sb	Ar	Co	Hg	Sn	Ti	V
Industry Name	**gpd**	**mg/L**		**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Industries																								
Alliance Finishing & Manufacturing	--																							
Aluminum Precision Products	7,000	N/A	7.8	9	NA	4	2,063		0.0023	0.007	0.021	0.0075	0.21	0.0118		0.004								
Arcturus Manufacturing	25,000	N/A	8.3	NA	NA	14	N/A		0.004	0.01	0.04	0.009	0.008	0.065		0.004								
Automotive Racing Products*																								
Boskovich Farms	250,000	364	N/A	176	0.10	6	N/A																	
Cal Sun Produce	32,000	171	7.3	135	0.1	7	N/A																	
Coastal Green Vegetable Co.	220,000	219	7.2	300	0.02	5	N/A																	
Coastal Metal Finishing/Limons Metal Finishing	1,000	N/A	7.8	N/A			N/A	1	0.0200	0.2000	0.5000	0.0800	0.6000	1.3000	0.0200	0.0050	0.1000							
Consolidated Precision Products	11,907																							
Deardorff Family Farms	10,000	31	7.9	46	0.1	6	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Duda Farm Fresh Foods	37,000	507	7.3	156	0.02	9	N/A																	
EF Oxnard	15,000	N/A	7.7	N/A	0.20	4	2,842		0.0103	0.0403	0.0245	0.0528	0.1841	0.0263										
Elite Metal Finishing	14,000	N/A	8.1	N/A	NA	NA	N/A		0.01	0.06	0.1	0.03	0.14	0.15	0.01	0.03								
Frozsun Foods	350,000	371	7.2	119	0.10	N/A	N/A																	
Gill's Onions	250,000	185	7.5	53	0.38	5	N/A																	
Harris Water Conditioning	138,000	2	6.9-8.5	19	0.10	3	20,883	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Herzog Wine Cellars	10,000	2,187	7.2	190	0.5	6	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
J.M. Smucker Co.	148,000	139	7.7	224	0.12	4	N/A	na																
Mission Linen Supply	39,000	217	7.4	134	0.02	41	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
New Indy	300,000	28	7.4	26	0.04	5	3,390	0.67	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Oxnard Lemon Co.	35,000																							
Pacific Ridge Farms	30,000	559	6.9	322	0.25	6	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Parker Hannifin	26,000	995	6.8	8	NA	5	N/A	0.037					0.05											
Proctor and Gamble	1,400,000	112	6.2-9.3	214	0.02	23	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Puretec Industrial Water	100,000	14	6.3-9.3	43	0.02	5	N/A	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na	na
Raypak	11,000	N/A	6.8-9.9	N/A	NA	6	N/A	0.03	0.02	0.06	0.02	0.05	0.12	0.04		0.031								
Saticoy Lemon #4	50,000	131	8.3	214	0.1	15	N/A																	
Scarborough Farms	17,000	25	7.2	432	0.1	NA	N/A																	
Schlumberger Technology																								
Seaboard Produce Distributors	25000																							
Seminis	19,000	156	8.1	455	0.1	17	N/A	0.46					0.29											
Simba Cal	750	N/A	9.3	N/A	NA	NA	N/A	<1 mg/l	0.01	0.052	0.67	0.05	0.21	0.027	0.013	0.005								

Table 4 Industry Water Quality Data 2013-2014 for all Industrial Dischargers to the City of Oxnard WWTP
Advanced Water Purification Facility
City of Oxnard

Industry Name	2013 ADF	Avg BOD	Avg pH	Avg TSS	Avg H2S	Avg O&G	TDS	TTO	Cd	Cr	Cu	Pb	Zn	Ni	Ag	CN-	As	Sb	Ar	Co	Hg	Sn	Ti	V
	gpd	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Terminal Freezer (Del Mar, Suncoast, Tree Top)	730,000	84	8.0	102	N/A		N/A																	
Ventura Pacific Co.	70,000	408	7.6	88	0.12	13																		
Other Agencies																								
City of Oxnard Desalter	1,500,000	N/A	7.2	5	N/A	N/A	1,580																	
Crestview Municipal Water Co.	0																							
NBVC Point Mugu	223,722																							
NBVC Port Hueneme	452,807																							
Port Hueneme Water Agency	347,947																							
Santa Clara Waste Water Co.	150,000	185	7.7	26	0.02	5	N/A	0.34	<0.01	0.01	0.02	0.03	0.06	0.01	0.01			<0.05	<0.01	<0.005	<0.005	0.01	0.01	0.03

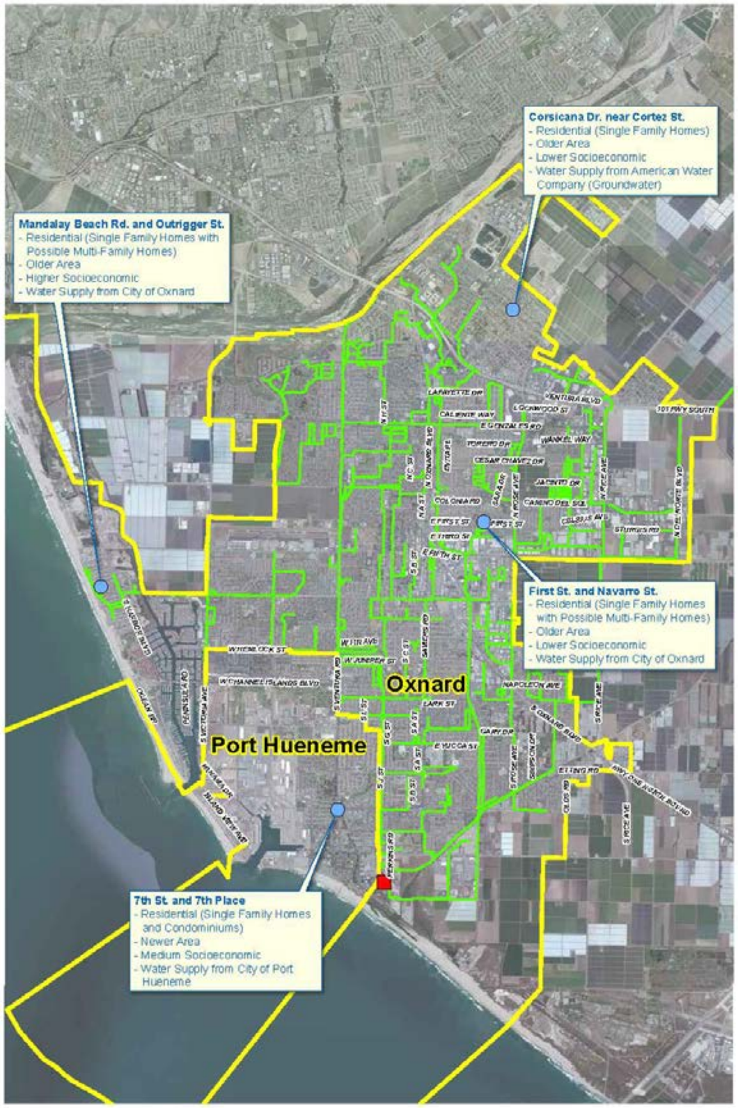

Figure 3 Four Residential Sampling Locations Included in the Local Limits Study

and for some more stringent limits are to follow. All collection system monitoring samples are tested for the constituents listed, however, many of the industries do not produce or use these contaminants in their processes as shown by the blank cells. Internal monitoring program data is also available in the Local Limits study and internal auditing can take place by the SCPM when collection system monitoring data does not align.

4.3 Residential (only) Water Quality Results

The domestic/residential sectors of the service area had not been sampled in over 15 years prior to the recent Local Limits study. Four sampling locations were chosen for the study, based on collection system discharges and trunk lines (Figure 3). Concentrations from residential dischargers for a limited set of constituents tested are shown in Table 5, below.

These results provide baseline concentrations for OWTP influent monitoring, allowing the isolation of industrial and domestic discharge inputs.

Table 5 Residential Wastewater Concentrations from 4 Sampling Locations Listed in Figure 3
Advanced Water Purification Facility
City of Oxnard

Constituent	Units	Average	Geometric Mean
Ammonia Nitrogen	mg/L	39	38
Antimony Total	ug/L	1.011	1.009
Arsenic Total	ug/L	2.31	2.09
Barium Total	ug/L	45.46	40.1
Beta, Gross	pCi/L	21.96	21.04
Biochemical Oxygen Demand	mg/L	258	248
Boron Total	mg/L	0.77	0.76
Cadmium Total	ug/L	0.505	0.504
Calcium Total	mg/L	98	88
Chloride	mg/L	123.1	116.8
Chromium Total	ug/L	1.39	1.24
Copper Total	ug/L	89.04	75.48
Fixed Dissolved Solids	mg/L	839	776
Fluoride	mg/L	0.54	0.53
Gross Alpha	pCi/L	3.55	3.44
Iron Total	mg/L	0.93	0.56
Lead Total	ug/L	1.81	1.54
Magnesium Total	mg/L	34.1	30.4
Manganese Total	mg/L	0.043	0.037
Mercury	ng/L	23.43	6.08
Molybdenum Total	ug/L	10.53	9.45
Nickel Total	ug/L	6.99	6.68
Potassium Total	mg/L	21.7	21.3
Selenium Total	ug/L	5.4	5.35
Silica	mg/L	27.8	26.5
Silver Total	ug/L	0.508	0.507
Sodium Total	mg/L	151.4	148.5
Specific Conductance	umho/cm	1689	1659
Strontium	mg/L	0.91	0.81
Sulfate	mg/L	325.4	284.7
Total Dissolved Solids	mg/L	1252	1187
Total Kjeldahl Nitrogen	mg/L	61	59
Total phosphorus as P	mg/L	7.3	7
Total Suspended Solids	mg/L	241	211
Uranium	ug/L	5.07	4.3
Zinc Total	ug/L	177.46	161.77

Notes: Concentrations were averaged for all 5 sampling locations for all dates tested.

4.4 Raw Wastewater Water Quality Results

As part of the Local Limits discharge update study, raw wastewater was tested for regulated, industrial and NPDES contaminants. Results are included in the Local Limits study. ***It is important to note that although many contaminants were tested for, few were found at detectable concentrations in the raw wastewater.*** This provides a further level of confidence for downstream treatment and secondary effluent source protection.

5.0 PROPOSED ENHANCED SOURCE CONTROL PROGRAM FOR POTABLE REUSE

Title 22 Regulations require a source control program to be in place prior to operating an IPR facility. As previously discussed, Oxnard's current source control program meets all of the requirements, however, an enhanced source control program (ESCP) is recommended as an additional barrier for producing purified water from IPR. An ESCP would build on an existing source control program in place, with increased monitoring frequency and an additional location, secondary effluent. The following section provides a framework for an ESCP, which could be implemented in Oxnard.

5.1 Source Control Program Manager

The current structure of the source control program at the City of Oxnard includes multiple points of contact covering the collection system, wastewater treatment plant, drinking water treatment plant and groundwater injection. In order to ensure all data is reported, logged and analyzed, a Source Control Program Manager (SCPM), acting as a single point of contact should be hired into a full-time position and charged with the following tasks:

- Collect and log all data from the collection system, OWTP, AWPF and groundwater monitoring program.
- Analyze online data for trends indicating potential upsets in the treatment process.
- Report any concerns, issues, and violations to City management. Any finished water violations would be reported by other City staff to the RWQCB.
- Plan and facilitate all industrial stakeholder workshops.
- Plan and oversee all residential outreach efforts.
- Ensure staffing needs are met for industrial audits, collection system sampling and outreach efforts.
- Update any new industrial dischargers or housing developments to source control program.
- Ensure all SIUs report monthly and annual TTO monitoring results.
- Annual review of slug discharge control plans from SIUs.

Data collected and provided to the SCPM will be analyzed under the supervision of this person to create baseline trends and identify when there are outliers, events, or a constituent is slowly increasing in the treatment process. All information from the pretreatment program, wastewater, AWPF, drinking water and compliance/permitting processes must go through the SCPM. The SCPM should have a second in command who is knowledgeable about the status of the source control program in the event the SCPM is not available. Having a single point of contact will contribute to risk mitigation by allowing for early detection of trends, monitoring efforts and process upsets.

5.2 Recommended Parameters, Detection Levels, and Methods

Monitoring wastewater influent, secondary treated wastewater, RO concentrate and AWPF water in one program can pose challenges due to analytical methods. The same contents could be monitored in each water type, but will likely require at least 2 different methods, if not 4. Methods for detecting all Title 22 monitored constituents in RO concentrate (very low water quality) and purified water (very high water quality) exist, but prove to be challenging due to their unique water qualities. Current analytical monitoring practices are described in detail below.

5.2.1 General Monitoring Provisions

General monitoring provisions proposed by the City include flow rate and water quality of the secondary effluent, AWPF finished water, receiving groundwater supply and production (ASR) wells. This enhanced source control document focuses on secondary effluent and AWPF finished water quality.

Compliance with RWQCB waste discharge requirements (WDRs) will be evaluated based on the analytical monitoring data. Monitoring reports produced by the SCPM will include at a minimum:

- Analytical results across the collection system through AWPF finished water (see Section 7.2).
- A clear map identifying the location of each sampling station, including groundwater monitoring and production wells (details following permit approval)
- Analytical test methods used and corresponding method report limits (MRLs).
- Name(s) and copies of laboratory certifications granted by the DDW's Environmental Laboratory Accreditation Program (ELAP).
- Quality assurance and control information.

Brief details about analytical testing methods and reporting are included in subsequent sections.

5.2.2 Sampling and Analytical Protocols

Though not required to be included in the monitoring reports unless specifically requested by DDW or the RWQCB, the City will have in place sampling protocols including procedures for handling, storing, testing, and disposing of purge and decontamination waters generated from sampling events. For groundwater monitoring, the sampling protocols will outline the methods and procedures for: measuring water levels; purging wells; collecting samples; decontaminating equipment; containing, preserving, and shipping samples; and maintaining appropriate documentation such as Chain of Custody (COC).

All wastewater samples and industrial wastewater samples will use the methods and QA/QC procedures contained in 40 CFR Part 136. All purified water samples will be analyzed and use the QA/QC procedures included in 40 CFR Part 141.

Where no methods are specified for a given pollutant, by methods approved by the DDW, RWQCB, and/or SWRCB. The City will select the analytical methods that provide MRLs lower than the limits prescribed in the WDR or as low as possible that will provide reliable data.

The City will instruct outside contract laboratories to establish calibration standards so that the MRLs (or its equivalent if there is a different treatment of samples relative to the calibration standards) are the lowest calibration standard. At no time will analytical data extrapolated from below the calibration curve be used.

5.2.3 QA/QC Procedures

The RWQCB, DDW and the SWRCB Quality Assurance Program may specify maximum MRLs in any of the following situations:

- When the pollutant has no established method under 40 CFR 141.
- When the method under 40 CFR 141 for the pollutant has a MRL higher than the limit specified in the WDR.
- When the City proposes to use a test method that is more sensitive than those specified in 40 CFR Part 141.

For regulated constituents, the laboratory conducting the analyses will be certified by ELAP or approved by the DDW, LARWQCB, and/or SWRCB for a particular pollutant or parameter.

Samples will be collected with method specific containers and preservatives and analyzed within defined holding time limits as specified in 40 CFR Part 141. All QA/QC analyses will be run simultaneously with collected samples. The City SCPM will retain the QA/QC documentation in its files and make those files available for inspection and/or submit them when requested by the RWQCB or the DDW. Proper chain of custody procedures will be followed and a copy of this documentation will be submitted with the quarterly report.

5.2.4 Unregulated Chemical Procedures

For unregulated chemical analyses, the City will select methods according to the following approach:

- Use drinking water methods, if available and matrix appropriate.
- Use DDW-recommended methods for unregulated chemicals, if available and matrix appropriate.
- If there is no DDW-recommended or approved drinking water method for a chemical, then City staff will use the method that results in the lowest MRL for that chemical in the applicable matrix.
- If there is more than a single USEPA-approved method available, the most sensitive of the USEPA-approved methods for the applicable matrix will be used.
- If there is no USEPA-approved method for a chemical in the applicable matrix, and more than one method is available from the scientific literature and commercial laboratory, after consultation with DDW, use the most sensitive method.
- If no approved method is available for a specific chemical, the City's laboratory (or contract laboratory) may develop methods or use its own methods and will provide the analytical methods to DDW for review. Those methods may be used until DDW-recommended or USEPA-approved methods are available. This option is likely to be used when an unregulated contaminant needs to be traced back through the collection system and no raw wastewater matrix method exists or when sampling RO concentrate for the unregulated contaminant.

5.2.5 Online and Benchtop Constituent Monitoring

Online monitoring data from the OWTP and the AWPF will be reported to the SCPM and analyzed to create a baseline for nominal concentrations and process performance. Total Organic Carbon (TOC), Electrical Conductivity (EC), BOD, Turbidity, and UV Transmittance (UVT) are all relevant monitoring parameters and will be continuously collected to award pathogen log removal (LRV) credits across the OWTP and AWPF. The online data trends used for LRV information will be directly applied to contaminant removal correlations. If a new contaminant or a slug load is detected, a process upset or unusual online data trend is observed, an intervention into the responsible process can be identified and responded to promptly to prevent further contaminant loading.

Accuracy and confidence in monitoring tools is important. Benchtop measurements are not necessarily more accurate that online monitors, however they provide an independent measure of the parameters being tracked. Therefore, benchtop measurements should be conducted frequently to compare online meter measurements and discrepancies should be evaluated, and calibrations on either benchtop or online meters should be performed immediately. Benchtop measurements as well as calibration dates and times should be well-documented and reported to the SCPM weekly. Online sampling parameters and benchtop verification frequencies are shown in Table 6.

Table 6 Online Sampling Parameters and Benchtop Verification Frequencies for the Potable Reuse Enhanced Source Control Program Advanced Water Purification Facility City of Oxnard

Online Monitoring Parameters	Location and Frequency of Sampling				
	OWTP	Secondary Effluent	RO Influent	RO Permeate	Purified Water
TOC			Online	Online	
Bench			Bi-weekly	Bi-weekly	Bi-weekly
EC	Online	Online	Online	Online	Online
Bench	2 X daily	2 X daily	2 X daily	2 X daily	2 X daily
BOD					
Bench	Daily	Daily			
Turbidity	Online	Online	Online		
Bench	Daily	Daily	Daily		
UVT		Online	Online	Online	Online
Bench	Daily	Daily	4 X Daily	4 X Daily	4 X Daily

5.2.6 Regulated and Unregulated Constituents

Tables 7 through 12 constitute the required water quality performance, consistent with CDPH (2014). The tables of constituents referenced in CDPH (2014) are found in CDPH (2014a). Within each table is a specific reference to the table within the regulation (e.g., Primary MCLs are listed in Table 7 below and also found in Table 64431-A).

SWRCB (2013) lists specific compounds for monitoring for groundwater injection projects (Table 13). The initial monitoring program is intended to be quarterly, followed by semi-annual monitoring for the duration of the project.

The RWQCB requires specific monitoring for CECs. This list, provided to our team by Elizabeth Erickson on 10/29/2014. This list is provided below as Table 14.

5.3 Monitoring and Enforcement Programs

As part of this enhanced source control monitoring plan for potable reuse, regulated and unregulated constituents will be monitored with the same frequency (for the first year of operation) and given equal scrutiny for detection and available health criteria in the source water (OWTP secondary effluent) and the purified effluent of the AWPF. All regulated MCLs and unregulated contaminants (Secondary MCLs, NLs and CECs) are provided in Tables 7 through 14.

Table 7	Inorganics with Primary MCLs[(1)] Advanced Water Purification Facility City of Oxnard		
Constituents	**Primary MCL (in mg/L)**	**Constituents**	**Primary MCL (in mg/L)**
Aluminum	1.0	Fluoride	2
Antimony	0.2	Lead	0.015[(4)]
Arsenic	0.006	Mercury	0.002
Asbestos	7 (MFL)[(2)]	Nickel	0.1
Barium	1	Nitrate (as NO_3)	45
Beryllium	0.004	Nitrite (as N)	1
Cadmium	0.005	Total Nitrate/Nitrite (as N)	10
Hexavalent Chromium	0.010	Perchlorate	0.006
Copper	1.3[(3)]	Selenium	0.05
Cyanide	0.15	Thallium	0.02

Notes:

(1) Based on **Table 64431-A.**
(2) MFL = Million fibers per liter, with fiber lengths > 10 microns.
(3) Regulatory Action Level; if system exceeds, it must take certain actions such as additional monitoring, corrosion control studies and treatment, and for lead, a public education program; replaces MCL.
(4) The MCL for lead was rescinded with the adoption of the regulatory action level described in footnote 'd'.

Table 8	Radioactivity[(1)] Advanced Water Purification Facility City of Oxnard		
Constituents	**MCL (in pCi/L)**	**Constituents**	**MCL (in pCi/L)**
Uranium	20	Gross Beta particle activity	50[(2)]
Combined radium-226 & 228	5	Strontium-90	8[(2)]
Gross alpha particle activity	15	Tritium	20,000[(2)]

Notes:

(1) Based on **Tables 64442 and 64443**.
(2) MCLs are intended to ensure that exposure above 4 millirem/yr does not occur.

Table 9 Regulated Organics[1]
Advanced Water Purification Facility
City of Oxnard

Constituents	MCL (in mg/L)	Constituents	MCL (in mg/L)
Volatile Organic Compounds			
Benzene	0.001	Monochlorobenzene	0.07
Carbon Tetrachloride	0.0005	Styrene	0.1
1,2-Dichlorobenzene	0.6	1,1,2,2-Tetrachloroethane	0.001
1,4-Dichlorobenzene	0.005	Tetrachloroethylene	0.005
1,1-Dichloroethane	0.005	Toluene	0.15
1,2-Dichloroethane	0.0005	1,2,4 Trichlorobenzene	0.005
1,1-Dichloroethylene	0.006	1,1,1-Trichloroethane	0.2
cis-1,2-Dichloroethylene	0.006	1,1,2-Trichloroethane	0.005
trans-1,2-Dichloroethylene	0.01	Trichloroethylene	0.005
Dichloromethane	0.005	Trichlorofluoromethane	0.15
1,3-Dichloropropene	0.0005	1,1,2-Trichloro-1,2,2-Trifluoroethane	1.2
1,2-Dichloropropane	0.005	Vinyl chloride	0.0005
Ethylbenzene	0.3	Xylenes	1.75
Methyl-tert-butyl ether (MTBE)	0.013		
SVOCs			
Alachlor	0.002	Hexachlorobenzene	0.001
Atrazine	0.001	Hexachlorocyclopentadiene	0.05
Bentazon	0.018	Lindane	0.0002
Benzo(a) Pyrene	0.0002	Methoxychlor	0.03
Carbofuran	0.018	Molinate	0.02
Chlordane	0.0001	Oxamyl	0.05
Dalapon	0.2	Pentachlorophenol	0.001
Dibromochloropropane	0.0002	Picloram	0.5
Di(2-ethylhexyl)adipate	0.4	Polychlorinated Biphenyls	0.0005
Di(2-ethylhexyl)phthalate	0.004	Pentachlorophenol	0.001
2,4-D	0.07	Picloram	0.5
Dinoseb	0.007	Polychlorinated Biphenyls	0.0005
Diquat	0.02	Simazine	0.004
Endothall	0.1	Thiobencarb	0.07/0.001[2]
Endrin	0.002	Toxaphene	0.003
Ethylene Dibromide	0.00005	2,3,7.8-TCDD (Dioxin)	$3x10^{-8}$
Glyphosate	0.7	2,4,5-TP (Silvex)	0.05
Heptachlor	0.00001		
Heptachlor Epoxide	0.00001		

Notes:
(1) Based on Table 64444-A.
(2) Second value is listed as a Secondary MCL.

Table 10	**Disinfection By-Products(1) Advanced Water Purification Facility City of Oxnard**		
Constituents	**MCL (in mg/L)**	**Constituents**	**MCL (in mg/L)**
Total Trihalomethanes	0.080	Bromate	0.010
Total haloacetic acids	0.060	Chlorite	1.0

Notes:
(1) Based on **Table 64533-A.**

Table 11	**Constituents/Parameters with Secondary MCLs Advanced Water Purification Facility City of Oxnard**		
Constituents(1)	**MCL (in mg/L)**	**Constituents(2)**	**MCL (in mg/L)**
Aluminum	0.2	TDS	500
Color	15 (units)	Specific Conductance	900 *u*S/cm
Copper	1	Chloride	250
Foaming Agents (MBAS)	0.5	Sulfate	250
Iron	0.3		
Manganese	0.05		
Methyl-tert-butyl-ether (MBTE)	0.005		
Odor Threshold	3 (units)		
Silver	0.1		
Thiobencarb	0.001		
Turbidity	5 (NTU)		
Zinc	5		

Notes:
(1) Based on **Table 64449-A.**
(2) Based on **Table 64449-B.**

Table 12 Constituents with Notification Levels[1,2]
Advanced Water Purification Facility
City of Oxnard

Constituents	NL (in μg/L)	Constituents	NL (in μg/L)
Boron	1000	Manganese	500[2]
n-Butylbenzene	260	Methyl isobutyl ketone (MIBK)	120
sec-Butylbenzene	260	Naphthalene	17
tert-Butylbenzene	260	N-Nitrosodiethylamine (NDEA)	0.01
Carbon disulfide	160	N-Nitrosodimethylamine (NDMA)	0.01
Chlorate	800	N-Nitrosodi-n-propylamine (NDPA)	0.01
2-Chlorotoluene	140	Propachlor**	90
4-Chlorotoluene	140	n-Propylbenzene	260
Diazinon	1.2	RDX	3
Dichlorodifluoromethane (Freon 12)	1000	Tertiary butyl alcohol (TBA)	12
1,4-Dioxane	1	1,2,3-Trichloropropane (1,2,3-TCP)	0.005
Ethylene glycol	14000	1,2,4-Trimethylbenzene	330
Formaldehyde	100	1,3,5-Trimethylbenzene	330
HMX	350	2,4,6-Trinitrotoluene (TNT)	1
Isopropylbenzene	770	Vanadium	50

Notes:
(1) Based on http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/notificationlevels/notificationlevels.pdf.
(2) The web link above also contains the levels of the pollutants in this table that must result in a removal of the water source from service.

Table 13	**Monitoring Trigger Levels for Groundwater Recharge, as Listed in SWRCB (2013) Advanced Water Purification Facility City of Oxnard**		
Constituents	**Relevance/ Indicator Type/ Surrogate**	**Monitoring Trigger Level (in µg/L)**	**Removal Percentages (%)**
17B-estradiol	Health	0.0009	--
Caffeine	Health & Performance	0.35	>90
NDMA	Health & Performance	0.01	25-50, >80(1)
Triclosan	Health	0.35	--
DEET	Performance	--	>90
Sucralose	Performance	--	>90
Electrical Conductivity	Surrogate	--	>90
TOC	Surrogate	--	>90

Notes:
(1) 25 to 50 % removal by RO, >80% removal by RO followed by UV, depending upon the UV dose.

Table 14	**CECs Required for Monitoring by LARWQCB(1) Advanced Water Purification Facility City of Oxnard**	
Constituents	**Sample Type**	**Reporting Level, ng/L**
17-alpha-estradiol	Composite	0.5
Caffeine	Composite	10
DEET	Composite	10
Iodinated Contrast Media (Iopromide)	Composite	10
Triclosan	Composite	10
NDMA	Composite	10
Sucralose	Composite	100

Notes:
(1) Information provided by Elizabeth Erickson to the project team on 10/29/2014.

Each class of constituent (regulated, CECs, etc.), monitoring location and proposed monitoring frequency are shown in Table 15. Following acceptable monitoring performance during the first year of operation, the sampling frequency in the secondary effluent will decrease for select classes of constituents.

Table 15	**Class of Constituents, Location and Frequency Monitoring Plan Advanced Water Purification Facility City of Oxnard**		
	Monitoring Plan(1)		
Class of Constituents	**Collection System**	**Secondary Effluent**	**Purified Water**
Industrial Discharge	Monthly and Internally (by permit requirement)	Monthly	Monthly
Local Limits	Monthly	Monthly (year 1) and Quarterly (starting year 2)	Monthly
NPDES Permit	Monthly	Monthly	Monthly
Regulated (MCLs)		Monthly (year 1) and Quarterly (starting year 2)	Monthly
Secondary Treatment Goals MCLs		Monthly (year 1) and Quarterly (starting year 2)	Monthly
Notification Levels		Monthly (year 1) and Quarterly (starting year 2)	Monthly
Contaminants of Emerging Concern (CECs)		Monthly (year 1) and Quarterly (starting year 2)	Monthly

Note:
(1) Monitoring frequency for industrial dischargers will be determined by flow, as outlined in each industry permit.

5.3.1 Finished Water Monitoring and Enforcement

At a minimum, pursuant to Section 60320.201 of Title 22 (CDPH 2014), the AWPF purified water effluent must be analyzed for all MCLs and NLs monthly for the first year. For subsequent years, a permit change can be granted with the monitoring frequency reduced to a minimum of quarterly. The monitoring and enforcement plans currently required by Title 22 for IPR finished water are shown as Figure 4 through 7. This sampling pertains to finished water quality for potable water reuse; and is not an added sampling effort for the ESCP. However, the data obtained as part of this required sampling is a useful component of the ESCP.

The proposed ESCP will be including secondary MCLs and a SRWQCB approved list of CECs to this monitoring plan for both monthly and quarterly sampling of the secondary effluent. The ESCP program calls for continuous monthly sampling of the purified water, with no decrease in frequency following the first year of operation, regardless of acceptable plant process performance.

An ESCP action and enforcement plan for purified water is provided in Figure 8. Mimicking Titile 22 requirements for potable reuse source control plans, the finished water plan is based on two response procedures, regulated and unregulated contaminants. An additional step in the ESCP requires a more rigorous response to regulated contaminant detection, where a detected regulated contaminant (above or below the action level) will require resampling and subsequent *tracking through both the wastewater treatment plant and collection system*. Where unregulated contaminants are detected and reported above the health action level, the same response plan as regulated contaminants reported below their corresponding action level will be enforced.

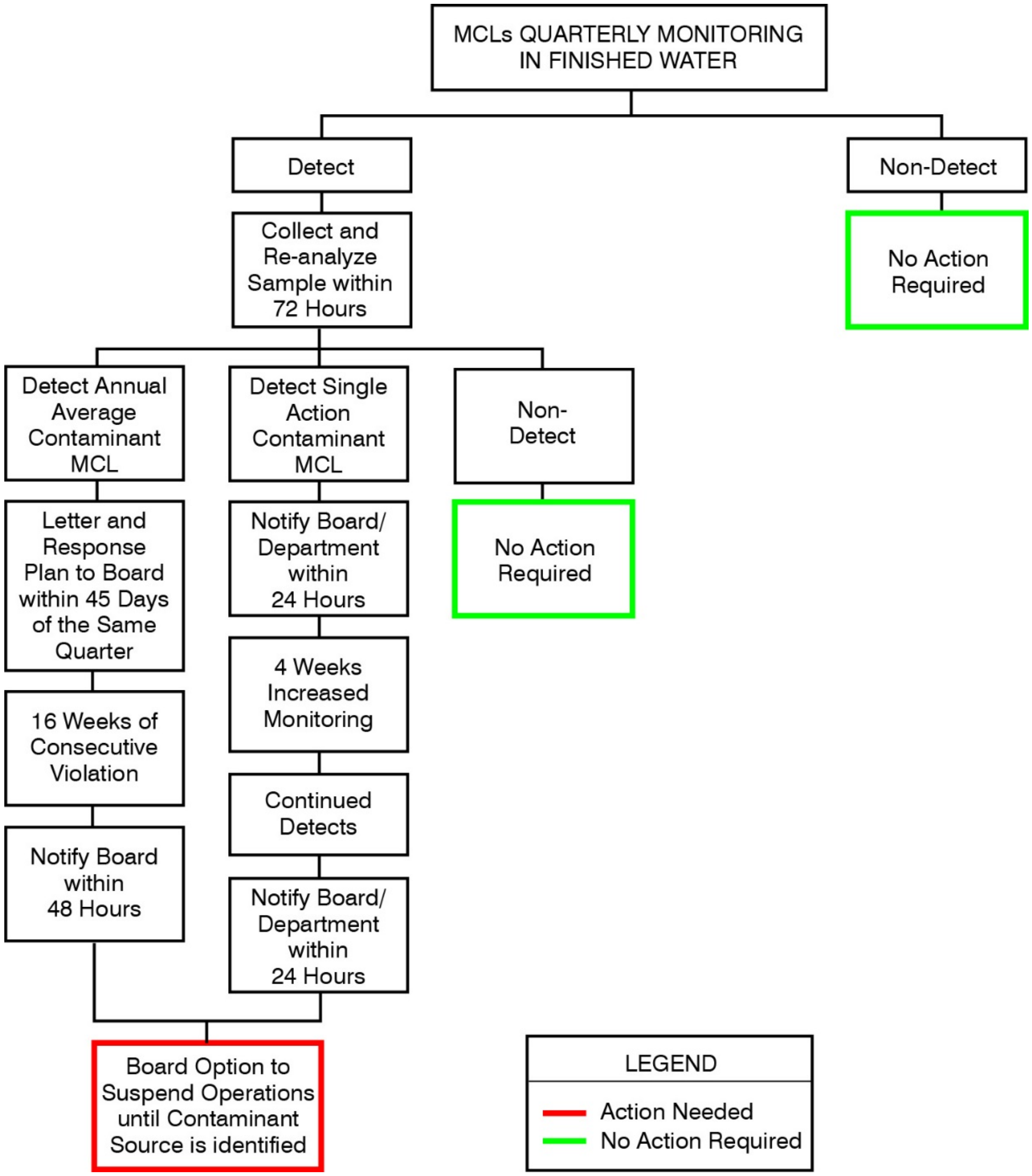

Figure 4 Title 22 MCL Monitoring Requirements and Action Plan for IPR Finished Water.

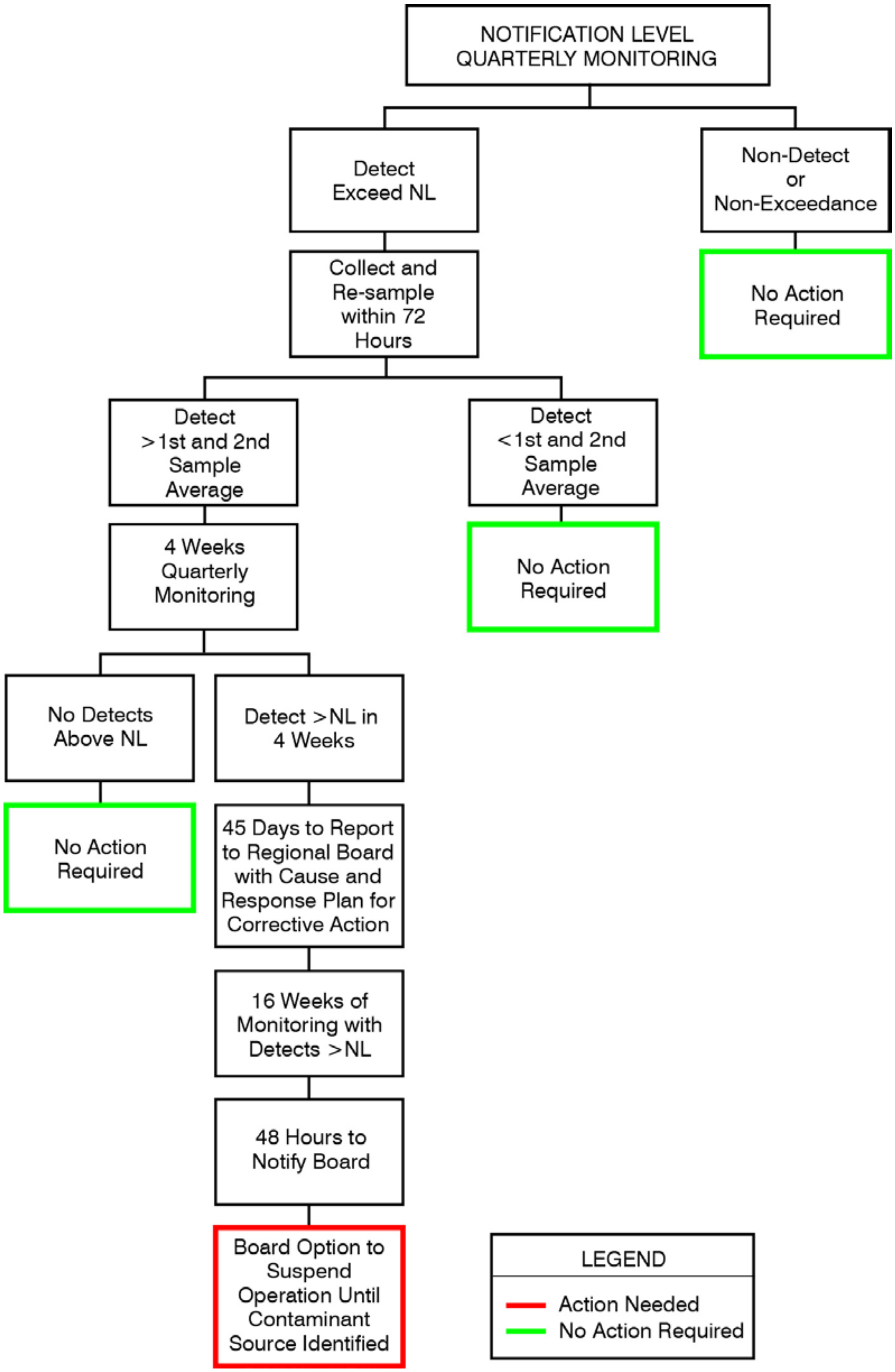

Figure 5 Title 22 Notification Levels Monitoring Requirements and Action Plan for IPR Finished Water.

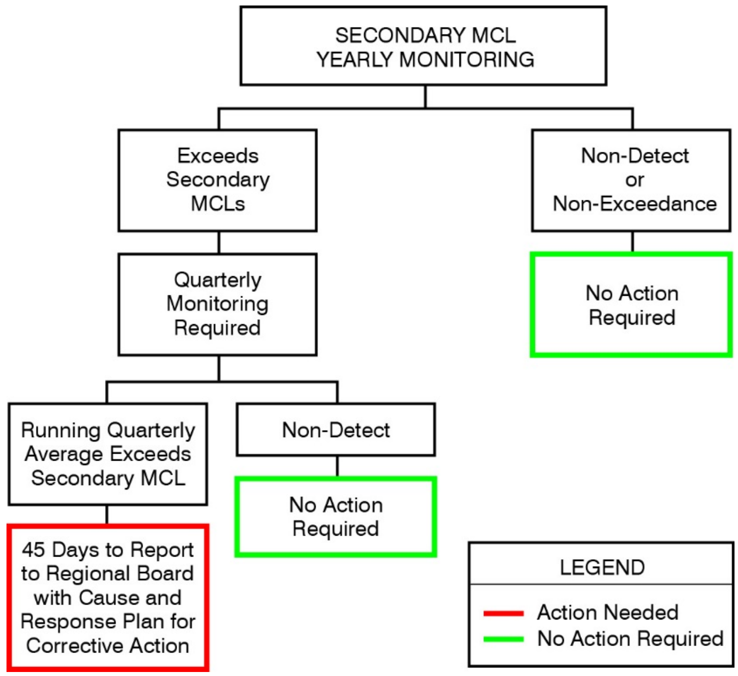

Figure 6 Title 22 Secondary MCL Monitoring Requirements and Action Plan for IPR Finished Water.

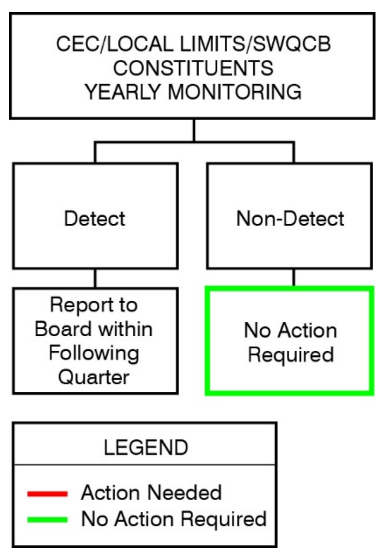

Figure 7 Title 22 CEC, Local Limits and Board RequiredContaminants Monitoring and Action Plan for IPR Finished Water.

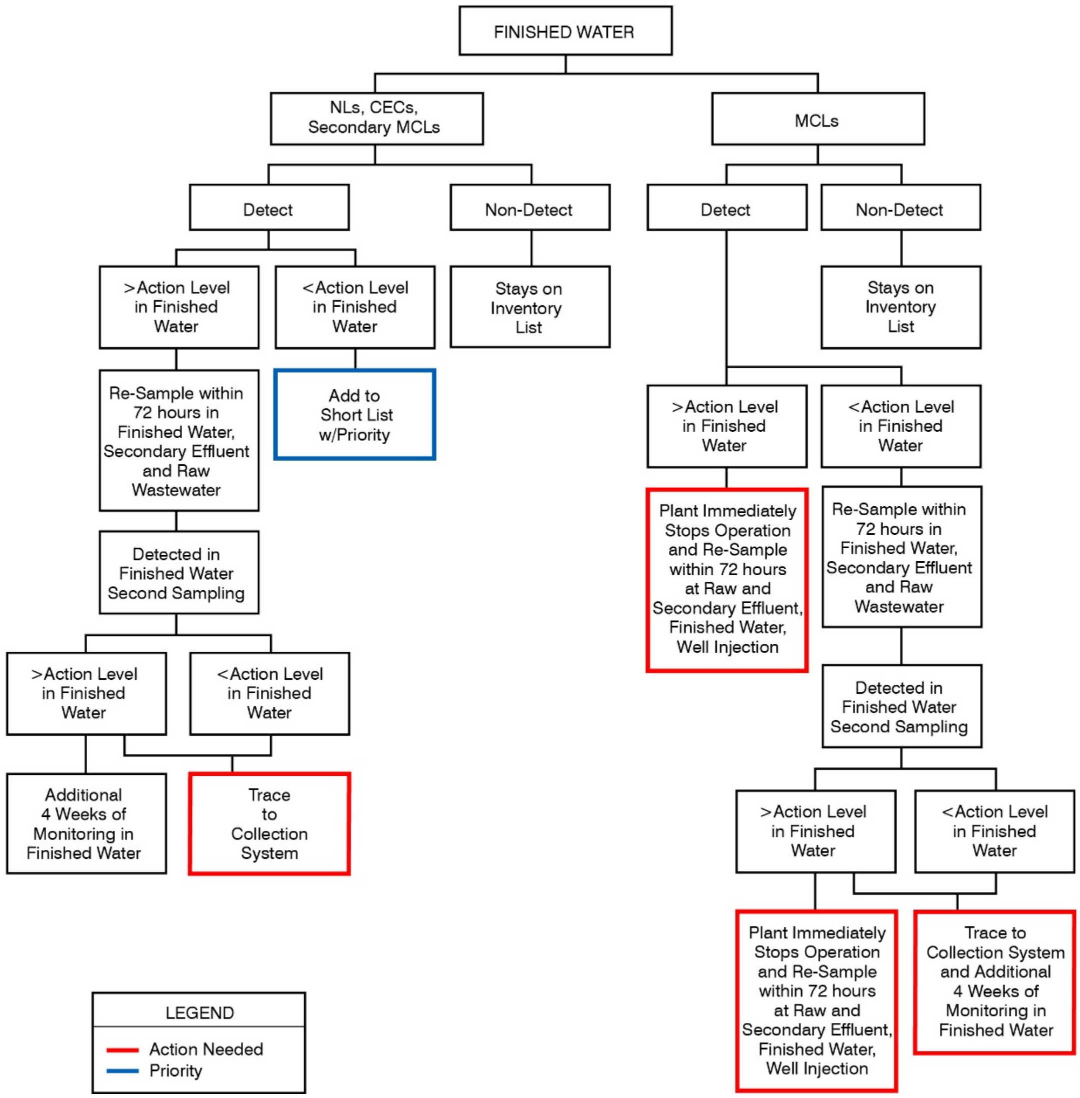

Figure 8 Finished Water Monitoring Response Plan for Proposed ESCP

5.3.2 Secondary Effluent Monitoring and Enforcement

This proposed enhanced source control program includes monitoring of the secondary effluent source water, matching the schedule of the purified water sampling frequency for the first year. Monitoring action plans tailored to secondary effluent sampling are included in Figures 9 and 10. *Secondary effluent sampling constituents are broken into two lists, Short List and Inventory List, which correspond to varying monitoring frequencies.*

A full list of all regulated and unregulated contaminants sampled for are included in the "Inventory List." All detected contaminants will be put into a more frequent monitoring registry called the "Short List." The "baseline" percent removal for wastewater treatment and contaminant removal corresponds to the contaminant removal percentage through secondary wastewater treatment measured during the Local Limits evaluation.

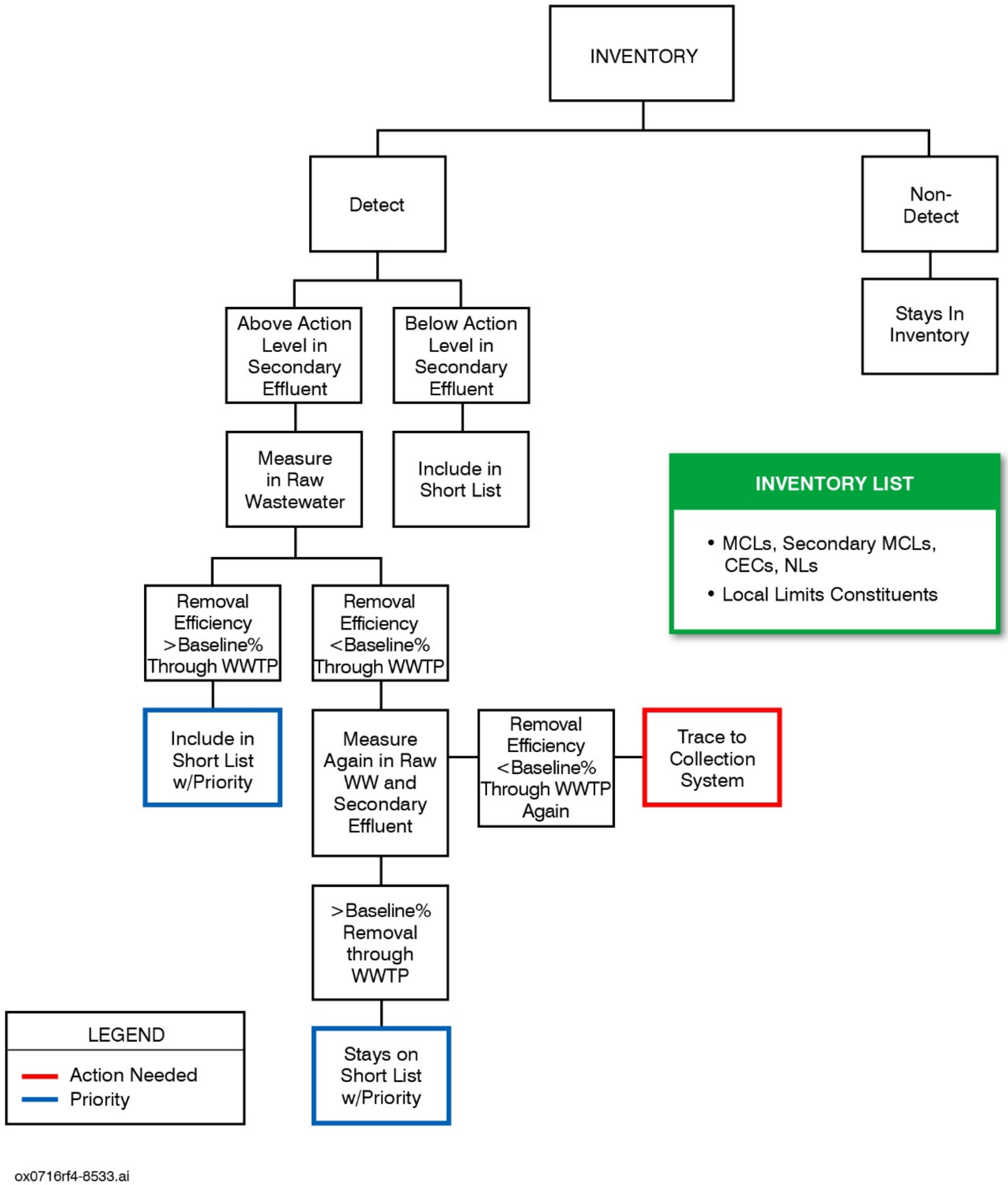

Figure 9 Secondary Effluent Source Inventory Monitoring Action Plan for Proposed ESCP

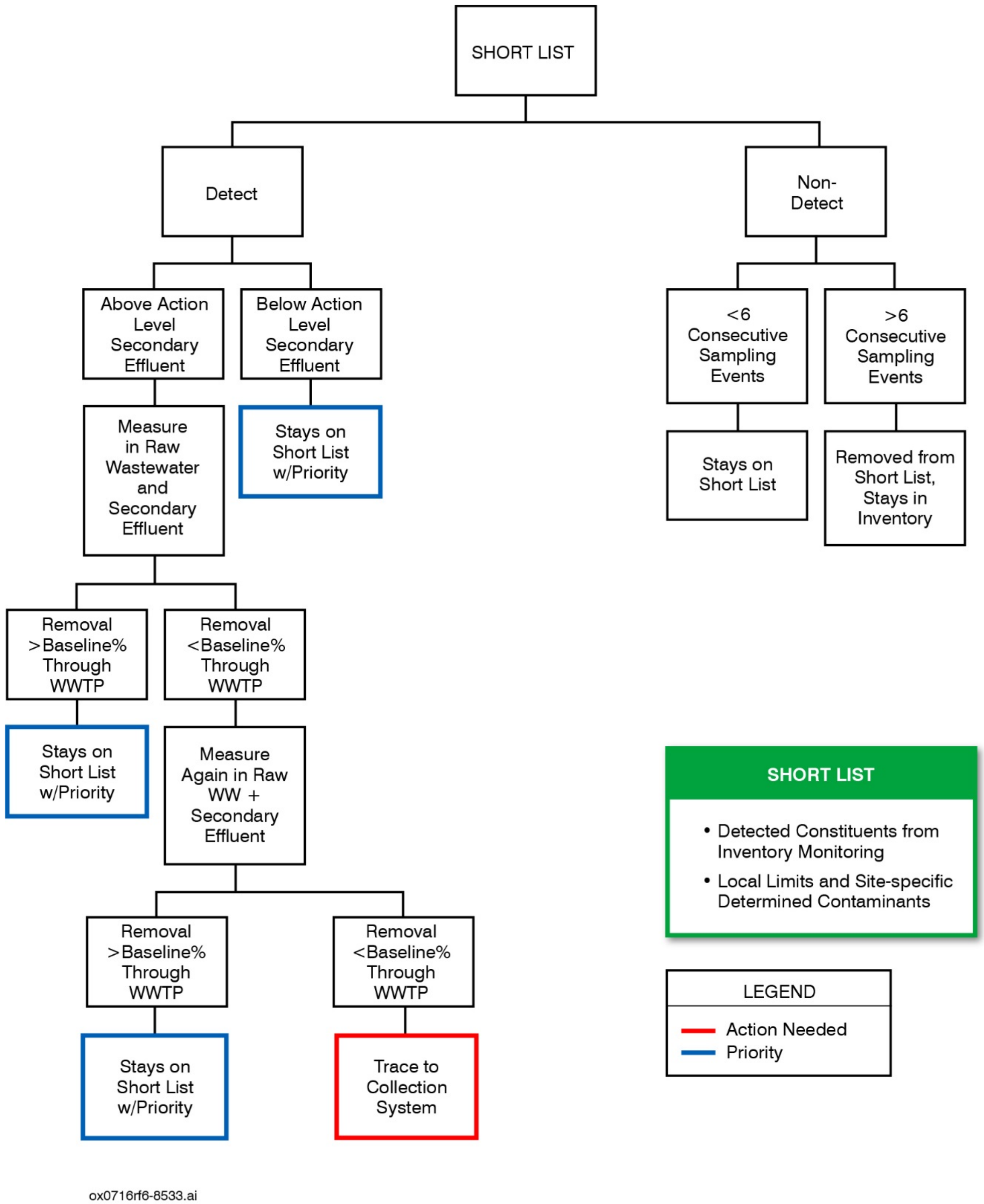

Figure 10 Secondary Effluent Source Short List Monitoring Action Plan

The Short List contains all detected contaminants from Inventory monitoring and any additional Local Limits constituents. Monitoring parameters on the Short List are revolving and contaminants can be added due to routine monitoring or a new discharge permit. If a contaminant is detected in the routine Inventory List, thereby going on the Short List, and no longer detected during monthly sampling of the Short List for 6 consecutive sampling events (6 months), the contaminant will then be removed from the frequently monitored list and monitored quarterly.

A contaminant added to the Short List with Priority, will be closely monitored for changes during the subsequent sampling periods and the detections will be noted during the Industrial Source Control Workshops held quarterly by the SCPM.

5.4 Source Mapping Strategy

The City currently has a collection system tracing strategy that has proven effective by the "gross-beta" incident. For enhanced source control monitoring, a defined area strategy is proposed. This strategy includes defining areas of the collection system from which all major trunks meet and allows for increased isolation between domestic and industrial dischargers. Example mapping areas are shown below in Figure 11 as (M1 - M6). Each area will be monitored at the major junctions on a monthly basis for the Local Limits contaminants, and as needed for priority events where mapping contaminants through the system is necessary.

The initial discharge area in M4 will be monitored as a "baseline" for collection system contaminant accumulation. This will provide information about loading rates through each sampling event. Industry measured contaminant discharge data and flow rates will be used to create a mass balance for industry-specific loading rates. If these loading rates remain within a +/- (TBD by City)% margin, the loading rates will be acceptable. If out of this range, all industrial dischargers known to discharge this specific contaminant will be contacted. Household dischargers could also be responsible for contributing to this difference in industrial contaminant discharge. This approach is not meant to replace downstream monitoring of industrial discharge by the City for confirmation of each industry, only to provide a larger data set for long-term monitoring and a first look at monthly data trending for increasing dischargers in the service area. This will also provide confirmation of residential input, not only industry input.

To reduce the likelihood that harmful pollutants enter the OWTP, a monitoring and enforcement response plan similar to the SCWW "gross-beta incident" must be implemented. Monitoring and sampling effluent wastewater on a semiannual basis (to analyze for radioactivity) allows for early detection of contaminants. If a contaminant is found, research should be conducted to locate the source. Once locations are identified, samples should be taken from several locations - upstream, downstream, onsite and adjacent to suspected violators. If unacceptable concentrations of contaminants are found, proper action by the City should be taken to control the problem. This can include an order to Cease-and-Desist discharge, a Notice of Violation, and/or suspension of Industrial Waste Discharge Permit that would prohibit the discharge of any wastewater by the violators to the Oxnard Collection System.

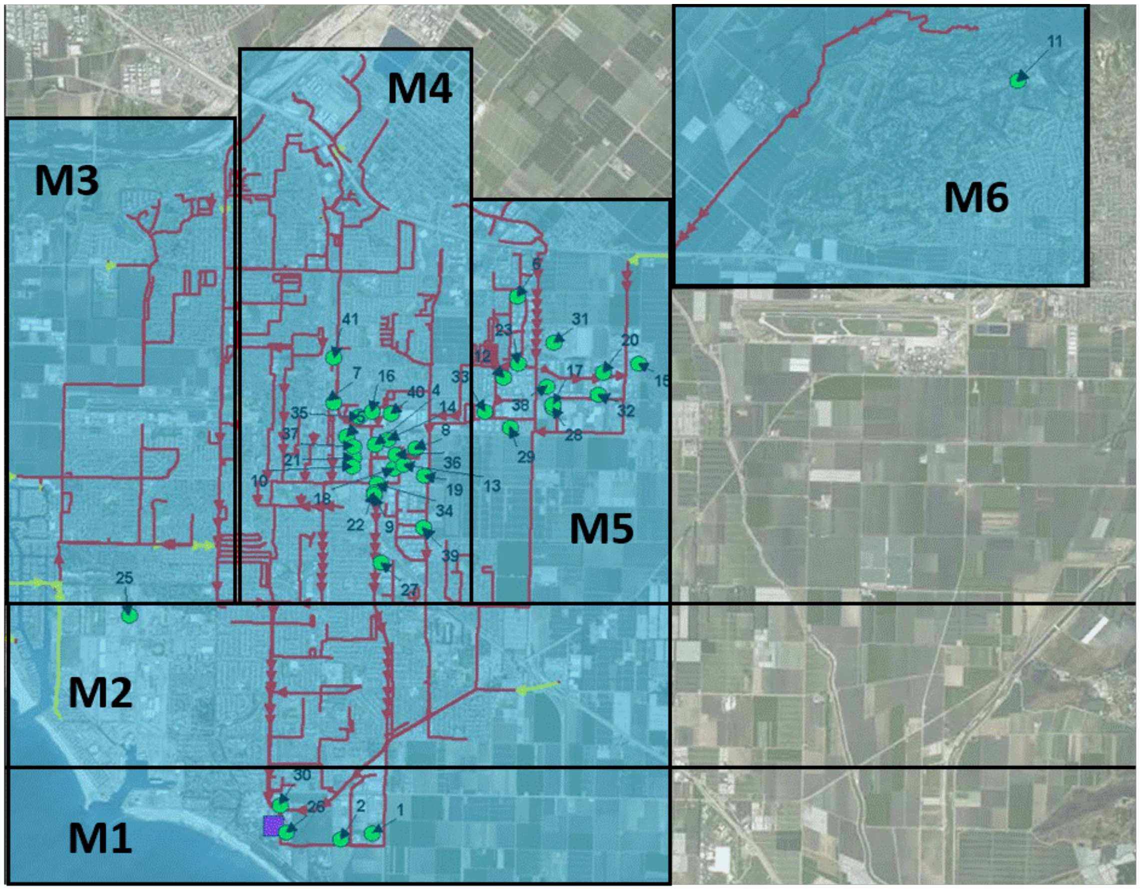

Figure 11 Proposed Collection System Strategic Monitoring Strategy for Both Routine Monitoring and Action Plan Response.

The City of Oxnard has a mostly residential section of town and another section that contains significant numbers of industrial dischargers. If a household is discharging a contaminant of concern, it will be difficult to pinpoint which house is causing the violations. In order to minimize painstaking contaminant tracking through the sewage discharge lines, a heavy emphasis will be put on household outreach and education. Additionally, the City will provide a hazardous waste disposal program where the public can bring medications, pesticides, and other hazardous waste items to the landfill for treatment, recovery, or burial. The plans for public outreach can be found in Section 6.3.

5.5 Hospital Discharge Program

Hospital waste discharge monitoring is not currently required in source control programs. The City of Oxnard has several hospitals, including animal hospitals, shown in Figure 12. There are many pharmaceuticals and personal care products monitored for in the Inventory List of contaminants and if an unexplained detection of these contaminants is found in the secondary effluent or purified water when tested, the compound will move to the Short List. If the action plan indicates the pharmaceutical contaminant should be traced back into the collection system (Figure 12), previously determined sampling locations downstream of the hospital dischargers will be utilized. Facilities with the highest discharge flow will be targeted first.

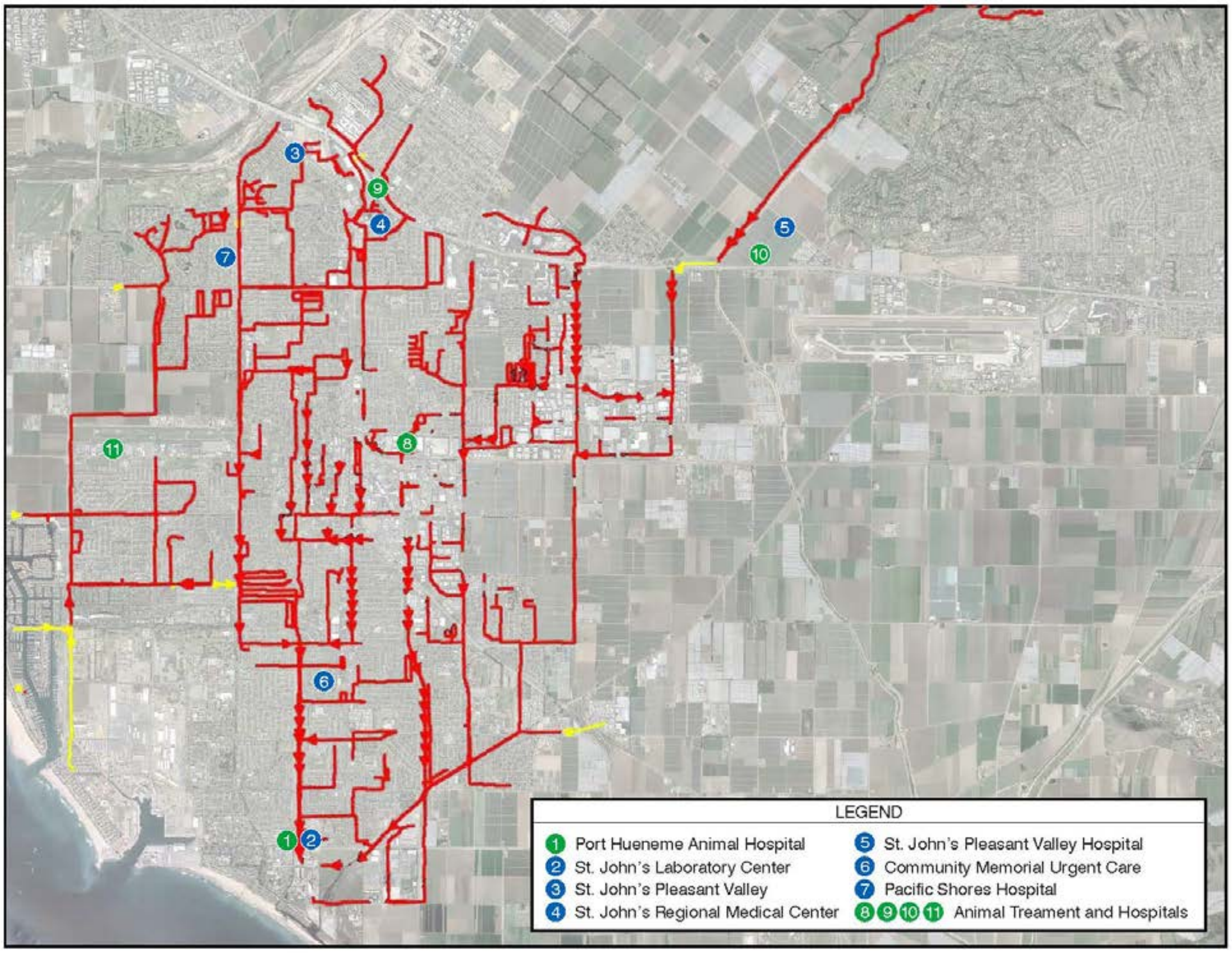

Figure 12 Short List of Human and Animal Hospitals Discharging to OWTP

5.5.1 Iohexol Hospital Discharge Indicator

Distinguishing hospital discharge versus residential discharge can prove challenging. Iohexol can be used as a potential indicator with which to identify hospital discharge locations and determine their contributions to the total flow. Iohexol is introduced into the wastewater collection system almost exclusively through the urine of patients in hospitals that have undergone medical imaging. Iohexol acts as a contrasting agent for medical imaging, and is designed to have no impact on human or animal health. Advanced oxidation processes efficiently remove Iohexol, and the compound is typically completely degraded in secondary treated wastewater. If incorporating a hospital discharge program into the ESCP becomes necessary, Iohexol should be used to help track medical dischargers.

6.0 OUTREACH PROGRAMS

6.1 Industrial Outreach

Meetings with all dischargers in groups will take place as described in the Local Limits Study. During these meetings, each discharger will be given their new discharge limits for all registered constituents. The rollout of the industrial discharge outreach program will be included in these meetings, where a clear plan will be made with each industrial discharger for what to do in the event of any constituent release changes. Changes could include a slug discharge event, a new contaminant introduced into production and needing to be added to the inventory list, removing a contaminant from a discharge list, and others.

Industrial dischargers will be reminded of the changes taking place downstream of them, and the effects discharging waste in violation of their permit could have on downstream potable reuse treatment and subsequent public consumption. The outreach plan will include 30 minutes to 1 hour monthly webinars to provide updates on their discharge statuses to each other and the City can provide the latest monitoring data and any updates or changes to the source control program. Monthly webinars will include information on any program updates, questions asked and answered by other dischargers during that time period and potable reuse monitoring information.

Quarterly 3-hour meetings will take place with all industries to send 1 representative to an update meeting in lieu of the monthly webinar. An example agenda for this meeting is shown as Figure 13. These meetings will be led by the SCPM with support from Oxnard staff. All industrial dischargers should participate with a short update on their recent monitoring and discharge information.

To encourage further engagement by industries, a yearly award will be given to those companies who have not had a discharge violation during audits or routine collection system monitoring. The "Enhanced Source Control Responsible Partner Award" is a yearly reminder to all industries that public health protection is a partnership with the community and water treatment system operations Figure 14.

6.2 Periodic Industry Reviews

In addition to educational outreach and coordinated industry discharger meetings, site audits currently run through the City's pre-treatment program will continue. The auditors will submit all data, reports, and meeting summaries directly to the SWPM immediately following site visits. The SWPM will then compile the data and files to ensure each industry is being properly monitored.

City of Oxnard Quarterly Source Control Dischargers Meeting

Meeting Month Day, Year

8:00 AM - 11:00 AM

Meeting Location

Welcome and Introductions (SCPM)	8:00 - 8:20
Source Control Program Updates (SCPM)	8:20 - 8:45
OWTP Monitoring Trends from Quarter (Oxnard Staff)	8:45 - 9:15
Individual Discharger Updates (Industry Representative)	9:15 - 10:30
Discussion and Q&A (Everyone)	10:30 - 10:50
Set Next Meeting Date and Agenda Items (SCPM)	10:50 - 11:00

Figure 13 Example Quarterly Industrial Dischargers Source Control Meeting Agenda

Figure 14 ESCP Responsible Partner Award Certificate (Example)

If a violation is found during a site audit, the current enforcement plan for pre-treatment violations will apply, unless a more stringent enforcement plan is needed during audits in the future. Any violations reported or recorded will be discussed during the quarterly and monthly industry outreach meetings that include representatives from each industry.

In the event of a new discharge license being issued by the City, a source control review will be triggered. This review will be discussed and integrated into the industry discharger partnership attending monthly and quarterly meetings. All business licenses for dischargers will be reviewed annually by the industry's assigned auditor. The licenses are required to be within expiration date, show proper fees have been paid to the City for the annual time period, and no new constituents or major changes have been made to the discharge matrices.

6.3 Residential Outreach

Household outreach and education is the major residential source control strategy for most communities. Due to the increased risk involved in potable reuse, the residents should be strongly educated as to where their waste is going and the potential impacts to the communities drinking water supply. An outreach plan for public acceptance purposes is already planned for this project, and the discharge information could be rolled out along with this initiative upfront. Providing a proactive awareness program for household discharges prior to the operation of IPR in the community can provide increased confidence to the City in their residential source water control strategy.

Contaminant discharges causing unwanted impact to the water supply cannot be tracked easily in residual areas due to the quantity of individual dischargers with low-volume inputs. In order to prevent unwanted discharges from households in the sewer line, educational tools and disposal centers will be used for the public to have options for disposing of unwanted items.

Discharge information will address a list of household items that would potentially be detrimental to the wastewater and water purification process, and alternative disposal options for the residents provided by the City or otherwise available. Educational materials will include a website developed to address safe disposal practices. For example, the public would be educated that flushing leftover antibiotics or pharmaceuticals is unsafe, however, household cleaners are acceptable. A detailed list with brand examples will be made available to ensure public understanding of the issue. An example of a public outreach website for residential discharge was developed by the San Francisco Public Utilities Commission (SFPUC). The website offers top things not to flush, and a flyer you can print with the title "Think Before You Flush". The website can be accessed here: http://sfwater.org/index.aspx?page=151

The majority of households in Oxnard primarily speak Spanish, therefore it is imperative that bilingual educational materials are developed alongside of materials in English. The

SFPUC in the above example provides 4 language options (English, Spanish, Mandarin and Tagalog) to cater to that city's demographics. To direct residents to the informational website, a link and description will be highly visible on their monthly water bills mailed, or in their water bills provided online. Provided internet is not available in the household, annual residential source control program meetings will be organized by the SWPM to provide another educational option for City residents.

7.0 OWTP AND AWPF WATER QUALITY RESULTS

7.1 Secondary Effluent Water Quality Standards and Results

In order for AWPF effluent to be used for indirect potable reuse, the water must first meet the existing NPDES OWTP effluent regulations and Los Angeles Region Basin Plan (Basin Plan) objectives. Since secondary effluent is the influent source for AWPF treated water, the higher the secondary effluent water quality, the higher our source water quality is for IPR.

7.1.1 NPDES Permit Regulations

The NPDES Permit for the OWTP includes regulations for major wastewater constituents such as 5-day biological oxygen demand (BOD_5) and total suspended solids (TSS), marine aquatic life contaminants, and contaminants relevant to human health (both carcinogens and non-carcinogens). A complete list of the NPDES permit water quality requirements is provided in Appendix B.

Per the NPDES permit, Oxnard already does periodic monitoring (quarterly) of the plant influent.

- Flow - continuous.
- pH, TSS, BOD - daily.
- Oil & Grease - weekly.
- Benzedrine, Heptachlor epoxide, PCBs, TCDD equivalents - quarterly.
- Everything else - semiannually.

7.1.2 Relevant Basin Plan Objectives

The Basin Plan was adopted in 1994 and outlines water quality requirements for waters in the Los Angeles region of which Oxnard is a part. All Basin Plan objectives pertaining to water designated for human consumption, are consistent with DDW requirements.

7.2 OWTP and AWPF Wastewater Quality

The OWTP has been in full compliance with its NPDES permit. Historical effluent data for BOD, TSS, turbidity, residual chlorine, pH, ammonia, oil and grease, and settleable solids are continuously measured in the OWTP effluent. Historical values for these parameters are provided in Tables 16 through 18. A summary of data for metals and trace pollutants in the OWTP effluent is shown in Table 17, including new data collected as part of the 2015 Local limits evaluation. The data provided in Tables 16 and 17 indicate that the OWTP provides high quality secondary-treated effluent suitable for advanced treatment and potable reuse. Further, the high beta radioactivity has been addressed through the source control program with the cease of all discharge from Santa Clara Wastewater, as demonstrated with the low beta radioactivity shown in Table 17.

The OWTP data collected to date was intended to demonstrate compliance with the existing NPDES permit and to address the local limits evaluation, and was not intended to address future potable reuse water quality standards. However, the OWTP secondary effluent data (Table 18) shows for any contaminant monitored under Title 22, the measured secondary effluent data meets or exceeds Title 22 maximum contaminant concentrations, with the exception of one event, where subsequent sampling consistently showed a much lower concentration. As discussed in the subsequent section, additional analytical testing of secondary effluent, ROP, and UV AOP effluent will be done during the startup of the AWPF and the production of non-potable recycled water, which will be done in the summer of 2016.

Table 16 Effluent Regulatory Limits and OWTP Data - Typical Wastewater Constituents
Advanced Water Purification Facility
City of Oxnard

Parameter	Units	NPDES Permit Limit: Discharge Limit	NPDES Permit Limit: Criteria	OWTP Data[1]
BOD_5	mg/L	30	Monthly Average	14 - 22
		45	Weekly Average	11 - 28
	lbs/day	7,900	Monthly Average	2,326 - 3,621
		12,000	Weekly Average	1,880 - 4,403
TSS	mg/L	30	Monthly Average	5.8 - 10.4
		45	Weekly Average	4.6 - 19.1
	lbs/day	7,900	Monthly Average	965 - 1,696
		12,000	Weekly Average	760 - 3,063
Turbidity	NTU	75	Monthly Average	2.9 - 6.8
		100	Weekly Average	2.7 - 12.9
		225	Daily Maximum	20.7
Total Residual Chlorine	mg/L	0.085	Monthly Performance Goal	0.01 - 0.04
	lbs/day	23		1.4 - 7.2
pH		6.0 - 9.0	Instantaneous Minimum to Maximum	7 - 7.9[2]
Ammonia Nitrogen	mg/L	25	Monthly Performance Goal	25 - 34
	lbs/day	6,600		4,259 - 5,781
Oil and Grease	mg/L	25	Monthly Average	4.9 - 4.9
		40	Weekly Average	4.9 - 5.1
	lbs/day	6,630	Monthly Average	782 - 827
		10,600	Weekly Average	769 - 850
Settleable Solids	ml/L	1	Monthly Average	0.01 - 0.016
		1.5	Weekly Average	0.01 - 0.036
		3	Daily Maximum	0.10

Notes:
(1) Based on 2013 Data.
(2) From daily grab samples.

Table 17 Effluent Regulatory Limits and OWTP Data – Other Pollutants Advanced Water Purification Facility City of Oxnard

Contaminant	Units	Effluent Limitations		Title 22 Contaminant Action Levels[1] and OWTP Discharge Goals	
		Average Monthly	Maximum Daily	Annual Average or Single Action	OWTP Data[2]
Marine Aquatic Life Toxicants					
Arsenic	ug/L	-	-	10	0.7
Cadmium	ug/L	-	-	5	<0.5
Chromium VI	ug/L	-	-	10	<0.3
Copper	ug/L	-	-	1300	28
Lead	ug/L	-	-	15	<5
Mercury	ug/L	-	-	2	<0.2
Nickel	ug/L	-	-	100	5
Selenium	ug/L	-	-	50	2.4
Silver	ug/L	-	-	100	1
Zinc	ug/L	-	-	5000	19
Cyanide	ug/L	-	-	0.15	-
Phenolic Compounds (non-chlorinated)[3]	ug/L	-	-	5[4]	<23
Phenolic Compounds (chlorinated) [3]	ug/L	-	-	0.42[4]	<5
Endosulfan[3]	ug/L	-	-	0.05[4]	<0.03
HCH[3]	ug/L	-	-	0.1[4]	-
Endrin	ug/L	-	-	2	<0.01
Chronic Toxicity[3]	Tuc	-	99	-	-
Radioactivity					
Alpha Radioactivity	Pci/L	-	15	15	1.67 ± 0.24
Beta Radioactivity	Pci/L	-	50	50	94 ± 3.939[5,6]
Combined Radium-226 & Radium-228	Pci/L	-	5	5	-
Tritium	Pci/L	-	20000	20000	-
Strontium-90	Pci/L	-	8	8	-
Uranium	Pci/L	-	20	20	-
Human Health Toxicants - Non Carcinogens					
Acrolein[3]	ug/L	-	-	10[4]	<5
Antimony	ug/L	-	-	6	<2
Bis (2-chloroethoxy) methane[3]	ug/L	-	-	25[4]	<1
bis (2-Chloroisopropyl) ether[3]	ug/L	-	-	10[4]	<1
Chlorobenzene[3]	ug/L	-	-	2.5[4]	<1

Table 17 Effluent Regulatory Limits and OWTP Data – Other Pollutants Advanced Water Purification Facility City of Oxnard

Contaminant	Units	Effluent Limitations: Average Monthly	Effluent Limitations: Maximum Daily	Title 22 Contaminant Action Levels[(1)] and OWTP Discharge Goals: Annual Average or Single Action	OWTP Data[(2)]
Chromium (III)	ug/L	-	-	50	<5
Di-N-Butyl phthalate[(3)]	ug/L	-	-	0.19[(4)]	<1
Dichlorobenzenes	ug/L	-	-	260	<3
Diethyl phthalate	ug/L	-	-	63	<1
Dimethyl phthalate[(3)]	ug/L	-	-	10[(4)]	<1
2-Methyl-4,6-dinitrophenol[(3)]	ug/L	-	-	25[(4)]	<5
2,4-Dinitrophenol[(3)]	ug/L	-	-	25[(4)]	<10
EthylBenzene	ug/L	-	-	600	<1
Fluoranthene[(3)]	ug/L	-	-	0.039[(4)]	<1
Hexachlorocyclopentadiene	ug/L	-	-	5	<1
Nitrobenzene[(3)]	ug/L	-	-	5[(4)]	<1
Thallium	ug/L	-	-	2	<2
Toluene	ug/L	-	-	150	<1
Tributyltin[(3)]	ug/L	-	-	0.0263[(4)]	<0.005
1,1,1-Trichloroethane	ug/L	-	-	200	<1
Human Health Toxicants - Carcinogens					
Acrylonitrile[(3)]	ug/L	-	-	10[(4)]	<2
Aldrin[(3)]	ug/L	-	-	0.025[(4)]	<0.005
Benzene	ug/L	-	-	1	<1
Benzedrine	ug/L	0.0068	-	-	<10
Beryllium	ug/L	-	-	4	<0.5
Bis (2-chloroethyl) ether[(3)]	ug/L	-	-	5[(4)]	<1
Bis (2-ethylhexyl) phthalate[(3)]	ug/L	-	-	50[(4)]	10
Carbon Tetrachloride	ug/L	-	-	0.5	<1
Chlordane	ug/L	-	-	2	<0.01
Chlorodibromomethane[(3)]	ug/L	-	-	0.61[(4)]	<.001
Chloroform[(3)]	ug/L	-	-	1.2[(4)]	<1
DDT[(3)]	ug/L	-	-	0.25[(4)]	<0.01
1,4-Dichlorobenzene[(3)]	ug/L	-	-	0.041[(4)]	<1
3,3-Dichlorobenzidine[(3)]	ug/L	-	-	25[(4)]	<5
1,2-Dichloroethane	ug/L	-	-	5	<1
1,1-Dichloroethylene	ug/L	-	-	6	<1
Bromodichloromethane[(3)]	ug/L	-	-	2.5[(4)]	<1

Table 17	Effluent Regulatory Limits and OWTP Data – Other Pollutants Advanced Water Purification Facility City of Oxnard				
		Effluent Limitations		Title 22 Contaminant Action Levels(1) and OWTP Discharge Goals	
Contaminant	Units	Average Monthly	Maximum Daily	Annual Average or Single Action	OWTP Data(2)
Dichloromethane	ug/L	-	-	5	<1
1,3-Dichloropropene	ug/L	-	-	0.5	<2
Dieldrin(3)	ug/L	-	-	0.05(4)	<0.01
2,4-Dinitrotoluene(3)	ug/L	-	-	25(4)	<1
Azobenzene (1,2-Diphenylhydrazine)(3)	ug/L	-	-	5(4)	<1
Halomethanes	ug/L	-	-	80	<4
Heptachlor	ug/L	-	-	0.04	<0.01
Heptachlor epoxide	ug/L	0.002	-	0.02	<0.01
Hexachlorobenzene	ug/L	-	-	1	<1
Hexachlorobutadiene(3)	ug/L	-	-	5(4)	<1
Hexachloroethane(3)	ug/L	-	-	5(4)	<1
Isophorone(3)	ug/L	-	-	5(4)	<1
N-Nitrosodimethylamine (NDMA)	ug/L	-	-	10	<1
N-Nitrosodi-N-propylamine (NDPA)	ug/L	-	-	10	<1
N-Nitrosodiphenylamine	ug/L	-	-	10	<1
PAHs(3)	ug/L	-	-	0.097(4)	<19
PCBs	ug/L	0.0019	-	0.5	<17.5
Total 2,3,7,8-TCDD Equivalence(3)	ug/L	0.00000039	-	-	<0.00001
1,1,2,2-Tetrachloroethane	ug/L	-	-	1200	<1
Tetrachloroethylene	ug/L	-	-	5	<1
Toxaphene	ug/L	-	-	3	<2.5
Trichloroethylene	ug/L	-	-	5	<1
1,1,2-Trichloroethane	ug/L	-	-	5	<1
2,4,6-Trichlorophenol(3)	ug/L	-	-	0.35(4)	<1
Vinyl chloride	ug/L	-	-	0.5	<1

Notes:
(1) OWTP not regulated according to Title 22 MCL, NL, Secondary MCL or action levels.
(2) Based on August 2014 Data. "<" values are below the reporting limit.
(3) No Title 22 sampling or enforcement requirement.
(4) When not listed under Title 22, OWTP discharge goals are used.
(5) Recent sampling for this pollutant showed RO permeate levels <2 Pci/L.
(6) The source of the gross-beta was found to be Santa Clara Wastewater, and they are no longer allowed to discharge to the City collection system or OWTP. Subsequent testing has demonstrated very low gross-beta results and compliance with the NPDES permit.

Table 18	AWPF Removal Efficiencies (Local Limits Constituents) Advanced Water Purification Facility City of Oxnard			
Constituent	**Units**	**Secondary Effluent**	**Finished Water**	**Removal Efficiency(1)**
Ammonia	mg/L	33.9	1.67	95.1%
Antimony	ug/L	0.84(2)	<1	40.5%
Arsenic	ug/L	2.09(2)	<1	76.0%
Barium Tot	ug/L	23.0	<2	95.7%
Beta, Gross	pCi/L	5.96(2)	<3	74.8%
Biochemical Oxygen Demand, total	mg/L	6.91(3)	2.31(3)	66.6%
Boron	mg/L	1.09	0.74	31.9%
Cadmium	ug/L	<0.5	<0.5	--
Calcium	mg/L	164	7.52	95.4%
Chloride	mg/L	548	18.7	96.6%
Chromium	ug/L	0.52(4)	<1	4.2%
Copper	ug/L	7.16	<2	86.0%
Fixed Dissolved Solids	mg/L	1,603	1.14(4)	99.9%
Fluoride	mg/L	0.70	0.02	96.4%
Gross Alpha	pCi/L	26.5	<3	94.3%
Iron Total	mg/L	0.30	0.01(4)	96.2%
Lead Total	ug/L	<0.5	<0.5	--
Magnesium	mg/L	67.8	0.23	99.7%
Manganese	mg/L	0.11	<0.002	99.1%
Mercury	ng/L	6.01(2)	1.52	74.7%
Molybdenum	ug/L	16.4	<2	93.9%
Nickel	ug/L	6.57(2)	<5	62.0%
Potassium	mg/L	35.1	1.43	95.9%
Selenium	ug/L	8.05(2)	<5	69.0%
Silica	mg/L	30.8	1.01	96.7%
Silver Total	ug/L	<0.5	<0.5	--
Sodium	mg/L	397	17.4	95.6%
Specific Conductance	umho/cm	3,346	141	95.8%
Strontium	mg/L	1.55	0.01(4)	99.6%
Sulfate	mg/L	543	1.27	99.8%
Total Dissolved Solids	mg/L	1,869	69.9	96.3%
Total Kjeldahl Nitrogen	mg/L	34.3	1.70	95.0%
Total phosphorus as P	mg/L	1.45	0.03	97.8%
Total Suspended Solids	mg/L	5.32(2)	<10	6.1%
Uranium	ug/L	8.49	<1	94.1%
Zinc Total	ug/L	17.3(2)	<20	42.2%

Table 18	AWPF Removal Efficiencies (Local Limits Constituents) Advanced Water Purification Facility City of Oxnard

Notes:

(1) Where the reported value is < reporting limit, the removal efficiency was calculated assuming the reported value equaled one half of the reporting limit.

(2) Some data points in this dataset were extrapolated below reporting limit based on other reported data at the sampling location. These datasets had three or more data points above the reporting limit to allow regression analysis for extrapolating concentrations below the level of detection.

(3) BOD data were collected on 9 days from 6/11/15 through 8/30/15.

(4) These datasets had less than three data points above the reporting limit which makes a regression analysis inaccurate. Thus, a geometric mean of all data points was used. Data reported below the reporting limit were assumed to be one half the reporting limit for calculating the geometric mean.

8.0 SUMMARY

An ESCM Program framework has been proposed in this document, building on the existing source control program already in place at the City of Oxnard. The proposed ESCM for the City of Oxnard will include:

- A source control program manager overseeing all data collection and regulatory issues relating to discharge from the first user to groundwater wells.
- More frequent sampling than currently required of the secondary effluent and AWPF finished water, including for regulated, unregulated and industry-specific constituents.
- Use of historical and online monitoring data currently required for operation to create baselines and predict trends in process performance.
- Substantial industrial and residential outreach programs for potable reuse education and discharge initiatives.
- Mapping strategies for fast-acting collection system tracing of detected contaminants of health concern.
- Optional additions to discharge mapping, including hospitals.

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ACRONYMS

-A-	
ASR	Aquifer Storage and Recovery
AWPF	Advanced Water Purification Facility
-B-	
bgs	below ground surface
BOD	Biological Oxygen Demand
-C-	
CEC	Constituents of Emerging Concern
CEQA	California Environmental Quality Act
City	The City of Oxnard
CIUs	Categorical Industrial Users
CMWD	Calleguas Municipal Water District
CWC	California Water Code
-D-	
DDW	Division of Drinking Water
DIT	Direct Integrity Test
-E-	
EC	Electrical Conductivity
EDCs	Endocrine Disrupting Compounds
ELAP	Environmental Laboratory Accreditation Program
-F-	
FCGMA	Fox Canyon Groundwater Management Authority
-G-	
GRPs	Groundwater Recharge Projects
GRRP	Groundwater Replenishment Reuse Project
GWRS	Groundwater Replenishment System
-H-	
H_2O_2	Hydrogen Peroxide
-I-	
IPR	Indirect Potable Reuse
-L-	
LARWQCB	Los Angeles RWQCB
LAS	Lower Aquifer System
LASAN	LA Sanitation
LPHO	Low-Pressure High-Output
LRV	Log-Removal Value
-M-	
MCLs	Maximum Contaminant Levels
MDL	Method Detection Limit
MF	Microfiltration
MRP	Monitoring and Reporting Program
MWDSC	Metropolitan Water District of Southern California
-N-	
ND	Non-Detected
NLs	Notification Levels
NOV	Notice of Violation

NWRI	National Water Research Institute
-O-	
OMMP	Operations, Maintenance, and Monitoring Plan
ORP	Oxidation Reduction Potential
OVMWD	Ocean View Municipal Water District
OWTP	Oxnard Wastewater Treatment Plant
-P-	
PDT	Pressure Decay Test
PEIR	Program Environmental Impact Report
PHWA	Port Hueneme Water Authority
POTW	Publicly-Owned Treatment Works
PPCP(s)	Pharmaceuticals and Personal Care Products
-Q-	
QAPP	Quality Assurance Project Plan
-R-	
RO	Reverse Osmosis
ROP	RO Permeate
ROSA	Reverse Osmosis System Analysis
ROWD	Report of Waste Discharge
RRT	Response Retention Time
RWC	Recycled Water Contribution
RWQCB	Regional Water Quality Control Board
-S-	
SCVWD	Santa Clara Valley Water District
SIU(s)	Significant Industrial User(s)
SNMP(s)	Salt Nutrient Management Plan(s)
SWP	State Water Project
SWRCB	State Water Resources Control Board
-T-	
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
TSP-SC	Technical Services Program – Source Control
TTO	Total Toxic Organics
-U-	
UAS	Upper Aquifer System
UV AOP	Ultraviolet Light and Hydrogen Peroxide
UVT	UV Transmittance
UWCD	United Water Conservation District's
-W-	
WDR(s)	Waste Discharge Requirement(s)
WRD	Water Replenishment District
WRR	Water Recycling Requirement

APPENDIX A – BEST MANAGEMENT PRACTICES (BMPS) FOR CENTRALIZED WASTE TREATMENT (CWT)

APPENDIX A – BEST MANAGEMENT PRACTICES (BMPS) FOR CENTRALIZED WASTE TREATMENT (CWT)

CALIFORNIA ASSOCIATION OF SANITATION AGENCIES (CASA)

BEST MANAGEMENT PRACTICES
FOR
CENTRALIZED WASTE TREATMENT (CWT) FACILITIES
(SUBCATEGORY D MULTIPLE WASTESTREAM)
October 12, 2015

Purpose

These Best Management Practices (BMPs) have been endorsed by several major POTW's in California that currently accept CWT waste discharges. These major California POTWs have developed and adopted these BMPs to serve as guidance, and to help assure uniform compliance among POTWs in California with their mandates under the U.S. EPA pretreatment program requirements.

These requirements are designed to protect POTW wastewater treatment processes and conveyance systems; to assure compliance with the regulations governing discharge of treated effluent, water reuse, biosolids disposal/reuse, and air emissions; and to protect worker and public safety and the environment.

Acknowledgement

The following agencies participated in the development and review of this BMP.

- City of Oxnard
- County Sanitation District of Los Angeles
- City of San Jose (SJ/SC Water Pollution Control Plant)
- City of Los Angeles
- Orange County Sanitation District

Background

Centralized Waste Treatment (CWT) facilities are defined in Rule 40 CFR 437 as those that accept hazardous or non-hazardous industrial metal-bearing wastes, oily wastes and organic-bearing wastes received from off-site for pretreatment processing before discharge to a water of the U.S., or to a Publically Owned Wastewater Treatment (POTW) facility. Specifically, CWT Subcategory D dischargers are those that receive for treatment a combination of two of more any of the following three major categorical waste streams: metal-bearing wastes, oily wastes, and organic-bearing wastes.

CWTs are required to be permitted and to comply with all federal and local rules and regulations set by Rule 40 CFR 437. They are also required to meet those rules and regulations set by the local agency that owns and operates the POTW facility and administers the POTWs pretreatment program, if the CWT discharges to a POTW.

The EPA's guidance document labeled "Small Entity Compliance Guide, Centralized Waste Treatment (CWT) Effluent Limitations and Guidelines and Pretreatment Standards (40 CFR 437) (EPA 821-B-01-003; June 2001; Version 3.0) "sets guidance for businesses that are subject to the Rule in complying with the national regulations and limitations set forth in the Rule." A Subcategory D discharger must establish that its facility provides "equivalent treatment" in terms of comparable pollutant removals to the applicable treatment technologies used as the basis for the federal limitations and pretreatment standards (40 CFR 437.2).

Best Management Practices

The following summarizes the recommended Best Management Practices (BMPs) for CWT facilities discharging to California POTWs. These recommended BMPs are organized based on the following topical headings:

- Waste Receiving Requirements
- Treatment Requirements
- Effluent Discharge and Sampling/Testing Requirements
- Recommended Certification and Documentation Requirements.

1. Waste Receiving Requirements

a. The waste hauler bringing waste to a CWT shall submit a Waste Manifest to the CWT upon arrival at the CWT processing facility. The Waste Manifest shall include the following minimum information:
   i. Information as defined in Chapter 5 of Small Entity Compliance Guide, Centralized Waste Treatment (CWT) Effluent Limitations and Guidelines and Pretreatment Standards (40 CFR 437) (EPA 821-B-01-003; June 2001; Version 3.0). This shall include a date and time stamp.

b. The following mandatory tests shall be performed for confirmation of the Waste Manifest in accordance with 40 CFR 403 General Pretreatment Regulations and the analytical methods and sampling techniques stipulated in 40 CFR 136:
   i. Heavy Metals
   ii. Cyanides
   iii. Total Phenol
   iv. Sulfides
   v. Volatile Organic Compounds
   vi. Oil and Grease
   vii. Total Toxic Organics (TTOs)
   viii. BOD and TSS

c. Combining waste from multiple location into one tank truck (i.e. "Milk Runs") is prohibited.
d. Additional random sampling of waste haulers by the CWT may be requested by the POTW to confirm the waste characteristics are as described in the Waste Manifest.

2. Treatment Requirements

a. The minimum required treatment shall be as specified in 40 CFR 437, and as described in the Small Entity Compliance Guide, Centralized Waste Treatment (CWT) Effluent Limitations and Guidelines and Pretreatment Standards (40 CFR 437) (EPA 821-B-01-003; June 2001; Version 3.0).
b. Emergency shutoff and re-routing procedures must be in place.
c. Treatment reliability and redundancy requirements must meet. As a minimum, those that are established by the most recent version of the '*Ten-State Standards' (Board of State and Provincial Public Health and Environmental Managers, Health Research, Inc., Health Education Services Division).*
d. Holding tanks for the purpose of dilution will not be allowed.
e. A logbook shall be maintained of the operating parameters of the treatment process.

3. Effluent discharge and sampling/testing requirements.

a. Batch discharge will be required. Continuous discharge is not permitted.
b. The batch tanks will be continuously mixed.
c. A representative sample will be taken and analyzed by a POTW approved, State certified laboratory, before a decision is made to discharge to the POTW sewer system. Testing shall, as a minimum, be for the following:
    i. Local Limits as established by the POTW.
    ii. Applicable 40 CFR 437 Categorical Limits, adjusted by the combined waste stream formula if non-regulated waste streams are discharged at the compliance point.
    iii. Toxicity as determined by Specific Oxygen Uptake Rate (SOUR), Method 1683, EPA-821-R-01-014.
    iv. Any other limits imposed by the POTW.
d. The batch discharge will only be allowed if the above test results meet the applicable discharge limits.
e. Adequate emergency shut-off/rerouting procedures must be established. Incoming wastes must be halted or diverted to storage if an emergency shutdown of the treatment system is required.
f. If the federal or local discharge limitations are not met for a parameter other than pH, then the tank contents shall to be returned to the beginning of the treatment process train for reprocessing. If the federal or local pH limits are not met based on pH only, then the CWT Facility can add an acid or base to bring the pH into the allowable range before discharge. The POTW may have restrictions on the acid or base chemical that can be used for pH adjustment.
g. Installation of flow metering of the discharge to the POTW is required and must be maintained and calibrated routinely by a qualified professional.

4. Recommended General Certification and Documentation Requirements

Documents must be developed and submitted to the POTW, and be available for the POTW to review at the CWT site all times.

Note that all documents, forms, and other submittals must be certified and stamped by a registered professional engineer in California with expertise in industrial treatment. This list includes, but is not limited to the following.

1. **Initial Certification Statement.**
   a. Submit initial Certification Statement to the POTW in accordance with 40 CFR 437.41.
   b. The initial Certification Statement must be reviewed and approved by the POTW before a Permit to Discharge is granted to the CWT by the POTW.
2. **Plans/Procedures**
   a. Monitoring, Sampling and Testing Plan (MSTP). The MSTP shall specify: location, frequency, and methodology for all monitoring/sampling of waste received, treatment processes and performance, and treated effluent discharged to the POTW.
   b. Monitoring Plan Reporting: Monthly and annual reports shall be submitted summarizing all mandatory and self-monitoring data results.
   c. Slug Discharge Control Plan.
   d. Spill Containment plan.
   e. Flow Metering Plan.
   f. Rainwater and Stormwater Management Plan (Note: stormwater cannot be commingled with received and/or treated CWT wastes).
   g. Solvent Management Plan.
   h. Waste Minimization Plan.

5. Treatment Process/Facility Information.

a. O&M Manual
   i. Routine O&M Procedures
   ii. Emergency Response, Bypass, and Storage O&M Procedures
   iii. O&M Logbook
b. Unit process sizing and design criteria. Information shall be sufficient for independently assessing the rated treatment capacity of all unit operations, including physical dimensions, and process design criteria (e.g. hydraulic detention times, overflow rates, pollutant removals, etc.).
c. Engineering Design Drawings (100% Design Drawings/As-built).
d. Process and Instrumentation diagram. This shall show the following information:
   i. Process flows for all major unit operations (routine and emergency conditions). This shall include identification of all flow and recycle streams for each treatment process
   ii. Process monitoring parameters (location and metrics). As a minimum these shall include:
      a. Flow rates
      b. pH
      c. Temperature
      d. Others as recommended by the POTW.

e. Wastewater Treatment Operator Requirements.
f. Water Usage. Copies of historical water bills and/or local well records showing water usage for a five-year (5) period.
g. Operating Records. All plant operating and performance records relating to wastewater discharge and waste manifests for up to five (5) years, including all monitoring, testing, and analytical results (See Testing and Monitoring *Information*, below).

6. Received Waste Documentation

a. Comprehensive list of all generators accepted by the CWT.
b. Waste Hauler Reports.
c. Logbook of all prequalification for each of the CWTs clients, this includes;
    i.. Generator information
    ii. Initial Sample information
    iii. Requalification tests
d. Customer Laboratory Treatability Information.

7. Testing and Monitoring Information

a. All sampling, testing and laboratory analyses must be performed by an independent testing laboratory that is licensed and certified in California.
b. All laboratory analytical results, including QA/QC information, shall be submitted monthly, and records maintained for a five-year period.
c. Effluent pH recordings from the previous 180 days
d. Flow Meter Calibration and Maintenance Reports (Note: must be signed and stamped by a registered professional engineer in California).
    i. Flow meter locations
    ii. Flow meter descriptions
    iii. Flow meter system details
    iv. Calibration methods/results
    v. Corrective measures
    vi. Discharge log (with signature(s) from responsible party at time of release from CWT facility to the POTW system.)
    vii.. Time, date, and volume of when the contents from the tank are discharged to the sewer
    viii. Signature from responsible operator
    ix Other observations
e. Chain of custody forms for monitoring samples with signatures.
f. All other sampling reports.

8. Compliance Paperwork

a. On-site Compliance Paperwork, as required by 40 CFR Part 437.47(a)(4)
b. Periodic Certification of equivalent treatment statement in the Self-Monitoring Report 40 CFR Part 437.41(b)
c. Facility shall continue to submit application information on a five-year cycle, with all applicable documentation and any information pertaining to changes planned for the future years. The information provided must include changes in the nature or volume of the discharge, or anticipated customers.

APPENDIX B – OXNARD WASTEWATER TREATMENT PLANT NPDES PERMIT REGULATIONS PER CURRENT ORDER R4-2013-0094

APPENDIX B – OXNARD WASTEWATER TREATMENT PLANT NPDES PERMIT REGULATIONS PER CURRENT ORDER R4-2013-0094

Table B.1 - Oxnard WWTP Permit Regulations		
Constituent	**Units**	**Average Monthly Limitation**
BOD	mg/L	30
TSS	mg/L	30
pH	Standard	6.0-9.0
Oil & Grease	mg/L	25
Setteable Solids	ml/L	1.0
Turbidity	NTU	75
Marine Aquatic life Toxicants(1)		
Arsenic	µg/L	2.0
Cadmium	µg/L	1.0
Chromium (VI)	µg/L	8.0
Copper	µg/L	30
Lead	µg/L	23
Mercury	µg/L	0.3
Nickel	µg/L	8.0
Selenium	µg/L	4.7
Silver	µg/L	1.9
Zinc	µg/L	36
Cyanide	µg/L	25
Chlorine Residual	mg/L	0.13
Ammonia as N	mg/L	32
Phenolic compounds (non-chlorinated)	µg/L	5.0
Phenolic compounds (chlorinated)	µg/L	0.42
Endosulfan	µg/L	0.05
HCH	µg/L	0.1
Endrin	µg/L	0.05
Chronic toxicity	TUc	99(2)
Radioactivity(2)		
Gross alpha	PCi/L	15
Gross beta	PCi/L	50
Combined Radium-226 & Radium-228	PCi/L	5.0

Table B.1 - Oxnard WWTP Permit Regulations		
Constituent	**Units**	**Average Monthly Limitation**
Tritium	PCi/L	20,000
Strontium-90	PCi/L	8.0
Uranium	PCi/L	20
Human Health Toxicants – Non Carcinogens(1)		
Acrolein	µg/L	10
Antimony	µg/L	2.5
Bis(2-chloroethoxy) methane	µg/L	25
Bis(2-chloroisopropyl) ether	µg/L	10
Chlorobenzene	µg/L	2.5
Chromium (III)	µg/L	8.0
Di-n-butyl-phthalate	µg/L	0.19
Dichlorobenzenes	µg/L	2.5
Diethyl phthalate	µg/L	10
Dimethyl phthalate	µg/L	10
2-Methyl-4,6-dinitrophenol	µg/L	25
2,4-Dinitophenol	µg/L	25
Ethyl benzene	µg/L	2.5
Fluoranthene	µg/L	
Hexachlorocyclopentadiene	µg/L	25
Nitrobenzene	µg/L	5
Thallium	µg/L	5
Toluene	µg/L	2.5
Tributylin	µg/L	0.0263
1,1,1-Trichloroethane	µg/L	2.5
Human Health Toxicants - Carcinogens		
Acrylonitrile	µg/L	10
Aldrin	µg/L	0.025
Benzene	µg/L	2.5
Benzidine	µg/L	0.0068
Beryllium	µg/L	2.5
Bis(2-chloroethyl) ether	µg/L	5.0
Bis(2-ethylhexyl)phthalate	µg/L	50
Carbon tetrachloride	µg/L	2.5
Chlordane	µg/L	0.5
Chlorodibromomethane	µg/L	0.61

Table B.1 - Oxnard WWTP Permit Regulations		
Constituent	**Units**	**Average Monthly Limitation**
Chloroform	µg/L	1.2
DDT	µg/L	0.25
1,4-Dichlorobenzene	µg/L	0.041
3,3'-Dichlorobenzidine	µg/L	25
1,2-Dichloroethane	µg/L	2.5
1,1-Dichloroethylene	µg/L	2.5
Bromodichloromethane	µg/L	2.5
Dichloromethane	µg/L	2.5
1,3-Dichloropropene	µg/L	2.5
Dieldrin	µg/L	0.05
2,4-Dinitrotoluene	µg/L	25
1,2-Diphenylhydrazine	µg/L	5
Halomethanes	µg/L	4.4
Heptachlor	µg/L	0.05
Heptachlor epoxide	µg/L	0.002
Hexachlorobenzene	µg/L	5
Hexachlorobutadiene	µg/L	5
Hexachloroethane	µg/L	5
Isophorone	µg/L	5
N-Nitrosodimethylamine	µg/L	5
N-Nitrosodi-N-propylamine	µg/L	25
N-Nitrosodiphenylamine	µg/L	5
PAHs	µg/L	0.097
PCBs	µg/L	0.0019
TCDD equivalents	µg/L	3.9×10^{-7}
1,1,2,2-Tetrachloroethane	µg/L	2.5
Tetrachloroethylene	µg/L	2.5
Toxaphene	µg/L	2.5
Trichloroethylene	µg/L	2.5
1,1,2-Trichloroethane	µg/L	2.5
2,4,6-Trichlorophenol	µg/L	0.35
Vinyl chloride	µg/L	2.5

Notes:
(1) Values reflect monthly performance goals.
(2) Maximum daily limitation.

APPENDIX B – PRELIMINARY HYDROGEOLOGICAL STUDY REPORT, CITY OF OXNARD GREAT PROGRAM, CAMPUS PARK GROUNDWATER REPLENISHMENT AND REUSE PROJECT

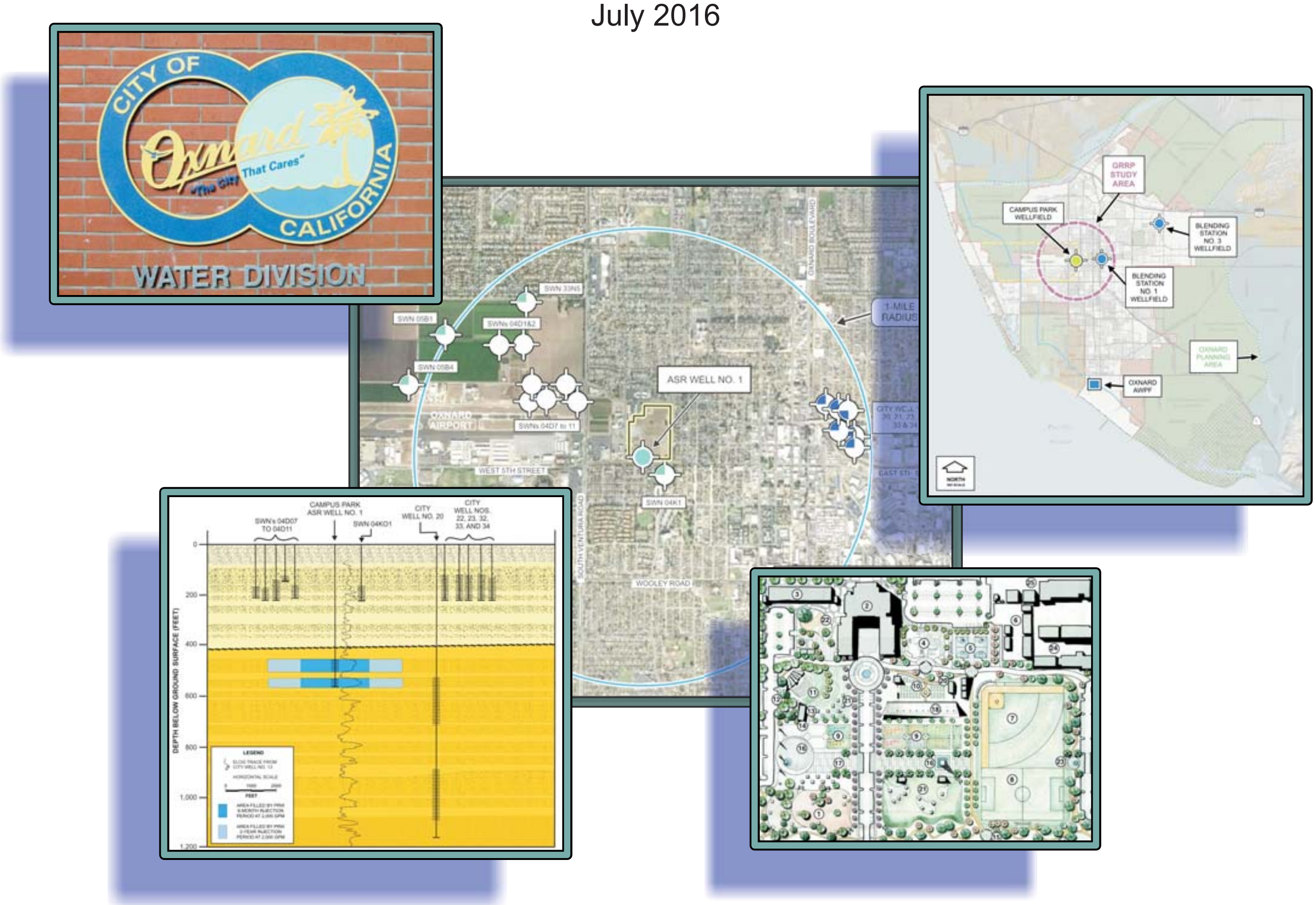
HOPKINS GROUNDWATER CONSULTANTS, INC.

PRELIMINARY HYDROGEOLOGICAL STUDY

CITY OF OXNARD GREAT PROGRAM
CAMPUS PARK GROUNDWATER REPLENISHMENT AND REUSE PROJECT
OXNARD, CALIFORNIA

Prepared for:
City of Oxnard

July 2016



HOPKINS
GROUNDWATER
CONSULTANTS, INC.
THE WATER RESOURCE SPECIALISTS

July 26, 2016
Project No. 01-011-09E

City of Oxnard
305 West Third Street, Second Floor, East Wing
Oxnard, California 93030

Attention: Mr. Daniel Rydberg
Public Works Director

Subject: Preliminary Hydrogeological Study, City of Oxnard Great Program, Campus Park Groundwater Replenishment Reuse Project, Oxnard, California.

Dear Mr. Rydberg:

Hopkins Groundwater Consultants, Inc. (Hopkins) is pleased to submit this final report summarizing the findings, conclusions, and recommendations developed from a preliminary study evaluating the feasibility of a Groundwater Replenishment Reuse Project (GRRP) that is proposed as part of the City of Oxnard Groundwater Recovery Enhancement and Treatment (GREAT) Program. The study findings indicate that the Campus Park GRRP site proposed for Indirect Potable Reuse is a feasible location and that the replenishment and recovery of groundwater with an improved quality could be achieved by the project for Indirect Potable Reuse. The study provides detailed hydrogeological findings in compliance with Groundwater Replenishment Using Recycled Water regulations designated DPH-14-003E, dated June 18, 2014, to augment the Indirect Potable Reuse engineering report required for the project, and to facilitate discussion with State regulatory agencies, local groundwater management agencies, and stakeholder groups that may have a direct interest in the project.

As always, Hopkins is pleased to be of service. If you have questions or need additional information, please give us a call.

Sincerely,

HOPKINS GROUNDWATER CONSULTANTS, INC.

REGISTERED GEOLOGIST
CURTIS J. HOPKINS
EG NO. 1800
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

Curtis J. Hopkins
Principal Hydrogeologist
Professional Geologist PG 5695
Certified Hydrogeologist HG 114
Certified Engineering Geologist EG 1800

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P.O. Box 3596, Ventura, California 93006 Phone: (805) 653-5306 e-mail: chop4@earthlink.net

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ACRONYM LIST

AFY – Acre-Feet Per Year

ASR – Aquifer Storage and Recovery

AWPF – Advanced Water Purification Facility

BGS – Below Ground Surface

BS-1 – Blending Station No. 1

BS-3 – Blending Station No. 3

CDPH – California Department of Public Health

CRWQCB – California Regional Water Quality Control Board

DDW – California Department of Drinking Water

FCGMA – Fox Canyon Groundwater Management Agency

GPM – Gallons Per Minute

GREAT – Groundwater Recovery Enhancement and Treatment

GRRP – Groundwater Replenishment Reuse Project

GRURW – Groundwater Replenishment Using Recycled Water

IPR – Indirect Potable Reuse

LAS – Lower Aquifer System

MSL – Mean Sea Level

MG/L – Milligrams Per Liter

PRW – Purified Recycled Water

PSI – Pounds Per Square Inch

TDS – Total Dissolved Solids

UAS – Upper Aquifer System

UWCD – United Water Conservation District

VCWPD – Ventura County Watershed Protection District

CITY OF OXNARD GREAT PROGRAM CAMPUS PARK GROUNDWATER REPLENISHMENT AND REUSE PROJECT

INTRODUCTION

GENERAL STATEMENT

Presented in this report are the findings, conclusions, and recommendations developed from a preliminary hydrogeological study conducted by Hopkins Groundwater Consultants, Inc. (Hopkins) to assist the City of Oxnard (City) in evaluating the feasibility of a Groundwater Replenishment Reuse Project (GRRP) using purified recycled water (PRW). This hydrogeological study was conducted to support the City's Groundwater Recovery Enhancement and Treatment (GREAT) Program by developing an aquifer storage and recovery (ASR) project that will provide Indirect Potable Reuse (IPR) of the PRW produced at the City's Advanced Water Purification Facility (AWPF).

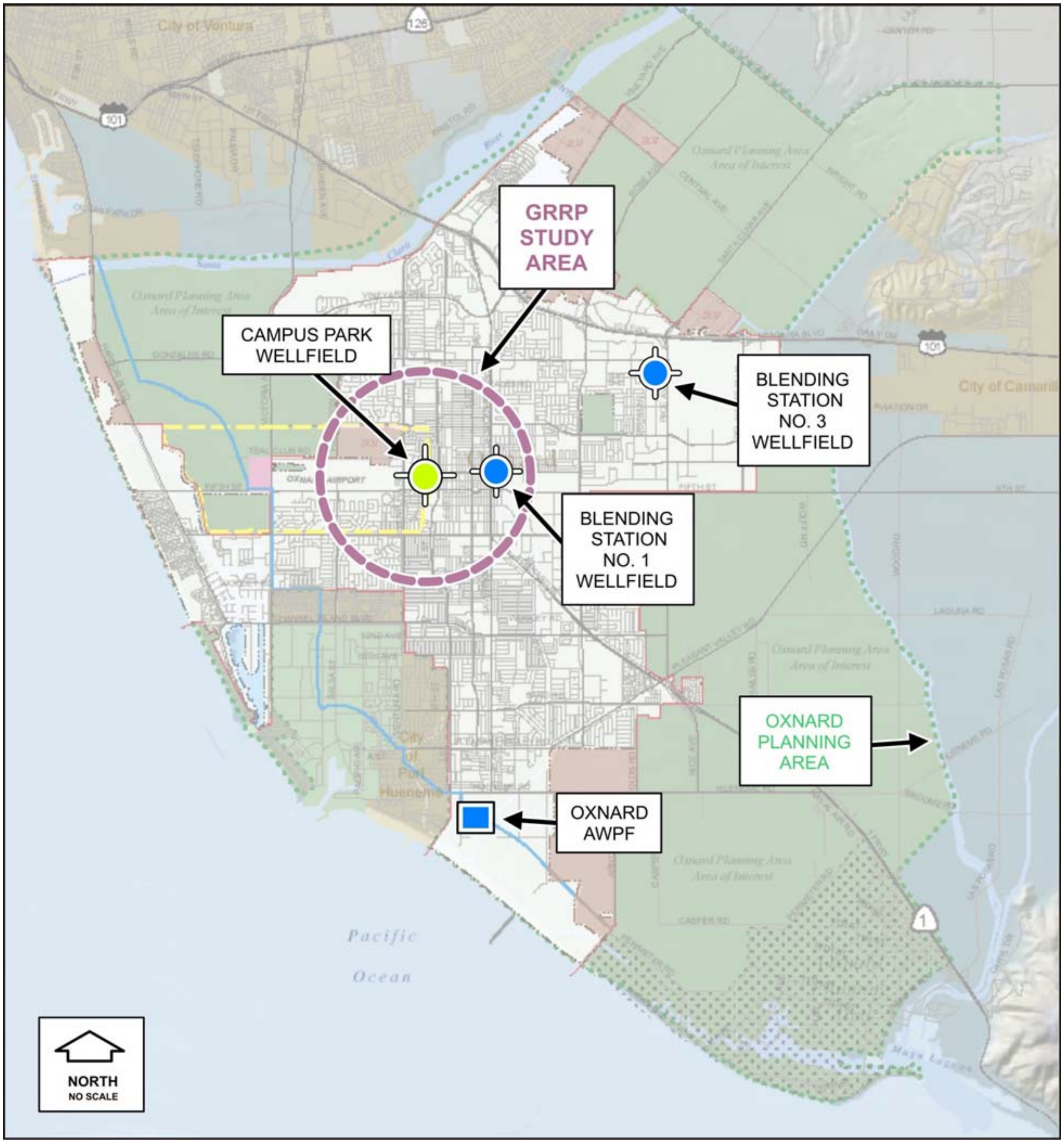
The proposed City GRRP includes developing a sustainable program for groundwater replenishment and IPR of PRW using aquifer units located in the Oxnard Plain Groundwater Basin. The proposed GRRP is intended to augment the City's potable water system by; 1) improving the delivered water quality, 2) increasing the available supply, and 3) providing greater reliability through source redundancy. The GRRP study area is indicated on Figure 1 – Study Area Location Map.

BACKGROUND

The present City water supply is a combination of sources including; a) imported water from the State Water Project, b) groundwater produced by the United Water Conservation District (UWCD), and c) groundwater produced by the City wellfields at Blending Station Nos. 1 and 3 (BS-1 and BS-3). Historically, the City has improved the quality of its municipal supply by blending the higher quality imported water with its local groundwater supplies. The recent construction of the brackish groundwater desalter facilities located at BS-1 has provided the City with the means to further improve its water quality through the desalination of poor quality groundwater. During the desalination process, approximately 20 percent of the produced groundwater feeding the desalter is lost as brine reject that is discharged to the sewer ocean outfall.

The present operation of the City's groundwater desalter has allowed the City to shift groundwater production from the higher quality aquifer zones in the Lower Aquifer System (LAS) to the poorer quality aquifer zones in the Upper Aquifer System (UAS). This shift of pumping was designed to comply with the most recent groundwater management strategies of the Fox Canyon Groundwater Management Agency (FCGMA).

Figure 1 – Study Area Location Map



The GREAT Program was originally developed at a time when recycled water regulations treated all recycled water in the same manner. State regulations required onerous project development studies, monitoring and reporting programs, and dilution requirements utilizing another potable supply. Soil and aquifer treatment criteria could require extended retention times and travel distances through an aquifer to provide additional treatment prior to beneficial potable reuse. With these regulations, the City believed the best approach was to inject the PRW into the local aquifer system at a location that optimized basin management strategies, and extract a like amount of native groundwater from another area of the basin for municipal use. Consistent with this approach, the City proposed the direct use of the PRW for permissible agricultural purposes. Subsequently, a transfer of the unused groundwater would be provided to the City for municipal uses. Both of these strategies would provide the City with a source of potable groundwater in exchange for its recycled water.

This original approach required that the City purify a greater portion of the groundwater with a desalter and resulted in additional treatment costs and a loss of approximately 20 percent of the produced groundwater supply. The present approach for IPR would eliminate the additional step of desalting groundwater by allowing the indirect reuse of the high quality PRW. This will conserve energy and prevent wasting 20 percent of the supply as part of the redundant treatment process. The stored and recovered PRW by the GRRP can be blended with lower quality groundwater to achieve the City's water quality objectives.

Since construction of the GREAT Program AWPF, Federal and State recycled water regulations have been updated to the present Groundwater Replenishment Using Recycled Water (GRURW) regulations designated DPH-14-003E, dated June 18, 2014. These regulations accommodate the use of highly treated effluent produced by the PRW process by reducing or eliminating the requirement for soil/aquifer treatment. The State has recognized that the threat to public health is significantly lower after municipal wastewater receives advanced purification and disinfection using reverse osmosis, advanced oxidation, and ultraviolet radiation treatment processes. Because of the PRW extreme high quality, the new GRURW regulations significantly reduce the requirements for IPR compared to wastewater treated to secondary or tertiary standards.

PURPOSE

The purpose of this hydrogeological assessment of the proposed GRRP is to provide specific information to comply with the GRURW regulations pursuant to section 60320.200(h) and permit the preliminary investigation to develop site specific information that is required for the GRRP Title 22 engineering report. The findings of this study are also intended to further define the conceptual components of the ASR program that will be necessary to implement the IPR of PRW as a municipal supply in accordance with regulation provisions.

As part of the GRRP, the City proposes a project that:

1) utilizes (to the extent practicable) existing pipelines and facilities to control potential costs,

2) recharges aquifer zones that preserve the water quality during underground storage,

3) minimizes the risk to other potable well facilities,

4) is consistent with the FCGMA and UWCD groundwater management strategies,

5) has operational flexibility to adapt to changing system demands and aquifer conditions,

6) demonstrates the ASR capacity of the Oxnard Plain LAS,

7) can be increased to facilitate future AWPF expansion, and

8) can simplify monitoring and reporting to UWCD, the FCGMA, the California State Water Resources Control Board Division of Drinking Water (DDW), and the California Regional Water Quality Control Board (CRWQCB).

This hydrogeological study utilizes the City GREAT Program Update, dated June 25, 2012, as the guide for the anticipated capacity of the AWPF and the initial availability of PRW. This study is intended to provide the mandatory hydrogeological assessment to accompany the engineering report required pursuant to section 60323 of the Title 22, California Code of Regulations, GRURW regulations for a new GRRP.

Additionally, this hydrogeological assessment is intended to provide operational criteria based on aquifer parameters estimated from historical well data, which will define the range of ASR capacity that can be reasonably anticipated from the underlying aquifer system. Subsequently, a conceptual GRRP operational schedule can be developed for the ASR operations to comply with the response retention time requirements of the GRURW regulations for IPR that is based on reasonable expectations of the natural aquifer system constraints.

Sources of available data and published information that were used for the study include; a) City data and reports, b) UWCD data and reports, c) United States Geological Survey, and d) Ventura County Watershed Protection District (VCWPD) databases.

HYDROGEOLOGICAL CONDITIONS

The City recognizes that the threat of seawater intrusion is a regional issue. The City has historically complied with FCGMA regulations and participated in UWCD groundwater supply management programs. Implementation of the GREAT Program is intended to continue this cooperative management effort and the beneficial use of the local groundwater resources in the vicinity of the City. The proposed GRRP using PRW includes ASR wells constructed in aquifer zones that comprise the LAS. Recharge into the LAS will store water in aquifer zones that receive significantly less groundwater recharge than the UAS because of the regional confined aquifer conditions. The UAS readily receives groundwater recharge derived from natural percolation of rainwater and Santa Clara River flows in the Oxnard Forebay Basin, as well as from river flow diversions into the engineered recharge facilities operated by UWCD.

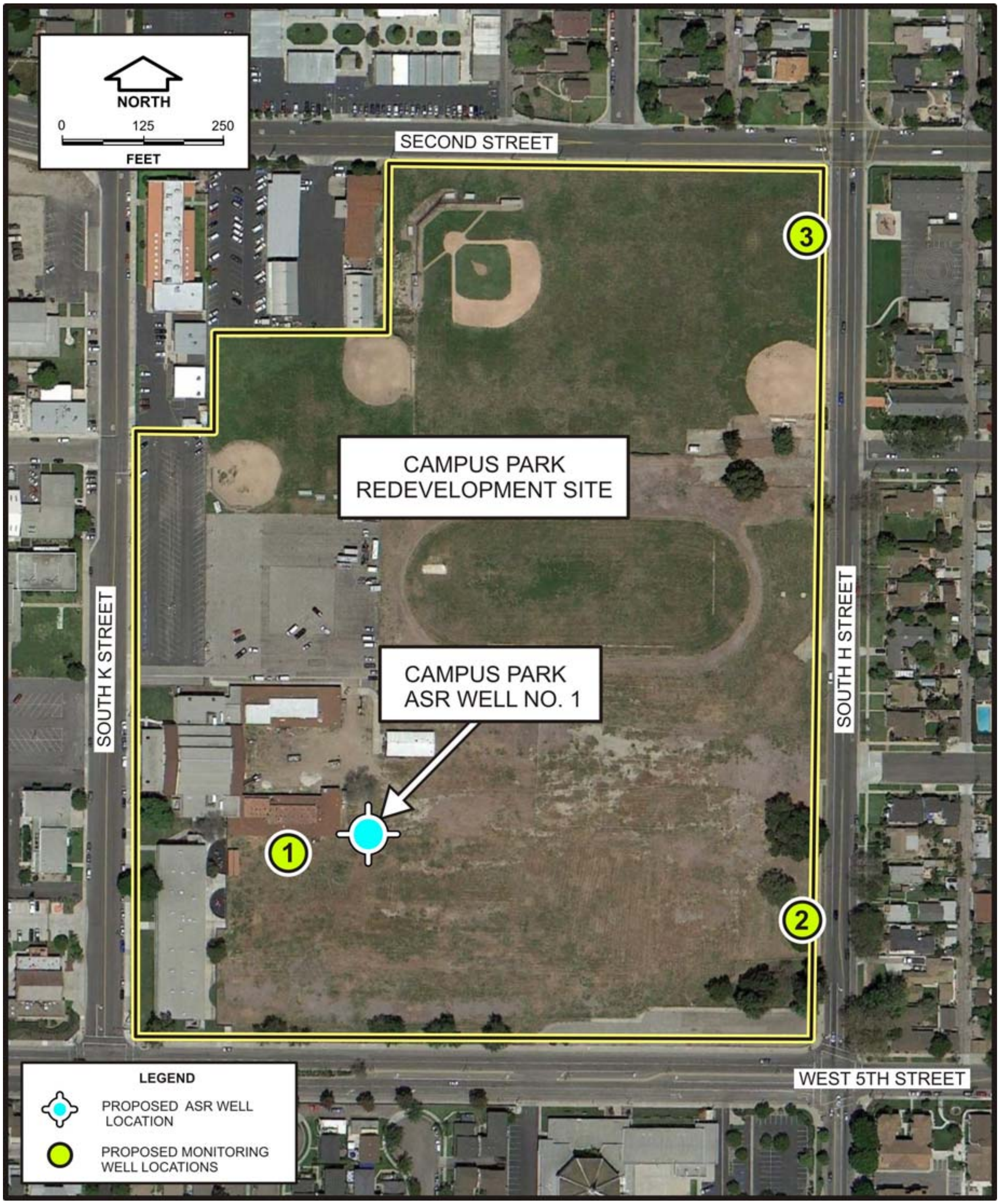
The GRRP ASR Well will be designed to inject PRW into discrete aquifer zones in the LAS and subsequently facilitate groundwater extraction after the response retention time is achieved and regulatory approval is granted. The proposed ASR Well No. 1 is anticipated to be constructed with a completion depth of about 580 feet below ground surface (bgs) and with a screened interval limited to a discrete aquifer zone(s) in the LAS. The well will be designed for an injection capacity of up to 2,000 gallons per minute (gpm). Plate 1 – Preliminary ASR Well No. 1 Design Drawing provides preliminary design details that reflect the anticipated hydrogeology and comply with the VCWPD sealing zone requirements.

Water to be injected during initial testing is proposed to be 100 percent PRW. Initially, the water may be conveyed to the ASR well from the City recycled water system using temporary piping. The initial phase of aquifer testing will determine the percentage of recovery that occurs prior to evidence of native groundwater mixing with the PRW along with any change in the PRW chemistry that could occur as it travels through the aquifer matrix. During the test period, PRW that is extracted from the ASR well will be discharged back into the recycled water transmission main and subsequently used for irrigation.

The ASR demonstration program, as developed, will comply with GRURW regulations and last for an anticipated period of between 2 and 4 months. During the initial demonstration period, monitoring well data and water quality samples will be collected and analyzed to verify the preliminary estimations of aquifer parameters, groundwater storage volumes, and groundwater travel times effectuated by PRW recharge. These data will be utilized to finalize the permit application required for full-scale project operation using the PRW generated by the AWPF.

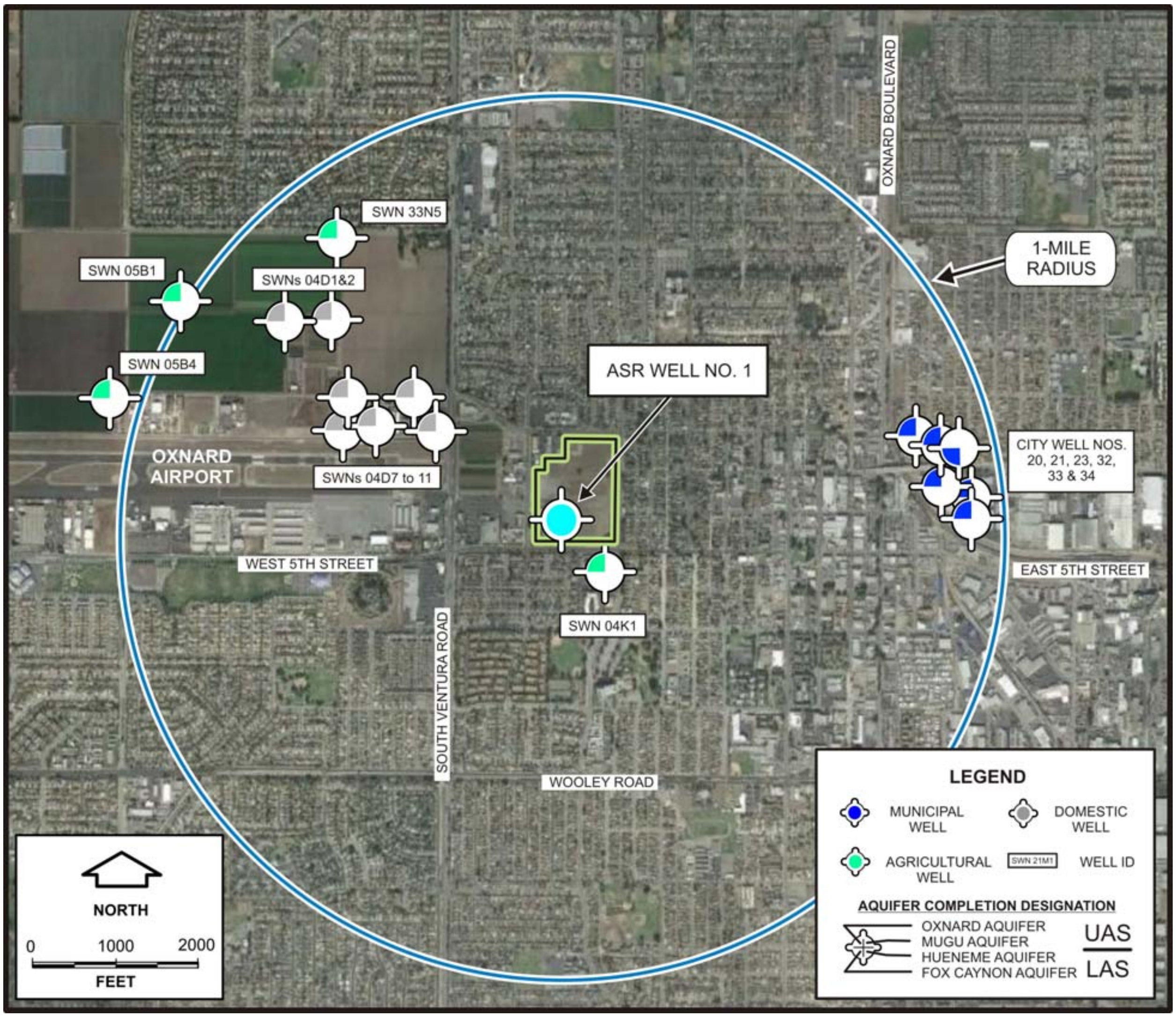
The proposed GRRP would ultimately be sized to accommodate the first phase of the AWPF, providing the ability to store and reuse up to 1,500 acre-feet per year (AFY). The GRRP location identified for groundwater recharge wells is indicated in Figure 2 – Proposed GRRP ASR Well Site Location Map. This location serves to isolate City groundwater facilities within the City boundaries where it has control of surrounding land uses and future groundwater development.

Figure 2 – Proposed GRRP ASR Well Site Location Map



The property selected for installation and operation of the GRRP ASR Well is owned by the City and had an existing City well proximately located and constructed in the LAS (City Well No. 13). While the old City well has since been destroyed, several smaller wells are presently active in the unincorporated area north of the Oxnard Airport along the western City limit. Figure 3 – Existing Well Location Map shows all the active wells within a 1-mile-radius of the GRRP ASR well location.

Figure 3 – Existing Well Location Map



As shown, many proximate wells are constructed in the UAS and as such will not be hydraulically connected with the LAS aquifer zones proposed for use by the GRRP. Review of available data indicates that the nearest well constructed in the LAS is almost 1 mile away and is a municipal supply well owned by the City. The closest existing LAS well is City Well No. 20 located at BS-1. As such, the City ASR well location appears to provide more than a sufficient distance from existing LAS wells to allow GRRP operations without interference.

HYDROGEOLOGY AND AQUIFER DELINEATION

Geology

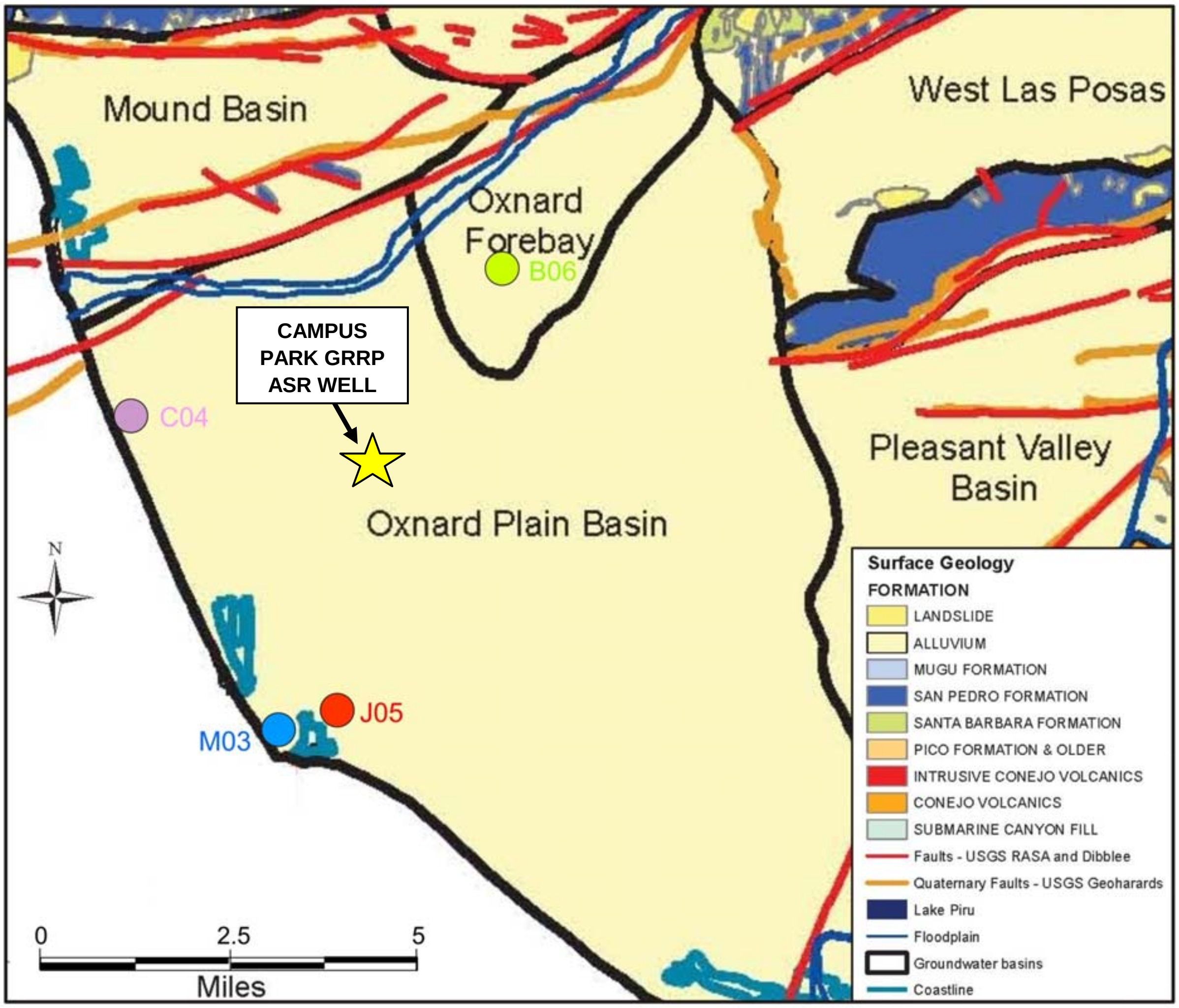
The proposed City project is located in the Oxnard Plain Groundwater Basin, which is part of the Transverse Ranges geologic/geomorphic province and defined by a number of geologic structures and features that separate it from the adjacent groundwater basins. The geology of the Oxnard Plain Basin has been described in detail by several authors including the California State Water Resources Board (SWRB, 1953), Turner (1975), and UWCD (2012). Figure 4 – Generalized Geologic Map and Oxnard Plain Basin Boundaries shows the project location in relation to the adjacent boundaries of the Oxnard Plain Basin with the Mound, Oxnard Forebay, West Las Posas, and Pleasant Valley Basins.

Plate 2 – Hydrogeological Cross-Section Location Map shows the location of cross-sections constructed from available well data to illustrate the subsurface profiles of the geological formations that comprise the underlying aquifer systems. Plate 2 also shows the location of wells that provided geophysical data near the Campus Park GRRP site. Plates 3 and 4 – Hydrogeological Cross-Section A-A' and B-B', respectively, provide an interpretation of the hydrostratigraphy in the study area. This conceptual understanding of the confined Oxnard Plain Basin aquifer system is key to the understanding of how the GRRP potential impacts are limited by natural conditions. It also illustrates how the GRRP was developed to utilize discrete aquifer zones that will allow rotation of the three phases of project operations; 1) injection/recharge of the PRW produced from the AWPF, 2) storage/response retention time, and 3) recovery and reuse/IPR.

Aquifer Zone Designation

The subsurface geology that controls groundwater flow in the study area is differentiated into two primary geologic units that include; the Holocene and late Pleistocene alluvium, and the San Pedro Formation. The first unit is comprised largely of unconsolidated sedimentary deposits and includes all older and Recent alluvial deposits. These shallower units are coarse-grained sand and gravel layers that form the Oxnard and Mugu Aquifers and comprise the UAS in the Oxnard Plain Basin (see Plates 3 and 4). The San Pedro Formation consists of consolidated marine and nonmarine clay, silt, sand, and gravel deposits that comprise the Hueneme and Fox Canyon Aquifers that are designated as the LAS. The low permeability geologic formations underlying the San Pedro Formation are generally considered to be non-water-bearing and effectively define the base of fresh water.

Figure 4 – Generalized Geologic Map and Oxnard Plain Basin Boundaries

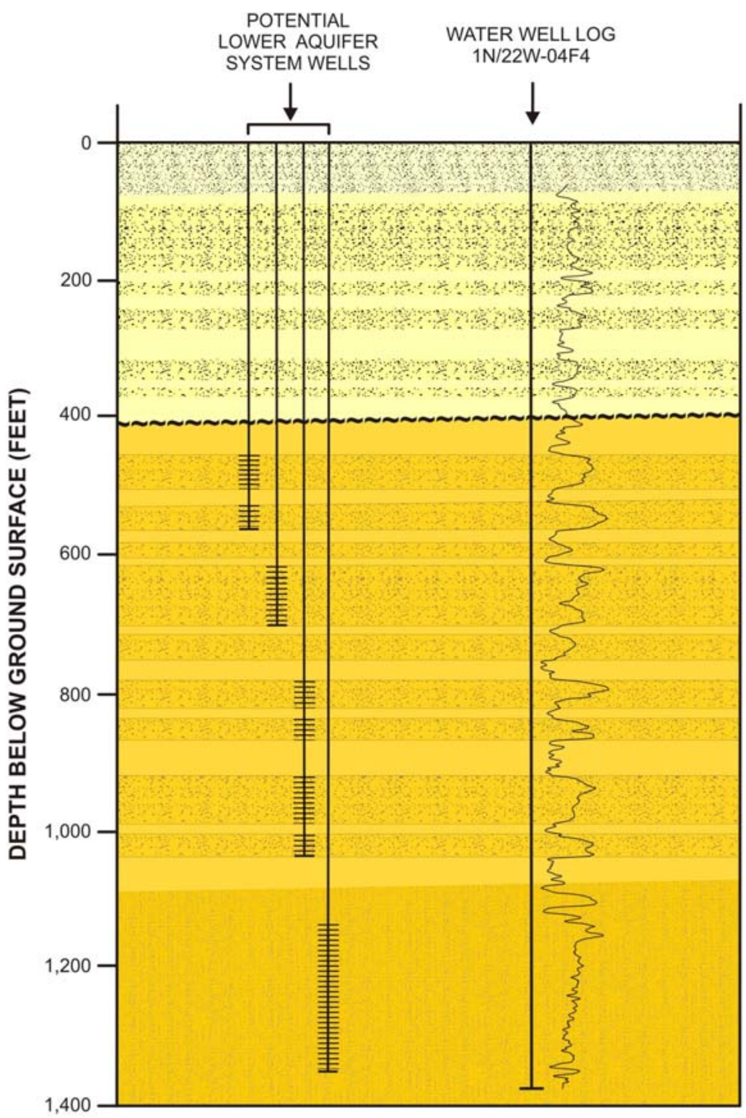


FROM UWCD, 2012

The groundwater in the Oxnard Plain Basin LAS is isolated from overlying land uses by the laterally extensive aquitard (silt and clay) layers that separate and confine the Hueneme and Fox Canyon Aquifer zones. The conceptual subsurface profile shown in Figure 5 – Discrete Aquifer Zone Delineation uses the geophysical survey (electric log) from the proximate City Well No. 13 to show the anticipated geology and aquifer zones beneath the Campus Park GRRP site. The aquifer zones shown in Figure 5 are discretely separated by clay layers that are laterally continuous and appear as marker beds in other well logs shown in Plates 3 and 4. The significance of the highly confined condition that results from the discretely layered aquifer system is that wells located in close proximity (50 feet apart) but producing from different aquifer layers, do not have hydraulic connectivity with each other.

Figure 5 shows a series of proposed wells that could be designed to utilize the storage capacity of discrete aquifer units while being effectively isolated from each other by the natural confining clay layers. This concept can allow the design and use of discrete aquifer zones as individual storage units, as demonstrated by Well Nos. 28, 29, 30, and 31 located at City BS-3. One aquifer zone can be filled without affecting wells that are competently constructed in other aquifer zones. The benefit of this natural condition to the GRRP is that multiple wells can be operated on the same site with a rotating schedule which allows discrete recharge, storage (response retention time), and recovery from separate aquifer zones.

Figure 5 – Discrete Aquifer Zone Delineation

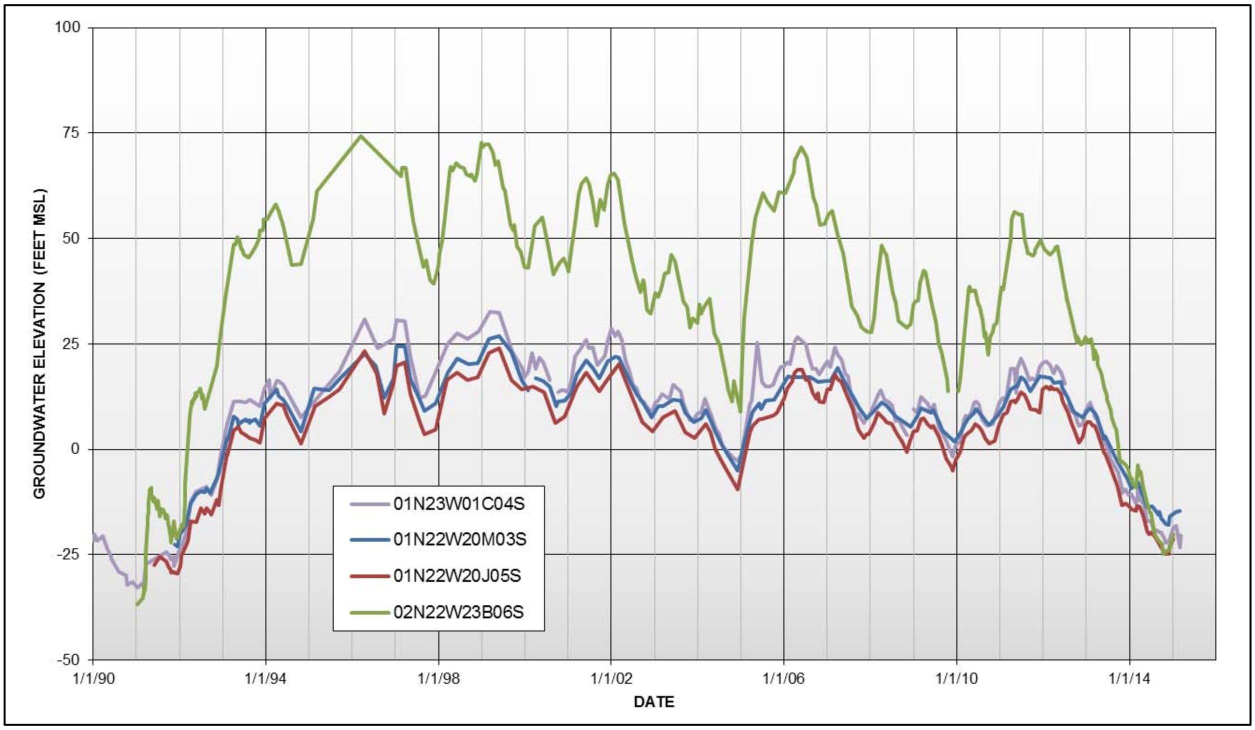


The proposed GRRP utilizes this natural confined aquifer condition to develop an operational scenario that is unique in its application. It can satisfy the GRURW regulations that require a minimum 2-month retention response time, while optimizing the proposed ASR well facilities at a single site. It can operate independent of groundwater flow direction and serve to minimizing the potential risk and consequence of PRW treatment violations (to be explained in following sections).

Groundwater Levels

Groundwater elevations in the Oxnard Plain Basin vary over time. Figure 6 – Groundwater Elevation Hydrograph shows the fluctuation of water levels in the upper Hueneme Aquifer zones in LAS. These data are from discretely screened monitoring wells in aquifer zones that correlate to the aquifer zones proposed for use by ASR Well No. 1. The location of the wells is shown on Figure 4 using the same color for the well symbols as is used for the water levels in the Figure 6 graph. Three of the wells are coastal monitoring wells, and one is located in the Oxnard Forebay where the upper Hueneme Aquifer zones lie unconformably beneath the overlying alluvium of the UAS. The Oxnard Forebay Basin is the primary source of recharge to the LAS.

Figure 6 – Groundwater Elevation Hydrograph



The groundwater elevation in the LAS proximate to the GRRP study area has dropped to approximately 25 feet below mean sea level (msl) during the 1986 to 1990 drought and has risen as high as 20 to 25 feet above msl in wet years. These available data indicate that seasonal fluctuations in the Oxnard Plain Basin groundwater levels are typically around 5 to 10 feet. Dry climatic conditions result in consecutive annual declines in the coastal water levels of up to 45 feet (see Figure 6). These same dry climatic conditions result in water level declines in the Oxnard Forebay Basin on the order of 100 feet. These groundwater level conditions indicate that ASR well operation may require the ability to operate/inject under pressure during high water level conditions while gravity-flow injection operations may be sustained during dry climatic periods.

Combining these water level conditions with the depth to the top of the proposed aquifer units, an injection pressure of 20 pounds per square inch (psi) should be allowable without adverse consequences. The deeper the aquifer zone(s), the greater the operational pressure that is allowable for recharge without creating the potential for adverse effects.

Groundwater Gradient and Flow Velocity

Utilizing data provided by the UWCD, the groundwater elevations in the vicinity of the GRRP were contoured quarterly for 2011 and 2013. These years are believed representative of normal to wet groundwater conditions (2011) and dry year groundwater conditions (2013). Water level data from August 2014 were also contoured and represent groundwater flow conditions after multiple dry years. A series of quarterly groundwater elevation contour maps for the years selected are provided in Appendix A – Groundwater Elevation Contour Maps. Table 1 – Groundwater Gradient and Flow Direction summarizes the results of groundwater gradient estimations using the maps in Appendix A.

For the purpose of the Campus Park GRRP study, the use of the groundwater gradients provided by these data are believed sufficient for understanding the seasonal and climatic changes that occur to the groundwater gradient and the approximate prevailing flow directions in the upper Hueneme Aquifer zones of the LAS.

Table 1 – Groundwater Gradient and Flow Direction

OBSERVATION PERIOD	ASR WELL NO. 1	
	FLOW DIRECTION	GRADIENT
JANUARY 2011	S 43º W	0.0008
APRIL 2011	S 41º W	0.0011
JULY 2011	S 44º W	0.0011
OCTOBER 2011	S 43º W	0.0009
JANUARY 2013	S 44º W	0.0004
APRIL 2013	S 47º W	0.0004
JULY 2013	S 67º W	0.0003
OCTOBER 2013	N 74º W	0.0002
AUGUST 2014	N 04º E	0.0002

TABLE DATA DISPLAYED GRAPHICALLY ON PLATES IN APPENDIX A

As shown, during normal and wet years, recharge in the Oxnard Forebay Basin is significant and establishes a predominant southwesterly groundwater flow direction in the Oxnard Plain Basin (see Appendix A). During the Spring of 2011, the upper Hueneme Aquifer groundwater gradient was generally 0.0011 (dimensionless) and the flow direction was S 41º W as shown on Figure 7 - LAS Groundwater Elevation Contour Map April 2011. The fall gradient in October 2011 was observed to flatten out to a value of 0.0009 (see Table 1).

During dry years like 2013, the groundwater flow direction was observed to be roughly the same as 2011 but the gradient continued to flatten out and the groundwater elevations were closer to sea level. This prevailing flow pattern continues until inland pumping causes water levels to fall below sea level. The lack of recharge during repeated dry years can result in inland groundwater elevations that are substantially below sea level. Figure 8 – LAS Groundwater Elevation Contour Map August 2014 shows the groundwater elevations and flow direction that developed under a 3-year-drought condition.

**Figure 7 – LAS Groundwater Elevation
Contour Map April 2011**

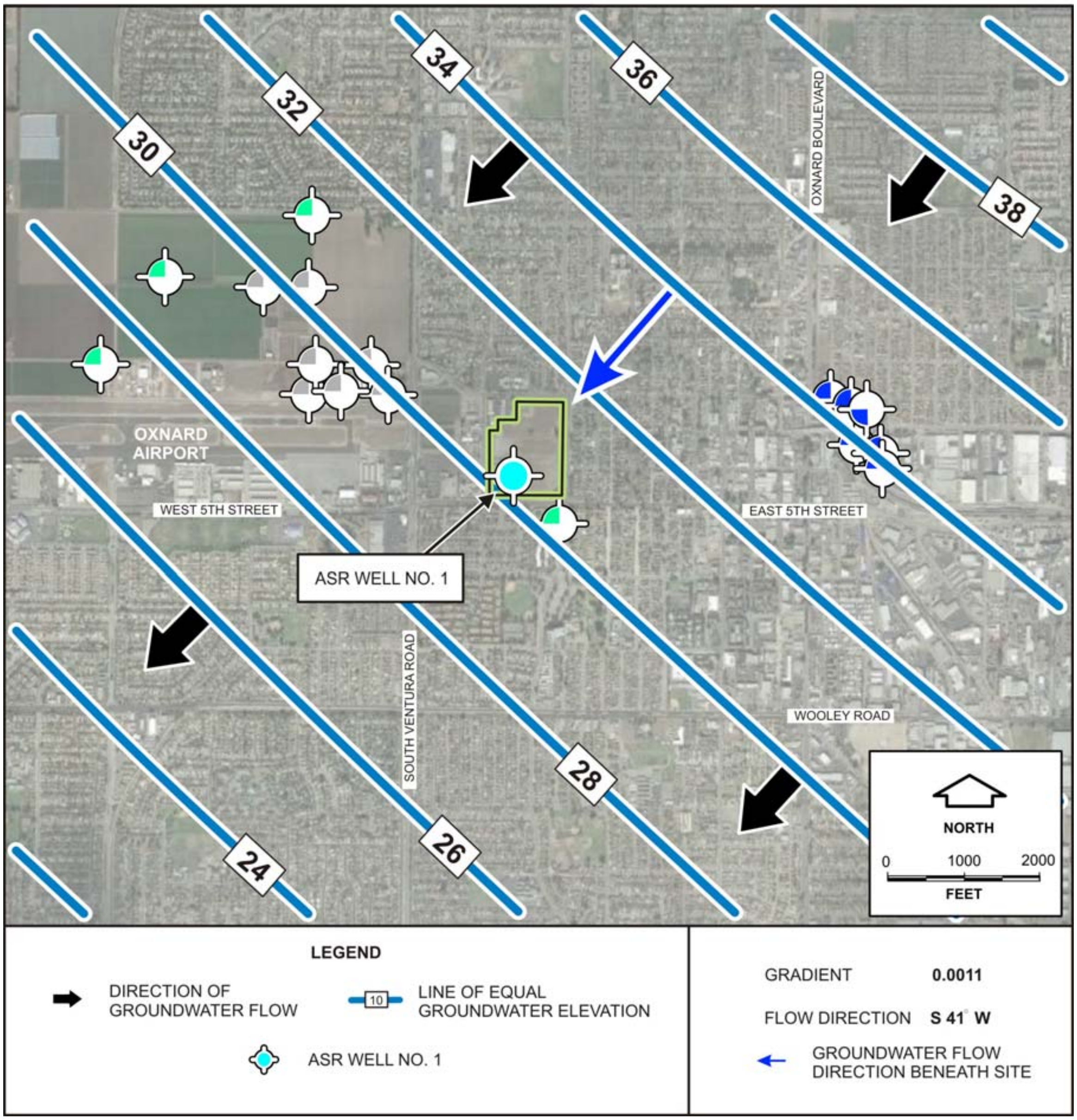
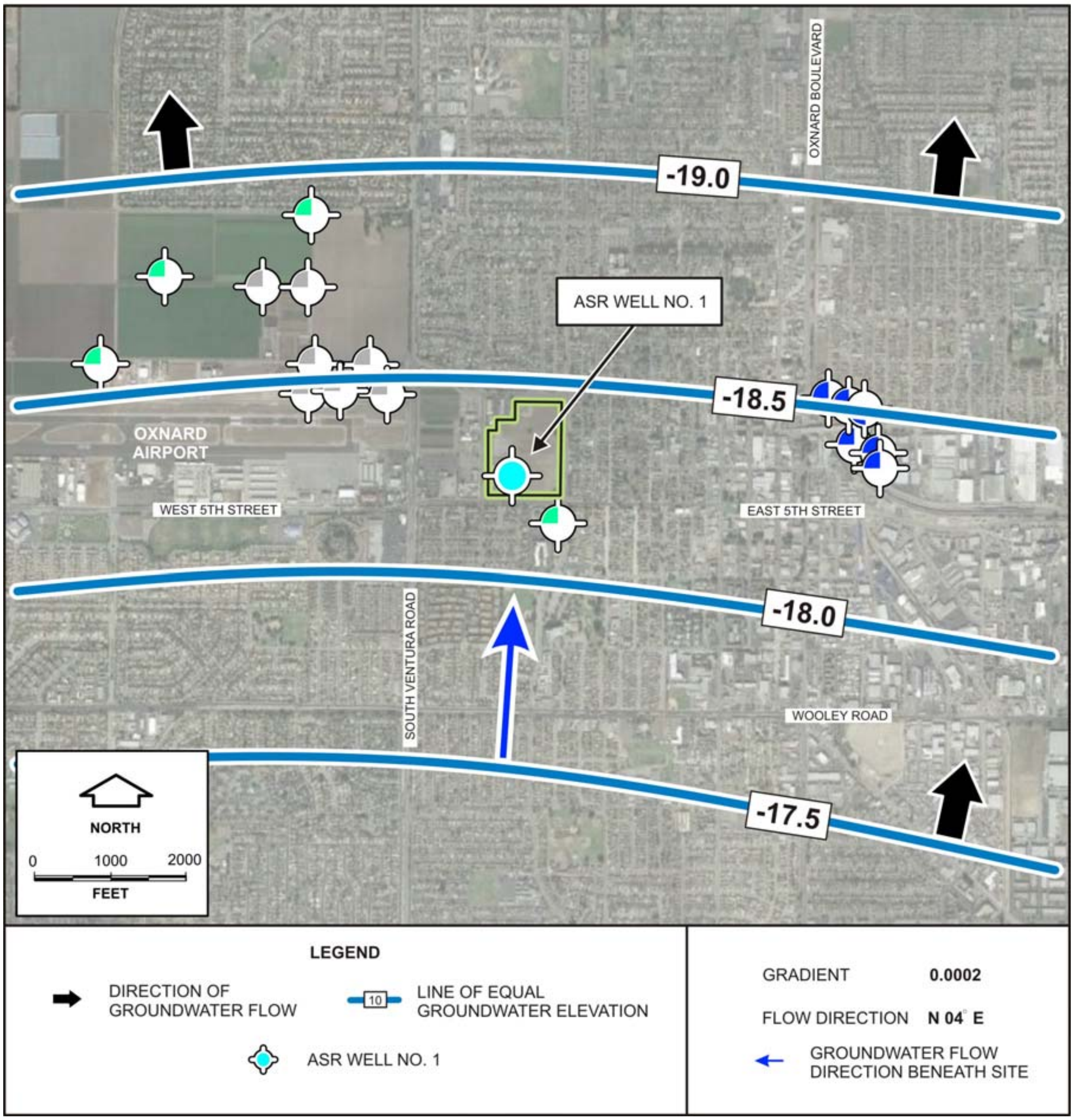


Figure 8 – LAS Groundwater Elevation Contour Map August 2014



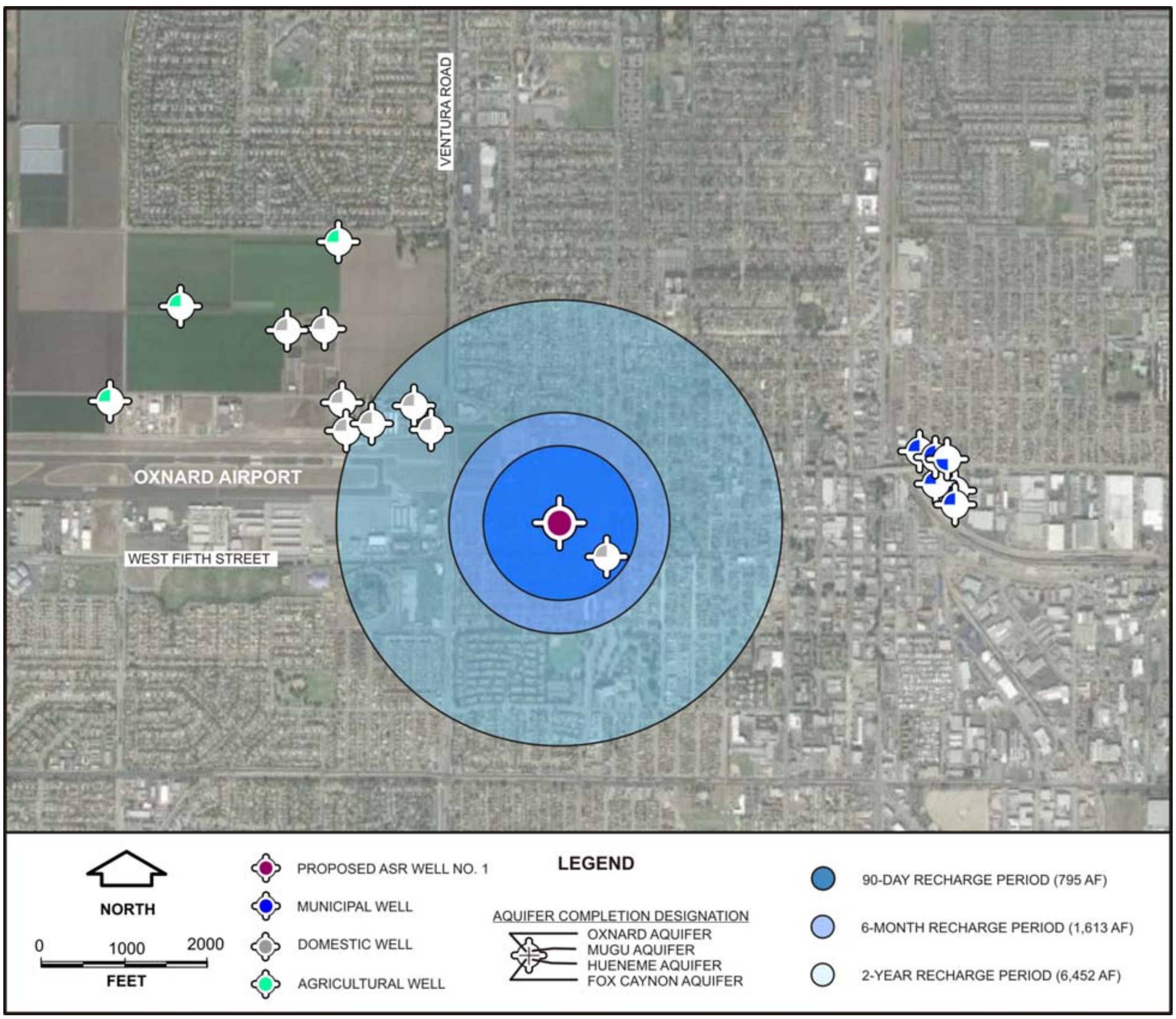
Aquifer Recharge and Retention

The area potentially influenced by recycled water recharge in the vicinity of the ASR well is determined by the aquifer area filled with the PRW during injection and the rate and direction of groundwater flow while it is in storage. The aquifer area filled by PRW replenishment was estimated by using;

- a discrete aquifer thickness of 85 feet,
- radial flow in the aquifer away from the center of recharge, and
- an average aquifer porosity of 15 percent (to be conservative).

The resulting aquifer area filled after injection of PRW at a rate of 2,000 gpm for a period of; 90 days (795 AF), 6 months (1,613 AF) and a period of 2 years (6,452 AF) is shown in Figure 9 – Aquifer Area Filled With Purified Recycled Water.

Figure 9 – Aquifer Area Filled With Purified Recycled Water



The aquifer area filled by these injection volumes would be proportionally less than those shown in Figure 9 as the porosity of the aquifer increases. Table 2 – Radial Distance Calculations shows the magnitude of change in the size of the recharge bubble within a range of typical aquifer porosity values.

Table 2 – Radial Distance Calculations

POROSITY	30-DAY RADIAL DISTANCE (FEET)	60-DAY RADIAL DISTANCE (FEET)	90-DAY RADIAL DISTANCE (FEET)	6-MONTH RADIAL DISTANCE (FEET)	2-YEAR RADIAL DISTANCE (FEET)
15 %	537	759	930	1,324	2,649
20%	465	658	806	1,147	2,294
25%	416	588	720	1,026	2,052
30%	380	537	658	937	1,873

AQUIFER THICKNESS IS 85 FEET AND THE INJECTION RATE IS 2,000 GPM

While the proposed City ASR operation will recharge the aquifer for a period of up to 3-months, a 6-month and 2-year-period of recharge were provided for comparison of potential project impacts. The estimated aquifer area filled with PRW in Figure 9 is believed conservative because a larger porosity value is highly likely. As shown, the nearest drinking water supply well (municipal well) constructed in the LAS is the City's and is beyond the 2-year aquifer replenishment area.

To approximate the area potentially influenced by PRW as it flows away from the point of recharge under the local groundwater gradient, the linear groundwater flow velocity was estimated by using;

- an average hydraulic conductivity value estimated from City Well No. 13 production test data (125 feet/day),
- the groundwater gradient at representative points in time (see Table 1),
- an average aquifer porosity of 15 percent (to be conservative), and
- the average linear flow velocity equation:

$$V = K\,I/\eta$$

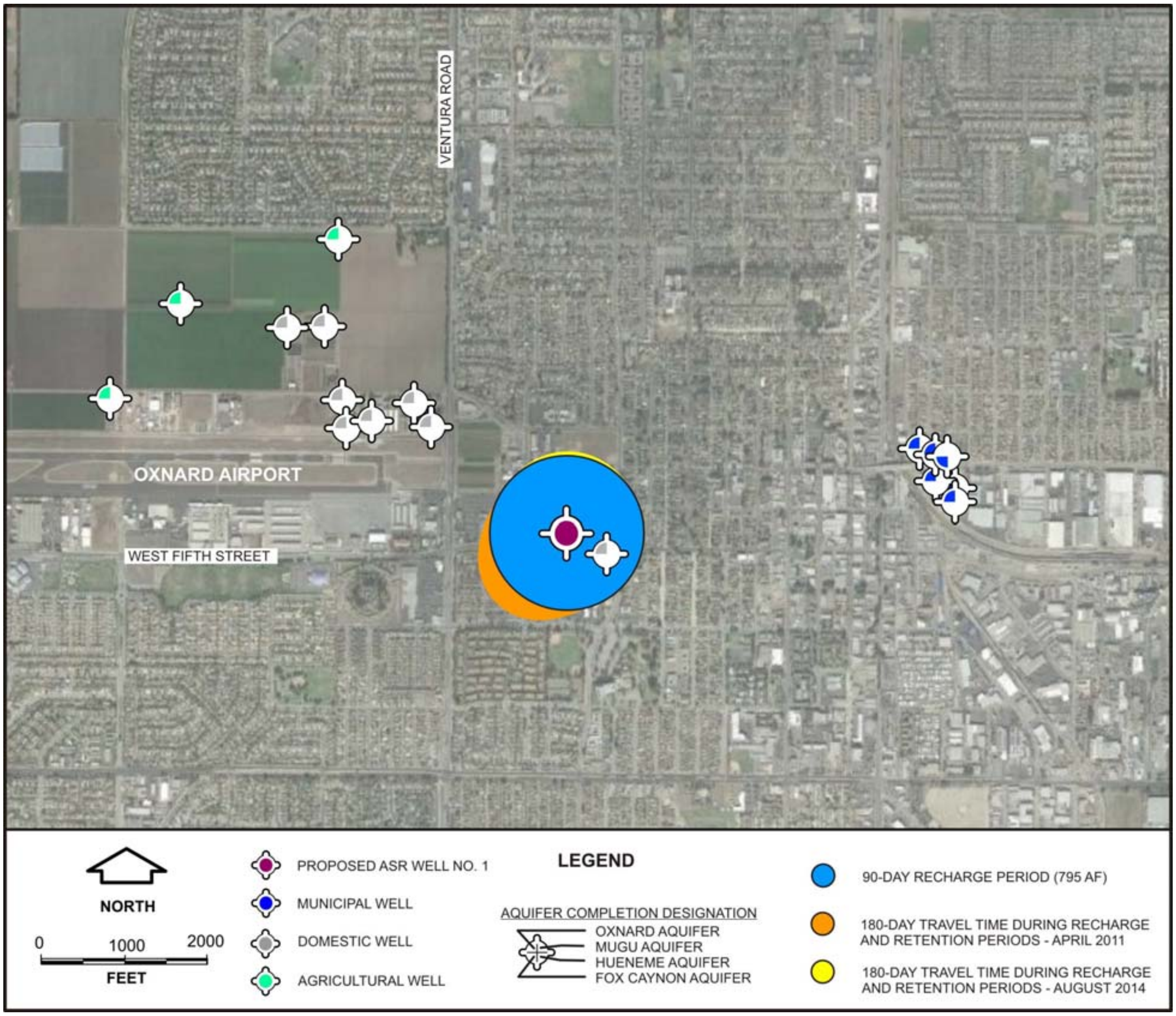
V	=	GROUNDWATER FLOW VELOCITY
K	=	AQUIFER HYDRAULIC CONDUCTIVITY
I	=	GROUNDWATER GRADIENT
η	=	AQUIFER POROSITY

The hydraulic conductivity of the upper Hueneme Aquifer zones was estimated from well production test data provided from City Well No. 13 combined with our experience and knowledge of wells in the Oxnard Plain Basin. The hydraulic conductivity of the aquifer zones that are proposed for ASR Well No. 1 was estimated to be 125 feet per day (ft/d). Using this hydraulic conductivity value and the range of groundwater gradients that are shown in Table 1, results in groundwater flow velocity estimates that range between 0.17 ft/d and 0.92 ft/d. Applying these two linear groundwater flow velocities over a 6-month period that includes the 3-month recharge period and the 3-month retention time, results in groundwater movement of a total distance between 30 feet and 165 feet.

The relative movement of the PRW from the ASR well during these 2 extreme conditions (April 2011 and August 2014) is shown in Figure 10 – Range of Purified Recycled Water Movement From ASR Well Location. These extremes are believed to bracket the actual anticipated movement of the recharge bubble in these aquifer zones. Because the quarterly groundwater measurements indicate a gradient of less than approximately 0.0011 exists a majority of the time (see Table 1), the transient groundwater gradient and flow direction will likely result in a cumulative movement that is between the two extremes indicated in Figure 10.

The result of this analysis indicates that the volume of water proposed for cyclical storage in the upper Hueneme Aquifer zone(s) of the LAS at the Campus Park GRRP well site will not have an adverse effect on any existing wells. Because of the assumptions stated above, these estimates are believed to be conservative and the area filled by PRW would likely be smaller. Based on the proposed cyclical recovery of the PRW for IPR, the distance of movement from the ASR well location could be significantly shorter. These factors indicate that the potential area of impact from the proposed GRRP presents little risk to existing well facilities.

Figure 10 – Range of Purified Recycled Water Movement From ASR Well Location



Water Quality

Review of historical water quality data indicate that groundwater in the LAS is generally a calcium sulfate chemical character of fair to poor quality with total dissolved solids (TDS) concentrations in the range of 900 to 1,300 milligrams per liter (mg/l) and sulfate concentrations that range from 400 to 650 mg/l. These historical data indicate that the storage of the proposed recycled water will improve the general mineral quality of groundwater in the LAS (a beneficial impact) and that injection water chemistry can likely be controlled (buffered) to be compatible with native groundwater and avoid degradation.

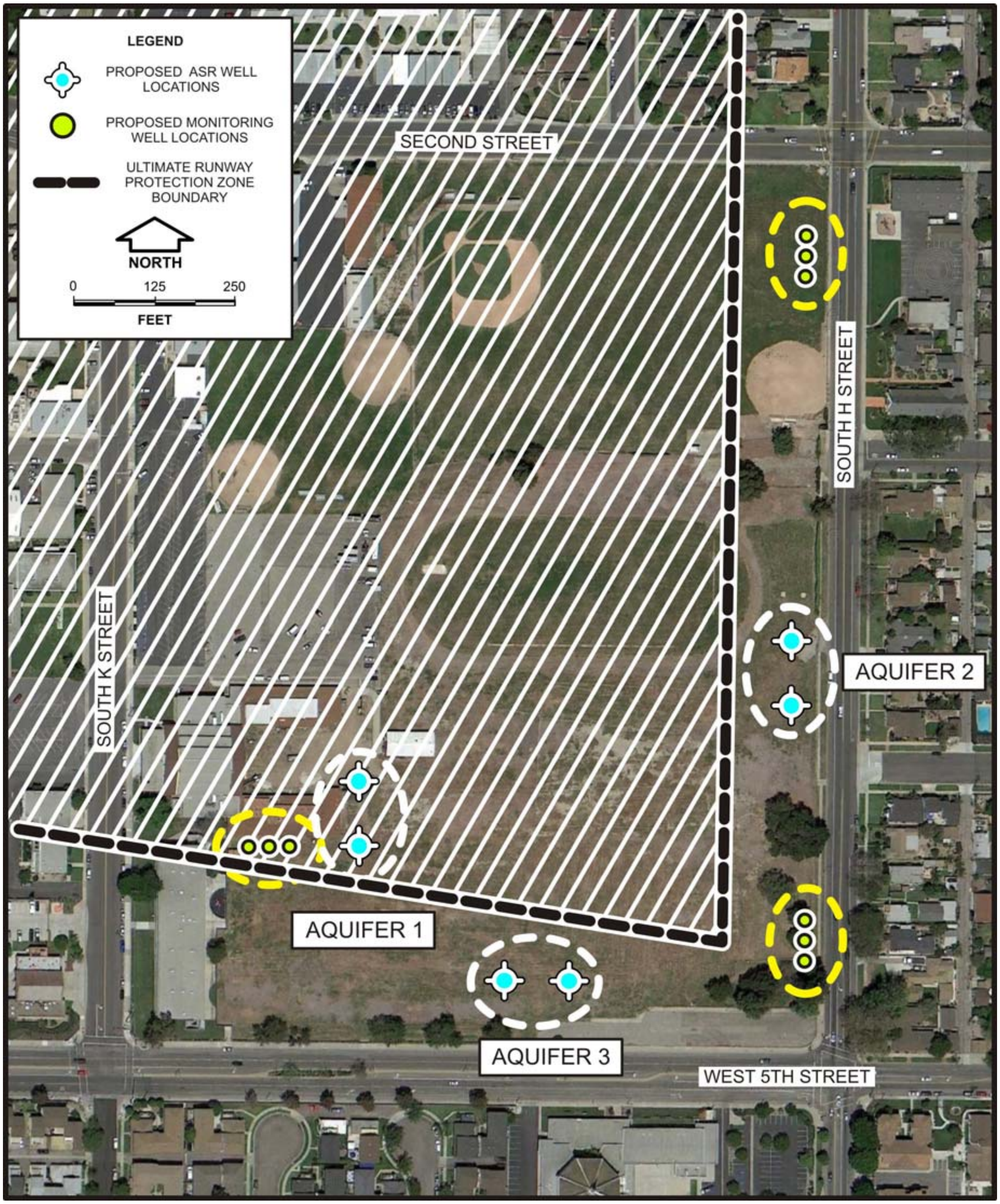
SITE LAYOUT AND FACILITIES DESIGN

To fully develop the Campus Park GRRP location, the City will utilize ASR well facilities that are constructed in discrete aquifer zones. These facilities will be used to conduct the demonstration testing required for final permitting of the IPR GRRP. The site specific groundwater data generated will further define the groundwater gradient, the aquifer materials, the site specific hydrogeology available for GRRP operations, local water quality, and ultimately the aquifer replenishment potential at the ASR well location. Initially, the proposed upper Hueneme Aquifer zone ASR well will be constructed along with 3 monitoring wells to develop information that establishes site specific data. Figure 11 – Proposed Campus Park ASR Wellfield Location Map shows the approximate location of the proposed ASR Wells and Monitoring Wells as they are positioned in the proposed City park development plan.

The proposed well locations were selected to construct facilities that will accomplish wellfield construction and data collection that complies with GRURW regulations and still be within the City property on the Campus Park site. As shown on Figure 11, the well locations are designed to be outside the ultimate runway protection zone boundary proposed by the County of Ventura Department of Airports for Federal Aviation Administration approval. This wellfield layout is designed to accommodate present and future conditions that may restrict the use of the Campus Park Property where drilling equipment of up to 60 feet high may be allowed to operate.

As shown, it is ultimately anticipated that a minimum of two wells will be required in each discrete aquifer zone(s) to achieve the full recharge and extraction capacities desired by the City. ASR Well No. 1 is located in the group labeled Aquifer 1 (see Figure 11). Aquifer 2 is the designated site for the wells that will utilize an aquifer(s) immediately below the Aquifer 1 wells. Accordingly, Aquifer 3 will utilize a deeper aquifer(s) to provide the final ASR capacity required for the recharge, retention, and recovery cycle to support continuous utilization of PRW produced from the AWPF. The initial demonstration ASR well location (see Figure 2) is within the Aquifer 1 area and the 3 monitoring wells are located within each of the monitoring well locations at variable distances from the ASR well.

Figure 11 – Proposed Campus Park ASR Wellfield Location Map



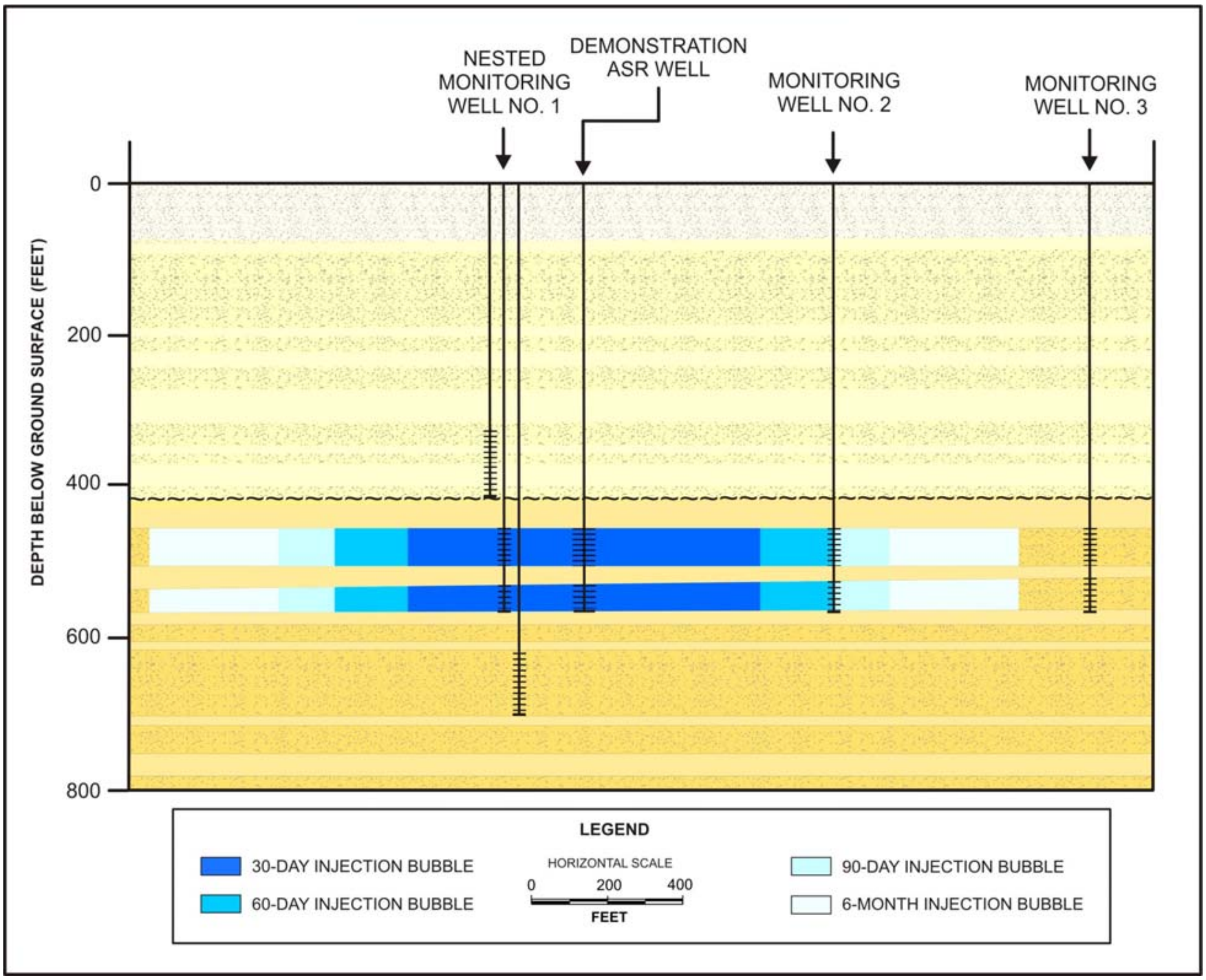
Well construction will be conducted by drilling and logging a pilot hole to select the aquifer(s) to be utilized by the ASR well(s). Based on these data, the final design of the demonstration ASR well and monitoring wells will be provided in the uppermost aquifer unit. The monitoring well locations selected are designed to test the aquifer properties and confirm groundwater travel time estimates at the Campus Park site in compliance with the GRURW regulations. Upon completion of well construction, groundwater tracer testing using an intrinsic tracer will be conducted to satisfy regulation provisions and obtain a CRWQCB permit for operation of the GRRP. Additional analyses to be conducted during the site investigation will include evaluating the geochemical compatibility of the PRW with the native groundwater and with the lithology of aquifer materials through direct sample analysis of the PRW during the recovery phase of the initial recharge cycle.

The locations of the monitoring wells are designed to; a) be far enough apart to collect water levels that will define the site specific groundwater gradient, b) be close enough to comply with GRURW regulation monitoring well requirements for GRRP permitting including a travel time of greater than 2 weeks and less than 6 months, and c) utilize the City owned parcel and minimize impacts to airport operations and future park development to be planned. The location of the demonstration ASR well is presently on the periphery of the future park property and positioned to allow the additional ASR wells to be constructed on the site.

Figure 12 – Subsurface Profile of PRW Travel Time Estimates shows the radial distances estimated that will be filled with PRW during replenishment in the discrete aquifer zones identified for storage using Campus Park ASR Well No. 1. These estimations were calculated using an aquifer porosity of 20 percent (which is believed a reasonable value for this purpose) and a test injection rate of 2,000 gpm. Variations in aquifer porosities will either decrease or increase the estimated travel time proportionally as shown in Table 2. As shown, the displacement volume from ASR Well No. 1 replenishment is anticipated to fill the aquifer at radial distances that will reach Monitoring Well No. 1 within approximately 2 weeks and Monitoring Well No. 2 in approximately 60 days. The estimated displacement volume from the proposed injection rate is not anticipated to reach Monitoring Well No. 3 for over 6 months and would likely be on the order of 9 months.

Based on the regional groundwater gradient, the travel time of PRW will be primarily dominated by the rate of injection and the displacement of native groundwater in the aquifer and not by the background flow of groundwater through Aquifer No. 1. Because the GRRP Wellfield is located within an area of the City where it has control over water well permitting, a prohibition of private wells constructed in the LAS can be implemented and prevent potential impacts to private well owners during the lifetime of the project. This condition effectively establishes the required isolation zone for future well construction.

Figure 12 – Subsurface Profile of PRW Travel Time Estimates

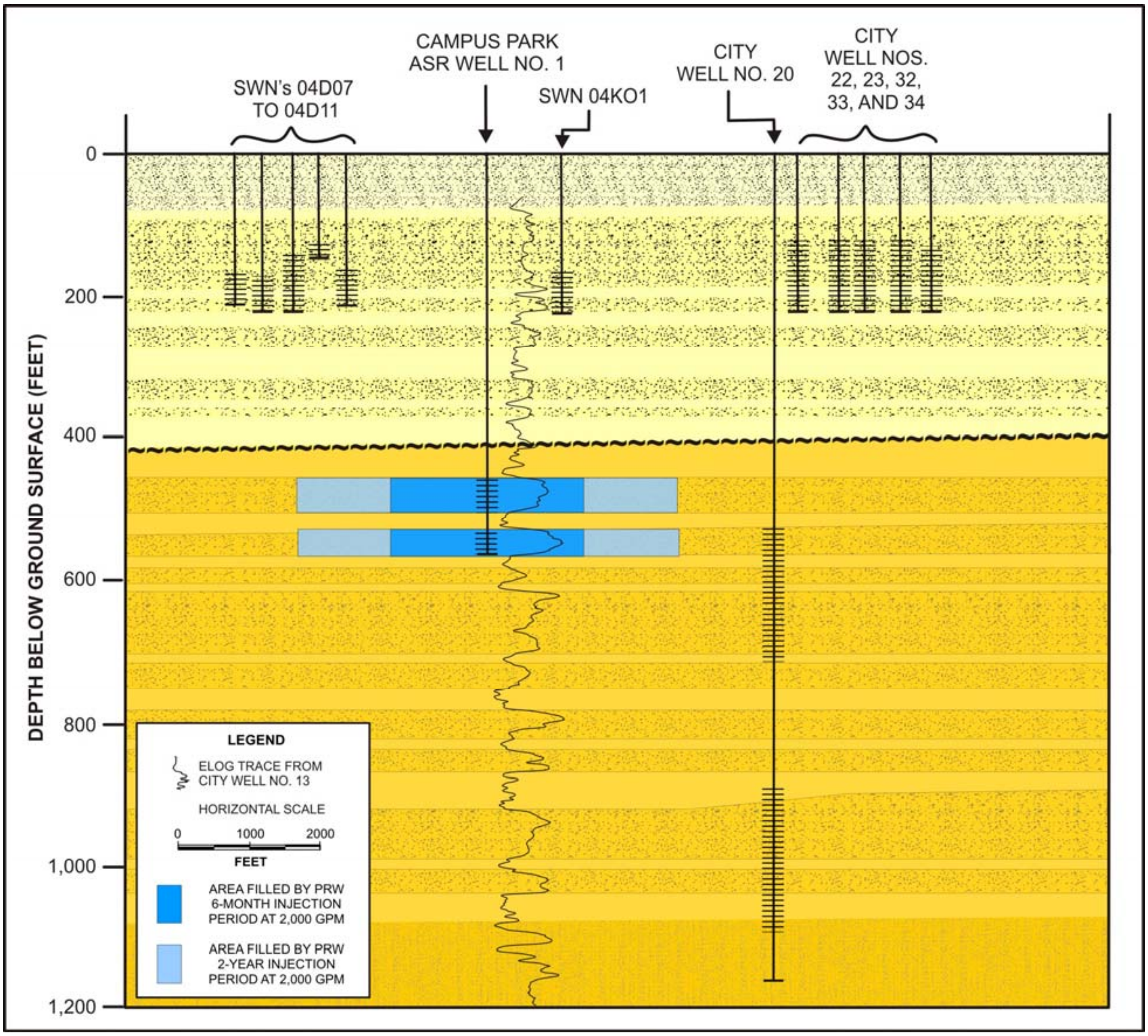


GRRP OPERATION AND VIOLATION MITIGATION

GRRP OPERATIONS

The conceptual design of the GRRP includes the cyclical recharge and storage of PRW in the discrete aquifer zones utilized by each ASR well. While it is anticipated that the majority of the recycled water produced by the AWPF during the first phase of production will be sold for in-City uses or for agricultural purposes, winter season demand will likely require injection and storage of the PRW to prevent plant shutdown or discharge to the ocean. The proposed use of the well is cyclical in nature, however, the actual amount that will be required for storage under full plant capacity is unknown and operational flexibility is always desirable. This study evaluated the merit of a 6-month and 2-year recharge/storage cycle (see Figure 9). The results indicated that these volumes can be accommodated if required, without adverse impacts to proximal well facilities. Figure 13 – Profile of Existing Wells shows the closest wells to the Campus Park site along with their approximate distance and completed depth. As indicated, City Well No. 20 is the only well within a mile of the site that is constructed in the LAS.

Figure 13 – Profile of Existing Wells



The injection volumes shown on the scaled drawing represent the radii of a 6-month and 2-year recharge period. This clearly indicates the low risk of the 3-month ASR cycle proposed. In addition, it illustrates the multiple confining layers and aquifer zones between the proposed ASR well constructed in the upper Hueneme Aquifer and the existing shallow 200- to 230-foot-deep wells constructed in the Oxnard Aquifer.

Preliminary analysis of the GRURW regulation requirements for treatment credits was performed by the City to understand the ability of the designed AWPF treatment process to satisfy the minimum 12-log reduction of enteric virus, 10-log reduction of Giardia cyst, and 10-log reduction of Cryptosporidium oocyst. The findings of that review indicated that the treatment process is capable of achieving the credits required for an IPR project for Giardia and Cryptosporidium, but is approximately 3-log reduction short of the requirement for enteric virus. Because of this finding, the aquifer used for storage may also be used for soil aquifer treatment to obtain the additional credit required for virus removal to achieve the IPR requirement (if no other treatment process is added to obtain additional credit). Based on the information in Table 60320.208 in the GRURW regulations, the necessary retention time will be approximately 3 months. The primary assessment of this hydrogeological study was to accommodate planned ASR operations on a 3-month cycle until treatment process improvements are implemented.

For initial GRRP operations, the City proposes to recharge the well for approximately 3 months with PRW. Upon completion of the recharge cycle, the City will allow a 3-month retention time (or less if additional treatment is provided) where the PRW will continue to move through the aquifer under the influence of the regional groundwater gradient (whichever direction that may be) and receive soil aquifer treatment throughout the retention time. Upon completion of the retention time necessary to achieve the required 3-log reduction credit, the stored water will be produced over an approximate 2- to 3-month recovery period. During recovery of the PRW, the well will discharge into the recycled water system and the recovered groundwater will be utilized for irrigation. Upon approval of use for IPR purposes, the groundwater will be recovered and conveyed to BS-1 for blending and use in the City municipal system.

Additional wells can be added to accommodate greater recharge and storage volumes or achieve higher retention time, as desired.

WATER QUALITY VIOLATION MITIGATION

The proposed GRRP is designed to allow rapid response and mitigation in the event of a AWPF treatment failure resulting in a water quality violation. Because the GRRP is designed to recapture the stored PRW at the point of replenishment, the ability for recapture of all of the water has a high level of certainty regardless of changes in the groundwater gradient direction. The steps toward mitigation at the time of violation detection would include the following components:

1. Stop aquifer recharge into the specific well(s) receiving the unsuitable water upon immediate discovery of a violation.

2. Address the treatment plant problem and supplement the recycled system, if necessary, with a potable supply.

3. Immediately begin removal/recapture of the tainted groundwater (if necessary) and discharge to a location other than the municipal water supply system until all the water has been removed from the aquifer system. The recovered water would be discharged either back into the recycled water system and used for irrigation (if suitable) or discharged to the sewer for disposal.

4. Initiate injection into another ASR well after the AWPF treatment problem has been solved and until the tainted groundwater in the previously active well has been remediated.

5. Allow the stored volume of water to remain in the aquifer for a greater response/retention time to receive additional soil aquifer treatment for the required time necessary based on the specific violation prior to subsequent removal and reuse.

Well discharge can be conducted until the affected aquifer zone is completely purged. Discharge from the affected well(s) can be directed to the most beneficial use allowable for its determined quality. City facilities provide multiple locations for discharge of the inadequately treated water, which include the City:

- sanitary sewer

- recycled water system for permitted irrigation reuse

- IPR after additional response retention time or aquifer travel time (soil aquifer treatment) has been achieved to mitigate the violation.

CONCLUSIONS AND RECOMMENDATIONS

In June 2014, the DDW released the final GRURW regulations that reflect its current thinking on the regulation for replenishing groundwater with PRW and the subsequent reuse as a potable supply. Based on the findings of this study, we conclude that available data indicate the proposed GRRP is feasible and that replenishment and recovery of groundwater with an improved quality could be accomplished in this portion of the Oxnard Plain Basin that would be consistent with the current GRURW regulations.

It is anticipated that properly designed and constructed ASR wells located at the proposed Campus Park GRRP site will provide operational well capacities beneficial for the proposed IPR program. Injection into the LAS in the Oxnard Plain Basin will require multiple wells that will likely be capable of sustained injection rates between 1,500 to 2,000 gpm. While the initial proposed demonstration project includes a single ASR well to achieve permitting, and a total of 3 ASR wells to achieve cycling for continual operation, additional wells can be added to facilitate a higher capacity GRRP operation in each of the aquifer storage units.

The City's review of the DDW regulations indicates that IPR operations may require a response retention time that achieves a 3-log removal credit for enteric virus and that the retention time of the PRW in the aquifer will likely be 3 months prior to reuse until additional treatment at the AWPF is provided. We conclude that it is feasible to inject PRW over a 3 to 6-month period into any discrete aquifer zone(s) and expect a high percentage of recovery after a 3-month retention period that allows full compliance with permit conditions. The proposed GRRP has direct control over the response retention time in that the ASR well facility that replenishes the aquifer(s) will remain off until the specified retention time has been achieved. Recovery of the final portion of the PRW will likely produce a component of groundwater with a reduced quality as a result of mixing with the native groundwater. Recovery percentages can be improved with the establishment of a buffer zone around the recharge bubble by originally using a greater quantity of the PRW than planned for recovery.

We conclude that while zone specific water level data from the Campus Park site are not available, the prevailing groundwater conditions indicated by available data in the Oxnard Plain Basin support the ability for effective capture and reuse of the higher quality recharge water from the Campus Park ASR Wellfield. As designed, the project does not rely on horizontal movement through an aquifer in any specific direction to allow capture at some distance away from the point of recharge. The point of capture is anticipated to be near the center of the PRW recharge bubble. We also conclude that in the event of a water quality violation where non-compliant water is injected in the aquifer system, the GRRP design will allow immediate mitigation and, as necessary, recapture of the non-compliant volume of PRW. There are no drinking water wells constructed in the LAS within ¾ of a mile of the proposed GRRP location. The only potable well in the LAS within a mile of the Campus Park is City Well No. 20.

Anticipated travel time to the nearest potable water supply well is greater than 2 years, if the PRW is not recovered for IPR. Because the City is the permitting agency and can control well construction within its limits, the proposed IPR operation has an effectively established isolation zone from future well construction.

We recommend the City drill a pilot borehole to a depth of 580 feet to define the site specific aquifer zone depths for use in final design of the GRRP ASR Well No. 1 in the upper Hueneme Aquifer zones (see Plate 1). We also recommend the City construct 3 monitoring wells at the designated locations which are preliminarily identified on Figures 2 and 11 to allow collection of groundwater data in compliance with the GRURW regulation pursuant to section 60320.200(h)(4). We recommend Monitoring Well No. 1 be constructed as a nested monitoring well to allow monitoring of the aquifer zones above and below the depths of Aquifer Storage Unit No. 1 during the operation of ASR Well No. 1.

PERSONNEL QUALIFICATIONS

The assessment of hydrogeological conditions for the proposed GRRP was conducted by and under the direction of Mr. Curtis J. Hopkins, Principal Hydrogeologist with Hopkins Groundwater Consultants, Inc. Mr. Hopkins is the company's president and is certified as a Professional Geologist (PG 5695), Certified Engineering Geologist (EG 1800) and Certified Hydrogeologist (HG 114) in the State of California. Mr. Hopkins has over 27 years of work experience on groundwater development projects performed throughout the Southern and Central California area and specifically, the Oxnard Plain Basin. Mr. Hopkins has extensive experience with water supply studies to establish municipal wellfields and with design and management of well construction projects.

CLOSURE

This report has been prepared for the exclusive use of the City of Oxnard and its agents for specific application to the City of Oxnard GREAT Program utilization of PRW treated at the AWPF and properly applied at the proposed Campus Park GRRP site for IPR. The findings, conclusions, and recommendations presented herein were prepared in accordance with generally accepted hydrogeological planning and engineering practices. No other warranty, express or implied is made.

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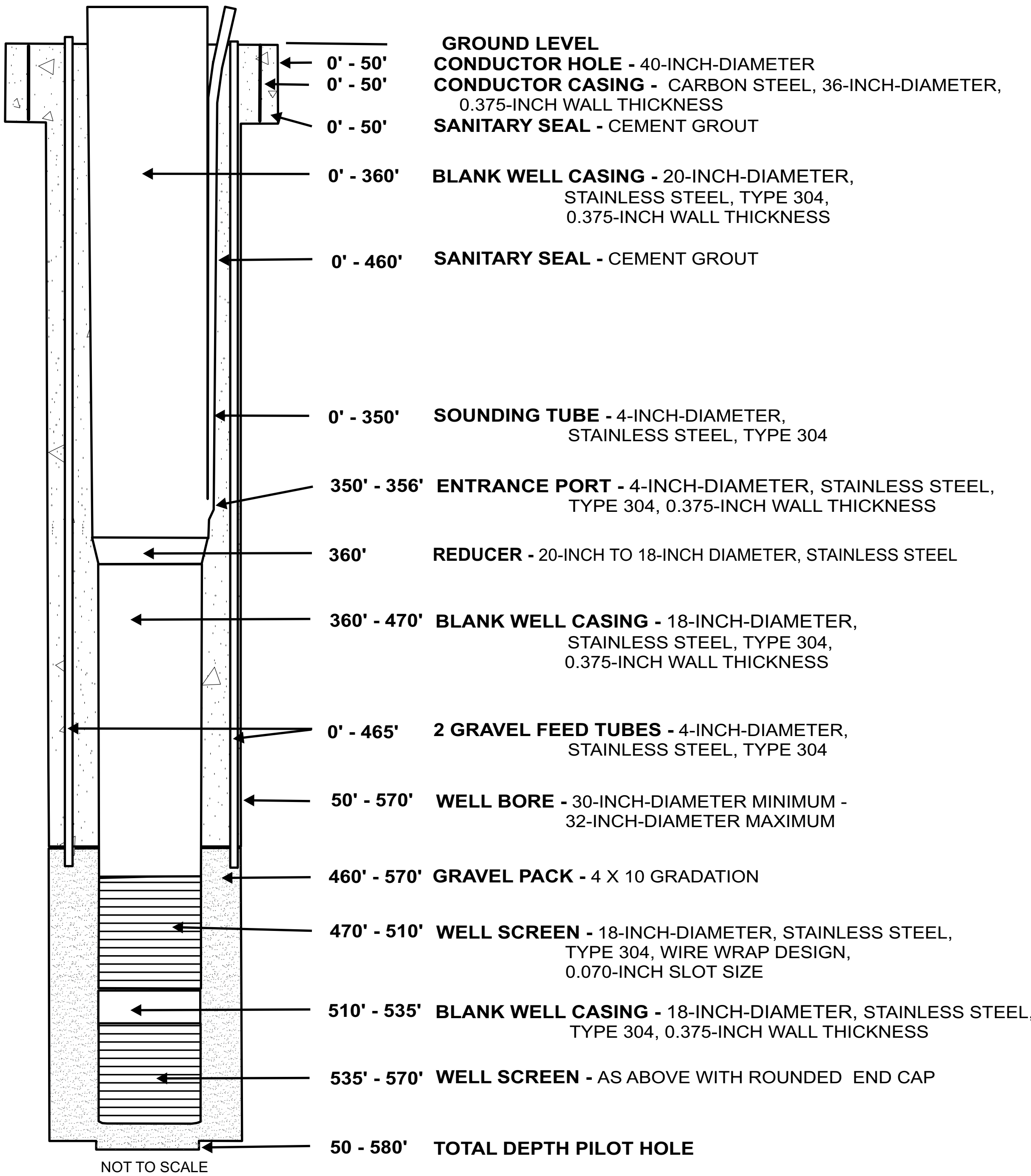
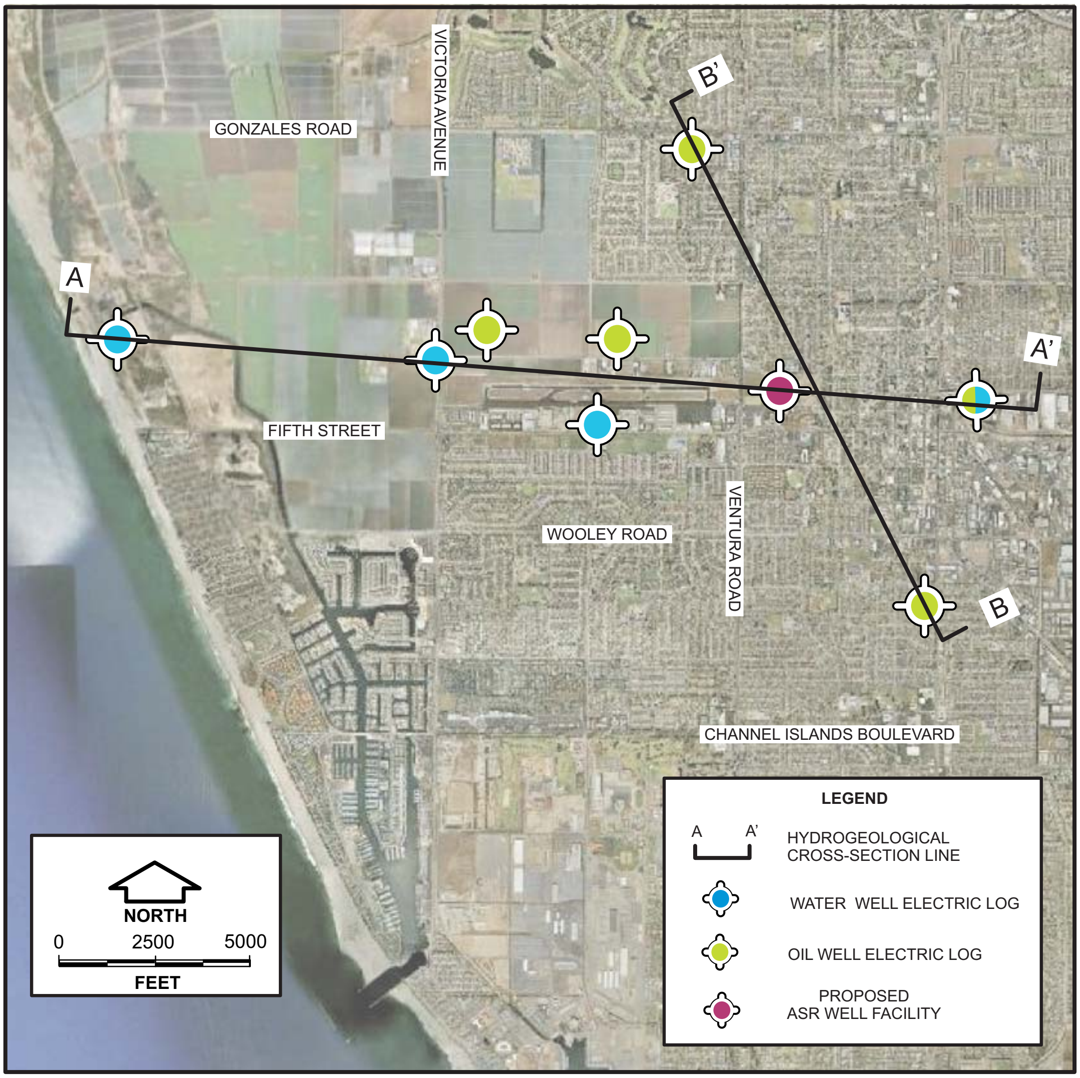
PLATES

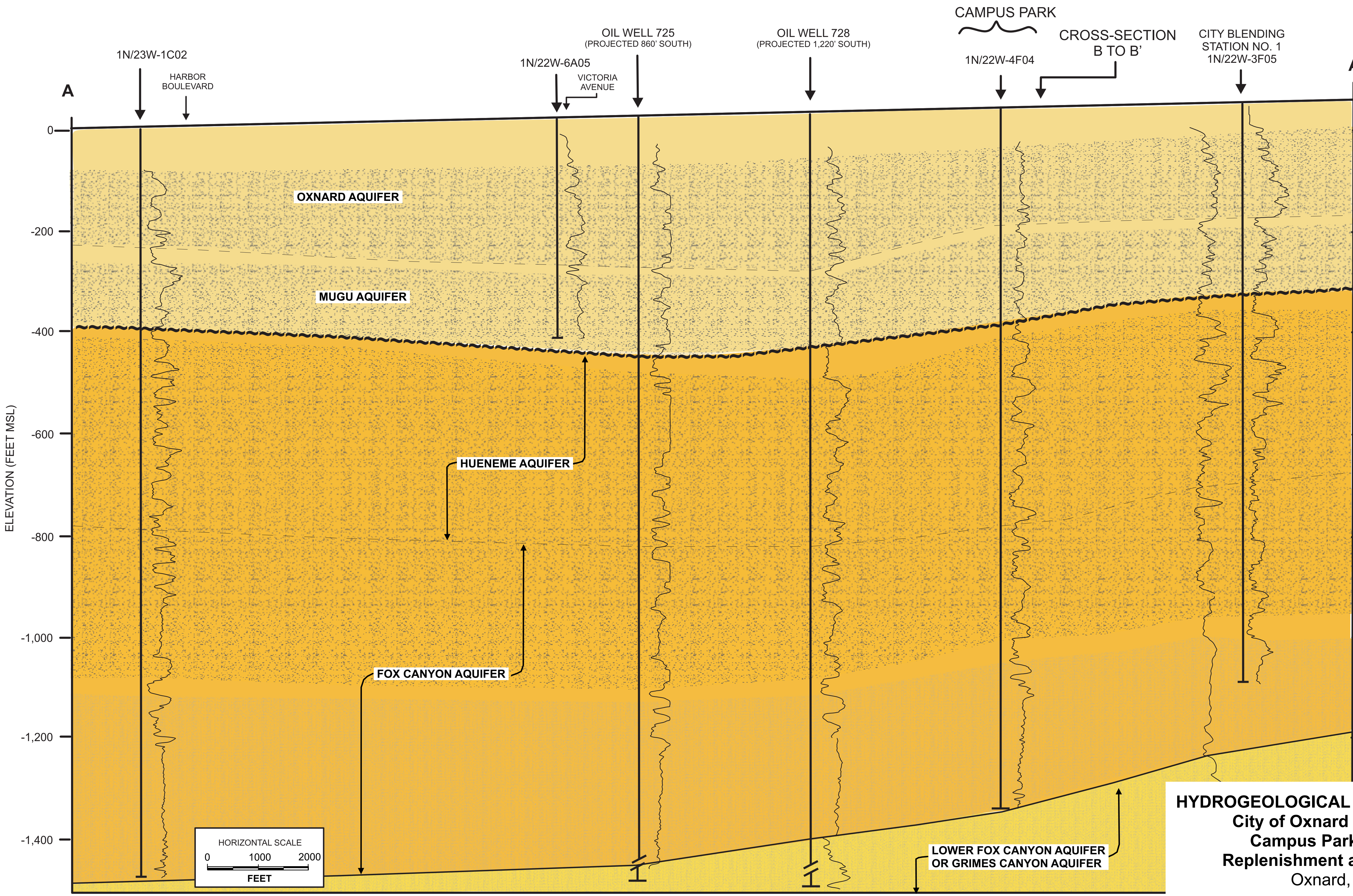


PRELIMINARY ASR WELL NO. 1 DESIGN DRAWING
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California

PLATE 1

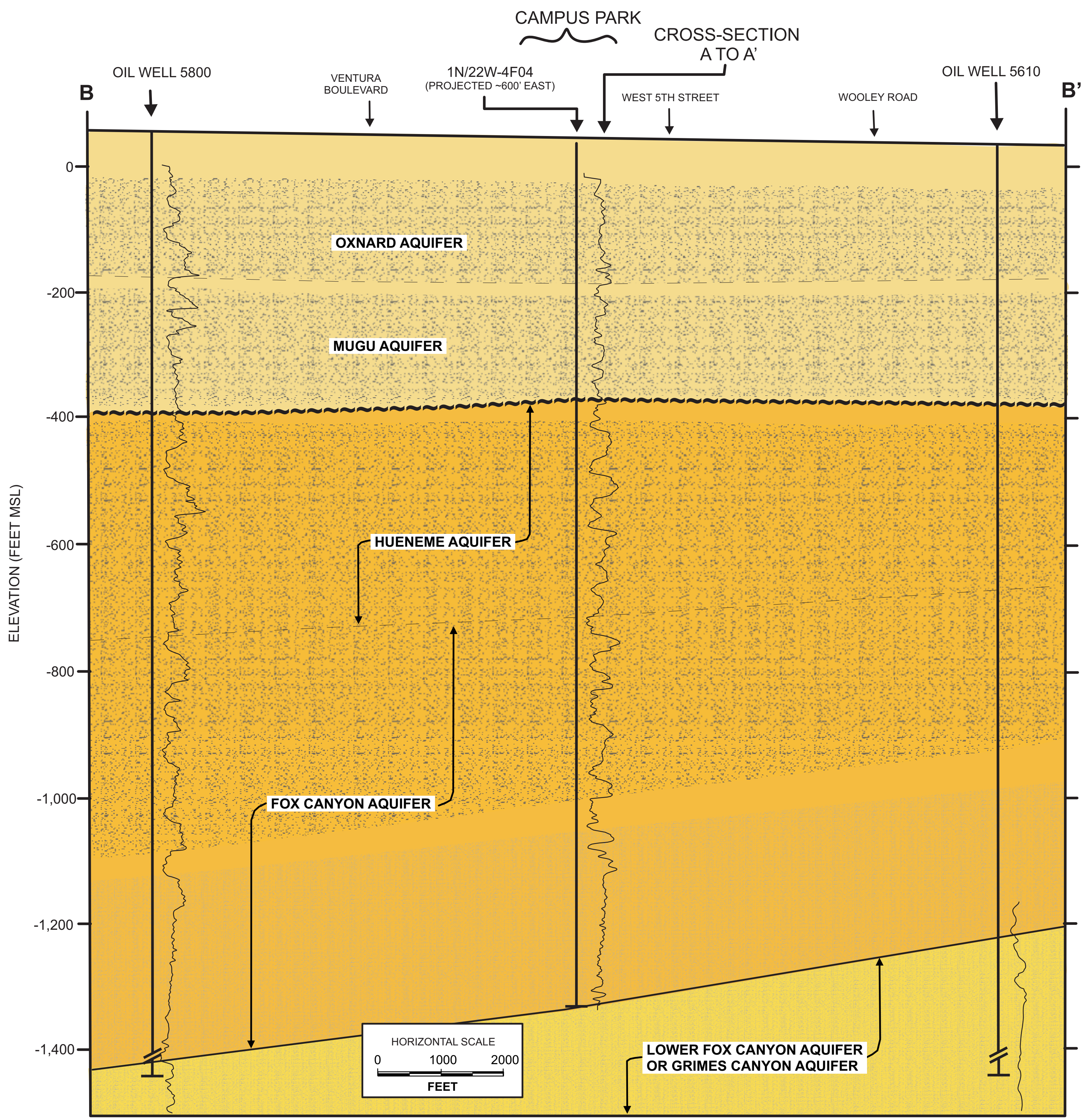


HYDROGEOLOGICAL CROSS-SECTION LOCATION MAP
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California



HYDROGEOLOGICAL CROSS-SECTION A - A'
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California

PLATE 3



LEGEND

QUATERNARY — HOLOCENE / PLEISTOCENE

Qoa — **UN-DIFFERENTIATED OLDER AND YOUNGER ALLUVIUM -** older alluvial gravel, and silt/clay

QTs — **SAUGUS FORMATION -** weakly consolidated alluvial deposits, light gray to light brown gravel composed of pebbles and small cobbles mostly of white to light gray granitic rocks, in coarse sandy matrix; weakly indurated sand, and fossiliferous sand, silt, and clay

Qtlp / Qsb — **LAS POSAS SAND OR SANTA BARBARA FORMATION -** weakly indurated, fine to medium grained sand, in Las Posas Hills contains thin lenses of calcareous fossiliferous pebbly sandstone; unconformity at base

SYMBOLS

Formation contact - dashed where inferred or indefinite

Unconformable formation contact

Electric Log Trace of Resistivity Curve

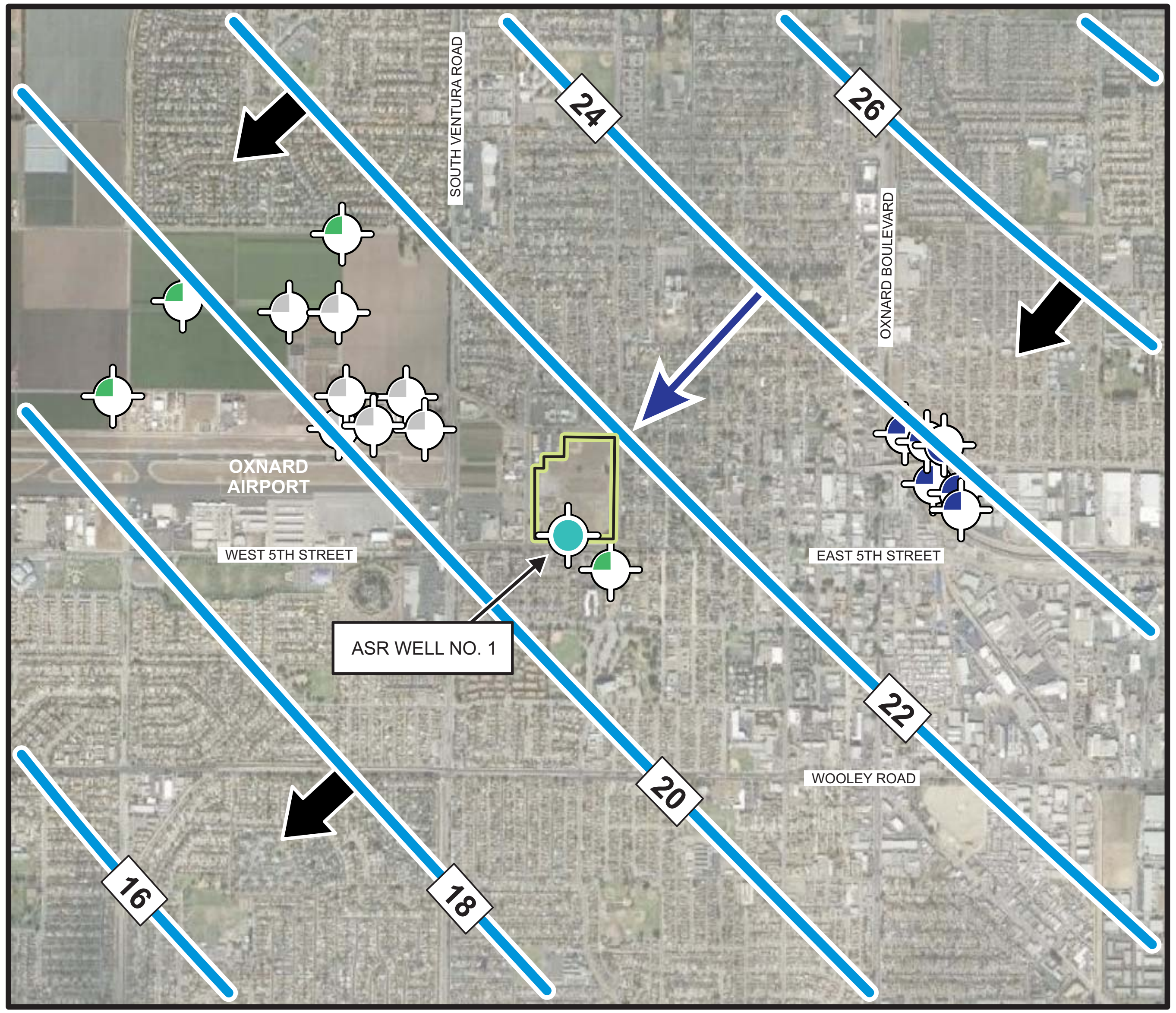
Location of Historical Water or Oil Well

Geology from: THOMAS W. DIBBLEE

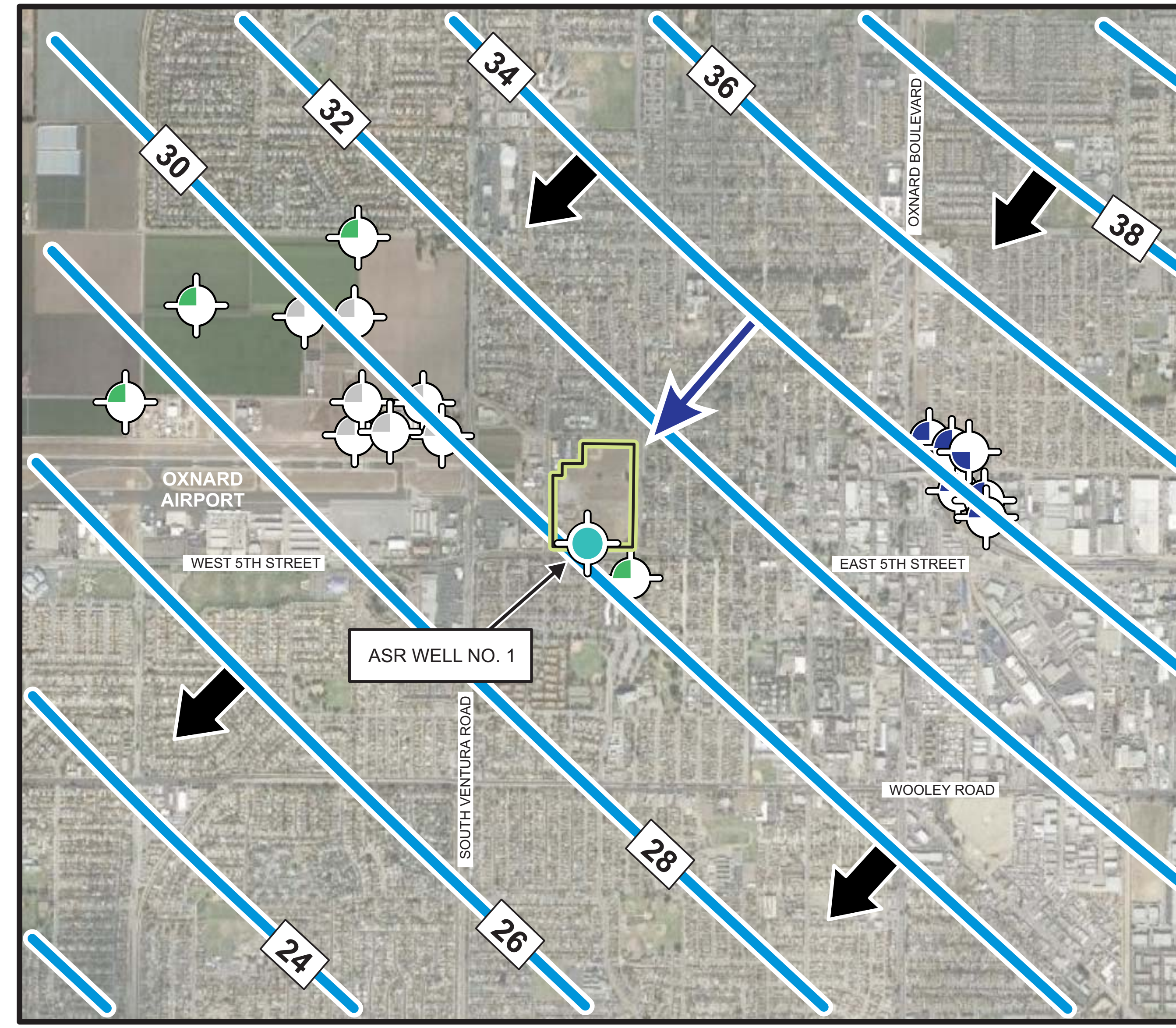
HYDROGEOLOGICAL CROSS-SECTION B - B'
City of Oxnard GREAT Program
Campus Park Groundwater
Replenishment and Reuse Project
Oxnard, California

PLATE 4

APPENDIX A
GROUNDWATER ELEVATION
CONTOUR MAPS



JANUARY 2011



APRIL 2011

GROUNDWATER LEGEND

10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0008**

FLOW DIRECTION **S 43° W**

NORTH

0 1000 2000

FEET

WELL LEGEND

MUNICIPAL WELL

DOMESTIC WELL

AGRICULTURAL WELL

SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER
HUENEME AQUIFER
FOX CAYNON AQUIFER

UAS
LAS

GROUNDWATER LEGEND

10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

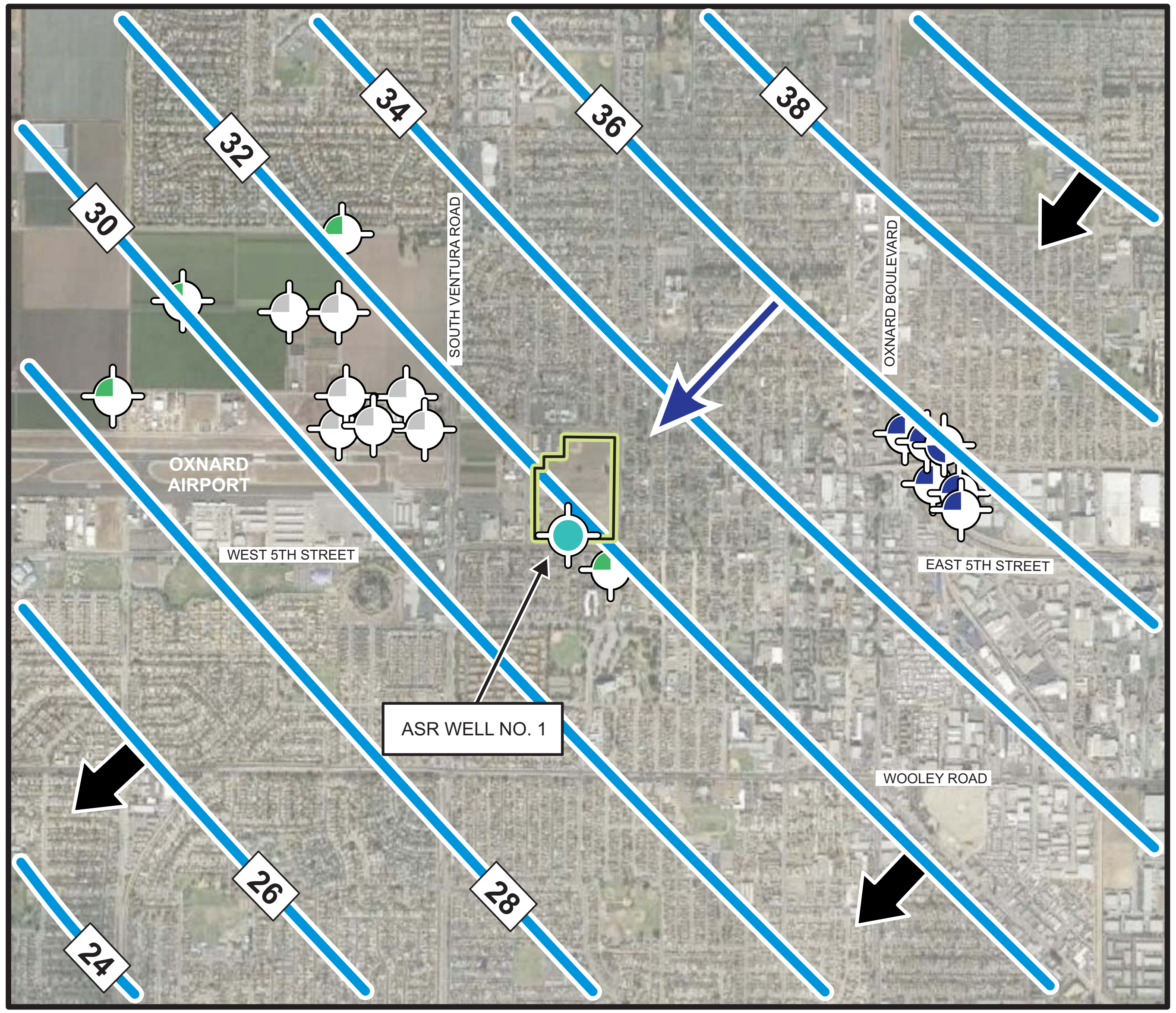
GRADIENT **0.0011**

FLOW DIRECTION **S 41° W**

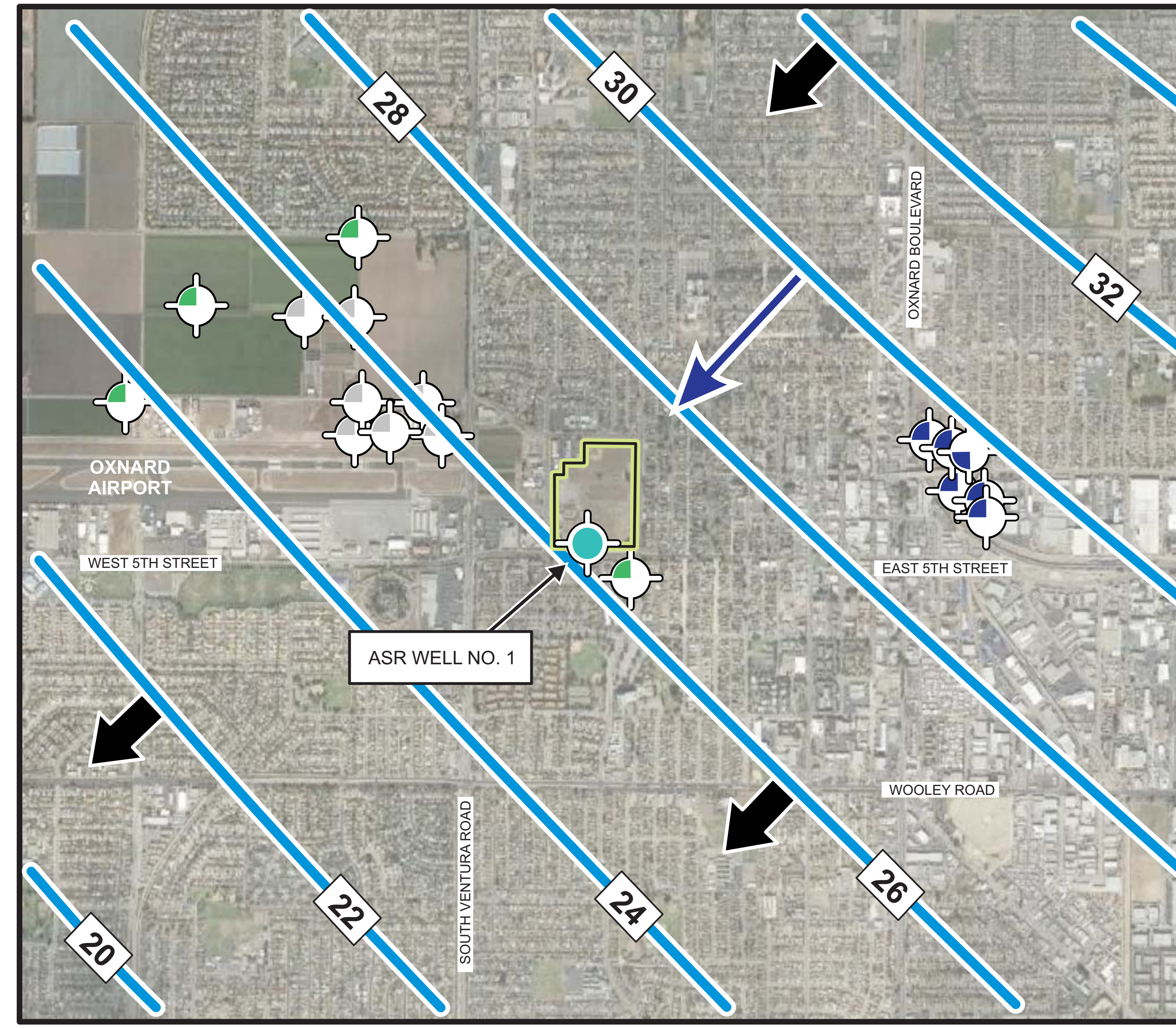
GROUNDWATER ELEVATION CONTOUR MAPS
JANUARY AND APRIL 2011
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California

PLATE A1

HOPKINS
GROUNDWATER
CONSULTANTS



JULY 2011



OCTOBER 2011

GROUNDWATER LEGEND

- LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0011**

FLOW DIRECTION **S 44° W**

NORTH

0 1000 2000

FEET

WELL LEGEND

MUNICIPAL WELL — DOMESTIC WELL — AGRICULTURAL WELL — SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER, MUGU AQUIFER — UAS

HUENEME AQUIFER, FOX CAYNON AQUIFER — LAS

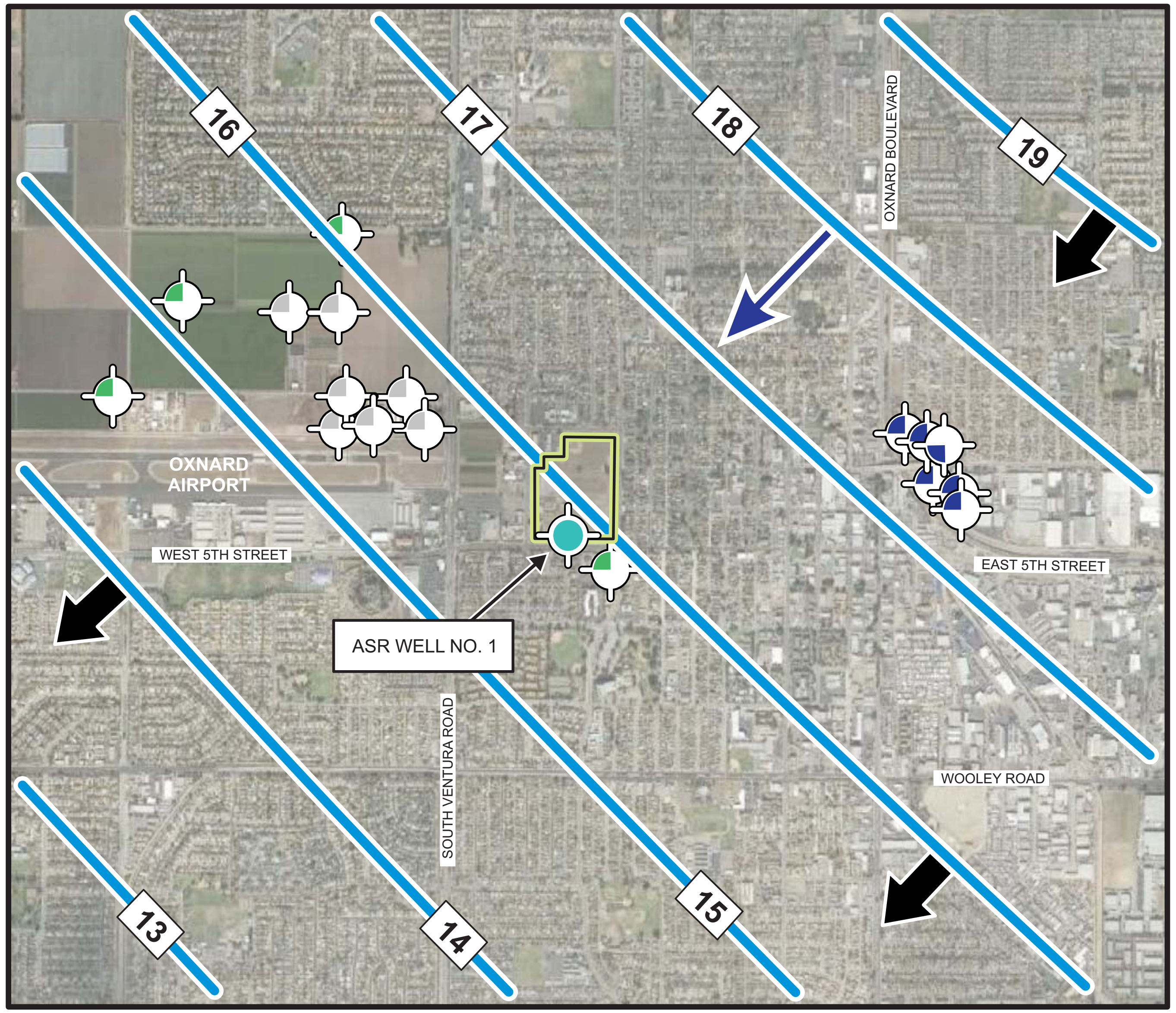
GROUNDWATER LEGEND

- LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

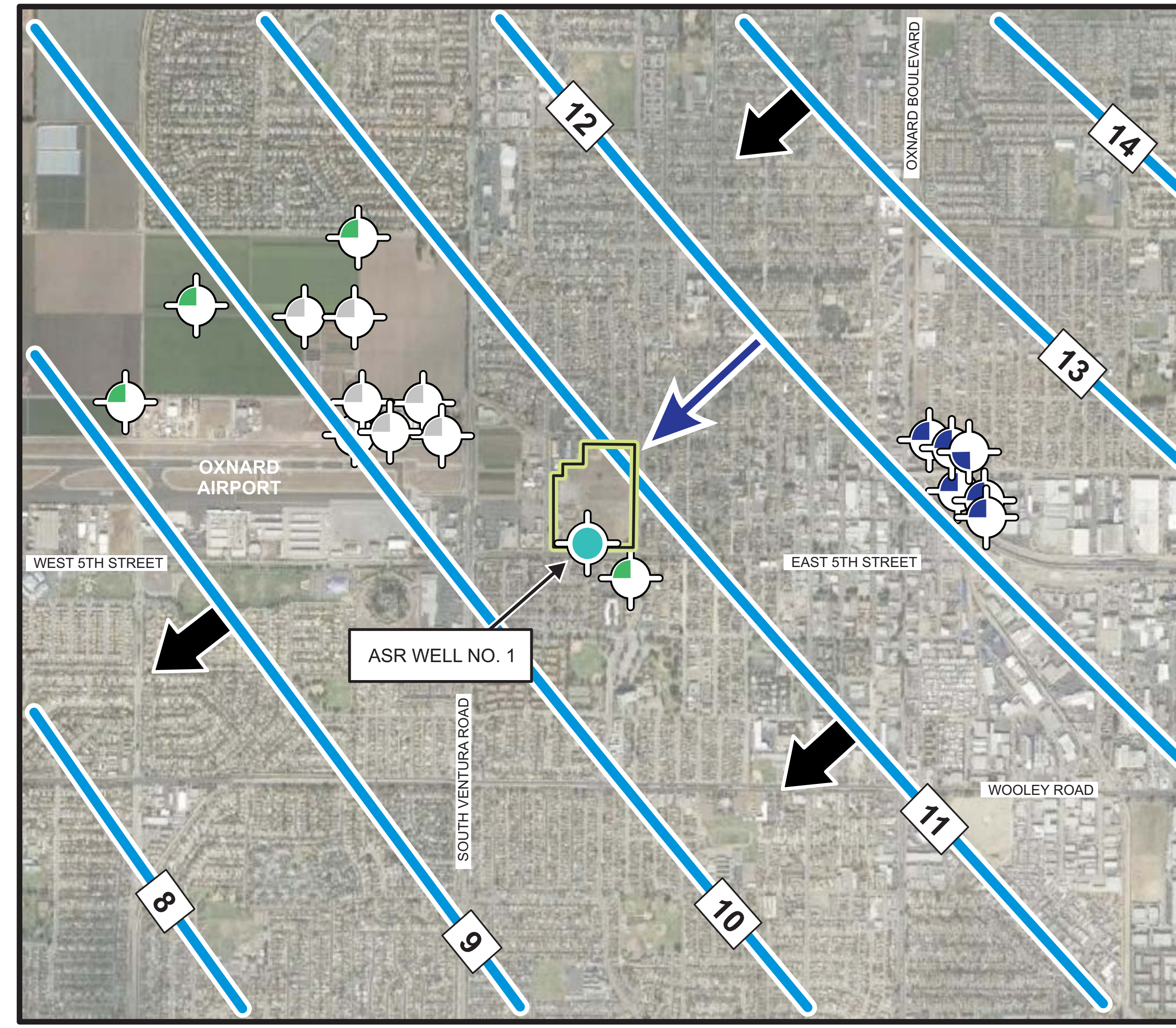
GRADIENT **0.0009**

FLOW DIRECTION **S 43° W**

GROUNDWATER ELEVATION CONTOUR MAPS
JULY AND OCTOBER 2011
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California



JANUARY 2013



APRIL 2013

GROUNDWATER LEGEND

10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0004**

FLOW DIRECTION **S 44° W**

NORTH

0 1000 2000

FEET

WELL LEGEND

MUNICIPAL WELL

DOMESTIC WELL

AGRICULTURAL WELL

SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER
HUENEME AQUIFER
FOX CAYNON AQUIFER

UAS
LAS

GROUNDWATER LEGEND

10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

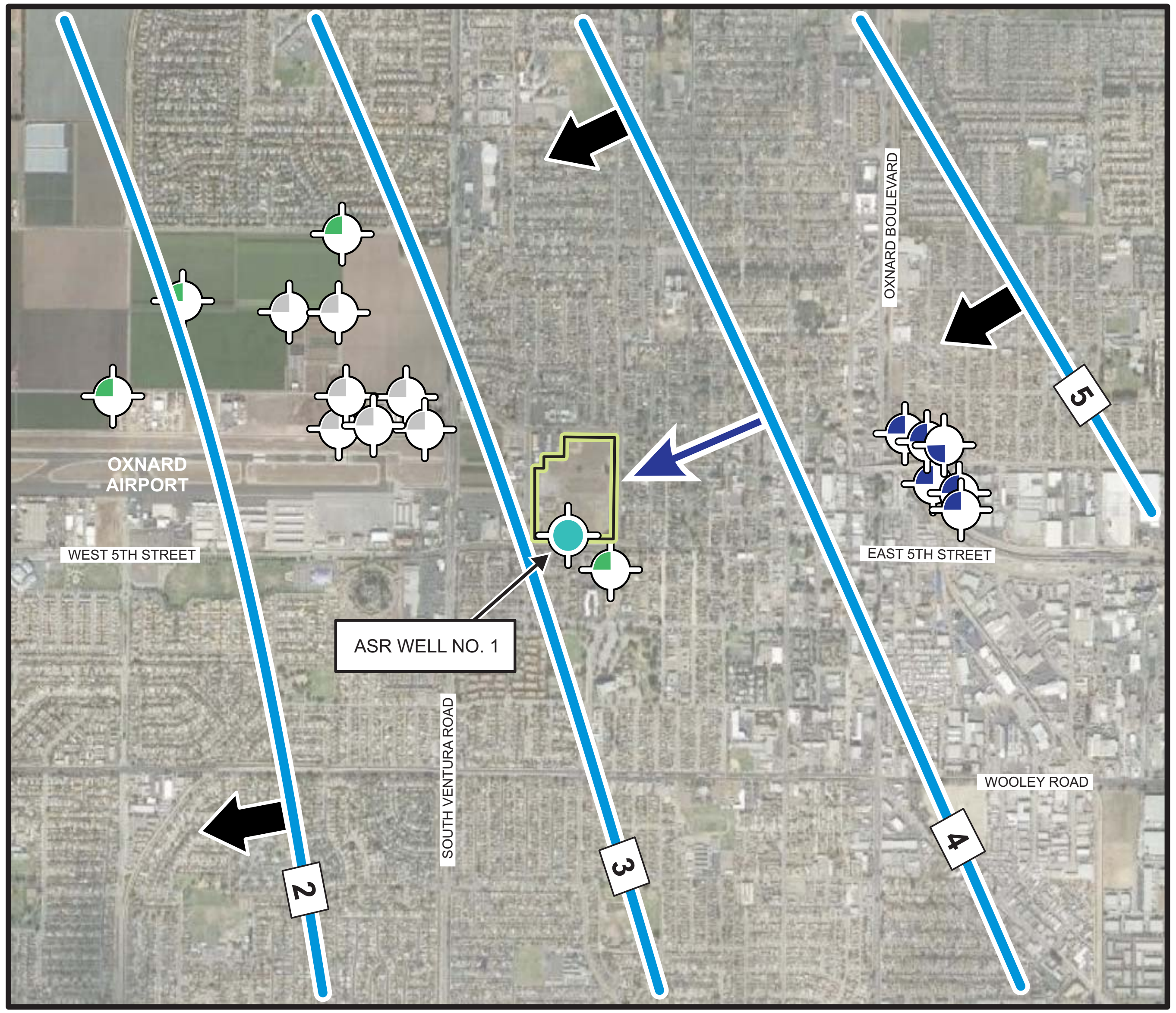
GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0004**

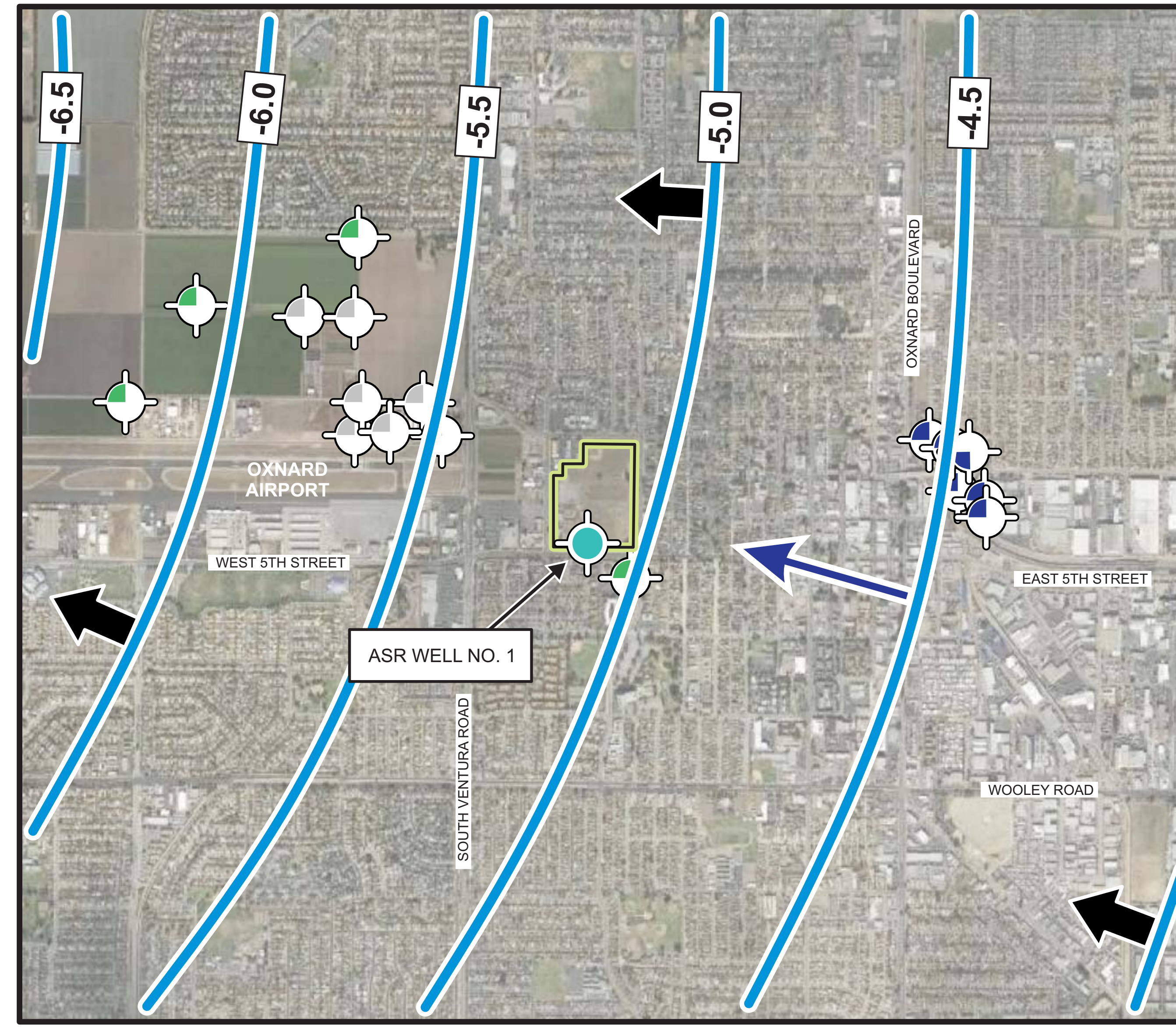
FLOW DIRECTION **S 47° W**

GROUNDWATER ELEVATION CONTOUR MAPS
JANUARY AND APRIL 2013
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California

PLATE A3



JULY 2013



OCTOBER 2013

GROUNDWATER LEGEND

10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT	**0.0003**
FLOW DIRECTION	**S 67° W**

NORTH

0 1000 2000
FEET

WELL LEGEND

MUNICIPAL WELL
DOMESTIC WELL
AGRICULTURAL WELL
SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER
HUENEME AQUIFER
FOX CAYNON AQUIFER

UAS
LAS

GROUNDWATER LEGEND

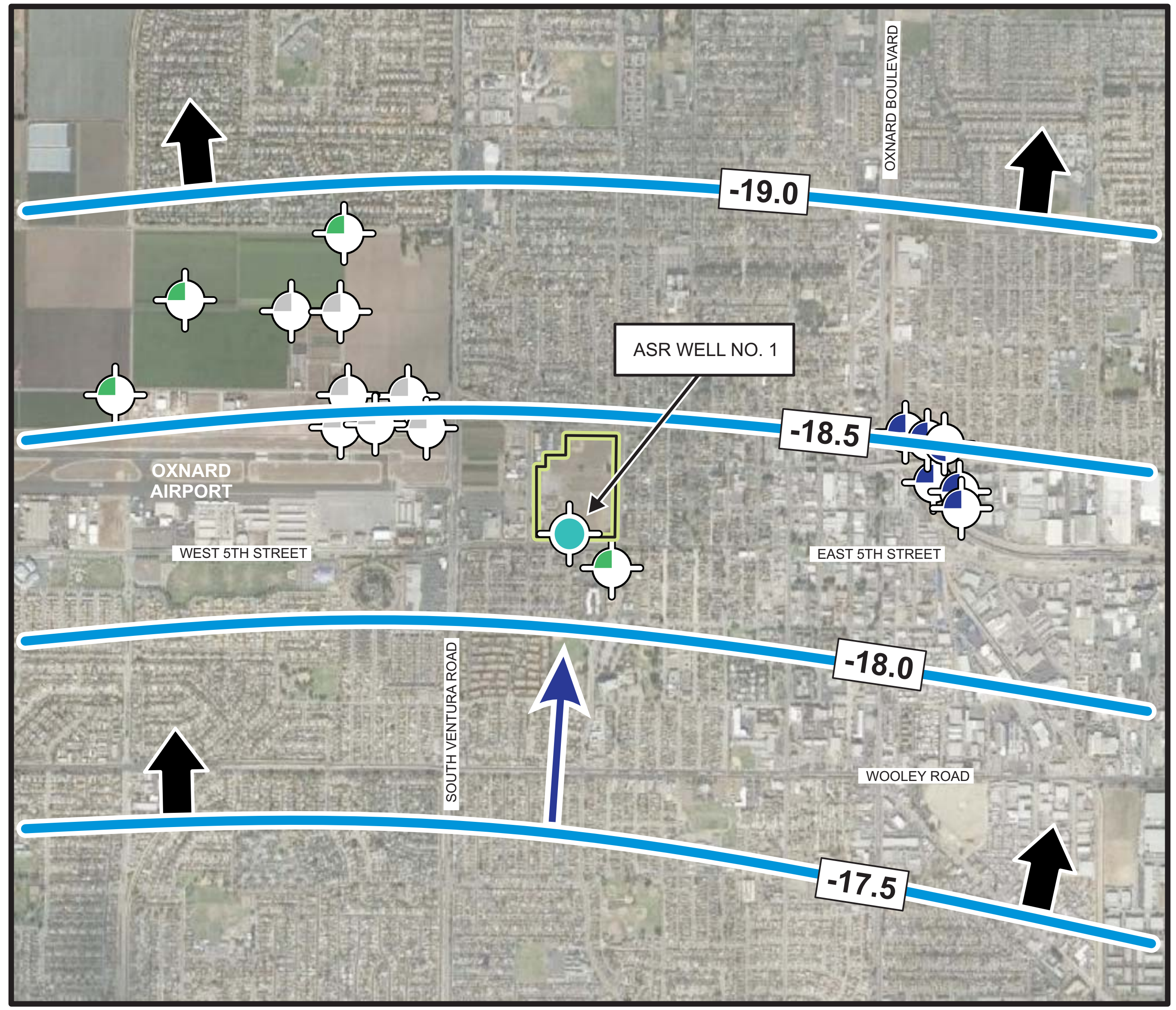
10 LINE OF EQUAL GROUNDWATER ELEVATION

DIRECTION OF GROUNDWATER FLOW

GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT	**0.0002**
FLOW DIRECTION	**N 74° W**

GROUNDWATER ELEVATION CONTOUR MAPS
JULY AND OCTOBER 2013
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California



AUGUST 2014

GROUNDWATER LEGEND

- LINE OF EQUAL GROUNDWATER ELEVATION
- DIRECTION OF GROUNDWATER FLOW
- GROUNDWATER FLOW DIRECTION BENEATH SITE

GRADIENT **0.0002**

FLOW DIRECTION **N 04° E**

NORTH

0 1000 2000

FEET

WELL LEGEND

- MUNICIPAL WELL
- DOMESTIC WELL
- AGRICULTURAL WELL
- SWN 21M1 WELL ID

AQUIFER COMPLETION DESIGNATION

OXNARD AQUIFER
MUGU AQUIFER
HUENEME AQUIFER
FOX CAYNON AQUIFER

UAS
LAS

GROUNDWATER ELEVATION CONTOUR MAPS
AUGUST 2014
City of Oxnard GREAT Program
Campus Park Groundwater Replenishment and Reuse Project
Oxnard, California

APPENDIX C – PALL MF PDT/LRV ANALYSIS

Resolution and LRV Calculations for Direct Integrity Testing Using the MFGM Method for Water Treatment Plant at 01.00106 Oxnard, CA

Objectives

The objective is to determine (1) the testing pressure required to meet the resolution criterion of 3 μm or less as specified in the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), (2) the pressure decay value (PDR) corresponding to required Log Reduction Value (LRV) for particles with the size of 3 μm at plant design conditions.

Calculation for Resolution and Sensitivity of the Membrane System

1. Determining Testing Pressure for Required Resolution (≤3 μm)

The testing pressure can be calculated per Equation (4.1)

$$P_{test} = (0.193 * \kappa * \sigma * \cos\theta) + BP_{\max} \qquad \text{Equation (4.1)}$$

Table 1. Calculation Variables (P_{test})

Item	Description	Unit	Value
P_{test}	Test pressure for required resolution	psi	17.47
k	Shape correction factor	dimensionless	1
σ	Surface tension of water @ 5 °C	dynes/cm	74.97
θ	Water contact angle of membrane medium	degree	0.00
BP_{max}	Sum of backpressure and static head	psid	3

Since the testing pressure to be used is 25 psi or above and the pressure decay is anticipated lower than 1 psi during the duration of the test for Pall MF system, the resolution criterion is satisfied.

2. Calculating Sensitivity (LRV_{DIT})

The LRV calculation is performed by using Equation (4.9) in USEPA's Membrane Filtration Guidance Manual (USEPA, 2005):

$$LRV_{DIT} = \log\left(\frac{Q_p * ALCR * P_{atm}}{\Delta P_{test} * V_{sys} * VCF}\right) \qquad \text{Equation (4.9)}$$

The air-liquid conversion ration (ALCR) is calculated using Darcy Equation by assuming that the hollow fiber breaks completely at the interface of potting layer, which results in a shortest flow path for bypass flow. The calculation also uses the highest trans-membrane pressure (TMP) during a filtration cycle. This results in a conservative result that has a low LRV.

Air-to-liquid-conversion ratio (ALCR):

$$ALCR = 170 * Y * \sqrt{\frac{(P_{test} - BP)(P_{test} + P_{atm})}{(460 + T) * TMP}} \qquad \text{Equation (C.4)}$$

$$Y \propto \left[\frac{1}{\frac{(P_{test} - BP)}{(P_{test} + P_{atm})}}, K \right] \qquad \text{Equation (C.5)}$$

K: resistant coefficient

$$K = f * \frac{L}{d_{fiber}} \qquad \text{Equation (C.6)}$$

The parameters used in the LRV calculation are presented in Table 2.

Table 2. Parameters Used for LRV Calculation

Item	Description	Unit	Value
Q_p	design (instantaneous) flow per rack	gpm	1,554
VCF [a]	volumetric concentration factor	dimensionless	1.00
ΔP_{test}	The smallest pressure decay rate associated w/ a breach	psi/min.	0.06
V_{sys} [b]	system hold-up volume	ft^3	44.17
P_{atm}	Atmospheric pressure	psi	14.7
BP [b,c]	back-pressure during pressure decay test	psi	0
T [b]	Temperature	^oF	80.6
TMP [b]	terminal trans-membrane pressure during filtration	psi	40
f	friction factor	dimensionless	0.025
L [c]	the length of flow path for breach	M	0.06
D	diameter of hollow fiber lumen	M	0.00064
P_{test} [b]	testing pressure for pressure decay test	psi	25.0

Note: a - *Dead-end filtration*
b - *Based on the design data*
c - *Assume worst-case fiber breakage (at the top potting layer)*

Find K:

$$K = f * \frac{L}{d_{fiber}}$$ Equation (C.6)

f: friction factor
L: the length of flow path of the breach (equal to the potting thickness)
d_{fiber} lumen diameter of the fiber.

$$K = 0.025 * \frac{0.06}{0.00064}$$

Find Y value using the chart on page A-22 from Crane:

$$Y \propto \left[\frac{1}{\frac{(P_{test} - BP)}{(P_{test} + P_{atm})}}, K \right]$$

Substitute Y into Equation (C.4):

Substitute ALCR into Equation (4.9):

Table 3. Additional Parameters Used for LRV Calculation

Item	Description	Unit	Value
K	Resistant coefficient	dimensionless	2.34
Y	Net expansion factor	dimensionless	0.63
ALCR	Air to liquid conversion ratio	dimensionless	22.84
LRV_{dit}	Sensitivity of direct integrity test	log	4.4

Therefore, the sensitivity of direct integrity testing is = LRV_{dit} in Table 3.

1. Calculate Upper Control Limit (UCL) and Alert Level (AL) for Direct Integrity Testing. The UCL for direct integrity testing, the pressure decay rate corresponding to the required LRV, is determined by rearranging Equation (4.9):

$$UCL = \frac{Q_p \bullet ALCR \bullet P_{atm}}{10^{LRC*} \bullet V_{sys} \bullet VCF} \qquad \text{Equation (4.17)}$$

Where: UCL - upper control limit for pressure decay rate, psi/min.
$LRC*$ - required LRV for the membrane system

If the required LRV for the membrane system is 4-logs, substitute $LRC*$ = 4 and the same parameters in Table 2:

The plot of LRV as a function of pressure decay rate is presented in Figure 1 in which the UCL is marked with red dotted line.

Table 4. Results of UCL Calculation

Item	Description	Unit	Value
UCL	Upper control limit	dimensionless	0.16

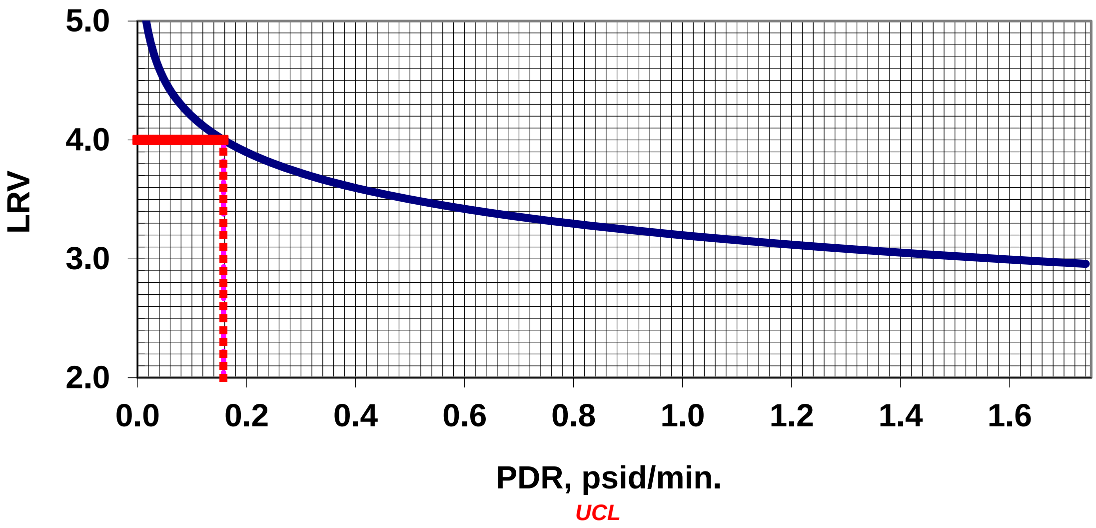


Figure 1: LRV as a function of pressure-decay rate (PDR)

UCL is indicated on the graph corresponding to LRV of 4-logs.

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carollo