4.0 Overview of Water Reuse Opportunities and Public Health Protection

Water Reuse Study

This section provides an overview of the water reuse opportunities investigated in the Study, as well as a brief description of the treatment technology, regulatory requirements and how public health is protected when recycled water is used. Further detail on these topics is in Appendix G of this report.

With a methodology in place and a diverse team of stakeholders and technical professionals engaged, the Study team developed a slate of reuse opportunities. Opportunities were first framed within the Council resolution authorizing the Study, which stated that the Study should evaluate "*a viable increased water reuse program, including but not limited to groundwater storage, expansion of the distribution system, reservoirs for reclaimed water, live stream discharge, wetlands development, and reservoir augmentation*" (R-298781). The Study team identified a list of reuse project opportunities and presented these to the Assembly and IAP for review. Based on stakeholder input, such opportunities were revised and analyzed, as shown in **Figure 4-1.**

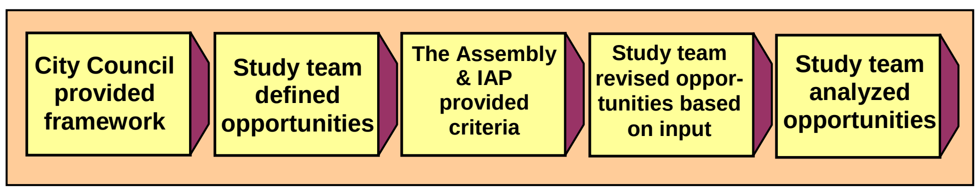

Figure 4-1 – Development of Reuse Opportunities

4.1 Stakeholder Input on Reuse Opportunities

The Assembly and IAP were asked to weigh in on these reuse opportunities early in the project process with full flexibility for new additions or changes. Participants could and were encouraged to suggest revisions, alternatives, and express the need to emphasize or de-emphasize different project components.

The first key piece of input was a suggestion on how opportunities could be presented. The Assembly suggested separating non-potable and IPR projects to aid in analysis. Additionally, the stakeholders suggested the investigation of specific uses, including:

- Residential front lawn uses,
- Carwashes,

- Commercial laundries,
- Construction activities, such as dust control and soil compaction,
- Street sweeping,
- Toilet flushing,
- Cooling towers and boiler makeup water, and
- Firefighting.

The Assembly participants also emphasized the need for recycled water "*to be safe and protect public health*" as the foundation of a reuse program. Therefore, this section also includes a summary of the science, technology and regulatory issues related to recycled water use. Additional information, as well as the references used herein, is also included in Appendix G.

4.2 Non-potable Reuse Description and Project Types

Non-potable recycled water reuse represents the largest and most successful type of water reuse to date in California. Typically utilizing recycled water that meets California water quality standards for uses that are not associated with drinking water, non-potable reuse plays a leading part in such projects as irrigation, industrial operations and wetlands creation. Non-potable applications have been proven safe, reliable and effective at reducing the need for potable water, particularly during peak summer months. During 2001, the California State Water Resources Control Board estimated that nearly 550,000 AF of water was recycled in California for various uses (**Figure 4-2**). Appendix G provides further details on specific non-potable reuse projects.

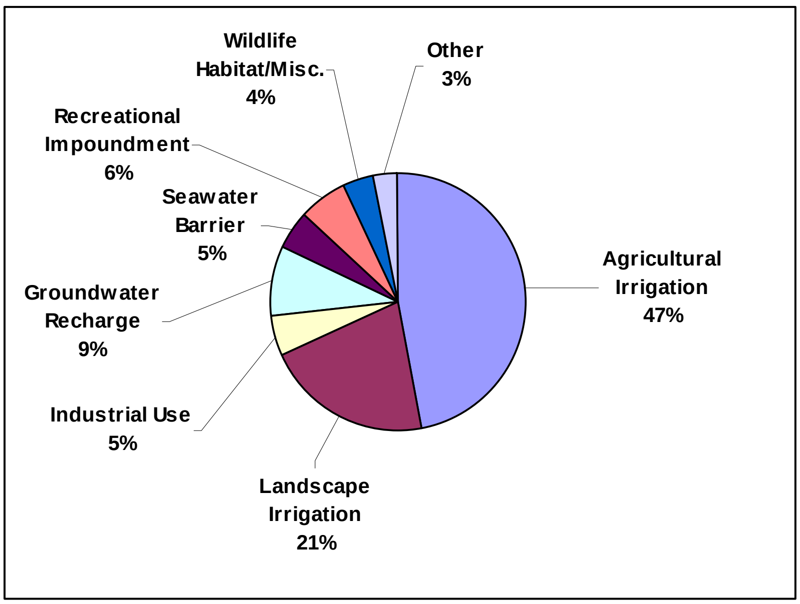

Figure 4-2 – 2001 California Recycled Water Use by Category
Source: Adapted from California State Water Resources Control Board data.

Agricultural and Landscape Irrigation

As illustrated in **Figure 4-2**, the primary non-potable use of recycled water in California is irrigation. In 2001, over two-thirds of all recycled water was used for agricultural and landscape irrigation. When using recycled water for agricultural irrigation, there are some contaminants of concern – primarily salinity, inorganic elements, residual chlorine, and nutrients. Although the presence of nutrients in recycled water is generally appreciated by irrigation customers and can be beneficial to plant growth, excess amounts of salinity are potentially harmful to plants and can have long-term adverse effects on the soil.

Industrial Uses

Approximately five percent of the recycled water use in California is through industry. There are a variety of industrial applications well-suited to recycled water. For many industries, cooling water for commercial air conditioning systems comprises the largest use of recycled water. Power plants (including geothermal energy) and refineries can use substantial amounts of cooling water. The use of recycled water for cooling is beneficial for its suppliers in that it typically has a more constant demand than landscape irrigation. Boiler water make-up is another opportunity, however unless there is a large user such as a refinery, the amount of water used in this process is typically small. Dual-plumbed buildings, where recycled water could be supplied to toilets and urinals, are another option.

Other Non-potable Opportunities

The remaining non-potable uses of recycled water represent either a much smaller amount of overall reuse potential or an application difficult to implement in San Diego. In general, these opportunities include private residential landscape irrigation, wildlife habitat enhancement or wetlands creation, recreational impoundments (lakes or ponds), and other uncommon or specialized uses.

Padre Dam Municipal Water District – Santee Lakes Recreation Preserve uses recycled water.

Private Residence Landscape Irrigation Use

Irrigation of single-family residential lots with recycled water is allowed in California, with the most notable and recent example being in the Northern California El Dorado Irrigation District, just east of Sacramento. Though private residential use of recycled water has been discouraged locally by the San Diego County Department of Environmental Health because of concerns regarding homeowner maintenance and cross-connection control, the El Dorado project overcame these concerns by forming a homeowner's association to manage the use of recycled water for landscape irrigation.

Recreational Impoundment and Wildlife Enhancement Uses

Environmental and recreational applications include wetland restoration and enhancements as well as incidental contact (fishing, boating) and direct contact (swimming, wading) uses. California allows recycled water use for these applications but with restrictions depending upon the likelihood and degree of body contact. Unrestricted recreational uses require disinfected tertiary recycled water and extra monitoring for pathogens such as *Giardia, Cryptosporidium* and viruses. In San Diego County, the Padre Dam Municipal Water District uses recycled water in their Santee Lakes Recreation Preserve.

Miscellaneous Uses

Although recycled water is used elsewhere in California for fire protection, snowmaking, construction/dust control, street sweeping, car washes and commercial laundries, these uses are generally small. With the exception of snowmaking, San Diego could use recycled water for these activities if these agencies and commercial enterprises expressed interest and the activities were in the vicinity of recycled water facilities, though it would need to be at the discretion of the City and the specific potential customers. Overall, these uses would tend to be relatively small compared to the potential of the other opportunities presented.

4.3 Indirect Potable Reuse Description and Project Types

The City purchases all of its imported water from the Water Authority, which in turn purchases its water from the Metropolitan Water District (MWD) of Southern California and the Imperial Irrigation District (IID). The water sold by MWD is a blend of Colorado River and California State Project Water, and the blend varies depending on price and supply availability. Approximately 80 to 90 percent of all drinking water in the City originates from these two sources.

California's annual use of Colorado River water has varied from 4.5 to 5.2 million AF over the last ten years. Historic and current use of up to 5.2 million AFY stems from the occurrence of surplus conditions and the availability of water apportioned to, but unused by, Arizona and Nevada. However, both states are approaching full use of their allocations, thereby reducing the likelihood that surplus Colorado River water will be available for purchase by MWD and other California water users.

In order to offset some of these losses to our future water supply, the Water Authority has reached an agreement to purchase up to 200,000 AF of Colorado River water apportioned to the IID. Part of this future supply will come from lining a 23-mile long section of the All American Canal, which currently loses approximately 67,700 AFY of water due to seepage into the ground.

The California State Project aqueduct is 444 miles long, starting from the Sacramento-San Joaquin Delta (Delta) and ending at Lake Perris in Riverside County. The Delta is a region where two of the California's largest rivers meet. Freshwater from the rivers mixes with saltwater from the Pacific Ocean, creating the West Coast's largest estuary. About two-thirds of all Californians and millions of acres of irrigated farmland rely on the Delta for water to supply the State Water Project and the federal Central Valley Project.

Unlike most river-supplied cities, San Diego's source water supply (a blend of local runoff, State Water Project and Colorado River waters), is of fairly good quality. That is not to say it is pristine mountain spring water. A few notable water agencies, including the City of San Francisco which receives 94% of its water from the Hetch Hetchy Reservoir filled with snowmelt from mountains in Yosemite National Park, and New York City, which receives over 90% of its water from highly protected watersheds in the Catskill Mountains, are exempt from federal treatment and filtration requirements prior to delivery to their customer's taps.

Conversely, San Diego's source water is superior to cities receiving water from the Mississippi River, Missouri River, or other rivers flowing through the central portion of the United States that have severely impacted water quality.

The Colorado and Sacramento-San Joaquin Rivers, like most rivers that pass through or near major cities, receive treated municipal wastewater and industrial inflows from upstream cities which blends with the river supply of downstream cities. The City of Las Vegas, for instance, discharges roughly 180,000 AF of tertiary treated municipal wastewater into Lake Mead each year, or about 2% of the total lake volume (as of November 2005 according to the U.S. Bureau of Reclamation volume data for Lake Mead; this percentage varies with lake volume). In addition to Las Vegas, there are about 650 total permitted dischargers, of which 360 are municipal and industrial dischargers into the Colorado River, upstream of the Colorado River Aqueduct intake point. Of these dischargers, 130 are relatively large dischargers (greater than 1.5 AF per day) and account for about 96.8% of the 2,610 AF per day of the total discharge back into the Colorado River. According to a 2004 U.S. Geological Survey (USGS) report on flow in the Colorado River Basin, the average daily river flow between 2001 and 2003 was slightly less than 14,800 AF per day. This roughly equates to discharges from Municipal and Industrial users into the Colorado River equaling 17.6% of the total river flow.

In the Sacramento and San Joaquin Rivers there are 339 permitted dischargers returning about 6,480 AF per day into these rivers (as of June, 2005). There are 137 relatively large dischargers (greater than 1.5 AF per day) along the Sacramento and San Joaquin Rivers accounting for about 98.8% of the total permitted discharges, however, these include agricultural returns as well as permitted municipal wastewater and industrial inflows. According to the California Department of Water Resources, the uninterrupted runoff into the combined Sacramento and San Joaquin Rivers averages about 68,800 AF per day. Therefore, discharges roughly equate to about 9.4% of the total combined river flow.

San Diego fully treats the "raw" or untreated water it receives using a conventional treatment process of chemical coagulation, flocculation, sedimentation, filtration and disinfection. Using this "conventional" treatment process, which most cities in the United States also use, San Diego has always met the water quality standards set by the EPA and DHS Drinking Water Standards. The City successfully removes all regulated chemical compounds and potential bacterial or protozoan pathogens to below the levels mandated for public health reporting to these regulatory agencies. For over 105 years, the City of San Diego Water Department has successfully delivered safe drinking water to all of its customers and continues to surpass all water quality standards set by state and federal public health agencies.

In side-by-side water quality analyses, tertiary treated water produced at the NCWRP has shown to have comparable or lower levels of all regulated chemical compounds compared to raw water supplies at lakes Miramar and Murray. Should the City proceed with an IPR project, such as augmenting a reservoir or groundwater basin with advanced treated water (post tertiary treatment, membrane filtration, reverse osmosis and advanced oxidation/disinfection), the same would hold true. In short: the resulting recycled water would be of superior quality to our current raw water supply.

Whenever a wastewater treatment plant discharges to surface water or groundwater that serves as a drinking water source for downstream cities, a form of IPR occurs, often referred to as unplanned reuse. This kind of reuse of treated wastewater, not necessarily of recycled water quality, has occurred for many decades throughout the United States. DHS does not consider such use IPR unless an individual wastewater discharge comprises more than five percent of the total water supply (California DHS, Bob Hultquist, personal communication, 2005).

In this Study, IPR is defined as advanced treated recycled water that is discharged into either groundwater or surface water that ultimately supplies the same area's drinking water system. Because it is intended for human consumption, this use receives a much higher degree of treatment than recycled water used for non-potable purposes.

The highly treated recycled water blends with the groundwater or surface water (which is usually imported water and local runoff) during a long residence time. The term "indirect" refers to the distinction that the advanced treated recycled water is not plumbed "directly" to the potable distribution system.

All indirect reuse projects in California require extensive planning, permitting and interaction with regulators. In IPR projects, all indications are that the water produced is of higher quality than most surface waters used as sources of drinking water in the US.

As there are no significant rivers in the San Diego vicinity, the City's treated wastewater is discharged to the ocean. To recycle this treated wastewater for IPR there are three basic types of projects that could be employed in San Diego:

- Groundwater recharge-spreading
- Groundwater recharge-injection
- Reservoir augmentation

Groundwater Recharge – Spreading

Surface spreading is a recharge method where recycled water is released into open basins and the water seeps down through the soil into the groundwater basin. It is used generally when enough land area is available, certain soil conditions are present, and if the groundwater basin is "unconfined" (water moves through the basin). Spreading of recycled water for groundwater replenishment has been done in Los Angeles and Orange Counties for many decades. See Appendix G for further details.

Groundwater Recharge – Injection

A more complex means of adding to groundwater resources is through injection. Recycled water injection simply pumps the recycled water down to the groundwater, bypassing the soil percolation step. Because injection introduces recycled water directly into the groundwater, it does not provide the treatment benefits that percolation provides. Accordingly, the injected water must be of higher quality than that used for surface spreading. Some states require treatment to drinking water standards. Injection of recycled water into groundwater basins has been done in Los Angeles County (West Basin Municipal Water District) since 1995 and in Orange County since the 1970's; details are available in Appendix G.

Reservoir Augmentation

Reservoir augmentation adds highly treated recycled water into a water reservoir to increase the overall water supply. Water used in reservoir augmentation projects undergo advanced treatment and disinfection. In addition to the advanced treatment, reservoir augmentation projects also allow the treated water to reside under natural environmental conditions for a period of time. This retention time provides an additional public health barrier, as natural reduction of trace contaminants occurs due to microbial degradation, oxidation, and dilution. The reservoir water would ultimately be pumped out and treated by a potable water treatment plant and used for drinking purposes. Reservoir augmentation has been in use at Occoquan, Virginia since 1978. Additional information can by found in Appendix G.

4.4 Recycled Water and Protection of Public Health

Risk assessment and risk management principles form the basis of California water regulations to protect public health. These regulations cover both the required treatment and allowable uses of recycled water. A multi-barrier treatment approach is recognized as a reliable means to protect public health and provide safe and reliable water supplies.

Risk Assessment and Management

Risk assessment has been defined as "the characterization of the potential adverse health effects of human exposures to environmental hazards" (National Research Council, 1983). Health risk assessments are used to determine if a particular chemical poses a significant risk to human health and, if so, under what circumstances. Risk assessment helps regulators develop consistent, realistic, and prioritized goals for reducing exposure to toxics so that health threats to the public can be reduced to a minimum.

The risk assessment process is typically described as consisting of four basic steps: hazard identification, exposure assessment, dose-response assessment, and risk characterization. Each of these steps is explained in detail in Appendix G. Government regulators turn to specialists to perform or assist with risk assessments. These specialists include scientists with degrees in toxicology (the study of the toxic effects of chemicals) and epidemiology (the study of disease or illness in populations), as well as physicians, biologists, chemists, and engineers. Risk assessments are designed to overestimate rather than underestimate potential risks in order to be conservative of public health.

Risk managers rely on these risk assessments when making regulatory decisions such as setting water quality standards. Because they are responsible for protecting human health, risk managers consider technological, socioeconomic, and political factors when arriving at their decisions.

Setting and Enforcing Standards

Risk assessment and risk management principles are used by both federal and state drinking water regulators. The Safe Drinking Water Act of 1974 requires the EPA to set drinking water standards. In addition, the EPA has developed many Drinking Water Health Advisories that provide guidance on various unregulated contaminants. The World Health Organization also produces “Guidelines for Drinking Water Quality” with comprehensive coverage of health-based values for water components, as well as providing management principles for providing safe drinking water.

States are also free to set their own standards, but state standards must be “at least as stringent as the federal standard”. California drinking water standards are set by the DHS using risk assessment information developed by the California Office of Environmental Health Hazard Assessment (OEHHA). California typically sets more stringent drinking water standards than those established by the EPA. The DHS sets drinking water maximum contaminant levels (MCLs) that carefully balance the health benefits with permit compliance feasibility/cost using the best available information. Water recycling projects that involve human contact (including drinking water) must meet these standards. Typically, the DHS includes drinking water MCL compliance requirements in the operating permits for recycled water projects that involve potential human contact. DHS can take enforcement action where compliance is not achieved.

In addition to establishing drinking water MCLs, DHS has developed enforceable regulations and guidance for recycled water projects. These are part of the permit issuance process the California regulatory agencies require cities and water districts to follow prior to granting approval for a recycling project to operate. The RWQCB issues the permits. DHS consults with the RWQCB and approves the public health and treatment requirements. To ensure that the proposed treatment method, distribution, and monitoring produces recycled water that meets the permit requirements and protects public health, the DHS evaluates every proposed water reuse project on a case-by-case basis.

Multiple-Barrier Approach to Public Health Protection

A multi-barrier water treatment approach is a proven means of protecting public health. Numerous, but not all, contaminants are regulated in drinking water and recycled water. The reason some contaminants are not regulated is because monitoring methods either do not exist or are too complicated for routine monitoring, or there is no reason to believe the contaminants are present to begin with. DHS regulators manage this uncertainty by using what is referred to as a multiple-barrier treatment approach (Velz, 1970; AWWA, 1987). This means that several treatment processes are used in a sequence to remove contaminants. In this manner, if one treatment barrier were to fail, the later independent treatment barriers would still insure proper treatment and removal of contaminants.

The multi-barrier approach is used for both drinking water treatment and recycled water treatment (Davies et al, 2003; Luna et al, 2004). It includes source control (prevention of contaminants from entering the water supply), use of multiple water treatment processes, and water quality monitoring and surveillance. The basis of this approach is to ensure that there are prudent checks and balances in place to minimize the risk of failure and, ultimately, prevent exposure of consumers to unsafe water. A major advantage of the use of multiple-barrier water treatment methods is that the methods can also be effective at removing unknown contaminants.

Source Control

An increasingly important additional barrier against unknowns is the use of source control. Source control requirements are part of the permit process to utilize recycled water as they identify and minimize the introduction of contaminants into the wastewater, eliminating the need for them to be removed through treatment. The City’s Metropolitan Wastewater Department (MWWD) regulates the quality of the wastewater that enters the wastewater system through an enforceable Industrial Wastewater Control Program (City of San Diego, 2005; EPA, 1992). A joint effort between the City, other agencies served by the system, and local industry, the program issues discharge permits, performs inspections, conducts wastewater monitoring, and enforces discharge standards at businesses and industries throughout the service area.

Similarly, the Orange County Sanitation District (OCSD) is adopting an enhanced source water control program that expands the list of pollutants of concern entering the treatment plant to include regulated and newly discovered drinking water contaminants. The OCSD will provide treated wastewater as the source water for the Orange County Water District's (OCWD) advanced treatment Groundwater Replenishment Project.

4.5 Water Treatment Technology

With today's technology, there are many differing individual treatment methods that can be linked together to provide water treatment for recycled water uses. In a multi-barrier approach these methods are carefully selected and placed in a specific order in a treatment plant depending on the required water quality needed. Both public health and the quality of water needed for the specific use guide the level of treatment needed. A more detailed description of water treatment methods and additional references is included in Appendix G.

Water treatment methods can be used to remove or reduce broad classes of contaminants including:

- Microorganisms (disease-causing bacteria, viruses and protozoa),
- Organic chemicals (pesticides, herbicides, trace contaminants),
- Inorganic chemicals (metals, nutrients, and minerals),
- Physical measurements (color, turbidity, and odor), and
- Radiologicals (radioactive substances).

Recycled water treatment methods are specifically designed and sequenced to reduce the amount of these contaminants to levels that consider the end use and protect the health of the public. Importantly, the treatment methods also provide multiple barriers to remove other similar contaminants. The effectiveness of removal depends on the method selected and how it is designed, operated and maintained. The general ability of each of the treatment methods to address classes of contaminants in water is shown in **Table 4-1**.

Non-potable reuse applications generally use source control, primary treatment, secondary treatment, tertiary treatment and chlorine disinfection. Special uses like industrial boiler water supply may require additional treatment to remove inorganic minerals that might damage the boiler.

Because the water will ultimately be consumed by people, IPR projects incorporate advanced water treatment methods (often including additional pretreatment). DHS requires RO and ultraviolet disinfection (UV) plus hydrogen peroxide in IPR projects to address health concerns related to trace organic contaminants, such as pharmaceuticals and personal care products (PPCPs). The City has many years of experience testing RO systems. In fact, results from current tests of these technologies indicate that, together, these processes can reduce trace contaminants in water to below the detection limits of the most sensitive test methods available. Studies conducted to date support both non-potable and IPR as feasible options for the City that can be implemented in a fashion that protects public health.

Table 4-1
Water/Wastewater Treatment Removal of Contaminants

	Contaminant Class						
		Pathogens					
Treatment Method	Particles	Bacteria	Viruses	Parasites	Inorganics	Organics	Radionuclides
Pretreatment	✓				✓	✓	✓
Primary Treatment	✓					✓	
Secondary Treatment	✓					✓	
Tertiary Treatment	✓	✓	✓	✓	✓	✓	✓
Microfiltration	✓	✓		✓			
Ultrafiltration	✓	✓	✓	✓		✓	
Reverse Osmosis	✓	✓	✓	✓	✓	✓	✓
Ion Exchange					✓		✓
Ozone		✓	✓	✓		✓	
UV + Hydrogen Peroxide		✓	✓	✓		✓	
Granular Activated Carbon						✓	
Soil Aquifer Treatment	✓	✓	✓	✓		✓	
Wetlands	✓				✓	✓	
Chlorine Disinfection		✓	✓				

Importantly, while both non-potable and IPR are supported by and allowed under California regulations, successful implementation of projects has only occurred where there is community and political support.

IPR projects produce advanced treated water that could be blended with local runoff and imported water from the Colorado River and the State Water Project. The blended water would then be stored in City-owned raw water reservoirs located in San Diego County. After a period of time, water taken from these reservoirs would be treated by one of the City's three water treatment plants: Alvarado, Miramar or Otay. Alvarado has a present drinking water production capacity of 120 MGD, and current expansion projects will increase its production capacity to 200 MGD. Also under expansion, Miramar will increase its drinking water production capacity from 140 MGD to 215 MGD. Otay has a drinking water production capacity of 34.5 MGD. Upgrades of these treatment facilities include the use of ozone at Alvarado and Miramar, and UV at Otay as primary disinfectants to reduce the amount of chlorine needed, thereby reducing odors, improving taste, and decreasing the production of disinfection byproducts (compounds combined with chlorine) in the water. These upgrades are expected to be completed by 2010.

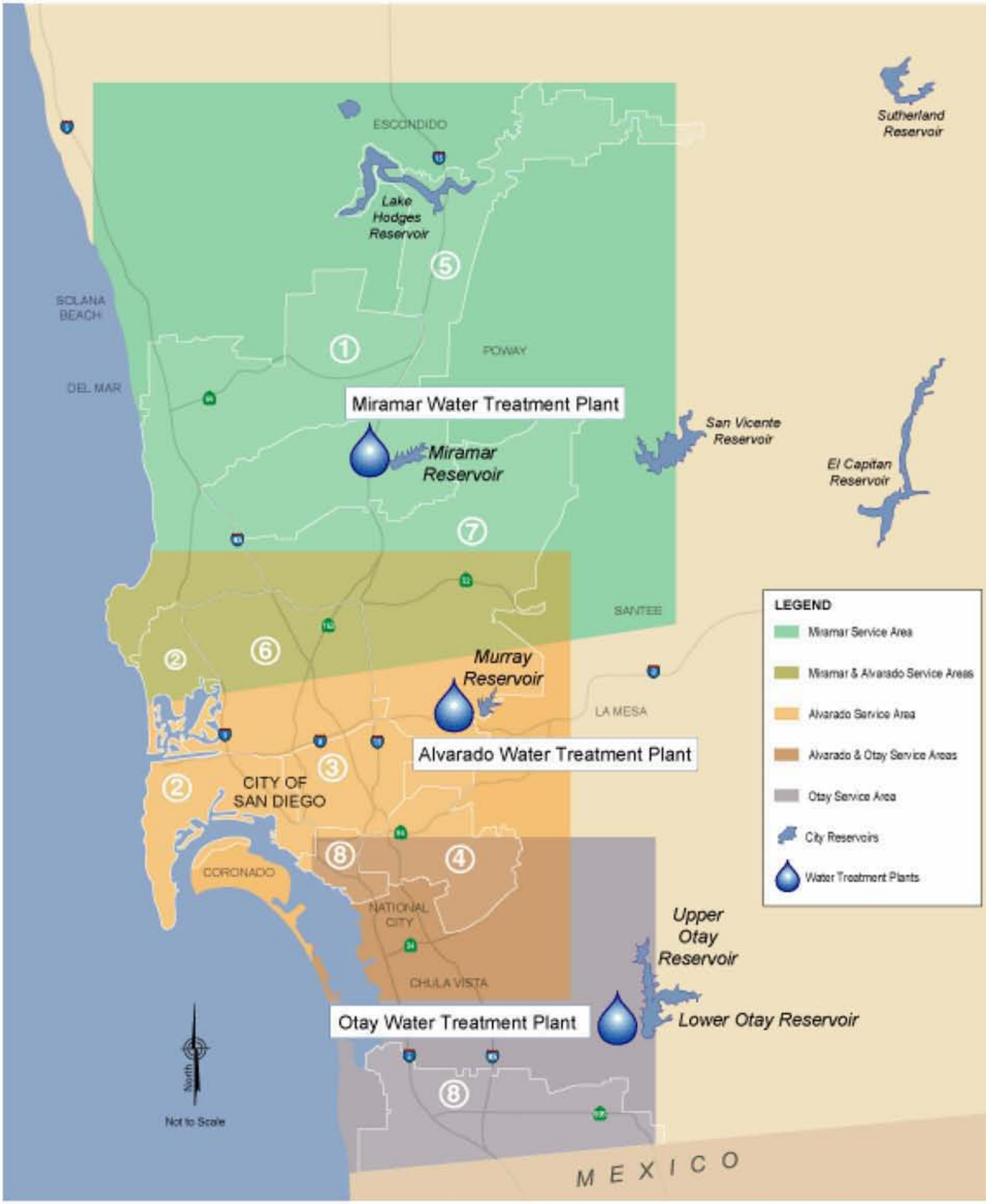

Figure 4-3 – Service areas for City of San Diego Water Treatment Plants (Circled numbers denote City Council Districts)

The service areas for the three City drinking water treatment plants are shown in **Figure 4-3**. Each of these service areas can be expanded to overlap and supplement water from one plant with that of the others. The City also provides water to other agencies outside of the City boundaries, such as the City of Del Mar and the California-American Water Company, which provides water to the City of Imperial Beach.

All of the City's water treatment plants use chemical coagulation, flocculation, sedimentation and disinfection by chloramines, the conventional water treatment process used throughout the United States today. In fact, conventional water treatment was deemed "*one of the most significant public health advancements of the 20th Century*" by the U.S. Centers for Disease Control and Prevention and the National Academy of Engineering (EPA, 2000). Diseases such as cholera and typhoid fever, which in 1900 resulted in more than 16 deaths per year for every 1,000 people living in the United States, have been virtually wiped out due to water filtration and disinfection using chlorine. The City's Water Quality Laboratory continuously tests water quality for compliance with all state and federal regulations. The raw water reservoirs, treatment plants and drinking water distribution systems are sampled and tested by the laboratory with results reported to the EPA and DHS.

4.6 Regulations and Public Health Issues Associated with Non-potable Reuse

City of San Diego Mandatory Reuse Ordinance

On July 24, 1989, Council adopted the Mandatory Reuse Ordinance (O-17327), stating in part that, *"Recycled water shall be used within the City where feasible and consistent with the legal requirements, preservation of public health, safety and welfare, and the environment."* Resolution R-297487, passed by Council on December 9, 2002, authorized City staff to work in conjunction with the PUAC to develop specific criteria to be applied in determining which particular properties would be required to use recycled water for suitable and approved purposes. Customers whose property lines are contiguous with the City's recycled water pipeline alignments and who use significant amounts of potable water for irrigation or industrial uses are likely to be subject to the pending criteria. These criteria were taken into consideration in the development of non-potable reuse opportunities.

The City's proposed Mandatory Reuse Ordinance criteria would require new buildings, constructed in proximity to the recycled water system, with cooling tower or boiler makeup water needs exceeding 5 AFY to plumb these facilities for recycled water. Some existing recycled water customers have already converted their sites. New development that meets the proposed criteria would be identified in the tentative map approval process and required to use recycled water. In addition, the City is evaluating dual plumbing for new schools, commercial, industrial and government buildings to provide recycled water to toilets and urinals. If pursued, the requirement would apply to new buildings in excess of 55 feet in height, projected to have at least 800 occupants or encompass 80,000 square feet. One new building in San Diego has been dual plumbed and another is pending inspection and approval.

Recycled Water Regulations for Non-Potable Uses

Section 13521 of the Porter-Cologne Act grants DHS the authority to set criteria for recycled water use where such use would require specific protection of public health. As a result, DHS developed comprehensive uniform regulations that established acceptable uses of recycled water, water quality, and treatment process requirements to ensure that recycled water use does not pose health risks. DHS also requires engineering reports, design documents, reporting and record keeping to ensure operational reliability of treatment. These requirements are regulated under Title 22 of the California Administrative Code (Title 22, California Code of Regulations, §60301 *et seq.*) and enforced by the RWQCBs. Each RWQCB issues permits for individual projects to conform to the regulations and recommendations adopted by DHS.

California has a number of definitions for differing grades of recycled water based on level of treatment and effluent water quality criteria, the allowable uses for which are listed in **Table 4-2**. The City's NCWRP and SBWRP provide disinfected tertiary recycled water. This is the highest quality of recycled water for non-potable uses as defined in Title 22.

Health and Safety of Non-Potable Uses

California has a long track record of producing safe recycled water for non-potable uses. Non-potable treatment requirements and regulations use the aforementioned risk assessment/ management principles and multi-barrier treatment approach to provide the appropriate levels of treatment and health protection for this specific use. Full-body contact (such as swimming) is allowed with tertiary treated Title 22 water.

The safety of playfields and parks irrigated with recycled water are among the key public health concerns related to the safety of non-potable water. As part of a 2005 WaterReuse Foundation study, James Crook, the study's author, conducted an extensive literature search on the safety of non-potable use of recycled water. The study concluded that the irrigation of parks, playgrounds, athletic fields, and schoolyards with highly treated and disinfected reclaimed water is safe and does not present any known health risks to children, adults or animals that are measurably different than risks associated with irrigation using potable water.

4.7 Regulations and Public Health Issues Associated with Indirect Potable Reuse

Recycled Water Regulations for Indirect Potable Reuse

The only form of IPR currently regulated in California is groundwater recharge, with the permit approval process under the auspices of the local RWQCB. DHS has developed draft regulations for groundwater recharge and uses those regulations as a guideline in setting parameters for other types of IPR projects. DHS provides recommendations to the RWQCB regarding the acceptability of IPR projects and uses the draft recharge reuse regulations as a key part of the approval process.

In addition to compliance with MCLs, DHS draft regulations place additional requirements on IPR projects. These include control of contaminants at the source, multi-barrier treatment methods to control pathogens, inorganic and organic contaminants, treatment standards, recharge methods, extraction well location, and monitoring requirements (see Appendix G for details).

Table 4-2
Allowable Non-potable Uses based on Title 22 Treatment Level

Types of Recycled Water Use	Recycled Water Treatment Level		
	Disinfected Tertiary	Disinfected Secondary	Undisinfected Secondary
Urban Uses and Landscape Irrigation			
Fire Protection	✓		
Toilet and Urinal Flushing	✓		
Irrigation of Parks, Schoolyards, Residential Landscaping	✓		
Irrigation of Cemeteries, Highway Landscaping		✓	
Irrigation of Nurseries		✓	
Landscape Impoundment	✓	✓ *	
Agricultural Irrigation			
Pasture for Milk Producing Animals		✓	
Fodder and Fiber Crops			✓
Orchards (no contact between fruit and recycled water)			✓
Vineyards (no contact between fruit and recycled water)			✓
Non-Food Bearing Trees			✓
Food Crops Eaten After Processing		✓	
Food Crops Eaten Raw	✓		
Structural Fire Fighting	✓		
Commercial Car Washes	✓		
Commercial Laundries	✓		
Artificial Snow Making	✓		
Soil Compaction, Concrete Mixing		✓	
Environmental and Other Uses			
Recreational Ponds with Body Contact (Swimming)	✓		
Wildlife Habitat/Wetland		✓	
Aquaculture	✓	✓*	
Groundwater Recharge			
Seawater Intrusion Barrier	✓*		
Replenishment of Potable Aquifers	✓*		

*Restrictions may apply

SOURCE: Water Recycling 2030, California's Recycled Water Task Force, June 2003.

DHS will not issue a recommendation for project approval unless the proponent provides extensive evidence that the project will not detrimentally affect human health. Their subsequent recommendations are based on treatment provided, effluent quality and quantity, spreading area operations, soil characteristics, hydrogeology, residence time, and distance to withdrawal.

Beginning with treated recycled water from the NCWRP or the SBWRP, a City groundwater or reservoir augmentation project could then undergo advanced treatment, including membrane filtration, RO, and disinfection. As described in Section 4.4, these combined treatment methods have been shown to be effective barriers against contaminant passage.

Preliminary discussions with DHS representatives (January 2005) indicated that any proposal for a reservoir augmentation project would need to consider recent changes made to the Draft Groundwater Recharge Reuse Regulations (State of California, December 2004). As described above, the new draft's regulations have requirements on organic contaminants (total organic carbon), inorganic contaminants (nitrogen) and source control. In addition, the RWQCB may add more requirements for inflows to a reservoir, particularly with regard to nitrogen. DHS would likely require two treatment barriers for each type of contaminant. As long as the project meets all DHS treatment and reservoir management requirements, introduction of highly treated recycled water into a drinking water source reservoir could be permitted.

Health and Safety of Indirect Potable Reuse

Permitted IPR projects are carefully regulated and protect the public health through:

- Use of advanced water treatment methods that reliably remove contaminants of concern.
- Careful operation and maintenance of those methods.
- Use of multiple monitoring systems to ensure consistently high quality water is produced.

With regard to IPR health and safety issues, the most comprehensive assessment to date was conducted by the National Research Council (NRC: Issues in Potable Reuse: The Viability of Augmenting Drinking Water Supplies with Reclaimed Water, 1998).

The report referenced several large-scale health effects studies of recycled water covering both microbiological and chemical contaminants, noting that these studies identified no obvious adverse health effects associated with IPR in the specific projects examined (Windhoek, South Africa; Los Angeles County, CA; Washington, D.C.; Denver, CO; San Diego, CA; and Tampa, FL). These studies varied widely in approach and should be considered individually (they are discussed further in Appendix G). There were also design drawbacks in each of these studies, which limit their individual and overall usefulness to assess health risks. The studies varied considerably from combinations of simple screening and chemical identification studies to toxicology testing. Only the Denver and Tampa studies addressed a broad range of toxicological concerns.

Nonetheless, the report included several important observations:

- Current projects and studies have demonstrated the capability to reliably produce water of excellent measurable quality.
- In communities using reclaimed water where analytical testing, toxicological testing, and epidemiological studies have been conducted, significant health risks have not been identified.
- The best available current information suggests that the risks from IPR projects are comparable to or less than the risks associated with many conventional supplies.

The general conclusion of the NRC report was that "*planned, indirect potable reuse is a viable application of reclaimed water - but only when there is a careful, thorough, project-specific assessment that includes contaminant monitoring, health and safety testing, and system reliability evaluation*."

IPR projects have been implemented in several communities. The available human health studies are sufficient to convince the DHS and other regulatory agencies that highly treated recycled water can be safely consumed by humans through IPR projects. In California, the West Basin Municipal Water District (El Segundo), the Orange County Water District (Fountain Valley), and the County Sanitation Districts of Los Angeles County (Montebello Forebay) currently operate IPR projects. The latter reuse project started in 1962. Additional studies and community experiences are discussed in Appendix G.