Sonoma County Water Agency

Low Impact Development (LID) Guidebook

Approaches to Water Conservation, Water Reuse, and Stormwater Management

SCWA conservation program

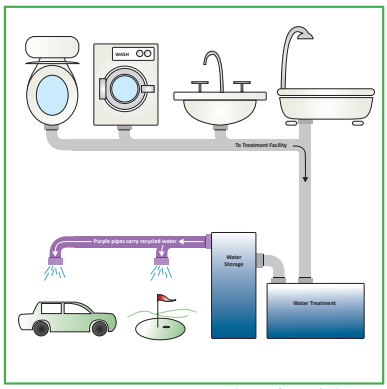
Water Submeter (Santa Clara Valley Water District)

Conservation program

Water Conservation

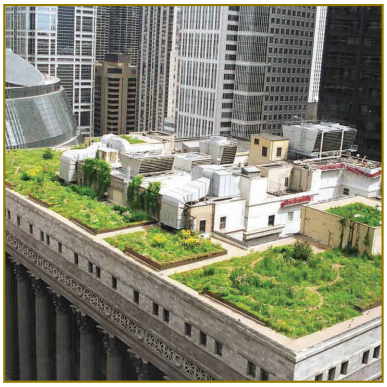
Rainwater harvesting system

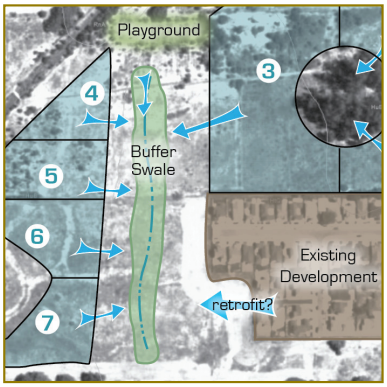
Rain barrels (www.wordpress.com)



Generation and use of recycled water

Water Reuse


Green Roof atop Chicago City Hall (Wikimedia Commons)



Drainage management areas

Vegetated swale in parking lot (RMC Water & Environment)

Stormwater Management

Horizon WATER and ENVIRONMENT

Draft

June 2010

Low Impact Development Guidebook

Draft

Prepared for:

Sonoma County Water Agency
404 Aviation Boulevard
Santa Rosa, CA 95406

Prepared by:

Horizon Water and Environment
1330 Broadway, Suite 424
Oakland, CA 94612

With assistance from:

RMC Water and Environment
222 Sutter Street, Suite 700
San Francisco, CA 94108

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List of Acronyms

AB	Assembly Bill
AF	Acre-Feet
afy	acre-feet per year
BMP	Best Management Practice
BO	Biologic Opinion
CCCWP	Contra Costa Clean Water Program
CII	Commercial, Industrial, and Institutional
CIMIS	California Irrigation Management Information Systems
CSD	Community Sanitation District
CUWCC	California Urban Water Conservation Council
DIR	Demand-Initiated Regeneration
DMA	Drainage Management Area
DOE, USDOE	United States Department of Energy
DWR	Department of Water Resources
EPA, USEPA	United States Environmental Protection Agency
ET	evapo-transpiration
FCDC	Flood Control and Design Criteria
gpd	gallons per day
gpf	gallons per flush
gpm	gallons per minute
gpr	gallons per rack
gpv	gallons per vehicle
HCD	Department of Housing and Community Development
HCP	Hydromodification Control Plan
HECW	High-Efficiency Clothes Washers
HET	High-Efficiency Toilet
HEU	High-Efficiency Urinal
HOA	Homeowners' Association
IRWM(P)	North Coast Integrated Regional Water Management (Plan)
LID	Low Impact Development
MBR	Membrane Bioreactor
MEP	Maximum Extent Practicable
mgd	million gallons per day
MOU	Memorandum of Understanding
MS4	Municipal Separate Storm Sewer System
NBWRP	North Bay Water Recycling Program
NPDES	National Pollutant Discharge Elimination System
NSCARP	North Sonoma County Agricultural Reuse Project
NSW	(Australia) New South Wales Government
O&M	Operations and Maintenance
PRMD	Sonoma County Permit and Resource Management Division
QWEL	Qualified Water Efficient Landscaper Certificate Program
RWQCB	North Coast Regional Water Quality Control Board
SB	Senate Bill
SCEIP	Sonoma County Energy Independence Program

SCGWG	Sonoma County Graywater Working Group
SCWA, the Agency	Sonoma County Water Agency
SRPCS	Santa Rosa Plain Conservation Strategy
SWRCB	State Water Resources Control Board
SZ	Sanitation Zone
TMDL	Total Maximum Daily Load
UWMP	Urban Water Management Planning Act

Chapter 1
Introduction & Purpose

1.1 The Opportunity of Low Impact Development

The Sonoma County Water Agency (SCWA) developed this LID guidebook to provide the residents of Sonoma County, land developers, city and county planning officials, and environmental regulatory agencies with a current reference guide to avoid and minimize potential water resource impacts while planning residential and commercial development.

Low Impact Development (LID) is a planning and design strategy used to avoid and reduce potential harmful water resource impacts associated with residential and commercial development. Most commonly, the LID approach is focused toward preventing excess runoff generation and water quality impacts associated with development and urban stormwater. The Environmental Protection Agency (EPA) defines LID as a sustainable landscaping approach that can be used to replicate or restore natural watershed functions and/or address targeted watershed goals and objectives (http://www.epa.gov/nps/lid). As a strategy, LID provides an opportunity to avoid and reduce water resource and watershed impacts beyond just the management of urban runoff. By integrating land use practices with water resource management, LID approaches can also help reduce water demand.

The three core subjects of this guidebook include a discussion of ways to increase water conservation, increase water reuse, and reduce stormwater impacts. These subjects have traditionally been reviewed and investigated as separate topics. However, this guidebook seeks to integrate these subjects within a single document to highlight potential areas of synergy and mutual benefit between the topics. Developers, planners, and water managers may benefit from considering the potential effects of development projects across the spectrum of water conservation, reuse, and stormwater topics. For example, a rainwater harvesting system or a bio retention swale that collects runoff may provide immediate benefits by reducing stormwater – but such treatments may also provide water for irrigation purposes, that in turn, reduces water demand.

It is envisioned that this guidebook can provide a basis for individual communities, developers, or water managers to develop their own more detailed action plans for their specific community or project needs.

The multi-objective scope of this guidebook also supports several regional goals and initiatives, including:

- Energy saving and sustainability initiatives are supported through the water conservation and water reuse approaches of this guidebook.
- Integrated Regional Water Management (IRWM) is supported through the integrated water management strategies promoted in this guidebook.
- Flood management programs are supported by the many stormwater reduction strategies described in this guidebook. SCWA is currently revising its Flood Control Design Criteria (FCDC) Manual. The FCDC manual has served as the primary hydrologic analysis and design guidance for the water agency and County since 1966. The revised FCDC Manual will reference LID approaches as described in this guidebook. SCWA has also recently revised its Stream Maintenance Program (SMP) to emphasize longer term and more sustainable maintenance approaches.

This guidebook also supports requirements of the recently revised Phase 1 National Pollution Discharge Elimination System (NPDES) Permit for discharges from municipal separate storm sewer systems (MS4) for the City of Santa Rosa, County of Sonoma, and the SCWA. The revised NPDES Permit (Order R1-2009-0050) was adopted October 1, 2009 and includes several LID related requirements[1]. The revised permit specifies that LID is the preferred Best Management Practice (BMP) to address runoff and water quality issues associated with development. Additionally, the NPDES Permit requires that the co-permittees develop an LID technical guidance manual. The required LID guidance manual should provide land planners, engineers, and developers with objectives and specifications on how to integrate LID strategies into the project planning and design process. This guidebook is intended to satisfy these requirements.

1.2 Water Resources in Sonoma County

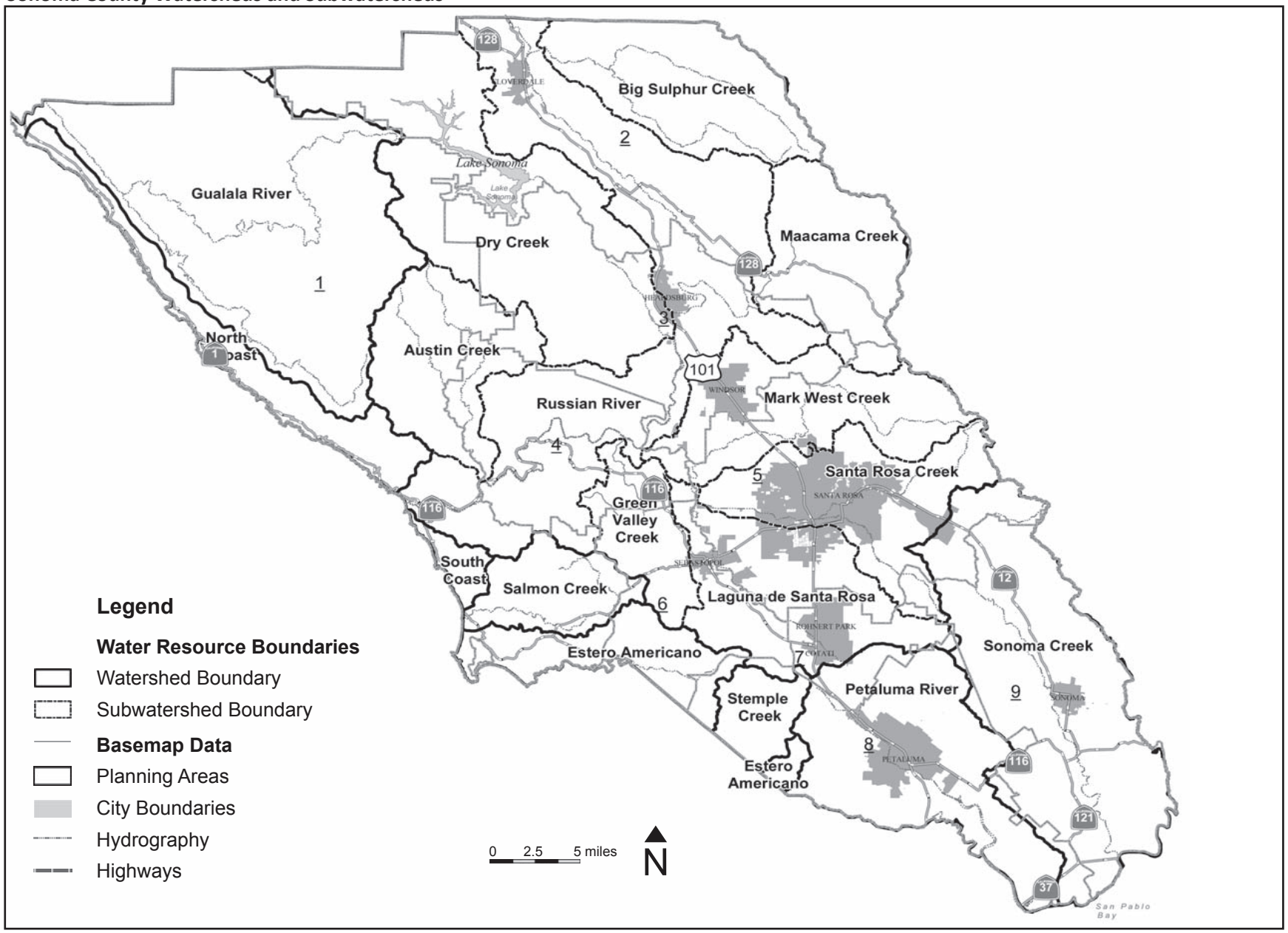
1.2.1 Surface Water

The Russian River watershed drains 1,485 square miles, including much of Sonoma and southern Mendocino counties and provides the majority of the surface water supply for the region. The river travels approximately 110 miles southward from its headwaters to Mirabel Park, and then flows westward to its discharge point at the Pacific Ocean near Jenner. There are five principal tributaries to the Russian River: the East Fork of the Russian River, Big Sulphur Creek, Mark West Creek, Maacama Creek, and Dry Creek, as shown in **Figure 1-1**.

Two important reservoir projects (Lake Mendocino and Lake Sonoma) provide water supply storage in the Russian River watershed. Additionally, PG&E's Potter Valley Project diverts Eel River water into the Russian River watershed for power generation. This Eel River water, which

[1] The Phase I NPDES Permit can be reviewed at: <www.swrcb.ca.gov/northcoast/water_issues/hot_topics/santa_rosa_ms4_npdes_stormwater_permit>

Figure 1-1
Sonoma County Watersheds and Subwatersheds



Source: Sonoma County PRMD, 2005

is not controlled by SCWA, supplements Russian River water flowing into Lake Mendocino. Lake Sonoma and Lake Mendocino also provide important flood control benefits. Under operational agreements with the United States Army Corps of Engineers (USACE), SCWA manages the water supply storage in these reservoirs, while the USACE is responsible for flood management activities including reservoir releases when water levels are above the water supply pool (typically during the winter flow season).

Lake Sonoma and Lake Mendocino are operated in accordance with flow criteria established by State Water Resources Control Board (SWRCB) Decision 1610. In Decision 1610, instream flow requirements are targeted to support water supply, recreation, fish, and wildlife needs. Recently, the combination of federally mandated reductions in Eel River imports, a series of dry years, and a federally mandated Biological Opinion (discussed below) required SCWA to apply to the SWRCB to temporarily lower instream flow requirements. Currently, SCWA has filed petitions with SWRCB requesting modifications to Decision 1610. SCWA must complete an Environmental Import Report to describe the impacts of the proposed changes, but there is no specific timeline for when the SWRCB will change Decision 1610.

Another key regulatory process that has influenced streamflow and surface water supply in the Russian River watershed is the September 2008 Biological Opinion (BO) issued by the National Marine Fisheries Service (NMFS). This BO analyzed the impacts of SCWA's existing water supply and maintenance activities on three fishery species listed under the federal Endangered Species Act. Implementing the BO will require reductions in instream summertime flows in the main stem Russian River, and limiting summer releases from Lake Sonoma to Dry Creek. Because restricting summer releases to Dry Creek reduces water delivery capacity, SCWA is currently investigating new water supply and conservation strategies to meet future water demands in a safe, economical, and reliable manner.

1.2.2 Groundwater

In addition to surface water supplies provided by Lake Mendocino and Lake Sonoma, groundwater is an important water source in Sonoma County. There are eleven separate groundwater basins in Sonoma County (DWR *Bulletin 118,* 2003). The four largest basins include the Santa Rosa Plain (125 sq mi), Petaluma Valley (70 sq mi), Sonoma Valley (70 sq mi), and Alexander Valley (47 sq mi) basins. In terms of geology, the Quaternary alluvial valleys, Tertiary/Quaternary sedimentary formations, and Sonoma Volcanic bedrock of the County can provide good aquifers where porosity and permeability are favorable.

Countywide, groundwater is the primary source of water for agricultural uses and is a significant source of water for the population in unincorporated areas of the County. It is estimated that groundwater provides approximately 42% of the net annual water supply in Sonoma County (Sonoma County General Plan 2020 Final EIR, Sonoma County Permit and Resource Management Department 2007). Groundwater provides a significant portion of the water supply for the cities of Sonoma, Sebastopol, Cotati, Rohnert Park, and Petaluma. The Valley of

the Moon Water District and SCWA also rely on groundwater to supplement their surface water supply. It is estimated that there are over 40,000 groundwater wells in Sonoma County, with 80% of them serving residential purposes and 20% serving agricultural needs (Sonoma County General Plan 2020, Sonoma County 2009).

In terms of LID, an increase in impervious surfaces from development occurring over effective infiltrating soils can diminish shallow infiltration, lessen deeper percolation rates and thereby reduce groundwater recharge below. In Sonoma County, the sandy and coarse gravel bed of streams and flood control channels are also important recharge zones. Recently a collaborative stakeholder process developed a groundwater management plan for the Sonoma Valley (2007). This Plan identifies a range of voluntary water management actions to sustain resources for future generations. Currently, the USGS is evaluating groundwater in the Santa Rosa Plain basin including assembling comprehensive data, developing a GIS system, characterizing the groundwater hydrologic budgets, and also developing a surface-groundwater flow model. The study will be completed by the end of 2010, with publication of the study results scheduled for early 2011. Results from the study will provide stakeholders with tools to assist in evaluating the hydrologic impacts of future climate-change scenarios and alternative groundwater management strategies for the basin. Additionally, the study could potentially form the technical foundation for a local non-regulatory groundwater management planning process.

1.2.3 Treated Wastewater

Recycled water is highly treated wastewater that is beneficially reused in a variety of non-potable applications such as irrigation of public parks and golf courses. Recycled water is reliable and sustainable and its proper use protects the environment and potable supplies. Recycled water in Sonoma County provides a valuable resource.

As discussed in more detail in Chapter 3 *Water Reuse*, the Subregional Water Reclamation System managed by the City of Santa Rosa treats wastewater from the cities of Santa Rosa, Rohnert Park, Cotati, Sebastopol, and the South Park Community Service District. The subregional facility generates approximately 25,000 acre-feet or 8 billion gallons of recycled water per year that is distributed throughout the county for landscaping, agricultural irrigation, and groundwater recharge for the purpose of geothermal energy generation. Additionally, the City of Petaluma, Forestville Water District, Bodega Bay Public Utilities District, and the Town of Windsor each generate recycled water (between 140 and 6,000 acre-feet per year) for reuse as agricultural or landscaping irrigation. As of 2005, over 33,000 acre-feet of recycled water is generated per year in Sonoma County at local wastewater treatment facilities and reused.

SCWA also operates nine sanitation districts and zones throughout the county. Some of these facilities provide recycled water for agricultural, forestland, and golf course irrigation. Sanitation agencies that distribute recycled water include the Occidental, Russian River, and the Sonoma Valley County Sanitation Districts, the Airport/Larkfield/Wikiup Sanitation Zone, and the

Sea Ranch Sanitation Zone. Approximately 2,800 acre-feet or 921 million gallons of recycled water is supplied by these SCWA-operated facilities.

Water recycling is an important component of LID-related discussions of water supply and water conservation. This guidebook incorporates LID approaches to protect and extend water supplies through county-wide implementation of water recycling, graywater reuse, and rainwater harvesting actions.

1.2.4 Water Supply Purveyors and Users

Sonoma County Water Agency (wholesale provider)

SCWA is the primary wholesale distributor of drinking water for approximately 600,000 residents in Sonoma County and northern Marin County[2]. The annual water supply delivered by the SCWA water transmission system to all of its users is approximately 50,000 to 60,000 acre-feet. A summary of current water delivery information in SCWA's service area is provided on SCWA's website at: http://www.scwa.ca.gov/water-delivery-data/.

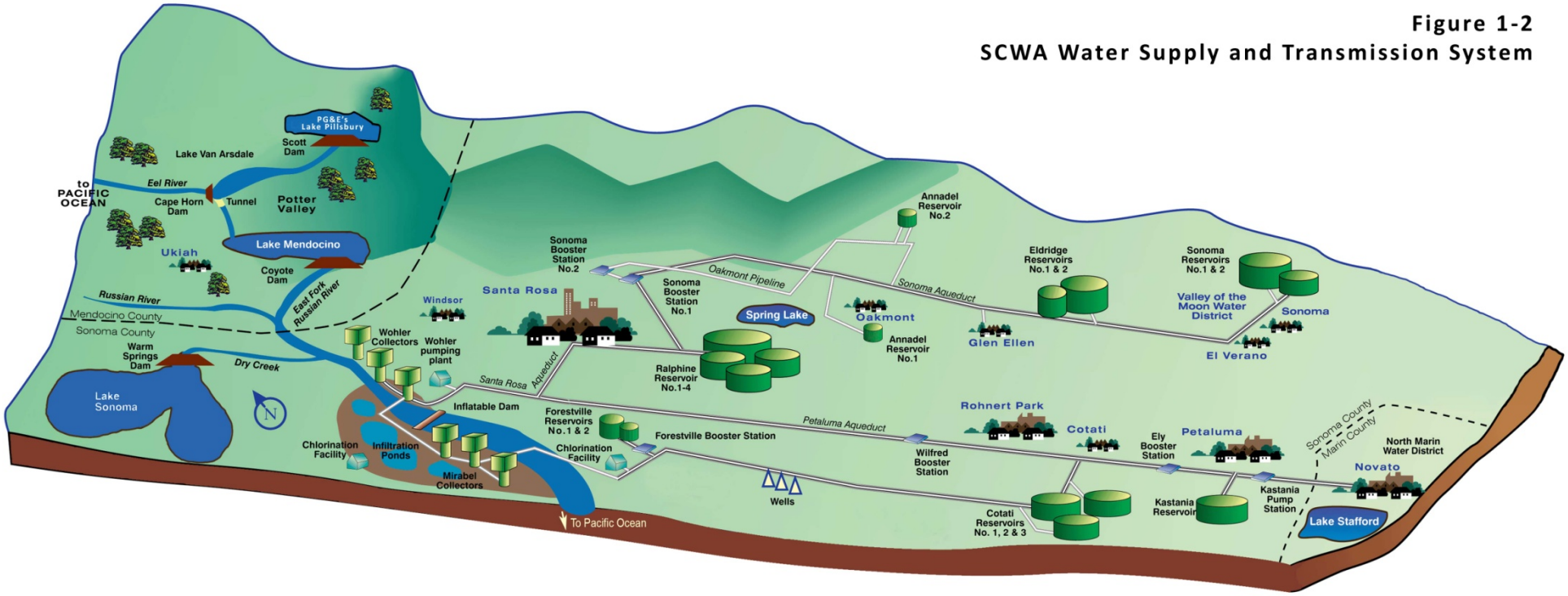
SCWA primary water supply storage is provided by Lake Mendocino and Lake Sonoma as described above. SCWA's transmission system to distribute this water includes diversion and water treatment facilities and an aqueduct system of pipelines, pumps, and storage tanks to deliver water to contractors and customers. The main components of SCWA's storage and transmission system are shown in **Figure 1-2**.

SCWA operates its transmission system under a water supply permit issued by the State Department of Public Health (DPH). Under this permit, SCWA is required to operate and maintain its water supply system in compliance with state water law. SCWA consistently meets state and national standards for drinking water quality and complies with the water quality monitoring requirements and various other conditions and criteria associated with the permit (SCWA 2009c).

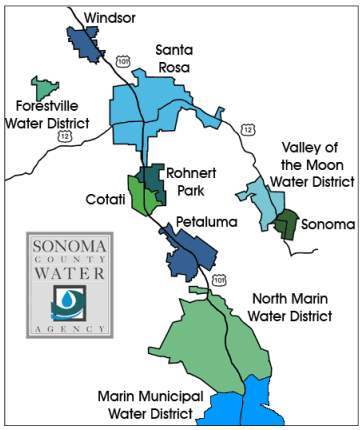
LID is important to SCWA as it provides an integrated strategy to reduce stormwater runoff while also lessening water demand through increased conservation and reuse.

[2] This guidebook focuses exclusively on the Sonoma County portion of SCWA's service area. SCWA does provide water supply to the North Marin Water District and the Marin Municipal Water District, which services Marin County. However, this guidebook does not discuss the Marin County service area.

Figure 1-2
SCWA Water Supply and Transmission System

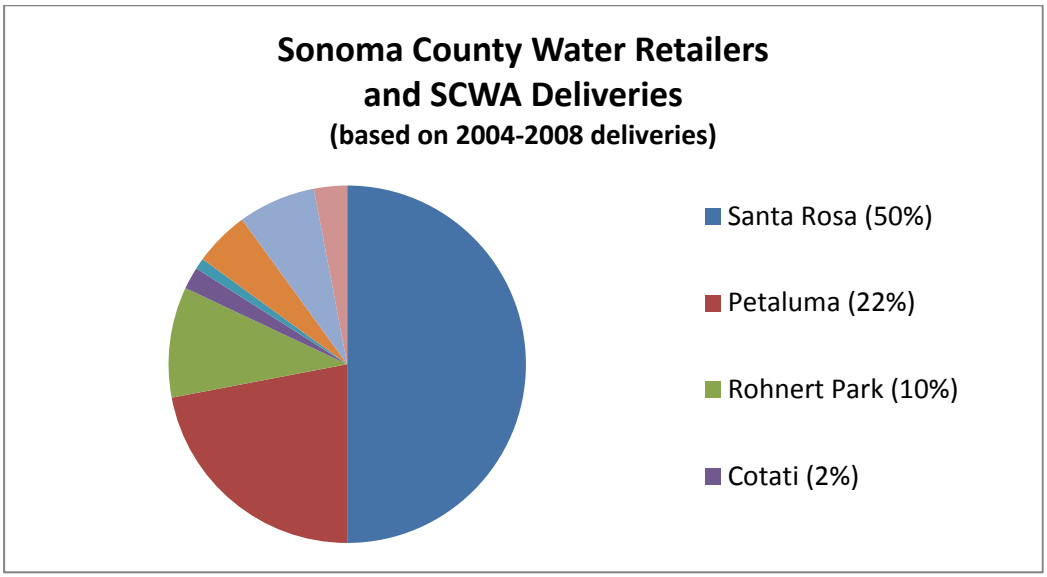


Retail water purveyors



Under an existing water supply agreement, SCWA distributes water to seven primary entities in Sonoma County including cities, towns, and special district contractors who deliver water to end users. The seven entities include the City of Santa Rosa, City of Petaluma, City of Cotati, City of Rohnert Park, Valley of the Moon Water District, City of Sonoma, and the Town of Windsor (see inset map). Each of these entities also has local groundwater sources to supplement their water supply. Annual SCWA delivery to these seven entities is approximately 44,000 ac-ft. The City of Santa Rosa is SCWA's largest water contractor, followed by the City of Petaluma. **Figure 1-3** shows the relative proportion of SCWA water deliveries to the seven primary Sonoma County contractors. SCWA also contracts with the Cal-American Water Company, the Penngrove Water Company, Forestville County Water District, and a few other local organizations to supplement groundwater supplies for those communities. Additionally, SCWA provides water supplies to the North Marin Water District and the Marin Municipal Water District. Similar to SCWA, Sonoma County's local water retailers can benefit from many of the LID conservation, reuse, and stormwater strategies described in this guidebook.

Figure 1-3: Chart of Sonoma County Retailers and Comparison of Annual Water Deliveries.



Notes on Figure 1-3: The SCWA Schedule of Actual Water Deliveries by customer type is available at: http://www.scwa.ca.gov/water-delivery-data/. Deliveries to Marin County (NMWD and MMWD) are not included in Figure 1-3.

Large public water systems

In Sonoma County there are other communities that are not directly supplied by SCWA but are serviced by local water suppliers operating one or more groundwater wells. These suppliers transmit locally derived groundwater, as well as, river underflow. Public water systems that

service more than 1,000 connections are referred to as "large" public water systems. Large public water systems in Sonoma County are operated in Cloverdale, Healdsburg, Sebastopol and by Sweetwater Springs, the Bodega Bay (Public Utilities District), and the Sea Ranch Water Company. The communities of Cloverdale and Healdsburg use treated Russian River water extracted via vertical wells adjacent to the river. This water source is considered Russian River underflow (and is a type of surface water resource). The communities of Sebastopol, Sweetwater Springs, and Bodega Bay (Public Utilities District) use groundwater wells, and the Sea Ranch Water Company uses surface water from the Gualala River.

Small public water systems

In Sonoma County there are nearly 500 small public water systems with less than 1,000 connections. Approximately 417 of these are state-regulated small public water systems that have between 15-999 connections. These include the Camp Meeker Recreation and Park District; Occidental Water Company; and the Russian River County Water District. Sonoma County includes another 65 smaller systems with 5-15 connections, that are county regulated. Small water distributors service unincorporated areas of the county, including isolated unincorporated areas within a city. It is uncertain how many very small and local unregulated water systems (with only 2-4 connections) exist in Sonoma County. All small public and community-owned water suppliers are regulated by the State DPH. Smaller and more local agencies and water districts have an important role in setting community LID targets that are appropriate for the communities they serve.

Individual users and well owners

Private subdivisions and rural residences throughout the county operate their own groundwater wells. These groundwater extractions are not monitored or reliably reported. While it is uncertain exactly how many county residents use privately provided local groundwater resources, it is estimated that there are about 40,000 private wells in Sonoma County, with approximately 80% of the wells used for residential supply and 20% of the wells used for agricultural purposes (Sonoma County General Plan 2020, Sonoma County 2009). In terms of LID, many of the technologies and approaches described in this guidebook are scaled for individual home owners and users.

1.3 Development, Land Use Planning, and Water Use

1.3.1 Sonoma County Land Use Planning Entities

General Plans and the Planning Process

Long-range land use plans, also known as general plans, are mandated by California law for each city and county in the state. A general plan is a legal document which includes specific goals, policies, standards, and/or implementation programs that constitute the formal policy of the County or municipality for land use, development, and environmental quality. The general plan also provides a foundation for more detailed plans such as area specific, community plans, or zoning ordinances. The duration of a general plan's effective timeframe (planning horizon) can vary, but the typical general plan is scoped for a 10-20 year planning horizon from the date of adoption.

At least once every five years, local planning agencies are encouraged to thoroughly review their general plan and revise the plan according to changing needs and priorities. State law requires every city and county to evaluate its *Housing Element* frequently and to revise it no less than every 5 years. The other elements of the general plans may be revised as new information becomes available and as community needs and values change regardless of the planning horizon. If and when a general plan amendment or update is undertaken, formal environmental and public review (CEQA) is required for adoption and implementation.

In addition to Sonoma County itself, there are several municipalities within SCWA's jurisdiction that conduct the general planning process. These municipalities and the status of their general plans are shown in **Table 1-1**:

Table 1-1: Sonoma County Land Use Planning Entities and General Plans

Land Use Planning Entity	Adoption Year of Most Current General Plan	General Plan Horizon Year
Sonoma County	2008	2020
City of Cloverdale	1999	2025
City of Cotati	1998	2023
City of Healdsburg	2004	2025
City of Petaluma	2008	2025
City of Rohnert Park	2000	2020
City of Santa Rosa	2009	2035
City of Sebastopol	1994	2014
City of Sonoma	2006	2020
Town of Windsor	1996	2015

Development Review Process

Once overall development patterns are established in the general plan, goals and policies are developed to guide local laws and zoning ordinances. Though anticipated as part of the general plan build-out, all new development is required to comply with adopted policies and zoning ordinances prior to approval. Typically, developers submit project design plans to the appropriate land-use planning entities. Development plans are reviewed to ensure compliance with adopted policies and zoning ordinances. A project design is approved if it fulfills the terms of all applicable regulations. If the development project is compliant, building permits are then issued to the developer which authorizes construction.

Development Planning and Water

An effective general plan appropriately balances and addresses a wide array of issues facing future growth demands. This includes forecasting and strategically planning for a variety of finite resources, among which water supply is paramount. Thorough planning requires close and continuous coordination between land use planners and water supply managers to ensure that future water demand is accurately forecast and that a sustainable supply is secured and achievable. When growth planning fails to consider water supply needs, severe system-wide infrastructure deficiencies emerge, often only treatable with very costly solutions.

In addition to water supply considerations urban development may cause harmful environmental effects including increasing surface runoff, stream erosion, and non-point source pollution while reducing infiltration, soil moisture, and groundwater recharge. These potential effects are described further in Sections 1.3.3 and 1.3.4 below. Good land use planning anticipates such effects and considers on-site approaches to conserve water, reuse water, or lessen stormwater runoff. As described in this guidebook, LID is a planning approach that uses site design process to maximize site benefits. LID also involves and encourages the use of many possible individual LID treatments that additionally help to conserve or reuse water and minimize runoff.

Working together, local land use planning agencies and water supply managers can develop strategies to accommodate future development while avoiding potential environmental impacts. This may include setting regional priorities and policies at the countywide scale, as well as targeting more specific requirements and zoning ordinances at the local implementation scale. This guidebook represents a first Sonoma countywide effort to identify and integrate LID planning and treatment approaches for water conservation, water reuse, and stormwater management topics.

As shown in Appendix 1, several land use planning agencies in Sonoma County have already adopted specific LID policies into their zoning ordinances. Many of these policies are aimed to reduce water demand, increase water conservation, and lessen runoff. Widespread adoption of LID strategies and requirements coupled with a planning review process that is practical and

solution-oriented can set a path for the County toward informed and balanced development that can be sustained over the long term under changing resource and energy availability.

Communication between developers and planners and regulators who review and permit a project is a critical step to ensure that such policies are successfully incorporated into a project design. The lack of coordination can result in lost time, increased project costs, and misunderstandings between applicants and permitting agencies.

1.3.2 Sonoma County Population Growth and Water Use

Population Trends

Significant population increases in Sonoma County began in the post-war years of the 1940s and 1950s, mirroring general population increases in California. Growth in the North Bay reflected the completion of the Golden Gate and Richmond-San Rafael bridges, the development and improvement of Highway 101, and the rapid increase in use of the personal automobile. Road and bridge improvements made it possible to quickly and easily transport agricultural goods from Sonoma County to the surrounding marketplace. The expanding economy and population base (**Table 1-2**) fostered other infrastructure improvements, including electrical transmission, water distribution, sanitation, and flood control facilities. Into the 1960s and 1970s, all of these improvements supported a rapidly urbanizing area with large tracts of residential development and commercial growth along key corridors such as Highway 101. The 1980's continued as a high growth period (2.6% annual increase). Sonoma County's population continued growing through the 1990's, though at a lesser rate (1.7% annual increase), and now grows at about 1% annually (2000-2010). This slow-down in annual growth rates are attributed to both regional economics and the gradual build-out of City and County general plans. Figure 1-1 shows the principal cities of Sonoma County.

Table 1-2: Population of Sonoma County

Year	*Sonoma County Population*
1900	38,480
1910	48,394
1920	52,090
1930	62,222
1940	69,052
1950	103,405
1960	147,375
1970	204,885
1980	299,681
1990	388,222
2000	458,614
2005	479,200
2010	497,900

U.S. Census Bureau 1995, 2000, 2009; ABAG, 2009; Sonoma County 2009; SCEDB 2009.

Changing Land Uses

Agriculture has been a core economic activity in Sonoma County since the founding of the Sonoma Mission (1823). In the 19th century, wheat, apples, pears, cherries, and prunes were first grown from seeds provided by Russian settlers from Fort Ross, and Mexican missionaries introduced olives and grapes to the region. In the post war era, Sonoma County emerged as a regional and state agricultural leader for several goods including Gravenstein apples (peaking in the 1950s), eggs, poultry, and prunes (peaking in the 1960s), and dairy production (through the 1980s). Since the 1970s Sonoma County, like its neighboring Napa County, has become internationally renowned for the quality of its grape and wine production.

Between 1984 and 2006, agricultural land area in Sonoma County decreased 7.6% while urban/developed land uses increased 26.7% during the same period (California Department of Conservation 2006). Overall, the amount of county land dedicated to agriculture remains high, with approximately 463,894 acres (46% of total county area) used for agriculture. Urban lands account for only 7% of the total county area and are concentrated in the southern County and along the Highway 101 corridor. The remaining 47% of non-agricultural or non-urban county land includes open water bodies, forests, riparian areas, mines, and other land uses (California Department of Conservation 2006).

Anticipated Growth

As shown in **Table 1-3**, population in Sonoma County is projected to reach 497,900 by the year 2020 and 561,500 by the year 2035 as projected by the Association of Bay Area Governments (ABAG). The annual growth rate between 2010 and 2035 is anticipated to be approximately 2.5% a year, but generally less than the historical growth rates (pre year 2000) shown in Table 1-2. By 2020, it is estimated that the nine incorporated cities of Sonoma County will contain 69% of the total population, a slight increase from 68% in 1990. The City of Santa Rosa will remain the most populated urban area. The cities of Cloverdale and Healdsburg will undergo the greatest relative population increases by 2035. Populations in the County's unincorporated areas are projected to remain a steady 30% of the county's total population through 2035. These trends reflect the city-oriented growth and development policies of the current and previous general plans (Sonoma County 2009).

Table 1-3: Sonoma County 2035 Expected Growth

Planning Area/City Urban Area	Current 2010 Population	Projected 2020 Population	Projected 2035 Population	Percent Change from 2010 to 2035 Populations
City of Cloverdale	8,900	11,200	11,900	34%
City of Healdsburg	11,900	13,160	14,300	20%
Town of Windsor	9,900	27,810	30,900	12%
City of Santa Rosa	162,500	187,070	189,000	16%
City of Sebastopol	7,900	9,620	8,300	5%
City of Rohnert Park	44,100	48,340	51,700	17%
City of Cotati	7,900	8,100	8,900	13%
City of Petaluma	58,600	70,390	68,300	17%
City of Sonoma	9,900	12,740	10,500	6%
Unincorporated Areas	158,600	147,660	167,700	6%
County Total	***497,900***	***536,090***	***561,500***	**13%**

ABAG 2009

Water Use

In California water use varies depending upon land use, population, climate, and other geographic factors. For context, the counties with the highest total water use in the state include Los Angeles, San Diego, Fresno, and San Luis Obispo counties, which use 5.4, 4.4, 3.7 and 3.1 billion gallons per day respectively (USGS 2000b). Los Angeles and San Diego counties are two of the most populous in the state, while Fresno and San Luis Obispo counties are two of the highest agricultural producers in the state. In comparison to these four highest water use counties, water use in Sonoma County is modest, at 159 million gallons per day. **Table 1-4** shows average daily water use information for Sonoma County.

Table 1-4: Average Daily Water Use in Sonoma County (Year-2000)

Sonoma County Population	**Water Use from Public Supply** (mgd)	**Water Use from Domestic Supplies** (e.g., private wells) (mgd)	**Ave. Industrial Use** (mgd)	**Ave. Irrigation Use** (mgd)	**Ave. Aquaculture Use** (mgd)	**Ave. Livestock Use** (mgd)	**Ave. Daily Use** (surface and ground water) (mgd)
458,614	56	8	7	74	8	6	159

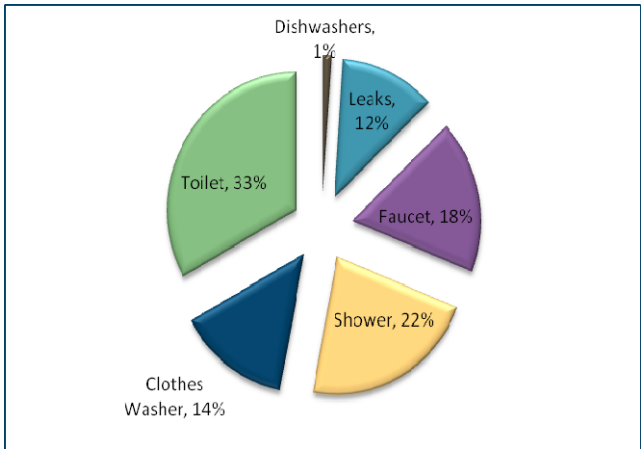
USGS 2000b

Table 1-4 is most easily understood reading the columns from left to right. Domestic and commercial water use provided by the SCWA and other county public water purveyors (56 mgd) accounts for about one-third of the total average daily use of 159 mgd (USGS, 200b). Domestic use from local private supplies and wells is much less (8 mgd) than the public supply, but still a significant use. Irrigation is the single largest water use in the County (74 mgd), representing nearly half of the total average daily water use. The paragraphs below describe interior and exterior residential and commercial water uses in more detail. LID approaches are most applicable for these water uses and these are the water use types that are the focus of the remainder of the guidebook.

Residential Water Use

Residential indoor water use includes water used in apartments, condominiums, single-family homes, and other residences. Water used for residential interior purposes typically includes showers, baths, toilets, dishwashers, clothes washers, and other uses. Residential water use does not include hotel rooms, which are considered a commercial water use.

Figure 1-4: Indoor Residential Water Use in California



Pacific Institute 2003

Figure 1-4 shows the allocation of residential indoor water use in California. Compared to the U.S. national data, Californians use relatively more water for toilets, showers, and faucets and relatively less for

clothes washing, baths, and leaks. These allocations are useful in understanding how to target effective conservation efforts. **Table 1-5** describes water amounts or rates used for the primary residential features shown in Figure 1-4.

Table 1-5: Typical Indoor Residential Water Usage

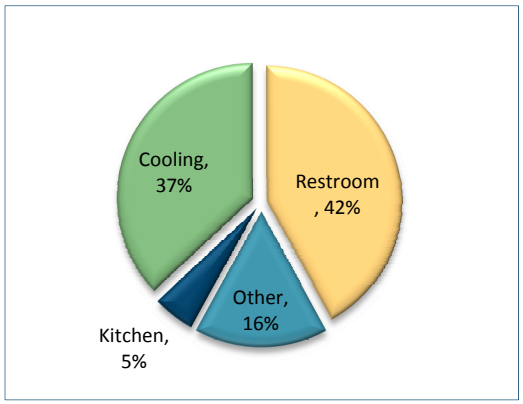
Category	Typical Water Useage
Toilets	Water use in toilets is based on the amount of gallons per flush (gpf) the fixture uses. GPFs can be generally assessed based on year of manufacture (*MWRA 2006)*: ▪ Pre-1980: 5 - 7 gpf ▪ 1980-1994: 3.5 gpf ▪ Post-1994: 1.6 gpf
Showers	Older showerhead fixtures (generally pre-1992) can use up to 5.5 gallons per minute (gpm). Newer fixtures average 2.2 gpm. The average showertime (8.2 minutes) results in the typical use of 18 gallons during a single shower with a 2.2 gpm fixutre, and up to 45 gallons with older fixtures. Note, baths use approximately 24 gallons per bath.
Faucets	On average, residential faucets use 10.9 gallons of water per day (*AWWARF 1999).* The national average flow rate for residential faucets is 1.3 gpm (*CUWCC 2009).*
Clothes Washers	On average, 15 gallons of water is used per day, per person for washing laudary (*AWWARF 1999)*. The national average load volume for a residential laundry machine is 40 gallons, and the average loads of laundry per day is 0.37 loads *(CUWCC 2009).*
Dishwashers	Residential dishwashers use about 1 gallon of water per person per day *(AWWARF 1999)*. The national average residential dishwasher load volume is 9.3 gallons, with an average frequency of 0.1 loads per person per day *(CUWCC 2009).*
Leaks	Residential water leaks (both indoor and outdoor) waste about 9.5 gallons of water per person, per day nationally *(AWWARF 1999).* A leaking toilet can waste as much as 18,000 gallons per year *(MWRA 2006).*

Commercial Water Use

The primary commercial, institutional, and industrial (CII) water uses include water for office buildings, hotels and restaurants, hospitals and medical offices, educational facilities, government and military facilities, service and manufacturing, and other municipal facilities including public parks, etc.

Total office building water use in California averages 300,000 acre-feet per year, or 300 million gallons per day (Pacific Institute 2003). **Figure 1-5** shows the allocation of average water uses in California office buildings. Cooling (37%) and restroom faucets and toilets (42%) represent nearly 80% of the total office water use. Kitchen and "other" water uses constitute a little over 20% of office water use.

Figure 1-5: Water Use in California Office Buildings



Pacific Institute 2003

Commercial buildings use a variety of interior fixtures including toilets, urinals, showers, and faucets. Water use information for fixtures used in commercial settings is provided in **Table 1-6**.

Water use at office buildings, hotels, hospitals, commercial washing machines, commercial kitchens, and commercial interior water fixtures vary as described below.

- On average hotels use 30,000 acre-feet of water per year, or 27 million gallons per day (Pacific Institute 2003).
- Hospitals in California use 36,700 acre-feet of water per year, or 33 million gallons per day (Pacific Institute 2003).
- Commercial washers typically use 34 gallons per cycle (AHAM 2006). Dry cleaning and service laundry facilities average 981 gallons of water per day, linen supply averages 977 gallons per day, carpet upholstery averages 984 gallons per day, and industrial launderers average 981 gallons per day (Pacific Institute 2003).
- Water use from commercial dishwashers ranges from 0.28 gpr (gallons per rack) to over 20 gpr. Dishwashers in California restaurants average 2.4 gpr and use approximately 429 gallons of water per restaurant per day (BuildingGreen 2009).

Table 1-6: Typical Water Use for Commercial Fixtures

Fixture	Gallons per day
Office Toilet	7.8
Hotel Toilet	12
School Toilet	6.3
Office Urinal	2
School Urinal	1.6
Hotel Shower	35.2
Office Faucet	0.4
Hotel Faucet	0.6
School Faucet	0.3
Restaurant Faucet	330 (8 sinks)

Pacific Institute 2003

Exterior Water Use

In this guidebook the topic of exterior water use focuses on urban and residential uses including water used outside by households, businesses, and municipalities for irrigation and landscaping, swimming pools, spas, personal car washing, and other outdoor uses.

The proportion of residential and commercial water used for exterior purposes is uncertain. AWWARF (1999) estimated that 59% of residential water use is used for exterior purposes. The Pacific Institute (2003) suggested that exterior water use accounts for 30% to 45% of total household water use. Data on exterior water use is vague for two primary reasons. One, not all outdoor water usage is monitored, and two, exterior usage varies greatly depending on location and climate. While exterior water use may account for 59-67% of total residential water use in dry climates, it may only account for about 22-38% in more moist climates (BuildingGreen 2009).

It is estimated that at least 50% of water used for landscaping in the United States is wasted through evaporation, over-watering, or watering hardscape areas and generating runoff (Atlantic Lighting and Irrigation 2008). Water use for landscape irrigation, recreational pools and spas, and outdoor cleaning are summarized below.

- On average, lawn watering uses approximately 25 gallons of water per irrigation cycle. Landscaping accounts for about 72% of total water use at elementary schools, 38% at office buildings, 16% at hospitals, 10% at hotels, and 6% at restaurants. Golf courses in California use about 300,000 acre-feet of water per year (or 270 MG per day) to irrigate turf areas.

- Residential houses with swimming pools use approximately 58% more exterior water than those without pools. Uncovered pools located in dry areas with high temperatures lose water through evaporation and need to be refilled regularly.
- A garden hose uses between 8-18 gpm. Actions such as washing a car or boat, cleaning the street, or washing off one's driveway with the hose at a constant flow can use hundreds of gallons of water during just one wash session (ACWA 2009).

1.4 Development and Hydrologic Impacts

1.4.1 Development and Stormwater Runoff

Runoff and streamflow represent the dynamic portion of the hydrologic cycle that is in movement across the land surface. Runoff is a broad category and includes a range of flows progressing from very shallow overland flows (or sheetwash), to the initial collection of flows in small rills, to the compounding of streamflow into larger creeks and rivers. Subsurface (or groundwater) hydrology represents the portion of the hydrologic cycle that is in movement or in storage beneath the surface.

Land development alters the quantity, quality, and timing of stormwater runoff in ways that may be detrimental to natural water bodies. Land development tends to increase impervious surfaces (roads, parking areas, sidewalks, rooftops, etc.), remove tree and vegetation cover, and compact or remove healthy soils. These changes reduce and disrupt infiltration and water storage processes provided by shallow surface depressions, upper soil layers, shallow subsurface flows, and vegetation uptake and evapo-transpiration. These changes result in increased surface runoff and increased pollutant loadings to receiving waters, while reducing infiltration and groundwater recharge.

Figure 1-6 illustrates components of the hydrologic cycle in hypothetical undeveloped and developed scenarios. The undeveloped left side of Figure 1-6 depicts the processes of precipitation, interception by vegetation, infiltration to soil, shallow subsurface interflow (or throughflow), and percolation to groundwater without urban or agricultural development impacts. The developed scenario shows increased radiant heat from the built environment, reduced vegetation interception, reduced infiltration, increased surface runoff, reduced shallow subsurface interflow, increased runoff in an engineered stormwater drainage system, and reduced percolation to groundwater. The storm event hydrograph for the developed landscape has a shorter lag time between precipitation and peak flow, higher peak flow rate, and a reduced baseflow recession compared to the non-developed hydrograph. In the built environment, streams and wetlands may also become wet throughout the year due to the increased release of summer urban flows and irrigation (as compared to extended baseflow in the undeveloped scenario). Water bodies that are "perennialized" in this way may not provide adequate habitat for native species and may contribute to other water quality concerns.

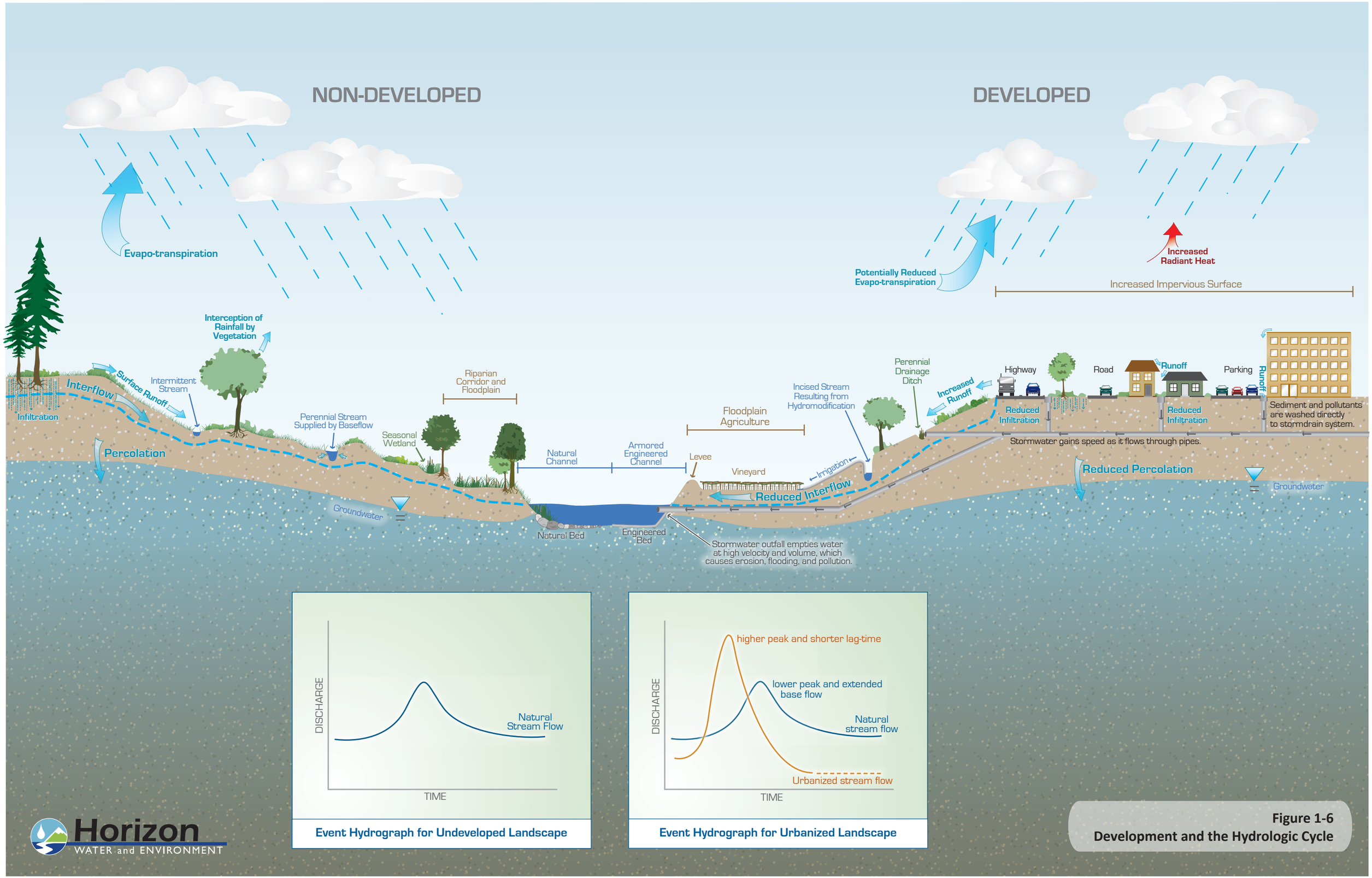


Figure 1-6
Development and the Hydrologic Cycle

1.4.2 Development and Water Quality

In terms of water quality, a developed landscape increases pollutant loading that quickly enters the stormwater system and is delivered directly to downstream receiving waters. The filtering benefits of infiltration, soil pore storage, and deeper percolation are reduced or eliminated. In developing areas, sediment loads may be very high during construction phases and then drastically fall after "build-out" when many upland sediment sources are capped, eliminated, or stored in reservoirs or basins. However, in the urban environment increased runoff and higher peak streamflows may increase channel erosion, and in this way replace upland sediment sources with eroded in-channel sediment sources. This hydromodification process may result in deepened or widened channels and degraded water quality.

To protect water quality and the beneficial uses of water from these effects, stormwater runoff is regulated by federal and state agencies. Specifically, the National Pollutant Discharge Elimination System (NPDES) program regulates stormwater and other discharges from development. The LID approach to development, which is strongly supported by the NPDES program, benefits water quality by reducing the harmful effects of urbanized runoff from its source. Additional information on the NPDES program is provided in Chapter 4 *Reducing Stormwater Impacts*.

1.5 LID and Opportunities to Reduce Environmental Impacts

The remaining chapters of this guidebook focus on describing LID approaches to enhance water conservation and reuse efforts while also reducing stormwater runoff. In this way LID provides an opportunity to avoid and address environmental impacts associated with development. This section summarizes some of the key issues and approaches raised in subsequent Chapters 2, 3, and 4 and also provides a brief overview of those chapters.

Water Conservation (Chapter 2)

Water conservation lessens development impacts by reducing the demand for potable water resources (both surface and groundwater supplies). Through fostering water supply sustainability and lessoning water demand and withdrawals, water conservation approaches reduce environmental impacts by protecting groundwater levels, water quality conditions, base level streamflows, and the riparian vegetation and wildlife supported by water resources.

Water in Sonoma County is highly valued for its economic role in supporting agriculture, commerce, and industry. Because opportunities to secure new or additional water supplies and water rights are limited; reducing water use through conservation provides the most efficient and sustainable approach to provide long-term water supply reliability. In Sonoma County, awareness to promote and apply national and state-level conservation directives locally is increasing. This guidebook encourages additional coordination between water supply wholesalers, retail contractors, local planning officials, and the broader Sonoma County

community to achieve greater conservation. Together with water reuse and stormwater management approaches (as discussed in this guidebook), water conservation is one of the core LID methods to ensure water supply reliability for people and the environment.

Conservation strategies commonly target behavioral practices which promote water use awareness and encourage reduced water use or technology improvements which reduce water use by design. Promotional campaigns and outreach to school children and other residents has proven to be very effective at reducing water consumption. In parallel, technology advances in toilet water use and other fixture efficiency have improved tremendously in the past 20-30 years. However, with continued population growth and additional climatic stresses, achieving water supply and sustainability goals will require increased conservation efforts.

The water conservation topic is fast moving and at the strategic forefront of all water providers in the country, and especially in California. As such, this guidebook will be updated periodically to include current information and recommendations for future conservation efforts.

Chapter 2 of this guidebook, *Reducing Water Use* first describes current state and national conservation standards and policies that guide and direct conservation efforts in Sonoma County. Chapter 2 then describes existing conservation programs in operation in Sonoma County. The description of current programs provides a basis to identify additional opportunities to conserve beyond the current 2010 baseline. As a guide to future developers and development permit reviewers, a brief checklist is provided to encourage implementation of conservation strategies throughout the county.

Water Reuse (Chapter 3)

Water reuse reduces potable water use by supplementing potable water with recycled wastewater, recycled graywater, and harvested rainwater. Recycled water is typically highly treated municipal wastewater that can be beneficially reused in a variety of non-potable applications. Graywater is water that flows out of bathroom sinks, showers, and laundry appliances that can be recycled for non-potable uses. Rainwater harvesting is the practice of collecting and storing rainwater for later non-potable use. These three primary water reuse efforts can effectively reduce potable demands on water resources, especially for landscaping and agricultural irrigation practices. As a result of reducing potable water demand, water reuse provides similar environmental and sustainability benefits as those identified above for water conservation.

Recycled wastewater and graywater are considered beneficial reuses of water because treated wastewater that would otherwise discharge to streams and water bodies is reused prior to discharge or other release in the hydrologic cycle. Large and continuous discharges of treated wastewater generally negatively impact the water quality and habitats of receiving waters. Erosion and discharge of improperly treated wastewater can heavily degrade a natural system.

With continued population growth and development in Sonoma County, water reuse efforts will become an increasingly important means to reduce impacts associated with treated discharges. Along with water conservation and stormwater management, water reuse is an important LID approach to consciously utilize existing and valuable water resources.

Chapter 3 of this guidebook provides information on water reuse efforts underway in the region and identifies future opportunities for expanded water reuse. Currently, many sanitary service districts in the County are treating and providing recycled wastewater for landscape and agricultural irrigation. Additionally, recycled wastewater is used to generate electricity at the Geysers' geothermal wells in northern Sonoma County. More about this water to energy project is discussed in Chapter 3. The future of water reuse opportunities is rapidly changing, particularly in the regulation of these reuse applications. This guidebook should be updated on occasion to reflect new regulations and standards, and hopefully new opportunities to use recycled water, graywater, and harvested rainwater.

Stormwater Management (Chapter 4)

LID stormwater management is a site design strategy to avoid and minimize hydrologic and water quality impacts associated with development. The strategy emphasizes design practices and techniques that effectively capture, filter, store, evaporate, detain, and infiltrate runoff close to its source. The stormwater management approach also seeks to conserve natural resources and preserve ecological functions. The LID concept is based on the premise that stormwater management involves more than just preventing flooding, and that runoff is a valuable resource if used wisely. Stormwater management recognizes the value of pre-existing hydrologic functions and their influence on the surrounding environment.

LID stormwater management relies on four fundamental principles:

1. **Avoid** hydrologic impacts by integrating site topography, soil, and hydrology assets into the site plan and design features.
2. **Conserve** existing soils, vegetation, and hydrologic features.
3. **Minimize** impervious areas and maximize permeability.
4. **Manage** stormwater on-site through LID features.

The first two principles emphasize protecting and using existing resources, while the last two principles shift focus to impact management and controls.

Chapter 4 describes several stormwater BMP features including biofilters, permeable paving, green roofs, rainwater harvesting systems, subsurface detention and infiltration strategies, and soil amendments. Chapter 4 provides guidance on incorporating these approaches into the site planning process. The combination of using site planning approaches and BMP treatments helps reduce and avoid harmful effects of stormwater runoff and water quality impacts resulting from urban development.

Chapter 4 also presents off-site, retrofit, and regional approaches to manage runoff beyond the immediate project site. The off-site and retrofit approaches consider a range of options and scales. At the simplest level, local off-site solutions may be pursued to mitigate individual projects that do not meet stormwater or flood control requirements. This might involve implementing the BMPs and techniques at another local project site or through applying in-lieu fees that support more regional stormwater and flood control solutions. Retrofit options are also discussed for situations where it is feasible to modify an existing land use or site design to reduce stormwater discharges.

1.6 Approaches to Implement LID and Reduce Local Water Use

The most effective way to implement LID is for individual communities to develop their own local LID action plans that reflect the needs and desires of the local community. Local LID action plans should be flexible, accommodate for local conditions and priorities, and should include quantifiable targets for conservation, reuse, or stormwater goals. The purpose of this guidebook is to provide local communities within Sonoma County a common reference that describes and identifies various LID treatments and measures for the water conservation, reuse, and stormwater topics. There are several ways for local communities to develop their own LID action plans. Below are three possible approaches:

Community Develops Reduction Target from Allowable Baseline Use Assessment

In this approach the local community will establish what the current allowable baseline water use is based on the current plumbing code and existing landscape ordinances. This provides the community with an allowable baseline that complies with current ordinances. From this baseline the local community would then set a water use reduction target (i.e. 15%, 20%, 30%) beyond the requirements of current state directives[3] and local codes and ordinances.

Community Develops Daily Allotment Based On Available Supply

In this approach the community establishes a reliable value for the water supply that is available for the community. The water supply value should be sustainable over the longer term. During the design and review of new development projects, land use planners and developers will need to prove that the local water supply will accommodate the new development's water demand needs. Typically this can be measured as a daily allotment available for new development.

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[3] As discussed further in Chapter 2, Senate Bill 7 which was passed in November 2009 established a statewide goal of reducing urban per capita water use by 20% by December 31, 2020. The bill requires all water suppliers to develop a water use target to achieve 20% reduction in urban water use by 2020 and have that target in place by December 31, 2010.

Reduced Connection Fees for LID Compliance

Through ordinances and local planning/zoning guidelines, the local community can establish a list of approved and recommended LID measures. If the developer can demonstrate implementation of LID measures (typically during the design review process), then the project's water connection fee can be reduced. The local community can set how such fee reductions would occur. In this approach the Developer has some flexibility in selecting which LID options to implement from the locally approved measures.

As described above, the role of this guidebook is to provide a common reference document for the communities in Sonoma County to develop their own local LID plans based on their specific needs. How to implement such measures locally will be determined by the individual communities. The local community may choose to follow one of the above processes, or draft their own approach that might be quite different but still achieves their local objectives. Whichever approach a local community takes to implement LID, some method of accounting for the potential water savings and benefits should be developed. **Table 1-7** provides an introductory template to identify and account for water savings associated with LID, including water conservation, water reuse, and stormwater management measures.

In the LID accounting template of Table 1-7, LID treatments supported by the community are listed, unit water savings per treatment are identified, and net annual water savings can be estimated. The unit water savings applied to individual projects are totaled for the year to calculate the net annual water savings. This value can then be compared to the percent reduction target established in the community's LID plan. Such an accounting template provides a snapshot of how much water the community saved that year through implementing LID measures. Local communities can develop their own accounting methods which reflect their unique LID implementation plans.

In addition to the water savings accounting worksheet provided in Table 1-7, Appendix 3 contains three example checklists to guide the development plan review process. Planning checklists for the water conservation, water reuse, and stormwater management topics are provided in Appendix 3. These checklists, or similar checklists prepared by individual communities, can be used by planners and developers to identify how projects use or apply LID treatments to meet the local water conservation targets and LID goals. The checklists walk the developer through the LID site planning and implementation processes that are described in this guidebook. In responding to the questions in each of the three checklists the developer or project applicant can document which LID features are incorporated into the project design and the reasoning behind the proposed project design. Land use planners can review the information in the checklists and consider the responses during the project approval process. In contrast to Table 1-7 which is community based, the checklists of Appendix 3 are project based and can be used to track water savings tracking per individual project. The checklists of Appendix 3 can be used to inform the overall community accounting of Table 1-7.

Table 1-7: Example Water Savings Accounting Worksheet (annual totals for entire city/service district)

LID Features	Estimated Savings per Unit	Estimated Number of Units Installed	Estimated Annual Water Savings	Percent of Local Target Goal
1. Water Conservation				
Educational and Outreach Programs				
Use of conservation targets in advertising and communications				
Increased public involvement in conservation initiatives				
Land Use Planning and Design for Conservation				
Development Site Planning				
Development sited to emphasize conservation (shading, wind aspect, etc.)				
Development located near source of recycled water				
Site and Building Layout Design				
Kitchens and bathrooms located closest to the water heater				
Landscaping designed to maximize irrigation efficiency				
Building Fixtures and Appliances – at minimum, must comply with local building code and Water Efficient Landscape Ordinance				
Development included high efficiency toilets and urinals				
Development included high efficiency showerheads				
Development included high efficiency kitchen and sink faucets				
Development included high efficiency clothes washing machines				
Development included high efficiency dishwashers				
Development included automatic rain shutoff controller for irrigation sprinklers				
Retrofit and Equipment Upgrades				
Commercial and Medical Appliances				
Installed commercial dishware sensors in restaurants and commercial kitchens				
Upgraded water-efficient x-ray, vacuum pump, sterilizers, exhaust hoods, and water filters in medical facilities				

Table 1-7: Example Water Savings Accounting Worksheet (annual totals for entire city/service district)

LID Features	Estimated Savings per Unit	Estimated Number of Units Installed	Estimated Annual Water Savings	Percent of Local Target Goal
Alternative faucets and toilets				
Upgraded water-efficient faucets and toilets in businesses				
Automatic car washes retrofitted to increase water use efficiency				
2. Water Reuse				
Rainwater Harvesting Systems				
Graywater Systems				
Clothes Washer Systems				
Simple Systems (less than 250 gallons per day)				
Complex Systems (more than 250 gallons per day)				
Water Recycling				
Urban Uses (indoor and outdoor)				
Other Uses (habitat enhancement)				
3. Stormwater Management				
Green Roofs				
Groundwater Recharge Functions				
Biofilters				
Permeable pavement				
Detention basins				
Total				