Tools:

- CASQA LID Portal (https://www.casqa.org/resources/california-lid-portal)
- Urban Greening Carbon Sequestration Quantification Tools
    - i-Trees (https://www.itreetools.org/)
    - CTCC (https://www.fs.usda.gov/ccrc/tools/tree-carbon-calculator-ctcc)

Resources:

- City of Philadelphia: "A Triple Bottom Line Assessment of Traditional and Green Infrastructure Options for Controlling CSO Events in Philadelphia's Watersheds" (https://www.casqa.org/sites/default/files/downloads/stratus_consulting_2009_-_a_triple_bottom_line_assessment.pdf)
- Council for Watershed Health (https://www.watershedhealth.org/)
- ASCE: "Downstream Economic Benefits from Stormwater Management" (http://ascelibrary.org/doi/abs/10.1061/(ASCE)0733-9496(2004)130:6(498))
- CPUC: "What will be the Cost of Future Sources of Water in California" (http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/PPD_Work/PPD_Work_Products_(2014_forward)/PPD%20-%20Production%20costs%20for%20new%20water.pdf)
- Urban Land Institute: "Harvesting the Value of Water" (https://americas.uli.org/wp-content/uploads/sites/125/ULI-Documents/HarvestingtheValueofWater.pdf)
- ASCE: "Integrated Management of Irrigation and Urban Storm-Water Infiltration" (http://ascelibrary.org/doi/pdf/10.1061/(ASCE)0733-9496(2006)132:5(362))
- Institute for Sustainable Infrastructure: Envision valuation tool (http://sustainableinfrastructure.org/envision/)
- Integrated Regional Water Management Publications (http://www.water.ca.gov/irwm/other_resources/publications.cfm)
- LID Center (https://lowimpactdevelopment.org/)
- LIDI Central Coast (https://www.centralcoastlidi.org/)
- Protect Every Drop Partners (http://www.protecteverydrop.com/)
- City of Elk Grove: "Assessing the Risks of Using Dry Wells for Stormwater Management and Groundwater Recharge" (https://www.elkgrovecity.org/UserFiles/Servers/Server_109585/File/Departments/Public%20Works/Drainage/Dry%20Wells/dry-well-doc-01.pdf)
- NRDC and the Pacific Institute: "Stormwater Capture Potential in Urban and Suburban California" (http://pacinst.org/wp-content/uploads/2014/06/ca-water-stormwater.pdf)
- State of California: 2016 California Plumbing Code (https://archive.org/details/gov.ca.bsc.title24.2016.05)
- National Blue Ribbon Commission for Onsite Non-potable Water Systems: "Blueprint for Onsite Water Systems" (http://sfwater.org/modules/showdocument.aspx?documentid=6057)
- Los Angeles Basin Study: The Future of Stormwater Conservation Task 6–Trade-Off Analysis & Opportunities (https://www.usbr.gov/lc/socal/basinstudies/LABasin.html)

- California Department of Public Health: Checklist for Minimizing Vector Production and Stormwater Management Structures (https://www.cdph.ca.gov/Programs/CID/DCDC/CDPH%20Document%20Library/ChecklistforVectorPreventioninBMPs.pdf#search=stormwater; see also Metzger et al 2017)
- Mosquito Vector Control Association of California: How Better Planning and Use of the California Environmental Quality Act Can Prevent Mosquitoes and Vector-Borne Diseases (http://www.mvcac.org/advocacy-and-legislation/resource-materials/)

4 Barriers, Drivers, and Factors Affecting Success

There are a variety of barriers to stormwater capture and use and its implementation in California. A preliminary list of barriers to capture and use was developed by the study team and integrated into a template (see Appendix C) developed to solicit stormwater capture and use case studies throughout California. The solicitation for stormwater capture and use case studies was sent out to the STORMS Project 1a/1b Project Advisory Group (PAG) on October 28, 2016, and the PAG was encouraged to submit case studies and forward the solicitation for case studies to others as well. A template for the case study information was developed and integrated into the solicitation. Although the template included the preliminary list of barriers for respondents to select from and identify barriers specific to their projects, the solicitation also encouraged respondents to identify additional barriers associated with their projects.

Several capture and use case studies were received from the solicitation. Some identified barriers. A subset of the case studies included new or unique barriers encountered in undertaking projects, along with solutions that municipalities used to overcome challenges. These case studies, along with representative examples of types of capture and use projects, are included in Appendix B. The case study survey forms for all of the case studies are provided in Appendix C. Capture and use also has shared barriers with the implementation of green infrastructure. A discussion of these barriers is included in WEF 2014.

Additional barriers to stormwater capture and use were identified based on the experiences of the Technical Advisory Committee (TAC) with stormwater capture and use projects. The TAC and PAG convened on September 19, 2017 to identify additional barriers that were not already captured in the case studies. All identified barriers fell within four general categories:

1) Financing/valuation
2) Education and guidance
3) Institutional and policy-related (including law and regulations)
4) Technological

The need for technical analysis that may be required to address any particular barrier categories should not be confused with the technology barrier category that identifies a lack of engineered/technological solutions. Table 2 describes potential projects to address the barriers identified in each category. The category and barriers are introduced in the following subsections.

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4.1 Financing/Valuation

Funding stormwater systems in California presents significant challenges. In 2014, the Public Policy Institute of California (PPIC) gave failing grades for lack of financial investments in both flood and stormwater infrastructure (Hanak et al. 2014). This was corroborated by the case study review, where funding was the most common barrier reported. The maintenance expense of stormwater projects increases the funding gap. Many projects claim that without grant funding, the project would not be viable. Local jurisdictions have been challenged by limited funding mechanisms (Farfsing and Watson 2014). Most recently, California Senate Bill No. 231 (SB 231) may have provided a path forward for MS4s to follow the same standards for setting fees as those applicable to water and sanitary service, addressing barriers to funding presented by the rules of California State Proposition 218 (Prop 218). As of this writing, this legislation has not been tested by municipalities and legal challenges have been promised.

Another funding barrier is "willingness-to-pay" considerations of residents. Residents of urban areas are more willing to pay for stormwater improvements if they are associated with additional environmental benefits such as habitat improvements. For instance, one study suggests that residents of Philadelphia were willing to pay as much as 2.5 times more annually per household for improvements that reduce combined sewer overflows (CSOs) and benefit the environment in some additional way when compared to traditional grey infrastructure improvements (Raucher 2009).

In the absence of broadly assessed benefits for stormwater projects that consider the potential economic, environmental, and social outcomes of projects, many project advocates fail to broadly engage community stakeholders as part of the planning processes. While environmental and economic factors are more readily quantified, California seems to rely on the public engagement process to consider social equity. However, unorganized public input does not always translate into the proper criteria and value weighting from stakeholders. Triple bottom line analysis is one way to organize public engagement around project objectives and promote the proper valuation of economic, environmental, and social benefits. This increases the likelihood of success of capture and use projects in the long run because preferred alternatives have increased community support.

A lack of quantitative analysis of benefits can also miss other funding sources for functions other than stormwater (e.g., urban greening, public safety, transportation). But depending on funding terms and conditions, some of these funding sources (e.g., transportation) do not explicitly allow financing of stormwater quality (or capture) infrastructure, which is a barrier to capture and use projects that will only be financially and politically viable as a multiple-benefit project. In this current year, California Senate Bill No. 1 (SB1) identified environmental mitigation as a function that can be funded, though inclusion of stormwater capture could be more explicit in the bill.

The potential benefits to include in capture and use cost studies are region-specific. Cities searching to maximize regional water supplies and reduce out-of-basin imports can look to include averted costs of water supply in benefit-cost calculations for new stormwater infrastructure. This is especially the case in downstream coastal cities, where maintaining groundwater basins is crucial to prevent adverse impacts of overusing local supplies such as seawater infiltration. Many parts of Southern California, where the cost of purchasing water from large import or wholesale agencies is more expensive (MWD 2015), can include averted costs of water supply in benefit-cost calculations for new stormwater infrastructure as well. Coastal cities also have an incentive to use and reuse as much water as possible from an anthropogenic

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perspective, as surface water discharges flow to the ocean. Inland and in some northern parts of California, averted costs of water supply are not as significant a driver. The unit cost of fresh water for supply is cheaper, and discharging water to surface water bodies supports aquatic ecosystems and downstream urban and agricultural users. Thus, no single set of benefits for stormwater capture and use will meet all needs for all agencies, but general guidelines about possible benefits are valuable for water utilities in financing studies.

Capture and use proponents need tools to estimate the marginal cost increase of capture and use compared to current treat and release practices. Current regulation requires infrastructure to treat and release stormwater for new development. Treat and release infrastructure is sunk cost due to existing requirements, so costs to enhance that infrastructure to accomplish capture and use should only consider the increase in cost over the treat and release infrastructure. Project proponents will perform a cost/benefit analysis on the additional costs of moving the retained water to the place of demand for water use. For example, a retention basin may achieve hydrologic requirements, but it may not infiltrate to useable aquifers. The addition of drywells would move the water to a point of use. The cost/benefit of the capture and use would only consider the cost of the drywells. Examples of marginal cost analysis of capture and use above current permit requirements for SCM are not available. However, some work has been done comparing LID costs to traditional storm sewer costs (EPA 2007).

Many tools should be considered in overcoming the funding barriers. These tools are explored further in STORMS Project 4b, "Eliminate Barriers to Funding Storm Water Programs and Identify Funding for Storm Water Capture and Use Projects."

4.2 Education/Guidance

Effective education, ranging from public education to detailed design training for engineers and landscape architects, is essential for successfully promoting capture and use projects. Case studies indicate that technical knowledge for capture and use exists among stormwater professionals; however, dispersing this valuable knowledge and lessons learned among utility managers, NGOs, stormwater professionals, and the general public will help avoid increased costs associated with custom analysis and design work as well as generate community support for projects. If the learning curve for LID is indicative of capture and use (over the last ten years, many talks about lessons learned have been presented at stormwater conferences), many of the barriers to stormwater capture and use may relate to a lack of awareness, understanding, and knowledge transfer by stormwater professionals of existing concepts and tools.

Education and training barriers have been addressed by cities like Santa Monica, who has a well-developed capture and use program (Santa Monica 2014). In this program, the tools described in Section 3.2 were applied at a local level to develop a comprehensive capture and use program. So the only substantial barriers are a lack of will and financing (see comments from City of Santa Monica, Appendix E).

Education and awareness is also needed to identify the purpose of existing regulations, so regulatory interpreters can gain a better understanding of how a particular regulation can potentially hinder the implementation of capture and use projects. Educational efforts can overcome regulatory barriers by either changing the text of a regulation or altering the interpretation of the regulation.

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In some watersheds, non-potable water demands are met by water recycling, so there is limited demand for direct use of stormwater. However, captured stormwater could be used to support continued delivery of ecosystem services. This also highlights the importance of developing master plans so that all water within a watershed is used and reused to provide the best triple bottom line outcome. State agencies as well as stormwater organizations such as CASQA will play essential roles in developing a consistent messaging effort for the public regarding capture and use. Additional organizations and potential projects to promote educational efforts are listed in Table 2.

Section 3.2 contains a list of available resources that can be useful for educating various target audiences. A few examples where additional guidance is needed for education efforts include:

- Guidance for the range of retrofit options for existing infrastructure, particularly for flood control facilities.
- Guidance for new centralized capture and use systems.
- Guidance on how to design to local conditions considering soil, instream flows, rainfall, climate, and demand.
- Guidance on storage limitations and treatment requirements for long-term storage to avoid worsening water quality.
- Training on Integrated Water Resource Planning and the one water approach.
- Training on the use of tools for and on the appropriate scale to apply triple bottom line analysis.
- Expand the DWR Water Management Planning Tool to incorporate stormwater infrastructure and analyze stormwater as a supply source.
- Guidance in the use of triple bottom line analysis to identify and evaluate the water source alternatives in the state's integrated watershed plans.
- Educational awareness to overcome perception barriers. Despite national guidance and demonstration sites, skepticism can still remain as a result of only one poorly-installed demonstration site. This can result in a long-term setback in the minds of some decision makers (WEF 2014).

4.3 Institutional/Policy

Laws, regulations, policies, and institutional practices can all pose barriers to stormwater capture and use projects. Laws are created by federal, state, and local agencies. The Clean Water Act is a primary legal driver of stormwater management, and along with associated laws, it affects how stormwater utilities devise programs. Regulations are developed by agencies as part of their stated authorities, which interpret and implement approved legislation. Regulations have the full force of law and can provide more specifics for or potentially fill gaps in legislation. Policies are rules or procedures, often formally adopted through decision-making processes, that govern how participants in an entity (jurisdiction, organization, or private company) must act. Finally, practices are typical modes and standards for operation and may or may not be directly linked to more formalized laws, regulations, and policies. Depending on the origin of a barrier, addressing it can require new legislation, revisions to existing regulations, new processes that promote better collaboration where it is currently limited, or other appropriate fixes.

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Each of these drivers (laws, regulations, policies, and practices) that shape organizational and individual decisions can provide a level of guidance regarding what actors must do to comply. But the level of guidance varies widely. These drivers can be restrictive, lenient, or breed uncertainty in decision-making. The absence of direction from one of these drivers, too, can yield uncertainty that presents a barrier to decision-making. There is no standard as to whether greater or less regulatory guidance will remove decision barriers, and often uncertainties related to these drivers can be perceived differently across various levels of government.

For capture and use, barriers fall into a number of general categories. Many barriers relate to institutional collaboration, which is often driven by practices and can be impeded by existing policies or regulations. Other barriers for capture and use exist regarding environmental regulations. Such barriers tend to be more legal and regulatory, but uncertainties in how courts interpret laws often slow innovative decision-making by local jurisdictions. Water rights in California can present specific barriers that connect projects to the complex web of California water laws. Public health requirements, too, can present barriers for capture and use as agencies seek to protect the well-being of urban residents. Public health requirements span laws, regulations, and policies. Regional health agencies can have differing guidance and requirements for the treatment and direct use of captured stormwater. Finally, with all these topics, unintended consequences can ensue from the presence or absence of guidance.

The section below describes these topics— identified through workshops and advisory committee input—and relates them to applicable types of institutional guidance and actions.

Institutional Collaboration

Institutional collaboration in metropolitan and water resources management is an old and on-going challenge. In California, the vast array of water agencies with diverse missions spread across varied geographies means that promoting collaboration outside of typical agency siloes usually requires formalized agreements and innovative institutional practices.

In California, many processes to promote integration and collaboration across water agencies use funding programs to promote agencies working together through better practices. These can have legal roots. For instance, statewide requirements for IRWM planning efforts were first specified by SB 1672 in 2002. In other cases, working groups and agreements form through bottom-up efforts. In general, however, only moderate progress has been made in moving agencies across sectors of water management to collaborate more closely, and this influences procedures for capture and use.

Institutional and policy barriers exist both in the public sector (i.e., water districts and municipalities) and private sector (i.e., development community) for capture and use. Many water agencies operate in their own distinctive “decision space” (supply, treatment, flood control) because water serves a number of functions. Thus, officials have divergent interests and political roles, making coordination and setting of priorities with respect to stormwater difficult and preventing multi-sector assessments of benefits. These divergent interests also impede collaboration on water issues, and integration of regional capture and use projects into a one water approach is lost.

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Some specific examples of barriers to capture and use related to institutional collaboration include:

- Water districts and municipalities are not required to collaborate on water supply and capture and use projects. This can either make projects funded solely by stormwater funds cost prohibitive or precludes efficient placement of these facilities within the footprint typically under the control of stormwater agencies. Cooperation must also include mechanisms for sharing costs and cost-savings benefits.
- Integrated water management requirements do not include stormwater as a potential supply source. For instance, Urban Water Management Plans filed by water supply utilities rarely mention stormwater and its capture and use. It is a recommendation to assess stormwater as a potential supply source in urban water management plans but not a requirement. SB 985 requires submittal of stormwater resource plans to IRWMP agencies, however there is no requirement for these agencies to integrate stormwater source potential into the water supply portfolio.
- Water resources (water supply, wastewater, recycled water, stormwater, and drainage) are integrated into developments independently, so sustainable water management with integration of water resources is not achieved.
- As noted earlier, there is no standard method for analyzing the environmental benefits and costs of urban runoff compared to other water sources, so capture and use systems are often undervalued. Projects that provide multiple benefits are not valued more than projects that do not. Stormwater agencies, too, often lack financial mechanisms to combine resources with water and other infrastructure agencies.
- Non-water infrastructure project proponents are not required to consult with water infrastructure proponents for the sake of maximizing social, environmental, and economic benefits.
- Regulations are inconsistent among regional agency jurisdictions, and often constrain or compete with each other.

Barriers to institutional collaboration on capture and use projects can exist across agencies with varying duties or within a hierarchy of agencies at different levels of government. For instance, regional water wholesalers and smaller water retailing member agencies, which create a distribution system for water in a region, can have specified missions and interactions that do not necessarily cover cooperative agreements on stormwater capture and use. Conflicting regulations can exist in adjacent jurisdictions, as well as across different regions of the state. Because urban runoff capture and use is still a fairly new concept in California, there are many opportunities to remove unnecessary barriers and help incentivize and facilitate implementation of these projects at various scales.

Environmental Regulations

Environmental regulations exist to protect habitat, groundwater quality, and other environmental factors that could be impacted by stormwater capture and use projects. The history of developing these laws, such as the Endangered Species Act that has governed habitat conservation and land use for decades, are highly detailed and related regulations have been deliberated through court processes.

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Existing regulations and law or the lack thereof can be barriers to capture and use. Some stakeholders see environmental regulations as too restrictive. But policies that are too lenient can result in capture and use projects with unintended negative environmental consequences. In many cases, lack of regulatory interpretations for projects leads to uncertainty. Vague or non-existent policies can create uncertainties that discourage capture and use (e.g., drywells in some California counties). Regulations can add to the costs and timeline of a project, require compliance with law other than that related to stormwater management, or prescribe a process or procedure that must be followed for a project to be implemented.

Some resource policies do not directly regulate capture and use but they can result in unintended consequences that may affect the feasibility of capture and use. For example, conservation demands and the desire to promote independence from imported water is encouraging increased reuse of treated wastewater and capture and use of dry and wet weather runoff. Although desirable from a water conservation perspective, these practices present a management challenge for ecological adaptation and resiliency to climate change. Urban and agricultural development over the past 75–100 years has converted naturally intermittent streams to streams with perennial or near-perennial flow (White and Greer 2006). Some of these "perennialized" streams now support sensitive species or species that may be sensitive to climate change, including some threatened or endangered species, such as the Least Bell's Vireo.

Changes to stormwater regulations designed to reduce pollution associated with urban runoff and desires to recycle treated wastewater for potable and non-potable uses are reducing stream flows to more historical levels. However, these reductions may decrease the resiliency of "naturalized" aquatic-dependent species to climate change effects by making them more vulnerable to the extended drought conditions expected to occur under changing rainfall patterns.

There may also be other environmental tradeoffs or impacts with the implementation of stormwater capture and use projects that are not fully evaluated. A few examples of environmental and human health concerns regarding stormwater capture and use include:

- Excessive capture of stormwater and routing away from the source of precipitation may disrupt local watershed processes and negatively impact desired ecosystems.
- Treatment standards and acceptable technologies for direct, non-potable water use are not established (ongoing work by the National Blue Ribbon Commission for Onsite Non-potable Water Systems will be providing a basis for developing local and statewide standards). In lieu of specific regulation of urban runoff systems, other standards like Title 22, which regulates reclaimed water use, are often applied to stormwater use systems.
- State-accepted frameworks for establishing ecosystem needs—particularly minimum baseflows though some proposed frameworks exist—are lacking (Hamel et al 2013).

Policies, like regulations, can be a barrier to some capture and use projects. However, if they are properly set, these limitations can give capture and use proponents more certainty

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concerning the impact of capture and use projects. Such certainty may actually increase the implementation of capture and use.

Future policy decisions will need to balance water quality, water supply, and species conservation objectives in light of climate induced changes in rainfall-runoff patterns and societal priorities. A framework to balance these values has yet to be established by the state. Some questions to ask when developing or improving regulation include: Does a regulation preclude capture and reuse? Does a regulation introduce a burdensome process? Does a regulation set up conflicts between programs? Does a regulation raise costs? These barriers are not easily removed because changing a regulation is often a long and difficult process.

Stormwater Permits and Planning

Statewide policies increasingly promote better planning by localities and communities towards use of "stormwater as a resource." This is especially true for arid and semi-arid urban areas that face potential reductions in imported water, as well as municipalities that must build out stormwater infrastructure to meet MS4 permit compliance but are struggling to organize sufficient funds. Stormwater permits and the associated processes to achieve compliance are driven by existing laws and regulations that can have highly restrictive aspects, such as specified receiving water body water quality targets, that complicate regional planning associated with new BMPs and capture and use infrastructure.

Senate Bill 985, California Water Code 10563, and requisite guidelines were assessed as a potential barrier to capture and use. As required in 10563, the purpose of the Storm Water Resource Plan Guidelines (Guidelines) is to establish guidance for public agencies for the development of Storm Water Resource Plans consistent with Water Code sections 10560 et seq. (as amended by Senate Bill 985, Stats. 2014, ch. 555, § 5) (State Water Board 2015A). Water Code section 10563, subdivision (c)(1), requires a Storm Water Resource Plan (Plan) as a condition of receiving funds for storm water and dry weather runoff capture projects from any bond approved by voters after January 2014. This is clearly a barrier to capture and use projects as it introduces additional steps to obtaining funding. This requirement applies to Proposition 1 (Prop 1). Prop 1 Guidelines further apply the requirement for a storm water resource plan to all stormwater projects, except those projects using funds that rolled over from funding sources that predate SB 985 (State Water Board 2015B). Prop 1 funding sought to mitigate this barrier by allowing funding for development of storm water resource plans (SWRPs), but this still requires time and effort to develop these plans. On the positive side, the effort to prepare SWRPs may be raising awareness of the benefits of capture and use such that decision makers may prefer them over traditional SCMs. The benefits evaluation requirements in a SWRP may also increase the quality of proposed projects. These positive effects could not be quantified or verified. In the short term, SB 985 appears to be a barrier to individual capture and use projects but it may encourage an increase in overall implementation of capture and use.

Many agency decisions, too, regarding MS4 permit compliance can impose barriers to capture and use. For instance, varied MS4 permit post-construction requirements among Regional Water Boards and the statewide NPDES permits makes creating statewide training programs and design guidelines difficult. In addition, the application of receiving water limitations (RWL) to

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stormwater conveyances, which have been determined in some cases to be so-called "waters of the US," may inhibit using the stormwater conveyance systems to convey stormwater to regional stormwater capture and use systems. The application of RWLs to the conveyance would require treatment to RWL standards prior to discharge to those conveyances. This increases treatment costs and may require treatment systems or capture and use infrastructure in places that are not cost-optimal. Finally, there is a lack of state regulations directing the inclusion of stormwater as a potential supply source as a condition of entitlement in general plans.

In many parts of the state, significant uncertainties exist regarding regulatory barriers for particular BMPs that can inhibit capture and use projects. For instance, many groundwater managers are cautious with infiltration technologies, especially those designed to connect land surfaces and drinking water aquifers through rapid conveyance. In particular, drywell systems for capture and deep infiltration of stormwater are not used in Northern California even though in Southern California there are many examples of drywells being implemented for this application. Implementation does vary by county and is not necessarily related to north-south groupings. Counties can be reluctant to allow drywell infiltration technologies unless pretreatment is used to meet existing groundwater quality levels. In some areas, drywells are restricted for certain land uses that are associated with a higher risk for groundwater contamination. This issue has been identified in verbal feedback during local outreach presentations as impeding drywell implementation. Similarly, some counties are concerned that the Porter-Cologne Act (Section 13382) requires a waste discharge permit for the implementation of injection wells, of which drywells seem to be included (Section 13051). While a waiver program is allowed (Section 13264), examples of waivers could not be found in the case studies.

As a final example of the disconnect between potential outcomes of planning processes and actual practices, while technologies have been successfully used internationally for direct use of urban runoff (Feldman 2017), a lack of state-approved testing or verification protocol may be limiting use of these technologies. Substantial progress has been made by the National Blue Ribbon Commission for Onsite Non-potable Water Systems. This work is ongoing and should be consulted for the latest guidelines that may be useful in establishing performance criteria for a testing and verification program.

Water Rights

Water rights in California are detailed and complex. They influence many aspects of water management, from decisions on diversions to actions regarding statewide conveyance. For stormwater, a potential legal impediment to capture and use projects is the lack of clarity around when and to what extent water rights are implicated in stormwater capture projects. Typically, a water right is needed whenever surface waters are diverted and applied to beneficial use. (Wat. Code, §§ 1200 et seq.; Cal. Code Regs., tit. 23, §§ 650 et seq.) In general, an entity capturing fleeting, ephemeral flows of stormwater and slowing down, diverting, treating, or percolating such water for flood control or water quality protection is not exercising a surface water right. However, if the water is subsequently put to a beneficial use, such as irrigation, water rights may be implicated. Water right determinations are thus fact-specific.

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Where a water right permit is required for a stormwater capture project, the Division of Water Right's temporary water right permit program may be utilized to facilitate a streamlined and expedited process for permitting of the project. As part of the efforts to address emergency flood control measures in 2017, Governor Brown's Executive Order B-39-17 directs the State Water Board to prioritize temporary water right permits for projects that enhance the ability of a local or state agency to capture wet weather high runoff events for local storage or recharge. The Executive Order suspends the California Environmental Quality Act (CEQA) provisions for State Water Board actions on these types of temporary permits, allows for an expedited review process, and substantially reduces application-filing fees.

A legal constraint to stormwater use in the form of rainwater capture systems has been previously addressed through legislation. The Rainwater Capture Act of 2012 clarified that use of rainwater collected from rooftops does not require a water right permit from the State Water Board (Wat. Code §§ 10570 et seq). The act defines rainwater as "precipitation on any public or private parcel that has not entered an offsite storm drain system or channel, a flood control channel, or any other stream channel and not previously been put to beneficial use" (Wat. Code, § 10573). For these particular types of projects, the legislation removed the fear of downstream claims or the expense of checking for impacts on downstream rights. For all other types of stormwater capture and use projects, a water right may be required.

4.4 Technology

Technology was not reported as a limiting factor in the ability to implement stormwater capture and use case study projects. However, a particular strategy that has not been attempted is integrating capture and use with other underground utilities in a high-density urban environment where space for traditional capture and use is not available. Integration of stormwater systems with other utilities has unknown technological requirements to protect the utilities (e.g., telecom infrastructure) or to avoid health or environmental impacts (e.g., sanitary sewer and potable water infrastructure).

4.5 Potential Statewide Solutions

Integrated regional water management plans (IRWMPs) codify watershed-scale planning processes to encourage broad agency partnerships for improved water resources management. For urbanized watersheds, stormwater planning is a critical component to IRWMP processes. Owners and operators of municipal separate storm sewer systems (MS4s) must be included in the development of IRWMPs. Moreover, existing enhanced watershed management plans (EWMPs) in Southern California and stormwater resource plans (SWRPs) in other parts of the state are pushing localities to consider how to better use stormwater as a resource.

In addition, public agencies are required to develop SWRPs, or functionally equivalent plans, as a condition of receiving Prop 1 grant funds for stormwater and dry weather runoff capture projects. To further improve collaboration among local agencies and nongovernmental organizations throughout a watershed, SWRPs could be legislatively required outside of applying for grant funds as well. However, because IRWMPs are not required to integrate information from SWRPs this approach may not have the intended outcome. Consequently, updating IRWMP requirements may be a more effective solution to integrating capture and use into regional plans and improving collaboration among organizations.

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Table 2 is a matrix of different barriers to urban runoff capture and use. Although not exhaustive, the matrix identifies specific barriers in each category that were identified either through an analysis of the submitted case studies or through the project experiences of the study team. Experience, though anecdotal, provides critical insight into barriers because much of the experience in failed capture and use concepts is not well-documented. A survey across MS4s may yield quantifiable results, but that was outside the scope of this study.

Included in the matrix are drivers for the identified barriers as well as factors for success in overcoming the identified barriers. Additionally, potential solutions that could be implemented on a statewide level to help remove the specific identified barriers are outlined.

The barriers, and efforts to address them, follow the four broad categories previously discussed: financing/valuation, education/guidance, institutional/policy (including regulatory), and technology. Many of the efforts to address a barrier in a project will apply to more than one category (e.g., every solution will likely involve education and training).

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Table 2: Capture and Use Barriers Matrix

Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
Financing/Valuation					
1. Projects infeasible without augmentation from temporary funding sources (e.g., grants, local bond measures)	1. Lack of value of stormwater as a resource 2. Lack of start-up funds to perform triple bottom line (large projects) or minimum alternatives analysis (small projects) 3. Stormwater valuation seems impossible without addressing the undervaluation of other water sources due to federal and state subsidies of the surface water capture and distribution systems	1. Lack of implementation of stormwater capture and use projects 2. Lack of ability to identify multiple benefits through a triple bottom line analysis or minimum alternatives analysis	1. Identification of multiple benefits and of other sources of funding (e.g., the Caltrans fund has provided startup costs for some projects that support TMDL compliance—see Appendix D for funding criteria)	A. Approaches to the valuation of stormwater as a resource B. Guidance on identification of multiple benefits of projects and associated funding sources C. Providing project development money for alternatives analysis. Could require reasonable assurance analysis (RAA) as a prerequisite to help ensure work products are useful D. Guidance on how to plan/develop projects considering partnerships and site specific conditions (e.g., LADWP Capture Master Plan provides example of leveraging ongoing projects that benefit stormwater	A. Phase II STORMS Project 1d; Related STORMS project: Eliminate Barriers to Funding Stormwater Programs and Identify Funding for Stormwater Capture and Use Projects B. APWA, NMSA, WERF etc. C. Legislature D. APWA, CASQA, NAFSMA E. CUWA, APWA, State Water Board

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
	4. Urban stormwater capture costs vary greatly based on site-specific conditions—such as infrastructure requirements to transfer, treat, and store the supply—and local hydrology including options to capture storm water in both groundwater basins and surface water reservoirs			management agencies and other agencies to share costs) E. Create guidance on how to plan/develop projects based on local conditions and cost per yield	
2. Lack of guidance to quantify all water and non-water benefits in a multiple-benefit project	No guidance for the identification of multiple benefits for projects	1. Lack of cost savings and implementation of multiple benefit projects 2. Lack of ability to pursue additional funding sources specific to the multiple benefits identified	1. Triple bottom line analysis performed to help identify multiple benefits 2. Multiple-benefit analysis conducted early in the project	A. Guidance on how to perform a multiple-benefit analysis to pull funding from the maximum number of sources B. Stakeholders must acknowledge that	A. Potential to reframe STORMS Phase II project: Develop and Establish a Monetary Value of Stormwater B. Ongoing EPA Project may relate to barrier

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
to solicit additional funds			3. Scale ($) required to support triple bottom line	project partners may have contrasting/diverse motivations for project investments	
3. Roadway infrastructure can be challenging to integrate with stormwater systems due to limitations on funding	Transportation funding sources may not allow funds to be used for stormwater project elements	1. Loss of opportunities for more cost-effective location of water infrastructure 2. New roadways are built without integrated water systems and existing natural ecosystem function is lost	1. Integrated transportation and water systems 2. Transportation funding sources that allow water infrastructure improvements 3. Recognizing transportation corridors (road and rail) as potential stormwater capture and/or distribution locations	Education and outreach to transportation officials and legislators to incorporate water infrastructure and water funding sources into transportation funding	FHWA, NMSA, AASHTO, TRB, NACTO
Education/Guidance					
4. Lack of technical and policy guidance regarding the range of options for centralized	1. Water demand 2. Cost of water 3. Space availability for	1. One-off centralized project designs increase costs and may miss opportunities for efficiency in design	1. Water district experience with centralized capture and use systems (i.e., spreading grounds and infiltration basins)	A. Technical guidance regarding centralized capture and use systems and a tool that calculates the present worth of water	A. APWA, ASCE, EPA, WEF, WERF, AIA B. Related STORMS Project 1d: Develop and Establish a

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
capture and use systems	centralized systems 4. Lack of awareness of available technology		2. Municipal experience of centralized BMPs 3. Los Angeles MS4 permit considers onsite retention (no discharge) of a design storm to meet the alternative compliance standard for receiving water limitations 4. Diffusion of ideas from organizations with experience regarding capture and use and centralized BMPs to those without via a central online location such as the CASQA LID Portal	from various sources across a timescale that includes both excess and drought periods producing a value that would be used to determine the contribution to stormwater funding portfolios and whether the amount is worth pursuing B. Establish a regulatory incentive as a statewide RAA principle that simplifies or eliminates water quality modeling and monitoring efforts for projects that fully retain up to the water quality design storm sized for that watershed	Monetary Value of Stormwater C. Water Boards developing the principles for RAA is ongoing via Project 3a: Develop Guidance for Alternative Compliance Approaches for Municipal Storm Water Permits Receiving Water Limitations and Project 3b: Develop Watershed-Based Compliance and Management Guidelines and Tools; Also related to STORMS Projects to Develop Watershed Based Compliance Management and Tools
5. Lack of public education and outreach to enhance acceptance of capture and use	1. Stormwater management (i.e., green infrastructure) looks different	1. Fewer capture and use systems being built due to public pressure to not use public funds for systems that are not understood	1. Outreach efforts that educate the public about stormwater capture and use and its multiple benefits	A. Statewide education campaign about stormwater capture and use B. Guidance on outreach to	A. Protect Every Drop partners B. EPA, APWA, LGC or other national agency C. NMSA, EPA, WEF

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
at different scales (i.e., regional, neighborhood, parcel)	2. Perception of consolidating contaminants 3. Lack of public education and outreach about different scales of capture and use systems 4. Lack of understanding at the public and decision maker level	2. Less than optimal solutions due to lack of understanding of project benefits and impacts	2. Numerous small-scale, neighborhood-accessible outreach meetings 3. Field outreach events in neighborhoods where projects will be built 4. Outreach to public officials	communicate triple bottom line and approach and increase community ownership of water project decisions C. National programs to educate decision makers	

Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
6. Roadway infrastructure can be challenging to integrate with stormwater systems due to well established planning and design standards	1. Limited roadway rights-of-way 2. Lack of guidance on integration of stormwater capture and use and green infrastructure into existing or new roadways	1. Loss of opportunities for more cost-effective locations of water infrastructure 2. New roadways are built without integrated water systems and existing natural ecosystem function is lost	1. Integrated transportation and water systems 2. Recognizing transportation corridors (road and rail) as potential stormwater capture and/or distribution locations 3. Some guidance available on green streets and NCHRP for volume capture in highway environments (NCHRP Report No. 802; Raje et al. 2013)	Education and outreach to integrate water capture infrastructure into transportation projects	FHWA, NMSA, NACTO, AASHTO, TRB, APA

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
7. All non-potable water demands are met	Existing recycled water infrastructure already in place meets non-potable demand	Reduced implementation of capture and use	Focus on restoration of natural ecosystem function to restore or enhance desired ecosystems	Education and outreach	Joint promotion by Water Boards, CASQA, CWH, LID Center, LIDI CWP, Water Foundation, and similar advocates
8.1 Lack of awareness of opportunities to capture smaller flows from flood control detention basins **8.2 Lack of knowledge of downstream water rights**	1. Flood control capacity 2. Maintenance 3. Cost of retrofits 4. Timing of use of water 5. Flood control basins are often not managed by MS4 programs 6. Agencies are unfamiliar with existing infrastructure across their respective counties (NRA and DWR 2013) 7. Existing rights map is	1. Dry weather flows or smaller storms are not effectively used 2. Distributed systems are constructed at higher costs relative to retrofitting a flood control basin 3. High cost to assess water rights	1. Hydrologic evaluation of basins 2. Geotechnical evaluations 3. Demand and timing analysis 4. Groundwater recharge need 5. Larger projects have economies of scale to support the cost of water diversion application	A. Guidance for evaluation and design of retrofit of flood control basins for capture and use (IRWD 2012) B. Better water rights data	DWR, NAFSMA, NMSA, State Water Board

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
	difficult to navigate				
9.Timing for the use of captured stormwater	1. Irrigation water may not be needed for months after storm event 2. Time of demand 3. Vector control can become an issue for extended storage periods	Low oxygen in water stored for long periods of time requires additional treatment at more cost	1. Alternative demand (besides irrigation) 2. Infiltration to aquifer 3. Long-term storage	A. Guidance for storage of capture and use water for irrigation and identification of innovative technologies to expand storage times B. Clarify regulatory constraints	ARCSA, AWWA, National Blue Ribbon Commission for Onsite Non-Potable Water Systems
10. Lack of triple bottom line analysis for watershed plans that would identify and rank multiple benefits including water supply for projects	1. Minimal understanding of triple bottom line by watershed plan proponents 2. Guidance for identification of multiple benefits non-existent 3. Guidance on performing triple bottom line for	1. Reduced implementation of multiple-benefit projects 2. Implementation of stormwater and watershed projects that do not consider environmental and social impacts and benefits 3. Lack of public support 4. Reduced implementation of projects that increase	1. Integration of triple bottom line at the beginning of a watershed plan 2. Water districts as part of the stakeholder group for a watershed plan 3. Triple bottom line criteria and value setting steps included in the public and stakeholder outreach process	Statewide requirement and guidance on using triple bottom line analysis for: 1. Watershed planning 2. Stormwater projects and programs 3. Water supply plans 4. IRWMP and SWRP guidance	DWR, APWA or Envision for triple bottom line guidance

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
	watershed planning non-existent	resiliency to climate change			
11. Lack of consideration of stormwater as a supply	Lack of connection between types of water infrastructure GIS	Lost opportunities to implement projects with water supply function	Regional policies that are supportive of stormwater as a supply (LADWP 2006)	Expand the DWR Water Management Planning tool to incorporate stormwater infrastructure and analyze stormwater as a supply source.	DWR
Institutional/Policy: Regulatory Legal					
12.1. Unknown design criteria for supporting ecosystems by protection or restoration of natural hydrologic function **12.2. Other potential environmental impacts**	1. MS4 permitting treatment sizing may not be appropriate for capture and use 2. MS4 permits do not specify design standards for capture and use vs. treat and release (the same design storms are often assumed for both)	1. Oversized systems that are expensive to implement leads to fewer systems implemented and a smaller fraction of watershed restoration 2. Under-designed systems (too small) result in incomplete restoration of natural ecosystem function 3. Implementing systems that cause an altered water balance and results in habitat or other ecosystem impacts exacerbates a groundwater quality issues	1&2. Permit language that requires retention unless technically infeasible (Caltrans), but limiting the retention target to the water quality design storm reduces chance of oversizing 2. Phase II Permit recognizes the benefits of developing design criteria based on local watershed conditions and processes (e.g., Central Coast Phase II sizing approach) 3&4. Site-specific analysis and careful design	A. Modeling the desired water balance in MS4 areas throughout the state as a regulatory or voluntary target for capture and use; consider desired ecosystem objectives (see STORMS Project 1 C) B. Quantify (or develop methods to quantify) evapotranspiration, shallow infiltration, and deep infiltration relative to annual average precipitation C. Investigate the circumstances where	A. Water Boards (Related to STORMS Phase II Project 3f: Develop Guidance for Post-Construction Requirements to Improve Watershed Health) B. State Water Board C. CDFW

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
		4. Projects that have unanticipated environmental impacts will decrease public support for future projects and contribute to unfounded concerns for future projects with no likely impacts	3&4. Coordination with resource agencies and experts 3&4. Integration of environmentally beneficial design features	stream dewatering might be a constraint worthy of site-specific analysis, develop factors to consider that would trigger the need for further analysis, and guidance on scale of project that would need study	
13.1. Inconsistent regulations regarding restricting infiltration based on land use (e.g., industrial land uses) for protection of groundwater **13.2. Inconsistent pretreatment requirements for protection of groundwater** **13.3. Lack of state-endorsed drywell**	1. Regional Board autonomy 2. County autonomy 3. Lack of detailed understanding of surface water effects on groundwater motivate many counties to take a conservative (and restrictive) approach, while others may not be adequately protective. Implementatio	1. Potential contamination of groundwater by infiltration of pollutants (e.g., selenium) 2. Reduced implementation of infiltration when appropriate results in lost opportunities to recharge groundwater, restore natural ecosystem functions, and reduce surface water pollutant loads 3. Potential groundwater contamination or exacerbation of existing groundwater conditions (i.e., selenium issues in	1, 2 & 3. Regulations based on understanding of pollutant sources, quantities, and fate and transport to extractable aquifers 1, 2 & 3. Understanding of natural hydrologic and hydrogeomorphic processes to support ecosystems 1, 2 & 3. Site-specific information regarding groundwater and surface water interaction, local contamination plumes, and stormwater quality	A. Develop statewide regulation regarding restriction of infiltration based on land uses or pretreatment performance standards; determine appropriate application of MCL and basin plan objectives, addressing pretreatment vs. attenuation within the vadose zone; consider recent research results on passive treatment approaches to protect groundwater (Beganskas and Fisher 2017); and address WQO 68-16	A. Ongoing Water Boards project B. Water Boards C. CASQA D. DWR

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
standards and pretreatment performance standards **13.4. Lack of clarity regarding anti-degradation policy as applied to groundwater**	n of the Sustainable Groundwater Management Act (SGMA) may lead to an increased understanding of surface water effects on groundwater or may cause unnecessary caution or analysis 4. WQO 68-16	Newport Bay Watershed)		B. Training and education of Regional Water Board staff C. Training and education of county regulators D. State-endorsed drywell design standards	
14. Different Department of Public Health (DPH) requirements and guidance for use and treatment of captured stormwater for direct use	1. Public health threats from direct use of stormwater 2. Autonomy of local public health agencies	1. New learning curve for implementing capture and use systems in different jurisdictions 2. Longer timeframe for implementing capture and use systems	1. The flexibility to use purple pipe for distribution of captured and treated stormwater 2. Availability of DPH staff for pre-project meetings with proponents to coordinate and understand regulations	A. Develop stormwater treatment and piping distribution guidance (WEF 2014) B. Adopt treatment requirements that do not require Title 22 for all captured stormwater that would exclusively use existing, unused purple pipe (no comingling with recycled water)	AWWA or other professional association (except DDW because they don't have explicit regulations on stormwater treatment for non-potable uses); Water Boards (low priority due to limited applicability and potentially short-term issue once POTWs are

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
					upgraded to use purple pipe); National Blue Ribbon Commission for Onsite Non-potable Water Systems may be addressing this issue at a national level
15. Constraining, competing, or inconsistent local regulations among jurisdictions	Different levels of government are not coordinated regarding requirements	1. Impedes training design professionals and MS4 plan reviews 2. New learning curve for implementing capture and use systems in different jurisdictions 3. Longer timeframe for implementing capture and use systems	Coordinated regulations based on common science-based approach and adopted at different levels of government	Develop model policies, regulations, or amendments that local jurisdictions will be able to replicate and integrate into their regulatory structure; various project timelines to address different policy barriers may make a single project difficult to implement	No specific lead identified, but all projects with regulatory implications should include a review of local regulations to identify conflicts and recommend improvements
16. Multiple-benefit projects that provide a water supply benefit do not receive preference over projects that do not offer	1. Multiple-benefit projects are not valued significantly more than other projects 2. Water supply benefits are not significantly valued more	1. Lost opportunities to achieve optimal multiple social and environmental benefits via projects 2. Increase social costs of separate projects to achieve singular benefits	Some funding sources have criteria for funding that significantly values multiple-benefits projects higher than other projects	A. Establishing funding criteria for multiple-benefit projects B. Perform simplified triple bottom line analysis as part of project evaluations	Although issue is acknowledged in STORMS Project and CASQA funding website, more might be done through CASQA, AWWA, APWA, and EPA

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Barriers	*Drivers (Causes)*	*Consequences (Effects)*	*Factors Affecting Success in Case Studies*	*Potential Projects for Statewide Solutions*	*Potential Lead Agency or Advocate of Solution*
multiple benefits	than other benefits				
17. Downstream water rights	State Law; prior downstream appropriation; unknown risk	1. Added cost to determine rights 2. Decreased capture	California Rainwater Capture Act of 2012 clarified that use of rainwater collected from rooftops does not require a water right permit from the State Water Board (Wat. Code §§ 10570 et seq)	Change in state law	State Water Board
Institutional/Policy: General					
18. Developers are not required to consider stormwater capture and use options early enough in the entitlement process	1. Stormwater and LID are not an integrated step and municipalities do not require stormwater capture/LID consideration early enough in the entitlement process 2. Lack of LID site planning/site design and stormwater capture and use training/guidan	1. Additional redesign costs or increased costs due to retrofitting after the development is built 2. Fewer opportunities for preservation of natural ecosystem due to development of prime areas for BMPs	1. Long-term land use planning considers stormwater a potential water supply 2. Green infrastructure provides a number of benefits including improved water quality, reduced flood losses and infrastructure costs, and cost savings of combined sewer overflow mitigation 3. Studies tying real estate values to presence/absence of green infrastructure found that total	Guidance for stormwater capture and use planning for developers and municipal planners to be adopted into city and county ordinance governing entitlement (see Johnson and Loux 2010, for insights on California water planning); groundwater and surface water conflicts and information on policy to address water needs in CEQA noted here: http://waterinthewest.	APA, CASQA, Governor's Office of Planning and Research, ULI

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Barriers	Drivers (Causes)	Consequences (Effects)	Factors Affecting Success in Case Studies	Potential Projects for Statewide Solutions	Potential Lead Agency or Advocate of Solution
	ce for developers 3. Developers prefer not to deviate from past development processes		benefits to property owners on average is 2-5% of property value for all properties within a flood plain (Braden 2004) 4. Results of completed LID projects indicate that the higher initial landscape cost of LID are offset by decreased costs associated with infrastructure and site preparation; on average LID projects can be completed at a cost reduction of 25-30% over conventional projects (Hager 2003; CA LID Portal 2017)	stanford.edu/groundwater/conflicts/index.html	
19. Lack of communication and collaboration among agencies (primarily	1. Water districts prefer the cleanest and most reliable sources and	1. Lost opportunities for areas where stormwater capture and use is viable 2. Less groundwater recharge in key	1. Established relationships among agencies 2. Third party intervention (i.e., developer)	Increased incentives (i.e., grant programs or State Revolving Funds or SRF that require water suppliers and stormwater dischargers	Ongoing coordination effort within the State Water Board between DFA and SGMA to ensure GSAs recognize

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