| *Barriers* | *Drivers (Causes)* | *Consequences (Effects)* | *Factors Affecting Success in Case Studies* | *Potential Projects for Statewide Solutions* | *Potential Lead Agency or Advocate of Solution* |
|---|---|---|---|---|---|
| **municipalities and water districts) on opportunities for stormwater capture and use projects** | groundwater contamination concerns may result in additional analysis requirements for stormwater infiltration projects<br>2. Lack of understanding of other agency regulatory drivers<br>3. Lack of successful examples for collaboration<br>4. Lack of interest due to capture amounts<br>5. Cost of potable water | locations for water districts<br>3. Less resiliency in the water management systems to combat the effects of climate change | 3. Common regulatory driver (i.e., TMDL)<br>4. Political support/policy (e.g., LA Mayor's Executive Directive to reduce the City's purchase of imported water by 50% by 2024) | to collaborate); SGMA implementation can foster stormwater recharge partnerships with MS4 runoff | MS4 runoff capture opportunities |
| **20. Lack of triple bottom line analysis for non-water infrastructure that could** | Incorporating multiple benefits can be perceived as scope creep and as adding | 1. Lost opportunities for cost savings and for integration of capture and use and restoration of natural ecosystem functions | 1. Coordination among many different agencies<br>2. Address increased project risk associated | A. Concept paper identifying non-water infrastructure that has the highest opportunity for integration of stormwater capture | APWA, Envision, APA, Governor's Office of Planning and Research |



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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* |
|---|---|---|---|---|---|
| **incorporate capture and use** | risk to the project and jeopardizing the primary objective | 2. Loss of cost savings as stand-alone capture and use projects will need to be implemented | with adding stormwater | and use and how it could better support water infrastructure and vice versa; Envision and tools from APWA may provide a start<br>B. Perform an in-depth analysis to evaluate the urban form when developing new communities or subdivisions or refurbishing older communities to better integrate stormwater capture and use and LID principles (e.g., permeable surfaces and bioretention) and show how triple bottom line can be done in the context of stormwater capture and use | |
| **21. Lack of triple bottom line analysis of environmental benefits of** | Multiple environmental benefits | 1. Lack of implementation of multiple-benefit projects<br>2. Lack of identification of multiple benefits and | Triple bottom line analysis for all project alternatives and/or project elements | Triple bottom line analysis guidance for stormwater projects and programs, including the value to out-of-basin water | California Natural Resources Agency, DWR, etc. |



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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* |
|---|---|---|---|---|---|
| **stormwater capture and use** | | other funding sources specific to the multiple benefits<br>3. Lost opportunities to gain further public support for projects by evaluating the social benefits of projects<br>4. Lost opportunities to implement truly sustainable projects that are resilient to climate change<br>5. Inability to compare projects with similar costs that have different levels of environmental and social benefits | | sources that will have less demand, reduced environmental impacts, and reduced energy consumption for water delivery | |



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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* |
|---|---|---|---|---|---|
| **22. Lack of state approval for design and performance of treatment, storage, and distribution technologies for direct use** | 1. Lack of funding for testing program<br>2. Administrative burden | 1. Lack of confidence and high risk limits innovation<br>2. Use of systems that do not work<br>3. Use of systems that are needlessly expensive | Comprehensive testing with 3rd party oversight | State or federal testing program for BMPs and technologies for direct use (irrigation, indoor, etc.); expand WEF's STEPP to address capture and use; track ongoing development around the world including work in Australia (Feldman 2017) | ITRC, ASCE, WEF, WERF, NMSA, ASTM, AWWA, ARCSA; related STORMS Project 5a will develop data standards for green infrastructure and LID BMPs to inform a standard set of monitoring information and meta data so that a more comprehensive analysis is possible |



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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* |
|---|---|---|---|---|---|
| **23. Lack of financial mechanisms for agencies to combine resources** | 1. Agencies have individual budgets and budgetary processes<br>2. Joint power authorities (JPAs) are a solution but are difficult to establish | Loss of opportunities to implement centralized projects due to costs and program authorities | 1. Agreements on joint agencies pursuing funding<br>2. Collaborative planning to integrate and combine funding | Promote GSA JPAs that include MS4s as signatories (see DWR fact sheet for GSA formation) | DWR and DWQ with DFA/SGMA;<br>related STORMS Phase II project: Increase Stakeholder Collaboration to Promote Stormwater as a Resource |
| **Technology** | | | | | |
| **24. Competing uses for rights-of-way in high density development settings** | 1. Utilities<br>2. Limited rights-of-way | Integrated water infrastructure rarely materializes in ultra-urban settings | 1. Innovative design for new buildings and roadways<br>2. Upgrade of utilities and integration of stormwater infrastructure | A. Integration of stormwater capture infrastructure with utilities and other infrastructure<br>B. Triple bottom line and multiple benefit guidance for all infrastructure | APWA, EPA, FHWA, Envision, etc. |



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### 4.6 Creating or Increasing Incentives

Incentives provide motivation. In the near term, the next phase of projects addressing capture and use are largely addressing barriers, so outside of funding sources or regulatory relief, these projects may not provide incentives. Current incentives include:

- Total maximum daily load (TMDL) and alternative compliance paths to receiving water limitations
- Water supply resilience
- Sustainable groundwater requirements
- Groundwater salinity intrusion
- Subsidence
- Ecosystem management, especially for endangered and threatened species

These incentives do not apply equally throughout the state. For example, TMDLs and alternative compliance have thus far excluded small, rural municipalities due to fewer TMDL drivers. Also, water supply costs vary so this is an inconsistent motivator for stormwater capture and use. Sustaining groundwater levels will provide some incentives for GSAs to partially fund urban runoff deep infiltration projects at price points that relate to local water market pricing.

## 5 Findings and Recommendations

Findings represent the key messages for the stormwater community based on input from the project team, TAC, and PAG. Recommendations contain a summary of next steps on the primary projects identified in Table 2.

### 5.1 Findings: Constraints and Barriers

These findings are meant to focus on successfully implementing capture and use projects, despite the barriers identified in the study. By presenting barriers in the context of successful projects, these findings are meant to summarize ways of supporting project proponents in their implementation of capture and use. The following twelve findings have been grouped into five categories. They range from supporting new efforts and policies to eliminating barriers and developing messaging for public outreach emphasizing the benefits of capture and use. The first group, Motivating Change, might be the most critical in promoting capture and use. As seen in case studies and comments from municipalities, most barriers are overcome when people have the will to change how stormwater is managed. The remaining groups are Viable Urban Water Supply, Better Information Needed, Identifying Tradeoffs and Consequences, and Hybrid Strategies.

#### *Motivating Change*

*Finding 1*: Capture and use projects or BMPs that increase on-site runoff retention also reduce the effects and associated liability of discharging to local watersheds. A project or BMP that mimics the pre-urban hydrologic condition (e.g., surface runoff volumes/rates, infiltration, evapotranspiration) also preserves (new construction) or restores (retrofit construction) ecosystem processes, thereby setting a context for sustainable water resource management by

managing water volumes appropriately to protect historic ecologic end use. Additionally, the cost of achieving water quality standards in surface waters is reduced when natural watershed processes are present. Further studies are required to quantify the water quality benefits and to properly credit capture and use toward water quality goals such as TMDLs.

*Finding 2:* Public engagement is key to increasing BMP integration into other public and environmental objectives, and it will increase the likelihood of robust, multiple-benefit, and cost-effective projects. Consistent and effective messaging is a critical component to engaging the public and increasing community buy in. Specialized expertise and broad coordination (CASQA 2017a) will also help formulate and convey messaging efforts.

### *Viable Urban Supply*

*Finding 3:* Urban runoff can provide a sizeable water supply. In some parts of the state, urban stormwater runoff currently constitutes 10% or more of urban supplies. Utilizing urban runoff as a supply augments and diversifies water portfolios. Diversified regional water portfolios will relieve pressure on foundational supplies and make communities more resilient against drought, flood, population growth, and climate change (CNRA 2016).

*Finding 4:* Technological limitations were not reported in case studies. Instead, reported barriers relate to policy, finance, institutional structure, and awareness. Awareness of technological capabilities can overcome some perceived barriers. For example, space limitations and lack of permeability in near-surface soils are perceived barriers that can potentially be addressed by increased awareness of drywell technologies.

*Finding 5:* Given California's varying climate, it is likely infeasible to meet all urban demands using stormwater capture alone. The scale of capture and use required to meet typical urban needs would necessitate volume storage that is many times greater than current stormwater design storms. Additionally, since this volume typically falls over a span of several storms throughout the year in most parts of the state, peak volume storage would be extensive. Due to these large storage requirements, urban areas with underlying aquifers are ideally situated to capture and store water, as aquifers provide a cost-effective storage solution and clearer path to overcoming existing storage barriers for capture and use projects. Where aquifer storage is not available, methods such as conservation and surface water capture should be emphasized. The location of capture facilities in relation to the location of desired end uses is another key to controlling distribution cost.

### *Better Information Needed*

*Finding 6:* In most parts of the state, using urban runoff as a water supply is more expensive than utilizing existing sources. Distributed stormwater capture, which is easier to implement in dense urban areas, is more expensive, while larger centralized stormwater capture requires substantial tracts of land that can be difficult to site in densely urbanized areas. When comparing stormwater capture to existing sources it is important to realize that current water rates often do not accurately reflect full water supply costs. Existing water supply infrastructure was built and paid for in part decades ago.



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Improved rate-setting procedures in water districts could allow for better comparisons of existing and new infrastructure cost estimates. While there may be limitations associated with Proposition 218, sunken treatment costs should be considered as well as the incentive provided by clean water act regulation. Water districts can contribute to proper valuation by using rate setting techniques that consider factors such as increasing environmental costs associated with different water sources and cost increases associated with likely climate change scenarios that can cause water scarcity. Water districts typically set standards based on a 5-year future projection, which fundamentally limits their ability to make investments in alternative water sources based on longer term changes (City of Vallejo 2016).

*Finding 7:* Standardized procedures or decision support tools do not currently exist for stormwater capture and use planning. Several major stormwater planning applications now include modules to support LID and BMP implementation, but cost and performance data is dispersed and few studies have effectively considered the potential for stormwater capture to comprise a significant source of urban water supply. Capture and use approaches are typically more expensive than upgrading existing grey infrastructure when comparing new vs. marginal cost increases, and when failing to include benefits and costs for environmental and social aspects of system management.

Improving valuation—both economic and non-economic—of capture and use can increase community and political support, which helps overcome financial and institutional barriers. Increased capture and use could be realized by recognizing the benefits of capture and use on water quality, air quality, education, and health-related benefits. Small-scale options for stormwater management also offer municipalities an opportunity to implement capture and use projects that support local economic activity, rather than relying on specialized labor and materials from outside the local area (WEF 2014). Proper valuation of multiple-benefit projects will also make capture and use projects more attractive for various funding sources (e.g., transportation). Decision support tools can assist in optimizing new system designs with green and grey infrastructure that better promote sustainable and holistic water management, exemplified by *OneWater* approaches being pursued in some areas of the state.

*Finding 8:* Stormwater infrastructure can support multiple objectives to provide the greatest benefits, but these must be considered early in the design process. For example, centralized strategies can more effectively achieve multiple benefits when agencies charged with managing different types of natural resources collaborate to meet resource objectives (e.g., water supply, flood control, habitat, air quality, receiving water protection). Decentralized strategies tend to be implemented within land uses that are primarily dedicated to other infrastructure (e.g., transportation). Choosing approaches that support a diversity of infrastructure will be critical in marshalling funding designated for that infrastructure.

*Finding 9:* There are thousands of stormwater control measures (e.g., flood control facilities and stormwater detention basins) in California, so retrofit or modification of existing regional facilities is a promising strategy to substantially increase capture and use. Better regulations clarifying uncertainty regarding existing water rights diversions and capture and use may encourage small-scale retrofits where the cost of investigating rights is high compared to the benefit derived from the project. Central repositories for regional data on BMP, LID, and capture and use performance and costs would support improved planning processes. In particular, regionally



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centralizing databases for runoff and flood infrastructure, which are currently housed in more than 1,000 different flood control agencies statewide, could be brought together in regional databases in support of opening access to information that allows for a more accurate assessments of benefits (DWR 2013).

### *Identifying Tradeoffs and Consequences*

*Finding 10:* Developing appropriate targets for capture and use requires considering the complex tradeoffs between benefits of capture and use as well as potential unintended consequences. For example, existing ecosystems that are dependent on current urban runoff flow regimes may support endangered species. Increased capture and use management strategies could reduce the flows that support these species. A framework for valuing the support of post-development ecosystems is needed to further evaluate the potential effects that capture and use projects may have on species that rely on elevated urban runoff flow regimes. Negative groundwater quality impacts is another example of unintended consequences.

### *Hybrid Strategies*

*Finding 11:* Future urban water management will require a mix of green and grey infrastructure. Costs, technologies, and social views are driving this trend toward hybrid systems. According to case studies, technology has not been reported as a barrier for capture and use projects; financial and policy barriers far exceed technical limitations. With respect to hybrid systems, this means designing green and grey infrastructure that use distributed infrastructure to capture and attenuate runoff throughout the landscape, coupled with key larger municipal infrastructure that assures performance. But, best practices for design and management are unclear and risks are still significant. For instance, decentralized capture and use strategies on private land may not be well maintained over time. Alternatively, investing in large infrastructure is expensive and may not directly achieve receiving water requirements or estimates of groundwater recharge, stifling additional investments. (Sedlak 2013; NAS 2016; Porse 2013).

Watershed scale decisions may fit well within IRWM planning and municipal general planning efforts that could require consideration of local stormwater as a supply source. The knowledge, guidance, and funding to conduct triple bottom line cost-benefit assessments for watershed ecosystems is needed to identify the optimum mix of green and grey infrastructure. MS4 permits and municipal code may need adjustments to allow for that mix. At a smaller scale for a particular development, decisions often rest with the developer.

*Finding 12:* Applying fit for purpose standards to the different uses of urban runoff may reduce unnecessary treatment costs. For example, risk-based treatment standards applied to harvested water for protection of public health based on likely exposure may result in decreased costs of direct use systems (SFPUC 2013).

## 5.2 Promising Actions

Some of the potential projects identified in Section 4.5 appear ready for further scoping and implementation. These projects and, where appropriate, actions identified in the CASQA Vision (2015) that may align with these projects are identified. The state actions also list the agencies



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best suited to lead the projects. Additional projects and organizations are listed in Section 2.3, however these local and state actions are recommended for immediate implementation.

*Local Actions*

1. Collect data necessary for asset management and justification for stormwater fees and develop costs for agreed-upon customer and environmental water services while minimizing life cycle costs (CASQA Actions 2.7 and 2.8)
2. Update municipal general plans to require consideration of stormwater as a water supply source (CASQA Action 1.1)
3. Align or leverage water services (e.g., water supply, flooding) with capture and use to the benefit of both (e.g., Hansen Spreading Grounds)
4. Use alternative analysis tools to engage stakeholders and develop support for water infrastructure that delivers social, economic, and environmental benefits (CASQA Action 2.5)
5. Capture and use project advocates (e.g., water districts and MS4 programs) coordinate with local and state transportation authorities to look for opportunities for shared projects and benefits such as the Elmer Avenue Stormwater Capture Project (CASQA Action 3.1)

*State Actions*

1. Explore options for funding stormwater capture and use (refer to Projects 4A and 4B as well as CASQA Action 2.7; State Water Board)
2. Improve consideration of urban runoff in IRWMPs (CASQA Action 1.1; State Water Board, DWR)
3. Resolve the policy questions regarding use of promising technologies and approaches
    a. Resolve regulatory and policy issues related to the use of drywells for stormwater management (State Water Board)
    b. Update IRWM guidelines and the online Water Management Planning Tool (http://wdl.water.ca.gov/irwm/) to consider local urban runoff as a potential source (DWR)
    c. Improve land use codes governing building footprints to adopt performance standards for new development and redevelopment to support decentralized capture and use technologies, such as LID for municipalities (Office of Research and Planning)
    d. Establish a framework to assess local ecological impacts, positive and negative, to capture and use diversions (DFW, State Water Board).
4. Expand/improve regulatory performance measurements to reflect capture and use objectives (State Water Board)
    a. Develop/align post-construction stormwater control requirements for capture and use objectives based on factors such as watershed processes, public use needs, and ecologic value of current flow regimes
5. Identify the most effective and feasible capture and use strategies
    a. The number, location, and volume of stormwater/flood control basins are a prime opportunity for significant benefit, so evaluate the regional and statewide



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opportunity to retrofit conventional detention basins to enhance capture and use (DWR or provide funding to local flood and stormwater agencies).

b. Establish design guidelines for public projects reflective of capture and use objectives (Water Board)

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# Appendix A: Tools and Benefits

## Tools and Benefits

Both structural and non-structural tools for urban capture and use provide benefits for communities and ecosystems.

### Structural

The benefits of structural stormwater control measures (SCMs) are often dependent on the scale of an individual project or the aggregate implementation of small-scale projects within a watershed. Table 1 presents centralized and decentralized SCMs because certain technologies are typically suited for a particular scale. The table provides a description, status, and capture and use potential relative to regional and local scale implementation.

Not all SCMs support capture and use in their current configuration. For example, flood control basins can be retrofitted to maximize groundwater recharge or to support ecosystems. A number of detention/retention basins in California have the potential for modification to accommodate stormwater capture and use objectives as well as provide community and environmental benefits. These types of SCMs are discussed in this appendix because they potentially offer the most cost-effective retrofit applications of capture and use technologies due to sunken costs associated with existing infrastructure.

Table 2 lists a variety of BMPs categorized by scale and identifies typical management components associated with each BMP. After identifying these management components, Table 3 then ties each component to a potential use and identifies ancillary benefits that may also be associated with each management component. Understanding typical multiple-benefit opportunities is essential to correctly valuing stormwater capture and use. A review of studies and additional insight from the TAC and PAG helped identify factors affecting success for each technology.

The list of potential ancillary benefits outlined in Table 3 is not exhaustive because future innovative solutions have the potential to create new structural tools and identify benefits not yet recognized. A comprehensive analysis of co-benefits or potential ancillary benefits can help increase community support for capture and use projects by correctly valuing those benefits for projects that would otherwise go unrecognized.

Current factors affecting the success of implementing capture and use are listed in Table 4. A variety of factors are assessed based on different uses, BMP scales, and whether the project is implemented via private or public development.



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Table A 1. Centralized and Decentralized Structural Stormwater Control Measures and their Potential for Capture and Use.

| | Centralized Stormwater Control Measures (regional scale technologies) | Decentralized Stormwater Control Measures (local scale technologies) |
|---|---|---|
| **Description** | Large SCMs capture stormwater runoff from many acres and multiple land use types. Typically designed to address impacts associated with large storm events (e.g., flooding, hydromodification) and either allow slow downstream release of captured flows or attenuation within the facility. | Small-scale SCMs manage rain and stormwater close to the source, typically at the urban, parcel, or neighborhood scale. Conventional decentralized SCMs function similarly to centralized SCMs to manage peak flows from large storm events while LID SCMs are designed to reestablish or mimic the natural hydrologic cycle for small storm events by allowing rainfall to infiltrate into the native soil. |
| **Status** | There are thousands of centralized SCMs in California. Many are detention/retention basins that are within urban areas. Regional, centralized SCMs are also prevalent throughout California. Centralized SCMs are still built as part of new and redevelopment requirements to address flood and hydromodification control requirements. | Decentralized SCMs are most often used in urban areas to address localized stormwater runoff volumes and pollutants. In response to community greening objectives and/or stormwater NPDES requirements for post-construction stormwater control, the number of LID and green infrastructure projects have increased. Interest in rain harvest technologies is also increasing primarily as a means to offset water supply for landscape irrigation use, and in some cases, indoor and non-potable uses (e.g., toilet flushing). |
| **Capture and Use Potential** | Centralized SCMs have the potential to provide significant volumes of water to meet water resource demands for both potable and non-potable demands. Because there are thousands of centralized SCMs in California, retrofit or modifications to existing regional facilities may represent a promising strategy to meet stormwater capture and use objectives as well as provide additional community and environmental benefits. Often, the regional strategy also improves the collaboration opportunity among agencies to meet their separate water resource objectives (e.g., water supply, flood control, receiving water protection, pre-treatment/nutrient removal/attenuation) in a more cost-effective manner. | Decentralized SCMs have the potential to efficiently manage rain and stormwater at the source to provide environmental and community benefits. Because of their small-scale footprint, these SCMs can be integrated into municipal settings with residential, commercial, and industrial applications. Green Streets are one example where the integration of stormwater quality and quantity objectives can support and leverage transportation and community health investments. Due to their relatively small size, often many facilities are required to provide adequate benefit, and nationally, many communities have developed or embarked upon urban greening plans to evaluate the costs and benefits of widespread and comprehensive implementation. The use of dry wells, either as a stand-alone SCM or in conjunction with other SCMs (such as bioretention), has the potential to greatly increase the deep infiltration of stormwater runoff in urban areas.<br><br>In headwater areas, protection of urban creeks may influence the selection of decentralized SCM over centralized. |



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Table A 2. Identification of BMP Capture and Use Approaches and Mechanisms

| Scale | BMP | Management Component | | | | | |
|---|---|---|---|---|---|---|---|
| | | *Treatment* | *Shallow Infiltration* | *Deep Infiltration* | *Direct Use** | *Open Storage* | *Enclosed Storage* |
| ***Centralized (difficult to scale down)*** | Detention Basin (lined) | | | | ✓ | ✓ | |
| | Detention Basin (retrofit with dry wells) | | | ✓ | ✓ | ✓ | |
| | Detention Basin (unlined) | | ✓ | | ✓ | ✓ | |
| | High Flow Bypass to Spreading Grounds | | ✓ | | ✓ | | |
| | Retention and Wet Basin | | ✓ | ✓ | | ✓ | |
| ***Centralized/ Decentralized (highly scalable)*** | Detention Vault/Cistern (lined) | | | | ✓ | | ✓ |
| | Shallow Infiltration Basin | | ✓ | | | ✓ | |
| | Dry Well | | | ✓ | | | |
| | Shallow Infiltration Galleries and Trenches | | ✓ | | | | ✓ |
| ***Decentralized*** | Bed Filter with Infiltration (underdrain) | ✓ | ✓ | | | ✓ | ✓ |
| | Bioretention Raingarden (underdrain) | ✓ | ✓ | | | ✓ | |
| | Bioretention Raingarden (no underdrain) | ✓ | ✓ | | | ✓ | |
| | Green Roofs | ✓ | | | | ✓ | |
| | Blue Roof | | | | | ✓ | |
| | Pervious Pavement | | ✓ | | | | ✓ |
| | Swales, Filter Strips (biofiltration) | ✓ | | | | | |

*When used with irrigation or other direct use system



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Table A 3. Identified Benefits of Capture and Use Approaches and Mechanisms

| | Potential Capture and Use | | | Potential Ancillary Benefits | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Management Component**[1] | Surface Water Supply | Groundwater Recharge | Ecosystems | Watershed Processes/Natural Hydrologic Function | Groundwater Supply | Surface Water Load Reduction | Surface Water Concentration Reduction (surface discharge quality) | Flood Protection[5] | Urban Greening—Social | Urban Greening—Environment[6] | Energy Savings[8] | Carbon Sequestration | Pollination |
| **Treatment** | | | ✓ | ✓ | | ✓ | ✓ | | | | | | |
| **Shallow Infiltration/ Evapotranspiration** | | | ✓[2] | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Deep Infiltration** | ✓ | ✓ | ✓[3] | ✓ | ✓ | ✓ | | ✓ | | | ✓ | | |
| **Direct Use (plumbing/irrigation)** | ✓ | | ✓[7] | ✓[4] | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| **Open Storage** | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | | | ✓ | | |
| **Enclosed** | | | ✓ | ✓ | | ✓ | | ✓ | | | ✓ | | |

[1]Determined by site-specific design (excludes how water is moved)
[2] Can support beneficial stream flow regimes; can support desirable vegetation that is beneficial to a target ecosystem
[3] Can support groundwater dependent ecosystems (e.g., wetlands and surface waters requiring baseflows)
[4]All benefits theoretically accrue incrementally (don't depend on achieving widescale deployment), however achieving measurable benefits will require a level of adoption that will depend on site-specific factors (e.g., depth to groundwater, soil type, and BMP/SCM type).
[5]Potential based on diversion of excessive flows caused by imperviousness
[6]Environment includes heat island effects and carbon sequestration
[7]Potential for irrigation systems to support desirable vegetation that is beneficial to a target ecosystem
[8] Potential based on shading and reduced cooling costs or reduced long-distance pumping cost



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Table A 4: Current Factors Affecting Success

| | | Location | Water Rights | Stream Flow Needs | Level of Planning | Scale of Implementation | Community Support | Political Support | Funding Mechanism | Water Scarcity | Regulatory Driver |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Use | Surface Water Supply | ✓[1] | | | ✓ | | ✓ | | ✓ | ✓ | |
| | Groundwater Recharge | ✓ | | | ✓[3] | ✓ | | | ✓ | ✓ | ✓ |
| | Ecosystem | ✓ | | | ✓ | | ✓ | | ✓ | | |
| Scale of BMP | Centralized | ✓[2] | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | |
| | Decentralized | | | | | | ✓ | | ✓ | | |
| Developer | Public | | | | | | ✓ | ✓ | ✓ | ✓ | ✓[4] |
| | Private | | | | | | | | | ✓ | ✓[4,5] |

[1] Surface water supply must be located near the demand.
[2] Centralized SCMs must be located where land is available and near storm drainage facilities.
[3] More planning may be required for dry wells under the current regulatory structure.
[4] Current regulatory drivers include TMDLs, which affect both public and private projects.
[5] Water quality regulations are enforced on private developments through local ordinances.



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## Non-structural Tools

Non-structural tools are essential components to successfully promoting the implementation of capture and use. They can help provide the necessary planning tools to account for budget, planning, and alternatives analysis. Setting appropriate capture and use targets may also encourage action as well as provide an incentive for capture and use by addressing the appropriate quantity of stormwater to capture. Suitable targets can help address concerns about minimum instream flows required for downstream beneficial uses.

Not all non-structural tools provide incentives. Regulatory tools such as permits and ordinances compel action. However, it is important to realize that regulatory and policy tools require adequate enforcement programs to maximize efficiency. Promoting the implementation of capture and use projects will require applying a combination of the tools identified in this section. The non-structural tools in Table 5 are categorized as regulation, incentives, fiscal, and institutional. As with other categories developed for this report, some of these tools are interdependent (e.g., funding is required for incentive programs).

### Regulation

Non-structural regulatory tools include regulating private and public property to promote the implementation of capture and use projects. Performance standards for new construction and redevelopment should require the implementation of stormwater controls that reflect regional needs. Collaboration among water districts and municipalities can also promote capture and use by establishing pathways to develop mechanisms for cost sharing. Water purveyors should regularly evaluate water supply systems to identify opportunities for increased efficiency and reuse. Explicit guidelines for the design, construction, and operation of on-site non-potable water systems developed by the San Francisco Public Utilities Commission (SFPUC) provides an example of non-structural regulatory tools utilized to streamline the implementation of capture and use projects.

### Incentives

Incentives would promote the implementation of capture and use projects via financial or other benefits to project managers. For example, one incentive could involve developing a fast track review for projects incorporating capture and use practices. Other incentives could include monetary or fee credits for projects incorporating capture and use management components.

### Fiscal

Non-structural fiscal tools include grants for capture and use projects with options for long term O&M as well as technical consultation and evaluation. Some case studies were funded by parcel fees. Communities throughout the state have pursued similar fees with mixed success (Farfsing and Watson 2014). Guidance for both water and non-water agencies to perform triple bottom line analysis can more accurately assess the benefits of capture and use.



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## Institutional

The development of institutional organizations such as stormwater utilities can provide a pathway to offer financial and other incentives. These institutions provide an essential funding pathway for stormwater programs. Rate structures can be adapted to adjust for crediting mechanisms to implement and carry out overall community stormwater management plans or advocate for other social and environmental objectives (Reese 1996).

Table A 5. Non-Structural Tools and Examples

| Tools | Examples |
|---|---|
| **Regulation of Private Property** | |
| Performance standards for new construction and redevelopment (requiring stormwater controls that reflect regional needs such as hydromodification or groundwater deficit) | Limited local examples. San Francisco has non-potable reuse and stormwater management ordinances (Kehoe 2013). LID requirements are common in MS4 permits but lack specifics on capture and use. |
| Retrofit requirements on existing developed properties | Not common. No examples found. |
| **Regulation and Local Policy Governing Public Property** | |
| New construction and redevelopment of public infrastructure requirements for stormwater controls that reflect regional capture and use needs | LID requirements are common in MS4 permits but lack specifics on capture and use. |
| Retrofit program for existing public development with stormwater controls that reflect regional capture and use needs | Some examples in MS4 permits; rarely voluntary; Alternative Compliance Pathways (ACP) may provide incentives |
| Requirements regarding growth type, such as density, infill, and zoning that consider local and regional water resources and needs | Not common. No examples found. |
| Policy of agency coordination, leveraging funds/project to overcome financial barriers (e.g., transportation, parks, and economic development) | Growing use in larger jurisdictions under ACP programs; smaller jurisdictions lack capacity. |
| **Incentives** | |
| Voluntary Offset Program—Property owners place bids for stormwater capture and use practices to be installed on their properties for free and the amount of money with which they would like to be compensated for accepting these practices on their properties. The bids are weighted according to the cost of the practice and the amount of environmental benefit it will provide. Bids are ranked according to least cost and largest environmental good. The bids are then awarded until the money available is expended. | Limited local examples. San Diego MS4 permit provides a good example of an offset program. |
| Fast Track Review—Provides a faster permit review process for projects that have incorporated LID | Not common. No examples found. |
| **Fiscal** | |
| Grants for capture and use projects with options for long-term O&M | Not Common. No examples found. |
| Parcel Fees | See Rory M. Shaw Wetlands Park and Sun Valley Park (Appendix C) |



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| | |
|---|---|
| Grants for technical consultation, evaluation, and capacity building/finance planning | Prop. 1: Technical Assistance. |
| Triple bottom line guidance for both water and non-water agencies to assess benefits of supporting stormwater capture and use; guidance on marginal cost of capture and use vs. treatment and release | Envision™ may be an appropriate tool for TBL (ISI, 2017); may need guidance on capture and use cost relative to ACP planning and costs. |
| **Institutional** | |
| Joint Powers Authority (JPA) or Enhanced Infrastructure Financing Districts (EIFDs) | JPA: Monterey One Water.<br>EIFDs: No current examples for stormwater. |



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# Appendix B: Highlighted Case Studies

## Highlighted Case Studies

Several case studies were received from the solicitation for stormwater capture and use case studies sent out to the STORMS Project 1a/1b Project Advisory Group (PAG) on October 28, 2016. This appendix highlights 6 case studies that are classified as different types of stormwater capture and use projects. The case study survey forms for the case studies received are included in Appendix C.

**Ballona Creek Rainwater Harvesting Pilot Project**

**Project Sponsor:** Safe Neighborhood Parks, Clean Water, Clean Air and Coastal Protection Bond act of 2000 through the Santa Monica Bay Restoration Commission

**Primary Contact:** Rafael Villegas, LADWP

The Ballona Creek Rainwater Harvesting Pilot Project is an example of a residential level stormwater capture and use project. The project was the first rainwater harvesting pilot project for the City of Los Angeles Stormwater Program and was completed in March of 2010. The City of Los Angeles Bureau of Sanitation initiated the pilot project as part of the city's stormwater program to improve the water quality of receiving waters while also conserving potable water. The pilot project provided and installed 55-gallon rain barrels and planter boxes designed to collect rainwater and reduce runoff to 600 homeowners and eight commercial building owners at no cost.

The project was funded by a state grant from the Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000 at a cost of $1 million. The project was implemented in the Jefferson, Sawtelle, and Mar Vista neighborhoods in the Ballona Creek Watershed. More than 3,000 applications were received from homeowners and business owners for participation in the program. The estimated total annual capture of stormwater by the pilot program was 1.8 acre-feet.

The project led to evaluation of implementation of the program on a citywide basis. The project created a website[1] that includes the following elements to encourage residents to implement rain barrels on their properties:

- Benefits of Owning a Rain Barrel
- Where to Get a Rain Barrel
- How to Install a Rain Barrel
- How to Use and Maintain a Rain Barrel
- Frequently Asked Questions (FAQs)

[1] http://www.lastormwater.org/green-la/low-impact-development/residential-solutions/rain-barrels-and-cisterns/



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The scale of the project was decentralized, the water source for the project was urban wet weather, and the benefit identified was surface water quality. The barriers associated with and overcome by this project include:

- Project infeasible without augmentation from temporary funding sources (e.g., grants, local bond measure)—State grant funds were used for the pilot project.
- Acceptance by the public at different scales (i.e., neighborhood) for stormwater capture and use projects— Outreach for the project was performed and public response was overwhelmingly positive.

**Penmar Park Stormwater Capture & Use Project**

**Project Sponsor:** City of Los Angeles and City of Santa Monica via Proposition O funding

**Primary Contact:** Vikki Zale, City of Los Angeles Department of Public Works

The Penmar Park Stormwater Capture and Use Project is an example of a subregional capture and use project, and shows how parks provide good opportunities for integration of stormwater capture and use. The project is located at Penmar Park, 1216 E Rose Ave, Venice, CA. In 2008, the Penmar Park Water Quality Improvement Project was split into two phases to accelerate compliance with the wet weather bacteria total maximum daily load (TMDL). Phase I of the project diverts stormwater and urban runoff to a detention tank and then conveyed to the Hyperion Water Reclamation Plant for treatment until Phase II of the project is brought online. Phase II, the first facility of its kind in the City of Los Angeles, provides onsite treatment of the diverted stormwater, and then distributes the treated stormwater to existing irrigation systems in the park.

Construction of Phase I of the project was completed in 2013, and consisted of a diversion structure in the county storm drain in Rose Avenue, a pump station, and a 2.75M gallon detention tank located under the baseball diamond and field at Penmar Park. The total cost for Phase I came in at $17.4 million. The project was funded by Proposition O and was allocated a total funding amount in 2007 of $23.6 million. In a joint effort with the City of Santa Monica and their 16th Street Watershed Runoff Use Project, the Penmar Project was also awarded a Proposition 84 Grant by the State of California in the amount of $2.1m.

The primary purpose of the project was to assist the City of Los Angeles in meeting the wet weather bacteria TMDL for the Santa Monica Bay beaches. Stormwater and dry weather runoff is captured and diverted from the 1,500-acre watershed. Phase II of the project provides capture and use of 108,000 gallons. The project will treat the stormwater onsite to LA County Department of Public Health standards for captured stormwater and use for irrigation. The water will then be placed into an irrigation distribution system that will distribute the water to Penmar Park, Penmar Golf Course (located across the street from the park), and to Santa Monica's Marine Park.

The barriers associated with and overcome by this project include:



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- Public Health Dept. requirements and guidance for use and treatment of captured stormwater (regulatory)—Project meets LA County Department of Public Health standards.
- Acceptance by the public at different scales (i.e neighborhood) for stormwater capture and use projects— Outreach for the project was performed for the project.
- Lack of financial mechanisms for agencies to combine resources—The City of Los Angeles and the City of Santa Monica were able to combine two different grant funding sources for the project.
- Centralized capture and use systems are difficult to implement due to cost and availability of land—The system was integrated into an existing city park and so acquisition of land was not needed.

## Hansen Spreading Grounds

**Project Sponsor:** Los Angeles County Flood Control District and Los Angeles Department of Water and Power

**Primary Contact:** Rafael Villegas, LADWP

The Hansen Spreading Grounds project is an example of a regional stormwater capture and recharge project. It also illustrates how water districts and water providers are evaluating and pursing regional stormwater capture and recharge projects.

The Hansen Spreading Grounds is a 156-acre parcel located at 10179 Glenoaks Blvd., Los Angeles, CA 91352, adjacent to the Tujunga Wash Channel downstream from the Hansen Dam. The project is utilized for capturing stormwater and recharging the groundwater basin for use by the City of Los Angeles. The Los Angeles County Flood Control District and the City of Los Angeles Department of Water and Power modernized the Hansen Spreading Grounds facility to increase storage capacity; and therefore, improve groundwater recharge, flood protection, and water quality. The other multiple benefits of the project include passive recreation and native habitat improvements. The total cost of the project was $8.4 million.

The project has three phases including: 1) Phase 1A deepened and combined 20 existing basins into 6 larger basins and was completed in 2009; 2) Phase 1B improved the intake capacity by replacing a radial gate with a new rubber dam and telemetry system and was completed in 2013; and 3) Phase 2 that will develop other compatible uses such as recreational trails and native habitat for the community.

The multiple benefits of the project include the following:

- Storage capacity increased from 279 to 1,460 AF
- Increased in wetted perimeter from 95 to 104 acres
- Average capture and recharge of 14,000 AFY; an increase of 2,100 AFY
- Enhanced downstream flood protection and water quality



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- Open space and recreational attributes to better serve the needs of wildlife and the community
- Phased approach to allow compatible uses to be integrated without compromising groundwater recharge, flood control, and water quality functions

The barriers associated with and overcome by this project include:

- Lack of communication and collaboration among agencies on opportunities for stormwater capture and use projects–The Los Angeles County Flood Control District and the City of Los Angeles Department of Water and Power were able to collaborate for the project.
- Lack of state guidance for design/performance siting to ensure operation and protection of groundwater resources—The project evaluated impacts to groundwater resources.
- Existing flood control detention basins discharge smaller flows which could be captured and used or infiltrated—The project was an existing flood control basin.
- Lack of financial mechanisms for agencies to combine resources—The Los Angeles County Flood Control District and the City of Los Angeles Department of Water and Power were able to combine funding sources for the project.
- Centralized capture and use systems are difficult to implement due to cost and availability of land—The system was integrated into property possessed by Los Angeles County.

**Elmer Avenue Stormwater Capture Project**

**Project Sponsor:** Council for Watershed Health

**Primary Contact:** Rafael Villegas, LADWP

The Elmer Avenue Stormwater Capture Project, a good example of what can be done on a neighborhood scale, provides a viable model of infiltration/recharge beneath a street that opens up opportunities for similar projects on other streets. The project is located in Sun Valley, in the northeast San Fernando Valley, on one block of Elmer Avenue between Stagg Street and Keswick Street.

The Elmer Avenue Stormwater Capture Project integrated various stormwater capture BMPs in the public right of way and on private property employing different strategies to provide multiple benefits including reduced flooding, water quality improvement, and groundwater recharge. The project included the construction of an infiltration gallery under Elmer Avenue that collects and infiltrates stormwater and the installation of bioswales, distributed rainwater collection systems, permeable pavement, and drought tolerant landscaping. Additionally, the street was repaired because it was severely degraded by consistent flooding during storm events. Sidewalks, curbs, gutters, and solar streetlights were also installed as the existing street lacked these features.

The project was completed in June of 2010 at a total cost of $2,837,452. The following were the funding sources of the project:



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- California Department of Water Resources Prop 50 Grant—$859,952
- City of Los Angeles In-Kind Support—$522,500
- Federal Appropriations—$492,000
- Water Augmentation Partners Support—$510,000
- US Bureau of Reclamation Support—$153,000
- Los Angeles Department of Water and Power (LADWP)—$300,000

The project partners for the Elmer Avenue Stormwater Capture Project included:

- Council for Watershed Health
- Residents of Elmer Ave
- US Bureau of Reclamation
- Metropolitan Water District of Southern California
- Regional Water Quality Control Board, Los Angeles Region
- LADWP

The benefits of the project include:

- Annual recharge (in an average rainfall year) for the suite of projects is between 30 and 40 acre feet
- Captures stormwater and dry-weather runoff to reduce flooding
- Reduction of impermeable surfaces and increased groundwater recharge
- Monitoring of stormwater flow and water quality pre- and post-construction
- Participation from residents in maintaining the improvements
- Reconnection of the neighborhood to the natural hydrology of the Los Angeles River Watershed
- Demonstrates multiple Low Impact Development (LID) strategies on both public and private lands.

The barriers associated with and overcome by this project include:

- Lack of communication and collaboration among agencies on opportunities for stormwater capture and use projects—All of the multiple project partners came together to make this project occur.
- Lack of technical and policy guidance for range of retrofit options and new centralized capture and use systems—The project evaluated a range of different stormwater retrofit systems and developed a comprehensive multiple-benefit system.
- Difficult to implement capture and use in ultra-urban settings due to competing uses for right-of-way—The project integrated an infiltration gallery under the street as well as other integrated systems.
- Roadway infrastructure can be challenging to integrate stormwater systems and specifically capture and use systems—The project integrated an infiltration gallery under the street overcoming utility conflicts and other constraints.
- Lack of financial mechanisms for agencies to combine resources—Multiple sources of funding were used for the project.



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- Centralized capture and use systems difficult to implement due to cost and availability of land—The project integrated an infiltration gallery under the street so land acquisition was not needed.

**Glassell Campus Stormwater LID Retrofit & Torrent Dry Well**

**Project Sponsor:** Riverside County Flood Control and Water Conservation District, State Water Board, and Santa Ana Watershed Project Authority

**Primary Contact:** Jian Peng, Orange County Public Works California

The Glassel Campus Stormwater LID Retrofit & Torrent Dry Well Project provides an example of a campus level retrofit with integration of a Torrent drywell system. The County of Orange has implemented a comprehensive LID retrofit of their Glassel Public Works campus. The 9.4-acre Glassel Campus, owned by OC Public Works, was subdivided into 17 distinct drainage areas intended to be managed independently. The site was designed to treat the runoff generated by the 85$^{th}$ percentile rainfall event.

The different BMPs integrated into the project include:

- Bioretention systems
- Biofiltration planter boxes
- Bioswales
- Aboveground cistern
- Underground cistern
- Permeable pavement (concrete, asphalt, and pavers)
- Modular wetland
- Filterra
- Maxwell Drywell

The total cost of the Glassel Campus Stormwater LID Retrofit & Torrent Dry Well Project was $2.6 million and a portion of the funding was from a Proposition 84 Grant.

Benefits of the project include:

- Improves water quality within the Santa Ana River watershed by diverting 95% of pollutants from entering the storm drain
- Captures and stores stormwater in cisterns for on-site landscape usage
- Promotes water infiltration to the ground, increasing drinking water supply
- Tests performance of permeable surfaces and drought-resistant plants
- Models the benefits of low impact development for a greener future

The barriers associated with and overcome by this project include:

- Public Health Department requirements and guidance for use and treatment of captured stormwater—The project integrates treatment consistent with the Orange County Department of Public Health guidance.

- Lack of technical and policy guidance for range of retrofit options and new centralized capture and use systems—The project evaluated a range of different stormwater retrofit systems and developed a comprehensive multiple-benefit system.
- Difficult to implement capture and use in ultra-urban settings due to competing uses for right-of-way—Project is evaluating BMPs that have applicability in ultra-urban areas such as Maxwell Drywell, Filterra, and the modular wetland
- Lack of financial mechanisms for agencies to combine resources—Multiple sources of funding were used for the project.
- Centralized capture and use systems are difficult to implement due to cost and availability of land—Project integrated two capture and use systems on the campus.
- Lack of guidance to quantify all water and non-water benefits in a multiple-benefit project to solicit additional funds—The project successfully identified the multiple benefits of the project for the Prop 84 grant.

**LADPW Stormwater Capture Master Plan**

**Project Sponsor:** Los Angeles Department of Water and Power

**Primary Contact:** stormwater@ladwp.com

The LADPW Stormwater Capture Master Plan[2] highlights a planning level project on a large geographic scale for stormwater capture and use. The City of Los Angeles Department of Water and Power (LADWP) developed the Stormwater Capture Master Plan in 2015. The plan covers hydrologic areas within the city boundaries and all areas that drain to and through the city boundaries. The plan recognizes that increasing stormwater capture will enable the city to regulate and reduce its purchase of imported water and develop a more reliable water supply portfolio. The plan includes an evaluation and characterization of the role that increased centralized and distributed stormwater capture can play in the city's water supply portfolio. The plan includes the following:

- The long-term potential of stormwater to contribute to the City of Los Angeles' water supply
- Alternative projects and programs available to LADWP to increase stormwater capture for water supply
- A range of project and program implementation rates at 5, 10, 15, and 20 years (in the years 2020, 2025, 2030, and 2035)
- A range of stormwater capture targets based on the implementation rates at 5, 10, 15, and 20 years

[2] https://www.ladwp.com/ladwp/faces/ladwp/aboutus/a-water/a-w-sourcesofsupply/a-w-sos-stormwatercapture?_adf.ctrl-state=r5ovro8o6_4&_afrLoop=358245210123190

- An estimate of the value of stormwater that is captured for recharge and/or for direct use, along with ancillary benefits
- Potential funding strategies that could be used for program and project implementation
- An implementation strategy for LADWP to meet projected targets, including both guiding principles and specific actions

The plan includes developing a comprehensive stormwater message including a public outreach plan (POP) as one of the first deliverables of the plan. The plan also includes the following sections:

- Introduction
- The Stormwater Message
- Background and Existing Conditions
- Implementation Scenarios
- Existing and Potential Stormwater Capture
- Stormwater Capture Alternatives
- Plan Implementation Timeline and Targets
- Implementation Strategy
- Conclusion

The barriers associated with and overcome by this project include:

- Lack of state regulations for design/performance siting to ensure operation and protection of groundwater resources—The plan provides information on ground water protection regulations.
- Lack of communication and collaboration among agencies (primarily municipalities and water districts) on opportunities for stormwater capture and use projects—The plan speaks to interagency collaboration.
- Lack of technical and policy guidance for the range of retrofit options and new centralized capture and use systems—The plan provides guidance on retrofit options for capture and use systems.
- Lack of integrated water management guidance on the optimal opportunities for stormwater capture and use given the existence of recycled water and different demands—The Plan speaks to integrated water management guidance.
- Acceptance by the public at different scales (i.e., neighborhood) for stormwater capture and use projects—The Plan has a section focused on messaging about stormwater capture and use to the public and stakeholders.
- Difficult to implement capture and use in ultra-urban settings due to competing uses for right-of-way—The plan provides some guidance on ultra-urban scenarios.
- Roadway infrastructure can be challenging to integrate stormwater systems and specifically capture and use systems—The plan provides guidance of integrating stormwater capture systems into roadways.
- Projects infeasible without augmentation from temporary funding sources (e.g., grants, local bond measure)—Funding strategies are identified in the plan.

# Appendix C: Case Study Solicitation

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