

## Section 2.0 Stormwater Management Approach

*This section describes the primary components of a comprehensive Stormwater Management Approach. Within these components, six types of Outcome Levels are introduced. Outcomes are the backbone of the strategic planning and assessment processes described in this document. They provide the structure and measurability needed to evaluate and improve Stormwater Management Programs over time.*

### 2.1 Background

Management approaches share a number of important similarities while the details of individual programs vary. Before looking further into specific planning and assessment approaches, it's useful to review the general model on which they're based.

### 2.2 Primary Components

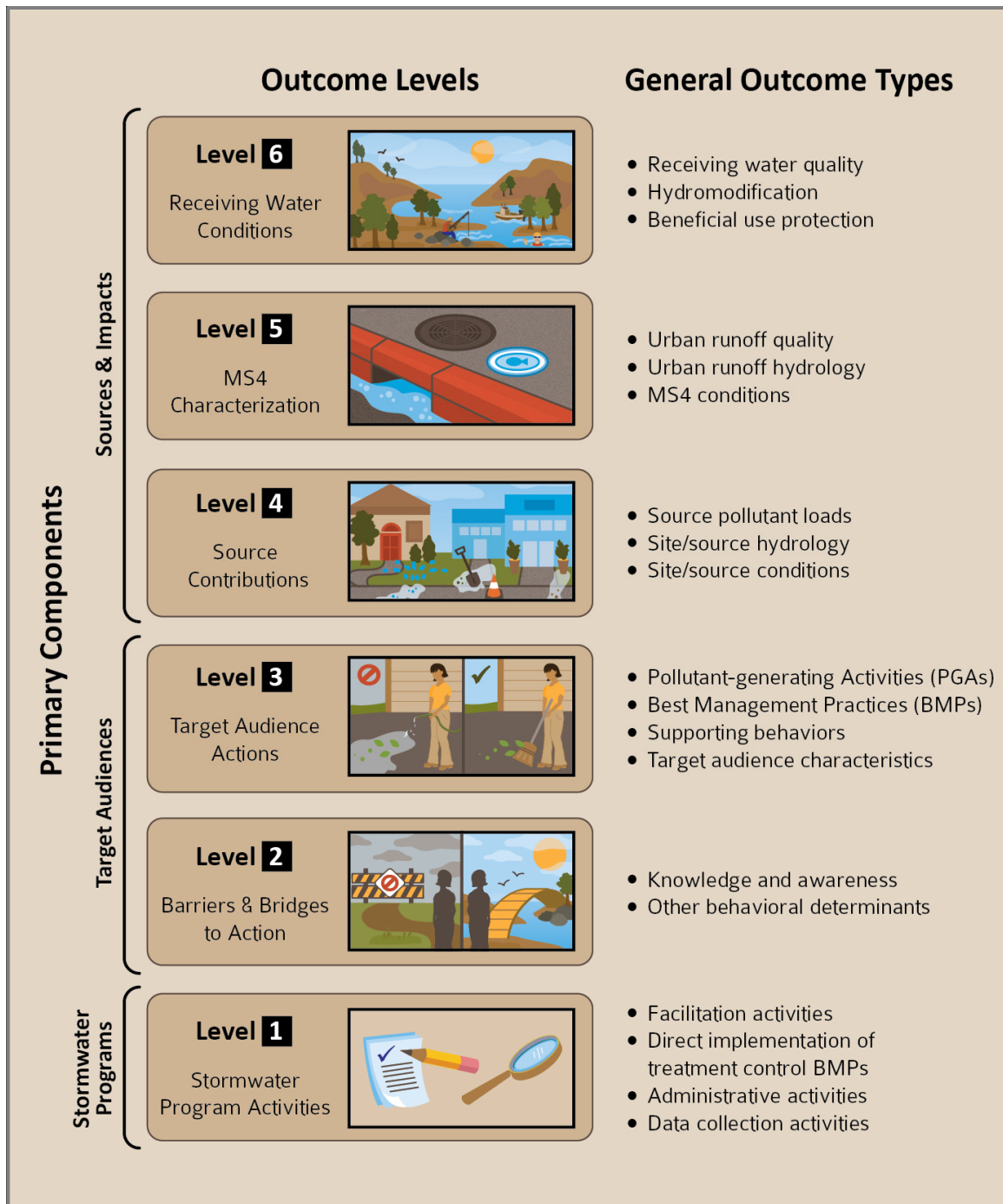
For the purposes of this document, stormwater management consists of three primary components:

- **Sources and Impacts** – This component addresses the generation, transport, and fate of urban runoff pollutants and flows. It includes sources (sites, facilities, areas, etc.), stormwater conveyance systems (also referred to as called Municipal Separate Storm Sewer Systems, or MS4s<sup>1</sup>), and the water bodies that ultimately receive source discharges via MS4s (receiving waters).
- **Target Audiences** – This component focuses on understanding the behaviors of the people responsible for source contributions. It explores the factors that determine existing behavioral patterns and looks for ways to replace polluting behaviors with nonpolluting behaviors.
- **Stormwater Management Programs** – Stormwater programs are the road map for the improvements that managers wish to attain in receiving water beneficial uses. Their immediate purpose is to describe the programs that will facilitate changes in the behaviors of key target audiences; however a number of administrative and data gathering functions also need to be considered during planning and assessment.

**Figure 2.1** illustrates the general relationship of these three components and introduces six different Outcome Levels and general Outcome Types associated with them.

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<sup>1</sup> Pollutants and flows can also be introduced to receiving waters via other pathways (overland flow, direct discharge, aerial deposition, etc.). This document only focuses on the MS4 pathway.



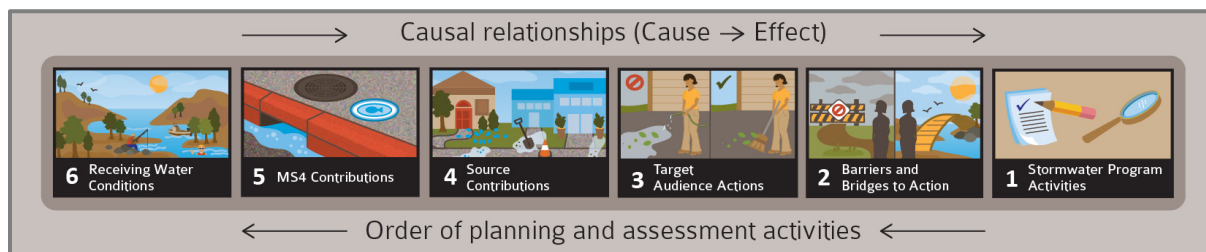
**Figure 2.1: General Stormwater Management Model**

## 2.3 Introduction to Outcomes

**Outcomes** are measurable endpoints associated with programs, people, and physical systems. They are the building blocks of the management approach described in this document. Outcomes establish the measurability and structure needed to successfully complete the various planning and assessment tasks described throughout this document. Because a variety of outcomes must be considered when planning and assessing programs, it's helpful to place them within a framework that provides a logical and understandable context.

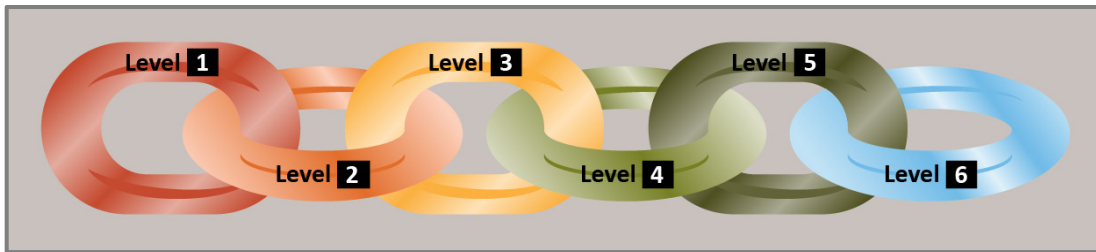
Outcomes are grouped according to the six categories, or Outcome Levels, shown in **Figure 2.1**. Starting with Level 1 and moving sequentially toward Level 6, they represent a general progression of conditions that are assumed to be related in a sequence of causal relationships. That is, conditions at any one level may influence conditions at the next highest level. For example, knowledge and awareness (Level 2) in target audiences will likely influence their behaviors (Level 3).

While it may initially seem counterintuitive, managers will normally address the six outcome levels in “reverse order” (from Level 6 to Level 1) during planning and assessment (**Figure 2.2**). The reason for this is that, in practice, they must work backwards from measured or observed effects to try and establish their causes.



**Figure 2.2: The “Counterintuitive” Order of Planning and Assessment Activities**

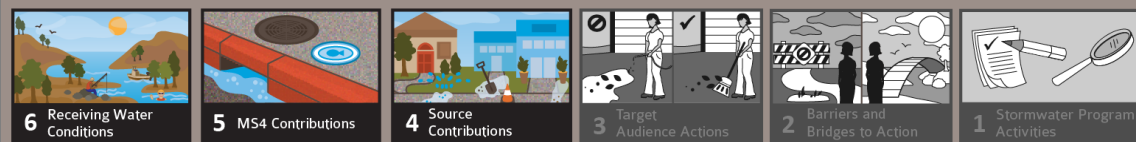
While it can be tempting to conclude that higher numbered Outcome Levels have greater importance, in practice, each plays a critical role in supporting effective management decisions because we do not completely understand all of the relevant variables and relationships between the variables. Level 6 outcomes are the most direct expression of desired water quality conditions. However, even when they can be demonstrated, it may be difficult to relate them back to specific management measures. To fully appreciate the inherent and unique value of each Outcome Level, it’s useful to visualize them as a chain of six links (**Figure 2.3**).



**Figure 2.3: Outcome Levels as a Chain of Six Links**

Similar to the saying “a chain is only as strong as its weakest link”, it’s also true that the design and assessment of Stormwater Management Programs requires a recognition and understanding of each Outcome Level both individually and in relation to the others that are influenced by it. This is critical in order for the Program to be measurable and effective in the long term. Each of the six individual outcome levels is introduced below within the context of the general component in which it occurs.

## Source and Impact Component



The **Source and Impact Component** is the physical component of the management approach, i.e., it deals with the generation, transport, and fate of pollutants and flows from the urban environment. It encompasses Outcome Levels 6, 5, and 4. During planning and assessment, managers will consider a variety of parameters to characterize water quality and hydrologic conditions at sources, within MS4s, and in receiving waters. Once problem conditions are identified and prioritized, goals for change can be established and strategies developed for achieving them. The starting point for Source and Impact planning and assessment is Outcome Level 6.



The primary objective of stormwater management programs is the protection of water bodies receiving discharges from MS4s. Level 6 outcomes describe receiving water conditions. They can apply either to existing conditions or to improvements that will be sought over time through program implementation. They can include virtually any chemical, biological, or physical parameter that can be measured or assessed in receiving

waters (i.e., chemical concentrations, dissolved oxygen levels, biological integrity, species diversity, eutrophication, microbiological or toxicological conditions, hydromodification, or trash). Level 6 successes are best expressed through the attainment of beneficial uses, traditionally measured as compliance with water quality objectives (WQOs). This is important, but managers should also identify receiving water conditions that they consider to be problematic even if the corresponding WQOs have not been exceeded.

Receiving water conditions can be helpful in assessing overall program effectiveness, but such conclusions should be drawn with extreme caution. Changes in these conditions usually lack specific, direct linkages to other outcome types and require extended periods of monitoring and analysis to confirm. Moreover, receiving water conditions usually reflect multiple influences and inputs other than stormwater discharges (e.g., sanitary sewer overflows, rising groundwater, agricultural or other non-point discharges, or aerial deposition). The vast number of potential pollutants and contamination pathways in the environment require that conclusions regarding management measure effectiveness include corroborating assessments from multiple outcome levels.

In California, most Phase I municipal stormwater programs have had receiving water monitoring programs in place for at least fifteen years. Although these programs provide a fairly extensive record of receiving water data and results, they reflect a period of rapid change in stormwater program implementation as well as urbanization. This record will be an important reference for future data comparisons.



Level 5 outcomes apply exclusively to MS4s, but are similar to the Level 4 Outcomes described below because both deal with discharges. The difference is that Level 4 Outcomes apply to discharges up until the point that they leave a source (a facility, a property, etc.), but once a discharge of pollutants or flow enters the MS4 (i.e., in a gutter, on the street, into a storm drain, etc.) it is considered “urban runoff.” Level 5 conditions may be measured within the MS4, or as discharges from it. In either case, evaluation typically focuses on flow conditions, pollutant concentrations or loads, or both.

Because Level 5 Outcomes provide a direct linkage between sources and receiving water impacts, they can provide a conceptually straightforward means of gauging program effectiveness, and a basis for refining efforts over longer periods of time. In practice, Level 5 outcomes are extremely challenging to quantify. MS4 conditions tend to be highly

variable both spatially and temporally. This can make it difficult to establish baselines, determine trends, and evaluate results. Moreover, it can be challenging to establish linkages between pollutants in MS4 discharges and any of the numerous sources where they may be generated, especially given the co-mingling that can occur from sources within the MS4.



## 4 Source Contributions

Level 4 Outcomes address sources and discharges from them. A **Source** is anything with the potential to generate urban runoff flow or pollutants prior to their introduction to the MS4. Most stormwater programs address a variety of sources corresponding to the major sectors of existing and new development. Typical examples are presented in **Table 2.1**.

**Table 2.1: Major Source Categories and Examples of Specific Source Types**

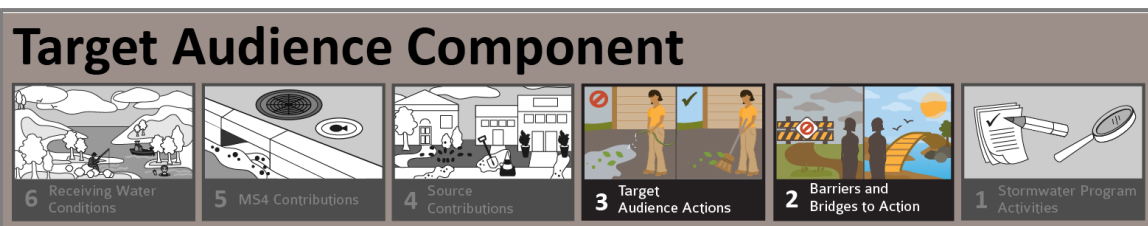
Municipal Sources	Residential Sources	Industrial & Commercial Sources	Construction & Development Sources
<ul style="list-style-type: none"> <li>• Solid waste facilities</li> <li>• Wastewater operations</li> <li>• Streets and roads</li> <li>• MS4s</li> <li>• Parks</li> </ul>	<ul style="list-style-type: none"> <li>• Single family housing</li> <li>• Multiple family housing</li> <li>• Apartments</li> <li>• Mobile homes</li> <li>• Rural residential areas</li> <li>• Inner city neighborhoods</li> </ul>	<ul style="list-style-type: none"> <li>• Restaurants</li> <li>• Automotive maintenance</li> <li>• Nurseries</li> <li>• Horse stables</li> <li>• Mobile operations (landscaping, pool care, pest control, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• Commercial and industrial development</li> <li>• Single family homes</li> <li>• Major subdivisions</li> <li>• Capital improvement projects</li> <li>• Redevelopment sites</li> </ul>

**Source contribution** can refer either to a source loading or to a reduction in that loading. **Source loadings** are the flows and pollutant loadings added by sources to a MS4. **Source reductions** are changes in the amounts of pollutants or reductions in flow associated with specific sources before and after control measures are employed. Because source loadings ultimately reach receiving waters through MS4s, managers stand to benefit from a better understanding of how they can be reduced.

Source contributions provide a crucial linkage between target audience behaviors and MS4 discharge quality. In practice, it's often not possible to directly measure source

contributions. Instead, managers often rely on estimates of **source potential** (also expressed as **threat-to-water-quality**). Source potential describes the likelihood that a given source type will discharge flows or pollutants during wet or dry weather conditions. Since individual sources can't be observed all the time, managers must often rely on such estimates to gauge their relative importance.

**Section 4.0** will introduce a number of conceptual approaches for estimating source loadings or reductions. Unfortunately, very few of these involve direct measurement, so they tend to be most useful for comparison. This means that even though permit requirements are increasingly focusing on quantifying source reductions, managers have yet to find more than a handful of approaches that are practical or affordable, or that go beyond the broad-scale application of assumptions and estimates. Overcoming these limitations is one of the greatest challenges for source contributions.



The **Target Audience Component** is the behavioral portion of the management approach i.e., the actions of target audiences and the factors that influence them. It encompasses Outcome Levels 3 and 2. Target audiences are the individuals and populations that a Stormwater Management Program is directed to, usually the people responsible for source contributions, but sometimes also others who play a supporting role in bringing about desired changes (industry associations, hotline callers, schoolchildren, etc.). Because source reductions can only be achieved by the people responsible for loadings, a successful program will be one that is able to induce positive behavioral changes in key target audiences. **Table 2.2** provides examples of a variety of specific target audiences.

As will be further explored in **Section 5.0**, source types and target audiences can both be extensively subdivided into more specific categories than those shown here.



Level 3 Outcomes address the actions of target audiences, and whether or not changes are occurring in them over time. A wide variety of behaviors may be addressed, and these can be broadly grouped into three types. Examples of each are provided in **Table 2.3**.

**Table 2.2: Major Source Categories and Examples of Associated Target Audiences**

Municipal Sources	Residential Sources	Industrial/ Commercial Sources	Construction & Development Sources
<ul style="list-style-type: none"> <li>• Road workers</li> <li>• Maintenance staff</li> <li>• Supervisors / managers</li> <li>• Contractors</li> <li>• Municipal employees</li> </ul>	<ul style="list-style-type: none"> <li>• Homeowners</li> <li>• Renters</li> <li>• Homeowners associations</li> <li>• Dog owners</li> <li>• Auto enthusiasts</li> <li>• Home gardeners</li> <li>• Schoolchildren</li> </ul>	<ul style="list-style-type: none"> <li>• Owners</li> <li>• Operators</li> <li>• Employees</li> <li>• Industry associations</li> </ul>	<ul style="list-style-type: none"> <li>• Developers</li> <li>• Engineers</li> <li>• Planning groups</li> <li>• Contractors</li> <li>• Skilled workers</li> <li>• Laborers</li> </ul>

**Table 2.3: Major Categories and Examples of Target Audience Actions**

<b>Pollutant-generating activities (PGAs)</b>	
<ul style="list-style-type: none"> <li>• Spills during materials loading and unloading</li> <li>• Releases of fluids during vehicle and equipment repair</li> <li>• Pressure washing without containment</li> </ul>	<ul style="list-style-type: none"> <li>• Overwatering</li> <li>• Improper pet waste disposal</li> <li>• Improper management of food grease</li> </ul>
<b>Best management practices (BMPs)</b>	
<ul style="list-style-type: none"> <li>• Integrated pest management (IPM) practices</li> <li>• Materials substitution</li> </ul>	<ul style="list-style-type: none"> <li>• Smart irrigation controls</li> <li>• Low Impact Development (LID) practices</li> <li>• Structural treatment controls</li> </ul>
<b>Supporting behaviors</b>	
<ul style="list-style-type: none"> <li>• Information seeking</li> <li>• Pollution reporting</li> </ul>	<ul style="list-style-type: none"> <li>• Participation and involvement</li> <li>• Administrative and procedural behaviors</li> </ul>

**Pollutant-generating Activities (PGAs)** are the behaviors that contribute pollutants to runoff (i.e., rinsing off a sidewalk or other surface with material such as sediment, trash, or vegetation on it). Their reduction or elimination is the primary focus of stormwater management programs. PGAs are not necessarily the result of current human behaviors, they may also include pollutant-generating features that may be the result of past behaviors (e.g., erosion from past road design and construction). For simplicity, the term



PGA will be used to describe both the existing features and current activities in a watershed that generate pollutants.

**Best Management Practices (BMPs)** are activities or other controls that are implemented to reduce or eliminate discharges of pollutants and flow. BMPs can take a variety of forms (source controls, treatment controls, prevention, infiltration, etc.), all of which may be considered as potential alternatives to PGAs. In fact, substitution of BMPs for PGAs can be a key measure of program success. BMPs are the most obvious facet of Level 3 success, but there's also value in understanding other “supporting” behaviors that can help to bring about BMP implementation.

**Supporting Behaviors** include a wide range of potential actions that are distinct from BMP implementation, but that help to form a bridge toward it. Examples include joining a watershed organization, calling a stormwater hotline, conducting employee training, or developing a Stormwater Pollution Prevention Plan (SWPPP). All of these actions are likely to facilitate the implementation of BMPs by target audiences.



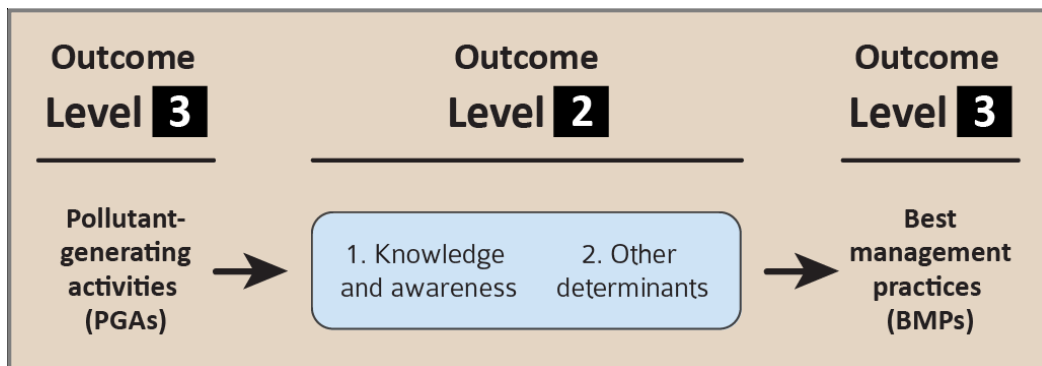
## 2

## Barriers & Bridges to Action

Level 2 outcomes are critical because they form the basis for achieving desired behavioral changes and provide a means of gauging progress toward their achievement. A myriad of factors affect the behavioral patterns of target audiences. Collectively, these are called **influencing factors**, but depending on whether a factor aids in or inhibits a desired behavior, it can be considered either a **barrier** or a **bridge** to action. In practice, the two are not completely distinct. For example, knowledge might be considered a barrier when levels are low, but a bridge when levels are high enough to positively affect a behavior.

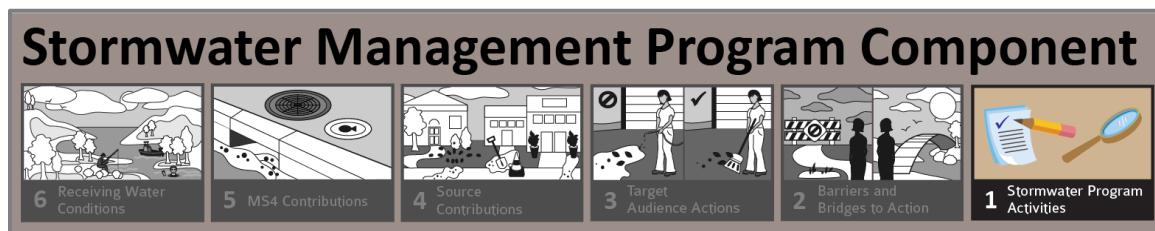
For a Stormwater Management Program to effectively influence or change the behaviors of target audiences, these factors must first be explored. **Figure 2.4** provides a simple representation of the role of Level 2 outcomes in mediating the conversion of PGAs to BMPs. As shown, the knowledge and awareness of target audiences constitute the first critical consideration in establishing a path toward correct behaviors. People won't act differently unless they first understand the problem, and then are motivated and able to change. Studies indicate that education alone is not always an effective driver of behavioral change. Conventional marketing-based educational approaches can be effective in creating public awareness and understanding, but are limited in their ability to

foster behavioral change. Because of this, it’s also important to consider the many other determinants that potentially exist for any given behavior. Examples include attitudes, costs, commitment, social norms, incentives, convenience, and perceptions of responsibility or accountability.



**Figure 2.4: The Relationship of Influencing Factors to PGAs and BMPs**

In recent years, many stormwater programs have invested extensively in the study of influencing factors. As managers increasingly understand the role of specific barriers and bridges in influencing targeted behaviors, they should become increasingly effective in achieving them.



The **Stormwater Management Program Component** focuses on the various activities that are conducted within a program.



Examples of Level 1 activities that are measured include providing education to residents, inspecting businesses, surveying target audiences, and conducting receiving water monitoring. As described below, it’s useful to divide Level 1 activities into four types.

- **Facilitation activities** are those which bring about (or “facilitate”) changes in target audiences. For example, a program manager seeking to increase BMP implementation by construction site workers might rely on facilitation activities such as training and

inspections. Conversely, a residential program element might be focused on education, incentives, and waste collection to encourage pesticide use reduction or picking up after pets. Managers typically find themselves seeking to bring about the broad-scale implementation of controls by regulated parties and other target audiences, more often than not, with limited control over the outcomes themselves. Because the success of a program is almost always determined by its ability to influence change in others, the selection of facilitation measures is one of the most critical decision points in the design and implementation of a control strategy.

- **Direct Implementation of Treatment Control BMPs** by the MS4 program is another important type of implementation activity. Given the increasingly stringent performance expectations put on MS4 programs in recent years, both for permit and TMDL requirements, emphasis on the direct implementation of structural treatment controls has also increased. Many programs are also now planning and funding the construction and maintenance of regional or sub-regional treatment control BMPs. These BMPs can be a critical part of a successful implementation strategy.
- **Administrative activities** support the operation or management of the stormwater program. Unlike facilitation activities, they focus on the operation of the program itself rather than its relationship to other outcome types. Typical examples include reviewing and updating source inventories and program documentation such as policies or procedures.
- **Data collection and analysis activities** provide the feedback necessary to plan and evaluate outcomes. Their primary purpose is to provide managers with the data and information they need to assess conditions, evaluate change, and determine whether specific outcomes are being achieved. Feedback is necessary for the evaluation of all outcome types. Data collection and analysis activities are an essential part of a program's assessment strategy.

While there is a tendency to think of Level 1 outcomes as “bean counting,” they are essential for bringing about changes at higher outcome levels and for providing the feedback necessary to evaluate success. It does managers little good to know that key changes are occurring if they don't understand what's driving them or where adjustments can be made to repeat or optimize results. It's not always necessary to report out on all Level 1 outcomes in detail, but it is crucial that managers understand what is being implemented, what data are necessary to track these activities, and where modifications should be made in the future.

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