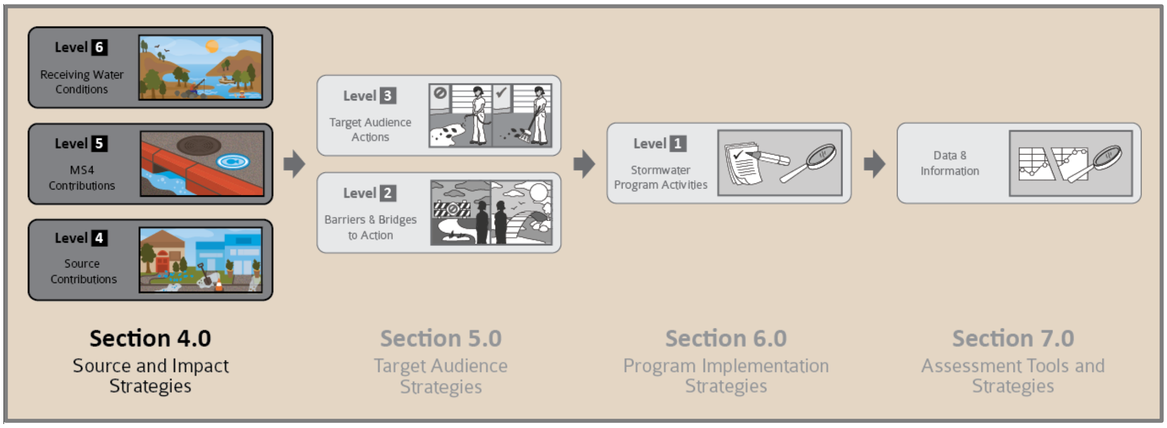
Section 4.0: Source and Impact Strategies



*This section describes the development of **Source and Impact Strategies**, the first of four strategic planning components initially introduced in Section 3.0. Source and impact planning addresses Outcome Levels 6, 5, and 4. This is the physical component of stormwater management. 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 water bodies. Once problem conditions are identified and prioritized, objectives for change can be established and strategies developed for achieving them.*

Completed Source and Impact Strategies will inform the subsequent development of Target Audience trategies in Section 5.0, and will inform the subsequent selection of Assessment Tools and Strategies in Section 7.0.

4.1 Background

This section utilizes the strategic planning process presented in **Section 3.0** to identify and prioritize sources of pollutants and flows to receiving waters. It begins with the evaluation of receiving water problems, and then "works back" toward potential contributing sources via MS4s and associated drainage areas (**Figure 4.1**). Following this approach, source priorities can be identified in response to demonstrated priority water quality impacts. However, since receiving water and MS4 impacts are often not well-documented, "preventive" approaches that focus primarily on the potential of sources to generate flows or pollutants must also be considered. Both scenarios can make sense depending on individual circumstances and data availability, and neither is necessarily advocated over the other.

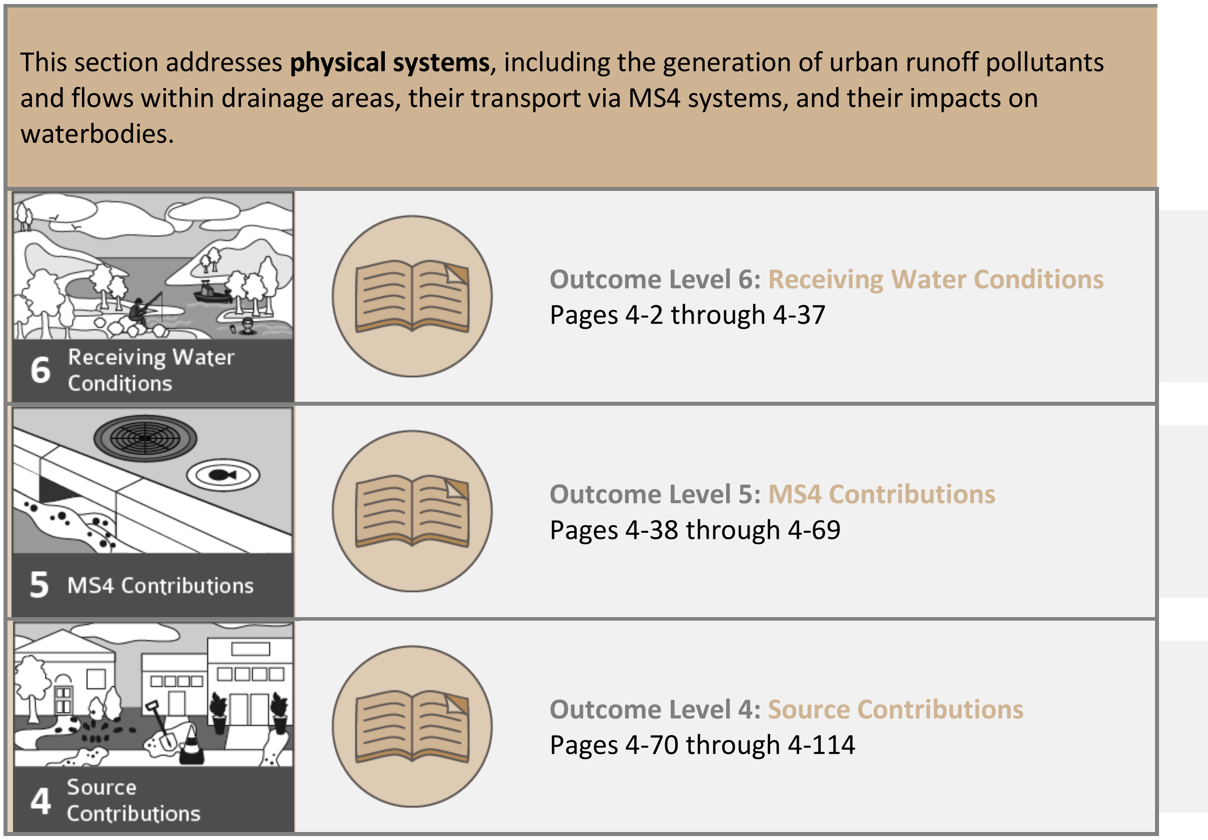
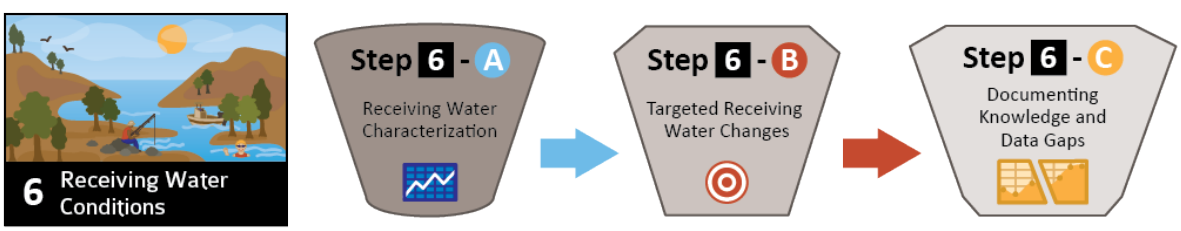


Figure 4.1 Primary Components of Source and Impact Strategies

4.2 Outcome Level 6: Receiving Water Conditions

Level 6 planning is a three-step process.



In **Step 6-A**, existing data and information are reviewed to evaluate conditions in receiving waters. Initial results are then narrowed to focus on priority problem conditions. **Step 6-B** focuses on defining the changes that will be sought in these conditions over time. Finally, **Step 6-C** identifies the knowledge and data gaps discovered along the way, so that future data collection initiatives can be directed toward resolving them.

Step 6 - A Receiving Water Characterization

As shown in **Figure 4.2**, Step 6-A consists of three tasks. Characterization begins with a review of available data and information for applicable receiving waters. **Table 4.1** identifies a variety of data and information resources that can be used to inform Level 6 strategic planning. These can include data collected by the MS4 program itself, most typically previously-conducted receiving water monitoring. Likewise, a variety of external sources such as regulatory agencies, research institutions, and published research, may be useful in augmenting data collected through local programs.

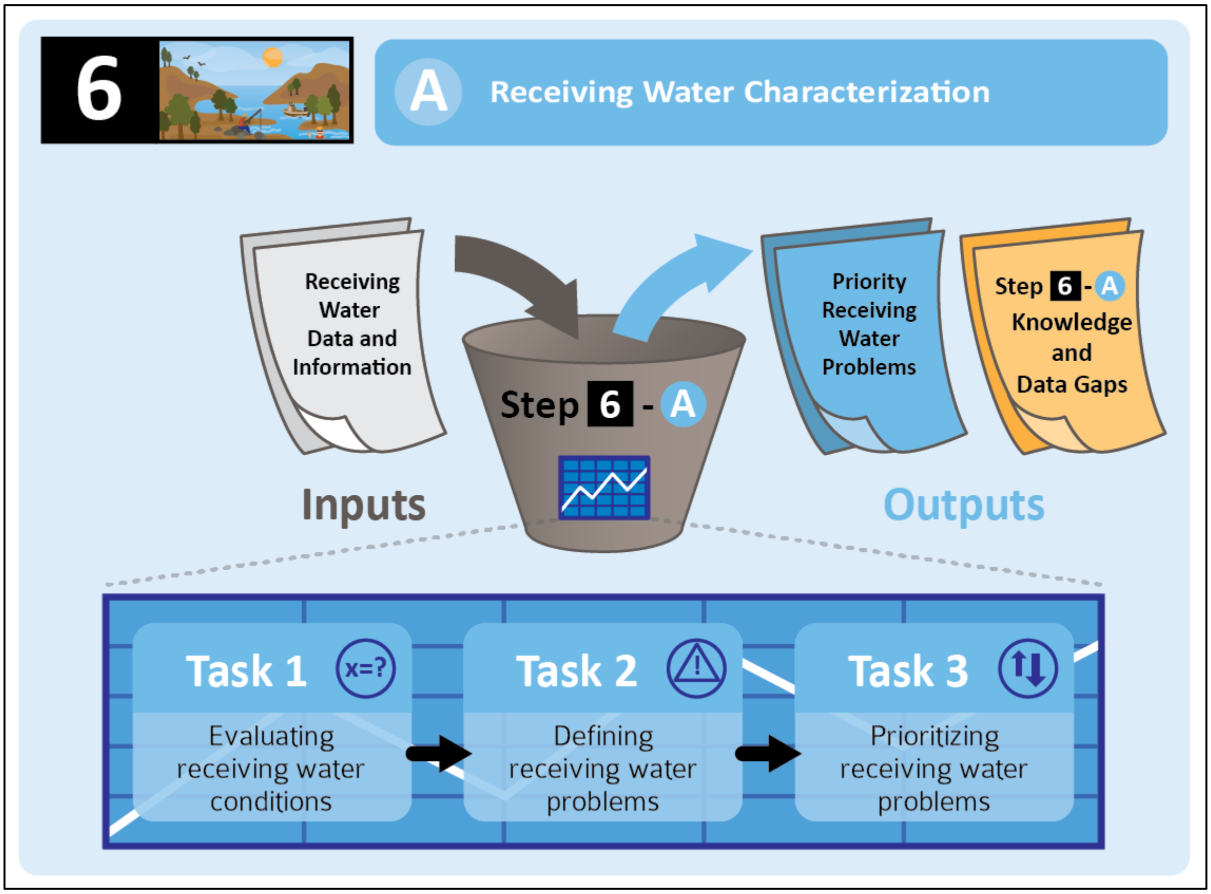


Figure 4.2: Receiving Water Characterization (Step 6-A)

Table 4.1: Potential Sources of Receiving Water Data and Information

- ☑ Receiving water and MS4 monitoring program sampling data and reports
- ☑ SWRCB Water Quality Control Plans (beneficial use designations, etc.)
- ☑ CWA Section 303(d) lists
- ☑ Total maximum daily loads (TMDLs)
- ☑ Regulatory agencies and research institutions (SCCWRP, WERF, etc.)
- ☑ Online repositories, directories, and databases (CERES, SWAMP, etc.)
- ☑ Published or unpublished research, literature, and technical reports
- ☑ Special investigations
- ☑ Other (as needed)

Task 1 Evaluating Receiving Water Conditions

Managers will first identify and evaluate available data and information for each water body receiving discharges from MS4s under their responsibility and control. At this point all receiving water conditions should be of interest. Evaluations are guided by two key questions.

Step 6-A Task 1 Key Questions
Evaluating Receiving Water Conditions

Inputs	Key Questions	Outputs
Available Data, Information, and Results	**Question 1:** What are current receiving water conditions? **Question 2:** How are receiving water conditions changing over time?	**Existing Receiving Water Conditions**

Question 1 What are current receiving water conditions?

Planning will initially focus on the current state of receiving waters. In this context, "receiving water" can mean entire water bodies, segments, or in some situations multiple water bodies. The receiving waters of most interest to managers should be those receiving discharges from drainage areas under their authority or responsibility.

Nature and Magnitude

The **nature** of a receiving water condition refers to its general characteristics or attributes. Although there are many ways to classify receiving water conditions, they're usually grouped according to chemical, biological, toxicological, or physical parameters. **Table 4.2** lists many conditions that are typically considered for receiving waters. It's important to emphase that many of these attributes will apply to each receiving water. That is, to fully characterize a water body, a variety of conditions will apply.

Table 4.2: General Types and Examples of Receiving Water Conditions

Type of Condition	Examples
Chemical Conditions	
Constituents in flows (wet, dry, and ambient)	• Chemical constituent concentrations or loads (metals, pesticides, nutrients, etc.)
Constituents in sediments	• Metals, pesticides, nutrients, etc.
Toxicological Conditions (aquatic and sediment; acute and chronic)	
Toxicity from chemical constituents	• Metals, pesticides, nutrients, etc.
Toxicity from other stressors	• Temperature, turbidity, etc.
Biological Conditions	
Pathogens and indicators	• Bacterial indictors in wet and dry weather flows • Pathogens (bacteria,. viruses, protozoa, etc.) in wet and dry weather flows
Habitat and communities	• Macro-invertebrate community integrity • Biodiversity • Algal abundance and diversity • Habitat integrity (wetlands, riparian cover, etc.)
Physical Conditions	
Physical condition of channels and banks	• Geomorphic conditions • Erosion and sedimentation • Hydromodification • Extent and amount of trash
Flow conditions within channels	• Presence or absence of flow or ponded water • Volume, velocities, and durations of flows
Other	• pH, temperature, conductivity, dissolved oxygen, turbidity

In addition to nature, it's necessary to understand the magnitude of each receiving water condition. **Magnitude** describes its dimension or scale. Depending on the type of condition, this might include a number of different things, e.g., the average concentration of a chemical constituent, the volume or weight of trash and debris, or the peak velocity of stormwater flows. Together, nature and magnitude provide a basic description of each receiving water condition. It's also important to consider how each condition varies in time and space.

Variability

Prevalence and distribution describe the variability of a receiving water condition. **Variability** refers to how spread apart the measurements in a distribution are, or how they vary from each other temporally or spatially. **Temporal variability** describes how often or frequently the condition occurs, or how it varies over time. For example, bacterial indicators that exceed regulatory benchmarks in one-third of sampling events over the dry season. **Spatial variability** describes the physical patterns of dispersal of the condition within the receiving water. For instance total zinc concentrations that are above water quality standards at 2 of 10 monitoring stations. These results might not be representative of the entire water body; whereas, exceedances at a higher number of stations might indicate a condition that is highly distributed.

Some receiving water conditions vary according to regular **patterns**. For example, dissolved oxygen concentrations are generally in a constant state of flux on a daily basis and seasonally. Many receiving water conditions vary significantly by season. For instance, changes in flow velocities, volumes, and durations, seasonal spikes in temperature, seasonal changes in macro-invertebrate abundance and community structure, and seasonal changes in nutrient levels and algal production. Wet and dry weather conditions, normally represent two entirely distinct situations. It's therefore often necessary to evaluate receiving water conditions independently for wet and dry weather.

Collectively, nature, magnitude, and temporal and spatial variability help to define the **significance** of a receiving water condition. Along with other factors considered below, significance plays an important role in determining whether or not a condition is considered a problem, and if it is a priority for future action.

Certainty and Controllability

Certainty refers to the confidence that managers have in their assessment of a receiving water condition. It makes little sense to expend significant program resources in addressing receiving water conditions that are not well understood. Conclusions drawn on small sample sizes can be misleading if they fail to adequately represent the nature, magnitude, prevalence, or distribution of a condition. Ideally, evaluation of receiving water conditions will include statistical analysis of data to determine trends, range, mean and variance within desired confidence levels. Due to the high variability of most water quality data, acceptable confidence levels usually require robust data sets or large changes. Unexplained variability indicates uncertainty. To achieve statistically sound support for management decisions, receiving water data must usually be collected over sufficient periods to establish baselines and confirm trends.

Resolving identified data and information gaps will increase the certainty associated with receiving water conditions, so it's important to continue characterizing conditions that are initially not well understood. Complex interactions between attributes of the receiving water (e.g., hardness and metals; pH and metals) often require additional data to establish reasonable certainty. Where possible, managers should rely on multiple data sets or lines of evidence including water quality, toxicity, biological and physical data.

Controllability describes the potential to influence changes in a receiving water condition. A condition that does not have a reasonable chance of being successfully controlled (e.g., levels of bacterial indicators immediately after storms) may also not be a good candidate for resource commitments. To understand the controllability of a receiving water condition, managers generally need to know something about contributing sources, migration pathways, and program implementation options. Since much of this information is not addressed until later planning stages, controllability can sometimes initially be difficult to characterize. It can be revisited as additional data and information become available.

Question 2 How are receiving water conditions changing over time?

Trends are increases, decreases, or other discernible changes in the magnitude, prevalence, or distribution of a condition over time. Receiving water conditions can sometimes change significantly over time. Managers should be interested in knowing whether a receiving water condition is trending upward or downward over time. For example, increases in hydromodification or pollutant loadings due to urbanization, or temperature increases due to climate change or the addition of impervious surfaces. Trend analysis is critical for describing change. Some changes in receiving water conditions can also be expected to result from program implementation over time. To support the evaluation of changes, it's important that a baseline of existing conditions be established, and that changes in key parameters are tracked over time.

The output of Task 1 will be the documentation of a variety of receiving water conditions. Each individual receiving water or segment evaluated may have its own list. Results may include a range of conditions and should be as inclusive as allowed by existing data and information. Where data are insufficient to fully describe a condition, knowledge and data gaps should be documented for consideration in future data collection strategies. Identification of problem conditions will occur in Task 2. **Figure 4.3** provides a Review Checklist to guide the completion of Task 1.

Review Checklist

Step 6-A Task 1

Evaluating Receiving Water Conditions

Apply this task very broadly across Outcome Level 6 sources of data and information. The purpose is to provide a "snapshot" of what is currently known about receiving water conditions.

✓ **Compile existing data, information, and results applicable to Outcome Level 6. Consider the following questions:**

Question 1: What are current receiving water conditions?

Consider: Nature, magnitude, prevalence, distribution, certainty, controllability, and spatial variability and trends

Question 2: How are receiving water conditions changing over time?

Consider: Variability and trends

✓ **Consolidate results into one or more summary lists of existing conditions. Categorize results as determined appropriate (by condition type, etc.).**

✓ **Compile supporting documentation for listed conditions.**

✓ **Select the conditions in the summary list(s) that will be further evaluated as potential problems in Task 2. Consider "back-up" lists for future evaluation as necessary.**

✓ **Document the critical data and information gaps identified during Task 1 completion.**

NOTES

Figure 4.3: Review Checklist for Evaluating Receiving Water Conditions

Task 2 Defining Receiving Water Problems

The objective of this task is to determine which of the receiving water conditions identified above constitute problems. Two key questions guide this evaluation.

Step 6-A Task 2 Key Questions
Defining Receiving Water Problems

Inputs	Key Questions	Outputs
Existing Receiving Water Conditions	**Question 1:** Does the receiving water condition represent a known or suspected beneficial use impact? **Question 2:** Is there independent evidence for designating the receiving water condition as a problem?	**Receiving Water Problems**

Question 1 Does the receiving water condition represent a known or suspected beneficial use impact?

The ideal reference point for defining receiving water problems is the establishment of linkages between measured conditions and their support for beneficial uses. **Beneficial uses** are the designated uses of a waterbody. Water Quality Control Plans (or Basin Plans) designate beneficial uses and establish water quality objectives for waters of the State. For waters within a specified area, a basin plan designates or establishes: (1) beneficial uses to be protected; (2) water quality objectives; and (3) a program of implementation to achieve the water quality objectives (Water Code §13050). **Table 4.3** provides a list of SWRCB beneficial uses. Objectives that support these uses can be numeric or narrative. To assess compliance with water quality objectives, available data are compared to the objectives themselves, or other applicable benchmarks, guidelines, or reference criteria. Exceedances of numeric objectives can be comparatively straightforward to interpret so long as applicable sampling and analytical protocols are adhered to. However, narrative objectives (e.g., ““waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses”) may require a higher level of effort to relate to specific receiving water conditions. **Table 4.4** provides a number of hypothetical examples of receiving water conditions linked to specific beneficial use impacts.

Table 4.3: SWRCB Beneficial Use Designations

Municipal and Domestic Supply (MUN) Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply. **Agricultural Supply (AGR)** Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing. **Industrial Process Supply (PROC)** Uses of water for industrial activities that depend primarily on water quality. **Industrial Service Supply (IND)** Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well re-pressurization. **Ground Water Recharge (GWR)** Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers. **Freshwater Replenishment (FRSH)** Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g., salinity). **Navigation (NAV)** Uses of water for shipping, travel, or other transportation by private, military, or commercial vessels. **Hydropower Generation (POW)** Uses of water for hydropower generation. **Water Contact Recreation (REC-1)** Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, or use of natural hot springs. **Non-contact Water Recreation (REC-2)** Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities. **Commercial and Sport Fishing (COMM)** Uses of water for commercial or recreational collection of fish, shellfish, or other organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes. **Aquaculture (AQUA)** Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes. **Warm Freshwater Habitat (WARM)** Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.	**Cold Freshwater Habitat (COLD)** Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates. **Inland Saline Water Habitat (SAL)** Uses of water that support inland saline water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates. **Estuarine Habitat (EST)** Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds). **Wetland Habitat (WET)** Uses of water that support wetland ecosystems, including, but not limited to, preservation or enhancement of wetland habitats, vegetation, fish, shellfish, or wildlife, and other unique wetland functions which enhance water quality, such as providing flood and erosion control, stream bank stabilization, and filtration and purification of naturally occurring contaminants. **Marine Habitat (MAR)** Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds). **Wildlife Habitat (WILD)** Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources. **Preservation of Biological Habitats (BIOL)** Uses of water that support designated areas or habitats, such as Areas of Special Biological Significance (ASBS), established refuges, parks, sanctuaries, ecological reserves, or other areas where the preservation or enhancement of natural resources requires special protection. **Rare, Threatened, or Endangered Species (RARE)** Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered. **Migration of Aquatic Organisms (MIGR)** Uses of water that support habitats necessary for migration, acclimatization between fresh and salt water, or other temporary activities by aquatic organisms, such as anadromous fish. **Spawning, Reproduction, and/or Early Development (SPWN)** Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish. **Shellfish Harvesting (SHELL)** Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes.

Table 4.4: Examples of Receiving Water Conditions Impacting the Beneficial Uses of a Stream and Estuary System

Type of Condition	Description of Condition and Supporting Data	Examples of Impacted Beneficial Uses	Applicable Criteria
Chemical Conditions			
Constituent concentrations in wet weather flows	Data compiled over a five-year period were compared to water quality objectives. Nutrient concentrations consistently exceed the objectives. The creek is 303(d) listed for nitrates.	WARM, EST	Water quality objectives, 303(d) listing
Biological Conditions			
Pathogens and indicators	Three years of data were reviewed to evaluate support for beneficial uses associated with human health. Determination of problem conditions is based on a comparison of existing conditions to water quality objectives based primarily on human health risk criteria.	REC-1, REC-2, MUN	Water quality objectives, AB 411 standards, TMDL limits
Toxicological Conditions			
Toxicity from chemical constituents	Analysis indicates toxicity in a limited number of samples at a few of the sites sampled. Toxicity Identification Evaluation indicates toxicity from organics, which is also corroborated by elevated pyrethroid measurements.	BIOL, RARE	Water quality objectives, California Toxics Rule, TMDL limits
Physical Conditions			
Habitat	Flow data indicate that increased imperviousness correlates to increases in the frequency of channel-forming flows. Comparisons to historic observations for these segments and comparisons to reference streams indicate that increased flows have reduced large woody debris, reduced vegetation, and widened the stream channel. Downstream sedimentation in the estuary is also observed. IBI scores appear low compared to reference streams, but data are not conclusive.	WILD, BIOL, REC2	Hydromodification requirements in MS4 permits and the Statewide Construction General Permit

Beneficial use impacts will often already have been identified through previous work. In particular, 303(d) listings and adopted TMDLs are by definition presumed to indicate one or more beneficial use impacts. Some NPDES permit requirements also establish specific objectives to protect designated beneficial uses. These are normally based on constituent concentrations or pollutant loadings, but they can also include biological, physical and toxicological criteria linked to a beneficial use. Non-compliance with any of these provisions may potentially be interpreted as evidence of beneficial use impacts.

Where evidence of a beneficial use impact exists, it may not always be definitive. Any determination of beneficial use attainment is only as valid as the data that it's built on. The science upon which any applicable criterion is based is also constantly evolving, and managers should remain cognizant of the need to consider the most currently available data and analysis. In some cases site-specific objectives that better represent actual conditions may be needed. As data sets are augmented over time, determinations of beneficial use impacts should be revised as needed.

Question 2 Is there independent evidence for designating the receiving water condition as a problem?

It's often not possible to directly link receiving water conditions to specific beneficial use impacts. In concept, the conditions that cause these impacts will eventually result in 303(d) listings, but it can often take years or decades for a listing to occur. In the meantime, many conditions can exist in a state that is not yet sufficient to trigger a listing, or for which future listings may be preventable. Many of these conditions can reasonably be considered to represent actionable problems.

To illustrate, monitoring of a stream's benthic macro-invertebrate community and habitat structure consistently produces low Index of Biotic Integrity (IBI) scores. IBI scores can be excellent integrators of the effects of changing water quality conditions over time, but might not in themselves demonstrate a clear lack of support for specific beneficial uses. It might be reasonably concluded that the scores represent a problem condition despite the lack of a defined beneficial use impact.

In a second example, nitrate concentrations in a stream are elevated, but below water quality objectives. DO levels are slightly depressed and historical patterns of development have removed much of the riparian canopy. There is substantial independent evidence that DO is impacted by eutrophication in aquatic systems and nutrient levels contribute to levels of eutrophication. There have been significant studies on the eutrophication of lakes, but the study of the relationship between nutrient levels, DO, algae mass and cover, bacteria concentrations, retention times and other factors in creeks, streams and estuaries is less comprehensive and often site-specific. Despite the absence of conclusive evidence of a beneficial use impact at this site, a weight of evidence suggests the existence of a potential problem condition.

The output of Task 2 will be a list of problems associated with each receiving water or segment evaluated. Results may include a range of confirmed or potential problems. Where data are insufficient to reasonably confirm a condition as a problem, it may be tentatively listed, and identified knowledge and data gaps considered for future data collection strategies. Prioritization of problem conditions will occur in Task 3.

Figure 4.4 provides a Review Checklist to guide the completion of Task 2.

Review Checklist

Step 6-A Task 2
Defining Receiving Water Problems

Apply this task individually to each Task 1 receiving water condition selected for further evaluation. The purpose of this task is to determine which of these conditions should be designated as problems.

✓ **For each identified condition, consider the following questions:**

Question 1: Does the receiving water condition represent a known or suspected beneficial use impact? If no, or if unknown, continue to Question 2.

Consider: 303(d) listings; TMDLs; exceedances of water quality objectives or other applicable criteria

Question 2: Is there independent evidence for designating the receiving water condition as a problem?

Consider: Variability and trends

✓ **Document known or suspected receiving water problem conditions.**

✓ **Consolidate results into one or more summary lists. Categorize results as determined appropriate (by problem type, known versus suspected, etc.).**

✓ **Compile supporting documentation for listed conditions.**

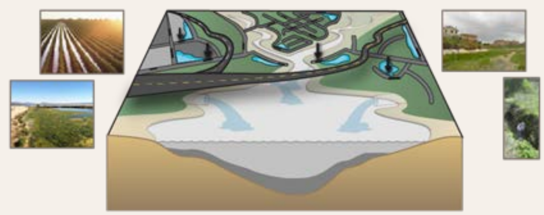
✓ **Document the critical data and information gaps identified during Task 2 completion.**

NOTES

Figure 4.4: Review Checklist for Defining Receiving Water Problems

Case Study 4.1 Linkages of Receiving Water Problems to MS4 and Source Contributions in a Drainage Area

In conducting Source and Impact Planning, it's helpful to consider a watershed scale example. Sources, MS4s, and receiving waters constitute a physically inter-connected system; pollutants and flows generated by watershed sources are transported by MS4s and eventually impact the condition of downstream receiving waters. This example illustrates how problem conditions observed for each of the three outcome levels can be related to each other.



Receiving Water Conditions

- *303(d) listings for eutrophication in the lower creek and estuary and sediment in the middle segment*
- *DO below water quality objective in creek and estuary*
- *Extensive algae in estuary during the summer*
- *Intermittent sediment toxicity and elevated pyrethroid concentrations*
- *Bioassessment data indicate benthic impairment*
- *Physical evidence of hydromodification in the creek*

Identified MS4 Contributions

- *MS4 outfall and agricultural runoff data indicate contributions of nutrients to receiving water above levels found in reference watersheds*
- *Data from construction site monitoring (SMARTS) show discharges of sediment*

Potential Source Contributions

A variety of residential and commercial sources exist in the watershed, but nutrient source identification studies indicate the highest loadings from agricultural runoff and groundwater. Sediment discharges are suspected from agricultural and construction sources.

Problem conditions for the MS4 outfalls and runoff from natural drainage channels are linked to eutrophication and decreases in dissolved oxygen levels in the receiving waters. Sources of nutrients causing eutrophic conditions can be confirmed as originating from agricultural runoff by comparing nutrient loadings from specific MS4 outfalls and contributing drainage areas. High total suspended solids in storm flows are potentially due to sediment loadings from constructions sites. As with many actual drainage area and watershed conditions, multiple potential problems coexist. It's currently unclear whether low DO, sedimentation, or pesticides are the primary causes of impairment to beneficial uses. Further delineation of MS4 and source contributions will also help to refine potential management options.

Task 3 Prioritizing Receiving Water Problems

Prioritization of receiving water problems is necessary in any instance where priorities are not already well-established, or where sufficient resources do not exist to address all identified problems. A structured prioritization process can also be useful for validating or refining existing priorities. The key questions described below are suggested to guide the prioritization of receiving water problems.

Step 6-A Task 3 Key Questions
Prioritizing Receiving Water Problems

Inputs	Key Questions	Outputs
Receiving Water Problems	**Question 1**: What is the priority rating of each receiving water problem? **Question 2**: What is the relative importance of each receiving water problem?	**Prioritized Receiving Water Problems**

As shown in **Figure 4.5**, prioritization is a two-step process. Each identified problem will first be reviewed to determine its **priority rating**. Ratings can then be considered together to determine their relative **priority ranking**. Managers may already have other preferred methods or approaches than those described here, and should choose those that work best for them. The process below is intended to apply across a variety of potential prioritization scenarios. It makes sense to explore a variety of potential scenarios, but it's also important to keep the number of potential receiving water priorities manageable.

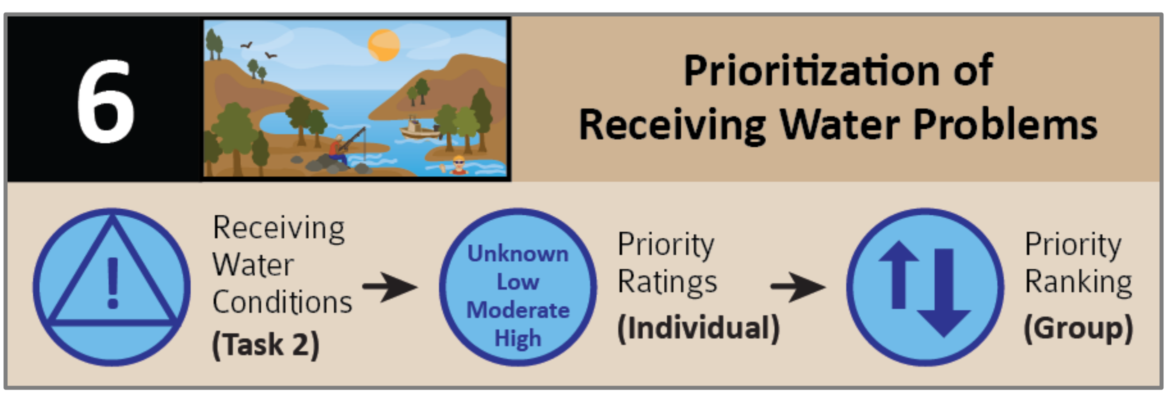


Figure 4.5: General Process for Prioritizing Receiving Water Problems

Question 1   What is the priority rating of each receiving water problem?

Prioritization starts with the assignment of a priority rating (e.g., Low, Moderate, or High Priority) for each receiving water problem. Assignment of ratings relies primarily on the review factors identified in Task 1 above. Their application to receiving water problems is described below. Potential "scores" for individual rating factors are indicated throughout for illustration, but managers should use any scoring methodology they find to be appropriate. As shown, simple qualitative scoring methods are recommended for each step of the process. Even where rating scores are derived from quantitative data, their application across different problem conditions can be extremely subjective.

Tier 1 Regulatory Screening

Receiving waters that are 303(d) listed, or that have adopted Total Maximum Daily Loads, must typically be treated as higher priorities. Other regulatory drivers can be limiting. For example, compliance with other state and federal laws (CEQA, 401 permits, Endangered Species Act, etc.) can constrain how or where resources may be directed, potentially impacting the controllability of a condition. Using a bacterial indicator as an example, **Figure 4.6** illustrates the Regulatory Screening process for a receiving water problem.

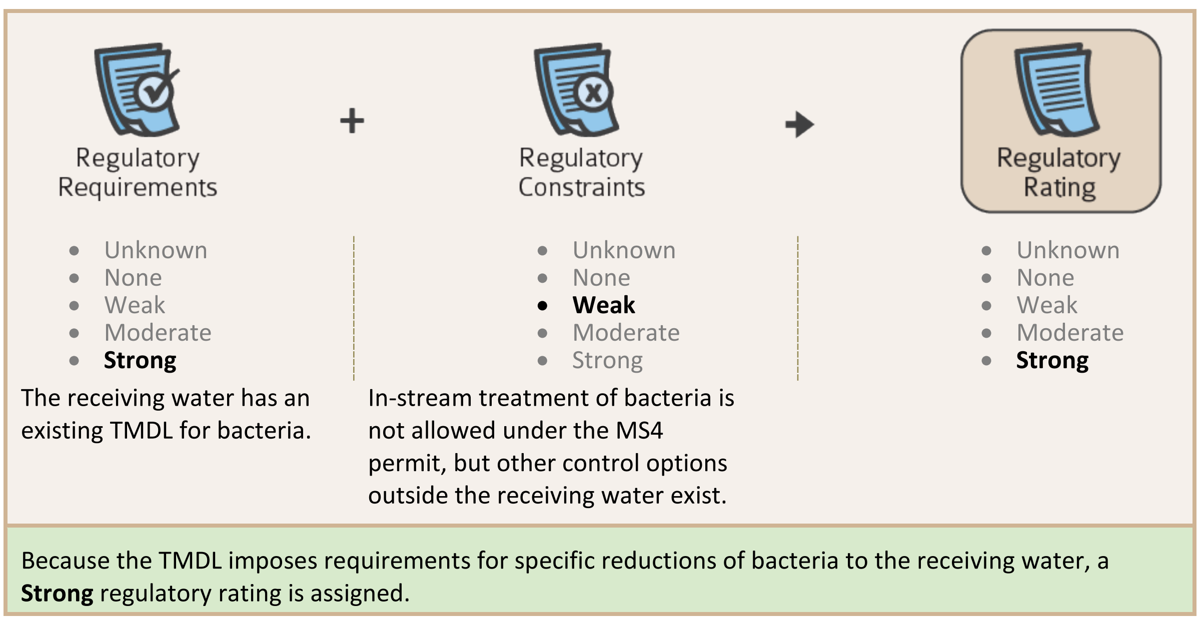


Figure 4.6: Establishing a Regulatory Rating for a Receiving Water Problem -- Bacterial Indicator Example[1]

[1] S = Strong, M = Moderate, W = Weak, N = None, U = Unknown. These are examples intended to illustrate potential rating designations.

It’s important to note the direction of each applicable regulatory influence since some requirements and constraints can affect priority in opposite ways. If multiple regulatory factors are identified, their collective, and potentially offsetting, influence will need to be characterized. It may be difficult to modify a priority that is based on an absolute regulatory requirement. Even so, it makes sense to continue with other prioritization steps to ensure that all applicable evidence has been considered. When regulatory requirements conflict with other evidence, managers must maintain compliance, but may also need to advocate for additional study, flexibility or regulatory change.

Tier 2 Technical Review

Using the same example as above, a Technical Rating for each receiving water problem will now be determined. Technical Ratings are based on three factors; significance, certainty, and controllability. Ultimately, each condition must be interpreted in terms of consistent, categorical ratings (unknown, weak, moderate, etc.) that allow for their comparison. While this can sometimes lead to oversimplification, it is necessary to enable prioritization across a range of disparate types of conditions.

Significance is the cornerstone of the technical review process. The technical factors introduced in Task 1 above (nature, magnitude, and variability) combine to describe the significance of any receiving water problem. **Figure 4.7** illustrates the application of these factors using a bacterial indicator example. Potential rating scales are indicated for each review factor except for nature (which does not lend itself to standardized scoring).

Discretion is essential in scoring each factor since every problem condition is in some aspects unique. For example, rating the magnitude of a chemical concentration in a receiving water will be very different than assigning a rating for species abundance or diversity. Regardless, to gain a complete understanding of the problem condition, it’s critical that each contributing factor be considered.

Certainty describes the confidence with which each receiving water problem condition can be asserted. Conclusions drawn on small samples or poor quality data can be misleading if they fail to adequately represent any contributing factor.

Controllability describes the potential to influence changes in the problem condition, primarily through changes in lower level outcomes. **Figure 4.8** illustrates how signficance, certainty, and controllability combine to establish a combined Technical Rating for a receiving water problem. Controllability is also considered further in **Case Study 4.2**.

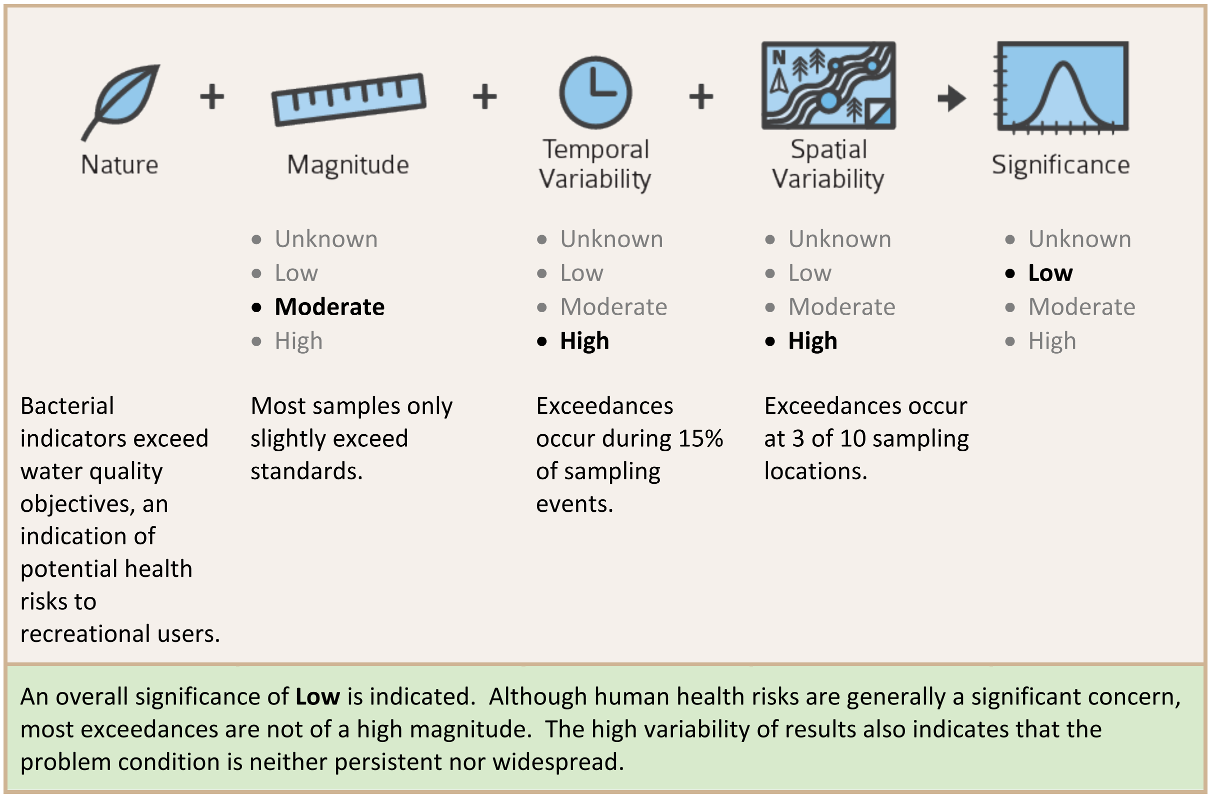


Figure 4.7: Receiving Water Problem Significance -- Bacterial Indicator Example

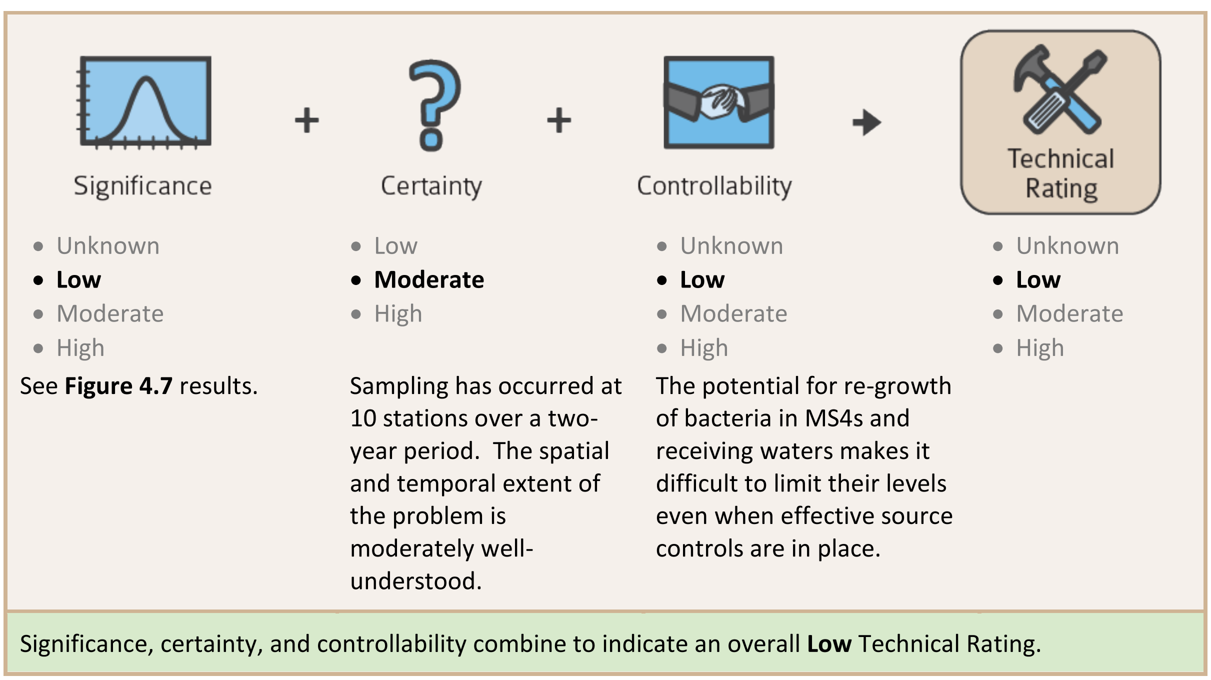


Figure 4.8: Establishing a Technical Rating for a Receiving Water Problem -- Bacterial Indicator Example

Case Study 4.2 A Closer Look at the Controllability of Dissolved Oxygen and TSS in a Stream and Estuary System

For the example introduced in **Case Study 4.1**, the measures needed to address DO levels observed in the estuary are not well understood. Nutrient reduction in dry weather flows and greater circulation in the estuary might address this problem, but the level of effort and feasibility of this strategy is not well defined. Moreover, if nutrient levels haven't been confidently established as the cause of the DO problem, solutions focusing on them might be misdirected. The controllability of nutrient levels in dry weather flows in the creek may also be rated as low. Factors other than nutrients (e.g., oxygen transfer, tidal flushing, etc.) can play a role in determining dissolved oxygen levels. In this case, the lack of clear linkages to a causative agent and identification of potential control measures might both be documented as data gaps and addressed in future data collection strategies.

The receiving water data that indicates TSS and turbidity levels above benchmarks in the wet weather flows are localized to areas with active construction. These data suggest potentially controllable sources as the cause of this localized impact. While the DO and nutrient issues in the stream and estuary are rated low for controllability, the TSS issue might be rated moderate or high.

Tier 3 Sustainability Review

Where possible, prioritization should also consider social and economic factors. **Economic factors** are essential because every problem and every proposed solution has one or more costs associated with it. This might, for example, include the cost of addressing the receiving water problem with current scientific knowledge and technology compared to the economic benefit achieved. **Social Impacts** are those related to target audiences, society at large, or other specific segments. Perceptions and opinions regarding specific receiving water problem conditions as well as acceptance of potential control strategies can strongly influence priority. The public generally expects to utilize and enjoy receiving waters, and can play an important role in instituting control measures to protect them.

Sustainability Ratings can be approached in either of two ways. Economic and social ratings may be developed individually, or a single combined rating may be developed for them together. Individual ratings would be a more likely choice in instances where managers want to give each factor greater overall weight to technical and regulatory factors. In most instances, knowledge of economic and social factors will be comparatively limited, so a single combined rating may be a more suitable choice.

Overall Priority Rating

As described in **Section 3.3 (Step A Task 3)**, Tier 1, 2, and 3 results are reviewed together to determine the **Overall Priority Rating** of each problem condition (**Figure 4.9**). Each rating is determined individually, i.e., independently of priorities for other conditions.

To determine a priority rating, the respective weightings of each of the results for each review tier must be considered. Although equal weightings have been assumed in this discussion for illustration, managers may want to determine their own approaches to the weighting and use of individual criteria and rating factors. Assigning weightings can be especially challenging given the fundamental differences in the nature of regulatory, technical, economic, and social factors. While it can sometimes be helpful to develop priority ratings using quantitative scoring methods, managers should bear in mind that prioritization approaches will still generally tend to lack precision. In most cases qualitative ratings are sufficient and appropriate. **Table 4.5** provides examples of the scoring of priority ratings for several receiving water problems.

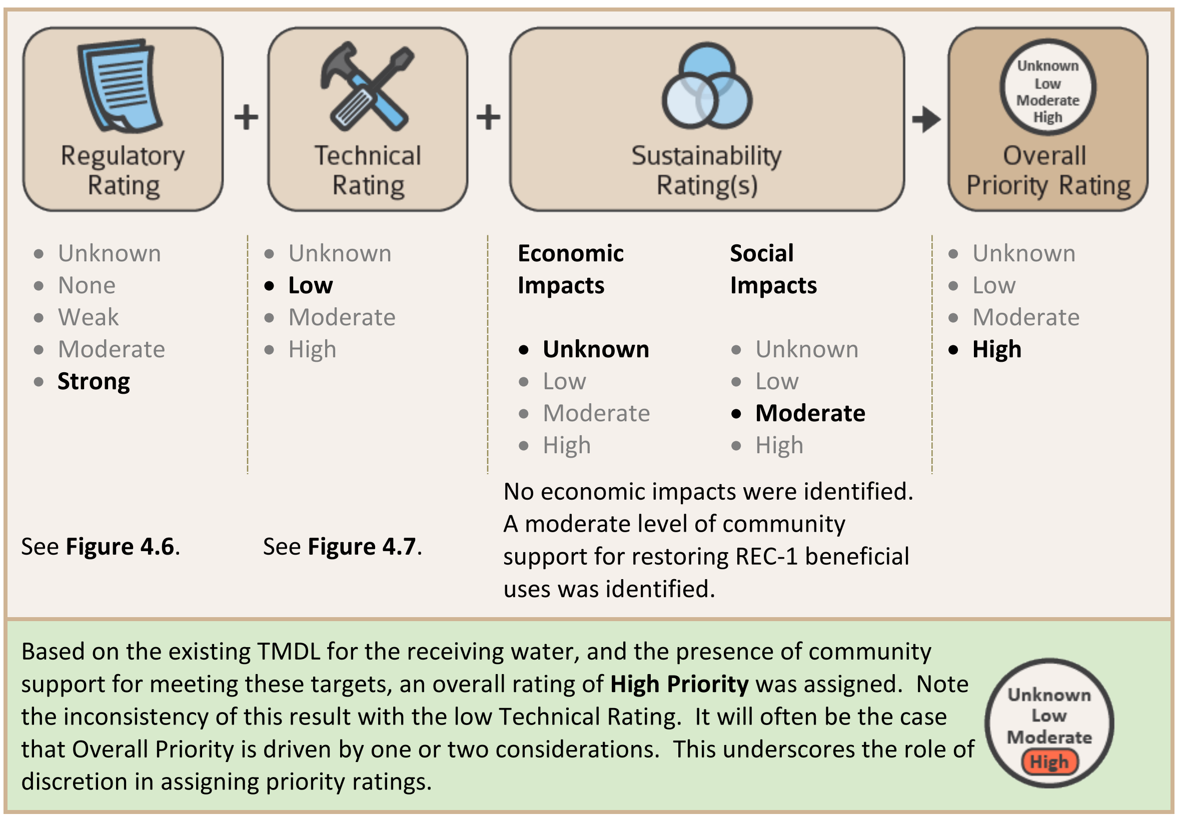


Figure 4.9: Establishing an Overall Priority Rating for a Receiving Water Problem -- Bacterial Indicator Example

Table 4.5: Examples[2] of the Assignment of Overall Priority Ratings to Receiving Water Problem Conditions

Problem Condition	Tier 1: Regulatory Screening	Tier 2: Technical Rating				Tier 3: Sustainability Ratings			Overall Priority Rating
		Significance	*Certainty*	*Controllability*	*Overall*	*Economic Factors*	*Social Factors*	*Overall*	
Chemical-Water Quality Problems									
TSS Concentrations above benchmarks in wet weather	**Strong**	Moderate	Moderate	Moderate	**Moderate**	Moderate	Low	**Low-Mod**	**Moderate**
Low DO levels in the estuary; 303(d) listing for eutrophication	**Strong**	Moderate	Moderate	Low	**Moderate**	Low	Moderate	**Low-Mod**	**Moderate**
Biological Problems									
Bacterial indicators exceed REC-1 standards	**Strong**	Low	Low	Low	**Low**	Unknown	Moderate	**Moderate**	**Moderate**
Bio-indicators show benthic impairment	**Strong**	Mod	Low	Low	**Low**	Low	Low	**Low**	**Low**
Toxicological Problems									
Bifenthrin above the LC50	**Unknown**	Moderate	Low	Low	**Low**	Low	Low	**Low**	**Low**
Physical Problems									
Physical evidence of hydromodification in creek	**Strong**	Low	Moderate	Moderate	**Moderate**	Moderate	Moderate	**Moderate**	**Moderate**

[2] These examples are hypothetical and for illustration only. They are not intended to imply a particular priority for any of the receiving water conditions listed.

Question 2 What is the relative importance of each receiving water problem?

For individual priority ratings to be useful in supporting decision-making, they must be evaluated together to determine their relative importance. Because programs must often address multiple receiving waters, considerations of scale are important. In some cases, managers will want to compare priorities across multiple receiving waters (e.g., copper exceedances in a river versus habitat degradation in an estuary); in others, they will want to prioritize conditions within a single receiving water or segment (e.g., copper exceedances versus habitat degradation in the same receiving water).

Using the examples of priority ratings presented in **Table 4.5**, two ranking options are illustrated in **Figure 4.10**. Identified problems can either be put into a ranked order or be grouped by their priority ratings. Establishing a **ranked order** consists of lining up the applicable problem conditions for each receiving water or segment from highest priority to lowest, with the higher priorities normally constituting the greater management priorities. A limitation to ranked order approaches is that receiving water problems may tend to have "tie scores". Using **grouped rankings** can reduce the need to conduct further analysis to differentiate between them.

↑ Increasing Priority ↑	RANKED ORDER EXAMPLE	GROUPED RANKING EXAMPLE
	1. Bacterial indicators exceed REC-1 standards 2. Low DO levels in estuary 3. Wet weather TSS above benchmarks 4. Hydromodification in creek 5. Benthic impairment 6. Bifenthrin toxicity	**GROUP A (Moderate)** • Bacterial indicators exceed REC-1 standards • Low DO levels in estuary • Wet weather TSS above benchmarks • Hydromodification in creek **GROUP B (Low)** • Benthic impairment • Bifenthrin toxicity

Figure 4.10: Potential Options for Ranking Receiving Water Problem Conditions

The final output of **Task 3** will be a ranked list of priority problem conditions for each receiving water or segment. It's important to keep the qualitative nature of this exercise in mind. Its purpose is simply to provide a method and informational basis for the comparison of different problem conditions. Rating and ranking systems, no matter how sophisticated, cannot replace judgment.

Figure 4.11 provides a Review Checklist to help guide the prioritization process. As in previous planning steps, significant data and information gaps are likely to be encountered along the way. It's important to document these deficiencies and consider them in the development of future data collection strategies.

Review Checklist

Step 6-A Task 3

Prioritizing Receiving Water Problems

Apply this task individually to all problem conditions identified in Task 2. Its purpose is to assess and rank the priorities of problem conditions.

✓ **For each identified problem condition, consider the following questions:**

Question 1: What is the priority rating of each receiving water problem?

☐ **Tier 1: Regulatory Screening** **REGULATORY RATING ________**

- ✓ Identify regulatory requirements and constraints affecting priority.
- ✓ Based on their collective impact, assign a Tier 1 rating.
- ✓ Note the overall direction of influence of the rating (requirement or constraint).
- ✓ Should an Overall Priority Rating be assigned based solely on regulatory criteria? If yes, stop and document. If no, continue to Tier 2 Review.

☐ **Tier 2: Technical Review** **TECHNICAL RATING ________**

- ✓ Evaluate the significance, certainty, and controllability of the problem. Establish individual weightings as appropriate for each of the three factors.
- ✓ Based on review of the above factors, assign a Tier 2 Rating.
- ✓ Should the problem be eliminated from further consideration or assigned a "low" Overall Priority Rating? If yes, stop and document. If no, continue to Tier 3 Review.

☐ **Tier 3: Sustainability Review** **SUSTAINABILITY RATING(S) ________**

- ✓ Identify economic factors and social factors affecting priority.
- ✓ Assign Tier 3 Rating (or Ratings) for economic and social factors.

☐ **Overall Priority Rating** **OVERALL PRIORITY RATING ________**

Collectively consider Regulatory, Technical, and Sustainability results to assign an Overall Priority Rating for each problem. Assign individual weightings to each factor as appropriate. Economic and Social factors may be counted individually or together.

Question 2: What is the relative importance of each receiving water problem?

☐ **Rank individual priority ratings for further consideration in Step B.**

✓ **Document the critical data and information gaps identified during Task 3 completion.**

NOTES

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Figure 4.11: Review Checklist for Prioritizing Receiving Water Problems

Step 6 - B Targeted Receiving Water Changes

Step 6-B addresses the establishment of measurable targets for changes in receiving waters. This is a critical step toward the development of the control strategies needed to resolve identified problems. As shown in **Figure 4.12**, it consists of three tasks, each of which is explored below.

Figure 4.12: Targeting Receiving Water Changes (Step 6-B)

Step 6-B begins with the list of **Priority Receiving Water Problems** established at the completion of **Step 6-A**. Considering again the Receiving Water Data and Information gathered for each receiving water condition on the list (**Step 6-A Task 1**), one or more specific, measurable targets and timelines for change can be considered for each identified priority problem. In addition to helping direct programs toward the resolution of problems, this will establish a context for establishing measurability, interpreting results, and evaluating success over time.

Task 1 Identifying end-state targets

This task focuses on defining the changes to be sought in identified priority problem conditions. It is guided by two general questions.

Step 6-B Task 1 Key Questions
Identifying End-state Receiving Water Targets

Inputs	Key Questions	Outputs
Priority Receiving Water Problems	**Question 1**: What are the end-state receiving water conditions? **Question 2**: When will end-state receiving water conditions be achieved?	**End-state Receiving Water Conditions**

Question 1 What are the end-state receiving water conditions?

End-state receiving water conditions are those that represent the absence of problems, or their reduction to acceptable levels. Targets for change should be considered at least for the highest priority receiving water conditions identified above. The establishment of targets should consider the review factors and general conceptual approaches described below.

Review Factors

Several review factors have general applicability in setting targets for receiving water change. As shown in **Figure 4.13**, these are the same factors introduced above during problem prioritization.

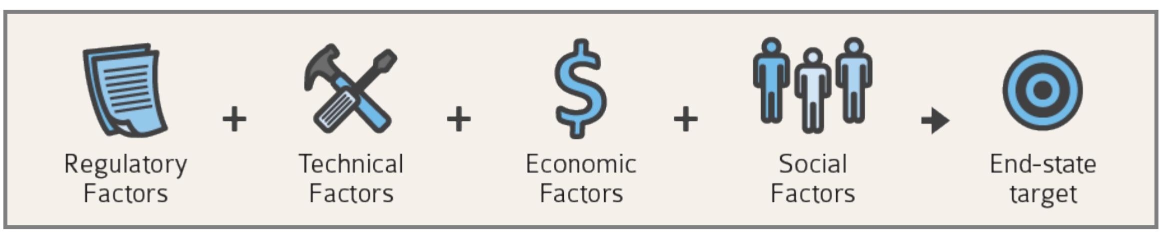


Figure 4.13: Factors Relevant to Setting Targets for Receiving Water Change

Draft targets can initially be established through a consideration of the regulatory and technical factors introduced above (see **Task 6-A-3**), and these results further reviewed and refined as necessary in the context of sustainability considerations. This process may need to be repeated multiple times as additional data and information become available.

General Approaches to Establishing End-state Receiving Water Targets

Targeting may follow any of the general approaches below, individually or in combination.

Setting Targets to Comply with Regulatory Requirements

Regulatory requirements often dictate the establishment of specific receiving water targets. This can be true in any case where a target is explicitly or implicitly defined in a permit or TMDL, e.g., compliance with Water Quality Objectives. Since regulatory directives often leave little room for interpretation, compliance with them must be maintained until other evidence can be obtained to support their revision or removal.

Setting Targets to Achieve Beneficial Use Protection

For receiving waters, the end-state condition will ideally be the attainment of specific beneficial uses. Since beneficial use attainment is a regulatory requirement, this approach can also be considered a subset of approach #1 above for receiving water changes. Where linkages are well-understood, it makes sense to target changes in receiving water conditions that will bring about attainment of these uses. This will typically be manifested as compliance with required load reductions or water quality objectives. It's important to be realistic about the attainability of any targeted condition, even where it represents a strict regulatory requirement. It makes little sense to set targets that can't be achieved. In cases where there the target itself is mandated, one option may be to set extended timeframes for achieving it, and to pursue interim targets that foster learning and adaptation along the way (see also approach #4 below).

Setting Targets to Resource Availability

Stormwater programs are rarely resourced to achieve all priority receiving water changes, so decisions must be made about how much and how quickly each of them can be reached. Individual targets established during planning should always reflect the sum of commitments being made, and the availability of resources to achieve them. It's important to emphasize, however, that targets based solely on resource availability may often fail to meet explicit regulatory requirements, or to satisfy the expectations of regulators or third parties.

Setting Targets to Learn and Adapt

This approach involves establishing targets for lower level "causal" outcomes (MS4 load reductions, target audience behavioral changes, etc.) to explore their potential for bringing about receiving water changes. In practice, managers will often have little idea of what receiving water changes can realistically be achieved, or of the timeframes needed to reach them. Likewise, they often lack the knowledge base needed to understand to potential implications of specific management initiatives. Where large structural controls are being contemplated, specific receiving water targets and timeframes may be predicted with a greater degree of certainty. However, this is not usually the case since most changes are targeted through the implementation of a variety of non-structural source controls. As emphasized throughout this document, planning is often hampered by the availability or sufficiency of data and information. As such, it may instead make sense to implement programs with a general objective of learning through experience. As previously discussed, problem conditions are assumed to be sequentially linked in "chains" of cause and effect relationships. It follows that managers will benefit from exploring the potential implications of "dialing" a particular lower level outcome up or down. This "trial and error" approach relies heavily on the accumulation of experience and making adjustments through an adaptive management process.

Experimental targets foster adaptive management by establishing and exploring assumptions or hypotheses about relationships between receiving water conditions and other outcomes. For example, if managers have a good idea of the reductions in loadings of a particular pollutant that can be achieved in a watershed area, they might establish a working hypothesis about the receiving water changes they hope to see. By establishing and tracking measurements for both types of outcomes, they may be able to establish linkages to receiving changes over time.

One specific way of approaching this is through the establishment of **stretch targets**. Managers will often have a good idea of what type and degree of receiving water changes they've achieved in the past, and therefore where they may be able to build on existing commitments to leverage additional improvements. Building on existing accomplishments provides a means of "stretching" to see what can be done cost-effectively or within available resource commitments (note the similarity of this approach to approach #3 above). In doing so, managers can continue to actively learn while pursuing increases in measurability that might later be used to explore linkages.

Interim targets are also critical to the learning process because they provide opportunities for obtaining feedback along the way toward end-state conditions (e.g., interim periods over the life of a 25-year TMDL target). These targets are discussed further under **Task 2**.

Table 4.6 provides a variety of examples of potential end-state receiving water targets for priority receiving water problems previously identified in **Table 4.5**. The uncertainty associated with many of these targets should be noted as this is often a prominent feature of the targeting process.

Table 4.6: Examples[3] of End-state Receiving Water Targets

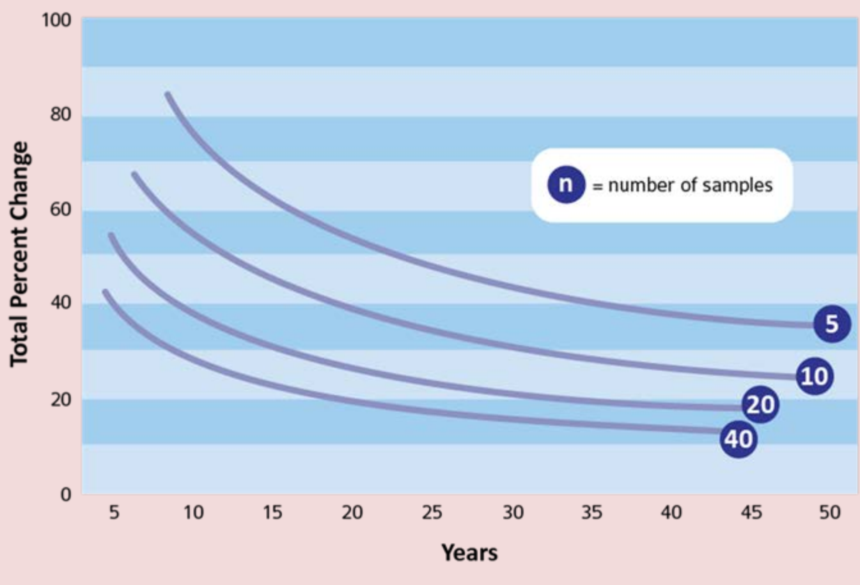
Problem Condition	Priority (from Table 4.5)	End-State Target	Explanation
Chemistry-Water Quality Priority Problems			
TSS concentrations and turbidity exceed benchmarks in wet weather	Moderate	Reduce TSS concentrations by 20%	20% reduction is targeted in combination with other programmatic stretch targets.
Low dissolved oxygen levels in creek	Moderate	Restore DO Levels to meet water quality benchmarks	Target is based on the direct linkage of the DO benchmark to beneficial use attainment.
Biological Priority Problems			
Benthic impairment in creek	Moderate	Achieve a bioassessment rating for a comparable reference site	Because the target is based on external conditions, its achievability may need to be determined over time.
Toxicity Priority Problems			
Toxicity from synthetic pyrethroid pesticide Bifenthrin	Low	Absence of toxicity from pesticide	An ideal target such as "no toxicity" may be achievable for some pollutants, such as pesticides, where adequate State and Federal authority are in place to control sources. For other pollutants for which statutory authority is lacking, such control may not be realistic.
Physical Priority Problems			
Physical evidence of erosion in creek	Moderate	Reduce peak flows and volumes	Target lacks a specific measurable endpoint or a timeframe. It might be initially approached experimentally with a goal of “filling in the gaps” through trial-and-error or ongoing evaluation of resource availability.

[3] These examples are hypothetical and for illustration only. They are not intended to imply a particular target or timeline for any of the receiving water conditions listed.

Key Concept 4.1 Variability and the Measurement of Receiving Water Changes

The inherent variability of most water quality parameters makes it extremely challenging to demonstrate improvements in receiving water quality over short periods. Based on a power analysis of wet weather receiving water data collected over a 5-10 year period in Southern California, this graph shows how many years it would take to verify various levels of change in water quality concentrations at a typical level of acceptable error (using a power of 80%). Each curve represents a different annual sampling frequency. For the data in this example, demonstrating a 40% change in water quality with 5 samples per year would require 35 years of sampling. Smaller changes (e.g., 10-20%), which would be more typical of those targeted by MS4 programs, would require substantially larger numbers of samples to verify, even within a 50-year horizon.

Since the sampling of stormwater flows is constrained by how many storms occur each year, a practical limitation exists on the potential for increasing sample size, leading to a conclusion that verification of targeted receiving water changes will generally require decades. This also underscores the need to focus on measurement of changes at other outcome levels (behaviors, source load reductions, etc.) over shorter time frames.



Courtesy of the County of Orange

Question 2 When will end-state receiving water conditions be achieved?

Every targeted change will ideally specify the timeframe needed to achieve it. As noted, some timeframes will already been established as permit or TMDL requirements. Numerical models (simple spreadsheets, complex numeric models, etc.) can be helpful for forecasting rates of potential change assuming specific implementation scenarios, but water quality and other receiving water conditions are highly variable. It's important to be realistic about how much time is needed to achieve and statistically define targeted changes. Targets for dry weather flows may often be more aggressive than wet weather flows that often require greater effort to achieve. For highly variable data sets, as is normally the case for both dry and wet weather receiving water conditions, the projection of end-state conditions based on small data sets or solely on measures of central tendency can be misleading.

As previously emphasized, end-state receiving water conditions can take decades to achieve (e.g., 20-50 years or longer; see **Figure 3.16**). Allowances should be made for the time it takes to "ramp up," refine, and fully implement the programs expected to drive these changes. There should be a point at which maximum gains can be expected, and possibly the acheivement of steady state conditions after that. Given this complexity, managers may often lack a basis for accurately forecasting specific timeframes, so their establishment up front may not always be possible. In such cases, timeframes can be established provisionally, and then reviewed and modified as additional data, information, and results become available.

Task 2 Establishing interim targets

Because of the extended timeframes typically needed to achieve end-state receiving water targets, it's important to establish incremental measures of progress. The establishment of interim targets is guided by two questions.

Question 1 What interim targets are needed to evaluate progress toward end-state receiving water conditions?

Interim targets are routinely established in TMDLs, and many MS4s permits are increasingly setting specific milestones for achieving change. They allow the assessment of incremental progress toward end-state conditions, and provide the feedback necessary for refining management approaches along the way.

Step 6-B Task 2 Key Questions
Establishing Interim Receiving Water Targets

Inputs	Key Questions	Outputs
End-state Receiving Water Targets	**Question 1**: What interim targets are needed to evaluate progress toward end-state receiving water conditions? **Question 2**: When will interim receiving water targets be achieved?	**Interim Receiving Water Targets**

Measurement of receiving water changes will often be based on constituent concentrations or pollutant loading trends evaluated over a timeframe where these targets are both measurable and acheivable. Managers should consider the specific targeted conditon, and the level of effort and resources available to address the problem. Where measurement is possible, interim targets should also reflect critical milestones in the "implementation curve" discussed under **Task 1** above. By obtaining feedback along the way, adjustments can be made along the way in response to early results.

Question 2 When will interim receiving water targets be achieved?

Timeframes for interim targets will be bounded by the schedule set for achieving the end-state condition, but will also reflect the need for specific feedback and ability to measure change along the way. For water bodies under a TMDL, or where MS4 permit conditions are prescriptive, interim targets may already be established.

Interim targets must account for the inherent variability of environmental data. Sampling over very short periods (e.g., 1-2 years) is unlikely to generate data that are useful for accurately characterizing receiving water changes. Interim targets should therefore be set to timelines that reflect both the time needed for changes to occur and for statistically valid measurement. Measurements less than five years from the implementation of targeted program activities will often be insufficient to detect change in receiving waters.

Where possible, strategies for measuring interim changes should incorporate sample sizes and timeframes that account for the variability of measurements within the receiving water. Likewise, they should reflect the time needed to achieve critical events in the projected "implementation curve" described above.

Task 3 Identifying Data Requirements

Once targets for receiving water change have been identified, it's necessary to identify how they will be measured, what data are needed to allow measurement, and how these data will be collected and analyzed. Planning is not complete unless managers are fully prepared to obtain and evaluate the data needed to assess targeted changes. The questions below should be addressed for each targeted outcome identified in **Step 6-B**.

Question 1 What metrics will be used?

End-state and interim receiving water conditions should both be expressed in unambiguous terms. This should include a specific formulation of the outcome statement, the assignment of units of measure or assessment, and units of time. **Section 7.3** provides additional detail on the establishment of metrics.

Question 2 What data collection methods will be used?

It's also essential that managers identify how data will be collected for each targeted receiving water outcome so that it can be tracked and assessed. **Section 7.4** provides additional detail on potential data collections options.

Question 3 What data analysis methods will be used?

The last consideration for any targeted receiving water outcome is how the data will be evaluated. The choice of analytical approaches and methods can dictate the specific metrics to be used, how data should be collected, and the quality of results. Where the establishment of receiving water data requirements cannot be satisfactorily addressed up front (e.g., there's no available option for collecting the desired data), this may need to be documented as a knowledge and data gap (Step 6-C). **Section 7.5** provides additional discussion of data analysis options.

Figure 4.14 provides a Review Checklist to guide **Step 6-B** completion.

Review Checklist

Step 6-B Tasks 1, 2, and 3

Targeted Receiving Water Changes

Apply this task individually to all conditions selected for targeting in Step 6-B. Its purpose is to identify specific targets for change in these conditions.

✓ **End-state Targets (Task 1)**
Consider the following questions:

Question 1: What is the end-state for the problem condition?
Question 2: When should the end-state condition be achieved?

✓ **Interim Targets (Task 2)**
Consider the following questions:

Question 1: What interim targets are needed to evaluate progress toward the end-state condition?
Question 2: When will interim targets be achieved?

✓ **Data Requirements (Task 3)**
Consider the following questions:

Question 1: What metrics will be used?
Question 2: What data collection methods will be used?
Question 3: What data analysis methods will be used?

✓ **For each priority receiving water problem, document interim and end-state targets, and the data requirements necessary to track and evaluate them.**

✓ **Compile one or more lists of targeted receiving water changes and supporting documentation for listed conditions.**

✓ **If a priority receiving water change is not or cannot be targeted, document the reason.**

✓ **Document all Step B data and information gaps.**

Figure 4.14: Review Checklist for Targeting Receiving Water Changes

Step 6 - C Documenting Knowledge and Data Gaps

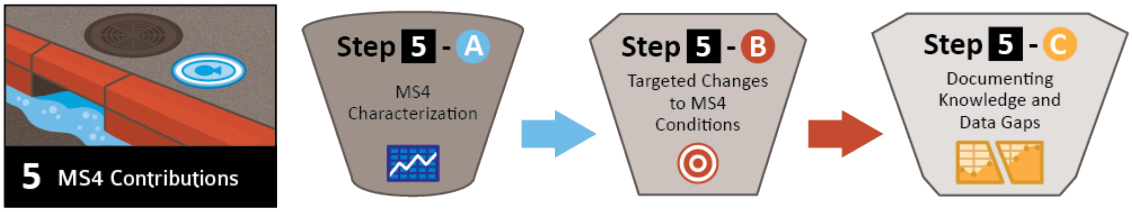
The identification of knowledge and data gaps should be ongoing throughout the entire Level 6 planning process. At its conclusion, managers should have developed a list of gaps that can be incorporated into an assessment strategy. **Section 7.0** provides additional guidance on assessment tools and strategies to support the development of these strategies. Because a comprehensive existing baseline of data and information does not usually exist for all receiving water conditions, Level 6 knowledge and data gaps can be significant. Critical gaps must be addressed to ensure that they are resolved over time. **Table 4.7** provides examples of general areas of inquiry where Level 6 knowledge and data gaps are likely to be encountered. These are intended to provide a framework for identifying actual knowledge and data gaps, which will be much more specific than those listed here.

Table 4.7: Potential Areas of Receiving Water Knowledge and Data Gaps

- ✓ Understanding of receiving water conditions (nature, magnitude, variability, and trends)
- ✓ Adequacy of sampling data (sample size, representative sampling, etc.)
- ✓ Adequacy of sampling methodologies
- ✓ Adequacy of beneficial use designations
- ✓ Adequacy of water quality objectives, regulatory criteria, etc.
- ✓ Adequacy of 303(d) listings
- ✓ Knowledge of regulatory requirements and constraints affecting receiving waters
- ✓ Knowledge of economic and social factors affecting receiving waters
- ✓ Methodologies, criteria, and data support for conducting problem identification
- ✓ Methodologies, criteria, and data support for conducting prioritization

4.3 Outcome Level 5: MS4 Conditions

Level 5 planning is a three-step process.



In **Step 5-A**, existing data and information are reviewed to evaluate MS4 conditions and identify priority problems. **Step 5-B** focuses on defining changes to be sought. **Step 5-C** identifies knowledge and data gaps to be addressed in future data collection initiatives.

Step 5 - A MS4 Characterization

As shown in **Figure 4.15**, MS4 characterization consists of three tasks. Characterization begins with a review of available data and information applicable to MS4 conditions.

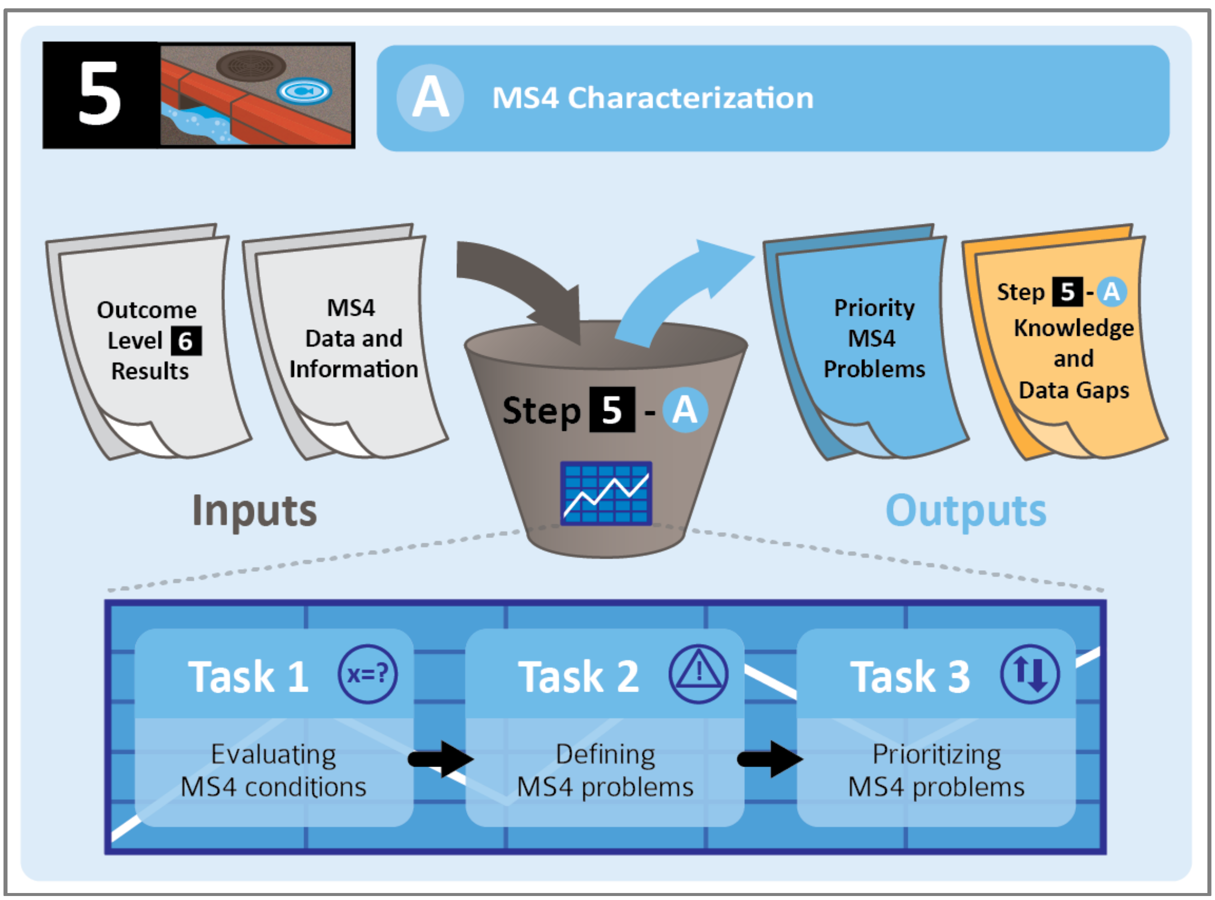


Figure 4.15: MS4 Characterization (Step 5-A)

Table 4.8 identifies a variety of data and information resources that can be used to inform Level 5 strategic planning. This includes Level 6 planning results, monitoring and maintenance data collected by the MS4 program, and a variety of external sources such as other regulatory agencies, research institutions, and published research.

Table 4.8: Potential Sources of Data and Information for Level 5 Planning

Outcome Level 6 Results (from Section 4.2)
Step 6-A
☑ Receiving water characteristics (Step 6-A; pollutant loadings, hydrology, etc.)
☑ Beneficial use designations
☑ CWA Section 303(d) listings
☑ Total maximum daily loads (TMDLs)
Step 6-B
☑ Priority receiving water problems (e.g., constituents, stressors, impacted segments)
Step 6-C
☑ Outcome Level 6 knowledge and data gaps
MS4 Data and Information
☑ MS4 monitoring program sampling data and reports
☑ MS4 maintenance inspections
☑ Regulatory agencies and research institutions (SCCWRP, WERF, etc.)
☑ Online repositories, directories, and databases (CERES, SWAMP, etc.)
☑ Published or unpublished research, literature, and technical reports
☑ Special investigations
☑ Other (as needed)

Task 1 Evaluating MS4 Conditions

Following on the results of Level 6 planning, managers will next identify and evaluate data and information relating to the MS4s under their responsibility and control. At this point the field of inquiry should be defined very broadly to include all potential facilities and conditions. Evaluations will address two key questions.

Step 5-A Task 1 Key Questions
Evaluating MS4 Conditions

Inputs	Key Questions	Outputs
Available Data, Information, and Results	**Question 1:** What are current MS4 conditions? **Question 2:** How are MS4 conditions changing over time?	**Existing MS4 Conditions**

Question 1 What are current MS4 conditions?

A **MS4** is a conveyance or system of conveyances, including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains. Stormwater runoff is commonly transported through MS4s and often discharged untreated into local waterbodies. MS4s are the means by which pollutants and flows generated in upland drainage areas are conveyed to receiving waters. The term MS4 can represent an entire conveyance system, or specific segments or portions of it. It's critical that managers understand how specific conditions within them affect the quantity and quality of these discharges. The more they know about how these conditions vary within specific portions of the MS4 the greater their ability will be to design specific targeted program approaches. A comprehensive understanding of MS4 conditions is also essential to developing baselines from which changes can be targeted.

Nature and Magnitude

The **nature** (i.e. general characteristics or attributes) of conditions within or discharging from MS4s is often similar to those already discussed for receiving waters (see **Step 6-A, Task 1**). As shown in **Table 4.9**, they can also be grouped according to the same general categories. MS4 characterization often focuses on constituent monitoring because urban areas generate a wide variety of pollutants that can be transported to receiving waters. Flow volumes, rates, and durations within and exiting these systems are also of interest both because they carry contaminants and because of their potential for contributing to hydromodification impacts in receiving waters. Other conditions such as toxicity, the presence of trash, or the physical condition of the MS4 itself, can also be of interest.

Table 4.9: General Types and Examples of MS4 Conditions

Type of Condition	Examples
Chemical Conditions	
Constituents in flows (wet, dry, and ambient)	• Chemical constituent concentrations or loads (metals, pesticides, nutrients, etc.)
Biological Conditions	
Pathogens and indicators	• Bacterial indictors in wet and dry weather flows • Pathogens (bacteria, viruses, protozoa, etc.) in wet and dry weather flows
Toxicological Conditions	
Toxicity of discharges from MS4 outfalls	• Metals, pesticides, nutrients, etc.
Physical Conditions	
Physical condition of MS4 facilities (channels, streets, roads, inlets, outlets, etc.)	• Geomorphic conditions • Erosion and sedimentation • Structural integrity • Extent and amount of trash
Flow conditions within the MS4 and from outfalls	• Presence or absence, volume, velocities, and durations of flows
Other	• pH, temperature, conductivity, dissolved oxygen, turbidity

Many permit programs require MS4 outfall monitoring. This typically includes dry weather flow monitoring and wet weather flow and chemical constituent analysis. Characterization of MS4 contributions will ideally include data that represent ongoing contributions and that are characteristic of sources within contributing drainage areas. Monitoring data that are focused on the identification and elimination of illicit discharges can also be useful for focused investigations, but may not be broadly representative of source contributions.

Magnitude (i.e., dimension or scale) is also critical to a complete understanding of MS4 conditions. To understand potential impacts and likely sources, managers generally need to know the levels of pollutants (e.g., average concentrations) and flows (volumes, peak velocities, etc.) within or discharging from the MS4. Together, nature and magnitude provide a basic description of each MS4 condition. It’s also necessary to consider how they vary in time and space.

Variability

Variability refers to how spread apart the measurements in a distribution are, or how they vary from each other temporally or spatially. The **temporal variability** of MS4 conditions can be significant over various periods (daily, seasonally, etc.). Occasional exceedances of a benchmark within one segment of the MS4 will likely represent a lesser priority than persistent exceedances throughout the system. Many stormwater programs have already conducted various levels of MS4 and urban runoff characterization monitoring. These results may provide a basis for understanding existing patterns. Some MS4 conditions vary according to regular patterns. For example, inputs of flows into MS4 systems will normally vary significantly by season, making it necessary to evaluate MS4 conditions independently for wet and dry weather. Likewise, patterns of activity within the watershed (early morning watering, weekend car washing, etc.) can produce patterns in flows or pollutant generation on daily or weekly cycles.

The **spatial variability** of conditions is especially critical in MS4s. MS4s are complex networks of drainages, and conditions within them can vary widely. Discharges from individual outfalls will be highly variable depending on the characteristics of the system itself and of the drainage areas contributing flows to it. To enable the development of targeted management approaches, it's important to define not only the contribution of the MS4 as a whole, but also which segments and outfalls represent the greatest contributions to receiving water impacts. It's therefore critical that specific, detailed relationships between receiving waters, MS4 outfalls, and drainage areas be established. A good understanding of the spatial distribution of MS4 conditions can provide a basis for establishing and refining these linkages.

Depending on the size and number of outfalls, characterization can be approached through a statically random sampling plan based on parameters such as land-use, outfall size, drainage area, or a combination. However, this may not always be useful in identifying the highest contributing outfalls to receiving waters. A combination of random and targeted monitoring approaches may be useful in helping to identify specific outfalls persistently discharging non-stormwater or stormwater.

Nature, magnitude, and temporal and spatial variability together define the **significance** of a MS4 condition. Along with other factors considered below, significance plays an important role in determining whether or not a MS4 condition will later be classified as a problem.

Certainty and Controllability

Certainty is the degree of confidence that managers have in their assessment of each MS4 condition. While many dry weather MS4 conditions are easily observed or measured, managers should be wary of results that are based on limited sampling. Where possible, evaluation should include statistical analysis of data over periods sufficient to determine trends, range, mean and variance within desired confidence levels. Due to the high variability of most water quality data, statistically sound support for management decisions can only be developed if appropriate timeframes for achieving and measuring change in MS4s are incorporated. Data and information gaps can heavily influence certainty. It's important to continue characterizing MS4 conditions that are initially not well understood, or that demonstrate significant variability.

Controllability is the potential for a program to influence changes in a MS4 condition. The degree to which a MS4 condition can be controlled directly affects its likelihood of positively influencing receiving water improvements. For example, if the condition is the presence of trash or debris in a particular segment of the MS4, it might be controlled through increased maintenance or volunteer clean-ups. However, elevated levels of bacteria in dry weather flows could be considerably more difficult to control. In instances like these where flows or materials cannot be treated, diverted, or removed, the controllability of conditions within the MS4 tends to be much lower. In these cases, management strategies must reflect an understanding of contributing sources and the presence of viable source control options for them. In both instances, costs and program resources also directly influence controllability.

Question 2 How are MS4 conditions changing over time?

Trends are increases, decreases, or other measurable changes in a condition over time. For example, increases in sediment or trash accumulation or pollutant loadings in the MS4 due to urbanization. In addition to understanding the inherent variability of MS4 conditions, it's important to know whether they are trending upward or downward over time (e.g., in response to population increases, program implementation, or aging of the MS4 itself). Trend analysis can be a very powerful tool for interpreting outcomes and describing change. It's especially important to know if trends in MS4 conditions are correlated to changes in receiving water conditions. To support the evaluation of changes, it's important that a baseline of existing conditions be established, and that changes in key parameters are tracked over time.

The output of **Task 1** will be the documentation of a variety of MS4 conditions. Lists may be generated for the MS4 as a whole, or for individual segments or portions of it. They may also be segregated by conditions within the MS4 and those discharging from it. Results should be as inclusive as possible given the availability of supporting data and information.

Because of the many-to-one relationship of MS4 conditions to receiving waters, it's also important to keep the number of potential conditions manageable. Where data are insufficient to fully describe a condition, knowledge and data gaps should be documented for consideration in future data collection strategies. Identification of MS4 problem conditions will occur in **Task 2**.

Figure 4.16 provides a Review Checklist to guide **Task 1** completion.

Review Checklist

Step 5-A Task 1
Evaluating MS4 Conditions

Apply this task very broadly across all sources of data and information for MS4s. The purpose is to provide a "snapshot" of what is currently known about MS4 conditions.

✓ **Compile existing MS4 data, information, and results.**
Consider the following questions:

Question 1: What are current MS4 conditions?

Consider: Nature, magnitude, temporal and spatial variability, certainty, controllability, and trends

Question 2: How are MS4 conditions changing over time?

Consider: Variability and trends

✓ **Consolidate results into one or more summary lists of existing conditions. Categorize results as determined appropriate (by location, drainage area, facility type, etc.).**

✓ **Compile supporting documentation for listed conditions.**

✓ **Select the conditions in the summary list(s) that will be further evaluated as potential problems in Task 2. Consider "back-up" lists for future evaluation as necessary.**

✓ **Document the critical data and information gaps identified during Task 1 completion.**

NOTES

Figure 4.16: Review Checklist for Evaluating MS4 Conditions

Task 2 Defining MS4 Problems

The objective of this task is to determine which of the MS4 conditions identified above constitute problems. Two key questions guide this evaluation process.

Step 5-A Task 2 Key Questions Defining MS4 Problems		
Inputs	Key Questions	Outputs
Existing MS4 Conditions	**Question 1:** Does the MS4 condition contribute to a receiving water impact? **Question 2:** Is there independent evidence for designating the MS4 condition as a problem?	**MS4 Problems**

Question 1 Does the MS4 condition contribute to a receiving water impact?

For MS4 contributions, the most direct expression of a problem condition will be a demonstrated linkage to a priority receiving water problem. Evaluation of potential linkages should be based on a comparison of available data for both sets of conditions. Where supported, managers should first look for commonalities such as constituent matches (chemical constituents, bacterial indicators, etc.), toxicity, or physical conditions (erosion and sedimentation, flow rates, etc.). Where qualitative matches exist, evidence of causal linkages can be further explored over time. Establishing linkages between outcome types can be one of the most challenging aspects of the evaluation process. The detection of a constituent match alone may not indicate a causal linkage, so additional evidence such as comparisons of concentrations or loads, or the timing of discharges, should be considered. The evaluation of physical conditions can also be relevant. For example, evidence of bank erosion, channel incising, and habitat impact within a receiving water can be compared to flows at MS4 outfalls or conditions within channels or drainage areas.

Where evidence of a MS4 problem condition does exist, it may not be final or absolute. Conclusions are only as valid as the data they're built on. Managers should remain cognizant of the need to consider the most currently available data and analysis. Likewise suspected linkages to receiving water impacts may require confirmation through additional sampling and analysis. Resource commitments to MS4 problems that are not supported by statistical analysis or other corroborating evidence should be made with caution.

Question 2 Is there independent evidence for designating the MS4 condition as a problem?

Where receiving water conditions do not provide an objective point of reference for identifying causally linkages, MS4 problem conditions may also be identified through other independent lines of evidence. For example, if copper is detected in MS4 outfalls from several residential communities, but not identified as impacting the receiving water, managers might still consider other evidence to determine if this represents a potential problem. Do copper levels in the MS4 consistently exceed established action levels or other established regulatory benchmarks? Are they outside the norm or higher than at outfalls in other similar drainage areas or land uses? Does experience show similar levels to be problematic elsewhere? Investigation of these and other relevant questions might indicate the presence of a problem condition, or of a potential future problem. The same is true for most other measurable parameters (toxicity, trash, erosion, etc.).

The output of **Task 2** will be one or more lists of MS4 problem conditions. This will constitute a subset of the list or lists generated for **Task 1** above. Results may include a range of confirmed or potential problems. Where data are insufficient to reasonably confirm a condition as a problem, it may be listed as tentative and identified knowledge and data gaps considered for future data collection strategies. Prioritization of problem conditions will occur in **Task 3** below.

Figure 4.17 provides a Review Checklist to guide **Task 2** completion.

Review Checklist

Step 5-A Task 2
Defining MS4 Problems

Apply this task individually to each Task 1 MS4 condition selected for further evaluation. The purpose of this task is to determine which of these conditions should be designated as problems.

✓ **For each identified condition, consider the following questions:**

Question 1: Does the MS4 condition contribute to a receiving water impact? If no, or if unknown, continue to Question 2.

Consider the following:

- Constituents common to receiving water problems (esp. for 303(d) listings or TMDLs)
- Exceedances of water quality objectives at outfalls
- Volumes, velocities, and durations of flows within and discharging from the MS4

Question 2: Is there independent evidence for designating the MS4 condition as a problem?

Consider the following:

- Exceedances of Action Levels, or other applicable criteria
- "Reference" conditions in other MS4 segments or outside the area of investigation

✓ **Document known or suspected MS4 problem conditions.**

✓ **Consolidate results into one or more summary lists. Categorize results as determined appropriate (by problem type, known versus suspected, etc.).**

✓ **Compile supporting documentation for listed conditions.**

✓ **Document the critical data and information gaps identified during Task 2 completion.**

NOTES

Figure 4.17: Review Checklist for Defining MS4 Problem Conditions

Task 3 Prioritizing MS4 Problems

Starting with the list of MS4 problem conditions identified above, further review can help to determine the highest priorities for action or additional study. A structured prioritization process can also be useful for validating or refining existing priorities. Two key questions guide the prioritization of MS4 problems.

Step 5-A Task 3 Key Questions
Prioritizing MS4 Problems

Inputs	Key Questions	Outputs
MS4 Problems	**Question 1:** What is the priority rating of each MS4 problem? **Question 2**: What is the relative importance of each MS4 problem?	**Prioritized MS4 Problems**

Prioritization of MS4 conditions is a two-step process (**Figure 4.18**). Each problem is first reviewed to determine its **priority rating**. Ratings are then considered together to determine their relative **priority ranking**. Managers may already have other preferred approaches than those described, and should choose those that work best for them.

Because MS4s normally exist in a many-to-one relationship with receiving waters, it's important to remember that a considerable number of individual priorities may be possible. For example, consider a very simple scenario where a single receiving water segment receives dry weather flows from ten MS4 outfalls. One approach might be to prioritize the contribution of each outfall (e.g., based on the magnitude of flows or pollutants); another would be to establish priorities for some or all of them as a group (grouped on outfall size, rates of flow, etc.). Another typical scenario is that multiple problem conditions will be identified at a single outfall or within a single MS4 segment, i.e., elevated levels of bacteria and of copper. In this case, managers will want to determine the relative importantance of each condition to that particular segment.

There is no single "right" approach to prioritization. In establishing MS4 priorities, managers will likely want to explore a variety of potential scenarios. But in doing so, it's important to keep the number of potential priorities manageable.

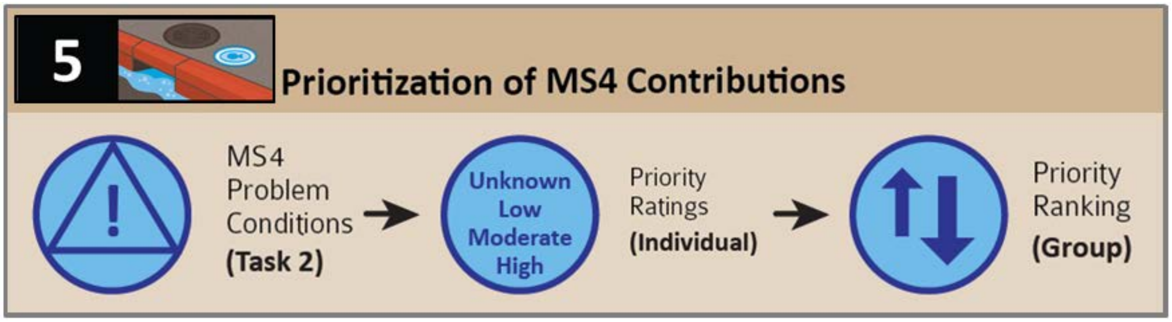


Figure 4.18: General Process for Prioritizing MS4 Problems

Question 1 What is the priority rating of each MS4 problem?

Prioritization starts with the assignment of a priority rating (e.g., Low, Moderate, or High Priority) for each identified MS4 problem. Assignment of ratings relies primarily on the review factors identified in Task 1 above. Their application to MS4 problems is described below. Potential "scores" for individual rating factors are indicated throughout for illustration, but managers should use any scoring methodology they find appropriate. As shown, simple qualitative scoring methods are generally recommended for each step of the process.

Tier 1 Regulatory Screening

Using copper exceedances as an example, **Figure 4.19** illustrates the Regulatory Screening process for a MS4 problem.

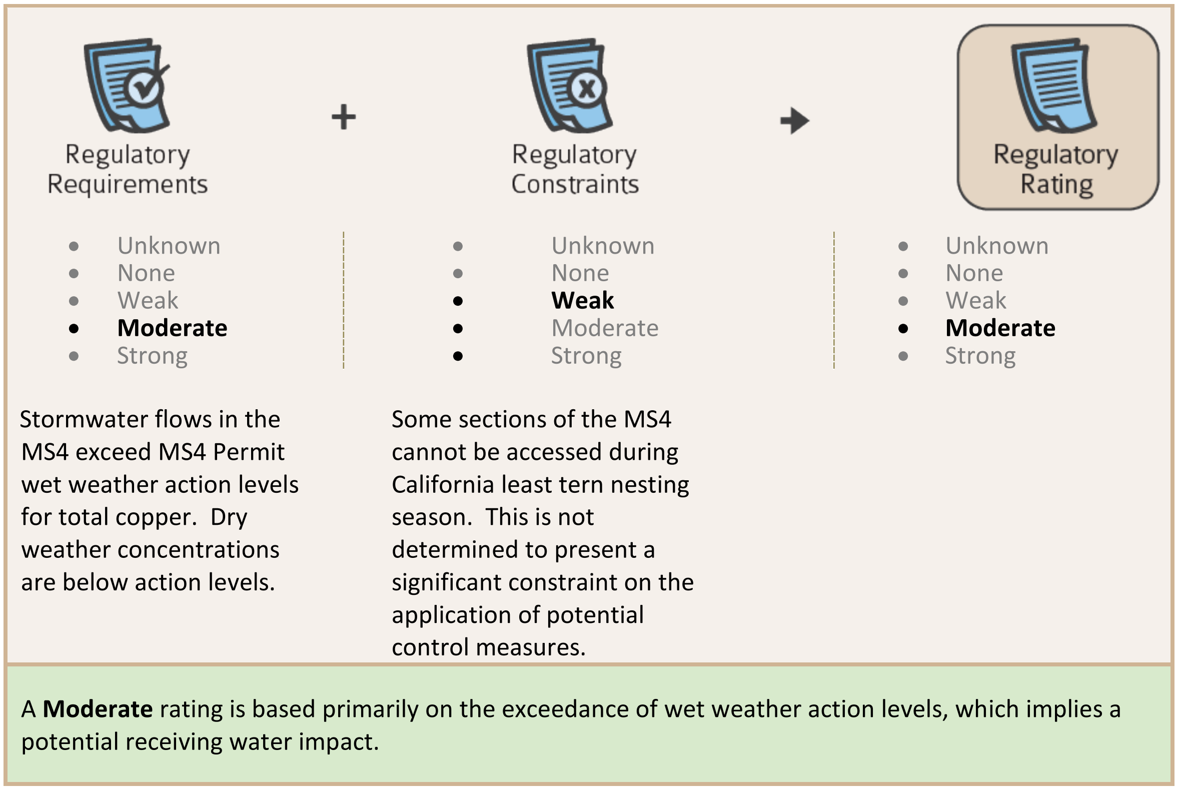


Figure 4.19: Establishing a Regulatory Rating for a MS4 Problem – Copper Example

MS4 conditions that exceed defined regulatory criteria (stormwater action levels, WQBELs, etc.), or that can be directly linked to 303(d) listings or adopted Total Maximum Daily Loads, will typically be treated as higher priorities. Compliance with other directives such as permitting or mitigation requirements or seasonal restrictions on maintenance work can also constrain how or where program activities can be directed. As previously noted, the direction of regulatory influences is important since requirements and constraints can affect priority in opposite ways. Where applicable, the collective influence of multiple regulatory influences may also need to be considered.

Tier 2 Technical Review

Using the same example, a Technical Rating for each MS4 problem can be determined. Technical Ratings are based on three factors; significance, certainty, and controllability.

Significance is the importance or meaning of the MS4 condition. As shown in **Figure 4.20**, the nature, magnitude, and temporal and spatial varibility of a condition help to determine its significance. Potential rating scales are indicated for each review factor except for nature, which is too varied to assign a standardized rating.

Nature	Magnitude	Temporal Variability	Spatial Variability	Significance
	• Unknown • Low • Moderate • **High**	• Unknown • Low • **Moderate** • Low	• **Unknown** • Low • Moderate • High	• **Unknown** • **Low** • Moderate • High
Stormwater flows within the MS4 exceed permit wet weather action levels for total copper.	Average levels are three times the action level and exceed water quality objectives for the downstream receiving water.	Action levels are exceeded in 40% of sampling events.	Sampling is confined to only a minor portion of the MS4.	

The high magnitude of the exceedances may indicate a significant problem. But the distribution of the condition is not clear. This condition might either be rated as **Low** significance or alternatively as **Unknown** until additional sampling can verify its distribution.

Figure 4.20: Evaluating the Significance of a MS4 Problem – Copper Example

Certainty describes the confidence with which a MS4 problem condition can be asserted. MS4 problem conditions that are characterized with a low degree of certainty (e.g., conclusions drawn on small sample sizes) will generally not be priorities for resource allocations. **Controllability** describes the potential to influence changes in the problem condition, primarily through changes in lower level outcomes. Conditions that do not have a reasonable chance of being successfully controlled (e.g., areas of the MS4 that tend to "incubate" bacterial indicators) are also unlikely to emerge as high priorities. **Figure 4.21** illustrates how significance, certainty, and controllability combine to establish a combined Technical Rating for a MS4 problem.

Tier 3 Sustainability Review

Economic factors are essential because every problem and every proposed solution has one or more costs associated with it. This might, for example, include the cost of addressing the MS4 problem with current scientific knowledge and technology compared to the economic benefit achieved. Or the costs of building and operating BMPs within the MS4. **Social factors** focus on the role or value of MS4 facilities, or potential solutions, to local communities or society at large. For example, individuals within a community might or might not support the proposed construction of facilities or controls within the MS4.

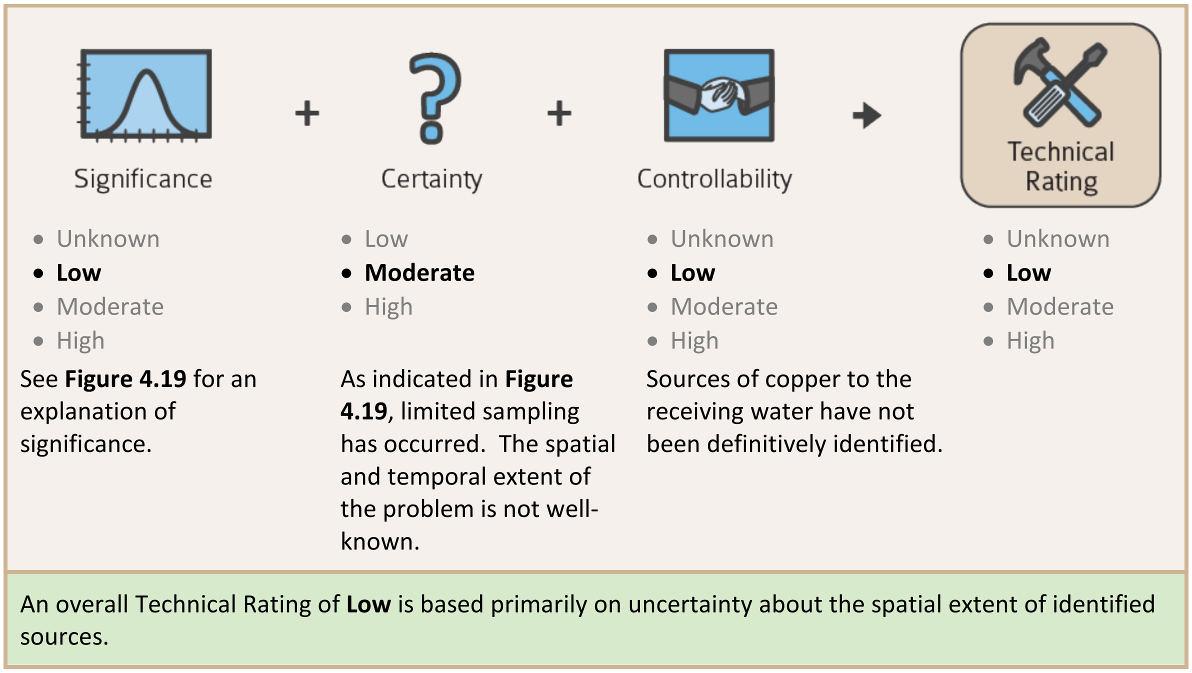


Figure 4.21: Establishing a Technical Rating for a MS4 Problem – Copper Example

Likewise, local residents often have strong opinions about other source control options such as increasing surveillance of homeless populations in or around MS4s. Economic and social ratings can be developed individually, or a single combined rating may be developed for them together. In most instances, detailed knowledge of economic and social factors associated with MS4 conditions will be lacking, so a single combined rating will be a suitable choice.

Overall Priority Rating

Tier 1, 2, and 3 results are next reviewed together to determine the **Overall Priority Rating** of each MS4 problem condition. A rating should be assigned for each condition.

Following on the example described above, **Figure 4.22** illustrates the determination of an Overall Priority Rating for exceedances of Wet Weather Action Levels for copper at MS4 outfalls. In this case, the Overall Priority Rating of Low is consistent with each of the individual sub-rankings used to determine it. In cases where individual factors are of different magnitudes or weigh in opposite directions (i.e., offset each other), discretion will be needed in assessing their collective impact.

Table 4.10 provides additional examples of the scoring of Overall Priority Ratings for other MS4 problem conditions. These examples are intended to illustrate a scoring process. The qualitative nature of the evaluation should once again be emphasized. To keep the exercise simple, equal weightings of rating factors have been assumed, but managers may also choose different weightings. Likewise, it should be emphasized that the results of each step in this process are subjective. Results are highly dependent on discretion, as well as the quality and availability of data and information at the time of the evaluation.

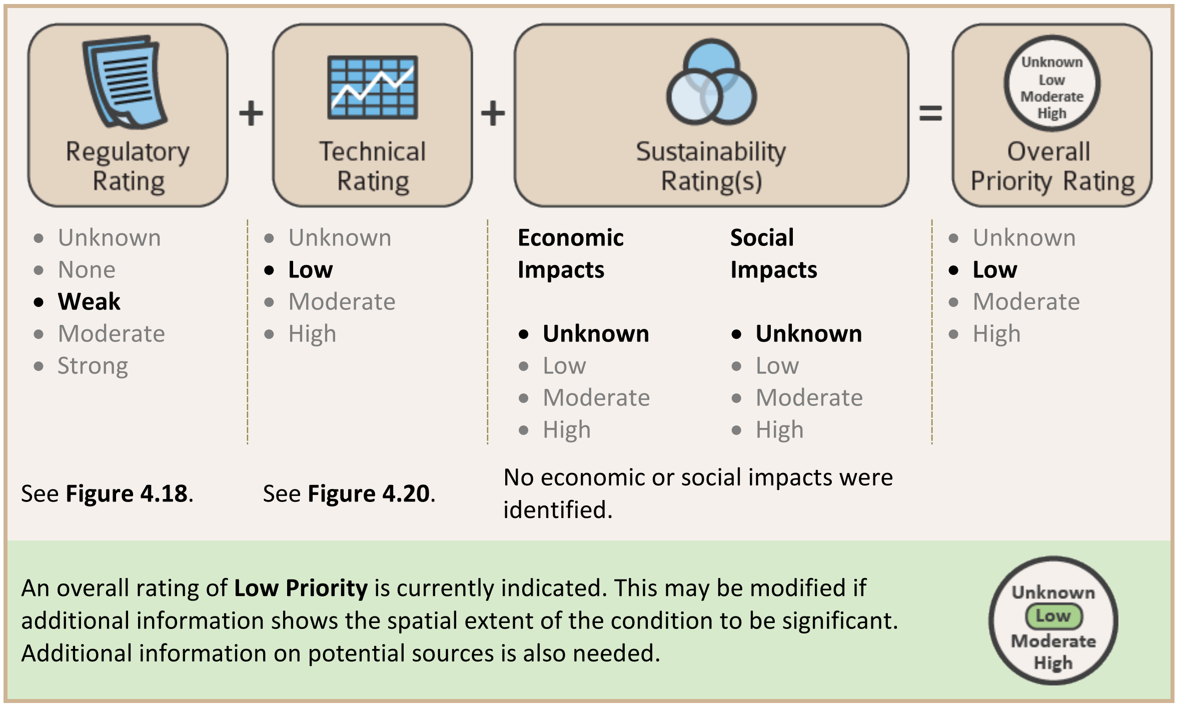


Figure 4.22: Establishing an Overall Priority Rating for a MS4 Problem – Copper Example

Table 4.10: Examples[4] of the Assignment of Overall Priority Ratings to MS4 Problem Conditions

Problem Condition	Tier 1: Regulatory Screening	Tier 2: Technical Rating				Tier 3: Sustainability Ratings			Overall Priority Rating
		Significance	*Certainty*	*Controllability*	*Overall*	*Economic Factors*	*Social Factors*	*Overall*	
Chemistry- Water Quality Problems									
Turbidity above Wet Weather Action Level at Outfall	**Strong**	Moderate	Moderate	Moderate	**Moderate**	Moderate	Low	Low-Mod	**High-Mod**
Nutrients exceed Water Quality Objectives in some portions of MS4	**Moderate**	Moderate	High	Moderate	**Moderate**	Moderate	Moderate	Moderate	**Moderate**
Copper above WQOs at 3 of 11 MS4 Outfalls	**Weak**	Low	Moderate	Low	**Low**	Unknown	Unknown	Unknown	**Low**
Toxicity Problems									
Limited wet weather data indicate Bifenthrin above the LC50 at MS4 outfalls	**Unknown**	Moderate	Low	Low	**Low-Mod**	Low	Low	Low	**Low**
Physical Problems									
High flow volumes and erosion within MS4; hydromodification in creek	**Unknown**	Low	Moderate	Moderate	**Moderate**	Moderate	Moderate	Moderate	**Moderate**

[4] These examples are hypothetical and for illustration only. They are not intended to imply a particular priority for any of the MS4 conditions listed.

Question 2 What is the relative importance of each MS4 problem?

For individual ratings of MS4 problem conditions to be useful in supporting decision-making, they must be evaluated together to determine their relative importance. As described, a variety of potential MS4 priorities are likely to be generated. Two types of scenarios should be considered. In the first, multiple MS4 segments or outfalls are compared to each other (e.g., the nitrate loadings of five outfalls to a receiving water). In the second, multiple priority problem conditions are compared at a single outfall or within a single MS4 segment. Both types of scenarios are important, and the approaches described here can be applied to either.

The final output of **Task 3** will be a ranked list of priority problem conditions for each MS4 or segment. Identified problems can either be put into a ranked order or be grouped by their priority ratings. Establishing ranked orders consists of lining up the applicable problem conditions for each receiving water or segment from highest priority to lowest, with the higher priorities normally constituting the greater management priorities. As illustrated in **Figure 4.23**, MS4 problems will sometimes have "tie scores." Rather than further differentiating between them, grouped rankings may be appropriate. Depending on the degree of information available, "sub-rankings might also be developed within each group.

↑ Increasing Priority ↑	RANKED ORDER EXAMPLE	GROUPED RANKING EXAMPLE
	1. Turbidity above wet weather action level 2. Nutrients above dry weather action level 3. High flow volumes and evidence of erosion 4. Copper above wet weather action level 5. Bifenthrin toxicity	**GROUP A (High-Mod)** • Turbidity above wet weather action level **GROUP A (Moderate)** • Nutrients above dry weather action level • High flow volumes and evidence of erosion **GROUP C (Low)** • Copper above wet weather action level • Bifenthrin toxicity

Figure 4.23: Potential Options for Ranking MS4 Problem Conditions

It's again important to emphasize the qualitative nature of this exercise. Its purpose is to establish an informational basis for comparing different types of MS4 problem. Rating and ranking systems cannot replace the role of judgment in evaluating results.

Managers must next decide which conditions will be targeted for change in **Step 5-B**. **Figure 4.24** below provides a Review Checklist to help guide the prioritization process. As in previous steps, significant data and information gaps are likely to be encountered along the way. It's critical to document these deficiencies and consider them in the development of future data collection strategies.

Review Checklist

Step 5-A Task 3
Prioritizing MS4 Problems

Apply this task individually to all problem conditions identified in Task 2. Its purpose is to assess and rank the priorities of problem conditions.

✓ For each identified problem condition, consider the following questions:

Question 1: What is the priority rating of each receiving water problem?

☐ **Tier 1: Regulatory Screening** **REGULATORY RATING ________**

- ✓ Identify regulatory requirements and constraints affecting priority.
- ✓ Based on their collective impact, assign a Tier 1 rating.
- ✓ Note the overall direction of influence of the rating (requirement or constraint).
- ✓ Should an Overall Priority Rating be assigned based solely on regulatory criteria? If yes, stop and document. If no, continue to Tier 2 Review.

☐ **Tier 2: Technical Review** **TECHNICAL RATING ________**

- ✓ Evaluate the significance, certainty, and controllability of the problem. Establish individual weightings as appropriate for each of the three factors.
- ✓ Based on review of the above factors, assign a Tier 2 Rating.
- ✓ Should the problem be eliminated from further consideration or assigned a "low" Overall Priority Rating based solely on technical criteria? If yes, stop and document. If no, continue to Tier 3 Review.

☐ **Tier 3: Sustainability Review** **SUSTAINABILITY RATING(S) ________**

- ✓ Identify economic factors and social factors affecting priority.
- ✓ Assign a Tier 3 Rating (or Ratings) for economic and social factors combined, or for each individually.

☐ **Overall Priority Rating** **OVERALL PRIORITY RATING ________**

Assign an Overall Priority Rating for each problem. Assign individual weightings to each factor as appropriate. Economic and Social factors may be counted individually or together.

Question 2: What is the relative importance of each MS4 problem?

☐ **Rank individual priority ratings for further consideration in Step B.**

✓ Document the critical data and information gaps identified during Task 3 completion.

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Figure 4.24: Review Checklist for Prioritizing MS4 Problems

Step 5 - B Targeted Changes to Urban Runoff and MS4 Contributions

Step 5-B addresses the establishment of measurable targets for changes in MS4 conditions. In addition to directing programs toward the resolution of problem conditions, targeting provides a context for establishing measurability, interpreting results, and evaluating success over time. Targeted changes should be considered wherever feasible, but at least for the highest priority MS4 conditions identified. As shown in **Figure 4.25**, targeting consists of three tasks.

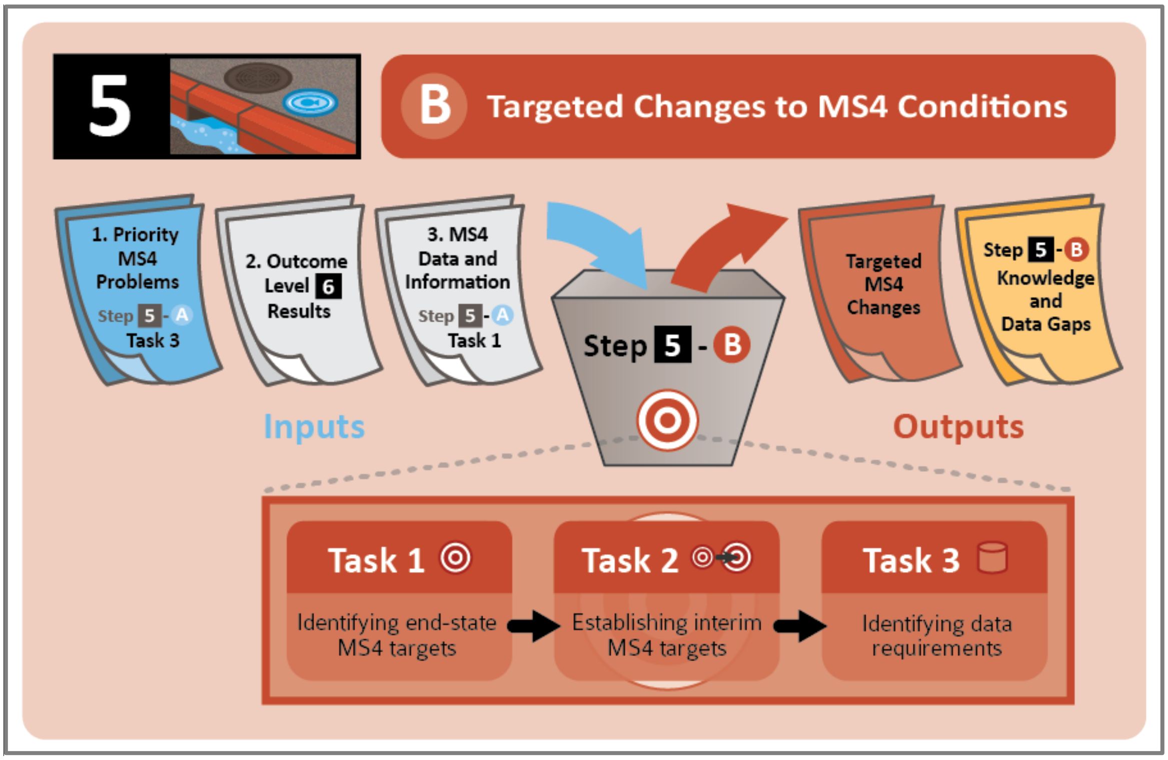


Figure 4.25: Targeting Changes to MS4 Conditions (Step 5-B)

Several types of inputs should be considered, starting with the list of **Priority MS4 Problems** identified in **Step 5-A Task 3**. For each identified priority MS4 problem, one or more specific targets for change should be considered. **Outcome Level 6 Results**, in particular, priority receiving water constituents, flows, and stressors, should also be reviewed for their applicability to MS4 priorities. Finally, managers should review all applicable **MS4 Data and Information** gathered in **Step 5-A Task 1**. Conditions that are common to receiving waters and MS4s (i.e., those for which there is a possibility of establishing causal linkages) are likely to emerge as higher priorities, so it's important that they be identified up front.

Task 1 Identifying end-state MS4 targets

This task focuses on defining the changes to be sought in identified priority problem conditions. It is guided by two general questions.

Step 3-B Task 1 Key Questions Identifying End-state MS4 Targets		
Inputs	Key Questions	Outputs
Priority MS4 Problems	**Question 1**: What is the end-state for the MS4 condition? **Question 2**: When will the end-state condition be achieved?	**End-state MS4 Targets**

Question 1   What is the end-state for the MS4 condition?

End-state MS4 conditions represent the absence of problems, or their reduction to acceptable levels. When targeting MS4 conditions, considerations of scale will be important. As already noted, MS4s normally exist in a many-to-one relationship with receiving waters. For example, consider a single receiving water segment for which ten contributing MS4 outfalls have been identified. Managers may determine that targeted outcomes should be developed for each outfall, or alternatively that targeting should apply to some or all of them as a group.

The establishment of targets should consider the review factors and general conceptual approaches described below.

Review Factors

As shown in **Figure 4.26**, several factors are applicable to establishing MS4 targets. These are the same general factors introduced above during problem prioritization.

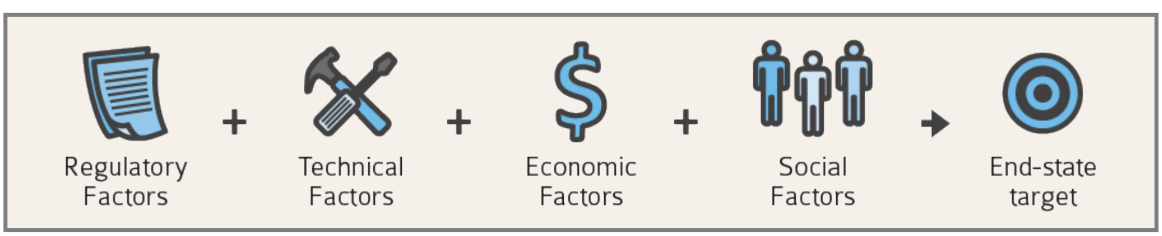


Figure 4.26: Factors Relevant to Setting Targets for MS4 Changes

Draft targets can initially be established through a consideration of regulatory and technical factors introduced above in **Task 5-A-3**, and those results further reviewed and refined as necessary in the context of sustainability considerations. This process may need to be repeated multiple times as additional data and information become available.

General Approaches to Establishing End-state MS4 Targets

Approaches to targeting may include any of the following, individually or in combination.

Setting Targets to Comply with Regulatory Requirements

Regulatory requirements should always be considered when setting MS4 targets. Since permits and other regulatory directives often leave little room for interpretation, compliance with them must be maintained. MS4 conditions that exceed defined regulatory criteria, or that can be directly linked to 303(d) listings or adopted Total Maximum Daily Loads, will typically be treated as higher priorities.

As discussed above for receiving water targets, end-state MS4 targets won't always be easily achievable within required timeframes. Where there is discretion to do so, it can make sense to set extended timeframes for achieving them. This allows managers to pursue interim targets that foster learning and adaptation along the way (see also approach #4 below).

Setting Targets to Achieve Receiving Water Improvements

This approach applies most directly to discharges from MS4s, but can also include changes that improve discharge quality or that reduce flow velocities within the MS4. The end-state for any MS4 problem will ideally be a condition that supports targets established for receiving waters. Where linkages between the two types of conditions are well-understood, it makes sense to target changes accordingly. This may be manifested as achievement of load reductions at MS4 outfalls or of specific conditions within the MS4 itself. Given their many-to-one relationship to receiving water impacts, this doesn’t necessarily mean the elimination of all MS4 contributions. It’s likely that changes in multiple MS4 contributions to any given receiving water will be targeted concurrently. The critical consideration in achieving receiving water improvements is the cumulative impact of reductions in MS4 contributions that are actually achieved. Some targets will most likely not be achieved and others may be exceeded. It’s therefore less important that each individual target be achieved than it is that they collectively not cause receiving water problems. Managers should also be realistic about the attainability of targeted conditions, and of the timeframes needed to achieve and measure them.

Setting Targets to Resource Availability

Stormwater programs are normally not be resourced to achieve all identified MS4 changes, so decisions must be made about how much and how quickly specific changes can be achieved. Every target must be established within the context of overall resource availability. Within these constraints, resource commitments will generally be greatest for those MS4 segments thought to represent the most significant contributions (e.g., pollutant loads or flows) to receiving water impacts. As above, it's important to emphasize that targets based solely on resource availability may fail to meet explicit regulatory requirements, or to satisfy the expectations of regulators or third parties.

Setting Targets to Learn and Adapt

This approach involves establishing targets to explore the potential for reducing MS4 contributions. Because MS4 conditions are sequentially linked both to level 6 and 4 conditions, managers can benefit from exploring relationships to both types of outcomes. **Experimental targets** support adaptive management approaches by exploring and testing assumptions or hypotheses about these relationships. As previously emphasized, planning is often hampered by the availability or sufficiency of data and information. Given that the types and amounts of changes in MS4 conditions that can be achieved will more often than not be unknown, it may sometimes make sense to explore potential changes experimentally. For example, if managers have a good idea of the types and levels of activities that can be directed to reducing loadings of a particular pollutant in a watershed area, they might establish a working hypothesis about the potential reductions at outfall levels. Pursuing changes in an "experimental" setting fosters increases in measurability that might eventually lead to the identification of causal linkages between observed changes.

One specific variation on this approach is through the establishment of **stretch targets**. Building on existing accomplishments can provide a reference point for "stretching" to see what can be done cost-effectively or within available resource commitments (note the similarity to approach #3 above). For example, existence frequencies of MS4 inspections or cleaning could be increased by a defined amount and results tracked to see if a relationship to improvements in specific MS4 or receiving water conditions (e.g., levels of trash) can be established.

Interim targets are also critical to the learning process because they provide opportunities for obtaining feedback along the way toward end-state conditions. These are discussed further under **Task 2**.

Table 4.11 illustrates a variety of examples of potential end-state MS4 targets for priority problems previously identified in **Table 4.10**. As described for receiving waters, the uncertainty associated with MS4 targeting is significant. The resolution of identified knowledge and data gaps should also be a priority for MS4 conditions.

Table 4.11: Examples[5] of End-state MS4 Targets

Problem Condition	Priority (from Table 4.11)	End-State Target	Explanation
Turbidity above Wet Weather Action Level at Outfall	High-Mod	Reduce TSS concentrations by 20%	20% reduction is targeted in combination with other programmatic stretch targets.
Nutrients exceed Water Quality Objectives in some portions of MS4	Moderate	Decrease levels to below WQOs at 50% of stations	Exceedance of WQOs within the MS4 is not a permit violation. Some flexibility exists in targeting so long as persistent exceedances are not occurring at outfalls.
Copper above WQOs at 3 of 11 MS4 Outfalls	Low	Maintain current conditions, or pursue measurable reductions through continued implementation	Exceedances are only at about one-quarter of outfalls, and there is no evidence of receiving water impacts. This is a low priority for change. Reductions might also be approached experimentally.
Limited wet weather data indicate Bifenthrin above the LC50 at MS4 outfalls	Low	Reduce Bifenthrin toxicity to below LC50 at 75% of outfalls	Reduction is not a strict regulatory requirement, so it doesn't need to apply to all outfalls. This might be approached as a stretch target and monitored over time.
Evidence of high flow volumes and erosion within MS4; corresponds to hydromodification in creek	Moderate	Reduce peak flows and volumes	Target lacks a specific measurable endpoint. It might be initially approached experimentally with a goal of "filling in the gaps" through trial-and-error or ongoing evaluation of resource availability.

[5] These examples are hypothetical and for illustration only. They are not intended to imply a particular target or timeline for any of the MS4 conditions listed.

Question 2   When will the end-state condition be achieved?

Whenever possible, a targeted MS4 change should specify the timeframe in which it is expected to be achieved. Without this, it's impossible to assess whether or not a program is making reasonable progress toward it. Where targets are already established by permit or TMDL requirements, these timelines may already be known. However, where there is discretion, managers should instead consider the time needed to realistically achieve the change. While changes in MS4 conditions can often be achieved on shorter timeframes than those in receiving waters (see **Figure 3.16**), they can still take decades or longer to achieve. Exceptions include conditions under the direct influence of the stormwater program, e.g., those related to MS4 maintenance or the construction and operation of structural controls. As discussed above for receiving waters, allowances must also be made for the time it takes to "ramp up," refine, and fully implement the programs expected to drive changes.

Due to the inherent variability of many MS4 conditions, their measurement should also reflect the timeframes needed to measure them with a reasonable degree of statistical certainty. As described in **Key Concept 4.2**, the ability to statistically detect change normally increases as a function of time.

Task 2 Establishing interim MS4 targets

Since end-state MS4 targets can often take years or decades to achieve, it's important to set a course of action that includes incremental measures of progress. The establishment of interim targets is guided by two questions.

Step 3-B Task 2 Key Questions

Establishing Interim MS4 Targets

Inputs	Key Questions	Outputs
End-state MS4 Targets	**Question 1**: What interim targets are needed to evaluate progress toward the end-state MS4 condition? **Question 2**: When will interim MS4 targets be achieved?	**Interim MS4 Targets**

Question 1 What interim targets are needed to evaluate progress toward the end-state MS4 condition?

Interim MS4 targets allow for the assessment of incremental progress toward end-state conditions, and provide feedback necessary for refining management approaches along the way. Approaches to targeting MS4 changes will generally be similar to those already discussed for receiving waters. Where possible, interim targets should reflect critical events in the implementation curve (e.g., the time it takes to "ramp up," refine, and fully implement the programs expected to drive changes).

For MS4s that discharge to water bodies under a TMDL, interim targets may be defined in the TMDL schedule for waste load reductions. Some may also be defined in MS4 permits for a given permit cycle or defind in permit-required watershed management plans. Interim targets for dry weather flows can usually be more aggressive than wet weather flows, but are still constrained by limits on the understanding of and ability to address contributing sources. Spatial considerations and resource availability can also be important in setting interim targets. For example, load reductions might be focused on the highest loading outfalls or a select set of outfalls that drain to a specific impacted segment of a receiving water. Doing so might allow a greater degree of experimentation and for more sampling resources to be dedicated to their assessment.

Question 2 When will interim targets be achieved?

Where timelines for achieving interim targets for MS4 change are not already be defined in TMDLs, NPDES permits, or permit-required plans, their establishment should reflect the same practical considerations noted above (the time needed to ramp up control measures, to realistically achieve and measure specific changes, etc.). The variability of water quality and other environmental data can be even more constraining for interim targets because of the challenges associated with statistically defining change on comparatively shorter timeframes. In most cases it will not be possible to assess attainment of changes over short intervals (e.g., 1-2 years) with reasonable confidence. Measurement of changes within MS4s (e.g., reductions in pollutant loadings or concentrations) should generally be based on data collected over periods greater than five years or greater. As noted, however, shorter timeframes may be appropriate for conditions under the direct influence of the stormwater program.

Task 3 Identifying data requirements

Now that targets for MS4 change have been identified, it's necessary to identify how they will be measured, what data are needed to allow measurement, and how these data will be collected and analyzed. Planning is not complete unless managers are fully prepared to obtain and evaluate the data needed to assess each targeted change. Each of the questions below should be addressed for every targeted outcome addressed in **Step 5-B**.

Question 1 What metrics will be used?

End-state and interim urban runoff and MS4 conditions should both be expressed in unambiguous terms. This should include a specific formulation of the outcome statement, the assignment of units of measure or assessment, and units of time. **Section 7.3** provides additional detail on the establishment of metrics.

Question 2 What data collection methods will be used?

It's also essential that managers identify how data will be collected for each targeted MS4 outcome so that it can be tracked and assessed. **Section 7.4** provides additional detail on potential data collections options.

Question 3 What data analysis methods will be used?

The last consideration for any targeted urban runoff and MS4 outcome is how the data will be evaluated. The choice of analytical method can dictate what specific metrics should be used, how the data should be collected, and the quality of the result. **Section 7.5** provides additional discussion of data analysis options. Where the establishment of MS4 data requirements cannot be satisfactorily addressed up front (e.g., there's no available option for collecting the desired data), this may need to be documented as a knowledge and data gap (**Step 6-C**).

Figure 4.27 provides a Review Checklist to guide **Step 5-B** completion.

Review Checklist

Step 5-B Tasks 1, 2, and 3

Targeted MS4 Changes

Apply this task individually to all MS4 conditions selected for targeting in Step A Task C (Prioritizing MS4 Conditions). Its purpose is to identify specific targets for change in problem conditions.

✓ **End-state Targets (Task 1)**
Consider the following questions:

Question 1: What is the end-state for the problem condition?
Question 2: When should the end-state condition be achieved?

✓ **Interim Targets (Task 2)**
Consider the following questions:

Question 1: What interim targets are needed to evaluate progress toward the end-state condition?
Question 2: When will interim targets be achieved?

✓ **Data Requirements (Task 3)**
Consider the following questions:

Question 1: What metrics will be used?
Question 2: What data collection methods will be used?
Question 3: What data analysis methods will be used?

✓ **For each priority MS4 problem, document interim and end-state targets, and the data requirements necessary to track and evaluate them.**

✓ **Compile one or more lists of targeted MS4 changes and supporting documentation for listed conditions.**

✓ **If a priority MS4 change is not or cannot be targeted, document the reason.**

✓ **Document all Step B data and information gaps.**

NOTES

Figure 4.27: Step 5-B Tasks 1, 2, and 3 Review Checklist

Step 5 - C Documenting Knowledge and Data Gaps

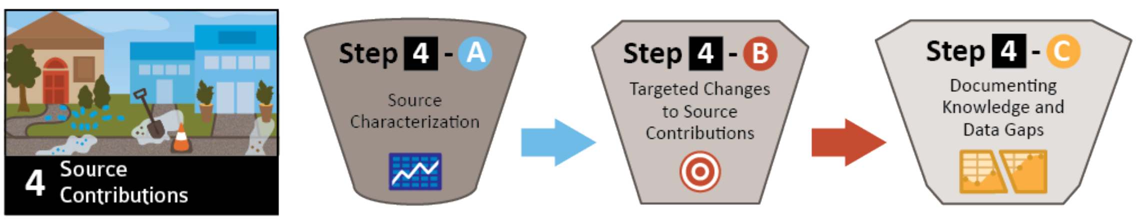
As previously described, the identification of knowledge and data gaps should be ongoing throughout the entire Level 5 planning process. At its conclusion, managers should have developed a list of gaps that can be incorporated into an assessment strategy. **Section 7.0** provides additional guidance on assessment tools and strategies to support the development of these strategies. Because an existing baseline of data and information does not exist for many urban runoff and MS4 conditions, Level 5 knowledge and data gaps can be significant. Critical gaps must be addressed to ensure that they are resolved over time. **Table 4.12** provides examples of general areas of inquiry where Level 5 knowledge and data gaps are likely to be encountered. These are intended to provide a framework for identifying actual knowledge and data gaps, which will be much more specific than those listed here.

Table 4.12: Potential Areas of MS4 Knowledge and Data Gaps

- ✓ Understanding of MS4 conditions (nature, magnitude, variability, and trends)
- ✓ Adequacy of sampling data (sample size, representative sampling, etc.)
- ✓ Adequacy of action levels or other regulatory criteria
- ✓ Knowledge of regulatory requirements and constraints affecting MS4s
- ✓ Knowledge of economic factors affecting MS4s
- ✓ Knowledge of social factors affecting MS4s
- ✓ Methodologies, criteria, and data support for conducting problem identification
- ✓ Methodologies, criteria, and data support for prioritization

4.4 Outcome Level 4: Source Contributions

Level 4 Outcomes deal with sources of pollutants and flow to MS4s and receiving waters. 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. Sources are the final component of the physical system described in this section. Pollutants and flows generated by sources are transported via MS4s (Level 5) to receiving waters (Level 6) where they can cause or contribute to a number of potential problem conditions. Level 4 planning addresses their identification and characterization as a basis for the further development of control strategies in Section 5.0 (Target Audience Strategies) and Section 6.0 (Program Implementation Strategies). It is a three-part process.



In **Step 4-A** managers review existing data and information to evaluate drainage areas, individual sources, or source categories. Initial results are then narrowed to focus on priority problem conditions. **Step 4-B** focuses on defining the changes that will be sought in within priority drainage areas over time. Finally, **Step 4-C** identifies the knowledge and data gaps discovered along the way, so that future data collection initiatives can be directed toward resolving them.

Step 4 - A Source Characterization

As shown in **Figure 4.28**, source characterization consists of three tasks. It begins with a review of available data and information for contributing drainage areas and sources. Drainage areas are considered first because they define the potential scope of applicable source contributions. With the exception of "preventive" and "experimental" program initiatives (see **Task 1, Question 1** and **Step 4-B, Task 1** below) the direction of resources to sources that do not have a physical connection or an otherwise reasonable linkage to priority MS4s or receiving waters should be avoided.

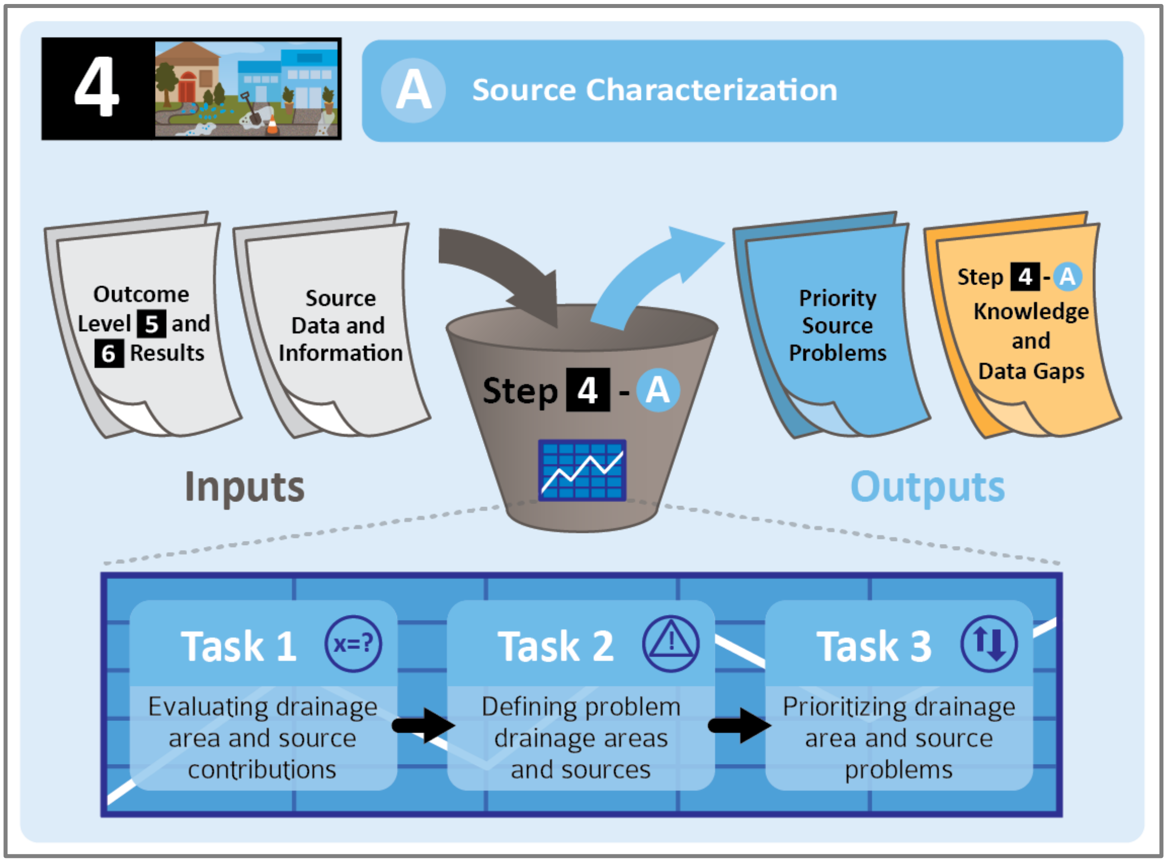


Figure 4.28: Source Characterization (Step 4-A)

Table 4.13 identifies a variety of data and information resources that can be used to inform Level 4 strategic planning. A good starting point is to review data collected by the MS4 program itself, most typically previously-conducted receiving water and MS4 monitoring. Likewise, a variety of external sources such as regulatory agencies, research institutions, and published research, may be useful in augmenting locally-collected data. While a number of sources exist for drainage areas and a variety of source types, detailed data and information can often be lacking. For example, while inventories and locations of commercial and industrial sources can often be compiled relatively straightforwardly (e.g., through business license databases), detailed data on specific attributes associated with facilities (PGAs and pollutants, discharge potential, etc.) can be difficult to obtain. Ultimately the development of effective control strategies for many sources may require a level of knowledge that does not yet exist. The identification and resolution of critical knowledge and data gaps is therefore an important consideration for Level 4 planning (see **Step 4-C**).

Table 4.13: Potential Sources of Drainage Area & Source Data and Information

Outcome Level 5 & 6 Results (From Sections 4.2 and 4.3)

- ☑ Receiving Water and MS4 Characteristics (pollutant loadings, hydrology, beneficial use designations, CWA Section 303(d) listings, TMDLs, etc.)
- ☑ Priority Receiving Water and MS4 Problems (priority constituents and stressors, impacted sites, segments, or locations, etc.)
- ☑ Targeted Receiving Water and MS4 Changes
- ☑ Outcome Level 5 and 6 Knowledge and Data Gaps

Drainage Area Data and Information

- ☑ Drainage area maps (hard copy, GIS, etc.)
- ☑ Regulatory and planning agency data, maps, and reports (land use, hydrology, etc.)
- ☑ Online repositories, directories, and databases (CERES, SWAMP, etc.)
- ☑ Published or unpublished research, literature, and technical reports
- ☑ TMDLs (source delineation, pollutant loading estimates, etc.)

Source Data and Information

- ☑ Existing source inventories (commercial, industrial, construction, etc.)
- ☑ Facility or site inspections, monitoring, development plans, etc.
- ☑ Regulatory and planning agency data, maps, and reports (population, demographics, etc.)
- ☑ Published or unpublished research, literature, and technical reports
- ☑ Tax assessor databases
- ☑ Commercially available sources of business data (Standard and Poor, online or CD business directories, etc.)
- ☑ Published research, literature, and technical reports
- ☑ Special studies and investigations

Task 1 Evaluating Drainage Area and Source Contributions

Building on the results of Level 5 planning, managers will evaluate identified data and information relating to drainage areas and sources contributing discharges to MS4s and receiving waters. At this point all potential conditions should be of interest. Evaluations are guided by four key questions.

Step 4-A Task 1 Key Questions

Evaluating Drainage Area and Source Contributions

Inputs	Key Questions	Outputs
Available Data, Information, and Results	**Question 1:** Which drainage areas contribute pollutants and flows to MS4s? **Question 2:** Which sources contribute pollutants and flows to the MS4? **Question 3:** What are the current flow and pollutant contributions of drainage areas and sources? **Question 4:** How are drainage area and source contributions changing over time?	**Drainage Area and Source Contributions & Characteristics**

Question 1 Which drainage areas contribute pollutants and flows to the MS4?

This question focuses on the physical connectivity between priority MS4s (**Step 5-A, Task 3** above) and the sources that contribute pollutants or flows to them. A critical concept in the identification of sources is the drainage area. A **drainage area** is any geographic area (watershed, watershed-jurisdiction, basin, sub-basin, etc.) that contains sources of pollutants or flow. Drainage areas are distinct from **drainage basins**, which are defined solely by patterns of runoff or flow. Drainage areas are different in that they represent decisions made during program planning about how assemblages of potential source contributions will be defined. A drainage area can contain multiple drainage basins, and vice versa. The alignment of drainage areas and drainage basins can be extremely important to gaining a proper understanding of pollutant and flow contributions.

Figure 4.29 illustrates drainage areas mapped at a variety of different scales (jurisdiction, watershed, sub-watershed, drainage management area, neighborhood, etc.). As shown, there are numerous potential options for defining drainage areas. Depending on specific objectives, many of these can also be explored in combination. Regardless of scale, the critical issue in all cases is understanding the connectivity of the selected drainage area to the MS4 or specific MS4 segments, and indirectly to receiving waters.

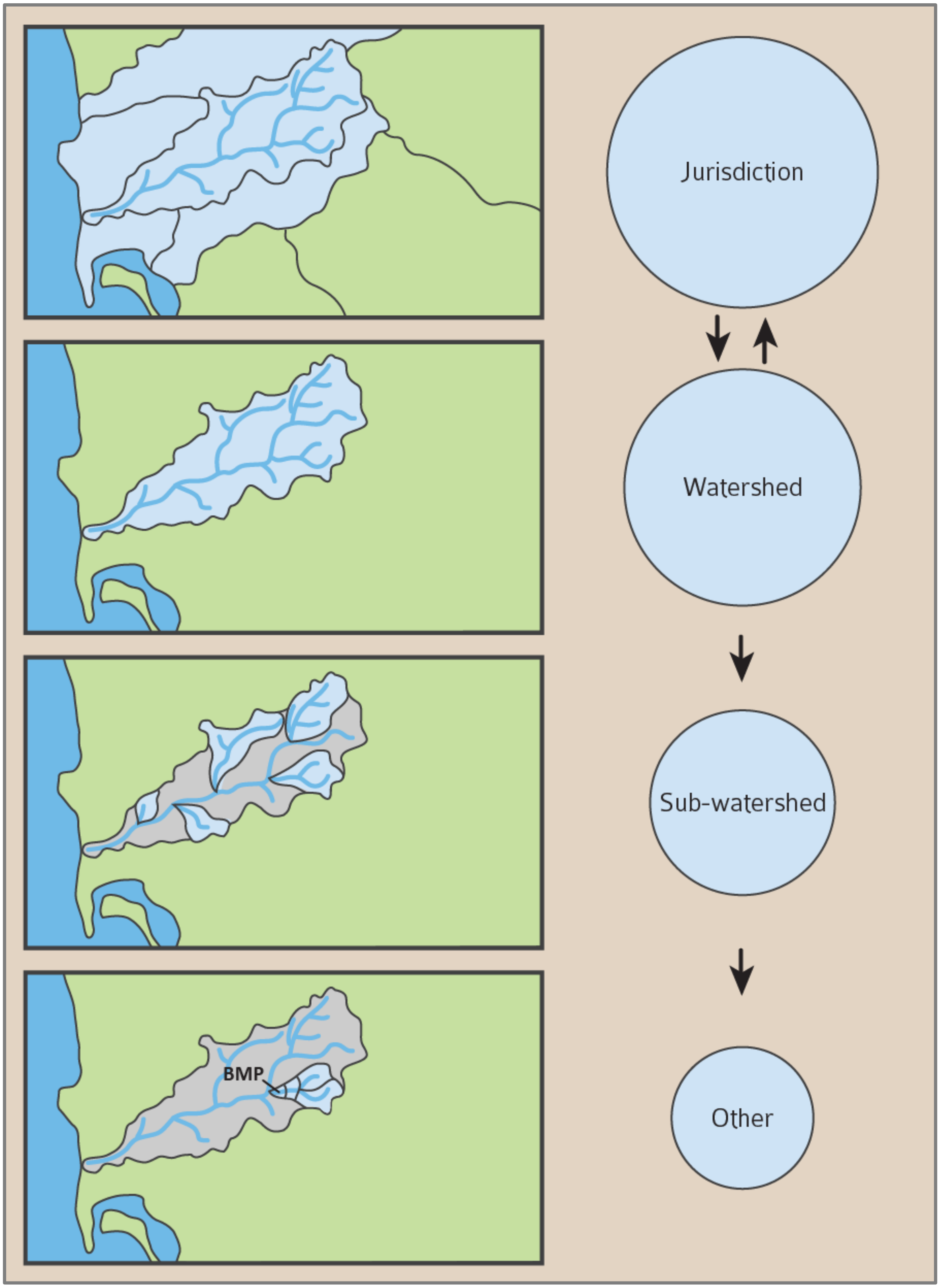


Figure 4.29: Drainage Areas at Various Scales[6]

[6] In this example, jurisdictions and watersheds are interchangeable since either can contain the other.

Normally managers will be most interested in drainage areas that discharge to priority receiving waters through MS4s. In a very broad sense drainage areas can be, and often are, treated as sources since they represent the collective loadings of all the individual sources they contain. Drainage areas also define opportunities for other interventions such as the construction of structural treatment controls.

Failure to adequately define drainage areas can result in the misdirection of control strategies toward sources that are not actually contributing to priority receiving water problems. Scale is a critical consideration. In general, the finer the scale (e.g., a sub-watershed or smaller drainage area rather than an entire jurisdiction or watershed), the more likely that control strategies can be directed with greater precision. A broadly based program element that assumes a physical connection between all priority sources and receiving water impacts within the drainage area can actually result in a "mismatch" of problem conditions and potential solutions. It's critical that sources and impacts be aligned with as much specificity as possible so that the correct contributing sources can be targeted for each priority impact.

While the most critical consideration in defining a drainage area is initially its boundaries, each individual area will also have a number of other attributes that should be considered during characterization. These will later be important in the development of control strategies. Examples of attribute types are provided in **Table 4.14**. Once applicable drainage areas have been identified and characterized, the focus of planning will shift to the sources of pollutants and flows contained within them. However, as shown, sources (residential areas, commercial inventories, etc.) are also an important consideration for defining drainage areas. In this sense, planning does not always follow a linear process. Contributing sources will need to be identified provisionally during the definition of drainage areas, and later evaluated in greater detail during source prioritization and targeting.

Table 4.14: Examples of Drainage Area Attributes

Land Area Characteristics
☑ Geographic boundaries
☑ Land uses (residential, industrial, transportation, etc.)
☑ Zoning classifications (residential, commercial, mixed use, etc.)
Sources of Pollutants and Flow
☑ Areas of pollutant and flow generation (area-wide, land use-specific, etc.)
☑ Source locations (industrial areas, facility locations, etc.)
Population Characteristics
☑ Demographics (ethnicity, gender, age, etc.)
☑ Population distribution (density, communities, etc.)
Physical Characteristics
☑ Locations of receiving waters and MS4s
☑ Patterns of precipitation and runoff
☑ Topography, soil types, and vegetation
☑ Areas of imperviousness, open space, or infiltration

Question 2 Which sources contribute pollutants and flows to the MS4?

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. The identification and characterization of sources is a critical part of the planning process because it largely defines how control strategies will be directed. It's therefore useful to consider the ways in which decisions about source content and priorities can be approached. There are two primary approaches to identifying potential sources.

- Source-based ("preventive") approaches, and
- Constituent-based ("corrective") approaches.

One begins with an understanding of problem conditions in receiving waters and MS4s, and the other with the sources themselves. Either can be useful depending on the situation, and managers should generally find both to be necessary. No program can be considered to be entirely source-based or constituent-based.

Source-based approaches focus first on sources and associated target audiences (Levels 2, 3, and 4) within a defined drainage area, often in the absence of a detailed knowledge of existing water quality impacts. They are normally designed to anticipate potential problems, and as such can be considered "preventive." Although the details vary, MS4 permits and programs are typically organized according to the broad source categories identified in **Table 4.15**[7]. To varying degrees, each of these categories will play some part in most stormwater management strategies.

The primary advantage of a source-based emphasis is its close alignment with existing regulatory and operational programs (business inspection programs, building permit programs, capital improvement programs, etc.), making the selection of sources, and the subsequent development and administration of many program activities, fairly straightforward. As such, source-based approaches often have a high return on investment.

Table 4.15: Major Source Categories and Examples of Specific Source Types

Existing Development			New and Redevelopment	
Municipal Sources	**Residential Sources**	**Industrial/ Commercial Sources**	**Construction Sources**	**Development & Redevelopment Sources**
• Solid waste facilities • Wastewater operations • Streets and roads • MS4s • Parks • Office buildings	• Single family housing • Multiple family housing • Apartments • Mobile homes • Rural residential areas • Inner city neighborhoods	• Restaurants • Automotive maintenance • Nurseries • Horse stables • Mobile operations (landscaping, pool care, pest control, etc.)	• Commercial and industrial development • Single family homes • Major subdivisions • Capital improvement projects • Redevelopment sites	• Commercial and industrial development • Single family homes • Major subdivisions • Capital improvement projects • Redevelopment sites

While source categories are useful for organizational purposes, they are often too broad and inclusive for many detailed strategic planning tasks. In practice, each will usually require further subdivision into more specific source types (e.g., commercial sources into restaurants, automotive service establishments, etc., or residential sources into

[7] Note the close correspondence of these source categories to the CASQA BMP Manuals and the profiles presented in **Attachment A** of this manual).

apartments, rural residential, etc.) and target audiences (equipment operators, food service workers, dog walkers, etc.) to which particular management initiatives can be directed. **Figure 4.30** provides an example of a source-based organizational approach. In this example, note the position of priority constituents at the bottom of the figure. Because source-based approaches tend to focus first on the identification of sources and target audiences, and then the activities and practices associated with them, constituents or stressors tend to be considered much later in the planning process. This is a hypothetical example. Real world conditions are much more complex. A typical MS4 permit contains requirements to address all major source categories, each of course subdivided into numerous additional individual source types, target audiences, and activities and practices. Each identified activity or practice might also address multiple priority constituents.

As control strategies are later developed for priority constituents and sources, it will also be important to know as much as possible about each of them. Managers should therefore always be interested in characterizing the relevant attributes of each priority source. **Table 4.16** lists a number of general attributes that might be considered. The actual selection of attributes will depend on resource availability, and the nature and priority of the source. Often the priority of individual source types won't yet have been determined, so this aspect of characterization may need to be returned to later.

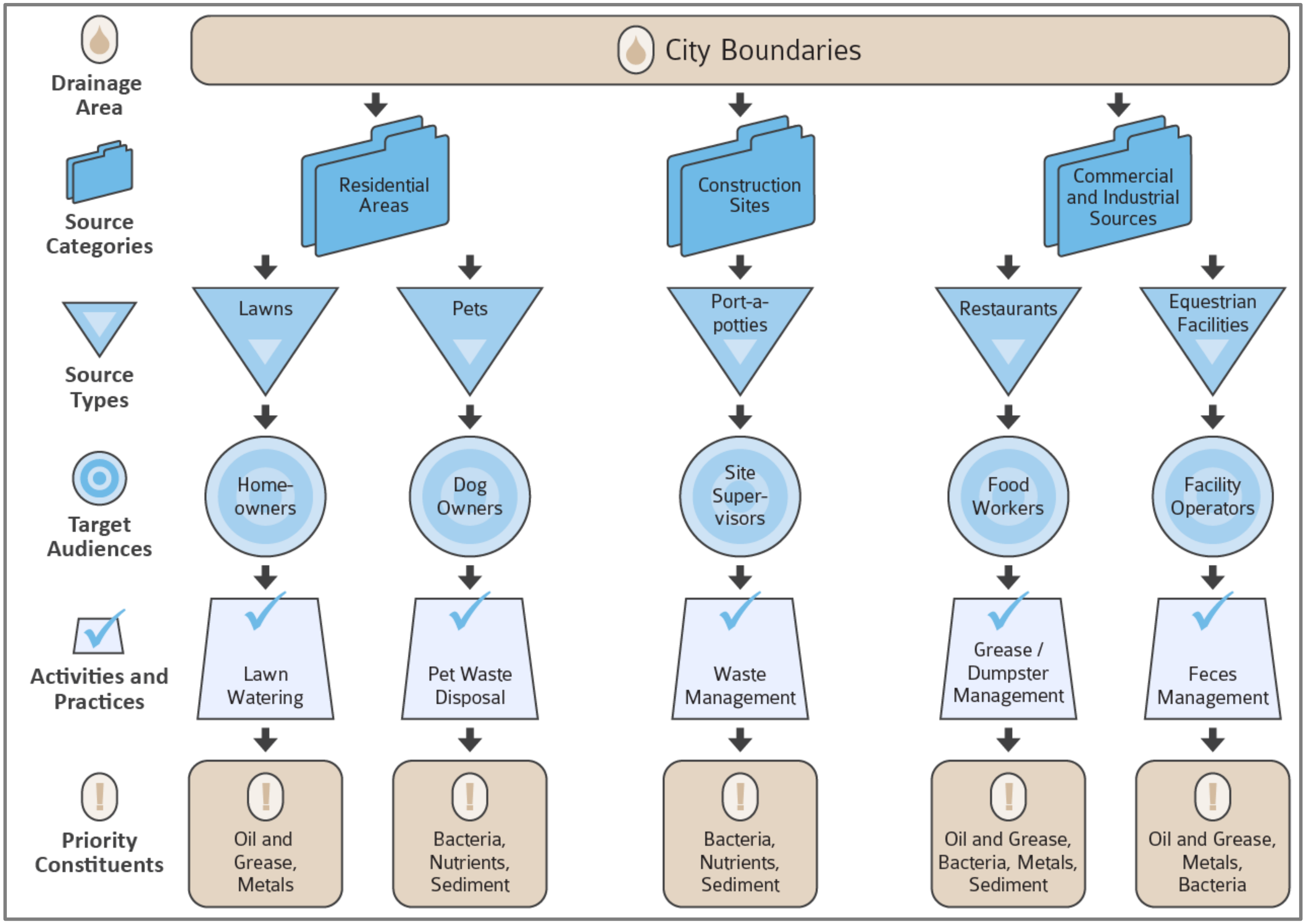


Figure 4.30 Simple example of a source-based (or "preventive") organizational approach

Table 4.16: Examples of Source Attributes

Site or Facility Information

- ☑ Number, size and types of sites or facilities (businesses, residences, etc.)
- ☑ Locations (proximity to receiving waters and MS4s, clustering, etc.)
- ☑ Onsite hydrologic conditions (incl. areas of imperviousness, open space, or infiltration)

Activities and Practices

- ☑ Operations conducted
- ☑ Materials and wastes
- ☑ PGAs and BMPs conducted
- ☑ Presence of structural BMPs

Target Audience Attributes

- ☑ Identification of target audiences (incl. primary and secondary, and segmentation as necessary)
- ☑ Job responsibilities
- ☑ Numbers and types of employees, contractors
- ☑ Levels and types of education or training
- ☑ Population distribution (density, communities, etc.)

Source Contributions

- ☑ Dry weather discharges of pollutants or flows (potential or actual)
- ☑ Wet weather discharges of pollutants or flows (potential or actual)

Constituent-based approaches are more typical of watershed management initiatives, particularly those associated with Total Maximum Daily Loads (TMDLs). Here the starting point is the establishment of the priority constituents associated with receiving water and MS4 impacts. Numerous constituents may be of interest. The list below currently represents the constituents that are most frequently 303(d)-listed in California. Detailed profiles of each are provided in **Attachment C**.

- Bacteria
- Sediment
- Nutrients
- Mercury
- Pesticides
- Trash

Constituent-based approaches are typically "corrective" in that they are designed to resolve documented receiving water or MS4 problems (Levels 5 and 6[8]) within a defined area. **Figure 4.31** provides an example of a constituent-based approach and illustrates how other organizational parameters can be accommodated within it. In this case, note the position of a priority constituent (bacteria) at the top of the figure.

Constituent-based approaches can be preferable if a good understanding of receiving waters or urban runoff conditions has been established – often the case where monitoring programs have been in place for long periods. The primary advantage of these approaches is their "problem-solving" orientation to priority water quality issues. By allowing the exclusion or de-emphasis of sources, target audiences, and pollutant-generating activities that do not contribute to these problems, resource commitments can often be reduced or redirected to those that do.

This does not mean that source-based approaches are inherently less efficient. Most managers have extensive experience managing their source inventories, and may often have a detailed understanding of their source priorities -- whether or not they're directed to resolving identified water quality problems.

Each approach follows a slightly different path, but both eventually bring managers to essentially the same place, i.e., the selection of stormwater program activities to bring about specific behavioral changes in priority target audiences. Which approach is better depends on the situation, and one is rarely chosen exclusively over the other. In most instances, programs will reflect a mix of source-based and constituent-based elements.

Question 3 What are the current flow and pollutant contributions of drainage areas and sources?

By far the most critical attributes of drainage areas and sources will be their flow and pollutant contributions to priority MS4s and receiving waters. Since the primary focus of most stormwater management programs is to facilitate reductions in these contributions, it's necessary to first understand what they are.

[8] This is a definitional distinction. It's possible that management approaches can be designed to "correct" source loadings without actual knowledge of the receiving water or MS4 impacts caused by them. However, an approach is considered "corrective" here when it is designed to respond to a known or suspected impact.

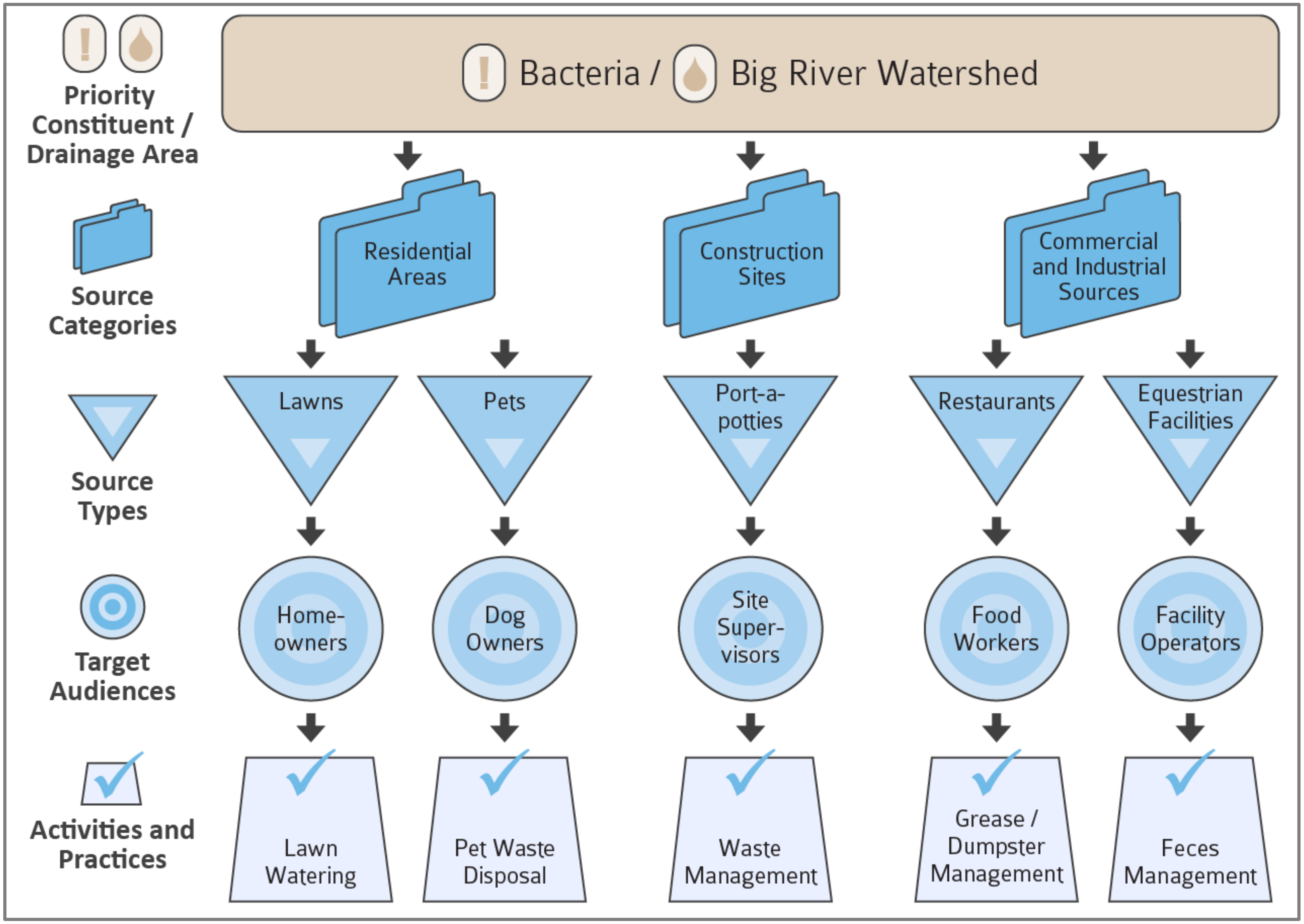


Figure 4.31 Simple example of a constituent-based (or "corrective") organizational approach

Source contributions can refer either to **source loadings** (flows and pollutant loadings added by sources to a MS4) or **source reductions** (reductions in flows or amounts of pollutants associated with specific sources before and after control measures are employed). Source reductions are the primary means by which stormwater programs are able to induce positive changes in receiving waters. In practice, it's often not possible to directly measure or observe a loading or reduction. Instead managers often rely on estimates of **source potential** (also typically 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. Managers must often rely on estimations of source potential to determine the magnitude or relative importance of a source contribution.

The discussion below applies to the characterization of both pollutant and flow contributions. It's also important to remember that drainage areas can sometimes be treated as sources, especially with regard to the estimation of source contributions from broad geographic areas (e.g., residential land uses). For example, TMDLs often contain pollutant waste load allocations for specific land uses. In this respect "drainage area contributions" are a form of "source contribution."

Nature and Magnitude

The **nature** of a source contribution refers primarily to its substance. **Substance** is the physical composition of the flow or pollutant loading being discharged from the source (i.e., what is being loaded or reduced?). As shown in **Table 4.17**, substance can be categorized in three ways.

- Materials and Wastes (street sweeping debris, used motor oil, etc.)
- Pollutants (copper, nitrates, bacteria, etc.)
- Flows (volume, rate, etc.)

The purpose of these categories is to facilitate characteriztion. They are not mutually exclusive. For example, a flow can contain pollutants or a pollutant could be one of multiple substances comprising a material (e.g., nitrates in fertilzer). The selection of one type of substance over another will be situation-specific. Also note that the examples of substances included in **Table 4.17** correspond very closely with conditions many of the previously described for receiving waters and MS4s. The primary difference is that only substances that can be discharged from a drainage area or source are included here.

Table 4.17: Examples of Drainage Area and Source Contribution Types

Type of Contribution	Examples
Materials and Wastes	• Fertilizers • Yard waste • Paint • Automotive fluids (motor oil, brake fluid, etc.) • Trash and debris
Pollutants	
Chemical Constituents	• Metals (e.g., Cd, Cu, Cr, Pb, Ni, Ag, Zn) • Pesticides (e.g., organophosphates, pyrethroids) • Nutrients (e.g., nitrates, phosphates)
Biological Constituents	• Bacterial indictors (total and fecal coliform, enterococcus, etc.) • Pathogens (bacteria, viruses, protozoa, etc.)
Physical Constituents	• Sediment • Floatables • Temperature
Flows	• Stormwater flows (volume, velocities, and durations) • Non-stormwater flows (presence or absence, volume, velocities, and durations)

Source contributions have traditionally concentrated on materials, wastes, or pollutants. However, recent trends in permitting have shifted some of that focus to the impacts of flows generated by specific source types or within drainage areas. This is because changes in stream hydrology (e.g., more frequent flooding, destabilized stream banks, or degradation of stream habitat) are often associated with the impervious surfaces that are created when urbanization takes place. As such, understanding and managing hydrologic conditions on or discharging from properties or sites is also now an important objective for many programs. To date, most of this emphasis has been on new development and redevelopment sites, but some MS4 permits are now requiring that flow conditions be addressed for areas of existing development.

In addition to its nature, it's necessary to understand the magnitude of each contribution. **Magnitude** describes dimension or scale. Depending on the type of condition, and the particular approach to its measurement, magnitude can be expressed in a number of different ways, e.g., the concentration or weight of a chemical constituent, the volume or weight of a material, or the peak velocity of a stormwater flow. Regardless of how it's expressed, magnitude provides an indication of the relative importance of a particular contribution, and therefore of its potential priority. The magnitude of each source loading will also have temporal and spatial aspects.

Temporal characteristics address the rate, duration, and timing of the source contribution. **Rate** is a quantification of the amount of a loading or reduction over a unit of time (e.g., 50 lbs./year), whereas **duration** defines the period over which it occurs (an hour, a year, a season, etc.). Along with nature and magnitude, rate and duration are necessary for the quantification of source contributions. Examples of both are provided in **Table 4.18**. The specific **timing** of source contributions (e.g., weekend versus weekday) is also very important to gaining a full understanding of the condition, as well as potential options for controls. However, timing isn't as critical for quantifying loadings.

Table 4.18: Examples of Temporal Characteristics of Source Contributions

Rate	Duration	Timing
• 4 gallons (e.g., an "instantaneous" event) • 10 ft^3 / min.(e.g., continuous discharge of process water) • 3-10 gal. / minute (intermittent or variable discharge)	• Instantaneous (e.g., littering or dumping oil in a drain) • Six hours, two weeks, three months, etc. • An annual reporting period (one year) • A rainfall event	• Evenings, weekends, business hours, etc. • Wet or dry season • Daily, weekly, monthly, etc. • Episodic (e.g., only during rainfall)

Spatial scale is also important for describing the magnitude of a source contribution. Scale defines where and how loads or reductions can be measured or calculated. As shown in **Figure 4.32**, four scales are of particular importance.

- **Individual practices** are PGAs and BMPs. Analysis of PGAs will typically be used for investigating source loadings and BMPs for reductions. This can also include structural controls such as infiltration basins and treatment control BMPs.
- **Sites** are discrete locations such as commercial facilities or residences. Depending on the specific scale, they can be treated as either point or area features.

- **Land areas** are geographically-based units. Land areas can only be represented as area features. Land area approaches are frequently used to develop waste load allocations for TMDLs.
- **Populations** are the groups of individuals associated with sources. The term "population" can sometimes be used inter-changeably with target audience. Populations normally represent heterogeneous distributions of individuals, so the variability within them is an important consideration.

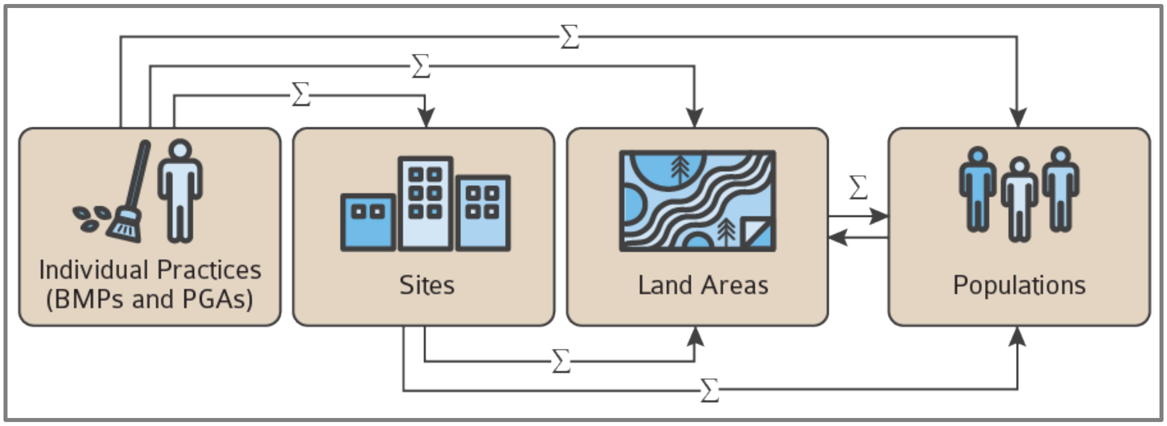


Figure 4.32: Potential Scales for Estimating Source Contributions

Relationships between each of these different scales have important implications for the way that source contributions can be approached. Most significantly, individual practices (BMPs or PGAs) can be "summed" across any of the other three scales. That is, source contributions for sites, land areas, and populations can all be calculated as the sum of the individual practices occurring within them. This relationship has broad-ranging and important implications because it's often not possible to develop reliable estimates directly at the site or land area scale. Population-based estimates in particular can be approached through the quantification of contributions associated with individual behaviors or practices (through surveys, inspection results, etc.). Results obtained at the site level can also be summed across land areas and populations.

Together, nature and magnitude provide a basic description of each source contribution. It's also important to consider how they vary in time and space.

Variability

Variability refers to how spread apart the measurements of source contributions within a distribution are, or how they vary from each other temporally or spatially. Not unexpectedly, the **temporal variability** of source contributions can also be quite significant. In fact this variability is likely reflected in that observed for many receiving water and MS4 conditions.

Looking at a hypothetical population of residences, it may be known that residents tend to wash their cars and do yard work more on weekends than during the week. However, while such generalizations can be useful in directing control strategies, they can also sometimes oversimplify (e.g., not everyone washes their cars on weekends). Understanding the variability of these behavioral patterns can lead to a more accurate prediction of when and where they may be generating source loadings. A control strategy that considers this variability is more likely to be effective.

Likewise it's important to define not only the contribution of a source type as a whole, but also which specific sources within that distribution provide the greatest contributions to MS4 and receiving water impacts. Outcomes rarely exist individually, i.e., they tend to be distributed within defined populations of outcomes of a particular type (e.g., the source contributions of all the residences within a jurisdiction, or of all the dog-walkers within a residential population, etc.). In a typical normally distributed population, the greatest numbers of individuals will be distributed toward the center of the distribution (i.e., grouped around the average value) and others toward the tails. To properly target control strategies it will be important to understand the degree of variability within a distribution and what it represents. In particular, sources that are the most prevalent or highly distributed throughout a drainage area, or portions of it, are more likely to represent significant loadings of flow or pollutants. As described above for MS4 contributions, statistically-based approaches can help to characterize and manage the variability associated with source contributions.

Collectively, nature, magnitude, and variability help to define the **significance** of a source contribution. Along with other factors considered below, significance plays an important role in determining whether or not a contribution is considered a problem, and if it is a priority for future action.

Certainty and Controllability

Certainty describes the confidence that managers have in their assessment of each drainage area or source contribution. Given the number of potential sources within a drainage area of interest, it's quite likely that many of them will not be characterized with a high degree of certainty. Because sources must often be approached as large populations (groups of people, of pets, of restaurants, of lawns, etc.), modeling and statistical approaches can be important in understanding their variability, and therefore in reducing the uncertainty associated with their respective contributions. An important informational gap that can contribute to uncertainty is a lack of knowledge regarding actual discharges from specific source types. As previously noted, managers often need to rely on estimates of **source potential** to determine the likelihood that a given source type will discharge flows or pollutants. This typically involves "profiling" the attributes (operations, PGAs, etc.) of specific source types, which may require the use of numerous untested assumptions. This can in turn lead to significant errors or a general lack of precision in estimating source potential. While these exercises are essential for planning, it's equally important to characterize the uncertainty associated with them and to address critical data gaps over time.

Controllability is the potential for a program to influence changes in a drainage area or source contribution. Management strategies should reflect an understanding of contributing sources and the presence of viable source control options for them. Controllability will be highly variable for different source areas or types. In general, highly regulated sources (e.g., construction and development) will tend to be comparatively more controllable than less regulated ones (residences, businesses that are not inspected, etc.). As such, portions of drainage areas that reflect a particular source composition, most typically expressed as differences in land use, are likely to experience similar differences in controllability.

Controllability also depends on the potential for intervention by the stormwater program. In some cases, available controls may be technically feasible, e.g., MS4 maintenance or installation of structural controls, but not within the resources of a program to conduct or impose. Controllability should therefore include a realistic assessment of the costs and program resources associated with each management option.

Analytical Approaches to Quantifying Source Contributions

Whether during planning or assessment, quantifying the loads or reductions associated with any source or source type is one of the most challenging aspects of stormwater management. This section briefly introduces several key considerations that can be useful in deciding how to approach quantification. Analytical approaches can be broadly classified according to monitored, modeled, and combined approaches.

1. **Monitored approaches**

Monitored approaches are empirical, and as such rely on sampling and observations as a basis for estimating source contributions. They include two important variants:

- Measurement of discharges, and
- Measurement of materials and wastes

Figure 4.33 provides an overview of these two approaches and provides examples of how they can be applied. As shown, monitored approaches can be desirable both for planning and assessment because they rely on actual measurements rather than assumed parameters. However, in practice, comparatively few program activities or controls provide directly measured data for use in source loading or reduction calculations.

The use of monitored approaches tends to be limited to individual practices or sites. However, in some instances where waste streams represent a "summation" across larger geographic areas (MS4 cleaning, household hazardous waste collection, etc.) results may have broader applicability. Monitored approaches can also be applied more broadly where individual results represent a statistically-based sample of a larger population of loads or reductions.

2. **Modeled approaches**

Rather than relying on direct measurement, **modeled approaches** infer loadings or reductions from the attributes, characteristics, or design of sources, drainage areas, or individual controls (behaviors, EMCs, design capacity, efficiency, etc.). Modeled approaches encompass a variety of tools, ranging from simple spreadsheets to sophisticated computer models. Spreadsheets can be important tools for generating basic planning input, especially where the data support needed for more complex models is lacking.

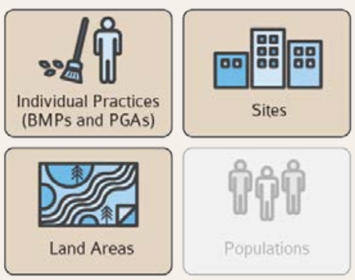
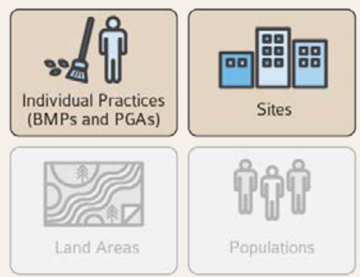
	A. Measurement of discharges	B. Measurement of materials and wastes
General Description	1. Loads or reductions are inferred from the quality and/or rates of effluent discharging from a point or a control. 2. Discharges at scales other than from individual BMPs (e.g., sites and land areas) are usually co-mingled with other discharges. 3. Measurement of effluents is direct, but to obtain an actual loading or reduction, conversions or adjustments are often required (e.g., extrapolation over multiple rainfall events, maintenance history, etc.).	1. Can apply in any situation where a material or waste is collected or quantified, e.g., street sweeping, MS4 cleaning, or collection of used oil, household hazardous waste, or trash. 2. Applicability is limited to waste streams within the physical possession of programs or regulated parties. 3. Measurement of materials is often direct, but to determine an actual loading or reduction, conversions or adjustments are often required (material-to-constituent conversions, assumptions about % of material likely to reach MS4, etc.).
Analytical Scale		
Potential Applications	• Structural treatment controls • Industrial facility monitoring • Land use monitoring	• Street sweeping • Creek clean-ups • Household hazardous waste collection • MS4 structural controls

Figure 4.33: Overview of Monitored Approaches to Evaluating Source Contributions

These are by far the most widely applicable approaches because they do not require direct access to data on the wastes or discharges associated with the source contributions under consideration. However, modeled approaches can often be very imprecise because of their heavy reliance on a variety of assumed parameters and values. In cases where estimates are calculated from multiple, sometimes poorly understood factors, the potential for propagation of error can be significant. In general, this makes modeled approaches more suitable for planning-level estimates or comparisons of source contributions, where precision is less critical.

The application of "pure" modeling approaches to the assessment of source contributions can be problematic because estimates built primarily on assumed parameters can't be reliably used as a basis for establishing baseline conditions or for measuring post-implementation reductions. As such, purely modeled approaches should be utilized primarily as planning tools, at least until a sufficient basis can be developed to support their use as assessment tools. **Figure 4.34** provides an overview of modeled and combined approaches and provides examples of how they can be applied.

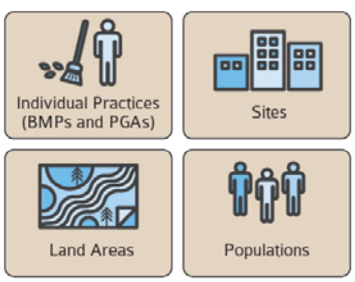
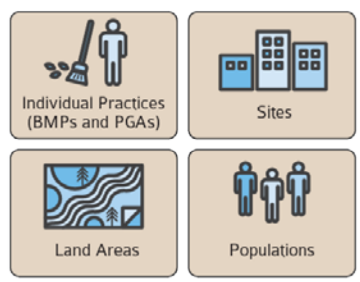
	Modeled Approaches	**Combined Approaches**
General Description	1. Loads or reductions are "constructed" from a variety of calculated or assumed parameters (implementation rates of PGAs or BMPs, rainfall patterns, runoff coefficients, BMP efficiencies, EMCs, material-to-constituent conversions, assumptions about % of material likely to reach MS4, etc.). 2. Particularly useful for planning. 3. Variety of tools available (simple spreadsheets, computer models, etc.).	1. Preferable to modeled approaches because they're partially supported by measurements 2. Also useful for planning. More useful than modeled approaches for assessment. 3. Measurement of materials can often be direct, but to determine an actual loading or reduction, conversions or adjustments are often required (material-to-constituent conversions, assumptions about % of material likely to reach MS4, etc.).
Analytical Scale		
Potential Applications	• All potential planning scenarios (including treatment controls, infiltration BMPs, source controls, and all examples in **Figure 4.29** above). • Not recommended for assessment.	• Same as for modeled approaches, but limited to applications where data from sampling or observation are available.

Figure 4.34: General Applicability of Modeled and Combined Approaches to Source Contributions

3. **Combined approaches**

In practice, most programs utilize a combination of modeling and monitoring approaches to estimating source contributions. **Combined approaches** often represent a useful compromise by bringing a moderate degree of data support to the more broadly applicable modeled approaches. One way this occurs is through the **validation** of monitoring parameters. That is, monitoring or other data collection is conducted to either support existing modeling assumptions or to "fine tune" them to a specific local application. Validation of assumptions is critical to reducing errors and improving accuracy over time. However, even a validated modeling approach can be somewhat limited in its application to actual assessment scenarios.

Another option is to combine available monitoring results with other assumed parameters. For example, a survey of restaurant operators might be conducted to characterize rates of key polluting behaviors. Results could be used in combination with other assumed parameters (numbers of applicable employees, loadings associated with key behaviors, etc.) to generate source contribution estimates that are partially data supported. By repeating this exercise in the future (or substituting other forms of observation such as inspection results), managers might be able to reasonably estimate loading reductions. Of course this type of exercise can also be highly speculative, but it illustrates an important pathway for improving source reduction estimates over time through the resolution of knowledge and data gaps.

Question 4 How are source contributions changing over time?

Source loadings are dynamic, and can sometimes change significantly over time. Knowing whether source contributions are **trending** upward or downward is critical to measuring program success. For example, are increases in hydromodification or pollutant loadings in receiving waters due to specific changes in source contributions? Trend analysis can be very useful in discerning these changes. To enable the evaluation of changes, it's important that a baseline of existing contributions be established, and that changes are tracked over time. Given the variety of sources within any drainage area, and the current state of knowledge for many of them, this can be especially challenging.

The outcome of **Task 1** will be the documentation of a variety of source contributions and associated attributes. Key drainage areas may have their own lists of corresponding source contributions. Results should be as inclusive as allowed by existing data and information. Where data are insufficient to fully describe a contribution or other source attributes, knowledge and data gaps should be documented for consideration in future data collection strategies. Identification of problem conditions will occur in **Task 2**. **Figure 4.35** provides a Review Checklist to guide the completion of **Task 1**.

Review Checklist

Step 4-A Task 1

Evaluating Drainage Area and Source Contributions

Apply this task very broadly across Outcome Level 4 sources of data and information. The purpose is to provide a "snapshot" of what is currently known about drainage areas and sources.

✓ **Compile existing data, information, and results applicable to Outcome Level 4. Consider the following questions:**

Question 1: Which drainage areas contribute pollutants and flows to MS4s?

Question 2: Which sources contribute pollutants and flows to the MS4?

Question 3: What are the current flow and pollutant contributions of drainage areas and sources?

Question 4: How are drainage area and source contributions changing over time?

✓ **Consolidate results into one or more summary lists of existing conditions. Categorize results as determined appropriate (by drainage area, source type, etc.).**

✓ **Compile supporting documentation for listed conditions.**

✓ **Select the conditions in the summary list(s) that will be further evaluated as potential problems in Task 2. Consider "back-up" lists for future evaluation as necessary.**

✓ **Document the critical data and information gaps identified during Task 1 completion.**

NOTES

Figure 4.35: Review Checklist for Evaluating Drainage Area and Source Contributions

Key Concept 4.2 Source Identification versus Source Characterization

As managers seek to identify the specific contributions of sources to MS4 and receiving water problems, it's important to understand the differences between source characterization and source identification. Source characterization seeks to understand the type and magnitude of constituents that may potentially be discharged to stormwater from a defined area or population such as high density residential land uses or auto repair facilities. Whereas a source identification study investigates the specific sources or activities associated with a measured constituent or impact within the MS4 or receiving waters.

For example, during MS4 assessment, a manager may have identified priority constituents such as copper that are related to receiving water problems. With limited data available on individual sources, they may first want to identify which land use types correspond to higher MS4 outfall concentrations and frequencies. Using GIS analysis or other available data sources, it might then be possible to determine which land areas have the highest potential for discharging copper to MS4 s and receiving waters. Further source characterization might also establish differences in the discharge potential of older, lower-density, residential land uses and higher density residential land use. These results may then help to focus source identification studies that will investigate the sources of copper within the lower-density residential land use that may include copper architectural features, gutters or roof flashing.

Source characterization and identification are not mutually exclusive, and may often complement each other. Managers may sometimes choose to first conduct source characterization as a means of informing subsequent more detailed source identification studies. For example, prior to initiating a source identification study, managers may also want to use available inspection and enforcement data along with GIS data to identify the likeliest contributing sources of copper and bacteria within the drainage area. This information can be useful in focusing a more detailed source investigation study. Given the potential costs and resources needed to conduct detailed investigations, this can be an important preparatory step. Results of both processes can be helpful in developing specific management strategies to abate source contributions.

The Source Profiles provided in Attachment B may also be used to help focus source characterization and identification initiatives.

Task 2 Defining Problem Drainage Areas and Sources

The objective of this task is to determine which of the drainage areas and sources identified above actually constitute problems. Two key questions guide this evaluation process.

Step 4-A Task 2 Key Questions

Defining Problem Drainage Areas and Sources

Inputs	Key Questions	Outputs
Drainage Area and Source Contributions & Characteristics	**Question 1:** Is the drainage area or source contribution causally linked to a known or suspected MS4 or receiving water problem? **Question 2:** Is there independent evidence for designating the drainage area or source contribution as a problem?	**Problem Drainage Area and Source Contributions**

Question 1 Is the drainage area or source contribution causally linked to a known or suspected urban runoff or receiving water problem?

Ideally the identification of problem drainage areas and source contributions will be based on the establishment of clear linkages to higher outcome levels. Problem contributions can be defined in relation to either MS4s or receiving water problems, or both. Determining a direct causal linkage between source contributions and higher level conditions can be based on a comparison of their common attributes. A comparison of sources to a list of priority constituents identified either for receiving waters or MS4s can sometimes elucidate problem source contributions. For example, if sediment in wet weather was identified as a priority water quality problem in a 303(d)-listed receiving water segment, and construction inspection data from upstream sites indicate issues with turbidity and TSS, it may be possible to establish linkages between both sets of problem conditions. Normally the most compelling evidence of a causal linkage will include data at the source, the MS4, and the receiving water, as well as a physical linkage between applicable drainage areas and MS4s. Likewise, linkages that are supported by statistical analysis are generally preferable to those established anecdotally.

Question 2 Is there independent evidence for designating the drainage area or source contribution as a problem?

This question acknowledges the practical reality that direct linkages between problem conditions are difficult to establish. Problem conditions must often be identified through other lines of evidence when drainage area and source contributions cannot be definitely linked to receiving water or MS4 problems. To illustrate, over-irrigation in a residential area cannot be directly linked to obseved MS4 or receiving water problems even though irrigation water discharges contain a number of constrituents above water quality benchmarks. Understanding that irrigation water discharges also create dry weather flows that provide migration pathways for these and other constituents, managers may elect to treat these discharges as priority contributions. Such linkages can also be consistent with the preventive approaches described above.

Ideally a linkage can be established to a specific portion of the MS4, but this isn't always possible. In such cases, it also makes sense to evaluate source contributions with respect to directly adjacent or downstream receiving waters. Even where a physical connection has not been established, constituent matches can be compelling. For example, if a receiving water is impaired for pyrethroids, a high level of urban uses of pyrethroids reported in the appropriate county would support additional consideration and investigation of a potential causal linkage.

The output of **Task 2** is one or more lists of problem source contributions. Results may include a range of confirmed or potential problems, and should be organized by drainage area. Drainage areas discharging significant flows or pollutant loads may also be designated as problems. Where data are insufficient to reasonably confirm a condition as a problem, it may be tentatively listed, and identified knowledge and data gaps considered for future data collection strategies. Prioritization of conditions will occur in **Task 3**.

Figure 4.36 provides a Review Checklist to guide the completion of **Task 2**.

Review Checklist

Step 4-A Task 2

Defining Problem Drainage Areas and Sources

Apply this task individually to each Task 1 drainage area or source contribution selected for further evaluation. The purpose of this task is to determine which of these contributions should be designated as problem conditions.

- ✓ **For each identified drainage area or source contribution, consider the following questions:**

  Question 1: Is the drainage area or source contribution causally linked to a known or suspected MS4 or receiving water problem?

  Question 2: Is there independent evidence for designating the drainage area or source contribution as a problem?

- ✓ **Document known or suspected drainage area or source problems.**
- ✓ **Consolidate results into one or more summary lists. Categorize results as determined appropriate (by drainage area, constituent type, source type, etc.).**
- ✓ **Compile supporting documentation for listed conditions.**
- ✓ **Document the critical data and information gaps identified during Task 2 completion.**

NOTES

Figure 4.36: Review Checklist for Defining Problem Drainage Areas and Sources

Task 3 Prioritizing Drainage Area and Source Problems

Starting with the list of drainage area and source contributions identified above, further analysis will determine which represent the highest priorities for directed action or additional study. A structured process can be helpful not only for identifying priorities, but for validating or refining existing ones. The key questions below are suggested to guide the prioritization of drainage area and source problems.

Step 4-A Task 3 Key Questions

Prioritizing Drainage Area and Source Problems

Inputs	Key Questions	Outputs
Problem Drainage Area and Source Contributions	**Question 1**: What is the priority rating of each drainage area or source contribution? **Question 2**: What is the relative importance of each drainage area or source contribution?	**Priority Drainage Area and Source Contributions**

As shown in **Figure 4.37**, prioritization is a two-step process. Each identified source contribution will first be reviewed to determine its **priority rating**. Ratings can then be considered together to determine their relative **priority ranking**. Given the number of sources likely to be identified, it makes sense to explore a variety of potential scenarios. However, it's also important to keep the number of potential priorities manageable.

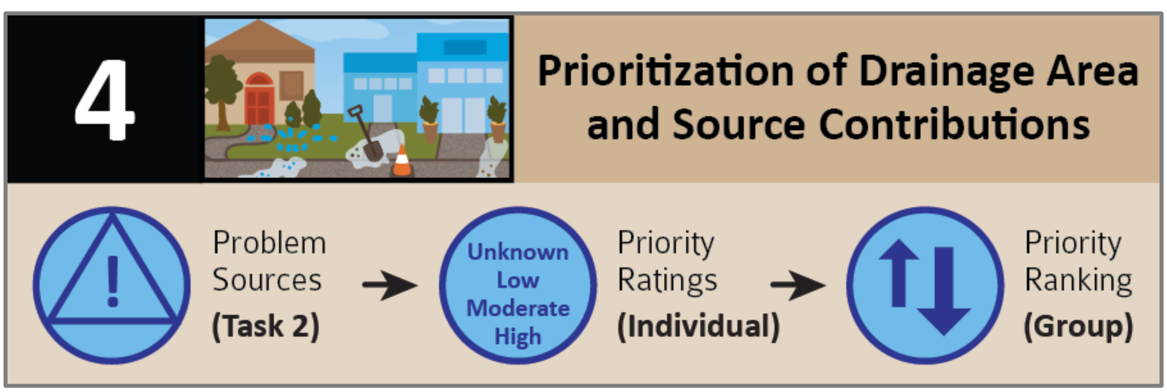


Figure 4.37: General Process for Prioritizing Drainage Area and Source Contributions

Question 1 What is the priority rating of each drainage area or source contribution?

Prioritization starts with the assignment of a priority rating for each drainage area or source contribution. Assignment of ratings relies primarily on the review factors identified in **Task 1** above. As shown, simple qualitative scoring methods are generally recommended throughout the rating process.

Tier 1 Regulatory Screening

Source contributions that can be directly linked to 303(d) listings, TMDLs, or permit requirements may need to be treated as higher priorities. **Figure 4.38** illustrates a Regulatory Screening process for nutrients in a residential drainage area. As shown, requirements and constraints are not significant, so their influence is relatively weak. The potential of requirements and constraints to offset each other should also be considered.

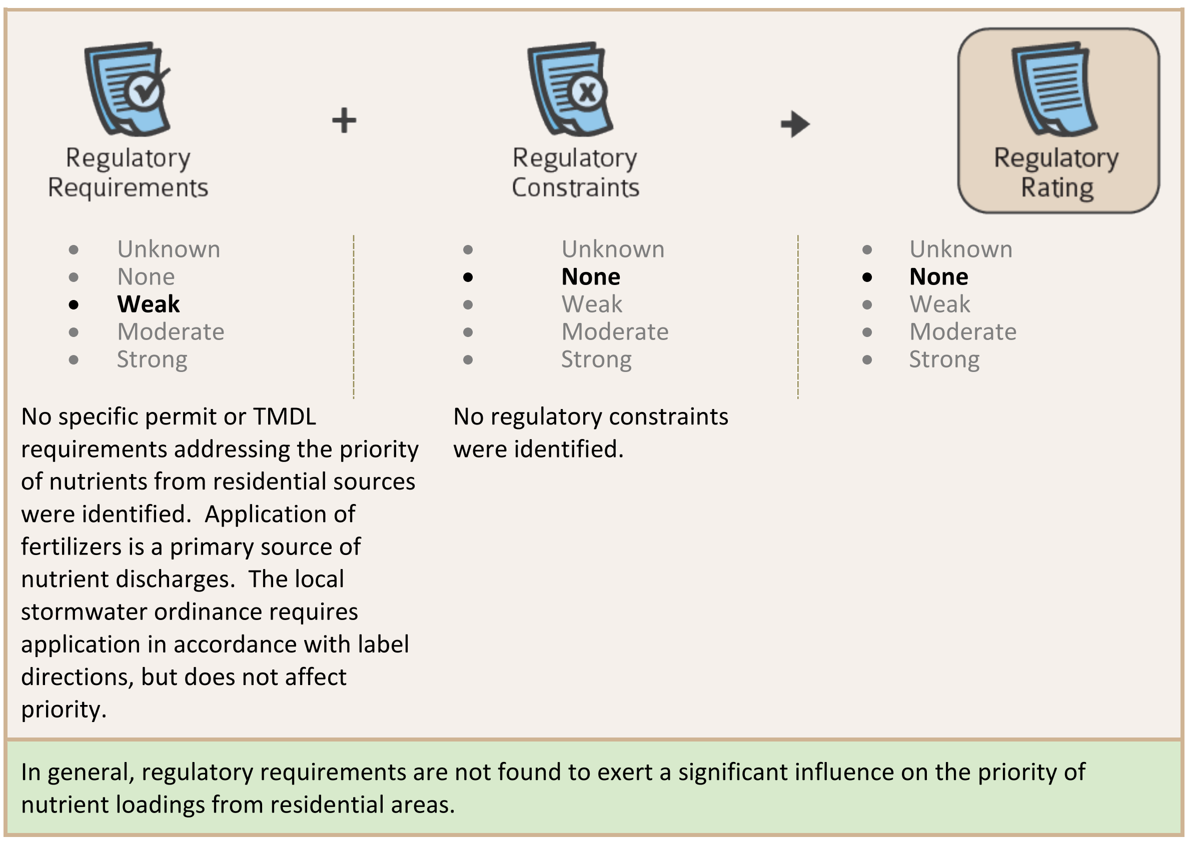


Figure 4.38: Establishing a Regulatory Rating for a Residential Source Contribution -- Nutrient Example[9]

[9] S = Strong, M = Moderate, W = Weak, N = None, U = Unknown. These are examples intended to illustrate potential rating designations.

Tier 2 Technical Review

Technical Ratings reflect a combined consideraion of three factors; significance, certainty, and controllability. The technical factors introduced in **Task 1** above (nature, magnitude, and varibility) combine to describe the **significance** of the source contribution (see **Figure 4.39**). As above, discretion is needed in scoring each of these factors due to the unique characteristics of each source loading scenario.

Evaluations of **certainty** should reflect an understanding of the precision associated with available data sources, or the methods used to analyze them. As an example, area-based pollutant loadings are often generated by applying Event Mean Concentrations (EMCs) for different land use types to a particular drainage area. Since EMCs are often derived from literature values, or from very limited local sampling, their use in estimating source or drainage area contributions can often be imprecise.

Nature	Magnitude	Temporal Variability	Spatial Variability	Significance
	• Unknown • Low • **Moderate** • High	• Unknown • Low • **Moderate** • High	• Unknown • Low • Moderate • **High**	• Unknown • Low • **Moderate** High
Wet weather monitoring data indicate nutrient exceedances of WQOs from residential areas.	Average values only slightly exceed the WQO for downstream receiving waters.	WQO is exceeded in 25% of sampling events.	Sampling over multiple years is broadly representative of residential sources within the drainage area. Exceedances are concentrated in 10% of sampling sites.	

An overall significance of **Moderate** is based primarily on magnitude. Temporal and spatial variability indicate that the contribution is neither persistent nor highly distributed. Additional investigation may be warranted in areas where exceedances are concentrated. Reevaluation of significance may be warranted only within those areas.

Figure 4.39: Establishing the Significance of a Residential Source Contribution -- Nutrient Example

While land area-based loading estimations are critical to planning, their use in prioritization and targeting should be approached with caution. Over time, they should be refined or augmented with other more precise indicators of source potential.

Controllability describes the potential to influence changes in a source contribution, primarily through the implementation of control measures. For any identified drainage area or source contribution, a variety of treatment or source control options may exist. Where they do, controllability will also depend on the ability of a program to direct resources to the problem, as well as that of regulated parties to implement identified solutions. Program resources and costs are therefore critical consideration in assesing controllability. Likewise, it can be dificult to control source contributions that are not well-understood (i.e., uncertain). In these cases, additional data collection may be needed to ensure that resource commitments are directed to the correct sources.

Figure 4.40 illustrates how significance, certainty, and controllability are jointly considered in the development of a Technical Rating using the same nutrient loading example.

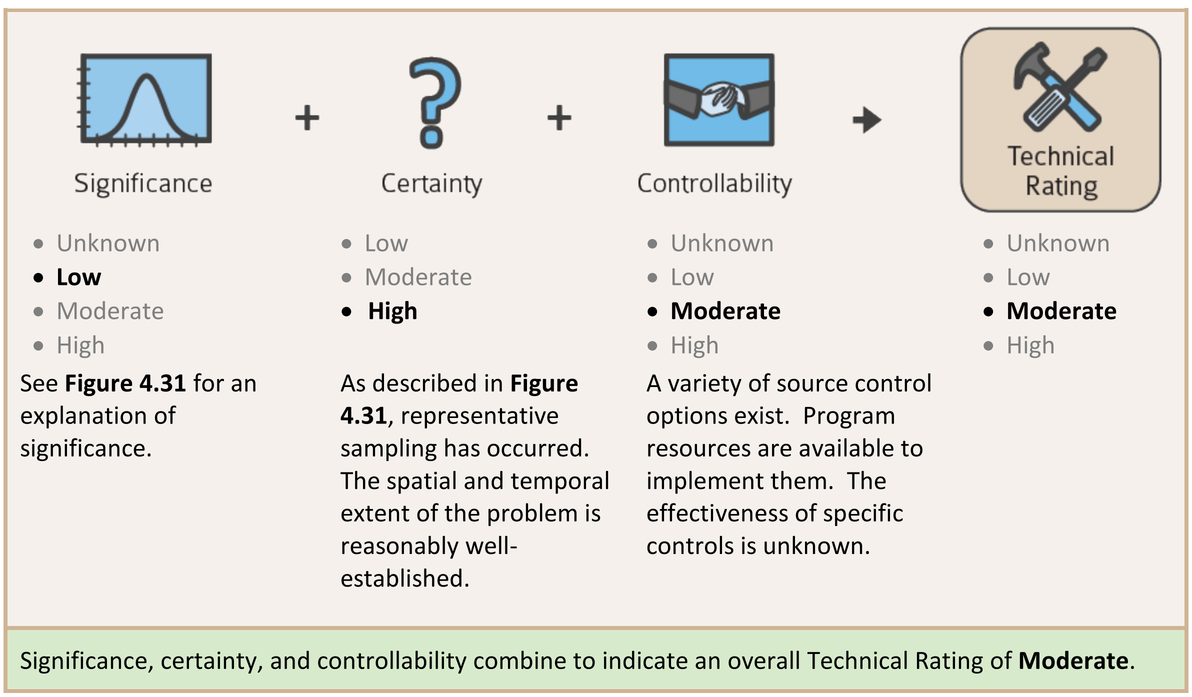


Figure 4.40: Establishing a Technical Rating for Residential Sources -- Nutrient Example

Tier 3 Sustainability Review

Wherever possible, prioritization should also consider social and economic factors. **Economic factors** are essential because both source loadings and reductions have costs associated with them. For example, if source loadings of bacteria are causing postings or closures of a receiving water, there is a cost associated with the reduction or loss of that beneficial use. Likewise, there the costs of implementing potential control strategies must also be considered. Depending on the specific source type, implementation costs are likely to be borne by regulated parties, stormwater programs, and possibly the public as a whole.

Social Impacts are those related to target audiences, society at large, or other specific segments. Perceptions and opinions regarding the implementation of potential control strategies can strongly influence priority. While the public generally expects to utilize and enjoy receiving waters, they will not always support the implementation of specific control measures needed to protect them.

Economic and social ratings may be developed individually, or a single combined rating may be developed for them together. Individual ratings would be a more likely choice in instances where managers want to give each factor greater overall weight to technical and regulatory factors. In most instances, knowledge of economic and social factors will be comparatively limited, so a single combined rating may be a more suitable choice.

Overall Priority Rating

As described in **Section 3.3 (Step A Task 3)**, Tier 1, 2, and 3 results are reviewed together to determine the **Overall Priority Rating** of each drainage area or source contribution. In the example shown in **Figure 4.41**, an Overall Priority Rating of High is assigned for residential loadings of nutrients.

As previously explained, equal weightings for all three sets of rating factors have been assumed. This is in keeping with the general recommendation made throughout this section to keep prioritization approaches as simple as possible. As described, simple qualitative approaches are generally appropriate given the lack of precision associated with most prioritization schemes. Discretion and judgment are necessary ingredients in the interpretation of results.

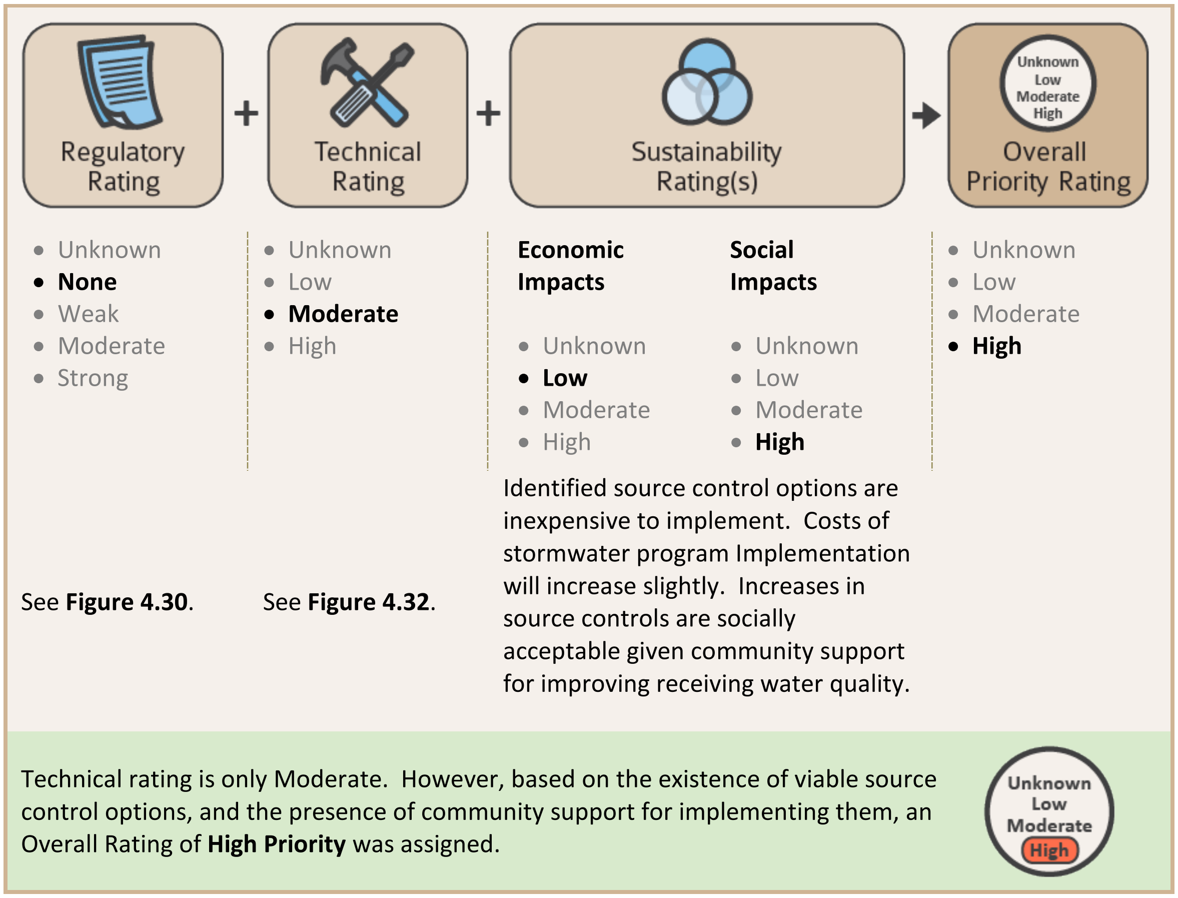


Figure 4.41: Establishing an Overall Priority Rating for Residential Sources -- Nutrient Example

Question 2 What is the relative importance of each drainage area or source contribution?

Individual priority ratings must now be evaluated together to determine their relative importance. Because programs must normally address a considerable number source contributions within any drainage area, considerations of scale are important. In some cases, managers will want to compare priorities across multiple drainage areas or source types (e.g., a comparison copper discharges from two drainage areas, or of several source types within a drainage area); in others, they will want to different types of contributions (e.g., copper versus bacteria) within a drainage area, or associated with a specific source type (e.g., industrial facilities or constructuion sites). All are legitimate analytical options, and may be pursued depending on the specific situation. For additional discussion on the significance of physical scale, see **Task 1, Question 2** above.

Two ranking options are illustrated in **Figure 4.42**.

↑ Increasing Priority ↑	RANKED ORDER EXAMPLE	GROUPED RANKING EXAMPLE
	1. Residential loadings of nutrients	**GROUP A (High)** • Residential loadings of nutrients
	2. Metals from industrial facilities	**GROUP B (Moderate)** • Metals from industrial facilities
	3. Bacterial loadings from improper	**GROUP C (Low)** • Bacterial loadings from improper • Sediment loadings from construction sites
	4. Sediment loadings from construction sites	

Figure 4.42: Potential Options for Ranking Source Problems within a Drainage Area

Identified problems can either be put into a **ranked order** or be **grouped** according to priority ratings. Establishing a ranked order consists of lining up the applicable problem conditions for each receiving water or segment from highest priority to lowest, with the higher priorities normally constituting the greater management priorities. A limitation to ranked order approaches is that receiving water problems may tend to have "tie scores". Using grouped rankings can reduce the need to conduct further analysis to differentiate between them.

Step 4 - B Targeted Changes to Source Contributions

Step 4-B addresses the establishment of measurable targets for drainage area and source reductions. As shown in **Figure 4.43**, it consists of three tasks, each of which is explored below.

Step 4-B begins with the list of **Priority Drainage Areas and Sources** established in **Step 4-A Task 3** above. Considering again the Drainage Area and Source Data and Information gathered for each condition on the list (**Step 4-A Task 1**), managers will establish specific, measurable targets and timelines for changes to be sought. For each identified priority contribution, one or more specific targeted reductions change should be considered.

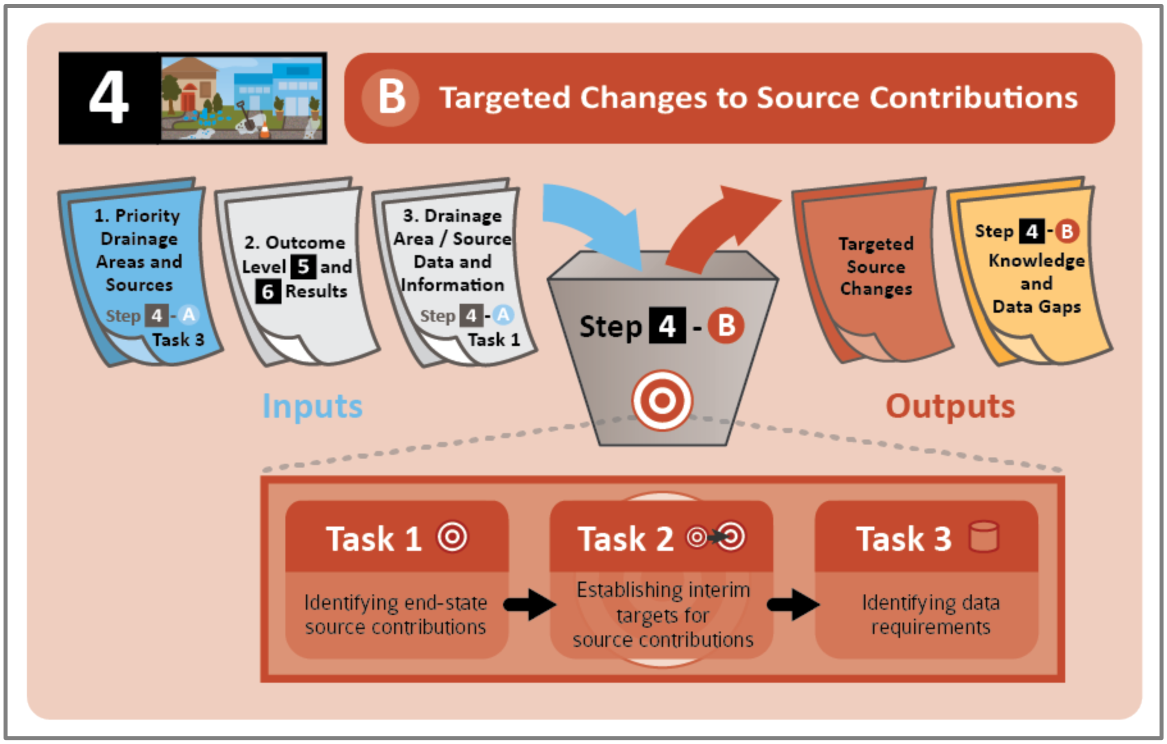


Figure 4.43: Targeting Changes to Source Contributions (Step 4-B)

Task 1 Identifying end-state targets

In **Step A**, users defined the nature and magnitude of individual problem conditions. In this task, they will focus on defining the changes to be sought in those conditions. It is guided by two general questions.

	Step 4-B Task 1 Key Questions Identifying End-state Targets	
Inputs	Key Questions	Outputs
Priority Source Contribution	**Question 1:** What is the end-state for the drainage area or source contribution? **Question 2:** When will the end-state condition be achieved?	**End-state Source Contributions**

Question 1 What is the end-state for the drainage area or source contribution?

End-state contributions are those that represent the absence of problems, or their reduction to acceptable levels. Targets for change should be considered at least for the highest priority contributions identified above. The establishment of targets should consider the review factors and general conceptual approaches described below.

Review Factors

Several review factors have general applicability in setting targets for drainage area or source reductions. As shown in **Figure 4.44**, these are the same general factors introduced above during problem prioritization.

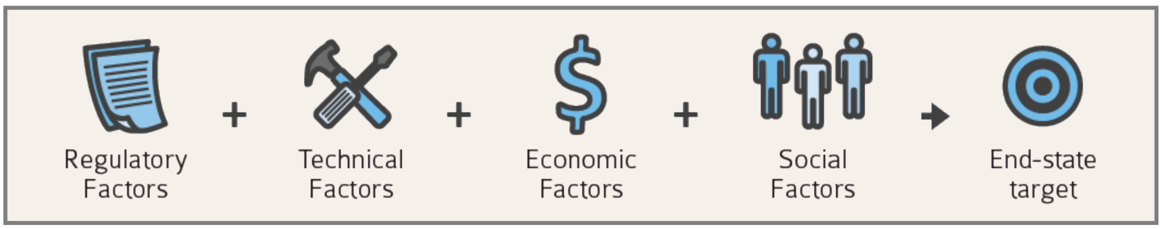


Figure 4.44: Factors Relevant to Setting Targets for Drainage Area and Source Reductions

Draft targets can initially be established through a consideration of the regulatory and technical factors introduced above (see **Task 4-A-3**), and these results further reviewed and refined as necessary in the context of sustainability considerations.

General Approaches to Establishing Targets for Drainage Area and Source Reductions

Targeting may follow any of the general approaches below, individually or in combination.

Setting Targets to Comply with Regulatory Requirements

Regulatory requirements can apply when setting targets for drainage area and source reductions. Sources or area-wide reductions that are specifically called out in Total Maximum Daily Loads will typically be treated as higher priorities. MS4 permits often establish priorities for specific source types, but normally do not establish corresponding requirements for specific reductions from them.

Setting Targets to Achieve MS4 and Receiving Water Improvements

For drainage area and source contributions, the end-state condition will ideally be the attainment of reductions that, in combination with other reductions, will reduce identified MS4 contributions to receiving water impacts. Given the many-to-one relationship of sources to MS4 and receiving water impacts, it’s likely that many source reductions will be targeted concurrently. The critical consideration is not necessarily whether or not each target can be achieved, but rather their cumulative impact. Some targets will most likely not be achieved and others may be exceeded. Managers should also be realistic about the attainability of any targeted conditions, and of the timeframes needed to achieve and measure them.

It should also be noted that targeted changes other than source reductions may be sought within a drainage area to help bring about Level 5 and 6 improvements. For instance, changes in land use or zoning, retention of open space, and increases in infiltration can all potentially contribute to the reduction or mitigation of source contributions prior to their discharge to the MS4.

Setting Targets to Resource Availability

Given the wide array of sources potentially contributing to any MS4 or receiving water impact, resource limitations can make it especially challenging to effectively target source contributions. Since programs will not be resourced to achieve all identified reductions, decisions must to be made about how much and how quickly each of them can be achieved. While resource allocations will tend to be proportional to the relative priority of each contribution, other factors such as controllability and return on investment should also be considered. Resource allocations may also need to be concentrated in specific drainage areas rather than distributed evenly across them.

Setting Targets to Learn and Adapt

In some instances, targets may be established simply to explore the relationship of source contributions to higher or lower level outcomes, or the potential for achieving specific source reductions. **Experimental targets** are intended to establish and explore assumptions or hypotheses about these relationships.

Most of the time, the actual reductions that can be achieved will be unknown. For example, if managers might have a good idea of the specific behavioral changes they want to pursue in a priority target audience, but little idea of whether or not that might translate to a measurable source reduction. By establishing and tracking measurements for both types of outcomes, they may be able to increase measurability and establish linkages between them. One specific way of approaching this is through the establishment of **stretch targets**. Building on existing accomplishments, they can "stretch" to see what can be done cost-effectively or within available resource commitments (note the similarity of this approach to approach #3 above). This fosters an active learning process while pursuing increases in measurability that might later be used to explore linkages.

Interim targets are also critical to the learning process because they provide opportunities for obtaining feedback along the way toward end-state conditions. These are discussed further under **Task 2**.

Question 2 When will the end-state condition be achieved?

Every targeted source reduction will ideally specify the timeframe needed to achieve it. Some timeframes will already been established as permit or TMDL requirements. Managers should also consider how much time is needed to realistically achieve the change. While end-state receiving water conditions and MS4 can take decades to achieve (e.g., 20-50 years or longer; see **Figure 3.16**), it's expected that some source reductions can be acheived on shorter timeframes due the greater degree of direct control that can be exerted. However, in many cases, the inherit variability of many types of drainage area and source data will be unknown. Managers may therefore need to address significant data gaps before metrics and methods can be developed to forecast or measure source reduction with confidence. Likewise, allowances should be made for the time it takes to "ramp up," refine, and fully implement the programs expected to drive these changes. Due to the speculative nature of forecasting these events, their establishment up front may not always be possible. Specificity and statistical certainty should always be a goal, but end-state timelines will often need to be established without them. In such cases, timeframes can be established provisionally, and then reviewed and modified as additional data, information, and results become available.

Table 4.19 provides a variety of examples of potential targets for end-state drainage area and source reductions. The uncertainty associated with many of these targets should be noted as this is often a prominent feature of the targeting process.

Table 4.19: Examples[10] of End-state Targets for Drainage Area and Source Reductions

Problem Condition	Priority	End-State Target	Explanation
Drainage Area Contributions			
Residential land uses discharge 414 lbs. of nitrates / year	High-Mod	Reduce nitrate loadings from residential areas by 45%	Because this is not a required reduction, it can be approached in combination with other programmatic stretch targets. This is an aggressive target that will require the initiation of a variety of control measures. Establishing measurability is key to learning which of them work and which don't.
Source Contributions			
Construction sites discharge sediment to MS4s	Moderate	Reduce sediment discharges by 10%	An existing baseline of contributions from which to measure has not been established.
Pet waste is estimated to represent 3% of bacterial loadings	Low	Reduce amount of pet waste in public parks by 75%	Reduction is focused in an area of high controllability. Loadings cannot be directly measured, so estimation of reductions must be approached through surveys and observations of staff.
Residential lawn watering contributes 23% of dry weather flows to MS4 outfalls	Moderate	Reduce overwatering by 20% (volume)	20% reduction in existing contribution represents 4.6% of the total. Other contributions would likely need to be concurrently targeted.

[10] These examples are hypothetical and for illustration only. They are not intended to imply a particular target or timeline for achieving any of the conditions listed.

Task 2 Establishing interim targets

Every targeted end-state condition will have a timeframe associated with it. Since many of these can take years, decades, or longer to achieve, a course of action will normally need to be set for incrementally achieving them. The establishment of interim targets follows two guiding questions.

Step 4-B Task 2 Key Questions
Establishing Interim Targets

Inputs	Key Questions	Outputs
End-state Targets	**Question 1:** What interim targets are needed to evaluate progress toward end-state drainage area or contributions? **Question 2:** When will interim targets be achieved?	**Interim Targets**

Question 1 What interim targets are needed to evaluate progress toward the end-state drainage area or source contributions?

Interim targets are routinely established in TMDLs, and many MS4s permits and permit-required watershed plans are increasingly setting specific timelines for achieving change. Change is not linear, so managers should be realistic about how quickly they can expect source reductions to change. As previously described, a challenge in establishing interim milestones is the ability of managers to forecast the implementation curve associated with targeted changes (e.g., time to “ramp up,” refine, and fully implement programs). Given this complexity, the forecasting of specific events in that curve can be speculative, and may not always be possible. In such cases, targets and timeframes can be established provisionally, and then reviewed and modified as additional data, information, and results become available.

Interim targets for source contributions may include achieving a percentage of the end-state target, or focusing on reductions within a specific drainage or set of priority drainage areas. Targets should also consider the level of effort needed to achieve a target given the understanding of the contribution, existing control strategies, and resources available to address them.

Question 2   When will interim targets be achieved?

Timeframes for acheiving interim drainage area or source reductions will initially be bounded by the schedules set for achieving end-state reductions, but should also reflect the need for specific feedback along the way. At a minimum, they should reflect the time needed to achieve critical events in the projected "implementation curve" described above. For sources addressed under a TMDL, or where MS4 permit conditions are prescriptive, interim targets and timelines may already be established.

Interim targets should be set to timelines that reflect both the time needed for projected changes to occur and for statistically valid measurement. As such, they should also account for the inherent variability of drainage area and source data. Since many applicable source-related data sets will not yet have been established, variability may often not be known. It's therefore important that source-related knowledge and data gaps continue to be addressed. As for other outcome levels, the commitment of resources to drainage areas and sources based on limited or anecdotal informaton should be approached with caution. Reasonable statistical support for the evaluation of end-state and interim targets should always be a goal. This issue is especially critical for interim targets because the timeframes needed for data collection and analysis are much shorter.

Task 3 Identifying data requirements

Now that targets for source reductions change have been identified, it's necessary to identify how they will be measured, what data are needed to allow measurement, and how these data will be collected and analyzed. Planning is not complete unless managers are fully prepared to obtain and evaluate the data needed to assess each targeted change. Each of the questions below should be addressed for every targeted outcome addressed in **Step 4-B**.

Question 1   What metrics will be used?

End-state and interim source reductions should both be expressed in unambiguous terms. This should include a specific formulation of the outcome statement, the assignment of units of measure or assessment, and units of time. **Section 7.3** provides additional detail on the establishment of metrics.

Question 2 What data collection methods will be used?

It's also essential that managers identify how data will be collected for each targeted source reductions so that it can be tracked and assessed. **Section 7.4** provides additional detail on potential data collections options.

Question 3 What data analysis methods will be used?

The last consideration for any targeted source reductions is how the data will be evaluated. The choice of analytical method can dictate what specific metrics should be used, how the data should be collected, and the quality of the result. **Section 7.5** provides additional discussion of data analysis options.

Figure 4.45 provides a Review Checklist to guide **Step 4-B** completion.

Review Checklist

Step 4-B Tasks 1, 2, and 3

Targeted Changes to Source Contributions

Apply this task individually to all conditions selected for targeting in Step 4-B. Its purpose is to identify specific targets for change in these conditions.

✓ **End-state Targets (Task 1)**
Consider the following questions:

Question 1: What is the end-state for the drainage area or source contribution?
Question 2: When will the end-state condition be achieved?

✓ **Interim Targets (Task 2)**
Consider the following questions:

Question 1: What interim targets are needed to evaluate progress toward end-state drainage area or contributions?
Question 2: When will interim targets be achieved?

✓ **Data Requirements (Task 3)**
Consider the following questions:

Question 1: What metrics will be used?
Question 2: What data collection methods will be used?
Question 3: What data analysis methods will be used?

✓ **For each priority source contribution, document interim and end-state targets, and the data requirements necessary to track and evaluate them.**

✓ **Compile one or more lists of targeted source reductions and supporting documentation for listed conditions.**

✓ **If a priority source reduction is not or cannot be targeted, document the reason.**

✓ **Document all Step B data and information gaps.**

NOTES

Figure 4.45: Review Checklist for Targeting Source Reductions

Step 4 - C Documenting Knowledge and Data Gaps

The identification of knowledge and data gaps should be ongoing throughout the entire Level 4 planning process. At its conclusion, managers should have developed a list of gaps that can be incorporated into a Monitoring and Assessment Strategy. **Section 7.0** provides additional guidance on assessment tools and strategies to support the development of these strategies. Because an existing baseline of data and information does not exist for many sources, Level 4 knowledge and data gaps can be significant. Critical gaps must be addressed to ensure that they are resolved over time. **Table 4.20** provides examples of general areas of inquiry where Level 4 knowledge and data gaps are likely to be encountered. These are intended to provide a framework for identifying actual knowledge and data gaps, which will be much more specific than those listed here.

Table 4.20: Potential Areas of Drainage Area and Source Knowledge and Data Gaps

- ✓ Understanding of drainage area contributions (EMCs, monitoring data, methodologies, etc.)
- ✓ Understanding of drainage area attributes (land uses, areas of pollutant and flow generation, population distribution, etc.; see also **Table 4.14**)
- ✓ Understanding of source contributions (potential or actual wet and dry weather discharges of pollutants or flows)
- ✓ Understanding of source attributes (number, size and types of sites or facilities; activities and practices; operations conducted; materials and wastes; see also **Table 4.15**)
- ✓ Adequacy of facility or other monitoring data (sample size, representative sampling, etc.)
- ✓ Knowledge of target audience attributes
- ✓ Knowledge of economic and social factors affecting drainage areas and sources