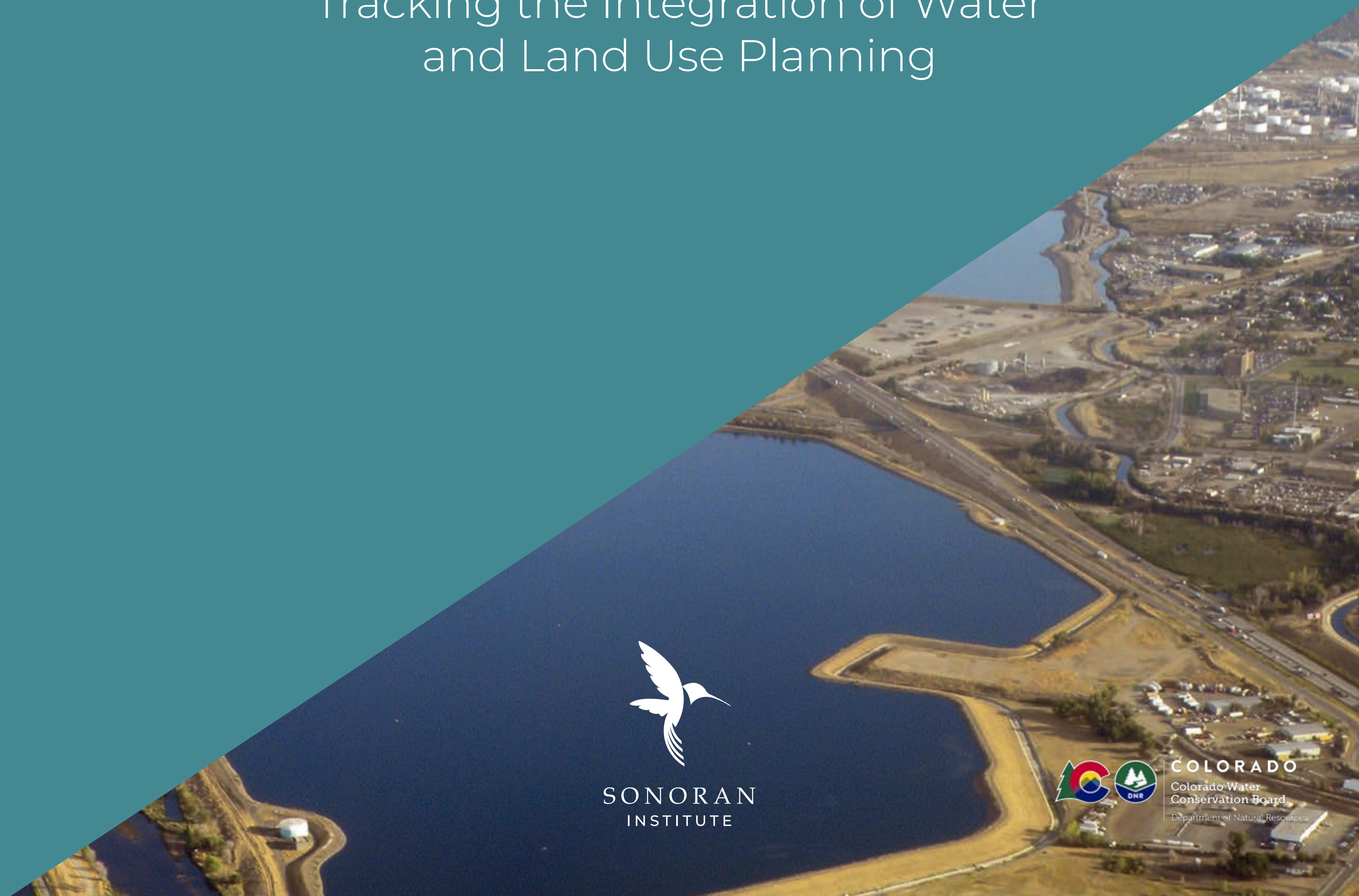
2020

GROWING WATER SMART **METRICS**

Tracking the Integration of Water and Land Use Planning



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ACKNOWLEDGEMENTS

In 2019, the Sonoran Institute and Brendle Group launched this project to identify metrics that can be used by water providers and land use planners to track the integration of water and land use planning as well as the impact of those integration efforts.

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A Center of the Lincoln Institute of Land Policy

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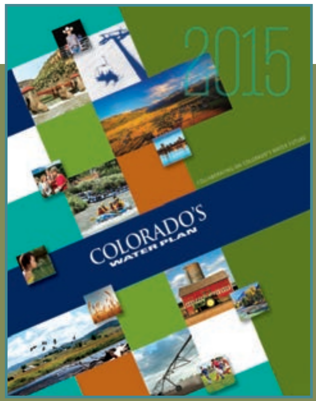
EXECUTIVE SUMMARY



The **2015 Colorado Water Plan** sets forth objectives, goals, and actions needed for Colorado to reliably meet projected future water demands. The integration of water and land use planning was identified as one crucial action to close the gap between future water supplies and demands. Taking that action requires collaborative engagement between planners who lead the way on community land use, and water providers who supply water and implement conservation and efficiency programs in those communities.

Previous efforts have defined the intersections of water and land use planning and established best practices for integration. *Integrating Water Efficiency into Land Use Planning in the Interior West: A Guidebook for Local Planners* (Nolon Blanchard, 2018) is a compilation of best practices for integrating water efficiency into land use planning. *Best Practices for Implementing Water Conservation and Demand Management Through Land Use Planning Efforts: Addendum to 2012 Guidance Document* (Castle & Rugland, 2019) identifies best practices for implementing water conservation and demand management through land use planning strategies. Growing Water Smart workshops, hosted by the Sonoran Institute and the Babbitt Center for Land and Water Policy, a center of the Lincoln Institute for Land Policy, are offered in Colorado and Arizona to bring together water planners, land use planners, and elected officials to work through local challenges inherent in implementing these best practices (Sonoran Institute, 2019a).

This guidebook builds on that past work by recommending common metrics that should be used where relevant and appropriate to measure the progress of water-land use planning integration and the impacts of those integration efforts at community, regional, and State scales. This guidebook presents 24 recommended metrics, 10 of which measure integration progress *(Table 1)* and 14 of which measure integration impacts *(Table 2)*. Additional metrics evaluated during the course of the project may be of interest to some communities *(Appendix B: Metrics Inventory)*.

Table 1. Summary of Recommended Progress Metrics

PROGRESS METRICS

METRIC #	COMMUNITY SCALE	REGIONAL/STATE SCALES
Development of long-range plans		
# 1	The community's long-range land use plan integrates water efficiency	Percent of population living in communities with a long-range land use plan that integrates water efficiency
# 2	The community's long-range water plan integrates land use strategies	Percent of population living in communities with a long-range water plan that integrates land use strategies
Implementation of conservation and efficiency programs		
# 3	The community is served by provider(s) using conservation-oriented system development charges	Percent of population served by provider(s) with conservation-oriented system development charges
# 4	The community is served by provider(s) using conservation-oriented pricing structures	Percent of population served by provider(s) with conservation-oriented pricing structures
Adoption of landscaping and building codes		
#5	The community has adopted the most recent International Code Council version and/or the International Green Construction Code	Percent of population living in communities that have adopted the most recent International Code Council version and/or the International Green Construction Code
#6	The community has adopted reuse water into local code	Percent of population living in communities adopting reuse water into local code
#7	The community has adopted outdoor efficiency standards that exceed State standards	Percent of population living in communities with outdoor efficiency standards that exceed State standards
Implementation of adequate water supply rules		
#8	The community has adopted water supply adequacy requirements that exceed State minimum standards	Percent of population living in communities with water supply adequacy requirements that exceed State minimum standards
Extent of regionalization/collaboration		
#9	Community planners and provider(s) have regular coordination meetings	Percent of population living in communities where planners and provider(s) have regular coordination meetings
#10	The community routes development proposals to provider(s) for review and comment	Percent of population living in communities that route development proposals to provider(s) for review and comment

Table 2. Summary of Recommended Impact Metrics

IMPACT METRICS

METRIC #	DESCRIPTION	PRECURSOR METRIC
Trends in water demand and use		
# 11	Total water distributed by providers	--
# 12	Total potable water distributed by providers	11
# 13	Percent of municipal demands served by potable water supplies	11, 12
# 14	Total water reused/reclaimed	11
# 15	Total non-potable water use	11
# 16	Per capita water demands	11
# 17	Percent of distributed water serving outdoor uses	11
# 18	Average irrigation rate	17, 23
# 19	Percent of irrigation demands supplied by non-potable or reuse supplies	17
# 20	Water demands by land use type	11
# 21	Forecasted water demands based on future land use plan	20
# 22	Gap between annual water supplies and demands	21
Trends in development patterns and land use		
# 23	Total irrigated area within provider service areas	--
# 24	Population density	--

There are myriad benefits to tracking these metrics, foremost the potential for more informed decision-making and policy-setting. From an ecosystem health perspective, use of these metrics can help influence land use activities that benefit streamflows and natural habitats. From an economic and financial health perspective, use of these metrics can lead to reduced development costs, reduced infrastructure investments, and preservation of tourism and agricultural economies. Finally, the use of these metrics can help increase community resiliency by improving water supply reliability, fostering collaboration across organizations, reducing risks from natural hazards, lowering energy use, and avoiding greenhouse gas emissions.

Future work should focus on (1) selected communities calculating the recommended metrics, (2) advancing incentives to encourage communities and water providers to not only calculate the metrics but also to report results to the State to inform policy and planning directions, and (3) refining implementation recommendations for a wider rollout across the State.

Barriers and challenges to calculating the recommended metrics include:

- Data availability, which will vary by community.
- Ability to align data between and across communities.
- Staff capacity and technical expertise needed to calculate the metrics.
- Data privacy concerns and sensitivities about sharing metric results.

Photo Credit: Jeremy Stapleton

CHAPTER 1
INTRODUCTION

ABOUT COLORADO'S STATE WATER PLAN

The **Colorado Water Plan** sets forth critical actions necessary to address Colorado's growing water gap (State of Colorado, 2015; Colorado Water Conservation Board, 2018; State of Colorado, 2019b). The gap between water supplies and demands in the municipal and industrial sector is expected to grow to as much as 750,000 ac-ft by 2050, even with continued conservation and the completion of dozens of water projects (State of Colorado, 2019b). In addition to traditional conservation and storage strategies, the Plan includes a measurable objective that "75 percent of Coloradans will live in communities that have incorporated water-saving actions into land use planning by 2025 (*Figure 1*)."

The Colorado Water Plan also recognized severe funding challenges, setting a measurable objective to raise $100 million annually in additional revenue for plan implementation. Colorado voters in 2019 passed Proposition DD, which will provide a new revenue stream to fund water projects (State of Colorado, 2020a).

Figure 1. Colorado Water Plan Objectives (Colorado Water Conservation Board, 2018)

ABOUT THE PROJECT

The State of Colorado ignited water and land use planning integration activities by including the aforementioned objective in the Colorado Water Plan and funding related projects through Colorado Water Plan implementation grants (Colorado Water Conservation Board, 2019c). But while the Water Plan objective is clear and measurable, the plan does not specify how to assess progress towards the goal or how to assess the water-saving impacts of those activities.

Based on research conducted by the Babbitt Center and analyzed by the Brendle Group, 89 percent of Colorado's current population of 5.6 million lives in a community with a water element or section in their long-range comprehensive plan (Rugland, 2019; Colorado Department of Local Affairs, 2019a). Is that finding sufficient to claim that Colorado has achieved the Water Plan objective? How much does this number really tell us about the extent to which communities have integrated water and land use planning, and even more importantly, whether those actions have saved water?

The purpose of this project was to **identify and evaluate meaningful metrics** that communities and the State can use to measure the progress of water-land use planning integration as well as the impacts of those integration efforts.

Water Demands Defined

- **Municipal and industrial demands**
  This term refers to municipal and industrial water demands inclusive of self-supplied industrial demands.
- **Municipal demands**
  Portion of distributed water attributable to uses typical of municipal systems, including residential, commercial, light industrial, non-agricultural-related irrigation, firefighting, and non-revenue water. Demands for self-supplied households not connected to a public water supply are also included.
- **Self-supplied industrial (SSI) demands**
  Water demands from large industrial users that have their own water supplies or lease raw water from others. Industrial needs met by municipal water providers are incorporated into municipal water demands and are not part of SSI demands.

(State of Colorado, 2019b)

Project Objectives

- Curate a set of metrics that are useful to measure the progress and impact of water-land use planning integration efforts.
- Engage community planners and water providers from around the State to provide input on what metrics are valuable and to inform the benefits and barriers of calculating those metrics.
- Recommend common metrics for all communities to adopt and which can be synthesized at regional and State scales to establish baseline conditions and to track progress over time.

A Call to Action

As the Colorado Water Plan highlights, even with efficiency improvements and new infrastructure projects, the State could face a gap of up to 750,000 acre-feet of water annually in the municipal and industrial sector (State of Colorado, 2019b). Integrating water and land use planning is important for designing efficient water systems and communities to mitigate demands in the face of climate uncertainty.

Data and information are essential: How are we doing, what is working well, and what is not working well? To help answer these questions, we hope Colorado's water and planning professionals will use the metrics presented in this guidebook to establish baseline values, set targets, and inform decision-making at local, regional, and State levels.

This guidebook is a call to action to community land use planners, water providers, consultants, government agencies, universities, and non-profit organizations to lead the way in collaboration and data-driven decision-making. This is an opportunity to step beyond siloed roles and jurisdictional boundaries to collaborate with different members of your community and with the communities around you.

ABOUT THIS GUIDEBOOK

Purpose

The purpose of this guidebook is to assist water and planning professionals in assessing and tracking the quantity, quality, and impact of integrated water and land use planning efforts in Colorado.

The audience for this work is intended to be broad and inclusive of community land use planners, water providers, consultants, government agencies, universities, and non-profit organizations. Interested parties may benefit from the metrics and methodologies described in this guidebook; others may benefit from the metric results themselves.

Guidebook Principles

- This guidebook focuses on how to measure the progress and impact of water-land use planning integration efforts. Other references serve to define how to integrate water and land use planning (Castle & Rugland, 2019; Nolon Blanchard, 2018; Sonoran Institute, 2019b).
- The recommended metrics should result in values that are clearly impacted by land use decisions.
- The recommended metrics should be useful to a range of practitioners including water providers, land use planners, and regional and State government representatives.
- The recommended metrics should make sense at a variety of scales including water service areas, community planning areas, regional jurisdictions, and the State.
- The recommended metrics should be applicable to diverse communities – from the Denver metropolitan area to the suburban Front Range and from the Western Slope to the Eastern Plains to the Southern desert.
- Piloting the metrics, establishing baseline values, and setting target values are the next steps in this effort.

Guidebook Users

- Are looking to make the case for measuring the relationship between water and land use planning.
- Are interested in quantifying and monitoring efforts made to integrate water and land use planning.
- Are looking for an educational tool to understand metrics, their relevance, and the level of resources needed to implement.
- Should consider using a consistent methodology for their own area of interest to support regional and Statewide findings.
- Are looking for recommendations to overcome barriers and maximize benefits from the outcomes.

Metric Results Users

- Are looking to make data-based decisions that can be used to guide policies, programs, funding, and allocation of technical resources.
- Are interested in bringing water efficiency and conservation into long-range comprehensive plan development.
- Are interested in bringing land use strategies into long-range water planning.
- Seek to identify and resolve gaps in development codes and/or planning and coordination processes.
- Seek to identify gaps to inform future research.

Though this guidebook was developed using information specific to Colorado, many of the metrics apply more broadly to any community in the arid West seeking to better understand the progress and impact of integrated water and land use planning efforts.

A Quick Look at the Rest of the Guidebook

Chapter 2: Anchor discusses foundational concepts, including a short synopsis of the intersections between water and land use planning, the benefits of measuring integrated water and land use planning efforts, and the distinction between progress and impact metrics.

Chapter 3: Define presents the recommended progress and impact metrics.

Chapter 4: Activate addresses implementation considerations, opportunities, and barriers.

Chapter 5: Next Steps briefly describes recommended next steps and conclusions.

Appendix A: Project Approach presents a summary of the research project and stakeholder engagement process that led to the development of this guidebook.

Appendix B: Metrics Inventory shows the full list of metrics considered during this research project.

CHAPTER 2
ANCHOR

This chapter introduces concepts that are foundational to developing a common understanding and ultimately laying the groundwork to recommending progress and impact metrics.

Key questions:

1. What constitutes land use authorities and water providers?
2. Where do land use planning and water-saving actions intersect?
3. Why should communities track metrics?
4. What metrics should be considered?

WHAT CONSTITUTES LAND USE AUTHORITIES AND WATER PROVIDERS?

As a Home Rule state, municipalities in Colorado are self-governing, with the ability to pass their own laws. In incorporated areas, the municipal government is the governing land use authority; in unincorporated areas, the county government is the governing land use authority. For the purposes of this guidebook, the term “local” is used to refer to the governing land use authority (municipal or county government). All local governments are subject to the State of Colorado, which has the authority to set minimum requirements governing land use, though local entities can choose to exceed minimum standards. Where no State standards are established, local governments are free to establish local standards.

Municipalities and counties may also be members of a regional Council of Governments (COG) or Metropolitan Planning Organization (MPO). These quasi-governmental organizations serve as regional conveners but typically do not exercise land use authority.

Water services may be provided by a municipality or by a special district under Title 32 of the Colorado Revised Statutes (Colorado Department of Local Affairs, 2019c). Special districts that provide water services include water districts, water and sanitation districts, and some metropolitan districts.

It is very common for water service area boundaries to differ from land use authority boundaries, certainly when special districts are providing water services, but even when both entities are housed within the same municipal government. These jurisdictional differences may present challenges when calculating the metrics recommended in this guidebook.

The key foundational concepts include:

- Land use authorities may be separate entities from the special districts that provide water services.
- Communities can be served by multiple water providers, or one water provider can serve multiple communities.
- Water providers can serve both incorporated and unincorporated areas, subject to multiple land use authorities.

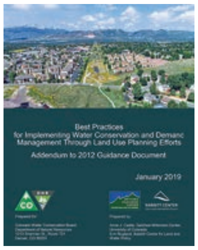
What are intergovernmental agreements (IGAs)?

Two governmental (or quasi-governmental) entities may choose to enter into an IGA to formalize a shared intent to work together to address problems of mutual concern. For example, a municipality and a county might enter into an IGA to plan for land owned by the county but within the Growth Management Area of the municipality. IGAs are instruments to formalize the collaboration among and between entities that is advocated for in this guidebook.

WHERE DO LAND USE PLANNING AND WATER-SAVING ACTIVITIES INTERSECT?

Previous research efforts have defined the intersections of water and land use planning and the best practices for their integration:

Integrating Water Efficiency into Land Use Planning in the Interior West: A Guidebook for Local Planners (Nolon Blanchard, 2018): This reference is a compilation of best practices for integrating water conservation and efficiency into land use planning processes. One of the most valuable elements of this reference is a matrix that shows the intersections between six types of land use planning (comprehensive plans, zoning regulations, subdivision regulations, site plan regulations, building codes, and plumbing codes) and five categories of water conservation measures (land use, equipment, landscape, monitoring and enforcement, and other). The matrix is reproduced for reference in *Figure 2*.



Best Practices for Implementing Water Conservation and Demand Management Through Land Use Planning Efforts (Castle & Rugland, 2019): This reference is an addendum to the State's *Municipal Water Efficiency Plan Guidance* document (Colorado Water Conservation Board, 2012). The reference provides detailed guidance to water providers about best management practices for using land use strategies to achieve water conservation and demand management goals. Water conservation and efficiency activities are organized into four categories:

1. **Foundational activities** include regular contact and sharing of information between water providers and planners, data alignment, and the integration of water considerations into the development approval process.
2. **Targeted technical assistance and incentives** are policy- and program-oriented activities that include setting conservation-oriented tap fees and providing model landscape plans.
3. **Ordinances and regulations** include the incorporation of water into zoning codes and procedures, building and plumbing codes, and development approval processes.
4. **Education and outreach activities** focus on sharing information through various communication channels.

Best practices for each of the four categories are summarized in *Table 3*.

Growing Water Smart: The Water-Land Use Nexus (Sonoran Institute, 2019b): This reference provides a toolkit for Arizona, California, and Colorado that helps communities take action in integrating water and land use planning by providing recommendations and templates organized within five topic areas:

1. Planning and policy making
2. Adequate and sustainable water supply requirements
3. Water smart land use policy
4. Healthy and resilient watersheds
5. Water conservation rate structuring

Coordinated Planning Guide: A How-To Resource for Integrating Alternative Water Supply and Land Use Planning (Fedak, et al., 2018): This guide and an accompanying research report explore how alternative water supplies in particular can be integrated into land use planning. The guide includes case studies as well as a "top ten" list for improving collaboration between community planners and water providers.

Together, these resources provide thorough guidance regarding the intersection of water and land use planning. Though these resources might individually be viewed as "community planner-led" or "water provider-led" depending on the type of plan being developed, the reality is that many of the implementation actions require coordination between community planners and water providers. For example, a long-range comprehensive master planning effort may be led by the planning department but should include representatives from other city or county departments, including water providers. Similarly, system development fees and water adequacy demonstrations are generally the responsibility of water providers, but these regulations have major impacts on development and should be coordinated with the planning department.

Table 3. Water-saving activities and land use planning matrix (Nolon Blanchard, 2018)

✓ = Measure is applicable

MATRIX OF IMPLEMENTATION TECHNIQUES						
Water Conservation Measures	Comp Plan	Zoning Regs	Subdivision Regs	Site Plan	Building Code	Plumbing Code
EQUIPMENT						
Green plumbing code	✓		✓	✓		✓
Indoor fixture efficiency standards	✓				✓	✓
Reuse of water	✓				✓	✓
Smart meters	✓				✓	✓
Submetering multifamily units	✓				✓	✓
Incentives	✓					
LANDSCAPE						
Landscape codes matched to land use type	✓		✓	✓		
Landscape plan requirements (xeriscaping)	✓	✓	✓	✓		
Soil quality requirements	✓		✓	✓		
Plant list/Allowable plants	✓		✓	✓		
Tree size requirement	✓		✓	✓		
Turf limitations (type and quality)	✓		✓	✓		
Artificial turf	✓		✓	✓		
Irrigation system efficiency requirements	✓		✓	✓		✓
Water waste rules	✓		✓	✓		
Rain sensors	✓		✓	✓		✓
Spray nozzles	✓		✓	✓		✓
Water harvest	✓		✓	✓		✓
Water harvesting into landscape irrigation	✓					✓
Fixture efficiency standards	✓					✓
Water loss limits	✓		✓	✓		✓
Positive shutoff	✓					✓
Incentives	✓					
MONITORING AND ENFORCEMENT						
Penalties - civil and criminal	✓	✓				
Post-occupancy violations	✓					
Intermunicipal inspections and prosecutions	✓					
OTHER						
Goal to be water wise	✓					
Percentage reduction in water use	✓					
Water fee based on size of structure and lot	✓					
EPA WaterSense standards	✓					
Model home requirements	✓					
Rebates	✓					

Figure 2. Best Management Practices for Implementing Water Conservation and Demand Management through Land Use Planning Efforts – Adapted from (Castle & Rugland, 2019)

FOUNDATIONAL ACTIVITIES	1. Establish Regular Contact and Information Sharing 2. Align Data and Information Used 3. Establish Coordinated Procedures for Post-Occupancy Monitoring and Enforcement 4. Integrate Water Considerations into the Development Approval Process 5. Integrate Long Term Land Use and Water Planning
TARGETED TECHNICAL ASSISTANCE AND INCENTIVES	1. Developer Incentives to Reduce Water Demand 2. Conservation-Oriented Tap Fees 3. Water Efficient Land Development Patterns 4. Model Landscape Plans 5. Incentives for Reduced Irrigation 6. Water-Smart Home Options 7. Become a WaterSense Partner 8. Low Water Use Demonstration Homes 9. Water Audits 10. Rainwater Reuse
ORDINANCES AND REGULATIONS	1. Examine Existing Land Use Regulations for Barriers and Conflicts 2. Adopt or Strengthen Water-Related Ordinances or Regulations 3. Water Conservation in New Development, Re-Development, and Annexation 4. Incorporate Water Efficiency into Zoning Codes and Rezoning Procedures 5. Subdivision or Site Plan Regulations that Include Water Conservation 6. Implement Requirements that Contribute to Water Efficiency and Compact Infrastructure 7. Water Efficient Landscape Code 8. Building and Plumbing Codes 9. Ordinances Promoting Efficient Fixtures in Existing Buildings 10. Regional Coordination of Water Policy and Procedures
EDUCATION AND OUTREACH ACTIVITIES	1. Consistent Online Information 2. Water Provider and Planning Department Work Together to Educate the Public 3. Lead by Example 4. Jointly Engage with the Development Community and HOAs 5. Share Success Stories and Case Studies with Other Communities and the Public 6. Coordinate Education and Outreach Across the Region

WHY SHOULD COMMUNITIES TRACK METRICS?

Input from more than 25 stakeholders was gathered through planning workshops and a survey to identify the motivations for, and the benefits of, tracking integration metrics. The input was organized into four categories of benefits described below.

Improved decision-making

The foremost benefit of using integration metrics is the ability to support more informed decision-making and policy-setting. Ultimately, these metrics can help guide land use and water system development decisions.

Metrics can also be an educational tool to demonstrate the relationship between land use and water consumption. In particular, metric results can be used to raise awareness of situations where water supplies are a limiting factor for continued growth.

Importantly, metric results can be used to judge success so that resources are directed to the most effective programs. Conversely, metric results may be used to identify gaps where new resources and programs are needed most.

What is a metric?

A standard of measurement of or relating to an art, process, or science of measuring.

Synonyms: benchmark, criterion, gold standard, measure, standard, yardstick

(Merriam-Webster, 2019)

Why should the State of Colorado track metrics?

- Demonstrate progress toward Colorado Water Plan objectives
- Assess impacts from integrated water and land use planning efforts
- Link State grant funding to integration efforts and outcomes
- Focus policy, planning, and funding priorities on areas that need improvement

Ecosystem health

From mountain peak to river valley, Colorado's water supports vibrant and diverse ecosystems, in addition to serving growing municipal and industrial demands. Land use planning and water conservation practices, when integrated, can support environmental objectives by helping preserve minimum streamflows, improve water quality through stormwater management, support wildlife through habitat connectivity; and safeguard native ecosystems through open lands.

Fiscal Health and Economic Performance

The integration of water and land use planning helps improve the fiscal health and economic performance of communities and water providers through reduced development costs, reduced infrastructure investments, reduced operating costs, and preservation of tourism and agricultural economies.

Water efficiency and conservation strategies are correlated with avoided costs (e.g., costs associated with acquiring new water rights, building new treatment and distribution infrastructure, and treating higher volumes of water). Reducing costs supports the overall fiscal health of water providers, but also helps to stabilize system development charges, which benefits developers and homeowners.

Water plays an important role in preserving Colorado's tourism and agricultural economies. Just as allocating water to rivers and lakes is important for preserving ecosystem health, it is also important for supporting boating and fishing industries. Scarcity in water rights has led many communities to purchase rights from agricultural lands, a practice known as "buy-and-dry." Avoiding buy-and-dry transactions is a priority for many communities given the importance of agriculture to local and State economies.

Ultimately, making data-driven decisions can help to maximize the value of water by meeting a variety of needs at a lower cost to water providers, developers, and the public.

Community resilience

The use of these metrics can help increase community resilience by improving water supply reliability and fostering collaboration across organizations. Water reliability can be improved by promoting alternative water supplies where feasible and cost-effective and through improved demand forecasting. Beyond resilient water systems, the use of these metrics may lead to land use and water use patterns that cultivate resilience through reduced flood risk, mitigation of the urban heat island effect, reduced energy use, and avoided greenhouse gas emissions.

WHAT METRICS SHOULD BE CONSIDERED?

For the purposes of this guidebook, metrics have been categorized into those that measure the progress of water-land use planning integration efforts (progress metrics) and those that measure the impacts of the integration efforts (impact metrics). While each metric can individually improve understanding and decision-making, using a suite of progress and impact metrics will permit a holistic evaluation and the correlation of integration actions with outcomes. Out of 70 metrics evaluated, 24 metrics are recommended by virtue of being related to both water and land use planning and applicable to a diverse range of communities. The following sections describe the 24 recommended metrics; Appendix B contains a full list of the 70 metrics that were considered.

PROGRESS METRICS OVERVIEW

Progress metrics measure policies or actions taken to integrate water and land use planning. In compiling a list of candidate metrics, six categories were used to define the scope of progress being measured:

- **Development of long-range plans:** Comprehensive plans and water efficiency (or water master) plans remain the key long-range planning documents for integration, as they lay the foundation for a community or organization's growth and policy direction. The State of Colorado now requires that water efficiency plans incorporate land use strategies for water conservation and demand management in order to qualify for implementation grant funding (Castle & Rugland, 2019).
- **Implementation of conservation and efficiency programs:** Planned conservation and efficiency programs, including those that employ land use strategies, are typically described in water efficiency plans developed by water providers. While developing a water efficiency plan is an important first step, implementing the conservation and efficiency programs is necessary to achieving water savings.
- **Adoption of landscaping and building codes:** Landscaping requirements and building codes are two key tools used by planners for incorporating water efficiency into new development.
- **Implementation of adequate water supply rules:** Water supply and infrastructure adequacy are essential for ensuring coordinated growth and managing the impacts of new developments on water systems.
- **Use of water supply and demand data to inform land use:** The coordination and sharing of land use and water data lay at the heart of making informed land use and water decisions.
- **Extent of regionalization/collaboration:** Collaboration between land use planners and water providers within a community or among different entities across communities indicates that conditions exist to scale the successful integration of water and land use planning.

Ten progress metrics are recommended for use across communities and providers (*Table 4*). The recommended metrics cover five of the six categories considered; no metrics from the category of "use of water supply and demand data to inform land use" are recommended. The metrics assigned to this category were deemed foundational to water conservation but not strongly tied to land use planning decisions. Each recommended metric is described in more detail in **Chapter 3: Define, Recommended Progress Metrics.**

Table 4. Recommended Progress Metrics

PROGRESS METRICS

METRIC #	COMMUNITY SCALE	REGIONAL/STATE SCALES
Development of long-range plans		
# 1	The community's long-range land use plan integrates water efficiency	Percent of population living in communities with a long-range land use plan that integrates water efficiency
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#10	The community routes development proposals to provider(s) for review and comment	Percent of population living in communities that route development proposals to provider(s) for review and comment

IMPACT METRICS OVERVIEW

Impact metrics measure actions or outcomes that result in water savings (or other desired outcomes) from integrated water and land use planning. In compiling a list of candidate metrics, three categories emerged that define the scope of impacts being measured:

- **Trends in water demand and use:** This category includes water use metrics that measure municipal demands, the balance between water supply and demand, the proportion of water used outdoors, and water use efficiency.
- **Conservation and efficiency program measures:** This category includes metrics that measure conservation program participation and outcomes.
- **Trends in development patterns and land use:** This category includes metrics that measure changes in land use. These metrics are intended to assess whether land use is being influenced through water-land use planning integration.

Fourteen impact metrics are recommended as common metrics across communities and providers (*Table 5*). Though these metrics are intended to demonstrate outcomes from integrated water and land use planning activities, it will be challenging to correlate outcomes from specific actions taken, such as integrating water into long-range comprehensive land use planning. Therefore, it is recommended to track progress and impact metrics together to help correlate actions and outcomes. The recommended metrics cover two of the three categories considered; no metrics from the category of "conservation and efficiency program measures" are recommended because, though they are foundational to demand management, they are not directly related to land use planning decisions. Each recommended metric is described in more detail in **Chapter 3: Define, Recommended Progress Metrics.**

Photo Credit: Jeremy Stapleton

Table 5. Recommended Impact Metrics

IMPACT METRICS

METRIC #	DESCRIPTION	PRECURSOR METRIC
Trends in water demand and use		
# 11	Total water distributed by providers	--
# 12	Total potable water distributed by providers	11
# 13	Percent of municipal demands served by potable water supplies	11, 12
# 14	Total water reused/reclaimed	11
# 15	Total non-potable water use	11
# 16	Per capita water demands	11
# 17	Percent of distributed water serving outdoor uses	11
# 18	Average irrigation rate	17, 23
# 19	Percent of irrigation demands supplied by non-potable or reuse supplies	17
# 20	Water demands by land use type	11
# 21	Forecasted water demands based on future land use plan	20
# 22	Gap between annual water supplies and demands	21
Trends in development patterns and land use		
# 23	Total irrigated area within provider service areas	--
# 24	Population density	--

Photo Credit: Jeremy Stapleton

CHAPTER 3
DEFINE

This chapter takes a closer look at each recommended metric including a description of the metric, desired outcomes, a methodological approach, data needs and sources, calculation considerations, and where to go for more information.

RECOMMENDED PROGRESS METRICS

Each of the recommended progress metrics puts focus on one type of action that can be taken to integrate water and land use planning. The recommended progress metrics are characterized by four commonalities:

- **The influence of scale on resulting values and units of measure:** For a community, the result of each metric will be a "yes" or "no" outcome, though the quality and comprehensiveness of the actions will vary from "minimum to be counted" to "gold standard." For a region or the State, the result of each metric will be a percentage value that varies between 0-100.
- **The need to develop an evaluation approach that quantifies the quality and comprehensiveness of the actions taken:** For each recommended progress metric, the "minimum to be counted" is defined in the following tables. However, defining the "gold standard" will require the development of evaluation rubrics that establish assessment methodologies to evaluate the quality and comprehensiveness of the efforts across communities. Over time, as new technologies and processes emerge and more information becomes available from calculating the metrics, the "gold standard" will evolve and it will be important to update the evaluation rubrics accordingly.
- **The timing of metric updates:** Each recommended progress metric could be calculated on an annual basis to take advantage of updated population data and to incorporate new integration actions. However, the effort required to calculate this suite of metrics may necessitate that at least some metric values be updated less frequently, perhaps every five years. Designing automated and repeatable systems to collect, analyze, and report metric results will help. Metrics will ideally be updated along with existing work processes, such as water efficiency plan updates or as needed to inform decision making.
- **The responsibility for calculating metrics:** At the local scale, local planners and water providers are best suited to evaluate these metrics. At all scales, data collection and analysis will be time-consuming and may require extensive staff capacity, technical expertise, and resources. Non-profit, university, or consultant services may be required unless a clear process is established for communities to calculate and self-report the metric values to support regional and State analyses.

1. THE COMMUNITY'S LONG-RANGE LAND USE PLAN INTEGRATES WATER EFFICIENCY

METRIC CATEGORY

Development of long-range plans.

METRIC DESCRIPTION

This metric encourages communities to incorporate water efficiency and conservation into long-range land use plans to establish a water vision, policy, and roadmap.

Statewide, this metric is used to measure progress toward the Colorado Water Plan objective that "75% of Coloradans will live in communities that have incorporated water-saving actions into land use planning by 2025 (State of Colorado, 2015)."

DESIRED OUTCOMES

Community
Encourage all communities to have a long-range comprehensive master plan that, at a minimum, includes water efficiency and conservation. While sustainability plans or other long-range plans may be developed by a community, a long-range comprehensive master plan is the preferred document.

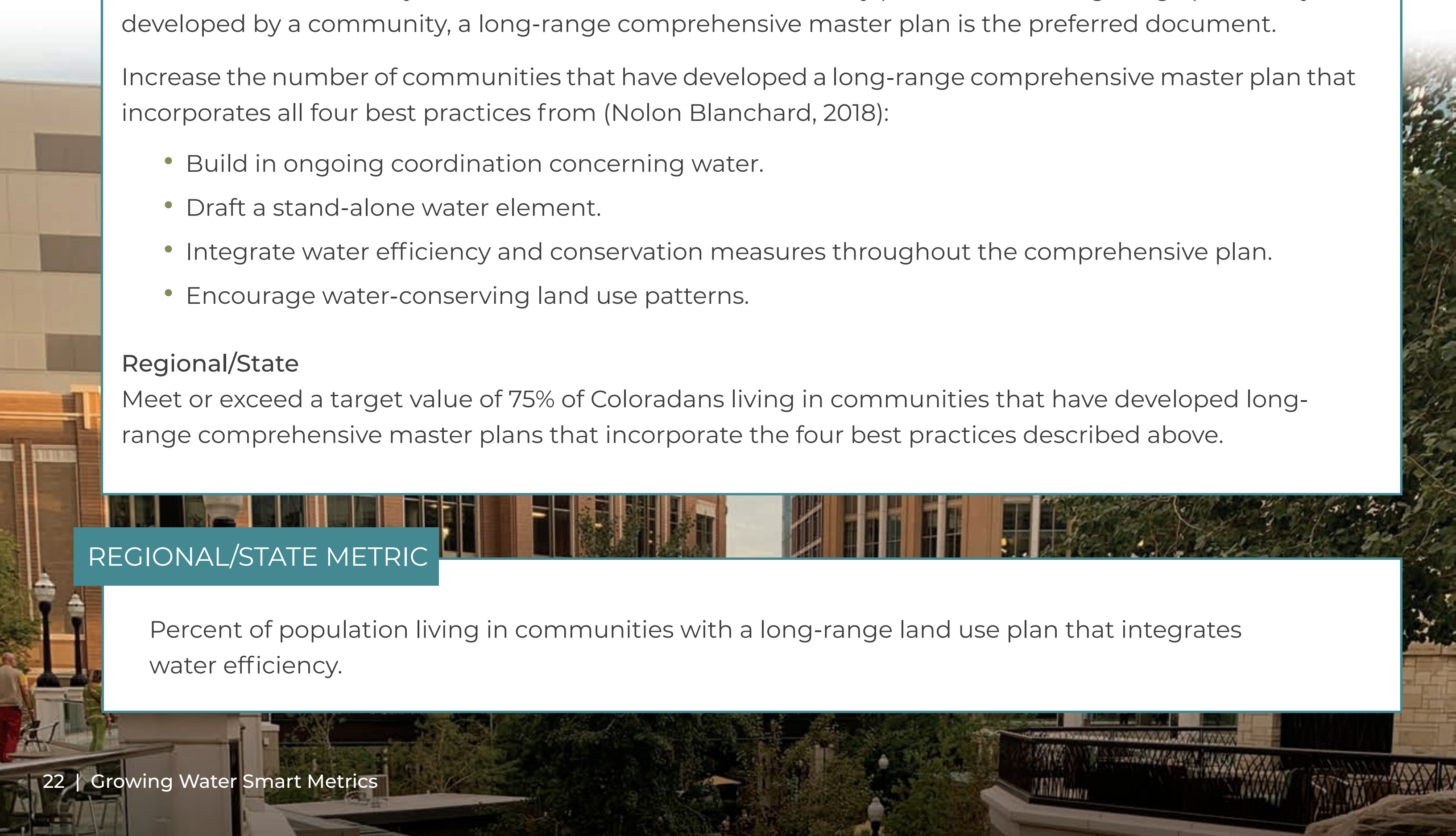
Increase the number of communities that have developed a long-range comprehensive master plan that incorporates all four best practices from (Nolon Blanchard, 2018):

- Build in ongoing coordination concerning water.
- Draft a stand-alone water element.
- Integrate water efficiency and conservation measures throughout the comprehensive plan.
- Encourage water-conserving land use patterns.

Regional/State
Meet or exceed a target value of 75% of Coloradans living in communities that have developed long-range comprehensive master plans that incorporate the four best practices described above.

REGIONAL/STATE METRIC

Percent of population living in communities with a long-range land use plan that integrates water efficiency.



REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having any mention of water efficiency and conservation in the long-range comprehensive master plan:

1. Identify the communities that have developed a long-range comprehensive master plan. Collect the plans.
2. Where such plans exist, calculate the population living in those communities.
3. Review each comprehensive plan for water efficiency and conservation.
4. Calculate the percentage of Coloradans living in communities with a long-range comprehensive master plan that incorporates water efficiency and conservation.

The Babbitt Center for Land and Water Policy has developed an evaluation matrix for comprehensive plans that could inform an evaluation rubric to define the "gold standard" for this metric (Lincoln Institute of Land Policy, 2019; Rugland, 2019).

DATA NEEDS AND SOURCES

Long-range comprehensive master plans originate from local land use authorities. Community and Statewide population data originated from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community

Not all communities are required to complete a long-range comprehensive master plan in Colorado. When developing a comprehensive plan, communities are not required to include a water element (Colorado Revised Statutes, 2018). In 2020, Colorado House Bill 20-1095 was passed, and specified that if a master plan includes a water supply element, the element "...must include water conservation policies...and may include policies to implement water conservation and other state water plan goals as a condition of development approvals..." Communities should evaluate this metric at the time that a long-range comprehensive master plan is being developed or updated.

Regional/State

DOLA, county, and regional government agencies would be interested in tracking this metric, as results could inform State policy and guidance on the development of long-range comprehensive master plans, including incentives for including water efficiency and conservation.

WHERE TO GO FOR MORE INFORMATION

How communities can develop long-range comprehensive master plans that integrate water efficiency and conservation, along with examples of communities that have done this well, can be found in (Nolon Blanchard, 2018; Rugland, 2019).

2. THE COMMUNITY'S LONG-RANGE WATER PLAN INTEGRATES LAND USE STRATEGIES

METRIC CATEGORY

Development of long-range plans.

METRIC DESCRIPTION

This metric encourages water providers to incorporate land use strategies into their long-range water plans. Where traditional conservation and efficiency programs have targeted water savings from existing buildings, the introduction of land use strategies encourages water efficiency in new developments and future growth. Providers can influence land use decisions through system development connection fees, water supply adequacy demonstrations, and development reviews.

DESIRED OUTCOMES

Community

Encourage all local water providers to have a long-range water plan, whether a water efficiency plan or a water master plan.

Increase the number of providers that have developed a long-range water plan that incorporates best practices from (Castle & Rugland, 2019) including:

- Addressing barriers to collaboration with land use authorities.
- Integrating best management practices for achieving water savings through land use strategies in the areas of foundational activities, targeted technical assistance and incentive programs, ordinances and regulations, and education and outreach activities.

Regional/State

Increase the percentage of Colorado's population receiving water from providers that have developed long-range water plans that incorporate best practices in using land use strategies for water savings.

REGIONAL/STATE METRIC FORMULATION

Percent of population living in communities with a long-range water plan that integrates land use strategies

REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having any mention of land use planning in the long-range water plan:

1. Identify the water providers that have developed a long-range water plan (master plan and/or water efficiency plan). Collect the plans.
2. Collect service population data by provider.
3. Review each plan for land use strategies and best management practices.
4. Where found, calculate the population served by those providers.
5. Calculate the percentage of Coloradans served by providers with a long-range water plan that incorporates water efficiency and conservation.

DATA NEEDS AND SOURCES

Long-range water plans originate from water providers. Service population information will originate from water providers or CDPHE (Colorado Department of Public Health and Environment, 2019a). Statewide population estimates will originate from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community

Water efficiency plans use a 7-10-year planning horizon, whereas water master plans tend to use a 20-50-year planning horizon. Water providers are only required to develop a water efficiency plan if they deliver more than 2,000 ac-ft/yr to customers (Colorado General Assembly, 2004). Other water providers voluntarily develop water efficiency plans in order to access State grant funding.

Regional/State

CWCB, county, and regional government agencies would be primarily interested in tracking this metric, as results could inform State policy and guidance on the development of long-range water plans, including grant funding for developing and implementing water efficiency plans and programs that employ land use strategies.

WHERE TO GO FOR MORE INFORMATION

The best source for more information about how water providers can develop water efficiency plans that integrate land use strategies, along with examples of providers that have done this well, can be found in (Castle & Rugland, 2019).

3. THE COMMUNITY IS SERVED BY PROVIDER(S) USING CONSERVATION-ORIENTED SYSTEM DEVELOPMENT CHARGES

METRIC CATEGORY

Implementation of conservation and efficiency programs.

METRIC DESCRIPTION

This metric encourages communities to reduce water demands from new developments through water system development charge fee structures (also known as connection or tap fees) that pay for water supplies and infrastructure to support reliable, high quality water services. System development charges can also be used in some cases to fund conservation programs, watershed protection and restoration activities, and education and awareness programs.

Where traditional fee structures calculate system development fees based on a broad customer type and meter size or equivalent residential unit (EQR) value, conservation-oriented system development fees are individualized to incentivize water efficiency and conservation measures (Nuding, 2018). These types of programs can be appealing to developers and home buyers as they reduce home prices while also promoting water efficiency and conservation.

DESIRED OUTCOMES

Community

Encourage all communities to adopt system development charge (SDC) fee structures that recoup the cost of providing water services to new developments, including the costs of water rights, treatment capacity and operations, and storage and distribution infrastructure.

Encourage all communities to develop, at a minimum, a voluntary program offering discounted connection fees in exchange for defined water conservation measures. For instance, communities can use lot size as one variable for calculating SDCs to encourage and incentivize smaller lots, which tend to use less water than larger lots, especially when combined with low-water using landscaping. As one example, the City of Fountain incentivizes water conservation through infrastructure and water acquisition fees applied to new residential and commercial developments that are reduced for residential developments that build smaller lots and implement water-conserving landscapes. A full case study on Fountain's program is presented in A Guide to Designing Conservation-Oriented Water System Development Charges (Nuding, 2018).

Increase the number of communities with mandatory programs offering discounted connection fees in exchange for water conservation measures.

Regional/State

Increase the percentage of Colorado's population receiving water from providers that have implemented conservation-oriented system development charges.

REGIONAL/STATE METRIC FORMULATION

Percent of population served by provider(s) with conservation-oriented system development charges.

REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having a voluntary program offering:

1. Identify the water providers that have developed a voluntary program.
2. Collect service population data by provider.
3. Calculate the percentage of Coloradans served by providers with conservation-oriented system development charges.

The calculation can be repeated for water providers with a mandatory program offering. Both metric values should be tracked over time.

DATA NEEDS AND SOURCES

System development fee structures originate from water providers. These are almost always available online. Service population information originates from water providers or CDPHE (Colorado Department of Public Health and Environment, 2019a). Statewide population estimates originate from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community
While many Colorado communities are growing in population, this metric may not be relevant (or the most impactful conservation strategy) for communities that aren't experiencing rapid growth.

Regional/State
CWCB, DOLA, county, and regional government agencies would be interested in tracking this metric to gain insights into development patterns and trends across the State.

WHERE TO GO FOR MORE INFORMATION

The best source for more information about how water providers can develop conservation-oriented system development charges, including case studies of providers that have developed voluntary and mandatory program offerings, can be found in (Nuding, 2018).

4. THE COMMUNITY IS SERVED BY PROVIDER(S) USING CONSERVATION ORIENTED PRICING STRUCTURES

METRIC CATEGORY

Implementation of conservation and efficiency programs.

METRIC DESCRIPTION

This metric encourages water providers to incentivize water conservation through conservation-oriented pricing structures (also known as monthly billing fees or water rates) that reflect the true value and cost of water. Conservation-oriented pricing structures are typically implemented as inclining block rate structures that include a variable component (where the fee assessed is a function of the water used) and where charges increase steeply by price tier with increased usage. Monthly billing is the primary lever by which utilities can recoup the ongoing cost of treating and distributing water. Monthly billing charges can also be used to fund conservation programs, watershed protection and restoration activities, and education and awareness programs.

DESIRED OUTCOMES

Community

At a minimum, encourage all water providers to adopt inclining block rate structures.

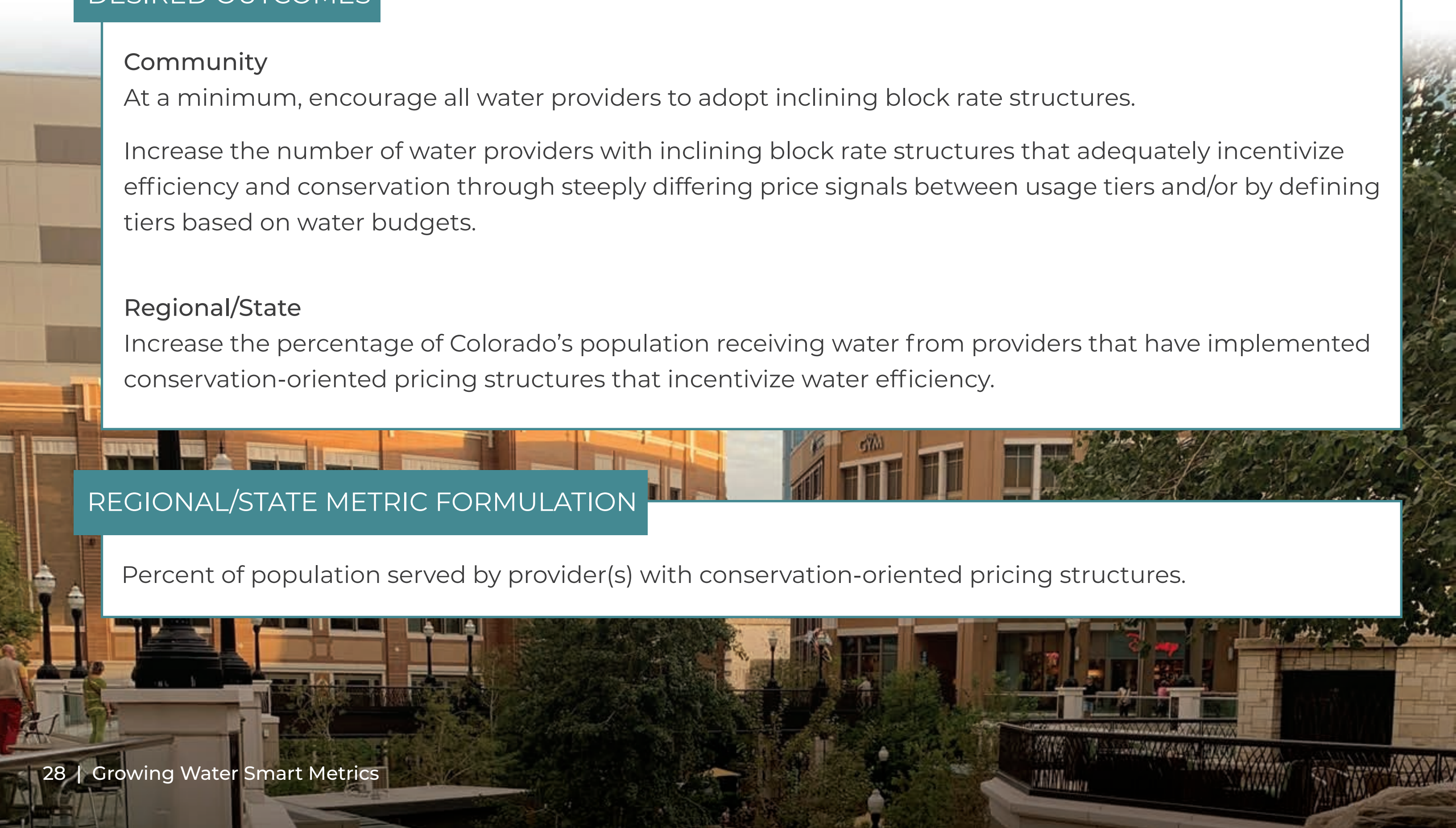
Increase the number of water providers with inclining block rate structures that adequately incentivize efficiency and conservation through steeply differing price signals between usage tiers and/or by defining tiers based on water budgets.

Regional/State

Increase the percentage of Colorado's population receiving water from providers that have implemented conservation-oriented pricing structures that incentivize water efficiency.

REGIONAL/STATE METRIC FORMULATION

Percent of population served by provider(s) with conservation-oriented pricing structures.



REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having an inclining block rate structure implemented:

1. Collect pricing structures from all water providers.
2. Review pricing structures to categorize the rate structure (e.g., inclining block, flat, or declining block rate structure).
3. Collect service population data by provider.
4. Calculate the percentage of Coloradans served by providers with inclining block rate structures.

DATA NEEDS AND SOURCES

Pricing structures originate from water providers. These are almost always available online. Service population information originates from water providers or CDPHE (Colorado Department of Public Health and Environment, 2019a). Statewide population estimates originate from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community

Most water providers in Colorado use inclining block rate structures, so the baseline value for this metric is expected to be high. However, there is likely much to be done to ensure that the slope of the tiered pricing is steep enough to encourage efficiency and conservation, to improve the tier limits, and to incorporate water budgets based on landscaped area.

This metric may be politically sensitive in communities concerned about water affordability and equity.

This metric may not be relevant (or the most impactful conservation strategy) for wealthy communities.

Regional/State

CWCB, county, and regional government agencies would be interested in tracking this metric to gain insight into conservation programs and trends across the State.

WHERE TO GO FOR MORE INFORMATION

The best source for more information about coupling conservation-oriented system development charges and monthly billing rates can be found in (Nuding, 2018). The American Water Works Association also publishes the foundational manual on developing system rates, fees, and charges (American Water Works Association, 2017).

5. THE COMMUNITY HAS ADOPTED THE MOST RECENT INTERNATIONAL CODE COUNCIL VERSION AND/OR THE INTERNATIONAL GREEN CONSTRUCTION CODE

METRIC CATEGORY

Adoption of landscaping and building codes.

METRIC DESCRIPTION

This metric is encouraging communities to adopt the latest codes, which primarily improve indoor water efficiency in new developments.

DESIRED OUTCOMES

Community
At a minimum, encourage communities to adopt the latest versions of either the ICC or the IGCC. At best, encourage communities to adopt the latest code versions with local code amendments that exceed (rather than relax) water efficiency measures in these codes.

Regional/State
Increase the percentage of Colorado's population living in communities that have adopted the latest versions of either the ICC or IgCC.

REGIONAL/STATE METRIC FORMULATION

Percent of population living in communities that have adopted the most recent International Code Council (ICC) version and/or the International Green Construction Code (IgCC).

REGIONAL/STATE METHODOLOGY

The State of Colorado does not have minimum building codes defined, except that energy codes must be updated to one of the three most recent versions of the International Energy Conservation Code upon updating building codes (State of Colorado, 2019e).

To calculate the metric based on a minimum qualification of having adopted the latest version of the ICC or IgCC:

1. Develop a list of local land use authorities.
2. Review building codes for all land use authorities.
3. Identify land use authorities that have adopted the latest version of the ICC or IgCC (regardless of local amendments).
4. Sum population data for the identified communities, taking care to use the municipal population or unincorporated county population, as appropriate.

DATA NEEDS AND SOURCES

Names and boundaries for land use authorities originate from DOLA. Building code versions originate from land use authorities. These are almost always available online. Community, county, and Statewide population estimates originate from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community

In addition to ICC code and IgCC versions released every three years, communities can pull useful guidelines from the EPA WaterSense® New Home Specifications, Envision, SITES, or LEED for Cities and Communities (US Department of Energy, 2019; International Code Council, 2019b; Institute for Sustainable Infrastructure, 2020; The Sustainable SITES Initiative, 2020; US Green Building Council, 2020).

Land use authorities can amend code standards once adopted. In some cases, local amendments can detract from the intent or regulatory authority of the original code language. Ensuring local amendments have not devalued the original code language would require a detailed evaluation.

Communities should also be aware that the State of Colorado has passed legislation mandating that new indoor fixtures sold in the State must be WaterSense® labeled (Colorado Water Conservation Board, 2019a; State of Colorado, 2019a). These requirements do not, however, regulate the number of fixtures installed.

Regional/State

DOLA, county, and regional government agencies would be interested in tracking this metric to gain insight into building codes and indoor efficiency. Recent legislation requires communities to report their latest energy codes to the State (Colorado Energy Office, 2019), which could serve as a model for communities to also report building and/or plumbing codes.

WHERE TO GO FOR MORE INFORMATION

For general information about building codes and the standards for each code version, the ICC website has a clearinghouse of information (International Code Council, 2019a; International Code Council, 2019b). For information about removing barriers to water conservation from existing code, look to (Nolon Blanchard, 2018).

6. THE COMMUNITY HAS ADOPTED REUSE WATER INTO LOCAL CODE

METRIC CATEGORY

Adoption of landscaping and building codes.

METRIC DESCRIPTION

This metric encourages communities to authorize reuse water (e.g., graywater and reclaimed water) where possible to reduce potable water demand.

DESIRED OUTCOMES

Community
Encourage communities to authorize reuse water - to promote alternative water supplies, reduce potable water demands, and restore streamflows - to the extent feasible and allowable under the water rights system and as cost-effective for the community's infrastructure.

Regional/State
Increase the percentage of Colorado's population living in communities that have authorized reuse water.

REGIONAL/STATE METRIC FORMULATION

Percent of population living in communities adopting reuse water into local code.

REGIONAL/STATE METHODOLOGY

The State of Colorado authorizes the use of reclaimed water under Regulation 84 and the use of graywater under Regulation 86 (Colorado Department of Public Health and Environment, 2018; Colorado Department of Public Health and Environment, 2015). Reclaimed water is most often produced by a centralized treatment system, such as the Sand Creek Water Reclamation Facility operated by the City of Aurora (City of Aurora, 2020). Graywater systems are most often decentralized systems installed in specific buildings.

REGIONAL/STATE METHODOLOGY, *CONT.*

To calculate the metric based on a minimum qualification of having at least one type of reuse water authorized in local code:

1. Develop a list of local land use authorities.
2. Determine which land use authorities have adopted reuse standards (through interview, survey, or reviewing local codes).
3. Sum population data for the identified communities, taking care to use the municipal population or unincorporated county population, as appropriate.

The calculation can be repeated for communities with both reclaimed and graywater systems authorized. Both metric values should be tracked over time.

DATA NEEDS AND SOURCES

Names and boundaries for land use authorities originate from DOLA. Landscape and building codes originate from land use authorities. These are almost always available online. Population estimates originate from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community

Not every community's water rights allow water reuse. As a general rule, water rights associated with trans-mountain diversions can be used to extinction, while return flows from local water rights must be returned for downstream water users. The role of alternative water supplies should be considered during long-range water planning.

The costs and benefits of implementing reuse infrastructure systems may be barriers. Reuse systems may have an unfavorable return on investment in rural communities, mountain communities, and existing developments. Homeowners may have low trust in reuse systems.

Regional/State

CWCB, county, and regional government agencies would be interested in tracking this metric to gain insight into alternative water supplies and trends. In interpreting the metric results, users will need to distinguish between communities that have chosen not to authorize reuse water versus communities that are not able to authorize reuse water (based on their water rights).

WHERE TO GO FOR MORE INFORMATION

For information about the production, water quality standards, and allowable beneficial uses of reclaimed and graywater systems, go to (Colorado Department of Public Health and Environment, 2018; Colorado Department of Public Health and Environment, 2015). For information about integrated water and land use planning specifically to promote water supply diversification, go to (Fedak, et al., 2018).

7. THE COMMUNITY HAS ADOPTED OUTDOOREFFICIENCYSTANDARDS THAT EXCEED STATE STANDARDS

METRIC CATEGORY

Adoption of landscaping and building codes.

METRIC DESCRIPTION

In 2019, the State of Colorado passed a bill that, for the first time, establishes minimum performance efficiency levels for irrigation equipment and requires all new equipment sold and installed in the State to meet these minimum requirements (State of Colorado, 2019a; Associated Landscape Contractors of Colorado, 2019). Under this law, spray sprinkler bodies must meet WaterSense® standards and include an integral pressure regulator. The law goes into effect January 1, 2021. While the new State standards are currently limited in scope, this metric is intended to accommodate future evolutions in State standards, always encouraging communities to go above and beyond minimum standards in achieving improved outdoor water efficiency.

DESIRED OUTCOMES

Community

Increase the number of communities that have adopted water-efficient landscaping and irrigation standards. Communities can achieve outdoor water efficiency through a number of strategies including:

- Restrictions on high-water using turf vegetation
- Lists of approved low water using plants
- Soil amendment requirements that include depth requirements and topsoil composition requirements
- Irrigation technology and performance requirements such as specifying the minimum acceptable performance levels for sprinkler technologies and system components as well as irrigation system controls
- Site-wide targets for irrigation application rates (measured as gallons per square foot per year)
- Irrigation application rates by vegetation type or land use type (measured as gallons per square foot per year)
- Outdoor water budgets (optionally allocated by hydrozones)
- Water efficiency certifications for landscape and irrigation installers
- Integrating landscaping and irrigation standards into the development codes to make the information easily available

DESIRED OUTCOMES, *CONT.*

Regional/State

Increase the percentage of Colorado's population living in communities that have regulated landscaping and irrigation standards which, together, influence the amount of water used outdoors for irrigation.

REGIONAL/STATE METRIC FORMULATION

Percent of population living in communities with outdoor efficiency standards that exceed State standards.

REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having at least some aspect of landscaping and irrigation standards that exceed State minimum standards:

1. Develop a list of local land use authorities.
2. Review the codes for each authority for landscaping and irrigation standards.
3. Compare the standards against State requirements. Note the communities that have exceeded the minimum.
4. Sum population data for the identified communities, taking care to use the municipal population or unincorporated county population, as appropriate.

DATA NEEDS AND SOURCES

Names and boundaries for land use authorities originate from DOLA. Landscaping codes originate from land use authorities. These are almost always available online. Landscaping and irrigation codes may exist as a standalone document, but are often found within a community's development code, land use code, zoning code, subdivision regulations, site regulations, or other code sections relevant to land use. Population estimates originate from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CONT. ON NEXT PAGE

CALCULATION CONSIDERATIONS

Community

Minimum performance efficiency levels for irrigation systems can be specified for a variety of sprinkler heads, system components, and system controllers. For example, Denver Water offers an Efficiency Credit Pilot program which provides a monetary credit to the System Development Charge for building to higher water efficiency standards (Denver Water, 2018a). Site requirements include:

- Depending on size of landscaped area, sites must use Denver Water's Landscape Water Requirement Calculator or be designed to use less than 10 gal/sq ft/yr.
- Soil amendment requirements of four cubic yards per 1,000 sq ft of landscaped area tilled to a depth of 6 inches.
- Irrigation system requirements include (Denver Water, 2018b):
- Spray irrigation is prohibited in areas less than eight feet in width.
- "Smart" irrigation controllers are required with battery backup.
- Central control systems are recommended for larger areas.
- Master valve, flow sensors, and rain sensors are required.
- Fixed sprays must be no less than 6" high, with internal check valves and pressure regulator.

The City of Aspen has established water efficient landscaping standards, including a target of 7.5 gal/sq ft/season (12 inch/season) as a maximum applied water budget limiting total irrigation water use (Magill, 2018).

Regional/State

CWCB, county, and regional government agencies would be interested in tracking this metric to gain insight into outdoor water use and trends.

WHERE TO GO FOR MORE INFORMATION

For information about the State law going into effect in 2021, refer to House Bill 1231 (State of Colorado, 2019a).

For information about irrigation equipment efficiency standards, refer to EPA WaterSense® outdoor water efficiency criteria for sprinkler irrigation and micro-irrigation systems (US Department of Energy, 2019). Efficiency guidelines can also be found through green building certification programs such as Leadership in Energy and Environmental Design (LEED) and the Sustainable Sites Initiative (US Green Building Council, 2019).

A number of water budget calculators are available, such as the EPA WaterSense® Water Budget Tool (US Environmental Protection Agency, 2019). Sustainable landscape guidelines are available from the Alliance for Water Efficiency (Alliance for Water Efficiency, 2019).

8. THE COMMUNITY HAS ADOPTED WATER SUPPLY ADEQUACY REQUIREMENTS THAT EXCEED STATE MINIMUM STANDARDS

METRIC CATEGORY

Implementation of adequate water supply rules.

METRIC DESCRIPTION

This metric encourages communities to go above and beyond State minimum standards to ensure that water supplies and infrastructure are sufficient to serve new developments.

DESIRED OUTCOMES

Community

Increase the number of communities that have adopted water supply adequacy and/or infrastructure concurrency requirements that exceed minimum State standards.

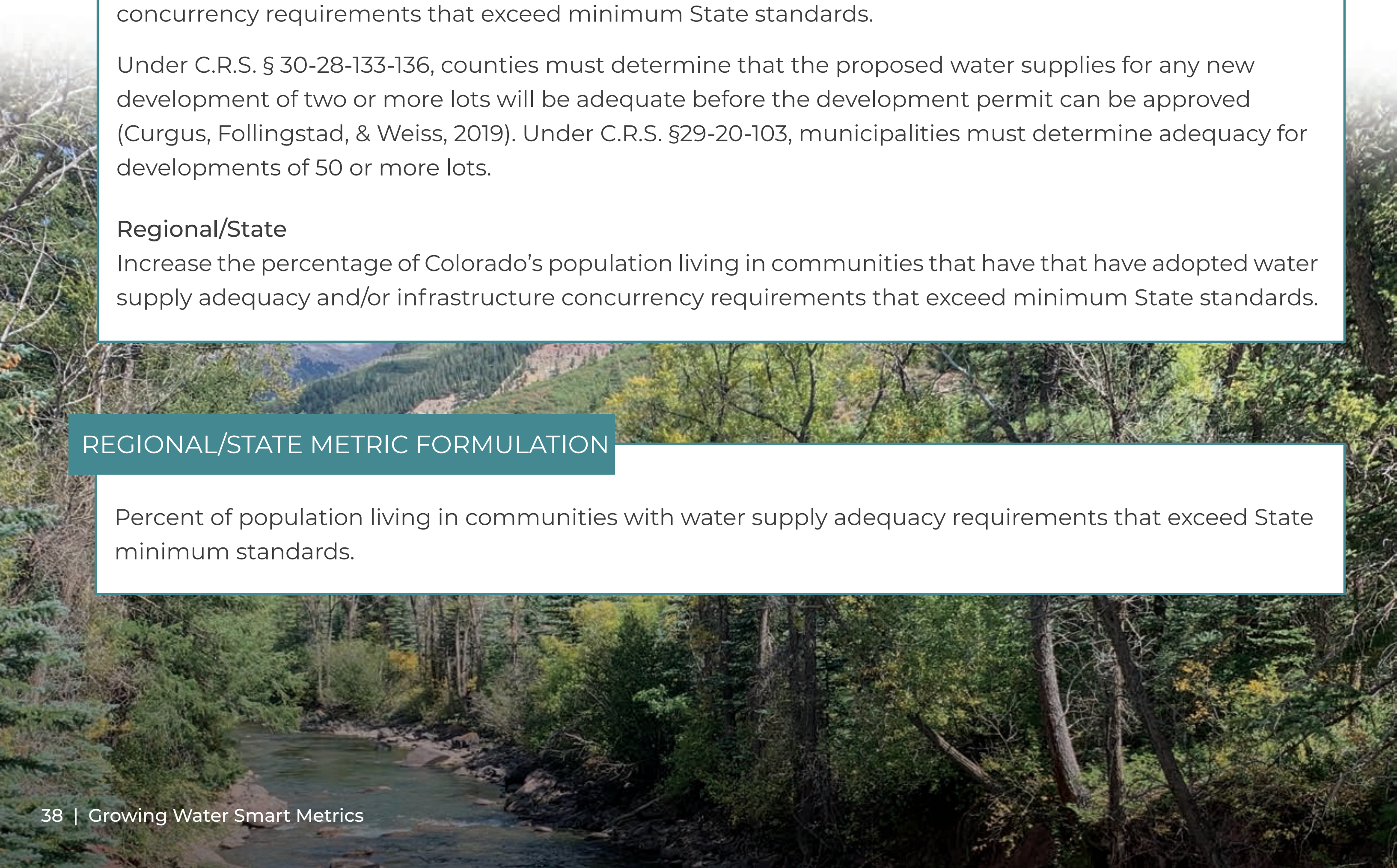
Under C.R.S. § 30-28-133-136, counties must determine that the proposed water supplies for any new development of two or more lots will be adequate before the development permit can be approved (Curgus, Follingstad, & Weiss, 2019). Under C.R.S. §29-20-103, municipalities must determine adequacy for developments of 50 or more lots.

Regional/State

Increase the percentage of Colorado's population living in communities that have that have adopted water supply adequacy and/or infrastructure concurrency requirements that exceed minimum State standards.

REGIONAL/STATE METRIC FORMULATION

Percent of population living in communities with water supply adequacy requirements that exceed State minimum standards.



REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having at least one aspect of the water supply adequacy demonstration requirements that exceed State minimum standards:

1. Develop a list of local land use authorities.
2. Collect development code information for all land use authorities.
3. Compare the development code information for each land use authority against the State standards and note the communities that have exceeded the minimum.
4. Sum population data for the identified communities, taking care to use the municipal population or unincorporated county population, as appropriate.

DATA NEEDS AND SOURCES

Names and boundaries for land use authorities originate from DOLA. Development codes originate from land use authorities. These are almost always available online. Population estimates originate from DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community
Land use authorities have the option to improve upon the minimum State requirements by (Castle & Rugland, 2019):

- Requiring water efficiency and conservation measures as part of the water supply adequacy demonstration.
- Applying water supply adequacy requirements to developments with less than 50 units.
- Specifying long planning horizons (e.g., greater than 100 years).

Regional/State
CWCB, DOLA, county, and regional government agencies would be interested in tracking this metric to gain insight into water demands and trends associated with new developments.

WHERE TO GO FOR MORE INFORMATION

For more information about the State requirements, refer to Colorado's Revised Statutes (Colorado Revised Statutes, 2019). For more information about approaches to exceed the minimum requirements, refer to (Castle & Rugland, 2019; Sonoran Institute, 2019b; Curgus, Follingstad, & Weiss, 2019).

9. COMMUNITY PLANNERS AND WATER PROVIDER(S) HAVE REGULAR COORDINATION MEETINGS

METRIC CATEGORY

Extent of collaboration and regionalization.

METRIC DESCRIPTION

This metric encourages community planners and water providers to collaborate on long-range land use planning within and across jurisdictions, to ensure that planning scenarios are supported by current water supplies and infrastructure.

DESIRED OUTCOMES

Community

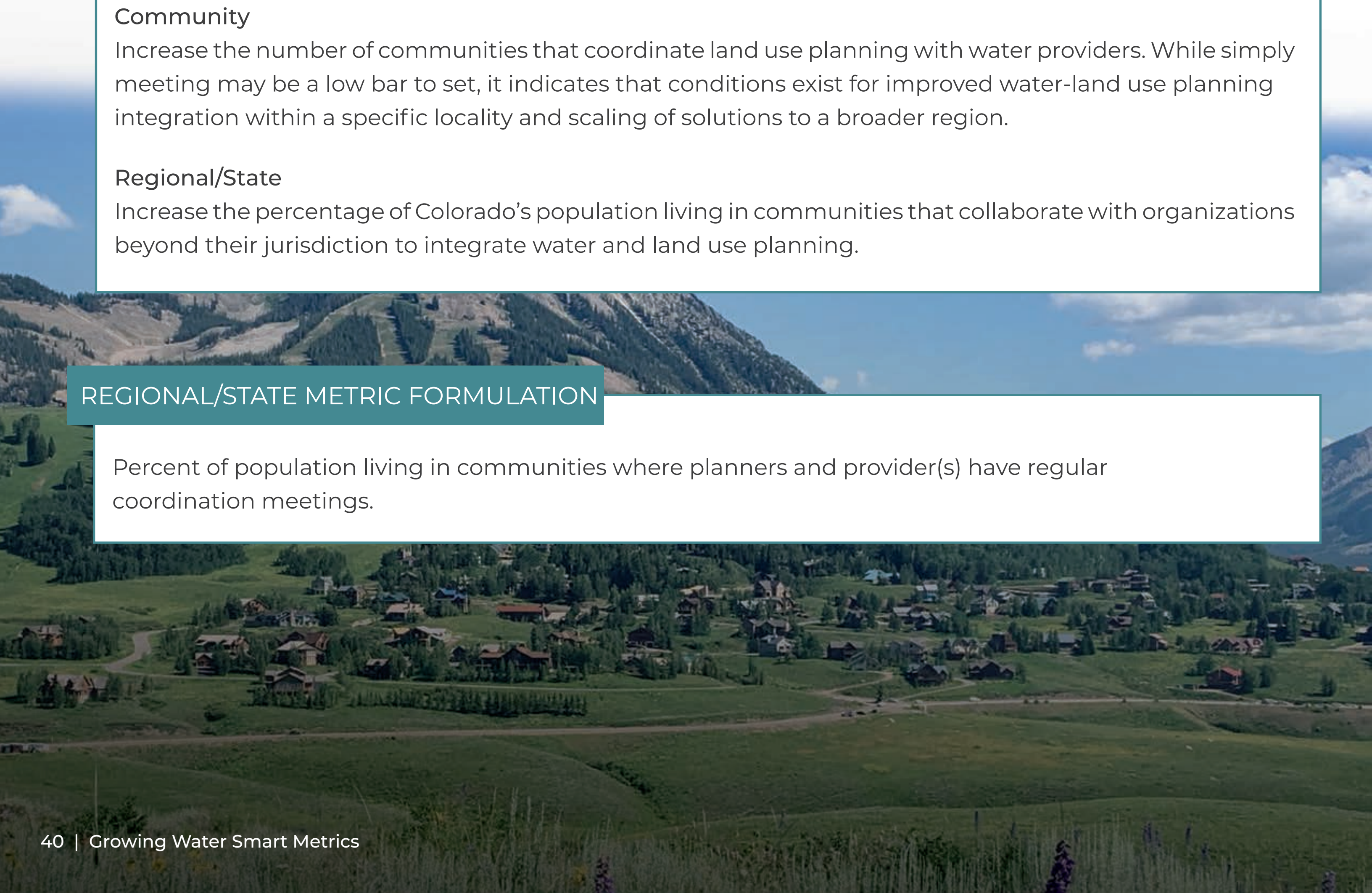
Increase the number of communities that coordinate land use planning with water providers. While simply meeting may be a low bar to set, it indicates that conditions exist for improved water-land use planning integration within a specific locality and scaling of solutions to a broader region.

Regional/State

Increase the percentage of Colorado's population living in communities that collaborate with organizations beyond their jurisdiction to integrate water and land use planning.

REGIONAL/STATE METRIC FORMULATION

Percent of population living in communities where planners and provider(s) have regular coordination meetings.



REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having at least some coordination on land use planning between planners and water providers:

1. Develop a list of local land use authorities.
2. Survey, interview, or otherwise collect information from the land use authority about the coordination process.
3. Sum population data for the identified communities, taking care to use the municipal population or unincorporated county population, as appropriate.

DATA NEEDS AND SOURCES

Names and boundaries for land use authorities originate from DOLA.

Population estimates originate from DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community
Coordination between community planners and water providers on land use planning can take a number of forms:

- Water providers and community planners meet regularly to discuss land use planning.
- Water providers and community planners work together on land use plans and development codes.
- Water providers and community planners develop intergovernmental agreements to align land use plans, development codes, and planning scenarios.

Regional/State
CWCB, DOLA, county, and regional government agencies would be interested in tracking this metric for insights into land use planning and trends in water demands, collaborative processes, and community needs.

WHERE TO GO FOR MORE INFORMATION

For more information about approaches, refer to (Castle & Rugland, 2019; Nolon Blanchard, 2018; Fedak, et al., 2018).

10. THE COMMUNITY ROUTES DEVELOPMENT PROPOSALS TO APPLICABLE PROVIDER(S) FOR REVIEW AND COMMENT

METRIC CATEGORY

Extent of regionalization/collaboration.

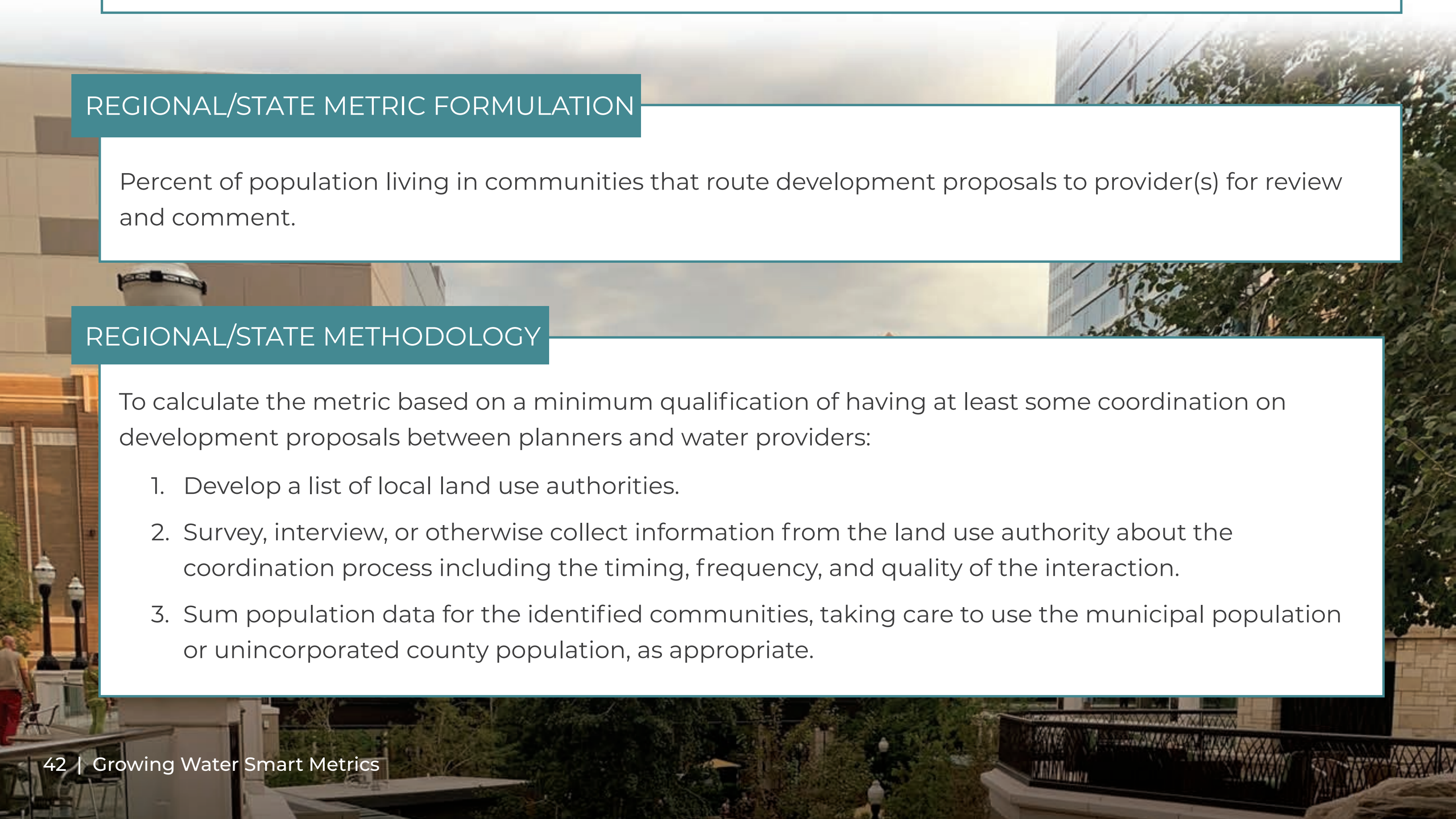
METRIC DESCRIPTION

This metric encourages community planners and water providers to collaborate on development applications, to ensure that development decisions are supported by current water supplies and infrastructure.

DESIRED OUTCOMES

Community
Increase the number of communities that coordinate development approvals with water providers.

Regional/State
Increase the percentage of Colorado's population living in communities that coordinate development approvals with water providers.



REGIONAL/STATE METRIC FORMULATION

Percent of population living in communities that route development proposals to provider(s) for review and comment.

REGIONAL/STATE METHODOLOGY

To calculate the metric based on a minimum qualification of having at least some coordination on development proposals between planners and water providers:

1. Develop a list of local land use authorities.
2. Survey, interview, or otherwise collect information from the land use authority about the coordination process including the timing, frequency, and quality of the interaction.
3. Sum population data for the identified communities, taking care to use the municipal population or unincorporated county population, as appropriate.

REGIONAL/STATE METHODOLOGY, *CONT.*

To calculate the metric based on a "gold standard" of coordination, an evaluation approach needs to be developed. If a self-reporting process is not desired, the effort to collect information would expand by an order of magnitude to be able to assess the number of applications submitted against how many comments were received from the water provider.

Additional evaluation considerations may include defining the applications routed for review and characterizing the quantity, quality, and timing of responses from providers. Involving water providers early (for example, during the pre-application meeting and entitlement process) is preferred.

DATA NEEDS AND SOURCES

Names and boundaries for land use authorities originate from DOLA. Population estimates originate from the DOLA State Demography Office (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community
Coordination between community planners and water providers on development proposals can take a number of forms:

- Water provider attends a pre-application meeting with the developers.
- Water provider submits written comments to the community planner to support the review and decision-making process.
- Water provider and community planners meet regularly to review development proposals.
- Water provider has the authority to impose water conservation and verification requirements in the development agreement.

Regional/State
CWCB, DOLA, county, and regional government agencies would be interested in tracking this metric to gain insight into water demands and trends associated with new developments.

WHERE TO GO FOR MORE INFORMATION

For more information about approaches, refer to (Castle & Rugland, 2019; Nolon Blanchard, 2018).

RECOMMENDED IMPACT METRICS

Each of the recommended impact metrics puts focus on one outcome related to integrated water and land use planning that is desired to be tracked. The recommended impact metrics are characterized by four commonalities:

- **The influence of scale on methodologies:** The result of each recommended metric will be a numerical value, whether calculated at a community, service area, regional, or State scale. A community planner or water provider is likely to want to adapt a methodology to best reflect local conditions and decision-making needs, whereas at a regional or State scale, consistent methodologies will be required to combine results across communities and providers.
- **The timing of metric updates:** Each recommended impact metric should be calculated, at a minimum, on an annual basis to track progress and make course corrections as needed. Metrics should also be updated along with existing work processes, such as water efficiency plan updates or whenever useful to inform decision-making.
- **The influence of scale on the responsibility for calculating metrics:** At a community scale, local planners and water providers are best suited to evaluate these metrics. At a regional or State scale, the data collection and analysis process will be time-consuming. Non-profit, university, and/or consultant services may be required to supplement State and regional resources unless processes are established for communities to calculate (and then report) the metric values using common methodologies.
- **The ability to interpret results and assign causality to water-land use planning integration:** Each of the impact metrics can be influenced by water conservation and land use planning actions beyond those recommended in this guidebook. To best interpret metric results, the full complement of recommended progress and impact metrics should be tracked together.

11. T0TAL WATER DISTRIBUTED BY PROVIDERS

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric is foundational to establishing the amount of water distributed by water providers to serve municipal demands. In combination with per capita water use metrics, this metric is the basis for assessing water use and water efficiency and conservation trends.

VALUES/UNITS OF MEASURE

The result of this metric will be a volume most often expressed in units of acre feet (ac-ft), gallons (gal), or million gallons (MG).

DESIRED OUTCOMES

Municipal demands in Colorado have increased throughout recorded history and are expected to continue to do so as a result of population growth *(Figure 3)*.

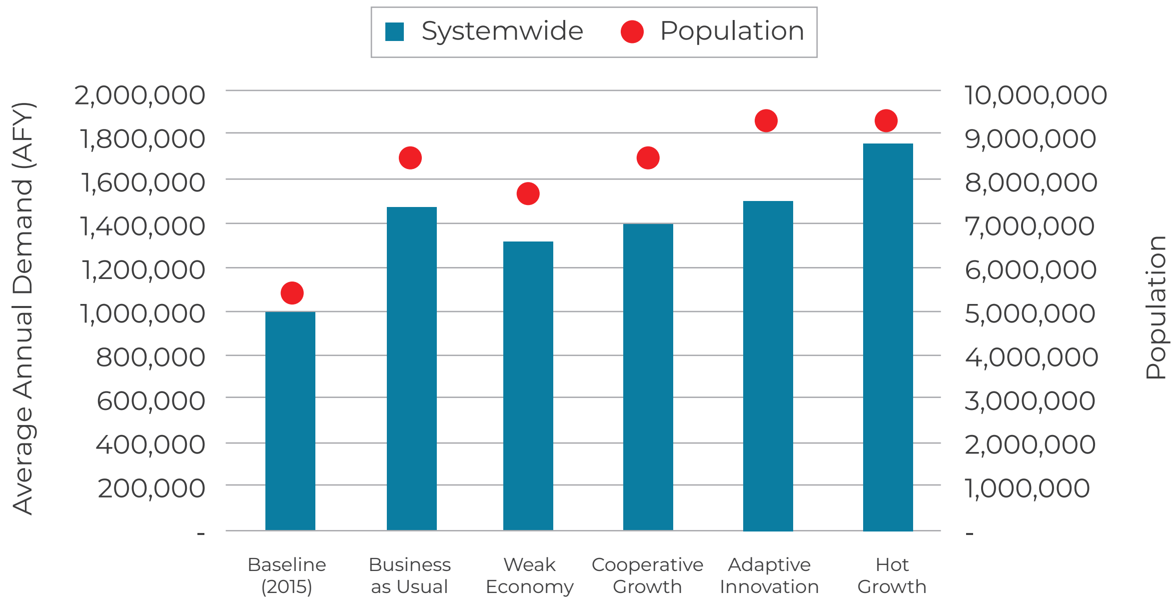


Figure 3. Baseline and projected population and municipal demands in Colorado (State of Colorado, 2019b)

DESIRED OUTCOMES, *CONT.*

While no single target value has been established, it is desirable to affect the trend of this metric - ideally to achieve a trend whereby this metric shows less growth, flattens, or even declines over time. However, with a growing population, overcoming growth in this metric will be a formidable challenge.

Arizona is one western state that has faced and overcome this challenge, successfully decoupling population growth from increasing water demands *(Figure 4)*.

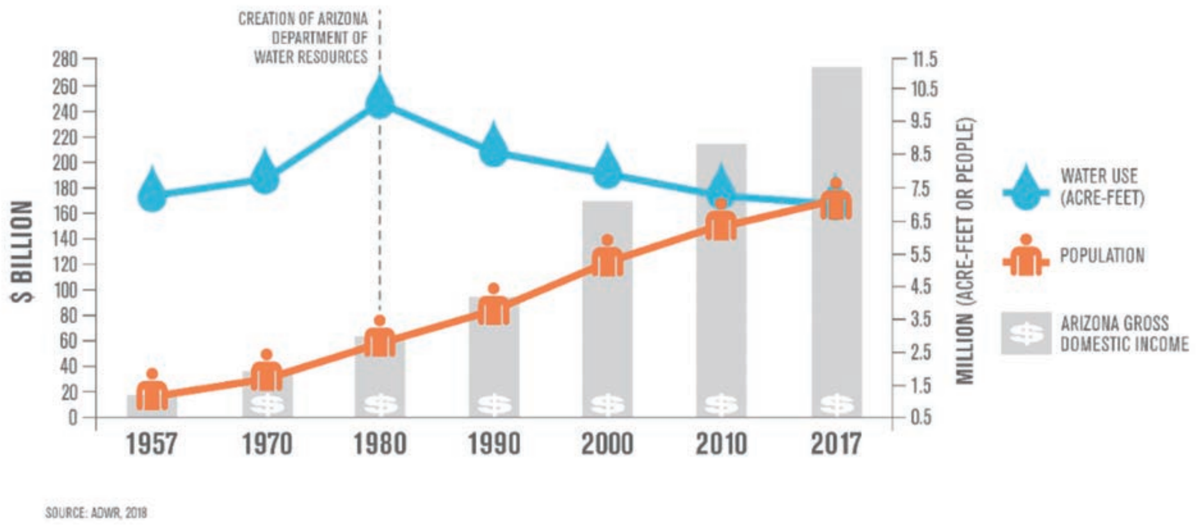


Figure 4. Population and water use in Arizona (Arizona Water Facts, 2020)

METHODOLOGY

This metric should be calculated to represent:

- Distributed water (the volume of water entering the municipal distribution system) calculated as total water production from all sources, excluding water exported to another water provider, placed into long-term storage, or delivered for agricultural use (State of Colorado, 2019b; State of California, 2010).
- All types of water, treated or untreated, including potable, non-potable, and reuse water (Open Water Foundation and WaterDM, 2018).
- All uses of water, whether domestic, irrigation, etc.

CONT. ON NEXT PAGE

DATA NEEDS AND SOURCES

Water providers will be the primary source of distributed water volumes.

CALCULATION CONSIDERATIONS

It is common for methodologies to vary across water providers, influencing values by 20-30% or more. Common differences include:

- Water volumes used (alternatives to distributed water include water diversions, production volumes, and water delivered to customers).
- Excluded water volumes, especially for non-potable and reuse water. For example, many raw water systems in Colorado are not metered (Colorado Water Conservation Board, 2012).

The longer the historical data record, the better the ability to analyze trends in water use. Weather, billing rates, pricing structures, economic conditions, regulations, metering infrastructure, and other factors influence water use from year to year. It's common to normalize annual demands to remove the influence of weather if the historical record is sufficiently long.

As presented, this metric excludes self-supplied industrial (SSI) demands which represent 13% of total municipal and industrial demands in Colorado (State of Colorado, 2019b). The metric also excludes self-supplied households that rely on wells for domestic water.

It is important for communities and water providers to understand SSI users and self-supplied households in on near their service areas, as those users could become customers under future scenarios. Water providers can access information about SSI users, water rights, and historical diversions from the State of Colorado's Decision Support Systems (State of Colorado, 2019c). Water providers can locate and estimate water use for self-supplied households using the Colorado Division of Water Resources well permit database (Colorado Division of Water Resources, 2020).

WHERE TO GO FOR MORE INFORMATION

For more information about calculating water use metrics, consult the following resources (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b).

12. T0TAL POTABLE WATER DISTRIBUTED BY PROVIDERS

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric establishes the amount of potable water distributed by water providers to serve municipal demands. This metric, in combination with per capita water use metrics, can be used to assess potable water use and potable water efficiency and conservation trends.

VALUES/UNITS OF MEASURE

The result of this metric will be a volume most often expressed in units of acre feet (ac-ft), gallons (gal), or million gallons (MG).

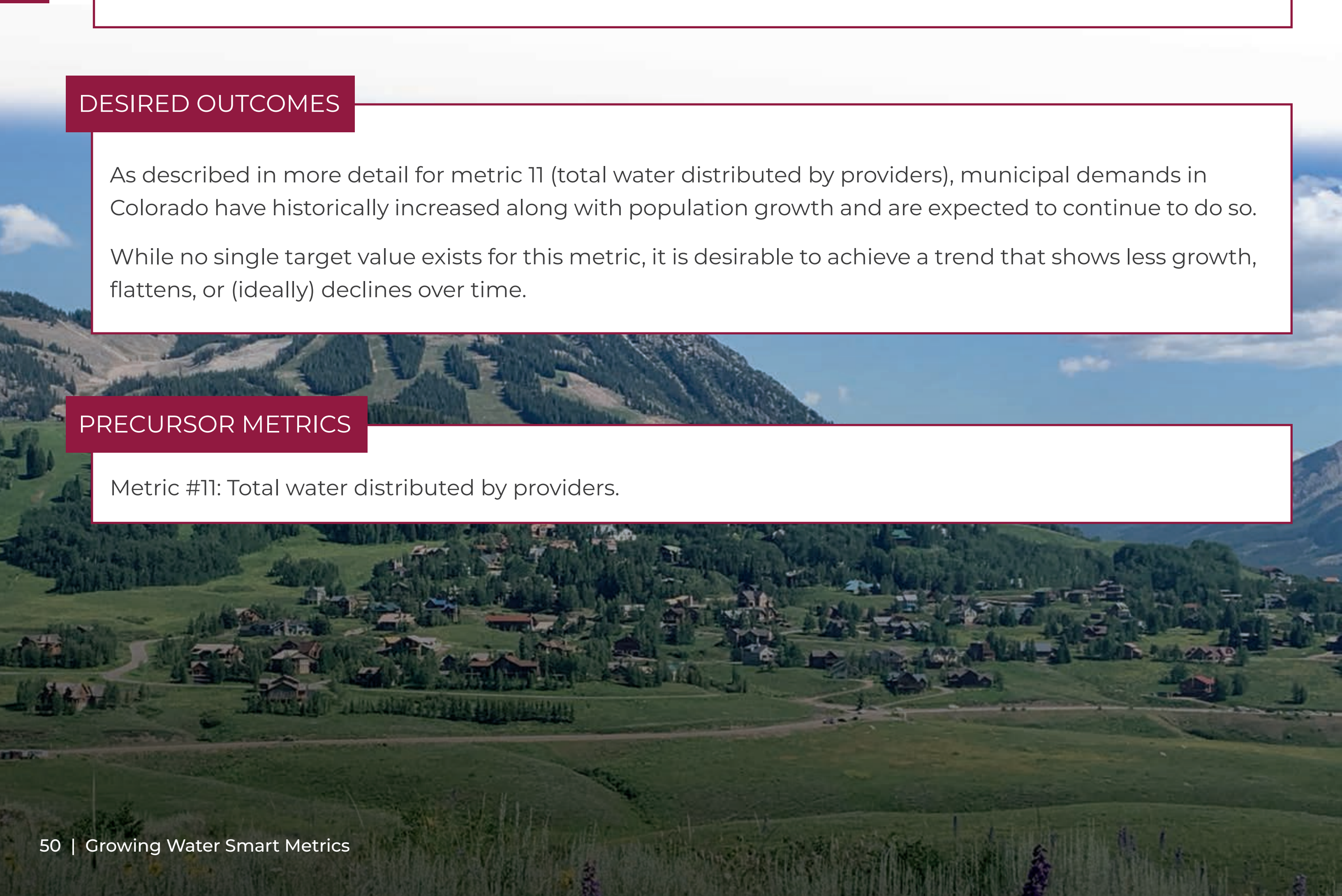
DESIRED OUTCOMES

As described in more detail for metric 11 (total water distributed by providers), municipal demands in Colorado have historically increased along with population growth and are expected to continue to do so.

While no single target value exists for this metric, it is desirable to achieve a trend that shows less growth, flattens, or (ideally) declines over time.

PRECURSOR METRICS

Metric #11: Total water distributed by providers.



METHODOLOGY

This metric should be calculated to represent:

- Distributed water, or the volume of water entering the municipal distribution system, calculated as total potable water production from all sources, excluding water exported to another water provider, placed into long-term storage, or delivered for agricultural use (State of Colorado, 2019b; State of California, 2010).
- Potable water volumes only.
- All uses of water, whether domestic, irrigation, etc.

DATA NEEDS AND SOURCES

Water providers will be the primary source of distributed water volumes.

CALCULATION CONSIDERATIONS

As described previously for metric #11 (total water distributed by providers), it is common for methodologies to vary across water providers, influencing values by 20-30% or more. One common difference arises from the water volumes used (alternatives to distributed water include water diversions, production volumes, and water delivered to customers).

The longer the historical data record, the better the ability to analyze trends in water use. It's important to note that weather, billing rates, pricing structures, economic conditions, regulations, metering infrastructure, and other factors influence water use, especially potable water use, from year to year. It's common to normalize annual demands to remove the influence of weather if the historical record is sufficiently long.

WHERE TO GO FOR MORE INFORMATION

For more information about calculating water use metrics, consult the following resources (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b).

13. PERCENT OF MUNICIPAL DEMANDS SERVED BY POTABLE WATER SUPPLIES

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric quantifies the proportion of municipal demands distributed by water providers met by potable supplies.

VALUES/UNITS OF MEASURE

The result of this metric will be a percentage value ranging from 0-100%.

DESIRED OUTCOMES

This metric is intended to be used to assess progress regarding the allocation of the right water quality to the right use, and the promotion of non-potable supplies for irrigation, cooling, and others uses that do not require water treated to the level of drinking water standards.

While no single target exists for this metric, from an integrated systems perspective it is desirable to achieve a declining trend whereby a lower proportion of municipal demands are being met by potable supplies (Paulson, Stephens, & Broley, 2017).

PRECURSOR METRICS

Metric #11: Total water distributed by providers

Metric #12: Total potable water distributed by providers

METHODOLOGY

This metric can be calculated as the total potable water distributed by providers (metric #12) divided by the total water distributed by providers (metric #11).

DATA NEEDS AND SOURCES

Water providers will be the primary source of distributed water volumes.

CALCULATION CONSIDERATIONS

Many water providers do not currently calculate this metric on a regular basis, at least in part due to a lack of data for non-potable and reuse water volumes.

WHERE TO GO FOR MORE INFORMATION

For more information about calculating water use metrics, consult the following resources (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b).

14. TOTAL WATER REUSED/RECLAIMED

METRIC CATEGORY

Trends in water demand and use.

PRECURSOR METRICS

Metric #11: Total water distributed by providers

METRIC DESCRIPTION

This metric quantifies the municipal demands met by reuse water supplies such as reclaimed water and graywater. Blackwater reuse and direct potable reuse are excluded from consideration as they are not common water sources at this time (WateReuse Colorado, 2018).

In this guidebook, reuse water supplies (that are treated before use) are considered separately from non-potable water supplies (that are not treated before use).

VALUES/UNITS OF MEASURE

The result of this metric will be a volume most often expressed in units of acre feet (ac-ft), gallons (gal), or million gallons (MG).

DESIRED OUTCOMES

This metric is intended to be used to assess progress related to the allocation of the right water quality to the right use, and the promotion of reuse water supplies for irrigation, cooling, toilet flushing, and other approved uses, to reduce pressures on potable water supplies.

While no single target value exists for this metric, from an integrated systems perspective it is desirable to affect the trend of this metric, and ideally to achieve an inclining trend whereby a higher volume of reuse water is being used to serve municipal demands.

METHODOLOGY

This metric should be calculated to represent the sum of:

- Distributed reclaimed water, where reclaimed water is defined in Regulation 84 (Colorado Department of Public Health and Environment, 2018). Distributed water is defined as the volume of reclaimed water entering the municipal ("purple pipe") distribution system, calculated as total reclaimed water production, excluding water exported to another water provider, placed into long-term storage, or delivered for agricultural use.
- Graywater reuse, where graywater is defined in Regulation 86 (Colorado Department of Public Health and Environment, 2015).

DATA NEEDS AND SOURCES

Reclaimed water is produced by treating wastewater. At a utility scale, water and wastewater providers that operate centralized water reclamation facilities will have reclaimed water data analogous to that of a potable water system. The State of Colorado already requires the largest water providers to report data about reclaimed water volumes on an annual basis (Colorado Water Conservation Board, 2011).

It is also common to have distributed water reclamation facilities (e.g., manufacturing facilities such as breweries and food processing plants). These systems are permitted by CDPHE and are required to have continuous flow monitoring (Colorado Department of Public Health and Environment, 2019b).

Graywater systems are implemented at a site or building scale to serve indoor toilet flushing and outdoor subsurface irrigation demands (Colorado Department of Public Health and Environment, 2015). Graywater systems are authorized only in communities that have implemented a local graywater control program. While flow monitoring is not required, the control programs are required to track the location of the systems, as well as the design capacity (which can be used to estimate the graywater reuse).

Similar to graywater reuse, blackwater reuse systems are also implemented at a site or building scale. As of 2019, these systems are limited to small-scale demonstration and research projects and do not need to be included in calculations until they become a significant source of water supplies.

CALCULATION CONSIDERATIONS

It will be easier to collect reclaimed water volumes than graywater reuse and blackwater reuse volumes.

In most cases, water providers do not regulate or otherwise oversee water reuse systems. The exception is reclaimed water production by a utility that provides both water and wastewater services. Gathering the data will require collaborating with wastewater utilities, industrial site managers, and others.

In interpreting the metric results, users will need to distinguish between communities that have chosen not to authorize reuse water versus communities that are not able to authorize reuse water (based on their water rights).

WHERE TO GO FOR MORE INFORMATION

To understand reclaimed water and graywater reuse, including water quality standards and approved uses, refer to (Colorado Department of Public Health and Environment, 2018; Colorado Department of Public Health and Environment, 2015). For more information about the future of direct potable reuse in Colorado, refer to (WateReuse Colorado, 2018).

For calculating water reuse metrics, consult the following resources (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b).

15. TOTAL NON-POTABLE WATER USE

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric quantifies the municipal demands met by non-potable water supplies (e.g., raw water, rainwater, stormwater).

In this guidebook, reuse water supplies (that are treated before use) are considered separately from non-potable water supplies (that are not treated before use).

VALUES/UNITS OF MEASURE

The result of this metric will be a volume most often expressed in units of acre feet (ac-ft), gallons (gal), or million gallons (MG).

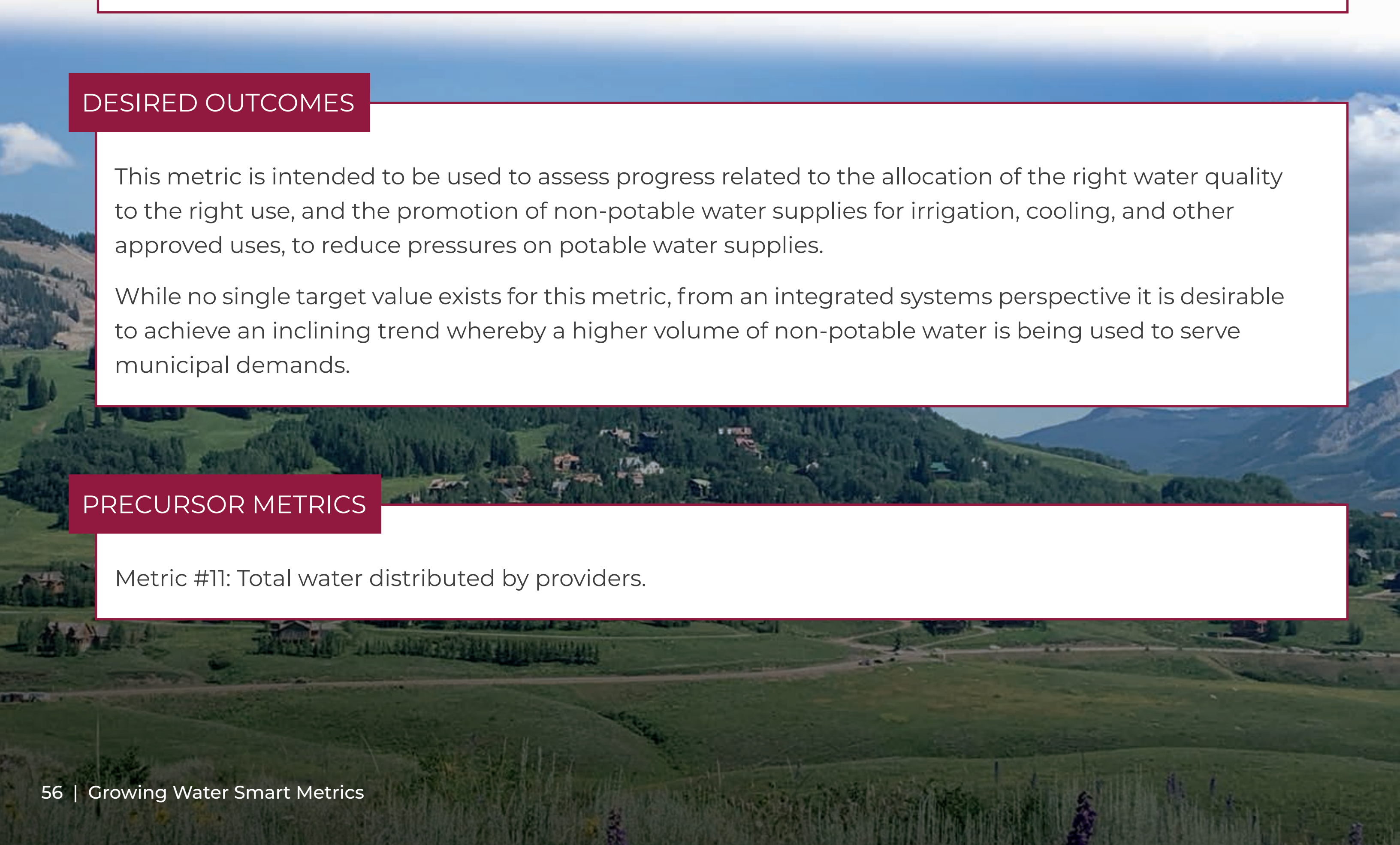
DESIRED OUTCOMES

This metric is intended to be used to assess progress related to the allocation of the right water quality to the right use, and the promotion of non-potable water supplies for irrigation, cooling, and other approved uses, to reduce pressures on potable water supplies.

While no single target value exists for this metric, from an integrated systems perspective it is desirable to achieve an inclining trend whereby a higher volume of non-potable water is being used to serve municipal demands.

PRECURSOR METRICS

Metric #11: Total water distributed by providers.



METHODOLOGY

This metric should be calculated to represent the sum of:

- Distributed raw water, defined as the volume of untreated surface water or groundwater entering the municipal distribution system, calculated as total diversions (for surface water) or pumped volumes (for groundwater), excluding water exported to another water provider, placed into long-term storage, or delivered for agricultural use.
- Rainwater harvesting, defined as capturing water from an impermeable surface and then storing and using the supplies (Beers, 2016; Colorado Water Conservation Board, 2019b).
- Stormwater use, defined as collecting or directing stormwater runoff onto landscaped areas.

DATA NEEDS AND SOURCES

Raw water volumes, whether surface water diversions or groundwater pumping volumes, should be available from water providers as well as the State of Colorado's Decision Support System, which provides access to all water rights and related data (State of Colorado, 2019c). The State of Colorado requires the largest water providers to report data on raw water volumes on an annual basis (Colorado Water Conservation Board, 2011).

Rainwater and stormwater systems are implemented at a site or building scale. Residents in Colorado are allowed to collect rainwater into two 55-gallon drums (Beers, 2016). CWCB runs a rainwater harvesting pilot project program and tracks systems under this program, including the volume of water collected and used (Colorado Water Conservation Board, 2019b). Additional rainwater and stormwater collection systems can be identified through participation in augmentation plans used to replace the collected water.

CALCULATION CONSIDERATIONS

Rainwater and stormwater systems are implemented at a site or building scale and may be difficult to quantify. Requiring collection and storage volume calculations on site plans would aid data collection and analysis.

WHERE TO GO FOR MORE INFORMATION

To understand the requirements around rainwater harvesting, refer to (Colorado Water Conservation Board, 2019b; Beers, 2016).

For more information about calculating water use metrics, consult the following resources (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b).

16. PER CAPITA WATER DEMANDS

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric is one of the most commonly calculated and used water use metrics. It is used to assess systemwide water efficiency as well as efficiency in the residential sector and to account for population growth in a service area.

VALUES/UNITS OF MEASURE

The units of this metric are gallons per capita per day (gpcd).

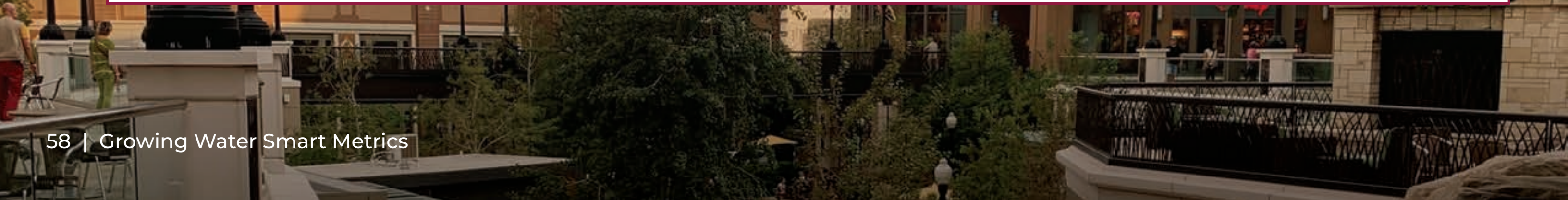
DESIRED OUTCOMES

This metric as recommended is intended to be calculated to represent systemwide water use inclusive of residential, commercial, institutional, and industrial demands.

While no single efficiency target has been established, a technical update to the Colorado Water Plan established a baseline value of 164 gpcd in 2015 and forecasted values out to 2050 under a range of planning scenarios of 143-169 gpcd (State of Colorado, 2019b).

Factors that will drive the metric value down (indicating improved efficiency) include (State of Colorado, 2019b):

- Passive water savings from increasingly efficient fixtures and appliances.
- A weak economy, which historically has slowed population growth and adversely affected water-dependent businesses.
- Cooperative growth that fosters environmental stewardship and efficient development.
- Technical innovations supporting improvements in water efficiency and conservation that exceed expectations.
- Cooler temperatures, which decrease irrigation demands and shorten growing seasons.



DESIRED OUTCOMES, *CONT.*

Factors that will drive the metric value up (indicating decreased efficiency) include (State of Colorado, 2019b):

- Warmer temperatures, which will increase irrigation demands, lengthen the growing season, and reduce water supplies.
- Population growth that outpaces gains in efficiency
- Low density and rural developments outpacing higher density developments.

PRECURSOR METRICS

Metric #11: Total water distributed by providers

METHODOLOGY

The metric of per capita water demands is calculated by dividing municipal water demands by the population served.

Municipal demands are calculated in metric #11 (total water distributed by providers).

Service population may need to be estimated in parts as follows:

- Permanent resident population within incorporated areas.
- Permanent resident population outside of incorporated areas.
- Visiting population served, which may be further broken down into day visitors, defined as 1) visitors that do not stay overnight; and 2) transient population, defined as visitors that stay overnight.

DATA NEEDS AND SOURCES

Water providers will be the primary source of distributed water volumes. Permanent resident population within incorporated areas should be sourced from the DOLA State Demography Office or from U.S. census data (Colorado Department of Local Affairs, 2019a). Permanent resident population outside of incorporated areas may need to be estimated based on number of accounts served and average number of residents per household. Depending on the characteristics of the community, and the significance of tourism, the visiting population may be negligible or may be significant to the metric result. Often, a community's planning or economic development department will have estimates of the visiting population for use, but the data are often not updated at the same frequency (annually) as permanent resident population data.

CALCULATION CONSIDERATIONS

Community

Water providers and communities often calculate this metric in the way that best represents local conditions, data availability, and decision-making and reporting needs.

It is common for methodologies to vary across water providers, influencing values by 20-30% (when water demands at different points in the supply and treatment train are used) or by up to 300% (depending on whether or not the visiting population is included). For these reasons, it can be quite misleading to compare results across providers. At a minimum, providers should clearly document the data and assumptions used in their calculations.

Many providers will have relatively long historical records for this metric, which will allow analysis and interpretation of historical trends. Once a long historical record has been established, values can be further normalized to remove the influences of weather, economy, and other factors to isolate efficiency trends.

While the metric is recommended to analyze systemwide water use, it is also informative to calculate this metric by sector (e.g., residential, commercial, institutional, industrial) and sub-sector (e.g., single family residential, multi-family residential, restaurants, lodging). This metric is easiest to interpret for the single-family residential sector which tends to be more homogeneous than the commercial, institutional, and industrial sectors.

Regional/State

Historically, the State of Colorado has calculated this metric using distributed water volumes and permanent resident population only, which artificially inflates values for tourism-based communities. While this methodology is appropriate to achieve consistent results at a State level, it can be detrimental to show the results at an individual community level (for the reasons stated above).

WHERE TO GO FOR MORE INFORMATION

For more information about calculating water use metrics, consult the following resources (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b).

For more information about calculating per capita water use in the residential sector, refer to (DeOreo, Mayer, Dziegielewski, & Kiefer, 2016).

For more information about calculating water use metrics in the commercial and institutional sectors, refer to (Fedak, Hannon, Taylor, & Volckens, 2019).

17. PERCENT OF ANNUAL DISTRIBUTED WATER SERVING OUTDOOR USES

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric quantifies the percentage of distributed water that serves outdoor irrigation uses. Reducing outdoor water use is a continuing efficiency and conservation opportunity in the residential sector.

VALUES/UNITS OF MEASURE

The result of this metric will be a percentage value ranging from 0-100%.

DESIRED OUTCOMES

This metric is intended to be used to assess whether the State is progressing in reducing outdoor irrigation demands by reducing water waste, improving irrigation equipment efficiency, improving irrigation practices, and/or selecting native vegetation landscapes that require less water than turf.

The Colorado Water Plan reported that in 2008, 39% of municipal water across the State was used outdoors. This metric can vary from 15% for high elevation communities to 60% for low elevation communities.

PRECURSOR METRICS

Metric #11: Total water distributed by providers.

METHODOLOGY

This metric is calculated as the total water distributed by providers that is used outdoors divided by the total water distributed by providers (metric #11).

Total water distributed by providers that is used outdoors will require summing across a two-step analysis:

- Where metered use represents outdoor use only, sum water use across those accounts.
- Where metered use represents combined (indoor and outdoor) use, conduct a seasonal water use analysis as follows:

METHODOLOGY, *CONT.*

- Analyze the monthly use data for seasonal irrigation patterns, to define winter months (when no irrigation is assumed to occur) and irrigation months (when irrigation is assumed to occur).
- Calculate the average monthly use for the winter months, then multiply by 12. This value is assumed to represent the annual indoor use.
- Subtract the annual indoor use from the total annual use. The difference is assumed to represent the outdoor water use.

The total outdoor water use is estimated by summing the actual metered use from dedicated meters and the estimated outdoor water use from combined meters.

DATA NEEDS AND SOURCES

This metric requires monthly water use data. Water providers will be the source of the data.

CALCULATION CONSIDERATIONS

This metric (or at least the data required to calculate this metric) is often presented in water efficiency plans.

Where a seasonal analysis on combined meters is performed to estimate outdoor water use, providers should consider other water uses that increase in the summer that may confound the analysis. For example, water-using cooling systems such as cooling towers, water use associated with seasonal businesses such as pools and car washes, and even system losses increase in the summer along with irrigation use. Conversely, there are some factors that confound the seasonal analysis by increasing winter use (which then artificially increases the annual indoor water use estimate) or decreasing summer use (which then artificially decreases the annual outdoor water use estimate).

As climate change alters regional temperature and precipitation patterns, a useful permutation of this metric may be "percent of annual distributed water serving outdoor uses during the growing season." Colorado's growing season is expected to lengthen as a result of climate change, leading to additional outdoor water use (US Environmental Protection Agency, 2016).

In being expressed as a percentage, this metric value can decline (indicating less water is being used outdoors) at the same time that total outdoor water use increases. Therefore, this metric should be used in combination with other metrics to ensure that overall efficiency and conservation goals are being achieved.

WHERE TO GO FOR MORE INFORMATION

For historical values in Colorado, see (State of Colorado, 2015). For historical values in individual communities, refer to available water efficiency plans, which are commonly available on-line from water providers or from the CWCB where State grant funds were used to develop the plans. For calculating water use metrics, see (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b).

18. AVERAGE IRRIGATION RATE

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric quantifies the amount of municipal water applied to irrigated lands, excluding the agricultural sector.

VALUES/UNITS OF MEASURE

The result of this metric will be in units of volume per area, most often expressed as gallons per square foot (gal/sq ft) or acre-feet per acre (ac-ft/ac).

DESIRED OUTCOMES

This metric is intended to be used to assess whether the State is progressing in improving outdoor water use efficiency by reducing water waste, improving irrigation equipment efficiency, improving irrigation practices, and/or promoting native and xeric landscapes rather than turf.

While no single efficiency targets exist, communities are starting to define site standards, efficiency benchmarks, and irrigation guidelines. For example:

- In 2017, the City of Aspen enacted a Water Efficient Landscaping Standards Ordinance specifying that total site irrigation cannot exceed a maximum applied water budget of 7.5 gal/season/sq ft of irrigated landscape area (Magill, 2018).
- Denver Water has established efficiency benchmarks for outdoor water use by customer type (Denver Water, 2018c):
  - **Single-family and multi-family residential:** 12 gal/sq ft of irrigable landscaped area per year
  - **Public spaces:** Efficiency benchmarks are defined by land use typology:

Landscape Use Typology	Target Water Use (gal/sq ft/yr)
Event Areas	22
Athletic Fields	20
General Recreation	16
Aesthetic Areas	12
Farms and Gardens	10
Rights of Way/Medians	10
Synthetic Fields	5
Irrigated Native Grass	5
Non-Irrigated Areas	0

PRECURSOR METRICS

Metric #17: Percent of annual distributed water serving outdoor uses

Metric #23: Total irrigated area within provider service areas

METHODOLOGY

This metric can be calculated as the total water distributed by providers that is used outdoors (a byproduct of metric #17: percent of annual distributed water serving outdoor uses) divided by the total irrigated area (metric #23).

DATA NEEDS AND SOURCES

Water providers will be the source of water use data.

Irrigated area will be available from water providers, community providers, or GIS datasets.

CALCULATION CONSIDERATIONS

Given the heavy processing requirements associated with high-resolution datasets used to determine irrigated area, this metric should be calculated every five years to assess trends compared to previous years.

The State of Colorado currently requests that water providers, as part of the annual water use reporting requirements for covered entities, submit the typical irrigation application rate for their service area (Colorado Water Conservation Board, 2011).

This metric is much easier to calculate at the site scale than at the community scale. Ideally, developers are submitting information about landscaped areas on site plans along with development applications, and providers are tracking that information over time.

WHERE TO GO FOR MORE INFORMATION

For more information about tracking and reporting irrigated area and landscaped area water use, consult the following resources (Colorado Water Conservation Board, 2011; State of California, 2010).

19. PERCENT OF IRRIGATION DEMANDS SUPPLIED BY NON-POTABLE OR REUSE SUPPLIES

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric quantifies the proportion of irrigation demands met by non-potable and reuse supplies, including raw surface water, groundwater, reclaimed water, graywater reuse, rainwater harvesting, and stormwater management.

VALUES/UNITS OF MEASURE

The result of this metric will be a percentage value ranging from 0-100%.

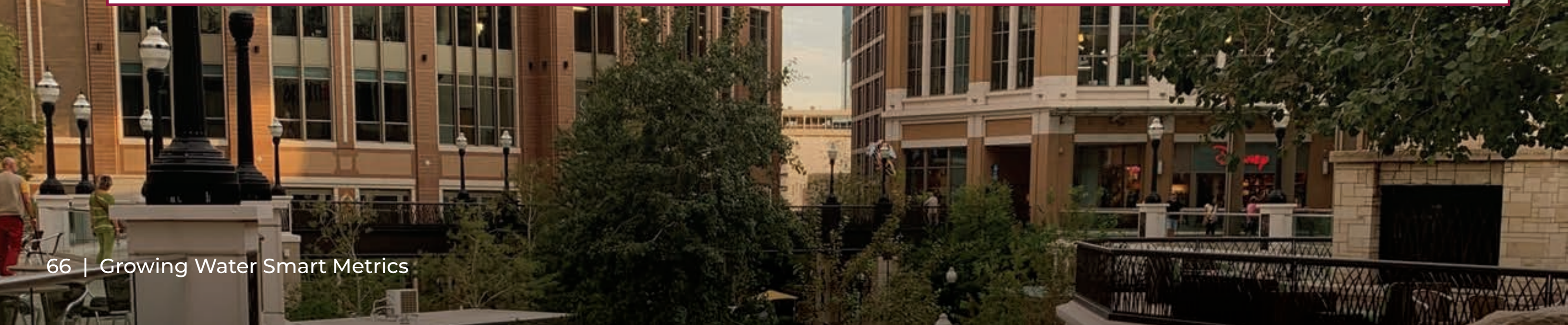
DESIRED OUTCOMES

This metric is intended to be used to assess whether the State is progressing in promoting non-potable and reuse supplies for irrigation. While using non-potable and reuse supplies in place of potable supplies does not save water, it can save energy and money associated with pumping and treatment processes.

While no single target exists, from an integrated systems perspective it is desirable to achieve an inclining trend whereby a higher proportion of irrigation demands is being met by non-potable and reuse supplies.

PRECURSOR METRICS

Metric #17: Percent of annual distributed water serving outdoor uses.



METHODOLOGY

This metric is calculated as the total non-potable and reuse water serving irrigation demands divided by the total distributed water serving outdoor uses (a byproduct of metric #17: percent of annual distributed water serving outdoor uses).

Total non-potable and reuse water serving irrigation demands will require summing across a two-step analysis:

- Where metered use represents outdoor use only, sum water use across those accounts.
- Where metered use represents combined (indoor and outdoor) use, conduct a seasonal water use analysis as described for metric #17 (percent of annual distributed water serving outdoor uses).

DATA NEEDS AND SOURCES

Water providers will be the primary source of distributed water volumes.

CALCULATION CONSIDERATIONS

Many water providers do not currently calculate this metric on a regular basis, at least in part due to a lack of data for non-potable and reuse water volumes.

WHERE TO GO FOR MORE INFORMATION

For more information about calculating water use metrics, consult the following resources (Colorado Water Conservation Board, 2012; Open Water Foundation and WaterDM, 2018; State of California, 2010; State of Colorado, 2019b)

20. WATER DEMANDS BY LAND USE TYPE

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric quantifies municipal water demands by land use type categories.

VALUES/UNITS OF MEASURE

The result of this metric will be normalized water use by land use type in units of gallons per household per day (gal/hh/d), gallons per capita per day (gpcd), or acre-feet per acre (ac-ft/ac) (Castle & Rugland, 2019).

DESIRED OUTCOMES

Unlike other metrics recommended in this guidebook, the results of this metric are not intended to be assessed against a single targeted value. Rather, the intention is to use the metric results to better understand the water use implications of land use decisions to (1) inform zoning and future land use categories to better reflect anticipated water use, (2) compare old and new developments to understand water use trends, (3) support forecasting water use based on zoning and land use planning scenarios, and (4) inform water adequacy determinations and system development charges (Castle & Rugland, 2019).

PRECURSOR METRICS

Metric #11: Total water distributed by providers.

METHODOLOGY

This metric can be calculated as follows:

- Collect historical water use data by meter.
- Gather land use information for the period of time that water use data are available.
- Link meter to land use category using a common identifier or GIS overlay analysis.
- Analyze water use by land use category using descriptive statistical analysis.

DATA NEEDS AND SOURCES

Water providers will be the primary source of water use data. Community planners will be the primary source of land use information, ideally in a format that enables spatial analysis.

CALCULATION CONSIDERATIONS

Community

This metric requires extensive data collection and processing and may present significant technical challenges to communities aspiring to calculate it. The metric requires data sharing and collaboration between water providers and land use authorities where the entities are separate (e.g., where a special district provides water services). Where multiple water providers serve one community, or where a water provider serves multiple communities, it may be difficult to assemble comprehensive and consistent water use and land use information.

Land use categories are recommended for this metric (over zoning districts) because actual land use often does not conform to the zoning district. For instance, a city may have a residential area that is mostly comprised of single-family homes, even though the area is zoned for higher densities. Land use categories are also expected to be more standardizable across communities. Eventually, the results of this metric may help to refine or suggest common land use categories (such as single-family homeowners associations) that are good predictors of water use.

Regional/State

The main issue in calculating this metric at a regional or State level is that each community uses different land use categories, rendering the results difficult to synthesize. Developing standard land use categories that are used across jurisdictions and are correlated with water demands will be an important step toward calculating this metric on a regional or Statewide scale.

WHERE TO GO FOR MORE INFORMATION

For more information about calculating this metric, consult the following resources (Castle & Rugland, 2019; Nolon Blanchard, 2018).

21. FORECASTED WATER DEMANDS BASED ON FUTURE LAND USE PLAN

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric adds municipal demand forecasting based on a future land use scenario to the stable of demand forecasts typically employed by water providers as part of their water supply planning processes.

VALUES/UNITS OF MEASURE

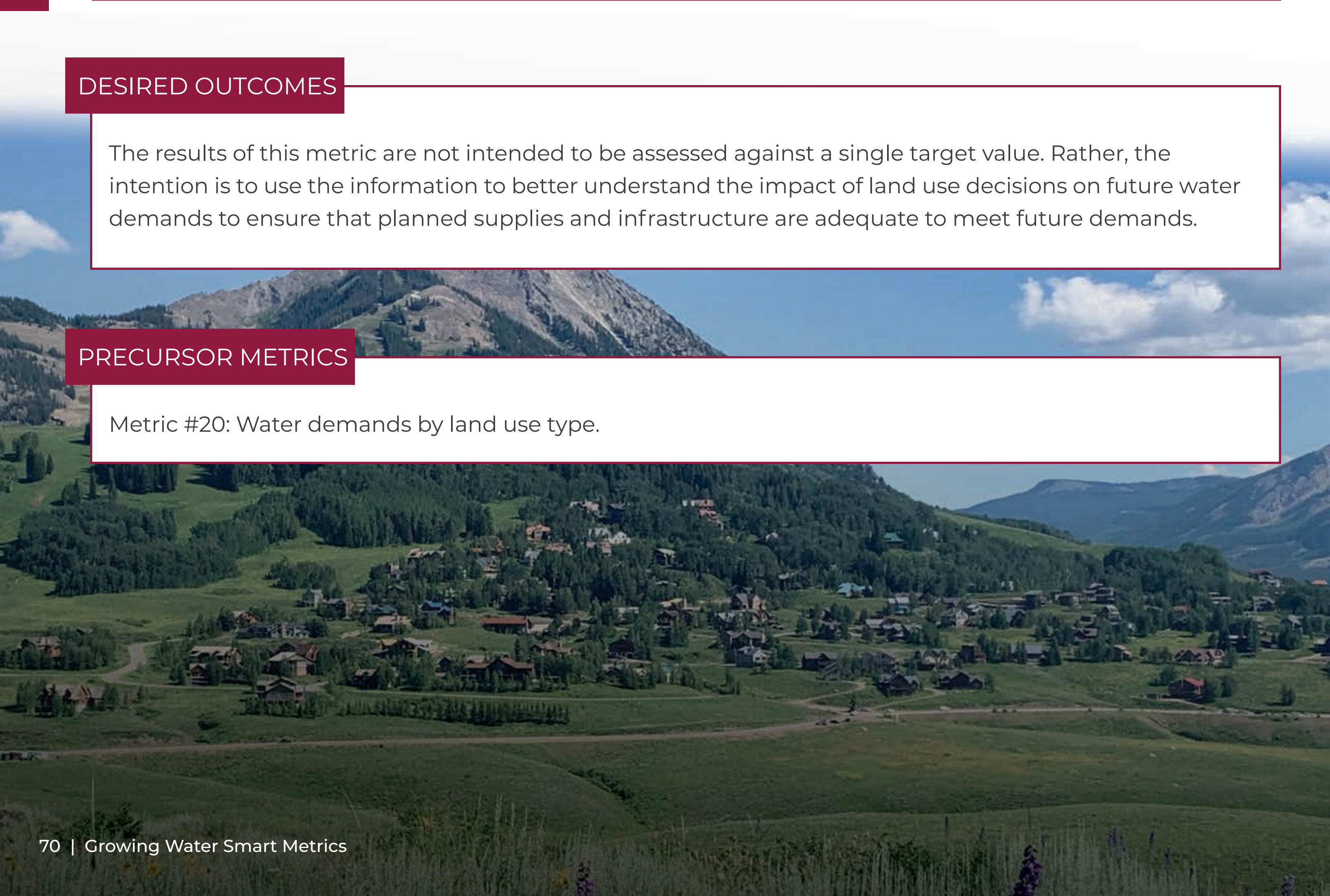
The result of this metric will be a water use volume with units of million gallons (MG) or acre-feet (ac-ft).

DESIRED OUTCOMES

The results of this metric are not intended to be assessed against a single target value. Rather, the intention is to use the information to better understand the impact of land use decisions on future water demands to ensure that planned supplies and infrastructure are adequate to meet future demands.

PRECURSOR METRICS

Metric #20: Water demands by land use type.



METHODOLOGY

Demand forecasting approaches range from simple (multiplying per capita water demands by an estimate of the future service population) to complex (regression models that predict water use based on weather, billing rates, pricing structures, economic conditions, regulations, metering infrastructure, and other factors that influence water use from year to year). In its simplest incarnation, this metric can be calculated as follows:

- Select a future point in time to forecast demands. The Colorado Water Plan forecasts demands to 2050, so it may be helpful to choose this point in time in addition to other meaningful local milestones (e.g., anticipated date of community buildout).
- Develop a future land use plan with land use categories, housing estimates, and population estimates.
- Calculate future water demands using the future land use plan in conjunction with a database of water demands by land use type (metric #20: Water demand by land use type).

Given the inherent uncertainty associated with future conditions, it's common to forecast a range of possible outcomes using scenario planning.

DATA NEEDS AND SOURCES

Community planners will be the primary source of future land use scenarios and housing and population projections. Water provider or community planners may be responsible for maintaining a database of water demands by land use type.

CALCULATION CONSIDERATIONS

Community

This metric requires extensive data collection and processing and may present significant technical challenges to communities aspiring to calculate it. The metric requires data sharing and collaboration between water providers and land use authorities where the entities are separated (e.g., where a special district provides water services). Where multiple water providers serve one community, or where a water provider serves multiple communities, it may be difficult to assemble comprehensive and consistent water use and land use information.

Regional/State

The main issues in calculating this metric at a regional or State level are synthesizing demand forecasts produced using different methodologies and for different planning horizons. Additionally, future land use categories may not align between different land use jurisdictions.

WHERE TO GO FOR MORE INFORMATION

For more information about forecasting water demands using land use information, consult the following resources (Castle & Rugland, 2019; Colorado Water Conservation Board, 2012; Nolon Blanchard, 2018).

22. GAP BETWEEN ANNUAL WATER SUPPLIES AND DEMANDS

METRIC CATEGORY

Trends in water demand and use.

METRIC DESCRIPTION

This metric quantifies the difference between municipal supplies and demands at a point in time.

VALUES/UNITS OF MEASURE

The result of this metric will be a water use volume with units of million gallons (MG) or acre-feet (ac-ft).

DESIRED OUTCOMES

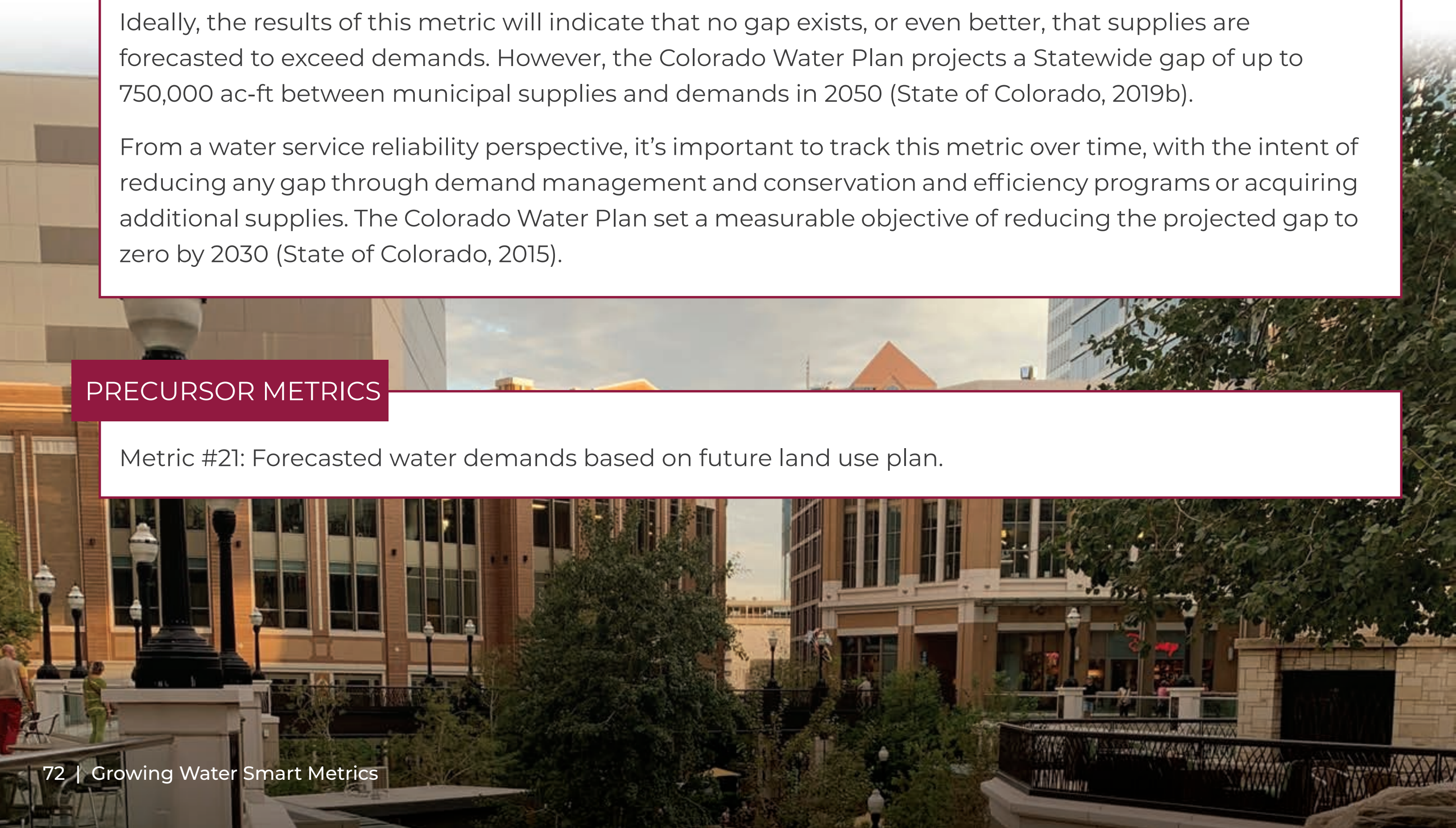
This metric is intended to be used to assess whether a community, region, or the State can reliably meet future municipal demands with planned supplies.

Ideally, the results of this metric will indicate that no gap exists, or even better, that supplies are forecasted to exceed demands. However, the Colorado Water Plan projects a Statewide gap of up to 750,000 ac-ft between municipal supplies and demands in 2050 (State of Colorado, 2019b).

From a water service reliability perspective, it's important to track this metric over time, with the intent of reducing any gap through demand management and conservation and efficiency programs or acquiring additional supplies. The Colorado Water Plan set a measurable objective of reducing the projected gap to zero by 2030 (State of Colorado, 2015).

PRECURSOR METRICS

Metric #21: Forecasted water demands based on future land use plan.



METHODOLOGY

This metric relies on calculating the difference between a water supply forecast and a water demand forecast (metric #21: forecasted water demand based on future land use plan). As with demand forecasts, water supply forecasts can be developed using a range of techniques that vary in complexity. Hydrologic and water allocation models are commonly employed for this purpose.

Given the uncertainty in future conditions, it's common to forecast a range of possible outcomes using ensemble forecasting or scenario planning, as was done in the technical update to the Colorado Water Plan (State of Colorado, 2019b). In forecasting supplies and demands under multiple future scenarios, a range of factors can be evaluated including impacts from climate change, population growth scenarios, and more.

To calculate a gap between forecasted demands and forecasted supplies that makes sense, the future time horizon and the modeled scenario between the two forecasts should align. The State of Colorado uses 2050 as the main planning horizon, so this date is recommended for consistency in addition to other milestones of local importance (State of Colorado, 2019b; State of Colorado, 2015).

DATA NEEDS AND SOURCES

Water providers will be the primary source of both water supply and water demand forecasts.

WHERE TO GO FOR MORE INFORMATION

For more information about calculating this metric, consult the following resources (Nolon Blanchard, 2018; State of Colorado, 2015).

23. TOTAL IRRIGATED AREA WITHIN PROVIDER SERVICE AREAS

METRIC CATEGORY

Trends in development patterns and land use.

METRIC DESCRIPTION

This metric quantifies the amount of outdoor vegetated area that is supplied with irrigation water, excluding agricultural lands.

VALUES/UNITS OF MEASURE

The result of this metric will be in units of area, typically acres or square feet.

DESIRED OUTCOMES

This metric is intended to be used to assess trends in irrigated area in urban and suburban (not agricultural) areas. Additionally, it will support the assessment of irrigation efficiency for metric #18 (average irrigation rate).

While no single target exists, it is presumably desirable to achieve a declining trend whereby less area is being sustained through supplemental irrigation. In reality, the trend is likely to increase given the amount of population growth and development in Colorado, offset only to a small degree by turf replacement and native vegetation restoration projects.

METHODOLOGY

At a community, regional, or State scale, this metric requires remotely sensed data and processing using geographic information systems (GIS)::

- Collect or purchase high-resolution aerial imagery.
- Process aerial imagery to map irrigated lands.
- Define the area of interest using community and/or water provider service area boundaries.
- Summarize the irrigated lands within the designated boundary.

DATA NEEDS AND SOURCES

Aerial imagery can be purchased from a number of commercial enterprises.

DOLA maintains GIS data representing boundaries for municipalities, counties, and special districts, including those that provide water services (Colorado Department of Local Affairs, 2019b).

CALCULATION CONSIDERATIONS

Timing

Given the heavy data processing requirements, this metric should be calculated every five years to assess trends.

Responsibility

The State of Colorado currently requests that irrigated acreage information be submitted as part of the annual water use reporting requirements for covered entities (Colorado Water Conservation Board, 2011).

Given the high cost of aerial imagery and the heavy data processing requirements, it may be beneficial for the State or a third-party entity to take responsibility for calculating this metric, rather than individual communities. There is precedent for this approach, as the State of Colorado already maps irrigated agricultural lands every five years (State of Colorado, 2019d).

Community

Some organizations quantify permeable or irrigable lands, rather than irrigated lands, as permutations of this metric. The methodology needs to be tested for the ability to differentiate between irrigated permeable and non-irrigated permeable areas and to test that changes in irrigated area can be detected at the scale at which remote sensing data are collected.

While some communities already calculate and track this metric, others find the cost of aerial imagery and processing effort to be prohibitive. Given the onerous data collection and processing requirements, this metric should undergo more rigorous piloting in communities with high-resolution data and/or through research with higher education institutions before rolling out to all communities.

Depending on the GIS systems maintained by a community, these data can also be pieced together from site plans and local GIS/land cover data.

Regional/State

The main issue in calculating this metric at a regional or State level is using sufficiently high-resolution aerial imagery that can detect relatively small changes in irrigated area over time.

WHERE TO GO FOR MORE INFORMATION

For more information about tracking and reporting irrigated area, consult the following resources (Colorado Water Conservation Board, 2011; State of California, 2010).

24. POPULATION DENSITY

METRIC CATEGORY

Trends in development patterns and land use.

METRIC DESCRIPTION

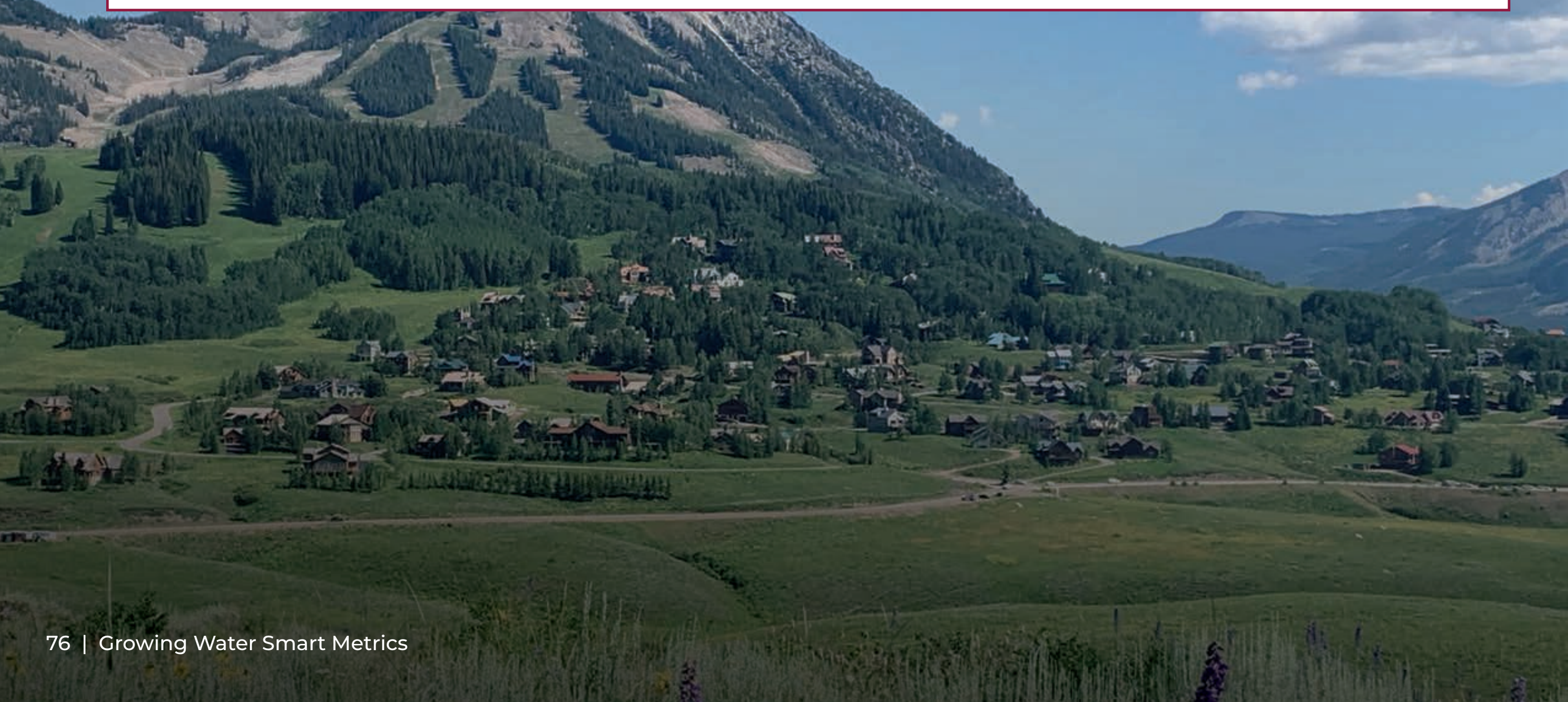
This metric quantifies population density as one measure of development patterns and trends that affect water use.

VALUES/UNITS OF MEASURE

The result of this metric will be a normalized value in units of dwelling units per acre (dua) or persons per square foot.

DESIRED OUTCOMES

Numerous studies have shown that high density developments save infrastructure costs and reduce water use (Castle & Rugland, 2019). This metric is intended to be used to assess whether population density is increasing over time.



METHODOLOGY

This metric can be calculated by dividing population (or alternatively, the number of dwelling units) by the total area.

DATA NEEDS AND SOURCES

Community land use planners will be the primary source of boundary data.

Total population and/or housing unit data may be available from land use planners, or can be sourced from the DOLA State Demography Office or U.S. census data (Colorado Department of Local Affairs, 2019a).

CALCULATION CONSIDERATIONS

Community
Each community seeks to promote water-efficient development in a way that makes sense for their unique conditions. For example, techniques for promoting water-efficient development include cluster development, infill development, allowing accessory dwelling units, and more. In selecting the relatively common, but coarse, metric of population density, the intent is to promote higher development densities without judging the best way to do so.

Regional/State
The main issue at the regional and State level is distinguishing between basic population growth (which will cause the metric value to increase) and more efficient development patterns.

WHERE TO GO FOR MORE INFORMATION

For more information about calculating this metric, consult the following resources (Nolon Blanchard, 2018; Keystone Policy Center, 2018).

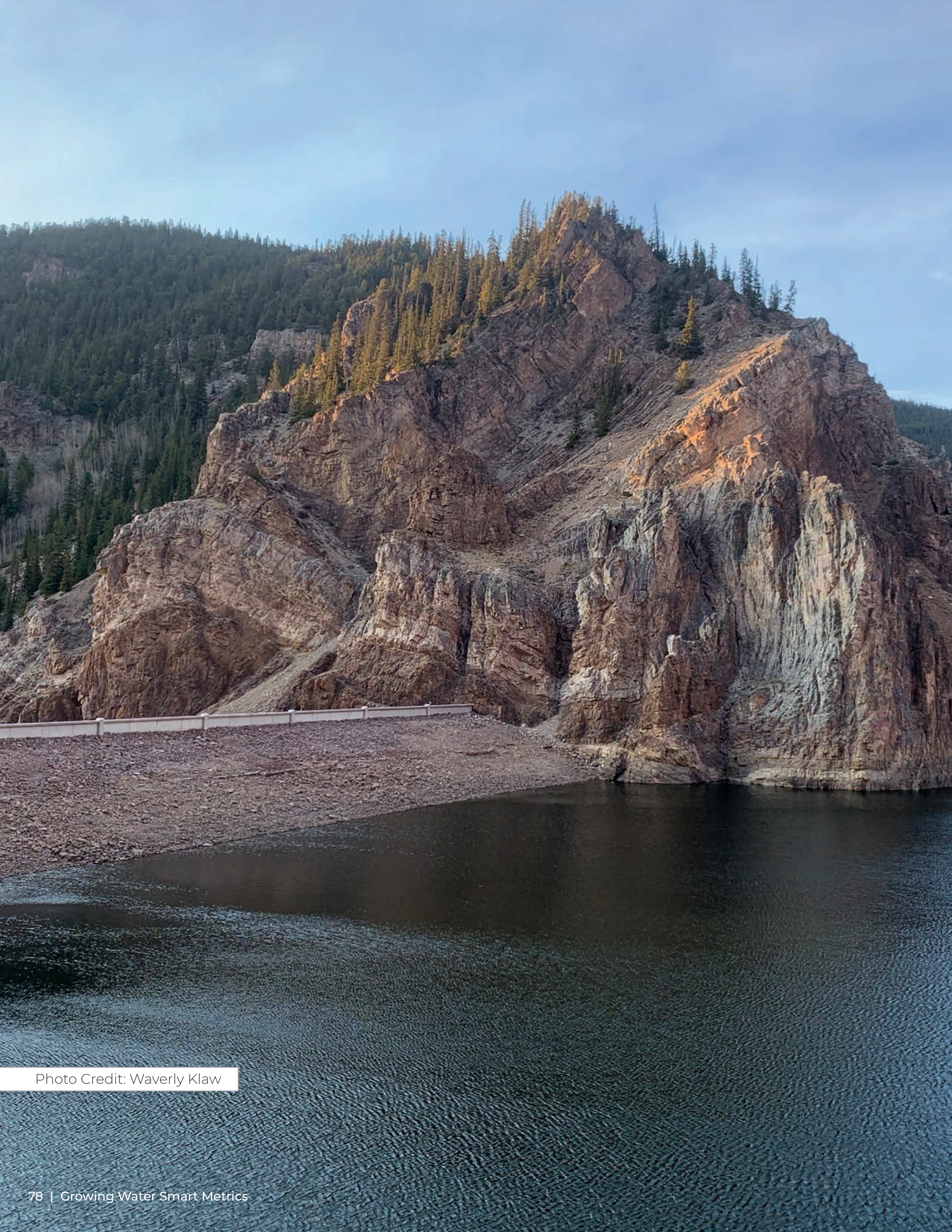


Photo Credit: Waverly Klaw

CHAPTER 4
ACTIVATE

This chapter addresses implementation considerations, including barriers and opportunities, for the recommended metrics.

BARRIERS AND CHALLENGES

Data availability and alignment

High quality and consistent data lay at the foundation of any effort to calculate metrics. Data availability, quality, and formats vary widely between communities and even across departments within a community. And while making assumptions and methods more transparent is an important first step toward broader alignment, moving to agreed-upon metrics, data sources, and methodologies will help even more.

Willingness to share information

Communities and water providers may not be willing to share data and metric results outside of their organizations, especially where findings are deemed politically sensitive in a growing State constrained by available water resources. Ultimately, communities are encouraged to share metric results publicly at an aggregated scale to support regional and Statewide analyses, while adhering to local data sharing and privacy guidelines.

OPPORTUNITIES

Rules, requirements, and policies

High quality and consistent data lay at the foundation of any effort to calculate metrics. Data availability, quality, and formats vary widely between communities and even across departments within a community. And while making assumptions and methods more transparent is an important first step toward broader alignment, moving to agreed-upon metrics, data sources, and methodologies will help even more.

Incentives

The State of Colorado already requires that water efficiency plans incorporate best management practices for water conservation and demand management through land use planning efforts (Castle & Rugland, 2019). State approval of a water efficiency plan is required for providers to be eligible for certain types of grant funding and low-interest infrastructure loans. The State similarly has the opportunity to require the inclusion of a water element in all long-range comprehensive plans. While the State currently allows communities to include a water element, it is not required as it is in other States such as California and Arizona.

The State of Colorado also already requires large water providers (defined as water providers that deliver more than 2,000 ac-ft/yr of retail water) to report annually on water use and conservation (Colorado Water Conservation Board, 2011). The State could expand upon these requirements to include the progress and impact metrics recommended in this guidebook.

Incentives

One of the most powerful opportunities to activate Colorado communities to integrate water and land use planning and to report associated metrics is financial incentives. DOLA and CWCB each year disburse funding for water efficiency projects and comprehensive plans. The grant application, evaluation, and selection processes could be modified to require or reward communities that track integration metrics or that demonstrate favorable trending in their water-land use planning integration metrics.

Communities may also be incentivized to integrate water and land use planning and to report associated metrics through recognition programs. A new recognition program could be developed to identify communities that are leading the way in this field as well as individuals who serve as important ambassadors to educate and guide others.

Partnerships

Cultivating strong partnerships is necessary for the successful implementation of the metrics proposed in this guidebook. Important partners and stakeholders beyond the community planners and water providers emphasized in this guidebook include:

- Representatives from municipal departments such as buildings, parks and recreation, economic development, housing, fire, police, and sustainability and resiliency officers.
- The development community, which has a vested stake in conversations regarding growth, land use, and water.
- Non-governmental organizations, consultants, and academic institutions that may be able to help tackle challenges such as:
    - The Colorado Water and Land Use Planning Alliance meets quarterly to assist planning and water professionals in disseminating information and educational materials.
    - The American Planning Association's Colorado Chapter and Sustainability Committee serve as important educators, advocates, and conveners on this topic.
    - CU-Denver and other higher education institutions can provide research and information technology support, such as developing a statewide data portal, as well as integrating water and land use planning into curricula to teach the next generation of practitioners.
    - Sonoran Institute and the Babbitt Center for Land and Water Policy continue to offer Growing Water Smart workshops and technical assistance programs.

CHAPTER 5
NEXT STEPS

This guidebook recommends common metrics that can be used to measure the progress of integrated water-land use planning and the impacts of those integration efforts at local, regional, and State scales. Next steps should focus on (1) selected communities calculating the recommended metrics, (2) advancing incentives to encourage communities and water providers to not only calculate the metrics but also to report results to the State to inform policy and planning directions, and (3) refining implementation recommendations for a wider rollout across the State. One potential delivery model for statewide rollout includes the Colorado Water Loss Initiative which provided water providers with free targeted technical assistance and training on the best practices for conducting water loss audits (Colorado Water Conservation Board, 2020).

The metrics recommended in this guidebook will be piloted with selected communities to help test:

- Methodologies for different implementation scales
- Data availability and accessibility
- Data collection and analysis processes
- Calculation and reporting challenges
- Using the results to inform policy and planning decisions
- Staff time, technical expertise, and other resources needed
- Ability to set target values and track progress over time
- Ability to attribute outcomes to integration efforts

Beyond this project, planning stakeholders were asked to identify projects that the State could lead or support to bolster the integration of water and land use planning.

Responses included:

- Establish minimum building codes that include best practices for water efficiency
- Regulate the number of water fixtures per dwelling unit
- Require long-range comprehensive plans to include water efficiency
- Establish broader reporting requirements for water and land use planning
- Tie grant funding to the demonstration of integration activities
- Put a water metric on the State of Colorado Governor's dashboard to continue to demonstrate the State's commitment to water (State of Colorado, 2020b)
- Develop a Statewide dataset of high-resolution aerial imagery
- Fund data collection, analysis, and capacity building
- Bolster adequate water supply regulations
- Implement more stringent requirements for special districts supplying water to new developments
- Establish a statewide data portal building off the current Colorado Water and Land Use Planning Alliance website
- Deliver statewide training to educate community planners and water providers and to promote metric implementation

IN CONCLUSION

Communities across Colorado have already begun integrating water and land use planning. To understand how these varied activities are making progress toward the Colorado Water Plan integrated water and land use planning objective, and how the integration efforts are resulting in water savings, a comprehensive and common set of metrics should be used. This guidebook recommends a suite of common metrics for these purposes. Though the recommended metrics are intended for use across all Colorado communities, the guidebook recognizes that communities have differing needs and capacities to implement these metrics. Measuring regional and statewide progress will require standardized methodologies and reporting protocols. We hope this guidebook provides a blueprint for communities and the State of Colorado to continue leading the way in water and land use planning integration. Finally, though this guidebook was developed specifically for Colorado, we hope the work is transferrable and useful to other communities in the Colorado River Basin.

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APPENDIX A: PROJECT APPROACH

The Growing Water Smart Metrics project was born out of a need to better understand the quality, reach, and impact of water-land use planning integration efforts occurring across the State of Colorado. The purpose of this project was to select a set of metrics that community and State officials can use to track their progress in meeting the Colorado Water Plan integrated water and land use planning objective (State of Colorado, 2015).

TASK 1: DESIGN STAKEHOLDER ENGAGEMENT APPROACH

The project was executed in collaboration with the Sonoran Institute, which helped define the project scope on behalf of the Colorado Water and Land Use Planning Alliance. The project was a year-long, stakeholder-driven process that included three planning workshops. To ensure this guidebook was practical and represented diverse Colorado communities across a range of geographic scales, stakeholders from across the State from planning departments and water utilities were invited to provide input. More than 25 stakeholders were engaged during the project.

Objectives

Stakeholders were asked to actively participate, share their expertise, act as ambassadors, and review the proposed metrics. Cultivating a team of representative practitioners (i.e., water providers, consultants, local planners, and regional planners) was central to the process to ensure project outcomes were actionable and pragmatic.

Who was involved?

The Project Advisory Team (PAT) served as the guiding body for the implementation of this project. The PAT included representatives from the State of Colorado (DOLA and CWCB), the Lincoln Institute for Land Policy, and the Sonoran Institute.

Brendle Group executed the project including designing a stakeholder engagement approach, facilitating the stakeholder engagement, conducting the research, and developing this guidebook. Brendle Group conducted best practice research, developed an inventory of potential metrics *(Appendix B)*, and designed a survey to garner feedback from the Stakeholder Team.

The Stakeholder Team included representatives from local and State governments; non-profit institutes and universities; and private consulting firms. This diverse team represented both land use planning and water provider perspectives.

TASK 2: CONDUCT ENGAGEMENT PROCESS

The Stakeholder Team was engaged at three project milestones: Anchor, Define, and Activate. The guidebook is organized around these engagement points. Upon completion of the draft guidebook, the PAT and the Stakeholder Team reviewed and provided comments.

Anchor

The **Anchor** phase sought to establish a shared pool of understanding as the foundation of this project. During the Anchor phase, Brendle Group facilitated a meeting to provide an overview of best practice research and projects to date. During this meeting the Stakeholder Team provided critical feedback to clarify the boundaries and intersections between land use planning and water saving actions. Additionally, the Stakeholder Team spent a significant portion of the meeting discussing the distinction between progress metrics and impact metrics. Split into four groups, the Stakeholder Team developed a list of potential progress and impact metrics to consider during the course of the project. While some of the proposed metrics were already being tracked in communities across the State, others were proposed as new possibilities. The outcomes from this first workshop were used to frame the remainder of the project, and to begin developing the metrics inventory. Brendle Group collected the proposed metrics, added several more identified during the literature review of best practice research, and sought to define each metric. This consolidated metric inventory was presented to the Stakeholder Team at the second workshop for review and refinement.

Define

During the **Define** phase, the Stakeholder Team was asked to review the full list of metrics and to identify missing metrics, flag metrics for removal, and suggest amendments to the metrics as proposed. The Stakeholder Team also discussed potential barriers and opportunities to implementing the metrics. Input from this second meeting was used to refine the list of recommended metrics. Brendle Group developed and disseminated a survey to garner feedback on the status and importance of each recommended metric. Survey participants were asked to identify barriers related to their community or organization.

Activate

The Stakeholder Team was engaged in a third workshop during the **Activate** phase of the project. The Activate phase focused on finalizing the guidebook and identifying next steps to help communities overcome barriers to implementing metric tracking.

TASK 3: RESEARCH

Metrics identified during the course of the project, whether from the literature review or the workshop process, were inventoried using the following information:

- **Metric Definition:** This field defined the metric and identified the value to be measured.
- **Metric Type:** This field identified whether the metric was categorized as a progress or impact metric.
- **Metric Category:** Metric categories were used to help organize the metric inventory.
- **Metric Descriptors:** Units, value ranges, targets, and desired trends were defined for each metric.
- **Relevancy to Land Use:** For progress metrics, relevance to land use was evaluated qualitatively by assessing whether the activity described in the metric directly related a land use decision and best practices presented in key background resources. For impact metrics, relevance to land use was evaluated qualitatively by assessing whether land use activities could directly and substantially be linked to the metric.
- **Candidate for Short List:** Relevance to land use planning and decision-making was considered essential to the identification of recommended metrics. Relevance to water savings was considered important, but not essential.
- **Minimum that counts:** Used to identify a minimum standard by which communities or water providers could assess whether they had completed the activity described by the metric. This field was most relevant to progress metrics.
- **Gold standard:** Identified the gold standard by which communities or water providers could assess whether they had completed the activity described by the metric. This field was most relevant to progress metrics.
- **References:** This field tracked the origin and related resources for each metric.
- **Scale:** Denoted the scale at which the metric is most useful: site, provider, community, county, and/or State scale. Metric recommendations focused on the community/service area, regional, and State scales.
- **Data needs:** This column identified the potential data sources required to calculate the metric.
- **Data availability:** This field identified the ease or difficulty of collecting the data.
- **Update/calculation frequency:** This field identified how often the metric could and should be calculated, based on the availability of data and the utility of calculating the metric with a given frequency.
- **Quality considerations:** This field noted any special quality issues or concerns associated with the metric that may influence the metric result.
- **Rollup considerations:** This field identified barriers to using the metric to evaluate the integration of water and land use planning at a regional or State level.
- **Party responsible for calculating:** This field identified parties responsible to collect the data.
- **Methodology notes:** This column was used to track considerations for calculating the metric.

Approximately 70 metrics were inventoried and evaluated by Brendle Group, the PAT, and the Stakeholder Team before narrowing the list to the 24 recommended metrics.

APPENDIX B: METRICS INVENTORY

Table 6. Inventory of Progress Metrics Evaluated

PROGRESS METRICS	
Development of long-range plans	
# 1	Percent of population living in communities with a long-range land use plan that integrates water efficiency
# 2	Percent of population living in communities with a long-range water plan that integrates land use strategies
# 3	Percent of communities with water element/section in long-range comprehensive plan
Implementation of conservation and efficiency programs	
# 4	Percent of population served by providers with conservation-oriented system development charges
# 5	Percent of population served by providers with conservation-oriented pricing structures
# 6	Number of registered addresses with installed graywater systems
# 7	Percent of total water infrastructure dedicated to distributing alternative supplies (i.e., raw, reclaimed)
# 8	Percent of population served by providers with water budgets developed to educate about use or to inform pricing structures
# 9	Percent of population served by providers with water savings goals associated with land use strategies as part of efficiency planning
# 10	Percent of providers implementing water-saving projects or strategies related to land use
# 11	Percent of conservation program budget allocated by providers to projects or strategies linked to land use
# 12	Percent of population served by providers with water waste (i.e., waste of water) ordinances
# 13	Percent of conservation staff time invested by providers implementing land use-related projects
# 14	Total design capacity of reclaimed water treatment plants
# 15	Total design flow for graywater systems by category
Adoption of landscaping and building codes	
# 16	Percent of population living in communities that have adopted the most recent International Code Council version and/or the International Green Construction Code
# 17	Percent of population living in communities adopting reuse water into local code
# 18	Percent of population living in communities with codified outdoor water efficient equipment standards that exceed State standards
# 19	Percent of population living in communities with water efficient landscaping and irrigation standards

PROGRESS METRICS

Implementation of adequate water supply rules

#20	Percent of population living in communities with water supply adequacy requirements in code that exceed State minimum standards
#21	Percent of communities with water infrastructure adequacy (i.e., concurrency) requirements in code

Use of water supply and demand data to inform land use

# 22	Percent of population served by providers requiring sub-metering for outdoor use
# 23	Percent of population served by providers with system development charges commensurate with water supply and infrastructure needs (i.e., development pays for itself, pay as you grow)
# 24	Percent of population served by providers with water meters installed
# 25	Percent of population served by providers including water usage volume on bill
# 26	Percent of population served by providers with automated meter reading and/or advanced metering infrastructure
# 27	Percent of population served by providers that conduct meter testing and replacement
# 28	Percent of population served by providers billing on a monthly basis
# 29	Percent of population served by providers that provide access to real-time usage data

Extent of regionalization/collaboration

# 30	Percent of population living in communities that route development proposals to applicable water providers for review and comment
# 31	Percent of population in communities where planners and providers have regular land use planning and water coordination meetings
# 32	Percent of population living in communities with IGAs/MOUs between local governments and water providers (or between providers) on land use applications
# 33	Percent of customers served by providers participating in a regional water authority promoting water-saving land use strategies
# 34	Percent of population in communities where land use plans have been coordinated across jurisdictional boundaries

Table 7. Inventory of Impact Metrics Evaluated

IMPACT METRICS	
Trends in water demand and use	
# 1	Total water distributed by providers
# 2	Total potable water distributed by providers
# 3	Percent of municipal demands served by potable water supplies
# 4	Total water reused/reclaimed
# 5	Total non-potable water use
# 6	Per capita water demand
# 7	Percent of annual distributed water serving outdoor uses
#8	Average irrigation rate
#9	Percent of irrigated demands supplied by non-potable or reuse supplies
# 10	Water demand by land use type
# 11	Forecasted water demand based on future land use plan
# 12	Gap between annual supply and demand
# 13	Gallons per capita per pervious area
# 14	Volume of water shared between municipal & agriculture sectors using alternative transfer methods
# 15	Monthly summer peaking factor (e.g., average monthly summer use divided by average monthly winter use)
# 16	Ratio of annual supply to demand
# 17	Year in which annual demands are expected to exceed supplies

IMPACT METRICS

Conservation & efficiency program measures

# 18	Water savings have been estimated from land use integration strategies
# 19	Percent of rainwater volume managed through LID/GI/stormwater BMPs
# 20	Percent of properties with LID/GI/stormwater BMPs installed
# 21	Percent of total area with native plantings, xeriscaping, or other waterwise landscapes
# 22	Participants in turf replacement (or other landscape conversion) rebate programs
# 23	Water savings from water budget program
# 24	Participants in educational programs (i.e., residential irrigation efficiency or vegetation, landscaper certification, etc.)
# 25	Number of water-efficient fixtures exceeding State WaterSense standards
# 26	Number of audits completed for large-use customers
# 27	Raw water delivered by providers

Trends in development patterns and land use

# 28	Total irrigated area within water provider service areas
# 29	Population density
# 30	Residential density
# 31	Number of properties implementing low water use landscapes
# 32	Number of conversions from well permits to taps (i.e., as surrogate for system expansion and rural to suburban development)
# 33	Developed land area
# 34	Undeveloped land area
# 35	Land use scenario fits within available water supplies

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