SECTION 3
REVISITING THE GAPS

The Colorado Water Plan set an adaptive management framework for future water planning activities, and described five planning scenarios under which demands, supplies, and gaps were to be estimated. The planning scenarios included new considerations, such as climate change, that were not a part of prior SWSI analyses. The CWCB and Division of Water Resources have developed new consumptive use and surface water allocation models that were not previously available for use in prior SWSI phases. As a result of these factors, the Technical Update takes a different and more robust approach to estimating potential future gaps.

3.1 SWSI 2010 GAP METHODOLOGY

Gaps in SWSI 2010 were focused on municipal and self-supplied industrial water users and were defined as a "future water supply need for which a project or method to meet that need is not presently identified." The gaps accounted for new future water needs and also anticipated yields from Identified Projects and Processes (IPPs) projected to provide future supply. Gaps were calculated using the following formulas:

M&I Water Supply Gap = 2050 net new water needs – 2050 projects

Where:

2050 Net New Water Needs = (2050 low/medium/high M&I baseline demands – high passive conservation – current M&I use) + (2050 low/medium/high SSI demands – current SSI use)

2050 IPPs = Water Provider Anticipated Yield from: Agricultural Transfers + Reuse + Growth into Existing Supplies + Regional In-basin Projects + New Transbasin Projects + Firming In-basin Water Rights + Firming Transbasin Water Rights

Information on specific IPPs and estimated yields were obtained from CWCB interviews and data collected from water providers throughout the State in 2009 and 2010, the original SWSI effort in 2004, and information from basin roundtables from 2008 to 2010. The overall IPP "success" was then adjusted to create varying levels of M&I gap based on the likelihood that a specific IPP would produce its full yield

Agricultural shortages were estimated in SWSI 2010. The shortages were estimated by calculating the difference between the amount of water consumed by a full-irrigated crop and the amount of water actually consumed by crops under water short conditions. The shortages were field-based, meaning that they did not account for water needed for conveyance and other losses. Agricultural shortages were not described as gaps, in part because they were conceptually different than the infrastructure gaps calculated for M&I water uses.

CALCULATING THE GAP

Gaps calculated in SWSI 2010 were based on future water demands and accounted for the degree to which future projects might meet future demands. Gap projections in the Technical Update do not include estimates of basin-identified project yields. This is primarily due to the lack of specific project data that would allow projects to be modeled. Forthcoming basin plan updates will reevaluate projects and consider strategies to address gaps.

REGARDING PROJECTS

IPPs in SWSI 2010 referenced "Identified Projects and Processes" that were being pursued by water providers to meet future demands. The Technical Update refers to these simply as "projects."

3.2 GAP METHODOLOGY IN THE TECHNICAL UPDATE

The methodology for calculating gaps in the Technical Update is very different from that used in prior SWSIs. The new methodology was necessary to address new analysis needs, to provide basin roundtables with the tools to develop implementation strategies within the adaptive management framework, and to take advantage of new models and data sets.

New Analysis Needs

The Technical Update estimates future available water supplies and gaps under the five different planning scenarios described in the Colorado Water Plan. Previous SWSIs were conducted prior to the Water Plan and, therefore, did not consider the scenarios. The planning scenarios incorporate water supply and demand drivers associated with the potential effects of climate change, population growth, and many other factors.

New Planning Process

In the BIPs, the basin roundtables cataloged various projects and methods to mitigate future water supply gaps. The Technical Update focuses on developing tools and more detailed datasets to help the basin roundtables update their portfolios of projects and methods for meeting future water needs in a targeted manner, with forthcoming updates to their BIPs.

New Models and Data Sets

New analysis tools and data sets have been developed since SWSI 2010. Consumptive use and surface water allocation models developed through the CDSS are now available in most river basins. The CDSS tools allow the evaluation of gaps under a variety of hydrologic conditions. Municipal water demand and conservation data is available via HB10-1051 reporting. The availability of these new tools and data sets allows for a more robust approach to assessing future water availability and potential gaps.

The new gap methodology uses the CDSS tools to evaluate demands and supplies available to meet demands over a range of time and under a variety of hydrologic conditions. As a result, time series of gaps were developed to help examine how gaps change in wet, average/normal, and dry conditions at key locations in each basin (see illustration in Figure 3.2.1). In addition, the CDSS tools were used to estimate M&I and agricultural gaps on the same platform, which creates uniformity in how the respective gaps were estimated. In short, the analyses and data sets are more consistent and robust than what the CWCB was able to achieve in the past.

3.2.1 Important Considerations and General Differences

The new gap methodology has some important differences from SWSI 2010 that need to be understood and considered by basin roundtable members and others who use the findings, tools, and data from the Technical Update. Differences are summarized in Table 3.2.1 on the following page.

Figure 3.2.1 Example Time Series of Gaps

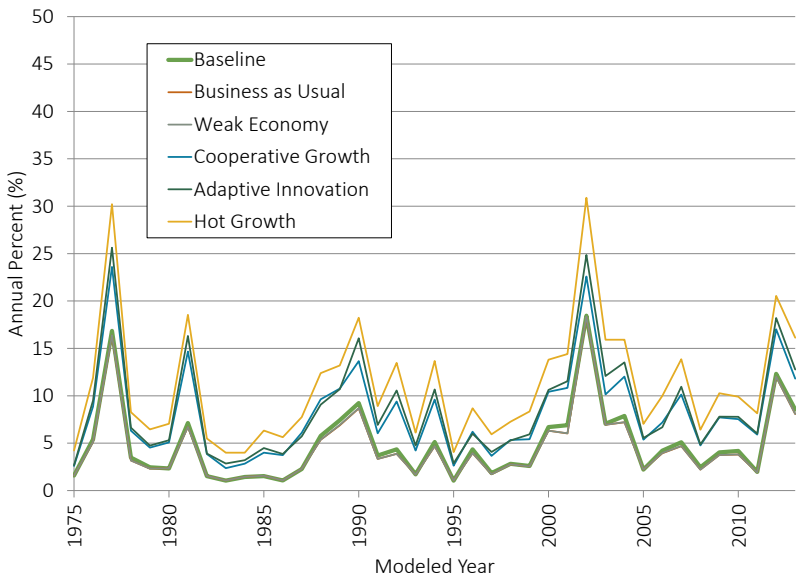


Table 3.2.1 Summary of Differences Between SWSI 2010 and Technical Update

Item	SWSI 2010	Technical Update
Consideration of alternative future conditions	✓	✓
Inclusion of yield from projects (or IPPs) in gap	✓	
Variability in future conditions (2050)		✓
Agricultural gaps using surface water modeling		✓
Quantification of livestock water demands [*]	✓	
Simultaneous consideration of active and passive municipal water conservation [**]		✓
Consideration of climate change		✓
Use of water allocation models reflecting variable supplies, demands, and river operations		✓
Simulation of existing reservoirs		✓
SDO population projections to the year 2050 [***]		✓

[*] Livestock water demands are relatively small on a basin scale and are not simulated in the CDSS tools used in the Technical Update
[**] SWSI 2010 considered active and passive conservation separately, but the Technical Update considers them jointly
[***] SWSI 2010 used complex projections to extend estimates to 2050 because SDO 2050 projections were not available at that time

Results represent 2050 conditions: The planning scenarios in the Water Plan describe assumed future conditions, but they do not contemplate the progression of changes that will occur between now and 2050. As a result, the Technical Update models and data sets represent conditions in the year 2050 and do not depict how drivers of future conditions change between now and then. For example, M&I water demands reflect the needs of Colorado's population in the year 2050 and not prior years. It should be noted that demands and supplies vary in the models, but the variation is reflective of typical ups and downs in future supplies and demands under stable hydrologic cycles, amounts of irrigated land, and population.

Climate change is considered in the Technical Update: Projections of future climate conditions were not a part of SWSI 2010 and have a significant influence on estimated gaps. Planning scenarios that consider a hotter and drier future climate have higher agricultural and municipal diversion demands (for outdoor uses) combined with lower amounts of available water supply—factors that both tend to drive larger gaps.

Agricultural gaps are based on diversion demands and described in new ways: The Technical Update quantifies and describes agricultural gaps differently than 2010.

- Agricultural gaps based on diversion demand: As explained in Section 2, water demands in the agricultural sector are based on diversion demands at a river headgate or wellhead. Unlike SWSI 2010, irrigation conveyance and on-farm efficiencies were considered in the agricultural demands and gaps in the Technical Update. As a result, the agricultural gap in the Technical Update will be significantly larger than the agricultural shortages described in SWSI 2010.
- Total and "incremental" agricultural gaps are provided**:** It is anticipated that basin roundtables may want to understand both the total agricultural gap and the degree to which existing agricultural gaps may increase under various scenarios. To meet this need, total and incremental gaps are provided in the Technical Update, and they are described in more detail below.
    - *Total Gap*: The total agricultural gap reflects the overall shortage of agricultural water supplies to meet diversion demands required to fully irrigated crops.
    - *Incremental Gap*: The incremental gap quantifies the degree to which the gap could increase beyond what agriculture has historically experienced under water shortage conditions.

- Total and incremental gaps are quantified as averages. Shortages in agriculture vary across irrigators depending on the seniority of their water rights and based upon hydrologic conditions and their source of supply (tributaries, main steam rivers, groundwater or surface water, etc.). Because of this variability, agricultural gap reporting focuses on averages, though maximum gaps are also presented in Section 4 results tables.

Municipal gaps focus on maximum shortages:

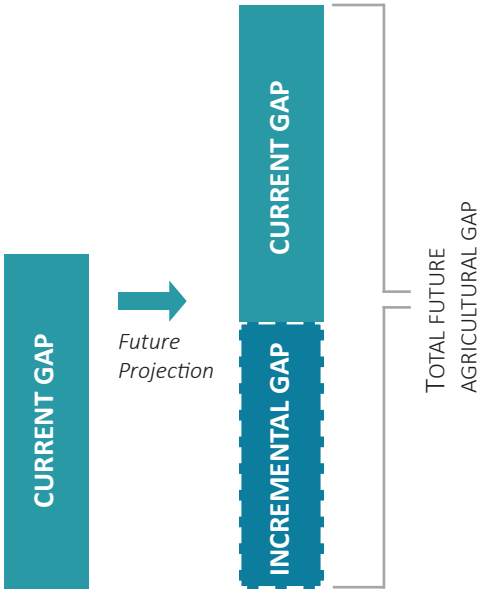
Water providers generally consider and plan for worst-case scenarios. As a result, M&I gaps described in the Technical Update focus on maximum annual shortages or gaps. For perspective, average gaps are presented as well.

Conservation is incorporated into the scenarios:

In SWSI 2010, active and passive conservation measures were considered separately. In the Technical Update, they were jointly considered in the context of the scenario narratives in the Water Plan. Additional levels of conservation beyond what was described in the scenario narratives would be considered a project that a basin roundtable could pursue to help eliminate future gaps.

Water allocation models provide for more robust analyses:

Water allocation models not readily available for use in SWSI 201 are used extensively in the Technical Update. The water allocation models reflect variable supplies, demands, and river operations using existing infrastructure and therefore provide for more robust analyses than prior SWSIs. Using models can lead to different gap results due to the wide variety of additional considerations that influence how supplies are used to meet demands.



3.2.2 Differences in Foundational Municipal Demand Data

In addition to the factors above, two foundational data inputs for estimating municipal water demands have changed since the publication of SWSI 2010—population projections and per capita demand. The changes in both of these data inputs tend to result in lower municipal water demands in the Technical Update than in SWSI 2010.

Population Projections

SWSI 2010 needed to extend the then-current SDO projections for 2035 out to the year 2050 using complex analyses. As noted in Table 3.2.1, the Technical Update was able to rely on newly developed SDO projections for 2050, and estimated high and low ranges based on historical growth statistics.

Figure 3.2.2 provides a comparison of the population projections between SWSI 2010 and the Technical Update. Note that results of population projections are described further in Section 4, but statewide results are shown here for comparison purposes. All of the Technical Update planning scenario projections for 2050 anticipate lower population than the SWSI 2010 high population projection. The Technical Update medium growth projection that is used for *Business as Usual* and *Cooperative Growth* is similar to the SWSI 2010 low population projection (within about 2 percent). The Technical Update high growth projection that is used for *Adaptive Innovation* and *Hot Growth* is similar to the SWSI 2010 medium population projection. Basin-level population projections vary from the comparison above due to the variable distributions under the scenario planning methodology, but mimic similar patterns of lower projections than were developed for SWSI 2010.

BASIN MODELING

In general, modeling was conducted at the basin scale. Due to model availability, some basins were more easily broken out into sub-basins. This was done for the following regions:

- YAMPA-WHITE-GREEN BASIN
  Individual models were available for the Yampa (which includes Green River operations) and White basins. Results of basin analyses were preseted for individual sub-basins and the combined Yampa-Green Basin.
- SOUTH PLATTE BASIN
  A model exists for the South Platte Basin but not the Republican Basin. The results of basin analysis were presented for the South Platte and Republican basins both separately and combined. In addition, the South Plate Basin model does not specifically represent the Metro Basin Roundtable region, and gap results for the Metro region are incorporated in the South Platte Basin Gap results; however, Metro-region M&I demands are specifically quantified and are presented individually (as well as combined with Republican and the remaining South Platte Basin regions).

Per capita and overall municipal demands. The statewide baseline per capita system-wide demand has decreased from 172 gpcd in SWSI 2010 to approximately 164 gpcd, which is nearly a 5 percent reduction in demands between 2008 and 2015. The reduction is associated with improved data availability, conservation efforts, and ongoing behavioral changes. Per capita demand reductions combined with lower population projections compared with SWSI 2010 resulted in lower overall municipal water demands in the Technical Update.

Figure 3.2.3 provides a comparison of the Technical Update results with the SWSI 2010 projected demands for 2050. Note that it is challenging to directly compare the municipal demand projections due to differences in the methodologies. The SWSI 2010 projections selected for Figure 3.2.3 are intended to show a range of the spread in the SWSI 2010 projections relative to the Technical Update projections.

The Technical Update demand projections for all planning scenarios fall within the spread of the SWSI 2010 high population demands with passive-conservation savings and the SWSI 2010 medium population growth with passive and high active-conservation savings. This result was anticipated with the Technical Update methodology, considering that the updated projections represent potential demands under conditions described for each scenario and do not necessarily represent the full potential for conservation programs under each scenario. All of the planning scenarios, with the exception of *Hot Growth*, project municipal water demands that are below the SWSI 2010 low population demands with passive conservation savings.

Figure 3.2.2 Comparison of SWSI 2010 and Technical Update Statewide Population Projections

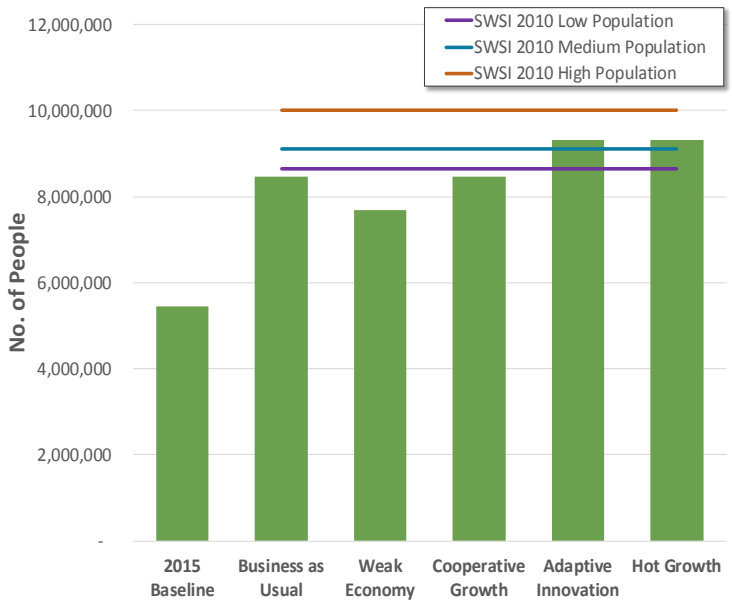


Figure 3.2.3 Comparison of SWSI 2010 and Technical Update Statewide Municipal Diversion Demands