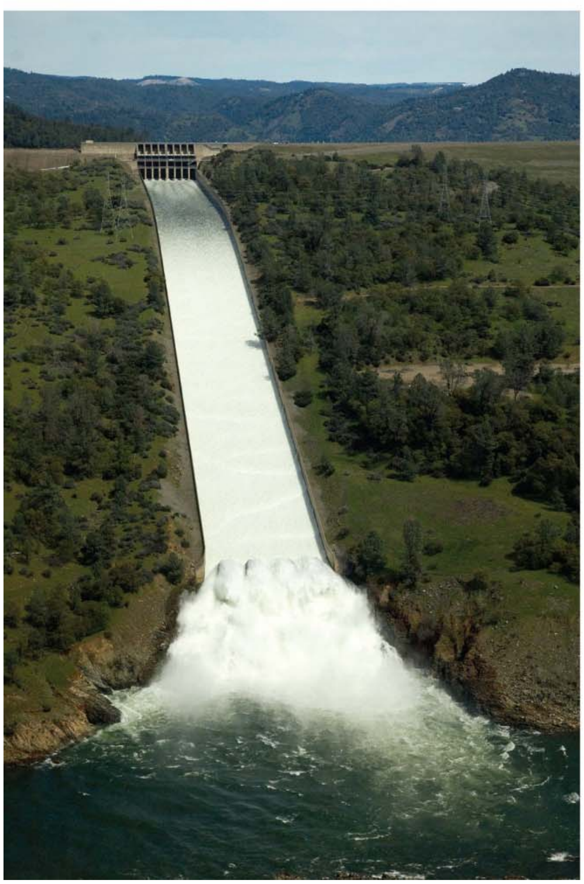
CHAPTER 3

A More Reliable Water Supply for California (as amended April 26, 2018)



ABOUT THIS CHAPTER

This chapter provides an overview of California's water supply, where it comes from, and how it is used. It also describes California's water policy foundations, including federal, State of California (State), and local policies, laws, and programs, and the need for continued improvements in local water planning, management, and information. It explains the special role of the Sacramento-San Joaquin Delta (Delta) in California's water, including its history, conflicts and challenges, and necessary investments and changes to achieve flexibility, improve resiliency, and increase water supply reliability.

As a starting point for this Delta Plan, four core water strategies must be implemented throughout the state to achieve the coequal goal of providing a more reliable water supply for California:

- Increase water conservation and expand local and regional supplies
- Improve groundwater management
- Improve conveyance and expand storage
- Improve water management information

These core strategies form the basis of the 2 policies and 19 recommendations found at the end of the chapter.

In 2018, the Delta Stewardship Council amended the Delta Plan to promote options for water conveyance[1], storage systems, and the operation of both as required by Water Code Section 85304, based on historical information and the best currently available science[2]. The additional recommendations for Delta water management system operations and supporting infrastructure improvements, together and in combination with existing Delta Plan policies and recommendations, will further the coequal goals. The amendment recommendations are based upon the *19 Principles for Water Conveyance in the Delta, Storage Systems, and for the Operation of Both to Achieve the Coequal Goals*[3] adopted by the Delta Stewardship Council in November 2015 and input from Council members and the public.

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[1] "Conveyance" is defined in the Delta Plan as the movement of water from one place to another. Conveyance infrastructure includes natural watercourses as well as canals, pipelines, and control structures including weirs. See also Glossary.

[2] "Best available science" means the best scientific information and data for informing management and policy decisions (23 California Code of Regulations Section 5001).

[3] http://deltacouncil.ca.gov/docs/19-principles-water-conveyance-delta-storage-systems-and-operation-both-achieve-coequal-goals

RELEVANT LEGISLATION

The Sacramento-San Joaquin Delta Reform Act of 2009 declares State policy for California's water resources and the Delta (Water Code section 85054):

> *"Coequal goals" means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.*

The Legislature declares the following objectives inherent in the coequal goals for management of the Delta (Water Code section 85020):

> *(a) Manage the Delta's water and environmental resources and the water resources of the State over the long term.*
>
> *(d) Promote statewide water conservation, water use efficiency, and sustainable water use.*
>
> *(f) Improve the water conveyance system and expand statewide water storage.*

The Legislature declared that:

> *85004(b) Providing a more reliable water supply for the state involves implementation of water use efficiency and conservation projects, wastewater reclamation projects, desalination, and new and improved infrastructure, including water storage and Delta conveyance facilities.*

Reduced reliance on the Delta for water supplies is established as State policy, along with an associated mandate for regional self-reliance (Water Code section 85021):

> *The policy of the State of California is to reduce reliance on the Delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency. Each region that depends on water from the Delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts.*

Water Code sections 85302, 85303, 85304, and 85211 provide direction on measures that must be included in the Delta Plan to meet the statewide water supply policy goals and objectives, and ultimately the coequal goal of increased water supply reliability:

> *85302(d) The Delta Plan shall include measures to promote a more reliable water supply that address all of the following:*
>
> > *(1) Meeting the needs for reasonable and beneficial uses of water.*
> >
> > *(2) Sustaining the economic vitality of the State.*
> >
> > *(3) Improving water quality to protect human health and the environment.*
>
> *85303 The Delta Plan shall promote statewide water conservation, water use efficiency, and sustainable use of water.*
>
> *85304 The Delta Plan shall promote options for new and improved infrastructure relating to the water conveyance in the Delta, storage systems, and for the operation of both to achieve the coequal goals.*
>
> *85211 The Delta Plan shall include performance measurements that will enable the council to track progress in meeting the objectives of the Delta Plan. The performance measurements shall include, but need not be limited to, quantitative or otherwise measurable assessments of the status and trends…*
>
> > *(b) The reliability of California water supply imported from the Sacramento River or the San Joaquin River watershed.*

The longstanding constitutional principle of reasonable use and the Public Trust Doctrine form the

foundation of California's water management policy, and are particularly applicable to the Delta watershed and to the others areas that use Delta water as the basis for resolving water conflicts (Water Code section 85023). The constitutional principle is defined in Section 2 of Article X of the California Constitution as:

> *The right to water or to the use or flow of water in or from any natural stream or water course in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water.*

Water Code sections 85031 and 85032 provide clarification that existing water rights, procedures, or laws are not affected:

> *85031(a) This division does not diminish, impair, or otherwise affect in any manner whatsoever any area of origin, watershed of origin, county of origin, or any other water rights protections, including, but not limited to, rights to water appropriated prior to December 19, 1914, provided under the law. This division does not limit or otherwise affect the application of Article 1.7 (commencing with Section 1215) of Chapter 1 of Part 2 of Division 2, Sections 10505, 10505.5, 11128, 11460, 11461, 11462, and 11463, and Sections 12200 to 12220, inclusive.*
>
> *(b) For the purposes of this division, an area that utilizes water that has been diverted and conveyed from the Sacramento River hydrologic region, for use outside the Sacramento River hydrologic region or the Delta, shall not be deemed to be immediately adjacent thereto or capable of being conveniently supplied with water therefrom by virtue or on account of the diversion and conveyance of that water through facilities that may be constructed for that purpose after January 1, 2010.*
>
> *(c) Nothing in this division supersedes, limits, or otherwise modifies the applicability of Chapter 10 (commencing with Section 1700) of Part 2 of Division 2, including petitions related to any new conveyance constructed or operated in accordance with Chapter 2 (commencing with Section 85320) of Part 4 of Division 35.*
>
> *(d) Unless otherwise expressly provided, nothing in this division supersedes, reduces, or otherwise affects existing legal protections, both procedural and substantive, relating to the state board's regulation of diversion and use of water, including, but not limited to, water right priorities, the protection provided to municipal interests by Sections 106 and 106.5, and changes in water rights. Nothing in this division expands or otherwise alters the board's existing authority to regulate the diversion and use of water or the courts' existing concurrent jurisdiction over California water rights.*

85032 This division does not affect any of the following:

> *(a) The Natural Community Conservation Planning Act (Chapter 10 (commencing with Section 2800) of Division 3 of the Fish and Game Code).*
>
> *(b) The California Endangered Species Act (Chapter 1.5 (commencing with Section 2050) of Division 3 of the Fish and Game Code).*
>
> *(c) The Fish and Game Code.*
>
> *(d) The Porter-Cologne Water Quality Control Act (Division 7 (commencing with Section 13000).*
>
> *(e) Chapter 8 (commencing with Section 12930) of Part 6 of Division 6.*
>
> *(f) The California Environmental Quality Act (Division 13 (commencing with Section 21000) of the Public Resources Code).*
>
> *(g) Section 1702.*
>
> *(h) The application of the public trust doctrine.*
>
> *(i) Any water right.*
>
> *(j) The liability of the state for flood protection in the Delta or its watershed.*

CHAPTER 3

A More Reliable Water Supply for California

In California, the conflicts over water are legendary. The connotations of wealth and power associated with control over water were captured in dramatic fashion in the 1974 film *Chinatown*. A decade later, Marc Reisner's bestselling nonfiction book, *Cadillac Desert*, described vast, arid California land tracts turned to lush, productive fields through the modern magic of water diversion and irrigation. California is known for many things: the urban, cultural giant that is Los Angeles; the great Central Valley, breadbasket to the world; cutting-edge technological advances hailing from Silicon Valley; and the fertile human-made islands of the Delta. The thread that ties these places together is a supply of fresh water from the Sacramento-San Joaquin watershed. Similarly, dozens of fish species—some of them threatened by extinction—and a diverse palette of flora and fauna also depend on this water. As described in Chapter 1, at the heart of California's water troubles are scarcity of supply and competing uses—in particular, conflict with the water needs of the ecosystem. This dynamic of conflict characterizes the essential debate over management of the Delta.

Building on the foundations of California water policy, the Delta Reform Act established the goal of providing "a more reliable water supply for California." This is coequal with the goal of "protecting, restoring, and enhancing the Delta ecosystem." Both must be accomplished while protecting and enhancing the unique values of the Delta as an evolving place. (See sidebar, What Does It Mean to Achieve the Goal of Providing a More Reliable Water Supply for California?)

The Delta Reform Act recognizes that the "Delta watershed and California's water infrastructure are in crisis and existing Delta policies are not sustainable" (Water Code section 85001(a)). The economies of major regions of the state are reliant upon the ability to use water within the Delta watershed or on water imported from the Delta watershed. Yet, the long-term impacts of these diversions, on the Delta and its watershed, in combination with many other factors, are causing native fisheries to decline. In recent years, the populations of salmon and several other fish species have reached their lowest numbers in recorded history, and many of California's salmon runs are now listed as endangered by the State or federal government. The courts have responded by imposing constraints, particularly in dry years, on water diversions through the Delta. As a result, water deliveries—particularly those that come from the State Water Project (SWP) and the federal Central Valley Project (CVP)—have become increasingly unpredictable.

The Delta and California's water supply systems are in crisis (Nichols et al. 1986; Service 2007; Moyle et al. 2013, 2016; Moyle 2014; Luoma et al. 2015), and existing Delta water management practices are not sustainable (Lund, 2016). The recent drought followed by record precipitation underscores this crisis (Medellín-Azuara et al. 2015; Lund 2016). For decades, human-produced alterations to the Delta's landscape and the operations of water management projects in the Delta and throughout the watershed have combined with multiple other factors to create stressors that imperil the Delta ecosystem and state-wide water supply reliability (Hanak et al. 2013; Mount et al. 2012).

The Delta Reform Act mandates many strategies that the Delta Plan must address to improve water supply reliability for California:[4]

- Promote, implement, and invest in water efficiency and conservation
- Implement and invest in wastewater reclamation and water recycling
- Increase and invest in desalination and advanced water treatment technologies
- Promote and implement options for improved water conveyance
- Expand and invest in storage
- Improve water quality to protect human health and the environment
- Invest in local and regional water supply projects and coordination
- Prohibit waste and unreasonable use, consistent with Article X, Section 2 of the California Constitution, and protect public trust resources consistent with the Public Trust Doctrine

California's precipitation is extremely variable, and both droughts and floods are not uncommon, even occurring in back-to-back years. Therefore, the State must adapt its water infrastructure and operations in the Delta to make better use of the greater volumes of water that are and, in the future, will continue to be available during wet years, and to take less water during dry years when conflicts with the Delta ecosystem and in-Delta water quality are at their greatest. Concurrently, the development and careful management of local water resources hold tremendous potential for improving water reliability and must be a priority for California.

Management of any natural resource is a continual balancing act. Establishment of the coequal goals provides policy priorities when it comes to managing water, but continuing disputes are inevitable. Given that water in California is scarce, actions that occur in one corner of the state can have ripple effects hundreds of miles away. Levee failures in the Delta may interrupt water supplies to industry in San Diego. Conversely, the way Southern California regions manage their water may affect California's water-dependent ecosystems. The management of a salinity regime to benefit the environment has implications for in-Delta water users. Upstream water use can affect the quality and quantity of water for all downstream users—urban, agricultural, or environmental. Decades-old decisions to drain swamps, build intrastate water projects, and mine gold have left legacy imprints on California's water and ecosystem management.

Although exports from the Delta account for only a fraction of California's water supplies, the Delta is of widespread importance given its geographic location and influential role in ecosystem dynamics. Those who live in the Delta watershed are concerned about how management actions in the Delta may affect them; those who live in the Delta are keenly aware of others' interest in their backyard; and those who rely fully or partially on Delta exports, in some cases located hundreds of miles from the Delta itself, fear the impacts of reduced water supply reliability on their local economies and standard of living.

The broad influence of the Delta is precisely why the Delta crisis cannot be resolved by taking actions in the Delta alone. The Delta Reform Act establishes a new policy for California of reducing "reliance on the Delta in meeting California's future water supply needs" (Water Code section 85021). Reduced reliance is to be achieved through a statewide strategy of investing in improved local and regional supplies, conservation, and water use efficiency so that "each region that depends on water from the Delta watershed shall improve its regional self-reliance." The State's water planning document, the *California Water Plan – Update 2009*, estimates that California could reduce water demand and increase water supply in the range of 5 to 10 million acre-feet (MAF)

[4] See Water Code sections 85004(b), 85020(d) and (f), 85021, 85023, 85302(d), 85303, and 85304.

by 2030 just through the implementation of existing strategies and technology (DWR 2009). This amount of water is more than enough to meet the projected water demands of California's growing population through 2050. An integrated approach that includes increased water efficiency, local and regional diversification of water supplies, reduced reliance on water from the Delta, improved regional self-reliance, and concurrent improvements to storage and Delta infrastructure will build the resiliency and reliability of California's water supply.

Accordingly, the Delta Stewardship Council (Council) envisions a future in which California has achieved the coequal goal of improved water supply reliability. In the future:

- California's water resources will be better managed, consistent with the State's Reasonable Use and Public Trust Doctrines.
- Improved efficiency and a greater diversity of sources will make more water available to meet the state's demands.
- Groundwater resources will be sustainably managed, and critical overdraft in groundwater basins will have been eliminated.
- Water suppliers in regions that use water from the Delta watershed will have reduced their reliance on this water and improved their regional self-reliance. California will be better prepared to meet the challenges of climate change and catastrophic events that may affect future water deliveries.

WHAT DOES IT MEAN TO ACHIEVE THE GOAL OF PROVIDING A MORE RELIABLE WATER SUPPLY FOR CALIFORNIA?

Achieving the coequal goal of providing a more reliable water supply for California means better matching the state's demands for reasonable and beneficial uses of water to the available water supply.

- This will be done by promoting, improving, investing in, and implementing projects and programs that improve the resiliency of the state's water systems, increase water efficiency and conservation, increase water recycling and use of advanced water technologies, improve groundwater management, expand storage, and improve Delta conveyance and operations. The evaluation of progress toward improving reliability will take into account the inherent variability in water demands and supplies across California.

Regions that use water from the Delta watershed will reduce their reliance on this water for reasonable and beneficial uses, and improve regional self-reliance, consistent with existing water rights and the State's area of origin statutes and Reasonable Use and Public Trust Doctrines.

- This will be done by improving, investing in, and implementing local projects and programs that increase water conservation and efficiency, increase water recycling and use of advanced water technologies, expand storage, improve groundwater management, and enhance regional coordination of local and regional water supply development efforts.

Water exported from the Delta will more closely match water supplies available to be exported, based on water year type and consistent with the coequal goal of protecting, restoring, and enhancing the Delta ecosystem.

- This will be done by improving conveyance in the Delta and expanding groundwater and surface storage both north and south of the Delta to optimize diversions in wet years when more water is available and conflicts with the ecosystem less likely, and limit diversions in dry years when conflicts with the ecosystem are more likely. Delta water that is stored in wet years will be available for water users during dry years, when the limited amount of available water must remain in the Delta, making water deliveries more predictable and reliable. In addition, these improvements will decrease the vulnerability of Delta water supplies to disruption by natural disasters, such as earthquakes, floods, and levee failures.

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In the future, water exports from the Delta will more closely match water supplies available to be exported, consistent with California's variable hydrology and the coequal goal of protecting, restoring, and enhancing the Delta ecosystem. Conveyance facilities in the Delta will be improved, and additional groundwater and surface storage, both north and south of the Delta, will help optimize diversions in wet years when more water is available and conflicts with the ecosystem are less likely, and limit diversions in dry years when conflicts with the ecosystem are more likely. These patterns of Delta exports will be consistent with more natural flow patterns in the Delta, which will aid native species and reduce regulatory uncertainty. At the same time, deliveries of Delta water will be more predictable due to use of storage to deliver wet-year water that is exported and stored for future use. Flexibility of export operations will be enhanced through implementation of local and regional water efficiency, improved conveyance to reduce conflicts with the ecosystem, and water supply projects that reduce pressure on the Delta and reliance on these deliveries.

MANY ENTITIES, MANY ROLES

Many agencies, boards, districts, commissions, and other entities are engaged in managing the Delta at federal, State, regional and local levels. Consequently, the recommendations in this chapter interact with the planning, implementation, and/or regulatory activities of many entities. Their roles, responsibilities, and missions vary significantly, and none bear sole responsibility for taking action to achieve the coequal goals.

Some of the recommendations included in this chapter pertain to project proponents who are implementing projects related to conveyance, storage, and their operations, while others pertain to agencies with planning or regulatory review responsibilities. The Council appreciates that agencies with regulatory responsibilities, such as the State Water Resources Control Board and local governments, have an important role in the review and approval of the actions recommended in the Delta Plan. An important function of the Council is to foster collaboration and coordination among the many entities engaged in projects or planning in the Delta to support decision making that will further the coequal goals.

California's Water Supply Picture

California's water supply picture makes it unlike any other state in the nation. Geography, hydrology, circumstance, and governance have shaped the political landscape of California water in a manner that has both intrigued and frustrated people for decades. Engineering alterations have enabled urban metropolises to thrive—and sprawl—and expansive agricultural regions with global influence to flourish with supplemental water, imported in some cases from hundreds of miles away and across county and even state boundaries. A complex and sometimes conflicting system of laws and policies means that in dry years, frequent in California, a given water district might have surplus supplies with which to grow lettuce or alfalfa, while a district next door battles drought conditions and the associated economic and environmental impacts.

A growing awareness of how past water management practices have led to current environmental conflicts and overall competition for water supplies, combined with the knowledge that past climate patterns are not necessarily indicative of the next century's hydrograph, are shaping how California plans for its water future (see Figure 3-1).

Today, our existing and planned conveyance and storage projects must be operated to meet multiple objectives. The 2009 Delta Reform Act signaled a resolve by the State to implement solutions that would achieve the coequal goals.

> *Coequal goals means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. –Water Code section 85054*

How California's Water Is Used

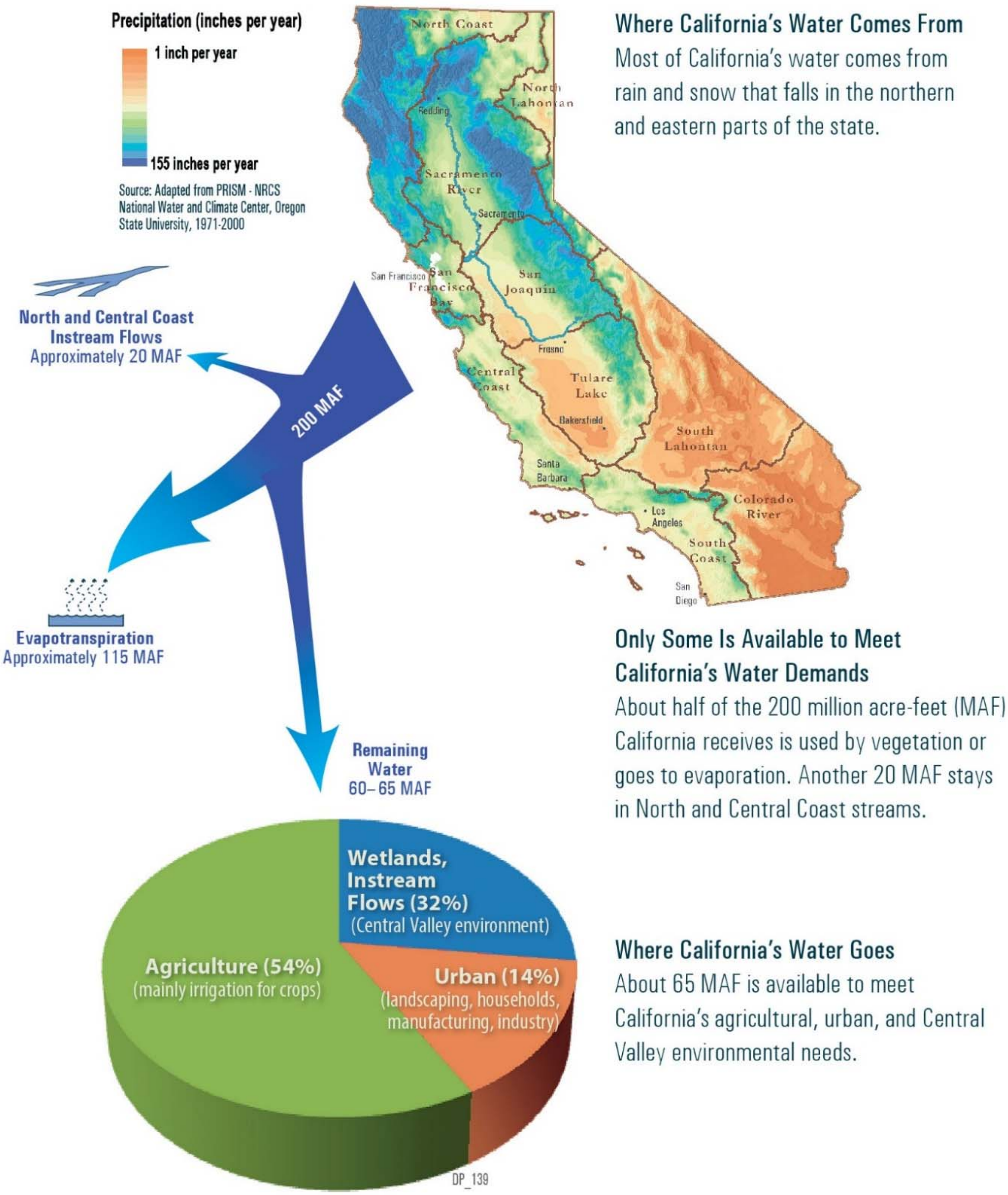

Figure 3-1 *Sources: Adapted from DWR 2009, USGS 2010*

The Delta Plan includes a portfolio of policies and recommendations intended to build regional water supply reliability; reduce reliance on the Delta; improve the Delta's ability to support viable populations of native resident and migratory species and to protect and restore habitats for these species; promote statewide water conservation and water use efficiency and sustainability; and improve water quality to protect human health and meet drinking water needs. The Plan also seeks to protect and enhance the unique characteristics of the Delta as an evolving place.

Our current water management system, as constructed and operated today, is not capable of achieving the Delta Plan's coequal goals. In particular, the use of existing south Delta intake facilities as the sole point of diversion for two large water conveyance systems – the SWP and the CVP – continues to result in entrainment[5] of native fish and changes to water quality and Delta food webs, posing fundamental challenges to improving ecosystem health and providing better water management (Mount et al. 2012).

Continuation of the status quo in the Delta is not sustainable with respect to ecosystem health or water supply reliability. The state's most recent drought resulted in severe impacts to listed fish species and a precipitous decline in the delta smelt population (Lund et al. 2008). Concurrently, historically low contract allocations and water exports via SWP and CVP facilities caused severe water shortages to some urban and agricultural areas. The drought also triggered the first ever imposition of state-wide emergency water conservation regulations. The experience and impacts of this recent five-year drought, the second multiyear near state-wide drought in less than ten years, underscores the state's and the Delta's vulnerability if the status quo is maintained. It also illustrates the pressing need to implement solutions to achieve the coequal goals.

The current decline of aquatic resources in the Delta and the erosion of water supply reliability will continue as the state's changing climate places additional stressors on ecosystem and water management. Extended, intense droughts and more extreme floods are expected to occur more frequently in the future due to climate change (Mann et al. 2017; Das et al. 2013; Pierce et al. 2013; Berg and Hall 2015; Cook et al. 2015; Differbaugh et al. 2015; Savtchenko et al. 2015; Stewart et al. 2015; Williams et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017). Since 2007, California has experienced nine years of below average runoff and only two years out of eleven have had precipitation amounts above the long-term average. As noted above, California's recent five-year drought has reinforced our understanding of the harmful effects of sustained dry periods on ecosystem health and the correlation between Delta exports and overall State water supply reliability (Hanak et al. 2015; Medellín-Azuara et al. 2015; Chang and Bonnette 2016; Lund 2016; Moyle et al. 2016).

In stark contrast, historically high combined rainfall and snowpack in late 2016 and early 2017 has called to question the capacity of flood management systems to accommodate future precipitation extremes. Water management and ecosystem sustainability strategies must recognize these climatic trends and work to improve system robustness and resiliency (Jenkins et al. 2004; Opperman et al. 2009; Cahill and Lund 2013; Kiparsky et al. 2014; Null et al. 2014; Lund 2015; Dettinger et al. 2015; Dettinger et al. 2016b).[6]

5 "Entrainment" is defined by the National Marine Fisheries Service as "the incidental trapping of any life stage of fish within waterways or structures that carry water being diverted for anthropogenic use." See also Glossary.

6 "Resilience" is defined in the *California Water Plan* as the capacity of a resource or natural system to adapt to and recover from changed conditions after a disturbance (DWR 2013).

The experience of two prolonged droughts in the last ten years has also reinforced the need to implement a comprehensive strategy that increases the diversity of regional water supply portfolios, creates more sustainably managed local water sources, and achieves greater water use efficiency (Aghakouchak et al. 2014; Ayars 2013; Cahill and Lund 2013; Null et al. 2014; Bachand et al. 2016; Elias et al. 2016; Fournier et al. 2016; Hanak et al. 2017). The benefits of water storage during an extended drought were also demonstrated, as were the detriments to water supply reliability, ecosystem health, and groundwater levels when storage is not adequate or is ineffectively managed (Reclamation 2015). Further, the Sustainable Groundwater Management Act (SGMA) has prioritized the need to address severe overdraft of groundwater basins in many areas of California. There is an urgent need to conjunctively manage surface water and groundwater supplies as part of a comprehensive approach to statewide water management, and support the recovery of critically overdrafted basins (Jenkins et al. 2004; Castle et al. 2014; Lund 2016; Pulido-Velazquez et al. 2016).

This section provides an overview of where California's water comes from and how it is used, the state's vast water supply infrastructure system, and the implications of climate change on California's water supplies.

Sources of California's Water Supply

Variability and uncertainty are the dominant characteristics of California's water resources. Precipitation is the primary source of California's water supply. However, this precipitation varies greatly from year to year, as well as by season and where it falls geographically in the state, which makes management of the state's water resources complex and challenging. Groundwater, which is often connected to surface supplies, contributes to a significant portion of California's water use, on average supplying 8 MAF (20 percent) of California's urban and agricultural uses; but in some areas, this figure is considerably higher and can be as much as 60 to 80 percent of a region's water supply (DWR 2009). Groundwater, and implications for its overuse, is discussed in greater detail later in this chapter.

The total amount of precipitation in an average year provides California with about 200 MAF of surface water falling as either rain or snow (DWR 2009).[7] The actual volume of water the state receives each year varies dramatically depending on whether the year is dry or wet. California may receive less than 100 MAF of water during a dry year and more than 300 MAF in a wet year (Western Regional Climate Center 2011a).

The term "average water year" in California is useful for explanatory purposes, but can be misleading as a measurement for planning. In fact, California experiences the most unpredictable pattern of precipitation in the nation, with the bulk of its annual water falling within just 5 to 15 days (Dettinger et al. 2011). This means that in years when fewer storms pass over California, the state faces the problem of too little water; conversely, a few extra storms may result in flooding. For example, between 2005 and 2008, Los Angeles experienced both its driest and wettest years on record (California Natural Resources Agency 2008). The historical record shows that California has frequently experienced long multiyear droughts, as well as extremely wet years that coincide with substantial flooding and consequent risk to people and property (Hanak et al. 2011).

Most of California's precipitation occurs between November and April, yet most of the state's agricultural and urban water demand is in the hot, dry months of summer and early fall, creating a management challenge. In addition, most of the precipitation falls in the mountains in the middle to northern half of the state, far from major population and agricultural centers. In some years, the far north of the state can receive 100 inches or more of precipitation while the southernmost

[7] Includes up to 10 MAF of precipitation that occurs in Oregon, Mexico, and the Colorado River and is imported into California.

regions receive only a few inches (Western Regional Climate Center 2011b). These basic characteristics of precipitation in California—seasonal timing and geography—and their fundamental disconnect with where and when Californians demand water provide the basic explanation for why water in California is such a complicated and controversial matter.

How California's Water Is Used

The amount of water available to meet agricultural, urban, and ecosystem water demands starts with the state's annual precipitation. On average, about half of this water evaporates; is used by surface vegetation for transpiration; or flows to deep subsurface areas, saline sinks, or the ocean (DWR 2009). The rest of this water—known as "dedicated water"[8]—is used to supply urban municipal and industrial uses, agricultural irrigation, water for ecosystem protection and restoration, and for storage in surface and groundwater reservoirs (DWR 2009).

Patterns of how and when water is used in the state vary with the type of water year. In fact, although best available estimates are included in this Delta Plan, state water managers often work with limited or incomplete information related to water use. The California Department of Water Resources (DWR) uses five water year–type classifications for planning and management purposes: wet, above normal, below normal, dry, and critically dry. In wet years, due to plentiful local rainfall, agricultural and urban landscape irrigation water demands are generally lower. Water demands are usually highest in years of reduced rainfall and because local supplies are low (DWR 2009). Ironically, agricultural and urban water demands may be lower during critically dry years because of short-term water use reduction actions, such as rationing or cropland fallowing to cope with water shortages.

In an average water year, this dedicated water totals approximately 80 to 85 MAF.[9] Again, the fluctuations between wet and dry years can be extreme, with wet years providing more than 95 MAF and critically dry years producing less than 65 MAF of available supply (LAO 2008, DWR 2009, USGS 2010).

However, not all of the 80 to 85 MAF is available to meet water demands within the Central Valley, Bay Area, and Southern California. In the late 1970s, the California Legislature secured State and federal protection of California's North Coast rivers and, in doing so, precluded major diversions from these rivers, including parts of the Trinity, Scott, Salmon, Eel, and Klamath rivers. Water from these rivers is now largely mandated to the environment by law, with the exception of diversions from the Trinity River to the Sacramento River for CVP supplies that are limited by federal law (Hanak et al. 2011). As a result, in an average year, approximately 20 MAF (out of the available supply of 80 to 85 MAF) are reserved for Wild and Scenic Rivers and other instream flow requirements in the North Coast and San Francisco Bay regions and some Central Coast and South Coast areas. Most of this water falls outside the Delta watershed. Although original State water plans and State and federal water contracts envisioned its capture and conveyance, permanent legal protections now prohibit it. (See the CVP and SWP Water Delivery Challenges section.)

This means that the remaining water supply (of 60 to 65 MAF in an average year) goes to meet agricultural and urban demands and Central Valley environmental needs.[10,11] In an average year, irrigated agriculture uses approximately 34 MAF (54 percent) of this water, urban areas use about 9 MAF (14 percent), and 20 MAF (32 percent) is mandated to meet instream flow requirements, including

8 DWR uses the terms "dedicated" and "developed" interchangeably in their publications. DWR identifies California's average annual dedicated water supply as 85 MAF.

9 All statewide average water use values were calculated using information in Volume 5 DWR Water Plan 2009 (including average values for years 1998 through 2005) and results from CALSIM II model runs prepared for DWR State Water Project Reliability Studies (DWR 2010b, DWR 2011c).

10 Data are from 2000, which DWR categorized as an "average" rainfall year for the state.

11 The "remaining water" of approximately 60 to 65 MAF, (62.4 MAF for purposes of percentage calculations) is referred to throughout this chapter as "total water use," unless otherwise specified. Total

State Water Resources Control Board (SWRCB) Delta water quality requirements and Central Valley wildlife refuge commitments (DWR 2009).

Accounting for how much water each sector actually uses is complicated because water may be reused several times for different purposes or it may be taken from surface or groundwater storage held from previous years.[12] The lack of consistent and accurate estimates of statewide water use is a significant challenge that has important implications for improved water management in California.

Future population and economic growth is expected to result in increased water demand. Today, California's water supply supports a population of 36.5 million people, an economy of $1.9 trillion, and diverse natural resources (LAO 2011). The largest economic sectors in the state are trade, transportation, and financial services, with agricultural services contributing about $38 billion (2 percent). Projections by the California Department of Finance in 2010 forecast that the population may grow to 60 million people by 2050, but the rate of growth is slowing and could be much lower.[13] As more development occurs, water use will continue to shift away from agricultural toward urban uses (DWR 2005, DWR 2009, LAO 2008, Hanak et al. 2011). At the same time, increasing water needs for ecosystem protection will likely exacerbate conflicts with agricultural and urban water demands.

California's Water Supply Infrastructure

To provide more reliable water supplies despite the state's hydrologic variability and diverse geography, and also to manage floods during wet years, State, federal, and local agencies have built a vast, interconnected infrastructure system throughout California (see Figure 3-2). The Delta, because of its geographic location and role in conveying water supplies, is often described as the "linchpin" of California's water infrastructure. Rivers and dredged channels act as conveyance canals, and pumping plants provide the momentum to move stored water to areas south. California's overall system includes a range of surface reservoirs, aqueducts, pumping plants, operable gates, groundwater wells, and water treatment facilities constructed over the last hundred plus years.

water use includes urban, agricultural, and Central Valley environmental uses such as instream flow requirements and non-CVP-managed wetlands.

12 For example, water that is dedicated to instream flows often becomes available for downstream diversion to agricultural and urban uses. Some portion of the water that is used for agricultural irrigation or drinking water is returned to the ecosystem through agricultural tailwater releases, infiltration of irrigation water into groundwater, and discharges from sewage treatment plants. The State does not have a system for documenting these multiple uses.

13 Growth projections by the California Department of Finance are regularly revised and over the past 2 decades reflect a trend toward slower expected growth for the state. Between 1993 and 2004, the California Department of Finance's population projections for 2040 declined by 12 million people, from 62 million to 50 million.

Moving and Storing California's Water

Figure 3-2 Large State, federal, and local dams and canal systems play an important role in storing and conveying water throughout California to meet a variety of urban and agricultural water demands.

Source: Adapted from DWR 2009

Californians have long adapted to the state's highly variable hydrology, characterized by sustained long-term droughts and occasional massive floods (Dettinger and Ingram 2013; Dettinger 2016a; Kelley 1989). In fact, the state has the most variable annual precipitation patterns of any state within the United States (Dettinger et al. 2011). The existing State and federal water systems were designed principally to address the state's geographic imbalance between abundant, seasonal water supplies north of the Delta, and emerging agricultural, municipal and industrial water demands to the south (Barnes and Chung 1986; Reclamation 2008). In these systems, Delta channels work in combination with water management infrastructure both inside and outside the Delta, including reservoirs, water intakes, pumping facilities, pipelines, and canals.

On average, local and regional water supplies account for 52 MAF (84 percent) of the state's total water use. Of the 52 MAF, about 44 MAF (84 percent) of the water supply comes from local surface water storage and deliveries, and includes sources such as the Santa Ana, Los Angeles, and Ventura river watersheds in Southern California; local diversions from the Sacramento and San Joaquin rivers; and stream drainages in the central coastal areas. In addition, groundwater supplies about 8 MAF (13 percent) of the state's total water use in average years (20 percent of urban and agricultural water use), and during droughts, can provide up to 60 percent or more for specific regions (DWR 2009). A small but rapidly growing percentage of local water comes from recycled water and water reuse projects.

Supplemental water supplies are conveyed from wetter regions of California, primarily through diversions of runoff from the great Sierra Nevada mountain range and some water from the Trinity River in the north state. In most regions, these imported water supplies augment local and regional sources, especially in dry years and dry seasons. On average, approximately 10.1 MAF (16 percent) of the state's total water use comes through a combination of major conveyance and storage facilities from water sources within California and from other states, with the SWP and CVP making up the majority of these imports (5.1 MAF, about 8 percent), and Hetch Hetchy (0.2 MAF), Mokelumne (0.3 MAF), and the Los Angeles Aqueduct (0.2 MAF) comprising the remaining in-state imports. A significant portion of the state's water supplies are imported from outside California, primarily from the Colorado River (4.3 MAF) through the Colorado River Aqueduct, which serves agricultural and urban demand in Southern California.

The network of infrastructure to store and convey water in California is impressive by modern standards and compared to other states. The state's single largest "reservoir" is the Sierra Nevada snowpack, which holds approximately 15 MAF per year on average (DWR 2009). However, for comparison, local, State, and federal agencies in California have constructed more than 1,200 major reservoirs with a combined storage capacity of 43 MAF, about half the average annual runoff for the entire state (Hanak et al. 2011, DWR 2011a).

Most of California's largest surface storage reservoirs are owned and operated by the federal government and total approximately 17 MAF of storage capacity. The largest federal facility, part of the CVP, is Shasta Lake, which holds 4.5 MAF. The State's single largest storage facility and keystone feature of the SWP, Lake Oroville Dam on the Feather River, has a capacity of 3.5 MAF (LAO 2008). Operating with other reservoirs as a system, these multibenefit facilities reduce the potential for floods at the same time that they make water available for seasonal water agricultural and urban demand, particularly in the summer and fall. They also generate clean electricity. Although these storage facilities provide many benefits, they have also significantly altered the natural ecology of these rivers. Dams and their associated facilities can present barriers to migrating fish and reduce or eliminate downstream gravel and sediment replenishment to the detriment of native species such as salmon. Moreover, reservoir operations have significantly modified the amount and timing of instream flows, as well as water temperature, further contributing to the decline of the state's native fish and ecological resources.

Looking to the future, fewer high-yielding surface storage sites are available in the state now because most of these areas have already been developed (NRC 2012). However, there are significant opportunities throughout California to expand groundwater storage and to reoperate surface storage in conjunction with groundwater storage (also known as conjunctive management or groundwater banking) and other programs to maximize the water supply and environmental benefits of these systems.

Conveyance, system storage, and operations are part of a broad and integrated portfolio of actions described in the Delta Plan. They are water management tools that are inextricably linked to the management of habitat conditions given the variable nature of the state's water supplies. Deploying one tool independent of the others is ineffective. It is only through the combination of new and improved Delta conveyance, the effective management of existing and expanded surface water and groundwater storage, and the balanced operations of both – combined with other actions and recommendations contained in the Delta Plan – that the coequal goals can be achieved.

Climate Change Complicates Management of California's Water

With climate change, the state's water supply will become even more erratic. Weather patterns are expected to become more extreme with long, multiyear droughts becoming more frequent as well as extremely wet years. Since 1906, California has seen "dry or critically dry" years one-third of the time. This trend is increasing (California Data Exchange Center 2011).

By 2050, temperature increases of 1 to 3 degrees Celsius are expected to cause more winter precipitation to fall as rain, as opposed to snow, and to reduce the Sierra Nevada snowpack (the source of much of California's runoff) by 25 to 40 percent (DWR 2010d). Runoff patterns will shift, leading to greater cool-season runoff and decreased warm-season runoff (Reclamation 2011a). The pattern of spring runoff is also expected to change, with a more rapid spring snowmelt leading to a shorter, more intense spring period of river flow and freshwater discharge accompanied by higher flooding risks (Knowles and Cayan 2004, Knowles et al. 2006, Null et al. 2010, Willis et al. 2011). Because the Delta watershed provides a portion of the water supply for approximately 27 million Californians and irrigates millions of acres of farmland, rising sea levels leading to increased salinity intrusion, along with changes in the form of precipitation and timing of snowmelt, will profoundly alter the way water is managed in California.

Specifically, an anticipated shift in runoff patterns will present a management challenge to existing reservoir operations, with large runoff events increasingly putting pressure on reservoirs managed for multiple benefits, including flood control. Reduced natural water storage in the form of snowpack will diminish statewide carryover storage capacity, making the state increasingly vulnerable during prolonged dry periods and negatively affecting water supply reliability.

Sea level rise, as much as 55 inches by 2100 (OPC 2011), will result in high salinity levels in the Delta interior, which will impair water quality for agricultural and municipal uses, and change habitat for fish species. Maintaining freshwater conditions in the Delta could require unanticipated releases of water from storage, which will reduce available water supplies for fish. Rising seas also will dramatically increase the risk of catastrophic interruption of water exports as a result of levee failure and flood events, particularly in the interior Delta where substantial subsidence has already occurred. Warmer temperatures throughout the state will cause higher evaporation rates, particularly during the hot summer and early fall months, contributing to reduced streamflows, drier soils, reduced groundwater infiltration, higher losses of water from surface reservoirs, increased urban and agricultural demand for irrigation water, and more water needed for ecosystem protection (California Natural Resources Agency 2008).

The precise local impacts of climate change on regional water resources remain less certain. Many communities in the state already experience water shortages during droughts (California Environmental Protection Agency 2006, LAO 2009). Improved modeling, especially downscaling of global climate change information to regional and local levels, will help communities to evaluate the extent of their vulnerability and to develop water management strategies that will increase the resilience of their water supply systems (USEPA and DWR 2011).

Foundations of Water Policy in California

Over the past 160 years, the California water rights system has evolved into a complex mix of public and private rights and contractual obligations that were intended to create more certainty about how water is to be allocated among urban, agricultural, and environmental uses during droughts, catastrophic interruptions in water supplies, and other times of scarcity. (See sidebar, California's Complex Water Rights System.) Yet some of these rights and obligations conflict, and now, in many years, there is insufficient water in California to support them all.

California's legal system recognizes limitations on water rights based on the longstanding doctrines of Reasonable Use and Public Trust (NRC 2012). The Delta Reform Act reiterates that the principles of reasonable use and public trust "shall be the foundation of state water management policy" and that they are "particularly important and applicable to the Delta" (Water Code section 85023). The coequal goals of improving water supply reliability for the state and restoring the Delta cannot be achieved by actions in the Delta alone. Every region in California, along with the cities and farms that receive Delta water, will need to improve their management of the state's scarce water resources.

This section discusses the legal foundations for California water policy, explains the state's system of water rights, and describes new water policies and priorities, including reduced reliance on the Delta and improved regional self-reliance, established by the Delta Reform Act.

Reasonable Use and the Public Trust Doctrines

The Reasonable and Beneficial Use and Public Trust Doctrines, in combination with existing water rights and the State's area of origin statutes, have long been the legal and policy foundation for water management in California. The State's Reasonable and Beneficial Use Doctrine specifically limits all water rights and water use in California to "such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water" (California Constitution, Article X, Section 2).

The SWRCB is the primary agency responsible for ensuring that water is not wasted and that the reasonable use standard is not violated. However, DWR also shares with them the duty to "take all appropriate proceedings and actions…to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion in this state" (Water Code section 275). The SWRCB also is responsible for determining whether any water remains available in a stream or watershed for appropriation and whether the water is being fully used for "beneficial uses," consistent with State law that identifies the types of water uses that are permitted.[14] The State can review and modify existing water rights as well as consider approval of new permits and water rights

14 Beneficial uses recognized in California include domestic, fire protection, fish and wildlife, industrial, irrigation, municipal, power production, recreation, and other uses (SWRCB 2010).

to reflect new conditions, including California statutes that require efficient water use and improved water management.

The Public Trust Doctrine provides the State with additional authority to reconsider past water allocation decisions in light of new information and changing water demands and social values, and to modify or revoke previously granted water rights if warranted. In a 1983 landmark legal decision, the California Supreme Court unanimously affirmed that the state's navigable lakes and streams are resources that are held in trust for the public and are to be protected for navigation, commerce, fishing, recreational, ecological, and other public values. The State "has an affirmative duty to take the public trust into account in the planning and allocation of water resources and to protect public trust uses whenever feasible" (*National Audubon Society v. Superior Court*, 33 Cal. 3d 419, 658 P.2d 709, 189 Cal. Rptr. 346, 1983 Cal.). This has significant implications for governance of water resources. In fact, both the Public Policy Institute of California and Appeals Court Associate Justice Ron Robie recently called for the establishment of a public trust advocate at the SWRCB to ensure that the State's duty to protect California's public trust resources is being performed adequately (Robie 2012, Hanak et al. 2011).

California's Water Rights System and Use Reporting

California's water rights system is of great legal significance. However, our water rights system does not and cannot guarantee a supply of water that exceeds what nature provides. Nor does any individual, business, industry, or agricultural enterprise "own" the water they use.

The amount of water used in California's stream systems is not fully known because water users under pre-1914 and riparian water rights have not been required, until recently, to submit annual reports accounting for their diversions. In 2009, the State adopted statewide water diversions reporting requirements (Water Code section 5100 et seq.); and in 2010, the SWRCB adopted regulations requiring online reporting of water use by all water rights holders, including all surface and groundwater users. In addition, there is limited information available to the State on consumptive use or the number of times that water is used within a stream system.

Discussed previously, the SWRCB has the authority to determine when a river or stream has been "over-appropriated," in other words, whether the amount of water available in a stream is less than the demands placed on that water. A right to use water represents potential diversions and uses. Actual water use in many rivers and streams is frequently far less than the total volume of asserted water rights. The difference between water rights and water received can be explained by restrictions or conditions in the permits/licenses, operation restrictions on the storage and transport facilities themselves, physical and economic limitations, non-consumptive uses such as hydroelectric power generation, and the use and reuse of water.

Understanding and reconciling the human demands for water to the supply available, while providing enough water to ensure desired and legally protected environmental and water quality goals, is a difficult process. This process is nonetheless essential to achievement of the coequal goals.

CALIFORNIA'S COMPLEX WATER RIGHTS SYSTEM

Whatever the type of water right that is held by an individual, business, or public agency, no one "owns" the water they use in California (Littleworth and Garner 2007). All water within the state is held in trust for the benefit of all the people of California (Water Code sections 102, 1201). Water rights holders have the right to "take and use water, but they do not own the water and cannot waste it" (*Central and West Basin Water Replenishment District v. Southern California Water Co.* (2003) 109 Cal. App. 4th 891, 905).

Riparian Rights – Landowners who own property that abuts a natural water course are entitled to make reasonable use of water on or flowing past their property. The water must be from a natural flow (not released stored water). Water cannot be stored under a riparian right and may only be used on property that is within the drainage of the water's source. If there is not enough water in a watershed to satisfy both riparian and appropriative rights, then riparian rights must be fulfilled first. In times of shortage, riparian right holders allocate the reduced water supply by sharing the shortage among the riparian users.

Appropriative Rights – An appropriative right is typically used when the prospective water user intends to use water on nonriparian land or the water user needs to store water for later use. Pre-1914, these rights were asserted in a manner similar to the filing of a mining claim; a water user filed a public notice of his or her intent to divert water and then diverted the water for a legally recognized beneficial use such as mining, irrigation, or drinking water. In times of shortage, appropriative right holders allocate the reduced water supply among themselves under a first in time, first in right priority system. Generally, water received through appropriative rights is more predictable than riparian rights, but appropriative rights can be lost through nonuse (because beneficial use is the basis for receiving the right), and shortages are allocated based on seniority (NRC 2012). California law recognizes water conservation as a "reasonable beneficial use" so that water efficiency improvements cannot be used as a reason to reduce appropriative rights held by a water user (Water Code section 1011(a)).

CVP and SWP Contractors – The Bureau of Reclamation and DWR hold appropriative water rights for the operation of the CVP and SWP, respectively. In many instances, these project rights are junior in priority to the rights held by water users in the Delta and within the Delta watershed. This means that during droughts and other periods of water shortages, the ability of the SWP and CVP to divert water from the Delta is limited by riparian owners and by more senior appropriative water rights.

Area of Origin Laws – Several statutes provide protections to areas within the Delta and the Delta watershed where the rivers originate (Littleworth and Garner 2007). Also known as "watershed protection" statutes, these laws provide the opportunity for water users in these areas to obtain water rights with a more senior priority than the SWP and CVP contractors so that local demands might be met before water becomes available for export.

Reasonable Use and Public Trust Doctrines – The SWRCB has the authority to review and modify existing water rights as well as approve new rights. This is an important principle because it enables the State to consider what is "reasonable" based on modern societal values, the need to protect other water users, protect the environment, and prevent the waste and unreasonable use of water. This authority derives in part, from the Public Trust Doctrine, under which the State has an ongoing duty to protect the navigable waters of the state for environmental protection, fishing, navigation, and commerce; and from the Reasonable Use Doctrine of the California Constitution, a provision mandating the reasonable and beneficial use of all waters in the state (Article X, Section 2).

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The Coequal Goals and Reducing Reliance on the Delta

In 2009, California further defined its water policy priorities as they relate to the Delta, including express recognition that the Delta crisis cannot be resolved by taking action in the Delta alone. Given the interconnected nature of the Delta with the water use patterns of large parts of Northern, Central, and Southern California, the new coequal goals of statewide water supply reliability and an improved, protected, and restored Delta ecosystem will fundamentally reshape California water management over the course of this century. Achieving these coequal goals is expected to be done, in significant part, through compliance with the Delta Reform Act's various mandates and goals relating to statewide water conservation, efficiency, and sustainable use, including the State's new policy to reduce reliance on the Delta and related mandate to improve regional self-reliance.

In particular, the Delta Reform Act mandates many statewide strategies that the Delta Plan must address to achieve the coequal goals, including water efficiency and conservation; wastewater reclamation and recycling; desalination and advanced water treatment technologies; improved water conveyance, surface, and groundwater storage; improved water quality; and implementation of local and regional water supply projects (Water Code sections 85004(b), 85020(d) and (f), 85021, 85023, 85303, and 85304).

These measures help achieve the requirements of Water Code section 85021, which declares that the State's policy is "to reduce reliance on the delta in meeting California's future water supply needs through a statewide strategy of investing in improved regional supplies, conservation, and water use efficiency." That section also mandates that "[e]ach region that depends on water from the delta watershed shall improve its regional self-reliance for water through investment in water use efficiency, water recycling, advanced water technologies, local and regional water supply projects, and improved regional coordination of local and regional water supply efforts."

Consequently, to achieve the statewide water supply mandates and the coequal goal of statewide water supply reliability, regions located outside the Delta also must take actions outside the Delta to increase water efficiency and develop sustainable local and regional sources of water, which will contribute to improved water supply reliability.

Individual actions by water suppliers throughout the state will be vital to success in this regard. The implementation of programs and projects that result in a significant reduction in the amount of water used, or in the percentage of water used, from the Delta watershed (evaluated at the local, regional, and statewide levels) will be the foundational measures for assessing the State's progress in achieving these policies. The baseline for this evaluation will be existing water use and supplies, as documented in the most recently adopted urban and agricultural water management plans. (See Appendix G, Achieving Reduced Reliance on the Delta and Improved Regional Self-Reliance.)

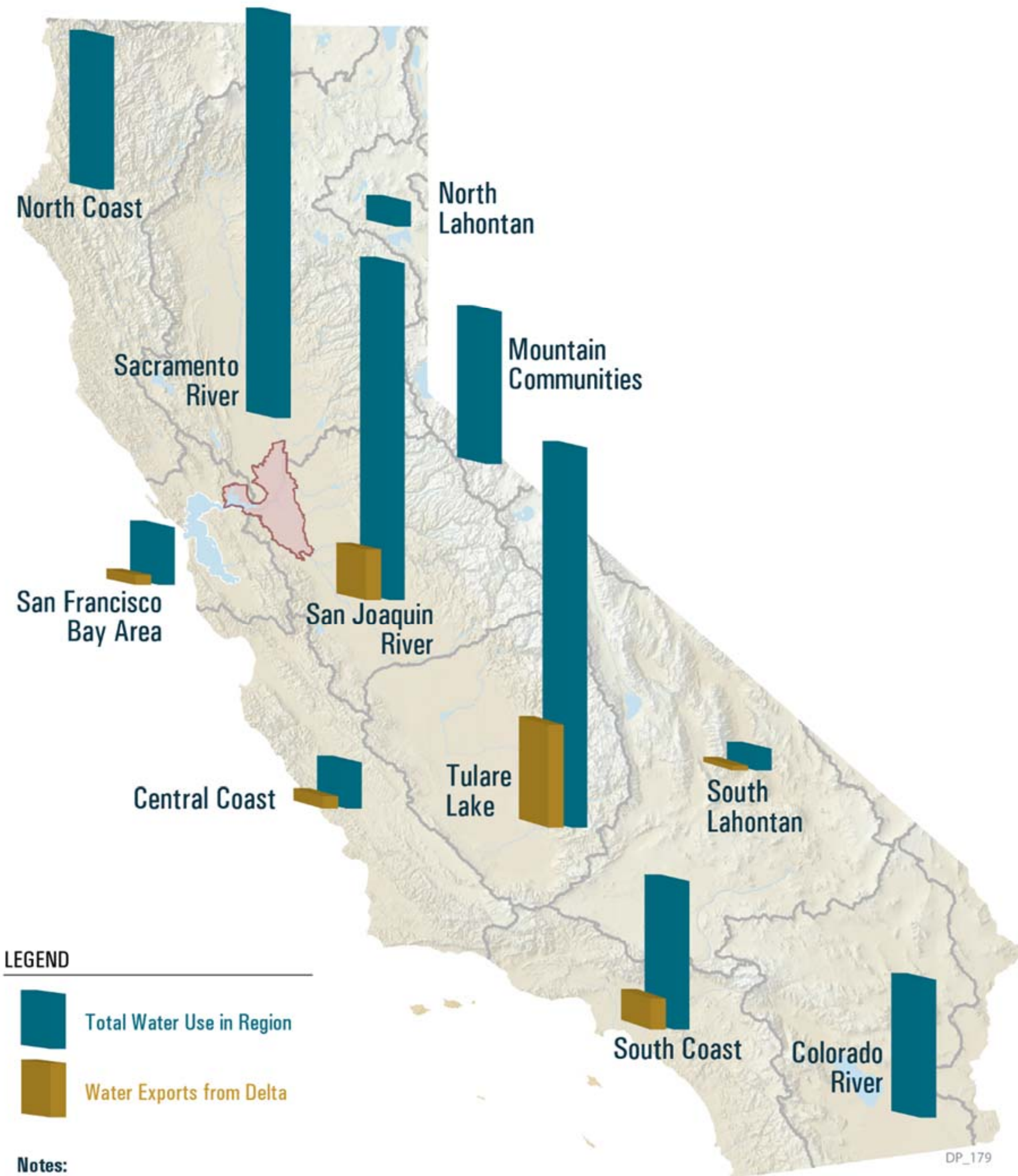
It is important to recognize that reliance on water from the Delta and the Delta watershed varies throughout California, from region to region, and supplier to supplier. (See sidebar, Reliance on the Delta Varies by Region.) Some water suppliers have greater access to alternative water supplies or have a greater ability to implement a diverse range of water efficiency and water supply projects. Others, particularly in the upper watershed, may have a narrower range of options. The key is that every supplier is doing its part and is taking appropriate action to contribute to the achievement of the coequal goals, including the State's policy of reduced reliance and associated mandate to improve regional self-reliance.

The Delta's Role in California's Water Supply

The Delta is the terminus for California's largest watershed, which encompasses the western slopes of the Sierra Nevada, the eastern slopes of the coastal range, and the valleys that lie between these ranges. Water in the Delta watershed starts as precipitation in the Sacramento River and San Joaquin River watersheds and, unless diverted or otherwise used, flushes San Francisco Bay and flows out to the ocean under the Golden Gate Bridge. Once again, this estuarine delta where California's two largest rivers meet is at the geographic and political center of water in California.

The CVP and the SWP rely on the Delta's artificial network of channels to convey water stored in upstream reservoirs to regions south of the Delta including the Bay Area, San Joaquin Valley, Tulare Lake Basin, Central Coast, and Southern California. (See sidebar, Reliance on the Delta Varies by Region, and Figure 3-3.)

Local Water Sources Meet Most of California's Water Needs



Notes:
1. Hydrological regions are those defined by the Department of Water Resources
2. Delta water exports include contract amounts to maintain wetlands

Sources: DWR 2009, Reclamation 2011b, DWR 2011c

Figure 3-3 The vast majority of California's water comes from local sources. Exports from the Delta comprise 8 percent of California's water use. Yet, the Delta supply is important to many regions south of the Delta.

RELIANCE ON THE DELTA VARIES BY REGION

Water exported from the Delta supplies about 8 percent of the state's total water use, and local and regional water supplies provide over 84 percent on average. However, reliance on water from the Delta watershed varies throughout California from region to region, supplier to supplier, and user to user.

For example, in the Sacramento and San Joaquin river watersheds, including water uses on the valley floor, foothills, mountain communities, and the Delta, the vast majority of the water supply comes from local sources: the rivers and reservoirs that flow into the Delta or from local ground-water resources that are replenished from runoff within the Delta watershed. Most of this water is used for irrigated agriculture, although increasing amounts are being shifted to drinking water and other municipal uses by the cities and towns that are growing in these regions. High-growth areas surrounding the Delta, including Fairfield, Sacramento, Stockton, and Tracy, are increasing urban water use and decreasing agricultural water use as the communities are developed.

Other regions, including the Tulare Lake region of the Central Valley, the San Francisco Bay Area, the South Coast, and the Central Coast, receive some portion of their water supply from diversions from the Delta's eastern tributaries or from water that is pumped from the Delta to supplement their limited local surface water and groundwater supplies. These exports vary by region and, for specific water users, the significance of these exports varies dramatically. For example:

- **Tulare Lake:** This region relies upon exports delivered through the Central Valley Project (CVP) and State Water Project (SWP) for 27 percent of its regional water supply, and most of this water use is for irrigated agriculture (on average 96 percent of CVP water deliveries and 89 percent of SWP deliveries). Kern County Water Agency, a water wholesaler, has the largest SWP import contract in the Tulare Lake Basin at nearly 1 million acre-feet (MAF) (DWR 2009).
- **San Francisco Bay Area:** This region's predominant water supply is from local sources (57 percent from surface and groundwater alone). However, diversions from the Delta's tributary streams provide up to 27 percent of this region's water, and CVP and SWP exports account for another 16 percent (DWR 2009). The reliance of the region's individual water suppliers on water from the Delta varies dramatically; the Marin Municipal Water District uses none (MMWD 2010), and the Zone 7 Water Agency in Alameda County receives as much as 82 percent of its water from SWP exports (Zone 7 2010).
- **Southern California:** This region is home to 50 percent of the state's population (with most in densely urbanized areas), and 80 percent of its water use is for drinking water, municipal, and industrial uses. SWP exports from the Delta account for roughly 25 percent of the region's water supplies, and local sources (groundwater, surface water, and increasingly recycled water) comprise another 50 percent, and imported water from the Colorado River about 25 percent (DWR 2009). Within the Metropolitan Water District of Southern California, the largest wholesaler in Southern California, the dependence of its member agencies on SWP imports can vary dramatically. Some agencies have few alternative water sources, while others have sufficient local supplies and are now planning to reduce their future reliance on imported water or to roll off the system completely (WBMWD 2010, City of Santa Monica 2012).

With increasing uncertainty over the reliability of Delta water exports, many communities have developed plans and projects to increase and diversify local water supplies and to increase water efficiency. Even with improvements in Delta operations that provide more reliable Delta water exports, regions will need to implement additional local and regional water management strategies to reliably meet their future water demands.

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Because of the Delta's central location, the water demands of many Californians are connected in some way to the Delta. Water diverted from the Delta watershed provides some portion of water supply for more than 27 million of the state's residents and approximately 3 million irrigated acres of farmland (DWR 2007a, DWR 2009, DWR 2011c, Reclamation 2011b). This water plays a critical role in helping to sustain a major portion of the state's $1.9 trillion economy.

This section provides an overview of water use and water infrastructure in the Delta watershed, followed by a description of water project operations in the Delta and the challenges and conflicts associated with these. The section concludes with a discussion of the importance of improving the flexibility of project operations, through improved conveyance, storage, and water management, in achieving the coequal goals.

Use of Water from the Delta Watershed

About half the state's runoff flows through the Delta watershed. Since the 1849 Gold Rush, communities throughout California have planned and constructed facilities to tap into this water to support economic development.

Many diversions in the Delta watershed occur in the upper watershed. On average, approximately 31 percent of the flow from the Delta watershed is diverted before it ever reaches the Delta (DWR 2011c). See Figure 4-5 in Chapter 4. These diversions are done through an extensive network of locally constructed dams, canals, and diversion structures that have been built over the past 160 years on nearly every stream and drainage within the Delta watershed (California Natural Resources Agency 2010). Some of the water diverted from Delta tributaries is returned to the tributaries through wastewater effluent and agricultural return flows, albeit at a degraded quality.

Water from these diversions sustains the economies of the residents, businesses, and growers who live in the areas where the water comes from—the "area of origin"—as well as the economies in the export areas. Some of these historical diversions occur through two large aqueduct and reservoir systems that were constructed early in the twentieth century to serve the growing water demands of San Francisco and East Bay Area communities. These facilities divert water before it reaches the Delta and convey it directly to reservoirs, treatment facilities, or customers in the Bay Area region. The Hetch Hetchy reservoir system on the Tuolumne River, and the Pardee and Camanche reservoirs system on the Mokelumne River account on average for approximately 0.5 MAF, or about 1.6 percent of the flow from the Delta watershed, of annual water deliveries from the Delta's upper watershed (DWR 2009).

Within the Delta, growers and residents historically have relied on water from the Delta. In-Delta water use has remained relatively constant over the past 100 years (DWR 2007a) and averages about 4 percent (0.9 MAF) of inflows into the Delta. Most of this water is used for agricultural irrigation, and small and large communities throughout the Delta.

The CVP and SWP export systems became operational in the late 1940s after much of the local Delta development had occurred. Exports from the Delta now range from approximately 3 MAF in dry years to around 6.5 MAF in wet years (DWR 2009, Reclamation 2011b, Reclamation 2011c). In total, the SWP and CVP facilities export on average approximately 5.1 MAF per year from the Delta. These water diversions account for 24 percent of the inflows into the Delta (see Figures 3-4a and 3-4b).

Where Delta Water Comes From and Goes

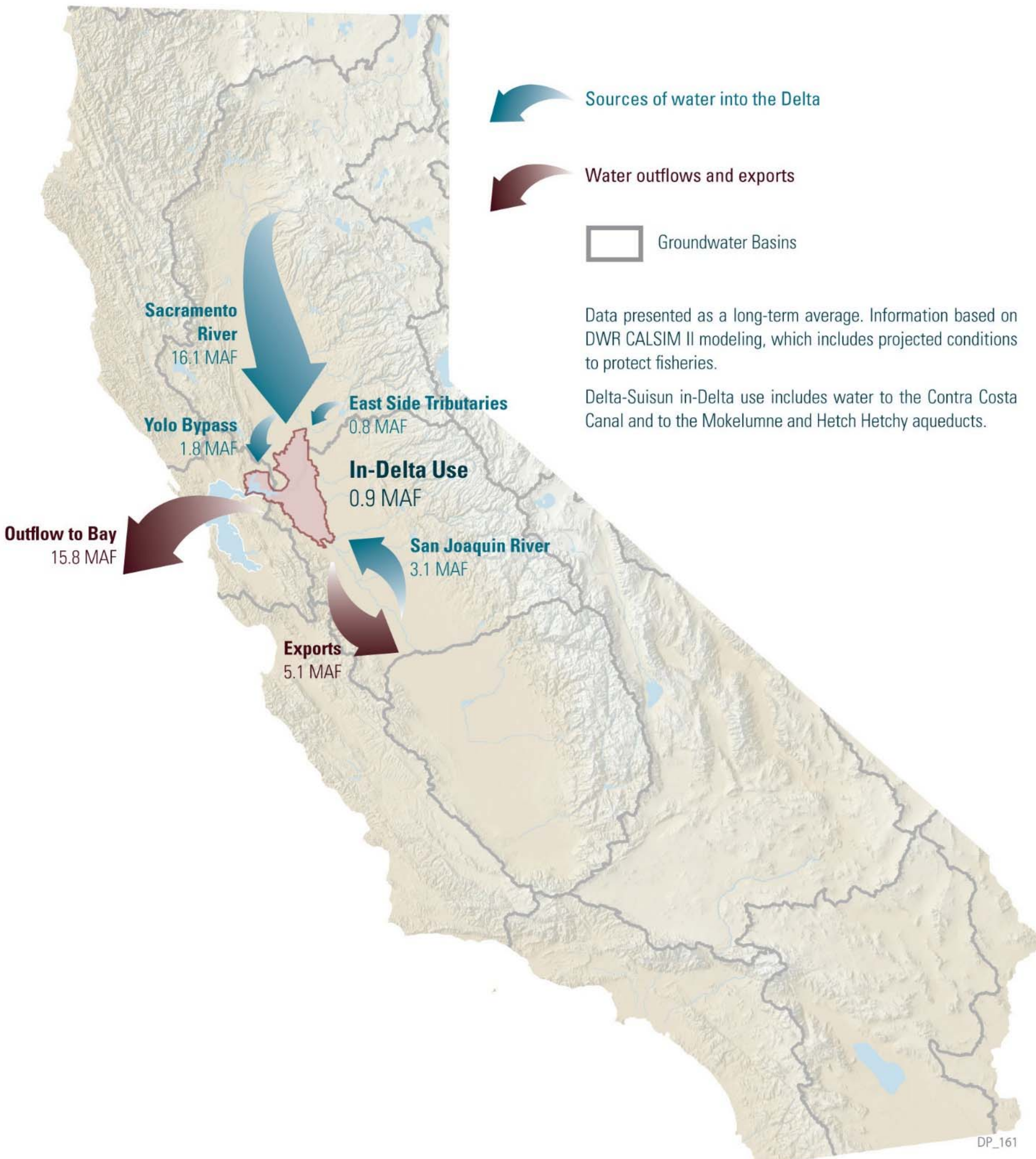

Figure 3-4a Over the past century, the combination of regional diversions from within the Delta watershed and water diverted directly from the Delta has transformed the Bay-Delta ecosystem, reducing historical outflows by an average of 50 percent.

Sources: LAO 2008, Reclamation 2011b, DWR 2011c

Delta Water Flows in Wet and Dry Years

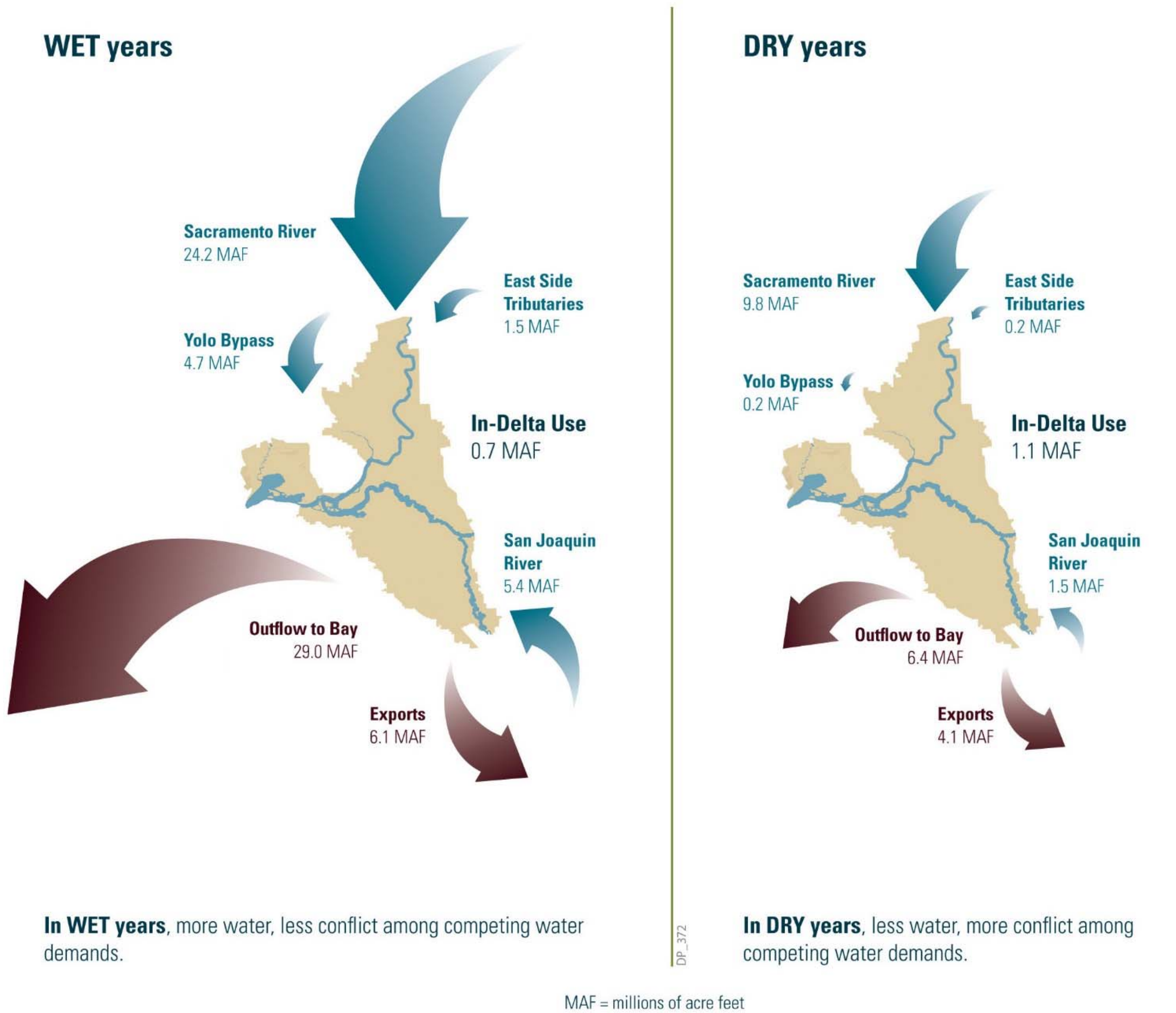

Figure 3-4b *Sources: LAO 2008, Reclamation 2011b, DWR 2011c*

Joint Federal and State Delta Operations

The federal CVP and California SWP were born out of long-range planning documents developed from the 1870s through the 1920s, including the 1919 Marshall Plan completed by U.S. Geological Survey and the 1930 Division of Water Resources Bulletin No. 25, "Report to the Legislature of 1931 on State Water Plan." These planning investigations developed and evaluated alternatives to provide:

- Fresh water to industries in Contra Costa and Alameda counties along Suisun and San Pablo bays
- Irrigation water to portions of the San Joaquin Valley that have substantial and increasing groundwater overdraft conditions, especially in the Tulare Lake region

- Supplemental water for Southern California urban development totaling 2 million acres in San Diego, Orange, and Ventura counties and the San Gabriel and San Bernardino valleys with water from Owens Valley, Mono Basin, and Colorado River

The California Legislature approved this plan in 1941 as the first State Water Plan (now the current California Water Plan), which included a description of facilities that would eventually be constructed as part of the CVP and SWP. Although design and construction of storage and conveyance facilities was done separately for CVP and SWP, both are operated in a coordinated manner for Delta operations.

Central Valley Project

Congress appropriated $20 million in Emergency Relief Appropriation Funds and authorized construction of the CVP by the U.S. Army Corps of Engineers (USACE) as part of the Rivers and Harbors Act of 1935. When the Rivers and Harbors Act was reauthorized in 1937, the construction and operation of the CVP was instead assigned to the Bureau of Reclamation (Reclamation).

Construction of the CVP by the federal government began in 1937. The first water was sold from the CVP to the City of Antioch from the initial reaches of the Contra Costa Canal in 1940, to support shoreline industries.

By the late 1940s, it had become apparent that California's rapid urban, agricultural, and industrial growth would quickly increase demands for water and power to levels that exceeded the initial CVP system capacity. In response, Congress authorized additional federal reservoirs and conveyance facilities over the next few decades, including Folsom Dam along the American River, Tehama-Colusa Canal along the west side of the Sacramento Valley, Trinity River Dam to provide additional water from the Trinity River into the Sacramento River for CVP operations, and New Melones Dam on the Stanislaus River. In 1960, the San Luis Unit, in the western San Joaquin Valley, was authorized by Congress to be constructed under a contract between the federal government and the State.

The CVP is the largest surface water storage and delivery system in California, with a geographic scope covering 35 of the state's 58 counties. The project includes 20 reservoirs with a combined storage capacity of approximately 11 MAF, 8 power plants and 2 pumping-generating plants, 2 pumping plants, and approximately 500 miles of major canals and aqueducts. The CVP provides water through water service contracts and water rights agreements for a total of about 9.6 MAF per year (including water service contractors that use water from the Stanislaus River and San Joaquin River).

State Water Project

In 1947, the State began an investigation to consider the next phases of the State Water Plan to meet the state's anticipated supplemental water demands through development of the SWP and to control salinity intrusion in the Delta. In 1953, the State adopted the Abshire-Kelly Salinity Control Barrier Act to evaluate placement of a saltwater barrier near Suisun Bay to protect Delta water users and allow transfer of fresh water from the Sacramento Valley to the San Joaquin Valley. This plan was not implemented primarily due to costs and technical considerations, but alternatives continue to be evaluated today.

In 1957, Bulletin No. 3 was published, which described the need for SWP facilities to convey water from the Sacramento Valley to water-short areas of California. The report identified an urgency to expand statewide water facilities because of projected population growth and to support a balanced economy; major industrial growth; 6,875,000 acres of irrigated agriculture, or approximately 25 percent of all agricultural acreage in the United States; and flood control in Northern California. The study identified that there was a "seasonal deficiency" of 2,675,000 acre-feet of water in 1950 that had been met with groundwater pumping primarily from overdrafted aquifers. In 1960, California voters authorized the Burns-Porter Act to construct the initial projects of the SWP, including Oroville Dam and Lake Oroville on the Feather River, San Luis Dam and Reservoir to be jointly constructed and operated with Reclamation, the North and South Bay aqueducts, and the 444-mile California Aqueduct. Notably, DWR continues to project a 1- to 2-MAF deficit in average annual groundwater pumping from overdrafted aquifers (DWR 2009). A more detailed discussion of groundwater is provided later in this chapter.

Delta Operations

Prior to the 1960s, the CVP and SWP operated in the Delta unrestrained by environmental regulations. However, beginning in the 1970s, with the passage of environmental laws, including the federal Clean Water Act, Endangered Species Act, Central Valley Project Improvement Act, Porter-Cologne Water Quality Control Act, California Endangered Species Act, Wild and Scenic legislation, and many others, protection of the ecosystem became an explicit legal obligation for the SWP and CVP in addition to delivery of fresh water for agricultural and urban use.

In the modern context, CVP and SWP facilities operate according to a complex web of permits, licenses, and, in some cases, court orders that impose explicit conditions on how, when, and how much water can be exported from the Delta. Some of the entities that regulate water project operations in and upstream of the Delta include:

- The SWRCB and regional boards require the SWP and CVP to meet specific water quality criteria that result in operational standards within the Delta and the Delta watershed. The SWRCB also sets instream flow standards.
- USACE sets operational "rule curves" for reservoirs that provide flood protection upstream of the Delta. The Central Valley Flood Protection Board regulates encroachments on designated floodplains and floodways. (See Chapter 7.)
- The presence of threatened and endangered species in California's waterways and landscapes requires the California Department of Fish and Wildlife (DFW), U.S. Fish and Wildlife Service, and National Marine Fisheries Service to regulate water project operations in the Delta. Federal biological opinions that govern agency regulatory activities have been the subject of extensive recent litigation by water agencies and other interested parties.

To comply with these regulations and to optimize system efficiencies, DWR (for the SWP) and Reclamation (for the CVP) jointly coordinate their pumping operations in the Delta under the 1986 Coordinated Operating Agreement (COA). One of the benefits of the COA is that it resulted in improved reliability of deliveries for the SWP (DWR 2008). They also jointly manage portions of the water delivery facilities in the Central Valley. There are times when the CVP may use SWP export capacity or that the SWP may need to use CVP export capacity. This close coordination has resulted in flexible operation of the Delta facilities to improve reliability of Delta water deliveries as well as to reduce system vulnerability to disruption.

Additional operational changes are on the horizon for the CVP and SWP. The SWRCB has initiated a phased process to review and amend—or to adopt new—water quality and flow objectives for the Delta by 2014. Phase 1 of that review is focused on southern Delta water quality and San Joaquin River flows. Phase 2 is focused on other changes that may be needed to the remainder of the Bay-Delta Water Quality Plan to protect fish and wildlife beneficial uses.
See Chapter 4 for more information on flow in the Delta and the relationship to ecosystem health, and Chapter 6 for more information on the Council's recommendations on the SWRCB process to update the Bay-Delta Water Quality Plan. Furthermore, conveyance alternative projects could mean large-scale changes to Delta infrastructure and operations.

Challenges and Conflicts in the Delta

Over time, the Delta has been transformed, mostly by human hands, to serve many purposes. As mentioned, the SWP and CVP were originally engineered to reliably deliver water to water service contractors and water rights holders without commensurate consideration for impacts on native species. The Delta is the only saltwater estuary in the world that is used as a conveyance system to deliver fresh water for export. This creates substantial water supply and ecosystem conflicts.

Legal changes in recent decades, combined with growing societal awareness and scientific understanding of water project operations on ecosystem health, had major implications for water operations in the Delta. The collision of changing societal values, growing demands for water deliveries from the Delta, and declining health of the Delta ecosystem have resulted in numerous complex and often bitter legal challenges that have increasingly shifted critical Delta water management decisions to the courts.

Today, demands on water infrastructure have fundamentally changed (Lund 2016) as California's population and diversified economy has grown, societal values informing how water and other natural resources are managed has evolved, our climate is changing, and water needs have increased. In addition, populations of several endangered and threatened fish species have declined drastically since the construction of the State and federal water systems and other infrastructure in the Delta watershed. The declines are due to multiple factors (Mount et al. 2012), including: entrainment, changes to natural flow regimes[15] and flow direction, water exports (particularly in dry years), disconnection of rivers and streams from adjacent lands resulting from levee construction and channelization, habitat loss and alteration, urbanization, a warming climate, food availability, predation, and invasive species (Healey et al. 2016; Mount et al. 2012). Among these many factors, CVP and SWP diversions represent one of the most directly observable sources of fish mortality (Grimaldo et al. 2009). Consequently, our water management systems are now called upon to meet ecosystem needs not envisioned when they were originally built in an increasingly complex regulatory environment (Reclamation 1992).

This conflict came to a crisis point in 2007 when a federal court significantly curtailed water deliveries south of the Delta to protect delta smelt. This launched a seven-year process in the federal courts examining the balance between fish protection requirements under the Endangered Species Act and water operations. Differing federal court orders ensued, some of which protected native fish and restricted water exports, while others recognized urban and agricultural water needs and ordered increased water exports. This period of litigation and court ordered operations of the water projects highlighted the difficulty in resolving this conflict under the status quo system of water conveyance. Reviews by federal and State wildlife agencies have shown that maintaining status quo conditions will likely result in further deterioration of threatened and endangered fish populations, which will necessitate additional restrictions on water supply exports (National Marine Fisheries Service (NMFS) 2009; NMFS 2014; U.S, Fish and Wildlife Service 2009). If not addressed, this trend may be irreversible and make the achievement of the coequal goals infeasible.

Conflicting Operational Priorities

A fundamental conflict exists today between water operations for ecosystem management (temperature and flow), water quality (both in-Delta and for water exported from the

15 "Flow regime" refers to the regulation of ecological processes in river ecosystems, including the magnitude, frequency, duration, timing, and rate of change of hydrologic conditions (see Glossary, Delta Plan, Delta Stewardship Council, 2013, as amended). In the Delta, seasonal and diurnal flow patterns (flow hydrograph) have been altered by upstream water diversions and reservoir operations, Delta water exports (especially during dry periods), and physical changes to the Delta (channelization, sedimentation, and land use changes). Changes to flow regime have directly affected habitat conditions – including habitat diversity, quality, and extent – and proven harmful to native species. Sources: Bunn and Arthington (2002), Petts (2009), SWRCB (2010).

Delta), and water supply reliability. This conflict is magnified during critically dry periods and periods of lower flow when the ecosystem is under increased stress and water suppliers are most vulnerable to shortages. Conflicts in the use and timing of water movement through the Delta for multiple purposes could be more easily addressed by improved water conveyance and storage infrastructure with greater capacity and operational flexibility, combined with investments in regional self-reliance as cited throughout the Delta Plan. This includes increased capacity to safely convey water through the Delta during wetter periods such that exports can be curtailed when fish are at risk, and expanded water storage capacity throughout the state to manage Delta flows and water temperature, and carry over water supplies from wet periods for use in dry periods. Additional storage and conveyance capacity would provide the flexibility needed to adapt to dynamic future conditions and our revolving understanding of ecosystem needs.

An example of this conflict relates to degraded water quality in the Delta during periods of lower flow, which affects the treatability of water for municipal and industrial uses and creates public health concerns that often must be addressed through higher-cost water treatment processes. Water quality for exports can be improved by moving diversion locations, but doing so also has the potential to degrade water quality for in-Delta uses. These impacts must be carefully monitored and mitigated. Improving, monitoring, and adaptively managing the operation of water systems in the Delta would augment our capacity to balance these priorities and further achievement of the coequal goals.

CVP and SWP Water Delivery Challenges

Overall, exports from the Delta have been rising over the past 4 decades (see Figure 3-5). Historically, the SWP and CVP have pumped more water from the Delta during dry years than wet years; but over time, exports have increased in all water year types, except in critically dry years. The SWP and CVP have each reached record exports in the past 10 years. In part, this is because recent increases in surface and groundwater storage south of the Delta have enabled more water to be taken during wet years. Increased south-of-Delta storage has also led to more agricultural-to-urban water transfers, which help improve the flexibility of operations in the Delta.

Yet, many factors threaten the ability of State and federal water managers to continue pumping water through the two projects at current export levels. Subsidence of the agricultural lands on the Delta islands, rising sea level, and earthquakes threaten the physical integrity of the Delta ecosystem and the levees that protect the export water quality. The location of the two pumping stations (one each for the CVP and SWP) in the south Delta is a problem for fisheries. Described previously, most of the water enters the Delta from the north through the Sacramento River. Pumping stations for the CVP and SWP are located in the south Delta and, when operating, frequently cause a net "flow reversal" in the central and south Delta channels. (See Chapter 4 for more details.) This reverse flow affects fish movement, including migration through the Delta, and often results in species that are free-floating or have weak swimming capability being drawn into the pumping facilities where they can be entrained (Grimaldo et al. 2009).

Historical Exports and In-Delta Use

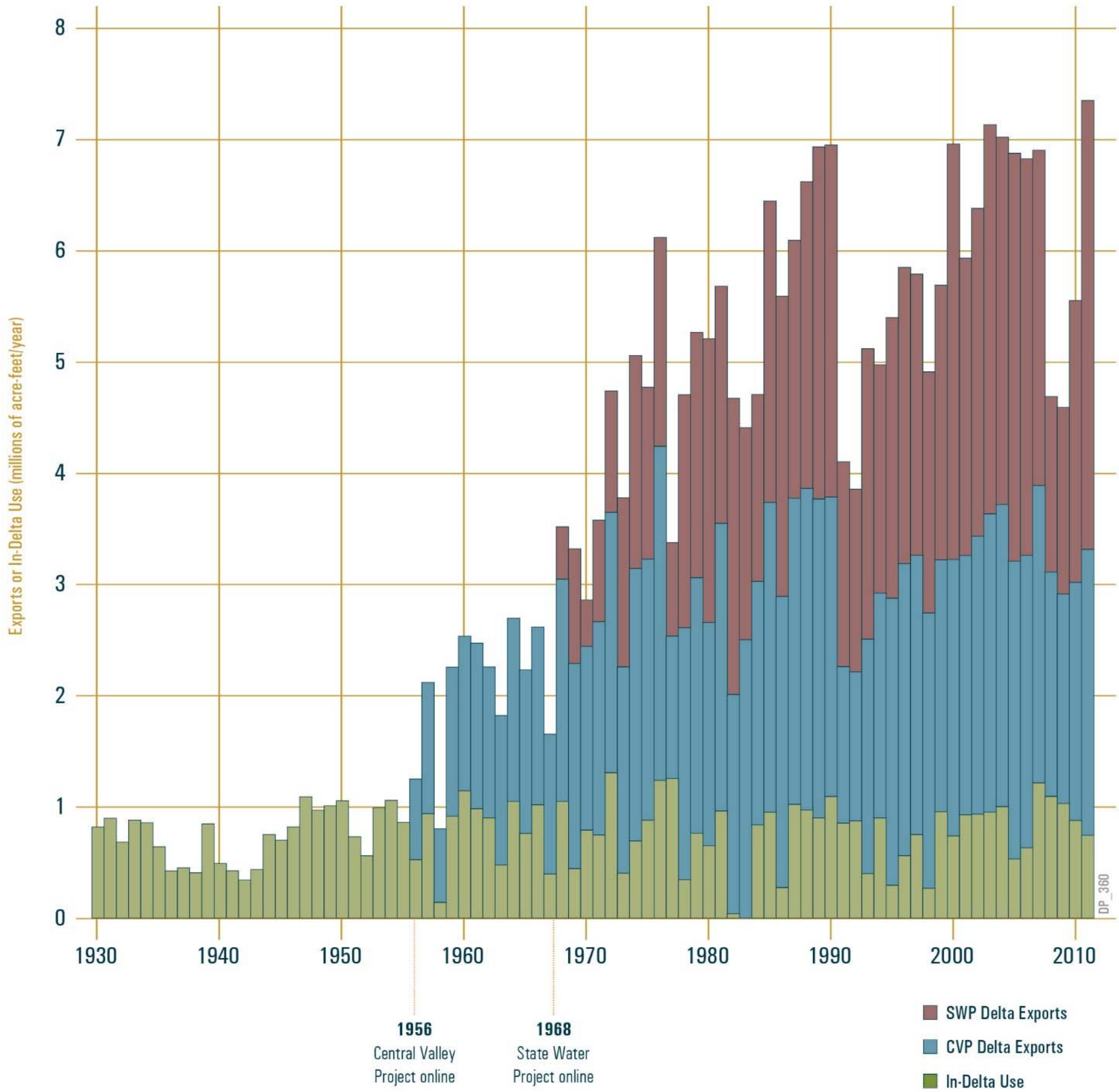

Figure 3-5 Overall exports from the Delta have been rising over the past 4 decades, while in-Delta uses have remained fairly constant. Exports by the CVP and SWP have reached record levels in the past 10 years.

Water quality is an issue too. A portion of the water flowing into the Delta is specifically allocated to Delta outflow to help repel salinity intrusion from the San Francisco Bay and to maintain low-salinity water near the western edge of the Delta. This means that water that might otherwise be used for exports must be released from upstream reservoirs to help control salinity (NRC 2012).

Conflicts over water use are further complicated by original SWP and CVP contracts that assumed greater water export quantities than consistently can be delivered. Since 1990, the CVP has fulfilled 100 percent of its contract water allocations only three times, and the SWP has delivered 100 percent of its contract amounts only twice (Reclamation 2011c, DWR 2010b). The CVP's ability to meet maximum contracted amounts, particularly during dry years, has diminished since the addition of new municipal and industrial contractors who have priority over agricultural water deliveries.[16] Also, the 1992 passage of the Central Valley Project Improvement Act dedicated up to 800,000 acre-feet of CVP exports for wildlife refuges and environmental needs (Public Law 102-575, section 3406(b)(2)). The original SWP contract amounts were based on assumptions that additional major new dams and conveyance facilities would be constructed at a later date, which did not occur. As a result, even though the SWP had contracted to supply 4.2 MAF, average SWP exports between 1996 and 2006 were just 2.9 MAF (DWR 2008).

The reality is that the State and federal systems have never been able to reliably deliver the full contract amounts. Now, additional court-ordered and regulatory restrictions on State and federal pumping of export water, in combination with the 2007 through 2009 drought, further reduced the reliability of Delta water exports to SWP and CVP contractors. According to DWR, SWP deliveries are now expected to average 60 percent of maximum contract amounts in future years, down from 66 to 69 percent estimated in 2005 (DWR 2010b).

The process for allocating water shortages within the State and federal projects also impacts the extent to which various contractors experience different levels of Delta water supply reliability. Within the SWP, shortages are uniformly distributed across all water contractors. Within the CVP, municipal and industrial water users have a higher priority than agricultural water users. As a result, in dry years, CVP water rights contractors, such as the Sacramento River Settlement Contractors, may receive 100 percent of their water allocations while non-water rights contractors, including Westlands Water District, may receive as little as 10 percent.

North-to-south water transfers across the Delta can be an important tool for improving water supply reliability. However, transfers require the use of SWP or CVP facilities and, as such, are subject to the regulatory constraints on Delta exports. Because Delta pumping windows of opportunity are shorter and generally filled by contract deliveries, excess capacity for water transfers is increasingly hard to come by.

Although lesser known, an increasing challenge to Delta export reliability relates to the operations and maintenance of the large, complex facilities that make up the SWP. The SWP has experienced a significant and growing decline in operational reliability that has directly impacted DWR's ability to store and move water, produce electricity, and export water from the Delta when the appropriate hydrological conditions present themselves (DWR 2010b). These challenges include maintaining SWP delivery capabilities under continued manpower resource limitations, aging infrastructure, and constraints in providing competitive employee compensation despite adequate SWP funding. Further resource challenges

[16] Additional municipal and industrial water contracts were implemented in the late 1980s for the CVP San Felipe Unit and in the last 10 years for the CVP American River Division.

are attributed to complex and cumbersome State contracting processes and State hiring freezes.

Much of ~~this~~ the State's water infrastructure is also aging and vulnerable to natural hazards, and planned components of the State and federal systems were never completed (Lund et al. 2007). Recent events, including damages sustained at the Oroville Dam flood control spillway and at the Clifton Court Forebay intake structure during 2017, have also highlighted the need to inspect and adequately maintain water infrastructure, and ensure adequate long-term funding for ongoing inspections and maintenance.

Continued Delta Ecosystem Decline

Human activities and their associated effects on land and water management over the last century and a half have irrevocably changed California's aquatic ecosystems. This is profoundly evident in the Delta, where natural flow patterns have been altered and water has been confined to canalized channels where shallow wetlands once existed (Whipple et al. 2012; SFEI 2014). Under the existing configuration for water export, which features single, adjacent points of water diversion in the south Delta for both the SWP and CVP, operations result in direct fish losses at the pumps, change the way water and fish move through the Delta, create harmful reverse flow conditions, and place fish at greater risk of predation (NMFS 2014; Castillo et al. 2012; Gingras 1997). These effects have been compounded by the influx of invasive non-native species and changes to habitat quality and quantity upstream from the Delta. The result has been a dramatic decline in native species, including some aquatic species now on the brink of extinction.

Despite recent restoration efforts and investments, aquatic species continue to decline (Moyle et al. 2010, NMFS 2014). These species also remain highly vulnerable to changing hydrologic conditions such as warmer water temperatures, longer water residence time, increased water clarity, and reduced flow. Further, significant uncertainty exists regarding the effects of projected climate on the hydrology of the Delta watershed and its ecological health.

Water temperatures have warmed and water quality in the Delta has changed over time, as was particularly evident during California's recent drought. Water quality degradation affects not only the Delta ecosystem, but also the ability of waterways to support sustainable agriculture, recreation, and other quality of life amenities for residents and local communities. Water dedicated to the environment, including storage reserved for water temperature and flow management in the Delta and its tributaries, will become increasingly important over the coming century (Hanak et al. 2012).

Improving Delta Water Supply Reliability through Investments in System Flexibility

Because California's annual precipitation is remarkably variable, the past expectation that each year—wet or dry—should yield the same quantity of water exported from the Delta watershed is unrealistic and can be an obstacle to necessary improvements in water supply reliability.

The greatest conflicts between the water needs of people and fish within the Delta occur during dry years. That is when the least amount of water is flowing into the Delta and, historically, when exports have been a much larger percentage of Delta inflows than in wet years (see Figure 3-6). On average, exports have diverted about 17 percent of Delta inflows in wet years and about 36 percent during dry years (DWR 2011c). In past years, exports have exceeded 60 percent of Delta inflows in some dry months, but recent regulatory decisions now constrain such operations.

The recovery of the Delta ecosystem and listed species will help reduce regulatory restrictions on Delta exports and increase the long-term stability and predictability of rules governing Delta pumping.

Historical Delta Inflow and Delta Exports

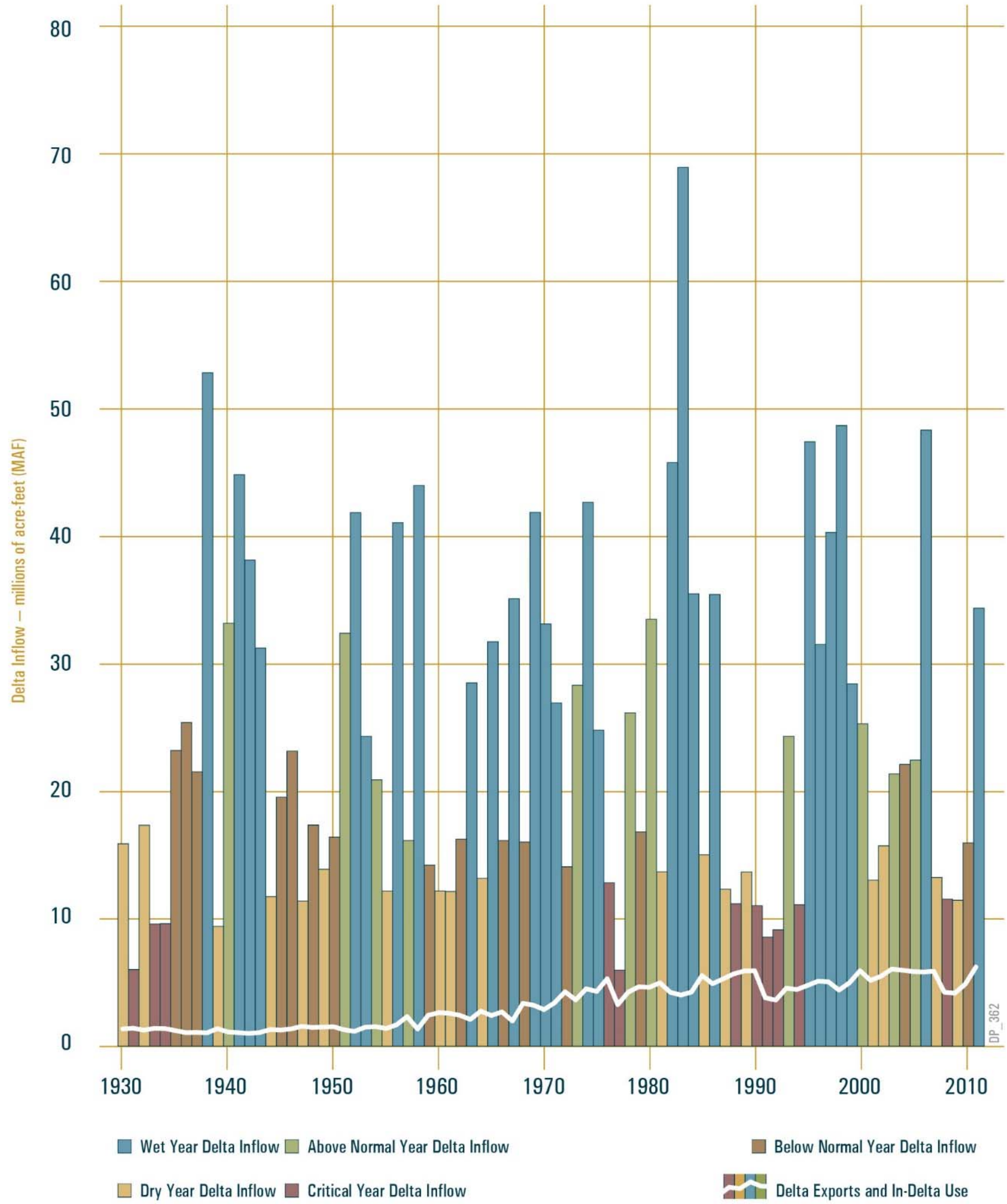

Figure 3-6 In many years, water flowing into the Delta greatly exceeds the amount of water that is exported from or used in the Delta. However, in dry years, total exports and in-Delta use have averaged as much as 36 percent of inflows.

Source: DWR 2012a

More natural flow patterns in the Delta can be compatible with improving the reliability of water deliveries from the Delta. More water can be taken in wet years when more water is available, less water will be taken in dry years when it is needed for in-Delta water quality and environmental protections, and operations can be improved to increase seasonal flexibility to avoid impacts on Delta species and habitat. Many local water management actions that help reduce reliance on the Delta and improve regional self-reliance are also essential to improving overall flexibility of Delta operations and improving reliability of water supplies during periods when pumping is constrained.

Upstream, downstream, and in-Delta improvements can all add to export system flexibility, producing both water supply and ecosystem benefits. Storage capacity, however, is a current limitation to this scenario, and will worsen under anticipated climate change conditions. Were sufficient storage available, flows that exceed water needed to meet environmental and other requirements could be captured and stored. This stored water could then be released later in the year or carried over into subsequent years.

Fish predation and mortality at the export pumps could be reduced if the diversion points of the State and federal water projects in the Delta were moved or modified. Risks to a reliable source of fresh water conveyed through the Delta could be reduced through conveyance alternatives that could provide multiple diversion locations in the Delta and through strategic levee investments.

New and improved conveyance, water storage, and the operations of both—alongside other actions and policies identified in the Delta Plan—are integral to managing the Delta and achieving the coequal goals. They are part of an integrated approach that uses all available water management tools to provide operational flexibility, while striving to achieve a balance among Delta uses recognized by the State. The cost of new and improved major storage and conveyance infrastructure will be significant, but the risk of taking no action is unacceptably high and will lead to additional, irreparable damage to the ecosystem and insufficient water supplies to support a healthy state economy (Hanak et al. 2017). Under climate change alone, average annual south of Delta SWP and CVP export reliability is expected to fall from about 4.9 MAF to about 4.6 MAF; this decline could be substantially larger should additional regulatory restrictions be placed on exports (Hanak et al. 2015; Hanak et al. 2011). Maintaining the status quo will make achieving the coequal goals impossible in the future. To address the challenges and to meet the coequal goals, water managers operating California's water supply systems need to integrate their operation to take advantage of regional supply sources and leverage the use of new and existing facilities for conveyance, system storage, and the optimal operations of both (Lund 2016; Gray et al. 2015; Lund et al. 2014; Null 2016).

It is important to note that storage can increase the benefits of conveyance improvements, and conveyance improvements may be limited without the benefit of added storage. Improved operational flexibility, consistent with ecosystem restoration, can result in more reliable water supplies for all beneficial uses from year to year and, when managed for multiple benefits, can also ensure adequate flows to meet public trust needs, including the protection of the Delta ecosystem.

To achieve the coequal goals, there is a need to change the way water is managed and water systems are operated in the Delta. Maintaining the status quo will make achieving the coequal goals impossible in the future, and poses a significant risk of continued habitat and species decline and uncertainty in water supplies exported from the Delta. The magnitude of operational changes needed to achieve the coequal goals will not be possible without new investments in water infrastructure, namely improvements to water conveyance and storage facilities.

Further, operational and infrastructure improvements need to progress together and in coordination with other actions identified in the Delta Plan, such as those related to restoring and enhancing the Delta ecosystem (Chapter 4), improving water quality (Chapter 6), achieving greater regional self-reliance and reduced reliance on the Delta (Chapter 3 and Appendix G), and reducing risks to people and property (Chapter 7).

There is no single solution to water management in California, as a whole, and in the Delta in particular (Luoma et al. 2015). Rather, a combination of near-term and long-term improvements to water conveyance, system storage, and operations are needed (Hanak et al. 2017). These improvements should seek to balance what can often be competing operational objectives (e.g., protecting threatened fish species and providing reliable water supplies) while minimizing conflicts and protecting the Delta's unique values. Further, as our knowledge of the Delta ecosystem continues to grow there remains significant uncertainty over the effectiveness of planned actions to protect, restore, and enhance the Delta. Consequently, adaptive management consistent with the framework outlined in the Delta Plan is essential for all actions that seek to further the coequal goals.[17]

The Role of Storage in Increased Flexibility

Water storage is an effective water management tool available to even out the variability of the state's hydrology across time and space, and to optimize the benefits of improved conveyance for both the environment and water supply reliability.

Statewide water storage capacity, both above and below ground, is currently inadequate, especially south of the Delta, to facilitate export of water at times of surplus when the impacts on the Delta's ecosystem are reduced and the only impediment is lack of available storage capacity (DWR 2009). For example, in 2010, the SWP and CVP pump operations were slowed even though water was available to be pumped at a time when it would not have conflicted with endangered species or other water quality requirements. The SWP and CVP could not convey the surplus water through the Delta at that time because storage capacity south of the Delta was full.

Improved water storage in both surface reservoirs and groundwater is needed to accommodate changing hydrology throughout the Delta watershed, to better achieve the beneficial functions of more natural and variable flows, to maintain better temperature conditions in the Delta and its tributaries, to allow the storage of water supplies for later use during dry periods, and to sustainably manage the state's aquifers. Moreover, improvements to conveyance and storage must be operated in an integrated manner (Null et al. 2014) that furthers achievement of the coequal goals while protecting and enhancing the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. Throughout California, water managers are actively pursuing opportunities to implement integrated strategies and improvements to water conveyance, system storage, and the operations of both to achieve local and regional goals.

California's interconnected network of surface water and groundwater storage lacks the capacity and conveyance flexibility to manage ecosystem, water reliability, and public safety needs under the state's highly variable climate. New and expanded surface water reservoirs, improved groundwater storage, and the conjunctive management of both are critical to provide reliable water supplies for all uses, including flow and temperature management to benefit the Delta ecosystem in the face of increasingly intense drought and a changing climate (Reclamation 2016; Ho et al. 2017).

[17] Water Code section 85052 defines "adaptive management" as a framework and flexible decision making process for ongoing knowledge acquisition, monitoring, and evaluation leading to continuous improvement in management planning and implementation of a project to achieve specified objectives. See also Appendix C.

<table>
<tr><th colspan="3">Applying Adaptive Management To Water Management Decisions</th><th>An adaptive management approach for water management decisions should be taken to plan for and as sess the water supply outcomes of conveyance and storage improvement actions. The following is a hypothetical example of how the Council's three-phase and nine-step adaptive management framework (see Appendix C) could be applied to a water management decision.</th></tr>
<tr><th colspan="3">Adaptive Management Step</th><th>Hypothetical Water Supply Reliability Improvement Project</th></tr>
<tr><td rowspan="4">Plan</td><td>1</td><td>Define/redefine the problem</td><td>Current storage and conveyance configuration is not adequate for providing a more reliable water supply to south-of-Delta users under modern operating rules.</td></tr>
<tr><td>2</td><td>Establish goals and objectives</td><td>Goal: Improve water supply reliability for south-of-Delta water users.
Objective: Optimize storage for south-of-Delta water users in wet years so that interruptions in deliveries are reduced and the amount of water delivered during wet years can be increased consistent with environmental regulations in the Delta.</td></tr>
<tr><td>3</td><td>Model linkages between objectives and proposed action(s)</td><td>There are inadequate options for south-of Delta water users to optimize storage in wet years, leading to vulnerability to interruptions and reduced capacity to divert water when it is available. The San Luis Reservoir is the only CVP water source for San Luis Unit, Cross-Valley Contractors, and San Felipe Division (SFD) water users. SFD serves water to Santa Clara and San Benito counties. As the San Luis Reservoir is drawn down during the summer and into the late fall (when predictable water supplies are needed most), a dense layer of algae develops near the surface. As the water level lowers, this algae gets captured by SFD intakes. The algae degrade water quality and make water more difficult to treat. As a result, SFD deliveries can be interrupted when the reservoir falls below 300,000 acre-feet. It is hypothesized that improving the San Luis Reservoir low-point intake would increase the predictability of water deliveries and make more water available to south-of-Delta water users during dry years. Alternatives to improving the low-point intake could include expanding the Pacheco Reservoir to provide storage for SFD water users. As a result of taking one or a combination of these actions, progress would be made toward improving water supply reliability for south-of-Delta water users by (1) reducing potential for interruptions, (2) diverting more water during wet years, and (3) making this water available during dry years when water from the Delta may not be available.</td></tr>
<tr><td>4</td><td>Select action(s) (research, pilot, or full-scale) and develop performance measures</td><td>Selected Action: Conduct feasibility analyses and modeling to determine which option would enable the highest increase in the reliability of water conveyance for south-of-Delta users in compliance with environmental requirements.
Performance Measures:
▪ Administrative – Complete feasibility analyses and modeling.
▪ Output – Select and implement an improvement project (e.g., improve the low-point intake at San Luis Reservoir only).
▪ Outcome – Progress toward improving water supply reliability by (1) reducing potential for interruptions, (2) diverting more water during wet years, and (3) making this water available during dry years when water from the Delta may not be available.</td></tr>
<tr><td rowspan="2">Do</td><td>5</td><td>Design and implement action(s)</td><td>Design and implement the feasibility analyses and modeling.</td></tr>
<tr><td>6</td><td>Design and implement monitoring plan</td><td>Design and implement the monitoring plan, including baseline monitoring, and measurement of (1) reduced interruptions of SFD deliveries when the reservoir falls below 300,000 acre-feet, (2) the amount of increased delivery of water during wet years, and (3) the amount of increased water deliveries from the reservoir during dry years to offset reduced Delta diversions.</td></tr>
<tr><td rowspan="3">Evaluate and Respond</td><td>7</td><td>Analyze, synthesize, and evaluate</td><td>Analyze, synthesize, and evaluate the feasibility analyses and model outputs, and make recommendations for selecting a project or adjusting the conceptual model.</td></tr>
<tr><td>8</td><td>Communicate current understanding</td><td>Provide project manager(s) and decision makers with synthesized information learned. For example, present information on the extent to which interruptions would be reduced, the value of the reduced interruptions, and the benefits of a specific operation scheme as part of a cost-benefit analysis.</td></tr>
<tr><td>9</td><td>Adapt</td><td>The DWR, Reclamation, and SFD contractors decide on a pilot- or full-scale improvement project.</td></tr>
</table>

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With climate change, reservoirs in the Delta watershed will need to adjust their operations to accommodate warmer and more intense winter storms, more precipitation occurring as rainfall, and earlier spring snowmelt (Anderson et al. 2008; Huang et al. 2012; Berghuijs et al. 2014; Goulden and Bales 2014; Van Lienden et al. 2014; Savtchenko et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017). These changes will make it increasingly difficult to meet water temperature and flow objectives for native fish and water supply reliability for municipal, industrial, and agricultural uses. With current facilities and management practices, shifts in precipitation and runoff will directly affect deliveries and reservoir storage levels for the SWP and CVP. Lower carryover storage is projected for both the SWP and CVP, presenting risks for water supply reliability, hydropower production, and cold water pool storage for fish protection. The warmer climate and significant shift in seasonal runoff will result in consistently lower water delivery capability (Anderson et al 2008). Further, warmer and more intense winter storms will require adjustments to reservoir operations to provide adequate space for floods and protect public safety, which may come at the risk of environmental and water supply needs if reservoirs cannot be refilled later in the season. Without new or expanded storage, current conflicts between the use of water for ecosystem management (flow and temperature), water quality (for in-Delta use and exporters), and supply reliability could intensify (Wilson et al. 2016).

New or expanded surface water and groundwater storage across the state can contribute in different ways to achieving the coequal goals. Improved water storage in the Delta watershed – both seasonal and permanent – can help manage flow and water quality conditions to support a healthier Delta ecosystem, while maintaining water quality for agricultural and municipal users, recreation, and fish. Native fish species may benefit from improved water storage in the Delta watershed, including storage space dedicated to ecosystem benefits such as flow management, water temperature management, other water quality benefits, or providing water supplies to wildlife refuges. However, it is recognized that opportunities for increased surface water storage on on-stream reservoirs may be limited by potential ecological impacts. Studies indicate that the average annual amount of water available for storage in the Delta watershed is about 10 MAF, increasing to as much as 22 MAF in wet years (Association of California Water Agencies 2017; DWR 2017). As described in the Delta Plan (see page 74), the availability of water for diversion to storage or use is subject to the restrictions or conditions of specific water rights, as well as the operation restrictions of storage and transport facilities, physical and economic limitations, nonconsumptive uses (such as hydroelectric power generation), and the use and reuse of water.

New and expanded surface water and groundwater storage – within the Delta watershed, and within the Delta water export area – is needed to support reduced reliance on the Delta, achieve greater regional self-reliance, and sustainably manage the state's aquifers. Increased storage can allow water to be moved through the Delta when there are sufficient flows to support ecosystem needs and water can be more safely exported, for storage and later delivery when exports must be reduced to protect water quality and native fish. This shift in the timing of water movement and increased ability to carry over stored water from season to season can reduce reliance on the Delta during critical periods.

Groundwater provides about 40% of California's average annual total water supply, a figure that increases significantly during droughts and when surface water supplies are limited. Sustainable management of the state's groundwater resources is an important component of providing safe and reliable water supplies, contributing to reducing reliance on the Delta, and improving regional self-reliance. While difficult to quantify, available groundwater storage capacity in the state is estimated to exceed 200 MAF (DWR 2015). However, surface water supplies must be conjunctively managed with groundwater to leverage this available capacity and avoid groundwater overdraft, which can lead to subsidence and permanent loss of aquifer capacity. Expanded surface water storage can contribute to sustainable groundwater management by providing surface water at the right time for recharge and replenishment, providing water for in-lieu use to allow aquifers to recharge, and facilitate groundwater banking and exchange. This is particularly true in the San Joaquin Valley, where replenishment of aquifers and conjunctive use are limited by the availability of surface water supplies for recharge.

In the past decade, the State has spent tens of millions of dollars on integrated studies to evaluate how large surface storage and conveyance may be improved. DWR is now completing surface storage investigations that were initiated under CALFED more than 10 years ago (DWR 2010a). The three proposed new major surface storage reservoirs that are being evaluated are the North-of-the-Delta Offstream Storage (Sites Reservoir), Los Vaqueros Reservoir Expansion, and Upper San Joaquin River Basin Storage investigation (Temperance Flat Reservoir). DWR expects to make its decision on recommended projects by 2014.

In the meantime, smaller facility improvements, particularly for storage, are being implemented. Since 1995, more than 1.2 MAF of additional surface storage has been constructed at the regional level, including the Diamond Valley, Seven Oaks, and Olivenhain reservoirs in Southern California, and the Los Vaqueros Reservoir in Contra Costa County.[18] The sidebar, Applying Adaptive Management to Water Management Decisions, provides a hypothetical example of an approach to providing more reliable water supplies.

A legacy of both overdraft and water quality contamination has compromised groundwater storage in many regions of the state; however, important improvements are being made through expanded regional groundwater storage north and south of the Delta. Notably, an assessment of groundwater storage in 2000 identified more than 21 MAF of potential groundwater storage in Southern California and the southern portion of the San Joaquin groundwater basin (AGWA 2000). A more detailed discussion of groundwater management in California is included later in this chapter.

Significant opportunities are available to improve the operation of existing storage and conveyance facilities, build small-scale storage projects, or enhance opportunities for groundwater conjunctive management and water transfers in the next 5 to 10 years that are consistent with the coequal goals. DWR is leading a System Reoperation Task Force with Reclamation; USACE; and other State, federal, and local agencies to study and assess opportunities for reoperating existing reservoir and conveyance facilities to improve flood protection and capture of available water runoff, particularly in the context of climate change. Reservoir reoperation is also addressed in Chapter 7.

The value of new and/or expanded storage infrastructure should be assessed along with its connectivity to other surface storage, conveyance systems, and groundwater systems to maximize water supply and ecosystem benefits. Conveyance system integration affects the ability to make use of existing and new storage capacity in different parts of the state. Given the state's variable hydrology, the ability to operate conveyance in the Delta in a "big gulp, little sip" manner that balances ecosystem and water supply reliability needs is dependent on the availability of storage capacity in reservoirs and aquifers, and of conveyance infrastructure to move water supplies to and from storage facilities.

Many local storage and conjunctive management projects were identified through competitive State and federal grant funding application processes in the past decade. Most of these projects could not be funded because of limited funding and restrictions in some of the grant provisions. Later in this chapter, the New Water for California section provides

18 Contra Costa Water District will complete a 160,000-acre-foot expansion of Los Vaqueros Reservoir in 2012. The feasibility of an additional 275,000-acre-foot expansion is still under consideration by State and federal agencies.

further detail on the range of options and describes necessary steps that regions should take to improve regional self-reliance and reduce reliance on the Delta.

The Role of Conveyance in Increased Flexibility

Conveyance improvements can enhance the operational flexibility of the Delta system to divert and move water at times and from locations that are less harmful to fisheries, or to reliably transport environmental water supplies to specific locations at times when it can benefit fish and water quality (California Natural Resources Agency 2010). Existing configurations of Delta water conveyance and associated conveyance facilities do not provide adequate long-term reliability to meet current and projected water demands for SWP and CVP water exports from the Delta watershed (DWR 2009).

Conveyance improvements in the Delta are needed so that water supplies can be safely moved when they are available and conflicts between water supply deliveries and species protection can be avoided. This will allow exports to be reduced in dry periods when aquatic ecosystem needs are magnified, and promote more effective use of surface and groundwater storage to carry over supplies from wet to dry periods. Conveyance improvements outside the Delta are also needed to better leverage periods when conflicts between water exports and species protection are reduced, such that exported supplies can be managed conjunctively with local surface and groundwater supplies and storage facilities (Hanak et al. 2017).

The current system of natural and engineered conveyance infrastructure in the Delta lacks sufficient capacity and flexibility to manage water operations to benefit the ecosystem and enhance water supply reliability. System capacity and operational flexibility are needed to create more natural, variable flows and improve temperature conditions to support ecosystem health, maintain water quality for in-Delta uses, and move more water during wetter periods when supplies are available for both environmental and consumptive uses such that water can be sported less from the Delta in dryer periods when native fish are more vulnerable.

Current water conveyance infrastructure is also aging and Delta channels are vulnerable to earthquakes, floods, and other hazards as further discussed in Chapter 7 of the Delta Plan. Failure of this infrastructure poses significant risks for environmental harm and water supply disruption (Working Group on California Earthquake Probabilities 2003; Mount and Twiss 2005; Sneed et al. 2013; Farr et al. 2015; Robinson and Vahedifard 2016; Vahedifard et al. 2016). Climate change also is altering precipitation patterns in the Delta watershed and changing the timing and amount of stream flow, affecting water available for both ecosystem management and supply reliability. Sea level rise will increase salinity intrusion into the Delta, degrade water quality for agricultural and municipal uses in and outside the Delta, and alter ecosystem conditions (Anderson et al. 2008; Fleenor and Bombardelli 2013; Van Lienden et al. 2014).

For well over 50 years, State, local, and federal entities have worked to identify long-term solutions to protect the beneficial uses of the Delta, including new and improved water conveyance in the Delta. Conveyance options considered over time have taken many different routes, forms, sizes, and configurations (DWR and Reclamation 2016). They have included isolated conveyance (moving water across or around the Delta via tunnels, pipelines, and aqueducts); improvements to existing Delta channels and new Delta channels; and combinations of both isolated conveyance and through-Delta channels (also known as dual conveyance). Numerous operational scenarios have also been considered and evaluated that incorporate a range of upstream and in-Delta flow objectives, changed reservoir operations, changes to the timing of water conveyance and exports (seasonally and by year type), and many other regimes.

In accordance with Water Code section 85304, to promote options for improved conveyance in the Delta, the Delta Plan recommended that State and federal agencies complete the Bay Delta Conservation Plan (BDCP) and receive incidental take permits by December 31, 2014. Had that recommendation been fulfilled, the BDCP's conveyance provisions could have been incorporated automatically into the Delta Plan pursuant to Water Code section 85320(a).

In 2015, however, the State announced a new preferred alternative that would not complete the BDCP as a Natural Community Conservation Plan and Habitat Conservation Plan, but instead would pursue conveyance facilities through a DWR and Reclamation initiative called California WaterFix. A parallel effort called California EcoRestore was concurrently proposed to accelerate implementation of a suite of habitat restoration actions in the Delta.

In response to this new alternative, the Council began to review the issue of conveyance as well as storage and operations per Water Code section 85304:

> "The Delta Plan shall promote options for new and improved infrastructure relating to the water conveyance in the Delta, storage systems, and for the operation of both to achieve the coequal goals."

The Council developed the Conveyance, Storage Systems, and the Operation of Both (CSO) Amendment to meet the Water Code requirement. The recommendations from the CSO Amendment are included in this chapter in WR R12, and the entire Amendment has been included as an exhibit (Exhibit A) to this chapter.

Conveyance improvements are being evaluated as part of the California WaterFix project. Once decisions are made regarding whether to build and, if so, in what manner to build conveyance improvements, construction of these facilities will likely take at least a decade or more and will not provide near-term reliability improvements. This means that Delta operations and deliveries of export supplies will continue to be constrained by existing infrastructure for at least the next 15 years.

A great body of work exists exploring the potential positive and negative effects, risks, and uncertainties associated with different Delta conveyance options:

- If managed for conservation objectives, an isolated conveyance facility (one that moves water over, under, or around the Delta via artificial means) could facilitate more variable flow patterns, operating in a way that more closely mimics the natural flows that existed before the CVP and SWP export facilities were constructed and reducing entrainment—two actions scientists consider quite promising (Hanak et al. 2013; Moyle and Bennett 2008; Fleenor et al. 2010). Construction of screened diversion and intake facilities in multiple locations in the Delta would also reduce reliance on the State and federal export facilities in the south Delta. Operation of the existing CVP and SWP export facilities draws water toward the south Delta, which can reverse the natural direction of flow in Old River, Middle River, and other Delta channels. These flow reversals disorient and reposition vulnerable fish populations, resulting in fish losses from entrainment, predation, and capture and release practices. Access to one or more intakes in the northern Delta would provide operational flexibility to reduce south Delta exports and limit harmful reverse flow conditions, particularly during periods of lower flow, while at the same time managing water quality. Needed improvements to Delta hydrodynamic conditions and aquatic habitat will be more difficult without some suitably operated form of isolated water conveyance (Lund et al. 2008; Hanak et al. 2011; Moyle et al. 2012).
- Improvements to through-Delta conveyance alone are insufficient to provide effective protection for native fish, and to mitigate current water operation conflicts with listed species that result in export curtailments. Operational history and scientific studies indicate that exclusive dependence on south Delta pumping facilities will continue to cause reverse flow conditions in Old

and Middle rivers, drawing salmon and smelt into the interior channels of the Delta where they are vulnerable to predation and entrainment. Further, anticipated changes associated with sea-level rise, land subsidence, invasive species, climate change, and earthquakes will make it impossible to preserve the Delta in its current state (Moyle et al. 2012). Significant cost and uncertainty is associated with maintaining existing through-Delta conveyance and export operations, including operation and maintenance of aging export facilities and costs to repair and improve levees and channels. In addition, increased salinity will impose higher water treatment costs on Delta water users on the order of hundreds of millions of dollars per year. The cost of a large-scale levee failure from an earthquake, though difficult to estimate, would also be very high - both in terms of repair and restoration of affected levees and in terms of habitat loss and environmental harm (Lund et al. 2008). Although physical improvements to through-Delta conveyance can complement isolated conveyance by providing additional fish protection measures, sole reliance on improved through-Delta conveyance is unlikely to result in achievement of the coequal goals.

- Even with the construction of some form of new isolated conveyance, through-Delta conveyance will remain an important component of California's water supply system. The implementation of isolated conveyance without consideration of flow needs within existing Delta channels and waterways has the potential for detrimental effects on water quality and associated resources (such as aquatic habitat and species, recreation, and in-Delta water uses). Depending on the location of new intakes, dual conveyance may decrease the salinity of exported water but additional flow releases from upstream reservoirs may be required to meet in-Delta salinity standards. Analyses of different options for dual conveyance indicate that some in-Delta agricultural water users may encounter more frequent periods of high salinity while others may experience the opposite (Fleenor and Bombardelli 2013). With sea level rise, crop revenue losses in the Delta are estimated to be similar (less than 0.5%) with either through-Delta conveyance or dual conveyance of Delta exports (Medellín-Azuara et al. 2014). To provide flexibility to adapt to changing conditions, conveyance solutions (both through-Delta and isolated conveyance) should be integrated and operated in tandem with enhanced water storage in the Delta watershed to optimally achieve the coequal goals while protecting and enhancing the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

- California's hydrology is highly variable, requiring flexibility in water management operations to adjust to changing conditions. Adaptive management of new conveyance infrastructure in the Delta and its watershed can provide a framework for adjusting operations to changing conditions and our evolving understanding of ecosystem needs (Georgakakos et al. 2012). Adaptive management is a central component of the Delta Plan, and a requirement for covered actions under the plan's regulatory policy G P1.

- Large infrastructure projects ultimately have effects on the local environment and communities where the facilities are located. Above-ground isolated conveyance, in either a canal or above-ground pipeline, would permanently impact the landscape of the Delta—including native habitat, agriculture, transportation, recreation, and local communities. In comparison, below-ground conveyance reduces these impacts over the long-term (DWR and Reclamation 2016). However, below-ground conveyance – depending on its location, size, design, and associated physical details – will have impacts on Delta communities, including legacy communities[19], during extended construction periods that would span years. Several existing Delta Plan policies (which are regulatory) and recommendations (which are not

[19] A "legacy community" is a rural community registered as a Historic District by either a State or federal entity. Bethel Island, Clarksburg, Courtland, Freeport, Hood, Isleton, Knightsen, Rio Vista, Ryde, Locke, and Walnut Grove are the Delta's legacy communities (Public Resources Code section 32301(f)).

regulatory) promote protection of Delta communities, land uses, and restoration opportunity areas that may be affected by new infrastructure.

- Delta Plan regulatory policy DP P2 requires water management infrastructure be sited to avoid or reduce conflicts with existing land uses and those uses described in general plans.
- Delta Plan recommendation DP R5 addresses the need to plan for the provision of adequate infrastructure, including streets and roads. A large-scale infrastructure project – taking place in multiple locations, on land and on waterways, over a decade or more – will impact existing and future planned infrastructure. Plans should be made to accommodate the goals of transportation planning in the affected area, as well as to mitigate those impacts.
- Delta Plan recommendation DP R14 is aimed at enhancing nature-based recreation within the Delta, and recommendation DP R17 promotes enhancing opportunities for visitor-serving businesses. Construction of new conveyance and future maintenance activities can negatively affect visitor-serving recreation and businesses, and thoughtful and collaborative planning is needed to minimize these impacts such that the intent of these recommendations can be achieved, even during an extended construction period.
- Delta Plan recommendation DP R3 encourages planning for the vitality and preservation of legacy communities.
- Delta Plan regulatory policy G P1 requires covered actions not exempt from CEQA to include applicable feasible mitigation measures identified in the Delta Plan's Program Environmental Impact Report, including those related to impacts to Delta communities.

Advice from the Delta Protection Commission, affected local communities and local governments, and agencies responsible for protecting and restoring the Delta environment must be considered in selecting conveyance alternatives and mitigation measures. Minimizing impacts during construction to the normal, daily course of business in the affected communities and minimizing disruptions during normal operations and maintenance activities should be a priority for facility planners. A phased construction schedule, developed in coordination with local governments and communities in the Delta, could help minimize disruptions from large-scale infrastructure construction activities. Mitigation measures appropriate to the physical scale of new conveyance facilities, the length of the construction period, and anticipated maintenance needs should be planned in collaboration with the affected communities to minimize disruptions to residents and businesses. Further, collaboration, communication, and public engagement should continue throughout design, construction and, ultimately, operation and maintenance of new facilities.

- There is a need to address impacts to terrestrial and aquatic species from new infrastructure development in the Delta. Delta Plan regulatory policy ER P3 requires avoidance of or mitigation for significant adverse impacts to high priority habitat restoration areas, including designing projects such that they will not preclude or interfere with future habitat restoration projects in these areas. Habitat mitigation projects should be implemented in advance of construction activities, such that replacement habitat is establishing and functioning prior to the start of construction. Furthermore, project proponents should design new or improved Delta conveyance infrastructure to enhance ecosystem restoration opportunities, flood risk reduction, recreation, and quality of life for Delta communities. More natural flow patterns linked with connections to improved habitat areas can create opportunities to re-establish important ecological processes associated with interactions between land and water that more closely resemble historical conditions within the Delta (Whipple et al. 2012; Lund et al. 2008). Conveyance infrastructure can and should be designed to enhance the connectivity of surrounding riparian and floodplain habitats, as well as in-Delta habitats, to better support native ecosystems (Opperman et al. 2009; Hanak et al. 2013; DiFrancesco and Tullos 2014, 2015).

- It will take many years to implement large-scale improvements to conveyance infrastructure in the Delta and, even with the construction of such facilities, the CVP and SWP pumping facilities in the south Delta will continue to operate. Various studies have examined the feasibility of installing fish screens at Clifton Court Forebay or the entrance channels to the CVP and SWP pumping facilities. Most fish screens rely on sweeping flows moving past (parallel to) the screen to prevent impingement and entrainment; additionally, the terminal location and large pumping capacity of the CVP and SWP export facilities make it difficult to design a facility with sufficient sweeping flows to safely screen delta smelt and salmon. Further, fish screens would not address the effect that pumping operations have in reversing flows in some Delta channels and drawing fish toward the south Delta, where they would remain subject to predation and other harmful conditions. Given this, there is a need to identify and implement near-term actions to protect native fish and reduce fish losses associated with existing water export facilities, particularly in the south Delta (California Natural Resources Agency 2016). This includes evaluating structural changes to the export facilities, improving salvage and release operations, and identifying, monitoring, and adaptively managing actions to address predation (Grossman 2016; NMFS 2014; Gingras 1997).

Based on the findings and considerations identified above, new conveyance in the Delta should:

- Be a combination of new isolated conveyance and improved through-Delta conveyance facilities (dual conveyance) with access to multiple points of diversion, including one or more screened diversions;
- Be resilient to current and future hazards;
- Be adaptively managed and operated to adjust to changing conditions and scientific understanding, providing flexibility in operations to help achieve the coequal goals today and into the future;
- Be designed to avoid or minimize adverse effects while preserving and enhancing opportunities for ecosystem restoration, recreation, sustainable agriculture, and resilient local economies and communities;
- Be constructed and operated to minimize disruptions to the normal, daily course of business in affected communities, including minimizing disruptions during routine operations and maintenance; this includes implementing formal, collaborative processes with local governmental representatives to develop detailed construction implementation plans and policies that are responsive to the needs of affected communities, their economic activities, and quality of life during construction and beyond; and
- Be paired with near-term actions to address native fish losses at Delta export facilities.

Improved conveyance in the Delta can contribute to reducing fish losses and improving delivery reliability; however, conveyance alone is unlikely to provide the flexibility necessary to provide the water flow, temperature, and quality in the Delta and its watershed that are needed to achieve ecological goals. Similarly, improved Delta conveyance can improve export reliability but alone may not provide the flexibility needed for water managers to reduce reliance on the Delta and improve regional self-reliance. New conveyance in and outside the Delta should be developed and operated in coordination with existing and expanded storage systems (both surface storage and groundwater) to maximize the water management benefits and contributions to the coequal goals. However, improvements to conveyance alone are not sufficient to eliminate conflicts between water exports and species protection, or to optimize water system operations. Those conflicts are at their height during hydrologic extremes, such as droughts and floods. For this reason, improvements to conveyance must be considered along with increased water storage to ensure that flow, temperature, and water quality needs can be managed in the Delta, now and into the future.

Steps must also be taken to implement local water management programs and projects, described later in this chapter. Additionally, the State needs to address the continuing vulnerability of the Delta levee system and make improvements to protect the existing in-Delta conveyance system from catastrophic failure. (See Chapter 7 for a discussion of the benefits and vulnerabilities of Delta levees.) In particular, immediate improvements to the Delta levee system are critical because of the current instability and interdependence of the levees—the failure of one can affect the entire system (NRC 2012).

The Role of Integrated, Coordinated Operations of Storage and Conveyance

To develop a robust water management system that provides flexibility to adapt to changing conditions, conveyance should be integrated and operated in tandem with enhanced water storage in the Delta watershed and the Delta export area to optimally achieve the coequal goals while protecting and enhancing the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

The operation of water management projects in and tributary to the Delta are subject to laws and regulations administered and enforced by a variety of agencies, including water flow and quality standards as defined by the State Water Resources Control Board. These laws and regulations effect the operation of upstream reservoirs to meet flow and quality standards, and govern the timing and volume of water that may be conveyed through and exported from the Delta. Water operations are also subject to the conditions associated with individual water rights. Within this regulatory environment, a complex system of State, federal, and local water management infrastructure in the Delta and its watershed is operated to meet diverse and increasingly competing needs (Lund 2016).

Many of the State's conveyance and storage systems are inextricably linked by the Delta and surrounding environments, and conveyance and storage must be operated in an integrated manner to realize their full and combined potential. This includes operations to take better advantage of periods of ample supply such that less water is exported during critical dry periods. Operational flexibility of conveyance and storage systems is particularly important when considering climate change and uncertainties associated with future water demands (Georgakakos et al. 2012). Further, sustained drought conditions are expected to intensify in the future, putting additional stress on the operation of Delta conveyance and water storage infrastructure to meet both ecosystem and water supply needs.

Given these challenges and uncertainties, adaptive management is critical to successfully operating water management facilities in the Delta to achieve the coequal goals, as described in the Delta Plan. Adaptive management should address specific and measurable operating objectives for ecosystem and water quality requirements, changing climate conditions, and changing water demands (Georgakakos et al. 2012; Null et al. 2014; Kistenmacher and Georgakakos 2015; Null and Prudencio 2016; Rheinheimer et al. 2016). Further, for adaptive management to be effectively implemented, adequate funding must be provided to monitor conditions before, during, and after projects are implemented.

Water management systems in the Delta must be operated to reduce hydrodynamic and biological impacts of exporting water through Jones and Banks pumping plants and minimize the frequency, magnitude, and duration of reverse flows in Old River and Middle River in order to reduce the likelihood that fish will be diverted from the San Joaquin or Sacramento rivers into the southern or central Delta substantially increasing their likelihood of mortality (NMFS 2014, NMFS 2009). Studies suggest that SWP and CVP water diversion impacts on fish can be mitigated by altering the timing of exports, and that fish losses can by minimizing reverse flows during periods when delta smelt and other fish are migrating into the Delta (Grimaldo et al. 2009). Conveyance operations must also be coordinated with storage operations to provide adequate flows in the Delta to meet the needs of fish and other native species.

The benefits of coordinating surface and groundwater storage with conveyance operations greatly surpasses the benefits of expanding storage capacity alone (Lund et al. 2014). Integrated or coordinated operation of conveyance and storage, within and outside of the Delta, can contribute to sustainable management of the state's aquifers, promote conjunctive use, leverage local supplies, and reduce reliance on the Delta during dry periods and droughts.

A recent study by the Association of California Water Agencies indicates that integrating the operation of eight proposed storage projects (both north and south of the Delta) with expanded conveyance in the Delta can improve delivery reliability and contribute to sustainable groundwater management over expanding storage alone, while meeting regulatory flow and water quality requirements. For example, the study estimated an average annual increase in water deliveries with the proposed storage projects alone of about 400 thousand acre-feet (TAF); this figure increased to about 800 TAF when simulated in combination with improved Delta conveyance. Similarly, the study showed reduced groundwater pumping and increased recharge with a combination of storage and conveyance. Groundwater storage increased by about 250 TAF annually with new storage projects alone, increasing to 460 TAF annually with a combination of storage and improved Delta conveyance (Association of California Water Agencies 2017). Other studies have suggested that groundwater storage in the San Joaquin Valley alone could increase by as much as 500 TAF with a combination of new surface storage and conveyance improvements (Lund et al. 2014).

A recent study by DWR shows more than 1 MAF of surface water available on an average annual basis for groundwater replenishment within the Delta watershed and areas receiving Delta export supplies (DWR 2017). Conveyance improvements with expanded surface storage can increase the ability to capture and transport surface water supplies for groundwater recharge and replenishment and/or in-lieu recharge. Surface storage can be operated to store water during wet periods, for delivery in late spring and summer and during dry periods as in-lieu supply for existing groundwater users; this operation increases the use of available groundwater storage capacity, providing greater water supply benefits than if surface and groundwater facilities were operated independently (Lund et al. 2014).

By taking into account effects on the Delta, conveyance outside of the Delta can be operated to complement Delta conveyance and expanded storage. Local conveyance improvements and sustainable water management actions taken outside the Delta can contribute to the coequal goals through a comprehensive, integrated water management approach that considers multiple water supply sources, including but not limited to surface water storage, groundwater, stream flow, imported water, water transfers, stormwater, desalinated water, and recycled water, as applicable (Howitt et al. 2010; Hanak et al. 2012; Howitt et al. 2015).

Changing Conditions

Conflicting priorities in water and ecosystem management will be intensified by climate change, which will alter the magnitude, timing, duration, frequency, and rate of change of stream flows in the Delta watershed (Anderson et al. 2008; Huang et al. 2012; Berghuijs et al. 2014; Goulden and Bales 2014; Van Lienden et al. 2014; Savtchenko et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017).[20] Climate change will result in higher ambient temperatures, reduced Sierra Nevada snowpack, more precipitation falling as rain rather than snow, snow melting earlier and more rapidly, warmer stream temperatures, and higher amounts of water loss through evapotranspiration (Anderson et al. 2008; Huang et al. 2012; Berghuijs et al. 2014; Goulden and Bales 2014; Van Lienden et al. 2014; Savtchenko et al. 2015; Jepsen et al. 2016; Udall and Overpeck 2017; Ficklin et al. 2013). Climate change is also expected to trend toward more frequent and extended periods of drought as well as more frequent and intense floods (Das et al. 2013; Pierce and Cayan 2013; Pierce et al. 2013; Seager et al. 2013; Berg and Hall 2015; Cook et al. 2015; Differbaugh et al. 2015; Stewart et al. 2015; Walton et al. 2017).

Climate change will also contribute to rising sea levels along California's coast and within its estuaries (Griggs et al. 2017). Rising sea levels will place additional burdens on the water management system in the Delta in the years to come (Cayan et al. 2008; NRC 2012b; Van Lienden et al. 2014). Through-Delta conveyance is very likely to experience salinity increases with sea level rise, which will ultimately rise above appropriate concentrations for drinking water and irrigation in some areas of the western Delta if freshwater outflows are not increased (Fleenor and Bombardelli 2013). It is projected that salinity at Jersey Point could increase by 23% in the early 21st century (2012-2040) and 88% by the end of the century, assuming an estimated mean sea level rise of 36 inches (92 centimeters (cm)) (Van Lienden et al. 2014). For the SWP and CVP, a projected 11.8 inches (30 cm) rise in sea level by the mid-21st century would raise salinity enough to reduce by 10% the amount of time that the projects can operate (Anderson et al. 2008). Reservoir releases to repel salinity are expected to reduce Delta water exports by about 10% by 2050 and by about 25% by 2100 (Dettinger. 2016a). In other words, a 1-foot (30 cm) rise in sea level would require almost 500,000 acre-feet of additional Delta outflow to meet current Delta salinity requirements (Healey et al. 2016; Mount et al. 2012). With sea level rise and increasing temperatures, new and expanded water storage will play a critical role in providing adequate flows in the Delta to manage water flow and water quality (salinity) for all uses.

In addition, California's population is expected to increase from about 39 million in 2016 to more than 44 million by 2030 (California Department of Finance 2016). Population growth and increased economic activity, in combination with land-use changes, economically-driven grower choices that favor permanent crops, and demand hardening from advances in conservation and water use efficiency, will alter water demand patterns (Kiparsky et al. 2014; Bauer et al. 2015; Dettinger et al. 2015; Wilson et al. 2016). Continued progress in urban conservation is likely to offset some demand increases due to population growth (Wilson et al. 2016; Lund 2016), and agricultural water demand is expected to decrease over time. Environmental water demands[21], however, are expected to increase in the coming years (Hanak et al. 2012). All of these factors will place stress on the existing system of conveyance and storage in the state. This creates a much more difficult situation in which to maintain a healthy Delta ecosystem while providing reliable water supplies.

[20] "Climate change" is defined in the Delta Plan as any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change may result from (1) natural factors, including changes in the sun's intensity or the Earth's orbit around the sun, (2) natural processes within the climate system, or (3) human activities that change the composition of the atmosphere. See Glossary.

[21] "Environmental water" use is defined in the Delta Plan as Water dedicated to instream environmental needs. See Glossary.

Reducing Reliance on the Delta

Many regions of the state rely on the Delta, to varying degrees, to meet their water supply needs. Reducing reliance on the Delta for water supply is essential to providing more flexibility in both meeting water supply reliability goals and protecting the ecosystem, especially in times of lower flow when there is maximum stress on both goals. Reducing reliance on the Delta is State policy, along with an associated mandate for improving regional self-reliance (Water Code section 85021), and reducing reliance is a prominent component of the Delta Plan (reflected in Chapter 3, which includes regulatory policy WR P1, Appendix G, and performance measures). Many agencies have made significant investments in developing their local and regional supplies, including groundwater banking, on- and off-stream surface water storage, recycled water, and desalinated supplies, while also achieving significant decreases in imported water demand through conservation and water use efficiency efforts. Reduced reliance on the Delta can be achieved through diversification of water supply portfolios at the regional and local levels, can improve overall supply reliability through providing alternative sources of supply during periods when water exports from the Delta are reduced (Hanak et al. 2015; Hanak et al. 2011).

Not all areas of the state have the same opportunities and resources to uniformly reduce reliance on Delta exports. Inland agricultural regions may not produce enough wastewater to replace agricultural irrigation with recycled water, although opportunities to use recycled water for groundwater recharge may be available. Other areas may be challenged by limited ability to dispose of brine, a byproduct of brackish and recycled water desalination, or geology and geography may limit the ability to store significant amounts of water during wetter periods. The cost effectiveness of any local supply strategy is of major importance and a valid criterion for any decision to implement a new local supply, as is avoiding or mitigating significant environmental impacts in the local area. Although new supply development opportunities may vary throughout the state, all regions reliant on Delta exports can reduce their reliance by increased water efficiency and aggressive water conservation.

New and improved conveyance, system storage, and the operations of both can complement water conservation and local supply development activities by providing a more stable and reliable source of supply. Combined with existing Delta Plan regulatory policy WR P1 and associated strategies for reduced reliance (see Chapter 3 and Appendix G), conveyance and storage can provide the flexibility local water managers need to sustainably manage their local supplies and reduce reliance on the Delta, especially during dry periods when the ecosystem is most vulnerable, water quality is degraded, and exports are limited.

New Water for California

The fact that water is a scarce resource does not mean that California is "running out of water" (NRC 2012). It does mean that California will need to develop plans, and implement programs and projects that can adapt to a highly variable and uncertain water future. The primary source of new water supplies for California in the future will come from local and regional sources. This section discusses local water supply opportunities, the importance of local and regional water management planning, and the need for improved groundwater management and water data so that the state can better match its water demands to the available supplies.

California's Wealth of Water Opportunities

California has many new and underused water resources that can be developed to improve regional self-reliance. In 2009, DWR estimated that the state could further reduce water demand and increase water supplies in the range of 5 to 10 MAF by 2030 through the use of existing strategies and technologies (see Figure 3-7).[22] If the state developed only half this water (about 5 MAF) through water efficiency and new local supplies, it would be sufficient to support the addition of almost 30 million residents, more than the population growth that is expected to occur by 2050.[23]

Nearly all these potential supplies will come from a combination of improved conservation and water use efficiency in the urban and agricultural sectors, local groundwater and surface storage, conjunctive management, recycled water, drinking water treatment, groundwater remediation, and desalination. DWR has identified 27 "resource management strategies" that water suppliers should con-sider when expanding their water management programs throughout the diverse regions of the state (DWR 2009).
Resource managers can combine these strategies into a response package, crafting them to provide multiple water resource benefits, diversify their water portfolio, and become more regionally self-reliant.

Often, the new local and regional water supplies have the additional advantage of being available even during extreme drought conditions, making them some of the most reliable sources of water for urban and agricultural uses. In particular, recycled water and the treatment and reuse of poor-quality groundwater are two of the most resilient water supplies under conditions of drought and climate change. The treatment of poor-quality groundwater also can significantly improve drinking water supplies, especially for rural and economically disadvantaged communities that have limited alternatives to secure clean water. In 2012, the California Legislature enacted Assembly Bill (AB) 685, declaring the established State policy that "every human being has the right to safe, clean, affordable, and accessible water adequate for human consumption, cooking, and sanitary purposes" (Water Code section 106.3 (a)). For more about drinking water quality, see Chapter 6.

For some local water resources, California has adopted specific targets, including:

- **Urban water conservation.** The State's goal is to achieve a reduction in statewide per capita urban water use of 20 percent, from a 2005 baseline of an estimated 198 gallons per capita daily (GPCD) to 166 GPCD (DWR 2012b). This represents a potential annual water savings of approximately 1.8 MAF per year that will be accomplished by 2020. This is consistent with DWR's 2009 estimate that 2.1 MAF can be conserved in roughly the same period through increased use of water-efficient appliances, reduced water use for landscaping, and tiered rate structures, such as increasing block rates or budget-based rate structures.

[22] The range of 5 to 10 MAF is a conservative estimate and is consistent with recent studies that assess California's potential for increased water savings and water supplies. DWR provides a cautionary note that the water supply benefits summarized in the California Water Plan are not intended to be additive, recognizing the same resource management strategies may complement or compete with one another for funding, system capacity, or other elements that are necessary for implementation. In addition, unlike the 2005 version, DWR did not include in the 2009 California Water Plan an estimate for water supply benefits from improved conveyance. Instead, DWR states that the main benefits of conveyance improvements are increased water supply reliability, water quality protection, and operational flexibility (DWR 2009).

[23] Under California law, water conservation is considered a source of supply (Water Code section 1011(a)). A 2008 report from the Los Angeles Economic Development Corporation found that "using water more efficiently reduces demand, which has the same effect as adding water to the system." For Southern California, the report concludes that "urban water conservation could have an impact equivalent to adding more than 1 MAF of water to the regional supply (about 25 percent of current annual use)" (LAEDC 2008).

- **Recycled water.** The State's goal is to increase the use of recycled water over 2002 levels by at least 1 MAF per year by 2020, and by at least 2 MAF per year by 2030 (DWR et al. 2010). DWR's 2009 estimate indicates that as much as 2.25 MAF could be recovered, about half of the amount of wastewater that is treated and released to flow to the ocean.
- **Stormwater runoff.** The State's goal is to increase capture and reuse of stormwater by at least 500,000 acre-feet per year by 2020, and at least 1 MAF per year by 2030 (DWR et al. 2010). The 2008 Scoping Plan for California's Global Warming Solutions Act of 2006 (AB 32) finds that up to 333,000 acre-feet of stormwater could be captured on an annual average for reuse in Southern California alone (CARB 2008).

California's Wealth of New Water Supplies

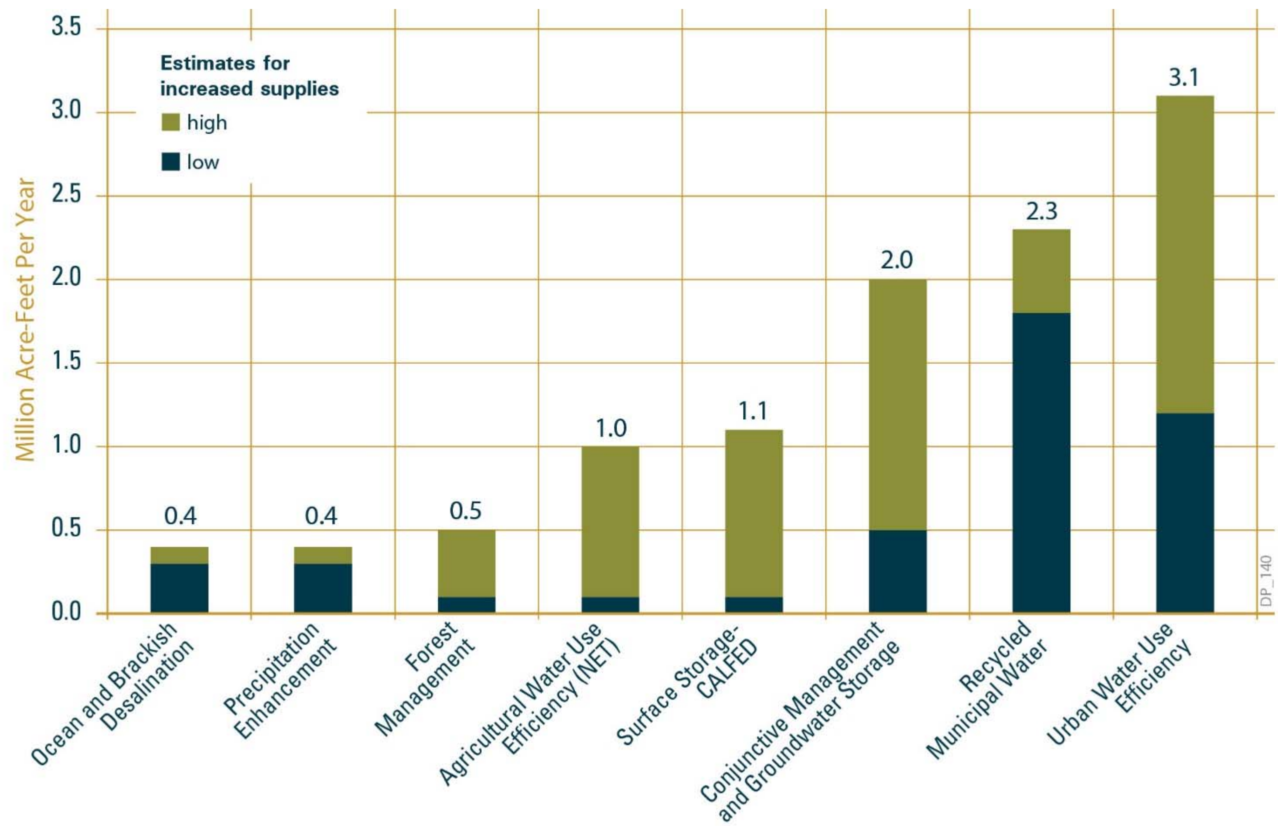

Figure 3-7 DWR estimates that California could further reduce its water demands and increase water supplies by 5 to 10 MAF per year over the next 30 years through the use of existing technologies.

Source: DWR 2009

CALIFORNIA WATER ACTION PLAN

The *California Water Action Plan* (California Natural Resources Agency et al., 2014; http://resources.ca.gov/california_water_action_plan/) lays out decisive actions needed to meet three broad objectives: developing more reliable water supplies, restoring important species and habitats, and providing a more resilient, sustainably managed water resources system (water supply, water quality, flood protection, and environment) that can withstand anticipated and unforeseen pressures in the coming decades. The plan further highlights the need for adaptive management in operating water facilities and in implementing conservation actions, particularly during drought. Action is required throughout California, but the Delta's central role in water management for many regions and citizens of the state makes success in Delta foundational to overall success. The comprehensive actions in the California Water Action Plan include:

- Make conservation a California way of life
- Increase regional self-reliance and integrated water management across all levels of government
- Achieve the coequal goals for the Delta
- Protect and restore important ecosystems
- Manage and prepare for dry periods
- Expand water storage capacity and improve groundwater management
- Provide safe water for all communities
- Increase flood protection
- Increase operational and regulatory efficiency
- Identify sustainable and integrated financing opportunities.

Fortunately, California has taken several steps to implement these actions, as described in the *California Water Action Plan 2016 Update* (California Natural Resources Agency et al. 2016; http://resources.ca.gov/california_water_action_plan/).

The Importance of Local Water Management Planning

Over the past few decades, the State has built on successful local water management planning and, when possible, has provided funding for local districts to develop and implement water management plans. These plans are of benefit to all regions, not just those who rely on the Delta or Delta watershed.

These programs and projects increase the reliability of water supplies by increasing water efficiency and diversify the portfolio of water sources for urban and agricultural water suppliers that are more resilient under conditions of drought, emergency shortage, and climate change. Water developed through these activities can help reduce conflicts among urban, agricultural, and environmental uses, and can contribute to the ability of regions in California to reduce their reliance on water from the Delta watershed.[24]

The responsibility for implementing most of these water management strategies and achieving State objectives lies with over 600 local water agencies, including several privately owned and operated companies, plus wastewater districts, community service districts, and other special districts. The sheer number of local agencies engaged in water management makes it difficult to monitor and account for the

[24] As used in the Delta Plan, "regions" refer to the 10 hydrologic areas identified by DWR that correspond to the state's major water drainage basins, and included the two regional overlays for the Mountain Counties area and the Delta. The use of these regions as planning boundaries allows consistent tracking of their natural water runoff and accounting of surface and groundwater supplies.

significant new amounts of water supplies and increased water efficiency that is being implemented. Later in this chapter, the Informed Decision Making Requires Information section details this challenge and associated water management implications.

Since the mid-1980s, California has enacted progressively more stringent water conservation, efficiency, and water planning requirements for urban and agricultural water suppliers (see Appendix H). Beginning in 1983, wholesale and retail municipal water suppliers (those with at least 3,000 connections or delivering at least 3,000 acre-feet per year) have been required by the Urban Water Management Planning Act to prepare 20-year urban water management plans to guide investments in future water reliability. This law has been strengthened through several revisions to include specific water conservation goals (such as the 20 percent reduction in urban per capita water usage by 2020 adopted in 2009), compliance with demand management measures including adoption of rate structures that promote water conservation (AB 1420 in 2007), landscape conservation requirements (AB 1881 in 2006), and required installation of water meters (AB 2572 in 2004).

Existing law requires that urban water suppliers include a water supply reliability element and water shortage provisions in their urban water management plans, recognizing that suppliers need to prepare for extended droughts, the effects of climate change, and potential catastrophic interruption of deliveries caused by earthquakes or other events.

Water suppliers must evaluate whether their water sources may be available at a consistent level of use and describe their plans for supplementing or replacing these sources, to the extent practicable with alternatives or water demand management measures (Water Code section 10631(c)(2)). Water suppliers must also describe the tools and options that will be used to maximize resources and minimize the need to import water from other regions (Water Code section 10620(f)).

Agricultural water suppliers (those that provide water to 25,000 or more irrigated acres, or 10,000 irrigated acres and who receive State funding to implement the plan provisions) have a requirement similar to urban suppliers and must prepare agricultural water management plans. The Agricultural Water Management Planning Act was adopted in 2009 (Senate Bill X7 7 [SBX7 7]). Requirements include reporting on farm gate water deliveries, adoption of rate structures that promote water conservation, and identification and implementation of locally cost-effective and technically feasible water efficiency measures.

Since 2000, the State has also promoted voluntary integrated regional water management plans (IRWMPs), recognizing that collaboration among multiple agencies, especially within watersheds, provides opportunities for better water management decisions and coordinated infrastructure investments. Significant bond funding has been made available to support implementation of projects identified through these IRWMPs. A 2006 report on the investments made for IRWMP projects identified over 1.2 MAF of water benefits in combined water supply and demand reductions that have been achieved through the expenditure of $1 billion in State bond funds in local and regional projects (DWR 2009). An additional $1 billion or more of local dollars were leveraged because of this State investment. Applicants for IRWMP funding must now demonstrate how their plans help reduce their region's dependence on water imported from outside their region (DWR 2010c).

As climate change begins to affect California's water supplies, the U.S. Environmental Protection Agency (Region 9) and DWR are encouraging water managers to plan for these impacts and to take steps to adapt to them. IRWMPs, and the agricultural and urban water management plans provide an excellent framework for addressing water-related climate change impacts (USEPA and DWR 2011). Because each region is unique, there is no single "correct" planning approach. Key concepts include risk assessment, such as the potential for interruption of water supplies for up to 36 months due to catastrophic events impacting the Delta, including earthquakes or floods. For example, DWR identified the potential for some portion of Delta deliveries to be interrupted for up to 36 months if a catastrophic earthquake occurred (DWR 2010b). Although this would have a primary impact on water suppliers that rely on water from the Delta, it might also affect upstream water suppliers that may be called upon to release more water into the Delta during the crisis.

Another useful tool is the regional water balance. According to DWR, the purpose of a regional water balance is to provide an accounting of all water that enters and leaves a specific hydrologic region, how it is used, and how it is exchanged between regions. A regional water balance can be used to compare how water supplies and uses in a region can vary between wet and critically dry hydrologic conditions, and how each region's water balance compares with other regions and with the state's overall water balance. This is important to all water planning activities and provides a basis for evaluating unsustainable water management practices and making appropriate improvements (DWR 2009).

The Human Right to Water

The Delta Plan must "promote statewide water conservation, water use efficiency, and sustainable use of water" (Water Code section 85303) and include measures to promote a more reliable water supply by meeting water needs, sustaining the economic vitality of the state, and improving water quality to protect human health. The Council must consider incorporating actions in the Delta Plan to implement specific subgoals and strategies, including improving water quality to meet drinking water goals. These requirements relate closely to California's policy in Water Code Section 106.3 that "every human being has the right to, safe, clean, affordable, and accessible water adequate for human consumption, cooking and sanitary purposes." The Delta Plan acknowledges that the Council must consider this policy. In addition, the eight inherent objectives for management of the Delta include protecting and enhancing the Delta as an evolving place. This goal indicates that the evolving needs of the people who rely on the Delta must be considered.

The human right to water extends to all Californians, including disadvantaged individuals and groups, and communities in rural and urban areas. Disadvantaged communities are disproportionately affected by water resource challenges related to groundwater, as many small and rural communities rely on groundwater for all or a large portion of their supplies (SWRCB 2013). Further, many small and rural communities rely on impaired or contaminated groundwater for their water supplies, and struggle with the cost of providing safe drinking water. During the recent 2012 to 2016 drought, about two-thirds of drought-impacted public water systems and household water outages were in disadvantaged communities, and nearly one-third of drought-impacted systems served cumulatively burdened communities. These impacted communities are concentrated outside the Delta, in the San Joaquin Valley, the North Coast, and the Central Coast.[25] Similar geographic trends were also reported for drought-impacted household water systems (systems with fewer than 15

[25] Disadvantaged communities have a median household income of less than 80 percent of the state median. Cumulatively Burdened Communities are those that rank in the top quarter of census tracts in the state for environmental burdens and socioeconomic vulnerability. Source: Feinstein et al. 2017. An interactive map of disadvantaged communities within California can be found at https://gis.water.ca.gov/app/dacs/.

household connections, including individual household wells or water supplies)(https://mydrywatersupply.water.ca.gov/report/publicpage). Improvements to conveyance, system storage, and the operations of both can support sustainable water management in many areas of the state, especially disadvantaged communities, and help assure the right to safe, clean, affordable and accessible water for human consumption and domestic use.

Implementing a Path to Success in Local Water Management

Many agricultural and urban water suppliers are taking commendable action to improve water conservation and efficiency, and to expand their local and regional water supplies. (See sidebar, Regional Success Stories.) However, others are not.

For example, despite longstanding State laws that require preparation and implementation of urban water management plans, many water suppliers still regard these plans as voluntary because the only consequence of not completing them has been ineligibility to receive State grant and loan funding to implement water projects. In the 2005 round of urban water management plan submittals, this incentive increased the number of plans submitted over previous years; however, only 75 percent of agencies that should submit plans actually did as of December 31, 2006, and more than 50 percent of these failed to include required conservation or drought contingency plans (DWR 2006). In the 2010 round of urban water management plan submittals, 66 percent of the agencies required to submit plans actually did by the August 2011 deadline. One year later, this percentage had increased to 85 percent, but no assessment for completeness has been performed (DWR 2012b).

Widespread compliance with existing water management laws alone would achieve great progress in improving water supply reliability for California. Compliance with all State water efficiency and management statutes and policies, at a minimum, should be the starting point for assessing a water supplier's reasonable use of California's water. In particular, water suppliers that do not engage in efficient use of water, particularly where the implementation of proven measures and technologies are economically justifiable, locally cost effective, and do not harm other water users, should be held accountable for wasting water. The SWRCB should be encouraged to use its authority to prevent waste and unreasonable use by seeking enforcement of these requirements. The potential for this type of action was anticipated in the Water Conservation Act of 2009 (SBX7 7), which explicitly recognized that the failure of urban water suppliers to reduce urban per capita water demand consistent with the State's 20 percent by 2020 conservation targets can be used after January 2021 to establish a violation of the law for the purposes of State administrative or judicial proceedings (Water Code section 10608.8(a)(2)).

Importantly, for those who prepare them, urban water management plans and integrated regional water management plans appear to be working. As a result of these efforts and increased irrigation efficiency, the amount of water needed to meet future urban and agricultural demands has changed. Since 1980, the total volume of water used in the urban and agricultural sectors has declined. Urban areas that have implemented the strongest water conservation programs show the greatest improvements in water efficiency and the largest reductions in water use (see Figure 3-8).

REGIONAL SUCCESS STORIES

Significant improvements in water management are being implemented throughout California, especially in regions that rely upon water from the Delta and the Delta watershed. The 2010 urban water management plan updates and voluntary IRWMP grant applications filed in 2010 provide insight into what individual water agencies and regional planning efforts are doing to improve water efficiency and develop additional local water supplies. Examples of successful strategies to reduce reliance on the Delta and improve regional self-reliance follow.

In Southern California:

- **West Basin Municipal Water District.** Increased water efficiency and diversification of the district's water supplies between 2010 and 2035 will enable West Basin Municipal Water District to reduce its potable water demand despite expected future population growth. The total volume of imported water usage is projected to decline by 40,000 acre-feet over this period, and conservation, recycled water, and ocean desalination will expand the district's water resources by over 60,000 acre-feet (RMC Water and Environment 2011).
- **City of Los Angeles.** Today the City of Los Angeles uses less water than it did 30 years ago, despite population growth of more than 1 million residents. In 2011, per capita water usage was 123 gallons daily—the lowest in Los Angeles in more than 40 years and the lowest among any United States city with a population over 1 million (LADWP 2012). Through regional watershed planning efforts, the city is bringing together local and county public works departments, planning agencies, local and regional water supplies, and citizen groups to develop integrated multibenefit projects. In 2004, the city overwhelmingly approved Proposition O, which authorized $500 million in local bonds to fund water efficiency, stormwater capture, water treatment, recycled water, flood protection, open space, recreation, and other projects.

In the central San Joaquin Valley and Tulare Lake regions:

- **Poso Creek Regional Water Management Group.** The IRWMP focuses on more effective coordination of each participating irrigation district's water assets, recognizing that competition for the three sources of water that meet the region's demands (local supplies/Kern River, CVP, and SWP) is increasing. Proposed improvements include 400 acres of spreading ponds and additional conveyance (canals, pipelines, and pumping plants) between the Friant-Kern Canal and California Aqueduct and among irrigation districts, which will enable the region to take advantage of wet-year (unscheduled) water diversions from the Delta and reduce diversions in dry years (Semitropic Water Storage District 2011).

In the Delta:

- East Contra Costa County. Located entirely within the statutory Delta, all the water suppliers that participate in this IRWMP rely upon the Delta for more than 80 percent of average-year water demands, with three water suppliers receiving 100 percent. The IRWMP priorities for reducing reliance on the Delta include expanded use of recycled water, installation of water meters, increased water conservation, and new wellhead treatment for groundwater supplies (Contra Costa Water District 2011).

In the Bay Area:

- **City and County of San Francisco.** Increased water efficiency has resulted in general decline in total consumption and per capita water use since the mid-1970s to record low levels in the state despite growth in the county's population. Recognition of the vulnerability of the city's Hetch Hetchy Reservoir and aqueduct system to earthquakes and other emergencies, San Francisco is working to diversify its local water supplies, including increased conservation, new local groundwater wells, expansion of recycled water, use of gray water, rainwater harvesting, and participation in the Bay Area Regional Desalination Project with Contra Costa Water District, East Bay Municipal Utility District, Santa Clara Valley Water District, and Zone 7 Water Agency (San Francisco Public Utilities Commission 2011).

In the Delta upper watershed:

- **American River Basin.** The IRWMP features reduced reliance on water in the Delta's American River tributaries through expanded conjunctive use operations, development of recycled water, and increased water conservation. More water will be diverted during wetter periods and made available as groundwater in drier periods, which will help increase regional water supply reliability while improving flow and temperature conditions that benefit salmon and steelhead fisheries in the lower American River (Regional Water Authority 2011).

DP-348

Trends in California's Water Use

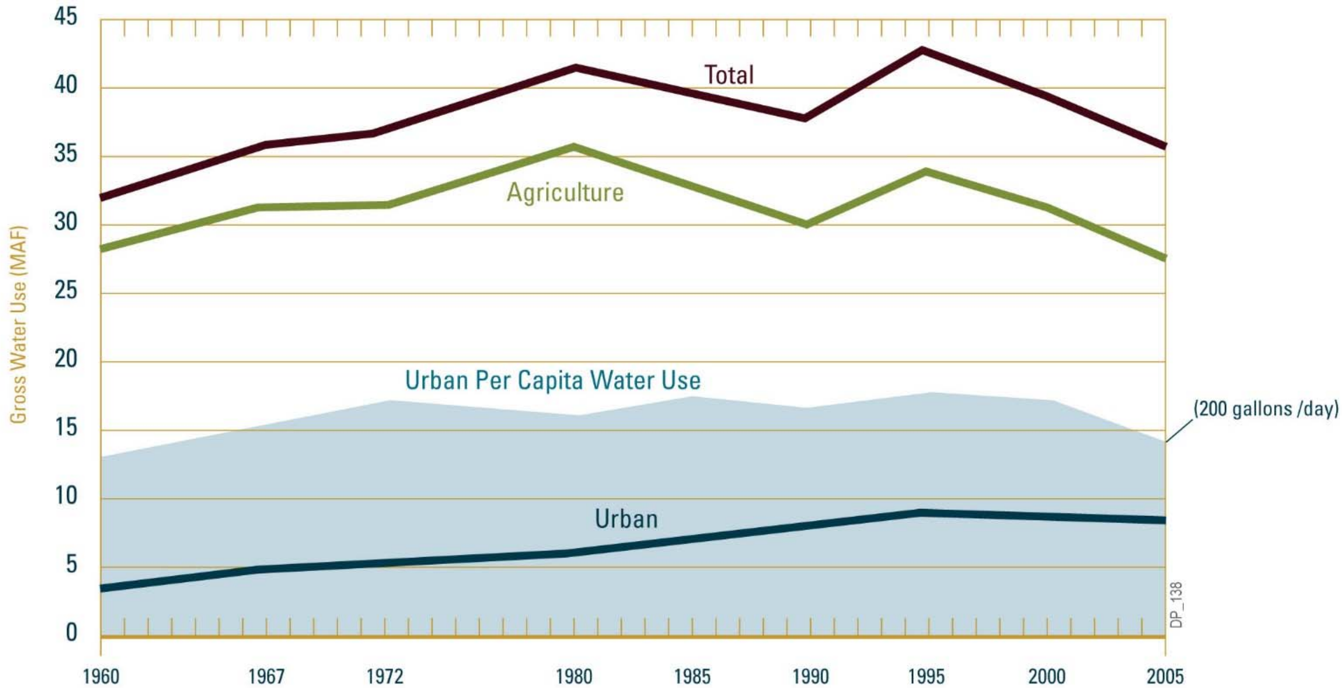

Figure 3-8 California's water use is declining, primarily due to increased water efficiency in both agricultural and urban areas. The City of Los Angeles, like many other cities, reports that it is using the same amount of water as it did over 30 years ago, even though its population has grown by more than 1 million people.

Sources: Hanak et al. 2011; adapted from DWR 2009

Groundwater Overdraft Is an Impediment to the Coequal Goals

Groundwater is a major source of water supply for nearly every region in California and a vital component of the state's water storage system, particularly during droughts (DWR 2009). More than 40 percent of Californians rely on groundwater for part of their water supply, and many small- to moderate-sized towns and cities are entirely dependent on groundwater for their drinking water systems (DWR 2003a, SWRCB 2015). The state's most significant groundwater use occurs in regions that also rely on water from the Delta watershed, including the San Joaquin Valley, Tulare Lake, Sacramento Valley, Central Coast, and South Coast (see Figures 3-9 and 3-10). The Tulare Lake region alone accounts for more than one-third of the state's total groundwater pumping (DWR 2009). Because of historical groundwater overdraft[26] and resulting land subsidence experienced in these regions, water users switched to using surface water from the CVP and SWP when the water projects were completed in the late 1960s. However, groundwater pumping

26 "Groundwater overdraft" is defined in the Delta Plan as The condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years during which water supply conditions approximate average conditions. See Glossary.

and overdraft continued to become more severe as water demands continued to exceed available supplies. Recent satellite imaging revealed that the Central Valley lost approximately 25 MAF of stored groundwater during the period of October 2003 to March 2010 (Famiglietti et al. 2011).

As a result of use continually exceeding recharge, many of California's groundwater basins are in overdraft, and groundwater levels are declining over the long term (Faunt 2009). In some areas, overdraft can lead to a permanent loss of groundwater storage. According to DWR, a groundwater basin is in a state of "critical overdraft" when continuation of present water management practices would result in significant adverse overdraft-related environmental, social, or economic impacts. DWR estimates statewide average overdraft of about 1 to 2 MAF per year (DWR 2009). Groundwater use is also increasing, and is expected to grow at a faster rate in future decades as climate change reduces the reliability of surface water deliveries and increases the potential for extended droughts (DWR 2009). Without more efficient management, the state's groundwater resources will be significantly impacted, and in severe overdraft conditions, the aquifer's capacity to store groundwater may be irretrievably lost (DWR 2003a). Improved management is also needed to take advantage of opportunities to store water underground, particularly to aid flexibility when done in coordination with improved operations in the Delta.

California has established laws, regulations, and programs to protect the quality of its groundwater resources. Despite the major importance of this water supply to California, however, the quantity of groundwater used by agencies or individuals is largely unregulated at the State level. Except for Texas, California is the only state where use of its groundwater resources is managed at the local rather than State level. The lack of State oversight means that limited and often incomplete information is available to the public about how California's groundwater basins are being managed. So little is known, that in 2003, DWR was unable to revise the designation of critically overdrafted basins in its update on California's groundwater (DWR 2003a). Lacking current information and having limited resources to complete additional investigations, DWR simply republished the list of 11 basins identified in 1980.

Some regions appear to be making significant progress in developing sustainable groundwater management programs through regional water balances and voluntary groundwater management plans (known as AB 3030 plans), local ordinances, and court adjudications (Nelson 2011).[27] In 2009, the State created a mandatory statewide program for local reporting of groundwater elevation data, the California Statewide Groundwater Elevation Monitoring Program. This program will collect reported groundwater elevations and make the data available online.

[27] The State encourages additional voluntary development of locally controlled groundwater monitoring programs and related management plans through AB 3030 (1992), AB 303 (2000), AB 599 (2001), and SB 1938 (2002); through the IRWMP Program (through funding provided by Propositions 13, 50, and 84); and by limiting availability of State funding for water infrastructure to those agencies that have adequate groundwater management plans in place. The State also provides technical assistance to help local agencies more efficiently and sustainably manage groundwater resources, and has identified 14 required and recommended components for groundwater plans. Prior to 2002, there were no required elements for groundwater plans.

Critically Overdrafted Groundwater Basins

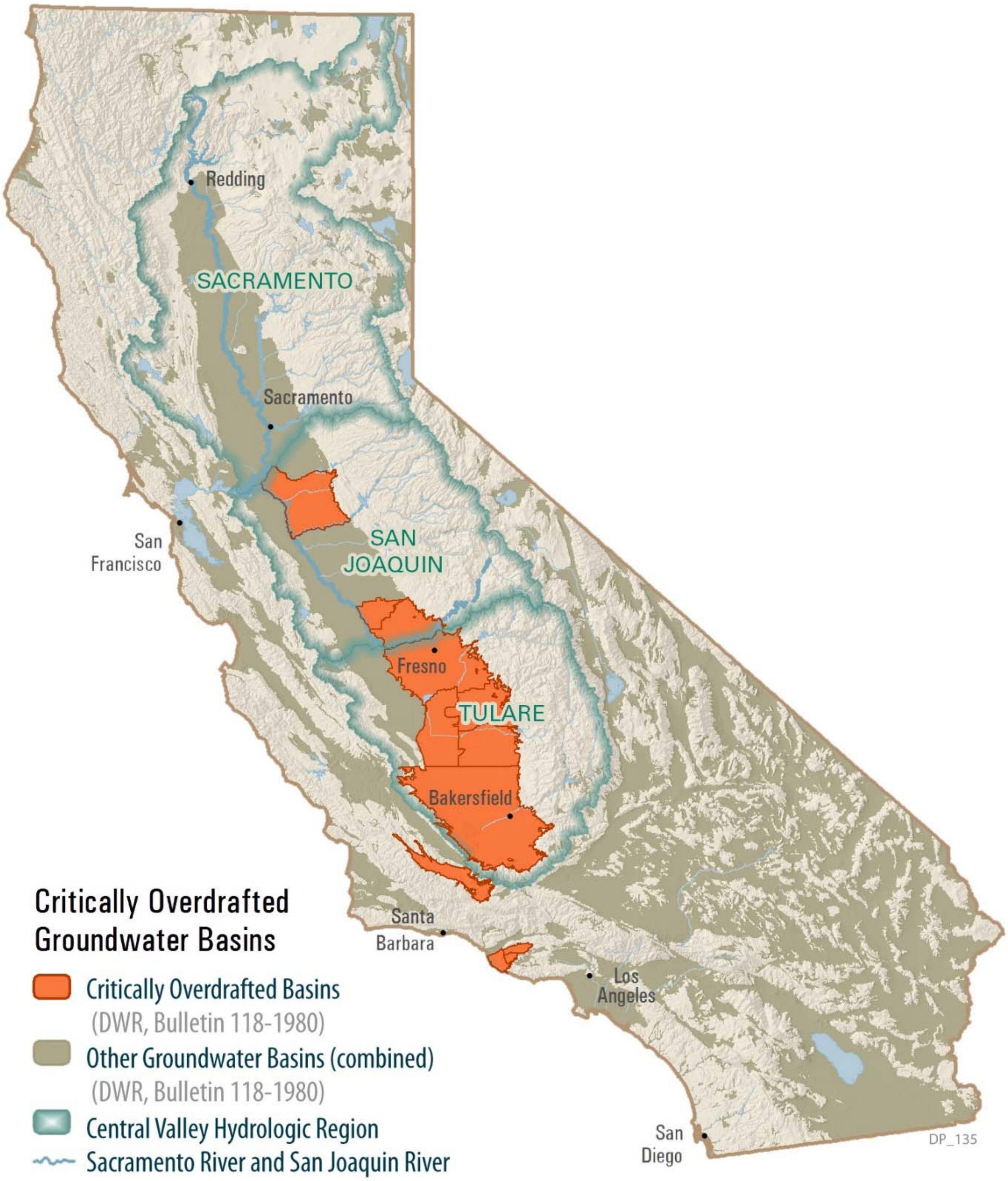

Figure 3-9 Groundwater overdraft is a critical water supply problem, especially in the Central Valley. More than 40 percent of Californians rely on groundwater for some portion of their supply, and many small- and moderate-sized communities are entirely dependent on groundwater for drinking water.

Sources: DWR 2003a; DWR 2009

San Joaquin Groundwater Pumping Is Unsustainable

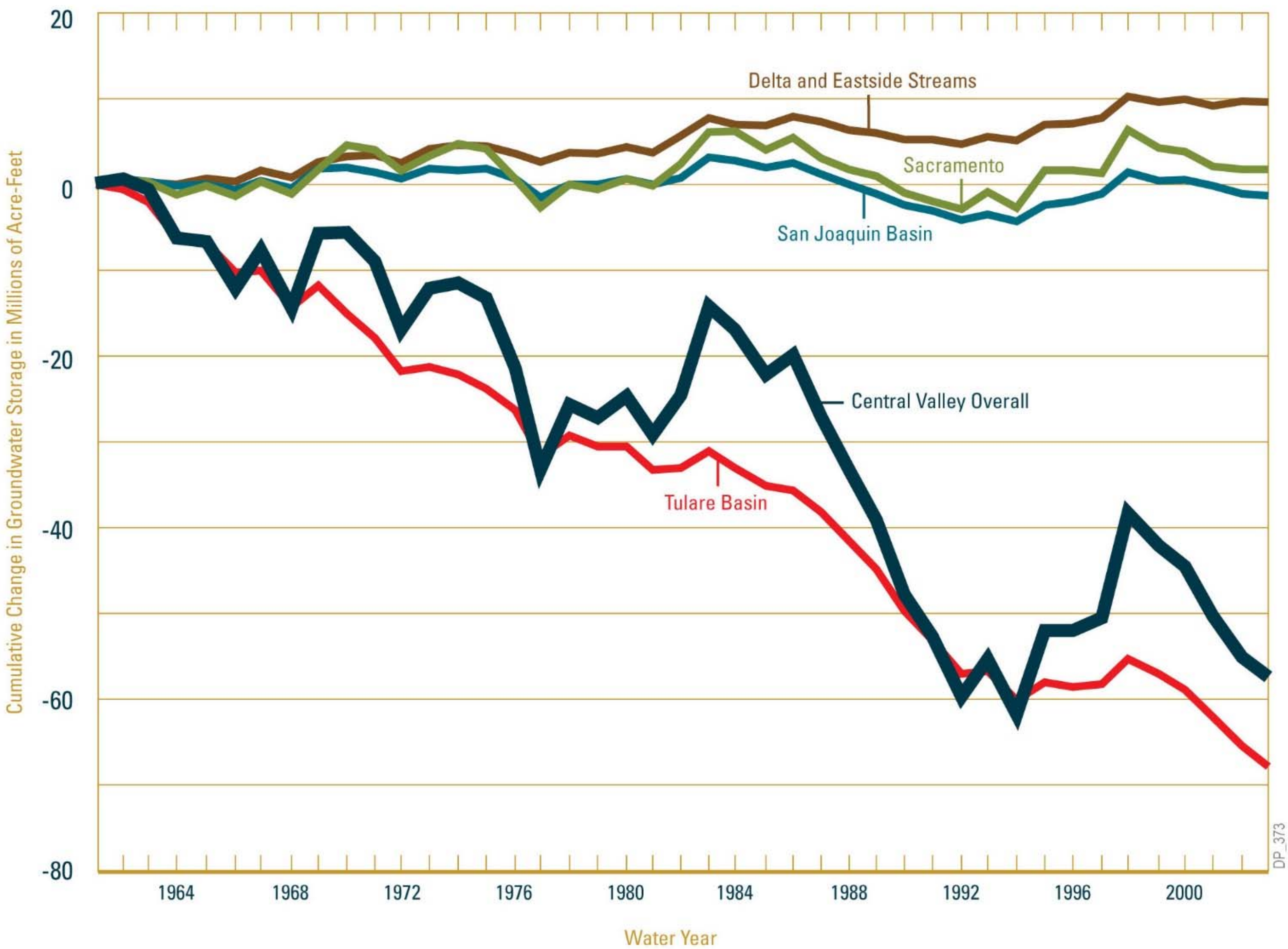

Figure 3-10 Estimated cumulative annual changes in groundwater storage in the Tulare Lake Basin due to over-pumping are more than 60 MAF since 1960. Serious land subsidence and loss of groundwater storage capacity impacts more than half of this region.

Source: Faunt 2009

GROUNDWATER AND DROUGHT

As demonstrated during California's recent drought, heavy reliance on groundwater can lead to groundwater overdraft, subsidence due to falling groundwater levels, and loss of access to groundwater in some communities. Extraction of groundwater in the Central Valley region, in particular, has reduced both the groundwater level and underground storage capacity due to subsidence (Famiglietti et al. 2011; Weiler 2014).

Groundwater pumping in the Central Valley during the drought was estimated to be about five million acre-feet (MAF) in 2014 and about six MAF in 2015 (Howitt et al. 2015). Conjunctive management of surface and groundwater supplies, including passive and active groundwater recharge and in-lieu recharge, is an important tool for sustainable groundwater management (Fournier et al. 2016). "In-lieu recharge" is the process of decreasing the amount of groundwater pumped from an aquifer in combination with a proportional increase in surface water deliveries or recycled water deliveries. Decreased groundwater pumping allows the aquifer to naturally recharge and be available for use during dry years.

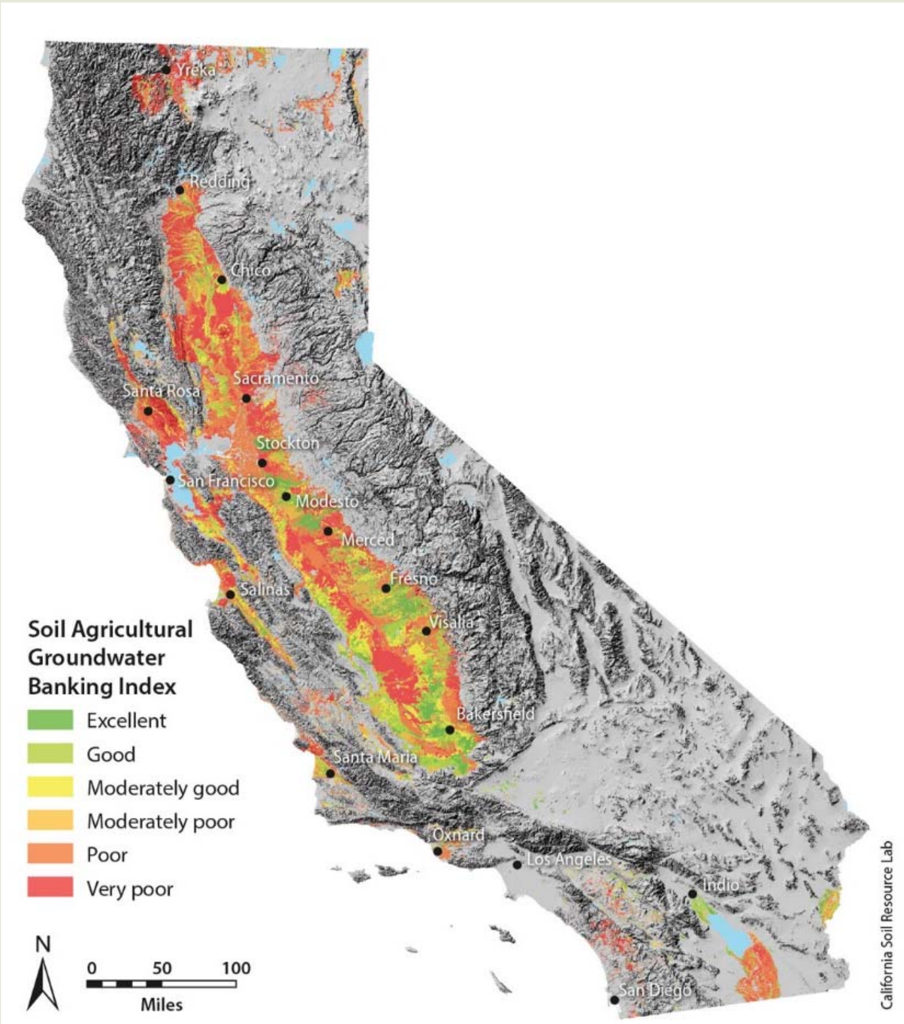

Figure 3-11 **Soil Agricultural Groundwater Banking Index Identifying Potential Areas for Groundwater Banking on Agricultural Lands**

Source: Green, A.T. et al. 2015. California Agriculture. Soil suitability index identifies potential areas for groundwater banking on agricultural lands. Available at: http://ucanr.edu/repositoryfiles/cav6902p75-157818.pdf

Recent estimates of water available for replenishment of groundwater demonstrate that some surface water may be available for replenishment in each of the state's hydrologic regions and many of the planning areas, especially during relatively high flow events (California Department of Water Resources (DWR) 2017). Improvements to conveyance, system storage, and the operations of both can support conjunctive management and contribute to sustainable groundwater management in many areas of the state.

Informed Decision Making Requires Information

One of the greatest challenges to California water management is the lack of consistent, comprehensive, and accurate estimates of actual water use by the type of use (agricultural, urban, and environmental) and by hydrologic region. The water use that is reported to the State is a combination of measured uses and estimated use that are not measured, with limited verification of actual water use. This means that California does not have a clear understanding of its water demands, the amount of water available to meet those demands, how water is being managed, and how that management can be improved to achieve the coequal goals for the Delta.

Key concerns include:

- Not all water uses are required to be monitored and measured. Many water rights were issued decades ago when water measurement was not required. Until reforms were approved by the California Legislature in 2009, water rights holders were not required to provide detailed information on water diversions and use. As a result, total diversion amounts are currently unknown and may be over-allocated in some locations or during dry periods (SWRCB 2008, SWRCB 2011, NRC 2012). Similarly, many groundwater withdrawals are not monitored or reported.
- Not all water users report data even when they are required to do so. A 2009 report prepared for the Legislature by the SWRCB on the development of a coordinated measurement database indicated that historically, about 67 percent of water permit and license holders actually report their water use information, and fewer than 35 percent of other water right claimants who are required to report actually do so (SWRCB 2009).
- SWP contractors are not required by DWR to provide data similar to that collected by Reclamation for CVP contractors. Reclamation has established best management practices for water efficiency, consistent with the federal Reclamation Reform Act and the Central Valley Project Improvement Act, and performs a "Water Needs Assessment" for each federal contractor with input from that contractor. Reclamation also requires contractors to submit an annual report that includes a full water balance (production from all sources, system losses, and changes in storage and water), and implement an effective water conservation and efficiency program based on the contractor's approved water conservation plan (Reclamation 2011b).
- SWP contract amendments in the past have not always been developed and approved in a transparent manner, and have resulted in litigation over implications for the management of the state's water supplies. In 2003, as part of a legal settlement, DWR adopted policies for how future contracts and contract amendments would be reviewed and adopted through an open and transparent process (DWR 2003b). Consistent application of this policy is important (see Appendix B).
- More detailed information on changes in groundwater levels, rates of groundwater extraction, and the location of basins with severe and chronic overdraft is needed as a baseline for the State's water resource management efforts. Basic groundwater management data (estimates of safe yield, monitoring of changes in storage in the aquifers and water quality conditions, and identification of replenishment sources and connections with surface water supplies) need to be quantified for many areas, but especially in those regions that rely upon water from the Delta watershed (DWR 2003a). The State's goal should be to sustainably maintain and maximize long-term reliability of these groundwater supplies, with a focus on preventing significant degradation of groundwater quality (DWR 2003a, ACWA 2011).

Recent legislation has resulted in significant improvements to the State's water monitoring and reporting requirements. However, time and resources will be necessary to assess the results from these improvements, which will also serve to inform future Delta Plan updates. For example, recently enacted provisions are now being implemented for:

- Groundwater monitoring (Water Code section 10920 et seq.)
- In-Delta and statewide water diversion reporting (Water Code section 5100 et seq.)
- In-Delta enforcement investigations under the authority of the Delta Watermaster (Water Code section 85230)
- Compliance with the State's goal of achieving a 20 percent reduction in statewide urban per capita water use by 2020 (Water Code section 10608 et seq.)
- Improved reporting on agricultural water use efficiency measures (Water Code section 10608 et seq. and 10800 et seq.)

In late 2010, the SWRCB also adopted regulations requiring online reporting of water use by all water rights holders, including appropriative, riparian, and pre-1914 surface water users, and groundwater users. Since 2008, DWR, SWRCB, and the California Department of Public Health have been working to develop a coordinated database to track the urban and agricultural water use data that are provided to each agency. This tool is central to the development of a statewide integrated system for streamlined data collection and analysis that will support improved water management in California.

POLICIES AND RECOMMENDATIONS

Policies and recommendations for providing a more reliable water supply for California are based on four core strategies:

- Increase water conservation and expand local and regional supplies
- Improve groundwater management
- Improve conveyance and expand storage
- Improve water management information

Increase Water Conservation and Expand Local and Regional Supplies

Approximately 84 percent of California's water supplies come from local and regional sources, including surface runoff, groundwater, recycled water, and water made available through advanced treatment. Improved management of these resources, including water conservation and efficiency, is central to the state's ability to better match its demands to the amount of supply that is available. Over the next 30 years, the *California Water Plan Update 2009* estimates that, with the use of existing technology, the state can reduce its demands and increase its water supplies in the range of 5 to 10 MAF. This is more than enough water to meet California's projected water demands beyond 2050 and to sustain its economic vitality.

The State's constitutional principle of reasonable use and the Public Trust Doctrine form the legal foundation for California's water management policies. Importantly, along with the coequal goals, the Delta Reform Act also established a new policy for California of reducing reliance on the Delta and improving regional self-reliance in meeting California's future water supply needs. The Delta Reform Act mandates many strategies that the Delta Plan must address to improve water supply reliability for California including water efficiency and conservation, wastewater reclamation and recycling, desalination and advanced water treatment technologies, improved water conveyance, surface and groundwater storage, improved water quality, and implementation of local and regional water supply projects and coordination (see Water Code sections 85004(b), 85020(d) and (f), 85201, 85023, 85303, and 85304).

An assessment of future water supply reliability is now required in urban water management and agricultural water management plans, as well as in voluntary regional water planning documents known as IRWMPs. In areas that rely upon water from the Delta watershed, water suppliers will need to identify, evaluate, and implement locally cost-effective and technologically feasible measures that reduce their reliance on the Delta and improve regional self-reliance.

Problem Statement

The lack of participation by some water suppliers throughout California to implement laws, programs, and projects that improve water efficiency, expand local and regional water supplies, and reduce reliance on the Delta and the Delta watershed contributes to higher water demands, less water supply to meet these demands, greater pressure on the Delta ecosystem for its water, and more vulnerability to the impacts of climate change and catastrophic events. Given the Delta Reform Act mandates to improve water supply reliability for California, reduce reliance on the Delta, and improve regional self-reliance, at a minimum, all water suppliers should demonstrate full compliance with State water efficiency and management laws, goals, and regulations to demonstrate reasonable and beneficial use of the state's water resources. California's success in achieving the policy of reduced reliance on the Delta and improving regional self-reliance will be demonstrated through a significant reduction in the amount of water used or in the percentage of water used from the Delta watershed. See Appendix G for additional information regarding how to achieve reduced reliance on the Delta and improved regional self-reliance.

Policies

WR P1. Reduce Reliance on the Delta through Improved Regional Water Self-Reliance

(a) *Water shall not be exported from, transferred through, or used in the Delta if all of the following apply:*

(1) One or more water suppliers that would receive water as a result of the export, transfer, or use have failed to adequately contribute to reduced reliance on the Delta and improved regional self-reliance consistent with all of the requirements listed in paragraph (1) of subsection (c);

(2) That failure has significantly caused the need for the export, transfer, or use; and

(3) The export, transfer, or use would have a significant adverse environmental impact in the Delta.

(b) For purposes of Water Code section 85057.5(a)(3) and section 5001(j)(1)(E) of this Chapter, this policy covers a proposed action to export water from, transfer water through, or use water in the Delta, but does not cover any such action unless one or more water suppliers would receive water as a result of the proposed action.

(c) (1) Water suppliers that have done all of the following are contributing to reduced reliance on the Delta and improved regional self-reliance and are therefore consistent with this policy:

(A) Completed a current Urban or Agricultural Water Management Plan (Plan) which has been reviewed by the California Department of Water Resources for compliance with the applicable requirements of Water Code Division 6, Parts 2.55, 2.6, and 2.8;

(B) Identified, evaluated, and commenced implementation, consistent with the implementation schedule set forth in the Plan, of all programs and projects included in the Plan that are locally cost effective and technically feasible which reduce reliance on the Delta; and

(C) Included in the Plan, commencing in 2015, the expected outcome for measurable reduction in Delta reliance and improvement in regional self-reliance. The expected outcome for measurable reduction in Delta reliance and improvement in regional self-reliance shall be reported in the Plan as the reduction in the amount of water used, or in the percentage of water used, from the Delta watershed. For the purposes of reporting, water efficiency is considered a new source of water supply, consistent with Water Code section 1011(a).

(2) Programs and projects that reduce reliance could include, but are not limited to, improvements in water use efficiency, water recycling, stormwater capture and use, advanced water technologies, conjunctive use projects, local and regional water supply and storage projects, and improved regional coordination of local and regional water supply efforts.

23 CCR Section 5003
NOTE: Authority cited: Section 85210(i), Water Code.
Reference: Sections 10608, 10610.2, 10610.4, 10801, 10802, 85001(c), 85004(b), 85020(a), 85020(d), 85020(h), 85021, 85022(d)(1), 85022(d)(5), 85023, 85054, 85300, 85302(d), 85303, and 85304, Water Code.

Recommendations

WR R1. Implement Water Efficiency and Water Management Planning Laws

All water suppliers should fully implement applicable water efficiency and water management laws, including urban water management plans (Water Code section 10610 et seq.); the 20 percent reduction in state-wide urban per capita water usage by 2020 (Water Code section 10608 et seq.); agricultural water management plans (Water Code section 10608 et seq. and 10800 et seq.); and other applicable water laws, regulations, or rules.

WR R2. Require SWP Contractors to Implement Water Efficiency and Water Management Laws

The California Department of Water Resources should include a provision in all State Water Project contracts, contract amendments, contract renewals, and water transfer agreements that requires the implementation of all State water efficiency and water management laws, goals, and regulations, including compliance with Water Code section 85021.

WR R3. Compliance with Reasonable and Beneficial Use

The State Water Resources Control Board should evaluate all applications and petitions for a new water right or a new or changed point of diversion, place of use, or purpose of use that would result in new or increased long-term average use of water from the Delta watershed for consistency with the constitutional principle of reasonable and beneficial use. The State Water Resources Control Board should conduct its evaluation consistent with Water Code sections 85021, 85023, 85031, and other provisions of California law. An applicant or petitioner should submit to the State Water Resources Control

Board sufficient information to support findings of consistency, including, as applicable, its urban water management plan, agricultural water management plan, and environmental documents prepared pursuant to the California Environmental Quality Act.

WR R4. Expanded Water Supply Reliability Element

Water suppliers that receive water from the Delta watershed should include an expanded water supply reliability element, starting in 2015, as part of the update of an urban water management plan, agricultural water management plan, integrated water management plan, or other plan that provides equivalent information about the supplier's planned investments in water conservation and water supply development. The expanded water supply reliability element should detail how water suppliers are reducing reliance on the Delta and improving regional self-reliance consistent with Water Code section 85201 through investments in local and regional programs and projects, and should document the expected outcome for a measurable reduction in reliance on the Delta and improvement in regional self-reliance. At a minimum, these plans should include a plan for possible interruption of water supplies for up to 36 months due to catastrophic events impacting the Delta, evaluation of the regional water balance, a climate change vulnerability assessment, and an evaluation of the extent to which the supplier's rate structure promotes and sustains efficient water use.

WR R5. Develop Water Supply Reliability Element Guidelines

The California Department of Water Resources, in consultation with the Delta Stewardship Council, the State Water Resources Control Board, and others, should develop and approve, by December 31, 2014, guidelines for the preparation of a water supply reliability element so that water suppliers can begin implementation of WR R4 by 2015.

WR R6. Update Water Efficiency Goals

The California Department of Water Resources and the State Water Resources Control Board should establish an advisory group with other State agencies and stakeholders to identify and implement measures to reduce impediments to achievement of statewide water conservation, recycled water, and stormwater goals by 2014. This group should evaluate and recommend updated goals for additional water efficiency and water resource development by 2018. Issues such as water distribution system leakage should be addressed. Evaluation should include an assessment of how regions are achieving their proportional share of these goals.

WR R7. Revise State Grant and Loan Priorities

The California Department of Water Resources, the State Water Resources Control Board, the California Department of Public Health, and other agencies, in consultation with the Delta Stewardship Council, should revise State grant and loan ranking criteria by December 31, 2013, to be consistent with Water Code section 85021 and to provide a priority for water suppliers that includes an expanded water supply reliability element in their adopted urban water management plans, agricultural water management plans, and/or integrated regional water management plans.

WR R8. Demonstrate State Leadership

All State agencies should take a leadership role in designing new and retrofitted State-owned and -leased facilities, including buildings and California Department of Transportation facilities, to increase water efficiency, use recycled water, and incorporate stormwater runoff capture and low-impact development strategies.

Improve Groundwater Management

Groundwater is the source, on average, of 20 percent of California's urban and agricultural water supplies. The state's most significant groundwater use occurs in regions that also rely upon water from the Delta watershed. In many of these groundwater basins, more water is pumped than is recharged, and groundwater levels are declining over the long term. The *California Water Plan Update 2009* estimates that the state, on average, overdrafts its groundwater basins by about 1 to 2 MAF per year and that the level of unsustainable groundwater pumping is increasing.

Problem Statement

The continued existence of major California groundwater basins in a chronic condition of overdraft combined with key regions of the state that depend on water from the Delta watershed and have poor groundwater practices, including unsustainable groundwater pumping, water quality contamination, irreversible loss of groundwater storage, and no groundwater plan for addressing *these problems, is a major impediment to the achievement of the coequal goals.*

Policies

No policies with regulatory effect are included in this section.

Recommendations

WR R9. Update Bulletin 118, California's Groundwater Plan

The California Department of Water Resources, in consultation with the Bureau of Reclamation, U.S. Geological Survey, the State Water Resources Control Board, and other agencies and stakeholders, should update Bulletin 118 information using field data, California Statewide Groundwater Elevation Monitoring (CASGEM), groundwater agency reports, satellite imagery, and other best available science by December 31, 2014, so that this information can be included in the next California Water Plan Update and be available for inclusion in 2015 urban water management plans and agricultural water management plans. The Bulletin 118 update should include a systematic evaluation of major groundwater basins to determine sustainable yield and overdraft status; a projection of California's groundwater resources in 20 years if current groundwater management trends remain unchanged; anticipated impacts of climate change on surface water and groundwater resources; and recommendations for State, federal, and local actions to improve groundwater management. In addition, the Bulletin 118 update should identify groundwater basins that are in a critical condition of overdraft.

WR R10. Implement Groundwater Management Plans in Areas that Receive Water from the Delta Watershed

Water suppliers that receive water from the Delta watershed and that obtain a significant percentage of their long-term average water supplies from groundwater sources should develop and implement sustainable groundwater management plans that are consistent with both the required and recommended components of local groundwater management plans identified by the California Department of Water Resources Bulletin 118 (Update 2003) by December 31, 2014.

WR R11. Recover and Manage Critically Overdrafted Groundwater Basins

Local and regional agencies in groundwater basins that have been identified by the California Department of Water Resources as being in a critical condition of overdraft should develop and implement a sustainable groundwater management plan, consistent with both the required and recommended components of local groundwater management plans identified by the California Department of Water Resources Bulletin 118 (Update 2003), by December 31, 2014. If local or regional agencies fail to develop and implement these plans, the State Water Resources Control Board should take action to determine if the continued overuse of a groundwater basin constitutes a violation of the State's Constitution Article X, Section 2, prohibition on unreasonable use of water and whether a groundwater adjudication is necessary to prevent the destruction of or irreparable injury to the quality of the groundwater, consistent with Water Code sections 2100 and 2101.

Improve Conveyance, Expand Storage, and Improve the Operation of Both

The greatest conflicts between the water needs of people and fish within the Delta occur during dry years. That is when the least amount of water is flowing into the Delta and, historically, when exports have been a much larger percentage of Delta inflows compared with wet years. The timing and pattern of Delta diversions must be shifted so that more water can be exported during wet years, when there is significantly more water available for diversion, and less is taken in dry years, when the water is needed for in-Delta water quality and ecosystem protections.

The ability to export larger amounts of water from the Delta during wet years will require improved conveyance to increase operational flexibility as well as more storage both north and south of the Delta so that this water can be captured, stored, and ultimately delivered to meet the water needs of both people and fish. With these improvements, Delta operations and, importantly, Delta export deliveries will become more predictable.

As an interim step toward increasing California's water supply reliability, the State should identify, prioritize, and implement smaller and more incremental operational, conveyance, and storage improvements (such as expanding existing facilities or constructing new ones) that can be accomplished quickly, preferably within the next 5 to 10 years.

With regard to new and improved infrastructure—relating to water conveyance in the Delta, water storage systems, and the operation of both to achieve the coequal goals—the Delta Plan promotes the design, implementation, and operation of new and improved water conveyance infrastructure and new or expanded water storage that are consistent with the criteria in the recommendations below. To develop a robust water management system that provides flexibility to adapt to changing conditions, conveyance should be integrated and operated in tandem with enhanced water storage in the Delta watershed and the Delta export area to optimally achieve the coequal goals while protecting and enhancing the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place. These recommendations contain a suite of actions to be collectively pursued in an integrated manner with existing Delta Plan policies and recommendations. All promoted options should be managed so Delta water supplies further the coequal goals and incorporate the best currently available science and adaptive management. Further, Delta Plan performance measures can assist the Council in tracking progress in meeting its objectives, including those related to conveyance, storage systems, and the operation of both.

Problem Statement

The state's interconnected network of surface and groundwater storage is insufficient in volume, conveyance capacity, and flexibility to achieve the coequal goals. The implementation of major new Delta conveyance improvements and surface and groundwater storage facilities are needed but may take many years to implement, which will require more near-term actions to improve Delta operations and reduce the state's vulnerability to potential disruptions in water exports from the Delta due to floods and earthquakes or the need for additional regulatory protections for the environment.

Policies

No policies with regulatory effect are included in this section. See Appendix A, The Delta Stewardship Council's Role Regarding Conveyance.

Recommendations

WR R12a. Promote Options for New and Improved Infrastructure Related to Water Conveyance

Subject to completion of environmental review and approval by the lead agency, and applicable regulatory approvals from other public agencies, the following infrastructure options are hereby promoted:

(1) The California Department of Water Resources (DWR) the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), and local beneficiary agencies should pursue a dual-conveyance option for the Delta. Dual conveyance is a combination of through-Delta conveyance and isolated conveyance to allow operational flexibility. Dual conveyance alternatives should be evaluated, and a selected plan designed and implemented, consistent with WR R12b, below. Dual conveyance should incorporate existing and new intakes and facility improvements for both isolated, below-ground conveyance and through-Delta conveyance of State Water Project (SWP) and Central Valley Project (CVP) water supplies from the Sacramento River to the south Delta, as follows:

(a) The isolated conveyance should incorporate one or more new screened intakes that protect native fish and that are operated to minimize harmful reverse flow conditions in Old and Middle rivers while maintaining water quality for in-Delta uses. Isolated conveyance should complement existing and improved through-Delta conveyance to promote operational flexibility, protect water quality, and support ecosystem restoration.

(b) To protect the Delta ecosystem, the State Water Resources Control Board should ensure that operational criteria for new and improved conveyance facilities comply with applicable State Water Resources Control Board requirements, including any flow criteria adopted pursuant to Water Code 85086(c)(2).

(c) Dual conveyance requires continued maintenance and further improvement of through-Delta conveyance. Through-Delta conveyance improvements may include channel improvements consistent with the Delta Plan and additional facilities that could provide for improved operations for native fish protection.

(2) DWR in collaboration with local beneficiary agencies should pursue new intake and conveyance facilities for conveying SWP supplies from the Sacramento River to SWP contractors in Solano and Napa Counties. This is both to protect native fish and improve the quality and reliability of water supplies delivered via the North Bay Aqueduct.

(3) Local agencies, in coordination with DWR and Reclamation, should pursue new conveyance facilities or conveyance facility improvements that allow use of multiple Delta intakes associated with the Los Vaqueros Project. This would increase operational flexibility for local, SWP, and CVP municipal and environmental water supplies conveyed from the south Delta.

(4) DWR, Reclamation, and local beneficiary agencies, in coordination with the California Department of Fish and Wildlife, National Marine Fisheries Service and U.S. Fish and Wildlife Service, should evaluate and identify for near-term implementation feasible actions to contribute to reducing fish losses associated with existing pumping operations at the Banks Pumping Plant and Jones Pumping Plant, consistent with the 2009 Biological Opinion and Conference Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan; the 2009 Biological Opinion on the Coordinated Operations of the Central Valley Project and State Water Project in California; and the 2014 Recovery Plan for Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. These actions may include, but are not limited to:

(a) Implementing changes to the operations and physical infrastructure of the facilities where such changes can improve fish screening and salvage operations and reduce mortality from entrainment and salvage.

(b) Evaluating and implementing effective predator control actions, such as fishery management or directed removal programs, for minimizing predation on juvenile salmon and steelhead in Clifton Court Forebay and in the primary channel at the Tracy Fish Collection Facility.

(c) Evaluating and implementing effective predation reduction actions associated with salvage operations, such as transporting and releasing fish in multiple locations in the Delta.

(d) Installing equipment to monitor for the presence of predators and to monitor flows at the fish collection facilities.

(e) Modifying Delta Cross Channel gate operations and evaluating methods to control access to Georgiana Slough and other migration routes into the interior Delta to reduce diversion of listed juvenile fish from the Sacramento River and the San Joaquin River into the southern or central Delta.

WR R12b. Evaluate, Design, and Implement New or Improved Conveyance or Diversion Facilities in the Delta

(1) In selecting new and improved Delta infrastructure for conveying SWP, CVP, and market transfer water supplies from the Sacramento River to the south Delta, project proponents should analyze and evaluate a range of alternatives including, but not limited to the following:

(a) A reasonable range of flow criteria, rates of diversion, and other operational criteria required to satisfy applicable requirements of State and federal fish and wildlife agencies and the State Water Resources Control Board, and other operational requirements and flows necessary for protecting, restoring, and enhancing the Delta ecosystem under a reasonable range of hydrologic conditions (as described under WR R12h, below). This includes identifying water available for export and other beneficial uses, consistent with water quality requirements of the State Water Resources Control Board.

(b) A reasonable range of dual-conveyance alternatives, including options for the number and location of new intakes, a range of isolated conveyance capacities, through-Delta conveyance improvements, and other facilities that could improve operations for native fish and in-Delta water quality, as applicable.

(c) The potential effects of climate change on the conveyance alternatives under consideration, including possible precipitation and runoff pattern changes, temperature, and sea level rise estimates consistent with guidance provided by the California Natural Resources Agency, National Research Council, or other appropriate projections.

(d) The potential effects on migratory fish and aquatic resources and habitats.

(e) The potential effects on Sacramento River and San Joaquin River flood management.

(f) The resilience and recovery of Delta conveyance alternatives to catastrophic failure caused by earthquake, flood or other natural disaster.

(g) The potential effects of each Delta conveyance alternative on Delta water quality, flows, and water levels, including the effects of these changes on in-Delta water users.

(h) The operational benefits and/or detriments of providing multiple intake locations.

(i) The potential short-term and long-term effects of each Delta conveyance alternative on terrestrial species.

(j) The potential effects of each Delta conveyance alternative on the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.

(k) The cost-effectiveness of the alternatives in furthering the coequal goals. Cost-effectiveness means the degree to which a project or action is effective in achieving desired outcomes in relation to its cost.

(2) Project proponents should design and implement new or improved conveyance infrastructure in the Delta consistent with the following parameters:

(a) Located in areas with seasonally favorable freshwater conditions, and areas that are less vulnerable to degradation during sustained droughts and under anticipated future climate change and sea level rise conditions.

(b) Located to avoid impacts to and, where possible, improve conditions for habitat restoration opportunities in priority restoration areas identified in the Delta Plan, and other important restoration opportunity areas identified by the California Department of Fish and Wildlife.

(c) Located, designed, and operated to minimize adverse conditions for native aquatic and terrestrial species, including but not limited to those conditions related to flow direction and water quality.

(d) Designed to avoid or minimize native fish entrainment and impingement.

(e) Designed to balance adverse project impacts against the project's long- and short-term benefits.

(f) Designed to minimize disruptions to transportation and business activities during routine maintenance activities, with consideration given to scheduling planned maintenance activities in consultation with local governments to minimize impacts to residents and businesses, and establishing communication protocols to notify residents of planned and unplanned maintenance activities.

(g) Designed to complement the Delta landscape and minimize aesthetic impacts, including visual impacts of spoils material stockpiles.

(h) Designed to maximize beneficial reuse of spoils materials to the extent practicable and feasible.

(i) Implemented in accordance with detailed project implementation plans developed in cooperation with affected communities, local governments, the Delta Protection Commission, and stakeholders to minimize and/or mitigate adverse environmental effects consistent with Delta Plan Policy GP 1, and avoid or reduce conflicts with existing or planned land uses consistent with Delta Plan Policy DP P2, and in consideration of Delta Plan recommendations DP R14, DP R16 and DP R17. Project implementation plans should consider and protect the unique character and historical importance of legacy communities, be consistent with the State's policy regarding the human right to water, and incorporate good neighbor policies to avoid negative impacts on agricultural lands, residents, and business. Items that should be addressed in the plans include, but are not limited to, the following:

i. Construction sequencing or phasing;

ii. Temporary and long-term spoils placement;

iii. Plans for temporary traffic routing that are consistent with local transportation plans, including consideration of permanent improvements to transportation and alternative transportation routes to avoid the most severe impacts to levels of service during construction;

iv. *Effects of construction activities on recreation and other visitor-related activities and businesses, including disruptions to transportation, temporary waterway closures, aesthetic and noise effects, and access to marinas, parks, and other recreation facilities;*

v. *Effects on local surface water and groundwater supplies during construction;*

vi. *Mechanisms for communicating with landowners, communities, and local governments before and during construction;*

vii. *Mechanisms by which community members and stakeholders can raise concerns during construction and in association with ongoing facility operations and maintenance; and*

viii. *Legally-permissible project delivery methods which are cost effective and provide for an expedited design and construction timeline that minimizes disruption to affected communities.*

WR R12c. Improve or Modify Through-Delta Conveyance

(1) Project proponents should design, implement, and adaptively manage improved or modified through-Delta conveyance and appurtenant facilities (such as gates, permanent barriers, or fish handling facilities) to:

(a) Substantially lessen or avoid impacts and provide net improvements to riparian habitat and channel margin habitat along anadromous fish migratory corridors and, where feasible, enhance conditions for native fish.

(b) Substantially lessen or avoid impediments and provide net improvements to anadromous fish migration.

(c) Substantially lessen or avoid impacts to public safety and include or contribute to levee improvements along Old and Middle Rivers consistent with Chapter 7 of the Delta Plan.

(d) Modify the conveyance capacity or hydraulic characteristics of existing Delta waterways (e.g., improving levees and/or dredging) in a manner that provides multiple benefits, including: taking advantage of periods when water flow and quality conditions are favorable for improving water supply delivery reliability, quality, and flexibility and for protecting, restoring, and enhancing the Delta ecosystem; improving floodplain values and functions; improving habitat conditions during fish migration; and reducing flood risks.

WR R12d. Promote Options for New or Expanded Water Storage

Subject to completion of environmental review and approval by the lead agency, and applicable regulatory approvals from other public agencies, options for new or expanded water storage are hereby promoted as follows:

(1) Within the Delta watershed, project proponents should design and operate new or expanded offstream or onstream surface water storage projects consistent with the criteria in WR R12h to:

(a) Provide water supply reliability , water quality, operational flexibility to adapt to changing conditions, and ecosystem benefits under variable hydrologic conditions, and, where possible, flood risk management benefits.

(b) Improve resilience to the effects of climate change, sea level rise, higher stream temperatures, long-term drought conditions, and emergency supply disruptions.

(c) Allow greater flexibility in storing water supplies during periods when more water is available for carryover into periods when less water is available and/or Delta exports are reduced.

(d) Take advantage of periods when the water flow, quality, and environmental requirements of State and federal agencies are being met, for improving water supply delivery reliability and flexibility and protecting, restoring, and enhancing the Delta ecosystem.

(e) Contribute to improved conjunctive management of both surface and groundwater resources to maximize efficient water use and contribute to sustainable management of groundwater basins, consistent with the Sustainable Groundwater Management Act.

(2) Within the Delta water export area, project proponents should implement new or expanded surface water storage projects that improve resilience to the effects of climate change and drought and are operated to allow storage of exported and local surface water supplied during wetter

periods for use during dryer periods when exports from the Delta are reduced. Opportunities to store stormwater and recycled water supplies of suitable quality should also be promoted as a strategy for improved regional water management and reduced reliance on the Delta. This includes projects in the San Francisco Bay Area, San Joaquin Valley, Central Coast region, and Southern California.

(3) Within the Delta watershed and Delta water export area, project proponents should implement groundwater storage and extraction projects, including facilities for groundwater withdrawal, recharge, injection, and monitoring that are consistent with the criteria in WR R12f, below.

(4) The State Water Resources Control Board should review and consider revisions to existing regulations to facilitate the safe use of recycled water, stormwater, and other local water supplies for groundwater replenishment.

WR R12e. Design, Construct and Implement New or Expanded Surface Water Storage

(1) Project proponents should design, implement, and adaptively manage new or expanded surface storage projects in the Delta, its watershed, and Delta water export areas to:

(a) Improve resilience of the State's water supply system through demonstration of benefits under current and anticipated future conditions, including climate change, changing water demands, and regulatory conditions.

(b) Contribute to regional self-reliance and reduced reliance on the Delta.

(c) Demonstrate contributions to the goals of the Sustainable Groundwater Management Act by promoting conjunctive use to achieve long-term groundwater basin sustainability.

(d) Enable participation in water exchanges and transfers that benefit the Delta ecosystem and improve regional water supply reliability.

(e) Demonstrate cost-effectiveness, where cost-effectiveness means the degree to which a project or action is effective in achieving desired outcomes in relation to its cost.

(f) Minimize and mitigate the impacts of storage on stream flows and water quality, including impacts during construction.

(2) Project proponents should design and implement new or expanded surface water storage projects in the Delta and Delta watershed, where feasible, to further achievement of the coequal goals by:

(a) Providing for the dedicated storage of water during wet periods for carry over and later use during dry periods, while balancing the benefits of providing more natural, functional flows to the Delta and its tributaries, meeting other ecosystem needs and providing flood risk management benefits.

(b) Enhancing water temperature management on Delta tributaries either directly or through coordinated operations with other facilities.

(c) Incorporating storage space dedicated to ecosystem benefits, such as flow management, water temperature, other water quality benefits, or providing water supplies to wildlife refuges.

(d) Integrating new and/or expanded storage with other existing or planned storage and conveyance systems to increase ecosystem and water supply benefits. This includes developing and/or updating coordinated operations plans, and/or agreements with other storage and conveyance systems.

(e) Contributing to the protection of water quality in the Delta and its watershed for all beneficial uses consistent with the State Water Resources Control Board's Bay-Delta Plan.

(f) Contributing to more natural, functional flows that support ecosystem health.

(3) Project proponents should design and implement, where feasible, new or expanded surface water storage projects outside the Delta watershed, but within the Delta water export area, such as projects within the San Joaquin Valley, Central Coast, or Southern California regions, to:

(a) Contribute to reduced reliance on the Delta and regional self-reliance and, particularly during dry periods, through storage of available water supplies during wet periods for use during dry periods.

(b) Promote conjunctive management of surface and groundwater resources, and contribute to achieving

groundwater sustainability goals established pursuant to the Sustainable Groundwater Management Act or applicable local plans, as appropriate.

(c) Contribute to a comprehensive, integrated water management approach that considers multiple water supply sources including, but not limited to, stream flow, groundwater, imported water, stormwater, and recycled water, as applicable.

WR R12f. Implement New or Expanded Groundwater Storage

(1) Funding, planning, and technical support provided by State and regional agencies for groundwater projects should:

(a) Promote multiple benefits, minimize harmful effects to the ecosystem, help achieve Bay-Delta Plan objectives, as applicable, and be consistent with guidance from the State Water Resources Control Board and DWR for implementing the Sustainable Groundwater Management Act.

(b) Promote increased groundwater recharge using locally available water, such as recharge via stream-aquifer interactions, floodwater or stormwater capture, recharge using recycled water, or others, provided such actions do not result in harmful impacts to functional flows in local streams.

(c) Promote conjunctive management of surface water and groundwater resources, including in-lieu recharge.

(d) Promote new or expanded groundwater banking and exchange projects.

(e) Promote the construction of new or improved local conveyance infrastructure to convey water to and from groundwater recharge and recovery facilities.

(f) Promote the construction of new or improved conveyance infrastructure that interconnects Delta export conveyance facilities with local conveyance facilities.

(g) Promote implementation of the Central Valley Salt and Nitrate Management Plan and achievement of management goals and priorities for protection of water quality, where appropriate.

(h) Promote wellhead treatment, access to conjunctively-managed surface supplies, or other means of providing access to safe, clean, and affordable water supplies for communities relying on impaired groundwater.

(i) Demonstrate consistency with applicable Groundwater Sustainability Plans under the Sustainable Groundwater Management Act.

(j) Include new infrastructure that is consistent with WR R12f (1)(a)-(c), above.

(k) Assess the ecosystem and water supply impacts and benefits to the Delta, including providing mitigation, as appropriate.

(l) Promote opportunities for storage of flood waters (e.g., floodplain storage) or stormwater that can be managed for groundwater recharge.

(2) DWR should develop a model ordinance for groundwater recharge that urges cities and counties to incorporate groundwater recharge and storage into land-use planning and zoning, and to protect areas with the highest potential for groundwater recharge from incompatible uses. (Note: A representative map showing the soil suitability index for groundwater banking projects on agricultural lands is shown in Figure 3-11.

(3) DWR or the State Water Resources Control Board should prepare a proposal for an incentive program, in coordination with the Department of Conservation or the U.S. Department of Agriculture's conservation programs, for landowners to protect lands with high groundwater recharge potential for the purpose of contributing to sustainable groundwater management.

WR R12g. Promote Options for Operations of Storage and Conveyance Facilities

Subject to completion of environmental review and approval by the lead agency, the following options for the operation of conveyance and storage are hereby promoted:

(1) DWR, in coordination with Reclamation, should develop a Drought Water Operations Strategy for the SWP and CVP to meet State Water Resources Control Board-specified flow and water quality criteria during extended drought conditions lasting up to six years, or for the extended timeframe recommended by the Real Time Drought Operations Team (RTDOT) describing opportunities and tools to improve routine operations to adapt to drought conditions. In developing the Strategy, DWR and

Reclamation should include criteria for defining appropriate levels or stages of drought affecting the SWP and CVP, in coordination with the RTDOT agencies and the North, Central, and South Delta Water Agencies. The Strategy should consider in-Delta actions and activities, and operations and storage of other facilities or projects that support achievement of the coequal goals. This strategy should be submitted to the Delta Stewardship Council by 2020 and be updated following future declarations of emergency associated with extreme hydrological conditions pursuant to the California Emergency Services Act (Government Code Sections 8550-8668), within one year of completing an After-Action Report, or when physical or regulatory changes necessitate an update.

(2) DWR and Reclamation should use an adaptive management approach, consistent with the Delta Plan's adaptive management framework and in alignment with existing collaborative adaptive management efforts, for the coordinated operation of SWP and CVP through-Delta conveyance to promote the coequal goals, including considerations for protecting, enhancing, and restoring the ecosystem and maintaining adequate flows, flow direction, water levels, and water quality for Delta agriculture, recreation, and communities.

(3) Lead agencies for new or modified conveyance facilities, and new and expanded storage facilities—including those options identified in WR R12a and WR R12d should develop operational plans consistent with WR R12h, below.

(4) To improve water management flexibility and to support coordinated operations with new storage facilities, local agencies—in coordination with DWR and Reclamation, as appropriate—should pursue the following new or improved conveyance facilities outside of the Delta, to reduce reliance on the Delta and promote regional self-reliance :

- *(a) Facilities that promote the movement or exchange of SWP, CVP, and local water supplies, such as between the east and west sides of the San Joaquin Valley or between other regions.*
- *(b) Facilities that improve groundwater recharge and/or conjunctive use in overdrafted aquifers of the San Joaquin Valley, Tulare Lake Basin, and other Delta water export areas.*
- *(c) Facilities that increase groundwater banking or exchange, or that promote increased use of stormwater, recycled water, desalinated water, or other local water supplies in regions tributary to, or that rely on, Delta water supplies.*

WR R12h. Operate Delta Water Management Facilities Using Adaptive Management Principles

(1) Project proponents should develop plans for the operation or reoperation of water conveyance and control facilities in the Delta, or new or modified storage facilities in the Delta and its watershed, that incorporate adaptive management consistent with the Delta Plan's adaptive management framework and further achievement of the coequal goals by:

- *(a) Including specific and measurable operating objectives (consistent with State Water Resources Control Board's Bay-Delta Plan objectives), that address:*
  - *i. Protection for and enhancements to the Delta ecosystem, including improved water temperature management, while reliably delivering water.*
  - *ii. Avoidance or mitigation of adverse effects on in-Delta recreation and in-Delta water quality, including identifying salinity targets for the south Delta that are designed to prevent severe water quality degradation and toxic events in dry and critically dry years.*
  - *iii. Avoidance or mitigation of adverse effects on stream flows and water quality.*
  - *iv. Avoid or mitigate adverse effects on agriculture in the Delta, including identifying salinity targets suitable for the types of crops grown in the Delta.*
  - *v. Protection of the quality, reliability, and affordability of water supplies for communities relying on impaired water supplies, including disadvantaged communities, consistent with California Water Code section 106.3.*
- *(b) Enabling diversions during periods when Delta water flow, quality, and environmental requirements are being met for improving water supply delivery reliability and flexibility to changing conditions, and for protecting, restoring, and enhancing the Delta ecosystem.*

(c) Incorporating adaptive management plans, consistent with the Delta Plan's adaptive management framework and developed in coordination with operators and applicable regulatory agency staff, for modifying operations to meet State Water Resources Control Board flow and water quality requirements, and California Department of Fish and Wildlife conservation and recovery goals, under the following:

i. Extended drought conditions (more than three years in duration).

ii. Changed climate conditions including sea level rise and changed hydrologic conditions over the anticipated project life.

iii. Extreme wet years and flood events.

(d) Demonstrating that projects can contribute to a more reliable water supply, and can protect, restore, and enhance the Delta ecosystem under a range of future conditions, including changing climate and sea level rise projections from the California Natural Resources Agency or National Research Council, or other appropriate projections.

(e) Evaluating the applicability of forecast-informed reservoir operations.

(f) Considering coordination and integration of operations with existing and/or planned conveyance and water storage facilities to maximize their potential to contribute to the goals of the Sustainable Groundwater Management Act, and the goals of other applicable programs and plans related to sustainable groundwater, stormwater, and floodwater management.

(g) Reviewing and updating, as needed, the flood space reservation guidelines for upstream reservoirs in coordination with the U.S. Army Corps of Engineers and reservoir owners or operators.

(2) Project proponents should develop operation plans for new water conveyance facilities in the Delta, and new or expanded storage facilities in the Delta watershed, that:

(a) Ensure that operations are adequately monitored, evaluated, and revised using adaptive management to make progress towards achieving defined performance measures.

(b) Be based upon accurate, timely, and transparent water accounting and budgeting.

(c) Ensure that operations provide water levels, water flow, and water quality suitable for in-Delta agricultural and recreational uses.

WR R12i. Update the Bay-Delta Plan and Consider Drought

(1) In developing and implementing updates to the Bay-Delta Plan, and flow requirements for priority tributaries to the Delta to protect beneficial uses in the Bay-Delta watershed, the State Water Resources Control Board should:

(a) Consider and contribute to achievement of applicable Delta Plan performance measures.

(b) Require water diverters in the Delta and its watershed that are responsible for meeting Bay-Delta Plan requirements, including but not limited to DWR and Reclamation, to develop a process and plan for meeting applicable flow and water quality requirements during extended drought conditions (characterized by multiple, successive dry years) to further the coequal goals and minimize reliance on temporary urgency change petitions and related requests.

WR R12j. Operate New or Improved Conveyance and Diversion Facilities Outside of the Delta

(1) Conveyance facilities outside the Delta should be operated in consideration of effects on Delta water quality, the timing and magnitude of flows in the Delta, water supplies available for export from the Delta, and effects on opportunities to protect, restore, and enhance the Delta ecosystem.

(2) In allocating funding for new water conveyance and conveyance improvement projects outside the Delta that support regional self-reliance, the State should give preference to projects that:

(a) Reduce reliance on the Delta for water supply during dry and critically dry years by the specific designation, in operational agreements or plans, of carryover storage for beneficial use during these periods.

(b) Improve conjunctive management of surface and groundwater resources and contribute to achieving groundwater sustainability goals established pursuant

to the Sustainable Groundwater Management Act or local plans, as appropriate.

- *(c) Support ecosystem enhancement and/or provide more natural, functional flows in the Delta and its tributaries.*
- *(d) Improve the ability of regions that rely on the Delta, for all or a portion of their water supplies, to withstand and adapt to changing current and future hydrologic conditions.*
- *(e) Improve the quality, reliability, and affordability of water supplies for communities relying on impaired water supplies, including disadvantaged communities, consistent with California Water Code section 106.3.*
- *(f) Contribute to a comprehensive, integrated water management approach that considers multiple water supply sources including, but not limited to, stream flow, groundwater, imported water, stormwater, desalinated water, water saved through increased efficiency, and recycled water, as applicable.*
- *(g) Improve flexibility to accommodate water market transfer and exchange opportunities that benefit the environment.*

WR R12k. Promote Water Operations Monitoring Data Management, and Data Transparency

In meeting the requirements of the 2016 Open and Transparent Water Data Act, DWR should coordinate with the Council to incorporate information related to Delta Plan performance measures and links to the Council's online tracking and reporting tools, as appropriate, in an effort to promote transparency and accessibility of data in tracking progress toward achieving the coequal goals.

WR R13. Complete Surface Water Storage Studies

The California Department of Water Resources should complete surface water storage investigations of proposed off-stream surface storage projects by December 31, 2012, including an evaluation of potential additional benefits of integrating operations of new storage with proposed Delta conveyance improvements, and recommend the critical projects that need to be implemented to expand the state's surface storage.

WR R14. Identify Near-term Opportunities for Storage, Use, and Water Transfer Projects

The California Department of Water Resources, in coordination with the California Water Commission, Bureau of Reclamation, State Water Resources Control Board, California Department of Public Health, the Delta Stewardship Council, and other agencies and stakeholders, should conduct a survey to identify projects throughout California that could be implemented within the next 5 to 10 years to expand existing surface and groundwater storage facilities, create new storage, improve operation of existing Delta conveyance facilities, and enhance opportunities for conjunctive use programs and water transfers in furtherance of the coequal goals. The California Water Commission should hold hearings and provide recommendations to the California Department of Water Resources on priority projects and funding.

WR R15. Improve Water Transfer Procedures

The California Department of Water Resources and the State Water Resources Control Board should work with stakeholders to identify and recommend measures to reduce procedural and administrative impediments to water transfers and protect water rights and environmental resources by December 31, 2016. These recommendations should include measures to address potential issues with recurring transfers of up to 1 year in duration and improved public notification for proposed water transfers.

Improved Water Management Information

One of the greatest challenges to improved management of California's water supplies is the lack of consistent, comprehensive, and accurate estimates of actual water use in the state, both by sector of use (agricultural, urban, and environmental) and by regions within the state. The sheer number of water management agencies in California is a key logistical factor. Current data reported to various State agencies is a combination of measured uses and estimated uses, with limited verification of actual water use. This means that California does not have a clear understanding of its water demands, the amount of water available to meet those demands, how water is being managed, and how that management can be improved to achieve the coequal goals.

Problem Statement

Accurate, timely, consistent, and transparent information on the management of California water supplies and beneficial uses is an important tool used in the achievement of the coequal goals. The State needs sufficient information to assess the current reliability of its water supplies or to meaningfully measure progress toward achievement of more reliable water supplies for California.

Policies

The appendices referred to in the policy language below are included in Appendix B of the Delta Plan.

WR P2. Transparency in Water Contracting

(a) The contracting process for water from the State Water Project and/or the Central Valley Project must be done in a publicly transparent manner consistent with applicable policies of the California Department of Water Resources and the Bureau of Reclamation referenced below.

(b) For purposes of Water Code section 85057.5(a)(3) and section 5001(j)(1)(E) of this Chapter, this policy covers the following:

(1) With regard to water from the State Water Project, a proposed action to enter into or amend a water supply or water transfer contract subject to California Department of Water Resources Guidelines 03-09 and/or 03-10 (each dated July 3, 2003), which are attached as Appendix 2A; and

(2) With regard to water from the Central Valley Project, a proposed action to enter into or amend a water supply or water transfer contract subject to section 226 of P.L. 97-293, as amended or section 3405(a)(2)(B) of the Central Valley Project Improvement Act, Title XXXIV of Public Law 102-575, as amended, which are attached as Appendix 2B, and Rules and Regulations promulgated by the Secretary of the Interior to implement these laws.

23 CCR Section 5004
NOTE: Authority cited: Section 85210(i), Water Code.
Reference: Sections 85020, 85021, 85300, and 85302, Water Code.

Recommendations

WR R16. Supplemental Water Use Reporting

The State Water Resources Control Board should require water rights holders submitting supplemental statements of water diversion and use or progress reports under their permits or licenses to report on the development and implementation of all water efficiency and water supply projects and on their net (consumptive) use.

WR R17. Integrated Statewide System for Water Use Reporting

The California Department of Water Resources, in coordination with the State Water Resources Control Board, California Department of Public Health, California Public Utilities Commission, California Energy Commission, Bureau of Reclamation, California Urban Water Conservation Council, and other stakeholders, should develop a coordinated statewide system for water use reporting. This system should incorporate recommendations for inclusion of data needed to better manage California's water resources. The system should be designed to simplify reporting; reduce the number of required reports where possible; be made available to the public online; and be integrated with the reporting requirements for the urban water management plans, agricultural water management plans, and integrated regional water management plans. Water suppliers that export water from, transfer water through, or use water in the Delta watershed should be full participants in the database.

WR R18. California Water Plan

The California Department of Water Resources, in consultation with the State Water Resources Control Board and other agencies and stakeholders, should evaluate and include in the next and all future California Water Plan updates information needed to track water supply reliability performance measures identified in the Delta Plan, including an assessment of water efficiency and new water supply development, regional water balances, improvements in regional self-reliance, reduced regional reliance on the Delta, and reliability of Delta exports, and an overall assessment of progress in achieving the coequal goals.

WR R19. Financial Needs Assessment

As part of the California Water Plan Update, the California Department of Water Resources should prepare an assessment of the state's water infrastructure. This should include the costs of rehabilitating/replacing existing *infrastructure, an assessment of the costs of new infrastructure, and an assessment of needed resources for monitoring and adaptive management for these projects. The California Department of Water Resources should also consider a survey of agencies that may be planning small-scale projects (such as storage or conveyance) that improve water supply reliability.*

Timeline for Implementing Policies and Recommendations

Figure 3-12 lays out a timeline for implementing the policies and recommendations described in the previous section. The timeline emphasizes near-term and intermediate-term actions.

TIMELINE CHAPTER 3: Reliable Water Supply

	ACTION (REFERENCE #)	LEAD AGENCY(IES)	NEAR TERM 2012–2017	INTERMEDIATE TERM 2017–2025
POLICIES	Reduce reliance on the Delta through improved regional water self-reliance (WR P1)	Water suppliers	●	●
	Transparency in water contracting (WR P2)		●	●
RECOMMENDATIONS	Implement water efficiency and water management planning laws (WR R1)	Water suppliers	●	●
	Require State Water Project contractors to implement water efficiency and water management laws (WR R2)	DWR	●	●
	Compliance with reasonable and beneficial use (WR R3)	SWRCB	●	●
	Expanded water supply reliability element (WR R4)	Water suppliers receiving Delta water	●	
	Develop water supply reliability element guidelines (WR R5)	DWR	●	
	Update water efficiency goals (WR R6)	DWR and SWRCB	●	●
	Revise State grant and loan priorities (WR R7)	DWR, SWRCB, and DPH	●	
	Demonstrate State leadership (WR R8)	State agencies	●	●
	Update Bulletin 118, California's Groundwater Plan (WR R9)	DWR	●	●
	Implement groundwater management plans in areas that receive water from the Delta watershed (WR R10)	Water suppliers receiving Delta water and uses groundwater	●	
	Recover and manage critically overdrafted groundwater basins (WR R11)	Local and regional agencies	●	●
	Promote options for conveyance, storage, and the operation of both (WR R12) (see Exhibit A Delta Plan Amendment for Conveyance, Storage Systems, and the Operation of Both)	Federal, State, and local agencies	●	●
	Complete surface water storage studies (WR R13)	DWR	●	
	Identify near-term opportunities for storage, use, and water transfer projects (WR R14)	DWR	●	
	Improve water transfer procedures (WR R15)	DWR	●	
	Supplemental water use reporting (WR R16)	SWRCB	●	
	Integrated statewide system for water use reporting (WR R17)	DWR	●	●
	California Water Plan (WR R18)	DWR	●	
	Financial needs assessment (WR R19)	DWR	●	●

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Agency Key:

Council: Delta Stewardship Council
DPH: California Department of Public Health
DWR: California Department of Water Resources
RWQCB: Regional Water Quality Control Board(s)
SWRCB: State Water Resources Control Board
Water suppliers: refers to both urban and agricultural water suppliers

Figure 3-12

Science and Information Needs

An improved understanding of the state's hydrologic systems, patterns of water use, and effects of climate change, especially within the Delta watershed and areas that receive water from the Delta, is essential to improving the management of California's water supplies to achieve the coequal goals. Key areas of needed research include:

- Improved projections for and measurement of surface water flows (amounts, timing, quality) and how they may be impacted by environmental regulations, changing land uses, and climate change
- Improved water supply and demand forecasting models that incorporate vulnerability to extreme events (droughts, floods, earthquakes) and account for the impacts of climate change
- Improved methods for downscaling climate change models (including dynamic downscaling) and improved models for water scenario planning that incorporates these data
- Improved information on effective watershed management actions to restore and enhance capacity of rural and urban landscapes to process stormwater for water quality and water supply benefits
- Improved models for assessing the interaction between water management scenarios in the Delta and ecosystem function, including implications of revised instream flow requirements on inflows to the Delta and revised wet year/dry year export scenarios
- Improved information on changing water use patterns in response to urban and agricultural water efficiency measures, including water pricing, and implications for future water demands
- Improved characterization of groundwater basins and subbasins, and improved estimates of groundwater supplies (amounts, quality)
- Improved models of aquifer and surface-groundwater relationships, which include the effects of climate change on evaporation, runoff, groundwater recharge, subsurface interactions, and the implications of these effects for safe yield and implementation of conjunctive use and water transfer programs

Issues for Future Evaluation and Coordination

Additional areas of interest and concern related to water supply and the Delta may deserve consideration in the development of future Delta Plan updates, including:

- **Delta water delivery predictability.** A Delta Delivery Predictability Index should be developed that depicts, by hydrologic year types, the estimated streamflows entering the Delta and suggested levels of water exports that would be consistent with in-Delta and ecosystem protections. As part of the index, a system for tracking the use of stored Delta water also should be developed. The index will lead to a better understanding of how water exported and stored during wet years would be available to urban and agricultural users during dry years to offset reduced exports. This information is key to better understanding how investments in new storage and improved conveyance contribute to improved reliability of California's water supplies.
- **Performance measures for reduced reliance on the Delta.** The Delta Plan identifies two core measures for assessing progress in reducing reliance on the Delta: (1) a significant reduction in the amount of water used from the Delta watershed, or (2) a significant reduction in the percentage of water used from the Delta watershed. The Council will collaborate with DWR, SWRCB, and stakeholders to develop a standardized method or methods by which progress to reduce reliance on the Delta and improve regional self-reliance should be reported (1) in the urban and agricultural water management plans; (2) in IRWMPs; and (3) in the California Water Plan. Potential additional measures should be identified and evaluated that will benefit the amount of water, quality of water, and timing of flows in and

through the Delta, and contribute to reduced reliance on the Delta and improving regional self-reliance consistent with Water Code section 85021.

- **Evaluation of urban and agricultural water management plans.** The Council will work with DWR and the State Legislature to identify resources and secure authority, if necessary, to conduct further evaluation of water management information contained in urban and agricultural water management plans. The goal of these actions is to improve knowledge about water management in California and, specifically, to facilitate the aggregation and evaluation of water management data over time to gauge success toward reducing reliance on the Delta, increasing regional self-reliance, and achieving the coequal goals.
- **Integrated water resource management.** The value of integrated regional water management planning is widely recognized, but information on how to implement effective integrated water management projects is not well understood. The number of conjunctive management programs that combine green urban design, flood control, stormwater infiltration, water conservation, recycled water, and groundwater elements are increasing. Information about the successful integration of water management infrastructure needs to be shared and consideration given as to how to effectively promote implementation of these integrated strategies.
- **Agricultural and urban water efficiency.** Improved demand management through urban and agricultural water conservation and efficiency is the fastest and least expensive strategy for making more water available to the Delta through inflows and reducing the pressure to export more water from the Delta. Additional best management practices should be identified and promoted, including evaluation of new water conservation-based rate structures and how they contribute to water savings while maintaining more stable revenue for water suppliers.
- **Delta Watermaster.** The Delta Watermaster is in the process of completing an assessment of potential illegal water diversions within the Delta. This assessment should be expanded to evaluate illegal water diversions throughout the Delta watershed.
- **Reoperation of upstream reservoirs.** DWR is working with USACE and other agencies to develop a coordinated proposal for the reoperation of reservoirs above the Delta to address the impacts of climate change on flood protection and water supply operations. This proposal should include consideration of improved watershed management actions that will also help attenuate flood flows as well as improve ecosystem functions and water supply availability.

Performance Measures

Development of informative and meaningful performance measures is a challenging task that will continue after adoption of the Delta Plan. Performance measures need to be designed to capture important trends and to address whether specific actions are producing expected results. Efforts to develop and track performance measures in complex and large-scale systems like the Delta are commonly multiple-year endeavors. The recommended output and outcome performance measures listed below are provided as examples and subject to refinement as time and resources allow. Final administrative performance measures are listed in Appendix E and will be tracked as soon as the Delta Plan is completed.

Output Performance Measures

- Water suppliers that receive water from the Delta watershed have documented the expected outcome for a measureable reduction in reliance on the Delta and improvement in regional self-reliance. (WR R1, WR R4)
- Progress made in achieving existing water conservation and water supply performance goals, and setting expanded future goals for local, regional, and statewide

water conservation, water use efficiency, and water supply development. (WR R6)

- Information in updated Bulletin 118 is included in the next (2013) California Water Plan Update and in the 2015 urban water management plans and agricultural water management plans. (WR R9)

Outcome Performance Measures

- Progress toward increasing local and regional water supplies, measured by the amount of additional supplies made available (reported in 5-year increments from 2000). (WR P1)
- Progress toward meeting California's conservation goal of achieving a 10 percent reduction in statewide urban per capita water usage by 2015 and a 20 percent reduction by 2020. (WR R1)
- Progress toward improved reliability of Delta water exports and reductions in the vulnerability of Delta exports to disruption. (WR R12, ER P1, RR P1)
- Progress toward increasing the predictability of water deliveries from the Delta in a variety of water year types. (WR R12, WR R14)
- Progress toward achieving California's goal for the increased use of stormwater runoff of at least 500,000 acre-feet per year by 2020 and by at least 1 MAF per year by 2030. (WR R6)

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