

Other Resource Management Strategies



A Resource Management Strategy of the California Water Plan

California Department of Water Resources

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Acronyms and Abbreviations

af	acre-foot, acre-feet
ASU	Arizona State University
CVP	Central Valley Project
CVPIA	1992 Central Valley Project Improvement Act
DWR	California Department of Water Resources
GHG	greenhouse gas
MWD	Metropolitan Water District of Southern California
PVID	Palo Verde Irrigation District
USBR	U.S. Bureau of Reclamation
WRP	Natural Resources Conservation Service's Wetlands Reserve Program
WWD	Westlands Water District

Other Resource Management Strategies

This narrative highlights a variety of water management strategies that can potentially generate benefits that meet one or more water management objectives, such as water supply augmentation or water quality enhancements. However, these management strategies have limited capacity to strategically address long-term regional water planning needs. These are unique strategies and do not fit into the other classified strategies. In some cases, such as dewvaporation, the strategy involves emerging technologies that will require more research and development. Other cases, such as crop idling and irrigated land retirement, involve voluntary and often temporary tradeoffs from one sector of use to another (i.e., agricultural to urban) that will likely be unpredictable and limited in scope. Finally, implementation of strategies, such as rainfed agriculture, will have limited applicability in California because of the variability and uncertainty of precipitation patterns from year to year.

The strategies discussed in this resource management strategy report are:

- Crop idling for water transfers.
- Dewvaporation or atmospheric pressure desalination.
- Fog collection.
- Irrigated land retirement.
- Rainfed agriculture.
- Snow fences.
- Waterbag transport/storage technology.

Crop Idling for Water Transfers

Crop idling is removing lands from irrigation with the aim of returning the lands to irrigation at a later time. Crop idling may be done once or can be episodic. Crop idling for water transfers is done to make the water that would have been used to grow a crop available for transfer (see the resource management strategy report, *Water Transfers*, for more information). If growers increase their irrigation efficiency and reduce the consumptive use of surface water applied for irrigation, then the volume of water saved can also be transferred under the category of cropland idling. Land retirement for water transfer and for solving drainage and drainage-related problems is discussed in the land retirement strategy later in this resource management strategy report. Crop idling, with the intent of soil and crop management and for soil and crop sustainability and productivity, is discussed in the resource management strategy report, *Agricultural Land Stewardship*.

Crop Idling Programs

Westlands Water District Lease-Back Program

The Westlands Water District (WWD) has implemented a lease-back land fallowing program for about 30,000 acres. These lands are expected to be returned to irrigation if the U.S. Bureau of Reclamation (USBR) provides drainage service to the lands.

Palo Verde Irrigation District Land Management, Crop Rotation, and Water Supply

Program

This crop idling program helps provide more reliable water supply for urban Southern California, while helping Palo Verde Irrigation District (PVID) farmers and the local economy. PVID's program includes crop idling of a predetermined duration. The principles of the proposed agreement followed a pilot program from 1992 to 1994. Under the pilot program, Metropolitan Water District of Southern California (MWD) compensated farmers for setting aside a portion of the land for two years in return for the water that otherwise would have been used to grow hay, cotton, or other field crops. Program participants reported spending 90 percent of the money on farm-related investments, purchases, and debt repayment.

Wetlands Reserve Program

The objective of the Natural Resources Conservation Service's Wetlands Reserve Program (WRP) is to preserve and enhance the nation's wetlands. Under the WRP, willing farmers sell long-term agricultural production easements to the federal government. Creating new wetlands under the WRP may result in improving the quality of drainage waters from irrigated lands, if that drainage flows through the wetlands.

Summer Alfalfa Dry-Down Research Program

Alfalfa summer dry-down is the practice of cutting off irrigation for one or two summer months and then reapplying water again in the fall when temperatures are cooler. The water saved during this period can be transferred to other uses. Summer cuttings have a low yield and quality. Early alfalfa production in desert regions used alfalfa summer dry-down to control weeds and conserve water. This episodic event/program is currently under research and development, and offers a unique tool for drought water management for several reasons. The program has potentially large water savings. It might save one acre-foot (af) per acre or 0.5 million af to 1 million af statewide, and net water savings can easily be verified. Water storage and transfer decisions can be made as late as June. Yield is generally reduced by only 20 to 40 percent, which diminishes the impact of crop idling on local communities. Research on alfalfa summer dry-down during the past 15 years has had mixed results, with crop loss being the major limitation.

Potential Benefits

Crop idling could enhance water supply reliability by making water available for redistribution, enhance water quality, and protect and restore fish and wildlife. The water made available from crop idling depends on how long irrigation is interrupted. The Palo Verde Irrigation District Land Management Program is expected to have an estimated annual water supply of 25-111,000 af for transfer to the MWD.

The crop idling program helps the farming community and urban areas by infusing money into the local economy while increasing the reliability of water supplies for urban consumers. Avoided costs of new water supply should also be considered in the cost-benefit analysis of crop idling. Payments to farmers would provide stable income that can be used on farm-related investments, purchases, and debt repayment, as well as for local community improvement programs.

Potential Costs

Costs include loss of crop productivity and the annual cost of managing the lands to avoid negative impacts. Additional costs can include program development, administration, and mitigation of local and regional socioeconomic impacts.

Major Implementation Issues

Socioeconomic Impacts

Loss of agricultural productivity and loss of revenue to the local communities and regional and statewide socioeconomic impacts are issues of concern. Crop idling can significantly change the local population's way of life. It can reduce local tax revenues and cause a loss of community businesses and farm-related jobs locally and regionally. The third-party impacts can be significant, especially when crop idling is concentrated in areas where the communities provide labor and other services. If there is a significant amount of idled land, it can also have a statewide impact on the economy, food production, and food security.

Environmental Impacts

Land use changes can affect neighboring land and its productivity. They can introduce new wildlife species, weeds, pests, and illegal refuse dumping. They can affect the disposition of water and water rights issues and alter such resources as soils, groundwater, surface waters, cultural resources, and recreation, as well as have adverse biological and environmental impacts that involve human health, dust, and air quality. In addition, agricultural communities inherently have a high percentage of low-income and disadvantaged groups that can be affected by crop idling. Endemic impacts of land use changes, land idling, and land retirement can be seen in the fluctuation of school attendance by farm workers' children and the use of food banks in farm communities. The cumulative effects of short- and long-term crop idling could have impacts on habitat, water quality, and wildlife caused by changing the location, timing, and/or quantity of applied water, as well as reducing agricultural return flows to wildlife areas. For example, rice growing areas could have significant secondary benefits as wildlife habitat. Crop idling in these areas could either harm or benefit different species, depending on the implementation.

Crop idling can also be inconsistent with statutory mandates. This is discussed below in the "Land Retirement" section.

Recommendations to Encourage Crop Idling Programs to Benefit Water Management Strategy

1. The agency or entity leading the crop idling program must begin consultation early with other agencies and develop the necessary coordination structure to satisfy the agency's policy requirements and avoid conflicts.
2. Study local community impacts and other third-party impacts and develop and implement the necessary actions for maintaining the economic stability of local communities and mitigation of socioeconomic impacts.

Dewvaporation or Atmospheric Pressure Desalination

Dewvaporation is a specific process of humidification-dehumidification desalination. Brackish water is evaporated by heated air, which deposits fresh water as dew on the opposite side of a heat transfer wall. The energy needed for evaporation is supplied by the energy released from dew formation. Heat sources can be combustible fuel, solar, or waste heat. One design is a tower unit built of thin plastic films to avoid corrosion and to minimize equipment costs. Towers are relatively inexpensive because they operate at atmospheric pressure.

The technology of dewvaporation is still being developed. Arizona State University (ASU) laboratories have built and operate final demonstration project towers. The Salt River Project and the ASU Office of Technology Collaborations and Licensing are sponsoring the dewvaporation pilot plant program as an extension of grassroots support by the USBR.

Potential Benefits

Dewvaporation can provide small amounts of water in remote locations. The basic laboratory test unit produces up to 150 gallons per day. Eight of these units produced 1,000 gallons per day in a demonstration pilot plant by using the dewvaporation process.

Areas such as Yuma, Arizona and California's desert regions could reclaim salt water at a relatively low cost by taking advantage of their dry climates via this process.

Potential Costs

The capital cost of a 1,000-gallon-per-day desalination plant ranges between \$1,100 and \$2,000. Operating costs range from \$0.80 to \$3.70 per 1,000 gallons distillate, or about \$260 to \$1,200 per af, depending on fuel source, humidity levels, and plant size.

Major Implementation Issues Facing Dewvaporation

The major issues facing dewvaporation are (1) cost and affordability, (2) small scale, and (3) concentrate disposal.

Fog Collection

Precipitation enhancement also includes other methods, such as physical structures or nets, to induce and collect precipitation.

Precipitation enhancement in the form of fog collection has not been used in California as a management technique. However, it occurs naturally with coastal vegetation. Fog provides an important portion of summer moisture to California's coastal redwoods.

Several years ago, Dr. Paul Ekern had success capturing measurable amounts of water from fog by using a louvered device with slats set vertically for rapid draining. Dr. Ekern is certain that the device or other devices are applicable to areas such as the California coast, where fog may be more frequent than actual rainfall (California Department of Water Resources 1981).

Potential Benefits

Globally, interest in fog collection for domestic water supply has been expressed by some who reside in dry areas near the ocean, where there is frequent fog. Experimental projects have been constructed in Chile. Some areas in the Middle East and South Africa are also considering this. The El Tofo project in Chile yielded about 10,600 liters per day from about 3,500 square meters of collection net, about 3 liters per day per square meter of net (Schemenauer and Puxbaum 2001). Like Chile, South Africa has many places that are ideal for fog collection. The average daily yields in South Africa range from 5 liters to 10 liters per square meter of collecting surface. Because of its relatively small production, fog collection is

limited to producing domestic or small community water where few other viable water sources are available (Dower 2002).

Potential Costs

The lowest cost for fog collection in Chile, where labor is much less expensive than in California, was about \$1.40 per 1,000 liters, or about \$1,750 per af.

Major Implementation Issue Facing Fog Collection

Water quality is important if the water is used for drinking. The collecting net should be monitored to identify any chemical or biological material and atmospheric deposition that may pose a health threat.

Irrigated Land Retirement

Irrigated land retirement is the practice of removing farmland from irrigated agriculture. Permanent land retirement is perpetual cessation of irrigating lands from agricultural production, which is done for water transfers or for solving drainage-related problems (see the resource management strategy report, *Water Transfers*, for more information). Crop idling, or land fallowing, for crop management and for soil and crop sustainability and productivity is discussed in the resource management strategy report, *Agricultural Land Stewardship*.

Central Valley Project Improvement Act Land Retirement Program

The 1992 Central Valley Project Improvement Act (CVPIA) authorized purchases of agricultural land and associated water rights and other property interests which receive Central Valley Project (CVP) water from willing sellers. The program is expected to retire about 100,000 acres of irrigated farmland (Land Retirement Technical Committee 1999).

The CVPIA Land Retirement Program applies to lands that:

- Would improve water conservation or improve the quality of an irrigation district's agricultural drainage water.
- Are no longer suitable for sustained agricultural production because of permanent damage resulting from severe agricultural-drainage water management problems, groundwater withdrawals, or other causes.

From 1993 to 2011, the CVPIA Land Retirement Program acquired 9,203 acres of land — the Tranquility Site in the Westlands Water District and the Atwell Island Site in the Tulare Basin. The USBR manages the Tranquility Site, and the U.S. Bureau of Land Management (BLM) manages the Atwell Island Site.

USBR's Settlement Agreements

About 3,000 acres of problem drainage lands in the WWD have been retired as a part of the *Britz v. U.S. Bureau of Reclamation* settlement. Also, 33,000 acres in the WWD are planned for retirement over a three-year period as part of the *Sumner-Peck v. U.S. Bureau of Reclamation* settlement. These lands have been permanently retired and the associated water allocation was given to the WWD under an agreement.

Potential Benefits

Land retirement could enhance water supply reliability by making water available for redistribution, enhance water quality, and protect and restore fish and wildlife resources. However, the result is the loss of agricultural lands. The total water made available by irrigated land retirement is potentially 2 to 3.5 af per year for each retired acre, assuming the lands receive their water allocation.

Permanent land retirement in problem drainage areas would improve water quality, specifically reducing the risk of selenium exposure to fish and wildlife. Permanent land retirement can reduce drainage volume annually by about 0.3-0.5 af per acre, reducing the costs associated with drainage disposal. Permanent retirement of lands also creates an opportunity to establish upland or other habitat for wildlife.

Land retirement reduces agricultural drainage volume from impaired farmland. Land retirement demonstration projects reduced agricultural drainage by more than 3,700 af in 2011 (U.S. Bureau of Reclamation 2011).

Potential Costs

Costs include the price of land and the annual cost of managing the land to avoid environmental impacts similar to the impacts of crop idling discussed above. Additional costs may include program development, administration, and mitigation of local and regional socioeconomic impacts.

Major Implementation Issues Facing Land Retirement

Finding Willing Participants

Land retirement is voluntary, and most farmers do not want to sell their land or abandon their way of life.

Growth Inducement of Land Retirement

Land retirement could result in urban growth if water from retired lands is made available to urban areas for development.

Socioeconomic Impacts

Loss of agricultural productivity and loss of revenue to the local communities and regional and statewide socioeconomic impacts are issues of concern. Land retirement can significantly change the local population's way of life. It can cause a decline in the local tax base and the loss of community businesses and farm-related jobs locally and regionally. The third-party impacts can be significant, especially when land retirement is concentrated in areas where the communities provide labor and other services. Endemic impacts of land use changes, land idling, and land retirement can be seen in the fluctuation of school attendance by farm workers' children and the use of food banks in such communities. If a significant amount of land is retired, it can also have a statewide impact on the economy, food production, and food security.

Environmental Impacts

Land use changes can affect neighboring land and its productivity. They can introduce new wildlife species, weeds, pests, and illegal refuse dumping. They can affect the disposition of water and water rights issues and alter such resources as soils, groundwater, surface waters, cultural resources, and

recreation, as well as have adverse biological and environmental impacts that involve human health, dust, and air quality. In addition, agricultural communities inherently have a high percentage of low-income and disadvantaged groups that can be affected by land retirement. Cumulative effects of land retirement could have impacts on habitat, water quality, and wildlife, caused by changing the location, timing, and quantity of applied water and reducing agricultural return flows to wildlife areas. Land retirement could either harm or benefit different species, depending on the specific land use change.

Inconsistency with Statutory Mandates

Land retirement can contradict the statutory mandates of the California Water Code that promote orderly and coordinated control, protection, conservation, development, and utilization of the state's water resources. The contradiction is rooted in the reallocation of water supply to other competing sectors of society when an existing use is eliminated to make that supply available. It can also be pointed out that land retirement is inconsistent with many State and federal policies that promote agriculture and the preservation of productive agricultural lands.

Recommendations to Facilitate Land Retirement Programs to Benefit Water Management

1. The agency or entity leading the land retirement program should begin early consultation with other interested agencies and develop the necessary coordination structure to satisfy the agency policy requirements and avoid conflicts.
2. The land purchase price should be fair and costs associated with the mitigation of all impacts should be considered in developing the program. Land retirement programs should be voluntary.
3. Since alternative land-use management scenarios may achieve similar objectives, alternatives to permanent retirement to achieve the same objectives should be considered in developing land retirement programs. Also, there is a need to assist local water agencies with using land retirement as appropriate for local conditions regarding state and local benefits. This may include voluntary integration of land fallowing with conjunctive use and water exchange and transfers. When retiring lands, the highest priority should be given to lands of poor quality, low productivity, and high trace element contents.
4. The lead agency should evaluate the growth-inducement impacts of the program and ensure that the urban area receiving the water made available by land retirement has exhausted all means of reasonable water conservation, does not incur growth as a result of the program, and will put the land being retired to reasonable and beneficial uses.
5. Study local community impacts and other third-party impacts and develop and implement the necessary actions for maintaining the economic stability of local communities and mitigation of socioeconomic impacts.
6. Study regional impacts resulting from land retirement, including impacts from reduced agricultural production inputs, reduced farm income, and income received from land payments and habitat restoration.
7. Land retirement should comply with the California Environmental Quality Act. Land retirement programs should include the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies.

Rainfed Agriculture

Rainfed agriculture is when all crop consumptive water use is provided directly by rainfall in real time. Owing to the unpredictability of rainfall frequency, duration, and amount, there is significant uncertainty and risk in relying solely on rainfed agriculture. This is especially true in California, where there is little or no precipitation during most of the spring and summer growing season.

Climatic conditions in California provide excellent conditions for crop production. Little cloud cover provides ample solar radiation during the spring and summer growing season. Rain and snow occur mainly during the fall and winter months. However, the lack of sufficient and timely rainfall during the spring and summer throughout much of California severely limits the potential for expansion of rainfed agriculture.

Winter crops in California's interior valleys, North Coast, and Central Coast are fed directly by rain and, if needed, by irrigation water during the latter part of the winter season. These areas provide a relatively high return from high-value winter crops, such as vegetables in the coastal areas. Other important agricultural production sectors dependent on rainfall are pastoral areas, rangelands, and rolling hills. These areas produce significant amounts of feed and provide grazing areas for the state's large cattle industry, which produces dairy products and meat. Winter small-grains crops, such as winter wheat, account for about 4 percent (400,000 acres) of agricultural lands and provide a relatively small contribution to the state's total agricultural economy.

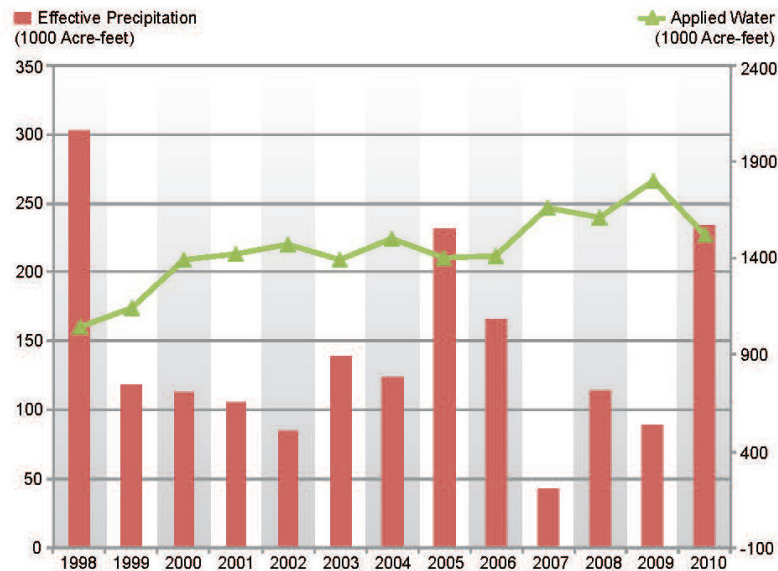
University of California researchers found that, even on the west side of the San Joaquin Valley, which has an average rainfall of 7 inches per year, farmers can reap benefits from growing winter cover crops without irrigation (University of California Agricultural and Natural Resources 2012).

The vast majority of California's agricultural production requires irrigation. Rainfall occurring before and during the irrigation season can reduce irrigation water requirements. During years with heavy springtime rains, soil moisture remains higher for a longer period and can measurably reduce irrigation requirements for the year. Growers and water districts factor effective rainfall into their water management practices. In addition, California Department of Water Resources (DWR) water-balance calculations for each region account for the portion of crop water requirements provided directly by rainfall.

As demonstrated in Figure 1, applied water and rainfall events are closely related. More rainfall, particularly during the early growing season, provides a significant quantity of rainfall for crop consumptive use. The figure shows the inverse relationships between effective rainfall and applied water. Based on the 13 years (1998-2010) of data for an area on the west side of the San Joaquin Valley, effective rainfall provided an average about 10 percent of the total crop consumptive use. In 1998, 2005, and 2010, which were above-average rainfall years with early season rainfall, effective rainfall amounted to 29 percent, 21 percent, and 18 percent of the crop consumptive use, respectively. In 2007, a dry year, effective rainfall amounted to only 4 percent of the total crop consumptive use. Similar examples exist in other regions in the state.

Potential Benefits

Improvements in rainfed agricultural production currently offer limited opportunities to further increase water supply in California. More acreage for winter crop production will reduce runoff flowing through

Figure 1 Effective Precipitation and Applied Water

surface water systems and to ocean outflows. Improvements in rangelands and grazing areas through improved plant varieties can provide crop yield benefits, but not a significant increase in water supply. One important aspect of improved rainfed agriculture is a better post-harvest/pre-planting soil management for such winter crops as wheat. Many winter wheat growers are already implementing prudent and adequate soil management practices for water and erosion management. Tilled land left fallow after harvest can cause the soil surface to seal with the first and second rainfall and increase runoff and erosion. Improved tillage practices, no-till or minimum-till, may improve water infiltration into the soil root zone, thereby increasing soil-water storage, and could contribute to the water supply by eliminating the first seasonal irrigation. Additionally, increased soil moisture reduces soil erosion, helps improve water quality, and may help increase water use efficiency and economic efficiency. Advances in plant genetics to provide higher crop yields from direct rainfall could replace some crops that rely on irrigation.

The quantification of potential water savings from improved rainfed agriculture, while very small, is not possible due to insufficient information. However, research conducted by the University of California is yielding more information about rainfed cover crops.

Potential Costs

Potential costs consist of on-farm soil management; the cost of research and development; and the demonstration, education, training, and dissemination of the technology. On-farm cost is an integral part of soil management, which is already part of growers' practices. Soil management practices may need to be adjusted for timing with no additional or minimal cost. It is possible that such activities can be funded by the DWR Water Use Efficiency Program's loans and grants.

Major Implementation Issues Facing Rainfed Agriculture

While rainfed agriculture provides some opportunities for increasing yield and water supply reliability, efforts will likely result in insignificant and unquantifiable contributions to the water supply. Nonetheless, increases of winter crops and winter cover-crop yields can be significant and benefit overall water management in California. Water supply improvements will require development of new varieties of plants and new and innovative soil and water management. Also, this strategy does not provide water supply benefits on a real-time basis. For example, improvements in soil management may provide the future benefit of storing more rainfall in the root zone only if the predicted weather conditions occur.

Recommendations to Increase Water Use Efficiency in Rainfed Agriculture

1. Develop improved varieties of winter rainfed crops, such as wheat, other small grains, cover crops, and winter crops. Provide funding for research and development institutions to develop new and improved varieties of winter rainfed crops. In addition, develop research that demonstrates innovative water management practices where growers with marginal lands and marginal production may shift from irrigated agriculture to rainfed winter crops.
2. Provide technical and financial assistance to promote no-till or minimum-till practices by growers who prepare their lands for planting during spring, but leave it fallow during the fall and winter. Cooperative efforts with the state's research and development institutions can provide benefits of this important aspect of rainfed agriculture.
3. Develop new and innovative technologies, management, and efficient water management practices for rainfed crops, particularly winter wheat.
4. Provide technical and financial assistance to implement better technologies and management practices for rainfed agriculture.
5. Develop and promote new and innovative activities and management practices for intensive and managed grazing.
6. Maximize, collect, and store runoff from rainfed agriculture. Develop cooperative efforts to link runoff from rainfed agriculture with water banking, conjunctive use activities, and groundwater recharge.
7. Disseminate practical information through educational and training opportunities.

Snow Fences

Snow fences have been used extensively by State transportation departments to reduce snow drifting over roadways. To improve watershed management, snow fencing could be strategically placed in small openings (clear-cut tree harvest areas or high-elevation meadows) of 1.25 acres or less. Effective snow fences are 6-12 feet high. As shown in Figure 2, when positioned perpendicular to the prevailing wind, snow fencing intercepts the wind to reduce snowflake velocity and create a snow sedimentation basin downwind of the fence. Snow mass collected behind the fence is distributed over a longitudinal area that can be up to 25 times the fence height.

Mountain stream runoff is expected to result in higher flows over shorter durations in the coming years, and thus cause earlier and greater spring flooding followed by a longer, drier summer. Local-scale strategic placement of properly designed snow fencing could be used as an effective tool for water management to strengthen forest and watershed management, protect sensitive environments, and facilitate slower snowmelt to extend runoff into the summer. For example, the Sierra Nevada produces more than 50 percent of California's water, and snow fences could be used in some locations to

- Benefit tribal lands.
- Increase interagency water management collaboration.

Potential Costs

Snow fencing is a highly economical alternative to snowplowing, and the application of snow fencing for water management and environmental purposes would follow the same basic cost structure as fencing for transportation uses. An unknown factor, however, is the benefit-to-cost ratio for the application of snow fencing for water management and environmental purposes in California.

Major Implementation Issues Facing Snow Fences

Besides the benefit-to-cost ratio not yet being known, permitting requirements for snow fencing would depend on the specific area in which the fencing would be applied. Whether the fencing would be proposed for placement on public or private land could be a factor, as would interagency cooperation and the willingness of private landowners to work with the agency or agencies involved in the fencing project. Potential sponsors of these fencing projects, as well as the funding, would have to be found. How the fences would be placed, by whom, and maintained are also matters that would need to be addressed.

Waterbag Transport/Storage Technology

Waterbag transport/storage technology involves diverting water in areas that have unallocated freshwater supplies, storing the water in large inflatable bladders, and towing them on the ocean by a tug boat to an alternate coastal region. Fresh water is lighter than sea water, so the bags float on the surface, which makes towing them easier. After discharging the contents, the empty bags are reeled to the deck of the tug boat, allowing for a speedier return to the source water area.

Although this strategy is not currently used in California, there have been several proposals to implement this technology throughout the world. The most recent was the proposal by Alaska Water Exports Company to divert up to 30 thousand af from the Albion and Gualala rivers in Northern California and transport the water to the San Diego metropolitan area. The proposal was greeted with significant local opposition in Northern California. In 2003, California designated the Albion and Gualala rivers as recreational via Public Resources Code Section 5093.53(c) and added them to the California Wild and Scenic Rivers System. This ended the plan to divert and export fresh water from these rivers to Southern California via waterbag transport technology.

Potential Benefits

- Provides water supply benefit.
- Improves drought preparedness.
- Improves water quality.
- Increases operational flexibility and efficiency.
- Provides environmental benefits
- Provides energy benefits.
- Reduces groundwater overdraft.

Potential Costs

The total cost for waterbag transport is highly project-specific and contingent upon several factors, such as facility costs for diverting and off-loading water, environmental mitigation, administrative costs, bag construction costs, and towing costs.

Major Implementation Issues Facing Waterbag Transport/Storage Technology

Third-Party Impacts

As with any type of transfer, there may be impacts on the area of origin. This includes projects that use surplus water and water that currently has a beneficial use. Other issues of concern expressed to proponents of recent projects include aesthetics and noise pollution from diversion facilities and the dissatisfaction on the part of origin communities that others are exporting a local resource.

Environmental Impacts

Although most proposed diversions for waterbag transport take place near the mouth of a source river, facilities may need to be built to convey the water from a significant distance upstream to prevent blending with high-salinity ocean water. Some areas may already have conveyance facilities in place, which could be accessed for waterbag storage and transport.

Water Rights

The implementation of this strategy would require a lengthy and expensive permitting process to ensure no water rights are violated, which would include environmental impact studies.

Climate Change

The projected climate change impacts include shifts in historical weather patterns, increased storm intensities, prolonged and more frequent droughts, continued sea level rise, and higher and increasing temperatures. These changes will threaten water supply reliability and, in most cases, increase the demand for water supplies. Climate change is already altering the way California manages its water, and the continued effects will require a portfolio of options to react effectively. Preparing adaptation strategies in advance of additional impacts will give water managers the flexibility to react to various conditions.

Adaptation

Climate change adaptation strategies will vary and also depend on the needs and capabilities of communities. Being prepared will minimize adverse consequences. Because droughts are expected to become prolonged and more frequent, maintaining the ability to move water through crop idling for water transfer, irrigated land retirement, or waterbag transport can serve as a potential climate adaptation strategy. Droughts and sea level rise may impede implementing crop idling and irrigated land retirement strategies because these climate changes reduce the amount of water available for transfer and hinder water conveyance systems (for more information, see the resource management strategy report, *Water Transfers*). Waterbag transport can be a short-term adaptation strategy by allowing one area the benefit of disposing excess water while providing this water to an area in need. For communities that do not have access to large water conveyance systems, dewvaporation and fog collection can be localized adaptation strategies to combat growing water demand from higher temperatures and droughts. However, fog

formation and location may be altered by climate change. Rainfed agriculture, such as non-irrigated cover crops, can be an adaptation strategy because it builds organic matter in the soil and increases its water storage capacity. This can provide weeks of extra water to cover summer droughts at the height of the growing season, as well as having the ability to grow food without accessory water. However, this measure may be less feasible in low-rainfall areas.

Mitigation

Mitigation strategies result in a reduction of greenhouse gas (GHG) emissions in the effort to reduce contributions to climate change. Mitigation can be accomplished by substituting a high GHG emissions system with a lower GHG emissions system, by creating an emissions sink, or by reducing the use of a high-emissions system. Climate models project that California already faces a certain amount of climate change and sea level rise based on current and past emissions. Climate change mitigation goals are reducing the severity and longevity of those projected climate changes. Crop idling for water transfer and irrigated land retirement are not necessarily mitigation strategies because they could potentially remove a carbon sink, especially if agricultural conservation practices are used on that land. On the other hand, these strategies could be considered mitigation if the land has drainage or runoff issues that require energy-intensive maintenance or remediation, or if the land is heavily amended with nitrogen fertilizer, as both situations result in increased GHG production. The use of transferred water will also determine if it is a mitigation strategy. If the water is used in a manner that is highly energy intensive, then it is no longer a mitigation strategy. Dewvaporation and fog collection typically are energy-intensive processes, so they would only be mitigation strategies if they replaced a water source that requires even higher energy to obtain it. Rainfed agriculture can be a mitigation strategy if it is converted from traditional agriculture and thus reduces the energy use required by traditional irrigation methods. Waterbag transport cannot be considered a mitigation strategy, as it is likely to consume more energy during construction of the bag and related diversion systems, as well as during transportation of the bag by sea, than using an alternate water source.

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