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| **Subject:** | **Resource Management Strategies Technical Memorandum** |
| **Prepared For:** | Merced Integrated Regional Water Management Plan – Regional Advisory Committee |
| **Prepared by:** | RMC Water and Environment |
| **Date:** | July 17, 2012 |
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The Merced Region is undertaking development of an Integrated Regional Water Management Plan (MIRWMP). This effort was initiated by the Merced Area Groundwater Pool Interests (MAGPI), which currently serves as an interim Regional Water Management Group (RWMG) responsible for developing the IRWM Plan. The Region has received a grant from the California Department of Water Resources (DWR) to prepare a plan that meets statewide IRWM Plan standards.

The purpose of this technical memorandum (TM) is to document the range of resource management strategies (RMS) considered to meet the IRWM objectives and to identify which RMS were incorporated into the MIRWMP. This TM will serve as the basis for the Resource Management Strategies section of the MIRWMP.

# Resource Management Strategies

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| Integrated Regional Water Management (IRWM) Plans must:* Document the range of RMS considered to meet the IRWM objectives and identify which RMS were incorporated into the IRWM Plan
* Consider the effects of climate change on the IRWM region when considering RMS
* Consier, at a minimum, the RMS found in Volume 2 of the California Water Plan (CWP) Update 2009
 |

A comprehensive range of resource management strategies (RMS) were considered to achieve the objectives identified for the Merced Region. This section identifies the RMS considered within this MIRWMP, documents the selection process used to determine appropriate RMS for the Region, and describes any existing efforts that are being taken within the Region for each RMS. This section considers all RMS covered in the California Water Plan 2009 Update (DWR 2009), assesses the Region’s IRWM Plan objectives outlined in Chapter X, and determines how the RMS identified in the California Water Plan 2009 Update (DWR 2009) can work together to achieve the Region’s specific IRWM Plan objectives.

## Resource Management Strategies Considered

The MIRWMP considered each RMS listed in the California Water Plan Update 2009 as required by the Proposition 84 and Proposition 1E IRWM Guidelines. The California Water Plan Update 2009 identified seven categories of RMS applicable to water management in California.

**Table 1** presents the seven categories of RMS considered for the MIRWMP. Though all the RMS identified by the California Water Plan Update 2009 were considered for inclusion in the MIRWMP, not all are appropriate for meeting the Region’s IRWM plan objectives. The RMS determined to be inappropriate for the Region included: conveyance-Delta, desalination, precipitation enhancement, surface storage-CALFED, fog collection, crop idling for water transfers, dewvaporation or atmospheric pressure desalination, irrigated land retirement, and waterbag transport/storage technology.

## Objectives Assessment

**Table 2** presents the RMS considered for the MIRWMP and describes the ways in which each RMS contributes to meeting the MIRWMP objectives. The table illustrates which strategies can be implemented to achieve each objective. In many cases, multiple RMS may be implemented together – or integrated - to fulfill one or more regional objecives. Descriptions of each RMS, including those not appropriate for the Region, can be found in Section 3: RMS Evaluation for the Merced IRWM Region.

Table 1: Resource Management Strategies Considered for the MIRWMP

|  |  |
| --- | --- |
| **Reduce Water Demand** | **Improve Flood Management** |
| Agricultural Water Use Efficiency  | Flood Risk Management  |
| Urban Water Use Efficiency | **Practice Resources Stewardship** |
| **Improve Operational Efficiency and Transfers** | Agricultural Lands Stewardship |
| Conveyance- Delta\*  | Economic Incentives (Loans, Grants and Water Pricing) |
| Conveyance- Regional/Local  | Ecosystem Restoration |
| System Reoperation  | Forest Management |
| Water Transfers | Recharge Area Protection  |
| **Increase Water Supply** | Water-Dependent Recreation  |
| Conjunctive Management and Groundwater Storage | Watershed Management |
| Desalination\*  | **Other Strategies** |
| Precipitation Enhancement\*  | Crop Idling for Water Transfers\* |
| Recycled Municipal Water | Dewvaporation or Atmospheric Pressure Desalination\*  |
| Surface Storage- CALFED\*  | Fog Collection\*  |
| Surface Storage- Regional/Local | Irrigated Land Retirement\*  |
| **Improve Water Quality** | Rainfed Agriculture |
| Drinking Water Treatment and Distribution  | Waterbag Transport/Storage Technology\*  |
| Groundwater Remediation/Aquifer Remediation  |  |
| Matching Quality to Use |  |
| Pollution Prevention |  |
| Salt and Salinity Management  |  |
| Urban Runoff Management |  |

\* RMS deemed inappropriate for the Merced IRWM Region

Source: DWR 2009

Table 2: Resource Management Strategies that Achieve MIRWMP Objectives

TO BE COMPLETED FOLLOWING FINALIZATION OF OBJECTIVES

| **Merced Region IRWM Objectives** | **Resource Management Strategies** |
| --- | --- |
| Agricultural Lands Stewardship | **Agricultural Water Use Efficiency** | **Conjunctive Mgmt and Groundwater Storage** | **Conveyance—Regional/Local** | **Drinking Water Treatment & Distribution** | **Economic Incentives** | **Ecosystem Restoration** | **Flood Risk Management** | **Forest Management** | **Groundwater /Aquifer Remediation** | **Matching Water Quality to Use** | **Pollution Prevention** | **Precipitation Enhancement** | **Recharge Area Protection** | **Recycled Municipal Water** | **Salt and Salinity Management** | **Surface Storage—Regional/Local** | **System Reoperation** | **Urban Runoff Management** | **Urban Water Use Efficiency** | **Water Transfers** | **Water-Dependent Recreation** | **Watershed Management** | **Other Strategies** |
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| **● Resource management strategy primarily and directly supports attainment of the IRWM Plan objective****○ Resource management strategy indirectly helps to achieve the IRWM Plan objective** |  |  |  |  |  |  |  |  |  |  |  |

## Process Used to Consider RMS

The inclusion of RMS in this IRWM Plan is based on a review of all 32 RMS identified by the California Water Plan Update 2009and the Proposition 84 and Proposition 1E IRWM Guidelines. The Regional Water Management Group has determined that 23 RMS were appropriate for inclusion in the Merced IRWM Plan as they are either currently being utilized or may reasonably be utilized in the management of water resources in the region.

The process of identifying RMS that address the regional goals and objectives identified for the Merced IRWM Plan involved evaluating all strategies in consultation with the Regional Advisory Committee (RAC). The full list of RMS was reviewed and discussed by the RAC to determine applicability of each strategy in meeting the Merced Region’s IRWM Plan objectives.

## RMS Evaluation for the Merced IRWM Region

The following sections describe the relevant RMS in further detail and provide examples of efforts currently underway in the Region that apply each strategy.

The RMS described within the following sections are consistent with the Region Description (*Chapter 1, Region Description*), IRWM Plan Objectives (*Chapter X, Objectives*), and Governance (*Chapter X, Governance*) requirements set forth in the IRWM Grant Program Guidelines (DWR 2012). In addition, each section below acknowledges where the RMS are currently being implemented in accordance with the Region's identified issues and needs (*Chapter X, Objectives*).

### Reduce Water Demand

#### RMS identified in the Reduce Water Demand category include:

* Agricultural Water Use Efficiency
* Urban Water Use Efficiency

These RMS are discussed in further detail below.

#### **Agricultural Water Use Efficiency**

Agricultural water use efficiency can reduce the quantity of water used for agricultural irrigation. This strategy could increase the Region’s net water savings, improve water quality, provide environmental benefits, improve flow and timing, and increase energy efficiency.

Strategies recommended by the California Water Plan Update 2009 to achieve agricultural water savings and benefits include:

improving irrigation system technology and management of water, both on-farm and at the irrigation district level to minimize water losses;

adjusting irrigation schedules to decrease the amount of water applied;

installing remote monitoring to allow districts to measure flow, water depth and improve water management and controls; and

developing community educational conservation activities to foster water use efficiency.

#### *****Merced IRWM Region Efforts*****

An example of current agriculture water use efficiency efforts employed by the Region’s primary agricultural water supplier (MID) is listed below.

**Merced Irrigation District Water Management Plan**. MID has prepared and periodically updates a Water Management Plan focused on establishing applicable Efficient Water Management Practices (EWMPs), which include agricultural water use efficiency and conservation efforts (MID 2003). According to information from MID’s Water Management Plan, agricultural water use efficiency efforts include improvements in the physical structure and operation of delivery facilities (including remote monitoring installation), as well as on-farm incentive programs (MID 2003).

#### **Urban Water Use Efficiency**

Due to the Region’s growing population and expanding urban development (refer to *Chapter 1, Region Description*), it is vital that urban water use efficiency strategies are adopted to reduce pressure on the Region’s groundwater and surface water supplies. Further, in accordance with provisions stipulated by Senate Bill x7-7 (the Water Conservation Act of 2009), all urban water suppliers within the Region must reduce urban water consumption by 20% by 2020.

Approaches recommended by the California Water Plan Update 2009 to increase urban water use efficiency include:

implementing programs such as Best Management Practices (BMPs);

reviewing the Urban Water Management Plan to ensure 20 percent water use reductions are achieved by 2020;

installing water efficient landscapes;

encouraging gray water and rain water capture to increase water conservation and improve water quality;

increasing public outreach and encouraging community involvement; and

funding incentive programs for small districts and economically disadvantaged communities.

#### *****Merced IRWM Region Efforts*****

Various aggressive measures are currently being implemented to increase urban water use efficiency in the Region. Example water demand management measures currently being implemented or planned to be implemented by the City of Merced to increase urban water use efficiency include:

**Residential Plumbing Retrofit:** The City is in the process of installing physical devices to reduce the amount of water used or to limit the amount of water that can be served to a customer;

**Water System Audits:** The City performs water system audits to quantify unaccounted-for water.

**Metering with Commodity Rates:** The City installs meters for all new connections to allow billing by volume of use.

**Public Information Program:** The City has an active public information program which distributes information to the public through a variety of methods including brochures, press releases, school curricula, educational flyers, commercials, etc.

**School Education Program:** The City is implementing a school education program that includes providing educational materials and instructional assistance.

**Water Conservation Coordinator:** The City employs a Water Conservation Specialist who serves as the City’s Conservation Coordinator.

**Water Waste Prohibition:** The Cityhas ordinances in place to prohibit the waste of water.

### Improve Operational Efficiency and Transfers

#### RMS identified in the Improve Operational Efficiency and Transfers category include:

* Conveyance - Delta
* Conveyance – Regional / Local
* System Reoperation
* Water Transfers

These RMS are discussed in further detail below.

#### **Conveyance- Delta**

The Delta conveyance system supplies water to the San Francisco Bay Area, Central Valley, and Southern California. The Merced Region does not currently receive imported water from the Delta.

Delta conveyance strategies identified by the California Water Plan Update 2009include:

establishing performance metrics that record quantity of water deliveries for agricultural and urban users;

utilizing Delta Vision Task Force and Bay-Delta Conservation Plan recommendations to increase operational flexibility and conveyance reliability to benefit water supply and aquatic ecosystems; and

developing strategies that maintain channel capacity in the Delta.

#### *****Merced IRWM Region Efforts*****

As the Region does not receive water supplies from the Delta, Delta conveyance is not applicable to the Region.

#### **Conveyance- Regional/Local**

As described in detail in *Chapter 1, Region Description,* the Region relies on both groundwater and surface water supplies. Surface water supplies can be used to offset groundwater demands and to recharge local groundwater basins, and therefore can be used to correct groundwater overdraft conditions within the Region. As such, the region would benefit from improvements in water supply reliability and conveyance infrastructure that increase operational efficiency and transfers of surface water and groundwater supplies. Benefits of improving regional/local conveyance infrastructure include: maintaining/increasing water supply reliability, protecting water quality, augmenting current water supplies, and providing water system operational flexibility.

Strategies identified by the California Water Plan Update 2009 for improving regional/local conveyance of water supplies include:

improving aging infrastructure, increasing existing capacities, and/or construction of new conveyance facilities;

replacing or improving canal structures to improve an irrigation district’s ability to manage and control water in the district and reducing spillage; and

constructing alternative water conveyance pipelines to improve water supply reliability.

#### *****Merced IRWM Region Efforts*****

Examples of current regional/local conveyance strategies employed within the Region are listed below.

**MID Regulating Reservoirs**. MID operates six regulating reservoirs that are used to regulate flows and balance MID’s water supply system. As of 2003, these reservoirs had a total active regulating volume of 3,235 acre-feet (MID 2003).

**MID Water Management Activities**. MID conducts a variety of water management activities designed to reduce diversions and improve delivery response. These projects included conveyance-related activities such as improving conveyance structures to remove capacity constraints (MID 2003).

**Canal Improvements.** MID canals are used to deliver water supplies, but are also used to discharge and convey stormwater flows (Merced County 2007). Improvements to MID canals will be required to address increasing stormwater discharges that are related to population increase and other factors (Merced County 2007).

#### **System Reoperation**

System reoperation strategies alter operation and management procedures for existing reservoirs and conveyance facilities to increase water related benefits from these facilities. Changes in water demands and changing climate may require reoperation of existing facilities to increase project yield or address climate change impacts. System reoperation strategies will require making changes to how projects operate to best meet the changing needs of the Region. Some of the potential benefits of system reoperation strategies include: increasing water supply reliability, additional flexibility to respond to extreme hydrologic events, and improving the efficiency of existing water uses.

System reoperation strategies identified by the California Water Plan Update 2009 include:

establishing a baseline hydrology and enhanced description of present water management system components;

considering possible climate change effects in reoperation projects; and

collaborating between federal, state, and local agencies on system reoperation studies.

#### *****Merced IRWM Region Efforts*****

An example of a Region-wide system reoperation strategy is listed below.

**Merced Groundwater Basin Groundwater Management Plan**. The 2008 MAGPI Groundwater Management Plan, which covers the majority of the Merced IRWM Region, establishes a baseline hydrology and a description of water management system components within the Region (MAGPI 2008).

#### **Water Transfers**

Water transfers are temporary or long-term changes in the point of diversion, place of use, or purpose of use due to transfer or exchange of water or water rights in response to water scarcity (DWR 2009). Benefits to establishing water transfers include improving economic stability and environmental conditions for receiving areas. Compensation for water transfers can fund beneficial projects/activities for the Region, reduce water rates, and/or improve facilities.

Water transfer strategies identified by the California Water Plan Update 2009 include:

developing and implementing groundwater management plans and monitoring programs;

allowing community participants to identify and respond to conflicts caused by transfers;

refining current methods on identifying and quantifying water savings for transfers using crop idling, crop shifting, and water use efficiency measures; and

improving coordination and cooperation among the local, state, and federal agencies to facilitate sustainable transfers.

#### *****Merced IRWM Region Efforts*****

The Region has employed various water transfer strategies including the following:

**City of Merced and MID Water Transfer**. The City of Merced and MID are working to develop a Memorandum of Understanding that would formalize an exchange of tertiary-treated wastewater effluent from the City of Merced for surface water from MID. Surface water would be used by the City of Merced to irrigate parks, and would be used to offset groundwater demands (City of Merced 2011).

**Buchanan Dam Water Transfer**.The Chowchilla Water District (CWD) currently coordinates with a federal agency, the United States Bureau of Reclamation, to implement a contract that allows CWD to pay to use approximately 24,000 acre-feet of water transferred from Buchanan Dam each year (CWD ND).

### Increase Water Supply

#### RMS identified in the Increase Water Supply category include:

* Conjunctive Management and Groundwater Storage
* Desalination
* Precipitation Enhancement
* Recycled Municipal Water
* Surface Storage – CALFED
* Surface Storage – Regional / Local

These RMS are discussed in further detail below.

#### **Conjunctive Management and Groundwater Storage**

The reliability of the Region’s water supplies can be improved through conjunctive use of both surface and groundwater supplies. Conjunctive management and groundwater storage refers to the coordinated and planned use and management of both surface water and groundwater resources to maximize the availability and reliability of water supplies to meet water management objectives. The conjunctive management and groundwater storage strategy seeks to increase water supply reliability and groundwater sustainability. Several benefits of utilizing conjunctive management and groundwater storage strategies include: improving water supply reliability and sustainability, reducing groundwater overdraft and land subsidence, protecting water quality, and improving environmental conditions.

Conjunctive management and groundwater storage strategies identified by the California Water Plan Update 2009 include:

implementing monitoring, assessment, and maintenance of baseline groundwater levels;

encouraging local water management agencies to coordinate with tribes and other agencies involved in activities that might affect long term sustainability of water supply and water quality, and;

local groundwater monitoring and management activities and feasibility studies to increase the coordinated use of groundwater and surface water.

#### *****Merced IRWM Region Efforts*****

Conjunctive management and groundwater storage strategies being considered within the Region are listed below.

**Merced Groundwater Basin Groundwater Management Plan**. Since its formation, the primary focus of MAGPI has been implementation of the Merced Groundwater Basin Groundwater Management Plan, which promotes conjunctive surface water and groundwater management (MAGPI 2009). As such, the fifteen municipal and agricultural water purveyors that comprise MAGPI work together on activities aimed at improving long term sustainability of the Merced Groundwater Basin (Merced Subbasin).

**MAGPI and DWR Memorandum of Understanding**. In 2001 MAGPI entered into an MOU with DWR to work cooperatively to promote conjunctive use projects within the Merced Subbasin (MAGPI 2009).

#### **Desalination**

Desalination, the process of removing salts and other minerals from saline water, requires complicated technologies and is an energy intensive technology. Desalination offers many potential benefits including: increasing water supply reliability during drought periods, reducing dependence on groundwater supplies, protecting public health, and facilitating water recycling and reuse.

Recommendations identified by the California Water Plan Update 2009 to facilitate desalination strategies include:

desalination projects should be given the same funding opportunities as other water supply and reliability projects;

ensure most economical and environmentally appropriate desalination technology is utilized; and

project sponsors need to ensure planning of desalination projects is a collaborative process that engages key stakeholders, the general public, and permitting agencies.

#### *****Merced IRWM Region Efforts*****

Desalination is not currently used within the Region. Due to the distance between the Merced IRWM Region and potential saline water sources, desalination is not likely to serve as a future water source for the Region and was not considered in the IRWM Plan.

#### **Precipitation Enhancement**

Precipitation enhancement strategies seek to artificially stimulate clouds to produce more rainfall or snowfall than would naturally occur. The benefit of this strategy is primarily to increase water supply.

Recommendations identified by the California Water Plan Update 2009 for implementing precipitation enhancement projects include:

seeking State support for development and funding of new precipitation enhancement projects;

collecting data and evaluations of existing California precipitation enhancement projects to perform research on the effectiveness of the technology; and

investigating the potential of augmenting Colorado River Water supply through cloud seeding.

#### *****Merced IRWM Region Efforts*****

Precipitation enhancement is not currently implemented within the Region. Although the Region relies on surface water from the Merced River, which varies depending upon rainfall patterns, precipitation enhancement is not a likely RMS for the Region due to its expense and uncertain effectiveness.

#### **Recycled Municipal Water**

One way to offset current and future water demands for the Region is to reuse highly treated wastewater for nonpotable uses (recycled municipal water). Recycled water use can be a potentially significant local resource that can be used to help reduce groundwater and surface water demands. Further, because recycled water supplies are minimally impacted by changes in hydrology; they are not expected to be significantly impacted by climate change.

Recycled municipal water strategies identified by the California Water Plan Update 2009 and Water Recycling 2030: Recommendations of California’s Recycled Water Task Force include:

increasing funding availability for water reuse/recycling facilities and infrastructure;

creating education curriculum for public schools and institutions of higher learning to educate the public about recycled water;

engaging the public in an active dialogue and encouraging participation in the planning process of water recycling projects;

providing resources (i.e. funding) to agencies that will perform comprehensive analysis of existing water recycling projects to estimate costs, benefits, and water deliveries; and

assessing water recycling technology to determine least costly and environmentally appropriate technology based on location and need.

#### *****Merced IRWM Region Efforts*****

Examples of water recycling strategies employed within the Region are described below.

**Water Reclamation Plants.** The cities of Merced and Atwater both have water reclamation plants that treat and reuse wastewater. The City of Merced’s water reclamation plant is capable of producing recycled water in accordance with Title 22 of the California Code of Regulations for irrigation and industrial uses (City of Merced 2011). While the City of Atwater’s water reclamation plant cannot produce Title 22-compliant water, the City beneficially reuses treated effluent for irrigation and wetland habitat augmentation purposes (City of Atwater 2006).

#### **Surface Storage- CALFED**

Potential benefits from CALFED surface storage include releases of new storage and system flexibility such that the operation of other facilities can be modified without reducing current benefits. The additional water storage can be used to improve ecosystem functions, conditions for target species, improve water quality, and supply reliability for water users.

CALFED surface storage strategies identified by the California Water Plan Update 2009include:

decreasing demand of imported water through water conservation programs;

engaging stakeholders, potential projects participants, tribes, the public, and agencies in identifying, evaluating, and quantifying potential projects that address the CALFED surface storage goals and their effects (positive and negative);

developing alternatives and potential future scenarios that incorporate alternative delta conveyance, operations, and possible climate change effects to allow potential participants to assess their interest in specific projects; and

developing mechanisms that provide assurance projects are being operated in a manner consistent with the objectives of CALFED surface storage.

#### *****Merced IRWM Region Efforts*****

The Merced IRWM Region does not currently benefit from surface storage projects related to the Delta, and does not use imported water. Therefore, CALFED surface storage resource management strategies are not reasonable for implementation within the Region.

#### **Surface Storage- Regional/Local**

Though groundwater is the predominant supply used in the Merced Region, the Region also uses surface water from MID as well as a system of canals, reservoirs, and dams for conveyance and storage of surface water supplies. Projects that incorporate regional / local surface water storage focus on alternatives to expand local surface storage capacity. Climate change threatens to change the timing of precipitation, with fewer, more intense rainfall events. Increased surface storge can provide flood management benefits, as well as improving the region’s ability to capture and store watershed runoff under changing climate conditions. Benefits of expanding regional/local surface storage include: improved flood management, ecosystem management, emergency water supply, river and lake recreation, capture of surface water runoff, and water supply reliability against catastrophic events and droughts.

Regional/local surface storage strategies identified by the California Water Plan Update 2009include:

development of a comprehensive methodology for analyzing project benefits and costs by local agencies;

continued studies, research, and dialogue to identify a common set of tools for determining costs and benefits of surface storage projects;

adaptively manage operations of existing surface storage facilities;

rehabilitation and/or enlargement of existing surface storage infrastructure; and

developing water purchasing agreements to buy water from other agencies that own storage reservoirs with substantial water supplies.

#### *****Merced IRWM Region Efforts*****

An example of a regional/local surface storage strategy employed within the Region is listed below.

**MID Regulating Reservoirs**. MID operates six regulating reservoirs that are used to regulate flows and balance MID’s water supply system by providing storage in times when water flows are high. As of 2003, these reservoirs had a total active regulating volume of 3,235 acre-feet (MID 2003).

### Improve Water Quality

#### RMS identified in the Improve Water Quality category include:

* Drainking Water Treatment and Distribution
* Groundwater Remediation/Aquifer Remediation
* Matching Quality to Use
* Pollution Prevention
* Salt and Salinity Management
* Urban Runoff Management

These RMS are discussed in further detail below.

#### **Drinking Water Treatment and Distribution**

Providing a reliable supply of safe drinking water is critical for protecting public health. Though the Region’s water purveyors provide high-quality drinking water that meets regulatory standards, public water systems must continue developing and maintaining adequate water treatment and distribution facilities to ensure that public health is protected. Climate change could reduce flows in the Merced River and increase saline intrusion in groundwater supplies, impacting the quality of existing supplies and increasing the level of treatment needed to provide drinking water that meets all regulatory requirements. Several benefits of drinking water treatment and distribution strategies include: improving public health, reducing water distribution delivery problems, and ensuring delivery of high-quality drinking water.

Drinking water treatment and distribution strategies identified by the California Water Plan Update 2009include:

working closely with the California Department of Public Health (CDPH) to quantify the total needs for water system infrastructure improvement and replacement;

regionalizing and consolidating public water systems;

developing incentives to allow water systems to reduce waste of limited water resources;

researching and developing new treatment technologies;

providing additional funding for water supply, water treatment, and infrastructure projects to ensure safe and reliable supply of drinking water for individuals and communities;

joining the California Water/Wastewater Agency Response Network (WARN) program, which provides mutual aid and assistance more quickly than through the Standardized Emergency Management System (SEMS); and

creating source control and reduction programs to address pharmaceuticals and personal care products.

#### *****Merced IRWM Region Efforts*****

Drinking water treatment and distribution strategies employed within the Region are listed below.

**Drinking Water Systems**. All of the water purveyors that provide drinking water have water systems that provide water to the Region’s residents. For specific information regarding the potable water systems of each agency in the Region, please refer to *Chapter 1 Region Description, Section 1.3.2 Water Systems and Distribution.*

**Monitoring**. Water purveyors in the Merced IRWM region monitor drinking water regularly according to state (CDPH) and federal (USEPA) regulations.

#### **Groundwater Remediation/Aquifer Remediation**

Groundwater is a valuable local resource that is comprehensively managed through MAGPI’s adopted Groundwater Management Plan. Groundwater Remediation/Aquifer Remediation strategies seek to improve the quality of degraded groundwater for beneficial uses. Groundwater contamination can come from a multitude of sources such as: heavy metals, salts, organic and inorganic pollutants, nitrates, arsenic, pesticides, septic systems, and urban and agricultural activities. Several benefits of adopting groundwater remediation/aquifer remediation strategies include: availability of additional water supplies, avoiding purchasing alternate water supplies, and storage of excess surface water supplies in remediated aquifers.

Groundwater remediation/aquifer remediation strategies identified by the California Water Plan Update 2009include:

limiting potentially contaminating activities in recharge areas;

identifying historic commercial and industrial sites with contaminated discharges and responsible parties to remediate sites;

implementing source water protection measures; and

establishing and supporting funding for detecting emerging contaminants by commercial laboratories and installation of wellhead treatment systems.

#### *****Merced IRWM Region Efforts*****

Groundwater remediation strategies employed within the Region are listed below.

**Castle Airport Aviation Groundwater Remediation**. Castle Airport, a former military base located outside of the City of Merced, has known plumes of trichloroethylene (TCE). This site is undergoing remediation, including implementation of groundwater extraction systems that are being used to remove TCE from the groundwater. As of 2007, 13.6 billion gallons of contaminated groundwater was extracted and treated near or within the Castle Airport remediation site (MAGPI 2008).

**Detection of Emerging Contaminants**. In 2007, research was completed by the University of California, Davis, and the United States Geological Survey, which involved surveying for pharmaceuticals in dairies located within the Merced Subbasin. This research resulted in a few detections of pharmaceuticals in shallow groundwater areas within the Merced Subbasin (MAGPI 2008).

#### **Matching Quality to Use**

Matching water quality to use is directly linked to four other resource management strategies: pollution prevention, recycled municipal water, salt and salinity management, and groundwater/aquifer remediation. Matching quality to use strategies recognize that water quality should suitably match its intended use such that water quality constituents do not adversely affect the intended use of water. Several benefits of maintaining and matching water quality to use include: reduction of disinfection byproducts in delivered drinking water sources, opportunities for blending water sources through improvements in treated water quality, potential to reduce energy use due to reduced quality needs, and avoiding costly treatment procedures.

Strategies for matching water quality to use identified by the California Water Plan Update 2009 include:

managing water supplies to optimize and match water quality to the highest possible use and to the appropriate technology;

encouraging upstream users to minimize the impacts of non-point urban and agricultural runoff and treated wastewater discharges;

supporting the development of salt management plans;

reviewing projects to determine the potential impacts from wastewater elimination into local streams; and

supporting research into solutions to the potential conflicts between ecosystem restoration projects and the quality of water for drinking water purposes.

#### *****Merced IRWM Region Efforts*****

Projects and programs that match quality to use in the Merced IRWM Region are listed below.

**Merced Salinity and Nutrients in Groundwater & Surface Waters Study**. Through the IRWM program, stakeholders in the Merced Region will be developing a salinity and nutrient management study, which will identify water quality issues in the region and provide a basis for managing salinity and nutrients in the Merced IRWM Region.

**Uses of Non-Potable Water.** Two municipalities within the Region, the City of Merced and the City of Atwater, currently supply treated wastewater to agricultural users and to wildlife management wetlands. This allows water reuse to occur without the additional treatment that may be required if this water were to be reused for other purposes (City of Atwater 2006 and City of Merced 2011).

#### **Pollution Prevention**

Pollution prevention strategies are vital for protecting and improving water quality at its source, and for preventing costly water treatment options. Preventing pollution throughout watersheds ensures that water supplies can be used and reused for a broad number of uses.

Pollution prevention strategies identified by the California Water Plan Update 2009 include:

developing proper land management practices that prevent sediment and pollutants from entering source waters;

establishing drinking water source and wellhead protection programs to protect drinking water sources and groundwater recharge areas from contamination;

identifying communities relying on groundwater contaminated by anthropogenic sources for drinking water and take appropriate regulatory action; and

addressing improperly destroyed, sealed and abandoned wells that can serve as potential pathways for groundwater contaminants.

#### *****Merced IRWM Region Efforts*****

Examples of current pollution prevention strategies employed within the Region are listed below.

**Merced Storm Water Management Program.** The City of Atwater, the City of Merced, the County of Merced, and the Merced Irrigation District are co-permittees (the Merced Storm Water Group) jointly implementing a regional Storm Water Management Program that covers the majority of the Region (Merced Storm Water Group 2007). The Merced Storm Water Group’s Storm Water Management Program addresses priority pollutants that are common in stormwater runoff from municipal areas, and therefore works to prevent pollution within the Region (Merced Storm Water Group 2007).

#### **Salt and Salinity Management**

Accumulation of salts in soil can impair crop productivity, making salinity management a critical concern for the Region’s highly productive agricultural industry. Salinity management strategies establish or improve salinity management in the Region based on an understanding of salt loading and trsnport mechanisms. Several potential benefits of establishing or improving salt and salinity management include: protecting water resources and improving water supplies, securing, maintaining, expanding, and recovering usable water supplies, and avoiding future significant costs of treating water supplies and remediating soils.

Salt and salinity management strategies identified by the California Water Plan Update 2009 include:

developing a regional salinity management plan, and interim and long-term salt storage, salt collection, and salt disposal management projects;

monitoring to identify salinity sources, quantifying the level of threat, prioritizing necessary mitigation action, and working collaboratively with entities and authorities to take appropriate actions;

reviewing existing policies to address salt management needs and ensure consistency with long-term sustainability; and

collaborating with other interest groups to optimize resources and effectiveness;

identifying environmentally acceptable and economically feasible methods for closing the loop on salt.

#### *****Merced IRWM Region Efforts*****

An example of a current salt and salinity management strategy employed by the Region is listed below.

**Merced Salinity and Nutrients in Groundwater & Surface Waters Study**. Through the IRWM program, stakeholders in the Merced Region will be developing a salinity and nutrient management study, which will identify water quality issues in the region and provide a basis for managing salinity and nutrients in the Merced IRWM Region.

#### **Urban Runoff Management**

Urban runoff management strategies involve managing both stormwater and dry weather runoff. To successfully manage urban runoff, agencies need to incorporate other resource management strategies such as pollution prevention, land use planning and management, watershed management, urban water use efficiency, recycled municipal water, recharge area protection, and conjunctive management. Several potential benefits of urban runoff management strategies include: minimizing soil erosion and sedimentation problems, reducing surface water pollution, protecting natural resources, protecting and augmenting groundwater supplies, and improving flood protection.

Urban runoff management strategies identified by the California Water Plan Update 2009 include:

coordinating efforts with agencies, stakeholders, and the public to decide how urban runoff management should be integrated into work plans;

encouraging public outreach and education concerning funding and implementation of urban runoff measures;

designing recharge basins to minimize physical, chemical, or biological clogging;

working with community to identify opportunities to address urban runoff management;

providing incentives for the installation of low impact development features on new and existing developments; and

emphasizing source control measures and strong public education/outreach efforts as being the most effective way to manage urban runoff in this highly arid region.

#### *****Merced IRWM Region Efforts*****

An example of a current urban runoff management strategy employed by the Region is listed below.

**Merced Storm Water Management Program.** The City of Atwater, the City of Merced, the County of Merced, and the Merced Irrigation District are co-permittees (the Merced Storm Water Group) that jointly implement a regional Storm Water Management Program covering the majority of the Region (Merced Storm Water Group 2007). The Merced Storm Water Group’s Storm Water Management Program addresses priority pollutants that are common in stormwater runoff from municipal areas, and emphasizes implementing urban runoff management strategies.

### Improve Flood Management

#### The RMS identified in the Improve Flood Management category is:

* Flood Risk Management

This RMS is discussed in further detail below.

#### **Flood Risk Management**

The Merced Region is subject to flooding, and many portions of the Region are located within the 100-year flood zone as defined by the Federal Emergency Management Agency (refer to *Chapter 2, Region Description* for more information). Reducing flood risks will require management strategies that enhance flood protection through projects and programs that assist in managing flood flows and to prepare for, respond to, and recover from floods.

Flood risk management strategies identified by the California Water Plan Update 2009 include:

Structural approaches that can consist of:

Setting back levees

Modifying channels to include lining (i.e. concrete, rip rap) to improve conveyance of flood flows

High flow diversions into adjacent lands to temporarily store flows

Improved coordination of flood operations

Maintaining facilities to secure the long-term preservation of flood management facilities

Land use management approaches that consist of:

Floodplain function restoration to preserve and/or restore the natural ability of undeveloped floodplains to absorb, hold, and release floodwaters

Floodplain regulation

Development and redevelopment policies

Housing and building codes

Disaster Preparedness, Response, and Recovery for flood risk management approaches such as:

Information and education

Disaster preparedness

Post-flood recovery

#### *****Merced IRWM Region Efforts*****

An example of a current flood risk management strategy employed by the Region is listed below.

**Merced IRWM Region Integrated Flood Study**. In conjunction with preparation of the IRWM Plan, the Region is working on an Integrated Flood Study that will improve integrated flood management in the Region. This effort will result in the preparation of a report that sill summarize opportunities to coordinate and integrate Merced IRWM flood management planning with progress made by the Central Valley Flood Management planning process (MAGPI 2010).

### Practice Resources Stewardship

#### RMS identified in the Practice Resources Stewardship category include:

* Agricultural Lands Stewardship
* Economic Incentives (Loans, Grants and Water Pricing)
* Ecosystem Restoration
* Forest Management
* Recharge Area Protection
* Water-Dependent Recreation
* Watershed Management

These RMS are discussed in further detail below.

#### **Agricultural Lands Stewardship**

Agricultural lands stewardship is the practice of conserving and improving land for various conservation purposes as well as protecting open spaces and rural communities. This strategy allows landowners to maintain their farms and ranches rather than being forced to sell their land due to pressures from urban development. Several potential benefits of agricultural lands stewardship management strategies include: protecting environmentally sensitive lands, recharging groundwater, improving water quality, providing water for wetland protection and restoration, increasing carbon sequestration within soil, and reducing costs of flood management.

Agricultural land stewardship strategies identified by the California Water Plan Update 2009 include:

stabilizing streambanks to slow bank erosion and filter drainage water from the fields;

installing windbreaks (i.e. trees and/or shrubs) along field boundaries to help control soil erosion, conserve soil moisture, improve crop protection among many other benefits;

performing conservation tillage to increase water infiltration and soil water conservation and reduce erosion and water runoff; and

encouraging irrigation tailwater recovery to help capture and reuse irrigation runoff water to benefit water conservation and off-site water quality.

#### *****Merced IRWM Region Efforts*****

An example of a current agricultural lands stewardship management strategy employed by the Region is listed below.

* **UC Merced Agricultural Conservation Courses**. The University of California, Merced (UC Merced) currently offers courses regarding conservation and other sustainable agricultural techniques. These courses vary, but may include things such as education regarding soil erosion and conservation tillage (UC Merced 2012).

#### **Economic Incentives (Loans, Grants and Water Pricing)**

Economic incentives can influence water management, amount of water use, time of use, wastewater volume, and source of supply. Types of incentives include low interest loans, grants, and water rates and rate structures. Free services, rebates, and use of tax revenues to partially fund water services have a direct effect on the prices paid by water users. Several potential benefits of establishing or improving economic incentive-based strategies include: promoting efficient water management practices and encouraging the adoption/improvement of water efficient/ on-site water recycling technologies.

Economic incentive management strategies identified by the California Water Plan Update 2009 include:

* instituting loans and grant programs that support better regional water management;
* adopting policies that promote long-term water use efficiency;
* developing modeling tools for economic analyses of economic incentives as well as guidelines and ranking criteria for grant and loan awards; and
* exploring innovative financial incentives.

#### *****Merced IRWM Region Efforts*****

Example economic incentive strategies employed by the Region are listed below.

* **MID Incentives**. MID implements several efficient water management practices that include economic incentives to promote water use efficiency (MID 2003).
* **City of Merced Water Use Efficiency.** The City of Merced implements several demand management measures that aim to promote long-term water use efficiency, including: water waste prohibition ordinances and metering with commodity rates that allow for billing to occur by volume of use (City of Merced 2011).

#### **Ecosystem Restoration**

Ecosystem restoration strategies are vital for improving modified natural landscapes and biological communities. Restoration of aquatic, riparian, and floodplain ecosystems are of primary concern as those are most directly affected by water and flood management actions and likeliest to be affected by climate change. Several potential benefits of establishing ecosystem restoration strategies include: improves water quality and quantity for wildlife, aquatic species, and human consumption, and increases diversity of native species and biological communities.

Ecosystem restoration strategies identified by the California Water Plan Update 2009 include:

* increasing the use of setback levees and floodwater bypasses;
* creating programs that support and fund the identification of stream flow needs;
* establishing biological reserve areas that connect or reconnect habitat patches;
* expanding riparian habitat;
* devising climate change adaptation plans that benefit ecosystems, water, and flood management;
* reproducing natural flows in streams and rivers;
* controlling non-native invasive plant and animal species; and
* filtering of pollutants and recharging aquifers.

#### *****Merced IRWM Region Efforts*****

An example of a current ecosystem restoration strategy employed by the Region is listed below.

* **Environmental Water Provisions.** The Region has a growing environmental water demand, and MID and other water purveyors regularly release water to augment natural flows in streams and rivers. For example, since 2000 MID has released approximately 60,000 acre-feet of water per year for the Vernalis Adaptive Management Plan to facilitate the migration of juvenile Chinook salmon (MAGPI 2008).

#### **Forest Management**

Forest management strategies focus on activities that are designed to improve the availability and quality of water for downstream users on both publicly and privately owned forest lands. Water produced by forest has an economic value that equals or exceeds that of any other forest resource (CWP 2009). Several potential benefits of establishing forest management strategies include: interception of rainfall, reduction of urban runoff, energy-efficient shade during hot weather, reduce flooding and increase dry-season base flows, and protection from surface erosion and filtering pollutants.

Several forest management strategies identified by the California Water Plan Update 2009 include:

* establishing long-term monitoring to understand hydrologic changes resulting from possible climate change effects through the installation of stream gages, precipitation stations, water-quality and sediment monitoring stations, and long-term monitoring wells;
* increasing research efforts into identifying effective BMPs for forest management and the effects of wildfires;
* assessing sediment sources and erosion processes in managed and unmanaged forested watersheds;
* increasing multi-party coordination of forest management;
* improving communication between downstream and upstream water users; and
* developing public education campaigns for water users.

#### *****Merced IRWM Region Efforts*****

Although local water agencies that constitute the RWMG currently have no responsibility to manage the upland forested areas that drain to the Region, protection of those headlands is important for ensuring high quality surface runoff supplies.

#### **Recharge Area Protection**

Recharge areas provide the primary means of replenishing groundwater. Strategies to protect recharge areas ensure the continual capability for the area to recharge groundwater. Protecting recharge areas requires the implementation of urban runoff management strategies, groundwater remediation strategies, and conjunctive management strategies. Several potential benefits of establishing recharge area protection strategies include: protecting and maintaining high-quality groundwater, increased amount of groundwater storage, reduction of urban runoff, and some removal of microbes and chemicals through percolation.

Recharge area protection strategies identified by the California Water Plan Update 2009 include:

* expanding research into surface spreading and the fate of chemicals and microbes in recharge water;
* increasing funding for the identification and protection of recharge areas;
* creating education and media campaigns to increase public awareness and knowledge on the importance of recharge areas and relevancy to groundwater;
* requiring source water protection plans; and
* developing methods for analyzing the economic benefits and costs of recharge areas.

#### *****Merced IRWM Region Efforts*****

An example of a current recharge area protection strategy employed by the Region is listed below.

* **Cressey Basin Direct Recharge Project.** MID has implemented a pilot direct recharge project at the Cressey Basin, which has the potential to recharge up to 10,000 acre-feet per year when surface water is available (MAGPI 2008).

#### **Water-Dependent Recreation**

Water-dependent recreation strategies are vital to ensuring enjoyment of water recreation activities currently and in the future. Maintaining and protecting water-dependent activities such as fishing, swimming, birding, boating, and others can provide economic, environmental, and social benefits.

Water-dependent recreation strategies identified by the California Water Plan Update 2009 include:

* using existing data and new surveys to determine recreational needs;
* partnering with schools to provide drowning prevention programs primarily aiming at youth from urban and low income families;
* developing partnerships with universities to coordinate monitoring of public recreation use, equipment, and emerging water recreation trends;
* developing a procedure to incorporate climate change assessments within all infrastructure planning, budgeting, and project development;
* researching, identifying, and mitigating impacts of stream flows that prevent Native Americans from participating in their traditional cultural activities; and
* developing invasive species prevention measures.

#### *****Merced IRWM Region Efforts*****

An example of a water-dependent recreation strategy employed by the Region is listed below.

* **Lake Yosemite**. Various recreational opportunities are available to residents and visitors in and/or around Lake Yosemite, these include: picknicking, fishing, boating, waterskiing, wind surfing, and swimming (County of Merced 2007).

#### **Watershed Management**

Watershed management strategies increase and sustain a watershed’s ability to provide for the diverse needs of the communities that depend on it. Managing at the watershed scale has proven effective in coordinating and integrating the management of numerous physical, chemical, and biological processes. Watershed management provides a basis for greater integration and collaboration among those policies and actions.

Watershed management strategies identified by the *California Water Plan Update 2009* include:

* creating a scientifically valid tracking and reporting method to document changes in the watershed;
* assessing the performance of projects and programs;
* providing watershed information to better inform local land use decision makers on how to maintain and improve watershed functions; and
* using watershed approaches in which all RMS strategies are coordinated.

#### *****Merced IRWM Region Efforts*****

An example of a watershed management strategy employed by the Region is listed below.

* **Merced River Alliance Project**. The Merced River Alliance was formed to establish and promote a river-wide, watershed-scale view of the Merced River to engage stakeholders in a collaborative effort to work together to protect this valuable resource. The Merced River Alliance Project Final Report focuses on assessing and evaluating the Merced River at the watershed-scale (EMRCD 2008).

### Other Strategies

The California Water Plan Update 2009 and the Proposition 84 and Proposition 1E IRWM Guidelines (DWR 2010) identified other potential RMS that can aid in meeting water management goals and objectives; however, these strategies are currently limited in their ability to address long-term regional water planning needs. These strategies consist of crop idling for water transfers, dewvaporation or atmospheric pressure desalination, fog collection, irrigated land retirement, rainfed agriculture, and waterbag transport/storage technology.

#### **Crop Idling for Water Transfers**

Crop idling is a strategy that removes lands from irrigation and makes water available for transfers. Several of the potential benefits from implementing this strategy include: enhancing water supplier reliability by making water available for redistribution, enhancing water quality, protecting and restoring fish and wildlife, and helping farm communities (as well as urban areas) infuse money into the local economy while increasing the reliability of water supply for urban consumers.

Crop idling strategies identified by the California Water Plan Update 2009 includes:

* developing necessary coordination structures to satisfy agency policy requirements;
* consulting with agencies and entities that will be leading crop idling programs; and
* understanding the local community impact and third party impacts to develop and implement necessary actions for maintaining economic stability of local communities and mitigating socioeconomic impacts.

#### *****Merced IRWM Region Efforts*****

With an agricultural production value of approximately $1.5 billion annually (within Merced County), which generates a large amount of secondary economic activity, agriculture is a significant economic driver in the Region (MAGPI 2009). Due to the high value of agricultural crops within the Region and the benefits that agriculture imparts to the Region’s economy, crop idling is not a feasible RMS for the Merced Region.

#### **Dewvaporation or Atmospheric Pressure Desalination**

The dewvaporation or atmospheric pressure desalination strategy would heat brackish water until deposits of fresh water are collected as dew from the opposite side of a heat transfer wall. The heat sources for this strategy can be derived from multiple sources (i.e. fuel, solar, waste heat) and the energy required for evaporation can be supplied by the energy released from the dew formation.

Though dewvaporation technology is still being developed in California, Arizona State University (ASU) currently has a dewvaporation pilot project underway. The potential benefits of this technology include the ability to provide small amounts of water in remote locations (basic tests have produced up to 150 gallons per day) and the ability to reclaim salt water at relatively low costs.

#### *****Merced IRWM Region Efforts*****

Dewvaporation or atmospheric pressure desalination is not currently being planned or explored in the Merced IRWM Region because it is not a feasible RMS. Due to low water yields expected from this strategy, it is unlikely to serve as a future water source for the Region.

#### **Fog Collection**

Fog collection is a form of precipitation enhancement that has yet to be used in California, although it does occur naturally along coastal zones. Though there is interest to use this strategy for increasing domestic water supplies in dry areas, such as California desert regions, this strategy is more appropriate for regions near the ocean.

The potential benefits of fog collection primarily include increasing water supplies. For example, a fog collection project in Chile yielded about 2,800 gallons per day from about 37,700 square feet of collection net. However, this strategy produces limited volumes of water supply.

#### *****Merced IRWM Region Efforts*****

Due to climactic conditions in the Region, which results in negligible amounts of fog, fog collection is not currently being planned or explored in the Merced IRWM Region.

#### **Irrigated Land Retirement**

Irrigated land retirement is the removal of farmland from irrigated agriculture and increasing water availability for redistribution for other uses. The potential benefits from retiring irrigated land include: enhancing water supply reliability, enhancing water quality, protecting and restoring fish and wildlife resources, reducing drainage volume and associated costs due to drainage disposal.

Strategies for facilitating irrigated land retirement programs identified by the California Water Plan Update 2009 include:

* evaluating and ensuring urban areas receiving water made available from land retirement have exhausted all means of water conservation;
* making all land retirement programs voluntary;
* studying local community and third party impacts from land retirement such as from reduced agricultural production inputs, reduced farm income, and habitat restoration; and
* developing and implementing necessary actions for maintaining the economic stability of local communities and mitigating socioeconomic impacts.

#### *****Merced IRWM Region Efforts*****

Irrigated land retirement is not currently being planned or explored in the Merced IRWM Region. As explained above with crop idling, high agricultural productivity and resulting economic outputs from the agricultural industry in Region make this highly unlikely in the near-term future.

#### **Rainfed Agriculture**

The rainfed agriculture strategy involves providing consumptive water use to crops by rainfall on a real time basis. Several of the potential benefits associated with rainfed agriculture include increases in water supply (though limited), improved post harvest/pre-planting soil management for winter crops, and decreases in soil erosion. However, due to the unpredictability of rainfall frequency, duration, and amount, this strategy is highly uncertain and risky. Additionally, the quantification of any potential water savings from rainfed agriculture, though small, will not be possible due to lack of available information.

Strategies for implementing rainfed agriculture programs identified by the California Water Plan Update 2009 include:

* developing new technologies, management, and efficient water management practices for rainfed agriculture;
* providing technical and financial assistance for implementing rainfed agriculture technologies and management practices; and
* developing cooperative efforts to link rainfed agriculture runoff and water banking and conjunctive use activities and groundwater recharge.

#### *****Merced IRWM Region Efforts*****

While rainfed agriculture is not currently employed within the Region, due to variable precipitation and the abundance of agriculture, this strategy could potentially be employed in the future.

#### **Waterbag Transport/Storage Technology**

The waterbag transport/storage technology involves diverting water in areas that have unallocated freshwater supplies, storing the water in large inflatable bladders, and towing them to an alternate coastal region. Currently, this strategy is not used in California though there have been various proposals for this technology worldwide. Several of the potential benefits associated to waterbag transport/storage technology includes: improvements in drought preparedness and water quality, reductions in groundwater overdraft, and provides environmental, energy and water supply benefits.

#### *****Merced IRWM Region Efforts*****

The Merced IRWM Region is located inland, and is surrounded by mountains. Because the Region lacks access to an ocean port, waterbag transport/storage technology is not currently being planned or explored in the Region.

## Adapting Resource Management Strategies to Climate Change

The variability of location, timing, amount, and form of precipitation in California, suggested as a result of climate change, could present some uncertainty to the availability of future surface water supplies for the Region. DWR has determined that the Sierra snowmelt is shrinking and that melting is occurring earlier, shifting runoff from the spring further into the winter and causing winter flooding. Concerns about climate uncertainty have resulted in the need to adapt existing flood management and water supply systems in response to changing conditions.

As vulnerability tools and assessments are developed related to impacts that climate change may have on water resources, additional adaptation strategies will be identified to address the potential region-specific impacts of climate change.

Achievable “no regret” management practices for addressing climate change concerns that the Merced IRWM Region can employ include:

* continued investment in local water conservation;
* diversification of local water supply portfolio;
* practicing integrated flood management;
* increasing conjunctive use of available water supplies;
* protecting and restoring water-related ecosystems;
* increasing water reuse and recycling;
* monitoring local and regional activities;
* tracking related legislation;
* investigating water supply/energy relationships and coordinating with larger water utilities; and
* following the State’s required adaptation strategies and legislation.

RMS that are implemented to manage water resources can also address climate change adaptation and/or mitigation. **Table 3** was adapted from the California Water Plan Update 2009; it categorizes resource management strategies and identifies greenhouse gas (GHG) reduction opportunities associated with each RMS.

Table 3: Resource Management Strategies and Greenhouse Gas (GHG) Reduction Opportunities

| Management Objectives | Resource Management Strategy | GHG Reduction Opportunities |
| --- | --- | --- |
| Reduce Water Demand | Agricultural Water Use Efficiency Urban Water Use Efficiency | Reducing water demands will reduce groundwater pumping demands, which result in GHG emissions. |
| Improve Operational Efficiency and Transfers  | Conveyance – Regional/localSystem ReoperationWater Transfers | Improving operational efficiencies can improve the overall efficiency of the Region’s water system, thereby reducing cumulative energy demands and GHG emissions. |
| Increase Water Supply | Conjunctive Management & Groundwater Precipitation EnhancementRecycled Municipal WaterSurface Storage – Regional/local | Localize water use, and efficiently reuse water to reduce groundwater pumping requirements and associated GHG emissions. |
| Improve Water Quality  | Drinking Water Treatment and DistributionGroundwater Remediation/Aquifer RemediationMatching Quality to UsePollution PreventionSalt and Salinity ManagementUrban Runoff Management | Stabilize water cycles by conserving water systems to their natural state. |
| Improve Flood Management  | Flood Risk Management | Controlling flooding in a holistic watershed-based nature will potentially reduce the need for construction of intensive flood control systems. This will reduce energy and associated GHG emissions that would be required for construction. |
| Practice Resources Stewardship | Agricultural Lands StewardshipEconomic Incentives (Loans, Grants and Water Pricing)Ecosystem RestorationForest ManagementRecharge Area ProtectionWater-Dependent RecreationWatershed Management | Provide opportunities for carbon sequestration, reforestation, and reduce climate change impacts by restoring/maintaining land surfaces. |
| Other | Rainfed Agriculture | Reduce energy requirements and GHG emissions from decreased groundwater pumping demands. |

Source: DWR 2009