Dreissenid Mussel Infestations in California
September 2011

INTRODUCTION

Quagga mussel infestations have been documented in California since early 2007. The quagga mussels were first discovered in California in Lake Havasu, part of the Colorado River, then subsequently, in the Colorado River Aqueduct. Since then, quagga mussels have spread to many other Southern California lakes and reservoirs that receive raw water from the Colorado River via the Colorado River Aqueduct. In January 2008, zebra mussels were found in San Justo Reservoir in San Benito County. At this time, zebra mussels have not, to our knowledge, spread beyond San Justo Reservoir. Table 1 below provides a list of the known quagga and zebra mussel infested waterbodies in California.

Table 1: Quagga and Zebra Mussel Infested Waterbodies

Waterbody Name	County Location	Date Infestation Found
Lake Havasu	San Bernardino County	January 2007
Colorado River at Parker Dam	San Bernardino County	January 2007
Copper Basin Reservoir	San Bernardino County	March 2007
Colorado River Aqueduct	Riverside County	July 2007
Lake Mathews	Riverside County	August 2007
Lake Skinner	Riverside County	August 2007
Lower Otay Reservoir	San Diego County	August 2007*
San Vicente Reservoir	San Diego County	August 2007*
Murray Reservoir	San Diego County	September 2007*
Lake Miramar	San Diego County	December 2007
El Capitan Reservoir	San Diego County	January 2008*
Sweetwater Reservoir	San Diego County	December 2007*
Dixon Lake	San Diego County	August 2007
Olivenhain Reservoir	San Diego County	March 2008
Lake Jennings	San Diego County	April 2008*
Lake Ramona	San Diego County	March 2009
Lake Poway	San Diego County	May 2010
San Justo Reservoir[1]	San Benito County	January 2008
Imperial Dam	Imperial County	February 2008
Kraemer Basin	Orange County	September 2009
Anaheim Lake	Orange County	September 2009
Irvine Lake	Orange County	April 2008*
Rattlesnake Reservoir	Orange County	May 2008*
Walnut Canyon Reservoir	Orange County	July 2009
Black Gold Golf Course Pond	Orange County	January 2010

This paper provides a summary of each of the infested waterbodies, including information on any Monitoring, Response, and Control Plans (Response Plans) submitted to the California Department of Fish and Game (DFG). When

[1] San Justo Reservoir is the only location at this time in California where a zebra mussel infestation has been found. Quagga mussels have currently not infested San Justo Reservoir.
* Quagga mussels were first discovered in the veliger stage by cross-polarized light microscopy prior to detection of adults.

available, water quality information has also been summarized. Appendix B of this document provides a summary of laboratory procedures used for analyzing samples for zebra and quagga mussel veligers.

Summaries are organized by water district and grouped by county. Several of the water districts in Southern California own and operate multiple reservoirs and have submitted Monitoring, Response, and Control Plans representing multiple infested waterbodies. Appendix C is the U.S Geological Survey map showing infested areas in California.

WATERBODY SUMMARIES

Metropolitan Water District of Southern California

Metropolitan Water District of Southern California (MWD) represents 26 cities and water districts and provides drinking water to over 19 million customers in Los Angeles, Orange, San Diego, Riverside, San Bernardino, and Ventura Counties. MWD has nine reservoirs within its system, three of which are infested with quagga mussels. These include Copper Basin, Lake Mathews, and Lake Skinner. In addition, MWD manages the Colorado River Aqueduct which stretches from Lake Havasu to Lake Mathews.

MWD applies chlorine at three locations within the Colorado River water canals and aqueduct. The locations are the effluent from Copper Basin on the Colorado River Aqueduct, and the effluent from Lake Mathews and Lake Skinner downstream of the outlet towers. The chlorine dose ranges between 0.9 and 1.2 mg/L, with a free chlorine residual target between 0.3 and 0.5 mg/L. The residual is measured downstream of the injection point so they can monitor and make adjustments to the chlorine dose if necessary. The free chlorine dissipates before it enters any downstream lakes.

In May 2008, MWD finalized Part l of their Quagga Mussel Control Plan, a boat inspection program for Diamond Valley Lake and Lake Skinner and submitted the Quagga Mussel Control Program – Part II to DFG. Part Il of MWD's Quagga Mussel Control Program (Control Plan) describes an overall approach for addressing the quagga mussel infestation when MWD releases water from quagga mussel infested waterbodies. The Control Plan establishes three categories for locations that may receive water as part of scheduled maintenance and shutdown activities. Category I locations have no quagga mussel impact to downstream locations. Category II locations are those locations that have been previously identified as infested with quagga mussels or are considered to have a high likelihood of infestation in the near future. Finally, Category III locations are non-contiguous waterbodies that are not currently infested with quagga mussels. MWD's Control Plan focuses on the Category III locations. When MWD identifies a discharge that could potentially lead to a Class III waterbody, a specific Risk-Reduction Plan will be submitted to DFG.

These Risk-Reduction Plans, or Raw Water Discharge Plans, are considered Part lll of MWD's Quagga Mussel control Program. They will identify actions MWD intends to follow to prevent quagga mussels from spreading into uninfested waterbodies from infested source water. Typically, actions will involve either percolating the infested water into the ground before it reaches an uninfested waterbody, followed by a period desiccation, or containing and returning the discharge water to the original waterbody. MWD has a legal obligation to release water into certain creeks or rivers. Risk-Reduction Control Plans would need to be developed for these releases if the source water contains quagga mussels.

When a water release is planned, MWD must submit a Raw Water Discharge Plan that describes the discharge event and control activities planned to prevent quagga mussels from entering an uninfested waterbody. The Raw Water Discharge Plan includes checkpoints along the route of the discharge. At each checkpoint, stream flow and rainfall are monitored. If the flow or rainfall is too high, the discharge event is either scaled back or terminated, if necessary. The raw water is allowed to percolate into the streambed, followed by desiccation for a minimum of 14 days. In some instances, MWD may incorporate chlorination and/or filtration into the Raw Water Discharge Plan. Each Raw Water Discharge Plan must be submitted to DFG for approval. To date, DFG has approved over ten separate Raw Water Discharge Plans for MWD. Most of these plans have been for routine maintenance activities. In addition, MWD has three existing water agreements in which they are required, by law to release water into downstream creeks or rivers. Two of these agreements are for water releases from Lake Skinner and Lake Mathews, both of which are infested with quagga mussels.

Lake Havasu

Lake Havasu is located on the Colorado River, behind Parker Dam, in San Bernardino County. The reservoir can hold up to 648,000 acre-feet of water. Its primary purpose is to store water for pumping into two aqueducts. The Mark Wilmer Pumping Plant pumps water into the Central Arizona Project aqueduct; the Whitsett Pumping Plant pumps water into the Colorado River Aqueduct in California.

Lake Havasu is well known for its recreational activities, including, boating, hiking, hunting, picnicking, swimming, and fishing for catfish, bluegill, crappie, largemouth and striped bass. Lake Havasu is also known for its fishing, power boating and waterskiing tournaments.

In January 2007, adult quagga mussels were found in Lake Havasu. They were likely introduced into Lake Havasu as a result of downstream migration from Lake Mead.

Copper Basin Reservoir

Copper Basin Reservoir is located in San Bernardino County, west of Lake Havasu. It is owned by MWD and is used for drinking water. There is no public access allowed at Copper Basin Reservoir. The reservoir can store up to 22,000 acre-feet of water.

In March 2007, adult quagga mussels were found in Copper Basin Reservoir. MWD has been continuously chlorinating at the reservoir's outfall to reduce the quagga mussel population before it enters the Colorado River Aqueduct.

Colorado River Aqueduct

The Colorado River Aqueduct (CRA) was constructed between 1932 and 1941 by MWD. It stretches 242 miles from Lake Havasu to Lake Mathews, in Riverside County. There are five reservoirs associated with the CRA: Gene Wash, Copper Basin, Lake Mathews, Lake Skinner, and Diamond Valley Lake. The CRA can deliver one billion gallons of Colorado River water daily to the metropolitan areas of southern California and has an annual delivery capacity of 1,212,000 acre-feet of water. The CRA is owned and managed by MWD. It is not accessible to the public. In July 2007, adult quagga mussels were found in the CRA.

Lake Mathews

Lake Mathews is a reservoir located in Riverside County in the foothills of the Santa Ana Mountains. It is the western terminus of the Colorado River Aqueduct. Lake Mathews is closed to the public. There is no boating, swimming or fishing allowed. Lake Mathews can store up to 182,000 acre-feet. The reservoir provides drinking water to Los Angeles and Orange Counties. Lake Mathews is owned by MWD, but managed by the Eastern Metropolitan Water District of Southern California (EMWD). EMWD was historically part of MWD, but became a separate water district in 1950. In 1951, EMWD became a MWD member agency.

In August 2007, adult quagga mussels were found in Lake Mathews. MWD developed a system-wide Quagga Mussel Control Program (Plan), which was submitted to DFG in May 2008. The Plan was approved by DFG on November 25, 2011. MWD's Plan is a general approach describing how they intend to address quagga mussels in their waterbodies and pipelines. Refer to the MWD discussion above for more information on this Plan.

An action plan for controlling quagga mussels in Lake Mathews was also provided to DFG in July 2008. MWD developed Phase I and Phase II actions to be taken to control quagga mussels in Lake Mathews. Phase I was to occur in the summer in the deeper areas of Lake Mathews and Phase II was scheduled for the fall in the shallow areas. Phase I involved using an onsite aerator to reduce dissolved oxygen concentrations to levels that are detrimental to adult mussels (typically less than 4 mg/L) for a minimum 3 week period. Phase II

involved partial drawdown of the reservoir to kill exposed mussels by desiccation. The initial plan was for a one year test period, since then MWD has been implementing the Phase I and Phase II actions approximately every three years. MWD has also implemented this action plan at Lake Skinner.

Lake Skinner

Lake Skinner is a reservoir located approximately 10 miles north of Temecula in Riverside County. Water from Lake Skinner feeds into the Robert A. Skinner Treatment Plant. The treatment plant supplies treated water for 2.5 million people who are customers of MWD member agencies, including Eastern and Western MWD and the San Diego County Water Authority (SDCWA). The reservoir can store up to 44,000 acre-feet of water.

Lake Skinner is also used as a recreational facility, allowing camping, fishing, hiking, picnicking, and boating activities, including rental boats. Fish species common at Lake Skinner include trout, catfish, bluegill, crappie, perch, bass, and carp. All boats that enter Lake Skinner must go through inspection prior to launching in the lake. Swimming is not allowed in the reservoir.

In August 2007, adult quagga mussels were found in Lake Skinner. MWD developed a system-wide Quagga Mussel Control Program (Plan), which was submitted to DFG in May 2008. The Plan was approved by DFG on November 25, 2011. MWD's Plan is a general approach describing how they intend to address quagga mussels in their waterbodies and pipelines. They have also developed and implemented a watercraft and equipment inspection program for both Diamond Valley Lake and Lake Skinner. The focus of the program at Lake Skinner is on watercraft exiting the lake; however, there are launch inspections in place, as well. All boats must be dry before leaving.

An action plan for controlling quagga mussels in Lake Mathews was provided to DFG in July 2008. This plan was also implemented at Lake Skinner. MWD developed Phase I and Phase II actions to be taken to control quagga mussels in Lake Mathews. Phase I was to occur in the summer in the deeper areas of the reservoirs and Phase II was scheduled for the fall in the shallow areas. Phase I involved using an onsite aerator to reduce dissolved oxygen concentrations to levels that are detrimental to adult mussels (typically less than 4 mg/L) for a minimum 3 week period. Phase II involved partial drawdown of the reservoir to kill exposed mussels by desiccation. The initial plan was for a one year test period, since then MWD has been implementing the Phase I and Phase II actions approximately every three years at both Lake Mathews and Lake Skinner.

United States Bureau of Reclamation

Colorado River at Parker Dam

The Colorado River at Parker Dam is part of the Lower Colorado River. The lower portion of the Colorado River begins at Parker Dam and flows to the Gulf of California. This stretch of the Colorado River is managed by the United States Bureau of Reclamation (USBR) Lower Colorado Region. USBR also owns the Imperial Dam and Reservoir in Imperial County. A description of the quagga mussel infestation in Imperial Reservoir can be found on page 17 of this report.

In January 2007, adult quagga mussels were found in the Lower Colorado River at Parker Dam. Since early 2008, USBR has implemented a mussel management program containing specific control measures at Parker Dam. USBR's program focuses on using different monitoring methods to track and control the infestation. USBR monitors artificial substrates for mussel presence with one-foot square steel plates placed underwater in the Parker Dam Forebay. USBR has also installed bio-boxes to monitor mussel settlement in the dam's cooling water pipes. The bio-boxes are visually inspected for mussels. If any mussels are found, the bio-box water supply pipelines are either flushed with hot water to kill the mussels or mechanically cleaned. USBR conducts monthly inspections of the exterior trash racks and domestic water line inlet. Quagga mussels are physically removed, as necessary. USBR is also evaluating certain techniques, like screen size and filter size, to evaluate their effectiveness at controlling quagga mussels. In addition, USBR is looking at different metal coatings to determine if they are effective at keeping quagga mussels from attaching to different surfaces.

City of San Diego Public Utilities Department

In September 2009, the City of San Diego Public Utilities Department (City of San Diego) submitted the Dreissena Mussel Response and Control Plan (Response Plan) to DFG. The Response Plan includes five quagga mussel infested reservoirs; Lower Otay Reservoir, San Vicente Reservoir, Murray Reservoir, Lake Miramar, and El Capitan Reservoir; and five that are not known to be infested, Lake Hodges, Morena Reservoir, Barrett Reservoir, Upper Otay Reservoir, and Sutherland Reservoir.

The Response Plan includes both a monitoring program, and a control and containment program. The monitoring program addresses both quagga mussel veligers and adults. Routine veliger sampling is conducted quarterly at Hodges, Sutherland, and Morena reservoirs, and the raw water supply system is monitored monthly. Adult quagga mussels are tracked on a monthly basis with artificial substrates. Substrates are used in El Capitan, Miramar, Murray, Lower Otay, San Vicente, Hodges, Morena, and Sutherland Reservoirs. Substrates are monitored monthly. In the event of a planned discharge, veliger monitoring will be conducted in the waterbody from which the discharge is planned. The final

aspect to the monitoring program is water quality profiling. Water quality profiles are done on a bi-weekly basis and monitor the following parameters: dissolved oxygen, pH, temperature, depth, conductivity, oxygen reduction potential, and chlorophyll pigment readings.

The City of San Diego's control and containment program includes boating and recreational restrictions, Best Management Practices (BMPs) during maintenance shutdowns and discharges, and research and development activities. The City has put into place restrictions on boating activities for all of the City of San Diego reservoirs. The City does not allow overnight slipping or mooring of any private boats at any of the reservoirs, which reduces the likelihood of quagga mussels attaching to boats. This requirement was put into place prior to quagga mussel infestations in response to liability and operational issues. The City provides educational materials to the public regarding quagga mussels, and posts signs at all launch ramps. The City also posted large metal signs at all infested reservoirs that provide instructions on what boaters must do prior to leaving the reservoir to ensure that quagga mussels are not spread to uninfested waterbodies. In addition, owners and operators of any vessel entering El Capitan Reservoir between June and September (busy boating season) will be instructed on quagga mussel cleaning procedures. City Ranger staff conduct weekly spot checks for boater compliance at each of the infested reservoirs instead of conducting inspections on all exiting watercraft. El Capitan Reservoir has daily spot checks during the busy season. Boating inspections of vessels entering the waterbodies are also in place at Sutherland Reservoir and Lake Hodges to reduce the spread of the quagga mussel into these uninfested waterbodies.

The City of San Diego has adopted BMPs to be followed during maintenance shutdowns and raw water discharges. These include filtering all discharges that could contain quagga mussel veligers and the development of site specific inspection plans and discharge operating plans for the raw water discharges.

The final component of the City's control and containment program involves research and development activities. The City conducted research on quagga mussel survivability in Miramar and Lower Otay reservoirs. The purpose of the study was to determine the survivability of the quagga mussels in the hypolimnion layer of the reservoirs. The City found that adult quagga mussels can survive in this layer for up to 25 days with dissolved oxygen concentrations below 0.5 mg/L. The City of San Diego intends to continue to be involved in research, training, and agency coordination opportunities as they become available.

Lower and Upper Otay Reservoirs

Otay Reservoir consists of Upper Otay Reservoir and Lower Otay Reservoir, both owned by the City of San Diego. Upper and Lower Otay reservoirs are located east of Chula Vista in San Diego County. Lower Otay Reservoir is the

terminus for the Second San Diego Aqueduct. Lower Otay Reservoir can store approximately 50,000 acre-feet of water, Upper Otay Reservoir can store 1,266 acre-feet of water.

Upper Otay Reservoir is a recreational reservoir used for catch and release shoreline fishing only. Fish species commonly found in Upper Otay Reservoir include bass, bluegill, bullhead and trout. Boating is not allowed on Upper Otay Reservoir.

Lower Otay Reservoir is used for water supply and recreation. Boating, fishing, (including tournament fishing), picnicking, and hiking are allowed at Lower Otay Reservoir. Fish species commonly found at Lower Otay Reservoir include bass, crappie, bluegill, and channel, blue and white catfish. It is also the home of the U.S. Olympic Training center for rowing sports.

In August 2007, quagga mussel veligers were found in the Lower Otay Reservoir. To date, quagga mussels have not been found in the Upper Otay Reservoir, which can drain into the Lower Otay Reservoir. In September 2009, The City of San Diego Public Utilities Department submitted the Dreissena Mussel Response and Control Plan (Response Plan) to DFG. This Response Plan represents five quagga mussel infested reservoirs, including Lower Otay Reservoir. Refer to the San Diego Public Utilities Department discussion above for a summary of this Response Plan.

San Vicente Reservoir

San Vicente Reservoir is located approximately 25 miles northeast of the City of San Diego. The reservoir is currently closed to the public during the SDCWA San Vicente Dam Raise Project, which will create an additional 152,000 acre-feet of water supply. The reservoir is scheduled to reopen to the public sometime between 2014 and 2017. Once the City reopens the reservoir, recreational activities will include picnicking, hiking, boating and fishing for bass, bluegill, crappie, sunfish, trout and channel, blue and white catfish.

Water supply for the San Vicente Reservoir comes from San Vicente Creek and the Colorado River via the First San Diego Aqueduct branch of the Colorado River Aqueduct from Lake Havasu. San Vicente Reservoir is the terminus for the First San Diego Aqueduct.

In August 2007, quagga mussel veligers were found in San Vicente Reservoir. In September 2009, the City of San Diego Public Utilities Department submitted the Dreissena Mussel Response and Control Plan to DFG. Refer to the San Diego Public Utilities Department discussion above for a summary of this Response Plan.

Murray Reservoir

Murray Reservoir is located between the City of San Diego and the City of La Mesa. It is owned and operated by the City of San Diego. Murray Reservoir is open to the public for recreational activities, including fishing, boating, and day use activities. Fish species commonly found in Murray Reservoir include bass, crappie, bluegill, trout and channel catfish. Murray Reservoir can store approximately 4,700 acre-feet of water.

In September 2007, quagga mussel veligers were found in Murray Reservoir. In September 2009, the City of San Diego Public Utilities Department submitted the Dreissena Mussel Response and Control Plan to DFG. Refer to the San Diego Public Utilities Department discussion above for a summary of this Response Plan.

Lake Miramar

Lake Miramar is located southwest of the City of Poway in San Diego County. The reservoir is owned and operated by the City of San Diego. This reservoir was built as part of the Second San Diego Aqueduct project. Water in Lake Miramar originates from the Colorado River Aqueduct and the California Aqueduct. Lake Miramar can store approximately 6,700 acre-feet of water. The reservoir is open to the public for recreational activities, including fishing, boating and day use activities. Fish species commonly found at Lake Miramar include bass, bluegill, sunfish, trout, and channel catfish.

In December 2007, adult quagga mussels were found in Lake Miramar. In September 2009, the City of San Diego Public Utilities Department submitted the Dreissena Mussel Response and Control Plan to DFG. Refer to the San Diego Public Utilities Department discussion above for a summary of this Response Plan.

El Capitan Reservoir

El Capitan Reservoir is located approximately 30 miles northeast of the City of San Diego on the San Diego River. The reservoir is owned and operated by the City of San Diego. El Capitan Reservoir is filled primarily with watershed runoff; however, sometimes water is imported from San Vicente Reservoir. El Capitan Reservoir is the City of San Diego's largest reservoir and can store 112,807 acre-feet of water. El Capitan Reservoir's primary purpose is to supply drinking water, but it also functions as a recreational facility. The public has access to the reservoir and can participate in activities such as fishing, hiking, picnicking, boating, waterskiing, wakeboarding, and use of personal watercrafts. Fishing tournaments are also held on El Capitan Reservoir. Fish species commonly found in El Capitan Reservoir include bass, bluegill, crappie, sunfish, and blue and channel catfish.

In January 2008, quagga mussel veligers were discovered in El Capitan Reservoir. In September 2009, the City of San Diego Public Utilities Department

submitted the Dreissena Mussel Response and Control Plan to DFG. Refer to the San Diego Public Utilities Department discussion above for a summary of this Response Plan.

Sweetwater Authority

Sweetwater Reservoir and Lake Loveland

Sweetwater Reservoir is located southeast of the City of San Diego. The reservoir is owned and operated by the Sweetwater Authority. Sweetwater Authority provides water service to approximately 187,000 people in National City, Bonita, and the western and central portions of Chula Vista. The Sweetwater Authority's watershed area includes the Sweetwater River and two impoundments along the river, Lake Loveland and Sweetwater Reservoir.

In April 2008 quagga mussel veligers were detected in Sweetwater Reservoir, and in January 2009 adult quagga mussels were found at the intake tower at the reservoir. To date, quagga mussels have not been detected in Lake Loveland.

Lake Loveland is located upstream of Sweetwater Reservoir. The lake can store up to 25,400 acre-feet of water and is a holding area for water which is released to Sweetwater Reservoir. Sweetwater Authority allows only shoreline fishing at Lake Loveland. It is common to find bass, catfish, bluegill, and redear sunfish in the lake. Lake Loveland receives water from Palo Verde Lake, which is a small upstream private lake owned and managed by the Palo Verde Lake Home Owner's Association. According to the Sweetwater Authority, it is unlikely for Palo Verde Lake, and therefore Lake Loveland, to become infested with quagga mussels because the Palo Verde Lake Home Owner's Association implements a boat inspection and decontamination program.

Sweetwater Reservoir receives water from Sweetwater River and Lake Loveland, groundwater from wells in National City and Chula Vista, and imported water from the Colorado River or the State Water Project. The reservoir can store up to 28,079 acre-feet of water. Sweetwater Reservoir is also used for limited recreational activities for the public. Public boating is not allowed at Sweetwater Reservoir but the Sweetwater Authority does allow some limited shoreline fishing for bass, carp and catfish. The Sweetwater Authority banned live bait at both Sweetwater Reservoir and Lake Loveland in an attempt to prevent quagga mussel infestations.

In October 2007, the Sweetwater Authority submitted the Sweetwater Authority Dreissenid Mussel Monitoring, Response, and Control Plan (Response Plan) to DFG. Comments on the October 2007 Response Plan were provided to the Sweetwater Authority and a revised Response Plan was submitted in February 2009. The revised Response Plan was approved by DFG on June 24, 2009.

The Sweetwater Authority's Response Plan is comprised of a monitoring component, a control component, and a public outreach component. The Response Plan provides information on four different types of monitoring activities: artificial substrate sampling, monitoring using remotely operated vehicles or divers, veliger monitoring through plankton tows, and visual inspections of surface areas and infrastructure.

Control activities in Sweetwater Reservoir include chemical control, mechanical control, and physical control. The Water Treatment Plant's processes have been shown to effectively remove and inactivate the quagga mussel veligers. Chemical controls include the application of chlorine or chlorine dioxide to the raw aqueduct pipeline water and the raw water that enters the Robert A. Perdue Water Treatment Plant. Mechanical control involves physically removing adult quagga mussels from intake screens during regular maintenance. In addition, the City may evaluate the use and durability of copper based coatings for intake screen surfaces. Additionally, Sweetwater Reservoir undergoes some physical changes that can help control quagga mussels. The reservoir has an anaerobic layer that forms in the lower reaches in the late spring and summer. This layer can potentially be maximized to control quagga mussels.

The Sweetwater Authority has boats that go between Sweetwater Reservoir and Lake Loveland. The Sweetwater Authority has a Dreissenid Mussel Boat Decontamination Protocol that they follow to prevent spreading quagga mussels to Lake Loveland.

The final component of the Sweetwater Authority's Response Plan is a public outreach and education component. The Sweetwater Authority is conducting outreach by making flyers and pamphlets available to the public at fishing areas at both Sweetwater Reservoir and Lake Loveland, posting information about the quagga mussel infestation on the Sweetwater Authority's website, and mailing educational information to customers with the bi-monthly water bills.

City of Escondido

Dixon Lake

Dixon Lake is owned and operated by the City of Escondido (City). It is located east of the City in San Diego County. The City supplies water to approximately 26,000 residential, commercial, and agricultural customers, some of which comes from Dixon Lake. Water in Dixon Lake is imported from the Colorado River and the State Water Project through the Metropolitan Water District of Southern California (MWD). The reservoir is also utilized for recreation by the general public for boating, camping, picnicking, hiking, and fishing for trout, catfish, bluegill, redear sunfish, and Florida bass. The City of Escondido only allows rental boats at the reservoir. Swimming and wading are not allowed in Dixon Lake.

In August 2007, adult quagga mussels were found in Dixon Lake. It is probable that the mussels were introduced via the Colorado River Aqueduct. In July 2009, the City submitted a Dreissenid Mussel Monitoring, Response, and Control Plan (Response Plan) to DFG. Comments on the July 2009 Response Plan were provided to the City and a revised Response Plan was submitted in April 2010. The revised Response Plan was approved by DFG on May 4, 2010.

The Response Plan is comprised of a monitoring component, a control component, and a public outreach component. The Response Plan provides information on three different types of monitoring activities: substrate sampling, monitoring using remotely operated vehicles or divers, and visual inspections. The City does not conduct veliger sampling at this time, since quagga mussels have already been found at Dixon Lake. Control activities in the reservoir include chemical control and mechanical control. Currently, the Escondido Waste Treatment Plant uses chlorine or chlorine dioxide during treatment of water from Dixon Lake. Mechanical control involves physically removing adult quagga mussels from intake screens during regular maintenance. In addition, the City may evaluate the use and durability of copper based coatings for intake screen surfaces. Since Dixon Lake does not allow private boats, they do not have boat decontamination protocols in place. Also, customers are not allowed to use their own motors or anchors, or other types of submersible equipment. The final component of the City's Response Plan is a public outreach and education component. The City is conducting outreach by making flyers and pamphlets available to the public at fishing areas, posting information about the quagga mussel infestation on the City's website, and making public contacts by the reservoir staff.

San Diego County Water Authority

Olivenhain Reservoir and Lake Hodges

The San Diego County Water Authority (SDCWA) serves the western third of San Diego County, extending from Orange and Riverside Counties to the border with Mexico. SDCWA provides water to 24 member agencies. The majority of SDCWA's water is received from the Metropolitan Water District of Southern California (MWD) facilities at Lake Skinner. The water originates from both the Colorado River and the State Water Project.

Olivenhain Reservoir and Lake Hodges are two reservoirs within the SDCWA system located outside the City of Escondido in San Diego County. Olivenhain Reservoir is a storage reservoir that is reserved as emergency supply in case imported water deliveries cease. It is owned by SDCWA and operated by Olivenhain Municipal Water District. There is no public access at Olivenhain Reservoir. The reservoir can store up to 24,789 acre-feet of water. Lake Hodges is a non-contact recreational reservoir owned by the City of San Diego.

Recreational activities allowed at Lake Hodges include boating, hiking, and fishing for bass, crappie, bluegill, channel catfish and carp. The reservoir currently receives water from Olivenhain Reservoir and through local runoff from rainfall. Lake Hodges provides drinking water to Santa Fe Irrigation District and San Dieguito Water District. Lake Hodges can store up to 30,251 acre-feet of water.

Since October 2007, SDCWA has been conducting vulnerability analyses throughout the entire SDCWA system In March 2008 adult quagga mussels were found in SDCWA's system at Olivenhain Reservoir and pipeline. Veligers were found shortly thereafter in the Olivenhain system. Since Olivenhain Reservoir is not open to the public, the source of the quagga mussel infestation was determined to be from imported Colorado River water. In April 2008, a single sample from Lake Hodges tested positive for quagga veligers. Since then all veliger tests have been non-detects. At this time, Lake Hodges is considered free of quagga mussels.

Once mussels were discovered, a routine monitoring program was put into place. This program includes artificial substrate monitoring, plankton tows, remotely operated vehicle (ROV) inspection, and other physical monitoring of the quagga mussel population. Substrate monitoring is conducted monthly and involves the use of coupons, either steel plates or PVC, at different locations in SDCWA's system. Plankton tows are conducted monthly during the months of March through November. Scripps Institution of Oceanography in San Diego analyzes the water samples for veligers using both Polymerase Chain Reaction (PCR) and microscopy. ROV inspections are performed three times a year to inspect critical facility components. Finally, SDCWA conducts physical monitoring during operational maintenance activities, including checking rocks and loose materials near the shoreline.

As part of the Emergency Storage Project, a system designed to make water available to the San Diego region in the event of a disruption of normal water deliveries, the SDCWA has recently completed a pipeline that connects Olivenhain Reservoir and Lake Hodges. This pipeline provides SDCWA with the ability to store 20,000 acre-feet of water at Lake Hodges for emergency use and will make water from Lake Hodges available to customers throughout the region. In addition, when water is transferred downhill from Olivenhain Reservoir to Lake Hodges, it will generate enough electricity for 26,000 homes. SDCWA submitted the Dreissenid Mussel Response and Control Plan (Response Plan) for both Olivenhain Reservoir and Lake Hodges. SDCWA's Response Plan was approved by DFG on January 3, 2011.

SDCWA's Response Plan is composed of seven management actions to manage the existing quagga mussel infestation and to control the spread of infestation to uninfested waterbodies. The seven management actions described include: (1) Evaluate system component vulnerability, (2) Perform regular system

monitoring, (3) Comply with established reporting requirements, (4) Perform outreach activities, (5) Participate in research projects, (6) BMPs to minimize mussel spread, and (7) Implement BMPs for mussel population management.

SDCWA's reporting requirements include water release reports and annual reports to be submitted to DFG and the Regional Water Quality Control Board, as necessary. Outreach activities are in place to promote awareness of the quagga and zebra mussel issue. SDCWA intends to present information to general staff, provide information to its 24 member agencies, and provide pamphlets, posters, and other publications to the general public. SDCWA also intends to participate in research projects, where practical, to improve response and control options for the quagga and zebra mussels.

The final two components of SDCWA's Response Plan are BMPs for both preventing the spread of quagga mussels and controlling existing quagga mussel infestations. For the Olivenhain Reservoir/Lake Hodges Project, SDCWA provided information that indicates that is likely that quagga mussel veligers will die as they pass through turbines prior to entering Lake Hodges. In addition, Lake Hodges experiences periods of anoxia. The combination of the turbines and the lake conditions may provide enough protection to keep quagga mussels from establishing in Lake Hodges. A BMP that SDCWA intends to use to control the spread of quagga mussels is the use of filtration during planned water releases. SDCWA has been using filtration since February 2008 and considers it to be a primary control for uninfested waterbody protection. BMPs that SDCWA intends to use to control existing infestations include reservoir drawdown for mussel desiccation, spot super-chlorination in isolated instances, and physical removal of mussels.

Helix Water District

Lake Jennings

Lake Jennings is owned and operated by Helix Water District. Helix Water District serves approximately 266,000 residents in the cities of La Mesa, Lemon Grove, El Cajon, and other unincorporated communities in San Diego County. In addition to Lake Jennings, Helix Water District includes Lake Cuyamaca, and portions of El Capitan Reservoir. Lake Jennings is located in the city of Lakeside in San Diego County, has a storage capacity of 9,790 acre-feet and serves as the Water District's primary source of operational and emergency water supply. It also serves as a recreational facility and offers activities such as fishing, boating, hiking, and camping to the public. Fishing boats are the only boats allowed on Lake Jennings. Fish species commonly found at Lake Jennings include trout, catfish, bluegill, and bass. Water sources for Lake Jennings include imported and local water sources, with SDCWA imports being the primary source.

In April 2008, quagga mussel veligers were found at Lake Jennings. Water from Lake Jennings is routed to the R.M. Levy Water Treatment Plant. The Plant currently utilizes treatment processes that effectively kill quagga mussel veligers, eliminating the possibility of an infestation in the treatment plant facility. Lake Cuyamaca is not connected to the imported SDCWA water supply system; therefore, it is not vulnerable to infestation from that source.

On November 30, 2009, Helix Water District submitted a Quagga Mussel Monitoring, Response, and Control Plan (Response Plan) to DFG to address the quagga infestation in Lake Jennings. The Water District's Response Plan was designed to provide technical and procedural guidance in the detection of adult and veliger quagga mussels.

The Helix Water District Response Plan is comprised of three components: monitoring, control, and public outreach. The monitoring component consists of monthly artificial substrate monitoring, periodic visual inspections of substrates, shorelines and surface walls, and fish screens. The control component includes leaving the lake at a minimum level for several weeks every year to control the population of quagga mussels in the upper 25 feet of the lake, as well as periodically taking sections of the pipeline system out of service for inspections. If any adult quagga mussels are found during inspections, they are removed. In addition to controlling the existing infestation in Lake Jennings, Helix Water District uses a filtration system to prevent the spread of mussels to uninfested waterbodies. All water that leaves Lake Jennings is passed through a 25 micron filtration system prior to release. The final component of the Water District's Response Plan is an education and outreach component. The Water District intends to educate the general public regarding the quagga mussel issue and the potential for spreading the mussels to uninfested waterbodies by providing materials and brochures to all customers launching private boats in Lake Jennings.

Ramona Municipal Water District

Lake Ramona

Lake Ramona is owned and operated by the Ramona Municipal Water District. It is located approximately two miles Northwest of Lake Poway in San Diego County. The lake can store up to 12,000 acre-feet of water, all of which, is provided by SDCWA. The water from Lake Ramona is used in the Highland Valley area for commercial growers. Lake Ramona is also a recreational facility for hiking, picnicking, and shoreline fishing for bass. Swimming, wading, rafting, boating, or float tubes are not allowed.

In March 2009, adult quagga mussels were found at Lake Ramona. In October 2009, the Ramona Municipal Water District submitted the Quagga Mussel Response Plan (Response Plan) to DFG. The Ramona Municipal Water

District's Quagga Mussel Response Plan is comprised of monitoring, control, and public outreach components. The monitoring component consists of monthly inspections of coupons placed in the lake; inspections of the shoreline, and inlet and outlet structures of the dam; monitoring the untreated water system routinely; and inspecting all tanks, pump stations, fire hydrants, water mains, and meter connections. The control component entails receiving pre-chlorinated water from the SDCWA aqueducts, not allowing any discharges of lake water to downstream areas, and annually lowering the lake's water level to kill off adult quagga mussels through desiccation of the lake perimeter. In addition, Ramona Municipal Water District intends to chlorinate the untreated water in the distribution system for a 30-day period every year. The final component of the Water District's Response Plan is a public outreach and education component. The Water District intends to provide information to the public by posting signs at the lake entrance, posting quagga mussel information on the Ramona Municipal Water District's web site, and distributing flyers at the main office.

City of Poway

Lake Poway

Lake Poway is located in the City of Poway in San Diego County. The lake, which can store over one billion gallons of water, is a domestic water supply reservoir owned and operated by the City of Poway. Water is imported to Lake Poway from the Colorado River and the Northern California Aqueduct. Water is routed from Lake Poway to the Lester J. Berglund Water Treatment Plant, where it is treated and then sent out to Poway customers.

In addition to being a domestic supply, Lake Poway also serves as a recreational facility. The City of Poway allows fishing, camping, picnicking, hiking, and boating at the lake. Fish species commonly found at Lake Poway include trout, Florida bass, bluegill, and channel catfish. Private boats are not allowed, but the City does provide rental boats. Row and electric boats are the only boats available for rent. Swimming and wading are prohibited. In May 2010, adult and veliger quagga mussels were discovered in Lake Poway.

San Benito County Water District

San Justo Reservoir

San Justo Reservoir is located approximately 3 miles southwest of the City of Hollister in San Benito County. The reservoir was built as part of the Central Valley Project. San Justo Reservoir is owned by the U.S. Bureau of Reclamation (USBR) and managed by San Benito County Water District (SBCWD). Water in San Justo Reservoir originates from the San Luis Reservoir. San Justo Reservoir can store 10,308 acre-feet of water that is primarily used to store water to ensure that the County has sufficient water supply during the peak water use

period of March through September. It is also a recreational reservoir. Recreational activities include fishing, boating using non-powered boats, and day use activities. Fish species commonly found at San Justo Reservoir include rainbow trout, black bass, catfish, bluegill, and crappie. The reservoir can also serve as a temporary water supply in the event that the San Luis Reservoir is shut down.

In January 2008, adult zebra mussels were found in San Justo Reservoir. Due to the zebra mussel infestation, the reservoir is no longer open to the public for recreational activities.

In October 2008, the San Francisco Estuary Institute, on behalf of USBR and SBCWD, developed an Action Plan to address the zebra mussel infestation in San Justo Reservoir. The Action Plan provides an assessment of possible eradication actions for the reservoir. The preferred treatment option described in the Plan involves adding potassium chloride (also known as potash) to the reservoir in concentrations that would kill all of the juvenile and adult mussels. A formal eradication plan for San Justo Reservoir is in the early stages of development by USBR. Environmental permitting requirements under the California Environmental Quality Act and the National Environmental Policy Act must be met prior to the finalization of the eradication plan. An Initial Study for the environmental permits is currently being developed. In addition, USBR will be applying for a Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 18 permit, through the California Environmental Protection Agency, to apply potash as a molluscicide. An expected completion date for the eradication plan is unknown at this time.

Imperial Irrigation District

Imperial Dam & Reservoir

Imperial Dam and Reservoir is located on the California/Arizona border, approximately 18 miles northeast of the City of Yuma in Arizona. The dam and reservoir are owned by USBR and operated by Imperial Irrigation District (IID). The Imperial Reservoir retains water from the Colorado River. Beyond the dam, water from the Colorado River goes through a desilting system and then into the All American Canal on the California side and the Gila Gravity Main Canal on the Arizona side. The desilting system removes most of the sediment in the water to keep the canals from clogging. The dam was originally built to raise the water surface by 25 feet to provide controlled gravity flow of water to the two canals. When built in 1938 Imperial Reservoir had a storage capacity of 85,000 acre-feet; however, the reservoir is filled with sediment and currently has a capacity of 1,000 acre-feet.

In February 2008, adult quagga mussels were found at Imperial Dam and Reservoir. USBR and IID staff are taking steps to control the quagga mussels.

The system was inspected to identify the facility's potential exposure to quagga mussels and the impacts the mussels may have. USBR and IID coordinated to develop a dive schedule to video quagga mussel activity on the trash racks and measuring devices. In addition, the USBR Yuma Area Office held a workshop so that member water districts of the Imperial Dam Advisory Board and other interested entities could exchange quagga mussel information and experiences.

Orange County Water District

Orange County Water District (OCWD) manages the groundwater basin beneath northern and central Orange County and supplies water to over 20 cities and water agencies. The District manages two dozen groundwater recharge basins, including Kraemer Basin and Anaheim Lake. OCWD's recharge basins mostly receive water from the Santa Ana River; however, water can be delivered from Lake Skinner and Lake Mathews by MWD.

In September 2009, veliger and adult quagga mussels were found in both Kraemer Basin and Anaheim Lake. Both of the groundwater recharge basins that were infested were drained and allowed to dry for more than two weeks, allowing for quagga mussel desiccation. In addition, OCWD submitted a Dreissena Mussel Monitoring, Response and Control Plan (Response Plan). There are three potential ways for quagga mussels to get into OCWD's recharge system. The first way is by purchasing raw Colorado River Aqueduct water from MWD. The second way is from Irvine Lake. According to OCWD, Irvine Lake occasionally spills into Santiago Creek and the Santiago Basins (one of OCWD's recharge basins) during wet winters. The Colorado River Aqueduct and Irvine Lake are already infested with quagga mussels, so any water received from these sources could contain mussels. The third possible method of introduction is through the use of privately owned fishing boats that have been used on infested waterbodies and then used on the Santa Ana River Lakes, since they are open to fishing. This third pathway for quagga mussel introduction has been addressed by OCWD banning all private boating on the Santa Ana Lakes. At this time, only rental boats are allowed.

OCWD's Response Plan is comprised of monitoring, control, and outreach components. OCWD monitoring activities focus on visual monitoring of the groundwater recharge basins. Surface surveys are conducted during dewatering events at each basin. OCWD focuses on hardened features and areas where it is likely for quagga mussels to colonize. Artificial substrate and veliger sampling are not conducted at this time, but may be incorporated in the future if further infestation of quagga mussels is discovered. The primary control mechanism currently in place by OCWD is the physical control method of dewatering each recharge basin for a minimum desiccation period of two weeks per year. In addition, some of the deeper recharge basins develop an anoxic hypolimnetic layer, which could aid in the control of quagga mussels. OCWD also has adopted a boat inspection and decontamination program for OCWD boats that go

between the different recharge basins that includes decontaminating all OCWD boats and basin cleaning vehicles after use. The final aspect of OCWD's Response Plan is a public outreach component. Outreach includes posting signs at recreational basins informing users about the potential for spreading quagga mussels to uninfested waterbodies, as well as information regarding decontamination methods. OCWD will provide awareness information to the public at OCWD offices and at the recreational basins.

Kraemer Basin

Kraemer Basin is a groundwater recharge basin located in Orange County. The basin is owned and operated by OCWD. OCWD receives water from the Santa Ana River, the Colorado River, the State Water Project, local precipitation, and recycled water. The basin can store up to 1,170 acre-feet of water and is a terminal basin in the OCWD system.

In July 2009, veliger and adult quagga mussels were discovered in Kraemer Basin. In October 2009, OCWD submitted the Dreissenid Mussel Monitoring, Response and Control Plan (Response Plan) to DFG. The OCWD Response Plan was developed for both Kraemer Basin and Anaheim Lake, as well as for several other uninfested groundwater recharge basins under OCWD's control. Refer to the Orange County Water District discussion above for a summary of this Response Plan.

Anaheim Lake

Anaheim Lake is a private fishing lake and groundwater recharge basin located in the City of Anaheim in Orange County. The lake is managed by OCWD. This lake is typically only open to the public when the Santa Ana River Lakes are closed for maintenance. When the lake is open to the public, it is common to catch catfish and trout. Anaheim Lake can store up to 2,260 acre-feet of water and is a terminal basin in the OCWD system.

In September 2009, veliger and adult quagga mussels were found in Anaheim Lake. In October 2009, OCWD submitted the Dreissenid Mussel Monitoring, Response and Control Plan (Response Plan) to DFG. The OCWD Response Plan was developed for both Kraemer Basin and Anaheim Lake, as well as for several other uninfested groundwater recharge basins under OCWD's control. Refer to the Orange County Water District discussion above for a summary of this Response Plan.

Irvine Ranch Water District and Serrano Water District

Irvine Lake

Irvine Lake is located in the City of Silverado in Orange County. The reservoir is jointly owned by Irvine Ranch Water District (IRWD) and Serrano Water District (SWD), and is managed by SWD. IRWD serves the city of Irvine and portions of

Costa Mesa, Lake Forest, Newport Beach, Tustin, Santa Ana, and Orange, and unincorporated Orange County. The District provides water to approximately 330,000 customers. SWD serves Villa Park and a small portion of the city of Orange. Irvine Lake's water is mostly imported from the Colorado River Aqueduct and the State Water Project through the Metropolitan Water District of Southern California (MWD). Water from Irvine Lake is directed to three treatment plants, the Michelson Water Reclamation Plant, the Los Alisos Water Reclamation Plant, and the Walter E. Howiler Water Filtration Plant.

Besides acting as a water supply, Irvine Lake is also a recreational facility. The lake is stocked with fish and fishing is allowed. Fishing tournaments for trout, bass, and catfish are held throughout each year. Other fish species found in Irvine Lake include crappie, bluegill, sunfish, and sturgeon. Private boats, kayaks, and float tubes are also allowed. There is no swimming in Irvine Lake. The reservoir also allows camping and day use activities. The reservoir can store up to 28,000 acre-feet of water; however, it typically holds approximately 25,000 acre-feet.

In March 2008, juvenile and adult quagga mussels were discovered in Irvine Lake. In March 2009, IRWD and SWD submitted a joint Invasive Mussel Monitoring and Control Plan (Response Plan) for Irvine Lake to DFG. Comments were provided to both IRWD and SWD on the Response Plan and a revised version was submitted in July 2009. The July 2009 Response Plan was approved by DFG on October 14, 2009.

IRWD and SWD's Response Plan is comprised of monitoring actions, preventative measures, control measures, and containment measures. IRWD and SWD conduct several different types of monitoring, including water quality monitoring, veliger monitoring, adult surveys, substrate monitoring, and dive surveys. Water quality monitoring for physical and basic water chemistry parameters is conducted from weekly to annually at various locations throughout the lake, depending on the specific parameter. To date, water quality sampling has shown that Irvine Lake water is conducive for the quagga mussel and zebra mussel infestation and settlement. The lake contains a suitable environment for dreissenid mussels; specifically calcium levels between 70 and 90 mg/L and pH levels between 6.6 and 9.0.

Veliger monitoring is conducted by IRWD and SWD twice a month. Plankton samples are analyzed with Polymerase Chain Reaction (PCR) to identify species, and microscopy to determine veliger density. Adult quagga mussels are monitored monthly by three different methods. The first is through visual inspections of surface areas like buoys, boats, docks, anchors, rocks, and vegetation close to the shoreline. The second method involves the use of coupons like steel plates or blocks, or PVC. The coupons are placed in various locations in the lake and checked monthly for adult mussel settlement. The third

method is the use of monthly dive surveys to check for initial colonization of new waterbodies and to evaluate the extent of existing infestations.

IRWD and SWD's Response Plan also includes preventative measures. Although preventative measures are not applicable for Irvine Lake, they are used for minimizing the spread of quagga mussels to uninfested waterbodies. IRWD and SWD's preventative measures include public education actions and regulations. IRWD and SWD informs the public about the quagga mussel issue through newspaper articles, television coverage, presentations, mailings, boat ramp signs, and prevention strategy handouts. They also notified their irrigation customers of the infestation and recommended the use of a chlorination system at each agency. SWD has put in place a boat inspection program for all boats entering Irvine Lake. The program involves filling out a questionnaire and a visual inspection to confirm that the boat is clean and dry. If a boat fails inspection, it cannot be launched into Irvine Lake. IRWD and SWD have also established new regulations to prevent the spread of quagga mussels. These regulations include not allowing live or frozen bait from outside of Irvine Lake and the mandatory boat inspections discussed above.

The third component of IRWD and SWD's Response Plan is a control component. IRWD and SWD's Response Plan includes cultural controls, physical controls, and chemical controls. Cultural controls are techniques put in place to create an environment that is less favorable for quagga mussels. IRWD and SWD have proposed using desiccation as a control in certain areas of the lake, using non-fouling materials and coatings to decrease quagga mussel attachment to substrates, and suffocation by reducing the dissolved oxygen levels in the lake. Suffocation can be accomplished by turning off the aeration system in the summer to decrease dissolved oxygen levels at lower depths.

Physical controls that IRWD and SWD intend to use include monthly underwater cleaning, through use of high pressure washers to remove adult mussels from intake screens, and potentially the use of biological controls. IRWD and SWD are keeping up-to-date on options for biological controls.

IRWD's chemical control program consists of the use of chlorination at the Irvine Lake Pipeline. Any water leaving Irvine Lake via IRWD passes through a chlorination point. According to IRWD, it is highly unlikely that veligers survive beyond the chlorination point. SWD uses potassium permanganate as its chemical control. Potassium permanganate is used at the entry to the Howiler Water Treatment Plant to protect the plant's infrastructure.

IRWD and SWD's Response Plan also includes a containment measure component. The objective of these containment measures is to prevent the spread of quagga mussels from Irvine Lake to uninfested waterbodies. IRWD and SWD have two main containment measures in place. These measures are a Boat Exit Plan and the chlorination of outgoing water at the Irvine Lake Pipeline.

The Boat Exit Plan involves notifying boat users that there is a mussel infestation in Irvine Lake and that users are required to clean, drain, and dry their boats prior to leaving the reservoir. Outgoing boats are inspected when possible.

Rattlesnake Reservoir

Rattlesnake Reservoir is located south of Irvine Lake in Orange County. The reservoir is owned and operated by Irvine Ranch Water District (IRWD). All of the water stored in Rattlesnake Reservoir is recycled, tertiary-treated wastewater from the Michelson Water Reclamation Plant and non-potable water from Irvine Lake via the Irvine Lake Pipeline. Public access is restricted; however, there is a private fishing club. Rattlesnake Reservoir can store up to 1,700 acre-feet of water.

In May 2008, quagga mussel veligers were found in Rattlesnake Reservoir. Since the reservoir does not allow access to the public and the private fishing club boats are moored at Rattlesnake Reservoir, it is most likely that the quagga mussel infestation came from water imported from the Irvine Lake Pipeline before the chlorination system was installed. In October 2009, IRWD submitted the Invasive Mussel Monitoring and Control Plan (Response Plan) for Rattlesnake Reservoir to DFG. The Response Plan was approved on February 17, 2010.

IRWD's Response Plan includes a monitoring component and a control component. IRWD intends to conduct monthly monitoring for juvenile and adult quagga mussels. Plankton tows are used to monitor for juvenile mussels. Although monitoring has occurred over the last few years, quagga mussel veligers have not been detected since July 2008. Monitoring for adult quagga mussels is conducted through the use of visual inspections of surfaces like docks, buoys, boat hulls, and vegetation near the shoreline and the use of artificial substrates to target newly settling quagga mussels. In 2009, no adult or veliger quagga mussels were detected during monitoring activities. IRWD used a remote-controlled underwater camera to evaluate underwater structures for the 2010 year. Monitoring for adults and juvenile quagga mussels will continue as described in IRWD's Response Plan. DFG will evaluate this waterbody based on the 2010 Annual Report to determine if the reservoir should still be considered infested.

IRWD's control plan includes chemical control and containment measures. Chemical control is done through chlorination of the water as it leaves the reservoir. There are no discharges of untreated water from Rattlesnake Reservoir. Containment measures have been put in place at the reservoir to prevent the spread of quagga mussels to uninfested waterbodies. These measures include using sampling equipment exclusive to Rattlesnake Reservoir, desiccating plankton nets after each use, and keeping the monitoring boats dry on site.

City of Anaheim

Walnut Canyon Reservoir

Walnut Canyon Reservoir is located in the City of Anaheim in Orange County. It is owned and operated by the City of Anaheim, and capable of storing up to 920 million gallons of water for supplying water to homes and businesses in the Anaheim hill and canyon area. Water in Walnut Canyon Reservoir is imported as untreated Colorado River water through MWD of Southern California. The water is then treated at the August F. Lenain Treatment Plant prior to delivery to Anaheim Public Utilities customers. The only public access allowed is a paved trail around the reservoir that is made available for running, walking and biking. In July 2009, adult quagga mussels were found in Walnut Canyon Reservoir.

Black Gold Golf Course

The Black Gold Golf Course is located in the foothills of Yorba Linda in Orange County. The golf course is owned by the City of Yorba Linda and open to the public. There are water features spread throughout the course. In January 2010, a golf ball with a single adult quagga mussel attached to it was found in one of the golf course ponds. Following this discovery, surveys and dives were conducted and it was found that a population of quagga mussels had become established in the golf course pond. Later, it was determined that the water supply for the golf course water features is the Colorado River. DFG is currently following up on this issue.

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APPENDIX A: ACRONYMS

BMP	Best Management Practice
DFG	California Department of Fish and Game
CRA	Colorado River Aqueduct
EMWD	Eastern Metropolitan Water District of Southern California
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
IID	Imperial Irrigation District
IRWD	Irvine Ranch Water District
MWD	Metropolitan Water District of Southern California
OCWD	Orange County Water District
PCR	Polymerase Chain Reaction
ROV	Remotely Operated Vehicle
SBCWD	San Benito County Water District
SDCWA	San Diego County Water Authority
SWD	Serrano Water District
USBR	United States Bureau of Reclamation

Appendix B: Water Sample Analysis Techniques

There are two main approaches to veliger sample analysis: (1) cross-polarized light microscopy and (2) Polymerase Chain Reaction or PCR. The following is a brief description of each of these approaches.

(1) Cross-Polarized Light Microscopy

Quagga and zebra mussel veligers in a plankton sample cannot be easily differentiated from other materials within a sample using standard microscopy methods. Cross-polarized light microscopy is a method that can be used to determine presence/absence of quagga and zebra mussel veligers. Cross-polarized light microscopy involves using two polarizing filters that are oriented at right angles to each other. Light that passes through the first filter will then be blocked by the second filter; however, if there is an object between the two filters that reorients the light it will pass through the second filter. When this happens the objects become visible under the microscope as a bright spot. In freshwater, veligers are one type of object that can be seen using cross-polarized light microscopy. By utilizing this method the laboratory technician can count the number of veligers; however, cross-polarized light microscopy does not differentiate between quagga mussels and zebra mussels. In order to differentiate between the two species, performing a DNA analysis using PCR may be necessary.

(2) Polymerase Chain Reaction (PCR)

PCR is used for plankton tow analyses when a technician needs to differentiate between zebra mussels and quagga mussels, to confirm cross-polarized light microscopy results, or to initially screen samples for the presence or absence of mussels. PCR is used to amplify a specific DNA sequence so that it can be easily analyzed. The DNA sequence targeted for amplification can be unique to quagga mussels, zebra mussels or both. After amplification, the DNA is evaluated by a process called gel electrophoresis. Gel electrophoresis allows for comparisons between DNA amplified in an unknown sample with DNA amplified from a positive control sample. If the amplified DNA compares favorably, the unknown samples is considered to be positive for the presence of mussel DNA. If the comparison is not favorable, or more typically if there is no DNA amplification in the unknown sample, it can be assumed that detectable mussel DNA is absent from the unknown sample.

Appendix C: Locations of Dreissena Mussels in California