BEFORE THE STATE WATER RESOURCES CONTROL BOARD

In the Matter of the State Water Resources Control Board (State Water Board) Hearing to Determine whether to Adopt a Draft Cease & Desist Order against California American Water Regarding its Diversion of Water from the Carmel River in Monterey County under Order WR 95-10	Hearing Date: July 23 - 25, 2008 Carmel River in Monterey County

EXHIBIT MPWMD-TC1

TESTIMONY OF THOMAS CHRISTENSEN

RIPARIAN PROJECTS COORDINATOR

MONTEREY PENINSULA WATER MANAGEMENT DISTRICT

TESTIMONY OF THOMAS CHRISTENSEN

I, Thomas Christensen, provide the following prepared testimony under penalty of perjury, under the laws of the State of California, in relation to the State Water Resources Control Board (State Water Board or SWRCB) hearing to determine whether to adopt a draft Cease and Desist Order (CDO) against California American Water (CAW or Cal-Am) regarding its diversion of water from the Carmel River in Monterey County under SWRCB Order WR 95-10.

Q1: PLEASE STATE YOUR NAME AND QUALIFICATIONS.

1. My name is Thomas Christensen. I am employed with the Monterey Peninsula Water Management District as the Riparian Projects Coordinator. Essential functions of this position include: coordination of riparian restoration activities along the Carmel River, monitoring health and vigor of the riparian corridor on the Carmel River, and direct operations of the riparian irrigation program. My education includes a B.S. in Natural Resources Management from California Polytechnic State University, San Luis Obispo, and a M. S. in Hydrology from the University of Nevada, Reno.

2. I have been quantifying and documenting moisture stress in riparian vegetation along the Carmel River for ten (10) years. These observations help determine the timing and method of irrigation to off-set impacts associated with groundwater extraction. In addition these observations and measurements are summarized in periodic Riparian Corridor Monitoring Reports.

3. In addition to serving as the Riparian Projects Coordinator, I spent two (2) years (1998-2000) as a research assistant with the University of Nevada, Reno. In this position, I was involved with monitoring of how changes in streamflow, stage, and depth to groundwater

impacted the establishment of Fremont cottonwoods on the lower Truckee River in Nixon, Nevada. My resume is provided as **Exhibit MPWMD-TC2**.

Q2: PLEASE DESCRIBE THE RIPARAIN CORRIDOR OF THE CARMEL RIVER.

4. The 36-mile long Carmel River has a riparian corridor that is comprised mostly of black cottonwoods (*Populus balsamifera*), willows (*Salix ssp.*), white alders (*Alnus rhombifolia*), and sycamores (*Platanus racemosa*). In the upper canyon controlled sections, the width of the corridor is relatively narrow because it is confined by steep canyon walls. The lower 16-mile alluvial section of the Carmel River allows for a wider riparian corridor. However, many of these areas are narrow and discontinuous because of urban and agricultural development.

5. Approximately 438 acres of riparian cover exists between San Clemente Reservoir (River Mile 18.6) and the Carmel River lagoon (River Mile 0) based on 2001 orthoimagery. Willows and white alders tend to recruit close to the active channel where soil moisture is abundant. Black cottonwoods and sycamores tend to tolerate drier conditions and are located higher up on terraces and functional floodplains.

Q3: PLEASE DESCRIBE THE PHYSICAL SETTING AND PROCESSES THAT HELP SHAPE THE EXTENT OF THE CARMEL RIVER RIPARIAN CORRIDOR.

6. Over the last century, the Carmel River has undergone a transformation from a wide, meandering, shallow watercourse to a moderately incised channel. Major alterations in the hydrologic regime began in 1921 with the construction of the San Clemente Dam and Reservoir (1,425 acre-feet of capacity) at River Mile 18.6. The Los Padres Dam and Reservoir (3,030 acre-feet of capacity) was built in 1948 at River Mile 25.0. A combination of floodplain development in the 16-mile alluvial section, trapping of sediment load behind the dams (San Clemente Reservoir now only holds approximately 60 acre-feet of water and Los Padres has lost at least

50% of its storage capacity to sedimentation), and gravel mining in the channel bottom downstream of the dams, led to channel incision as shown in **Exhibit MPWMD-TC3**.

7. This channel incision has abandoned old stands of riparian vegetation on the 1911 floodplain terrace (**Exhibit MPWMD-TC4**). Therefore, new areas where riparian vegetation can establish is limited to steep banks or instream gravel bars that have the proper hydrology and soil moisture for successful recruitment. Seeds are typically dispersed March through May for black cottonwoods and willows. These seeds are short lived and are dispersed by wind and water. Seeds usually collect along the waterline and germinate on saturated soil when flows recede. This leads to linear patterns of seedlings along banks oriented perpendicular to the elevation gradient. What becomes the limiting factor for successful recruitment is the rate of groundwater decline and the maximum depth during the summer season.

8. Above normal hydrologic years tend to help increase riparian coverage and acreage where droughts tend to reduce riparian area. Floods may temporarily remove riparian vegetation from the active channel and banks. However, recovery can be dramatic and rapid due to abundant soil moisture and nutrients that are left behind after a flooding event.

Q4: PLEASE DESCRIBE THE HISTORY OF THE RIPARIAN CORRIDOR OF THE MID AND LOWER CARMEL RIVER WITH EMPHASIS ON THE SHORT TERM CHANGES.

9. Increased demands on groundwater beginning in the 1960's in conjunction with a severe two-year drought (Water Years 1976-1977) put an enormous amount of pressure on the limited water resources in Carmel Valley. Groundwater levels declined to unprecedented lows causing widespread mortality to riparian vegetation (between River Mile 5 and 15). It was this combination of drought, groundwater pumping and diversions in upper portions of the Carmel River that made an impact on the Carmel River riparian corridor. The degradation of the river corridor and decline in the steelhead population galvanized efforts within the community to find

solutions to the environmental problems. Currently the California red-legged frog (*Rana aurora draytonii*) and steelhead (*Oncorhynchus mykiss*) are listed as threatened in the watershed under the Federal Endangered Species Act (ESA). In 1983, MPWMD began a restoration program after 83 percent of river-front property owners approved a benefit assessment zone along the river to help fund projects.

10. Since 1986 the Carmel River watershed has had variable rainfall consistent with a Mediterranean climate. Stress was evident in the riparian corridor in the late eighties and many trees died which led to erosion events along the mainstream of the Carmel River. Then in 1988, MPWMD implemented the Interim Relief Program which was designed to help maintain flow in the lower river by making changes in diversion points and quantities. In addition, the Interim Relief Program started MPWMD's irrigation program to offset impacts to riparian vegetation associated with groundwater extraction. Then in 1995 with SWRCB Order WR 95-10, which required pumping to be concentrated in the lower river, relatively normal rainfall years (**Exhibit MPWMD-TC5**), multiple restoration projects on the Carmel River, the riparian corridor made a significant recovery, especially after Water Year 1995 when 36.29 inches of rain fell (average is 21.40 inches at San Clemente Reservoir). Water year classes are based on selected exceedence frequency values computed from the long-term reconstructed unimpaired flow record at the San Clemente Dam site (**Exhibit MPWMD-TC6**)

11. The recovery of the riparian corridor is quantified in a technical memorandum titled, "Using GIS to Quantify Riparian Area Overlying the Carmel River Valley Alluvial Aquifer." This showed a 46.5% increase in riparian cover from San Clemente Dam to the Carmel River Lagoon from 1986 to 2001 (**Exhibit MPWMD-TC7**). The following table is an excerpt from the technical memorandum. Aquifer subunit 1 (AQ1) extends from San Clemente Dam to the USGS gauge at Robles Del Rio (RM 14.4). Aquifer subunit 2 (AQ2) extends from Robles Del Rio to the Narrows (in the vicinity of Scarlett Rd). Aquifer subunit 3 (AQ3) goes from the

Narrows to the old Near Carmel USGS gauge (RM 3.6) and Aquifer subunit 4 (AQ4) between the Near Carmel gauge and the Carmel River lagoon:

Percent change in acres from 1986 to 2001 for Carmel River riparian (wooded) areas
(San Clemente Dam to Carmel River Lagoon)

Aquifer Subunit	Wooded acres 1986	Wooded acres 2001	% Change 01-86
AQ1	69.83	67.85	-2.84
AQ2	65.16	128.57	97.31
AQ3	80.98	131.81	62.77
AQ4	82.72	109.33	32.17
Total	298.69	437.56	46.49

12. An example of this recovery can be seen in **Exhibit MPWMD-TC8** comparing an aerial photo of the Carmel River in 1989 to a 2006 aerial photo taken behind Mid-Valley Shopping Center at RM 8. The 1989 photo shows very little riparian vegetation along the banks where the 2006 photo shows a healthy riparian corridor providing quality habitat.

Q5: PLEASE DESCRIBE LIMITING FACTORS THAT CONTROL THE HEALTH, VIGOR, AND RECRUITMENT OF TREES IN THE RIPARIAN CORRIDOR.

13. After the Carmel River began to incise and abandon its historical floodplain areas suitable for recruitment of riparian vegetation decreased. This happened because the river became constrained by development, agriculture, and its own steep banks. Since CAW is required to pump from their lower valley wells first based on agreements between the State Water Resources Control Board, NOAA Fisheries, California Department of Fish and Game, and MPWMD, it is primarily in the lower river down stream of Schulte Bridge (River Mile 6.7) that groundwater extraction impacts existing riparian vegetation and recruitment.

14. The groundwater pumping capacity for CAW wells is shown in **Exhibit MPWMD-TC9.** With respect to impacts to riparian vegetation MPWMD is primarily concerned with the lower six wells (Rancho Cañada, San Carlos, Cypress, Pearce, Schulte, and Manor wells) as shown in **Exhibit MPWMD-TC10**. When the river is flowing only 5 cubic feet per second (cfs) in the summer the cumulative impact of these wells or just several wells in combination can dewater the river as the cone of depression expands and starts a steady decline in depth to groundwater until winter rains restore flow to the river and recharge the aquifer (**Exhibit MPWMD-TC11**). However, it is important to note that there is a lag time associated with a change in depth to groundwater and moisture stress in individual plants. Plant available moisture is a function of matric potential (capillary and surface binding forces), osmotic potential produced by solutes in the soil water, gravitational forces, and external pressure. As the water table drops, residual moisture in the soil still provides water for a limited time to plants.

15. Because established mature riparian vegetation has different requirements for survival versus seedlings it is important to distinguish between the two when it comes to stress. Mature cottonwoods have been observed to exist in areas where the water table is 23 to 29.5 feet deep and black cottonwoods along the Carmel River have survived periods of time 33 feet above the water table. Canopy ratings and pre-dawn moisture potential readings have shown that these trees experience stress in the lower river during these times. These conditions may lead to mortality from primary factors such as depth to groundwater or secondary factors such as disease or insect predation, but mortality of large groups of trees has not been observed since 1995. Therefore, we see that established riparian vegetation seems to be doing fairly well in areas impacted by groundwater extraction when we have normal and above rainfall years. On the contrary cottonwood seedlings require water tables within 3.3 and 6.6 feet of the established surface and a gradual decline that root growth can keep pace with. We have found that once a large erosion event occurs on the lower river, and established vegetation is lost, that revegetation and irrigation is required to regenerate the riparian trees.

16. With regards to mature vegetation, when you combine pumping with several years of drought it becomes increasingly difficult for riparian vegetation to survive. In studies contracted by the MPWMD, a close connection has been demonstrated between groundwater pumping and the health of the riparian vegetation and increased channel instability. It was determined that plant stress was directly related to soil water availability and depth to groundwater and that mitigation was necessary in the form of irrigation if all four of the following criteria were met **Exhibit MPWMD-TC12**.

1. Dry river channel
2. Drop in the water table by greater than 2 feet/week or seasonally 8 feet or more below the elevation of the river channel
3. Unacceptable soil moisture levels
4. Unacceptable vegetation stress

17. In order to give a range in what we have seen in the past years, in 2007, a "critically dry" water year, the peak water table drop during a one week period was approximately 3.85 feet at the San Carlos monitoring well starting July 27, 2007. In 2001, a "normal" year, a peak of 1.29 feet of draw down occurred in the same well starting June 1, 2001.

18. The impact of drought and pumping on depth to groundwater can be seen on the following graph. In 1991 after one "dry" year and three "critically dry" years and pumping not strictly focused on the lower four wells depth to groundwater at the Reimers monitoring (Schulte Road Area, River Mile 6.72) well peaked around 54 feet. Then in 1993 when normal rainfall returned maximum depth to groundwater decreased. In addition, the concentration of diversions in the lower river also helped eliminate the extreme depths seen in the early 1990's (**Exhibit MPWMD-TC13**).

Q6: PLEASE DESCRIBE ACTIVITIES THAT MPWMD CARRIES OUT TO MONITOR AND MAINTAIN THE RIPARIAN CORRIDOR OF THE CARMEL RIVER.

19. MPWMD has been monitoring vegetation moisture stress in the riparian corridor since 1986. These methods have evolved over time, but essentially focus on measuring depth to groundwater, soil moisture, pre-dawn leaf water potential, and rating canopy defoliation in the areas most susceptible to groundwater extraction (CAW's lower four well area). During the months of May through October, staff takes weekly measurements of leaf water potential on target willow and cottonwood trees to provide an indication of plant water stress and corresponding soil moisture levels. Four locations (Rancho Cañada, San Carlos, Valley Hills, and Schulte) are monitored twice a month for pre-dawn leaf water potential. A total of 14 willows and 13 cottonwoods at these locations provide a data set of established and planted sample trees that are representative of trees in the Carmel River riparian corridor. Soil moisture measurements are conducted at three of these sites (San Carlos, Valley Hills, and Schulte) using tensiometers. Soil moisture values are measured at seven stations with 18-inch and 36-inch tensiometers in the soil column. Combined with monthly readings from the District's array of monitoring wells and pumping records for large-capacity Carmel Valley wells in the CAW system, the District's monitoring provides insight into the status of soil moisture through the riparian corridor.

20. In the 2007 monitoring season, MPWMD focused on canopy ratings instead of pre-dawn leaf water potential readings in order take a broader view of the riparian corridor. In addition, photos were taken of monitoring trees and the river corridor to document vegetation canopy cover change over time.

21. The Riparian Monitoring Reports for the Carmel River in 2001, 2004, and 2007 are shown in **Exhibit MPWMD-TC14-15-16**. These show the most recent results of this monitoring effort.

22. In general, with the arrival of spring adequate soil moisture is present associated with shallow depths to groundwater because the river is still flowing to the ocean. However, as summer approaches streamflow slowly is reduced until portions of the Carmel River go dry. At this point we start to see an increase in depth to groundwater associated with groundwater extraction. The three Riparian Corridor Monitoring Reports show that riparian vegetation begins showing signs of stress usually in mid summer (July) depending on whether the rainfall year was normal or not and the proximity of major production wells (**Exhibit MPWMD-TC17**). Established riparian vegetation in general survives this stressful period from about August through October in normal rainfall years. It is only after several very dry years that we have seen some mortality in groups of trees that don't have access to adequate soil moisture. Mature trees with established root systems tend to tolerate greater depth to groundwater than young recruiting trees.

23. In addition to vegetation monitoring, MPWMD runs and provides help with up to 11 irrigation systems to help alleviate stress to riparian vegetation associated with groundwater pumping and diversion. **Exhibit MPWMD-TC18** shows the amount of irrigation water applied to restoration projects and mitigation areas to offset impacts associated with groundwater extraction. These systems use a mix of sprinkler and drip irrigation methods depending on water quality, access through poison oak, and water pressure constraints. Poor water quality areas tend to clog emitters and require frequent maintenance. Some of these locations have had sprinklers added to help alleviate some of these maintenance issues.

24. The MPWMD also revegetates bare banks and violation areas (illegal cutting) that have poor recruitment. Since 1983 MPWMD has planted more than 55,000 willows and cottonwoods. Depending on the locations of these sites irrigation systems are usually incorporated.

Q7: PLEASE DESCRIBE ADDITIONAL MONITORING OF CALIFORNIA RED-LEGGED FROG (CRLF) AND AVIAN DIVERSITY (SPECIES DEPENDENT ON THE RIPARIAN CORRIDOR).

25. The Carmel River watershed meets the habitat requirements of California Red-legged frog (*Rana aurora draytonii*), which have been observed in backwater and off-channel pools along the Carmel River and its tributaries. These backwater and off-channel pools provide breeding habitat that is associated with still water (**Exhibit MPWMD-TC19**).

26. MPWMD has been recording sightings of CRLF along the Carmel River since 1989. Most of these sighting occur during steelhead rescues because the use of a backpack electro fishing device. Sightings are recorded on a form that rates habitat suitability. In 2004, all sightings and records where placed on a Geographic Information System map (**Exhibit MPWMD-TC20**). This map shows presence of CRLF in many areas along the Carmel River mainstream. In summary, with the known population at Rancho San Carlos and recent data of CRLF reproduction along the Carmel River, the Carmel River Watershed is extremely important to the CRLFs current distribution.

27. MPWMD has also been monitoring Avian Diversity along the Carmel River. Avian use of riparian habitat provides an excellent indicator of wildlife habitat value. Riparian ecosystems are considered the most valuable habitat for the conservation of California's resident and migrant land birds. In 1992, the District established nine permanent sampling locations for avian species monitoring. The purpose of this program is to measure bird use at the monitoring sites, thus providing an indication of changing patterns of habitat values in the District's restoration project areas. Information on bird populations and avian species diversity collected as part of the District's Mitigation Program has assisted in documenting trends in the response of wildlife populations to habitat enhancements implemented by the District.

28. These reports show that riparian focal species (species dependent on the riparian corridor) have increased significantly over the past 15 years and that the Carmel River offers

relatively high wildlife value. However, published population targets for the Central Coast suggest that riparian focal species density values in the watershed could be improved by increased restoration efforts. In addition, since 1992 the Carmel River has not had a significant change in the diversity of birds or shown a significant difference in Species Diversity Index for perennially watered and seasonally dry reaches of the river. (**Exhibit MPWMD-TC21**)

Q8: PLEASE DESCRIBE HOW THE CDO MAY AFFECT THE HEALTH AND VIGOR OF RIPARIAN VEGETATION, CALIFORNIA RED-LEGGED FROG, AND AVIAN SPECIES ALONG THE CARMEL RIVER.

29. Without a detailed groundwater and surface water model that predicts aquifer response based on a phased cutback in water extraction, it is difficult to assess the overall benefit to established riparian vegetation if a cutback were to occur. Intuitively, we know additional water will help riparian vegetation, reducing the extent of the cone of depression. However, it is not clear if this cutback will make a clear and measurable difference to the riparian vegetation during the timeframe that CAW is looking for a replacement source of water to comply with SWRCB Order WR 95-10 especially if we have normal to wet years. What we know is that the maximum extent of groundwater drawdown, and the rate of decline, are the driving factors with regards to stress in the riparian corridor. Knowing how these change, will improve our understanding of the benefits.

30. A phased cutback may improve seedling recruitment potential in eroded sections and of the lower Carmel River. However, MPWMD usually plants these areas and irrigates them to help prevent erosion and improve habitat. Currently bare exposed reaches on the lower Carmel River are limited to a few distinct areas.

31. The impact of a phased cutback on CRLF is a more tenuous problem because off channel pools are connected hydraulically to the river (because of the high hydraulic conductivity of sand and gravel). As the river dries, these pools dry as the water table drops with

little or no lag time. A phased cutback may allow for a reduced number of rescue and relocation operations for tadpoles in the lower river.

32. MPWMD has tried to understand the relationship of surface flow in the lower river and its impact on avian diversity. With so many additional water sources such as ponds, garden baths, the upper river, and the lagoon MPWMD has been unable to demonstrate and filter all the factors that impact avian diversity as it relates to water extraction. If a phased cutback increased water availability and riparian habitat quality, one could make the case for increased diversity, but to which level is poorly understood.

Q9: PLEASE DESCRIBE ADDITIONAL MEASURES THAT THE CDO COULD INCORPORATE TO HELP RIPARIAN RESOURCES OF THE CARMEL RIVER.

33. Currently MPWMD is investigating GSFLOW (USGS Groundwater and Surface Flow) and how it could be linked with the current surface water model CVSIM to help gain detailed information about how a phased cutback will impact depth to groundwater. GSFLOW which combines a Precipitation Runoff Model System (PRMS) and MODFLOW (groundwater model) could combine basic data such as: streamflow, evapotranspiration, pumping, precipitation, soils, geology, depth to groundwater, and existing models. Once a model of this nature is developed impacts of the phased cutback could be quantified and then applied to site specific areas to help determine the benefits of the cutback.

34. During multiple "dry" to "critically dry" years, expand irrigation systems around major CAW production wells.

I, Thomas Christensen, declare under penalty of perjury that I have read the foregoing "Testimony of Thomas Christensen" and know its contents. The matters stated in it are true of my knowledge except as to those matters which are stated on information and belief, and as to those matters I believe them to be true.

Executed on July 2, 2008, at Monterey, California.

MONTEREY PENINSULA WATER
MANAGEMENT DISTRICT

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