EXECUTIVE SUMMARY

INTRODUCTION

The Santa Margarita Test Injection Well (SMTIW) is part of the Monterey Peninsula Water Management District's (District) ongoing investigation of Aquifer Storage and Recovery (ASR; aka injection/recovery) in the Seaside Groundwater Basin. As applied to the Monterey Peninsula, ASR involves the diversion, treatment, and conveyance of 'excess' water from the Carmel River alluvial aquifer system to dual-purpose injection/recovery wells in the Seaside Basin for injection, storage, and subsequent recovery. The source water for injection is captured by Cal-Am facilities during periods when the flow in the river exceeds the instream requirements of the State Water Resources Control Board and the National Marine Fisheries Service (NOAA-Fisheries). The injected and subsequently recovered water, therefore, represents the capture, storage, and utilization of surplus water that is available without harming existing users or the environment.

The District installed the SMTIW in 2001 with a design injection capacity of 1,000 gallons per minute (gpm) to assess the hydrogeologic characteristics of the Santa Margarita Sandstone for ASR. This report documents the testing and results of operations at the SMTIW during Water Year 2004 (WY2004), and constitutes the third annual summary report of the testing performed at the SMTIW (the final WY2003 summary report was presented to the District in March 2004). A brief summary of the relevant findings developed during WY2004 is presented below.

INJECTION TESTING

Injection operations were performed at the SMTIW during WY2004 during the period of February 6 to March 30, 2004. Despite the dry hydrologic conditions and limited available flows in the Carmel River for diversion, a total volume of approximately 160 acre-feet (AF)[1] of water was successfully injected into the Santa Margarita Sandstone of the Seaside Groundwater Basin during the period.

Injection was performed at average rates ranging between approximately 600 and 1,450 gpm (approximately 3 to 6 acre-feet per day). Following an initial decline during the first injection test of the season, injection performance increased and pumping performance generally remained stable during the season, indicating that plugging was minimal and was successfully managed by routine backflushing of the well between injection tests.

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1 One acre-foot of water is approximately the amount of water used annually by 2 to 3 average-sized homes on the Monterey Peninsula.

During injection testing, the SMTIW displayed a maximum water level increase (drawup) of approximately 240 feet, with the water level in the SMTIW remaining approximately 100 feet (or greater) below ground surface; therefore, there was at all times a significant amount of additional 'freeboard' in the well casing before the water level would reach ground surface. The amount of available drawup/freeboard indicates that an additional well at the site injecting at a similar (or greater) rate could be accommodated without causing undesirable interference effects (i.e., water levels reaching the ground surface).

Water levels in the aquifer system were monitored during the injection season at seven monitoring well locations ranging in distance from the SMTIW from several hundred to several thousand feet. Positive response to injection was observed at the monitoring wells, with increases in water levels in the Santa Margarita Sandstone due to injection ranging between approximately 1 and 6 feet. In addition, water levels remained below sea level at most monitored Santa Margarita Sandstone wells throughout the period, even at the peak of the injection season. These observations are consistent with those observed during WY2002 and WY2003.

RECOVERY TESTING

Following an approximate 15-week period of storage in the basin, approximately 555 AF was pumped (recovered) from the well into the Cal-Am distribution system during the period July 13 through October 6, 2004. This volume represents approximately 350 percent of the volume of water injected by the SMTIW during WY2004.

Water levels in monitoring wells in the basin perforated in the Santa Margarita Sandstone were drawn down to between 13 to 55 feet below sea level by the combined pumping of other wells in the Seaside Basin and the SMTIW recovery operations during the summer/fall months. These observations suggest that it is highly unlikely that any net loss of injected water to the Pacific Ocean occurs under these hydraulic conditions. Rather, the injected water partially filled, temporarily, the significant existing water level depression in the basin, and was subsequently recovered into the Cal-Am distribution system (either by the SMTIW itself and/or Cal-Am's existing wells, such as the Paralta Well) and/or served to replenish groundwater in storage in the basin. Again, these observations are consistent with those during WY2002 and WY2003

WATER QUALITY

During the injection, storage, and recovery operations a variety of water quality data was collected to assist with the assessment of the fate and stability of the injected waters in the subsurface. Specific findings regarding SMTIW water quality are summarized below:

- The electrical conductivity (EC) and chloride data collected during recovery suggest that the injected water is intermixing with native groundwater at the SMTIW. This is an anticipated result of pumping activities from the nearby Paralta and Ord Grove

No. 2 wells and mixing with natural inflow of groundwater from the Inland Fort Ord Subarea.

- Initial increases in disinfection-by-product (DBP) levels were observed during the storage period as a result of continued formation of these compounds (e.g., trihalomethanes [THMs] and haloacetic acids [HAAs]) due to reactions between the chlorine residual in the injectate and organic material in the source water.
- Following the initial increase in DBPs during storage, significant degradation of these compounds was observed, even when aquifer mixing/dilution effects were subtracted.
- The observed decline in DBPs after months of storage and subsequent recovery is consistent with other ASR sites with reduced (anaerobic) subsurface conditions.
- As observed in previous years, the hydrogen sulfide data collected during recovery suggests that injection of oxidized Carmel River water is capable of 'conditioning' the aquifer in the injection area, which represents an additional benefit of ASR in the Santa Margarita Sandstone by reducing the use of treatment chemicals at the Seaside Ozone Treatment Plant.
- No ion exchange reactions were observed during storage and recovery, indicating that clays within the geologic matrix are either not present or are not reacting adversely with the injected waters.
- Overall, the Lower Carmel Valley (LCV) wells are producing a water that is chemically favorable for ASR operations; however, from a physical standpoint Cypress and Rancho Canada are considered less desirable with respect to entrained gas production, and the Begonia Iron Removal Plant (BIRP) is demerited by its use of phosphate corrosion inhibitors and marginal particulate removal.

CONCLUSIONS

Based on the findings developed during WY2004 testing of the SMTIW, we conclude the following:

- Approximately 160 AF of water were successfully injected into the Santa Margarita Sandstone of the Seaside Groundwater Basin with the SMTIW during WY2004. A total of approximately 505 AF has been injected into the Seaside Groundwater Basin with the SMTIW to date.
- The general SMTIW operational procedure of injection at a rate of 1,000 gpm, with weekly backflushing cycles, continues to be an effective mode of operation to sustain injection well capacity and performance.
- Positive hydraulic response to injection operations was observed with increases in water levels at all of the Santa Margarita Sandstone wells monitored in the Basin during testing; although water levels in the Basin remained below sea level, even at the peak/end of the injection season. It is, therefore, unlikely that any significant net

'loss' of injected water to the Pacific Ocean occurs under these aquifer hydraulic conditions.

- For each acre-foot of potable water injected into the basin at the SMTIW (a total of approximately 505 AF to date), an acre-foot of potable water has been recovered into the Cal-Am distribution system.
- Following an initial increase, significant degradation of DBPs was observed during storage and recovery of the injected water.
- Reductions in the concentration of hydrogen sulfide were also observed in the recovered water (as compared to the native groundwater), even after a greater volume of water had been pumped from the well than was injected. These observations suggest that an ancillary benefit of ASR in the Santa Margarita Sandstone may include the 'conditioning' of the aquifer through the injection of Carmel River system water, which reduces the use of treatment chemicals prior to distribution.
- The available data indicate that a second well at the site could feasibly be constructed and operated with a 1,500 to 2,000 gpm injection capacity.

RECOMMENDATIONS

Based on the WY2004 injection testing results, and our experience with similar projects, we offer the following recommendations:

- Conduct additional injection operations during the 2005 water year. We estimate that approximately 350 AFY can be injected with the SMTIW during the periods when excess Carmel River flows are available, assuming a 'normal' rainfall year. During a 'wet' year, up to 800 AF could be injected.
- Based on the results of the testing, the SMTIW should be continue to be operated at a maximum injection rate of approximately 1,000 gpm with weekly backflushing to maintain performance.
- Perform dechlorination testing to investigate the possibility of reducing additional formation of DBPs in the subsurface during storage.
- Sampling and analysis of disinfection byproducts (THM's and HAA's) should continue to be included in the water quality parameters monitoring program to further assess the stability and fate of these compounds during aquifer storage.
- Coordinate with Cal-Am on the installation of a flow control valve and noise attenuation at the Luzern Booster Station.
- To increase the injection capacity of the existing SMTIW site, proceed with developing technical plans and specifications for a second well at the site based on the preliminary Basis-of-Design presented herein.

- Continue to coordinate with Cal-Am and seek approvals from the various Agencies that would be required to install and test a second injection well at this site.
- In order to provide more water from the Cal-Am system for injection operations at a second well at the site, the following capital improvements to the Cal-Am system should be also pursued:
  - Install temporary Hilby intertie pipeline along General Jim Moore Blvd.
  - Design and install additional booster pump capacity at the Hilby Tank site.
- The following site improvements should be pursued to improve ongoing operations at the SMTIW site:
  - Routine maintenance of backflush pit.
  - Minor site improvements to improve sampling, data collection, and site access.