EXECUTIVE SUMMARY

INTRODUCTION

The Santa Margarita Test Injection Well (SMTIW) is part of the Monterey Peninsula Water Management District's (District's) ongoing investigation of Aquifer Storage and Recovery (ASR; aka injection/recovery) in the Seaside Groundwater Basin. The District's ASR program 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 California American Water (Cal-Am) facilities in Carmel Valley 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 water injected as part of the ASR project 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). The well is approximately 720 feet deep and was installed to assess the hydrogeologic characteristics of the Santa Margarita Sandstone for ASR. The SMTIW program has been a success, and as a result the District is pursuing an expansion of the ASR program, with the addition of a second ASR well at the site - this expanded project is known as the Phase 1 ASR Project.

This report documents the testing and results of operations at the SMTIW during Water Year 2005 (WY2005), and constitutes the fourth annual summary report of the testing performed at the SMTIW. A brief summary of the relevant findings developed during WY2005 is presented below.

INJECTION TESTING

Injection operations were performed at the SMTIW during WY2005 during the period of January 4 to March 29, 2005. Injection was performed at average rates ranging between approximately 976 and 1,160 gpm (approximately 4 to 5 acre-feet per day). As a result of the above normal hydrologic conditions and associated available flows in the Carmel River for diversion, the full amount of the requested diversion water right for WY2005 of 350 acre-feet (AF)[1] of water was successfully injected into the Santa Margarita Sandstone of the Seaside Groundwater Basin during the period. Based on the flows in the Carmel River, additional water was available for injection; however, State Water Resources Control Board (SWRCB) permit conditions limited the amount the District could inject.

[1] One acre-foot of water equals 325,851 gallons and 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 (at the end of Injection Test No. 5). Even under these conditions, the water level in the SMTIW remained approximately 115 feet below ground surface indicating there remained a significant amount of additional 'freeboard' in the well casing and aquifer before the limiting condition of pressurized injection would occur. The amount of available drawup/ freeboard indicates that additional ASR well capacity at the site and/or other locations in the Seaside Basin injecting at similar (or greater) rates could be accommodated without causing undesirable effects (i.e., the 'daylighting' of water at the 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 6 to 18 feet. However, 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 previous injection seasons, and indicate that substantially more water could be injected without risk of loss to the ocean.

WATER QUALITY

During the injection and storage operations (note that recovery could not be conducted this year), 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. The water quality investigation during WY2005 included the performance of declorination (i.e., the removal of free chlorine residual) of the injectate at the site prior to injection. The purpose of the dechlorination experiment was to investigate the effects of dechlorination on the formation and degradation of disinfection-by-products in the subsurface. Specific findings regarding SMTIW water quality are summarized below:

- The electrical conductivity (EC) and chloride data collected during storage suggest that the injected water did not significantly intermix with native groundwater at the SMTIW, and the injection 'bubble' remained relatively intact at the well during storage.
- Increases in disinfection-by-product (DBP) levels were not observed during the storage period as had been observed during previous years. This is a direct result of the dechlorination of the injectate, which prevented continued formation of these compounds (e.g., trihalomethanes [THMs] and haloacetic acids [HAAs]) in the subsurface. While additional formation of DBPs during storage was not observed, laboratory results showed that significant degradation of THM compounds did not occur as in previous years.

- The observed stability in DBPs after months of storage is considered the likely result of persistent aerobic subsurface conditions in the injection area during the storage period. This observation is consistent with other ASR sites and past experience at the SMTIW, where degradation of DBP's occurs under reducing (i.e., anoxic or anaerobic) subsurface conditions.
- While DBP's did not degrade significantly during storage, they remained at the levels of the injectate (which is the same water served to the public by Cal-Am), and were less than 35 percent of the State MCL's for these compounds in drinking water.
- As observed in previous years, the hydrogen sulfide data collected during storage 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, indicating that clays within the geologic matrix are either not present or are not reacting adversely with the injected waters.

CONCLUSIONS

Based on the findings developed during WY2005 testing of the SMTIW, we conclude the following:

- Approximately 350 AF of water were successfully injected into the Santa Margarita Sandstone of the Seaside Groundwater Basin with the SMTIW during WY2005. A total of approximately 855 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.
- Dechlorination of the injectate limited the formation of additional DBP's during storage; however, significant degradation of DBPs was not observed either.
- Plugging rates during injection were higher during WY2005, likely as a result of dechlorination of the injectate, which allows greater proliferation of biofouling bacteria near the well screen.
- The inability to conduct recovery pumping operations prevented the full implementation of a complete injection/storage/recovery (ISR) cycle. As a result, increased residual plugging has occurred, which could affect injection performance in the future.
- The operational data continue to 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 WY2005 injection testing results, and our experience with similar projects, we offer the following recommendations:

- Conduct additional injection, storage, and recovery operations during the 2006 water year. 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 approximately 800 AF could possibly be injected.
- Based on the results of the testing, the SMTIW should continue to be operated at a maximum injection rate of approximately 1,000 gpm with weekly backflushing to maintain performance.
- Formal rehabilitation of the well should be performed as soon as possible. The SMTIW is almost five years old and has experienced declines in performance as would be expected with any ASR/injection well. The lack of recovery pumping in WY2005 has exacerbated residual plugging, making formal rehabilitation of increased importantance to prevent permanent plugging and loss of capacity.
- Additional dechlorination testing during WY2006 is not recommended for the following reasons:
  1. Dechlorination did not appear to be particularly beneficial, and is therefore not considered advantageous for the SMTIW site.
  2. Higher rates of plugging appear to result from implementation of dechlorination.
  3. The dechlorination experiment setup for WY2005 was temporary, and is not suitable for additional testing/operation. Should additional dechlorination testing be done, improved (and more costly) permanent equipment and facilities will be necessary.
- 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, and in particular, during recovery operations.
- Install one or two monitoring wells at the site to investigate DBP stability in the aquifer at distances away from the well.
- Coordinate with Cal-Am and regulatory agencies to ensure that recovery pumping can be conducted during WY2006.
- To complete the proposed Phase 1 ASR Project, the following should be done:
  1. Proceed with developing technical plans and specifications for a second well at the site, including the various site improvements, based on the preliminary Basis-of-Design presented in the WY2004 Summary of Operations Report.

2. 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.

3. In order to provide additional 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.