Appendix G5
Supplemental Groundwater Modeling Analysis

Memorandum

City of Malibu Civic Center Wastewater Treatment Facility Project

Subject: **Simulation of Anticipated Injections in Groundwater Flow Model**

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A numerical groundwater flow model (MODFLOW) of the Malibu Valley Groundwater Basin was prepared to estimate the maximum volume of recycled water that could be injected into the basin without causing adverse water elevation impacts (i.e. flooding) and to evaluate the impact of that injection on the groundwater basin, including determining if injected water would migrate to Malibu Creek and Lagoon. This modeling work was documented in a Model Report entitled *Groundwater Modeling Analysis of Proposed Wastewater Dispersal – City of Malibu, Malibu, California* (McDonald Morrissey Associates, Inc., April 3, 2014) and included a conceptual model of the Malibu Valley Groundwater Basin, a description of the construction and boundary conditions of the numerical groundwater flow model, model calibration documentation, and the results of injection scenarios (including particle tracking analyses) and sensitivity analyses.

Model results presented in the April 2014 Model Report indicated that the following maximum volumes of recycled water that could be injected into the groundwater basin on a continuous basis, by phase, without causing adverse impacts:

Phase 1 – 311,000 gallons per day (gpd)

Phases 1 & 2 – 498,000 gpd

Phases 1, 2 & 3 – 612,000 gpd

However, these values are in excess of the maximum recycled water production rates at the proposed Civic Center Wastewater Treatment Facility (CCWTF). Table 1, below, summarizes the anticipated CCWTF operations (total recycled water production rates), the estimated annual recycled water reuse via irrigation and other non-potable water uses, and the estimated average annual injection rates by phase.

Table 1: Estimated Average Injection Rates by Project Phase

	Phase 1	Phases 1 & 2	Phases 1, 2 & 3
Total Recycled Water Produced - No Irrigation (gpd)	191,000	361,000	507,000
Estimated Annual Reuse by Irrigation and Other Non-Potable Uses (gpd)	43,000	97,000	134,000
Estimated Injection Rate (gpd)	148,000	264,000	373,000

In order to evaluate what the impacts of the CCWTF Project operations on the underlying Malibu Valley Groundwater Basin under planned operational criteria, the numerical flow model was rerun assuming the estimated injection rates show in Table 1, above. The results of the modeling (water balance components in gallons per day or gpd) are shown below in Table 2. MODPATH (the particle tracking simulator) was also run for the same three anticipated CCWTF operating scenarios; the results of those simulations are shown below in Figures 1 through 3, below.

Conclusions

In summary, changes in groundwater outflows from the groundwater basin to Malibu Creek and Lagoon are significantly less under 'realistic' CCWTF operating scenarios. Increases are minimal from baseline conditions, with an increase of approximately 2.4% in outflows from the groundwater basin to Malibu Creek/Lagoon as a result of Phase 1 Project implementation. These increased outflows are likely attributable to the anticipated new commercial development simulated in the model and included in the recycled water volumes injected to the groundwater basin. While the injected flows themselves are not going to Malibu Creek and/or Lagoon (all injected flows go to the ocean, as shown in Figure 1), the hydraulic mounding resulting from the injection is resulting in the redirection of unimpacted, native upgradient flows towards the Creek and/or Lagoon. (Under the No-Project scenario, these flows would be either going to Malibu Creek and/or Lagoon or to the Pacific Ocean, depending on time-dependent hydraulic gradients.)

This trend continues into Phase 2 of the Project, with flows to Malibu Creek and/or Lagoon from the groundwater basin increasing from baseline conditions by 2.9%. In Phase 3, there is a reduction in the flow to Malibu Creek and Lagoon, with outflows from the groundwater basin reducing to a 2.1% increase in flows above baseline conditions. This is in response to the elimination of the influence of the domestic OWDS on the groundwater outflows. As with the Phase 1 injection scenario, all injected flows go to the Pacific Ocean (unchanged from scenarios with the maximum recycled water injections); it is the hydraulic mounding resulting from the point source injections that result in the redirection of unimpacted, native upgradient flows towards Malibu Creek and/or Lagoon.

The minimal anticipated increases of native groundwater flows to Malibu Creek and/or Lagoon as a result of project implementation are not considered significant as they are small relative to annual and seasonal changes in flows in the Creek and Lagoon. These minimal increases are not expected to affect Lagoon breaching patterns nor have a significant impact on Creek or Lagoon water quality.

Figure 1: Particle Tracking Results for Phase 1 CCWTF Operating Scenario

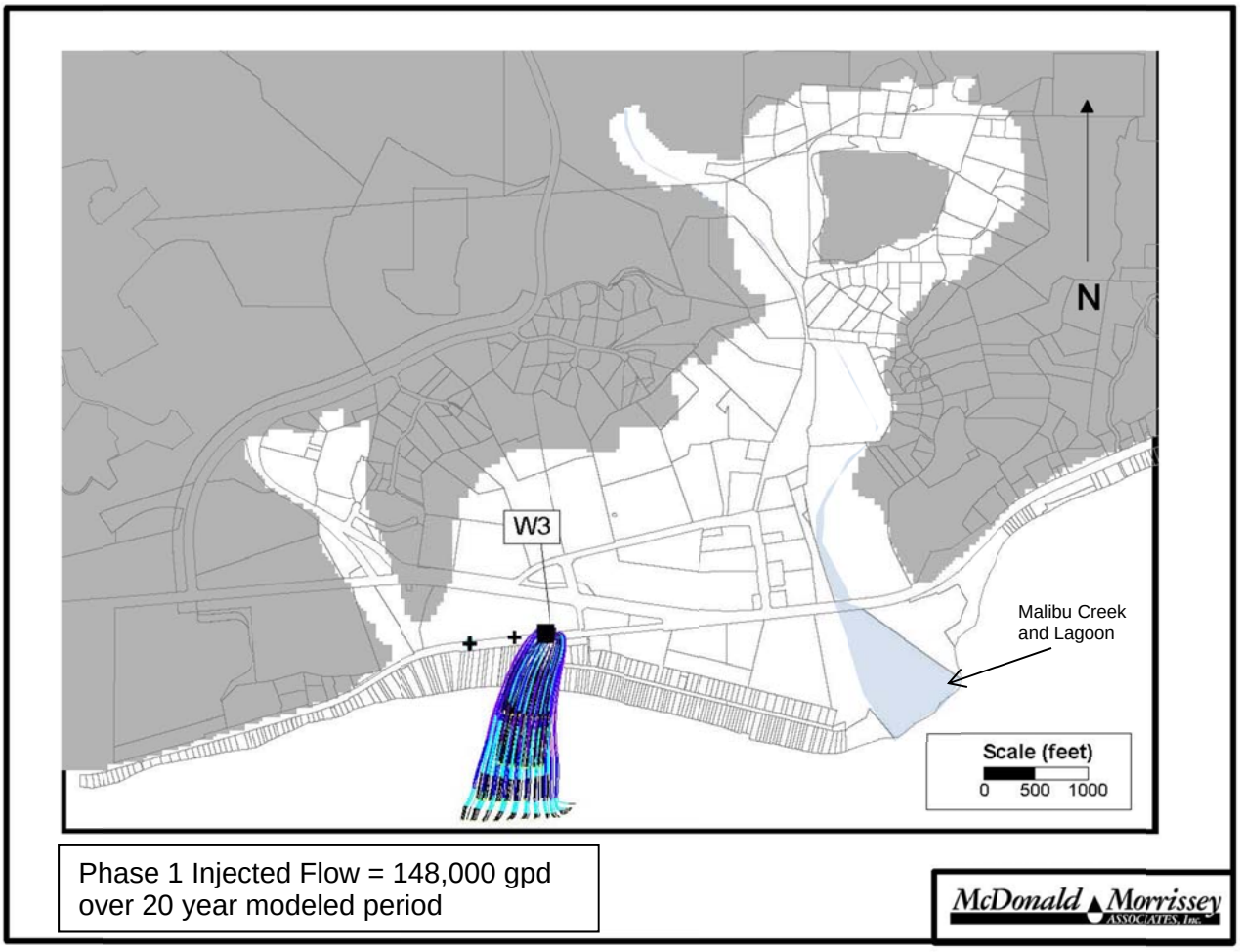

Figure 2: Particle Tracking Results for Phase 2 CCWTF Operating Scenario

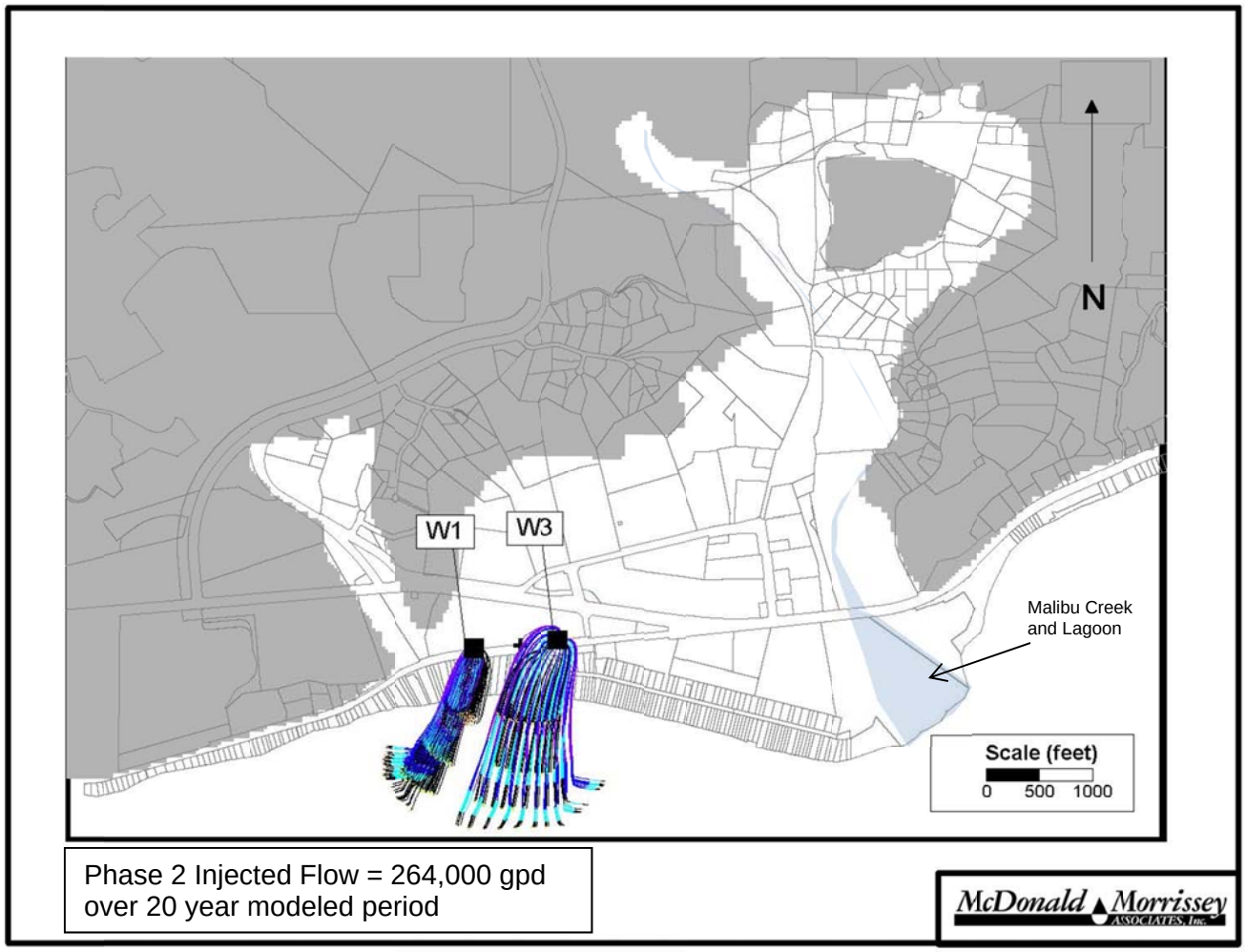

Figure 3: Particle Tracking Results for Phase 3 CCWTF Operating Scenario

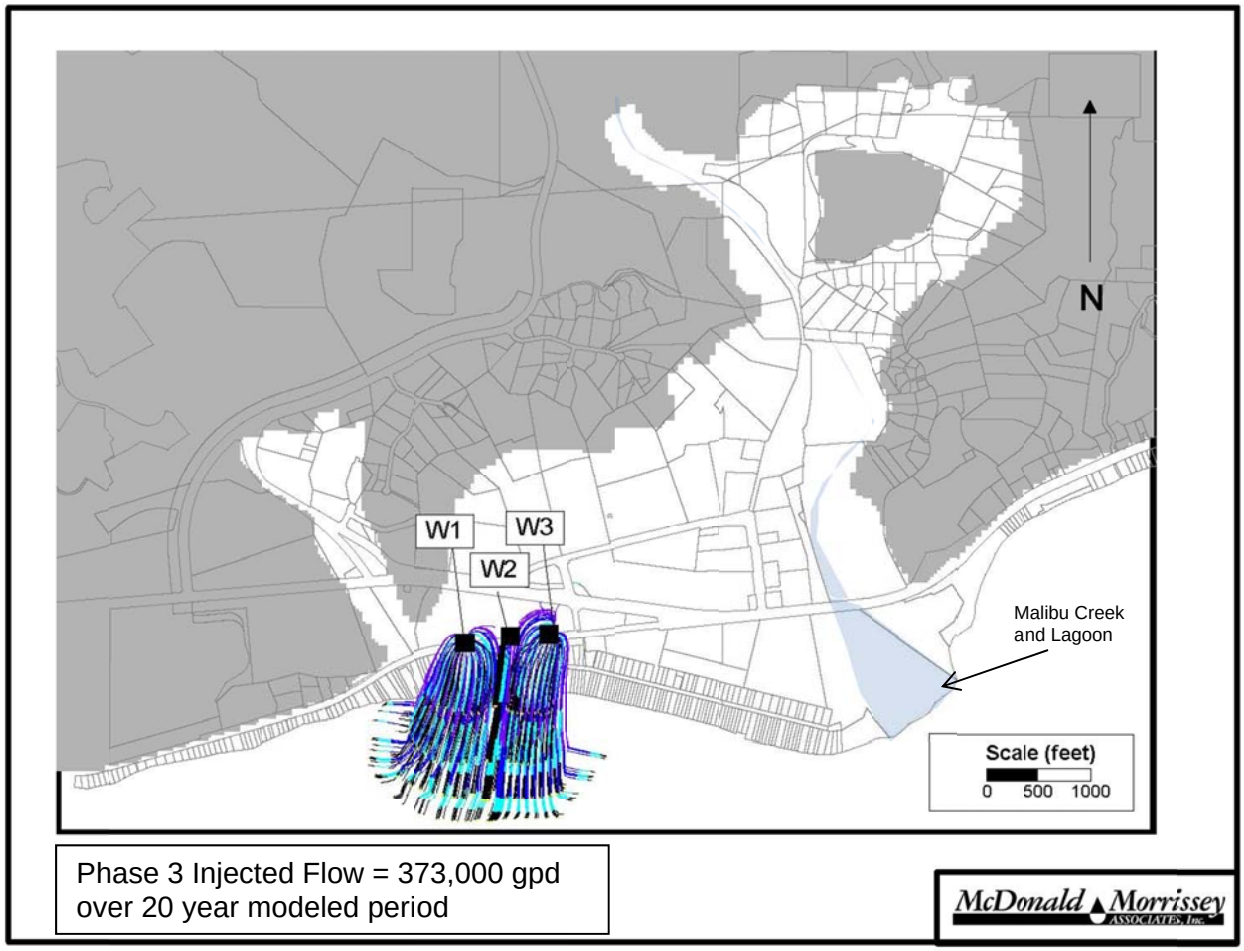

Table 2: Comparison of Water Balance Components by Phase for Anticipated Injection Scenarios and Maximum Injection Scenarios

		Anticipated Injection Scenarios			Maximum Injection Scenarios		
	Baseline	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
Injection Rate (gpd)	0	148,000	264,000	373,000	311,135	497642	611655
Modeled Flows into the Groundwater Basin (gpd)							
STORAGE	133,609	112,589	116,520	120,554	110,710	113,855	117,865
FLOW FROM OCEAN	3,355	3,377	3,399	3,503	3,326	3,323	3,411
SEPTIC (OWDS) INFLOW	382,412	281,792	131,959	8,875	281,792	131,959	8,875
INJECTION TO BASIN	0	148,000	264,000	373,000	311,135	497,642	611,655
IRRIGATION IN	127,915	127,915	127,915	127,915	127,915	127,915	127,915
INFLOW FROM MALIBU CREEK AND LAGOON	834,227	816,435	832,854	848,577	802,704	813,460	828,893
PRECIP RECHARGE	180,415	180,415	180,415	180,415	180,415	180,415	180,415
TOTAL INFLOW TO BASIN	1,661,933	1,670,523	1,657,063	1,662,839	1,817,996	1,868,569	1,879,029
Modeled Flows Out of the Groundwater Basin (gpd)							
STORAGE	129,536	105,567	108,067	111,721	104,685	106,821	110,451
FLOW TO OCEAN	879,909	898,985	881,236	889,999	978,110	998,822	1,017,342
DRAINS	3,376	3,073	2,487	2,231	3,347	2,832	2,576
EVAPOTRANSPIRATION	87,150	87,663	87,050	85,226	88,867	88,711	86,814
OUTFLOWS TO MALIBU CREEK AND LAGOON	561,957	575,233	578,230	573,683	642,985	671,369	661,840
TOTAL OUTFLOW FROM BASIN	1,661,929	1,670,522	1,657,071	1,662,859	1,817,994	1,868,556	1,879,022

Note: OWDS inflows to the groundwater basin are from OWDS systems outside of the Prohibition Zone that have the potential to flow to the groundwater basin.