Cover Letter Briefing

Las Virgenes Metropolitan Water District
Modeling Results for the Las Virgenes Reservoir for Pure Water Program

1 INTRODUCTION

This letter provides an overview of the modeling report prepared by Flow Sciences, Inc. at the direction of Trussell Technologies, Inc. in support of the Las Virgenes-Triunfo Joint Powers Authority (JPA) proposed surface water augmentation project (Pure Water). The Pure Water project involves taking excess recycled wastewater as generated at the Tapia Water Reclamation Facility, treating it through an advanced water treatment facility (AWTF), and conveying it to the Las Virgenes Reservoir (Reservoir) for eventual reuse. As required by the draft surface water augmentation regulations, any proposed project requires a calibrated hydrodynamic model of the reservoir in order to understand the mixing and dilution criteria within the reservoir itself. This effort represents the calibration of the hydrodynamic model, modeled results for several operational scenarios, and recommendations for next steps.

2 MODEL CALIBRATION

The project team selected a 3-D numerical modeling platform known as the Estuary, Lake, and Coastal Ocean Model or ELCOM. ELCOM was developed by the Center for Water Research at the University of Western Australia and is widely used throughout the world for modeling aquatic environments. Several inputs are needed to tailor ELCOM to the Las Virgenes Reservoir and this process is known as the calibration of the model:

Bathymetric Survey
One of the first steps in calibrating the model is to incorporate the correct shape of the Reservoir. To do this, a bathymetric survey of the Reservoir was performed by collecting data with a boat-mounted multibeam swath-sounding sonar system. This survey provided accurate bathymetry for the model as of March 2017.

Weather Data
The JPA provided data from a weather station located on the downside of a slope from the Westlake Filtration Plant. This data consisted of solar radiation, air temperature, wind speed, wind direction, relative humidity, and rainfall between January 1, 2015 and December 31, 2016.

The project team noted that the location of the weather station may result in interferences from the slope. In order to have as few potential interferences as possible, the project team recommends moving the weather station to the island within the Reservoir to ensure weather data is more representative.

Inflows and Outflows
The Reservoir has two main inflows and one main outflow:

- Inflows
  - Imported water from Metropolitan Water District of Southern California
  - Recirculating flow for the Westlake Filtration Plant
- Outflow
  - Raw water supply to the Westlake Filtration Plant

Flows (in and out) occur at or nearby the inlet/outlet tower located in the northwest corner of the Reservoir (Figure 1).

Aerator Operation
The Reservoir has two aerators (Figure 1) which are operated in the summer to provide partial vertical mixing near the inlet tower to the filtration plant. The JPA provided the air flow rates of both aerators for January 1, 2015 to December 31, 2016.

In performing the bathymetric survey, the project team noted that the Reservoir has two distinct troughs (see Figure 3) and both aerators are located within the northwestern-most trough (Figure 1). To improve mixing throughout the entire Reservoir, the project team recommends adding an aerator within the second trough. Improving mixing would increase dilution and minimize the impact of the Pure Water project on the Westlake Filtration Plant operations.

Figure 1 – Las Virgenes Reservoir Map

Model Calibration

Flow Science incorporated these various inputs into the model and was then able to accurately simulate water movement within the Reservoir. Figure 2 shows that the simulated water temperature over the depth of the reservoir matches the measured data.

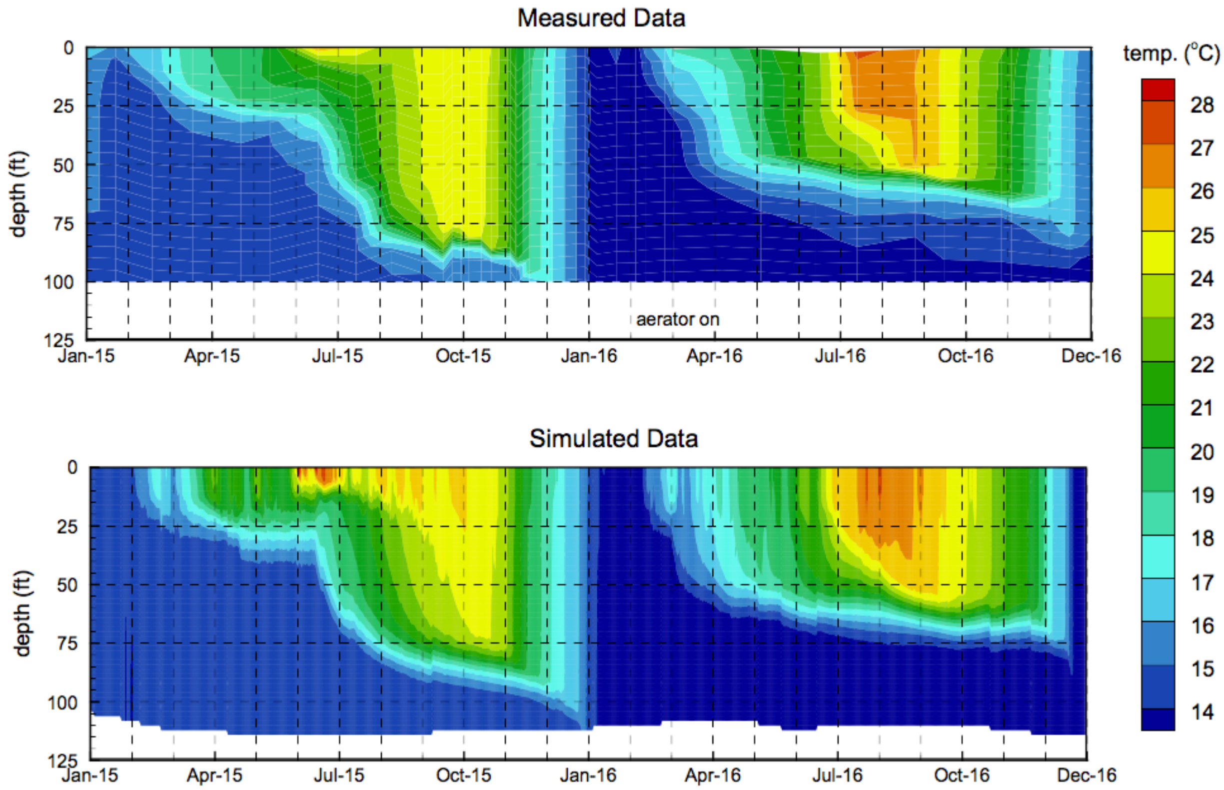

Figure 2 – Color Map Comparing Water Temperature over Depth with Time from Measured and Simulated Data

3 OPERATIONAL SCENARIOS

In order to understand how the Pure Water project will affect the Reservoir operations, the project team developed several scenarios to assess regulatory compliance.

Regulatory Compliance

The project team targeted two regulatory requirements as part of the modeling effort. The first is the theoretical retention time of the reservoir, as defined by the following equation:

$$Theoretical\ retention\ time = \frac{Volume\ of\ the\ Las\ Virgenes\ Reservoir}{Flow\ out\ of\ reservoir} \geq 6\ months$$

The regulations allow for some relaxing of this 6-month threshold. Retention times as low as 4 months can be approved with an additional log removal of pathogens with treatment and retention times as low as 2 months can be approved with written approval from the State Board. All operational scenarios developed were in compliance with this regulation. In the case of the routine and boundary year scenarios, the 6-month retention time was met. In the case of the emergency scenario, a minimum 2-month retention time was targeted.

The second requirement in the regulation is in regard to dilution in the reservoir. Any withdrawal of water from the reservoir can comprise no more than 10% (10:1 dilution) of the potable reuse water discharged into the reservoir during any prior 24-hour period. If the dilution is between 10:1 and 100:1, an additional log removal of pathogens is required. Table 1 provides a summary of the dilution requirement. The dilution obtained within the reservoir is the key output from each modeled operational scenario.

Table 1. Draft Dilution Requirement

DILUTION	ENTERIC VIRUS REMOVAL	*CRYPTOSPORIDIUM* REMOVAL	*GIARDIA* REMOVAL
Dilution > 100:1	12-log	10-log	10-log
100:1 > Dilution > 10:1	13-log	11-log	11-log
Dilution < 10:1	Not classified as surface water augmentation		

Operational Scenarios

With the regulatory requirements as a guideline, three operational scenarios were developed to bracket the intended use of the Reservoir with the Pure Water project and maximize flexibility by considering 'boundary' conditions. These are conditions that still meet the draft regulations but are up against the boundary of the regulations or possible uses of the project. Table 2 provides a summary of the three scenarios.

Table 2. Summary of Considered Scenarios

SCENARIO	PURIFIED WATER INFLOW (MGD)	WFP WITHDRAWAL (MGD)	THEORETICAL RETENTION TIME (MONTHS)	THEORETICAL RETENTION TIME REGULATORY OBJECTIVE (MONTHS)
Routine	AWTF flows during winter and Filtration Plant flows during summer. No modeling required.			
Boundary	1.7	5.0	8.5	> 6.0
Emergency	6.0	15.0	2.4	> 2.0

Routine: The first operational scenario considers the Pure Water project as it was developed in the concept report. During winter months, available potable reuse water will be discharged to the Reservoir. Then during summer months, the Westlake Filtration Plant would operate (i.e., drawing water from the Reservoir). Because input of the potable reuse water is not occurring simultaneously with the operation of the

Westlake Filtration Plant, the primary regulatory parameters, dilution and retention time, are less applicable and no modeling was required.

Boundary: The second operational scenario considers operating the Westlake Filtration Plant through a full winter, while simultaneously providing potable reuse water to the reservoir. In this scenario, during the summer, irrigation demand is still prioritized and there is minimal input to the Reservoir. In addition, to represent a worst-case scenario in terms of dilution, no other water source enters the reservoir (e.g., no MWD water received). In effect, this scenario represents the most aggressive regular use of the Pure Water project by incorporating all available potable reuse water, including the shoulder months (in Spring and Fall) where reuse water is available and the filtration plant is online.

Emergency: The third and final scenario considers an emergency scenario, where the MWD feeder line to the Reservoir is inoperable, either for long-term maintenance or as a result of failure. In this scenario, the maximum amount of potable reuse water is produced by the AWTF, 6 MGD, and the Westlake Filtration Plant produced the maximum amount of drinking water, which is 15 MGD. Flow Science then ran the model for approximately 7.4 months and stopped when the water level in the reservoir hit the inlet/outlet towers minimum withdrawal level of 1,000 feet. This scenario has a theoretical retention time of 2.4 months—above the minimum allowable retention time of 2 months but below the 4-month threshold which triggers additional log removal of pathogens.

4 MODELING RESULTS

Once the model was calibrated and the operational scenarios were established, model runs were performed, and pulses of tracer were injected into the reservoir, at regular intervals. Each pulse of tracer lasted 24-hours, per the regulations. The potable reuse water was introduced into the reservoir as a surface discharge along the northwest bank of the reservoir and one aerator was moved to the second low point in the reservoir to improve mixing. Figure 3 shows the locations of the aerators and the potable reuse water entry point.

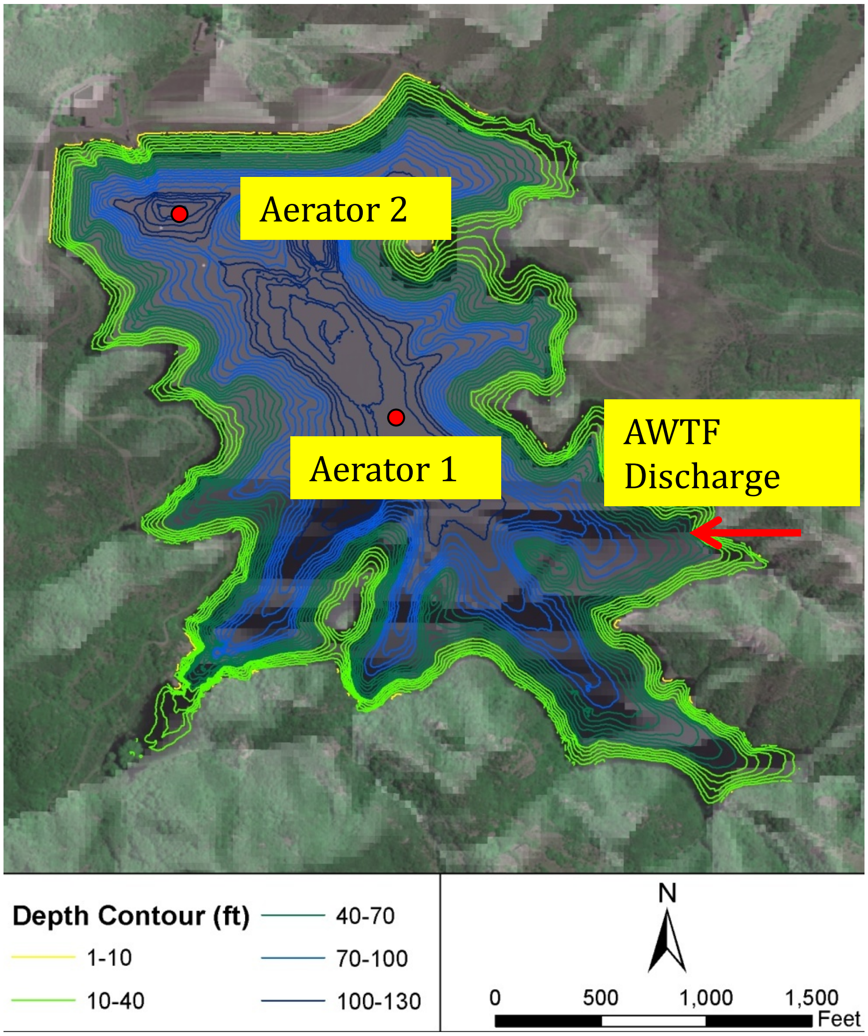

Figure 3 – Location of Potable Reuse Water Discharge and Aerators

Boundary Year Scenario

Figure 4 shows an example model run with the released tracer in the water. Modeling runs showed that when strong winds come from the southeast, the potable reuse water gets pushed along the water surface directly from the discharge point to the filtration plant's inlet tower. This phenomenon resulted in one exceedance beyond the 100:1 dilution threshold. The minimum dilution was 77:1, still well below the minimum 10:1 value that is required in the regulations. Figure 5 shows the modeled output of this tracer release that had a minimum dilution below the 100:1 dilution threshold.

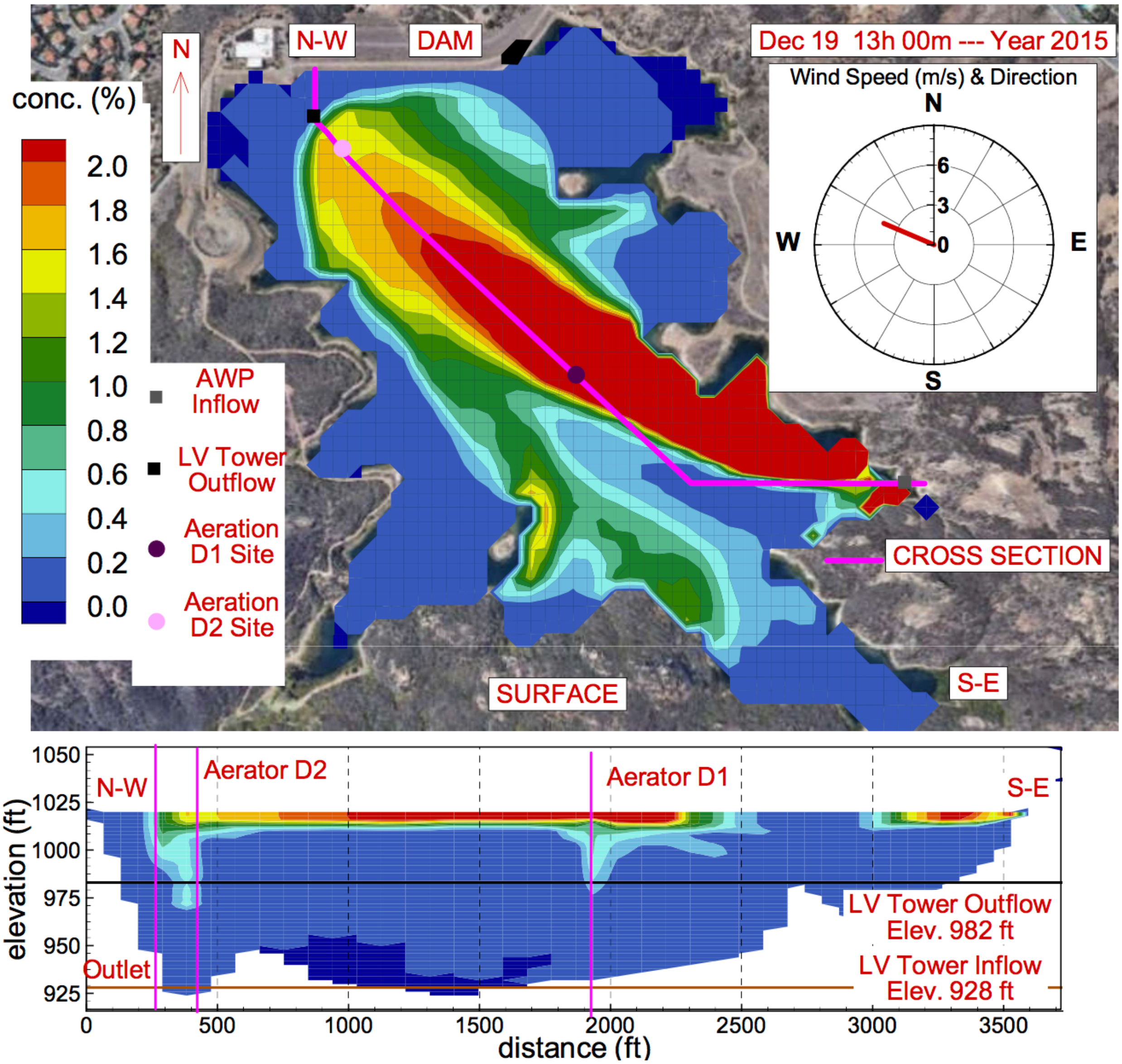

Figure 4 – Example model run with release of 24-hour tracer pulse

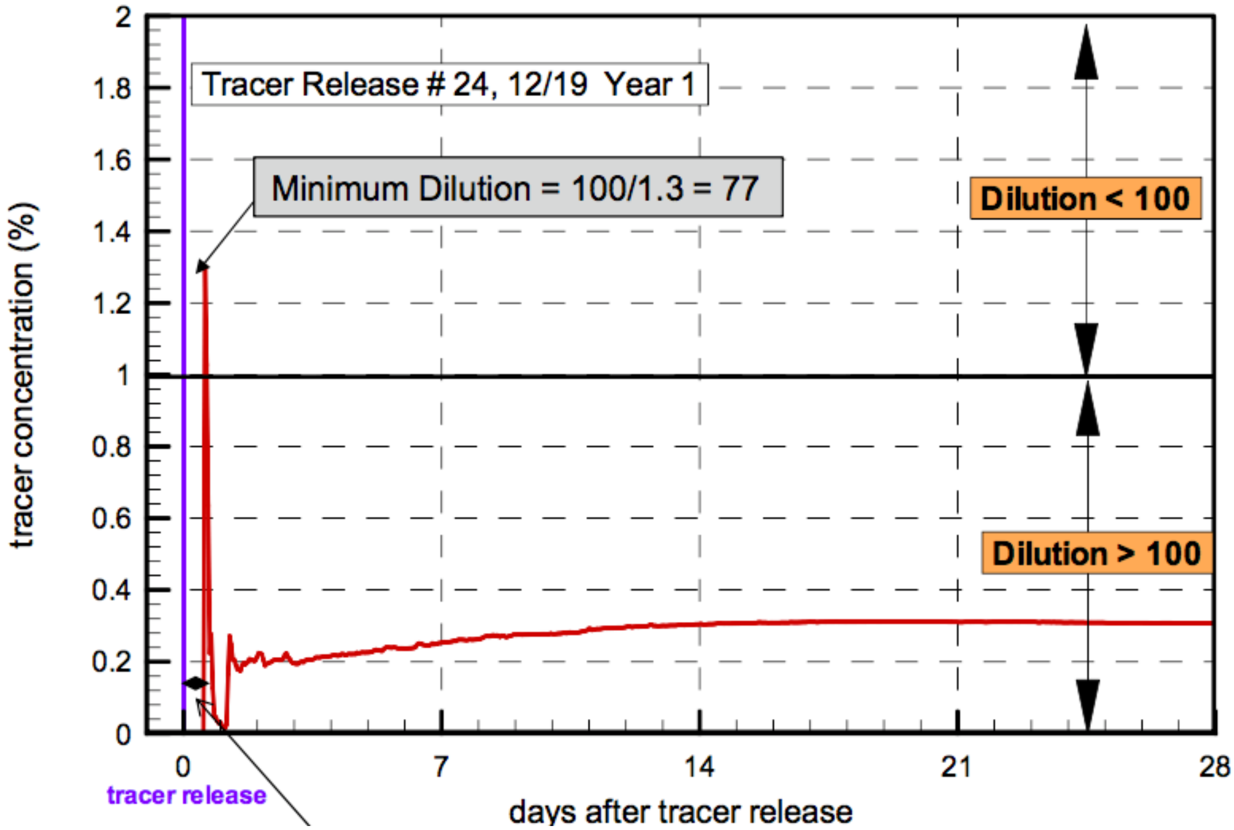

Figure 5 – Worse case modeled results for Boundary Condition (77:1 minimum dilution)

Emergency Scenario
The emergency scenario showed similar results as compared with the boundary condition scenario. Again, when winds come from the southeast, the potable reuse water short-circuits through the reservoir. In this case, two tracer releases exceeded the 100:1 dilution threshold. Again, none of these dilution values are above the minimum dilution of 10:1 as required by the regulations.

Potential Future Scenarios
The modeling results show a slight exceedance of the 100:1 dilution threshold. A potential solution includes the incorporation of a diffuser discharge at the bottom of the reservoir for the potable reuse water input. This would have the benefit of immediately mixing the warmer potable reuse water with the reservoir and lessen the impact of short circuiting. It is likely this would prevent any exceedance of the 100:1 dilution threshold, although future modeling runs with a diffuser should be performed to confirm this.

5 SUMMARY AND RECOMMENDATIONS

A range of operating scenarios were evaluated with the aim of maximizing the operational flexibility of the Pure Water project. The results of these conditions were favorable and indicate that the Pure Water project should be in compliance with the draft surface water augmentation regulations with all operational scenarios considered.

The following are recommendations and next steps for the Reservoir modeling:

- Move the weather station to ensure a representative location of wind speed and direction is obtained
- Move or add an aerator to the second trough in the Reservoir to improve mixing
- Perform a tracer release in the Reservoir and simulate the same tracer release in the model to validate the model (regulatory requirement)
- Assess the impact of a diffuser on the potable reuse water discharge to improve mixing and prevent short-circuiting to the Westlake Filtration Plant's inlet tower

References

State Water Resources Control Board, 2015. Regulations Related to Recycled Water. California Code of Regulations, Titles 22 and 17, Titles 22 and 17.