Attachment 1

Beverly Hills Reverse Osmosis Treatment Plant – Review of Operation Systems and Processes

Technical Memo 1 – Baseline Review Final

Final

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Executive Summary

The intention of this report is to provide a baseline review of operating systems and processes at the City of Beverly Hills Water Utility. It is focused on the management of the RO water treatment plant, as well as management of downstream water quality.

In the development of this report, we have interviewed plant staff, reviewed operational documentation and processes and reviewed operational performance. Our intent is to provide assistance to the city in minimizing risk to personnel, minimizing risk of breach of permit requirement and assisting in the construction of operational systems and processes that will result in optimized plant performance.

This review is focused in the main on plant systems and processes, however where we have seen them, we have highlighted process issues that we believe need to be addressed, particularly ensuring that this is managed in the long term with effective monitoring and reporting. It is recognized that a plant upgrade is under way with another consultant.

Overall, the plant has some significant operational issues both in terms of operational systems and processes as well as plant performance. While the current state of the plant has not compromised the safety of water supplied to the community, there are some major shortcomings that put the utility at risk of non-compliance to plant permits, risk of asset damage and degradation, and risk to safety of plant staff. But these challenges are not insurmountable, we believe that the plant staff are dedicated, enthusiastic and committed to a successful operation, and with some assistance will be able to return the plant to a high level of performance in all areas.

We stand ready to assist the city to achieve this.

Our major findings are as follows:

- **Plant Performance Targets should be clearly defined**. Targets for operations staff in terms of production, quality, safety and other regulatory requirements are not clearly defined. We recommend this so that staff can compare performance against targets.

- **Operating Performance is not sufficiently analyzed and trended**. There is a vast amount of information recorded on the HMI/SCADA and operating log sheets, however it is not presented or reviewed adequately to gauge plant performance. We recommend that trending of important parameters be set up and regularly reviewed to measure performance against overall plant and process unit specific targets. This is important for water quality targets and internal process performance targets.

- **Water Quality Management and Monitoring has shown great improvement.** This area in particular is advancing well, with robust procedures and a sampling plan being developed. We recommend using this work as a basis for a comprehensive water

quality management plan for the facility (which could be incorporated into a revised OMMP).

- **The Reverse Osmosis (RO) system data is not analyzed correctly**. The RO system performance data is not normalized, and consequently performance has not been reviewed adequately, leading to a substantial worsening of condition.

- **The RO system membranes (first stage in particular) are in very poor condition, leading to increased salinity in the treated water**. These membranes are leaking salt an order of magnitude above what is anticipated for membranes in this operation. The overall cause for poor condition must be investigated and resolved, followed by the installation of new membranes.

- **The RO Unit is not operating correctly, and requires a concentrate valve to be replaced as a matter of urgency**. This is critical for controlling RO recovery, which is itself critical for successful unit operation.

- **A concentrate reduction strategy should be considered**, with a review of current RO feed water chemistry, membrane selection and antiscalant to determine an optimum RO unit recovery. A higher recovery, if possible, can reduce brine production from unit and increase overall treated water yield from the plant.

- **Provide options for lower RO unit throughput, based on lower well yields.** This review (combined with the concentrate reduction strategy) may provide operating cost savings in terms of membrane costs, pumping energy costs and chemical dosing) as well as provide more suitable system hydraulic operating conditions.

- **Final Treated Water blend may be corrosive to concrete**. We recommend a review of water chemistry and blending along with monitoring of water stability indices to ensure protection of plant concrete infrastructure such as cement lined pipes and the concrete clear well

- **Arsenic Management Plan, a regulatory requirement outlined in the OMMP, does not appear to be followed**. This is a requirement of the permit, and included in the OMMP, however does not appear to be entirely operational. We recommend this plan is checked for compliance.

- **The Operations Maintenance and Monitoring Manual (OMMP) is not known to operators and is not in use. We recommend creating a revised, updated OMMP**. This is a major risk of non-compliance to the plant operating permit and in itself may constitute a non-compliance. We recommend as a matter of urgency that the city confirm with the State Regional Water Quality Control Board (formerly CDPH) if the version found during our visit is the current lodged with the regulator. Further, we

recommend that this form the basis of a thorough revision to include important shortcomings as well as updates to reflect existing operation.

- **Plant Weekly Operator Logs are Unwieldy and Unhelpful.** We have recommended a revised log sheet, as the current log contains a lot of data recorded but the key trends are not reviewed to determine plant performance or identify operational risks. It is data rich, but knowledge poor.

- **A non-conformance/corrective action process is recommended.** In order to capture learnings from problems or incidents, we recommend a non-conformance and corrective action system. This will involve reporting incidents, managing incidents and effectively taking from lessons learned to improve operations into the future.

- **A Safety and Emergency Management Plan is recommended.** We could not find a comprehensive safety plan on site covering the multiple safety issues that are encountered at an operational facility. We recommend that a plan be developed, to ensure safety hazards are effectively managed.

- **An Operator Training Program is recommended as a matter of urgency.** Operators are currently not sufficiently familiar with water chemistry, RO unit operation and other plant processes. We recommend a training program be developed to encompass process, operational procedures, safety and other necessary operational elements to ensure operators are well equipped to manage the plant.

- **Development for Standard Operating Procedures is recommended.** Leveraging from work already begun by the city, we recommend developing a number of robust operating procedures, developed with and by the operators themselves, to cover operation of all aspects of the plant. There are currently few procedures in use, and much operation is performed by memory and word of mouth. We additionally recommend a document change management system be established to keep track of version control and ensure changes to plant, process and operations are captured in the procedures.

- **More use of trending from the HMI should be adopted to keep track of process and water quality performance**. There is an abundance of data reported, however trends are more useful for performance analysis, diagnostics and decision making. We recommend that a set of standard trends be developed.

- **Develop a high level plant Dashboard Report, to define key performance requirements at a glance. This will be helpful to track performance against targets.**

- **Conduct a criticality and condition assessment** to determine appropriate spares and maintenance strategy to meet a desired plant availability.

Introduction

The purpose of this report is to provide a baseline review of the operating systems and processes at the City of Beverly Hills Water Utility, focusing specifically on the management of the reverse osmosis water treatment facility, and including downstream water quality management within the distribution system.

Our aim is to support the City to enhance and reinforce an operational framework to ensure the production of safe reliable water supply.

This report provides a baseline review of operations at the facility, to better understand where we are starting from. We have reviewed existing systems and processes, risks and bottlenecks to performance, opportunities for improvement and identified gaps that need to be addressed. This includes:

- A review of current plant targets and performance against those targets (focusing on production, water quality, and regulatory reporting).
- A review of plant process performance.
- A review of current documented systems and processes.
- Interviews with operations staff and operations management.
- A review of communication practices and protocols.
- A review of operator knowledge/training gaps.

Background to the Plant

Plant Description

The City of Beverly Hills currently receive the majority of their water supply from the Metropolitan Water District (MWD) of Southern California. Through an agreement with MWD the City developed a supplemental groundwater supply. The water treatment plant was built as part of a design/build/operate (DBO) contract with the first water purchased by the City in 2003. IN 2008 the City purchased the plant from the DBO contractor and have been responsible for its operation since that time.

The water treatment plant sources water from four wells, located along Santa Monica Boulevard and are connected via a common water main and transmitted to the water plant. At the water plant, approximately 60% of the feed water is directed to a 2 stage reverse osmosis (RO) treatment train, with the remaining 40% bypassing that train. The bypass provides a blended final treated water that contains sufficient calcium hardness and alkalinity to maintain a stable final water quality.

The water directed to the RO is dosed with sulfuric acid to reduce pH to both minimize scaling in the RO unit itself, and also to provide optimum conditions for a downstream hydrogen sulfide stripping process. It is then also dosed with antiscalant as an additional mitigation of scaling risk. Following dosing, the water is passed through 1 micron cartridge filtration prior to delivery to the RO high pressure feed pumps.

The RO system consists of 2 stages with 20 pressure vessels in the first stage, and 10 in the second stage, with each vessel containing 7 RO membrane elements each. It is physically arranged in three parallel banks of 10 vessels. The water is fed to the first 20 elements (arranged in two banks) where approximately half of the water is produced as a high quality permeate. The concentrate waste from the first stage is further directed to the second stage where additional permeate is produced. Permeate from both stages is blended together to produce a final RO permeate stream. Approximately 78% of the feed water becomes treated permeate, with the remaining 22% concentrate stream diverted as waste to sewer.

Pressure from the RO concentrate stream is converted to mechanical energy using a hydraulic turbocharger. The concentrate drives a turbine which in turn delivers energy to an impeller providing a boost in pressure to the second RO stage. This provides both a reduction in RO unit energy consumption and also assists in the hydraulic balancing of the system ensuring the correct amount of flow across all the membranes in operation.

Figure 1 - View of Reverse Osmosis Unit

The RO permeate is then directed to a stripping tower, where water is cascaded through a tower of plastic packing with a counter current flow of air which acts to remove both hydrogen sulfide (H_2S) and dissolved carbon dioxide from the water. The RO unit is operated in such that the RO permeate pH is at or below a 6.0 for optimum removal of H_2S.

The bypass stream is also treated to remove hydrogen sulfide through a stripping tower. In this case, the pH is adjusted by sulfuric acid to achieve the required pH for this process to operate efficiently. Air from both stripping towers is then treated in a scrubber to remove H_2S prior to release to the atmosphere.

Figure 2 View of stripping towers.

The combined RO permeate and treated bypass water are then blended in a clearwell, where sodium hypochlorite is added to provide a free chlorine CT (concentration x time) in the clearwell.

Upon leaving the clearwell, the water is dosed with ammonium hydroxide which combines with the free chlorine already present in the water to form a residual of chloramine, to provide water consistent with the MWD supply (approximately 2 mg/L as Cl_2). Following this dose, hydrofluorosilic acid (H_2SiF_6) is dosed to provide a fluoride level in the final treated water of between 0.8 to 1.1 mg/L, again consistent with MWD supplies.

Plant and Distribution Operations Management

The City organizes the management of water systems into two streams, for the treatment plant and for distribution.

The plant is staffed 24 hours per day 7 days per week with a staff of 5 operators (Water Worker class III), operating on a three shift per day basis with oversight provided by a Water Systems/Production Operations supervisor. Until recently, water workers from the distribution system (class I and II) had been rotating through as operators at the plant to gain experience.

The distribution network is managed by a Field Supervisor with a team of 11 water workers (class I and II) along with a Field Service Rep and a Water Technician. The focus of this report, with the exception of distribution network sampling, analysis and nitrification management does not focus on the operations of the distribution system.

A water quality specialist oversees all water quality sampling, analysis and reporting for the City. This is overseen by a plant supervisor. The city is currently in a transition phase due to the departure of the long term plant supervisor, and the position is currently managed on a temporary basis while a supervisor is being sought.

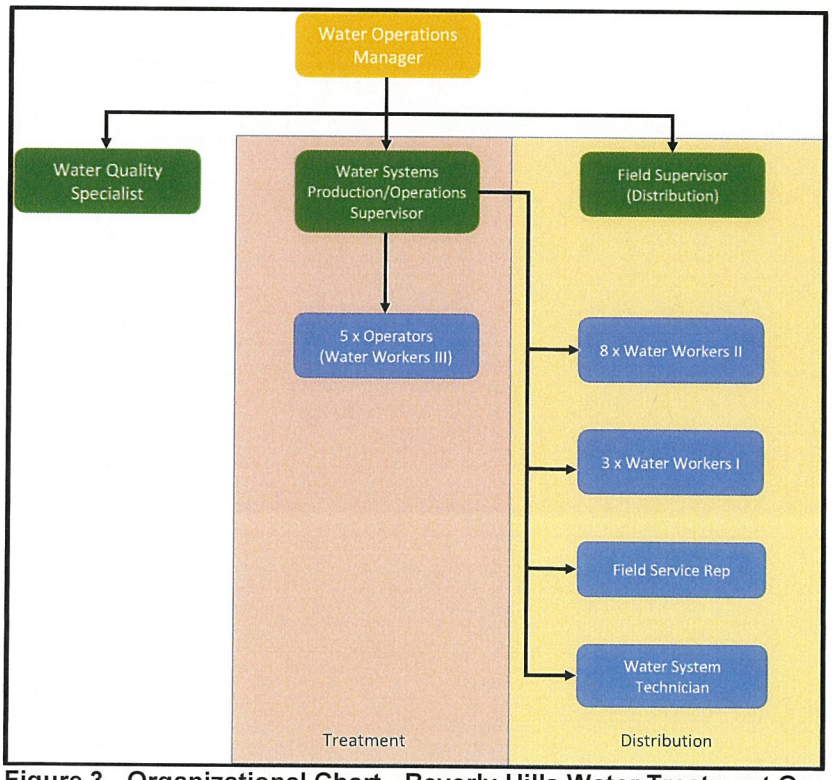


Figure 3 - Organizational Chart - Beverly Hills Water Treatment Operations

Plant Performance Targets

This section summarizes the key plant performance requirements, and in some cases reference to that requirement.

Water Production Targets

The production of the RO treatment facility is mentioned in several documents, however does not appear to have a regulated target. In the California Department of Public Health (CDPH) Engineering Report, Permit Amendment No 1910156PA-003 (page 9) the plant production is nominated as a "capacity of approximately 1880 gpm".

A version of the Operations, Maintenance and Monitoring Manual (Section 1 Page 1-51) (assumed completed in 2009 – no date found on the document) includes a set of different treated water production rates at which the plant will run, governed by different operating condition envelopes under which the plant may run. This is impacted by the level of total dissolved solids in the feed water or the requirement for additional system throughput.

Parameter	Normal	Normal + 15% TDS	Normal + 10% Flow	Normal + 15% Flow
	gpm	gpm	gpm	gpm
Total Feed	1874	1896	2060	2084
RO Feed	1098	1200	1207	1315
Permeate	856	936	942	1026
Blend Bypass	776	696	853	769
Reject (Concentrate)	242	264	265	289
Total Blended Product	1632	1632	1795	1795

Figure 4 - Treatment Process Operations Under Different Operating Conditions – (from OMMP).

This reflects the original design basis of the RO system, which acknowledges the different performance that will be achieved at these different conditions, and can provide guidance to operations on how to operate the plant under these different conditions. (Further detail on the design basis underpinning these operating settings is shown on in the OMMP on pages 1-49 and 1-50).

Actual Performance – Throughput

At the time of most plant visits during this review, the plant was not operational. The plant in recent months has had significant down time due to various maintenance issues.

Overall, the plant production is operating at approximately 20% to 30% below the design production rate when the plant has been in operation from 2013 to the present. We note that there have been significant periods with the plant off line in 2013 and also during this year.

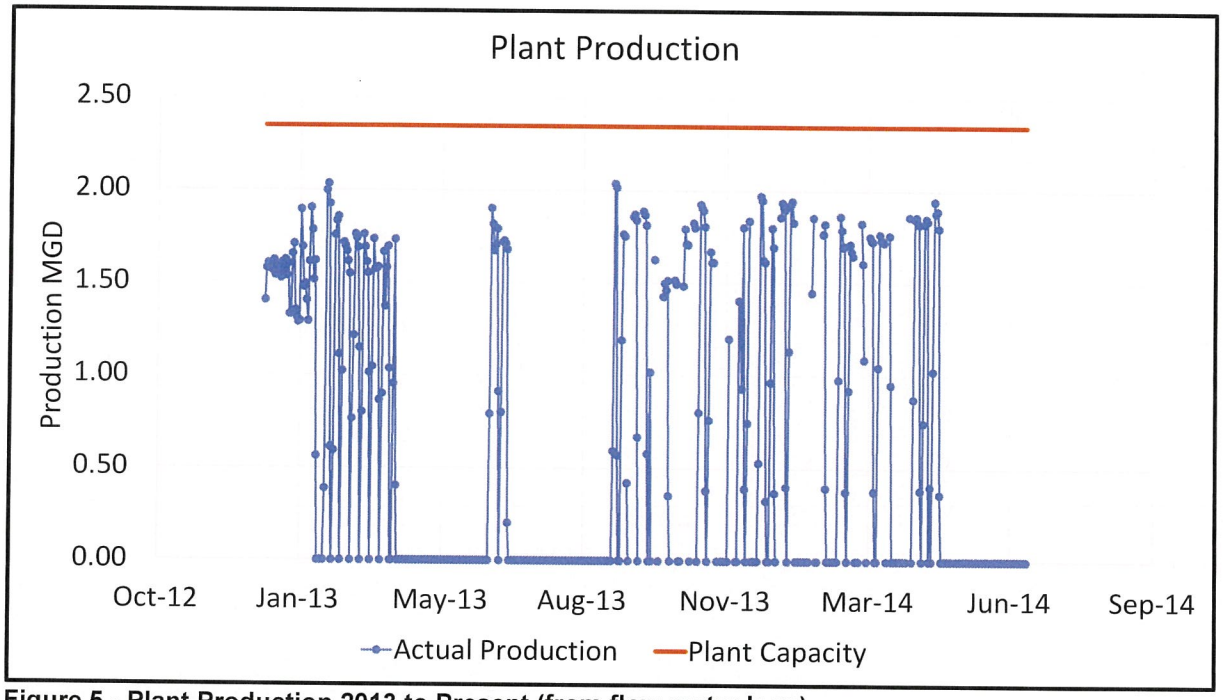


Figure 5 - Plant Production 2013 to Present (from flow meter logs)

The log sheets above provide daily production readings, and do not include any commentary of any plant shutdown events during that day. (Note that these data are taken manually, and some outliers may represent incorrect transcription).

On closer inspection from daily operator log sheets, we can see the instantaneous production rate is approximately 20% below design (taken from data during June 2014).

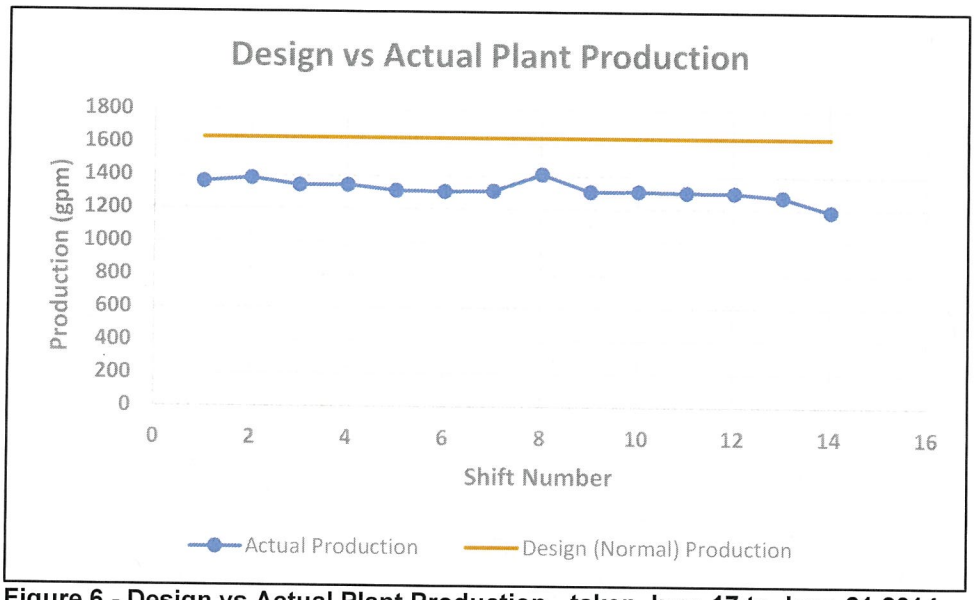


Figure 6 - Design vs Actual Plant Production - taken June 17 to June 21 2014.

The shortfall of plant production is the result of two things:

- A shortfall of plant feed water and
- The RO operating at a lower than design recovery

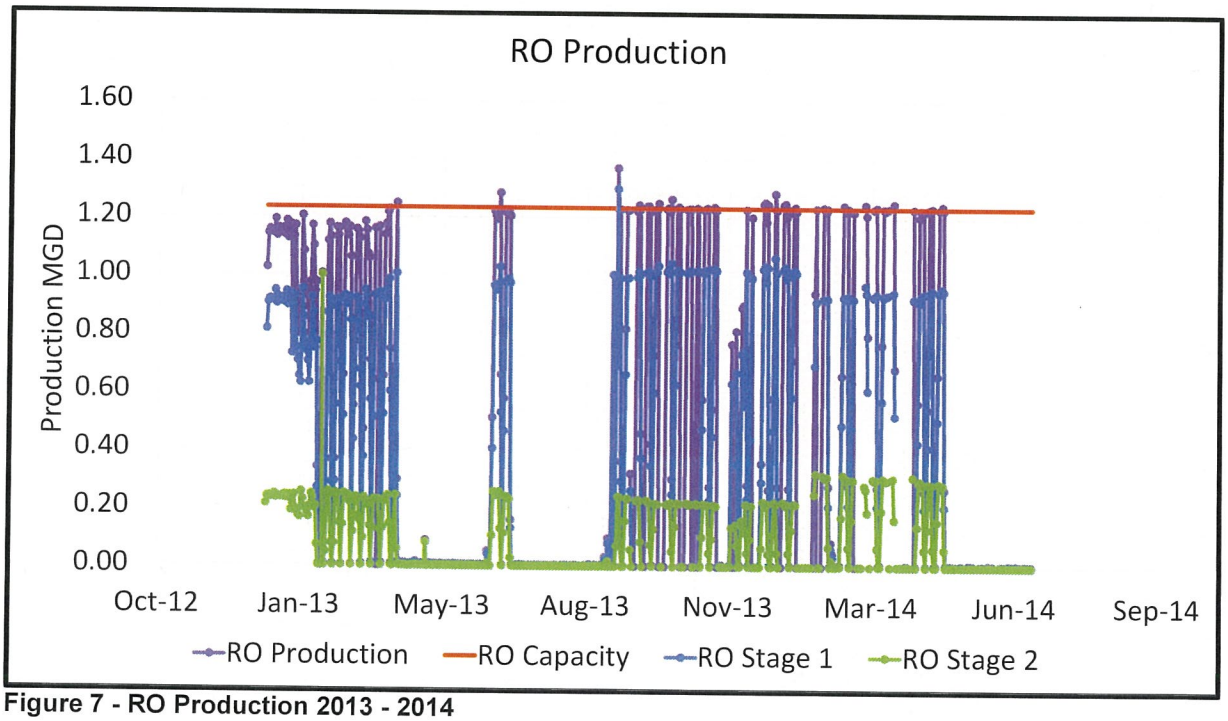


Figure 7 - RO Production 2013 - 2014

The RO unit itself, has been maintaining production consistent with the original design, as can be seen from both the daily flow logs, and weekly operator log sheets.

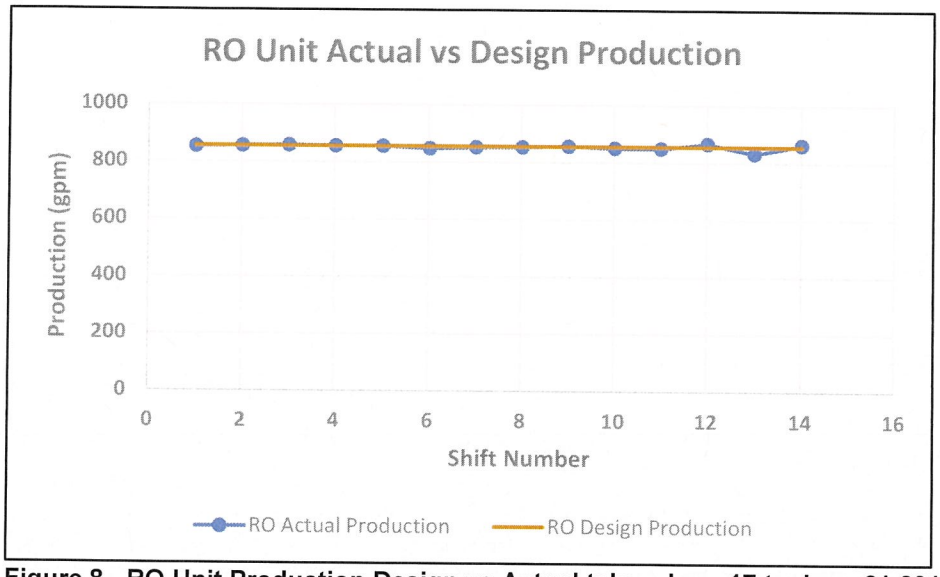


Figure 8 - RO Unit Production Design vs Actual taken June 17 to June 21 2014.

However, the RO unit is operating at a lower overall recovery (that is ratio of permeate flow to RO feed flow) than design (70% down from 78%), and as a result requires a greater portion of feed water from the wells than anticipated in the design (in this case an additional 120 gpm) in order to produce the same amount of RO permeate. Additionally, this results in 120 gpm of additional waste from concentrate to sewer. This presents increased operating costs both in terms of increased waste disposal, in addition to increased pumping energy costs as that additional flow of water must be pressurized through the RO unit. Based on the original design flow, this will result in an additional 15% energy consumption for the pump at a cost approaching $10,000 per year at continuous plant production.

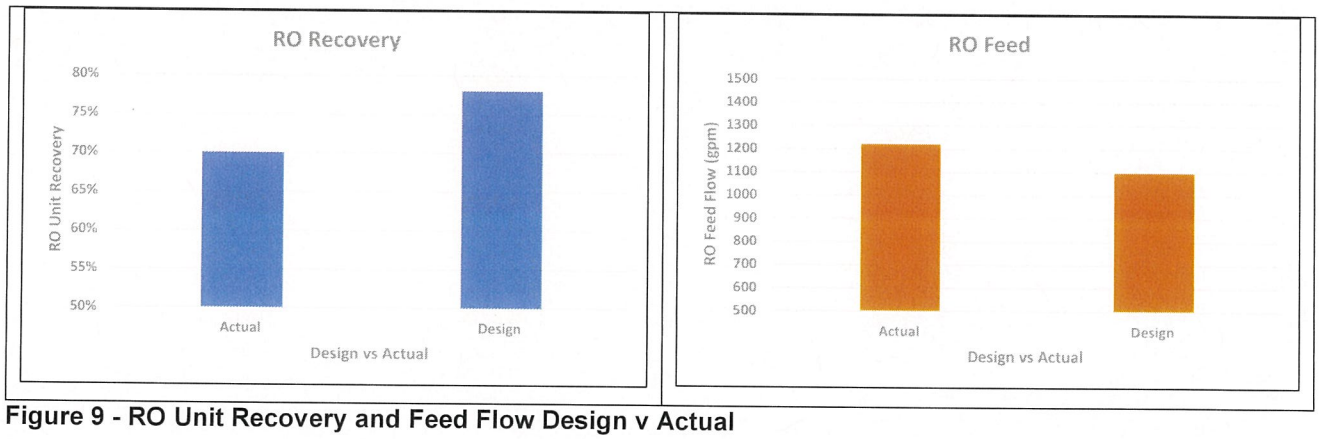


Figure 9 - RO Unit Recovery and Feed Flow Design v Actual

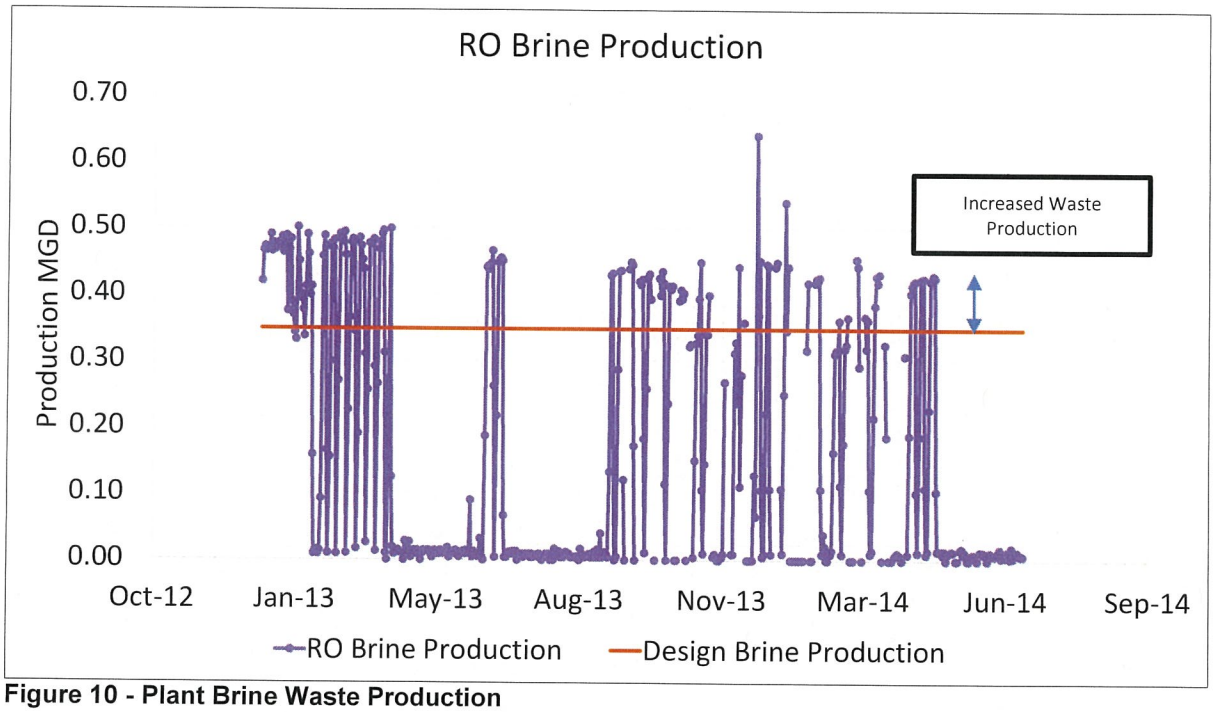


Figure 10 - Plant Brine Waste Production

We have noted that the RO recovery was lowered at some point prior to 2013. We are unsure of the reasoning, however it may have been done on the basis of a concern of scaling of the RO membranes. We recommend that this be further investigated. We additionally note, on our visit to site, that the RO concentrate valve, which is typically automated, is currently not connected to the unit, and rather the concentrate is throttled with a small diameter pipe restriction (acting as an orifice plate). The restriction and lack of control limits RO recovery.

Recommendation: We recommend an overall brine reduction strategy, with a review of RO unit recovery based on actual current feed water chemistry and options of antiscalant selection. We will work to provide options for improvement with the current infrastructure.

As well as additional feed water required for the RO unit, there is a lower rate of feed water being delivered from the wells themselves. It was noted in the project kick off meeting that this lower feed flow is limited by current well capacity constraints. This can be seen clearly in both the flow logs and weekly operator log data.

This lower well yield may limit the production capability of the RO unit. An RO is designed as a relatively constant flow device, and does not operate well at design flows significantly below its original design point.

Recommendation: We therefore recommend a review of options for reduced RO system overall throughput to allow for this reduction in well yield. We recommend a review of options for reduced RO system throughput, including items such as taking pressure vessels off line, and a review of hydraulic impacts.

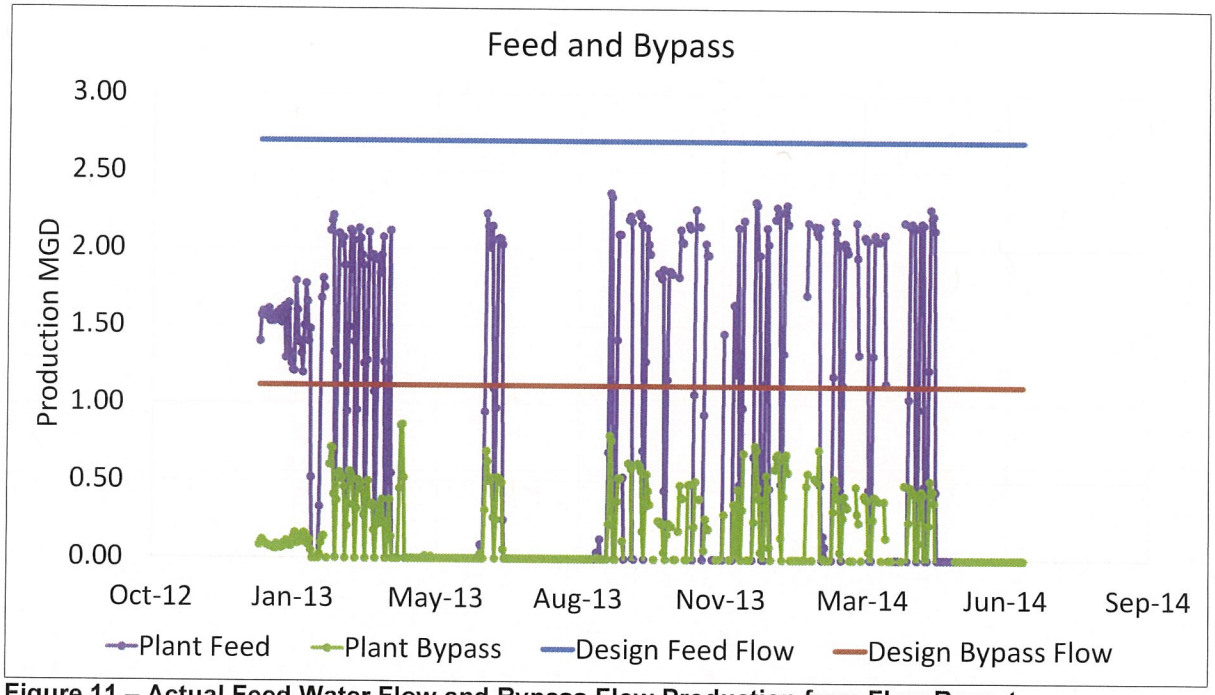


Figure 11 – Actual Feed Water Flow and Bypass Flow Production from Flow Reports

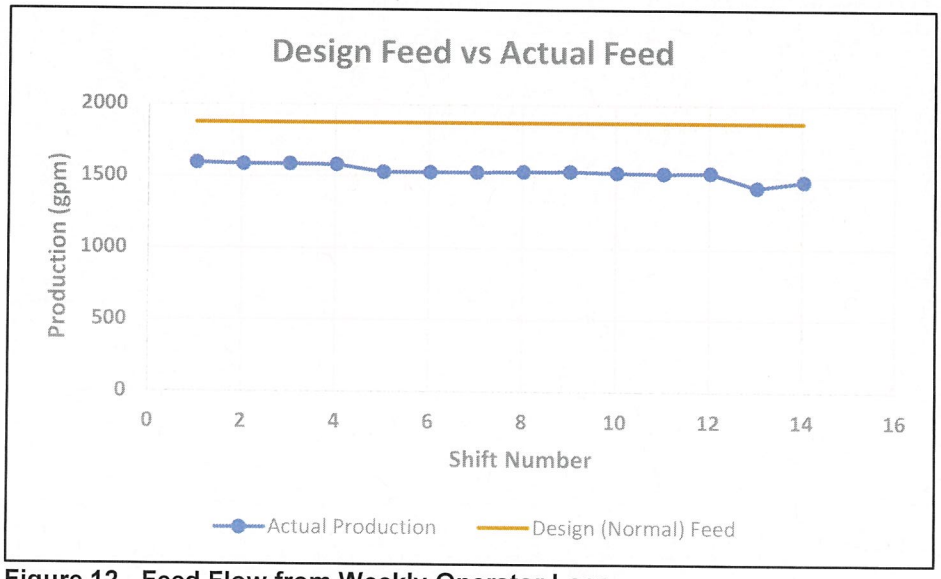


Figure 12 - Feed Flow from Weekly Operator Logs

This lack of feed water not only limits plant capacity, but also acts to impact treated water quality. The original blend design was set such that the final treated water blend would contain sufficient hardness and alkalinity to provide a non-corrosive, stable product water. With a much lower proportion of bypass water now in the final blend, careful attention should be paid

to the stability management of the final product water, as unstable water may corrode concrete infrastructure such as the Clearwater well.

Also, a loss of one well will change the overall feed water blend, and consequently the feed water quality to the RO unit and bypass streams. This may impact the risk of scaling to the RO and as a result the possible system recovery (which impacts both the amount of treated water that can be produced and concentrate waste generated).

Recommendation: Repair and replace RO concentrate valve, and work to confirm possible recovery based on feed water quality (this is discussed further later in the report).

Recommendation: Review capacity constraints on wells and review the impact of differing feed water blends and lower feed availability on plant and RO operation including impact of RO system recovery and throughput.
Recommendation: Review RO Feed Water Quality and current pH and antiscalant regime to determine sustainable RO recovery rate and minimize brine production

Treated Water Quality Targets

The water quality targets for the plant are governed under requirements of both Federal and State water regulation. The specific requirements for the plant are articulated through the Permit No 04-15-03P-003 and subsequent amendments 1910156PA-001, 002 and 003 (2003, 03/2010, 11/2010 and 01/2011 respectively).

This permit incorporates additional federal and state requirements for the plant which include:

- EPA Groundwater Rule.
- EPA Stage 2 Disinfection Byproduct Rule
- California Title 22 COR Chapter 15 Domestic Water Quality and Monitoring Regulations

Specifically, the permit requires (Amended permit, condition 6) that all water shall "meet all Maximum Contaminant Levels (MCLs) established by the department".

Additionally, the permit specifically requires:

- A fluoride level leaving the plant of between 0.8 and 1.1 mg/L.
- 4 log virus inactivation treatment, which was a requirement subsequent to positive coliform results from the RO system.
- A total chlorine residual of 2.0 mg/L (in the form of chloramine) in the distribution system (note this is not strictly required of the permit, but noted as the city target).

There are some additional water quality targets noted in documentation at the plant. In particular, a version of the Operations Monitoring and Maintenance Plan (OMMP) refers to some additional non-regulatory parameters, which we assume are from the original plant operations manual. These include:

Parameter	Product Concentration
Hydrogen Sulfide	< 0.3 ppm 90% removal with inlet pH = 6.0 (also noted as <0.01 in another section of the OMMP)
Total Hardness	< 150 mg/L as $CaCO_3$
T.D.S (180 deg C)	< 400 mg/L
LSI (Langlier Saturation Index)	Non-corrosivity

Recommendations:

While many of the water quality targets are listed in the permit and associated documents, we recommend that there is a clear set of targets listed in one place, so that the overall water quality requirements of the plant are clear.

- We recommend that all requirements be clearly articulated in one document, so that they are clear for operations. (This exercise has begun with the development of a Sampling Manual and we recommend it be completed, which could be later included in the OMMP).

- We recommend that some of the non-regulatory but operationally important parameters (water stability and total dissolved solids be included in this list).

- We specifically recommend a stability index (calcium carbonate precipitation potential, or LSI) target be defined and be regularly monitored at the clear well inlet and plant effluent to ensure water stability.

Treated Water Quality Performance

There is no regular updated report of overall treated water quality performance for the plant, but rather there is a limited combination of on-line trending, and regular regulatory reporting. On line trending reviews pH, turbidity and chlorine (free and total) only. Additionally, fluoride concentration is trended leaving the plant.

The remainder of performance parameters are measured as per regulatory requirements on discrete monthly reports. There is currently a very limited amount of data that is trended and reviewed, and as a result changes in performance and opportunities to take correction early may not be identified.

We have not included an exhaustive review of treated water quality performance in this report, but rather highlighted some important trends and aspects of treated water quality that merit further investigation. The Water Quality Monitoring and Reporting section below discussed the planning, sampling and reporting of water quality and provides recommendations in more detail.

Final Effluent Quality

The water quality data below is provided from regulatory reporting between January 2013 and July 2014. Of the set of data regularly reported, we have included Total Dissolved Solids, Fluoride, Arsenic and Manganese.

In reviewing all of this data, it is important to recognize that the quality is a function of the RO unit performance, the ratio of water that bypasses the RO unit and the feed water quality from the wells.

- **Total Dissolved Solids (TDS)** – we note that for all but one result, the level is below the secondary MCL of 500 mg/L, however it is above an originally desired level of 400 mg/L as noted in a section of the OMMP. Further, we can detect a significant trend of

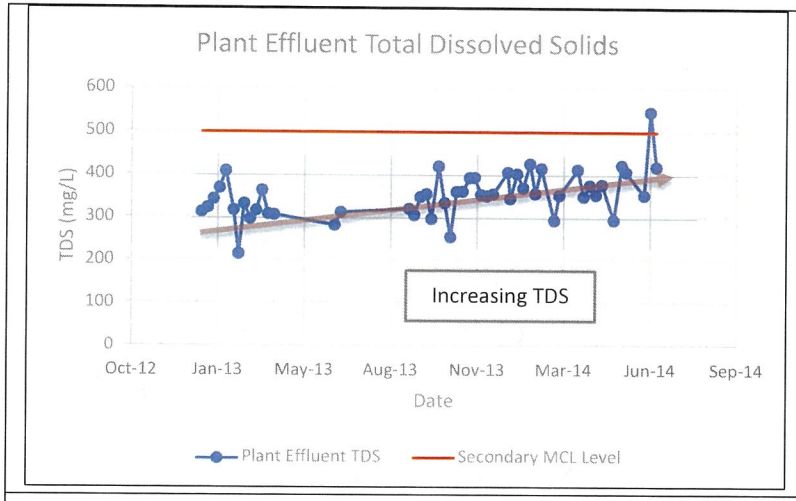
increasing TDS with time. This can be due to an increase in the water bypassing the RO, an increase in feed water TDS, changing operating conditions of the RO or an increase in salt passing through the membranes. A closer inspection of membrane performance and blending rates (later in this report) suggests that it is most likely due to a worsening in membrane condition allowing the passage of more salt. This is a very high rate of increase, and suggest a major problem with the membranes themselves or the membrane seals.

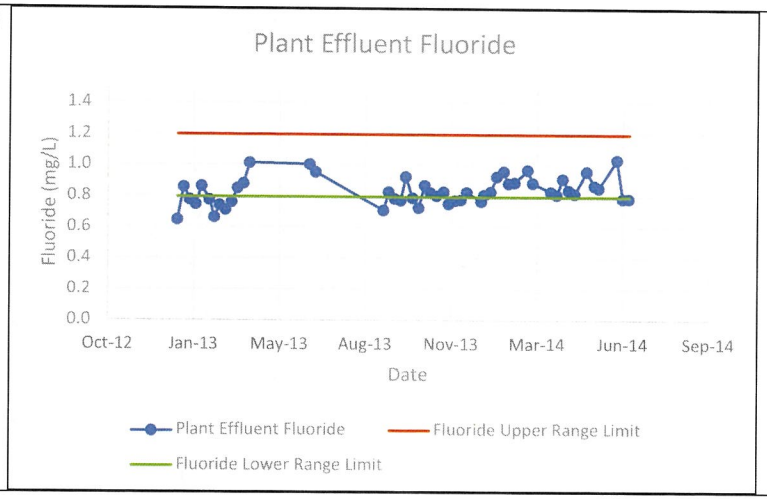
- **Arsenic** – arsenic is of particular interest due to high arsenic levels being present in one of the four wells feeding the plant (well 4) and subsequent arsenic management planning that has been implemented. While arsenic levels remain below the MCL of 10 ug/L, we note that it has been within 75% of this level on occasion. This may suggest a high proportion of high arsenic in the feed water. Close attention must be paid to the current arsenic management plan to ensure compliance.

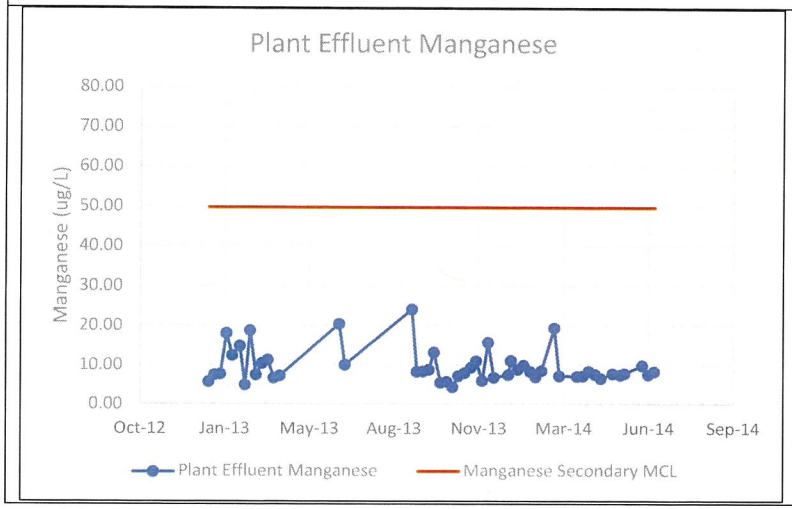
- **Manganese** – manganese remains below the secondary MCL of 50 ug/L, however we note peaks that coincide with arsenic peaks. This may similarly suggest high arsenic in the feed water.

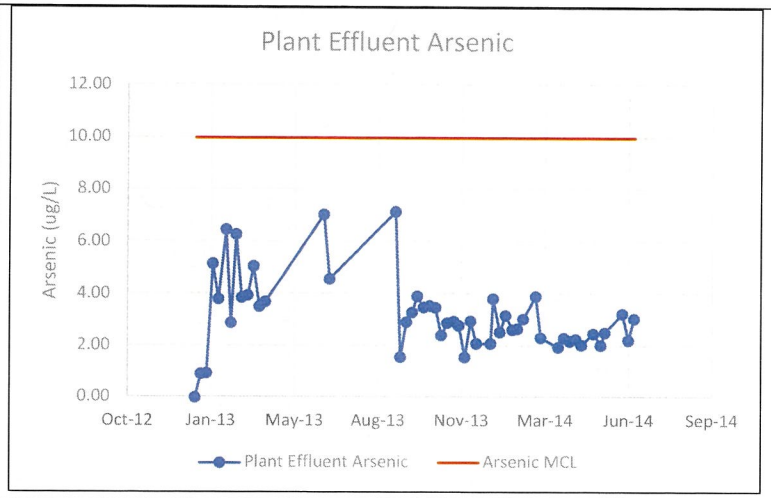
- **Fluoride** – fluoride is a controlled dose, however there is fluoride in the feed water for all wells. Depending on the fluoride levels in the wells, and the blend of wells used, the level of fluoride in treated water does fluctuate.

Table 1 - Plant Effluent Water Quality (from Monthly Regulatory Reports









Chlorine and turbidity data is both trended at the SCADA and logged by plant operators. We have not extracted significant trends from the SCADA for review, however we recommend that this be done and reported on a regular basis, again to identify trends in performance and to confirm compliance.

Daily logs checking both turbidity (reported from an on line analyzer) and chloramine (from a site test kit) provide some operational data. Data from shift logs the week of June 16 are shown below. We note that the turbidity level appears to have had an excursion beyond the desired 0.3 NTU, however it would need to be confirmed if this is an accurate result or reflects cleaning maintenance required at the instrument.

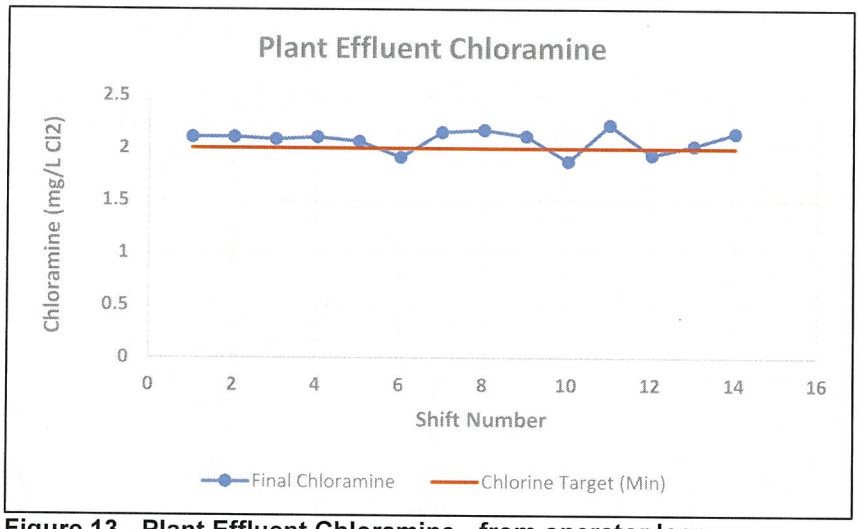


Figure 13 - Plant Effluent Chloramine - from operator logs

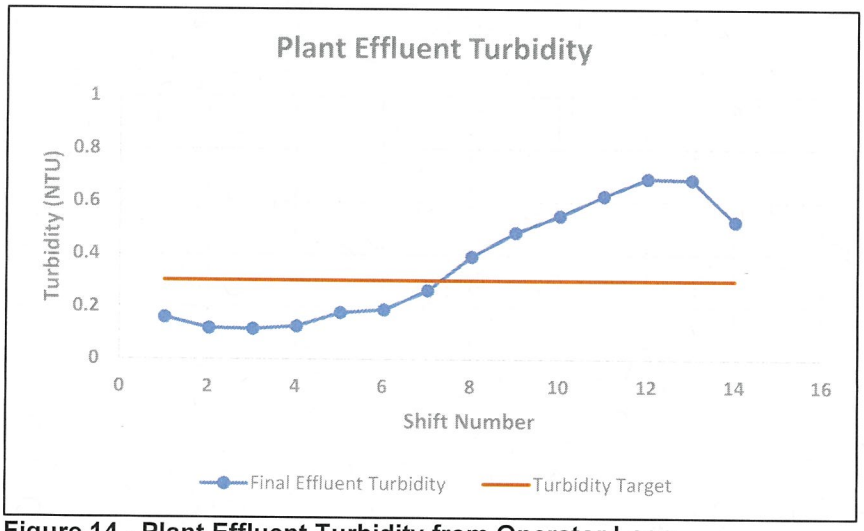


Figure 14 - Plant Effluent Turbidity from Operator Logs

Recommendation: Develop regular and trended water quality reporting, similar to those shown above, to provide an ongoing review of plant performance, and provide an opportunity to identify problems early and optimize performance.

Operating Systems and Processes

The long term success of any operating facility relies on a well-documented, up to date and functioning set of operating systems and processes. Operating systems and processes are systems by which infrastructure can be operated to function consistently and reliably. It is important that there is enough documentation to define the how, when, why and by whom for operations so that responsibilities are clear, tasks are repeated in a consistent timely fashion and a functioning history of performance is maintained.

Ideally, systems and processes are contributed to by staff, and act to empower them to make good operating and maintenance decisions.

This section reviews some of the system documentation that was identified at the plant during recent plant visits, and provides some recommendations on actions to improve or enhance the existing systems.

Overall, there appear to be a limited set of functioning, documented systems and processes in use at the facility. The working documents are limited to some operating log sheets, simple task planning schedules and operator log books. Notably, significant work has been done to further improve documentation of water quality requirements in development of a water quality Sampling Manual.

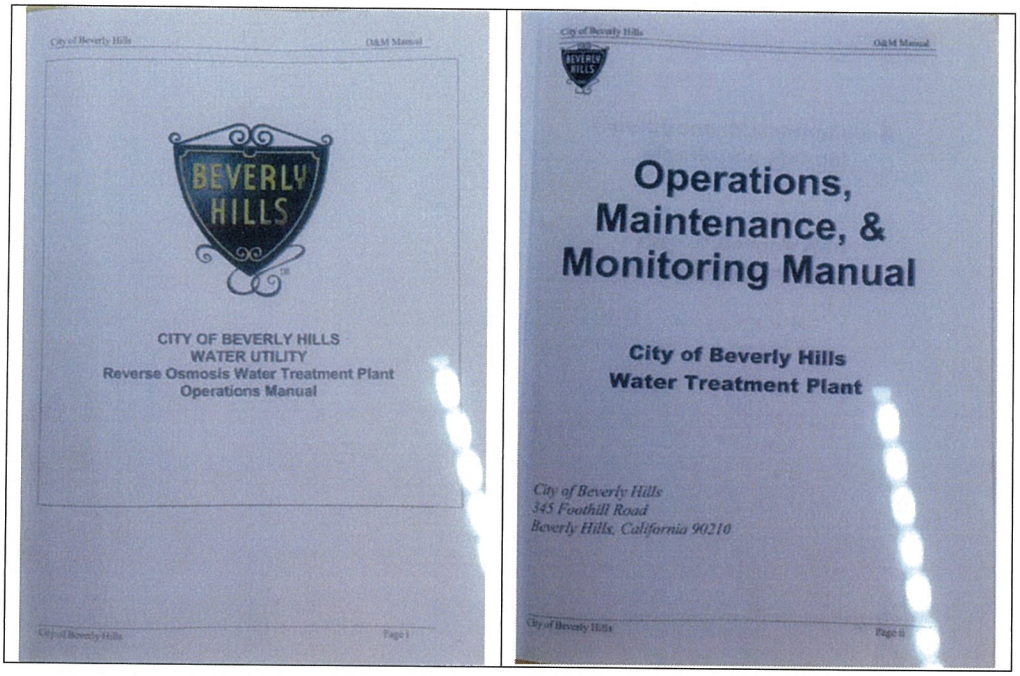
Of particular concern, much of the knowledge of plant operation appears to have been gained through verbal instruction, site experience and trial and error.

Operations Maintenance and Monitoring Manual

Existing Documents

The Operations, Maintenance and Monitoring Manual (OMMP) is a key requirement for the operations of the facility, and is an explicit permit requirement. The most recent permit amendment (Amendment 1910156PA-003, Jan 2011), condition 17 requires the city to update the OMMP within 120 days of that amendment being received, to update for change in plant ownership and the inclusion of a start-up monitoring procedure.

Table 2 - More Recent Operations Maintenance and Monitoring Manual sighted during plant review.



During this review, we have been able to located two versions of an OMMP for the plant.

The first version had been developed by the previous DBO contractor, and was not currently up to date. While much of the plant technical information is correct, it refers to previous management systems and plant management personnel within the DBO contractor's structure. Additionally it does not include a number of recent modifications to plant operation that have taken place including addition of fluoridation, the operation of free chlorine CT in the clearwell and current monitoring practices. This document appeared to be known to plant operators, and occasionally referenced for technical information. It is not in regular use.

The second version was uncovered in the previous Plant Supervisor's Office. This version of the document appears to be more up to date, and has removed most references to the previous DBO contractor. This document appears to have been revised to meet the requirements of the most recent permit amendment, as this permit amendment is specifically referenced in section 6, however there is no date of publication or revision on the document. The document appears as it may still be a draft, as there are numerous formatting errors within it and many areas appear that they have not been entirely updated to reflect current operation. Notwithstanding these problems, however, there is valuable information within the document that should be used in the updating of final documentation for the plant.

Most importantly, this version of the document appeared unknown to operations staff until it was uncovered in this review.

The second of the two OMMPs is divided into 10 sections:

- Section 1 – Introduction and System Description
- Section 2 – Process Flow (Process Description)
- Section 3 – System Safety
- Section 4 – Process Controls
- Section 5 – System Operations
- Section 6 – Operating Permits
- Section 7 – Monitoring and Sampling
- Section 8 – Chemical Storage and Handling
- Section 9 – Troubleshooting Procedures
- Section 10 – Drawings

Additionally, at the back of the manual is a draft Arsenic Blending and Treatment Plan. A Fluoride OM&M plan (explicitly required in the permit) is not explicitly included in the document, although fluoride operational information is incorporated into Section 8 of the report.

OMMP Section 1 – Introduction

This section provides an overview of main equipment at the plant and the equipment function for all equipment within the water treatment plant. It provides a great deal of detailed information including:

- Basic operating description of major plant components.
- A list of instruments including location, range and equipment part number.
- RO membrane specifications including membrane models at the time of writing.
- List of electrically operated valves including material information and valve function.
- Sample valve listing.
- RO performance design basis, including a list of operating scenarios, flows and treated water quality expectations.
- Plant overall flow balance.
- Chemical system details including chemical used, concentration, approximate doses and consumption.

Much of this section is very useful information, and important to be documented. We recommend that this information be used, and updated to reflect current plant equipment and operational information. Some of the more detailed information (such as equipment part numbers) could be recorded in a subsequent section or kept in a future asset register, however the main body of information is important.