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925.949.5800 phone
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TECHNICAL MEMORANDUM

DATE: February 26, 2024

Project No.: 988-50-24-10
SENT VIA: EMAIL

TO: George Lee, City Manager, City of Ione

CC: Justin Granados, WaterStone Services

FROM: Kathryn Gies, PE, RCE #65022
Allie Ahern, EIT

REVIEWED BY: Charles Hardy, PE, RCE #71015

REGISTERED PROFESSIONAL ENGINEER
KATHRYN ELIZABETH GIES
No. C65022
Exp. 6-30-25
CIVIL
STATE OF CALIFORNIA

SUBJECT: Updated Water Balance for City of Ione Wastewater Treatment Facility, Waste Discharger Requirements Order R5-2013-0022-001

This technical memorandum (TM) provides information and supporting documentation related to an updated water balance for the City of Ione (City) Wastewater Treatment Facility (WWTF). The following topics are addressed:

- Background Information
- Existing Facilities
- Historical Influent Flows
- Climate Data
- Current (2024) Influent Flows
- Projected 2030 Influent Flows
- Estimated Capacity of Existing Discharge Areas
- Operational Assumptions
- Water Balance Results

BACKGROUND INFORMATION

Waste Discharge Requirements

The City and the Jackson Rancheria Development Corporation (Jackson Rancheria) are the two entities permitted under Central Valley Regional Water Quality Control Board (Regional Board) Waste Discharge Requirements (WDRs) Order R5-2013-0022-001 and the associated Revised Monitoring and Reporting Program R5-2013-0022 REV1 (MRP) (Regional Board, 2014b) for the treatment of domestic wastewater at the WWTF and disposal and reuse of the secondary effluent. The WDRs were initially adopted on April 11, 2013, and revised December 5, 2014 (Regional Board, 2014c).

The WDRs present the following information related to the capacity of the WWTF and disposal system:

- The allowable influent average dry weather flow (ADWF)[1] to the WWTF is limited to 0.50 million gallons per day (mgd) based on the water balances that were included in the City's 2012 Report of Waste Discharge (ROWD) (GHD Inc., 2012a).
- The allowable influent ADWF to the WWTF can increase to 0.52 mgd following Executive Officer approval of a 2020 Capacity Expansion Completion Report. The WDRs were modified in 2014 to make this provision performance-based because of changes in City operations that occurred in 2013 that effectively increased the available disposal capacity provided by the percolation basins. However, the 0.52 mgd limit was not modified. The understanding at the time was the capacity limit would be modified with the submission of the 2020 Capacity Expansion Completion Report.
- WDRs Finding 29 states: "The City states that the current treatment capacity is 0.55 mgd."

Cease and Desist Order

On December 5, 2014, the Regional Bord adopted Cease and Desist Order 2014-0157 (CDO) (Regional Board, 2014a) that addressed the City's inability to comply with the following requirements of the WDRs:

- **Prohibition A.1:** Discharge of wastes to surface waters or surface water drainage courses is prohibited. (Only as this provision relates to the discharge of degraded groundwater into Sutter Creek).
- **Groundwater Limitation D.2:** Release of waste constituents from any portion of the WWTF shall not cause groundwater to contain constituents in concentrations that exceed either the Primary or Secondary Maximum Contaminant Levels established therein.
- **Discharge Specification E.1:** No waste constituent shall be released, discharged, or placed where it will be released or discharged, in a concentration or in a mass that causes violation of the Groundwater Limitations of [the WDRs].
- **Discharge Specification E.3:** The discharge shall remain within the permitted waste treatment/containment structures and land application areas (LAAs) at all times.

The CDO specifically requires a series of actions to be completed by the City to address the issues identified above. These actions are as follows:

- Construct facility improvements that will effectively stop the mechanisms that result in the mobilization and discharge of iron and manganese in violation of the Groundwater Limitations in the WDRs;
- Effectively stop any indirect discharge (seepage) of polluted groundwater to Sutter Creek; and
- Bring the facility into compliance with the WDRs.

[1] ADWF is defined in the WDRs as the total flow for the months of July through September, inclusive, divided by 92 days.

Compliance with the first requirement was to be demonstrated through achievement of specific groundwater numeric targets defined in the CDO. The CDO also requires that all ponds be lined or permanently closed if the specified groundwater numeric targets for iron and manganese defined in the CDO are not met by their compliance dates.

13267 Order Requirements

On August 14, 2024, the Regional Board issued a 13267 Order letter to the two WDRs permittees that requires submittal of an updated water balance for the WWTF to the Regional Board by December 13, 2024. The letter specifies the following three items that should be included in the water balance:

- The forecasted influent flows and proposed flows over the next 5 years based on population growth. Estimates must be supported by City planning documents.
- Any changes to collection system, treatment plant, and disposal features or their operation planned in the next 5 years.
- If the facility does not have sufficient capacity to treat and dispose of all wastewater onsite, the submittal must include the volume of excess effluent that would need to be disposed of each year to ensure all wastewater is treated and disposed of properly without causing or threatening to cause a violation of the permit or a condition of pollution.

The 13267 Order also states that the water balance must be in compliance with the requirements and guidance of the Regional Board's guidance document *Requirements for Water Balance Update and Calibration*.

In addition to the above requirements, Regional Board staff issued an email to the City that stated that the Regional Board cannot consider a water balance complete if it represents operation of a facility that causes violation of a WDRs and/or an enforcement order, with the following examples of reasons the Regional Board would consider a water balance incomplete:

1. The provided influent flow rate is higher than the treatment capacity, which could cause effluent limit exceedances.
2. The provided rate of treated wastewater being applied to a LAA is too high and threatens to impact groundwater or violate conditions of the WDRs such as runoff or saturated conditions.
3. The inclusion of disposal capacity via percolation ponds which are required to be lined or closed by an enforcement order.
4. The acceptance of a waste stream not described in the WDRs.
5. The operation of ponds or reservoirs that would exceed freeboard requirements of the WDRs.

Of the above-listed examples, Numbers 1 and 3 could pertain to the WWTF. Therefore, both topics are addressed herein.

Review Of Site-Specific Water Balance

On February 3, 2025, Regional Board staff issued a letter titled Review of Site Specific Water Balance that identified data gaps and deficiencies that must be addressed. The following specific changes were required:

- *The WDRs state that the total disposal capacity of the facility is 0.75 MGD, with the caveat that: "The water balances are based on the assumption of year-round cropping of all available LAAs. Therefore, this Order requires year round cropping of all LAAs and allows year-round irrigation with recycled effluent to meet crop water needs." The Town Field, a 67 acre land application area (LAA) that provides roughly 85% of the permitted disposal capacity, is leased to and managed by a farmer who does not crop year round. Standing water after rain events percolates slowly due to higher groundwater leaving the LAA saturated for long periods of time. Consequently, irrigation and cropping during the wet season is highly variable. Board staff's understanding is that the City has no control of how the LAA is managed.*

  In addition, since the WDRs were adopted the City modified the treatment train by lining Ponds 1-5. Ponds 1-4 were unlined treatment ponds, and pond 5 was a percolation pond. Lining Ponds 1-5 decreased the disposal capacity due to the loss of percolation.

  The water balance includes scenarios where Ponds 6 and/or 7 are used for percolation. This is not consistent with the requirements of the Ione WWTF WDRs or Cease and Desist Order (CDO) R5-2014-0157, which requires the lining or closure of the ponds. The effluent disposal capacity and flow limit in the WDRs have not been modified to reflect these changes. Therefore the 0.75 MGD effluent disposal capacity is an overestimation and should not be used. *The Report shall be updated to reflect the calculated current disposal capacity conditions within the requirements of the CDO and WDRs, and include supporting technical analysis to support that value.*
- *Rainfall data for a 1-100-year wet season is based on 2016/2017. Although the total rainfall is higher than 2020-2024 the distribution of storms is very different. In 2017 the rain was much heavier in January/February, but other months had more rain during 2020-2024 than they did in 2017. It may be more representative to distribute the total flow more evenly over the wet season of the 1-100 model year. However, as this is occurring in the midst of the wet season when storage capacity is high and irrigation potential is low the effect may be minimal. The Discharger shall examine the sensitivity of the water balance to changes in monthly rainfall and include narrative analysis of the findings. If needed a factor of safety should be integrated into the water balance to accommodate fluctuations in estimated monthly rainfall values.*
- *Tailwater flows from the Town Field are estimated as no flow data is available. However, for months when greater than eight (8) inches of precipitation are projected the submitted water balance caps the amount of tailwater received from the Town Field at eight (8) inches. More information shall be submitted to support this restriction* [i.e. the water balance caps the amount of tailwater received from the Town Field as the runoff calculated form eight (8) inches of rainfall], *or the water balance shall be revised to not include a cap on precipitation values used to estimate tailwater flows.*

- *The water balance shall reflect true site conditions, and not include operational decisions that would cause a violation of the WDRs, applicable enforcement Order, or any applicable regulation. For example, the water balance cannot include assumptions such as the use of an unpermitted discharge to surface water, irrigation when LAAs are saturated, or discharge at a flow rate that would cause violations of applicable effluent limits. If the current facility cannot accommodate current or projected 5 year flows the volume of that deficit shall be calculated as required by Item 3 of the 14 August 2024 Water Code Section 13267 Order. In order to properly examine the water balance calculations, it is necessary that the spreadsheets containing the data and formulas are submitted along with the narrative portion of the report. All spreadsheets used to construct the tables and surmise conclusions shall be submitted.*

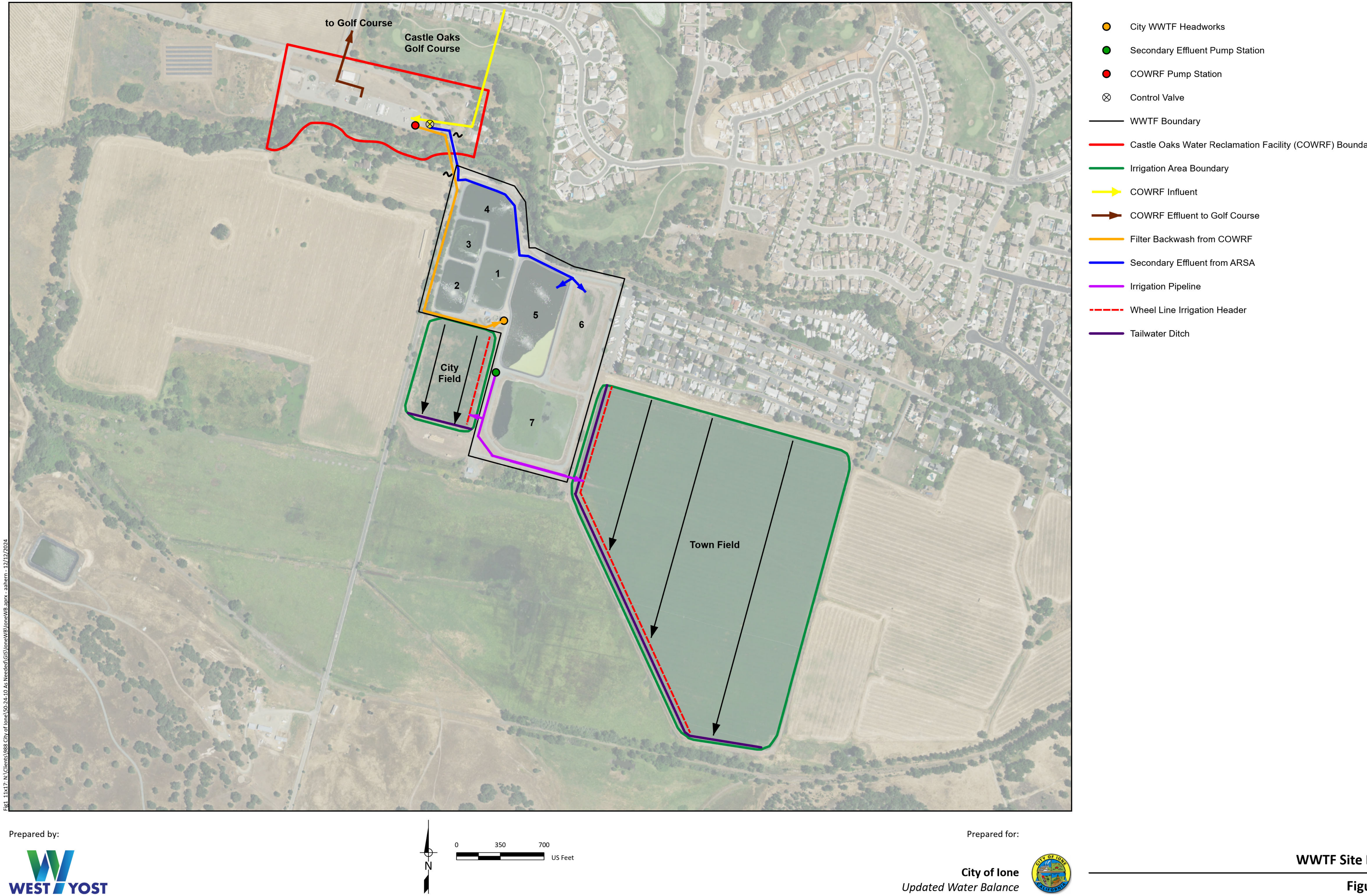
EXISTING FACILITIES

This section provides an overview of the WWTF pond system and LAA facilities.

WWTF Pond System

The WWTF is a pond-based treatment facility owned by the City and operated under contract by WaterStone Services, LLC. The WWTF is located south of the City, near the intersection of Marlette Road and Dave Brubeck Road. A map of the WWTF and connected facilities is shown on Figure 1. A flow schematic of the WWTF system is shown on Figure 2.

The WWTF treats wastewater generated from the City in five lined and aerated treatment ponds (Ponds 1 through 5). These ponds provide secondary wastewater treatment through aeration and settling. Pond 5 was historically operated as a percolation pond and is described as such in the current WDRs. However, with the lining and aeration improvements made since the WDRs were adopted, Pond 5 currently functions as a treatment pond. Ponds 6 and 7 are currently used for disposal through percolation and evaporation during periods when the effluent cannot be used for irrigation purposes.



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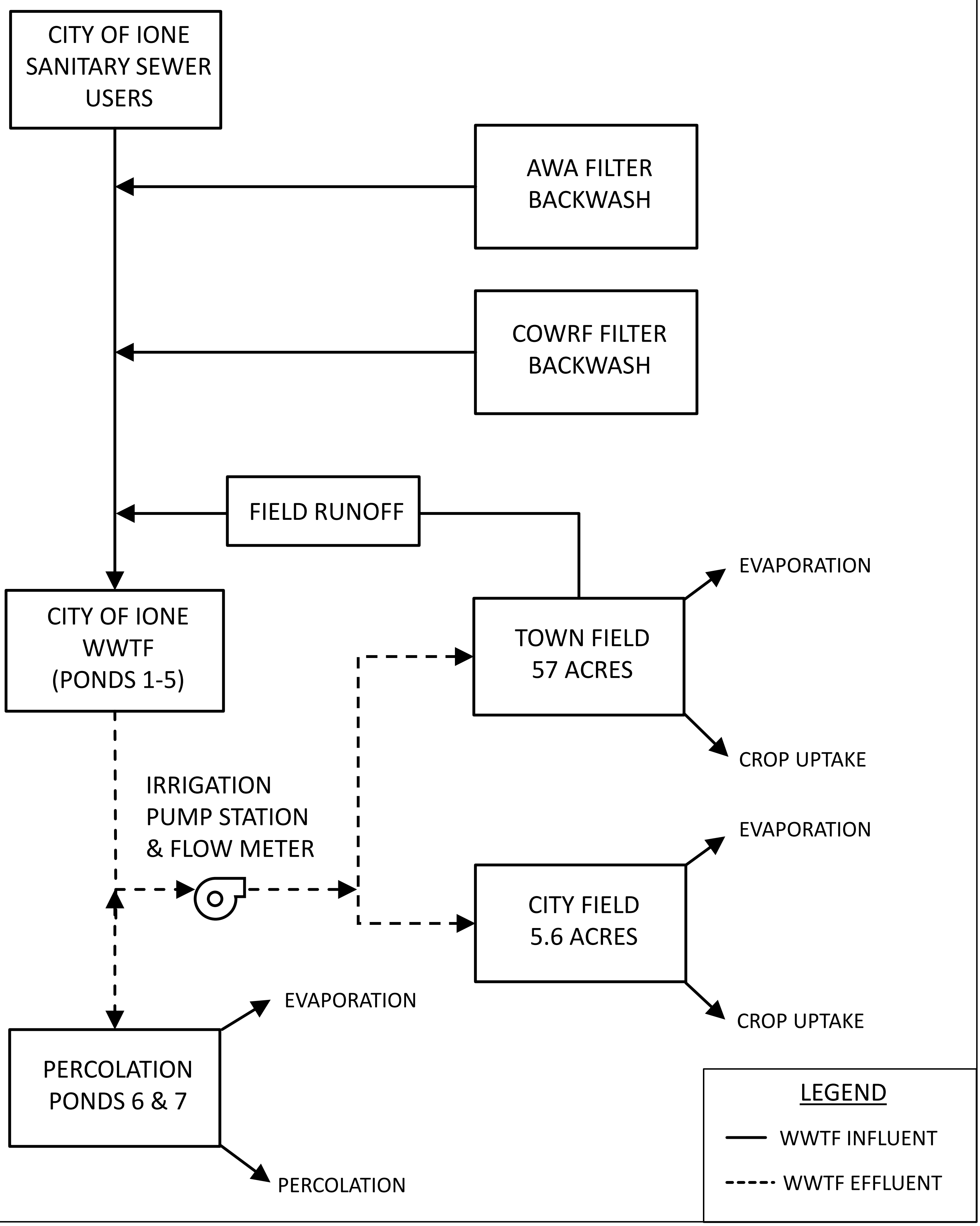
City of Ione
Updated Water Balance

WWTF Site Map

Figure 1

Figure 2. WWTF System Schematic



Detailed dimensions of each pond are presented in Table 1. Figure 3 provides a more detailed layout of the City's pond system, interconnection piping and groundwater monitoring piezometers described further below.

Table 1. WWTF Pond Dimensions

Pond[a]	Depth,[b] feet	Water Surface Area,[b] acres	Volume,[b] million gallons (MG)	Volume,[b] acre-feet	Pond Bottom Elevation, feet mean sea level (msl)
1	8.0	1.5	3.2	9.8	265.0
2	8.0	1.2	2.2	6.8	265.0
3	7.0	1.0	1.8	5.5	266.0
4	8.0	2.0	3.8	11.7	265.0
5	10.0	4.7	13.6	41.8	263.0
6	7.3	3.9	8.2	25.2	266.7
7	5.3	5.3	8.4	25.8	265.7

Source: 2017/2018 Pond 1-5 As-Built Survey

(a) Information for Ponds 1 - 5 is from the 2017/2018 Pond 1-5 As-Built Survey. Information for Ponds 6 and 7 is from the 2020 Capacity Expansion Completion Report.

(b) Depth, surface area and volume are shown at two feet of freeboard.

Quarterly groundwater monitoring is conducted at serval monitoring wells associated with the WWTF site. Piezometers 1, 2 and 3 (P1, P2 and P3) are specifically used to measure the groundwater elevations surrounding unlined Ponds 6 and 7. As shown on Figure 3, P1 lies on the east side of Pond 7, P3 lies in the northwest corner of Pond 7, and P2 lies northeast of Pond 6 adjacent to Sutter Creek. In this location, groundwater elevations at P2 are also likely influenced by creek water levels.

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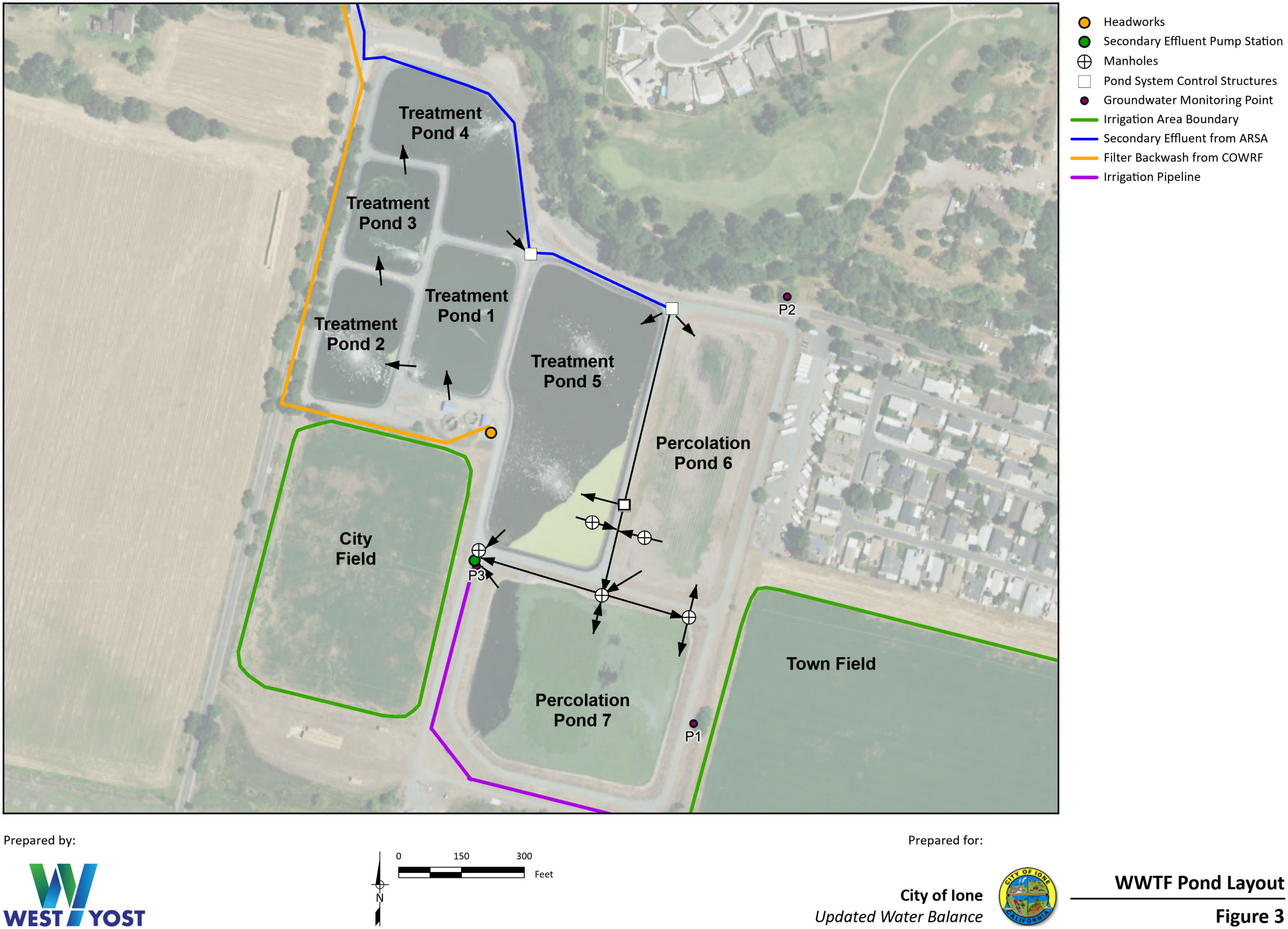

Prepared by:

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City of Ione

Updated Water Balance

WWTF Pond Layout

Figure 3

The influence of the WWTF ponds on the groundwater elevations at the WWTF site has changed significantly since the lining of Ponds 1 through 5 in 2019. Therefore, an assessment of depth to groundwater beneath the ponds should be based on data collected since 2019. A review of post 2019 quarterly groundwater monitoring data indicates that the highest groundwater elevations at P1, P2 and P3 occurred in the first quarter of 2023 (P2) and first quarter of 2024 (P1 and P3). The lowest groundwater elevations occurred in the third quarter of 2021 (for all 3). The groundwater elevations and corresponding depths below the invert of Ponds 6 and 7 for these periods are shown in Table 2 and Table 3. Groundwater elevation gradient maps from these monitoring periods are also included in Attachment A, taken from the respective quarterly monitoring reports prepared by others for the City.

Table 2. Pond 6 Depth to Groundwater

Measurement Period	Season	P2 Groundwater Elevation, feet msl	Groundwater Depth Below Pond 6, feet[a]
Q3 2021	Dry	257.30	9.4
Q1 2023	Wet	264.10	2.6
Q1 2024		262.64	4.1

(a) Groundwater depths below the invert of Pond 6 at 266.7 feet msl based on the respective P2 groundwater elevations.

Table 3. Pond 7 Depth to Groundwater

Measurement Period	Season	Groundwater Elevation, feet msl			Average Groundwater Depth Below Pond 7, feet[a]
		P1	P3	Average	
Q3 2021	Dry	256.80	251.60	254.20	11.5
Q1 2023	Wet	264.11	259.11	261.61	4.1
Q1 2024		264.61	260.44	261.03	4.7

(a) Groundwater depths below the invert of Pond 7 at 265.7 feet msl based on the respective averages of P1 and P3 groundwater elevations.

Land Application Areas

During the summer irrigation season, treated WWTF effluent is distributed via the secondary effluent pump station to two LAAs: the Town Field and City Field. Pertinent details regarding these two LAAs are as follows:

- Both LAAs are used to grow fodder crops (i.e. crops not intended for human consumption).
- As shown on Figure 1, the City Field is a 5.6-acre area located within the WWTF site. Currently, alfalfa is grown on the City field.
- The Town Field is a 57-acre irrigation site owned by Jackson Rancheria and is located directly east of the WWTF (see Figure 1).
- Since the City began irrigating the site with recycled water, alfalfa has been grown on this the Town Field.
- Both LAAs are irrigated by hand-move spray irrigation systems and are managed by an agricultural worker employed by Jackson Rancheria.

- Runoff is collected from the Town Field year-round and returned to the WWTF via the City's collection system.
- Runoff from the City Field is collected during the irrigation season. During the winter months, runoff is allowed to pond within the property until it evaporates or percolates.

A certification letter from Jackson Rancheria specific to the Town Field recycled water operations is provided in Attachment B.

Facility Changes Impacting Treatment Capacity Defined in the ROWD

The City has made significant changes to the WWTF since the development of the 2012 ROWD, as discussed above. These changes have impacted both the treatment and disposal capacity values that were stated in the ROWD, and that are documented in the WDRs[2].

With respect to treatment capacity, the WDRs state that the City reported that the influent ADWF capacity of the WWTF is 0.55 mgd. A disconnect between the stated capacity and the improvements made to the pond treatment system is found upon review of the June 2009 Wastewater Master Plan (Lee & Ro, Inc. and PMC, 2009), the March 2010 ROWD (Lee & Ro, Inc., 2010) and the November 2012 Supplement to the Revised ROWD (GHD Inc., 2012b). Specifically, the capacity statements made in the 2010 ROWD lean heavily on the 2009 Wastewater Master Plan values to define capacity with little to no assessment of the benefits provided by the City's projects that provided solids removal, pond lining, and increased aeration. Moreover, the 2009 Wastewater Master Plan does not characterize or assess the low load flows (i.e. backwash from the Castle Oaks Water Reclamation Facility (COWRF) and filter backwash from the Ione Water Treatment Plant (WTP)) that contribute to the ADWF entering the WWTF but have virtually no impact on treatment capacity.

Table 4 provides a summary of the aeration improvements made to the pond system since 2009. As shown, the City has significantly increased the aeration provided in the treatment ponds. This increase provides for added capacity through increased oxygen availability and improved mixing. More importantly, by lining and adding aeration to Pond 5, this facility no longer operates as a percolation/disposal pond as described in the WDRs. Indeed, Pond 5 is now better characterized as a treatment pond.

[2] As previously noted, and as documented in the 2014 WDR Amendment, the City has also made operational changes that have increased the available disposal capacity of the percolation ponds. However, because these water balances may not consider the percolation ponds as a vehicle for disposal, additional discussion regarding these changes is not included in this report.

Table 4. WWTF Pond System Aeration Improvements			
Facility	Original Aeration Capacity	Upgraded Aeration Capacity	Upgraded Aerator Type
Pond 1	1 aerator @ 15 horsepower (HP)	2@7.5 HP 1@ 15 HP	Floating Brush High-Speed Floating
Pond 2	1@ 7.5 HP	1@ 7.5 HP 1@ 15 HP	Floating Brush High-Speed Floating
Pond 3	1@ 7.5 HP	1@ 7.5 HP 1@ 15 HP	Floating Brush High-Speed Floating
Pond 4	1@ 7.5 HP	1@ 7.5 HP	Floating Brush
Pond 5	None	2@15) HP	High-Speed

A preliminary modeling analysis of the treatment pond system was developed to define the capacity of the ponds at current flow rates and at the projected 2030 flow rates, as defined in this TM. In addition, a model was developed to define the overall treatment capacity. For this analysis, the following assumptions were applied:

- Biochemical Oxygen Demand (BOD) removal in Ponds 1 through 4 is a first-order mechanism, where the first-order removal-rate constant "k" at 20 degrees Celsius (°C) is assumed to be 0.276 per day (U.S. Environmental Protection Agency, 2011).
- For Pond 5, the first order rate coefficient was defined based on the loading rate to the pond. Values ranged from 0.083 to 0.129 per day.
- The reaction rate coefficients were adjusted to reflect a treated water temperature of 10.9°C, which is based on the lowest monthly average measured influent temperature of Pond 5 in December and January. Assuming that the influent temperature of Pond 5 is the treatment temperature for all upstream ponds is a conservative assumption.
- The available volume of Pond 5 was adjusted down from the total capacity of 13.7 million gallons (MG) to 10.1 MG (or 31 acre-feet) based on average December through January operating levels (see Table 33 later in this TM).

The results of this analysis are shown in Table 5. As shown, the existing treatment system potentially has a theoretical ADWF capacity to process flows up to 0.72 mgd.

Table 5. WWTF Treatment Pond Modeling Analysis Results

Parameter	Units	Current (2024) Flows	Year 2030 Flows	Estimated Design Flows
Base Flow	mgd	0.41[(a)]	0.51[(b)]	0.58
ADWF[(c)]	mgd	0.55	0.65	0.72
Maximum Month Influent Flow	mgd	1.09	1.34	1.53
Maximum Month Influent BOD Load	pounds per day	1,450	1,800	2,060
Pond 4 Effluent BOD	mg/L	32	41	48
Pond 5 Effluent BOD	mg/L	20	24	30

(a) See Current (2024) Influent Flows section presented later in this TM.
(b) See Projected 2030 Influent Flows section presented later in this TM.
(c) Difference between Base Flow and ADWF values are the non-load inputs from sewer system inflow and infiltration, COWRF filter backwash, and AWA WTP filter backwash.

The City is currently working to update and calibrate the model of the treatment system. A final assessment of the current WWTF treatment capacity, including Pond 5, will be presented in a technical report prepared by a California Licensed Civil Engineer.

It is also noted that the effluent limitations described in the WDRs are specifically applied to effluent discharged to the percolation ponds. Since Pond 5 is lined it no longer is a percolation pond, these limits should apply only to discharges to Pond 6 and Pond 7. To remedy this, the City proposes a modification to the MRP[3] to change the effluent monitoring location.

[3] The City will need to develop new water storage and/or effluent management strategies to ensure compliance with the CDO. Once the new strategies are identified, the City will be in position to prepare and submit a new ROWD so support development of a new permit that incorporates changes to the treatment system.

A summary of the proposed changes to the MRP is provided in the table below.

The City of Ione shall collect un-disinfected effluent samples immediately downstream of Pond ~~4~~ 5 before the effluent is discharged into the percolation ponds. At a minimum, effluent monitoring shall include the following:

Constituent	*Units*	*Sample Type*	*Sample Frequency*	*Reporting Frequency*
ARSA secondary effluent flows to the percolation ponds	*gpd*	*Meter Observation*	*Daily*	*Monthly*
Total effluent flows to the percolation ponds[1, 2]	*gpd*	*Calculated*	*Daily*	*Monthly*
BOD_5	*mg/L*	*Grab*	*Monthly*	*Monthly*
Total dissolved solids	*mg/L*	*Grab*	*Monthly*	*Monthly*
Electrical conductivity	*µmhos/cm*	*Grab*	*Monthly*	*Monthly*
Total nitrogen	*mg/L*	*Grab*	*Monthly*	*Monthly*
pH	*pH units*	*Grab*	*Monthly*	*Monthly*
Standard minerals[3]	*mg/L*	*Grab*	*Annually*	*Annually*

1. *Sum of influent flows at the headworks and ARSA secondary effluent flows to the percolation ponds.*
2. *For continuous analyzers, the City shall document and report routine meter maintenance activities including date, time of day, and duration, in which the analyzer(s) is not in operation.*
3. *Standard minerals shall include, at a minimum, the following elements/compounds: arsenic, aluminum,boron, calcium, chloride, dissolved iron, magnesium, dissolved manganese, potassium, sodium, sulfate,total alkalinity (including alkalinity series), and hardness.*

HISTORICAL INFLUENT FLOWS

This section describes the historical flows from each source that contributes to the WWTF influent.

Total Influent Flows

Influent flows to the WWTF come from the following sources:

- Filter backwash from the Castle Oaks Water Reclamation Facility (COWRF)
- Filter backwash from the Ione Water Treatment Plant (WTP), operated by the Amador Water Agency (AWA)
- Base City flows (i.e. wastewater from City sewer customers)
- Wet weather flows, which including inflow and infiltration (I&I) to the wastewater collection system and tailwater runoff from the Town Field

The total historical average daily influent flows to the WWTF are shown in Table 6. The average annual flow (AAF) and ADWF to the WWTF for each year is also shown.[4]

As shown, flows were significantly higher in the 2024 irrigation season as compared to previous years. WWTF staff have reported that they suspect that during the 2024 irrigation season there was a leak in the valve that connects the COWRF and WWTF influent flow lines. This leak caused a portion of the flow sent from Preston Reservoir to enter the WWTF instead of the COWRF. This observation is supported by a review of the COWRF data that demonstrates the flow sent from Preston Reservoir was 100,000 to 300,000 gallons per day (gpd) higher than the reported COWRF influent flows. As discussed recently with the Regional Board staff, **the City has identified the cause of the leak as a damaged seal in the drain valves in the chlorine contact basins. The City has fixed the issue.**

[4] The ADWF period is defined as July through September, consistent with the definition in the WDRs.

Table 6. Historical Average WWTF Influent Flow									
Month	Average Daily WWTF Influent Flow, mgd								
	2016	2017	2018	2019	2020	2021	2022	2023	2024
October	0.381	0.423	0.395	0.486	0.502	0.490	0.390	0.615	0.860
November	0.329	0.352	0.386	0.530	0.431	0.343	0.433	0.447	0.583
December	0.371	0.318	0.344	0.430	0.346	0.555	0.510	0.431	-
January	0.433	0.656	0.406	0.480	0.399	0.412	0.451	0.894	0.545
February	0.386	0.582	0.353	0.805	0.361	0.434	0.396	0.575	0.723
March	0.474	0.454	0.609	0.790	0.460	0.351	0.395	0.939	0.656
April	0.364	0.422	0.471	0.495	0.473	0.395	0.546	0.582	0.590
May	0.375	0.375	0.438	0.546	0.538	0.395	0.485	0.607	0.849
June	0.406	0.381	0.404	0.470	0.562	0.462	0.457	0.597	0.839
July	0.386	0.418	0.333	0.355	0.563	0.520	0.454	0.578	0.784
August	0.395	0.453	0.247	0.447	0.554	0.505	0.474	0.656	0.897
September	0.413	0.490	0.375	0.517	0.536	0.465	0.409	0.616	0.894
AAF, mgd	**0.393**	**0.444**	**0.397**	**0.529**	**0.477**	**0.444**	**0.450**	**0.628**	**0.747**
ADWF, mgd	**0.398**	**0.454**	**0.318**	**0.440**	**0.551**	**0.497**	**0.446**	**0.617**	**0.858**

COWRF Backwash Flows

The COWRF provides tertiary recycled water to meet the irrigation demands of the Castle Oaks Golf Course (golf course). During the COWRF tertiary treatment process, a fraction of the flows through the COWRF is discarded as filter backwash and sent to the WWTF. Historical COWRF backwash flows are shown in Table 7. The COWRF ADWF for each year, which is used in calculating historical Base City flows, is also shown.

Table 7. Historical COWRF Backwash Flow

Month	Volume of COWRF Backwash Flow, MG								
	2016	2017	2018	2019	2020	2021	2022	2023	2024
October	2.2	3.0	1.9	4.0	3.4	2.4	1.7	7.3[(a)]	5.0
November	0	0	1.1	1.9	1.7	0	2.3	4.1[(a)]	1.7
December	0	0	0	0	0	0	0	0	-
January	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0
April	0	0	0	0	0	2.0	2.0	0.1	0
May	1.7	2.2	2.5	1.9	2.7	3.9	1.9	3.0	2.2
June	3.6	3.4	3.6	2.5	3.8	3.4	2.0	3.7	3.6
July	3.4	4.7	4.4	3.9	3.6	4.0	2.7	4.4	3.8
August	3.7	4.2	3.9	3.9	4.3	3.8	2.7	5.4[(a)]	5.1
September	4.1	4.1	3.5	4.0	4.0	2.6	2.2	6.4[(a)]	5.5
Total, MG	**18.7**	**21.7**	**20.9**	**22.1**	**23.4**	**21.9**	**17.5**	**34.4**	**26.9**
ADWF, mgd	**0.122**	**0.141**	**0.128**	**0.128**	**0.129**	**0.113**	**0.083**	**0.158**	**0.157**

(a) Backwash flows during this period were irregular due to filter maintenance. Values were not used in calculated average.

AWA Backwash Flows

The AWA discharges filter backwash flows from the Ione WTP to the City's wastewater system. Historical monthly backwash flows from AWA are shown in Table 8. The AWA filter ADWF backwash for each year, which was used in calculating the historical Base City flows, is also shown.

AWA flows to the WWTF decreased significantly after the completion of a filter upgrade project in 2016. Since then, intentional efforts have been made by AWA to further reduce flows. Between 2020 and 2021, the total volume of AWA flows sent to the WWTF decreased from 3.45 MG to 1.72 MG. Since 2021, total AWA flows to the WWTF have remained below 2 MG per year.

Table 8. Historical AWA Backwash Flow									
	Volume of AWA Backwash Flow, MG								
Month	2016	2017	2018	2019	2020	2021	2022	2023	2024
October	0.10	0.13	0.27	0.13	0.32	0.14	0.02	0.24	0.53
November	1.56	0.47	0.05	0.62	0.27	0.06	0.14	0.16	0.31
December	1.66	0.26	0.11	0.11	0.50	0.23	0.08	0.19	-
January	1.23	1.72	0.51	0.32	0.35	0.15	0.06	0.16	0.10
February	1.08	0.29	0.41	0.23	0.38	0.21	0.05	0.04	0.29
March	0.09	0.10	0.40	0.01	0.21	0.16	0.05	0.04	0.21
April	0.48	0.09	0.09	0.50	0.30	0.29	0.22	0.04	0.20
May	0.34	0.28	0.40	0.59	0.40	0.10	0.06	0.34	0.22
June	0.10	0.29	0.51	0.50	0.33	0.11	0.06	0.06	0.09
July	0.29	0.27	0.25	0.32	0.05	0.14	0.13	0.06	0.43
August	0.13	0.16	0.14	0.18	0.18	0.06	0.30	0.08	0.19
September	0.05	0.57	0.24	0.02	0.16	0.07	0.03	0.28	0.17
Total, MG	**7.11**	**4.60**	**3.38**	**3.53**	**3.45**	**1.72**	**1.20**	**1.69**	**1.90**
ADWF, mgd	**0.005**	**0.011**	**0.007**	**0.006**	**0.004**	**0.003**	**0.005**	**0.005**	**0.009**

Base City Flows

The base flow for the City can be determined by subtracting COWRF and AWA backwash ADWFs from the WWTF ADWF. The calculated daily average Base City flows for 2016 through 2024 are shown in Table 9.

Table 9. Historical Base City Wastewater Flows				
	ADWF, mgd			
Year	WWTF Influent ADWF	COWRF Backwash ADWF	AWA Backwash ADWF	Base City ADWF
2016	0.398	0.122	0.005	0.271
2017	0.454	0.142	0.011	0.301
2018	0.318	0.128	0.007	0.183
2019	0.440	0.128	0.006	0.306
2020	0.551	0.129	0.004	0.418
2021	0.497	0.113	0.003	0.381
2022	0.446	0.083	0.005	0.358
2023	0.617	0.158	0.005	0.454
2024	0.858	0.157	0.009	0.692
Average (2016-2023)[(a)]	**0.465**	**0.125**	**0.006**	**0.334**
(a) Averages exclude 2024 flow values due to the influence of Preston Reservoir flows being inadvertently directed to the WWTF.				

Wet Weather Flows

During wet weather months, I&I from the City's collection system and collected tailwater runoff from the Town Field enter the WWTF. These flows have been calculated for each month by subtracting COWRF backwash flows, AWA backwash flows and base City flows from the total WWTF influent flow. For this analysis the monthly Base City flows were calculated by multiplying the Base City flow determined for each year, as presented in Table 9, by the number of days in each month. Calculated wet weather flows are presented in Table 10.

Table 10. Historical Wet Weather Flows

Month	Volume of Wet Weather Flows, MG[a]							
	2016	2017	2018	2019	2020	2021	2022	2023
October	1.1	0.6	4.4	1.5	0	0.8	0	0
November	0.2	1.0	4.9	4.2	0	0	0	0
December	1.4	0.2	4.9	3.7	0	5.2	4.6	0
January	3.8	9.2	6.4	5.1	0	0.8	2.8	13.5
February	2.1	7.6	4.3	13.7	0	1.3	1.0	3.3
March	6.2	4.6	12.8	15.0	1.1	0	1.1	15.0
April	2.3	3.5	8.5	5.2	1.4	0	3.4	3.7
May	1.2	0	5.0	5.0	0.6	0	2.0	1.4
June	0.3	0	2.5	1.9	0.2	0	0.9	0.5
July	0	0	0	0	0.8	0.2	0.1	0
August	0	0.3	0	0.3	0	0	0.6	0.8
September	0.1	1.0	2.0	2.3	0	0	0	0
Total	**18.7**	**28.0**	**55.7**	**57.9**	**4.1**	**8.3**	**16.5**	**38.2**

(a) Calculated wet weather flows include I&I and collected tailwater runoff from the Town Field.

CLIMATE DATA

The California Department of Water Resources (DWR) has defined the average annual rainfall, 1-in-100-year annual rainfall, and the monthly distributions of rainfall based on rainfall data for the Ione National Climate Data Center (NCDC) weather station. These values are as follows:

- The average rainfall year was defined as having a total rainfall of 22.0 inches.
- The 1-in-100 rainfall year was defined as having a total rainfall of 41.1 inches.
- The monthly rainfall distribution values were defined based on the 1906 to 1997 "Normal" monthly values as calculated by the DWR.

Reference evapotranspiration (ET) for each month is based on long-term monthly average ET values for the Plymouth California Irrigation Management Information System (CIMIS) station, located approximately 13 miles northeast of the WWTF. This rainfall and reference ET information is presented in Table 11, based on the DWR information provided in Attachment C.

Table 11. Applicable Climate Data

Month	Average Rainfall,[a] inches	1-in-100 Year Rainfall,[a,b] inches	Reference ET,[c] inches
October	1.15	2.15	3.24
November	2.81	5.24	1.68
December	3.53	6.58	1.21
January	5.08	9.48	1.48
February	3.14	5.86	1.95
March	3.19	5.95	3.02
April	1.75	3.26	4.57
May	0.63	1.18	5.97
June	0.23	0.43	7.19
July	0.07	0.13	7.64
August	0.13	0.24	6.98
September	0.33	0.62	4.99
Total	**22.0**	**41.1**	**49.9**

(a) Ione NCDC weather station #044283.
(b) Monthly 1-in-100 rainfall values are calculated from the total 1-in-100 year rainfall value and the ratio of average monthly rainfall to average total rainfall.
(c) Plymouth CIMIS station #227.

CURRENT (2024) INFLUENT FLOWS

This section presents the estimated current (2024) influent flows to the WWTF from each source. These flows will be used to develop the current condition water balances.

Current Base Flows

Equivalent dwelling unit (EDU) data was used to calculate the average daily Base City flow per EDU for each year. The number of EDUs and calculated Base City flow per EDU for each year are presented in Table 12.

Table 12. Development of Daily Average Base City Flow per EDU

Year	Number of EDUs	Base City ADWF, mgd	Flow per EDU, gpd/EDU
2016	1,825[a]	0.271	148
2017	1,899[b]	0.302	159
2018	1,973[b]	0.183	93
2019	2,047[c]	0.306	149
2020	2,269[d]	0.418	184
2021	2,208[d]	0.381	173
2022	2,373[d]	0.358	151
2023	2,481[d]	0.454	183
2024	2,520[d]	0.692	275
	Average[e]	**0.334**	**164**

(a) From 2020 Expansion Completion Report by Dexter Wilson Engineering (2016).
(b) The 2017 and 2018 EDU values were calculated by taking the difference between the reported 2019 and 2016 EDUs and distributing their addition across the three years.
(c) From 2021 Water Balance Update and 2020 Expansion Completion Report by Coastland Engineers.
(d) From City Sewer January Billing Register for January of each year.
(e) Averages exclude 2018 and 2024 flow values.

As previously noted, the WWTF influent flows in 2024 included flows from Preston Reservoir that were inadvertently discharged to the WWTF. Atypical flows in 2024 is further demonstrated by that fact that the ADWF per EDU in 2024 was almost twice the ADWF per EDU of the four years prior. Due to the uncertainty associated with estimating this atypical influent flow to the WWTF, 2024 Base City flows have been excluded from the water balance analysis.

In addition, the 2018 Base City flow per EDU of 93 gpd is also anomalous when compared with the Base City flows of past and future years. Therefore, the data from 2018 has also been excluded from the calculation of the average Base City flow per EDU.

With the two exclusions noted above, the data in Table 12 demonstrates that the overall average daily base flow per EDU for 2016 to 2023 was calculated to be 164 gpd per EDU. To define the current daily base flow for use in the calibrated water balance, the overall average daily base flow per EDU was multiplied by the number of EDUs in 2024. **The current (2024) base flow is value is calculated to be 0.41 mgd.**

COWRF Backwash

The theoretical agronomic demands of the golf course, the COWRF influent rate needed to fulfill these demands, and the fraction of influent discarded as backwash were determined in the recently completed Castle Oaks Golf Course Recycled Water Demands TM, which is included as Attachment D. The calculated theoretical backwash flows will be used in the WWTF water balance analyses. The theoretical COWRF backwash flow for an average rainfall year is shown in Table 13. The theoretical COWRF backwash flow for a 1-in-100 rainfall year is shown in Table 14.

Table 13. Theoretical Monthly COWRF Backwash Flow for an Average Rainfall Year

Month	Average-Year COWRF Influent Flow, acre-feet	COWRF Backwash Flow as a Percentage of Influent Flow, percent	Average-Year COWRF Backwash to WWTF, acre-feet
October	27.3	18	4.9
November	0	19	0
December	0	-	0
January	0	-	0
February	0	-	0
March	0	-	0
April	35.3	15	5.3
May	70.1	13	9.1
June	92.4	13	12.0
July	100.9	13	13.1
August	91.1	13	11.8
September	64.6	17	11.0
Total, AFY	**481.7**	**-**	**67.2**

Source: Castle Oaks Golf Course Recycled Water Demands TM, Table 11

AFY = acre-feet per year

Table 14. Theoretical Monthly COWRF Backwash Flow for a 1-in-100 Rainfall Year			
Month	1-in-100-Year COWRF Influent Flow, acre-feet	COWRF Backwash Flow as a Percentage of Influent Flow, percent	1-in-100-Year COWRF Backwash to WWTF, acre-feet
October	11.3	18	2.0
November	0	19	0
December	0	-	0
January	0	-	0
February	0	-	0
March	0	-	0
April	11.9	15	1.8
May	61.7	13	8.0
June	89.4	13	11.6
July	99.9	13	13.0
August	89.4	13	11.6
September	59.9	17	10.2
Total, AFY	**423.5**	**-**	**58.2**
Source: Castle Oaks Golf Course Recycled Water Demands TM, Table 12			

AWA Backwash Flows

As previously noted, AWA flows to the WWTF decreased significantly since 2021. Therefore, AWA flow data from 2021 to 2024 were used as the basis for defining current AWA flows in the average water balances. Monthly AWA backwash flows from 2021 to 2024 are shown in Table 15. The average AWA backwash flow received was calculated for each month and was used directly in the average rainfall year and 1-in-100 rainfall year water balances.

Table 15. Historical AWA Backwash Flow

Month	Volume of AWA Backwash Flow, MG					Average, acre-feet
	2021	2022	2023	2024	Average	
October	0.14	0.02	0.24	0.53	0.23	0.71
November	0.06	0.14	0.16	0.31	0.17	0.52
December	0.23	0.08	0.19	-	0.17	0.52
January	0.15	0.06	0.16	0.10	0.12	0.37
February	0.21	0.05	0.04	0.29	0.15	0.46
March	0.16	0.05	0.04	0.21	0.12	0.37
April	0.29	0.22	0.04	0.20	0.19	0.58
May	0.10	0.06	0.34	0.22	0.18	0.55
June	0.11	0.06	0.06	0.09	0.08	0.25
July	0.14	0.13	0.06	0.43	0.19	0.58
August	0.06	0.30	0.08	0.19	0.16	0.49
September	0.07	0.03	0.28	0.17	0.14	0.43
Total	**1.72**	**1.20**	**1.69**	**2.74**	**1.90**	**5.83**

Town Field Tailwater Runoff

The City is required to collect winter tailwater runoff from the Town Field and recirculate it to the headworks. However, the volume of tailwater collected is not measured before it is combined with the overall WWTF influent flow. Therefore, an estimate of runoff must be made (as noted above, this estimated is also used to define the I&I relationship). A modified rational method for calculating runoff based on precipitation and ET was used to estimate theoretical monthly runoff volumes for inclusion in the water balance using the following equations:

Runoff = Precipitation – Crop ET - Interception - Infiltration

Infiltration = Infiltration Factor x (Precipitation – Crop ET - Interception)

Monthly total precipitation and reference ET from the Plymouth CIMIS Station were used to calibrate the theoretical runoff calculation parameters.[5] These values are presented in Table 16 and Table 17, respectively.

Table 16. Historical Monthly Precipitation

Year	Total Precipitation by Month, inches[(a)]												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	**Total**
2019	6.3	11.1	7.0	1.9	6.3	0	0	0	1.4	0	1.5	6.2	**42**
2020	2.2	0.0	6.4	3.3	2.5	0	0	0	0	0	1.8	1.8	**18**
2021	5.9	2.4	2.8	0.1	0.1	0	0	0	0	8.5	1.0	8.7	**29**
2022	0.3	0.1	1.0	3.9	0.1	0.3	0	0	0.7	0	0.5	15.9	**23**
2023	9.7	4.6	8.3	0.2	1.1	0.1	0	0	0.6	1.4	1.7	2.1	**30**

(a) Plymouth CIMIS station #227.

Table 17. Historical Monthly ET

Year	Total Reference ET by Month, inches[(a)]												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	**Total**
2019	1.8	1.6	3.0	4.6	5.0	7.2	7.8	7.1	4.9	3.9	2.2	1.5	**50**
2020	1.6	2.7	2.9	4.5	6.1	7.6	8.3	7.0	5.3	4.2	2.0	1.3	**53**
2021	1.4	2.0	3.4	5.5	7.2	7.8	8.4	7.1	4.4	1.1	1.3	0.8	**50**
2022	1.7	2.5	3.7	3.3	2.6	7.4	8.1	6.8	3.7	1.9	1.4	0.9	**44**
2023	1.3	1.7	2.3	5.0	5.8	6.7	8.5	7.3	4.7	3.6	2.0	1.2	**50**

(a) Plymouth CIMIS station #227.

The monthly crop ET was set equal to the monthly reference ET, as the alfalfa that is grown on the Town Field is typically assigned a crop coefficient of 1 (DWR, 2015).

Interception is the precipitation in inches captured on the vegetation, including the leaves and roots of the plants, and surface depressions in the soil. The calibrated interception value was determined to be 3 inches.

The formula for infiltration also includes an infiltration factor. Different infiltration factors were used for saturated and unsaturated soil conditions:

- For months with saturated soil conditions, an infiltration factor of 0.4 was used.
- For months with unsaturated soil conditions, an infiltration factor of 0.6 was used.

[5] The Ione NCDC weather station (#044283), which was used to define average and 1-in-100 year rainfall statistics previously in this TM is no longer an active station. Therefore, the Plymouth CIMIS station is the closest currently active rain gauge to the WWTF. Also, the Plymouth CIMIS station data does not have an adequate historical record to establish average and 1-in-100 year rainfall statistics.

Soil conditions were considered saturated when the two-month cumulative precipitation was greater than 10 inches. The two-month cumulative precipitation was calculated as the sum of total precipitation in the previous and current month.

Finally, the City has the ability to shut off tailwater flow from the Town Field when rainfall is heavy and tailwater flows threaten to inundate the WWTF. Shutting off the return flow causes stormwater to accumulate on the field, allowing it to infiltrate over a longer period and reduce the total runoff volume to the WWTF. This has been the historical practice to avoid overwhelming the plant. To calibrate the runoff and I&I models (both of which depend on the same flow data), the maximum monthly precipitation cutoff value used to calculate runoff was set to 8 inches for any month where the total precipitation was greater than 8 inches. Using this cutoff value, the combined runoff and I&I models provided reasonable results (i.e. if the value was not cutoff, the I&I calculations would be under-estimated). A summary of the calculated historical Town Field Runoff is provided in Table 18.

Table 18. Estimated Historical Town Field Runoff

Year	Total Runoff by Month, acre-feet												
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	**Total**
2019	2.8	4.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	**13.0**
2020	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.9**
2021	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.1	0.0	6.1	**15.1**
2022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
2023	7.2	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	**14.3**

As noted above, the historical values shown in Table 18 were used to define the I&I relationship. However, holding runoff on the Town Field may have historically resulted in runoff leaving the site. Therefore, the practice of holding runoff on the Town Field is not included in the analysis of future conditions. To address this in the water balance model, the minimum rainfall cutoff value was set to 20 inches, which far exceeds the monthly rainfall for any month. Therefore, the model effectively ignores this cutoff value[6].

A summary of the parameters used to calculate the theoretical tailwater runoff flows is shown in Table 19. The theoretical Town Field tailwater runoff for an average rainfall year is shown in Table 20. The theoretical Town Field tailwater runoff for a 1-in-100 rainfall year is shown in Table 21.

[6] The runoff cap feature of the model was retained in the event the model is used in the future where runoff capture is improved/allowed.

Table 19. Summary of Tailwater Runoff Calculation Parameters	
Parameter	Value
Interception, inches	3
Two-Month Cumulative Precipitation to Saturate Soil, inches	10
Unsaturated Soil Infiltration Factor	0.4
Saturated Soil Infiltration Factor	0.6
Maximum Monthly Precipitation Used to Calculate Runoff, inches	20[(a)]

(a) The calibrated value was 8 inches. However, future models apply 20 inches of rainfall, which far exceeds monthly rainfall values and is effectively negates the storage of runoff on the Town Field. The monthly maximum rainfall cutoff value is retained in the model in the event effective runoff capture is developed in the future.

Table 20. Theoretical Monthly Town Field Tailwater Runoff for an Average Rainfall Year

Month	Average Year Rainfall, inches[(a)]	ET, inches[(a)]	Theoretical Infiltration, inches	Theoretical Runoff, inches	Theoretical Runoff, acre-feet
October	1.15	3.24	0	0	0
November	2.81	1.68	0	0	0
December	3.54	1.21	0	0	0
January	5.09	1.48	0.36	0.24	3.5
February	3.14	1.95	0	0	0
March	3.2	3.02	0	0	0
April	1.75	4.57	0	0	0
May	0.63	5.97	0	0	0
June	0.23	7.19	0	0	0
July	0.07	7.64	0	0	0
August	0.13	6.98	0	0	0
September	0.33	4.99	0	0	0
Total	**22.0**	**49.9**	**0.36**	**0.24**	**3.5**

(a) From Table 11.

Table 21. Theoretical Monthly Town Field Tailwater Runoff for a 1-in-100 Rainfall Year						
Month	1-in-100 Year Rainfall, inches[(a)]	ET, inches[(a)]	Theoretical Infiltration, inches	Theoretical Runoff, inches	Theoretical Runoff, acre-feet	Theoretical Runoff without Rainfall Cap, acre-feet
October	2.15	3.24	0	0	0	0
November	5.24	1.68	0.3	0.2	3.3	3.3
December	6.58	1.21	0.9	1.4	20.7	20.7
January	9.48	1.48	2.0	3.0	22.2	43.7
February	5.86	1.95	0.4	0.5	8.0	8.0
March	5.95	3.02	0	0	0	0
April	3.26	4.57	0	0	0	0
May	1.18	5.97	0	0	0	0
June	0.43	7.19	0	0	0	0
July	0.13	7.64	0	0	0	0
August	0.24	6.98	0	0	0	0
September	0.62	4.99	0	0	0	0
Total	**41.1**	**49.9**	**3.6**	**3.7**	**54.2**	**75.7**

(a) From Table 11.

Inflow and Infiltration

Theoretical I&I into the City collection system was determined using a linear regression analysis of historical WWTF influent and climate data. Monthly data from 2019 to 2023 was analyzed. For each wet weather month, defined as November to April, monthly I&I was calculated using the following equation:

I&I = WWTF Influent - Base City Flow - AWA Backwash - Estimated Town Field Runoff

If the calculated I&I for any month was less than zero, that month was excluded from the analysis. The average daily I&I for each month was calculated by dividing the monthly I&I by the number of days in the month.

For each month, the average daily precipitation was calculated by dividing the monthly precipitation by the number of days in the month. The two-month average precipitation was calculated as the sum of the daily average precipitation of the previous and current month.

The average daily I&I and two-month average precipitation were plotted for each month and used to calculate a linear equation. The plotted data and corresponding equation are shown on Figure 4.

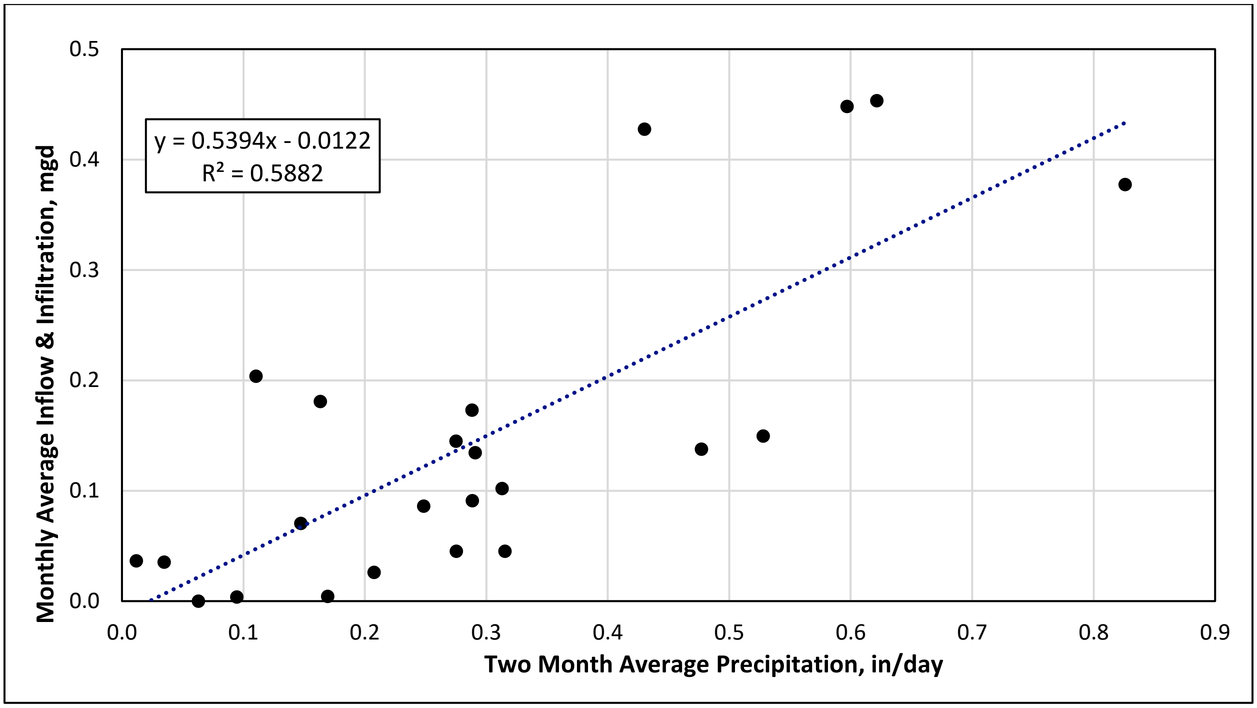

Figure 4. Two-Month Average Precipitation versus Daily Average I&I per Month

The slope and intercept from the linear regression equation were used to calculate the theoretical I&I for each month as a function of the two-month cumulative precipitation. The theoretical monthly I&I for an average rainfall year is shown in Table 22. The theoretical monthly I&I for a 1-in-100 rainfall year is shown in Table 23.

I&I is assumed to not increase appreciably with expansion of the City collection system in the next 5 years, as new infrastructure is less susceptible to I&I. Therefore, the same I&I was used for the current and Year 2030 water balance models.

Table 22. Theoretical Monthly I&I Flows for an Average Rainfall Year			
Month	Average Year Rainfall, inches[a]	Theoretical I&I, mgd	Theoretical I&I, acre-feet
October	1.15	0.61	1.9
November	2.81	1.50	4.6
December	3.54	1.89	5.8
January	5.09	2.73	8.4
February	3.14	1.68	5.2
March	3.2	1.71	5.2
April	1.75	0.93	2.9
May	0.63	0.33	1.0
June	0.23	0.11	0.3
July	0.07	0.03	0.1
August	0.13	0.06	0.2
September	0.33	0.17	0.5
Total	**22.0**	**11.8**	**36.1**

(a) From Table 11.

Table 23. Theoretical Monthly I&I Flows for a 1-in-100 Rainfall Year			
Month	1-in-100 Year Rainfall, inches[a]	Theoretical I&I, inches	Theoretical I&I, acre-feet
October	2.15	1.15	3.5
November	5.24	2.81	8.6
December	6.58	3.53	10.8
January	9.48	5.10	15.7
February	5.86	3.15	9.7
March	5.95	3.20	9.8
April	3.26	1.75	5.4
May	1.18	0.62	1.9
June	0.43	0.22	0.7
July	0.13	0.06	0.2
August	0.24	0.12	0.4
September	0.62	0.32	1.0
Total	**41.1**	**22.0**	**67.7**

(a) From Table 11.

Total Influent Flows

The current theoretical influent flows to the WWTF used for the average rainfall year and 1-in-100 rainfall year water balances are presented in Table 24 and Table 25, respectively. **As shown, the current ADWF is estimated to be approximately 0.55 mgd.**

Table 24. Current Theoretical Influent Flows for an Average Rainfall Year

	Inflows, acre-feet					
Month	Base City	I&I	Field Runoff	COWRF Backwash	AWA Backwash	Total
October	39.3	1.9	0	4.9	0.71	46.8
November	38.0	4.6	0	0	0.52	43.1
December	39.3	5.8	0	0	0.52	45.6
January	39.3	8.4	3.5	0	0.37	51.6
February	35.5	5.2	0	0	0.46	41.2
March	39.3	5.2	0	0	0.37	44.9
April	38.0	2.9	0	5.3	0.58	46.8
May	39.3	1.0	0	9.1	0.55	50.0
June	38.0	0.3	0	12.0	0.25	50.6
July	39.3	0.1	0	13.1	0.58	53.1
August	38.0	0.2	0	11.8	0.49	50.5
September	39.3	0.5	0	11.0	0.43	51.2
Total, AFY	**462.6**	**36.1**	**3.5**	**67.2**	**5.83**	**575.2**
AAF, mgd	**0.41**	**0.032**	**0.003**	**0.060**	**0.005**	**0.51**
ADWF, mgd	**0.41**	**0.003**	**0**	**0.127**	**0.005**	**0.55**

Table 25. Current Theoretical Influent Flows for a 1-in-100 Rainfall Year						
	Inflows, acre-feet					
Month	Base City	I&I	Field Runoff	COWRF Backwash	AWA Backwash	Total
October	39.3	3.5	0	2	0.71	45.5
November	38.0	8.6	3.3	0	0.52	50.4
December	39.3	10.8	20.7	0	0.52	71.3
January	39.3	15.7	43.7	0	0.37	99.1
February	35.5	9.7	8	0	0.46	53.7
March	39.3	9.8	0	0	0.37	49.5
April	38.0	5.4	0	1.8	0.58	45.8
May	39.3	1.9	0	8	0.55	49.8
June	38.0	0.7	0	11.6	0.25	50.6
July	39.3	0.2	0	13	0.58	53.1
August	38.0	0.4	0	11.6	0.49	50.5
September	39.3	1.0	0	10.2	0.43	50.9
Total, AFY	**462.6**	**67.7**	**54.2**	**58.2**	**5.83**	**670.0**
AAF, mgd	**0.41**	**0.06**	**0.048**	**0.052**	**0.005**	**0.60**
ADWF, mgd	**0.41**	**0.006**	**0**	**0.123**	**0.005**	**0.55**

PROJECTED 2030 INFLUENT FLOWS

The City reports that 75 to 100 homes per year are expected to be built in each of the next 5 years. The projected number of EDUs for 2025 through 2030 was calculated by conservatively adding 100 EDUs for each year to the reported 2,520 EDUs in January 2024. The projected daily Base City flow for each year was calculated by multiplying the number of EDUs by the calculated average daily base flow per EDU of 164 gpd per EDU (from Table 12). The projected Base City flows are summarized in Table 26.

Table 26. Projected Base City Flows		
Year	Projected Number of EDUs	Projected Base City Flow, mgd[a]
2025	2,620	0.43
2026	2,720	0.45
2027	2,820	0.46
2028	2,920	0.48
2029	3,020	0.50
2030	3,120	0.51

(a) Projected Base City Flow = (Projected Number of EDUs) x (Average Daily Base Flow of 164 gpd per EDU).

The projected Year 2030 theoretical influent flows to the WWTF used for the average rainfall year and 1-in-100 rainfall year water balances are presented in Table 27 and Table 28, respectively. **As shown, the projected 2030 ADWF is approximately 0.65 mgd[7].**

Table 27. Projected 2030 Influent Flows for an Average Rainfall Year

Month	Inflows, acre-feet					
	Base City	I&I	Field Runoff	COWRF Backwash	AWA Backwash	**Total**
October	48.5	1.9	0	4.9	0.71	56.0
November	47.0	4.6	0	0	0.52	52.1
December	48.5	5.8	0	0	0.52	54.8
January	48.5	8.4	3.5	0	0.37	60.8
February	43.8	5.2	0	0	0.46	49.5
March	48.5	5.2	0	0	0.37	54.1
April	47.0	2.9	0	5.3	0.58	55.8
May	48.5	1.0	0	9.1	0.55	59.2
June	47.0	0.3	0	12.0	0.25	59.6
July	48.5	0.1	0	13.1	0.58	62.3
August	47.0	0.2	0	11.8	0.49	59.5
September	48.5	0.5	0	11.0	0.43	60.4
Total, AFY	**571.0**	**36.1**	**3.5**	**67.2**	**5.83**	**683.9**
AAF, mgd	**0.51**	**0.032**	**0.003**	**0.060**	**0.005**	**0.61**
ADWF, mgd	**0.51**	**0.003**	**0**	**0.127**	**0.005**	**0.65**

[7] It is noted that this flow is lower than the current estimated treatment capacity for the WWTF including Pond 5. As noted, this capacity will be confirmed through future analyses and submitted to the Regional Board.

Table 28. Projected 2030 Influent Flows for a 1-in-100 Rainfall Year						
	Inflows, acre-feet					
Month	Base City	I&I	Field Runoff	COWRF Backwash	AWA Backwash	**Total**
October	48.5	3.5	0	2.0	0.71	54.7
November	47.0	8.6	3.3	0	0.52	59.4
December	48.5	10.8	20.7	0	0.52	80.5
January	48.5	15.7	43.7	0	0.37	108.3
February	43.8	9.7	8	0	0.46	62.0
March	48.5	9.8	0	0	0.37	58.7
April	47.0	5.4	0	1.8	0.58	54.8
May	48.5	1.9	0	8.0	0.55	59.0
June	47.0	0.7	0	11.6	0.25	59.6
July	48.5	0.2	0	13.0	0.58	62.3
August	47.0	0.4	0	11.6	0.49	59.5
September	48.5	1.0	0	10.2	0.43	60.1
Total, AFY	**571.0**	**67.7**	**54.2**	**58.2**	**5.83**	**778.7**
AAF, mgd	**0.51**	**0.06**	**0.048**	**0.052**	**0.005**	**0.70**
ADWF, mgd	**0.51**	**0.006**	**0**	**0.123**	**0.005**	**0.64**

ESTIMATED CAPACITY OF EXISTING DISCHARGE AREAS

This section describes the procedures used to calculate the theoretical capacity of the WWTF disposal areas. As previously noted, the WWTF currently relies on two ways to discharge effluent: land application and percolation.

Land Application Area Irrigation Demands

During the summer irrigation season, the WWTF sends secondary effluent to two LAAs, the 57-acre Town Field and 5.6-acre City Field. The capacity of the LAAs to accept flows is limited by the crop irrigation demands[8]. The theoretical irrigation demand of each LAA for an average rainfall year was calibrated using historical monthly irrigation demand values. The historical monthly irrigation demands for the Town and City Fields are shown in Table 29 and Table 30.

[8] It

Table 29. Historical Town Field Irrigation Demands								
Month	Volume of Secondary Effluent Used, MG							Average, acre-feet
	2019	2020	2021	2022	2023	2024	Average	
October	0	0	0	7.3	0	1.2	1.4	4.3
November	0	0	0	0	0	2.3	0.4	1.2
December	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0
April	0	0	3.6	0	0	0	0.6	1.8
May	0	0	1.0	0	0	0	0.2	0.6
June	2.6	4.7	7.8	8.6	0.3	5.7	5.0	15.4
July	3.2	5.4	3.7	4.6	1.8	7.9	4.4	13.5
August	4.6	6.9	7.3	4.4	5.2	12.8	6.9	21.2
September	1.3	5.3	4.6	1.0	4.6	5.9	3.8	11.7
Total	**11.7**	**22.3**	**28**	**25.9**	**11.9**	**35.8**	**22.7**	**69.7**

Table 30. Historical City Field Irrigation Demands								
Month	Volume of Secondary Effluent Used, MG							Average, acre-feet
	2018	2019	2020	2021	2022	2023	Average	
October	0	0	0	0	0.5	0	0.1	0.3
November	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0
April	0	0	0	0	0	0	0	0
May	0.4	0	0	0	0	0	0.1	0.3
June	0.3	0.3	0.2	0.3	0.9	0.4	0.4	1.2
July	0.5	0.7	0.2	0.3	0[(a)]	0.3	0.4	1.2
August	0.6	0.3	0.4	0.7	0[(a)]	0.8	0.6	1.8
September	0.3	0.1	0.7	0.8	0[(a)]	1	0.6	1.8
Total	**2.1**	**1.4**	**1.5**	**2.1**	**1.4**	**2.5**	**2.2**	**6.6**

(a) Values excluded from average. Effluent was not sent to the City Field during this period due to circumstances unrelated to irrigation demand.

Theoretical irrigation demands are calculated using the following formula:

Irrigation Demand = (Crop ET - Precipitation) / Crop Area / Irrigation Efficiency

The crop ET is calculated by multiplying the Reference ET shown in Table 11 by a representative crop coefficient. Crop coefficients for alfalfa crops such as those grown on the Town and City Fields are typically close to 1 (DWR, 2015). Irrigation efficiencies for hand-move spray irrigation systems like that used on the Town and City Fields can range from 60 to 80 percent (see Attachment E, Table 8.2b).

The theoretical irrigation demand can be calibrated by adjusting the irrigation efficiency value until the theoretical demand matches the historical irrigation volume supplied. However, assuming the highest irrigation efficiency value of 80 percent, the crop coefficient required to match the theoretical irrigation demand to historical irrigation volumes for the Town and City Fields was 0.32. These findings suggest that either (a) the historical reported irrigation flows are not accurate and/or (b) the fields are being irrigated well below agronomic rates (which would be the case if the field is not well drained). Given the uncertainty with the irrigation efficient values, it is suspected that the irrigation demands of the Town and City Fields are likely in between the historical irrigation demands and theoretical irrigation demands calculated with a crop coefficient of 1.

Discussions with City staff indicate that there is very little flow directed to the percolation basins during the summer irrigation season, suggesting that most of the flow is sent to the Town Field and City Field. This would not be the case if the crop coefficient was 0.32. Therefore, the water balance models were developed using two different methods:

1. Using the theoretical irrigation demand calculated with the calibrated crop coefficient of 0.32.
2. Using theoretical irrigation demand calculated with a crop coefficient of 1.

A comparison of these values with historical irrigation volumes for the Town Field is presented in Table 31 and for the City Field in Table 32. It is also noted that the City is planning to replace the effluent flow meter for the Town Field prior to the initiation of the 2025 irrigation season to allow for ongoing assessment of the crop coefficient and irrigation demands to be made.

Table 31. Historical and Theoretical Town Field Irrigation Demand			
		Theoretical Irrigation Demand, acre-feet[a]	
Month	Historical Average Irrigation Volume, acre-feet	Calculated with Crop Coefficient of 0.32	Calculated with Crop Coefficient of 1
October	4.3	4.0	12.4
November	1.2	0	0
December	0	0	0
January	0	0	0
February	0	0	0
March	0	0	0
April	1.8	5.4	16.7
May	0.6	10.1	31.7
June	15.4	13.2	41.3
July	13.5	14.4	44.9
August	21.2	13.0	40.7
September	11.7	8.9	27.7
Total, AFY	**69.7**	**69.0**	**215.5**
(a) Theoretical irrigation demand for an average rainfall year.			

Table 32. Historical and Theoretical City Field Irrigation Demand			
		Theoretical Irrigation Demand, acre-feet[a]	
Month	Historical Average Irrigation Volume, acre-feet	Calculated with Crop Coefficient of 0.32	Calculated with Crop Coefficient of 1
October	0.3	0.4	1.2
November	0	0	0
December	0	0	0
January	0	0	0
February	0	0	0
March	0	0	0
April	0	0.5	1.6
May	0.3	1.0	3.1
June	1.2	1.3	4.1
July	1.2	1.4	4.4
August	1.8	1.3	4.0
September	1.8	0.9	2.7
Total, AFY	**6.6**	**6.8**	**21.2**
(a) Theoretical irrigation demand for an average rainfall year.			

Percolation Ponds Percolation Rates

Effluent flows that exceed the demand of the LAAs are currently disposed of via percolation in Ponds 6 and 7. The capacity of the percolation ponds to accept flows is limited by the sustained percolation rate. As noted in the December 12 Water Balance TM, a percolation rate for Ponds 6 and 7 was estimated using a water balance approach around the ponds. This analysis demonstrated that the ponds have a sustained percolation rate of 3.0 inches per day in months where saturated soil conditions were likely to occur (February through May) and a percolation rate of 3.6 inches per day in other months (June through January). **However, as required by Regional Board staff, the water balances presented herein do not account for any percolation disposal in the ponds to reflect the requirements of the CDO.**

OPERATIONAL ASSUMPTIONS

This section addresses the operational assumptions applied in developing the water balances.

Pond 5

As previously noted, the City currently operates Pond 5 as a treatment pond, where it is used to equalize flows prior to discharge to the percolation ponds and LAAs. For purposes of the water balance, monthly net storage volumes for Pond 5 were matched to historical monthly storage volumes over the past five years. The average monthly Pond 5 storage volumes from 2019 to 2023 are shown in Table 33.[9] The overall average storage volume was calculated for each month and used in the water balances.

Table 33. Historical Pond 5 Storage

Month	Monthly Pond 5 Storage Volume, acre-feet					
	2019	2020	2021	2022	2023	Average
October	32.1	37.1	38.5	35.9	41.7	37.1
November	30.6	23.3	38.9	36.2	30	31.8
December	32.7	23.5	36.9	38.3	11.3	28.5
January	37.1	33.0	25.8	35.2	36.6	33.5
February	38.3	33.2	26.8	34.9	40.4	34.7
March	39.9	33.6	27.3	34.3	41.2	35.3
April	38.8	39.9	32.2	38.6	41.5	38.2
May	37.8	39.0	37.4	37.1	40.1	38.3
June	32.7	27.7	30.8	29.3	31.5	30.4
July	15.6	34.8	26.4	23.4	34.3	26.9
August	29.9	20.4	14.7	31.8	41.7	27.7
September	34.1	29.3	19.2	36.7	41.7	32.2

[9] A volume-to-depth curve was used to calculate the storage volume of Pond 5 from weekly freeboard measurements. The monthly averages of the calculated storage volumes are shown in Table 33.

Ponds 6 and 7

The analysis assumes that both Ponds 6 and 7 are emptied in October to another storage location (not yet defined). Each month thereafter, flows that exceed the storage/evaporative capacity of the two ponds are also assumed to be directed to the same storage location.

WATER BALANCE RESULTS

Water balance models were developed for the current and projected 2030 flow conditions assuming the disposal capacity provided by percolation ponds is eliminated and the ponds are converted to storage. To provide a better understanding of the range of potential operating conditions, models were developed for the following scenarios:

- Average rainfall year and crop coefficient of 0.32 for the Town and City Fields[10]
- Average rainfall year and crop coefficient of 1 for the Town and City Fields[11]
- 1-in-100 rainfall year and crop coefficient of 0.32 for the Town and City Fields
- 1-in-100 rainfall year and crop coefficient of 1 for the Town and City Fields

The results of the water balances are summarized for the current flow conditions in Table 34 and for the 1-in-100 yar conditions in Table 35. Additional details are provided in Attachment F. Key findings from this analysis are as follows:

- **At current City Base Flows of 0.41 mgd, the City would have an excess of up to 594 acre-feet of water that requires storage and/or disposal if the percolation ponds were lined.**
- **At projected 2030 City Base Flows 0.51 mgd, an excess of up to 697 acre-feet of water would require storage and/or disposal if the percolation ponds were lined[12].**

As a final note, Regional Board staff have requested that the City consider the sensitivity of the water balance to the distribution of rainfall. For this analysis, the existing facilities do not provide adequate capacity for storage and disposal and there is excess water each month. Given this, the amount of excess flow generated in each month will not impact the results of the analysis.

[10] The recent data suggests an unusually low crop coefficient for the Town and City Fields. Additional data collection is needed to confirm the value.

[11] A crop coefficient of 1 would be typical for the types of crops grown on the City and Town Fields.

[12] As discussed in the December Water Balance TM, the existing disposal capacity provided at the WWTF with the observed percolation rates is approximately 0.75 mgd ADWF. Therefore, there is no immediate risk of overflow based on the current configuration.

Table 34. Summary of Current Water Balance Results, No Percolation

Scenario	Base City Flow, mgd	Total WWTF Inflows, AFY	Irrigation, AFY				Pond 6 & 7 Flows, AFY				Excess Flow to Additional Storage, AFY
			Town Field Demand	Town Field Provided	City Field Demand	City Field Provided	Pond 7 Inflows	Pond 7 Outflows	Pond 6 Inflows	Pond 6 Outflows	
Average Rainfall Year											
Crop Coeff. of 0.32	0.41	572.0	69	69	7	7	474	0	462	0	453
Crop Coeff. of 1			215	215	21	21	313	0	301	0	292
1-in-100 Rainfall Year											
Crop Coeff. of 0.32	0.41	666.8	62	62	6	6	600	0	597	0	594
Crop Coeff. of 1			193	193	19	19	457	0	454	0	451

Table 35. Summary of 2030 Water Balance Results, No Percolation

Scenario	Base City Flow, mgd	Total WWTF Inflows, AFY	Irrigation, AFY				Pond 6 & 7 Flows, AFY				Excess Flow to Additional Storage, AFY
			Town Field Demand	Town Field Provided	City Field Demand	City Field Provided	Pond 7 Inflows	Pond 7 Outflows	Pond 6 Inflows	Pond 6 Outflows	
Average Rainfall Year											
Crop Coeff. of 0.32	0.51	683.9	69	69	7	7	586	0	574	0	563
Crop Coeff. of 1			215	215	21	21	425	0	413	0	403
1-in-100 Rainfall Year											
Crop Coeff. of 0.32	0.51	778.7	62	62	6	6	703	0	700	0	693
Crop Coeff. of 1			193	193	19	19	559	0	556	0	550

REFERENCES

California Department of Water Resources (DWR) and University of California, Davis, 2015. *Consumptive Use Program Plus (CUP+) Model, Version 6.1.* Accessed at https://water.ca.gov/Programs/Water-Use-And-Efficiency/Land-And-Water-Use/Agricultural-Water-Use-Models on December 11, 2024.

Central Valley Regional Water Quality Control Board, 2014a. *Cease and Desist Order R5-2014-0157 for City of Ione Wastewater Treatment Facility, Amador County.* December 2014.

Central Valley Regional Water Quality Control Board, 2014b. *Revised Monitoring and Reporting Program R5-2013-0022 (Rev 1) for City of Ione and Greenrock Ranch Lands, LLC., Ione Wastewater Treatment Facility, Amador County.* December 2014.

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Coastland Engineers, 2021. *City of Ione Water Balance Update and 2020 Capacity Expansion Completion Report.* March 2021

Dexter Wilson Engineering, Inc., 2016. *City of Ione 2020 Capacity Expansion Completion Report.* December 2016.

Lee & Ro, Inc. and PMC, 2009. *City of Ione Wastewater Master Plan*. December 2009.

Lee & Ro, Inc., 2010. *Ione Water Reclamation Facility Report of Waste Discharge.* March 2010.

GHD Inc., 2012a. *City of Ione Revised Report of Waste Discharge.* September 2012.

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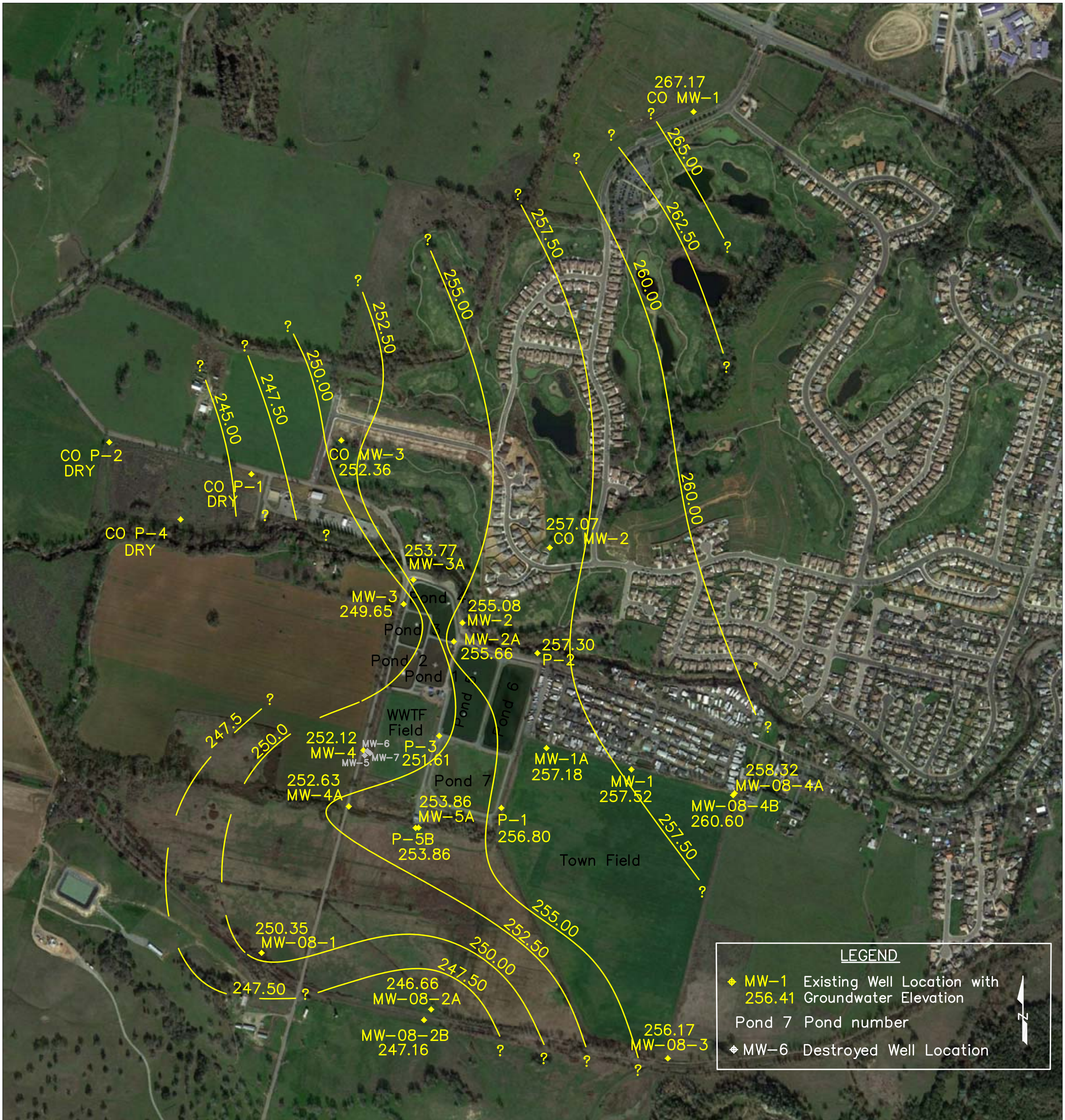
U.S. Environmental Protection Agency, 2011. *Principles of Wastewater Treatment Pond Systems for Plant Operators, Engineers, and Managers.* August 2011.

Attachment A

Groundwater Gradient Maps

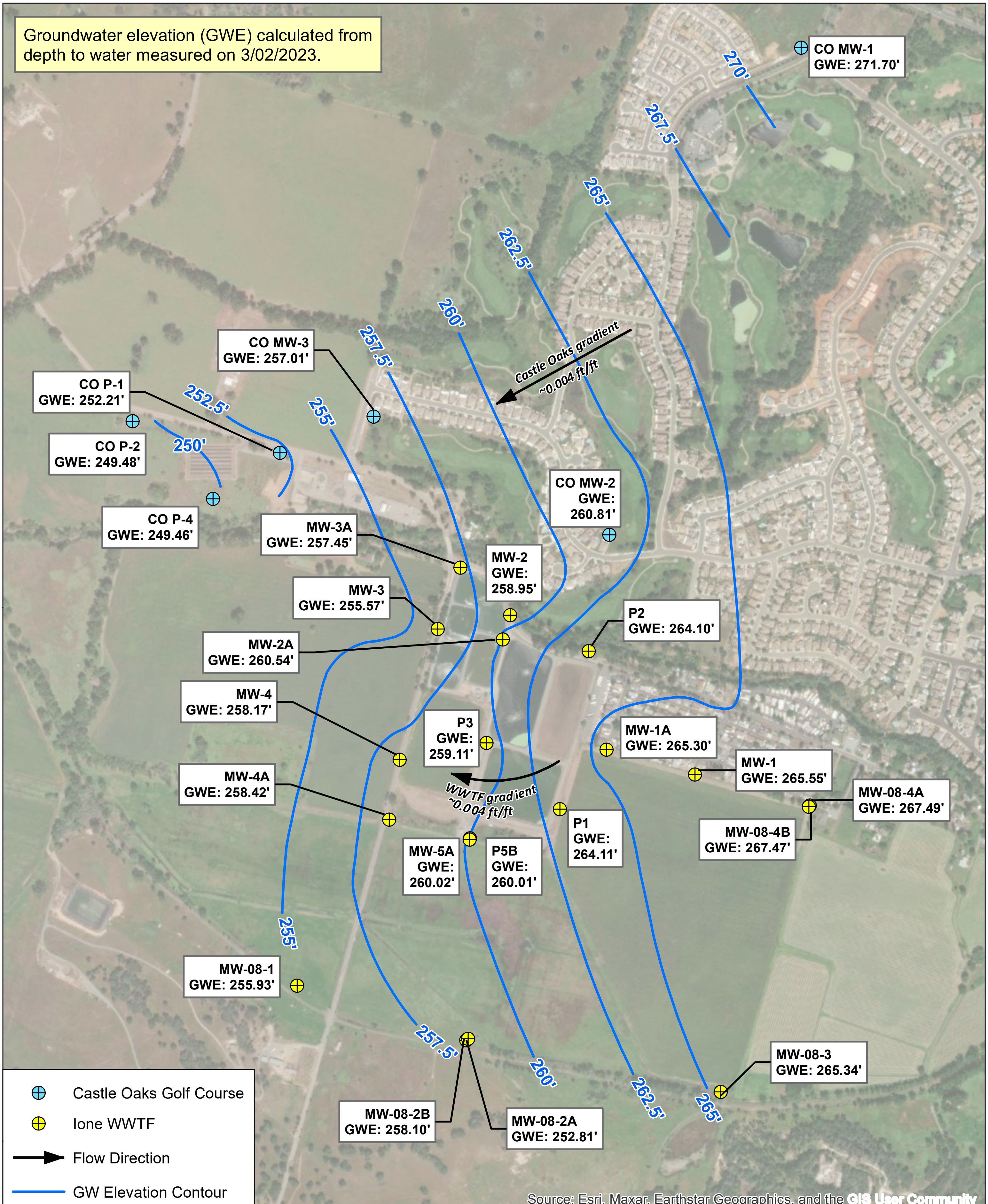


EcoUrban Associates
PO Box 411
Ione, CA 95640
(209)487-4802

Figure 3
Groundwater Gradient Map
Third Quarter 2021

Wastewater Treatment Facility
City of Ione
Ione, California

Project No.:	AMA.104.01
Drawn by:	CES
Dated:	10/20/21
Scale:	~1"=1,000'
Rev'd by:	CES



0 500 1,000

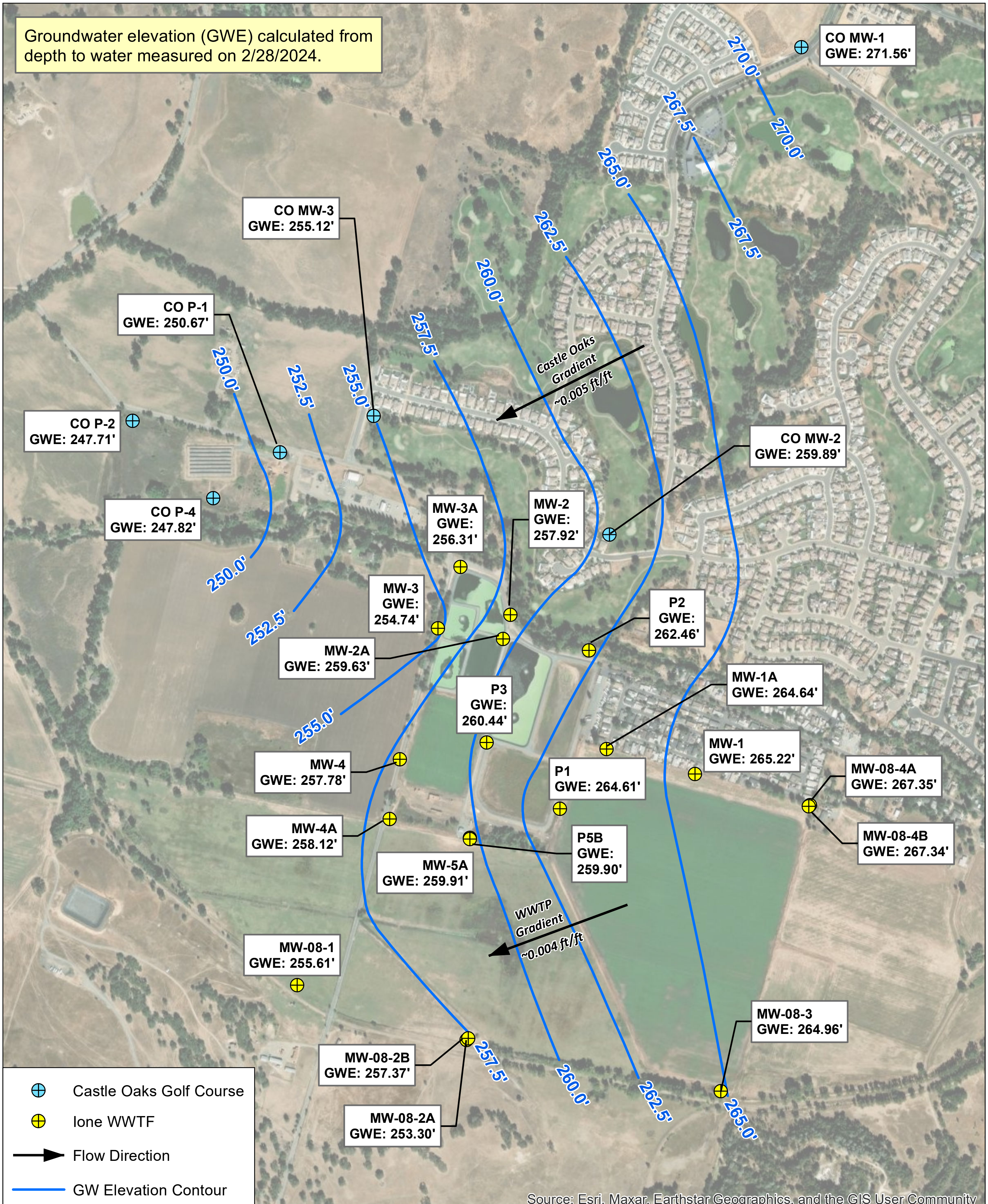
Feet

Groundwater Elevation Map

Ione WWTF & Castle Oaks Golf Course

PROVOST& PRITCHARD

3/28/2023 G:\Dellavalle-1020\102022001-Ione WWTP & Castle Oak GW Consulting\400 GIS\Map\1Q2023_GW_elevation_map.mxd



Groundwater Elevation Map

Ione WWTF & Castle Oaks Golf Course

PROVOST & PRITCHARD

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Attachment B

Jackson Rancheria Water Balance Certification Letter

December 10, 2024

John Baum, P.E. (sent via email: John.Baum@waterboards.ca.gov)
Assistant Executive Officer, Rancho Cordova Office
Central Valley Regional Water Quality Control Board
11020 Sun Center Drive, #200
Rancho Cordova, CA

Subject: Certification Letter Regarding Town Field Operations, Waste Discharger Requirements R5-2013-0022-001

Dear Mr. John Baum,

On August 14, 2024, the Central Valley Water Quality Control Board (Regional Board) issued a California Water Code section 13267 Order (Order) to the City of Ione (City) and Jackson Rancheria Development Corporation (Jackson Rancheria), the two entities permitted by the Regional Board under Waste Discharger Requirements (WDRs) R5-2013-0022-001, which regulates the treatment and disposal and reuse of domestic wastewater from the City's serviced area. The WDRs were initially adopted on April 11, 2013, and were revised December 5, 2014.

The City owns and operates its Wastewater Treatment Facility (WWTF) and delivers secondary-23 recycled water to Town Field, where Jackson Rancheria Development Corporation (the Property's owner) applies the recycled water to the land pursuant to the 2013 Recycled Water Agreement (Recycled Water Agreement), which is attached hereto.

The 13267 Order requires submission of an updated water balance for the WWTF to the Regional Board by December 13, 2024. The letter specifies the following three items that should be included in the water balance:

1. *The forecasted influent flows and proposed flows over the next 5 years based on population growth. Estimates must be supported by City planning documents.*
2. *Any changes to collection system, treatment plant, and disposal features or their operation planned in the next 5 years.*
3. *If the facility does not have sufficient capacity to treat and dispose of all wastewater onsite, the submittal must include the volume of excess effluent that would need to be disposed of each year to ensure all wastewater is treated and disposed of properly without causing or threatening to cause a violation of the permit or a condition of pollution*

Although Jackson Rancheria is a permittee under WDRs R5-2013-0022-001, the City is responsible for providing the information required to be submitted in the 13267 Order pursuant to the Recycled Water Agreement. Furthermore, the City owns and operates the pump station that delivers water to the Town

Field, and the City measures and records the flows that are sent. Consequently, the City is leading the development of the responses to the 13267 Order, which will be presented separately in the *Updated Water Balance for the City of Ione Wastewater Treatment Facility Waste Discharger Requirements R5-2013-0022-001 Technical Memorandum* (Ione WWTF TM).

Because the City controls the quality of water that is developed under the permit, the amount of relevant information that can be certified by Jackson Rancheria Development Corporation is very limited. This information is as follows:

- The Town Field is a 57-acre land application area (LAA) located east of the City's WWTF.
- The LAA is used to grow fodder crops (i.e., crops not intended for human consumption). Since the initiation of irrigation with recycled water, the field has been planted in an alfalfa crop.
- During the summer irrigation season, the water received from the City is applied to irrigation via a hand-move spray irrigation system.
- An agricultural employee manages the operations of the Town Field. The employee requests water deliveries based on observed crop needs.
- Runoff is collected from the Town Field year-round and returned to the WWTF.

The Chief Executive Officer (CEO) of the Jackson Rancheria Development Corporation has reviewed the contents of the Ione WWTF TM and hereby certifies the facts recited in the bullets above, with the following certification statement:

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this letter, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Sincerely,

Crystal Jack
CEO
Jackson Rancheria Development Corporation

CC: Kenny Croyle, PE, WDRS and Title 27 Compliance and Enforcement Unit, CVRWQCB

Howard Hold, Senior Engineering Geologist, WDRS and Title 27 Compliance and Enforcement Unit, CVRWQCB

Scott Armstrong, CVRWQCB, Rancho Cordova

Ginachi Amah, Recycled Water Unit Supervisor, Division of Drinking Water, State Water Resources Control Board

RECORDING REQUESTED BY AND WHEN RECORDED MAIL TO:

City Clerk
City of Ione
P.O. Box 398
Ione, CA 95640

No recording fee required pursuant to Government Code sections 6103 and 27383

Amador County Recorder
Kimberly L. Grady
DOC- 2013-0002941-00
REQD BY CITY OF IONE
Tuesday, APR 02, 2013 14:48
Ttl Pd $0.00 Nbr-0000237718
CT2/R1/1-17

THIS SPACE FOR RECORDERS USE ONLY

Recycled Water Agreement

This Recycled Water Agreement ("Agreement") is made and entered into as of March 5, 2013 ("Effective Date"), by and between Greenrock Ranch Lands LLC ("GREENROCK"), a Delaware Limited Liability Corporation, including designated lessees, agents, employees and assigns, and the City of Ione ("CITY"), a municipal corporation of the State of California. GREENROCK and the CITY are sometimes individually referred to herein as a "Party" and, together, as the "Parties."

RECITALS

A. The CITY owns and operates certain wastewater treatment and disposal facilities known as the City of Ione Wastewater Treatment Plant ("Treatment Plant"). The Treatment Plant, located at 1600 West Marlette Street (APNs 005-130-023, 039, 042, 043, 045), treats effluent to secondary standards in four treatment ponds and disposes of the effluent through three percolation/evaporation ponds (percolation ponds).

B. The Treatment Plant treats domestic wastewater from the City of Ione and filter backwash water from a water treatment plant operated by Amador Water Agency. The percolation/evaporation ponds also accept secondary effluent from Preston Reservoir, and in the future may receive additional wastewater and influent from these and other facilities.

C. The Treatment Plant operates under Waste Discharge Requirements Order No. 95-125 dated May 26, 1995 issued by the Central Valley Regional Water Quality Control Board ("Central Valley Board"). The Treatment Plant is subject to a Cease and Desist Order ("CDO") issued by the Central Valley Board concerning groundwater conditions near the percolation ponds at the Treatment Plant. As a component of the CITY's CDO compliance strategy, the CITY proposes to reduce the hydraulic loading to the percolation ponds by reducing storage in the percolation ponds during certain times of the year. In order to reduce storage and percolation to groundwater in the City's percolation/evaporation ponds, the CITY proposes to deliver Recycled Water to neighboring lands for irrigation purposes.

D. GREENROCK owns certain real property in Amador County, Assessor's Parcel No. 00513005200, consisting of approximately 65-acres ("Property"). The Property is depicted on the map attached hereto as Exhibit "A" and described in Exhibit "B," both of which are incorporated herein by reference. The Property is currently leased by GREENROCK for agricultural operations.

E. GREENROCK and the CITY contemplate that the CITY will provide and GREENROCK and its lessee will accept secondary-23 recycled water ("Recycled Water") for agricultural irrigation on the Property, as set forth herein.

COVENANTS AND AGREEMENT

NOW THEREFORE, based on the foregoing recitals, which are incorporated into the operative provisions of this Agreement, and for good and valuable consideration, the receipt and sufficiency of which are acknowledged by the Parties, the Parties covenant and agree as follows:

1. TERM

a. The term of this Agreement is for a period of 30 years, commencing upon execution of both Parties, and shall renew automatically for successive terms, without further action of either Party unless earlier terminated by mutual written agreement of the Parties, or as otherwise provided herein.

2. RECYCLED WATER DELIVERY

a. **Delivery Amount:** The CITY will deliver and GREENROCK will accept as much Recycled Water as GREENROCK may request for the reasonable irrigation of the Property. For illustrative purposes only, GREENROCK anticipates an average annual demand of approximately 280 acre feet of Recycled Water for irrigation of the Town Field..

b. **Location of Water Delivery:** The CITY will deliver Recycled Water to the Property near the location delineated "Point of Beginning" on Exhibit "A." The CITY at its sole costs and expense, and at no cost or expense to GREENROCK, will obtain all required easements, entitlements, permits and other property necessary to deliver Recycled Water to the Property, and the CITY will construct, install, control, operate, maintain, replace, and be responsible for, the pipeline, pumps, equipment and material required to deliver Recycled Water from the Treatment Plant to the Property.

c. **Coordination for Water Delivery:** The CITY and GREENROCK will each designate a representative to coordinate water delivery to the Property. The designated representatives shall develop a mutually acceptable delivery schedule through an "Implementation Agreement" that will govern the operations of both Parties with regard to water delivery and irrigation of the Town Field and any other irrigated lands covered by the City's Waste Discharge Requirements such as, but not limited to, the Clifton Field.

i) The CITY shall notify GREENROCK's designated representative at least fourteen (14) days prior to the commencement of scheduled delivery to confirm deliveries. Delivery of Recycled Water to the Property shall be supplied, to the extent feasible, to meet the irrigation demands of the Property.

d. **Limitations Precluding Delivery of Water:** The Parties acknowledge and agree that such delivery and/or use of Recycled Water may not be possible, feasible or practical at times, or may be prohibited for unanticipated reasons or for reasons beyond the control of the CITY and/or GREENROCK. The CITY will not be obligated to provide and GREENROCK will not be required to accept Recycled Water pursuant to the terms of this Agreement when such delivery and/or acceptance is prevented by, without limitation: Acts of God, shortage of Recycled Water not caused by the intentional or negligent acts of the CITY, reduction in transmission capacity, equipment malfunction, changes in operations on the Property, discharge or monitoring requirements, a determination by any regulatory agency that Recycled Water is not suitable for the intended use, a determination that the activity is unlawful, a determination that the activity may violate any operations permits, including but not limited to any National Pollutant Discharge Elimination System permits, a determination that a constituent of Recycled Water is harmful to the plants or animals on the Property, or any other unanticipated cause. In the event of such acts or any one of them causing delay or suspension of deliveries, the Parties shall immediately meet and confer and shall develop an alternative delivery schedule or such other resolution as may be acceptable to both parties.

3. RECYCLED WATER QUALITY AND USE

a. Recycled Water delivered to GREENROCK pursuant to this Agreement will be treated to the secondary-23 recycled water standards, and will be of a quality to comply with the CITY's Waste Discharge Requirements and any other permits administered by the Central Valley Regional Water Quality Control Board. The CITY will also maintain compliance with current California Department of Health Services regulations. The CITY will provide to GREENROCK copies of any test reports of Recycled Water as are periodically required of the CITY by regulatory agencies to characterize the Recycled Water.

b. GREENROCK will irrigate the Property pursuant to good farming and agricultural practices, consistent with runoff, ponding, and environmental restrictions required pursuant to statute, ordinance, regulation, permit or law, and not harmful to the Property or GREENROCK's operations thereon. CITY shall notify the GREENROCK in writing of modifications to the CITY's delivery practices to the extent necessary to comply with statute, ordinance, regulation, permit or law. In irrigating the Property, GREENROCK shall not use Recycled Water in violation of any statute, ordinance, regulation, permit or law.

c. Delivery of Recycled Water and GREENROCK's use thereof is subject to the "Defense, Indemnification, and Hold Harmless Agreement Between the City of Ione and Greenrock Ranch Lands LLC" entered into on October 2, 2012 and which is incorporated herein by reference and attached hereto as Exhibit "C."

4. CITY TO PAY COST OF RECYCLED WATER USE

a. The CITY at its sole costs and expense, with no cost or expense to GREENROCK, will pay all costs to construct, install, control, operate, maintain, and replace the irrigation equipment on the Property associated with the delivery and use of the Recycled Water. Such works may include but not be limited to land leveling, irrigation lines, pipelines, valves, meters, pumps, discharge equipment, and containment or tail-water recovery equipment ("Irrigation Equipment"). In the event that excavating a portion of the Property is necessary to construct, install, control, operate, maintain or replace the Irrigation Equipment, GREENROCK will notify the CITY in writing of the required work and City shall perform the work in accordance with all applicable laws.

b. Upon termination of this Agreement, the Irrigation Equipment shall become the property of GREENROCK, once the Parties negotiate a reasonable sale price for the residual value of any such equipment, unless GREENROCK notifies the CITY in writing prior to termination that it wants the CITY to remove the Irrigation Equipment. If GREENROCK notifies the CITY that it wants the CITY to remove some or all of the Irrigation Equipment, the CITY shall remove the designated Irrigation Equipment and return the Property to its original condition to the extent reasonably practicable.

5. EASEMENT FOR DELIVERY OF RECYCLED WATER AND IRRIGATION

a. **Easement:** GREENROCK grants and conveys to the CITY a non-exclusive easement to: (1) convey and deliver Recycled Water to and onto the Property and for irrigation of the Property; (2) construct, install, control, operate and maintain the Irrigation Equipment and/or other supporting or associated fixtures, equipment and appurtenances to the Turnout; and (3) enter upon and access the Property to accomplish the purposes of (1) and (2) above (collectively, "Easement"). The Easement granted herein may be used by the CITY's employees, agents, representatives and contractors. Prior to entry upon the Property, the CITY shall provide notice (written or oral) to GREENROCK of any required access, and shall work with GREENROCK to schedule a mutually convenient time for the CITY to access the Property.

b. **Interference with Operations:** When entering the Property, the CITY shall not interfere with the Property and GREENROCK's operations thereon except to the extent necessary to comply with any conditions of the Central Valley Board's Waste Discharge Requirements. In addition to the CITY's indemnity obligations pursuant to Exhibit "C," the CITY is solely responsible for any damage caused or liability suffered by GREENROCK resulting from the CITY entering the Property.

6. GREENROCKTO OWN EQUIPMENT AND CROPS

a. GREENROCK's operations and equipment on the Property, including all crops raised and harvested and any supporting or associated equipment and appurtenances, will be solely owned and controlled by GREENROCK. The CITY shall not interfere with GREENROCK's operations on the Property and shall not have or acquire any right, title or interest to any equipment or resulting benefit or asset, monetary or otherwise, associated with the operations.

7. CONSIDERATION

a. GREENROCK agrees to accept and use Recycled Water in return for the CITY's agreement to deliver Recycled Water and pay for all costs for facilities, works and other appurtenances necessary for delivery and use of the Recycled Water, pursuant to the terms of this Agreement. CITY agrees to construct, operate, maintain, replace and grant facilities and Irrigation Equipment, and deliver Recycled Water, as required in this Agreement.

b. In addition, CITY shall make a single payment to GREENROCK of $15,000 within 30 days of the effective date of this agreement, as fair and reasonable consideration for uncertainties in the delivery and timing of Recycled Water during the 2013 calendar year ("Temporary Easement Fee"). To the extent Recycled Water cannot be reliably delivered to GREENROCK pursuant to this agreement by October, 2013, the parties shall meet and confer to discuss whether the Temporary Easement Fee should be extended beyond 2013.

8. RIGHT OF FIRST REFUSAL TO ADDITIONAL WATER

a. To the extent that the CITY possesses, controls and/or owns Recycled Water in excess of the Committed Delivery that is available for the CITY to supply to a water user and which has not been previously committed to another water user as of the Effective Date ("Additional Recycled Water"), GREENROCK shall have the right to accept and take delivery of all or a portion of the Additional Water pursuant to the terms of this Agreement, either on the subject property or any other property owned or controlled by GREENROCK or its parent company, prior to the CITY offering and/or providing any of the Additional Water to another water user or otherwise disposing of the Additional Water. If the CITY has Additional Recycled Water available, it shall notify GREENROCK to determine if GREENROCK desires to accept and take delivery of the Additional Water. The Parties understand and acknowledge that the sources of the Additional Water are not limited to the current Recycled Water sources available to the CITY, but include any and all sources of Recycled Water that the CITY may have or obtain in the future.

b. The Parties acknowledge this provision excludes any Recycled Water receiving additional treatment beyond the existing supply that receives secondary treatment with disinfection, such as, but not limited to Recycled Water treated to tertiary standards. In no case, however, shall CITY reduce deliveries to GREENROCK subject to this Agreement as a result of secondary treatment to tertiary or other standards, except upon mutual agreement of the Parties.

9. RECORDATION

a. The Parties will cause this Agreement to be recorded promptly after its execution in the Official Records of the County of Amador, State of California.

10. METHOD AND PLACE OF GIVING NOTICE, SUBMITTING BILLS AND MAKING PAYMENTS

a. Except as otherwise specified in this Agreement, all notices, bills, and payments shall be made in writing and shall be personally delivered or sent by prepaid registered or certified mail, return receipt requested, to the following address:

CITY:	GREENROCK:
Attn: City Manager	Attn: John C. Telischak
City of Ione	Greenrock Ranch Lands, LLC
P.O. Box 398	45 Koch Road, Suite A
1 E. Main Street	Corte Madera, CA 94925
Ione, CA 95640	

When so addressed and sent by prepaid registered or certified mail, said notice, bill, or payment shall be deemed given or made upon deposit in the United States mail. In all other instances, notices, bills, or payments shall be deemed given or made at the time of actual delivery.

Changes may be made in the names or addresses of the person to whom notices, bills, or payments are to be given by giving notice pursuant to this paragraph.

11. BREACH; REMEDIES

a. Should one party breach any of the terms and conditions of this Agreement, the non-breaching Party shall give written notice to the other Party. If the breach is not cured within 30 calendar days from the date notice is given, the non-breaching party may, in addition to any remedies provided by this Agreement or by law or equity, terminate this Agreement on an additional 30 calendar days written notice.

12. ASSIGNMENT

a. Except as otherwise specified in this Agreement, no Party may assign its rights and obligations hereunder without the prior written consent of the other Party.

13. ENVIRONMENTAL COMPLIANCE

a. The CITY is solely responsible for its compliance with any statute, ordinance, regulation, permit, or law regulating the delivery, use and/or recovery of Recycled Water.

14. GENERAL PROVISIONS

a. **Authority:** Each Party represents that the representative of the Party executing this Agreement has the authority to enter into this Agreement on behalf of such Party and bind such Party to the terms and conditions of this Agreement and the performance of such Party's obligations and responsibilities as set forth in this Agreement, and this Agreement has been duly authorized by all required action and that the Party's execution of this Agreement and performance of its obligations under this Agreement will not violate any contract, transaction, option, covenant, condition, obligation or undertaking of such party, nor to the best of such Party's knowledge will it violate any law, ordinance, statute, order, permit or regulation.

b. **Construction and Interpretation:** To the fullest extent allowed by law, the provision of this Agreement shall be construed and given effect in a manner that avoids any violation of statute, ordinance, regulation, permit or law. This Agreement is entered into freely and voluntarily. This Agreement has been arrived at through negotiation; each Party has consulted with counsel and had a full and fair opportunity to revise the terms of this Agreement. As such, any interpretation of this Agreement should not favor any Party.

c. **Third-Party Beneficiaries:** This Agreement is not intended to create any third-party beneficiaries. This Agreement is for the sole benefit of the Parties and their respective successors and/or permitted assignees, and no other person or entity shall be entitled to rely on or receive any benefit from this Agreement.

d. **Severability:** If any provision of this Agreement is determined to be void by any court of competent jurisdiction, then such determination shall not affect any other provision of this Agreement, and all such other provisions shall remain in full force and effect provided, however, that the purpose of this Agreement is not frustrated. It is the intention of the Parties that if any provision of this Agreement is capable of two constructions, one of which would render the provision void and the other of which would render the provision valid, then the provision shall have the meaning which renders it valid.

e. Waiver: No waiver by either Party of any provisions or breach of this Agreement shall be deemed to be a waiver of any other provision hereof or of any subsequent breach by either Party of the same or any other provisions.

f. **Entire Agreement:** This Agreement contains the entire agreement of the Parties with respect to any matter covered or mentioned in this Agreement, and supersedes all prior negotiations, understanding and agreements, and no prior agreement or understanding pertaining to any such matter shall be effective for any purpose.

g. **Amendments:** No provision of this Agreement may be amended or added to except by an agreement in writing signed by the Parties or their respective successors in interest, expressing by its terms an intention to modify this Agreement.

h. **Successors and Assigns:** The right and benefit to receive and the obligation to take Recycled Water shall be a covenant running with the Property, and the obligation to provide Recycled Water to the Property shall be that of the CITY. Upon transfer of title or interest in the Treatment Plant or the Property, all rights, duties, and obligations undertaken by this Agreement shall succeed to the new owner(s), lessees, heirs, executors, or assigns.

i. **Attorneys' Fees:** The prevailing party in any action or proceeding to enforce or interpret this Agreement or otherwise arising out of or in connection with the subject matter hereof (including, but not limited to, any suit, arbitration, entry of judgment, post-judgment motion or enforcement, appeal, bankruptcy litigation, attachment or levy) shall be entitled to recover its costs and expenses, including, but not limited to, attorneys', experts' and consultants' fees and costs.

j. **Necessary Actions:** Each Party agrees to execute and deliver additional documents and instruments and to take any additional actions as may be reasonably required to carry out the purposes of this Agreement.

k. **Force Majeure:** No Party will be liable by reason of any failure or delay in the performance of its obligations for any cause beyond its reasonable control, including but not limited to electrical outages, riots, insurrection, war, fires, flood, earthquakes, explosions and other Acts of God.

l. **Governing Law and Venue:** This Agreement shall be construed and interpreted in accordance with the laws of the State of California. Any action brought relating to this Agreement shall be heard exclusively in a State court in the County of Amador.

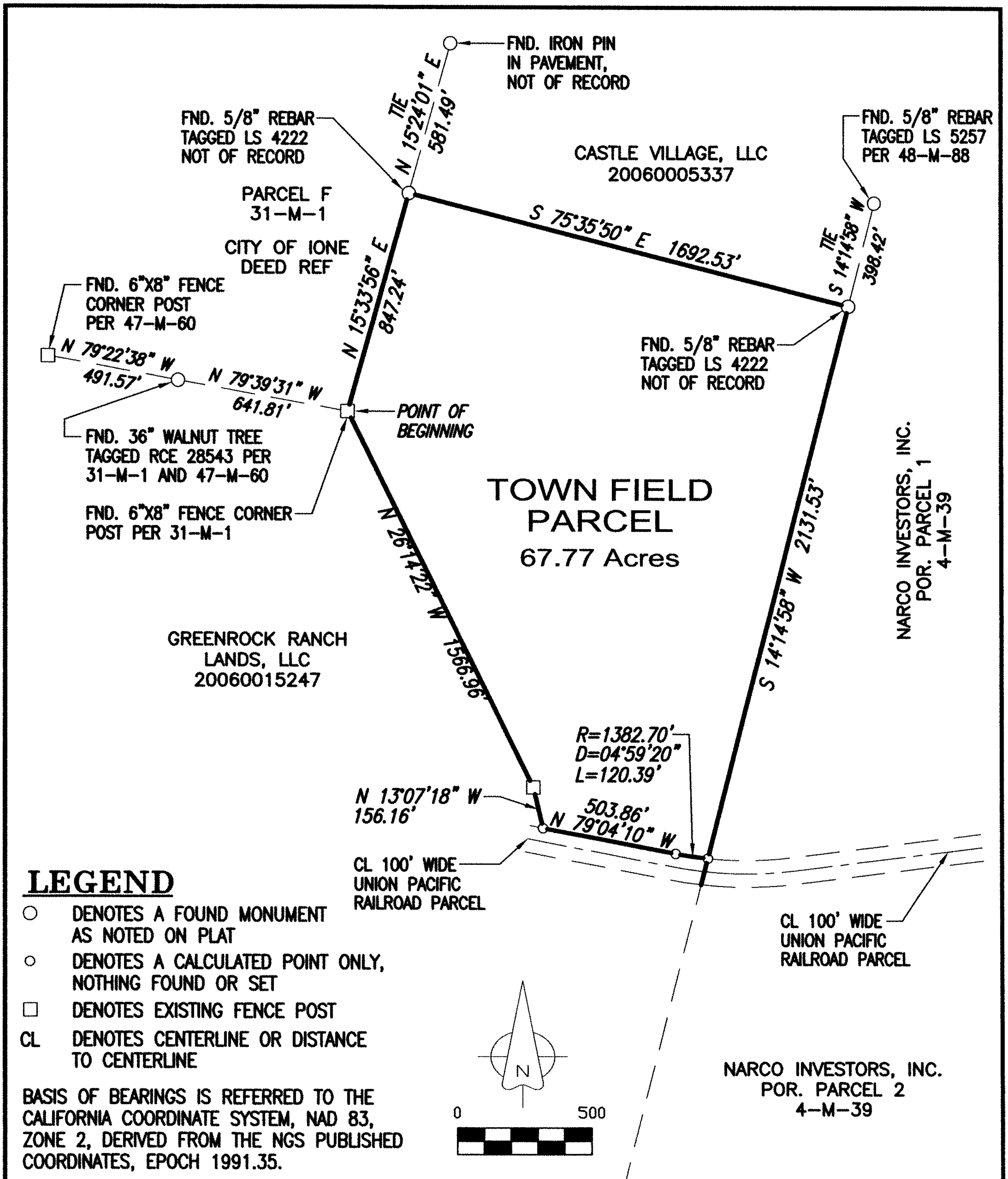
m. **Counterparts; Faxed/Electronic Signatures:** This Agreement may be signed in counterparts and facsimile or electronic signatures shall have the same effect as original signatures.

IN WITNESS WHEREOF, the Parties have fully executed this **AGREEMENT**.

GREENROCK RANCH LANDS, LLC By ______________________ John Telischak, Authorized Agent	CITY OF IONE By ______________________ Dan Epperson, Mayor of Ione
	CITY OF IONE APPROVED AS TO FORM: By ______________________ James D. Maynard, City Attorney

EXHIBIT "A"

Map Depicting Property



SHEET 1 OF 1 SHEETS

JOB NO.: 1211-11

DRAWN BY: GMW

SCALE: 1"= 500'

DATE: 12.13.2012

EXHIBIT MAP
TOWN FIELD PARCEL

BEING A PORTION OF THE RANCHO ARROYO SECO
AMADOR COUNTY, CALIFORNIA

TOMA & ASSOCIATES INC.
ENGINEERING - SURVEYING - PLANNING
41 Summit Street, Jackson, CA 95642
(209) 223-0156

REVISIONS | BY

<u>EXHIBIT “B”</u>

Legal Description of the Property

TOWN FIELD PARCEL 67.77 Acres

A parcel of land situated in the County of Amador, State of California, and being a portion of the Rancho Arroyo Seco, and being more particularly described as follows:

Beginning at a fence corner post at the Southeast corner of "PARCEL "F" 15.67 AC.", as shown and so designated upon that certain official map entitled "RECORD OF SURVEY A PORTION OF RANCHO ARROYO SECO AND THE CITY OF IONE AMADOR COUNTY CALIFORNIA", and recorded in the office of the Recorder of Amador County in Book 31 of Maps and Plats at Page 1, et seq; thence, from said point of beginning, along the East line of said Parcel F, North 15° 33' 56" East 847.24 feet; thence, leaving said East line, South 75° 35' 50" East 1692.53 feet to a 5/8 inch rebar lagged LS 4222 found on the West line of "PARCEL No 1 78.556 AC.", as shown and so designated upon that certain official map entitled "PLAT OF F.P. TOMAIUOLO RANCH", and recorded in Book 4 of Maps and Plats at Page 39, Amador County Records; thence, along said West line of Parcel No. 1, South 14° 14' 58" West 2131.53 feet to a point in the North line of the Union Pacific Railroad parcel of land; thence, along said North line of said Union Pacific Railroad parcel of land, along the arc of a non-tangent curve to the right, having a radius of 1,382.70 feet, through a central angle of 04° 59' 20", for an arc length of 120.39 feet; thence North 79° 04' 10" West 503.86 feet; thence, leaving said Union Pacific Railroad parcel of land, North 13° 07' 18" West 156.16 feet to a fence corner post; thence North 26° 14' 22" West 1,566.96 feet to the point of beginning, and containing 67.77 acres of land, more or less.

The basis of bearings for the legal description above is referred to the California Coordinate System, NAD 83, Zone 2.

12/13/12

Ciro L. Toma PLS 3570 License expires 6/30/14

PROFESSIONAL LAND SURVEYOR
CIRO L. TOMA
P.L.S. 3570
STATE OF CALIFORNIA

EXHIBIT "C"

Defense, Indemnification, and Hold Harmless Agreement between the City of Ione and Greenrock Ranch LLC

Attachment C

Rainfall and Reference ET Data

IONE, CALIFORNIA (044283)

Period of Record Monthly Climate Summary

Period of Record : 03/01/1906 to 06/30/1977

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)					Insuff	icient	Data						
Average Min. Temperature (F)					Insuff	icient	Data						
Average Total Precipitation (in.)	5.08	3.14	3.19	1.75	0.63	0.23	0.07	0.13	0.33	1.15	2.81	3.53	22.04
Average Total SnowFall (in.)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.
Max. Temp.: 0% Min. Temp.: 0% Precipitation: 99.9% Snowfall: 99.9% Snow Depth: 99.8%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

D

Rainfall Depth Duration Frequency at Ione

Station Number	Station	County	Latitude	Longitude	Elevation	Years Recorded
B00 4283 00	Ione	Amador	38.348	-120.938	284.0	89

Rainfall Statistics	1-Day	2-Day	3-Day	4-Day	5-Day	6-Day	8-Day	10-Day	15-Day	20-Day	30-Day	60-Day	1-Year
Pr=0.5	1.92	2.55	3.01	3.38	3.70	3.99	4.48	4.91	5.79	6.51	7.68	10.19	21.28
Pr=0.2	2.55	3.37	3.98	4.47	4.89	5.27	5.92	6.48	7.64	8.58	10.11	13.39	27.84
Pr=0.1	2.92	3.87	4.55	5.11	5.60	6.02	6.76	7.40	8.71	9.78	11.52	15.23	31.54
Pr=0.04	3.36	4.44	5.22	5.86	6.40	6.89	7.73	8.45	9.94	11.16	13.13	17.32	35.70
Pr=0.02	3.66	4.83	5.67	6.36	6.96	7.48	8.39	9.17	10.78	12.09	14.22	18.74	38.51
Pr=0.01	3.94	5.19	6.10	6.84	7.47	8.04	9.01	9.84	11.57	12.97	15.23	20.06	41.11
Pr=0.005	4.21	5.54	6.51	7.29	7.96	8.56	9.59	10.48	12.31	13.79	16.19	21.31	43.57
Pr=0.002	4.54	5.97	7.01	7.85	8.58	9.22	10.33	11.28	13.23	14.82	17.40	22.87	46.64
Pr=0.001	4.79	6.29	7.38	8.26	9.02	9.69	10.85	11.85	13.90	15.57	18.26	23.99	48.84
Pr=0.0001	5.53	7.26	8.50	9.52	10.39	11.15	12.48	13.62	15.96	17.87	20.94	27.46	55.66

Annual Maxima	1-Day	2-Day	3-Day	4-Day	5-Day	6-Day	8-Day	10-Day	15-Day	20-Day	30-Day	60-Day	1-Year
2007	---	---	---	---	---	---	---	---	---	---	---	---	---
2006	---	---	---	---	---	---	---	---	---	---	---	---	---
2005	---	---	---	---	---	---	---	---	---	---	---	---	---
2004	---	---	---	---	---	---	---	---	---	---	---	---	---
2003	---	---	---	---	---	---	---	---	---	---	---	---	---
2002	---	---	---	---	---	---	---	---	---	---	---	---	---
2001	---	---	---	---	---	---	---	---	---	---	---	---	---
2000	1.85	2.80	4.29	4.74	4.99	4.99	5.22	5.79	7.52	9.05	10.35	11.82	21.39
1999	2.02	2.44	3.42	3.42	3.42	3.42	3.42	4.17	5.51	5.72	8.41	10.90	15.39
1998	2.37	3.55	4.11	4.36	4.98	5.85	6.61	7.31	8.07	10.05	14.21	21.25	30.46
1997	2.37	3.55	4.11	4.36	4.98	5.85	6.61	7.31	8.07	10.05	14.21	21.25	43.59
1996	3.75	3.85	3.85	3.85	3.85	3.85	3.85	3.85	4.74	5.27	6.16	11.53	22.80
1995	2.90	4.71	5.05	5.33	5.58	5.71	7.45	8.02	9.08	9.83	12.42	16.90	35.50
1994	1.27	1.70	1.95	2.05	2.15	2.42	2.55	2.55	3.45	3.67	5.27	5.87	15.52
1993	1.81	2.26	2.26	2.84	3.18	4.50	4.91	5.13	7.10	7.52	10.16	16.58	29.21
1992	2.30	3.18	3.18	3.24	4.11	5.17	5.97	6.06	6.98	7.16	9.13	10.62	20.43
1991	1.60	2.28	2.88	3.52	3.52	3.52	4.08	5.15	6.28	7.38	10.07	11.94	16.59
1990	1.82	2.35	2.37	2.37	2.37	2.37	2.37	2.37	2.90	2.90	3.33	6.23	17.33
1989	1.05	1.90	2.05	2.06	2.26	2.41	2.52	2.82	3.36	3.75	5.85	7.67	16.85
1988	1.55	1.90	1.90	1.90	1.90	1.90	2.05	2.13	2.75	3.47	4.78	6.57	11.67
1987	1.81	2.43	2.54	2.54	2.87	2.87	3.38	3.62	3.62	5.31	5.31	9.80	13.86
1986	2.75	4.85	5.65	6.65	6.85	6.95	7.90	8.00	8.00	9.45	12.97	18.47	33.02
1985	---	---	---	---	---	---	---	---	---	---	---	---	17.93
1984	---	---	---	---	---	---	---	---	---	---	---	---	23.39
1983	---	---	---	---	---	---	---	---	---	---	---	---	41.81
1982	---	---	---	4.62	5.24	5.24	5.53	5.53	7.29	8.43	9.95	15.59	39.56
1981	2.04	2.94	3.80	4.17	4.32	5.01	6.02	6.02	6.21	6.21	6.62	11.24	17.15
1980	---	---	---	---	---	---	---	---	---	---	---	---	26.42

1979	1.54	2.28	2.83	3.82	3.82	3.82	4.02	4.97	5.49	6.53	7.09	12.65	20.87
1978	1.54	2.28	2.83	3.82	3.82	3.82	4.02	4.97	5.49	6.53	7.09	12.65	20.87
1977	0.92	1.03	1.09	1.12	1.12	1.12	1.24	1.26	1.26	1.26	2.18	3.32	8.73
1976	0.78	1.23	1.70	1.70	1.91	2.06	2.06	2.06	2.18	3.21	3.73	5.00	11.87
1975	1.97	2.56	3.14	3.27	3.38	3.52	4.84	6.08	7.82	8.47	8.50	15.06	28.24
1974	---	---	---	---	---	---	---	---	---	---	---	---	33.80
1973	2.48	2.76	3.51	4.54	4.86	4.86	6.09	7.38	8.60	9.26	12.09	19.82	35.95
1972	3.05	3.88	3.92	3.98	3.98	5.03	5.90	5.96	6.05	6.73	7.92	9.62	16.80
1971	3.05	4.40	5.02	5.13	6.25	6.57	6.57	7.61	8.20	8.22	9.81	13.34	21.20
1970	2.94	2.94	3.48	3.48	3.72	3.72	4.97	5.90	6.37	7.01	9.55	12.27	21.13
1969	2.75	3.15	3.15	3.23	3.31	3.54	5.63	6.09	8.33	8.80	9.89	16.66	30.23
1968	1.76	2.12	2.12	2.43	2.43	2.48	2.51	3.20	3.20	3.49	4.61	8.77	17.12
1967	2.52	4.13	4.15	4.63	4.97	4.99	5.38	6.53	7.36	7.36	7.89	11.44	29.07
1966	1.79	1.95	2.46	2.48	3.27	3.74	4.03	4.13	5.17	5.17	5.17	9.69	16.47
1965	---	3.43	---	---	---	---	---	7.18	8.10	---	---	---	25.01
1964	1.98	2.44	2.86	3.06	3.06	3.06	3.25	3.45	5.45	6.58	6.84	9.13	18.12
1963	2.88	3.52	4.20	4.65	4.65	4.65	4.65	4.65	6.07	6.38	6.38	10.35	24.44
1962	1.25	2.08	2.93	3.02	4.05	4.53	6.47	7.17	7.61	7.75	9.09	11.98	18.00
1961	1.38	1.68	2.16	2.16	2.16	2.26	2.40	2.77	2.93	3.23	4.81	6.51	13.82
1960	1.33	1.53	1.86	1.86	2.09	2.42	2.82	3.25	3.67	5.03	6.18	7.86	16.68
1959	1.65	2.09	2.09	2.55	2.88	3.22	3.68	4.01	4.01	4.75	6.13	10.54	13.45
1958	---	---	---	---	---	---	---	---	---	---	---	---	41.69
1957	---	---	---	---	---	---	---	---	---	---	---	---	18.93
1956	---	---	---	---	---	---	---	---	---	---	---	---	28.58
1955	---	---	---	---	---	---	---	---	---	---	---	---	18.28
1954	---	---	---	---	---	---	---	---	---	---	---	---	16.40
1953	---	---	---	---	---	---	---	---	---	---	---	---	15.10
1952	2.21	3.15	3.68	3.77	3.77	3.77	3.77	4.06	4.68	6.56	7.47	13.11	27.05
1951	4.65	5.30	5.30	5.30	5.55	5.70	6.24	6.25	6.25	8.87	10.85	14.60	28.76
1950	2.70	2.70	2.70	3.97	3.97	3.97	3.97	5.05	5.05	5.55	9.52	10.41	18.30
1949	1.76	2.71	3.14	3.14	3.14	3.14	3.72	3.86	4.87	5.45	6.93	10.49	17.23
1948	1.28	1.41	1.70	1.83	2.03	2.03	2.43	2.43	4.08	4.39	6.67	8.68	17.76
1947	2.16	3.12	3.20	3.20	3.91	3.91	3.91	4.13	4.13	4.13	4.82	7.33	14.54
1946	1.90	1.90	3.20	3.38	4.37	4.98	5.16	5.42	5.70	6.31	7.49	11.80	20.14
1945	2.68	3.88	4.78	4.78	4.98	5.27	5.27	5.27	5.66	5.66	5.66	9.58	23.66
1944	2.25	2.41	2.53	2.53	3.23	3.39	3.93	4.28	5.68	5.68	7.47	10.20	19.25
1943	2.05	2.78	3.58	3.81	4.43	4.77	5.38	5.42	7.10	8.03	10.13	15.90	27.61
1942	2.00	3.48	4.20	4.60	5.32	5.81	5.91	5.91	7.68	8.17	8.17	12.92	26.67
1941	1.85	2.40	2.46	3.46	5.46	5.46	4.17	4.52	7.17	8.59	11.13	14.00	25.17
1940	1.65	2.72	3.46	3.76	4.20	4.79	5.24	5.54	5.95	6.00	8.96	16.37	24.86
1939	1.72	2.40	2.55	2.80	2.80	2.80	2.80	2.80	2.80	3.17	3.42	5.93	14.01
1938	2.30	3.65	4.05	4.55	4.80	4.80	5.25	6.95	9.40	10.35	12.10	16.00	27.25
1937	4.40	4.65	5.85	6.15	6.60	6.95	7.70	8.15	8.70	9.50	10.10	19.90	34.99
1936	2.00	2.30	3.50	4.20	4.35	4.50	6.05	6.40	10.33	10.33	13.28	19.99	28.29
1935	2.50	2.72	2.72	2.72	3.25	4.30	4.52	4.52	5.22	5.65	6.35	9.47	23.94
1934	1.70	2.85	2.85	4.05	4.52	4.52	4.52	4.52	4.52	6.40	8.77	9.67	17.86

1933	1.20	1.72	1.72	1.72	2.32	3.12	3.12	3.82	3.82	3.82	5.07	7.87	12.77
1932	1.75	1.92	2.59	3.58	3.75	3.80	4.49	4.97	5.58	5.88	6.60	10.05	19.99
1931	1.65	1.65	1.65	2.53	2.53	2.53	2.65	2.65	2.65	2.65	3.92	6.39	12.62
1930	1.39	2.25	2.25	2.57	2.57	2.78	3.35	3.71	5.17	5.33	5.62	10.86	17.07
1929	1.91	2.98	3.49	3.49	3.49	3.49	3.49	3.57	4.07	4.07	4.07	6.57	15.52
1928	1.68	2.60	3.40	4.06	4.79	4.92	4.92	4.92	5.92	6.10	6.27	9.09	18.80
1927	1.50	3.00	3.00	4.25	4.25	4.51	5.46	5.96	6.26	6.91	7.41	10.51	24.11
1926	2.55	2.80	2.90	3.55	3.55	4.55	5.10	5.10	6.48	8.99	10.04	10.29	21.54
1925	1.95	3.05	3.27	3.27	3.52	3.74	4.27	5.79	5.94	7.79	8.41	11.84	28.60
1924	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	2.35	3.00	3.00	4.95	10.50
1923	2.20	3.00	4.30	5.30	5.30	5.30	5.50	6.10	6.70	6.70	9.30	14.15	26.07
1922	2.17	2.52	3.45	3.95	3.95	3.95	3.95	4.44	7.09	7.16	9.46	14.80	24.30
1921	3.85	3.95	4.50	4.72	4.72	4.72	4.72	5.72	6.62	7.02	7.72	13.51	26.57
1920	2.10	3.55	3.90	4.05	4.20	4.20	4.20	4.31	4.82	5.19	7.04	9.26	15.46
1919	2.25	3.55	3.90	4.00	4.05	4.40	4.60	4.70	5.00	6.45	8.15	10.35	18.75
1918	1.60	2.35	2.35	2.35	3.45	4.25	4.70	4.70	6.50	6.50	8.10	11.30	15.50
1917	1.30	2.30	2.60	2.90	3.25	3.55	4.10	4.35	4.55	4.55	5.35	7.25	17.70
1916	---	---	---	---	---	---	---	---	---	---	---	---	20.00
1915	1.50	1.95	2.15	2.30	2.83	3.03	3.88	4.20	5.88	6.20	7.77	10.87	22.80
1914	2.26	3.11	3.49	3.61	3.99	3.99	3.99	4.48	5.47	6.96	9.81	13.52	22.90
1913	1.20	1.84	2.22	2.72	2.95	3.36	3.36	3.55	4.01	4.01	4.01	4.86	14.26
1912	0.69	1.04	1.15	1.22	1.30	1.45	1.86	2.16	2.47	2.86	3.43	5.36	12.68
1911	2.17	3.57	5.27	6.12	6.45	7.30	7.80	8.42	10.82	15.51	18.06	24.30	30.46
1910	2.00	3.00	3.00	3.45	3.88	3.88	3.93	3.93	4.00	4.69	5.92	8.90	20.89
1909	1.45	2.60	3.80	4.42	4.54	5.07	5.99	6.39	7.99	9.21	12.66	19.24	26.01
1908	1.30	1.60	1.60	1.78	1.78	1.78	1.83	3.03	3.63	3.63	5.51	9.04	14.27
1907	4.37	6.79	7.38	7.53	8.38	8.53	8.53	8.53	8.53	10.60	12.20	18.04	33.82
1906	2.40	2.54	3.22	3.62	3.85	3.85	3.85	5.03	7.47	9.20	10.45	15.43	30.93
1905	2.90	2.90	2.90	3.20	4.20	4.20	4.55	4.85	5.55	5.55	5.50	9.65	25.95
1904	1.51	2.62	3.12	3.15	3.15	3.25	3.75	4.86	6.07	6.42	7.20	12.05	21.42
1903	1.85	2.92	3.58	4.10	5.01	5.03	5.03	5.53	5.53	7.54	9.71	10.34	22.39
1902	1.21	1.79	2.09	2.61	3.01	3.41	3.87	4.41	5.03	6.03	7.72	9.29	20.19
1901	2.05	2.79	3.61	4.03	4.03	4.72	5.54	5.52	5.54	7.35	7.69	11.29	25.48
1900	1.85	2.34	2.41	2.80	2.86	2.86	2.86	3.88	4.82	5.66	6.45	9.69	21.51
1899	1.93	2.56	3.20	3.54	4.04	4.04	4.94	7.17	7.80	7.93	9.00	9.22	20.03
1898	3.60	4.47	4.64	4.64	4.64	4.64	4.64	4.76	5.11	5.11	5.23	7.30	13.77
1897	---	---	---	---	---	---	---	---	---	---	---	---	---
1896	---	---	---	---	---	---	---	---	---	---	---	---	---
1895	---	---	---	---	---	---	---	---	---	---	---	---	---
1894	---	---	---	---	---	---	---	---	---	---	---	---	---
1893	---	---	---	---	---	---	---	---	---	---	---	---	---
1892	---	---	---	---	---	---	---	---	---	---	---	---	---
1891	---	---	---	---	---	---	---	---	---	---	---	---	---
1890	---	---	---	---	---	---	---	---	---	---	---	---	---
1889	---	---	---	---	---	---	---	---	---	---	---	---	---
1888	---	---	---	---	---	---	---	---	---	---	---	---	---

Monthly Average ETo Report

California Irrigation Management Information System (CIMIS)

Rendered in ENGLISH Units.

Printed on Wednesday, August 31, 2022

Average ETo Values by Station

Stn Id	Stn Name	CIMIS Region	Jan (in)	Feb (in)	Mar (in)	Apr (in)	May (in)	Jun (in)	Jul (in)	Aug (in)	Sep (in)	Oct (in)	Nov (in)	Dec (in)	Total (in)
227	Plymouth	SFH	1.48	1.95	3.02	4.57	5.97	7.19	7.64	6.98	4.99	3.24	1.68	1.21	49.92

CIMIS Region Abbreviations		
BIS - Bishop	CCV - Central Coast Valleys	ICV - Imperial/Coachella Valley
LAB - Los Angeles Basin	MBY - Monterey Bay	NCV - North Coast Valleys
NEP - Northeast Plateau	SAV - Sacramento Valley	SBE - San Bernardino
SFB - San Francisco Bay	SJV - San Joaquin Valley	SFH - Sierra Foothill
SCV - South Coast Valleys		

Attachment D

Castle Oaks Golf Course Recycled Water Demands TM

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Concord CA 94520

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TECHNICAL MEMORANDUM

DATE: December 10, 2024

Project No.: 988-50-24-10
SENT VIA: EMAIL

TO: George Lee, City of Ione

CC: Daniel Griffin, Castle Oaks Golf Course
Justin Granados, WaterStone Service

FROM: Allie Ahern, EIT

REVIEWED BY: Kathryn Gies, PE, RCE #65022

SUBJECT: Castle Oaks Golf Course Recycled Water Demands

This technical memorandum (TM) provides information and supporting documentation related to water needs of the Castle Oaks Golf Course (golf course), which receives recycled water from the Castle Oaks Water Reclamation Facility (COWRF). The purpose of this TM is to inform development of a water balance for the Amador Regional Sanitation Authority (ARSA) wastewater disposal system. The following topics are addressed:

- Background Information
- Golf Course Irrigable Acreage
- Golf Course Storage Ponds
- Golf Course Agronomic Water Demands
- COWRF Influent Flows
- Golf Course Tailwater and Overspray Control and Monitoring

BACKGROUND INFORMATION

This section provides background information relevant to this TM. The following topics are addressed:

- Regulatory History
- Applicable Regulatory Standards for Water Balances
- Golf Course Demands vs. COWRF Influent Flows

Regulatory History

The City of Ione (City), ARSA and Portlock International Ltd. (Portlock) are the three entities permitted the Central Valley Water Quality Control Board (Regional Board) under Water Reclamation Requirement Order 93-240 (WRRs) to land apply recycled water from the COWRF to the golf course. The City owns and operates the COWRF, which provides the recycled water to the golf course. The City also owns the golf course, which is leased and operated by Portlock. ARSA is permitted to supply water to the COWRF to meet the irrigation needs of the golf course.

On August 14, 2024, the Regional Board issued a 13267 Order letter to the three WRRs permittees that requires the submission of an updated water balance for the ARSA system to the Regional Board by December 13, 2024. The letter specifies six items (A through F) that must be provided. This TM addresses the requirements under Item B of this letter, which states:

> *The acreage and agronomic rate at which recycled water can be applied to the Castle Oaks Golf Course without violating setback requirements, Title 22 requirements, impacting groundwater, or causing runoff to surface water. These numbers and calculations should be provided and certified by Ione and Portlock International LTD. Supporting documentation and references must be included in the submittal. Information regarding tailwater control/return and monitoring plans for compliance with applicable land application area requirements must also be included.*

Applicable Regulatory Standards for Water Balances

The 13267 Order states that the water balance must be in compliance with the requirements and guidance of the Regional Board's guidance document *Requirements for Water Balance Update and Calibration*, which is provided as Attachment A to the 13267 Order. Several of the procedures defined in this guidance document are applicable to the development of this TM, as follows:

<u>Requirements for Water Balance Update and Calibration, Section 4:</u>

> *The normal operations and maintenance of land application areas should be considered. [Operations and Maintenance] O&M Manuals should be referenced as well as historical monitoring data (i.e. percolation rates, observed standing water). Specific conditions of the [WRRs] should also be taken into account. The following should be taken into consideration:*
>
> *A. Recycling area/land application area/disposal system hydraulic loading rates should be distributed monthly in accordance with expected seasonal variations based on crop evapotranspiration rates.*
>
> *B. The distribution of precipitation (i.e. storm intensity, light rain over a lot of days or heavy rain over a few days), as well as other factors such as wind and saturated conditions must be taken into account when determining the number of days a disposal system can be operated each month. The most reliable way to estimate this is based off of historical records from a water year of intensity similar to that which is being modeled.*
>
> *C. It should be specified whether the tailwater is collected, and if so if it is returned to the sprayfields directly or to one of the ponds.*
>
> *D. If applicable, storm water runoff shall be accounted for in the tailwater return calculations.*
>
> *E. Maximum disposal capacity of land application areas should be based on soil studies, cropping plans, percolation studies, and/or operator notes.*

Requirements for Water Balance Update and Calibration, Section 5:

A. All water balances shall start on 1 October and end on 30 September.

…

C. The water balance should include an assessment of the facility's capacity and performance during a normal water year and during a year with a total annual precipitation for a return period of 100 years.

D. Local precipitation data for the 100-year annual return period, distributed monthly in accordance with mean monthly precipitation patterns shall be used. However, periods of high intensity storms should also be considered in the calculations.

E. All water balances should be based on all available data. All data should also be quality controlled and used with discretion.

…

G. For each wastewater treatment, storage, or disposal pond and containment structure, provide the following information:

a. Identification (name) and function of the pond.

b. Surface area, depth, and volumetric capacity at two feet of freeboard.

c. Height (relative to surrounding grade), crest width, interior slope, and exterior slope of each berm or levee.

d. Materials used to construct each berm or levee.

e. Description of engineered liner, if any. Include a copy of the Construction Quality

f. Estimated steady state percolation rate for each unlined pond.

g. Depth to shallow groundwater below the base and pond inverts.

h. Precipitation and evapotranspiration data shall be from recognized stations. The source of this information shall be provided, including a link to the data.

i. Overfilling/overflow prevention features.

j. Operation and maintenance procedures.

Golf Course Demands vs. COWRF Influent Flows

During the COWRF tertiary treatment process, a fraction of the influent to the COWRF is discarded as filter backwash and sent to the City of Ione's Wastewater Treatment Facility (WWTF). The remaining influent to the COWRF is treated to tertiary standards and recycled at the golf course. Therefore, the influent flow to the COWRF needs to be greater than the agronomic water demand of the golf course to accommodate the losses due to filter backwash, and the ARSA water balances need to include the portion of influent sent as filter backwash to the WWTF.

The City is concurrently in the process of preparing a water balance for its WWTF in accordance with a separate 13267 Order. The WWTF water balance will also need to account for the COWRF backwash flows. Accordingly, this TM presents calculations that define both the COWRF influent flows needed to meet the golf course agronomic demands for use in the ARSA water balance and the backwash flow from the COWRF to the WWTF for use in the WWTF water balance.

GOLF COURSE IRRIGABLE ACREAGE

The irrigable acreage of the golf course was determined based on inspection of the golf course irrigation system and discussions with staff. This area was mapped and quantified using GIS mapping and data processing tools. Figure 1 presents the map created. The following areas of the golf course were not included in the calculated irrigable acreage:

- natural, undeveloped areas surrounding Mule Creek and Sutter Creek
- areas abutting residences surrounding the golf course; some of these areas are irrigated by residents while others remain unirrigated
- hardscape and permanent water features

The total irrigable area of the golf course was determined to be 130 acres.

COGC_TM_Fig1: W:\Clients\988 City of Ione\50-23-05 Title 22 Update\GIS\Title 22 Update\Title 22 Update.aprx - aahern - 11/6/2024

Prepared by:

WEST YOST

0 800 1,600 US Feet

Prepared for:

City of Ione

Castle Oaks Golf Course
Recycled Water Demands

Castle Oaks Golf Course Irrigable Area

Figure 1

GOLF COURSE STORAGE PONDS

The golf course has nine ponds that can be filled with recycled water during the irrigation season. The ponds serve as aesthetic features and water hazard obstacles for the golf course and are used to hold recycled water before it is pumped to the golf course. Limited construction information is available for the ponds, but the ponds are understood to be unlined and constructed of native soil material. Estimates of the depth, volume and percolation rates of the ponds are not available. However, it is estimated that on average, the depth of groundwater below the golf course ranges from 8 to 13 feet. The surface area of each pond has been estimated using GIS mapping and data processing tools and is presented in Table 1.

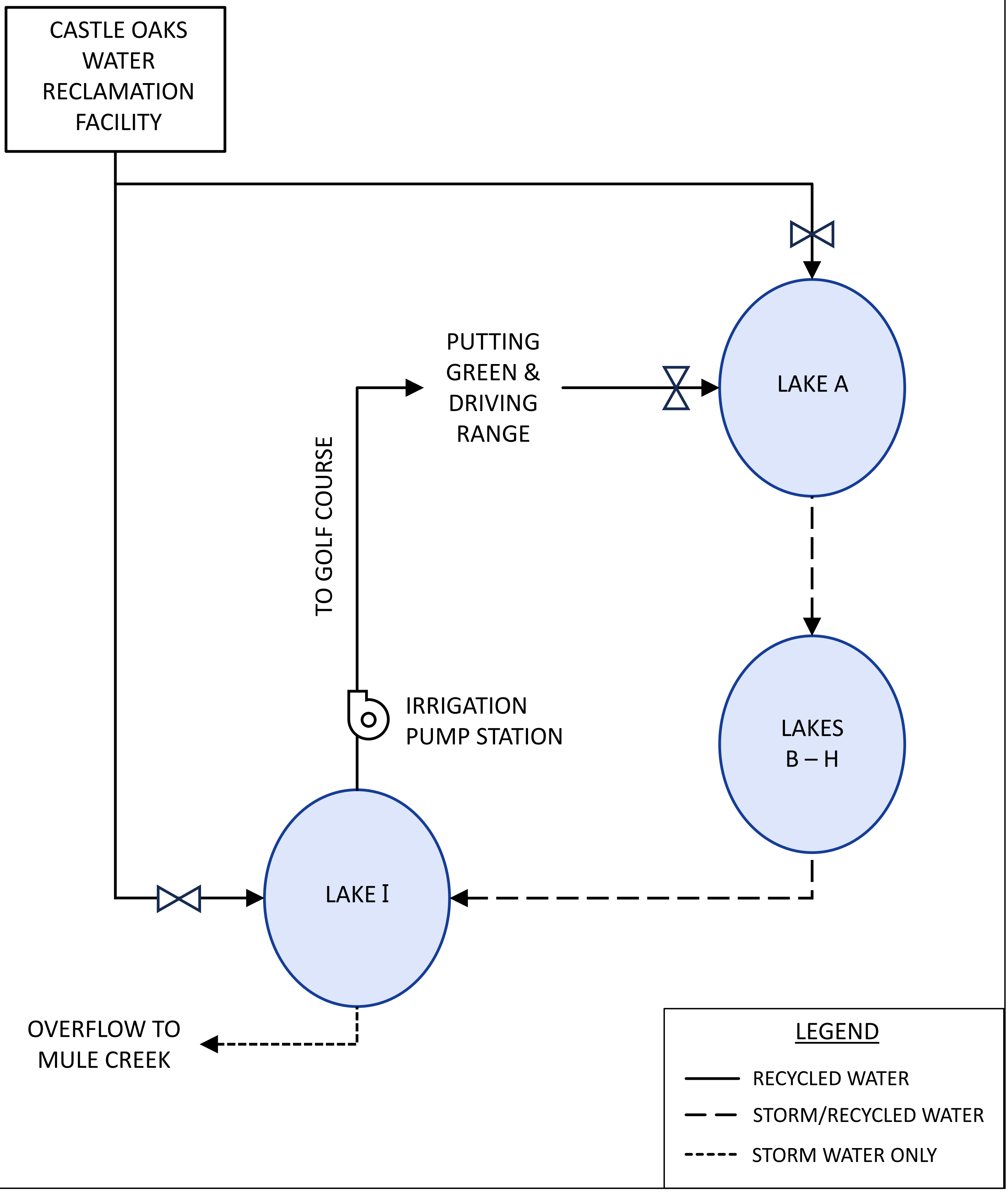
Table 1. Golf Course Storage Pond Surface Area

Pond Name	Surface Area, acres
Lake A	0.8
Lake B	1.2
Lake C	0.4
Lake D	1.1
Lake E	2.2
Lake F	1.1
Lake G	1.6
Lake H	1.4
Lake I	3.1

The ponds are hydraulically connected to each other. The maximum water level of each pond is controlled by a fixed standpipe located in an access port approximately 20 to 100 feet from the lake's edge. Water overflowing the standpipe of the upstream lake is conveyed by to the following lake downstream, with Lake A being the furthest upstream lake, and Lake I being the furthest downstream lake. The Lake I overflow standpipe connects to a wetlands area that is tributary to the nearby surface water body Mule Creek. Figure 2 presents a schematic of the recycled water irrigation system.

Recycled water from the COWRF can be pumped directly to either Lake I or Lake A. Recycled water is then pumped from Lake I to the golf course irrigation system. Under current operations, recycled water is sent by default to Lake I. Golf course staff relate that recycled water is only pumped to Lake A for short periods during the irrigation season, when golf course demands are not keeping up with flows from the COWRF and Lake I is at risk of overflowing. Typically, recycled water that is directed to Lake A will remain in the Lake until it has percolated or evaporated. However, recycled water can discharge from Lake A to the downstream lakes if Lake A overflows. However, golf course staff indicate that the amount of recycled water flow sent to Lake A is not enough to result in overflows.

Figure 2. Castle Oaks Golf Course Recycled Water Storage and Irrigation System Schematic



The ponds also serve as catchment for stormwater runoff the golf course. During the winter rainfall season, stormwater runoff will fill the nine ponds, and they will eventually overflow to Mule Creek. To prevent the discharge of recycled water to Mule Creek, recycled water is only delivered to the golf course during the irrigation season (typically between April and October). This allows for water in Lake I to percolate and evaporate before the rainy season begins. In addition, the recycled water remaining in Lake I at the end of the irrigation season is diluted with 1.2 million gallons of potable water. Golf course staff reported that this practice was developed in partnership with the California Department of Health Services1 to minimize the potential for discharge of recycled water to surface waters.

GOLF COURSE AGRONOMIC WATER DEMANDS

Calculation Procedures

The steps and major assumptions used to determine the rate at which recycled water can be supplied to the golf course are described below.

Climate Data

Rainfall data reported by the Ione National Climate Data Center (NCDC) weather station #0442832 was used to define the average annual rainfall, 1-in-100-year annual rainfall, and the monthly distributions of rainfall, as follows:

- The average rainfall year was defined as having a total rainfall of 22.0 inches.
- The 1-in-100 rainfall year was defined as having a total rainfall of 41.1 inches.
- The monthly distributions were defined based on the 1906 to 1977 monthly Normal rainfall distribution values, with the Normal values being statistically determined values reported by the California Department of Water Resources (DWR).

DWR defined all of these values. This information on is documented in Attachment A and summarized in Table 2.

Reference evapotranspiration (ET) for each month is based on long-term monthly average ET values for the Plymouth California Irrigation Management Information System (CIMIS) Station #227, located approximately 13 miles northeast of the golf course. This information is documented in Attachment A of this TM and summarized in Table 2, along with the monthly total rainfall values for the average and 1-in-100 rainfall years.

[1] CDPH has since been incororpated into the State Water Board as the Division of Drinking Water (DDW).

Table 2. Applicable Climate Data

Month	Average Rainfall,[a] inches	1-in-100 Year Rainfall,[a] inches	Reference ET,[b] inches
October	1.15	2.15	3.24
November	2.81	5.24	1.68
December	3.54	6.58	1.21
January	5.09	9.48	1.48
February	3.14	5.86	1.95
March	3.20	5.95	3.02
April	1.75	3.26	4.57
May	0.63	1.18	5.97
June	0.23	0.43	7.19
July	0.07	0.13	7.64
August	0.13	0.24	6.98
September	0.33	0.62	4.99
Total	**22.1**	**41.1**	**49.9**

(a) NCDC weather station #044283
(b) Plymouth CIMIS station #227

Crop ET

Monthly crop ET values for the golf course were calculated by multiplying the reference ET values from Table 2 by a representative crop coefficient. Grasses grown on the golf course include:

- perennial rye grass
- poa annua
- creeping bent grass
- tall fescue
- Bermuda grass

Apart from Bermuda grass, all grasses used on the golf course are considered cool season grasses. Meyer and Gibeault at the University of California, Irvine report monthly crop coefficients for cool season grasses (see of Attachment B). The average of these reported monthly crop coefficients for April to October, calculated to be 0.88, was used as a representative crop coefficient for all months.

Pond ET

Monthly ET values for the storage pond Lake I were set equal to the respective monthly reference ET values.

Historical Recycled Water Demands

Evaluation of historical recycled water demands was based on the following:

- To properly maintain the golf course greens, recycled water is delivered to the COWRF and golf course solely based on golf course demands.
- Golf course flow data is tracked by golf course staff, and total monthly and annual flow volumes based on this data are shown in Table 3.
- The historical average volume of recycled water delivered was calculated for each calendar month and was used to calibrate and confirm the theoretical recycled water demand for the golf course.

Table 3. Historical Golf Course Recycled Water Demand

Month	Volume of Recycled Water Used, million gallons (MG)									Average, acre-feet
	2017	2018	2019	2020	2021	2022	2023	2024	Average	
October	16.5	8.4	16.7	14.5	8.2	9.1	11.9	20.3[(a)]	12.2	37.4
November	0	3.2	13.9	6.1	0	9.1	0	2.6[(a)]	5.3	16.4
December	0	0	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	0	0	0	0	0
April	0	0	0	1.1	12.7	8.1	0.9	0	2.9	8.8
May	18.1	19.1	15.1	14.1	25.2	12.1[(b)]	15.8	17.6	17.9	54.9
June	25.6	26.5	21.1	19.6	21.4	10.8[(b)]	22.0	28.3	23.5	72.2
July	29.4	29.0	27.2	26.6	31.7	20.4	25.1	28.3	27.2	83.6
August	29.1	29.8	26.5	25.8	23.3	21.0	22.0	26.1	25.5	78.1
September	23.0	24.1	24.1	16.2	9.0[(c)]	15.7	15.0	24.2	20.3	62.4
Total, MG	**141.7**	**140.2**	**144.6**	**123.9**	**131.5**	**106.3**	**118.1**	**147.5**	**134.8**	**413.8**

(a) Values excluded from average calculation. The COWRF influent flow meter failed on October 9, 2024 and COWRF staff requested that water be sent to the COWRF at a steady rate of 800 gallons per minute until the end of the irrigation season in mid-November. Therefore, during this period, there was less ability to match the effluent flows from the COWRF to golf course agronomic demands and it is not clear these are representative values.

(b) Values excluded from average calculation. There was limited recycled water supply available from ARSA during the period of May to June 2022 and the golf course was under-irrigated.

(b) Value is excluded from average because it is anomalous when compared with September recycled water use volumes of other years. Operations staff responsible for this data are not available to confirm its accuracy.

Theoretical Recycled Water Demands

Theoretical recycled water demands for the golf course were developed based on the following:

- Theoretical agronomic demands are calculated by multiplying the difference between the calculated monthly crop ET and monthly rainfall values by the total area of the golf course (130 acres) and dividing by an irrigation efficiency factor. For months with more precipitation than ET, the irrigation demand was set equal to zero.

- Irrigation efficiencies for solid set spray irrigation systems like that used on the golf course can range from 60 to 85 percent (see Attachment C, Table 8.2b). A calibration process, described in the next section, has been used to define the irrigation efficiency for this site.
- Theoretical evaporative losses from the storage ponds are calculated by multiplying the difference between the reference ET and monthly rainfall values by the total area of the impoundment.
- As noted previously, recycled water is only sent to and pumped from Lake I. Therefore, evaporative losses from only Lake I (3.1 acres) are included.
- Losses are calculated for months only when recycled water is delivered to the golf course.
- There have been no attempts to quantify percolation losses from Lake I. Therefore, percolation losses are assumed to be zero.
- Total theoretical recycled water demands are the sum of the theoretical monthly golf course agronomic demands and the theoretical monthly evaporative losses from Lake I.

Average Year Theoretical Recycled Water Demand Calibration

The site-specific irrigation efficiency factor used to calculate the theoretical irrigation demand is determined by adjusting the irrigation efficiency value used in the calculation of the average-year theoretical recycled water demand until the demand matches the historical recycled water supplied.

The resulting irrigation efficiency is 84 percent, on the upper end of the typical range for spray irrigation cited above. ***This calibration process demonstrates that the golf course irrigation system is very efficient and experiences limited losses.***

1-in-100 Year Recycled Water Demand

The 100-year theoretical recycled water demand is calculated using the procedures described above but applying 1-in-100-year rainfall values and retaining the 84 percent irrigation efficiency determined from the average year water balance.

Agronomic Water Demands

The calculated average rainfall year theoretical demand to be used in the water balance analysis is shown in Table 4. The calculated average 1-in-100-year theoretical demand to be used in the water balance analysis is shown in Table 5.

The historical data show irrigation demands in November, but the theoretical demands do not indicate a need for irrigation water in this month. This discrepancy likely reflects the fact that rainfall typically does not begin until late November in this area, while there are still irrigation demands earlier in the month. Despite this discrepancy, the annual theorical demand matches closely to the historical values for the average year. Therefore, the methodology applied provides an accurate estimate for purposes of developing an annual water balance for COWRF.

Table 4. Monthly Golf Course Recycled Water Demand for an Average Rainfall Year

Month	(1)	(2)	(3)	(4)	(5)	(6)
	Climate Values, inches		Historical Demand, acre-feet	Theoretical Average-Year Demand, acre-feet		
	Rainfall	Reference ET		Irrigation Demand	Pond Losses	Total Demand
October	1.15	3.24	37.4	21.9	0.5	22.4
November	2.81	1.68	16.4	0	0	0
December	3.54	1.21	0	0	0	0
January	5.09	1.48	0	0	0	0
February	3.14	1.95	0	0	0	0
March	3.20	3.02	0	0	0	0
April	1.75	4.57	8.8	29.3	0.7	30.0
May	0.63	5.97	54.9	59.6	1.4	61.0
June	0.23	7.19	72.2	78.6	1.8	80.4
July	0.07	7.64	83.6	85.8	2.0	87.8
August	0.13	6.98	78.1	77.5	1.8	79.3
September	0.33	4.99	62.4	52.4	1.2	53.6
Total, acre-feet per year (AFY)	**22.0**	**49.9**	**413.8**	**405.1**	**9.4**	**414.5**

Notes:
(1) 1906-1977 monthly rainfall normals for Ione NCDC weather station #044283
(2) Long-term monthly average reference ET from Plymouth CIMIS station #227
(3) Average of monthly irrigation volumes applied to the golf course from 2017 to 2024 from Table 3
(4) = (irrigated area of 130 acres) x [Column 2 x (crop coefficient of 0.88) - Column 1] / (irrigation efficiency of 0.84) / 12 inches/foot
(5) = (storage pond area of 3.1 acres) x (Column 2 - Column 1) / 12 inches per foot
(6) = Column 4 + Column 5

Table 5. Monthly Golf Course Recycled Water Demand for a 1-in-100 Rainfall Year

	(1)	(2)	(3)	(4)	(5)
	Climate Values, inches		Theoretical 100-Year Demand, acre-feet		
Month	Rainfall	Reference ET	Irrigation Demand	Pond Losses	Total Demand
October	2.15	3.24	9.0	0.3	9.3
November	5.24	1.68	0	0	0
December	6.58	1.21	0	0	0
January	9.48	1.48	0	0	0
February	5.86	1.95	0	0	0
March	5.95	3.02	0	0	0
April	3.26	4.57	9.8	0.3	10.1
May	1.18	5.97	52.5	1.2	53.7
June	0.43	7.19	76.1	1.7	77.8
July	0.13	7.64	85.0	1.9	86.9
August	0.24	6.98	76.1	1.7	77.8
September	0.62	4.99	48.6	1.1	49.7
Total, AFY	**41.1**	**49.9**	**357.1**	**8.2**	**365.3**

Notes:

(1) = 100-year return period annual total distributed monthly in proportion to 1906-1997 monthly Normals for Ione NCDC weather station #044283

(2) Long-term monthly average reference ET from Plymouth CIMIS station #227

(3) = (irrigated area of 130 acres) x [Column 2 x (crop coefficient of 0.88) - Column 1] / (irrigation efficiency of 0.84) / 12 inches per foot

(4) = (storage pond area of 3.1 acres) x (Column 2 - Column 1) / 12 inches/foot

(5) = Column 4 + Column 5

COWRF INFLUENT FLOWS

Calculation Procedures

The theoretical influent flow to the COWRF is calculated for each month using the following formula:

Golf Course Irrigation Demand/(1-backwash percentage)

The Golf Course Irrigation Demands were discussed in the previous section. The backwash percentages are calculated based on historical COWRF influent and backwash flow data, as described in the sections below.

Historical COWRF Influent Flows

Historical monthly influent flows to the COWRF are shown in Table 6. Influent flows beginning in April 2022 are reported in the monthly COWRF discharge monitoring reports (DMRs). Prior to 2022, COWRF DMRs did not present influent flows. However, the influent flows were determined from available golf course demand data and backwash flow data.[2]

Table 6. Historical COWRF Influent Flows

Month	Volume of COWRF Influent Flow, MG								
	2017	2018	2019	2020	2021	2022	2023	2024	Average
October	19.5	10.3	20.7	17.9	10.5	10.9	19.2	27.7[(a)]	17.1
November	0	4.8	15.8	7.8	0	11.3	9.3	4.0[(a)]	8.8
December	0	0	0	0	0	0	0	0	0
January	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0
March	0	0	0	0	0	2.0	0	0	2.0
April	0	0	0	0.9	14.4	12.7	2.1	0	7.5
May	20.4	21.6	17.1	16.8	29.1	14.0[(b)]	18.8	19.8	19.7
June	29.1	30.1	23.7	23.0	24.7	13.1[(b)]	25.8	32.0	25.2
July	34.1	33.5	31.2	30.2	35.7	23.1	29.5	32.1	31.2
August	33.3	36.9	33.3	30.1	27.0	23.2	27.4	32.3	30.3
September	27.1	27.7	28.1	20.2	11.2[(b)]	18.5	21.4	28.0	22.8
Total, MG	**163.4**	**164.9**	**169.7**	**146.7**	**152.7**	**128.8**	**153.5**	**174.7**	**164.5**

(a) Values excluded from this evaluation. The COWRF influent flow meter failed on October 9, 2024. Reported influent is an estimate of the actual flow received during this period.

(b) Although values reported in these months are not representative of typical influent flows (and thus irrigation demands), they are useful in determining the percentage of backwash flow generated. Therefore, these values are not excluded from this portion of the analysis.

[2] To determine influent flows prior to April 2022, monthly COWRF effluent flows from the DMRs were compared to golf course flows and filter backwash flows. If the reported COWRF effluent flow was larger than the golf course flow, it was confirmed to be actual influent flow by verifying that it was equal to the sum of the golf course influent flow and the filter backwash flow. If the reported COWRF effluent flow was equivalent to the golf course flow, the COWRF influent flow was calculated by summing the COWRF effluent flow and filter backwash flow. The 2017 COWRF influent flows were calculated by summing monthly golf course influent flows and filter backwash flows because COWRF DMRs were not available.

Historical COWRF Backwash Flows

Historical monthly filter backwash flows from the COWRF are shown in Table 7 .

Table 7. Historical COWRF Filter Backwash Flows

Month	Volume of COWRF Filter Backwash Flow, MG								
	2017	2018	2019	2020	2021	2022	2023	2024	Average
October	3.0	1.9	4.0	3.4	2.4	1.7	7.3[(a)]	5.0	3.1
November	0	1.1	1.9	1.7	0	2.3	4.1[(a)]	1.7	1.2
December	0	0	0	0	0	0	0	0	0.0
January	0	0	0	0	0	0	0	0	0.0
February	0	0	0	0	0	0	0	0	0.0
March	0	0	0	0	0	0	0	0	0.0
April	0	0	0	0	2.0	2.0	0.1	0	1.4
May	2.2	2.5	1.9	2.7	3.9	1.9	3.0	2.2	2.5
June	3.4	3.6	2.5	3.8	3.4	2.0	3.7	3.6	3.2
July	4.7	4.4	3.9	3.6	4.0	2.7	4.4	3.8	3.9
August	4.2	3.9	3.9	4.3	3.8	2.7	5.4[(a)]	5.1	4.0
September	4.1	3.5	4.0	4.0	2.6	2.2	6.4[(a)]	5.5	3.7
Total, MG	**21.7**	**20.9**	**22.1**	**23.4**	**21.9**	**17.5**	**34.4**	**26.8**	**23.5**

(a) Values were not used in calculated average. Operations staff were performing excessive backwashing of the filters. This practice has since ceased.

Filter Backwash Flow Percentages

The percentage of COWRF influent flow that was discarded as backwash flow to the WWTF each month was calculated by dividing the backwash flow by the influent flow. Table 8 shows the results of this calculation. From the percentages shown, a monthly average was calculated. Monthly average backwash percentages range from 13 to 20 percent.

Table 8. Historical COWRF Filter Backwash Flow Percentage

Month	Filter Backwash Flow as a Percentage of Influent Flow, percent								
	2017	2018	2019	2020	2021	2022	2023	2024	**Average**
October	15	18	19	19	23	16	38[(a)]	18[(b)]	**18**
November	-[(c)]	23	12	22	-	20	44[(a)]	41[(b)]	**19**
December	-	-	-	-	-	-	-	-	**-**
January	-	-	-	-	-	-	-	-	**-**
February	-	-	-	-	-	-	-	-	**-**
March	-	-	-	-	-	-	-	-	**-**
April	-	-	-	-	14	16	7[(d)]	-	**15**
May	11	12	11	16	13	13	16	11	**13**
June	12	12	11	16	14	15	15	11	**13**
July	14	13	13	12	11	12	15	12	**13**
August	13	11	12	14	14	12	20[(a)]	16	**13**
September	15	13	14	20	23	12	30[(a)]	20	**17**

(a) Values were not used in calculated average. Operations staff were performing excessive backwashing of the filters. This practice has since ceased.

(b) Values excluded from this evaluation. The COWRF influent flow meter failed on October 9, 2024. Reported influent is an estimate of the actual flow received during this period.

(c) "-" indicate there were no flows to the COWRF during this period.

(d) The backwash percentage during April 2023 was abnormally low. Influent flow to the COWRF began six days before the end of the month and effluent and backwash were only discharged on two of the six days. This value was not used in the calculated average.

Theoretical COWRF Influent Flow

The calculated average rainfall year theoretical flow to the COWRF to be used in the water balance analysis is shown in Table 9. The calculated average 1-in-100-year theoretical flow to the COWRF to be used in the water balance analysis is shown in Table 10.

Table 9. Monthly COWRF Influent Demand for an Average Rainfall Year

Month	Average-Year Golf Course Recycled Water Demand,[a] acre-feet	COWRF Backwash Flow as a Percentage of Influent Flow,[b] percent	Average-Year COWRF Influent Flow,[c] acre-feet
October	22.4	18	27.3
November	0	19	0
December	0	-	0
January	0	-	0
February	0	-	0
March	0	-	0
April	30.0	15	35.3
May	61.0	13	70.1
June	80.4	13	92.4
July	87.8	13	100.9
August	79.3	13	91.1
September	53.6	17	64.6
Total, AFY	**414.5**	**-**	**481.7**

(a) From Table 4, Column 6
(b) From Average column in Table 8
(c) = Column 1/(1 - Column 2)

Table 10. Monthly COWRF Influent Capacity for a 1-in-100 Rainfall Year

Month	1-in-100-Year Golf Course Recycled Water Demand,[a] acre-feet	COWRF Backwash Flow as a Percentage of Influent Flow,[b] percent	1-in-100-Year COWRF Influent Flow,[c] acre-feet
October	9.3	18	11.3
November	0	19	0
December	0	-	0
January	0	-	0
February	0	-	0
March	0	-	0
April	10.1	15	11.9
May	53.7	13	61.7
June	77.8	13	89.4
July	86.9	13	99.9
August	77.8	13	89.4
September	49.7	17	59.9
Total, AFY	**365.3**	**-**	**423.5**

(a) From Table 5, Column 5
(b) From Average column in Table 8
(c) = Column 1 / (1 - Column 2)

Theoretical COWRF Backwash Percentages and Flows

A calculated theoretical backwash flow from the COWRF to the WWTF will be used in the water balance analysis for the WWTF, based on the influent flows from Table 9 and Table 10 and average historical backwash flow percentages by month from Table 8. The theoretical COWRF backwash flow for an average rainfall year is shown in Table 11. The theoretical COWRF backwash flow for a 1-in-100 rainfall year is shown in Table 12.

Table 11. Monthly COWRF Backwash Flow for an Average Rainfall Year

Month	Average-Year COWRF Influent Flow,[a] acre-feet	COWRF Backwash Flow as a Percentage of Influent Flow,[b] percent	Average-Year COWRF Backwash to WWTF,[c] acre-feet
October	27.3	18	4.9
November	0	19	0
December	0	-	0
January	0	-	0
February	0	-	0
March	0	-	0
April	35.3	15	5.3
May	70.1	13	9.1
June	92.4	13	12.0
July	100.9	13	13.1
August	91.1	13	11.8
September	64.6	17	11.0
Total, AFY	**481.7**	**-**	**67.2**

(a) From Table 9
(b) From Table 8
(c) = Column 1 x Column 2

Table 12. Monthly COWRF Backwash Flow for a 1-in-100 Rainfall Year			
Month	1-in-100-Year COWRF Influent Flow,[(a)] acre-feet	COWRF Backwash Flow as a Percentage of Influent Flow,[(b)] percent	1-in-100-Year COWRF Backwash to WWTF,[(c)] acre-feet
October	11.3	18	2.0
November	0	19	0
December	0	-	0
January	0	-	0
February	0	-	0
March	0	-	0
April	11.9	15	1.8
May	61.7	13	8.0
June	89.4	13	11.6
July	99.9	13	13.0
August	89.4	13	11.6
September	59.9	17	10.2
Total, AFY	**423.5**	**-**	**58.2**

(a) From Table 10
(b) From Table 8
(c) = Column 1 x Column 2

GOLF COURSE TAILWATER AND OVERSPRAY CONTROL AND MONITORING

This section provides information about Best Management Practices (BMPs) and monitoring for tailwater and overspray control from the golf course. The following topics are addressed:

- Golf Course Field Monitoring
- Golf Course Best Management Practices
- Golf Course Storage Pond Monitoring

Golf Course Field Monitoring

The City, in coordination with the golf course management, is required to perform daily, weekly, and monthly monitoring of the golf course when recycled water is being applied, as outlined in the WRR's Monitoring and Reporting Program (MRP). These requirements are summarized in Table 13. In addition to the elements outlined below, the daily inspections must note any evidence of erosion, field saturation, runoff or the presence of nuisance conditions.

The MRP was adopted December 21, 2021, and did not become effective until after the end of the 2021 irrigation season. Since its adoption, the MRP requirements related to the golf course operations shown in Table 13 have not been satisfied. The City and golf course staff are currently developing the protocols to implement this monitoring and will initiate the program beginning in the 2025 irrigation season.

Table 13. Golf Course Monitoring Requirements				
Constituent	Units	Type of Sample	Sampling Frequency	Reporting Frequency
Flow	gallons	Continuous	Daily	Monthly
Rainfall[a]	inches	Measurement		
Acreage Applied[b]	acres	Calculated		
Tailwater Runoff Observation	--	Observation		

(a) As measured at the weather station nearest to the disposal site.
(b) Specific disposal fields shall be identified.

Flow

Currently, golf course staff monitor the daily total flow that is applied to the golf course. This flow is measured from the irrigation pump station and recorded in the golf course's central computer system. The measurement can be reported in up to 15-minute increments. Golf course staff report the daily total flows to the City.

Rainfall

Rainfall collects in a plastic rain gage located at the maintenance yard, and golf course staff manually read the gage daily at approximately the same time of day. That measurement is compared to a reported weather station located in the nearby City of Jackson to confirm its accuracy. The onsite, measured rainfall data is reported to the City.

Acreage Applied

The golf course's central computer system has the ability report the areas that are watered each night. These areas are grouped and reported by area category according to the type of plant that is watered. The area categories are:

- Greens
- Tees
- Fairway
- Perimeter
- Rough
- Club House
- Driving Range
- Putting Green

Irrigation generally occurs on all areas of the golf course simultaneously. In rare instances an area category may be watered alone. Starting with the 2025 irrigation season, golf course staff will report the acreage that is watered daily and include that information in the flow report provided to the City monthly.

Tailwater Runoff Observation Monitoring

Starting with the 2025 irrigation season, City staff will inspect the golf course daily for evidence of runoff and overspray. These inspections will occur in the morning, just after irrigation occurs. During these inspections, special attention will be paid to the following five vulnerable areas, which have the most potential for recycled water to escape the use area:

- Castle Oaks Clubhouse
- Areas abutting Mule Creek
- Spyglass Drive near the Irrigation Pump Station
- Castle Oaks Drive and Shakeley Lane intersection
- Near the bathroom by Vista Lane

Monitoring each location will be done through an observatory drive by each location in the early morning. Evidence of runoff or overspray includes wet areas on hardscape sidewalks and roadways surrounding the extents of the landscaped area. If these areas are wet or water appears to be draining from landscape into the gutters, the irrigation system should be further investigated for problems. Inspection logbook entries for the golf course monitoring will be submitted with the monthly monitoring reports.

Golf Course Best Management Practices

Overspray and runoff of recycled water from the use area is minimized and controlled through the implementation of BMPs. Spray irrigation systems are vulnerable to inefficiencies related to runoff or overspray caused by pressure fluctuations, wind, or equipment malfunction. If any part of the system is not working optimally, the result is a less uniform application of water which increases the likelihood of water escaping the recycled water use area. Even the most efficiently designed system must be maintained and constantly monitored to mitigate system avoid problems.

The COWRF BMP strategies include engineered controls and mechanisms to minimize runoff or overspray and practices to improve the application of water to a use area. Specific BMPs employed to control for runoff or overspray include:

- Irrigation is ceased during extended and extensive windy periods.
- Irrigation is avoided when the soil is saturated to prevent runoff.
- All sprinkler heads are uniform in brand, model and nozzle size to apply water as uniformly across the plant material as possible.
- A minimum four-foot distance from neighboring backyards and buildings is maintained as practical throughout areas of the golf course. This has been done through head removal, spray range or arc reduction or elimination of a zone. In areas where the four-foot buffer cannot be maintained and irrigated turf is desired, such as near a tee, hole or walkways, the irrigation water is applied with lower impact heads with a smaller arc radius.
- Irrigation occurs in the evening or early morning hours to avoid public interaction, reduce evaporative loses, and take advantage of calmer wind patterns.
- Good horticultural practices are performed including, mowing, de-thatching, aeration, and pest control as necessary to increase the plant and soil water absorbance.
- Irrigation is applied as close as practical to match the amount of water lost through ET and the soil needs.

- Duration of water application is applied to match percolation rates to reduce runoff.
- Installation of low angle heads have been installed in areas near residential backyards to reduce mist from wind drift of spray.
- Tall plants are present along edges and perimeters to create a plant buffer.
- Regular maintenance is performed of the irrigation system which includes inspecting and repairing leaks.

Golf Course Storage Pond Monitoring

Monitoring of irrigation storage ponds when they contain recycled water is also required under the MRP. These requirements are summarized in Table 14.

Table 14. Golf Course Storage Pond Monitoring Requirements

Constituent	Units	Type of Sample	Sampling Frequency	Reporting Frequency
Freeboard	feet	Measurement	Twice Weekly – 3 days apart	Monthly
Odors	--	Observation	Weekly	
Dissolved Oxygen	milligrams per liter	Grab	Weekly	
pH	pH units	Grab	Monthly	

Similar to the irrigation area, the MRP requirements related to the ponds have not been consistently satisfied. The City and golf course staff are currently developing the protocols to implement this monitoring and will initiate the program beginning in the 2025 irrigation season.

Freeboard

The MRP requires the freeboard be monitored as the difference between the top of the bank of the storage pond to the level of the water. This measurement provides the City with confidence that recycled water cannot escape the storage pond containment area. However, as noted previously, each pond is equipped with a standpipe that serves as an overflow structure. Therefore, it is more appropriate to monitor freeboard as the difference between the top of the overflow structure to the top of the water surface.

Currently, the City has the ability to measure the freeboard of Lake A by means of a level monitoring rod. This capability is not set up in Lakes B through I. Lake I is manually kept at a level that is below the 12-inch overflow standpipe that conveys overflow water to a wetland area that eventually flows to Mule Creek. Prior to the start of the 2025 irrigation season, the City will need to install a level monitoring rod in each pond so that freeboard can be measured.

In addition, the City will employ the following monitoring practices in the 2025 irrigation season:

- Twice a week during the irrigation season, each storage pond should be observed, and freeboard monitored.
- For Pond I, it is expected that there will be recycled water present in the pond throughout the irrigation season and this pond should be monitored during each bi-weekly event.

- Recycled water is occasionally directed to Pond A. Therefore, this pond will be inspected as part of the bi-weekly monitoring. If there is standing water present in Pond A, then monitoring of this pond will be completed.
- If there is any evidence that Pond A has overflowed to Pond B (or any downstream pond) via the pond standpipes, then monitoring of the downstream ponds will also be performed.
- City staff will be responsible for making the appropriate observations to determine whether recycled water is being stored in any of the ponds.
- Golf course staff will provide information to the City regarding where COWRF flows are directed. Specifically, the monthly reports provided to the City will include information about which pond was receiving flow on each day.

Odors

The City is required to evaluate if any objectionable odors are being emitted from the storage ponds once every week. This will be needed for each pond that holds recycled water.

Dissolved Oxygen and pH

The City is required to collect and measure the dissolved oxygen and pH in a grab sample collected from each recycled water storage pond weekly. These measurements can be made using field test instruments provided that:

- The operator is trained in proper use and maintenance of the instruments,
- The instruments are field calibrated at the frequency recommended by the manufacturer,
- The instruments are serviced and/or calibrated at the manufacturer's recommended frequency, and
- Field calibration reports are maintained and a calibration log verifying calibration of all handheld monitoring instruments and devices are submitted with the monthly monitoring report.

Attachment A

Rainfall and Reference ET Data

IONE, CALIFORNIA (044283)

Period of Record Monthly Climate Summary

Period of Record : 03/01/1906 to 06/30/1977

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)					Insuff	icient	Data						
Average Min. Temperature (F)					Insuff	icient	Data						
Average Total Precipitation (in.)	5.08	3.14	3.19	1.75	0.63	0.23	0.07	0.13	0.33	1.15	2.81	3.53	22.04
Average Total SnowFall (in.)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Percent of possible observations for period of record.
Max. Temp.: 0% Min. Temp.: 0% Precipitation: 99.9% Snowfall: 99.9% Snow Depth: 99.8%
Check Station Metadata or Metadata graphics for more detail about data completeness.

Western Regional Climate Center, wrcc@dri.edu

D

Rainfall Depth Duration Frequency at Ione

Station Number	Station	County	Latitude	Longitude	Elevation	Years Recorded
B00 4283 00	Ione	Amador	38.348	-120.938	284.0	89

Rainfall Statistics	1-Day	2-Day	3-Day	4-Day	5-Day	6-Day	8-Day	10-Day	15-Day	20-Day	30-Day	60-Day	1-Year
Pr=0.5	1.92	2.55	3.01	3.38	3.70	3.99	4.48	4.91	5.79	6.51	7.68	10.19	21.28
Pr=0.2	2.55	3.37	3.98	4.47	4.89	5.27	5.92	6.48	7.64	8.58	10.11	13.39	27.84
Pr=0.1	2.92	3.87	4.55	5.11	5.60	6.02	6.76	7.40	8.71	9.78	11.52	15.23	31.54
Pr=0.04	3.36	4.44	5.22	5.86	6.40	6.89	7.73	8.45	9.94	11.16	13.13	17.32	35.70
Pr=0.02	3.66	4.83	5.67	6.36	6.96	7.48	8.39	9.17	10.78	12.09	14.22	18.74	38.51
Pr=0.01	3.94	5.19	6.10	6.84	7.47	8.04	9.01	9.84	11.57	12.97	15.23	20.06	41.11
Pr=0.005	4.21	5.54	6.51	7.29	7.96	8.56	9.59	10.48	12.31	13.79	16.19	21.31	43.57
Pr=0.002	4.54	5.97	7.01	7.85	8.58	9.22	10.33	11.28	13.23	14.82	17.40	22.87	46.64
Pr=0.001	4.79	6.29	7.38	8.26	9.02	9.69	10.85	11.85	13.90	15.57	18.26	23.99	48.84
Pr=0.0001	5.53	7.26	8.50	9.52	10.39	11.15	12.48	13.62	15.96	17.87	20.94	27.46	55.66

Annual Maxima	1-Day	2-Day	3-Day	4-Day	5-Day	6-Day	8-Day	10-Day	15-Day	20-Day	30-Day	60-Day	1-Year
2007	---	---	---	---	---	---	---	---	---	---	---	---	---
2006	---	---	---	---	---	---	---	---	---	---	---	---	---
2005	---	---	---	---	---	---	---	---	---	---	---	---	---
2004	---	---	---	---	---	---	---	---	---	---	---	---	---
2003	---	---	---	---	---	---	---	---	---	---	---	---	---
2002	---	---	---	---	---	---	---	---	---	---	---	---	---
2001	---	---	---	---	---	---	---	---	---	---	---	---	---
2000	1.85	2.80	4.29	4.74	4.99	4.99	5.22	5.79	7.52	9.05	10.35	11.82	21.39
1999	2.02	2.44	3.42	3.42	3.42	3.42	3.42	4.17	5.51	5.72	8.41	10.90	15.39
1998	2.37	3.55	4.11	4.36	4.98	5.85	6.61	7.31	8.07	10.05	14.21	21.25	30.46
1997	2.37	3.55	4.11	4.36	4.98	5.85	6.61	7.31	8.07	10.05	14.21	21.25	43.59
1996	3.75	3.85	3.85	3.85	3.85	3.85	3.85	3.85	4.74	5.27	6.16	11.53	22.80
1995	2.90	4.71	5.05	5.33	5.58	5.71	7.45	8.02	9.08	9.83	12.42	16.90	35.50
1994	1.27	1.70	1.95	2.05	2.15	2.42	2.55	2.55	3.45	3.67	5.27	5.87	15.52
1993	1.81	2.26	2.26	2.84	3.18	4.50	4.91	5.13	7.10	7.52	10.16	16.58	29.21
1992	2.30	3.18	3.18	3.24	4.11	5.17	5.97	6.06	6.98	7.16	9.13	10.62	20.43
1991	1.60	2.28	2.88	3.52	3.52	3.52	4.08	5.15	6.28	7.38	10.07	11.94	16.59
1990	1.82	2.35	2.37	2.37	2.37	2.37	2.37	2.37	2.90	2.90	3.33	6.23	17.33
1989	1.05	1.90	2.05	2.06	2.26	2.41	2.52	2.82	3.36	3.75	5.85	7.67	16.85
1988	1.55	1.90	1.90	1.90	1.90	1.90	2.05	2.13	2.75	3.47	4.78	6.57	11.67
1987	1.81	2.43	2.54	2.54	2.87	2.87	3.38	3.62	3.62	5.31	5.31	9.80	13.86
1986	2.75	4.85	5.65	6.65	6.85	6.95	7.90	8.00	8.00	9.45	12.97	18.47	33.02
1985	---	---	---	---	---	---	---	---	---	---	---	---	17.93
1984	---	---	---	---	---	---	---	---	---	---	---	---	23.39
1983	---	---	---	---	---	---	---	---	---	---	---	---	41.81
1982	---	---	---	4.62	5.24	5.24	5.53	5.53	7.29	8.43	9.95	15.59	39.56
1981	2.04	2.94	3.80	4.17	4.32	5.01	6.02	6.02	6.21	6.21	6.62	11.24	17.15
1980	---	---	---	---	---	---	---	---	---	---	---	---	26.42

1979	1.54	2.28	2.83	3.82	3.82	3.82	4.02	4.97	5.49	6.53	7.09	12.65	20.87
1978	1.54	2.28	2.83	3.82	3.82	3.82	4.02	4.97	5.49	6.53	7.09	12.65	20.87
1977	0.92	1.03	1.09	1.12	1.12	1.12	1.24	1.26	1.26	1.26	2.18	3.32	8.73
1976	0.78	1.23	1.70	1.70	1.91	2.06	2.06	2.06	2.18	3.21	3.73	5.00	11.87
1975	1.97	2.56	3.14	3.27	3.38	3.52	4.84	6.08	7.82	8.47	8.50	15.06	28.24
1974	---	---	---	---	---	---	---	---	---	---	---	---	33.80
1973	2.48	2.76	3.51	4.54	4.86	4.86	6.09	7.38	8.60	9.26	12.09	19.82	35.95
1972	3.05	3.88	3.92	3.98	3.98	5.03	5.90	5.96	6.05	6.73	7.92	9.62	16.80
1971	3.05	4.40	5.02	5.13	6.25	6.57	6.57	7.61	8.20	8.22	9.81	13.34	21.20
1970	2.94	2.94	3.48	3.48	3.72	3.72	4.97	5.90	6.37	7.01	9.55	12.27	21.13
1969	2.75	3.15	3.15	3.23	3.31	3.54	5.63	6.09	8.33	8.80	9.89	16.66	30.23
1968	1.76	2.12	2.12	2.43	2.43	2.48	2.51	3.20	3.20	3.49	4.61	8.77	17.12
1967	2.52	4.13	4.15	4.63	4.97	4.99	5.38	6.53	7.36	7.36	7.89	11.44	29.07
1966	1.79	1.95	2.46	2.48	3.27	3.74	4.03	4.13	5.17	5.17	5.17	9.69	16.47
1965	---	3.43	---	---	---	---	---	7.18	8.10	---	---	---	25.01
1964	1.98	2.44	2.86	3.06	3.06	3.06	3.25	3.45	5.45	6.58	6.84	9.13	18.12
1963	2.88	3.52	4.20	4.65	4.65	4.65	4.65	4.65	6.07	6.38	6.38	10.35	24.44
1962	1.25	2.08	2.93	3.02	4.05	4.53	6.47	7.17	7.61	7.75	9.09	11.98	18.00
1961	1.38	1.68	2.16	2.16	2.16	2.26	2.40	2.77	2.93	3.23	4.81	6.51	13.82
1960	1.33	1.53	1.86	1.86	2.09	2.42	2.82	3.25	3.67	5.03	6.18	7.86	16.68
1959	1.65	2.09	2.09	2.55	2.88	3.22	3.68	4.01	4.01	4.75	6.13	10.54	13.45
1958	---	---	---	---	---	---	---	---	---	---	---	---	41.69
1957	---	---	---	---	---	---	---	---	---	---	---	---	18.93
1956	---	---	---	---	---	---	---	---	---	---	---	---	28.58
1955	---	---	---	---	---	---	---	---	---	---	---	---	18.28
1954	---	---	---	---	---	---	---	---	---	---	---	---	16.40
1953	---	---	---	---	---	---	---	---	---	---	---	---	15.10
1952	2.21	3.15	3.68	3.77	3.77	3.77	3.77	4.06	4.68	6.56	7.47	13.11	27.05
1951	4.65	5.30	5.30	5.30	5.55	5.70	6.24	6.25	6.25	8.87	10.85	14.60	28.76
1950	2.70	2.70	2.70	3.97	3.97	3.97	3.97	5.05	5.05	5.55	9.52	10.41	18.30
1949	1.76	2.71	3.14	3.14	3.14	3.14	3.72	3.86	4.87	5.45	6.93	10.49	17.23
1948	1.28	1.41	1.70	1.83	2.03	2.03	2.43	2.43	4.08	4.39	6.67	8.68	17.76
1947	2.16	3.12	3.20	3.20	3.91	3.91	3.91	4.13	4.13	4.13	4.82	7.33	14.54
1946	1.90	1.90	3.20	3.38	4.37	4.98	5.16	5.42	5.70	6.31	7.49	11.80	20.14
1945	2.68	3.88	4.78	4.78	4.98	5.27	5.27	5.27	5.66	5.66	5.66	9.58	23.66
1944	2.25	2.41	2.53	2.53	3.23	3.39	3.93	4.28	5.68	5.68	7.47	10.20	19.25
1943	2.05	2.78	3.58	3.81	4.43	4.77	5.38	5.42	7.10	8.03	10.13	15.90	27.61
1942	2.00	3.48	4.20	4.60	5.32	5.81	5.91	5.91	7.68	8.17	8.17	12.92	26.67
1941	1.85	2.40	2.46	3.46	5.46	5.46	4.17	4.52	7.17	8.59	11.13	14.00	25.17
1940	1.65	2.72	3.46	3.76	4.20	4.79	5.24	5.54	5.95	6.00	8.96	16.37	24.86
1939	1.72	2.40	2.55	2.80	2.80	2.80	2.80	2.80	2.80	3.17	3.42	5.93	14.01
1938	2.30	3.65	4.05	4.55	4.80	4.80	5.25	6.95	9.40	10.35	12.10	16.00	27.25
1937	4.40	4.65	5.85	6.15	6.60	6.95	7.70	8.15	8.70	9.50	10.10	19.90	34.99
1936	2.00	2.30	3.50	4.20	4.35	4.50	6.05	6.40	10.33	10.33	13.28	19.99	28.29
1935	2.50	2.72	2.72	2.72	3.25	4.30	4.52	4.52	5.22	5.65	6.35	9.47	23.94
1934	1.70	2.85	2.85	4.05	4.52	4.52	4.52	4.52	4.52	6.40	8.77	9.67	17.86

1933	1.20	1.72	1.72	1.72	2.32	3.12	3.12	3.82	3.82	3.82	5.07	7.87	12.77
1932	1.75	1.92	2.59	3.58	3.75	3.80	4.49	4.97	5.58	5.88	6.60	10.05	19.99
1931	1.65	1.65	1.65	2.53	2.53	2.53	2.65	2.65	2.65	2.65	3.92	6.39	12.62
1930	1.39	2.25	2.25	2.57	2.57	2.78	3.35	3.71	5.17	5.33	5.62	10.86	17.07
1929	1.91	2.98	3.49	3.49	3.49	3.49	3.49	3.57	4.07	4.07	4.07	6.57	15.52
1928	1.68	2.60	3.40	4.06	4.79	4.92	4.92	4.92	5.92	6.10	6.27	9.09	18.80
1927	1.50	3.00	3.00	4.25	4.25	4.51	5.46	5.96	6.26	6.91	7.41	10.51	24.11
1926	2.55	2.80	2.90	3.55	3.55	4.55	5.10	5.10	6.48	8.99	10.04	10.29	21.54
1925	1.95	3.05	3.27	3.27	3.52	3.74	4.27	5.79	5.94	7.79	8.41	11.84	28.60
1924	1.35	1.35	1.35	1.35	1.35	1.35	1.35	1.35	2.35	3.00	3.00	4.95	10.50
1923	2.20	3.00	4.30	5.30	5.30	5.30	5.50	6.10	6.70	6.70	9.30	14.15	26.07
1922	2.17	2.52	3.45	3.95	3.95	3.95	3.95	4.44	7.09	7.16	9.46	14.80	24.30
1921	3.85	3.95	4.50	4.72	4.72	4.72	4.72	5.72	6.62	7.02	7.72	13.51	26.57
1920	2.10	3.55	3.90	4.05	4.20	4.20	4.20	4.31	4.82	5.19	7.04	9.26	15.46
1919	2.25	3.55	3.90	4.00	4.05	4.40	4.60	4.70	5.00	6.45	8.15	10.35	18.75
1918	1.60	2.35	2.35	2.35	3.45	4.25	4.70	4.70	6.50	6.50	8.10	11.30	15.50
1917	1.30	2.30	2.60	2.90	3.25	3.55	4.10	4.35	4.55	4.55	5.35	7.25	17.70
1916	---	---	---	---	---	---	---	---	---	---	---	---	20.00
1915	1.50	1.95	2.15	2.30	2.83	3.03	3.88	4.20	5.88	6.20	7.77	10.87	22.80
1914	2.26	3.11	3.49	3.61	3.99	3.99	3.99	4.48	5.47	6.96	9.81	13.52	22.90
1913	1.20	1.84	2.22	2.72	2.95	3.36	3.36	3.55	4.01	4.01	4.01	4.86	14.26
1912	0.69	1.04	1.15	1.22	1.30	1.45	1.86	2.16	2.47	2.86	3.43	5.36	12.68
1911	2.17	3.57	5.27	6.12	6.45	7.30	7.80	8.42	10.82	15.51	18.06	24.30	30.46
1910	2.00	3.00	3.00	3.45	3.88	3.88	3.93	3.93	4.00	4.69	5.92	8.90	20.89
1909	1.45	2.60	3.80	4.42	4.54	5.07	5.99	6.39	7.99	9.21	12.66	19.24	26.01
1908	1.30	1.60	1.60	1.78	1.78	1.78	1.83	3.03	3.63	3.63	5.51	9.04	14.27
1907	4.37	6.79	7.38	7.53	8.38	8.53	8.53	8.53	8.53	10.60	12.20	18.04	33.82
1906	2.40	2.54	3.22	3.62	3.85	3.85	3.85	5.03	7.47	9.20	10.45	15.43	30.93
1905	2.90	2.90	2.90	3.20	4.20	4.20	4.55	4.85	5.55	5.55	5.50	9.65	25.95
1904	1.51	2.62	3.12	3.15	3.15	3.25	3.75	4.86	6.07	6.42	7.20	12.05	21.42
1903	1.85	2.92	3.58	4.10	5.01	5.03	5.03	5.53	5.53	7.54	9.71	10.34	22.39
1902	1.21	1.79	2.09	2.61	3.01	3.41	3.87	4.41	5.03	6.03	7.72	9.29	20.19
1901	2.05	2.79	3.61	4.03	4.03	4.72	5.54	5.52	5.54	7.35	7.69	11.29	25.48
1900	1.85	2.34	2.41	2.80	2.86	2.86	2.86	3.88	4.82	5.66	6.45	9.69	21.51
1899	1.93	2.56	3.20	3.54	4.04	4.04	4.94	7.17	7.80	7.93	9.00	9.22	20.03
1898	3.60	4.47	4.64	4.64	4.64	4.64	4.64	4.76	5.11	5.11	5.23	7.30	13.77
1897	---	---	---	---	---	---	---	---	---	---	---	---	---
1896	---	---	---	---	---	---	---	---	---	---	---	---	---
1895	---	---	---	---	---	---	---	---	---	---	---	---	---
1894	---	---	---	---	---	---	---	---	---	---	---	---	---
1893	---	---	---	---	---	---	---	---	---	---	---	---	---
1892	---	---	---	---	---	---	---	---	---	---	---	---	---
1891	---	---	---	---	---	---	---	---	---	---	---	---	---
1890	---	---	---	---	---	---	---	---	---	---	---	---	---
1889	---	---	---	---	---	---	---	---	---	---	---	---	---
1888	---	---	---	---	---	---	---	---	---	---	---	---	---

Monthly Average ETo Report

California Irrigation Management Information System (CIMIS)

Rendered in ENGLISH Units.

Printed on Wednesday, August 31, 2022

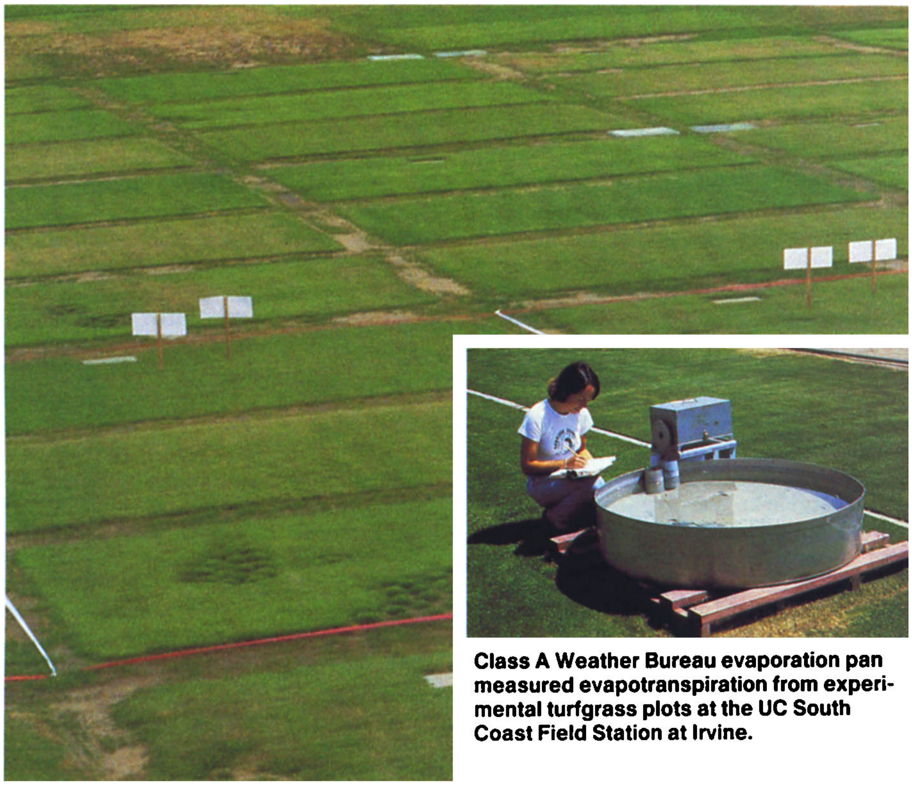
Average ETo Values by Station

Stn Id	Stn Name	CIMIS Region	Jan (in)	Feb (in)	Mar (in)	Apr (in)	May (in)	Jun (in)	Jul (in)	Aug (in)	Sep (in)	Oct (in)	Nov (in)	Dec (in)	Total (in)
227	Plymouth	SFH	1.48	1.95	3.02	4.57	5.97	7.19	7.64	6.98	4.99	3.24	1.68	1.21	49.92

CIMIS Region Abbreviations		
BIS - Bishop	CCV - Central Coast Valleys	ICV - Imperial/Coachella Valley
LAB - Los Angeles Basin	MBY - Monterey Bay	NCV - North Coast Valleys
NEP - Northeast Plateau	SAV - Sacramento Valley	SBE - San Bernardino
SFB - San Francisco Bay	SJV - San Joaquin Valley	SFH - Sierra Foothill
SCV - South Coast Valleys		

Attachment B

Turfgrass Performance Under Reduced Irrigation
Meyer and Gibeault



Class A Weather Bureau evaporation pan measured evapotranspiration from experimental turfgrass plots at the UC South Coast Field Station at Irvine.

Turfgrass performance under reduced irrigation

Jewell L. Meyer □ Victor A. Gibeault

Turfgrass in California requires irrigation during all or most of the year. Water restrictions imposed during the drought in 1976 and 1977 forced turf managers to reexamine many concepts about irrigation. Turfgrass managers had to make drastic cuts in water use and hope that the turf would survive. One significant result of the drought was the realization that lower levels of turf quality were acceptable in many situations and that large water savings could be achieved. No information was available, however, on the best conservation practices or on the minimum amounts of water needed to keep the turf alive.

Research was begun in 1979 to produce irrigation methodology that could be used to develop water-saving irrigation practices anywhere in California and in other arid and semiarid regions. The three-year study showed that major savings of water can be achieved, especially with warm-season grasses, with no appreciable loss of turf quality.

Turf-irrigation study

Specifically, the objectives of the research were to: (1) investigate the effects of applying reduced amounts of irrigation water calculated as a percentage of evapotranspiration of applied water on cool-season and warm-season turfgrasses; (2) evaluate a below-ground system as a potentially more efficient method of turf irrigation than standard sprinkler application; and (3) develop a set of crop coefficients that California turfgrass managers can use to determine on-site water use by both cool- and warm-season turfgrasses.

The study was conducted at the University of California South Coast Field Station, Irvine. The variables tested included: two irrigation methods, sprinkler application of water and a subterranean or buried trickle/drip water application (8-inch depth, 23-inch spacing); three irrigation regimes, 100, 80, and 60 percent of calculated evapotranspiration; and six commonly used turfgrasses, three cool-season varieties (Kentucky bluegrass, perennial ryegrass, and tall fescue) and three warm-season types (hybrid bermudagrass, zoysiagrass, and Seashore Paspalum).

The field plot was a randomized split-block design. The area was divided into two turf blocks, one for cool-season grasses and the other for warm-season grasses. Each block consisted of four replications, and within each replication were six randomized irrigation plots measuring 15 by 24 feet. Irrigation plots were divided into three turf subplots of 8 by 15 feet. The three sprinkler and three subterranean irrigation plots per replication were installed in September 1979 for above- and below-ground water application. Each sprinkler irrigation plot contained six high-pop brass sprinkler heads designed to apply 10 gallons of water per minute at a pressure of 35 pounds per square inch. The coefficient of uniformity was 87 percent.

Tensiometers at 3- and 6-inch depths in the cool-season grasses and 8- and 12-inch depths in the warm-season grasses indicated soil water status; neutron probe access tubes were installed in plots to a depth of 4 feet in the cool-season and 6 feet in the warm-season grasses. Scheduling was by the water budget technique calculated weekly using wind-modified pan evaporation data. State-of-the-art controllers were programmed with this irrigation scheduling information. The amount of irrigation was modified so that water did not pass below the 4-foot and 6-foot depths of the neutron probe access tubes during the irrigation season.

Annual crop coefficients, determined from previous research using applied water and evaporation pan data, were 0.7 annually for warm-season grasses and 0.8 for cool-season grasses. Monthly crop coefficients were developed in this experiment to evaluate responses of the six turfgrass species to 60 percent and 80 percent of replacement evapotranspiration for water conservation.

Turf performance

Overhead sprinkler irrigation provided acceptable performance of some turfgrass species, even when less than the optimum amount of water was applied. Subterranean irrigation did not provide acceptable turf with the shallow-rooted cool-season species, at the system depth and spacing used in this study. The very deeply rooted hybrid bermudagrass was the best-performing species with subterranean irrigation.

Under sprinkler irrigation, there was no significant difference in cool-season grass performance between the 100 percent and 80 percent regimes (table 1). This could be described as a potential level of water conservation amounting to 21.1 percent savings (77.2 inches versus 61 inches). The savings could be tenuous, however, because of more weed and disease activity (such as Gerlachia patch on Kentucky bluegrass) when irrigated with less than the optimum amount of water. The 60 percent regime significantly reduced the turf quality of the three cool-season grasses tested.

In the warm-season grasses, the appearance of hybrid bermudagrass and Seashore Paspalum was not significantly different under any of the irrigation regimes. As irrigation amounts were reduced, zoysiagrass appearance ratings declined because of nematode activity observed on the roots. Both Santa Ana hybrid bermudagrass and Adalayd (Excalibre) Seashore Paspalum had very good color, density, texture, uniformity, and freedom from weeds and diseases, irrespective of irrigation regimes. Clearly there is potential for considerable water savings with these grasses. This study showed a 40 percent reduction in actual water applied between the optimum and lowest irrigation regime (65.5 versus 39 inches).

Because of the field plot design necessary for this study, it wasn't possible to compare statistically the turf performance results between the warm- and cool-season grasses. Hybrid bermuda and Seashore Paspalum performed very well, however, with 52.7 inches of water applied (60 percent irrigation regime), whereas the cool-season grasses needed at least 82.4 inches (80 percent irrigation regime). Thirty-six percent less water was applied to the warm-season species than to the cool-season species for acceptable turf quality. If applied water in the 60 percent irrigation treatment in warm-season grasses (52.7 inches) is compared with that in the 100 percent treatment in cool-season grasses (104.4 inches), the saving in water is 49.5 percent.

Water application

The cool-season grass in the 100 percent regime received 43 inches of water in 1982 (table 2). Warm-season grasses received only 34 inches. Rainfall of 18.45 inches occurred primarily from November to March. The soil profile held about 10 inches depth of water in the top 6 feet. Rainfall did not appreciably affect the applied water during the primary growing season, April through November. Likewise, the 34 inches applied to the warm-season grasses was not appreciably affected by, nor was there evidence of, deep percolation during the primary growing season, when only 4 inches of rain fell. The rainfall is subtracted from the original evaporation pan reading and is therefore reasonably accounted for in the calculated applications.

In 1983, a higher than normal rainfall of 32 inches occurred. The soil profile was filled during the winter, however, and only 9 inches of rain fell from April to October 30, of which 4 inches occurred in early April. Water moved below the root zone only on June 29, August 29, October 5, and October 17 in all plots of 100 and 80 percent irrigation in 1983. Even during a season of higher than normal rainfall, the applied water, 38.7 inches in cool-season grasses (1983), was similar to that of the drier year (1982) with 43 inches applied. Most of the 5 inches of implied higher use by cool-season grasses may have moved through deep percolation.

The water applied to warm-season grasses was 34 inches in 1982 and 33 inches in 1983. This small difference indicates that managers can schedule carefully and conserve water in a wet or dry season.

TABLE 1. Cool- and warm-season turfgrass appearance ratings and water applied for the duration of the study (August 1981 to December 1983).

Irrigation regime	Turf appearance 8/81 - 12/83*			Water application (actual)	ET_{grass}†
% of ET				*in.*	
Cool season	Ken. blue	Per. rye	Tall fesc.		
100	5.5 y	6.2 y	5.8 y	104.4	77.3
80	5.3 y	5.9 y	5.7 yz	82.4	61.0
60	4.8 z	5.0 z	5.3 z	62.7	46.4
Warm season	Bermuda	Paspalum	Zoysia		
100	6.5 ns‡	5.8 ns	5.6 x	88.4	65.5
80	6.5	5.8	4.8 y	69.4	51.4
60	6.4	5.4	4.2 z	52.7	39.0

* Rated on a scale of 1 to 9, with 1 indicating worst appearance and 9 best. Values followed by common letters are not significantly different at the 5% level of probability.
† ET_{grass} equals the actual applied water divided by the extra water factor (EWF_{90}), which is 1.35.
‡ No significant difference.

TABLE 2. Actual water applied in 1982 (1/1/82 to 12/31/82) and 1983 (1/1/83 to 12/31/83)

Sprinkler plots	1982		1983	
	Water applied*	Rainfall	Water applied†	Rainfall
% of ET	*inches*			
Cool season				
100	43.2	18.45	38.7	31.78
80	35.0		31.9	
60	26.6		24.5	
Warm season				
100	34.0		33.0	
80	27.4		25.8	
60	21.6		19.6	

* Class A pan evaporation 55.0 inches for 1982.
† Class A pan evaporation 55.63 inches for 1983.

TABLE 3. Turfgrass crop coefficients (Kp and Kc) of warm- and cool-season grasses.

Month	Kp*		Kc†	
	Warm	Cool	Warm	Cool
J	.44	.49	.55	.61
F	.43	.51	.54	.64
M	.61	.60	.76	.75
A	.58	.83	.72	1.04
M	.63	.76	.79	.95
J	.54	.70	.68	.88
J	.57	.75	.71	.94
A	.57	.69	.71	.86
S	.50	.59	.62	.74
O	.43	.60	.54	.75
N	.46	.55	.58	.69
D	.44	.48	.55	.60

* Monthly crop coefficient (Kp) is used with a Class A Weather Bureau evaporation pan with the equation $ET_{grass} = ET_{pan} \times Kp$
† The crop coefficient Kc is used with reference evapotranspiration (ETo) from a CIMIS weather station with the equation $ET_{grass} = ETo \times Kc$.

Conclusions

The monthly crop coefficients (table 3) calculated and used for nearly three years proved to be very accurate for both warm- and cool-season turfgrasses. Crop coefficients can be used with reference evapotranspiration from the Department of Water Resources California Irrigation Management Information System (CIMIS) program. Turfgrass managers can use these crop coefficients to determine on-site water use by turfgrasses from either a Class A Weather Bureau evaporation pan or from a computerized weather station that gives reference evapotranspiration with the equation given in table 3.

In conclusion, warm-season turfgrasses have a greater potential for water conservation than do cool-season turfgrasses. Under the conditions of this study, sprinkler irrigation was superior to subterranean irrigation for water conservation and turfgrass performance. And lastly, a well-designed, uniform irrigation system is necessary to maximize water conservation in turfgrass management.

Jewell L. Meyer is Irrigation and Soils Specialist and Victor A. Gibeault is Environmental Horticulturist, Cooperative Extension, University of California, Riverside. *Financial support for this study was granted by the Metropolitan Water District of Southern California, City of Los Angeles Department of Water and Power, Municipal Water District of Orange County, and the San Diego County Water Authority. Also the support of the Southern California Turfgrass Council, the Lloyd Foundation, and the Golf Course Superintendent's Association of Southern California is appreciated. The authors acknowledge the assistance of Ralph Strohman and Mark Mahody, Staff Research Associates, UC Riverside.*

Attachment C

Water Application Efficiency,
Bill Kranz, University of Nebraska Lincoln Extension
Irrigation Specialist,
Northeast Research and Extension Center

Irrigation Chapter 8 - Irrigation Efficiencies

Author: Bill Kranz, University of Nebraska Lincoln Extension Irrigation Specialist, Northeast Research and Extension Center, Norfolk, NE.

Water Application **Efficiency**

The ability to manage an irrigation system is contingent on an accurate estimate of the percentage of water pumped that becomes available for crop use. No irrigation system delivers water at 100 percent efficiency. Water may be lost through delivery systems or pipelines and some water may remain in the **soil**, but not be used by the crop. Some water may run off the soil surface into lowland areas. Still other water may be lost to evaporation in the air, or from the soil and plant surfaces. *Figures 8.1a* and *8.1b* show the major losses for sprinkler and surface irrigation systems. To know how much water to pump, these losses must be totaled and added to the amount of water needed by the crop.

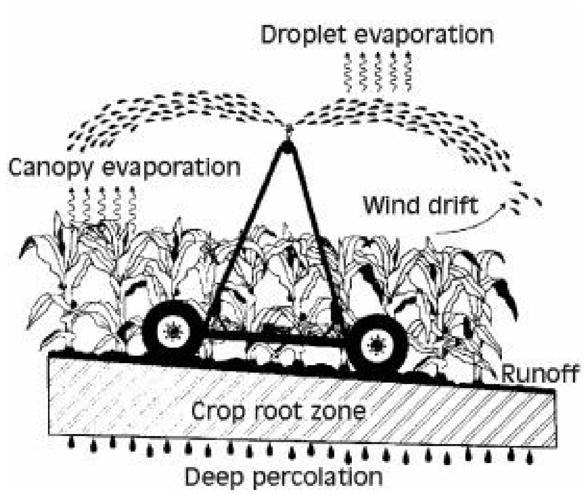


Figure 8.1. a) Potential water losses during irrigation with a center pivot. b) Potential water losses during irrigation with a **furrow irrigation** system.

In most cases, the goal is to insure that all areas of the field receive a **set** amount of uniformly applied water. Consider the catch can test data shown in *Figure 8.2.* The cans recording application depths below the horizontal line are not receiving enough water — catches are less than the desired 0.85 inches. Another application will be needed to insure that the entire field receives at least 0.85 inches of water. This will require using more water and energy than is necessary. If this pattern occurs during each irrigation, plants in the areas receiving less than 0.85 inches eventually could experience water stress. The cans recording application depths above the line receive at least 0.85 inches of water. Any extra water applied could lead to surface **runoff** or deep **percolation**.

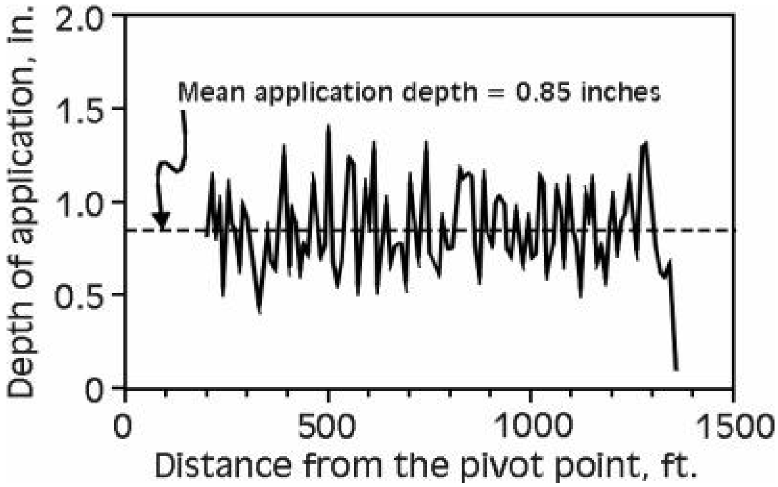


Figure 8.2. Example of catch-can data from a center pivot with low pressure spray nozzle, mounted at 10 foot intervals and 7 feet above the soil surface.

Water application efficiency accounts for how uniformly the water is applied and can be used for other assessments. If the center pivot owner is trying to decide whether switching to a new sprinkler package would be economical, the change in water application efficiency could be a major factor. If water becomes limited, changing to a system with a higher water application efficiency will provide more useable water to the crop and reduce pumping costs.

To maximize irrigation water use, it must be uniformly applied in the right amount and at the right time. Reaching these objectives requires knowledge of water delivery characteristics, field soils and slopes, and the expected crop water use rates.

Mathematical relationships have been developed to help quantify the amount of applied water that becomes available for plant use.

Water application efficiency refers to the amount of water applied that is stored in the crop root zone. This value is determined by water distribution characteristics, system management, soil conditions, the crop, and weather conditions. Water application efficiency pertains to an individual irrigation event.

Equation 8.1 is used to determine water application efficiency.

Equation 8.1 E_a **= [Depth of water stored in the rootzone (d_s) x 100** **Depth of water pumped (d_p)]**

where:

E_a = Average water application efficiency, %

Depth of water stored in the rootzone (d_s) = Average depth of water stored in the rootzone, inches

Depth of water pumped (d_p) = Average depth of water delivered from source, inches

Irrigation efficiency refers to the amount of water removed from the water source that is used by the crop. This value is determined by irrigation system management, water distribution characteristics, crop water use rates, weather and soil conditions. Irrigation efficiency pertains to the use of water for an entire growing season.

Depth Stored

The depth of water stored in the root zone can be estimated based on field observation of what happens to the water during an application event. Field observation reports should note if runoff occurs and estimate the amount of runoff. With experience, you'll begin to know where and when runoff is likely to occur. For example, runoff from center pivot systems will likely occur first near the outside edge of the irrigated area because the water application rate is greatest there. Other factors include low **infiltration** rate soils, steep slopes and lack of plant residue cover.

Another more accurate method is to record the **soil water** content before and after an irrigation event using one of the methods discussed in *Chapter 3, Soil Water*. If the hand-feel method is used, the **soil water content** will need to be recorded at enough locations to develop accurate estimates of the water stored in the crop root zone. The depth of water applied is found by subtracting the reading taken before the irrigation.

Equation 8.2 d_s = ***["After" reading – "Before" reading]***

Where:

d_s = Depth of water stored in the rootzone

Example 8.1

A center pivot irrigation system is supplied with enough water to apply 1.1 inches of water to an irrigated area. Soil water content readings recorded before the irrigation event showed an average water content of 3.5 inches in the top 3 feet of soil. Soil water content readings after the irrigation showed an average of 4.4 inches in the top 3 feet of soil. To find the average depth of water stored in the crop rootzone we subtract the before irrigation reading from the after irrigation reading.

Using *Equation 8.2* d_s = ["After" reading – "Before" reading]

d_s = [4.4 inches – 3.5 inches]

d_s = 0.9 inches

Depth Pumped

The depth of water pumped can be determined using the procedures presented in *Chapter 7, Flow Measurements and Basic Water Calculations*. The information needed includes an accurate estimate of the pumping rate in gallons per minute. This information can be recorded using a flow meter installed as part of the system or periodically using an attached flow meter (ultrasonic flow meter, pilot tube type meter, etc.).

The average flow rate can be determined by recording the accumulator reading prior to and after each irrigation event. Subtracting the reading recorded prior to the irrigation from the reading after the irrigation event will result in the total volume of water pumped. Taking the total volume and dividing by the irrigation time will give the average pumping rate. For this estimate to be accurate, the irrigation time must be accurate to the nearest hour if possible. A more precise record of the total irrigation time will improve the estimate of the pumping flow rate. (The hour meter on the motor or center pivot is accurate enough to estimate the pumping time.) *Equations 8.3* and *8.4* are used to make these calculations. The following example shows how to incorporate field data into the equations.

Equation 8.3 ***Pumping rate = [Reading 2 – Reading 1] / [Time]***

where:

Pumping rate = Water deliver rate, gallons per minute or acre-inches per minute

Reading 1 = Totalizer reading before the irrigation event, gallons or acre-inches

Reading 2 = Totalizer reading after the irrigation event, gallons or acre-inches

Time = Time required to complete the irrigation event, minutes

Example 8.2

The meter also has an accumulator at the bottom that registers total gallons pumped. Before the irrigation event, the accumulator reading was 6,553,300 gallons, and after the irrigation event the meter read 10,167,500 gallons. The irrigation event required 77 hours and 15 minutes.

Using *Equation 8.3*

Pumping rate = [Reading 2-Reading 1] / [Time]

Pumping rate = [10,167,500 - 6,553,300] gallons [(77 hr x 60 min/hr) + 15 min]

Pumping rate = [3,614,200] gallons / [4620 + 15] minutes

Pumping rate = 780 gallons per minute

If the accumulator records flow in acre-inches, the same process is used unless the desire is to determine the flow rate in gallons per minute. To convert acre-inches per minute to gallons per minute, multiply the result from *Equation 8.3* in acre-inches per minute by 27,154 gallons per acre-inch.

To convert the flow rate in gallons per minute to the gross depth of water pumped, we use *Equation 8.4.* If the result from *Equation 8.3* is in acre-inches per minute, the constant 27,154 gallons per acre-inch is not used.

Equation 8.4 d_p ***= [flow rate x time] / [area irrigated x 27,154]***

where:

d_p = Depth pumped = Average depth of water pumped, *inches*

Flow rate = Average water delivery rate, *gallons per minute*

Time = Total irrigation time, *minutes*

Area irrigated = Total irrigated area, *acres*

27,154 = Conversion factor, *gallons per acre-inch or gal / ac-in*

Example 8.3

Let's assume that the field area for Example 8.2 was 123 acres. We calculated the flow rate at 780 gallons per minute and the total irrigation time at 4635 minutes. Using *Equation 8.3*:

Depth pumped (d_p) = [Flow rate x time] / [Area irrigated x 27,154]

Depth pumped (d_p) = [780 *gal/min* x 4635 *minutes*] [123 *acres* x 27154 *gal / ac-in*]

Depth pumped (d_p) = [3,615,300]*gallons* / [3,339,942] *gallons / inch*

Depth pumped (d_p) = 1.08 inches

To complete the calculation of the water application efficiency, use *Equation 8.1* to compare the amount of water pumped with the increase in water stored in the crop rootzone.

Example 8.4

From Example 8.1 we found that 0.9 inches of water was stored in the three-foot crop rootzone. From Example 8.3 we found that 1.08 inches of water was pumped from the water source into the center pivot. To find the application efficiency we use *Equation 8.1.*

E_a = [Depth of water stored in the rootzone (d_s) x 100 Depth of water pumped (d_p)]

E_a = [0.9 inches / 1.08 inches] x 100

E_a = 83%

In these examples it was determined that only 83 percent of the water pumped from the irrigation source reached the soil and was usable by the crop. That means that 17 percent of the water was lost during application.

Potential Delivery Losses

The amount of water loss due to irrigation depends of the type of irrigation system — sprinkler or surface. In addition, the magnitude of each type of loss may be different. Let's begin by listing some major sources of water loss during irrigation. To keep the losses for surface and sprinkler irrigation separate, *Table 8.1* lists the potential losses for each type of system.

Table 8.1. Potential sources of water loss during an irrigation event for surface and sprinkler irrigation systems.

Sources of water losses	Surface Irrigation	Sprinkler irrigation
Distribution system	Yes	Yes
Air evaporation	No	Yes
Plant interception	No	Yes
Soil evaporation	Yes	Yes
Deep percolation	Yes	Yes
Runoff	Yes	Yes

Surface Irrigation Systems

The major losses for surface irrigation systems are deep percolation and surface runoff. These two losses could cause the water application efficiency to be reduced to less than 50 percent if the system is not managed properly. Ways to minimize these losses are discussed in *Chapter 11, Furrow Irrigation Management* (https://passel2.unl.edu/view/lesson/bda727eb8a5a/11).

Another source of water loss is in the distribution system. If the water flows across the head of the field in an open ditch, each foot of ditch loses water to soil infiltration and water surface evaporation. The best way to eliminate these losses is to transport the water through an enclosed pipeline. For many furrow irrigated fields this will require a small pumping plant to overcome the friction loss associated with forcing water through the pipeline.

Surface irrigation implies that surface evaporation will contribute to water loss. One way to limit soil evaporation loss is to wet less of the soil surface. For fields with slopes less than 1 percent, irrigating every other furrow is a viable option. This effectively cuts surface evaporation losses by nearly 50 percent without sacrificing crop production. Irrigating every other furrow also will reduce the amount of water lost to deep percolation and surface runoff.

Pipelines can have losses too. Worn gaskets or loose fitting pipeline connections could produce leaks at each joint. These losses are usually small in comparison to other losses, but by their sheer number could add up to substantial water losses. This kind of loss is the easiest to eliminate by replacing gaskets.

Sprinkler Irrigation Systems

Sprinkler irrigation systems, especially center pivots, typically have greater water application efficiencies than surface systems. While they may have more potential sources of loss, the magnitude of each loss is generally quite low. *Table 8.1* shows that sprinkler irrigation systems may experience loss from all six of the potential water loss sources while surface irrigation systems lose water from only four. This is because most sprinkler irrigation systems spray water into the air to deliver water to the entire soil surface with an upright crop canopy located between the sprinkler and soil.

Developments in sprinkler technology have reduced the amount of water lost between the sprinkler/nozzle and soil surface. The irrigation time or the accumulated time that water is applied to the crop canopy causes the major loss during sprinkler irrigation events. Applied water evaporates off the leaves of the crop canopy. Thus, the longer water droplets are delivered to the crop, the greater the total evaporation loss. Lowering the sprinkler/nozzle pressure reduces the wetted diameter of the sprinkler/nozzle thus reducing irrigation time and total canopy evaporation losses. In addition, lower wetted diameters reduce water evaporation losses in the air and wind drift losses.

Proper management of sprinkler irrigation systems can greatly reduce deep percolation losses. An irrigation system managed to keep the soil profile completely full at all times will experience some deep percolation losses. This is because the system does not apply water at 100 percent uniformity. Some areas will receive more water than others due to sprinkler pressure differences caused by soil elevation differences. Pressure regulators or flow control nozzles help insure that water delivered to the soil surface is as uniform as possible. Other portions of the field could be affected when wind distorts the water application pattern. Such distortion can be reduced by avoiding operation when winds exceed 10 mph.

How do I Evaluate Losses?

There are two main ways to evaluate water loss during irrigation: 1) take detailed field measurements; and 2) visually estimate losses. In some cases it may be necessary to combine these methods to develop an accurate estimate of where losses occur and how significant they are to the system's application efficiency. For example, to estimate water losses during irrigation, measure the flow rate of water entering the system with a flow meter. Visually estimate how much of the water is lost to runoff. This amount, however, will not account for other potential losses. *Table 8.2* presents the potential magnitude of some of these losses for different irrigation systems. For furrow irrigation systems record how long it takes for the water to reach a certain point in the field or record flow rates into the furrow and how long it takes water to reach the end of the furrow. When coupled with soil types and furrow slopes, a computer model can be used to estimate how efficiently the water is being applied.

Table 8.2a. Percent irrigation water losses for different furrow irrigation systems.

Type of irrigation system	Distribution system	Air evaporation	Soil evaporation	Canopy evaporation	Deep percolation	Surface runoff	Overall efficiency
Every row	1-5	<1.0	1--5	0.0	10-20	10-35	40-75
W/Surge valve	1-5	<1.0	1-5	0.0	5-15	5-15	60-85
W/Reuse	1-5	1-2	1-5	0.0	10-20	0	55-90
Siphon tube	5-10	1-2	1-5	0.0	15-25	15-25	40-75
Alternate row	1-5	<0.5	1-5	0.0	5-15	10-20	60-85

Table 8.2b. Percent irrigation water losses for different Sprinkler Irrigation systems.

Type of irrigation system	Distribution system	Air evaporation	Soil evaporation	Canopy evaporation	Deep percolation	Surface runoff	Overall efficiency
Handmove	<1.0	3-5	1-5	10-15	5-10	0-5	60-80
Solid set	<1.0	3-5	1-5	10-15	0-10	0-5	60-85
Traveler	<1.0	1-3	1-5	1-5	0-5	5-10	55-75
High pressure impact	<0.5	1-3	0-1	1-5	0-5	0-5	70-80
Low pressure impact	<0.5	1-3	0-1	1-3	0.5	0-10	75-85
Low pressure spray	<0.5	1-3	0-1	1-3	0-5	0-20	70-90
Low pressure bubble	<0.5	0.0	0-0.5	0.0	0-5	20-40	60-95
Drip irrigation	<0.5	0.0	0.0	0.0	5-30	0.0	70-95

Attachment E

Irrigation Efficiency

Irrigation Chapter 8 - Irrigation Efficiencies

Author: Bill Kranz, University of Nebraska Lincoln Extension Irrigation Specialist, Northeast Research and Extension Center, Norfolk, NE.

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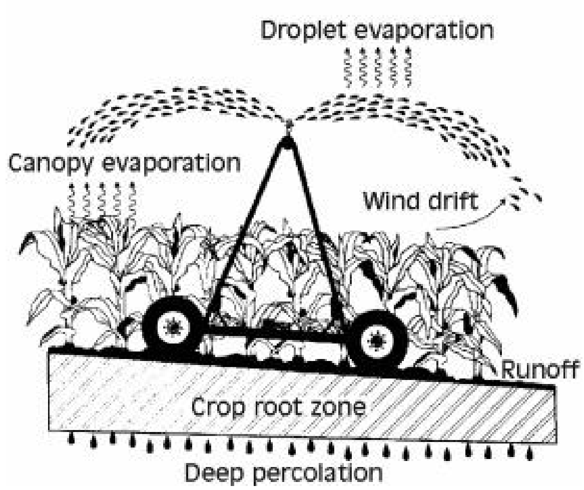
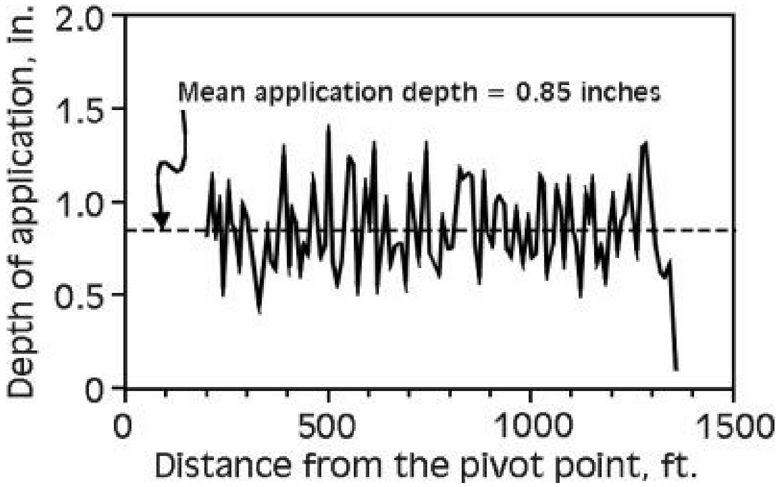


Figure 8.1. a) Potential water losses during irrigation with a center pivot. b) Potential water losses during irrigation with a **furrow irrigation** system.

In most cases, the goal is to insure that all areas of the field receive a **set** amount of uniformly applied water. Consider the catch can test data shown in *Figure 8.2.* The cans recording application depths below the horizontal line are not receiving enough water — catches are less than the desired 0.85 inches. Another application will be needed to insure that the entire field receives at least 0.85 inches of water. This will require using more water and energy than is necessary. If this pattern occurs during each irrigation, plants in the areas receiving less than 0.85 inches eventually could experience water stress. The cans recording application depths above the line receive at least 0.85 inches of water. Any extra water applied could lead to surface **runoff** or deep **percolation**.



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Mathematical relationships have been developed to help quantify the amount of applied water that becomes available for plant use.

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Irrigation efficiency refers to the amount of water removed from the water source that is used by the crop. This value is determined by irrigation system management, water distribution characteristics, crop water use rates, weather and soil conditions. Irrigation efficiency pertains to the use of water for an entire growing season.

Depth Stored

The depth of water stored in the root zone can be estimated based on field observation of what happens to the water during an application event. Field observation reports should note if runoff occurs and estimate the amount of runoff. With experience, you'll begin to know where and when runoff is likely to occur. For example, runoff from center pivot systems will likely occur first near the outside edge of the irrigated area because the water application rate is greatest there. Other factors include low **infiltration** rate soils, steep slopes and lack of plant residue cover.

Another more accurate method is to record the **soil water** content before and after an irrigation event using one of the methods discussed in *Chapter 3, Soil Water*. If the hand-feel method is used, the **soil water content** will need to be recorded at enough locations to develop accurate estimates of the water stored in the crop root zone. The depth of water applied is found by subtracting the reading taken before the irrigation.

Equation 8.2 d_s = ***["After" reading – "Before" reading]***

Where:

d_s = Depth of water stored in the rootzone

Example 8.1

A center pivot irrigation system is supplied with enough water to apply 1.1 inches of water to an irrigated area. Soil water content readings recorded before the irrigation event showed an average water content of 3.5 inches in the top 3 feet of soil. Soil water content readings after the irrigation showed an average of 4.4 inches in the top 3 feet of soil. To find the average depth of water stored in the crop rootzone we subtract the before irrigation reading from the after irrigation reading.

Using *Equation 8.2* d_s = ["After" reading – "Before" reading]

d_s = [4.4 inches – 3.5 inches]

d_s = 0.9 inches

Depth Pumped

The depth of water pumped can be determined using the procedures presented in *Chapter 7, Flow Measurements and Basic Water Calculations*. The information needed includes an accurate estimate of the pumping rate in gallons per minute. This information can be recorded using a flow meter installed as part of the system or periodically using an attached flow meter (ultrasonic flow meter, pilot tube type meter, etc.).

The average flow rate can be determined by recording the accumulator reading prior to and after each irrigation event. Subtracting the reading recorded prior to the irrigation from the reading after the irrigation event will result in the total volume of water pumped. Taking the total volume and dividing by the irrigation time will give the average pumping rate. For this estimate to be accurate, the irrigation time must be accurate to the nearest hour if possible. A more precise record of the total irrigation time will improve the estimate of the pumping flow rate. (The hour meter on the motor or center pivot is accurate enough to estimate the pumping time.) *Equations 8.3* and *8.4* are used to make these calculations. The following example shows how to incorporate field data into the equations.

Equation 8.3 ***Pumping rate = [Reading 2 – Reading 1] / [Time]***

where:

Pumping rate = Water deliver rate, gallons per minute or acre-inches per minute

Reading 1 = Totalizer reading before the irrigation event, gallons or acre-inches

Reading 2 = Totalizer reading after the irrigation event, gallons or acre-inches

Time = Time required to complete the irrigation event, minutes

Example 8.2

The meter also has an accumulator at the bottom that registers total gallons pumped. Before the irrigation event, the accumulator reading was 6,553,300 gallons, and after the irrigation event the meter read 10,167,500 gallons. The irrigation event required 77 hours and 15 minutes.

Using *Equation 8.3*

Pumping rate = [Reading 2-Reading 1] / [Time]

Pumping rate = [10,167,500 - 6,553,300] gallons [(77 hr x 60 min/hr) + 15 min]

Pumping rate = [3,614,200] gallons / [4620 + 15] minutes

Pumping rate = 780 gallons per minute

If the accumulator records flow in acre-inches, the same process is used unless the desire is to determine the flow rate in gallons per minute. To convert acre-inches per minute to gallons per minute, multiply the result from *Equation 8.3* in acre-inches per minute by 27,154 gallons per acre-inch.

To convert the flow rate in gallons per minute to the gross depth of water pumped, we use *Equation 8.4.* If the result from *Equation 8.3* is in acre-inches per minute, the constant 27,154 gallons per acre-inch is not used.

Equation 8.4 d_p ***= [flow rate x time] / [area irrigated x 27,154]***

where:

d_p = Depth pumped = Average depth of water pumped, *inches*

Flow rate = Average water delivery rate, *gallons per minute*

Time = Total irrigation time, *minutes*

Area irrigated = Total irrigated area, *acres*

27,154 = Conversion factor, *gallons per acre-inch or gal / ac-in*

Example 8.3

Let's assume that the field area for Example 8.2 was 123 acres. We calculated the flow rate at 780 gallons per minute and the total irrigation time at 4635 minutes. Using *Equation 8.3*:

Depth pumped (d_p) = [Flow rate x time] / [Area irrigated x 27,154]

Depth pumped (d_p) = [780 *gal/min* x 4635 *minutes*] [123 *acres* x 27154 *gal / ac-in*]

Depth pumped (d_p) = [3,615,300]*gallons* / [3,339,942] *gallons / inch*

Depth pumped (d_p) = 1.08 inches

To complete the calculation of the water application efficiency, use *Equation 8.1* to compare the amount of water pumped with the increase in water stored in the crop rootzone.

Example 8.4

From Example 8.1 we found that 0.9 inches of water was stored in the three-foot crop rootzone. From Example 8.3 we found that 1.08 inches of water was pumped from the water source into the center pivot. To find the application efficiency we use *Equation 8.1.*

E_a = [Depth of water stored in the rootzone (d_s) x 100 Depth of water pumped (d_p)]

E_a = [0.9 inches / 1.08 inches] x 100

E_a = 83%

In these examples it was determined that only 83 percent of the water pumped from the irrigation source reached the soil and was usable by the crop. That means that 17 percent of the water was lost during application.

Potential Delivery Losses

The amount of water loss due to irrigation depends of the type of irrigation system — sprinkler or surface. In addition, the magnitude of each type of loss may be different. Let's begin by listing some major sources of water loss during irrigation. To keep the losses for surface and sprinkler irrigation separate, *Table 8.1* lists the potential losses for each type of system.

Table 8.1. Potential sources of water loss during an irrigation event for surface and sprinkler irrigation systems.

Sources of water losses	Surface Irrigation	Sprinkler irrigation
Distribution system	Yes	Yes
Air evaporation	No	Yes
Plant interception	No	Yes
Soil evaporation	Yes	Yes
Deep percolation	Yes	Yes
Runoff	Yes	Yes

Surface Irrigation Systems

The major losses for surface irrigation systems are deep percolation and surface runoff. These two losses could cause the water application efficiency to be reduced to less than 50 percent if the system is not managed properly. Ways to minimize these losses are discussed in *Chapter 11, Furrow Irrigation Management* (https://passel2.unl.edu/view/lesson/bda727eb8a5a/11).

Another source of water loss is in the distribution system. If the water flows across the head of the field in an open ditch, each foot of ditch loses water to soil infiltration and water surface evaporation. The best way to eliminate these losses is to transport the water through an enclosed pipeline. For many furrow irrigated fields this will require a small pumping plant to overcome the friction loss associated with forcing water through the pipeline.

Surface irrigation implies that surface evaporation will contribute to water loss. One way to limit soil evaporation loss is to wet less of the soil surface. For fields with slopes less than 1 percent, irrigating every other furrow is a viable option. This effectively cuts surface evaporation losses by nearly 50 percent without sacrificing crop production. Irrigating every other furrow also will reduce the amount of water lost to deep percolation and surface runoff.

Pipelines can have losses too. Worn gaskets or loose fitting pipeline connections could produce leaks at each joint. These losses are usually small in comparison to other losses, but by their sheer number could add up to substantial water losses. This kind of loss is the easiest to eliminate by replacing gaskets.

Sprinkler Irrigation Systems

Sprinkler irrigation systems, especially center pivots, typically have greater water application efficiencies than surface systems. While they may have more potential sources of loss, the magnitude of each loss is generally quite low. *Table 8.1* shows that sprinkler irrigation systems may experience loss from all six of the potential water loss sources while surface irrigation systems lose water from only four. This is because most sprinkler irrigation systems spray water into the air to deliver water to the entire soil surface with an upright crop canopy located between the sprinkler and soil.

Developments in sprinkler technology have reduced the amount of water lost between the sprinkler/nozzle and soil surface. The irrigation time or the accumulated time that water is applied to the crop canopy causes the major loss during sprinkler irrigation events. Applied water evaporates off the leaves of the crop canopy. Thus, the longer water droplets are delivered to the crop, the greater the total evaporation loss. Lowering the sprinkler/nozzle pressure reduces the wetted diameter of the sprinkler/nozzle thus reducing irrigation time and total canopy evaporation losses. In addition, lower wetted diameters reduce water evaporation losses in the air and wind drift losses.

Proper management of sprinkler irrigation systems can greatly reduce deep percolation losses. An irrigation system managed to keep the soil profile completely full at all times will experience some deep percolation losses. This is because the system does not apply water at 100 percent uniformity. Some areas will receive more water than others due to sprinkler pressure differences caused by soil elevation differences. Pressure regulators or flow control nozzles help insure that water delivered to the soil surface is as uniform as possible. Other portions of the field could be affected when wind distorts the water application pattern. Such distortion can be reduced by avoiding operation when winds exceed 10 mph.

How do I Evaluate Losses?

There are two main ways to evaluate water loss during irrigation: 1) take detailed field measurements; and 2) visually estimate losses. In some cases it may be necessary to combine these methods to develop an accurate estimate of where losses occur and how significant they are to the system’s application efficiency. For example, to estimate water losses during irrigation, measure the flow rate of water entering the system with a flow meter. Visually estimate how much of the water is lost to runoff. This amount, however, will not account for other potential losses. *Table 8.2* presents the potential magnitude of some of these losses for different irrigation systems. For furrow irrigation systems record how long it takes for the water to reach a certain point in the field or record flow rates into the furrow and how long it takes water to reach the end of the furrow. When coupled with soil types and furrow slopes, a computer model can be used to estimate how efficiently the water is being applied.

Table 8.2a. Percent irrigation water losses for different furrow irrigation systems.

Type of irrigation system	Distribution system	Air evaporation	Soil evaporation	Canopy evaporation	Deep percolation	Surface runoff	Overall efficiency
Every row	1-5	<1.0	1--5	0.0	10-20	10-35	40-75
W/Surge valve	1-5	<1.0	1-5	0.0	5-15	5-15	60-85
W/Reuse	1-5	1-2	1-5	0.0	10-20	0	55-90
Siphon tube	5-10	1-2	1-5	0.0	15-25	15-25	40-75
Alternate row	1-5	<0.5	1-5	0.0	5-15	10-20	60-85

Table 8.2b. Percent irrigation water losses for different Sprinkler Irrigation systems.

Type of irrigation system	Distribution system	Air evaporation	Soil evaporation	Canopy evaporation	Deep percolation	Surface runoff	Overall efficiency
Handmove	<1.0	3-5	1-5	10-15	5-10	0-5	60-80
Solid set	<1.0	3-5	1-5	10-15	0-10	0-5	60-85
Traveler	<1.0	1-3	1-5	1-5	0-5	5-10	55-75
High pressure impact	<0.5	1-3	0-1	1-5	0-5	0-5	70-80
Low pressure impact	<0.5	1-3	0-1	1-3	0.5	0-10	75-85
Low pressure spray	<0.5	1-3	0-1	1-3	0-5	0-20	70-90
Low pressure bubble	<0.5	0.0	0-0.5	0.0	0-5	20-40	60-95
Drip irrigation	<0.5	0.0	0.0	0.0	5-30	0.0	70-95

Attachment F

Water Balance Model Results

Current Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	1.2	3.24	39.0	1.9	0.0	4.9	0.71		27.3	0.5	(1.5)	45.5	0.4	(1.1)	5.4	37.6	37.1	37.4	21.9	0.5	22.4	22.4	0.0	22.4
Nov.	2.8	1.68	37.8	4.6	0.0	0.0	0.52		0.0	1.3	(0.8)	43.5	1.0	(0.6)	(6.1)	31.5	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	3.5	1.21	39.0	5.8	0.0	0.0	0.52		0.0	1.7	(0.6)	46.4	1.2	(0.4)	(2.8)	28.7	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	5.1	1.48	39.0	8.4	3.5	0.0	0.37		0.0	2.4	(0.7)	53.0	1.8	(0.5)	4.2	33.0	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	3.1	1.95	35.2	5.2	0.0	0.0	0.46		0.0	1.5	(0.9)	41.4	1.1	(0.7)	1.8	34.8	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	3.2	3.02	39.0	5.2	0.0	0.0	0.37		0.0	1.5	(1.4)	44.7	1.1	(1.1)	0.7	35.5	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	1.8	4.57	37.8	2.9	0.0	5.3	0.58		35.3	0.8	(2.2)	45.2	0.6	(1.6)	3.4	38.9	38.2	8.8	29.3	0.7	30.0	30.0	0.0	30.0
May	0.6	5.97	39.0	1.0	0.0	9.1	0.55		70.1	0.3	(2.8)	47.1	0.2	(2.1)	(0.9)	38.0	38.3	54.9	59.6	1.4	61.0	61.0	0.0	61.0
Jun.	0.2	7.19	37.8	0.3	0.0	12.0	0.25		92.4	0.1	(3.4)	47.0	0.1	(2.5)	(7.9)	30.1	30.4	71.8	78.6	1.8	80.4	80.4	0.0	80.4
Jul.	0.1	7.64	39.0	0.1	0.0	13.1	0.58		100.9	0.0	(3.6)	49.2	0.0	(2.7)	(3.3)	26.8	26.9	83.4	85.8	2.0	87.8	87.8	0.0	87.8
Aug.	0.1	6.98	37.8	0.2	0.0	11.8	0.49		91.1	0.1	(3.3)	47.0	0.0	(2.4)	0.3	27.1	27.7	78.1	77.5	1.8	79.3	79.3	0.0	79.3
Sep.	0.3	4.99	39.0	0.5	0.0	11.0	0.43		64.6	0.2	(2.4)	48.7	0.1	(1.7)	4.4	32.2	32.2	62.4	52.4	1.2	53.6	53.6	0.0	53.6
Total, AFY	**22.0**	**49.9**	**459**	**36.1**	**3.5**	**67.2**	**5.83**		**481.7**	**10.5**	**(23.7)**	**558.8**	**7.7**	**(17.5)**	**(0.7)**			**413.2**	**405.1**	**9.4**	**414.5**	**414.5**	**0**	**414.5**

Base City Flow	0.410 mgd
Town Field Runoff Calculation Parameters	
Soil Interception, inches	3
Percent Infiltration, saturated soil	0.4
Percent Infiltration, unsaturated soil	0.6
Min 2-month Rainfall for Saturation, inches	10
Max Precip Before Runoff Capture, inches	20

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	0.32	0.32	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment				Storage	Percolation	
	1	2	3	4	5	6	7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

(1) Average year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In August, Column 16 is set to 22.9 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

Current Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32

	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7								Percolation Pond 6								
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/ Store Elsewhere
Oct.	77.0	4.3	4.0	4.0	73.0	0.3	0.4	0.4	0.0	35	35.0	0.5	(1.4)	0.0	(25.9)	0.0	60	60.0	0.4	(1.1)	0.0	(25.2)	0.0	OK	84.5
Nov.	81.5	1.2	0.0	0.0	81.5	0.0	0.0	0.0	0.0	50	50.0	1.2	(0.7)	0.0	50.5	25.8		24.7	0.9	(0.5)	0.0	25.1	25.1	OK	0.0
Dec.	78.7	0.0	0.0	0.0	78.7	0.0	0.0	0.0	0.0	50	50.0	1.6	(0.5)	0.0	51.0	25.8		51.0	1.1	(0.4)	0.0	(0.0)	25.0	OK	51.8
Jan.	83.0	0.0	0.0	0.0	83.0	0.0	0.0	0.0	0.0	50	50.0	2.2	(0.7)	0.0	51.6	25.8		51.6	1.7	(0.5)	0.0	(0.0)	25.0	OK	52.8
Feb.	74.8	0.0	0.0	0.0	74.8	0.0	0.0	0.0	0.0	40	40.0	1.4	(0.9)	0.0	40.5	25.8		40.5	1.0	(0.6)	0.0	0.0	25.0	OK	40.9
Mar.	79.5	0.0	0.0	0.0	79.5	0.0	0.0	0.0	0.0	44	44.0	1.4	(1.3)	0.0	44.1	25.8		44.1	1.0	(1.0)	0.0	0.0	25.0	OK	44.1
Apr.	79.8	1.8	5.4	5.4	74.4	0.0	0.5	0.5	0.0	35	35.0	0.8	(2.0)	0.0	33.8	25.8		33.8	0.6	(1.5)	0.0	0.0	25.1	OK	32.8
May	84.1	0.6	10.1	10.1	74.0	0.3	1.0	1.0	0.0	35	35.0	0.3	(2.6)	0.0	32.6	25.8		32.6	0.2	(1.9)	0.0	0.0	25.1	OK	30.9
Jun.	82.6	15.4	13.2	13.2	69.4	1.2	1.3	1.3	0.0	38	38.0	0.1	(3.2)	0.0	34.9	25.8		34.9	0.1	(2.3)	0.0	(0.0)	25.1	OK	32.7
Jul.	76.6	13.5	14.4	14.4	62.2	1.2	1.4	1.4	0.0	34	34.0	0.0	(3.4)	0.0	30.7	25.8		30.7	0.0	(2.5)	0.0	(0.0)	25.1	OK	28.2
Aug.	71.4	21.2	13.0	13.0	58.4	1.8	1.3	1.3	0.0	30	30.0	0.1	(3.1)	0.0	27.0	25.8		27.0	0.0	(2.3)	0.0	0.0	25.1	OK	24.7
Sep.	74.2	11.7	8.9	8.9	65.4	1.8	0.9	0.9	0.0	33	33.0	0.1	(2.2)	0.0	30.9	25.8		30.9	0.1	(1.6)	0.0	0.0	25.1	OK	29.4
Total, AFY	**943.1**	**69.7**	**69.0**	**69.0**	**874.2**	**6.8**	**6.8**	**6.8**	**0.0**	**474**	**474.0**	**9.7**	**(22.0)**	**0.0**	**401.7**		**60**	**462**	**7.2**	**(16.2)**	**0.0**	**(0.1)**			**453**

Percolation Pond 7	
Total Inflows:	**474**
Total Outflows:	**0**

Percolation Pond 6	
Total Inflows:	**462**
Total Outflows:	**0**

Total Excess Water: **453**

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.

Current Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	1.2	3.24	39.0	1.9	0.0	4.9	0.71		27.3	0.5	(1.5)	45.5	0.4	(1.1)	5.2	37.4	37.1	37.4	21.9	0.5	22.4	22.4	0.0	22.4
Nov.	2.8	1.68	37.8	4.6	0.0	0.0	0.52		0.0	1.3	(0.8)	43.5	1.0	(0.6)	(6.1)	31.2	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	3.5	1.21	39.0	5.8	0.0	0.0	0.52		0.0	1.7	(0.6)	46.4	1.2	(0.4)	(2.8)	28.4	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	5.1	1.48	39.0	8.4	3.5	0.0	0.37		0.0	2.4	(0.7)	53.0	1.8	(0.5)	4.2	32.7	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	3.1	1.95	35.2	5.2	0.0	0.0	0.46		0.0	1.5	(0.9)	41.4	1.1	(0.7)	1.8	34.5	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	3.2	3.02	39.0	5.2	0.0	0.0	0.37		0.0	1.5	(1.4)	44.7	1.1	(1.1)	0.7	35.2	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	1.8	4.57	37.8	2.9	0.0	5.3	0.58		35.3	0.8	(2.2)	45.2	0.6	(1.6)	2.9	38.1	38.2	8.8	29.3	0.7	30.0	30.0	0.0	30.0
May	0.6	5.97	39.0	1.0	0.0	9.1	0.55		70.1	0.3	(2.8)	47.1	0.2	(2.1)	0.4	38.5	38.3	54.9	59.6	1.4	61.0	61.0	0.0	61.0
Jun.	0.2	7.19	37.8	0.3	0.0	12.0	0.25		92.4	0.1	(3.4)	47.0	0.1	(2.5)	(7.8)	30.7	30.4	71.8	78.6	1.8	80.4	80.4	0.0	80.4
Jul.	0.1	7.64	39.0	0.1	0.0	13.1	0.58		100.9	0.0	(3.6)	49.2	0.0	(2.7)	(3.8)	26.9	26.9	83.4	85.8	2.0	87.8	87.8	0.0	87.8
Aug.	0.1	6.98	37.8	0.2	0.0	11.8	0.49		91.1	0.1	(3.3)	47.0	0.0	(2.4)	(0.0)	26.9	27.7	78.1	77.5	1.8	79.3	79.3	0.0	79.3
Sep.	0.3	4.99	39.0	0.5	0.0	11.0	0.43		64.6	0.2	(2.4)	48.7	0.1	(1.7)	4.7	32.2	32.2	62.4	52.4	1.2	53.6	53.6	0.0	53.6
Total, AFY	**22.0**	**49.9**	**459**	**36.1**	**3.5**	**67.2**	**5.83**		**481.7**	**10.5**	**(23.7)**	**558.8**	**7.7**	**(17.5)**	**(0.6)**			**413.2**	**405.1**	**9.4**	**414.5**	**414.5**	**0**	**414.5**

Base City Flow	0.410 mgd
Town Field Runoff Calculation Parameters	
Soil Interception, inches	3
Percent Infiltration, saturated soil	0.4
Percent Infiltration, unsaturated soil	0.6
Min 2-month Rainfall for Saturation, inches	10
Max Precip Before Runoff Capture, inches	20

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	1.00	1.00	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment				Storage	Percolation	
	1	2	3	4	5	6	7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

(1) Average year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In September, Column 16 is set to 0 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

	Current Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1																								
	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7								Percolation Pond 6								
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/Store Elsewhere
Oct.	77.0	4.3	12.4	12.4	64.6	0.3	1.2	1.2	0.0	26	26.0	0.5	(1.4)	0.0	(25.9)	0.0	51	51.0	0.4	(1.1)	0.0	(23.9)	0.0	OK	74.2
Nov.	81.2	1.2	0.0	0.0	81.2	0.0	0.0	0.0	0.0	50	50.0	1.2	(0.7)	0.0	50.5	25.8		24.7	0.9	(0.5)	0.0	25.1	25.1	OK	0.0
Dec.	78.4	0.0	0.0	0.0	78.4	0.0	0.0	0.0	0.0	50	50.0	1.6	(0.5)	0.0	51.0	25.8		51.0	1.1	(0.4)	0.0	0.1	25.1	OK	51.7
Jan.	82.7	0.0	0.0	0.0	82.7	0.0	0.0	0.0	0.0	50	50.0	2.2	(0.7)	0.0	51.6	25.8		51.6	1.7	(0.5)	0.0	(0.0)	25.1	OK	52.8
Feb.	74.5	0.0	0.0	0.0	74.5	0.0	0.0	0.0	0.0	40	40.0	1.4	(0.9)	0.0	40.5	25.8		40.5	1.0	(0.6)	0.0	0.0	25.1	OK	40.9
Mar.	79.2	0.0	0.0	0.0	79.2	0.0	0.0	0.0	0.0	44	44.0	1.4	(1.3)	0.0	44.1	25.8		44.1	1.0	(1.0)	0.0	0.0	25.1	OK	44.1
Apr.	79.5	1.8	16.7	16.7	62.7	0.0	1.6	1.6	0.0	23	23.0	0.8	(2.0)	0.0	21.8	25.8		21.8	0.6	(1.5)	0.0	0.0	25.2	OK	20.8
May	83.3	0.6	31.7	31.7	51.6	0.3	3.1	3.1	0.0	10	10.0	0.3	(2.6)	0.0	7.6	25.8		7.6	0.2	(1.9)	0.0	0.0	25.2	OK	5.9
Jun.	83.1	15.4	41.3	41.3	41.8	1.2	4.1	4.1	0.0	7	7.0	0.1	(3.2)	0.0	3.9	25.8		3.9	0.1	(2.3)	0.0	(0.0)	25.2	OK	1.7
Jul.	77.3	13.5	44.9	44.9	32.3	1.2	4.4	4.4	0.0	1	1.0	0.0	(3.4)	0.0	(2.3)	23.5		0.0	0.0	(2.5)	0.0	(2.5)	22.7	OK	0.0
Aug.	71.6	21.2	40.7	40.7	30.9	1.8	4.0	4.0	0.0	0	0.0	0.1	(3.1)	0.0	(3.0)	20.4		0.0	0.0	(2.3)	0.0	(2.2)	20.5	OK	0.0
Sep.	74.0	11.7	27.7	27.7	46.3	1.8	2.7	2.7	0.0	12	12.0	0.1	(2.2)	0.0	9.9	25.8		4.6	0.1	(1.6)	0.0	3.1	23.5	OK	0.0
Total, AFY	**941.9**	**69.7**	**215.5**	**215.5**	**726.4**	**6.8**	**21.2**	**21.2**	**0.0**	**313**	**313.0**	**9.7**	**(22.0)**	**0.0**	**249.7**		**51**	**301**	**7.2**	**(16.2)**	**0.0**	**(0.4)**			**292**

Total Inflows:	**313**
Total Outflows:	**0**

Total Inflows:	**301**
Total Outflows:	**0**

Total Excess Water:	**292**

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.

Current Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	2.2	3.24	39.0	3.5	0.0	2.0	0.71		11.3	1.0	(1.5)	44.7	0.8	(1.1)	5.0	37.2	37.1	37.4	9.0	0.3	9.3	9.3	0.0	9.3
Nov.	5.2	1.68	37.8	8.6	3.3	0.0	0.52		0.0	2.5	(0.8)	51.9	1.8	(0.6)	(5.8)	31.4	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	6.6	1.21	39.0	10.8	20.7	0.0	0.52		0.0	3.1	(0.6)	73.6	2.3	(0.4)	(2.5)	28.8	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	9.5	1.48	39.0	15.7	43.7	0.0	0.37		0.0	4.5	(0.7)	102.6	3.3	(0.5)	4.4	33.2	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	5.9	1.95	35.2	9.7	8.0	0.0	0.46		0.0	2.8	(0.9)	55.2	2.1	(0.7)	1.6	34.8	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	6.0	3.02	39.0	9.8	0.0	0.0	0.37		0.0	2.8	(1.4)	50.6	2.1	(1.1)	0.6	35.4	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	3.3	4.57	37.8	5.4	0.0	1.8	0.58		11.9	1.5	(2.2)	45.0	1.1	(1.6)	2.8	38.2	38.2	8.8	9.8	0.3	10.1	10.1	0.0	10.1
May	1.2	5.97	39.0	1.9	0.0	8.0	0.55		61.7	0.6	(2.8)	47.2	0.4	(2.1)	0.5	38.7	38.3	54.9	52.5	1.2	53.7	53.7	0.0	53.7
Jun.	0.4	7.19	37.8	0.7	0.0	11.6	0.25		89.4	0.2	(3.4)	47.1	0.2	(2.5)	(8.3)	30.3	30.4	71.8	76.1	1.7	77.8	77.8	0.0	77.8
Jul.	0.1	7.64	39.0	0.2	0.0	13.0	0.58		99.9	0.1	(3.6)	49.2	0.0	(2.7)	(4.1)	26.2	26.9	83.4	85.0	1.9	86.9	86.9	0.0	86.9
Aug.	0.2	6.98	37.8	0.4	0.0	11.6	0.49		89.4	0.1	(3.3)	47.1	0.1	(2.4)	1.7	27.9	27.7	78.1	76.1	1.7	77.8	77.8	0.0	77.8
Sep.	0.6	4.99	39.0	1.0	0.0	10.2	0.43		59.9	0.3	(2.4)	48.6	0.2	(1.7)	(4.1)	32.2	32.2	62.4	48.6	1.1	49.7	49.7	0.0	49.7
Total, AFY	**41.1**	**49.9**	**459**	**67.7**	**75.7**	**58.2**	**5.83**		**423.5**	**19.5**	**(23.7)**	**662.7**	**14.4**	**(17.5)**	**(8.4)**			**413.2**	**357.1**	**8.2**	**365.3**	**365.3**	**0**	**365.3**

Base City Flow	0.410 mgd
Town Field Runoff Calculation Parameters	
Soil Interception, inches	3
Percent Infiltration, saturated soil	0.4
Percent Infiltration, unsaturated soil	0.6
Min 2-month Rainfall for Saturation, inches	10
Max Precip Before Runoff Capture, inches	20

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	0.32	0.32	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment				Storage	Percolation	
	1	2	3	4	5	6	7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(1) 1-in-100 year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In August, Column 16 is set to 21.2 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Current Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32

	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7		
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond
Oct.	76.5	4.3	2.1	2.1	74.4	0.3	0.2	0.2	0.0	37	37.0
Nov.	90.4	1.2	0.0	0.0	90.4	0.0	0.0	0.0	0.0	59	59.0
Dec.	106.8	0.0	0.0	0.0	106.8	0.0	0.0	0.0	0.0	78	78.0
Jan.	134.2	0.0	0.0	0.0	134.2	0.0	0.0	0.0	0.0	101	101.0
Feb.	89.8	0.0	0.0	0.0	89.8	0.0	0.0	0.0	0.0	55	55.0
Mar.	86.4	0.0	0.0	0.0	86.4	0.0	0.0	0.0	0.0	51	51.0
Apr.	79.9	1.8	2.5	2.5	77.4	0.0	0.2	0.2	0.0	39	39.0
May	83.7	0.6	9.1	9.1	74.5	0.3	0.9	0.9	0.0	35	35.0
Jun.	83.4	15.4	12.8	12.8	70.6	1.2	1.3	1.3	0.0	39	39.0
Jul.	76.9	13.5	14.3	14.3	62.6	1.2	1.4	1.4	0.0	35	35.0
Aug.	71.0	21.2	12.8	12.8	58.2	1.8	1.3	1.3	0.0	29	29.0
Sep.	74.9	11.7	8.3	8.3	66.6	1.8	0.8	0.8	0.0	42	42.0
Total, AFY	**1053.9**	**69.7**	**61.9**	**61.9**	**992.0**	**6.8**	**6.1**	**6.1**	**0.0**	**600**	**600.0**
									Total Inflows:		**600**
									Total Outflows:		**0**

	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Percolation Pond 7					Percolation Pond 6								
Month	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/ Store Elsewhere
Oct.	0.9	(1.4)	0.0	(26.5)	0.0	63	63.0	0.7	(1.1)	0.0	(25.3)	0.0	OK	87.9
Nov.	2.3	(0.7)	0.0	60.6	25.8		34.8	1.7	(0.5)	0.0	25.1	25.1	OK	10.8
Dec.	2.9	(0.5)	0.0	80.4	25.8		80.4	2.1	(0.4)	0.0	0.0	25.1	OK	82.1
Jan.	4.2	(0.7)	0.0	104.5	25.8		104.5	3.1	(0.5)	0.0	0.0	25.2	OK	107.1
Feb.	2.6	(0.9)	0.0	56.7	25.8		56.7	1.9	(0.6)	0.0	(0.0)	25.2	OK	58.0
Mar.	2.6	(1.3)	0.0	52.3	25.8		52.3	1.9	(1.0)	0.0	(0.1)	25.1	OK	53.3
Apr.	1.4	(2.0)	0.0	38.4	25.8		38.4	1.1	(1.5)	0.0	(0.0)	25.1	OK	38.0
May	0.5	(2.6)	0.0	32.9	25.8		32.9	0.4	(1.9)	0.0	0.0	25.1	OK	31.3
Jun.	0.2	(3.2)	0.0	36.0	25.8		36.0	0.1	(2.3)	0.0	0.0	25.2	OK	33.8
Jul.	0.1	(3.4)	0.0	31.7	25.8		31.7	0.0	(2.5)	0.0	(0.1)	25.1	OK	29.3
Aug.	0.1	(3.1)	0.0	26.0	25.8		26.0	0.1	(2.3)	0.0	0.0	25.1	OK	23.8
Sep.	0.3	(2.2)	0.0	40.1	25.8		40.1	0.2	(1.6)	0.0	0.0	25.2	OK	38.6
Total, AFY	**18.2**	**(22.0)**	**0.0**	**533.1**		**63**	**597**	**13.4**	**(16.2)**	**0.0**	**(0.1)**			**594**
					Total Inflows:		**597**					**Total Excess Water:**		**594**
					Total Outflows:		**0**							

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.

Current Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	2.2	3.24	39.0	3.5	0.0	2.0	0.71		11.3	1.0	(1.5)	44.7	0.8	(1.1)	5.2	37.4	37.1	37.4	9.0	0.3	9.3	9.3	0.0	9.3
Nov.	5.2	1.68	37.8	8.6	3.3	0.0	0.52		0.0	2.5	(0.8)	51.9	1.8	(0.6)	(5.8)	31.6	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	6.6	1.21	39.0	10.8	20.7	0.0	0.52		0.0	3.1	(0.6)	73.6	2.3	(0.4)	(2.5)	29.0	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	9.5	1.48	39.0	15.7	43.7	0.0	0.37		0.0	4.5	(0.7)	102.6	3.3	(0.5)	4.4	33.4	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	5.9	1.95	35.2	9.7	8.0	0.0	0.46		0.0	2.8	(0.9)	55.2	2.1	(0.7)	1.6	35.0	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	6.0	3.02	39.0	9.8	0.0	0.0	0.37		0.0	2.8	(1.4)	50.6	2.1	(1.1)	0.6	35.6	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	3.3	4.57	37.8	5.4	0.0	1.8	0.58		11.9	1.5	(2.2)	45.0	1.1	(1.6)	3.0	38.5	38.2	8.8	9.8	0.3	10.1	10.1	0.0	10.1
May	1.2	5.97	39.0	1.9	0.0	8.0	0.55		61.7	0.6	(2.8)	47.2	0.4	(2.1)	0.3	38.8	38.3	54.9	52.5	1.2	53.7	53.7	0.0	53.7
Jun.	0.4	7.19	37.8	0.7	0.0	11.6	0.25		89.4	0.2	(3.4)	47.1	0.2	(2.5)	(8.3)	30.5	30.4	71.8	76.1	1.7	77.8	77.8	0.0	77.8
Jul.	0.1	7.64	39.0	0.2	0.0	13.0	0.58		99.9	0.1	(3.6)	49.2	0.0	(2.7)	(4.4)	26.1	26.9	83.4	85.0	1.9	86.9	86.9	0.0	86.9
Aug.	0.2	6.98	37.8	0.4	0.0	11.6	0.49		89.4	0.1	(3.3)	47.1	0.1	(2.4)	0.8	26.9	27.7	78.1	76.1	1.7	77.8	77.8	0.0	77.8
Sep.	0.6	4.99	39.0	1.0	0.0	10.2	0.43		59.9	0.3	(2.4)	48.6	0.2	(1.7)	(4.5)	32.2	32.2	62.4	48.6	1.1	49.7	49.7	0.0	49.7
Total, AFY	**41.1**	**49.9**	**459**	**67.7**	**75.7**	**58.2**	**5.83**		**423.5**	**19.5**	**(23.7)**	**662.7**	**14.4**	**(17.5)**				**413.2**	**357.1**	**8.2**	**365.3**	**365.3**	**0**	**365.3**

Base City Flow	0.410 mgd
Town Field Runoff Calculation Parameters	
Soil Interception, inches	3
Percent Infiltration, saturated soil	0.4
Percent Infiltration, unsaturated soil	0.6
Min 2-month Rainfall for Saturation, inches	10
Max Precip Before Runoff Capture, inches	20

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	1.00	1.00	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment				Storage	Percolation	
	1	2	3	4	5	6	7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(1) 1-in-100 year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In September, Column 16 is set to 0 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Current Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1

	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7								Percolation Pond 6								
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/ Store Elsewhere
Oct.	76.5	4.3	6.5	6.5	70.0	0.3	0.6	0.6	0.0	32	32.0	0.9	(1.4)	0.0	(26.5)	0.0	58	58.0	0.7	(1.1)	0.0	(25.4)	0.0	OK	83.0
Nov.	90.6	1.2	0.0	0.0	90.6	0.0	0.0	0.0	0.0	59	59.0	2.3	(0.7)	0.0	60.6	25.8		34.8	1.7	(0.5)	0.0	25.1	25.1	OK	10.8
Dec.	107.0	0.0	0.0	0.0	107.0	0.0	0.0	0.0	0.0	78	78.0	2.9	(0.5)	0.0	80.4	25.8		80.4	2.1	(0.4)	0.0	0.0	25.1	OK	82.1
Jan.	134.4	0.0	0.0	0.0	134.4	0.0	0.0	0.0	0.0	101	101.0	4.2	(0.7)	0.0	104.5	25.8		104.5	3.1	(0.5)	0.0	0.0	25.2	OK	107.1
Feb.	90.0	0.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	55	55.0	2.6	(0.9)	0.0	56.7	25.8		56.7	1.9	(0.6)	0.0	(0.0)	25.2	OK	58.0
Mar.	86.6	0.0	0.0	0.0	86.6	0.0	0.0	0.0	0.0	51	51.0	2.6	(1.3)	0.0	52.3	25.8		52.3	1.9	(1.0)	0.0	(0.1)	25.1	OK	53.3
Apr.	80.1	1.8	7.8	7.8	72.3	0.0	0.8	0.8	0.0	33	33.0	1.4	(2.0)	0.0	32.4	25.8		32.4	1.1	(1.5)	0.0	(0.0)	25.1	OK	32.0
May	84.0	0.6	28.4	28.4	55.6	0.3	2.8	2.8	0.0	14	14.0	0.5	(2.6)	0.0	11.9	25.8		11.9	0.4	(1.9)	0.0	0.0	25.1	OK	10.3
Jun.	83.5	15.4	40.1	40.1	43.4	1.2	3.9	3.9	0.0	9	9.0	0.2	(3.2)	0.0	6.0	25.8		6.0	0.1	(2.3)	0.0	0.0	25.2	OK	3.8
Jul.	77.1	13.5	44.6	44.6	32.5	1.2	4.4	4.4	0.0	2	2.0	0.1	(3.4)	0.0	(1.3)	24.5		0.0	0.0	(2.5)	0.0	(2.4)	22.7	OK	0.0
Aug.	70.8	21.2	40.0	40.0	30.8	1.8	3.9	3.9	0.0	0	0.0	0.1	(3.1)	0.0	(3.0)	21.5		0.0	0.1	(2.3)	0.0	(2.2)	20.5	OK	0.0
Sep.	73.9	11.7	25.9	25.9	47.9	1.8	2.5	2.5	0.0	23	23.0	0.3	(2.2)	0.0	21.1	25.8		16.8	0.2	(1.6)	0.0	4.7	25.2	OK	10.7
Total, AFY	**1054.3**	**69.7**	**193.4**	**193.4**	**860.9**	**6.8**	**19.0**	**19.0**	**0.0**	**457**	**457.0**	**18.2**	**(22.0)**	**0.0**	**395.1**		**58**	**454**	**13.4**	**(16.2)**	**0.0**	**(0.2)**			**451**

Pond 7	
Total Inflows:	**457**
Total Outflows:	**0**

Pond 6	
Total Inflows:	**454**
Total Outflows:	**0**

Total Excess Water:	**451**

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.

2030 Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	1.2	3.24	48.5	1.9	0.0	4.9	0.71		27.3	0.5	(1.5)	55.0	0.4	(1.1)	4.9	37.1	37.1	37.4	21.9	0.5	22.4	22.4	0.0	22.4
Nov.	2.8	1.68	47.0	4.6	0.0	0.0	0.52		0.0	1.3	(0.8)	52.7	1.0	(0.6)	(5.9)	31.2	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	3.5	1.21	48.5	5.8	0.0	0.0	0.52		0.0	1.7	(0.6)	55.9	1.2	(0.4)	(2.3)	28.9	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	5.1	1.48	48.5	8.4	3.5	0.0	0.37		0.0	2.4	(0.7)	62.5	1.8	(0.5)	3.7	32.7	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	3.1	1.95	43.8	5.2	0.0	0.0	0.46		0.0	1.5	(0.9)	50.0	1.1	(0.7)	1.4	34.1	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	3.2	3.02	48.5	5.2	0.0	0.0	0.37		0.0	1.5	(1.4)	54.2	1.1	(1.1)	1.2	35.3	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	1.8	4.57	47.0	2.9	0.0	5.3	0.58		35.3	0.8	(2.2)	54.4	0.6	(1.6)	3.6	38.9	38.2	8.8	29.3	0.7	30.0	30.0	0.0	30.0
May	0.6	5.97	48.5	1.0	0.0	9.1	0.55		70.1	0.3	(2.8)	56.6	0.2	(2.1)	(0.4)	38.5	38.3	54.9	59.6	1.4	61.0	61.0	0.0	61.0
Jun.	0.2	7.19	47.0	0.3	0.0	12.0	0.25		92.4	0.1	(3.4)	56.2	0.1	(2.5)	(7.7)	30.8	30.4	71.8	78.6	1.8	80.4	80.4	0.0	80.4
Jul.	0.1	7.64	48.5	0.1	0.0	13.1	0.58		100.9	0.0	(3.6)	58.7	0.0	(2.7)	(3.8)	27.0	26.9	83.4	85.8	2.0	87.8	87.8	0.0	87.8
Aug.	0.1	6.98	47.0	0.2	0.0	11.8	0.49		91.1	0.1	(3.3)	56.2	0.0	(2.4)	0.5	27.5	27.7	78.1	77.5	1.8	79.3	79.3	0.0	79.3
Sep.	0.3	4.99	48.5	0.5	0.0	11.0	0.43		64.6	0.2	(2.4)	58.2	0.1	(1.7)	3.9	32.2	32.2	62.4	52.4	1.2	53.6	53.6	0.0	53.6
Total, AFY	**22.0**	**49.9**	**571**	**36.1**	**3.5**	**67.2**	**5.83**		**481.7**	**10.5**	**(23.7)**	**670.7**	**7.7**	**(17.5)**	**(0.8)**			**413.2**	**405.1**	**9.4**	**414.5**	**414.5**	**0**	**414.5**

Base City Flow	0.510 mgd
Town Field Runoff Calculation Parameters	
Soil Interception, inches	3
Percent Infiltration, saturated soil	0.4
Percent Infiltration, unsaturated soil	0.6
Min 2-month Rainfall for Saturation, inches	10
Max Precip Before Runoff Capture, inches	20

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	0.32	0.32	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment				Storage	Percolation	
	1	2	3	4	5	6	7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

(1) Average year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In August, Column 16 is set to 22.9 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

	2030 Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32																								
	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7								Percolation Pond 6								
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/ Store Elsewhere
Oct.	86.5	4.3	4.0	4.0	82.5	0.3	0.4	0.4	0.0	45	45.0	0.5	(1.4)	0.0	(25.9)	0.0	70	70.0	0.4	(1.1)	0.0	(25.2)	0.0	OK	94.5
Nov.	90.2	1.2	0.0	0.0	90.2	0.0	0.0	0.0	0.0	59	59.0	1.2	(0.7)	0.0	59.5	25.8		33.7	0.9	(0.5)	0.0	25.2	25.2	OK	8.9
Dec.	87.9	0.0	0.0	0.0	87.9	0.0	0.0	0.0	0.0	59	59.0	1.6	(0.5)	0.0	60.0	25.8		60.0	1.1	(0.4)	0.0	(0.0)	25.1	OK	60.8
Jan.	92.7	0.0	0.0	0.0	92.7	0.0	0.0	0.0	0.0	60	60.0	2.2	(0.7)	0.0	61.6	25.8		61.6	1.7	(0.5)	0.0	(0.0)	25.1	OK	62.8
Feb.	83.1	0.0	0.0	0.0	83.1	0.0	0.0	0.0	0.0	49	49.0	1.4	(0.9)	0.0	49.5	25.8		49.5	1.0	(0.6)	0.0	0.0	25.1	OK	49.9
Mar.	88.3	0.0	0.0	0.0	88.3	0.0	0.0	0.0	0.0	53	53.0	1.4	(1.3)	0.0	53.1	25.8		53.1	1.0	(1.0)	0.0	0.0	25.1	OK	53.1
Apr.	88.8	1.8	5.4	5.4	83.4	0.0	0.5	0.5	0.0	44	44.0	0.8	(2.0)	0.0	42.8	25.8		42.8	0.6	(1.5)	0.0	0.0	25.2	OK	41.8
May	93.6	0.6	10.1	10.1	83.5	0.3	1.0	1.0	0.0	44	44.0	0.3	(2.6)	0.0	41.6	25.8		41.6	0.2	(1.9)	0.0	0.0	25.2	OK	39.9
Jun.	92.3	15.4	13.2	13.2	79.1	1.2	1.3	1.3	0.0	47	47.0	0.1	(3.2)	0.0	43.9	25.8		43.9	0.1	(2.3)	0.0	(0.0)	25.2	OK	41.7
Jul.	86.8	13.5	14.4	14.4	72.4	1.2	1.4	1.4	0.0	44	44.0	0.0	(3.4)	0.0	40.7	25.8		40.7	0.0	(2.5)	0.0	(0.0)	25.2	OK	38.2
Aug.	80.8	21.2	13.0	13.0	67.8	1.8	1.3	1.3	0.0	39	39.0	0.1	(3.1)	0.0	36.0	25.8		36.0	0.0	(2.3)	0.0	(0.1)	25.1	OK	33.8
Sep.	84.1	11.7	8.9	8.9	75.3	1.8	0.9	0.9	0.0	43	43.0	0.1	(2.2)	0.0	40.9	25.8		40.9	0.1	(1.6)	0.0	0.0	25.1	OK	39.4
Total, AFY	**1055.0**	**69.7**	**69.0**	**69.0**	**986.1**	**6.8**	**6.8**	**6.8**	**0.0**	**586**	**586.0**	**9.7**	**(22.0)**	**0.0**	**503.7**		**70**	**574**	**7.2**	**(16.2)**	**0.0**	**(0.1)**			**565**
									Total Inflows:		**586**					**Total Inflows:**		**574**					**Total Excess Water:**		**565**
									Total Outflows:		**0**					**Total Outflows:**		**0**							

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

2030 Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	1.2	3.24	48.5	1.9	0.0	4.9	0.71		27.3	0.5	(1.5)	55.0	0.4	(1.1)	5.7	37.9	37.1	37.4	21.9	0.5	22.4	22.4	0.0	22.4
Nov.	2.8	1.68	47.0	4.6	0.0	0.0	0.52		0.0	1.3	(0.8)	52.7	1.0	(0.6)	(5.9)	31.9	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	3.5	1.21	48.5	5.8	0.0	0.0	0.52		0.0	1.7	(0.6)	55.9	1.2	(0.4)	(3.3)	28.6	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	5.1	1.48	48.5	8.4	3.5	0.0	0.37		0.0	2.4	(0.7)	62.5	1.8	(0.5)	4.7	33.4	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	3.1	1.95	43.8	5.2	0.0	0.0	0.46		0.0	1.5	(0.9)	50.0	1.1	(0.7)	1.4	34.8	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	3.2	3.02	48.5	5.2	0.0	0.0	0.37		0.0	1.5	(1.4)	54.2	1.1	(1.1)	0.2	35.0	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	1.8	4.57	47.0	2.9	0.0	5.3	0.58		35.3	0.8	(2.2)	54.4	0.6	(1.6)	3.1	38.1	38.2	8.8	29.3	0.7	30.0	30.0	0.0	30.0
May	0.6	5.97	48.5	1.0	0.0	9.1	0.55		70.1	0.3	(2.8)	56.6	0.2	(2.1)	(0.1)	38.0	38.3	54.9	59.6	1.4	61.0	61.0	0.0	61.0
Jun.	0.2	7.19	47.0	0.3	0.0	12.0	0.25		92.4	0.1	(3.4)	56.2	0.1	(2.5)	(7.6)	30.4	30.4	71.8	78.6	1.8	80.4	80.4	0.0	80.4
Jul.	0.1	7.64	48.5	0.1	0.0	13.1	0.58		100.9	0.0	(3.6)	58.7	0.0	(2.7)	(3.3)	27.1	26.9	83.4	85.8	2.0	87.8	87.8	0.0	87.8
Aug.	0.1	6.98	47.0	0.2	0.0	11.8	0.49		91.1	0.1	(3.3)	56.2	0.0	(2.4)	0.2	27.3	27.7	78.1	77.5	1.8	79.3	79.3	0.0	79.3
Sep.	0.3	4.99	48.5	0.5	0.0	11.0	0.43		64.6	0.2	(2.4)	58.2	0.1	(1.7)	4.2	32.2	32.2	62.4	52.4	1.2	53.6	53.6	0.0	53.6
Total, AFY	**22.0**	**49.9**	**571**	**36.1**	**3.5**	**67.2**	**5.83**		**481.7**	**10.5**	**(23.7)**	**670.7**	**7.7**	**(17.5)**	**(0.7)**			**413.2**	**405.1**	**9.4**	**414.5**	**414.5**	**0**	**414.5**

Base City Flow	0.510 mgd
Town Field Runoff Calculation Parameters	
Soil Interception, inches	3
Percent Infiltration, saturated soil	0.4
Percent Infiltration, unsaturated soil	0.6
Min 2-month Rainfall for Saturation, inches	10
Max Precip Before Runoff Capture, inches	20

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	1.00	1.00	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment				Storage	Percolation	
	1	2	3	4	5	6	7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

(1) Average year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In September, Column 16 is set to 0 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

	2030 Flows: Average Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1																								
	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7								Percolation Pond 6								
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/Store Elsewhere
Oct.	86.5	4.3	12.4	12.4	74.1	0.3	1.2	1.2	0.0	35	35.0	0.5	(1.4)	0.0	(25.9)	0.0	60	60.0	0.4	(1.1)	0.0	(24.9)	0.0	OK	84.2
Nov.	90.9	1.2	0.0	0.0	90.9	0.0	0.0	0.0	0.0	59	59.0	1.2	(0.7)	0.0	59.5	25.8		33.7	0.9	(0.5)	0.0	24.8	24.8	OK	9.3
Dec.	88.6	0.0	0.0	0.0	88.6	0.0	0.0	0.0	0.0	60	60.0	1.6	(0.5)	0.0	61.0	25.8		61.0	1.1	(0.4)	0.0	(0.0)	24.7	OK	61.8
Jan.	92.4	0.0	0.0	0.0	92.4	0.0	0.0	0.0	0.0	59	59.0	2.2	(0.7)	0.0	60.6	25.8		60.6	1.7	(0.5)	0.0	(0.0)	24.7	OK	61.8
Feb.	83.8	0.0	0.0	0.0	83.8	0.0	0.0	0.0	0.0	49	49.0	1.4	(0.9)	0.0	49.5	25.8		49.5	1.0	(0.6)	0.0	0.0	24.7	OK	49.9
Mar.	89.0	0.0	0.0	0.0	89.0	0.0	0.0	0.0	0.0	54	54.0	1.4	(1.3)	0.0	54.1	25.8		54.1	1.0	(1.0)	0.0	0.0	24.7	OK	54.1
Apr.	88.5	1.8	16.7	16.7	71.7	0.0	1.6	1.6	0.0	32	32.0	0.8	(2.0)	0.0	30.8	25.8		30.8	0.6	(1.5)	0.0	0.0	24.8	OK	29.8
May	92.8	0.6	31.7	31.7	61.1	0.3	3.1	3.1	0.0	20	20.0	0.3	(2.6)	0.0	17.6	25.8		17.6	0.2	(1.9)	0.0	0.0	24.8	OK	15.9
Jun.	91.8	15.4	41.3	41.3	50.5	1.2	4.1	4.1	0.0	16	16.0	0.1	(3.2)	0.0	12.9	25.8		12.9	0.1	(2.3)	0.0	(0.0)	24.8	OK	10.7
Jul.	86.5	13.5	44.9	44.9	41.5	1.2	4.4	4.4	0.0	10	10.0	0.0	(3.4)	0.0	6.7	25.8		6.7	0.0	(2.5)	0.0	(0.0)	24.8	OK	4.2
Aug.	81.0	21.2	40.7	40.7	40.3	1.8	4.0	4.0	0.0	9	9.0	0.1	(3.1)	0.0	6.0	25.8		6.0	0.0	(2.3)	0.0	0.0	24.8	OK	3.7
Sep.	83.9	11.7	27.7	27.7	56.2	1.8	2.7	2.7	0.0	22	22.0	0.1	(2.2)	0.0	19.9	25.8		19.9	0.1	(1.6)	0.0	0.0	24.8	OK	18.4
Total, AFY	**1055.8**	**69.7**	**215.5**	**215.5**	**840.3**	**6.8**	**21.2**	**21.2**	**0.0**	**425**	**425.0**	**9.7**	**(22.0)**	**0.0**	**352.7**		**60**	**413**	**7.2**	**(16.2)**	**0.0**	**(0.1)**			**404**
									Total Inflows:		**425**					**Total Inflows:**		**413**					**Total Excess Water:**		**404**
									Total Outflows:		**0**					**Total Outflows:**		**0**							

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.

2030 Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	2.2	3.24	48.5	3.5	0.0	2.0	0.71		11.3	1.0	(1.5)	54.2	0.8	(1.1)	4.5	36.7	37.1	37.4	9.0	0.3	9.3	9.3	0.0	9.3
Nov.	5.2	1.68	47.0	8.6	3.3	0.0	0.52		0.0	2.5	(0.8)	61.1	1.8	(0.6)	(5.6)	31.1	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	6.6	1.21	48.5	10.8	20.7	0.0	0.52		0.0	3.1	(0.6)	83.1	2.3	(0.4)	(3.0)	28.0	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	9.5	1.48	48.5	15.7	43.7	0.0	0.37		0.0	4.5	(0.7)	112.1	3.3	(0.5)	4.9	32.9	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	5.9	1.95	43.8	9.7	8.0	0.0	0.46		0.0	2.8	(0.9)	63.8	2.1	(0.7)	1.2	34.1	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	6.0	3.02	48.5	9.8	0.0	0.0	0.37		0.0	2.8	(1.4)	60.1	2.1	(1.1)	1.1	35.2	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	3.3	4.57	47.0	5.4	0.0	1.8	0.58		11.9	1.5	(2.2)	54.2	1.1	(1.6)	3.0	38.2	38.2	8.8	9.8	0.3	10.1	10.1	0.0	10.1
May	1.2	5.97	48.5	1.9	0.0	8.0	0.55		61.7	0.6	(2.8)	56.7	0.4	(2.1)	0.0	38.2	38.3	54.9	52.5	1.2	53.7	53.7	0.0	53.7
Jun.	0.4	7.19	47.0	0.7	0.0	11.6	0.25		89.4	0.2	(3.4)	56.3	0.2	(2.5)	(8.1)	30.0	30.4	71.8	76.1	1.7	77.8	77.8	0.0	77.8
Jul.	0.1	7.64	48.5	0.2	0.0	13.0	0.58		99.9	0.1	(3.6)	58.7	0.0	(2.7)	(3.6)	26.4	26.9	83.4	85.0	1.9	86.9	86.9	0.0	86.9
Aug.	0.2	6.98	47.0	0.4	0.0	11.6	0.49		89.4	0.1	(3.3)	56.3	0.1	(2.4)	0.9	27.3	27.7	78.1	76.1	1.7	77.8	77.8	0.0	77.8
Sep.	0.6	4.99	48.5	1.0	0.0	10.2	0.43		59.9	0.3	(2.4)	58.1	0.2	(1.7)	5.4	32.2	32.2	62.4	48.6	1.1	49.7	49.7	0.0	49.7
Total, AFY	**41.1**	**49.9**	**571**	**67.7**	**75.7**	**58.2**	**5.83**		**423.5**	**19.5**	**(23.7)**	**774.6**	**14.4**	**(17.5)**	**0.5**			**413.2**	**357.1**	**8.2**	**365.3**	**365.3**	**0**	**365.3**

Base City Flow	0.510	mgd
Town Field Runoff Calculation Parameters		
Soil Interception, inches	3	
Percent Infiltration, saturated soil	0.4	
Percent Infiltration, unsaturated soil	0.6	
Min 2-month Rainfall for Saturation, inches	10	
Max Precip Before Runoff Capture, inches	20	

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	0.32	0.32	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Storage 5	Percolation 6	Percolation 7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

(1) 1-in-100 year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In August, Column 16 is set to 21.2 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

2030 Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 0.32

	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7								Percolation Pond 6								
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/ Store Elsewhere
Oct.	86.0	4.3	2.1	2.1	83.9	0.3	0.2	0.2	0.0	47	47.0	0.9	(1.4)	0.0	(26.5)	0.0	73	73.0	0.7	(1.1)	0.0	(25.3)	0.0	OK	97.9
Nov.	99.1	1.2	0.0	0.0	99.1	0.0	0.0	0.0	0.0	68	68.0	2.3	(0.7)	0.0	69.6	25.8		43.8	1.7	(0.5)	0.0	25.1	25.1	OK	19.8
Dec.	116.0	0.0	0.0	0.0	116.0	0.0	0.0	0.0	0.0	88	88.0	2.9	(0.5)	0.0	90.4	25.8		90.4	2.1	(0.4)	0.0	0.0	25.1	OK	92.1
Jan.	142.9	0.0	0.0	0.0	142.9	0.0	0.0	0.0	0.0	110	110.0	4.2	(0.7)	0.0	113.5	25.8		113.5	3.1	(0.5)	0.0	0.0	25.2	OK	116.1
Feb.	98.1	0.0	0.0	0.0	98.1	0.0	0.0	0.0	0.0	64	64.0	2.6	(0.9)	0.0	65.7	25.8		65.7	1.9	(0.6)	0.0	(0.0)	25.2	OK	67.0
Mar.	95.2	0.0	0.0	0.0	95.2	0.0	0.0	0.0	0.0	60	60.0	2.6	(1.3)	0.0	61.3	25.8		61.3	1.9	(1.0)	0.0	(0.1)	25.1	OK	62.3
Apr.	88.9	1.8	2.5	2.5	86.4	0.0	0.2	0.2	0.0	48	48.0	1.4	(2.0)	0.0	47.4	25.8		47.4	1.1	(1.5)	0.0	(0.0)	25.1	OK	47.0
May	93.2	0.6	9.1	9.1	84.0	0.3	0.9	0.9	0.0	45	45.0	0.5	(2.6)	0.0	42.9	25.8		42.9	0.4	(1.9)	0.0	0.0	25.1	OK	41.3
Jun.	92.1	15.4	12.8	12.8	79.3	1.2	1.3	1.3	0.0	48	48.0	0.2	(3.2)	0.0	45.0	25.8		45.0	0.1	(2.3)	0.0	(0.1)	25.1	OK	42.9
Jul.	86.1	13.5	14.3	14.3	71.8	1.2	1.4	1.4	0.0	44	44.0	0.1	(3.4)	0.0	40.7	25.8		40.7	0.0	(2.5)	0.0	0.0	25.1	OK	38.2
Aug.	80.4	21.2	12.8	12.8	67.6	1.8	1.3	1.3	0.0	39	39.0	0.1	(3.1)	0.0	36.0	25.8		36.0	0.1	(2.3)	0.0	0.0	25.1	OK	33.8
Sep.	83.8	11.7	8.3	8.3	75.5	1.8	0.8	0.8	0.0	42	42.0	0.3	(2.2)	0.0	40.1	25.8		40.1	0.2	(1.6)	0.0	0.0	25.2	OK	38.6
Total, AFY	**1161.8**	**69.7**	**61.9**	**61.9**	**1099.9**	**6.8**	**6.1**	**6.1**	**0.0**	**703**	**703.0**	**18.2**	**(22.0)**	**0.0**	**626.1**		**73**	**700**	**13.4**	**(16.2)**	**0.0**	**(0.1)**			**697**

Pond 7	
Total Inflows:	**703**
Total Outflows:	**0**

Pond 6	
Total Inflows:	**700**
Total Outflows:	**0**

Total Excess Water: **697**

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.

2030 Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(17)	(16)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
	Climate Values, inches		Inflows, ac-ft							Treatment Ponds			Storage Pond 5					Golf Course Irrigation						
Month	Rainfall	Ref. ET	Base City	I&I	Town Field Runoff	COWRF Backwash	AWA Backwash	CDCR	ARSA	Rainfall	Evap.	Total Inflow to Pond 5	Rainfall	Evap.	To/From Storage	Net Storage	Historical Storage	Historical Demand	Theoretical Demand	Theoretical Pond Losses	Total Theoretical Demand	Provided by Partners	Provided by City	Total Provided
Oct.	2.2	3.24	48.5	3.5	0.0	2.0	0.71		11.3	1.0	(1.5)	54.2	0.8	(1.1)	5.7	37.9	37.1	37.4	9.0	0.3	9.3	9.3	0.0	9.3
Nov.	5.2	1.68	47.0	8.6	3.3	0.0	0.52		0.0	2.5	(0.8)	61.1	1.8	(0.6)	(6.6)	31.3	31.8	16.4	0.0	0.0	0.0	0.0	0.0	0.0
Dec.	6.6	1.21	48.5	10.8	20.7	0.0	0.52		0.0	3.1	(0.6)	83.1	2.3	(0.4)	(3.0)	28.2	28.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jan.	9.5	1.48	48.5	15.7	43.7	0.0	0.37		0.0	4.5	(0.7)	112.1	3.3	(0.5)	4.9	33.1	33.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Feb.	5.9	1.95	43.8	9.7	8.0	0.0	0.46		0.0	2.8	(0.9)	63.8	2.1	(0.7)	1.2	34.3	34.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mar.	6.0	3.02	48.5	9.8	0.0	0.0	0.37		0.0	2.8	(1.4)	60.1	2.1	(1.1)	1.1	35.4	35.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Apr.	3.3	4.57	47.0	5.4	0.0	1.8	0.58		11.9	1.5	(2.2)	54.2	1.1	(1.6)	3.2	38.5	38.2	8.8	9.8	0.3	10.1	10.1	0.0	10.1
May	1.2	5.97	48.5	1.9	0.0	8.0	0.55		61.7	0.6	(2.8)	56.7	0.4	(2.1)	(0.2)	38.3	38.3	54.9	52.5	1.2	53.7	53.7	0.0	53.7
Jun.	0.4	7.19	47.0	0.7	0.0	11.6	0.25		89.4	0.2	(3.4)	56.3	0.2	(2.5)	(8.1)	30.2	30.4	71.8	76.1	1.7	77.8	77.8	0.0	77.8
Jul.	0.1	7.64	48.5	0.2	0.0	13.0	0.58		99.9	0.1	(3.6)	58.7	0.0	(2.7)	(3.9)	26.3	26.9	83.4	85.0	1.9	86.9	86.9	0.0	86.9
Aug.	0.2	6.98	47.0	0.4	0.0	11.6	0.49		89.4	0.1	(3.3)	56.3	0.1	(2.4)	1.0	27.3	27.7	78.1	76.1	1.7	77.8	77.8	0.0	77.8
Sep.	0.6	4.99	48.5	1.0	0.0	10.2	0.43		59.9	0.3	(2.4)	58.1	0.2	(1.7)	5.0	32.2	32.2	62.4	48.6	1.1	49.7	49.7	0.0	49.7
Total, AFY	**41.1**	**49.9**	**571**	**67.7**	**75.7**	**58.2**	**5.83**		**423.5**	**19.5**	**(23.7)**	**774.6**	**14.4**	**(17.5)**				**413.2**	**357.1**	**8.2**	**365.3**	**365.3**	**0**	**365.3**

Base City Flow	0.510 mgd	
Town Field Runoff Calculation Parameters		
Soil Interception, inches	3	
Percent Infiltration, saturated soil	0.4	
Percent Infiltration, unsaturated soil	0.6	
Min 2-month Rainfall for Saturation, inches	10	
Max Precip Before Runoff Capture, inches	20	

LAA Information	Town Field	City Field	Golf Course	Golf Course Pond
Area, acres	57	5.6	130	3.1
Crop Coefficient	1.00	1.00	0.88	--
Irr. Efficiency	0.80	0.80	0.84	--

Pond Information	Treatment 1	Treatment 2	Treatment 3	Treatment 4	Storage 5	Percolation 6	Percolation 7
Surface Area, acres	1.5	1.2	1.0	2.0	4.2	3.9	5.3
Storage Volume, ac-ft					41.7	25.2	25.8
Feb.-May. Perc. Rate, in/d						0.0	0.0
Jun.-Jan. Perc. Rate, in/d						0.0	0.0

(1) 1-in-100 year rainfall from Ione NCDC station (#044283)
(2) Reference evapotranspiration from Plymouth CIMIS station (Station 227)
(3) = (Base City Flow) x (number of days in month) x 3.07
(4) = 3.07 x (I&I in million gallons]. I&I in million gallons = 0.539 x (rainfall in inches) - 0.012, using linear equation developed in this TM.
(5) = (Column 1 - Column 2 - interception of 3 inches - infiltration in inches)/(12 inches per foot) x (surface area of Town Field, 57 acres). If Column 1 > 8 inches, then set value of Column 1 to 8 inches.
Infiltration in inches = (percent infiltration) x (Column 1 - Column 2 - interception of 3 inches). If the sum of Column 1 in the current and previous month >= 10 inches, percent infiltration is 0.4. Otherwise, percent infiltration is 0.6.
(6) = (Column 9) x (Percentage of monthly COWRF influent flow discarded as backwash as defined in COGC TM) (see Attachment D)
(7) Average monthly AWA backwash flow from 2021 to 2024
(8) = 0. Assume no CDCR flow.
(9) = Column 21 / (1 - COWRF filter backwash percentage as defined in COGC TM) (see Attachment D)
(10) = (Column 1)/12 x (surface area of Ponds 1-4, 5.7 acres)
(11) = (Column 2)/12 x (surface area of Ponds 1-4, 5.7 acres)
(12) = Column 3 + Column 4 + Column 5 + Column 6 + Column 7 + Column 10 + Column 11
(13) = (Column 1)/12 x (surface area of Pond 5, 4.2 acres)
(14) = (Column 2)/12 x (surface area of Pond 5, 4.2 acres)
(15) = Column 12 + Column 13 + Column 14 - (Column 23 + Column 28 + Column 32 + Column 34)
(16) = Column 16 of previous month + Column 15 of current month. If this is greater than the Pond 5 volume of 41.7 acre-feet, Column 16 is set to 41.7.
In September, Column 16 is set to 0 and the value in Column 34 is adjusted so that the formula in Column 15 predicts this value.
(17) Monthly average storage volume in Pond 5 from 2019 to 2024
(18) Historical irrigation demand for COGC, from COGC TM (see Attachment D)
(19) = [Column 1 - (Column 2 x crop coefficient of 0.88)]/12 x (surface area of golf course, 130 acres) x (irrigation efficiency of 0.84). If Column 19 < 0, then set Column 19 to 0.
(20) = (Column 1 - Column 2)/12 x (surface area of golf course pond, 3.1 acres). If Column 20 < 0, then set Column 20 to 0.
(21) = Column 19 + Column 20
(22) = Column 21 - Column 23
(23) = 0. Assume no flow from the City.
(24) = Column 22 + Column 23

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

2030 Flows: 1-in-100 Rainfall Year Water Balance for City of Ione Wastewater Treatment Plant, No Percolation, Crop Coefficient of 1

	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)
	Town Field Irrigation				City Field Irrigation				Percolation Pond 7								Percolation Pond 6								
Month	Avail for Town	Historical Demand	Theoretical Demand	Provided by City	Avail for City	Historical Demand	Theoretical Demand	Provided by City	System Excess	Empty Pond 5	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Empty Pond 7	Total Flow to Pond	Rainfall	Evap.	**Potential** Perc.	To/From Storage	Cum. Storage	Check for System Overflow	Discharge/ Store Elsewhere
Oct.	86.0	4.3	6.5	6.5	79.5	0.3	0.6	0.6	0.0	41	41.0	0.9	(1.4)	0.0	(26.5)	0.0	67	67.0	0.7	(1.1)	0.0	(25.2)	0.0	OK	91.8
Nov.	100.3	1.2	0.0	0.0	100.3	0.0	0.0	0.0	0.0	69	69.0	2.3	(0.7)	0.0	70.6	25.8		44.8	1.7	(0.5)	0.0	25.1	25.1	OK	20.8
Dec.	116.2	0.0	0.0	0.0	116.2	0.0	0.0	0.0	0.0	88	88.0	2.9	(0.5)	0.0	90.4	25.8		90.4	2.1	(0.4)	0.0	0.0	25.1	OK	92.1
Jan.	143.1	0.0	0.0	0.0	143.1	0.0	0.0	0.0	0.0	110	110.0	4.2	(0.7)	0.0	113.5	25.8		113.5	3.1	(0.5)	0.0	0.0	25.2	OK	116.1
Feb.	98.3	0.0	0.0	0.0	98.3	0.0	0.0	0.0	0.0	64	64.0	2.6	(0.9)	0.0	65.7	25.8		65.7	1.9	(0.6)	0.0	(0.0)	25.2	OK	67.0
Mar.	95.4	0.0	0.0	0.0	95.4	0.0	0.0	0.0	0.0	60	60.0	2.6	(1.3)	0.0	61.3	25.8		61.3	1.9	(1.0)	0.0	(0.1)	25.1	OK	62.3
Apr.	89.1	1.8	7.8	7.8	81.3	0.0	0.8	0.8	0.0	42	42.0	1.4	(2.0)	0.0	41.4	25.8		41.4	1.1	(1.5)	0.0	(0.0)	25.1	OK	41.0
May	93.5	0.6	28.4	28.4	65.1	0.3	2.8	2.8	0.0	24	24.0	0.5	(2.6)	0.0	21.9	25.8		21.9	0.4	(1.9)	0.0	0.0	25.1	OK	20.3
Jun.	92.2	15.4	40.1	40.1	52.1	1.2	3.9	3.9	0.0	18	18.0	0.2	(3.2)	0.0	15.0	25.8		15.0	0.1	(2.3)	0.0	0.0	25.2	OK	12.8
Jul.	86.3	13.5	44.6	44.6	41.7	1.2	4.4	4.4	0.0	11	11.0	0.1	(3.4)	0.0	7.7	25.8		7.7	0.0	(2.5)	0.0	(0.1)	25.1	OK	5.3
Aug.	80.2	21.2	40.0	40.0	40.2	1.8	3.9	3.9	0.0	9	9.0	0.1	(3.1)	0.0	6.0	25.8		6.0	0.1	(2.3)	0.0	(0.0)	25.1	OK	3.9
Sep.	83.8	11.7	25.9	25.9	57.8	1.8	2.5	2.5	0.0	23	23.0	0.3	(2.2)	0.0	21.1	25.8		21.1	0.2	(1.6)	0.0	0.0	25.1	OK	19.6
Total, AFY	**1164.2**	**69.7**	**193.4**	**193.4**	**970.8**	**6.8**	**19.0**	**19.0**	**0.0**	**559**	**559.0**	**18.2**	**(22.0)**	**0.0**	**488.1**		**67**	**556**	**13.4**	**(16.2)**	**0.0**	**(0.0)**			**553**

Percolation Pond 7: Total Inflows: **559** — Total Outflows: **0**

Percolation Pond 6: Total Inflows: **556** — Total Outflows: **0**

Total Excess Water: 553

Legend for Cell Shading
- Value not directly used
- Historical value used as reference
- Independent variable (manual input)

(25) = (Column 16 of previous month) + Column 12 + Column 13 + Column 14 - Column 23. If Column 25 < 0, then set Column 25 to 0.
(26) Monthly average historical irrigation demand for Town Field from 2019 to 2024
(27) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of Town Field, 57 acres) x (irrigation efficiency of 0.8). If Column 27 < 0, then set Column 27 to 0.
(28) If Column 25 < Column 27, Column 25. Otherwise, Column 27.
(29) = Column 25 - Column 28. If Column 29 < 0, then set Column 29 to 0.
(30) Monthly average historical irrigation demand for City Field from 2018 to 2023.
(31) = [Column 1 - (Column 2 x crop coefficient of 0.32)]/12 x (surface area of City Field, 5.6 acres) x (irrigation efficiency of 0.8). If Column 31 < 0, then set Column 31 to 0.
(32) If Column 29 < Column 31, Column 29. Otherwise, Column 31.
(33) = (Column 16 from previous month) + Column 15 - (Pond 5 volume, 41.7 acre-feet). If Column 33 < 0, then set Column 33 to 0.
(34) Manually entered to move water between Pond 5 and Pond 7 to approximately match historical Pond 5 volumes. Positive values indicate flow from Pond 5 to Pond 7. Negative values indicate flow from Pond 7 to Town Field/City Field.
(35) = Column 33 + Column 34
(36) = (Column 1)/12 x (surface area of Pond 7, 5.3 acres)
(37) = (Column 2)/12 x (surface area of Pond 7, 5.3 acres)
(38) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 7, 5.3 acres). Percolation rate set to 0 inches per day.
(39) = Column 35 + Column 36 + Column 37 + Column 38 - Column 41
(40) = Column 40 of previous month + Column 39 of current month. If this is greater than the Pond 7 volume of 25.8 acre-feet, Column 40 is set to 25.8. If this is < 0, Column 40 is set to 0. In August, Column 40 must be <= 0 in order for the balance to work.
(41) Manually entered to move water between Pond 7 and Pond 6. Positive values indicate flow from Pond 7 to Pond 6. Negative values indicate flow from Pond 6 to Pond 7.
(42) If Column 40 >= Pond 7 volume of 25.8 acre-feet, Column 42 = (Column 40 of previous month) + Column 39 + Column 41 - 25.8. If Column 40 < 25.8, Column 42 = Column 41.
(43) = (Column 1)/12 x (surface area of Pond 6,3.9 acres)
(44) = (Column 2)/12 x (surface area of Pond 6, 3.9 acres)
(45) = (percolation rate in inches per day)/(12 inches per foot) x (number of days in month) x (surface area of Pond 6, 3.9 acres). Percolation rate set to 0 inches per day.
(46) = Column 42 + Column 43 + Column 44 + Column 45
(47) = Column 47 of previous month + Column 46 of current month. If this is greater than the Pond 6 storage volume of 25.2 acre-feet, Column 47 is set to 25.2. If Column 47 < 0, set to 0. In July, Column 47 must be <= 0 in order for the balance to work.
(48) If (Column 46 of current month) + (Column 47 of previous month) > Pond 6 storage volume of 25.2 acre-feet, Column 48 = "Overflow". Otherwise, Column 48 = "OK".
(49) Manually entered to move water between Pond 6 and New Storage/Disposal Site to ensure pond storage capacity is not exceeded.