ROBINSON NOBLE

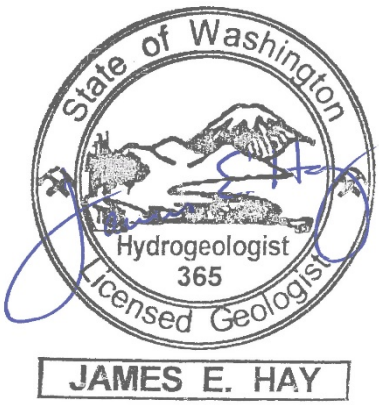
# Technical Memorandum

To: Henry Chen, Engineering and Capital Projects Director
Cascade Water Alliance

From: James E. Hay, LHG, CPG

Date: July 1, 2022

Subject: Independent Water Supply Audit
City of Redmond
(Robinson Noble project no.: 3400-001A)




## 1 – Audit Purpose

Cascade Water Alliance (Cascade) is a municipal corporation formed by its Member agencies under RWC 39.106, the Joint Municipal Utility Services Act. The seven Member agencies entered into the Cascade Joint Municipal Utilities Services Agreement, dated March 28, 2012 (the "Joint Agreement"). Cascade serves as a regional wholesale water supplier to its Members, some of which own independent water systems.

As a part of the water supply relationship under the Joint Agreement, Members with independent supply are responsible for maintaining that supply capacity and availability, with Cascade's supply obligation incremental to that independent supply. As a part of Cascade's original formation, each Member's water supplies were "audited" to determine both regulatory and physical capacity. These water supply audits formed part of the basis for, and terms of, membership and remain the basis for Members' independent supply obligations. Cascade is now conducting new and updated water supply audits of the four Members with independent supply, including the City of Redmond.

The results of these audits are only for Cascade's purposes of implementation of the Joint Agreement. The focus of these audits is to quantify the Members' available water supply capacity, both in terms of regulatory and infrastructure capacity, and their ability to meet established production requirements. The results will be used to update the inventory of Members' independent supplies, establish Members' independent supply capacity, and determine our Member's individual and collective ability to meet their related production requirements. Like prior audits, this evaluation primarily considers system characteristics and production data for a three-year period, in this case the 2017 – 2019 calendar years.

## 2 – Introduction

The City of Redmond is a municipal corporation that owns and operates a Group A community water system. Table 1 summarizes data for the system as presented in the Washington State Department of Health (Health) Water Facilities Inventory form, accessed on July 19, 2021. The City's water service area is shown in Figure 1.

*Table 1: City of Redmond Water System*

| | |
|---|---|
| **Water System Name:** | Redmond Water System, City of |
| **WSDOH System ID No:** | 71650 |
| **Address:** | 15670 NE 85th Street, Redmond, WA 98052 |
| **Operations Supervisor:** | John Burtsche |
| **Total Service Connections:** | 46,127 [a] |
| **Source Wells in Service:** | Well 1R, Well 2R, Well 3, Well 4, Well 5 |

[a] The total service connections indicated by Health on the WFI form (46,127) is the number of residential units that receive water from the water system. In contrast, purveyors typically count the physical number of service connections (19,015). This value is lower because a single, physical connection to a multi-family building serves multiple residential units.

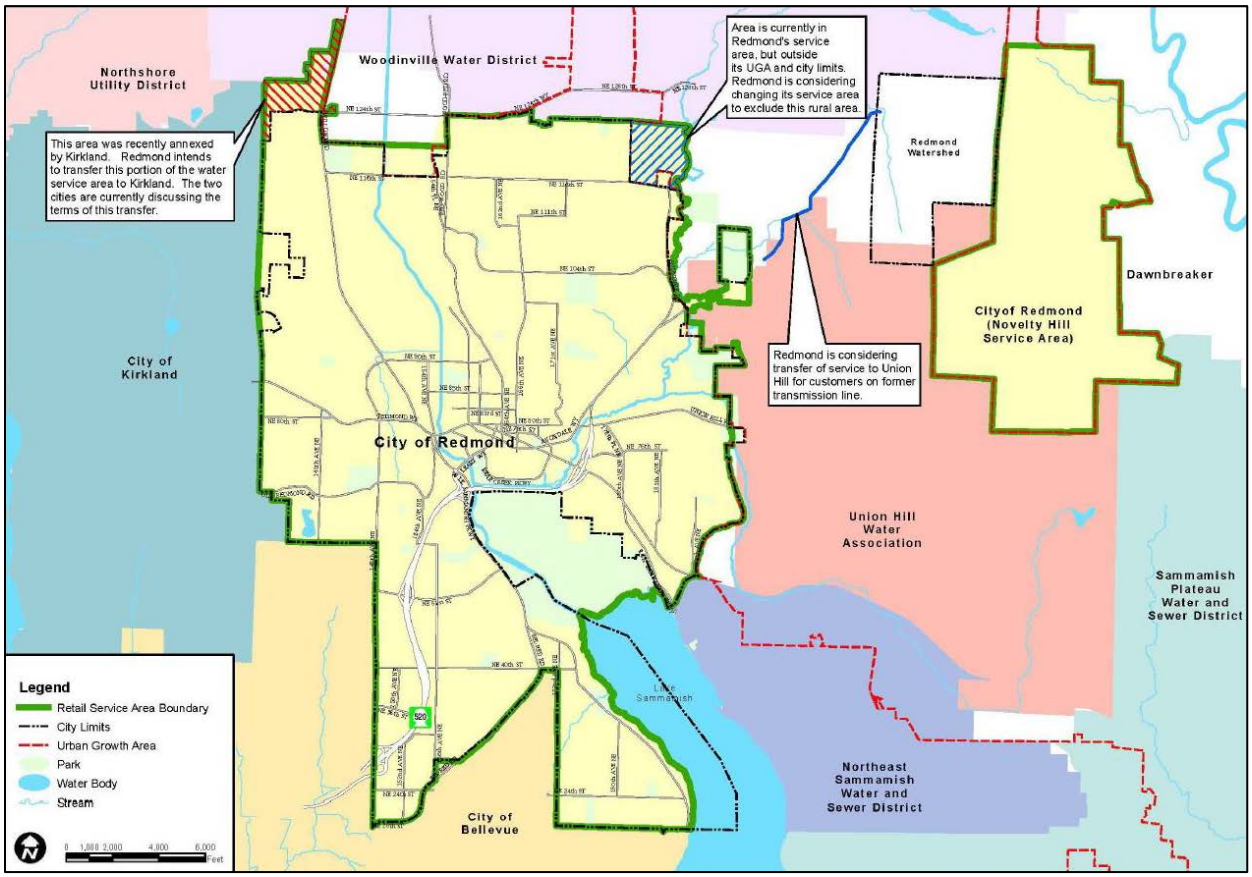



*Figure 1 Redmond Water System service area*
(excerpted from the City's 2011 Water System Plan)

## 3 – Independent Sources of Supply

The City currently has five source wells in service, summarized in Table 2.

*Table 2: Summary of Source Wells in Service*

| Well No. | Unique Well ID | Source No. | Year Drilled | Depth (ft bgs) [a] | Casing Diameter (in) [a] | Screen Diameter (in) | Screen Interval (ft bgs) | Test Rate (gpm) / year / SC (gpm/ft) [a,b] | Pump Capacity (gpm) |
|---|---|---|---|---|---|---|---|---|---|
| 1R | n/a [c] | 15 | 2003 | 82.5 | 24 | 24T [d] | 50 – 67 | 1,307 / 2003 / 71.0 | 900 |
| 2R | n/a [c] | 16 | 2003 | 86 | 24 | 18P [d] | 53 – 70 | 770 / 2003 / 29.5 | 500 |
| 3 | AAD-383 | 03 | 1968 | 46.5 | 12 | 10P | 36.5 – 46.5 | 513 / 1968 / 41.4 | 435 |
| 4 | AAS-270 | 04 | 1996 | 57 | 16 | 16T | 35 – 48 | 650 / 1997 / 40.6 | 578 |
| 5 | AAS-174 | 07 | 1983 | 41 | 20 | 18P | 20 – 35 | 1,530 / 1983 / 566.7 | 1,000 |

[a] ft bgs, feet below ground surface; in, inches; gpm, gallons per minute; SC, specific capacity; gpm/ft, gallons per minute per foot of drawdown

[b] Specific capacity, a measure of well efficiency calculated by dividing the production rate by the drawdown incurred, is technically only directly comparable for equivalent production rates and durations. Test durations, where specified, range from 24 hours (Well 5) to 72 hours (Wells 1R and 2R).

[c] No Unique Well I.D. is attached to the well and no Water Well Report is available in Ecology's online Washington State Well Report Viewer (which could be a database issue). Submittal of the Water Well report is the drilling contractor's obligation under WAC 173-160-141; however, the drilling contractor and the City have a shared obligation to tag wells with a Unique Well I.D. under WAC 173-160-311.

[d] "P" and "T" denote pipe- and telescope-size screen, respectively.

## 4 – Regulatory Status of Sources

### *4.1 – Water System*

The regulatory requirements for Group A water systems are specified in Chapter 246-290 WAC, governed by the Washington State Department of Health (Health). The fundamental planning and engineering document for water systems is their Water System Plan (WSP). The City's WSP, last updated in September 2011, contains detailed information about all aspects of the City's system, including infrastructure and service area, source approval, demand projections, production capacity, water rights, and overall regulatory compliance.

A summary of the City's wellhead protection plan, a primary source water protection requirement (WAC 246-290-135), is included in the WSP. The wellhead protection areas (WHPAs)[1] have been delineated for all four required TOT durations with numerical modeling techniques, widely considered to be the most sophisticated method of delineating the areas contributing water to source wells. How-

[1] A WHPA reflects a portion of the zone of contribution of water to a well, including both horizontal and vertical flow; however, WHPAs present a "flat" birds-eye view of the area contributing water to a well without respect to depth. Historically, WHPAs have consisted of three time-of-travel (TOT) boundaries: 1-year (Zone 1), 5-years (Zone 2), and 10-years (Zone 3). As of April 9, 1999, WAC 246-290-135(3)(c)(ii) requires that a six-month TOT boundary also be delineated as part of Zone 1.

ever, based on the WHPAs shown on Health's Source Water Assessment Program (SWAP) GIS Mapping Tool (GMT),[2] the WHPAs shown in the WSP appear to be an earlier generation of WHPAs, possibly derived analytically.[3,4] After its 2019 numerical modeling update, the City developed two Critical Aquifer Recharge Areas (CARAs), each of which included multiple TOT boundaries. The City plans to prepare an amendment to their WSP updating their TOT boundaries for compliance with WAC 246-290-100 and WAC 246-290-135.

Health also summarizes the current status of key aspects of the water system via reports accessible from Sentry Internet.[5] The Water Facilities Inventory Report, last updated on January 1, 2021, shows that Wells 1R, 2R, 3, 4, and 5 have the approved source numbers and pump capacities shown in Table 2. As of July 19, 2021, Health's Pre-Adequacy Data Summary Report indicates the City has a current and valid operating permit, a permit category color of green,[6] no current water quality violations or compliance actions, and the total approved connections are unspecified (not limited).

4.1.1 – Water Treatment

Source approval also indicates that water provided by the City's wells meets potable water standards after any necessary treatment and blending. As discussed in the WSP, water from all five wells is chlorinated and fluoridated. Water from all five wells is also pH-adjusted for corrosion control; this is accomplished with sodium hydroxide at Well 4 and $CO_2$-stripping at the other four wells. Well 4, when operating, adds a phosphate inhibitor to minimize the effects of iron and manganese in the water. This is done to sequester the iron and manganese, keeping it from precipitating out and staining household fixtures and clothes. The inhibitor is used when iron and manganese levels are elevated.

### *4.2 – Water Rights*

Water rights consist of an instantaneous quantity (gallons per minute, gpm) referred to as "Qi," and an annual quantity (acre-feet per year, afy), referred to as "Qa." These quantities may be additive or non-additive. Additive quantities define the full allocation of water that may be produced, whereas

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[2] https://www.doh.wa.gov/CommunityandEnvironment/DrinkingWater/SourceWater/GISMappingTool, accessed June 17, 2021.

[3] SWAP GMT shows two sets of overlapping WHPAs. The simpler, broader, and presumably older, WHPAs match the City's 6-month, 1-, and 5-year WHPAs shown on Figure 8-1 of the WSP; it is reasonable to assume that the narrower, more convoluted WHPAs correspond with the recent numerical modeling. The only 10-year WHPA in SWAP GMT appears to have been delineated with a numerical model.

[4] Four items were noted with respect to the TOT boundaries shown in Figure 8-1 of the WSP. First, each TOT boundary is given a sequential zone number. Per Health, the 1-year TOT boundary is Zone 1, which also contains the sanitary control area and the 6-month TOT boundary; the 5-year TOT boundary is Zone 2; the 10-year TOT boundary is Zone 3; and areas upgradient of Zone 3 are known as Buffer Zones. Second, Figure 8-1 does not have a traditionally delineated 10-year TOT boundary, rather "Zone 4" appears to be everything outside of the 5-year TOT boundary but within the City limits even though the 5-year boundary itself extends beyond the City Limits. Third, in some places, the easternmost limits of the 1- and 5-year WHPAs in the WSP and on SWAP appear to be erroneously constrained to the City's retail service area boundary. Finally, beyond the City's retail service area boundary, the 5-year WHPA seems oddly constrained along straight lines at the northern and eastern limits.

[5] https://fortress.wa.gov/doh/eh/portal/odw/si/Intro.aspx, accessed June 17, 2021.

[6] Per Health, "Systems in this category are considered adequate for existing uses and new service connections up to the number of approved service connections."

non-additive quantities provide flexibility in which sources produce the water. For the purposes of the current audit, it is the additive quantities that are most relevant.

As reflected in the Washington State Department of Ecology's (Ecology's) Water Right Tracking System (WRTS), the City maintains six groundwater rights authorizing an additive Qi of 3,680 gpm and an additive Qa of 5,005 afy, as summarized in Table 3. This data is consistent with that presented in the City's WSP.

*Table 3: Redmond Water System Groundwater Rights*

| | | Instantaneous Quantity (Qi) | | Annual Quantity (Qa) | |
|---|---|---|---|---|---|
| | Document No. | Additive | Non-additive | Additive | Non-additive |
| Wells in Service | | | | | |
| Well 1R | G1-*02043CWRIS<br>G1-00130CWRIS | 200 gpm<br>700 gpm [a] | | 224 afy<br>1,120 afy [a] | |
| Well 2R | G1-*04934CWRIS | 500 gpm [b] | | 381 afy [c] | 224 afy [c] |
| Well 3 | G1-*09901CWRIS | 480 gpm [d] | | 400 afy [d] | |
| Well 4 | G1-22608C | 800 gpm | | 1,280 afy | |
| Well 5 | G1-24204CWRIS | 1,000 gpm | | 1,600 afy | |
| | | 3,680 gpm | | 5,005 afy | |

[a] The WRTS entry indicates both Qi and Qa quantities are supplemental (non-additive), whereas the Report of Examination (ROE) and permit (initially for 1,000 gpm and 1,600 afy) split the Qa into 400 afy primary (additive) and 1,200 afy supplemental (non-additive). However, the Proof of Appropriation is annotated with 700 gpm and 1,120 afy and the certificate issued for these amounts without referencing supplemental quantities. The City's WSP states that a 2004 letter from Ecology confirms the full Qi and Qa quantities are primary (additive).

[b] The WRTS entry indicates the Qi is supplemental (non-additive); however, the permit, ROE, and certificate issued without this language. The City's WSP asserts the Qi is primary (additive).

[c] Ecology records are inconsistent as to whether the 381 or 605 afy is primary (additive). While the permit and certificate do not split the Qa into primary (additive) and supplemental (non-additive) quantities, the WRTS entry, the 1958 ROE for this right, and the 1969 ROE for G1-*09901CWRIS indicate that the Qa is split as shown. The WSP reflects this understanding that the 224 afy exercised as primary (additive) under G1-*02043CWRIS is thus supplemental (non-additive) under this right. However, both the 1976 ROE for G1-22608C and the 1983 ROE for G1-24204CWRIS include the entire 605 afy (in addition to the 224 afy under G1-*02043CWRIS) as primary (additive) when justifying the need for additional primary (additive) rights.

[d] The WRTS entry, ROE, and permit indicate both Qi and Qa quantities are supplemental (non-additive); however, the certificate issued without this language. The City's WSP asserts that both the Qi and Qa quantities are primary (additive) because the rights for Wells 1R, 2R, and 3 collectively fall below the 2,420 afy cap indicated in the ROE.

## 5 – Physical Status of Sources

Site visits to all five wells were conducted on February 14, 2020. Based on the information reviewed, all five wells appear substantially compliant with Chapter 18.104 RCW (Water Well Construction) and the subsequent WAC 173-160 (Minimum Standards for Construction and Maintenance of Wells).[7,8] The physical capacity of the City's wells to produce water is summarized below. For Wells 1 – 4, this capacity is indicated by both historical pump test data and the capacity of the installed pump. In the

[7] Note that Well 3 was constructed prior to the July 1, 1971, effective date of Chapter 18.104 RCW.

[8] The lack of Unique Well IDs and Water Well Reports for Wells 1R and 2R are minor deficiencies.

case of Well 5, this data also includes the results of a pump test conducted by City personnel as part of the audit process. Note that actual production capacities may be constrained by a variety of factors that are not evaluated here, including: short- and long-term variations in water level, groundwater recharge, and water quality; and both operations and resource management decisions.

### *5.1 – Well 1R*

According to this well's construction and testing report, Well 1R was originally tested at a constant rate of 1,344 gpm for 34 hours, then the rate was reduced to 1,277 gpm until the test was concluded at 72 hours; the average pumping rate for the test duration was estimated at 1,307 gpm. At the end of the test, the drawdown was "about 18.4 feet" (55% of available drawdown), indicating a 72-hour specific capacity of 71 gpm/ft. The installed well pump is capable of 900 gpm, and the discharge pipe, valves, and flow meter are 8-inch diameter.

### *5.2 – Well 2R*

According to this well's construction and testing report, Well 2R was originally tested at a constant rate of 770 gpm for 72 hours. At the end of the test, the drawdown was 26.14 feet (69% of available drawdown), indicating a 72-hour specific capacity of 29.5 gpm/ft. The installed well pump is capable of 500 gpm, and the discharge pipe, valves, and flow meter are 6-inch diameter with 8-inch distribution piping.

### *5.3 – Well 3*

According to this well's construction and testing report, Well 3 was tested at a rate of 513 gpm for an unspecified duration. At the end of the test, the drawdown was 12.4 feet (75% of available drawdown), indicating a specific capacity of 41.4 gpm/ft. The installed well pump is capable of 435 gpm, and the discharge pipe and valves are 4-inch diameter with 6-inch flow meter and distribution piping.

### *5.4 – Well 4*

According to this well's construction and testing report, Well 4 was tested at an average rate of 650 gpm for 52 hours. At the end of the test, the drawdown was 16 feet (84% of available drawdown), indicating a 52-hour specific capacity of 40.6 gpm/ft. The installed well pump is capable of 578 gpm, and discharge pipe and valves are 4-inch diameter with 8-inch flow meter and distribution piping. As of early 2018, however, production from Well 4 has been constrained due to declines in well efficiency and elevated levels of manganese.

### *5.5 – Well 5*

According to this well's construction and testing report, Well 5 was tested at a constant rate of 1,530 gpm for 24 hours. At the end of the test, the drawdown was 2.7 feet (21% of the available drawdown), indicating a 24-hour specific capacity of 566.7 gpm/ft. The installed well pump is capable of 1,000 gpm, and discharge pipe, valves, and flow meter are 8-inch diameter.

On October 8th, 2020, City personnel conducted a roughly 8.7-hour step-rate test of Well 5. Prior to the test, the well was offline for 14.4 hours, and the static water level was steady at 20.45 feet below top of casing. The well was pumped at 502, 751, and 888 gpm for between 68 and 87 minutes each; the last step, 1,005 gpm, was run for 4.9 hours. Drawdown slopes at each step were very essentially flat, and the 60-minute specific capacity values were 1,256, 1,073, 888, and 837 gpm/ft, respectively. Total drawdown at the end of the test was 1.3 feet by which point the average pumping rate had declined to roughly 1,003 gpm, indicating an 8.7-hour specific capacity of 771.6 gpm/ft. The

projected 24-hour specific capacity is estimated at 678 gpm/ft; although not directly comparable to the 1,530-gpm test at construction, it does not appear that the well's efficiency has changed considerably. At the 1,000-gpm rate, the well uses roughly 1.5 feet of drawdown (12% of the available drawdown) after 24 hours of continuous production.

### *5.6 – Interties*

In addition to multiple interties with the Cities of Bellevue, Kirkland, and Seattle as well as Sammamish Plateau Water & Sewer District for access to water supplied by Cascade, the City has six emergency intertie locations: three locations are connected to Union Hill Water Association (UHWA), two are connected to Woodinville Water District (WWD), and one is connected to Northeast Sammamish Sewer and Water District (NSSWD).

The City has three agreements with UHWA for the 224th Avenue NE intertie, Redmond Ridge Drive/238th Avenue NE Intertie, and the NE 92nd Street Intertie. The agreements for all of the interties are for emergency purposes, meaning unforeseen circumstances of short duration resulting from a failure of either parties' water system equipment or piping that necessitates transfer of water from one of the parties to the other to meet life safety demands and satisfy minimum levels of service for customers. The 224th Avenue NE intertie is a 12-inch diameter pipe located at the intersection of 224th Avenue NE at Novelty Hill Road near the northern edge of the Redmond Ridge Development. The Redmond Ridge Drive/238th Avenue NE Intertie is a 12-inch diameter pipe located at the intersection of Redmond Ridge Drive at the southern edge of the Redmond Ridge development adjacent to NE 80th Street. The NE 92nd Street Intertie is an 8-inch diameter pipe located within NE 92nd Street immediately west of Redmond Ridge Development near 220th Avenue NE.

The City has two agreements with WWD for the NE 133rd Street Intertie and 232nd Avenue NE Intertie. The NE 133rd Street Intertie is located adjacent to NE 133rd Street and the northwestern edge of the Trilogy at Redmond Ridge Development. This intertie will predominately serve WWD. The 232nd Avenue NE intertie is located adjacent to 232nd Avenue NE at the northern edge of the City's service area boundary in the Trilogy at Redmond Ridge Development. This intertie will predominately serve the City. The City shall use both interties during emergencies to protect lives or property.

The City has an agreement with NSSWD for a 12-inch diameter emergency intertie with a meter located at the intersection of 187th Avenue NE and NE 55th Street to provide both the City and NSSWD with emergency sources of water. The agreement is for emergency purposes that requires immediate operation to protect lives or property.

## 6 – Cascade Production Requirements

Combined production, in millions of gallons, from these five wells for 2017 through 2019 calendar years is presented in Table 4 (peak month and year **underlined and in bold**; peak season shaded).[9]

[9] This audit only considers production data from 2017 – 2019; it was not finalized until 2022 due to delays caused by the COVID-19 pandemic.

*Table 4: 2017 - 2019 Production (millions of gallons)*

| | J | F | M | A | M | J | J | A | S | O | N | D | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017 | 68.48 | 63.94 | 71.09 | 72.82 | 81.02 | 104.05 | 103.94 | 105.50 | 103.54 | 81.81 | 65.02 | 70.82 | 992.02 |
| 2018 | 70.62 | 60.09 | 71.28 | 72.37 | 97.18 | 109.57 | 106.09 | 104.48 | 90.76 | 83.32 | 71.80 | 75.81 | 1,013.37 |
| 2019 | 68.14 | 65.49 | 77.08 | 78.26 | 101.85 | 100.68 | 100.19 | 102.27 | 96.19 | 73.84 | 71.72 | 72.43 | 1,008.13 |
| Average | 69.08 | 63.17 | 73.15 | 74.48 | 93.35 | 104.77 | 103.41 | 104.08 | 96.83 | 79.66 | 69.51 | 73.02 | 1,004.51 |

As a Member of Cascade, the City agreed to maximum production requirements from their independent supply sources, based on three-year production averages (2001 – 2003).[10] Though there is a general waiver of production requirements currently in effect, Table 5 summarizes the City's recent average and peak-season day production, based on the data from Table 4, and peak-day values based on both well pump capacity[11] (Table 2) and additive instantaneous (Qi) water rights (Table 3).[12,13]

*Table 5: Independent Source Production Summary*

| Production Metric | Production Requirement | 2017 – 2019 Values | Peak Year (2018) Values | Peak Year Difference |
|---|---|---|---|---|
| Average Day | 2.60 MGD | 2.75 MGD | 2.78 MGD | 0.18 MGD |
| Peak-season Day | 3.51 MGD | 3.35 MGD | 3.37 MGD [a] | (0.14 MGD) [a] |
| **Production Metric** | **Production Requirement** | **Peak-day Values** | | **Peak-day Difference** |
| Peak-day Capacity | 3.90 MGD | 4.10 MGD (pump capacity)<br>4.42 MGD (additive water rights) | | 0.20 MGD<br>0.52 MGD |

[a] While 2018 is the overall Peak Year, the Peak Season production total for 2017 (417.03 MG) is slightly higher than the Peak Season production total for 2018 (410.90 MG). The Peak-season Day for 2017 is 3.42 MGD, which is only 0.09 MGD below the Cascade maximum production requirement of 3.51 MGD.

## 7 – Recommendations

### 7.1 – Unique Well IDs

While minor, it is a regulatory deficiency that no Unique Well ID is present on either Wells 1R or 2R. The City has this well tagging obligation under WAC 173-160-311(2) and submittal of this ID to Health

[10] As defined in the Member Water Audit prepared for Cascade, dated May 23, 2008.

[11] Note that this simple sum of pump capacities may be an overestimate of actual production capacity as it makes no allowance for drawdown interference between wells.

[12] Average Day production calculated by dividing the three-year average annual production by 365 days. Peak-season Day production calculated by dividing the three-year average peak season production (June through September) by 122 days. Peak-day capacity calculated by multiplying instantaneous capacity (either pump capacity or additive Qi water rights) multiplied by 20 hours of production (83.3% of maximum production).

[13] Members must manage their resources to meet a wide variety of physical and regulatory constraints, so production history may not be indicative of the ability or intent to produce a maximum volume of water in any given year.

is required under WAC 246-290-130(4)(f); however, Health does not consistently enforce this requirement, as evidenced by ongoing approvals of the City's WSP, so this does not impact the City's ability to meet its Cascade production requirements.

*Recommendation*: The City should request Unique Well ID tags from Ecology, permanently attach them to Wells 1R and 2R, submit completed tagging reports to Ecology, and provide this information to Health.

7.2 – Water Well Reports

Submittal of the Water Well Report within 30 days after completion of a well or after the drilling equipment has left the site is the drilling contractor's obligation under WAC 173-160-141(1). If this was either not done or the report is missing (and not Ecology's database omission), this is a regulatory deficiency.

*Recommendation*: Once obtained, the City should forward the Unique Well IDs for Wells 1R and 2R to the drilling contractor and request they submit Water Well Reports to Ecology. The City may also submit their own Water Well Report to Ecology under WAC 173-160-141(4) using the information in Appendix A of both well construction and testing reports. Copies of the Water Well Reports should also be submitted to Health.

7.3 – Wellhead Protection Plan

The presence of two sets of TOT boundaries in Health's SWAP GMT database is problematic, as it confounds Health's intent to publicize utilities' current WHPAs to help database users to prevent source contamination. This is not the City's deficiency, as Health has the correct WHPAs (in addition to the older, incorrect WHPAs); however, it is in the City's and Cascade's interest to have this corrected.

*Recommendation*: None beyond the planned amendment to the City's WSP updating their TOT boundaries for compliance with WAC 246-290-100 and WAC 246-290-135 and subsequent verification that the information in the SWAP GMT database is correct.

## 8 – Conclusion

The purpose of this audit has been to summarize current production status and alert members to potential risks, now and in the future. It is intended to be used by Members to help ensure that they remain able to comply with their contractual obligations to Cascade.

All Cascade Members, including the City of Redmond, have complied with their contractual production requirements to-date, particularly given the production waivers for all three metrics (Average Day, Peak-season Day, and Peak-day Capacity) discussed above. At some point, should such waivers expire and not be further extended, this audit and the production history indicate an ability to substantively meet the independent production requirements. Peak year production (2018) indicates that system capacity has largely met or exceeded the production requirements. The City maintains pump capacity and additive water rights in excess of its Peak-day Capacity commitment.