Gray & Osborne, Inc.
CONSULTING ENGINEERS

MEMORANDUM

TO:	DENNY SCOTT, WATER SYSTEM SUPERINTENDENT
FROM:	WARREN PERKINS, P.E. MIKE JOHNSON, P.E.
DATE:	JULY 10, 2021
SUBJECT:	WATER DEMAND REPORT TASK 2 – HYDRAULIC ANALYSIS, NORTH BEND CONNECTION ANALYSIS SALLAL WATER ASSOCIATION, KING COUNTY, WASHINGTON G&O #20544.00

EXECUTIVE SUMMARY

This memo assesses the ability of the Sallal Water Association to receive water from the City of North Bend while providing mitigation water from Sallal to North Bend. This memo also outlines the infrastructure necessary for exchange of water between North Bend and Sallal.

Hydraulic modeling was completed to assess the amount of water that could be obtained from North Bend into the Sallal 710 Zone. The following conclusions were drawn from this modeling:

1. Under all scenarios modeled, Sallal will be able to receive water from North Bend to meet demand and refill the reservoirs in the eastern part of the system as needed as a part of their normal fill/draw cycle.

2. Lowering the HGL of the 710 pressure zone to 701 feet increases the amount of water that can be transferred from North Bend to Sallal.

3. If the intertie and booster station is located near the intersection of 436th Avenue SE and North Bend Way, Sallal would be able to receive water from North Bend at a higher rate than if it is located at the west end of the system.

It is anticipated North Bend will likely require mitigation water from Sallal in September or October of each year if mitigation water is not available from Hobo Springs. Sallal currently has 1,691 gpm of instantaneous water rights. Reviewing recent maximum day water demands in September and October and projecting them forward, it is anticipated

that Sallal may have maximum day water demands of 826 gpm in September and October by 2040. This could leave approximately 865 gpm of water available for Sallal to provide to North Bend in September and October. If additional water is need for mitigation, hydraulic modeling shows that Sallal could obtain this from North Bend through the proposed intertie booster station into the 710 zone while still supplying demands in the upper zones with its own sources.

If North Bend were to need mitigation water during peak demand times of July and August, Sallal would have less water available to provide for mitigation. Current maximum day demands in July and August are approximately 1,000 gpm. By 2040, Sallal maximum day demands are projected to be 1,200 gpm. This would leave approximately 691 gpm available for mitigation in July and August currently, and approximately 491 gpm available for mitigation in July and August by 2040.

Recommended improvements to allow transfer of water from North Bend to Sallal include:

1. Construction of a duplex booster station near 436th Avenue SE
2. Adjustment of pressure reducing valves to lower the hydraulic grade of the 710 zone to 701 feet.

Recommended improvements to allow transfer of mitigation water from Sallal to North Bend include:

1. Connect the Well 2 piping to the North Bend mitigation line
2. Equip Well 2 with a variable speed drive.

INTRODUCTION

The intent of this analysis is twofold. First, assess the ability of the Sallal Water Association to receive water from the City of North Bend to meet member demand while providing mitigation to North Bend. Second, outline the infrastructure necessary for the exchange of water between North Bend and Sallal as stated in the water right documentation for the North Bend Centennial Well.

Current and future water demand by Sallal members was estimated in Task 1.

The Record of Examination for the water right for North Bend's Centennial Well states the following:

> *Up to 35% of Sallal's water right, 243.6 AFY, is available to North Bend from Sallal wells 1 and 2 for mitigation purposes as a supplement to the Hobo Springs source (p. 18). With all of the Sallal Well capacity in place, North Bend will have instantaneous access to at least 800 gpm during phase one construction with expansion to 1,000 gpm during phase two (p. 19).*

Based upon the Record of Examination, North Bend may request that Sallal provide up to 243.6 acre-feet (ac-ft) of water annually to North Bend and up to 1,000 gallons per minute (gpm) on an instantaneous basis. If Sallal provides mitigation water to North Bend, that water transfer is likely to occur in late September and early October when the Chester Morse Reservoir and Masonry Pool are at their lowest annual levels and leakage through the Masonry Dam, which sustains Hobo Springs flow, is at its lowest.

BACKGROUND

The following sections describe the configuration of the existing Sallal and North Bend distribution systems in the vicinity of the potential interconnection points and how potential connections might be made.

Provision of Water from North Bend to Sallal

The North Bend system adjacent to Sallal's west boundary has a hydraulic grade line elevation of 594 feet. The Sallal hydraulic grade line in this area is currently 710 feet. In order for Sallal to receive water from North Bend, a booster pump station will be needed that will boost the pressure by approximately 50 pounds per square inch (psi).

The Sallal 710 Zone, under normal operations, receives water from the Uplands and Rattlesnake Reservoirs and the Rattlesnake Wells. Water flows north through the system through a series of pressure reducing valves (PRVs). The final PRVs are the Chapman and the Riverbend PRVs located a short distance south of the South Fork Snoqualmie River (Figure 1). Water is then pumped from the 710 Zone into the higher easterly zones by three existing booster stations, Tanner, Lower Mount Si, and River Point. Under emergency situations, water also may be transferred back from the easterly zones to the 710 Zone.

PRVs modulate flow to maintain a manually set pressure/hydraulic grade line, in this case an elevation of 710 feet in Sallal's lowest zone. (The pressure in the zone varies as elevation varies, but the hydraulic grade line is constant in low-flow conditions.) Increasing the pressure on the downstream side of the PRVs by introducing another water source into the zone will reduce flow through the PRVs. If pressure/alternate source flow

is increased sufficiently, flow through the PRVs will be shut off. The largest pressure increase will be at the location of the North Bend connection to the Sallal system. Pressure increase will dissipate moving away from the connection point.

In the past, the general assumption had been that Sallal would pump from the North Bend system into its distribution network at the west end of the Sallal system into the 710 Pressure Zone near the North Bend Public Works facility.

Three changes have occurred that may allow for an increased rate of water transfer from North Bend to Sallal relative to earlier analyses. First, the assumption for this connection location was based upon Sallal taking unchlorinated water directly from the Centennial Well wellhead. Since the Sallal system is now chlorinate, receiving unchlorinated water is no longer a requirement.

Second, the Sallal 710 Zone historically was maintained at a hydraulic grade line of 701 feet until the construction of the Tannerwood plat. Though Sallal was providing pressure to the higher elevation services in the plat in accordance with DOH and WAC requirements, members at the highest elevation were dissatisfied with the pressure. Sallal thus raised the hydraulic grade line to 710 feet (approximately 4 psi) by adjustment of the Riverbend and Chapman PRVs feeding the zone. Upon completion of Phase 3 of the Tanner Road plat, Sallal staff was able to provide water to the higher elevation services in the Tannerwood plat from the higher zone (793 Zone), thus allowing for the potential reduction in the hydraulic grade line back to 701 feet. The west end of the Sallal system adjacent to North Bend has the highest pressure in the system, currently approximately 97 psi. Increasing the pressure at the west end of the system more than about 5 psi to above102 psi due to pumping from North Bend to Sallal is not advised since portions of this area of the Sallal system are served by PVC and asbestos-cement (AC) water mains. If the 710 Zone were lowered to 701 feet, the potential available driving pressure due to addition of North Bend Water at the west end of the Sallal system could be increased from 5 to 9 psi. We do not recommend lowering the hydraulic grade line below 701 feet as other services may become dissatisfied with low pressure, and internal fire suppression sprinkler systems may not function as designed.

Third, the North Bend system is soon to extend into the Sallal service area to provide water to the Cedar River Partners, Dahlgren Property. Relocation of the intertie point to the east would place it closer to the PRVs supplying water to the 710 Zone and it would therefore be more effective at slowing the flow from the PRVs. Additionally, the point of increase pressure due to the addition of water from North Bend moved away from the west end of the system where highest pressures occur towards areas with lower static pressure.

Provision of Water from Sallal to North Bend

The connection point for Sallal to deliver water to North Bend is near the Rattlesnake Wells on Cedar Falls Road so that it may flow into the Boxley Creek mitigation system. Sallal may provide water to North Bend directly from Well 2 or potentially from its distribution system. Delivery of water from Well 2 will require extension of the Well 2 CT water main, installed in the spring of 2020. Non-chlorinated water would be delivered by isolating the Well 2 CT water main from the Sallal distribution system with existing valves and turning off the chlorination system. The rate of mitigation water delivery would be directly controlled by the Well 2 production rate. Currently Well 2 has a constant speed pump whose discharge rate could be controlled by throttling a valve. If a variable speed drive was added to Well 2, the production rate could be varied more efficiently.

As an alternative to using water directly from Well 2, North Bend could tap into the Sallal distribution system, in which case the delivery rate would be controlled by a control valve between the two systems. If North Bend were to connect directly to the Sallal distribution system, North Bend would need to dechlorinate the water prior to entry into the mitigation system. This would require a more intensive chemical feed and control system.

HYDRAULIC ANALYSIS

The hydraulic model of the Sallal water distribution system that was developed as part of the Water System Plan was used to estimate the potential delivery rate of water from North Bend to Sallal under various scenarios. All scenarios assumed the current 710 Zone would revert back to the 701 Zone, except Scenario 2A which was completed for comparative purposes. In all scenarios, the assumed criteria that limited transfer of water from North Bend to Sallal was maintaining the distribution pressure at the west end of the system below 102 psi. The following scenarios were considered:

1. No intertie with North Bend
2a. 2019 Average Day Demands – Sallal HGL = 701 feet – Intertie at West End
2b. 2019 Average Day Demands – Sallal HGL = 710 feet – Intertie at West End
3. 2019 Average Day Demands – Sallal HGL = 710 feet – Intertie at 436th
4. 2040 Average Day Demands – Sallal HGL = 710 feet – Intertie at West End
5. 2040 Average Day Demands – Sallal HGL = 710 feet – Intertie at 436th
6. 2019 Maximum Day Demands – Sallal HGL = 710 feet – Intertie at West End
7. 2019 Maximum Day Demands – Sallal HGL = 710 feet – Intertie at 436th
8. 2040 Maximum Day Demands – Sallal HGL = 710 feet – Intertie at West End
9. 2040 Maximum Day Demands – Sallal HGL = 710 feet – Intertie at 436th

TABLE 1

Transfer of Water to Sallal Scenarios

Scenario	Demand Year	Zone HGL (ft)	Transfer Location	Flow from North Bend (gpm) (1)	Tanner BPS Flow (gpm) (2)	Flow from PRVs (gpm) (1)	Edgewick Reservoirs Fill Rate (gpm)	Daily Sallal Demand Met with North Bend Water (gpm) (3)
1	2040	701	None	0				
Average Day								
2	2019	701	West End	457	398	95	377	80
2A	2019	710	West End	217	438	390	447	0
3	2019	701	436th Avenue	613	441	0	421	192
4	2040	701	West End	477	402	180	377	100
5	2040	701	436th Avenue	703	447	0	422	281
Maximum Day								
6	2019	701	West End	507	388	325	333	174
7	2019	701	436th Avenue	880	435	0	379	500
8	2040	701	West End	563	378	230	315	248
9	2040	701	436th Avenue	1,093	434	0	370	723

(1) Maximum instantaneous flow with boosters running while maintaining less than102 psi at west end of system. When booster stations are not running, flow from North Bend will match member instantaneous demand in the 701 zone.

(2) Represents the instantaneous flow rate of the booster station.

(3) The difference between Flow from North Bend and the Edgewick Reservoirs Fill Rate.

The following conclusions can be drawn from the hydraulic modeling results summarized in Table 1.

1. Under all scenarios modeled, Sallal will be able to receive water to meet demand and refill the reservoirs in the eastern part of the system as needed as a part of their normal fill/draw cycle.

2. Lowering the HGL of the 710 pressure zone to 701 feet increases the amount of water that can be transferred from North Bend to Sallal.

3. If the intertie and booster station is located near the intersection of 436th Avenue SE and North Bend Way, Sallal would be able to receive water from North Bend at a higher rate than if it is located at the west end of the system.

Possible locations for the booster station near 436th Avenue include the strip of land between Tanner Road and North Bend Way or an easement from the Covenant Church, if the church is amenable. Short platting the Covenant Church property would likely trigger plat requirements from North Bend.

POTENTIAL WATER TRANSFER AMOUNTS FROM NORTH BEND TO SALLAL

The Centennial Well Record of Examination states that water from North Bend may be used to serve the Urban Growth Area (UGA), understood to mean the city limits and its associated UGA.

> *North Bend's water service area covers approximately 8.5 square miles. Additionally, North Bend's service area includes and specifically designates the wholesaling of water to the Sallal Water Association for service within the North Bend UGA.* (Section 2.2.1)

The Department of Ecology has stated that the accounting of water purchased from North Bend and sold by Sallal needs to happen on an annual basis (email from Jay Cook May 11, 2020). Assuming Sallal mitigation to North Bend is most likely to occur in the late summer and early fall, Sallal may need to purchase water from North Bend early in the year to be able to transfer up to of 243.6 ac-ft of mitigation water back to North Bend.

Task 1 estimated the demand in the various hydraulic zones for Sallal. The data tables in that task are reproduced below in Tables 2 through 5.

TABLE 2

Hydraulic Zone 2019 ERUs and Production

Zone	Zones that Potentially May Receive North Bend Water								Zones that Cannot Receive North Bend Water Without Additional Booster Stations										Total
	710	**793**	**840**	**883**	**903**	**920**	**1009**	**Subtotal**	**872**	**900**	**956**	**1056**	**1085**	**1086**	**1100**	**1156**	**1215**	**Subtotal**	
ERUs (2019)	1,337	357	88	93	18	38	69	2,000	10	24	1	78	6	15	13	24	601	771	**2,772**
Avg. Day Production (gpm)	174	46	11	12	2	5	9	260	1	3	0.1	10	1	2	2	3	78	100	**361**
Max. Day Production (gpm)	449	120	30	31	6	13	23	672	3	8	0.4	26	2	5	4	8	202	259	**931**
Peak Hour Production (gpm)	763	204	50	53	10	22	39	1,142	5	14	0.6	44	4	8	7	14	343	440	**1,582**
Annual (ac-ft/yr)	281	75	19	20	4	8	14	420	2	5	0.2	16	1	3	3	5	126	162	**582**

(1) Zones to the left of the first Subtotal column may potentially receive water from North Bend via existing Sallal booster pumps.
(2) Production equals the sum of all demands; consumption, DSL, flushing, etc.

TABLE 3

City, UGA, and County 2019 ERUs and Production

Zone	City	UGA	County	Total
ERUs (2019)	1,029	355	1,388	**2,772**
Average Day Production (gpm)	134	46	181	**361**
Maximum Day Production (gpm)	346	119	466	**931**
Peak Hour Production (gpm)	587	202	793	**1,582**
Annual (ac-ft/yr)	216	74	292	**582**

TABLE 4

Hydraulic Zone 2040 ERUs and Production

	Zones that Potentially May Receive North Bend Water								Zones that Cannot Receive North Bend Water Without Additional Booster Stations										
Zone	**710**	**793**	**840**	**883**	**903**	**920**	**1009**	**Subtotal**	**872**	**900**	**956**	**1056**	**1085**	**1086**	**1100**	**1156**	**1215**	**Subtotal**	**Total**
ERUs (2040)	1,959	438	94	150	19	41	74	2,775	10	26	1	83	7	16	14	26	612	795	**3,571**
Avg. Day Production (gpm)	255	57	12	20	3	5	10	361	1	3	0.1	11	1	2	2	3	80	104	**465**
Max. Day Production (gpm)	658	147	32	51	6	14	25	932	3	9	0.4	28	2	5	5	9	206	267	**1,200**
Peak Hour Production (gpm)	1,025	229	49	79	10	21	39	1,452	5	14	0.6	43	4	8	7	14	320	416	**1,868**
Annual (ac-ft/yr)	411	92	20	32	4	9	16	583	2	5	0.2	17	1	3	3	5	129	167	**750**

(1) Zones to the left of the first Subtotal column may potentially receive water from North Bend via existing Sallal booster pumps.
(2) Production equals the sum of all demands; consumption, DSL, flushing, etc.

TABLE 5

City, UGA, and County 2040 ERUs and Production

Zone	City	UGA	County	Total
ERUs (2040)	1,735	380	1,456	**3,571**
Average Day Production (gpm)	226	49	190	**465**
Maximum Day Production (gpm)	583	128	489	**1,200**
Peak Hour Production (gpm)	908	199	762	**1,868**
Annual (ac-ft/yr)	364	80	306	**750**

The results of the hydraulic analyses shown in Table 1 indicate that Sallal could receive water from North Bend at a sufficient rate to meet member demand in the zones identified in Tables 2 and 4. The ability to transfer water will, in part, be limited by the location of the booster station. This would allow Sallal to reduce production from its wells and build a water right "reserve" for use later in the year.

If Sallal is to purchase water early in the year, the seasonal demand for water must be considered to evaluate when 243.6 ac-ft of water may be available for mitigation. Sallal's average monthly production, as a percentage of the annual total, for the last 13 years is presented below in Table 6. Based upon 2019 production and recognizing that the anticipated amount of water that Sallal could purchase from North Bend is restricted to that sold within the city limits and UGA in any given year, the potential amount that could be purchased is presented in Table 6. (Note: Actual 2020 production was 599.7 ac-ft; predicted 2020 production from Water System Plan assumptions was 592.8 ac-ft).

TABLE 6

Monthly Production

Month	Percent of Annual Demand	Percent of Average Monthly Demand	Cumulative Amount Purchased 2020 (ac-ft)	Cumulative Amount Purchased 2040 (ac-ft)
January	7.0%	84.1%	29	41
February	6.4%	76.9%	56	78
March	6.3%	75.7%	83	115
April	6.8%	81.7%	111	154
May	7.4%	88.9%	142	198
June	9.6%	115.3%	183	254
July	12.4%	148.9%	235	326
August	13.4%	161.0%	291	404
September	10.1%	121.3%	334	463
October	7.4%	88.9%	365	506
November	6.2%	74.5%	391	542
December	6.9%	82.9%	420	583

The data presented in Table 6 indicates that Sallal could acquire 243.6 ac-ft from North Bend by early August under current demand and by the end of June under 2040 conditions. The intent of acquiring water early in the year is to avoid receiving water, to the maximum extent possible, when North Bend must supply mitigation water to the

Snoqualmie River and to have sufficient water available for mitigation for the fall when mitigation to North Bend is most likely needed. Sallal's annual water right is 696 ac-ft per year (ac-ft/yr). Assuming growth is not curtailed by water rights, Sallal is anticipated to need 750 ac-ft of water per year in 2040 (Table 4). Additional water from North Bend will be needed. The amount of water needed from North Bend by 2040 is thus projected to be 297 ac-ft/yr (243.6 + (750 – 696)).

POTENTIAL WATER TRANSFER AMOUNTS FROM SALLAL TO NORTH BEND FOR MITIGATION

The Report of Examination for the North Bend Centennial Well water right contemplated the availability of 800 gpm – 1,000 gpm of water from Sallal for North Bend mitigation. Sallal currently has 1,600 gpm of instantaneous water rights for the Rattlesnake Wells and 91 gpm of instantaneous water rights for the Edgewick Well. This provides a total of 1,691 gpm of instantaneous water rights. Since it is anticipated that mitigation water would be typically be necessarily in September and October each year, water usage during those months for the past several years was reviewed. Average day demands and maximum day demands for the months of September and October are summarized in Table 7.

TABLE 7

September / October Water Demands

Year	ADD	MDD	Peaking Factor
2017	525,358	945,933	1.8
2018	443,433	793,700	1.8
2019	369,263	923,000	2.5
Average	**446,018**	**887,544**	**2.0**

The maximum day demand in September/October 2019 was 923,000 gpd which is the equivalent of 641 gpm. Per Tables 2 and 4, water demands are anticipated to increase by about 28.8% by 2040. If the September/October maximum day demands are assumed to increase at the same rate, the projected 2040 maximum day demand for September/October would be approximately 826 gpm. Since Sallal has 1,691 gpm of instantaneous water rights, during the September/October period, Sallal may have up to 865 gpm available to supply North Bend as mitigation water in the months of September and October.

In the event that North Bend would need additional mitigation water beyond that which Sallal can produce during October and November, Sallal could potentially obtain water from North Bend through the proposed new booster station to meet demands in the 710 zone while producing mitigation water from Well 2.

The demand in the zones that may potentially receive North Bend water is shown as 672 gpm in 2019 and 932 gpm in 2040. The projected rate that Sallal may receive water from North Bend is 883 and 1,035 gpm in 2019 and 2040, respectively (Table 1), assuming the booster station is located near 436th Avenue. In both cases, the booster station could meet anticipated maximum day demand for those zones if it is located near the 436th Avenue interchange.

The anticipated maximum day demand by those zones that cannot be served by a new booster station from North Bend is shown in Tables 3 and 5. The 2040 maximum day demand is estimated at 267 gpm. Assuming North Bend can supply maximum day demand in the lower zones as shown in Tables 3 and 5, Sallal could have sufficient water rights and production capacity to provide up to 1,000 gpm of mitigation water and meet maximum day demand in the upper zones.

If North Bend were to need mitigation water during peak demand times of July and August, Sallal would have less water available to provide for mitigation. Current maximum day demands in July and August are approximately 1,000 gpm. By 2040, Sallal maximum day demands are projected to be 1,200 gpm. This would leave approximately 691 gpm available for mitigation in July and August currently, and approximately 491 gpm available for mitigation in July and August by 2040.

IMPROVEMENT RECOMMENDATIONS

Transfer of Water from North Bend to Sallal

For optimum transfer of water from North Bend to Sallal, we recommend that a duplex booster station be constructed near the 436th Avenue SE intersection with North Bend Way. Sallal could draw water from the North Bend water main to the Dahlgren (Cedar River Partners) property and discharge into the proposed new Sallal water main on SE Tanner Road or the new water main proposed adjacent to 436th Avenue SE. The booster pumps should be equipped with variable frequency drives to maintain a constant operator-set pressure within the system. This would allow Sallal to receive water to satisfy instantaneous demand and thus would not need storage to cycle water into the system. Since the 710 Zone is a closed zone, i.e., no storage, Sallal would pump from the booster station as needed to satisfy instantaneous demand. To optimize the transfer of water from North Bend to Sallal, the hydraulic grade line of the 710 zone should be

lowered to 701 feet by adjusting the settings of the pressure reducing valves supplying this zone.

Transfer of Water from Sallal to North Bend for Mitigation

The simplest method to provide water to North Bend for mitigation would be to supply unchlorinated water from Well 2. This could be done by simply turning off the chlorination to Well 2. To provide water most efficiently for mitigation, Well 2 should be equipped with a variable frequency drive.

WWP/hh
Encl.