FREELAND WATER & SEWER DISTRICT

ISLAND COUNTY **WASHINGTON**

HARBOR HILLS WATER SYSTEM PLAN UPDATE

WA DOH ID # 33860V

G&O #19611
MARCH 2020

Gray & Osborne, Inc.
CONSULTING ENGINEERS

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A. OVERVIEW

The Harbor Hills Water System (hereinafter referred to as the Harbor Hills system) is classified by the Washington State Department of Health (WA DOH) as a Group A Public Water System. The Freeland Water and Sewer District (hereinafter referred to as the District system) purchased the Harbor Hills system in 2007. The Harbor Hills system initially was operated as a satellite system. A vote to annex the Harbor Hills system into the District failed. In 2015, a permanent intertie was installed between the two systems to allow the Harbor Hills system to supply wholesale water to a high elevation area, via a new District pressure zone, in the northwest portion of the District's gravity system. The intertie is also equipped with a pressure reducing/sustaining feature to allow water to flow into the District's main pressure zone under emergency conditions such as high fire demand, water main break, or other system failure.

Both systems are managed by the Freeland Water & Sewer District Board of Commissioners, elected by voters living within the boundaries of the District. Following the District's purchase of the Harbor Hills system, the District applied its rules and regulations pertaining to ownership and management, operating programs (e.g., cross-connection control program), design standards, etc., to the operation of the Harbor Hills system. General information on these aspects of the Harbor Hills *Water System Plan*, are provided in the various chapters of the District's *2018 Water System Plan, and included in the appendices of this Plan*.

The information provided in this update of the Harbor Hills *Water System Plan* includes:

- Description of the current facilities with updated distribution system drawings and computer schematic drawings,
- As-built details of the intertie from the Harbor Hills system to the Freeland system,
- Growth projections (i.e., past water usage and future water demand estimate) and water right self-assessment,
- Capacity analysis, including an update of the hydraulic analysis of the distribution system, and
- Financial analysis.

The descriptions of some of the Harbor Hills programs (e.g., cross-connection control) are the same as the programs for the District. The various programs are discussed in Section I of this plan.

Information on ownership, commissioners, and contract system operator are provided in the District's *2018 Water System Plan*.

The Harbor Hill water system currently supplies 426 ERUs as of December 1, 2018. The WA DOH current authorized number of connections is 550 ERUs. Based on the planning analysis in Section C, the estimated number of build-out customers is 695 ERUs. This number includes 11 customers in the Harbor Hills wholesale area created by the 2015 system intertie.

CONSISTENCY STATEMENT

The Island County *Consistency Statement* is included in Appendix A.

STATE ENVIRONMENT POLICY ACT (SEPA)

The WA DOH does not require SEPA review for adoption of a Water System Plan unless the system supplies more than 1,000 connections.

SERVICE AREA AGREEMENT

The current Service Area Agreement between Island County and Harbor Hills is included in Appendix B of this plan.

PUBLIC MEETING

The record of the public meeting discussing the water system plan is included in Appendix C.

RESOLUTION ADOPTING WATER SYSTEM PLAN

The District's resolution adopting the water system plan is included in Appendix C.

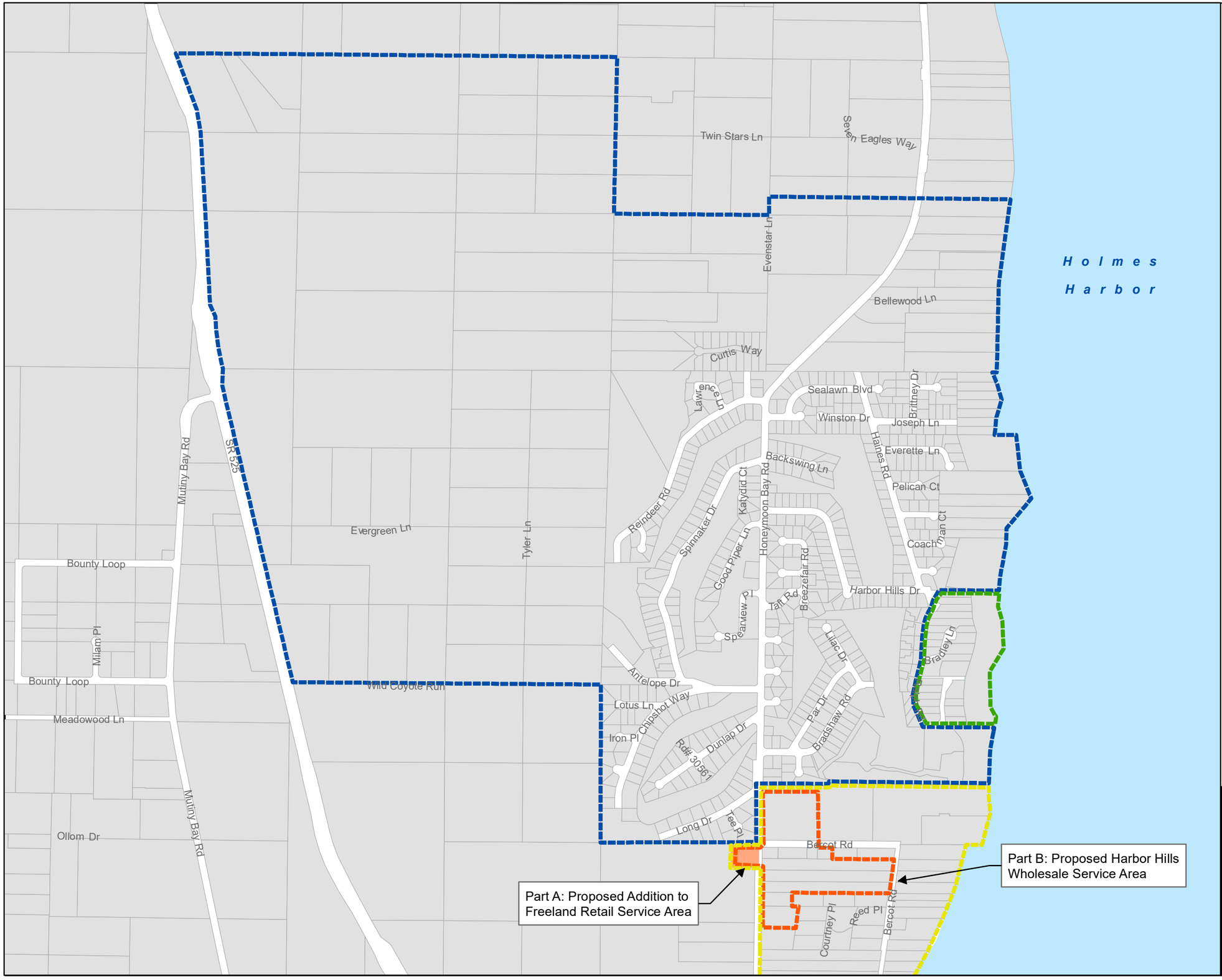
B. DESCRIPTION OF SYSTEM

The general configuration of the water system is grouped into the categories of (1) sources of supply; (2) water quality and treatment; (3) water storage, pumping, and pressure reduction; (4) distribution; and (5) wholesale supply. The water service area is shown in Figure 1.

SOURCES OF SUPPLY

There are three wells in the Harbor Hills water system: Well 3 is an active source, and the other two wells are emergency sources. A fourth well is now abandoned and the District no longer has an easement to use it. Major facilities are shown in Figure 2.

The South Well, also known as Well 1, is located on a District-owned lot on the east side of Honeymoon Bay Road approximately 340 feet south of Antelope Drive. The well is



Legend

- Harbor Hills Retail Service Area
- Bradshaw Addition Water System Service Area
- Freeland Retail Service Area
- Proposed Harbor Hills Wholesale Service Area
- Proposed Addition to Freeland Retail Service Area
- Parcels

Source: Freeland Water District, Island County

N

0 400 800 1,600 Feet

1 " = 800 '

HARBOR HILLS WATER SYSTEM

FIGURE 1

WATER SERVICE AREA

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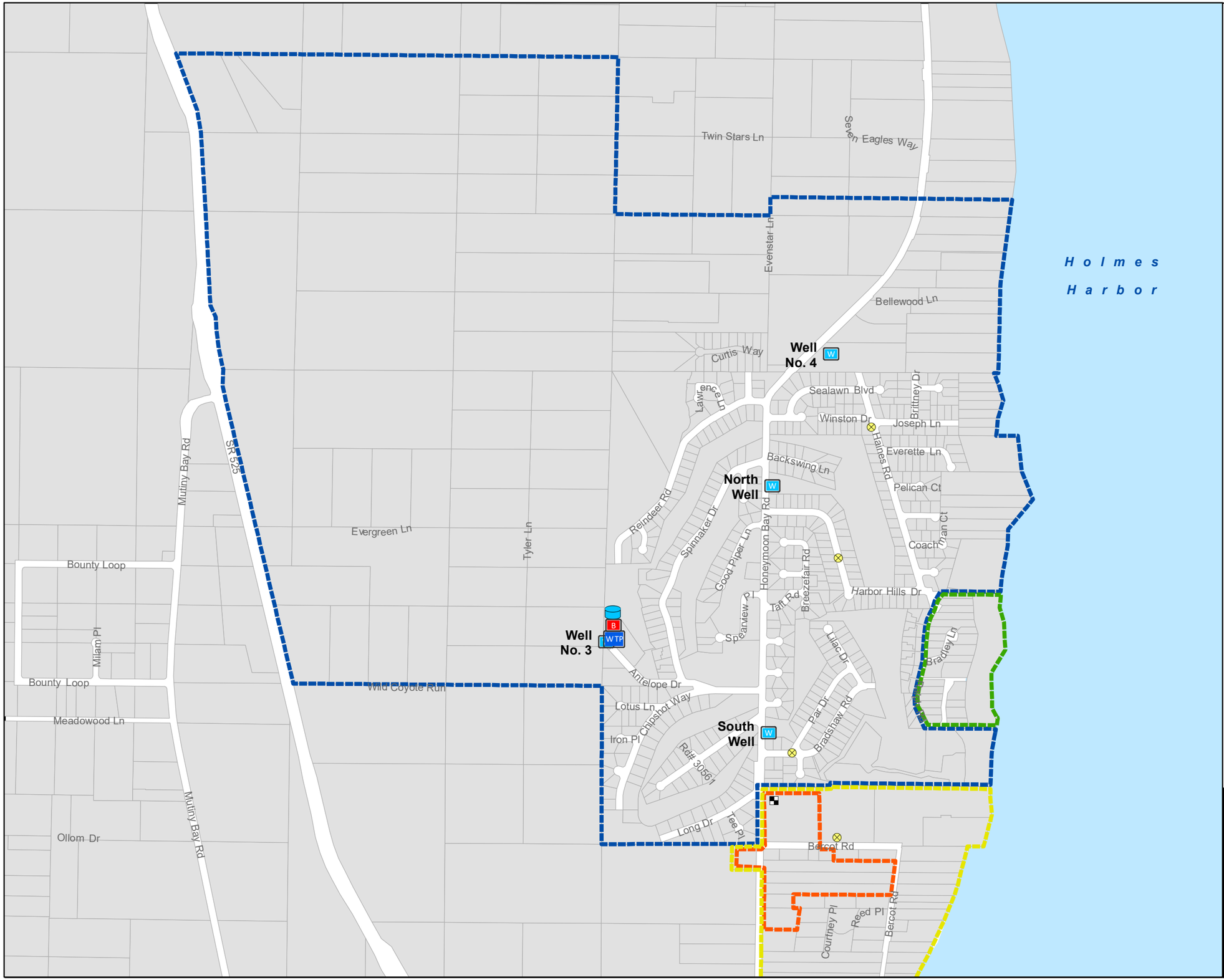

Legend

- Booster Station
- Intertie Meter
- Pressure Reducing Valve
- Reservoir
- Water Treatment Plant
- Well
- Harbor Hills Retail Service Area
- Bradshaw Addition Water System Service Area
- Freeland Retail Service Area
- Proposed Harbor Hills Wholesale Service Area
- Parcels

Source: Freeland Water District, Island County

N

0 400 800 1,600 Feet

1 " = 800 '

HARBOR HILLS WATER SYSTEM

FIGURE 2

MAJOR FACILITES

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equipped with a Grundfos model 75S75-12, 7.5 hp submersible pump. The well has not been operated in several years, but historically had a flow rate of 70 gpm. The 80 by 80-foot parcel containing the well originally also contained a 40,000-gallon reservoir with a pump station that discharged directly to the distribution system. In 2005 a raw water transmission main was installed from the well to the new water treatment plant on Antelope Drive. This project was funded from a Drinking Water State Revolving Fund loan. The reservoir and pump station have been abandoned, although the reservoir and pump house remain. The Board has decided to restart this source as a second full-time source. The project to restart this well is discussed in Section E, Recommended Improvements. This well will be controlled from the water treatment plant through an existing underground control cable installed along with the raw water transmission main. This source is not provided with an emergency generator.

The North Well, also known as Well 2, is located on a District-owned lot on the east side of Honeymoon Bay Road approximately 1,600 feet north of Antelope Drive. A 40,000-gallon reservoir and pump station are located on the 80 by 65-foot parcel. The well is equipped with a Grundfos model 80S100-10, 10 hp submersible pump. The well has not been operated in several years, but historically had a flow rate of 88 gpm. Due to inadequate funds from the Drinking Water State Revolving Fund loan, the 2005 project to connect this well via a raw water transmission line to the new water treatment plant on Antelope Drive was never started. The well remains connected to the 40,000-gallon on-site reservoir. These facilities are currently off-line, but can be reactivated if needed, discharging directly to the distribution system. This source is not provided with an emergency generator.

Well 3 is located on a District-owned 1.89-acre lot on the north side of Antelope Drive approximately 1,200 feet west of Honeymoon Bay Road. The well is connected to the treatment plant, completed in 2006. The well was initially equipped with a Grundfos Model 225S250-10, 25-hp submersible pump that supplied 135 gpm when pumping through the treatment system. The subsequent replacement pump, a Grundfos model 150S200-11, 20-hp submersible pump currently supplies 115 gpm. After treatment, water is stored in two reservoirs, which supply water to the distribution system via the booster station on the site. Per the superseding water right, Well 3 is limited to a maximum instantaneous withdrawal of 173 gpm. Emergency power for the Well 3 pump, treatment plant, and booster station is supplied from the generator at the water treatment plant.

TEL No. 2 Well, also known as Well 4, is located on the east side of Honeymoon Bay Road approximately 600 feet north of Reindeer Road. An 18,500-gallon reservoir and pump station were located on the approximate 10-acre parcel. The reservoir and pump house have been demolished. The well pump has been removed. Although the District no longer has an easement to use this well, it retains the water rights for the well.

Table 1, summarizing the information of the sources of supply, was copied from the Washington State Department of Ecology (WA Ecology) "Report of Examination," dated March 2002.

TABLE 1

Sources of Supply

	South Well	North Well	Well 3
Well Depth	273 feet	327 feet	288 feet
Access Port Elevation	250 feet	285 feet	230 feet
Static Depth	236 feet	305 feet	264 feet
Static Elevation	37 feet	22 feet	24 feet
Pumping Depth	230 feet	288 feet	248 feet
Pumping Elevation	20 feet	-3 feet	-18 feet
Pumping Rate (24-Hour Test)	70 gpm	88 gpm	173 gpm
Current Pumping Rate	0 gpm	0 gpm	115 gpm
Specific Capacity	4.1 gpm/foot	3.5 gpm/foot	4.1 gpm/foot

Each well is equipped with a flow meter. Level probes in the Antelope Drive reservoirs control Well 3 and the South Well, once it becomes operational, and a level probe in the North Reservoir controls the North Well.

The 100-foot sanitary control radius for the North and South Wells extend outside of the District-owned parcels. The 100-foot sanitary control radius for all of the wells extends onto County road right-of-way. Copies of declaration of covenants and restrictive covenants for all of the wells have been recorded and submitted to Island County. The well sites have been approved by the Island County Health Department.

The wells are not located in an area with reported chloride levels above 100 mg/L (indication of seawater intrusion). The wells are within 1/2-mile of the sea and withdraw water from the sea level aquifer.

Island County has established the following criteria for assessment of the risk of seawater intrusion:

Risk Category	Static Water Level Elevation (feet)	Chloride Concentration (mg/L)
Low	Greater than 8.4	Any level
Medium	Less than or equal to 8.4	Less than 100
High	Less than or equal to 8.4	Between 100 and 250
Very High	Less than or equal to 8.4	Greater than 250

Water level elevation refers to Mean Sea Level (MSL) datum. Based on static water levels being above 8.4 feet (see Table 1), the Harbor Hills wells are in the "Low Risk" category for seawater intrusion.

The following documents are provided in the appendices to this plan:

- Water right permits and certificates, Appendix D;
- Water right self-assessment form, Appendix D;
- WA Ecology Reports of Examination, Appendix D;
- Water Facilities Inventory (WFI) form, Appendix D;
- Well site approvals, Appendix E;
- Well Logs, Appendix E;
- Well pump curves, Appendix E;
- Well pumping test reports for all wells, Appendix E;
- Sanitary zone recorded Covenants, Appendix E;
- Wellhead Protection Plan, dated January 13, 1997, by Doug Dillenberger, P.G., Northwest Hydrogeo Consultants, Appendix F; and
- WA DOH "Ground Water Susceptibility Assessment Survey" forms, Appendix F.

Table 2 lists the water right permits and certificates (WA Ecology superseding or initial permits, all dated May 2002) for the above sources of withdrawal.

TABLE 2

Water Rights

Permit/Certificate	Date	gpm	Acre-Feet/Yr.
GWP-8957 (South Well) 2nd Superseding Permit	5/10/2002	100(1)	80(1)(2)
GWP-8956 (North Well) 2nd Superseding Permit	5/10/2002	100(1)	80(1)(2)
G1-27219 (North Well)	5/10/2002	100(3)	33
G1-26424 (Well 3)	5/10/2002	153(5)	180.2(2)
G1-24595 (TEL 2 Well)	5/10/2002	45(1)	5.3(1)
Total		**398(3)**	**378.5(4)**

(1) Location of withdrawal includes all four wells.
(2) Allots 30 acre-feet per year for irrigation to supplement reclaimed water system for golf course, from April 15th through October 15th.
(3) Total rate of withdrawal under G1-27219P and GWP 8956 is not to exceed 100 gpm; hence the total allowable withdrawal is 398 rather than 498 gpm.
(4) For allocation to domestic use the total acre-feet/year of 378.5 is reduced by 30 acre-feet/year for the golf course.
(5) Maximum allowable pumping rate for Well No. 3 is 173 gpm per Permits GWP 8957, GWP 8956, G1-24595C, and G1-26424A.

The water allocation of 30 acre-feet per year for golf course irrigation has not been utilized in several years and there are no longer any physical connections of the water system to the wastewater storage ponds. The Holmes Harbor Sewer District waste water treatment plant produces and stores more than adequate volumes of treated effluent to meet the irrigation demand.

Water Quality and Treatment

The water quality monitoring sites are shown in Figure 3. The current water quality monitoring schedule established by WA DOH is included in Appendix G. The latest *Consumers Confidence Report* is posted on the District's website. The Coliform Monitoring Plan is included in Appendix G.

Distribution System Monitoring

Monitoring for coliform bacteria and residual chlorine at multiple locations in the distribution system is required once every month. The system does not have a recent history of coliform bacteria presence in the distribution system.

Monitoring for lead and copper in the distribution system is required at 10 sampling locations once every 3 years. The "action levels" to trigger corrosion treatment is 0.015 mg/L and 1.3 mg/L for lead and copper, respectively. The levels of lead and copper are below the Federal action level. The following table shows the most recent 2018 lead and copper results.

TABLE 3

2018 Lead/Copper Monitoring Results

Site	Lead, mg/L	Copper, mg/L
1	0.001	0.041
2	0.001	0.015
3	0.002	0.276
4	0.001	0.022
5	0.001	0.034
6	0.001	0.111
7	0.001	0.062
8	0.001	0.078
9	0.001	0.093
10	0.001	0.037

Monitoring for disinfection byproducts (TTHM – total trihalomethanes and HAA5 – Halo-Acetic Acids) is required once annually. The levels of disinfection byproducts are below the MCL of 80 µg/L for TTHM and 60 µg/L for HAA(5). The following table shows the 2019 results of disinfection byproduct monitoring.

TABLE 4

2019 Disinfection Byproduct Results

TTHM	15.0	µg/L
HAA(5)	3.4	µg/L

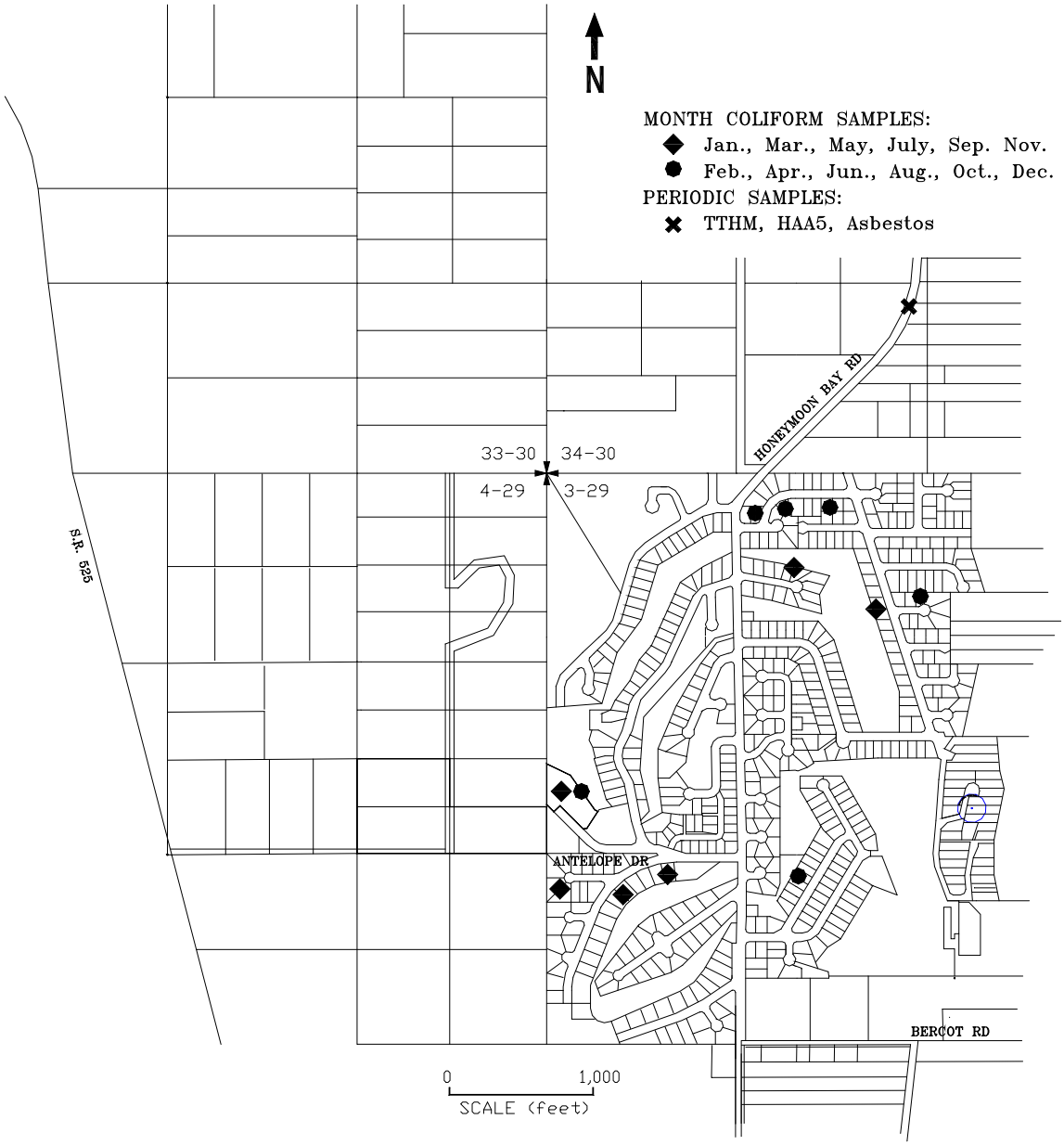


FIGURE 3

Location of Water Quality Monitoring Sites

Monitoring for asbestos in the distribution system is required once every 9 years, last completed in 2018. The quantity of asbestos cement pipe in Harbor Hills is greater than ten percent of the water main inventory. The asbestos level is below the WA DOH maximum contaminant level (MCL). With "hard" water, leaching of asbestos fibers from the inside of the pipe wall will not usually occur. Leaching of cement from the outside due to acidic groundwater conditions does not affect drinking water quality, but may affect the integrity of the pipe.

Source Monitoring

Monitoring for various constituents in drinking sources varies. Measured concentrations of the most pertinent inorganic chemical parameters are summarized in Table 5. For the South and North wells, raw water samples were last taken from each well in 2002. For Well 3, samples are currently taken after treatment, but prior to discharge to distribution system.

TABLE 5

Raw Water Quality Summary – Inorganic Chemicals

Parameter	Units	MCL	South Well (2002)	North Well (2002)	Well 3 (2019)
Arsenic(1)	Mg/L	0.010	0.006	0.010	0.001
Iron(2)	Mg/L	0.3	0.576	1.04	0.05
Manganese(2)	Mg/L	0.05	0.308	0.296	0.001
Total Nitrate/Nitrite(1)	Mg/L	10.0	0.5	0.5	0.5
Chloride(2)	Mg/L	250	20.0	20.0	11.0
Turbidity(3)	NTU	1.0	2.1	5	0.1
Sodium(4)	Mg/L		12	12	10.6
Hardness(4)	Mg/L		166	137	89.8
Electrical Conductivity(3)	uS/cm	700	375	331	245

(1) EPA Regulated – Primary
(2) EPA Regulated – Secondary
(3) State Regulated
(4) State Unregulated
ND – Not Detected
MCL – Maximum Contamination Level

Since 2002, raw water from the North and South wells has not been monitored for Complete Inorganic Chemicals (IOC). Complete IOC monitoring for all active sources is required every 9 years, and was last monitored for Well 3 in 2019. Monitoring for iron, manganese, and arsenic is required once every three years; however, monthly sampling of iron and manganese is performed as a tool to monitor the treatment plant's performance. The field monitoring of raw water from Well 3 has shown no significant change in iron or manganese levels since treatment began. The raw water quality in Well 3 currently meets WA DOH guidelines with the exception of iron, manganese, and turbidity. The high turbidity is a result of the iron and manganese.

Monitoring for nitrate is required once annually and is historically less than the required reporting limit of 0.5 mg/L. Monitoring for other constituents, all measuring below the MCL, includes:

- Volatile Organic Compounds (VOC) (last sampled in 2018 - required to sample every 6 years);
- Synthetic Organic Compounds (SOC – pesticides) (2015 – every 3 years);
- Synthetic Organic Compounds (SOC – herbicides) (2018 – every 9 years); and
- Radionuclides (2015 – every 6 years).

Iron and Manganese Treatment

The water treatment plant to reduce iron and manganese in the distribution system was completed in 2006. The building containing the treatment system also houses the booster pumping system. The initial water treatment system primarily consisted of two Structural North American 48-inch diameter fiberglass contact tanks, four Structural North American 48-inch diameter fiberglass filter media tanks with Birm® adsorbent media, four Clear Water Tech ozone generators supplied with oxygen, and two Mazzei injectors (one for each set of ozone generators). Two ozone generators were installed for operation of Well 3 as primary source, and two ozone generators were installed for combined operation of the North and South wells.

The treatment plant has continually performed to remove iron and manganese to levels better than the WA DOH guidelines. The Well 3 iron and manganese levels, after treatment, are typically:

Iron	0.1	mg/L
Manganese	0.01	mg/L
Turbidity	0.1	NTU

To maintain residual of free chlorine in the distribution system, a hypochlorinator (chemical feed pump) was installed to inject 0.2 mg/L of sodium hypochlorite in the treatment system product water supplied to the reservoirs.

Due to the high cost to maintain the ozone generators, the treatment process was changed in 2014. The oxidant was changed to sodium hypochlorite and the adsorbent media was changed to Filox-R™. All other components of the treatment system (e.g., piping and controls) remain the same except for the use of the Mazzei injectors. The Mazzei injectors are bypassed.

WATER STORAGE, PUMPING, AND PRESSURE REDUCTION

The current water storage is provided in two reservoirs located on Antelope Drive adjacent to Well 3. The Antelope Drive reservoirs consist of twin 30-foot diameter, 25-foot high Mt. Baker Silo reinforced concrete tanks, each with a nominal volume of 132,000 gallons (total of 264,000 gallons). Electrodes in the reservoirs currently control the operation of Well 3, and can control the South Well, once it becomes operational.

The Antelope Drive Pump Station is equipped with six 15-hp pumps, Berkeley model B2ZPL. The booster station provides domestic flow and fire flow. The booster pump curve is included in Appendix H. Control of the pumps is through pressure switches on a 1,440-gallon hydropneumatic tank. The on-off pressure range is 72 to 86 psi. Booster Pumps 1 and 2 alternate duty for domestic flow. If the pressure drops below 72 psi, Pumps 3 and 4 will alternate duty as a second pump, and if the pressure drops below 70 psi, Pumps 5 and 6 will alternate duty as a third pump. Therefore, as currently configured, only three booster pumps can run at any time. This is an unusual setup, and it would be beneficial if the system were controlled such that five pumps could be activated if needed, under the assumption that the sixth pump could be out of service.

The North Reservoir has a nominal storage volume of 40,000 gallons. The North Reservoir Pump Station is equipped with a constant pressure, skid mounted pump unit containing three 5-hp pumps for domestic demand and one 25-hp pump for fire flow. The booster pump curves are included in Appendix H. The unit includes a flow control valve discharging to the distribution system, and a pressure relief valve discharging into the reservoir. The reservoir and pump station are currently not in use and not physically connected to the distribution system.

The South Reservoir and Pump Station were abandoned in 2006. The South Well is now connected to a raw water transmission main and can discharge to the Antelope Drive water treatment plant.

The TEL 2 Reservoir and Pump Station were demolished in 2006.

A low elevation pressure zone is supplied from the high elevation pressure zone, which operates at a static hydraulic grade line of 427 feet. The lower pressure zone is operated at a static hydraulic grade line of 340 feet. Three pressure reducing valve stations supply the low elevation pressure zone. All pressure reducing valves are installed in below-ground concrete vaults.

PRV Station 1 on Haines Drive contains one 4-inch and one 2-inch Clayton pressure reducing valve. This station is the lead operating station for domestic demand and fire flow. PRV Station 2 on Harbor Hills Road contains one 2-inch Clayton pressure reducing valve. This station operates on standby for peak hour demand. PRV Station 3 on Bradshaw Drive contains one 4-inch and one 2-inch Clayton pressure reducing valve. This station operates on standby for peak hour demand and fire flow.

DISTRIBUTION

The distribution mains are mostly located in County road rights-of-way. The County Franchise Agreement for the Harbor Hills system is included in Appendix I to this plan. The Franchise Agreement expires in August 2021, and has been submitted for renewal.

Copies of the easements for mains crossing private property (golf course) are included in Appendix J to this plan.

Table 6 summarizes the distribution system pipe inventory.

TABLE 6

Distribution System Water Mains

Size and Material	Length, feet
8-inch, PVC and Ductile Iron	4,355
8-inch, Asbestos Cement	3,240
6-inch, PVC and Ductile Iron	12,875
6-inch, Asbestos Cement	4,695
4-inch, PVC	13,425
4-inch, Asbestos Cement	350
3-inch, Asbestos Cement	2,040
2-inch, PVC, PE and Galv. Steel	3,220
Total	**44,200**

Asbestos cement pipe makes up approximately 23 percent of the inventory.

Water main appurtenances include the following:

TABLE 7

Distribution System Appurtenances

Appurtenance	Quantity
Fire Hydrants	16
Gate Valves	45
Blow-Offs	9
Air Release Valves	3
Irrigation Services	0
Backflow Preventers	1

All domestic water services are metered. The irrigation services to the golf course are not active and are no longer physically connected; the golf course has adequate supply from the sewer treatment plant effluent.

The only backflow prevention assembly is a reduced pressure backflow assembly located on the service to the sewer treatment plant.

WHOLESALE SUPPLY

Until 2015 the District operated a booster pump station to supply a small area in the northwest part of the Freeland retail service area. The supply to this area was then changed to allow Harbor Hills to supply water through a metered intertie. A 4-inch compound water meter was installed in a concrete vault on the east side of the intersection of Honeymoon Bay Road and Long Drive. The intertie was made by the installation of approximately 500 feet of 8-inch main to interconnect the two systems at the intersection of Honeymoon Bay Road and Bercot Road.

The intertie currently supplies water on a continuous basis to five District customers on Honeymoon Bay Road and Bercot Road (formally supplied by the District's booster pump station), and provides a standby supply for fire flow and other emergencies through the District's Bercot Road PRV Station (formerly the District's booster pump station). The booster pumps in the vault were removed and pressure reducing valves installed.

The PRV Station contains one 4-inch and one 2-inch Clayton pressure reducing valve. The 4-inch pressure reducing valve is equipped with a pressure sustaining pilot to maintain a minimum upstream pressure at all locations within the Harbor Hills service area of 30 psi. Record drawings of the intertie are included in Appendix K.

The small area supplied upstream of the PRV station presently serves five residential customers, and has the potential for six additional customers (this count includes lots now supplied by private wells). One of the vacant lots was purchased by the District in 2018 for a future well and does not reside within the District or the Harbor Hills current retail service area. The addition of this lot will require a change to the District's retail service area which can be accomplished via submission of a "Water System Review" application to Island County, under the requirements of the Island County Coordinated Water System Plan (CWSP). Said application has been made to Island County.

Regarding the new wholesale service area, under the Municipal Water Law (MWL), the place-of-use change for the water rights granted to Harbor Hills (for the use of Harbor Hills' water within the District) simply needs to be shown in the water system plans for both the District and Harbor Hills, for review by WA DOH and WA Ecology. A copy of the District Resolution adopting policies for the intertie is included in Appendix K.

OTHER FACILITIES

The Holmes Harbor Sewer District serves a portion of the service area of the Harbor Hills water system with sewers. The Sewer District's waste water treatment plant is located adjacent to the west side of the Harbor Hills Antelope Drive well and reservoir site. Water is supplied through a 2-inch service to the wastewater treatment plant office and lab only. A reduced pressure backflow assembly is installed on the service.

C. PLANNING

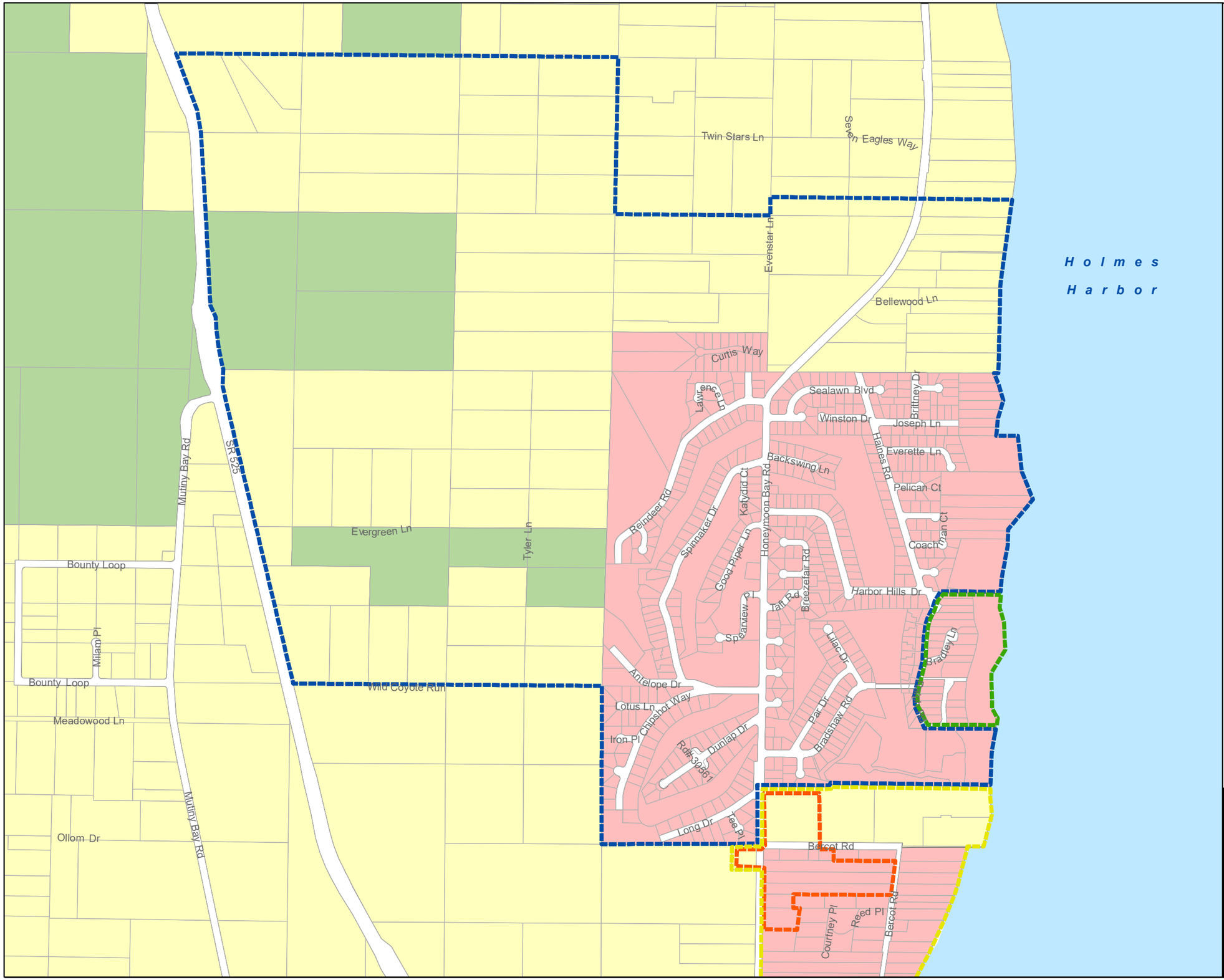
SERVICE AREA

The Harbor Hills water service area is shown in Figure 1. The Harbor Hills water system currently serves 421 single-family residences plus two commercial customers (total of 423 connections and 426 equivalent residential units, or ERUs). The commercial customers include the golf course club house (assessed as 2 ERUs) and the Holmes Harbor Sewer District's wastewater treatment plant (assessed as 3 ERUs). The billing data for 2017 and 2018 for both commercial customers indicates that water use remains less than the quantity allocated for their assessed ERUs. Included are five wholesale customers located within the District's boundaries.

The bulk of the Harbor Hills water system serves several subdivisions located primarily in the northwest and southwest quarters of Section 3, Township 29 North, and Range 2 East. The area is platted into single-family residential lots, plus the golf course parcels, including one large parcel at the northwest corner of the intersection of Antelope Drive and Honeymoon Bay Road. A 29 lot subdivision of the property (Chipshot Way Development) has been platted and is currently being developed with single-family homes. These areas are zoned as Rural Residential/Residential Areas of More Intensive Rural Development (RAID), with a base density of 3 du/acre. Zoning for the area is shown on Figure 4. The current total lot count in this area is 557. Of these, 374 lots (377 ERUs) are currently supplied with water. Of the remaining vacant lots, 183 are potential new customers.

The remainder of the service area lies primarily in three rural areas. The land use in these areas is primarily Rural (R) with one dwelling unit per five acres and Rural Forest (RF) with one dwelling unit per twenty acres:

- Rural areas located west of the platted development, including the northeast quarter of Section 4, Township 29 North, Range 2 East and the southeast quarter and portions of the southwest quarter of Section 33, Township 33 North, and Range 2 East. The total area to be provided service is approximately 390 acres. Three 5-acre parcels within the 390 acres are occupied by wastewater treatment plant lagoons, leaving 375 acres for residential customers. Assuming all of the area designated as Rural (R), is subdivided into 5 acre parcels, and the parcels designated



Legend

- Freeland Retail Service Area
- Proposed Harbor Hills Wholesale Service Area
- Bradshaw Addition Water System Service Area
- Harbor Hills Retail Service Area
- Parcels

Zone

- Rural
- Rural Forest
- Rural Residential

Source: Freeland Water District, Island County

N

0 400 800 1,600 Feet

1 " = 800 '

HARBOR HILLS WATER SYSTEM

FIGURE 4

ZONING

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as Rural Forest (RF) remain undivided, the total number of potential customers is 63. Currently, 6 customers are served in this area.

- Rural areas located to the north of the platted development, including portions of the southwest and southeast quarters of Section 34, Township 30 North, and Range 2 East. These areas include the Evenstar plat and parcels on either side of Honeymoon Bay Road. The total area to be provided service is approximately 107 acres, however, all but three parcels are already 5 acres in size or smaller. Assuming all of these parcels are eventually served by Harbor Hills, the total number of potential customers is 61. Currently, 38 customers are served in this area.

- A portion of the southwest quarter of Section 3, Township 29 North, Range 2 East which includes the 11 Freeland lots in the wholesale service area. This area is also zoned Rural at 5 acres per dwelling unit or Rural Residential at 3 dwelling units per acre, so no additional subdivision is expected.

Therefore, the total number of potential customers to be served by Harbor Hills is 692 lots (or 695 ERUs) at build-out (see Table 8). However, prior to the District approving extension of service into these areas, consideration should be made regarding the long-term risk and cost to maintain and operate a water main with so few customers. Water mains in these scenarios typically require additional flushing, since scouring velocities are not present, and although the extension would be funded by private sources, the District would be saddled with the long-term replacement cost that may surpass the revenue collected.

POPULATION AND CUSTOMER GROWTH PROJECTIONS

Table 8 summarizes the above information regarding the buildout number of customers in the service area.

TABLE 8

Buildout Number of Customers

	Total Available Lots	Current Customers	Current ERUs
Harbor Hills Subdivisions	557	372	372
Harbor Hills Commercial Customers	2	2	5
Rural West Area	63	6	6
Rural North Area	61	38	38
Wholesale Customers	11	5	5
Irrigation Systems	0	0	0
Total	692	423	426

Two of the above lots are occupied by commercial customers assessed at a total of 5 ERUs. The total commitment in the service area is 695 ERUs. The current number of WA DOH authorized connections is 550 ERUs.

The District is billed for wholesale water at the Harbor Hills commodity rate based on the intertie master meter readings. Wholesale customers within the District, however, are billed at the standard District base rates and commodity charges. The residential meters to the customers in the wholesale area are owned by the District.

As noted in Section D Capacity Analysis, for most of the remaining large parcels any short plat will require not only the extension of the water distribution system, but also looping of the system to provide adequate hydraulic capacity. Although a late-comers agreement may assist a developer in recovering the cost of a major extension and looping of the distribution system, the high cost of construction may be prohibitive to the development of a short plat. The minimum size of the subdivided properties allow for the drilling of individual private wells. Therefore, the full development potential requiring water service from the Harbor Hills system will likely not be realized.

The general geography/topography of the Harbor Hills service area is not a factor in the servicing of the remaining large parcels discussed above, due to the relative flatness of the area. The service pressure provided by the booster pumps is adequate to supply the requisite service pressure to the highest (elevation) potential customer.

Table 9 shows the customer growth history in the Harbor Hills service area.

TABLE 9

Number of Retail ERUs

Year	ERUs
2018 (Dec.)	426
2017	418
2016	406
2015	398
2014	395
2013	389
2003	227

In 2003 the number of connections (single-family residential plus commercial) was 227 ERUs, compared with the 2018 count of 426 ERUs. This was an increase in 15 years of 199 ERUs, (approximately 13 ERUs per year; or 4.3 percent increase per year). In the last 6 years, the growth has been from 389 ERUs to 426 ERUs (approximately 6 ERUs per year; or 1.5 percent increase per year).

According to the 2016 Island County Comprehensive Plan, the projected population growth in the South Whidbey Planning Area is estimated at 0.24 percent during the period from 2010 through 2036, with the Freeland Non-Municipal Urban Growth Area population estimated to grow at 0.95 percent. The recent growth rate in Harbor Hills of 1.5 percent is aggressive, but supported by recent development activity in the Harbor Hills service area.

From the data in Table 9, the following is the estimated number of future customers (ERUs):

	2018	2024 (6-yr plan)	2028 (10-yr plan)	2038 (20-yr plan)
Based on 1.5 percent growth	426	466	494	574
Based on 4.3 percent growth	426	548	649	695

The total commitment in the service area is 695 ERUs, including the 11 wholesale properties.

The above projections are only pertinent regarding the schedule for capital improvements. As noted above regarding a developer's cost of extending the distribution system to supply new short plats in the rural acreage northwest of the Harbor Hills subdivisions, the lower annual growth rate projection (1.5 percent) is most likely, but is still aggressive.

WATER DEMAND FORECAST

Table 10 shows the annual water production and consumption history for the Harbor Hills system. Water used for filter backwash at the water treatment plant averaged less than 6 percent of water production during the last three years, and is included in the average day demand calculations (ADD), but is not included for calculating Distribution System Leakage (DSL).

TABLE 10

Annual Water Production and Consumption History

Year	Production (gallons)	Consumption[4] (gallons)	3-yr Average DSL[5]	Average Day Demand (gpd/ERU)[6]	Maximum Month Day Demand (gpd/ERU)
2018[1]	23,887,162	22,257,162	5.7%	144	273
2017[1]	23,966,000	22,593,486	5.3%	150	238
2016[1]	21,300,000	20,300,904	6.0%	138	205
2015[2]	21,069,000		6.9%		
2014[2]	21,132,000		7.9%		
2013[2]	20,312,000		6.3%		
2012[2]	19,216,730		4.9%		
2011[2]	18,469,000		3.1%		
2003[3]	13,591,241		10.4%		

(1) Based upon actual production and consumption records.
(2) Information from the annual Water Use Efficiency reports submitted to WA DOH.
(3) Information from Harbor Hills 2004 Water System Plan.
(4) Consumption data includes filter backwash.
(5) DSL calculation does not include filter backwash.
(6) Average daily water use includes filter backwash.

The annual production increase from 13,591,241 gallons (2003) to 23,887,162 gallons (2018) was approximately 686,000 gallons per year. The annual production from 2013 to 2018 increase from 20,312,000 gallons to 23,887,162 gallons was approximately 596,000 gallons per year (2.7 percent per year).

The 3-year average day water demand (ADD), including filter backwash, is 144 gpd/ERU. Using a conservative DSL of 10 percent, the ADD for planning purposes, is determined to be **158 gpd/ERU**.

Calculation of Maximum Day Demand (MDD) is needed to properly design sources, treatment systems, and storage facilities to meet maximum demands. The District takes monthly readings of their production meters, as required. The maximum month average day demand (MMAD) occurred in July 2018, at 273 gpd/ERU. DOH recommends that MDD be determined from actual daily production meter data. In absence of such daily data, DOH recommends that MDD be calculated based upon maximum month average day demand (MMAD) times a peaking factor (1.7 for Western Washington). Therefore, the MDD for planning purposes is determined to be **465 gpd/ERU**.

Peak Hourly Demand (PHD) is needed to design the size of equalizing storage, distribution lines, and pumping facilities. A system must be able to provide a minimum of 30 psi throughout the distribution system during PHD. Lacking detailed daily demand information the following equation is used to estimate PHD:

$$PHD = (MDD/1440)[(C)(N) + F] + 18$$

Where PHD = Peak Hourly Demand (gallons per minute)
C = Coefficient Associated with Range of ERUs
N = Number of ERUs
F = Factor Associate with Ranges of ERUs
MDD = Maximum Day Demand (gpd/ERU)

Number of ERUs (N)	C	F
0-50	3.0	0
51-100	2.5	25
101-250	2.0	75
251-500	1.8	125
> 501	1.6	225

Based on this formula, and the less aggressive estimate of the number of ERUs served by the system, the **PHD is estimated at 306 gpm in 2018, 346 gpm in 2028, and 387 gpm in 2038**.

D. CAPACITY ANALYSIS

The attached calculations show the number of equivalent single-family residential connections (ERUs) the system may supply based on WA DOH design criteria, under the assumption that only Well 3 is in operation. Capacity for Well 3 only is provided in Table 11. As stated before, the District is planning to begin concurrently operating Well 3 and the South Well in 2020. Capacity with both wells operating is provided in Table 12.

WATER SOURCE CALCULATIONS

The Harbor Hills system currently operates on Well 3, designed to pump at 115 gpm. The South Well will begin operating again in 2020 and has an assumed pumping rate of 70 gpm. Total allowable instantaneous withdrawal, from all four wells, is 398 gpm and total allowable annual withdrawal is 378.5 acre-feet.

System Capacity from Annual Volume

The Harbor Hills system's water rights currently allow for an annual volume of 378.5 acre-feet of water to be withdrawn. This equates to 123,334,000 gallons per year, or 337,900 gallons per day. Based on an ADD of 158 gpd/ERU the annual water rights can support **2,138 ERUs**.

System Capacity from Instantaneous Water Right

The Harbor Hills system's water rights currently allow for an instantaneous withdrawal of 398 gpm, or 573,120 gpd, based on 24 hours of pumping. However, DOH recommends using less than 24 hours of pumping per day. Based on a MDD of 465 gpd/ERU and 22 hours of pumping, the water rights can support **1,130 ERUs**.

System Capacity from Instantaneous Well Pump Rate

The existing Well 3 pump can supply a total of 115 gpm, or 165,600 gpd, based upon 24 hours of pumping. However, DOH recommends using less than 24 hours of pumping per day. Based on a MDD of 465 gpd/ERU and 22 hours of pumping, the maximum pump capacity will support **326 ERUs**. By restarting the South Well, with an assumed pumping rate of 70 gpm based on historical pumping rates, the maximum pump capacity of 185 gpm will support **525 ERUs**.

WATER TREATMENT SYSTEM CALCULATIONS

The Harbor Hills water treatment system currently operates at an application rate of 5 gpm/sf, or 240 gpm, or 345,600 gpd. Based on a MDD of 465 gpd/ERU, the treatment system can support **743 ERUs**.

STORAGE CALCULATIONS

The Harbor Hills system owns and operates one dual-tank reservoir. Both tanks combined store 10,574 gallons per foot for a total of 264,350 gallons. Water storage must be sufficient to meet expected system demands by providing operational, equalizing, standby, and fire suppression storage volumes. Standby storage and fire suppression storage may be "nested" together – that is, the larger of the two volumes may be used as the total design requirement for both. Calculations are in accordance with the State Department of Health Design Manual (2019). The tanks are configured as follows:

Type: Two equally sized concrete tanks
Inside Diameter: 30 feet
Inside Height: 25 feet
Bottom Elevation: approx. 230 feet
Full Elevation: approx. 255 feet
Capacity: 5,287 gallons per foot per tank = 132,175 gallons per tank

Operational Storage (OS)

Operational Storage (OS) is the volume of water devoted to supplying the water system while, under normal operating conditions, the sources of supply are in "off" status (WAC 246-290-010). Operational storage is in addition to other storage components, thus providing a factor of safety for equalizing, standby, and fire suppression storage. As currently set by the Harbor Hills system, Well 3 source pump turns on when the water level in the tanks drops below 253.00, and turns off when the water level reaches 255.00. This allows an operating range of 2.0 feet, or 21,148 gallons. At 115 gpm pumping rate, with a conservative assumed average outflow of 50 gpm, the shortest pump cycle time is approximately 5 hours. At a pumping rate of 185 gpm, the shortest pump cycle is approximately 2-1/2 hours.

Equalizing Storage (ES)

Equalizing storage (ES) must be provided as part of the total storage for the system to provide water during periods of peak demand that cannot be met by the source production capacity. ES volume is based on PHD demand requirements, assuming peak demand for 2-1/2 hours. If the source pumps will, by themselves, meet PHD, then no equalizing storage is needed. The following equation is used to calculate equalizing storage volume:

$$ES = (PHD - Q_S)*150 \text{ min.}$$ where Q_S is the total source pumping capacity

Equalizing storage is calculated for Well No. 3 pumping at 115 gpm, and for Well 3 and the South Well combined pumping at 185 gpm.

Standby Storage (SB)

Standby storage (SB) provides a measure of reliability in case sources fail or unusual conditions impose higher demand than anticipated. SB volume is based on customer expectations. Generally, this emergency volume is two days' worth of ADD, as represented by the equation for systems with multiple sources:

$$SB = (2 \text{ days})[(ADD)(N) - 1440(Q_S - Q_L)]$$

where Q_L is the largest source and Q_S is the total of all sources

For the Harbor Hills system, with only one source in operation, two days of ADD is required. However, the Department of Health recommends a minimum standby storage of 200 gpd/ERU. With two sources in operation, standby storage is significantly reduced. Standby storage is calculated for Well 3 pumping at 115 gpm, and for Well 3 and the South Well combined pumping at 185 gpm.

Fire Suppression Storage (FSS)

Water systems must be capable of delivering fire flows in accordance with adopted fire flow requirements, while maintaining minimum pressure requirements (20 psi) throughout the system. Fire suppression requirements are set by the local Fire Marshall and are generally stated as a flow rate (FF) for a specific duration (t_M). Historically, Harbor Hills has been developed as only residential. According to the 1990 Island County Coordinated Water System Plan (CWSP), the minimum required fire flow for residential development is 500 gpm for 30 minutes. The hydraulic model for the system has been run to verify it can meet these requirements. Therefore, FSS can be calculated by the equation:

$$FSS = (FF)(t_M)$$

Nesting of Standby and Fire Suppression Storage is allowed in Island County, meaning the smaller storage volume can be excluded from the water system's total storage requirement. Therefore, additional storage for fire suppression is not required.

Dead Storage (DS)

Dead Storage (DS) is the volume of stored water not available to all customers at the minimum design pressure. This storage might be typically used to shift water between reservoirs, or to provide minimum pressure to a residence located at a higher elevation. Because Harbor Hills has a single storage facility, with the bottom of the tanks at elevation 230.00, and the water is discharged into the distribution system via booster pumps, no dead storage is required.

Tables 11 and 12 provide a summary of the storage calculations, for Well 3 operation only (Table 11) and also for Well 3 combined with the South Well operation (Table 12). Nesting of Standby and Fire Suppression Storages is utilized in this analysis. Based on the analysis, the Harbor Hills system's facilities do not show any source or storage deficiencies for the 20-year planning period, so long as the South Well is placed into operation at 70 gpm.

TABLE 11

Storage Requirements (gallons) – Well 3 Only

Design Parameter	Year		
	2018	**2028**	**2038**
ERUs	426	494	574
Operational Storage	21,148	21,148	21,148
Equalizing Storage	28,650	34,650	40,800
Standby Storage(1)	170,400	197,600	229,600
Fire Storage(2)	15,000	15,000	15,000
Total Storage Required(3)	220,198	253,398	291,548
Storage Provided	264,350	264,350	264,350
Deficiency?	No	No	Yes – 27,198

(1) Standby storage based on 200 gpd/ERU, as recommended.
(2) Based on 500 gpm for 30 minutes.
(3) Equal to OS + ES + greater of SB or FSS (FSS nested with SB).

TABLE 12

Storage Requirements (gallons) – Well 3 and the South Well

Design Parameter	Year		
	2018	**2028**	**2038**
ERUs	426	494	574
Operational Storage	21,148	21,148	21,148
Equalizing Storage	18,150	24,150	30,300
Standby Storage(1)	69,600	96,800	128,800
Fire Storage(2)	15,000	15,000	15,000
Total Storage Required(3)	108,898	142,098	180,248
Storage Provided	264,350	264,350	264,350
Deficiency?	No	No	No

(1) Standby storage based on 200 gpd/ERU, as recommended.
(2) Based on 500 gpm for 30 minutes.
(3) Equal to OS + ES + greater of SB or FSS (FSS nested with SB).

For the purposes of hydraulic modeling during fire flow for minimum pressure requirements, the water elevation in the tanks is assumed to be at the bottom of operating storage, equalizing storage, and standby storage, with credit taken for nesting fire suppression storage with standby storage, or:

Tank water elevation at bottom of fire suppression = 230.00-OS-ES-(greater of SB or FSS)

Treatment Storage is needed when the source water requires adequate contact time (CT) for routine disinfection or to meet surface water treatment requirements. The District currently is not required to disinfect their source water, therefore treatment storage for chlorine contact time is not required.

Analysis to determine the maximum ERUs, based only on meeting the storage requirements (230.00-OS-ES-greater of SB or FSS), results in a maximum ERU count of **517 with only Well 3 operating and 750 ERUs with Well 3 and the South Well operating**.

Table 13 summarizes how each system component controls the maximum ERUs that can be supported by the existing water system. Storage is the limiting component for the water system, assuming the South Well begins operation.

TABLE 13

Summary of Source and Supply ERUs

System Component	Maximum ERUs Well 3 Only	Maximum ERUs Well 3 and the South Well
Water Rights, Annual Volume	2,138	2,138
Water Rights, Rate	1,130	1,130
Pumping Capacity	326	525(1)
Treatment	743	743
Storage	517(2)	750

(1) Harbor Hills estimated to have 525 ERUs in Year 2032.
(2) Harbor Hills estimated to have 517 ERUs in Year 2031.

The Harbor Hills' water rights and treatment system are adequate to supply water to the service area for the next 20 years. However, the current pumping capacity and storage are not, and in fact, the current pumping capacity appears to be inadequate today to meet maximum day demand. This shortfall is bridged by utilizing the equalizing and standby storage in the reservoirs. However, this may only be sufficient for a few days under MDD. Therefore, it is not recommended that this bridging become a permanent solution. Standby storage is not typically utilized to bridge the gap between peak demands and source pumping capability, however, during periods of power outages or other system failures, where standby storage is utilized, water rationing would also be required, so meeting peak demands would not be required during emergencies. By bringing the South Well online, Harbor Hills has adequate capacity until Year 2032.

HYDRAULIC MODEL

This section presents information regarding the computer hydraulic model of the Harbor Hills' water system and the results of hydraulic analyses conducted to evaluate the existing and future capabilities of the water distribution system.

The development of a computer hydraulic model, which accurately and realistically simulates the performance of a water system in response to a variety of conditions and scenarios, has become an increasingly important element in the planning, design, and analysis of municipal water systems. The Washington State Department of Health's WAC 246-290 requires hydraulic modeling as a component of water system plans.

The operation of a municipal water system involves dynamic interactions between various water system components, including source, storage, transmission, and distribution system facilities. These interactions and their effect on the level of service provided to the customers are dependent on the distribution and magnitude of water demands within the system and the performance characteristics of the water system facilities. In addition, infrequent high water demand events, such as firefighting and other emergencies, can significantly alter the normal flow patterns and pressures in the municipal water system and its components. These factors must be considered in analyzing the ability of a water system to provide for future demands, while maintaining an adequate level of water service to customers.

Hydraulic Modeling Software

The Harbor Hills' water system was analyzed using Innovyze's InfoWater hydraulic modeling software, which operates in an ArcMap GIS environment. The InfoWater model was created from existing system schematics. Figure 5 illustrates the updated schematic of the water system.

The InfoWater model is configured with a graphical user interface. Each water system element, including pipes, valves, sources, and reservoirs, is assigned a unique graphical representation within the model. Each element is assigned a number of attributes specific to its function in the actual water system. Typical element attributes include spatial coordinates, elevation, water demand, pipe lengths and diameters, and critical water levels for reservoirs. With attributes of each system element as the model input, the InfoWater software produces the model output in the form of flows and pressures throughout the simulated water system.

Model Assumptions

The basic layout of the water system is recreated within the model. The lengths, diameters, and connection points of system piping are assigned using an updated base map of the water system. Elevations of nodes are assigned using data from the 2004 *Water System Plan*. Figure 6 illustrates the system's node assignments. The District operator also provided set points for all PRVs in the system, well capacities, and booster station pump curves. The assumptions regarding the modeling of the water sources, system demands, and the settings of PRVs are included in the following sections.

For the hydraulic model, the sources of supply are the South Well and Well 3. The wells are pumped to two reservoirs, which supply the booster station. All water originates in the upper zone (HGL = 427) and is transferred to the lower zone (HGL = 340) through three PRVs.

The booster station dictates the head within the upper zone and is included in the hydraulic model. Pump curves have been assigned to each of the six pumps based on data obtained from the District. The booster station pumps are controlled by sensors in a hydropneumatic tank, which calls the first pump on if pressure within the upper zone drops below 72 psi, and calls the pumps off if pressure in the upper zone exceeds 86 psi, thereby pressure in the upper zone in the model is limited to a maximum of 86 psi. If pressure drops below 70 psi, a second pump is called on, and if the pressure drops below 60 psi, a third pump is called. It should be noted that the controls for the pumps do not allow for more than three pumps to run. This should be reconfigured to run all the pumps, if needed to maintain pressure. Two pumps are operational during the modeling of peak hour demands, and three pumps are operational during the fire flow modeling. The model was run assuming five pumps were operating and a significant increase in fire flow capability can be realized if the controls are reconfigured.

Three PRV stations supply water from the upper zone to the lower zone. Each PRV has been modeled to match its actual pressure settings, as identified in the 2004 *Water System Plan*. Two PRVs open only during periods of low pressure, such as during a fire flow scenario. During the peak hour scenarios, the smaller-diameter valves at each PRV station are operational, while fire flow events cause the larger-diameter valves to open. PRV settings are included in Table 14.

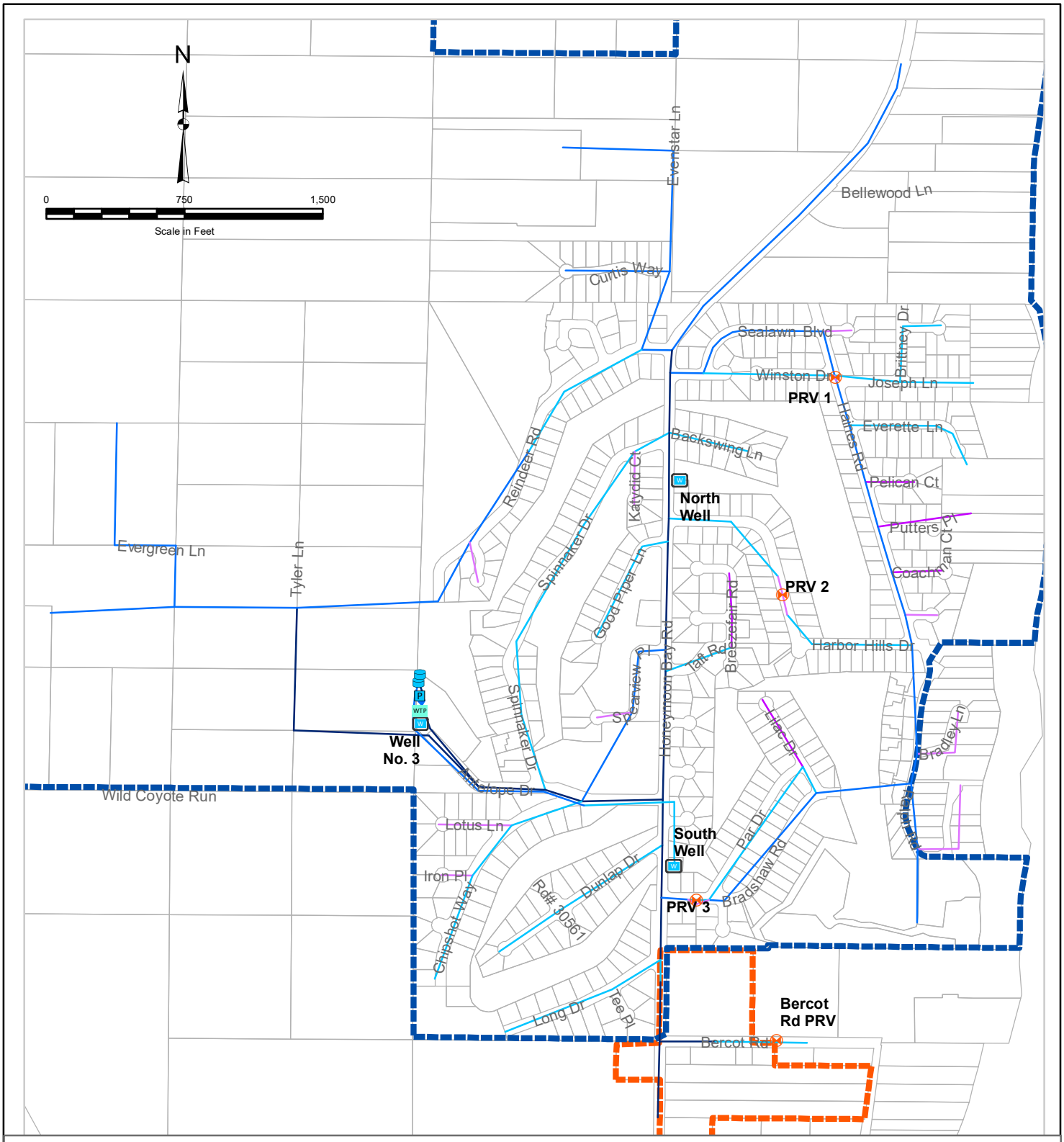
TABLE 14

PRV Settings

PRV	Location	Diameter	Setting
1	Haines Drive	4-inch	47 psi
		2-inch	54 psi
2	Harbor Hills Drive	2-inch	52 psi
3	Bradshaw Drive	4-inch	38 psi
		2-inch	42 psi

Model Scenarios

A key element in the hydraulic modeling process is the distribution of demands throughout the water system. Total demand on the system is based on the existing and projected demands from Section C. The water system demands are assigned to each node based on ERU counts. The Bradshaw Addition (nodes 201 and 202) are included in the modeling, but are only assigned demands in the buildout scenario.



Legend

- Reservoir
- PRV
- Water Treatment Plant
- Booster Station
- Well
- Service Area
- Wholesale Service Area

Pipe Diameter

- ≤ 2-inch
- 3-inch
- 4-inch
- 6-inch
- 8-inch

HARBOR HILLS WATER SYSTEM

FIGURE 5
SYSTEM SCHEMATIC

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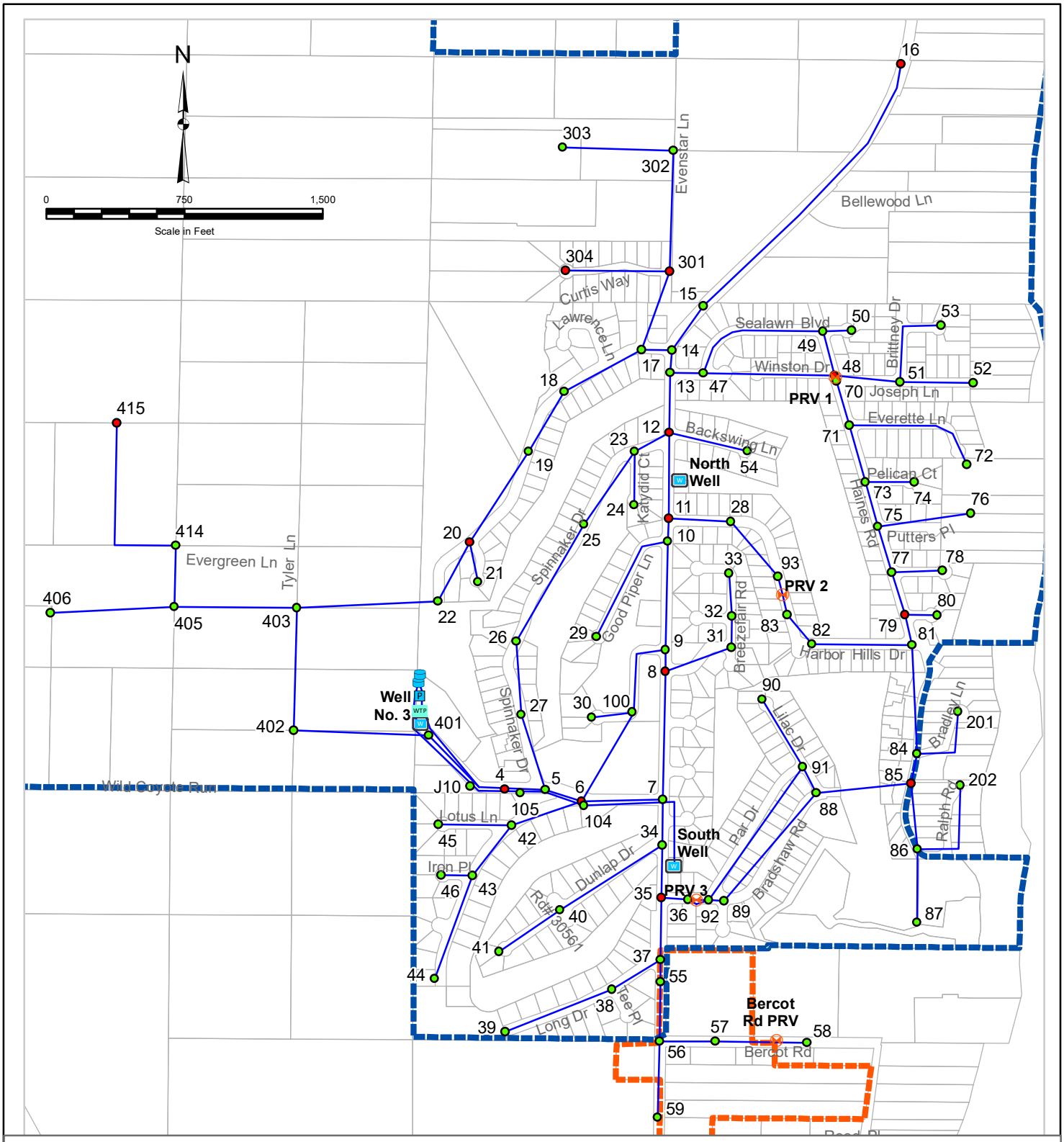
L:\Freeland Water District\GIS\HarborHillsSystemSchematic.mxd



Legend

- Model Node
- Hydrant Node
- PRV
- Reservoir
- Water Treatment Plant
- Booster Station
- Well
- Pipe
- Service Area
- Wholesale Service Area
- Parcels

HARBOR HILLS WATER SYSTEM

FIGURE 6
HYDRAULIC MODEL NODES

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L:\Freeland Water District\19611 Harbor Hills WSP\Water Model\Results\HarborHillsModelID.mxd

Eight demand scenarios were modeled:

- 2018 Peak Hour Demands: These demands were used to verify the system's current ability to meet the DOH standards to supply domestic water at a minimum system wide pressure of 30 psi.

- 2018 Maximum Day Demands: These demands were used to evaluate the system's current ability to meet the maximum day demands plus required fire flows at DOH's requirement of 20 psi.

- 2028 Peak Hour Demands: These demands were used to verify the system is able to meet the DOH standards to supply domestic water at a minimum system wide pressure of 30 psi through 2023.

- 2028 Maximum Day Demands: These demands were used to evaluate the system's ability to meet the maximum day demands plus required fire flows at DOH's requirement of 20 psi through 2023.

- 2038 Peak Hour Demands: These demands were used to verify the system is able to meet the DOH standards to supply domestic water at a minimum system wide pressure of 30 psi within the 20-year planning period.

- 2038 Maximum Day Demands: These demands were used to evaluate the system's ability to meet the maximum day demands plus required fire flows at DOH's requirement of 20 psi within the 20-year planning period.

- Buildout Peak Hour Demands: These demands were used to verify the system is able to meet the DOH standards to supply domestic water at a minimum system wide pressure of 30 psi at buildout.

- Buildout Maximum Day Demands: These demands were used to evaluate the system's ability to meet the maximum day demands plus required fire flows at DOH's requirement of 20 psi at buildout.

Model Conditions

Model input assumptions have significant impacts on peak hour and fire flow results. Table 15 shows the system conditions as they were modeled for each scenario.

During peak hour demand scenarios, the reservoir levels have been depleted of all operational and equalizing storage. During fire flow demand scenarios, fire-suppression storage has also been removed.

TABLE 15

Modeled System Conditions

Peak Hour Conditions	**2018**	**2028**	**2038**	**Buildout**
Peak Hour Demands	306 gpm	346 gpm	387 gpm	500 gpm
Source Conditions	Both Wells Active			
Booster Station Status	Two Pumps Active			
Upper Zone Reservoirs	245.7 ft HGL	245.3 ft HGL	244.8 ft HGL	243.6 ft HGL
Fire Flow Conditions	**2010**	**2017**	**2030**	**Buildout**
Maximum Day Demands	131 gpm	149 gpm	166 gpm	215 gpm
Source Status	Inactive			
Booster Station Status	Five Pumps Active			
Upper Zone Reservoirs	239.6 ft HGL	238.2 ft HGL	236.6 ft HGL	233.3 ft HGL

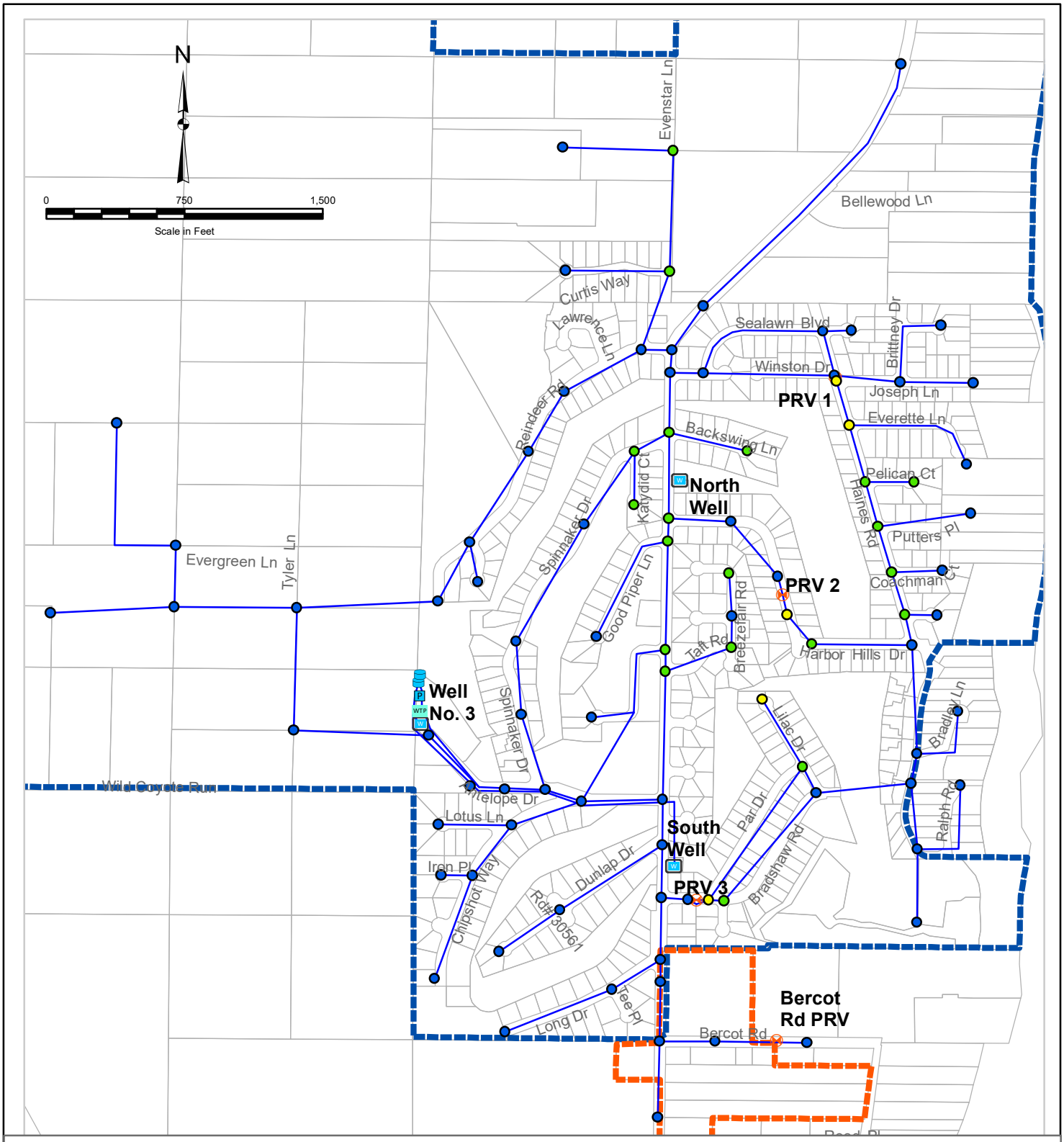
Peak Hour Analysis

According to WAC 246-290, a water system must maintain a minimum pressure of 30 psi in the distribution system under peak hour demand conditions. The existing distribution system has been modeled under 2018, 2028, 2038, and buildout peak hour demand conditions. Results of these analyses may be found in Appendix L. The results of the peak hour analyses are also displayed in Figures 7 through 9.

The peak hour analysis for 2018, 2028, 2038, and buildout do not reveal any system deficiencies, with all modeled pressures above 30 psi.

Available Fire Flow Analysis

The DOH *Water System Design Manual* states that a water system should be designed to provide adequate fire flow under peak day demand conditions, while maintaining a minimum system pressure of 20 psi. The results of fire flow modeling are presented in Appendix L. The results of the fire flow analyses are also displayed in Figures 10 through 12. According to the modeling, fire flows of over 600 gpm are available at all hydrants within the system, while maintaining 20 psi at all demand nodes. Available fire flow in the wholesale area exceeds 700 gpm.



Legend

Pressure (psi)

- <20 psi
- 20 - 30 psi
- 30 - 50 psi
- 50 - 80 psi
- >80 psi
- Service Area
- Reservoir
- PRV
- Water Treatment Plant
- Booster Station
- Well
- Pipe
- Wholesale Service Area

HARBOR HILLS WATER SYSTEM

FIGURE 7
MODEL RESULTS PHD 2018

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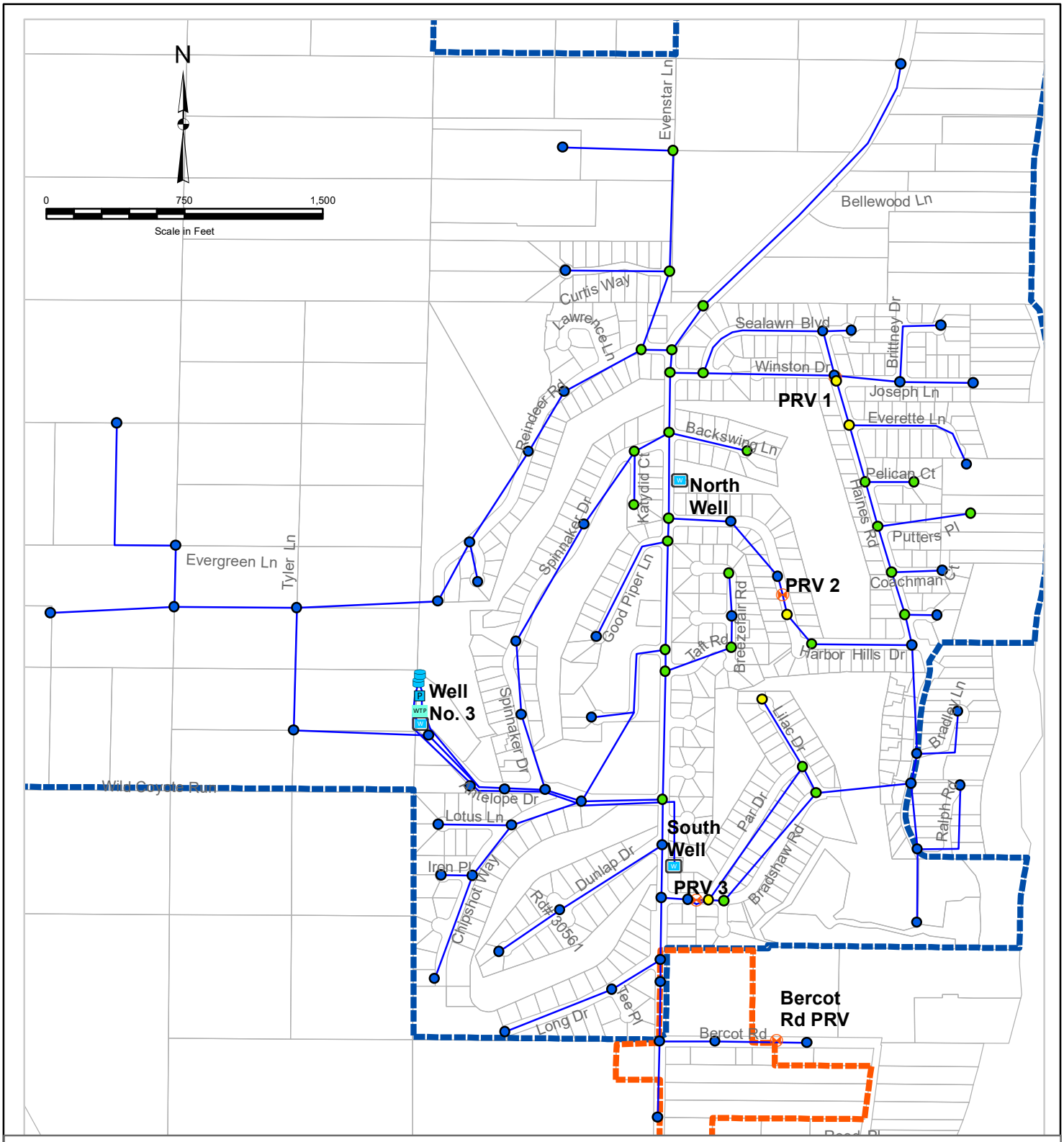
L:\Freeland Water District\19611 Harbor Hills WSP\Water Model\Results\HarborHillsModelResultsPHD18.mxd



Legend

Pressure (psi)

- <20 psi
- 20 - 30 psi
- 30 - 50 psi
- 50 - 80 psi
- >80 psi
- Service Area
- Reservoir
- PRV
- Water Treatment Plant
- Booster Station
- Well
- Pipe
- Wholesale Service Area

HARBOR HILLS WATER SYSTEM

FIGURE 8
MODEL RESULTS PHD 2028

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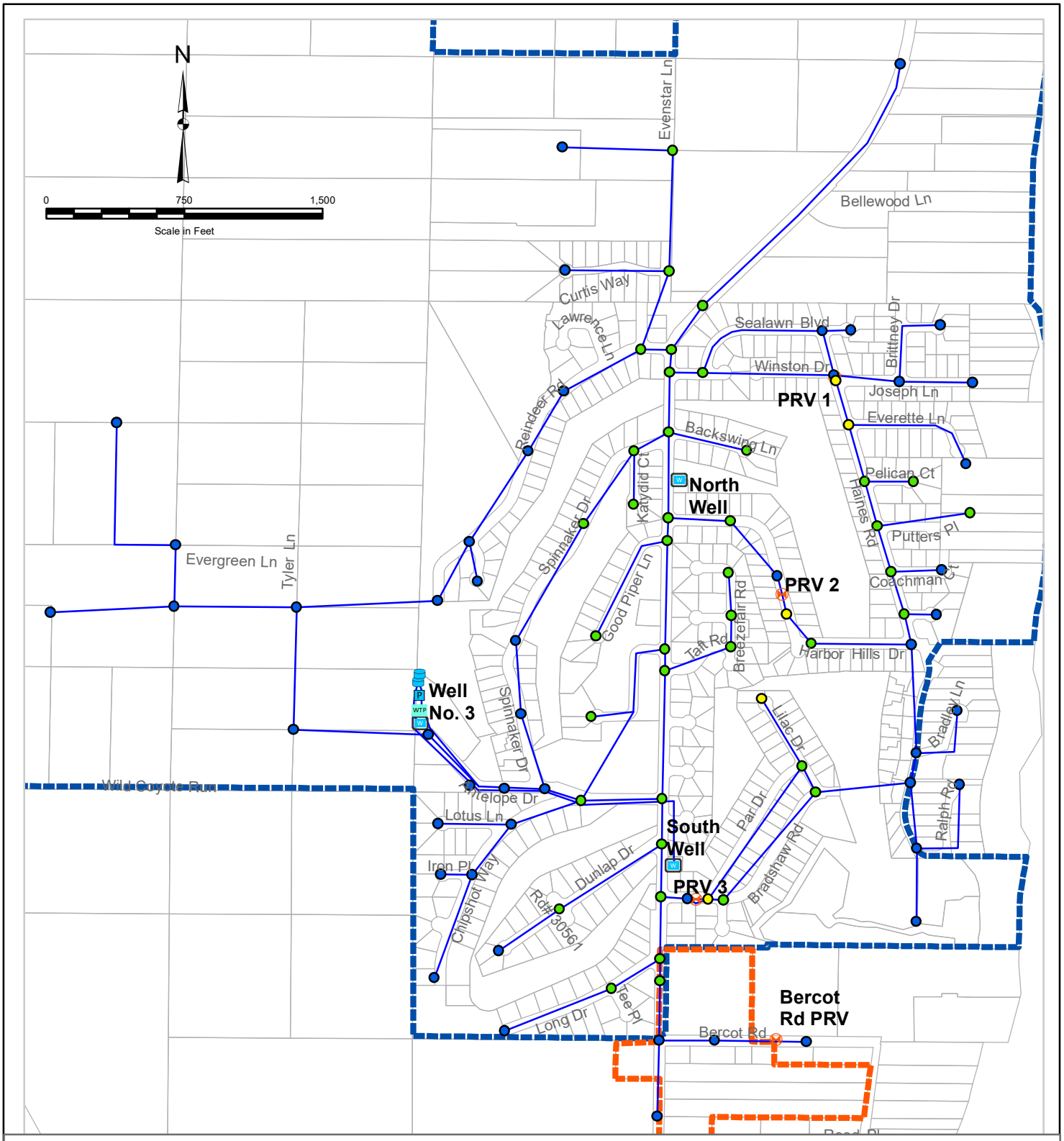
L:\Freeland Water District\19611 Harbor Hills WSP\Water Model\Results\HarborHillsModelResultsPHD28.mxd



Legend

Pressure (psi)

- <20 psi
- 20 - 30 psi
- 30 - 50 psi
- 50 - 80 psi
- >80 psi
- Service Area
- Reservoir
- PRV
- Water Treatment Plant
- Booster Station
- Well
- Pipe
- Wholesale Service Area

HARBOR HILLS WATER SYSTEM

FIGURE 9
MODEL RESULTS PHD 2038

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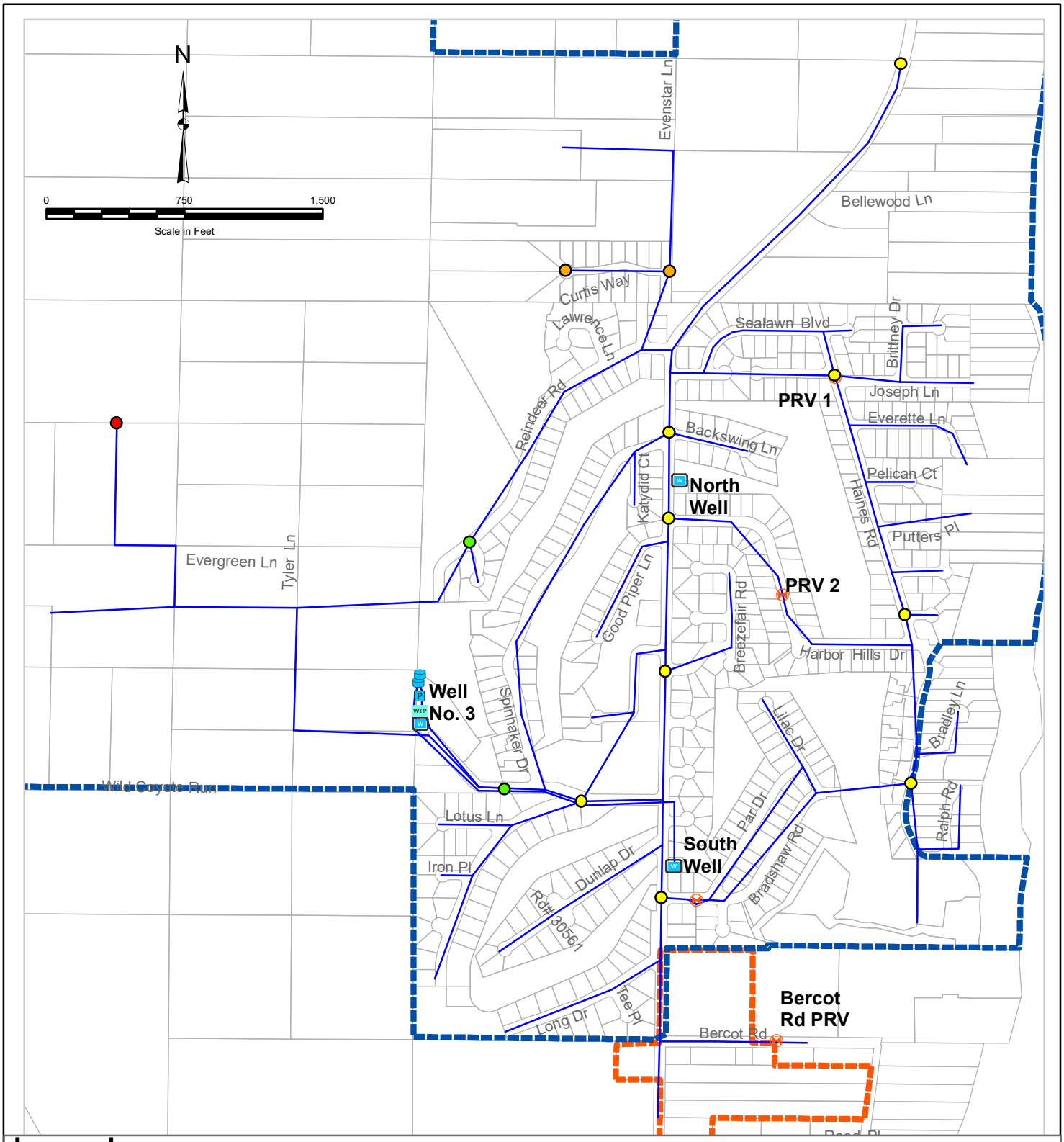
L:\Freeland Water District\19611 Harbor Hills WSP\Water Model\Results\HarborHillsModelResultsPHD38.mxd



Legend

Fire Hydrant Available Flow (gpm)

- < 650
- 650 - 700
- 700 - 750
- 750 - 800
- > 800
- Service Area

- Reservoir
- PRV
- Water Treatment Plant
- Booster Station
- Well
- Pipe
- Wholesale Service Area

HARBOR HILLS WATER SYSTEM

FIGURE 10
MODEL RESULTS FIREFLOW 2018

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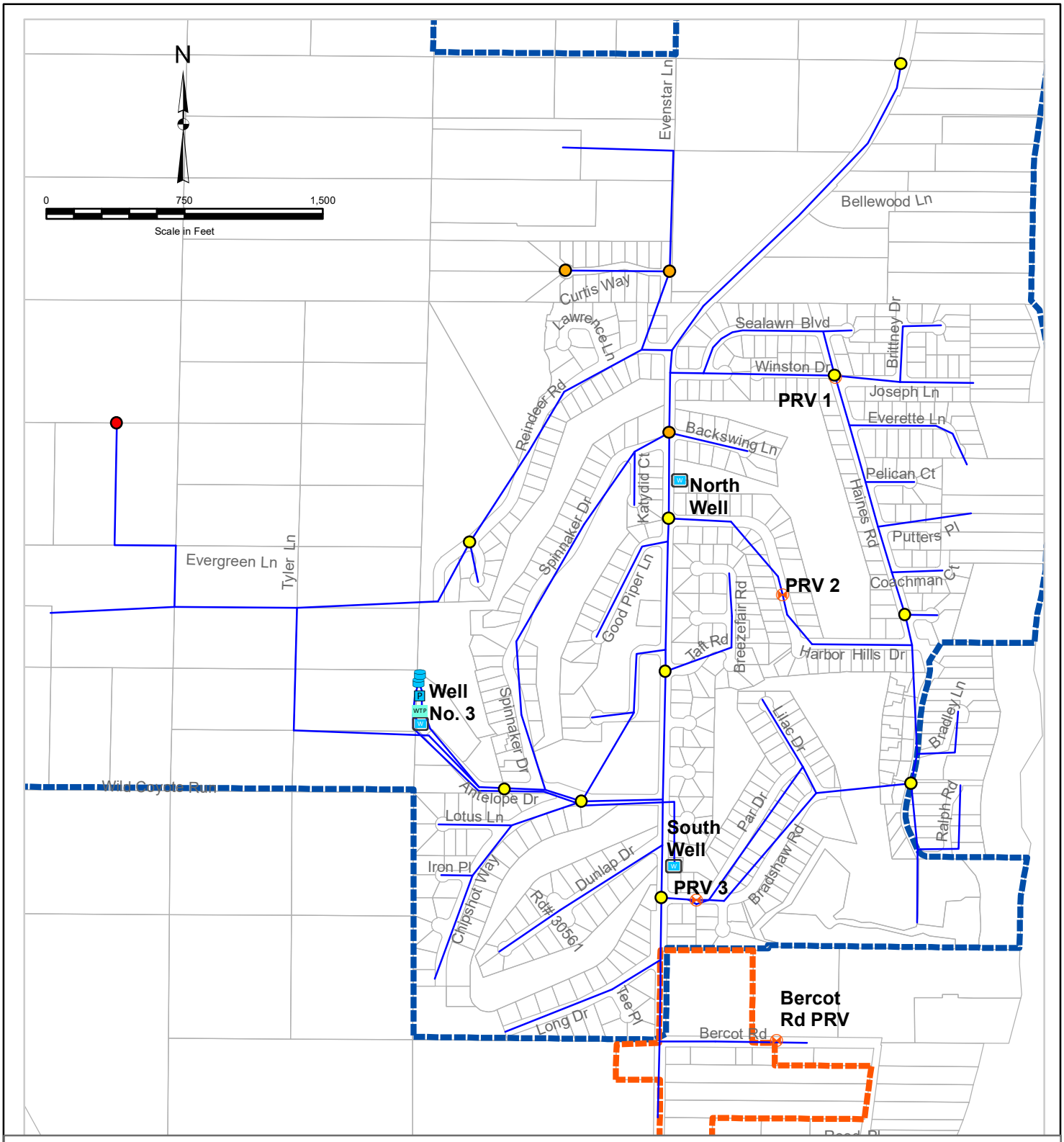

Legend

Fire Hydrant Available Flow (gpm)

- < 650
- 650 - 700
- 700 - 750
- 750 - 800
- > 800
- Service Area
- Reservoir
- PRV
- Water Treatment Plant
- Booster Station
- Well
- Pipe
- Wholesale Service Area

HARBOR HILLS WATER SYSTEM

FIGURE 11
MODEL RESULTS FIREFLOW 2028

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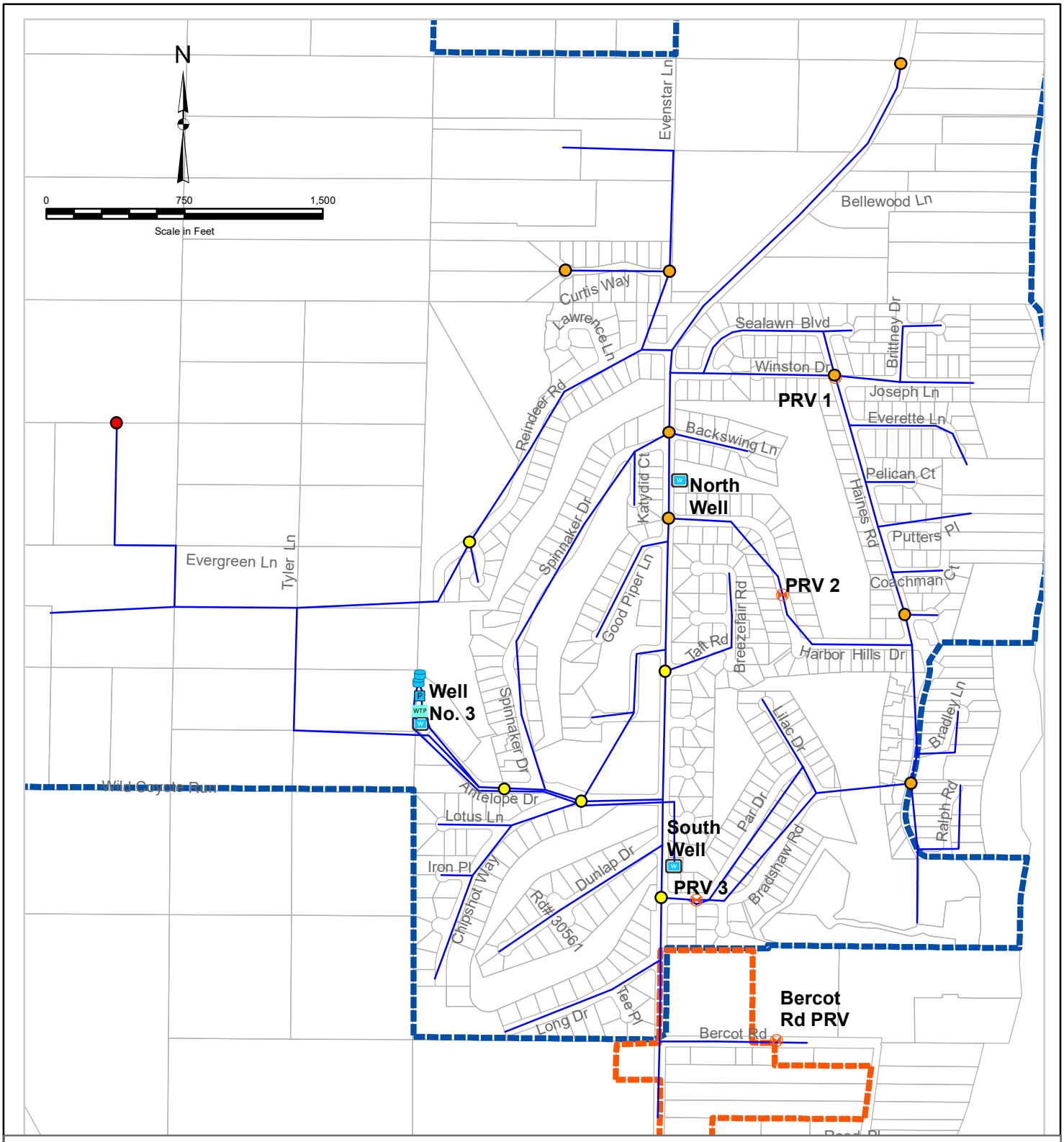

Legend

Fire Hydrant Available Flow (gpm)

- < 650
- 650 - 700
- 700 - 750
- 750 - 800
- > 800
- Service Area
- Reservoir
- PRV
- Water Treatment Plant
- Booster Station
- Well
- Pipe
- Wholesale Service Area

HARBOR HILLS WATER SYSTEM

FIGURE 12
MODEL RESULTS FIREFLOW 2038

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E. RECOMMENDED IMPROVEMENTS

To address the system deficiencies identified in Section D Capacity Analysis, and provide redundant water sources, the following projects are proposed:

1. Maintain a "minor project" budget of $20,000 per year as a placeholder for unforeseen problems and small projects. This amount is similar to past years.

2. Rehabilitate and/or re-equip Well 3 to increase its pumping capacity up to its allowed maximum of 173 gpm. The estimated cost for this project is $35,000 which includes replacing the pump column to a 4-inch diameter column, installing a higher horsepower submersible pump, cleaning the well screen, and miscellaneous electrical improvements. This cost does not include major electrical work such as new starter, new main control panels, etc.

3. Flush, clean, and test the South Well for water quality and pumping capability and begin running Well 3 and the South Well concurrently. Past records indicate this well can produce 70 gpm, but it should be cleaned and equipped to maximize its production. The control wire and transmission main to the water treatment plant are already installed and these also should be tested and flushed. This will require an adjustment (increase) to the chlorine injection upstream of the water treatment plant to provide for oxidation prior to treatment. The estimated cost for this project is $20,000 to cover any necessary minor repairs.

4. Prepare a written protocol and the necessary physical improvements for activating and connecting the North Well directly to the distribution system for un-treated emergency use only. Emergency use would be warranted upon the loss of production from Well 3 and/or the South Well and may also include stringent water conservation measures, depending upon the time of year to ensure adequate system pressures are maintained. The estimated cost for this project is $65,000 and includes installation of a variable frequency drive (VFD) for pump flow control, various electrical improvements, piping improvements for chlorine injection and wasting to reservoir, pressure regulation controls, and building repairs. It is recommended that the well be testing periodically to verify its proper operation.

5. Retain the North Well, its reservoir and pump station to permanently supply the system in the future. The following option was selected as the most desirable method to operate the North Well as a permanent source. The estimated cost of this project is $300,000. Other options that were considered included completing the 2005 project to install 1,700 feet of

6-inch transmission main from the North Well to the raw water transmission main to the water treatment plant and construction of an intertie booster station to supply water from Freeland to Harbor Hills.

i. Install water treatment to remove iron and manganese. The construction of a new building for the treatment equipment may require the purchase of additional property from the golf course.

ii. Install telemetry and a programmable logic controller (PLC) to coordinate operation of the booster pumps at both reservoir sites. The simplest telemetry control would have to alternate the operation of the two pump stations as lead supply. A more complex PLC program would operate a North Reservoir pump as a lag pump to the lead pump in the Antelope Drive Reservoir station.

6. Other projects for the District to consider include replacing water lines that are too small to provide fire flow and adding fire hydrants. These 2-, 3-, and 4-inch lines serve homes on all of the streets in Harbor Hills **EXCEPT**:

   i. Honeymoon Bay Road;
   ii. Antelope Drive;
   iii. Sealawn Boulevard;
   iv. Haines Road;
   v. Bradshaw Drive; and
   vi. Southern portion of Harbor Hills Drive.

7. Water meters are replaced rather than repaired. When the distribution system leakage (DSL) exceeds 10 percent, it may be necessary to replace service meters. DSL includes unaccounted-for water that may be due to the under registration of water meters. The water meter replacement may be scheduled over several years and the cost of replacement included in the maintenance budget.

As long as Project 3 is completed as soon as possible, a decision regarding which additional projects are to be implemented need not be made until the number of customers approaches 517 ERUs, or the production of the two sources becomes diminished. At a growth rate of 1.5 percent per year, additional production will not be needed until about 2032.

F. CAPITAL IMPROVEMENT PROGRAM

The following projects are recommended in this plan. Cost estimates are included in Appendix M.

TABLE 16

Capital Improvement Plan

Project Number	Description	Schedule	Estimated Cost[(1)]
1	Minor Projects	Annual	$20,000
2	Replace Well 3 pump and/or rehabilitate well to restore capacity to 173 gpm. Raise well casing and improve drainage.	2025	$35,000
3	Rehabilitate and restart the South Well	2020	$20,000
4	Equip the North Well as Emergency Supply	2028	$50,000
5	Equip the North Well as Permanent Supply	2031	$300,000
6	Replace Water Meters	2024	$100,000
7	Replace 1,000 feet of small diameter pipes, add hydrants	2030	$400,000
8	Replace 1,000 feet of small diameter pipes, add hydrants	2032	$400,000
9	Replace 1,000 feet of small diameter pipes, add hydrants	2034	$400,000
10	Replace 1,000 feet of small diameter pipes, add hydrants	2036	$400,000
11	Replace 1,000 feet of small diameter pipes, add hydrants	2038	$400,000
Total			**$2,540,000**

(1) 2019 dollars.

G. FINANCES

The District, as owner of the Harbor Hills system, has chosen to maintain separate accounts for the operation of the Harbor Hills and Freeland water systems. The following is the current schedule of water rates and charges for Harbor Hills.

TABLE 17

2018 Quarterly Water Rates and Charges

Base Rate (Meter Fee)		$85.00	
Commodity Rate			
0 to 1500	CF	$1.35	/100 CF
1501 to 3000	CF	$1.70	/100 CF
3001 to 4500	CF	$2.05	/100 CF
4500 to 6000	CF	$2.45	/100 CF
> 6000	CF	$2.85	/100 CF
Debt repayment to District		$6.03	

The water hook-up charge (connection charge) is $7,140 per ERU. The cost of a new water service and meter is paid by the applicant for service.

Capital improvements have been financed by the ratepayers, developers (i.e., water main extensions), and Drinking Water State Revolving Fund loans (i.e., reservoirs, pump station and water treatment). In addition, as noted above, the purchase of the system was financed from a loan by the District. The debt repayment schedule for loans is shown below.

TABLE 18

Loan Repayment Schedule

	DWSRF Loan 03-65103-020	DWSRF Loan 03-65103-019	Freeland W&SD Loan
2019	$2,560.50	$30,895.66	Paid in Full
2020	$2,525.25	$30,470.49	Paid in Full
2021	$2,490.02	$30,045.31	Paid in Full
2022	$2,454.78	$29,620.15	Paid in Full
2023	$2,419.55	$29,194.98	Paid in Full
2024	$2,384.31	$28,769.81	Paid in Full
2025	Paid in Full	Paid in Full	Paid in Full

The following revenue history is used for the revenue and expenditures forecast. Only the major revenue categories are included. Interest and other miscellaneous revenues are comparatively insignificant.

TABLE 19

Revenue History

Year	2016	2017	2018
Connections Dec 31st (ERUs)	406	418	426
Annual Production (gallons)	21,300,000	23,966,000	23,887,162
Average Use (gallons/ERU)	52,463	57,335	56,073
Commodity Revenue	$46,584	$47,964	$51,106
Base Rate Revenue	$84,880	$186,840	$152,767
Debt and Loan Revenue	$115,300	$52,911	$33,723
Hookup charge Revenue	$121,380	$64,260	$117,265
Total	**$368,144**	**$351,975**	**$354,861**

TABLE 20

Assumed 2019 Revenue and Expenditures (Base Year for Forecast)

Assumptions for Forecast		
Connections Dec 31st (ERUs)		432
Beginning O&M Balance		$66,571
Beginning Capital Balance		$198,592
Revenue		
1	Base Rates	$157,199
2	Loans	$33,457
3	Commodity Rates	$50,544
4	Other	$3,144
5	Connection charges*	$121,911
6	Total Revenue	$366,255
Expenditures		
7	Operations/Administration	$102,388
8	Loan Repayment	$33,457
9	Capital	$20,000
10	Total Expenditures	$155,845
11	Surplus (Deficit)	$210,410
Reserve Fund Targets		
12	Capital Replacement	$180,000
13	Operating (6 months)	$51,194
14	Emergency	$5,000

Notes: *Current amount collected. Assumption after 2019 is based on ERU growth.

Table 21, included in Appendix N, provides information regarding the 20-year financial forecast for the Harbor Hills water system. For the forecast, the following is assumed:

- Six months of operating expenses are retained in each year's beginning operating fund balance. All operational surpluses, less 6 months of operating expenses, are transferred to the capital budget.

- ERU growth is assumed at 1.5 percent per year.

- Meter fees (base rates) are increased 2 percent per year for inflation. Meter fees are the primary source of funds for operating and administration expenses.

- Commodity income is assumed to be proportional to the assumed increase in production, based off ERU growth.

- For new subdivisions, water hook-up charges (purchase of equity in the system) are not charged at the time of issuing the *Water Availability* form to the County. Each water customer pays the water hook-up charge at the time of building construction.

- No new large subdivisions are anticipated in the 10-year forecast.

- The connection charge is assumed to be unchanged for the forecast.

- The water commodity rates are assumed to be unchanged for the forecast.

- Administration, operation expenses are assumed to increase 2 percent per year for inflation.

- An annual capital construction expense of $20,000 is assumed for minor system improvements, such as treatment media replacement, etc. These expenses are assumed to increase at 3 percent per year for inflation.

- Specific capital projects are additional to the above assumed annual small system capital expenditures. Annual cost escalation (inflation) is assumed at 3 percent per year for all capital projects.

The present water rates and charges are adequate for the capital improvement plan. Growth of capital reserves is sufficient to fund capital projects, without using loans or grants. If there is slower than expected growth, major capital projects can be delayed in order to maintain reserves.

H. STANDARD PLANS AND SPECIFICATIONS

The *Standard Plans and Construction Specifications* included in the District's *2018 Water System Plan* are adopted. A copy is included in Appendix O of this plan.

I. OPERATIONS AND MAINTENANCE

WATER USE EFFICIENCY

The Department of Health adopted Part 8 of WAC 246-290 in 2007 to implement RCW 70.119A.180, requiring water systems to evaluate and implement water use efficiency measures. Per WAC 246-290-800, water purveyors are required to collect water use data, forecast water demand, evaluate water use efficiency measures, calculate distribution system loss (DSL), set goals for water use, and implement a program to accomplish those goals. Water is lost or wasted from the system in two distinct areas: supply and demand. Losses, or DSL, in the supply side include leaks and unaccounted water use such as firefighting, theft, flushing, etc. Losses on the demand side include customer leaks,

waste, and inaccurate metering. In accordance with WAC 246-290-800(4)(d)(i), Harbor Hills is required to evaluate or implement one water use efficiency measure now, but will have to evaluate or implement four measures when the number of connections reach 500. The Water Conservation Plan in the *2004 Water System Plan* pre-dates these requirements, but included recommendations such as:

- Implement an inclining rate structure to encourage conservation;
- Conducting a cursory water audit if DSL exceeded 9 percent, with a detailed water audit if 9 percent was exceeded for a second period;
- Provide historical water use on customer billing;
- Replace or calibrate service meters per the manufacturers' recommendations;
- Encourage low water use landscaping;
- Halt the practice of supplementing the golf course irrigation;
- Distribute education materials to new customers and periodically to all customers;
- Establish a goal of reducing maximum day demand to below 500 gpd/ERU; and
- Establish a long-term goal of replacing asbestos cement water mains.

Historically, the Harbor Hills water system has measured a DSL less than 8 percent, and more recently, the 3-year average is only 5.3 percent, well below the state requirement of ten percent. Therefore, measures to further reduce DSL are most likely not cost-effective. The District will continue to measure DSL and routinely monitor for leaking hydrants and pipes to limit DSL.

On the demand side, several of the recommendations from the *2004 Water System* Plan Water Conservation Plan have been implemented including an inclining rate structure, meter replacement, educating customers through water bill information, and alerting customers of potential leaks if metering shows a dramatic increase in water use. In addition, the maximum day demand of less than 500 gpd/ERU has been met since 2004, and the system has a 3-year average daily demand of only 158 gpd/ERU (including a 10 percent DSL allocation).

The Water Use Efficiency goal stated in the Harbor Hills 2018 Annual Performance Report is "to reduce customer demand by 1 percent by 2021." The last 5-years performance reports are included in Appendix P. Reducing demand to less than

158 gpd/ERU will be challenging to achieve since this is already a very low demand, and considering that demand can vary due to occupancy rates, weather, and demographics. A public meeting was held on February 12, 2020 to review the Harbor Hills Draft Water System Plan and establish goals for water use efficiency. The following goals were established:

1. Reduce customer demand by 1 percent by 2025.

2. Maintain an average 3-year DSL to less than 10 percent.

These goals can be achieved by implementing the following water use efficiency measures:

1. Continue to implement an inclining rate structure to encourage conservation.

2. Provide customers with notification if meter data indicates a potential leak.

3. Replace customer water meters as recommended by the manufacturer and when data suggests a meter is malfunctioning.

4. Provide historical water use information on customer bills.

5. In addition to the information now provided in the annual Consumer Confidence Report, include water conservation education materials in at least one other customer billing.

6. Continue tracking DSL and monitor for signs of leaking pipes and hydrants.

WATER SHORTAGE RESPONSE PLAN

The Water Shortage Response Plan in the *2004 Water System Plan* remains in effect. A copy is included in Appendix Q of this plan.

CROSS-CONNECTION CONTROL PROGRAM

The Cross-Connection Control Program in the District's *2018 Water System Plan* is adopted. This includes the standard plans for the installation of backflow prevention assemblies. A copy of the program (District Resolution 01-1) is included in Appendix R of this plan.

The Harbor Hills water system currently has only one backflow prevention assembly in its system. A reduced pressure backflow assembly is installed on the service to the Holmes Harbor Wastewater Treatment Plant.

The next risk survey of customer's premises is scheduled for 2020. The survey will consist of a questionnaire mailed to the customers.

WELLHEAD PROTECTION PLAN

The Wellhead Protection Plan in the *2004 Water System Plan* remains in effect. A copy is included in Appendix F of this plan. The mailing of an educational letter along with the water billing to all property owners (in addition to the property owners in the one-year time-of-travel) is planned for 2020. The letter will notify them of the presence of the wells and the need to prevent groundwater contamination.

EMERGENCY PLAN

The Emergency Plan in the *2004 Water System Plan* remains in effect. A copy is included in Appendix S of this plan.

SAFETY PROGRAM

Since system operation is undertaken by a contract operator, a safety program has not been developed by the system owner.

MAINTENANCE SCHEDULE

The routine maintenance task schedule for the distribution system is summarized in Table 22.

TABLE 22

Routine System Maintenance Schedule

Description	Schedule	Comments
Hydrant inspection and exercising	Annually	Wash, paint every 5 years
Line valve inspection and exercising	Annually	
Blow-off inspection and exercising	Annually	
Air release valve inspection	Annually	
Source meters testing and maintenance/calibration	Every 3 years	
Source meter reading	Monthly	
Customer meter testing and replacement	As needed	Not currently scheduled. Meters on 15-year replacement schedule
Water main flushing	Every 5 years	Water main flushed is scheduled in spring. Flush dead-ends annually.
Backflow assembly testing	Upon installation, annually thereafter	Customer owns backflow assemblies for premises isolation.
Cross-connection control risk survey	Every 3 years	Residential survey questionnaire mailed to customers.
Well static/pumping levels	Spring and Fall	Data reported to WA Ecology.
Chlorine Pump	Annually	Install overhaul kit.
Pressure Tank	Annually	Inspection.
Emergency Generator	Annually	Check battery, top off fluids.
Well 3 Pitless Adapter	Annually	Remove cap, check for leaks, replace seal if necessary.
Reservoirs	Bimonthly	Clean inside every 5 years.

J. SERVICE POLICIES

The District's *Service Policies* are applied to the Harbor Hills system. A copy of the *Service Policies* (FWSD Resolution 2103-02-008) is included in Appendix T.

K. MUNICIPAL WATER LAW

Under the *Municipal Water Law*, water system plans must address the following four thresholds for the duty to serve:

Capacity: Municipal water suppliers must include a capacity determination in their Water System Plan. Capacity determinations incorporate a water system's physical capacity and water right limitations. See Section D – Capacity Analysis.

Consistency: Consistency applies to locally adopted comprehensive plans, land use plans, development regulations, and utility service extension ordinances. Consistency determinations must evaluate land use, 6-year growth projections, service extension ordinances, new water service provisions, and other elements WA DOH determines are related to water supply planning. Municipal water suppliers must ask their local government(s) to determine consistency. If a local government does not complete the determination, the municipal water supplier must document its efforts to obtain local review and then determine consistency itself. See Appendix A for copy of Local Government Consistency Determination Form.

Water Rights: Department of Ecology is responsible for water right sufficiency determinations. Municipal water suppliers must include a water right self-assessment in their Water System Plan or Small Water System Management Program. WA DOH will forward a copy of the planning document and water right self-assessment to the Department of Ecology for review. WA DOH will incorporate water right limitations into service capacity approvals. See Appendix D for Water Right Self-Assessment.

Timely and Reasonable: Municipal water suppliers must include their service policies in their Water System Plan. They must describe how they will provide new service. See Appendices T for the District's service policies.

Unless otherwise stated in the District's *Rules and Regulations* (See Appendix T). The following policies shall pertain to the Municipal Water Law "duty to serve" new customers within the Harbor Hills water service area.

- Applicants for service located in the future or existing service area not served by existing distribution mains must request service from the Harbor Hills water system. Harbor Hills has the "right of first refusal" to provide service. If Harbor Hills cannot provide new service in a "timely and reasonable manner", the applicant may request service from another water system or develop a new public water system if another existing water system is not willing or able to provide service.

- The Public Water System Coordination Act defines "timely service" as 120 days. The Act does not specify at which point the 120-day period begins and ends. For Harbor Hills, the 120-day time frame starts on the date of a signed system extension agreement with the applicant, or effective date of the agreement. The signed system extension agreement may require the design of facilities and/or water main extension before the 120-day period begins; this design period being considered the same for the applicant as the time for design of a new public water system.

- The Public Water System Coordination Act does not define "reasonable service." For Harbor Hills, reasonable service is defined as:

    - Providing water for domestic use in the quantity and at the pressure outlined in the Harbor Hills current *Water System Plan* design criteria.

    - Providing water for fire protection consistent with the Island County Fire Marshall's requirements for the land use and building(s) to be constructed on the site(s).

    - Providing new water facilities consistent with the standards of construction for Harbor Hills.

    - Installing water mains and appurtenances in accordance with the District's adopted *Engineering and Construction Standards*, a copy of which is included in Appendix O.

    - Obtaining competitive bids for the installation of mains and/or construction of new facilities as stipulated in the system extension agreement.

Harbor Hills will respond to a request for new service within 60 days. This request shall outline the information required and procedures for implementing a water system extension agreement, or alternatively a satellite management ownership agreement or satellite management operating agreement.

If the applicant for service disagrees with the Harbor Hills conditions for service as "timely and reasonable", the applicant may appeal to the County. If either party to the appeal is not satisfied, they may choose to seek resolution through a civil judicial proceeding.