Chapter 3: System Analysis

The objective of this chapter is to determine if the existing system facilities are capable of supplying sufficient quality and quantity of water to meet the existing and projected demands as identified in Chapter 2, *Basic Planning Data and Water Demand Forecasting.*

3.1 System Design Standards

The following design standards provide the water system performance design criteria and are used to evaluate the existing and future water system.

Water Quality Parameters:
Water quality must meet standards established in state and federal regulations. Included in Appendix E is a copy of Chapter 246-290 WAC and of sections of 40 CFR Part 141 that have been adopted by reference by DOH. Pertinent maximum contaminant levels (MCLs) for various contaminants are established in the following sections of state and federal code:

- Inorganic chemicals. As established in WAC 246-290-310(3)
- Volatile organic chemicals. As established in 40 CFR 141.61(a)
- Synthetic organic chemicals. As established in 40 CFR 141.61(c)
- Radionuclides. As established in WAC 246-290-310(6)
- Bacteriological. As established in WAC 246-290-310(2)

Average Daily Demand (ADD):
ADD values are calculated based on 2009 monthly meter readings provided by the City of Sumas Water Department. The ADD was calculated by summing the monthly meter readings and dividing by 365 days per year. Large users were identified as those users that have a Maximum Daily Demand (MDD) greater than 800 gpd – see Table 3-1. Based on a review of the meter readings 21 large users were identified. Residential and small business ADD was calculated as the difference between the total and large user ADD. ADD calculations are provided in Appendix D.

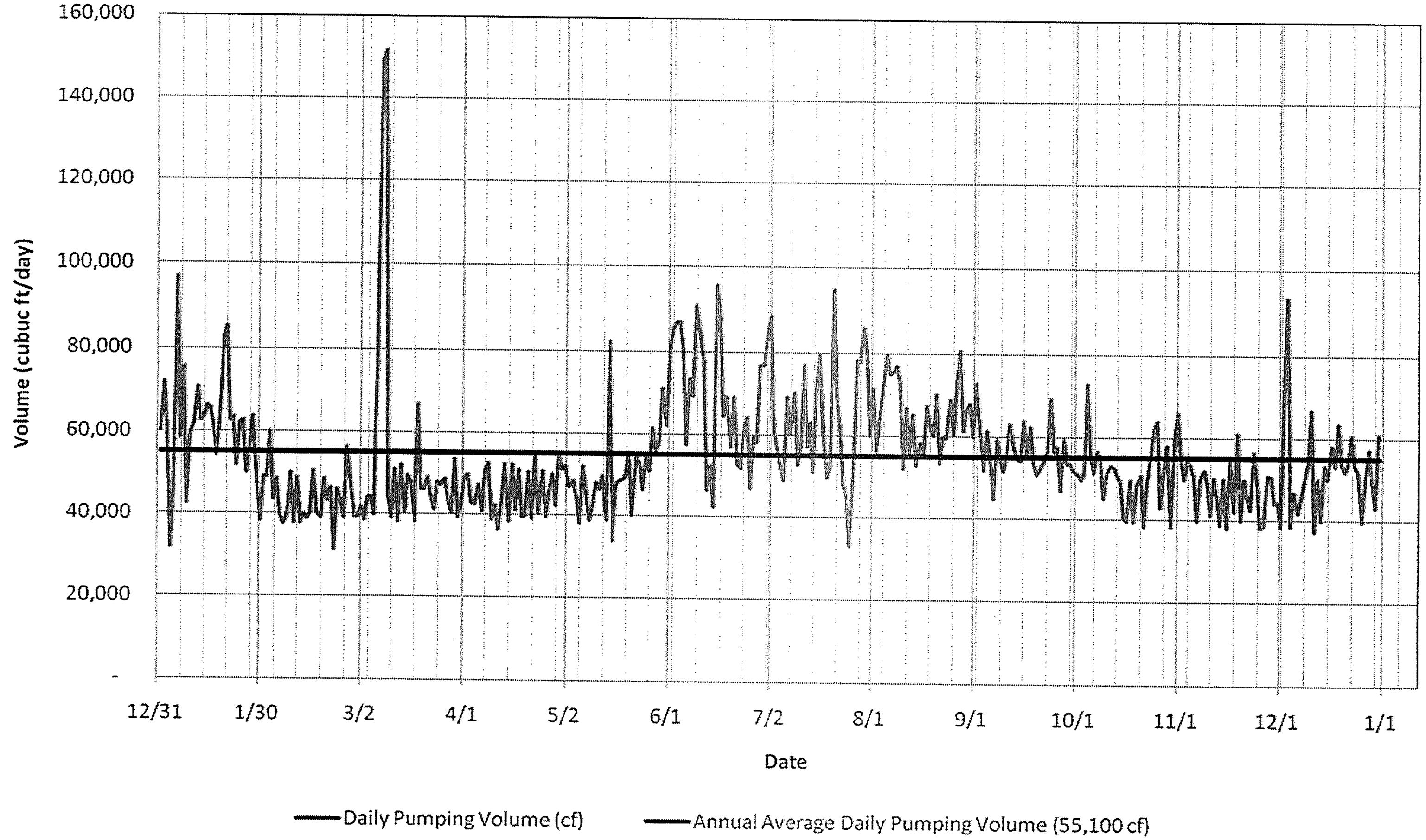
Maximum Daily Demand (MDD):
MDD values are calculated based on a peaking factor times the ADD values. Daily meter readings for 2009 on well pumps 4R and 5 (which supply water to the combined Sumas and Sumas Rural Water Association systems) have been recorded and are shown in Figure 9, *2009 Daily Meter Readings Wells 4R & 5*. From this information the average annual daily pumping volume is 55,100 cubic feet per day (412,000 gpd). Peaking pumping volumes are less than 100,000 cubic feet per day, or 1.8 times the annual average. (Peak readings on March 8 and 9 are attributed to a diversion to the PSE cogeneration plant, normally supplied by the May Road wellfield. This peak reading of 150,000 cubic feet per day is 2.7 times the annual average.) Based on this information a 2.0 peaking factor is very conservative and will be used for this analysis. MDD calculations are provided in Appendix D.

Figure 9. 2009 Daily Meter Readings Well 4R & 5

Table: 3-1: 2009: LARGE USERS: >800 gpd MDD

# of Services	Acct. #	Name	Address	Year Total (FT^3)	ADD (GPD)	MDD 2*ADD (GPD)	MDD (GPM)	PHD 4.0*MDD (GPM)
1	2011	Bromley's Market	315 Cherry St.	19,635	402	805	0.56	2.24
1	10530	Lo's Garden	520 Cherry St.	20,250	415	830	0.58	2.31
1	13485.2	Cedarprime	601 C W. Front St.	24,940	511	1,022	0.71	2.84
1	440	GSA	139 Cherry Street	31,800	652	1,303	0.91	3.62
1	15055	Hillview - Sprinklers	1305 Boon Street	32,480	666	1,331	0.92	3.70
1	10341.2	Sunshine Laundry	444 A Cherry St.	32,850	673	1,346	0.94	3.74
1	522	Tesoro	208 Cherry Street	34,845	714	1,428	0.99	3.97
1	4062	El Nopal	420 Cherry St.	37,279	764	1,528	1.06	4.24
1	14034	Creekside Sprinklers	1400 Boon Street	39,042	800	1,600	1.11	4.44
1	2081	Sumas Investment	334 Cherry Street	39,135	802	1,604	1.11	4.46
1	12761	Pay N Run	1015 Cherry St.	40,040	821	1,641	1.14	4.56
1		Old Ball Park	Easterbrook Road	42,950	880	1,760	1.22	4.89
1	260	Twin Firs	Canada-N of 705 Arthurs Way	56,800	1,164	2,328	1.62	6.47
1		New Ball Park 4" Meter	Hovel Road	71,300	1,461	2,922	2.03	8.12
1	12833	Teal Jones	530 W. Front St.	81,000	1,660	3,320	2.31	9.22
1	1092	Sumas Investment	121 Cleveland Street	103,035	2,112	4,223	2.93	11.73
1	10873	Bob's Burger	819 Cherry St.	121,400	2,488	4,976	3.46	13.82
1	10915	Cherry Street	725 Cherry St.	133,485	2,736	5,471	3.80	15.20
1	12134	Sumas RV	9600 Easterbrook Rd.	163,180	3,344	6,688	4.64	18.58
1	12811	Elenbaas	411 W. Front St.	180,700	3,703	7,406	5.14	20.57
1	14436	IKO	850 W. Front St.	780,665	15,998	31,997	22.22	88.88
21				**2,086,811**	**42,765**	**85,531**	**59**	**238**

Figure 9: 2009 Daily Meter Readings Wells 4R & 5



Peak Hourly Demand:

Peak Hourly Demand (PHD) is calculated based on the DOH *Water System Design Manual*, December 2009. PHD calculations are provided in Appendix D.

Equation 5-1: Determine PHD

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

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

Number of ERUs (N)	C	F
15 – 50	3.0	0
51 – 100	2.5	25
101 – 250	2.0	75
251 – 500	1.8	125
> 500	1.6	225

Storage Requirements:

Storage requirements are calculated based on Table 9-1: *Reservoir Storage Component Cross-Section Diagram* from DOH's *Water System Design Manual*, December 2009. Storage calculations are provided in Appendix D.

Fire Flow Rate and Duration:

Fire flow rate and duration requirements are based on the *Whatcom County Coordinated Water System Plan*, February 2000, Table *Minimum Fire Flow Requirements*, page 5-13 – see Table 3-2. Figure 10, *Fire Hydrant Coverage Areas*, identifies the city's zoning boundaries, existing hydrant locations and coverage area, and minimum fire flow requirements.

Figure 10, *Fire Hydrant Coverage Areas*,

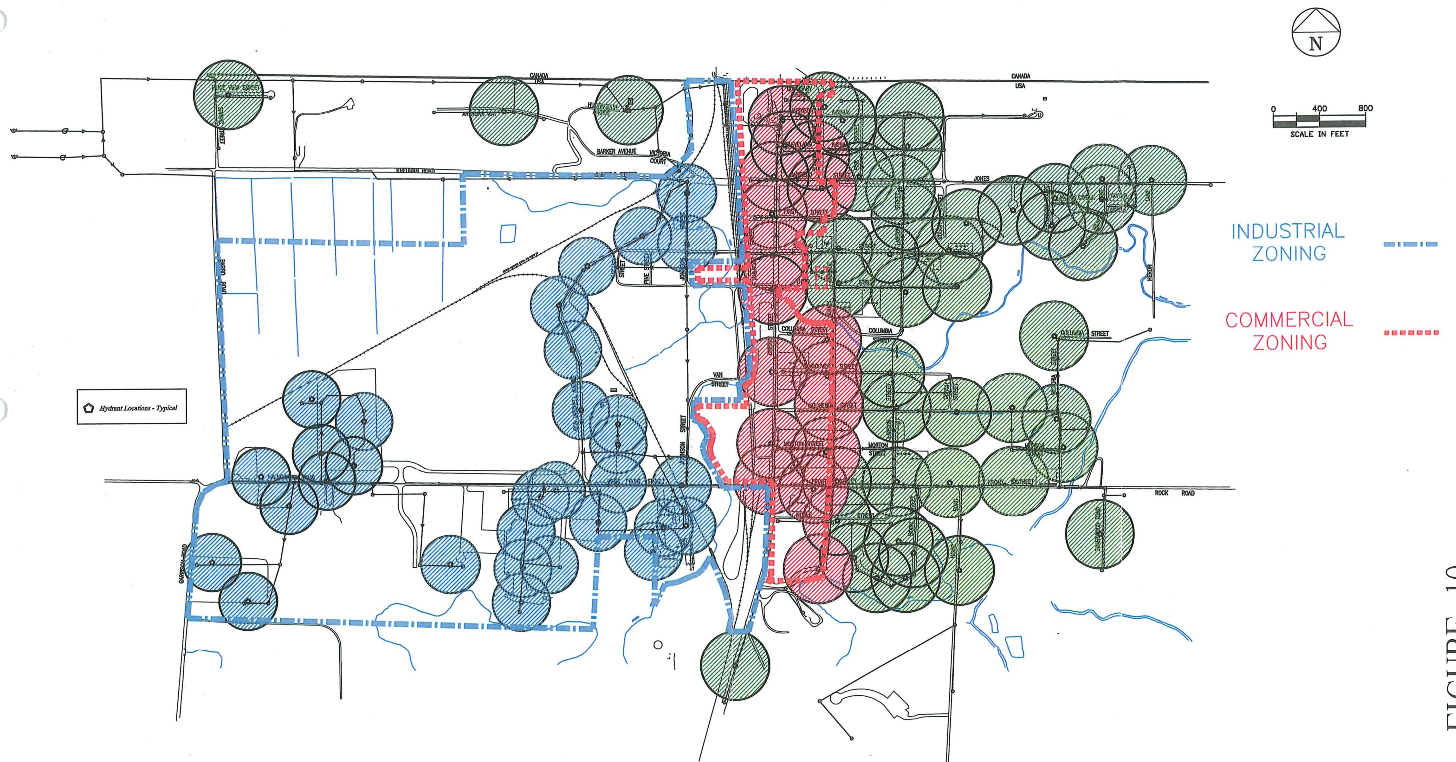


FIGURE 10

HYDRANT COVERAGE AREA AND MIN. FIRE FLOW REQUIREMENTS
RESIDENTIAL 600 FT SPACING (300' RADIUS) - 500 GPM FOR I HOUR
COMMERCIAL 600 FT SPACING (300' RADIUS)- 750 GPM FOR 1 HOUR
INDUSTRIAL 500 FT SPACING (250' RADIUS) - 1,000 GPM FOR 2 HOURS

Date:	2/07/2011
Scale:	1" = 400'

CITY OF SUMAS
PUBLIC WORKS DEPARTMENT
FIRE HYDRANT COVERAGE AREA

433 CHERRY STREET SUMAS, WA 98295 (360) 988-5711, FAX (360) 988-8855

CASCADE ENGINEERING GROUP, P.S., INC.
119 Grand Avenue, Suite D
Bellingham, Washington 98225
(360) 306-8161

3/18/2011 4:14 P... \S\SUMS0001\0400CAD\DWG\SHEETS\SUMAS HYDRANTS.DWG

Table 3-2: Minimum Fire Flow Requirements, Whatcom County Coordinated Water System Plan, **February 2000**

280145/cwsp/section5.doc
February 8, 2000

Zoning	Minimum Fire Flow Requirements
Industrial	1,000 gpm for 120 minutes
Commercial, Airport Operations	750 gpm for 60 minutes
URM 6, URM 12, URM 18	750 gpm for 60 minutes or commensurate with standards of the adjacent municipal corporation, whichever is greater
UR3, UR4, UR-MX	500 gpm for 60 minutes or commensurate with standards of the adjacent municipal corporation, whichever is greater
RR1, RR2, RR3	500 gpm for 60 minutes
RRI (Island)	No fire flow requirement
R2A, R5A, R1OA	No fire flow requirement
Agriculture	No fire flow requirement
Forestry	No fire flow requirement

Minimum System Pressure:

Minimum system pressure shall be 30 psi during peak hourly demand periods and 20 psi during fire flow conditions in accordance with Section 5.2.4 *Specific Provisions, Pressure Requirements* of the *Whatcom County Coordinated Water System Plan*, February 2000 and Section 8.1.5 *Minimum Distribution System Pressure* of the DOH *Water System Design Manual, 2009.*

Minimum Pipe Sizes:

Within the commercial and residential zones, minimum diameter for water lines is generally eight inches. Six-inch and/or four-inch diameter pipe may be allowed at the discretion of the City when: (a) future extension is not anticipated; and (b) hydraulic modeling confirms that required fire flow is available to hydrants on the line. The City may waive the requirement of hydraulic modeling in instances where the extension consists of a looped six-inch line less than 2,000 feet in length connected at each end to lines eight-inches or larger in diameter. Within the Industrial zone, minimum diameter for water lines is generally ten- inches. Eight-inch diameter pipe may be allowed at the discretion of the City when hydraulic modeling confirms that required fire flow is available to hydrants on the line.

Backup Power Requirements:

Sufficient backup power shall be present at each wellfield to maintain all pumps in simultaneous operation.

Valve and Hydrant Spacing:

Valves shall be resilient seated gate valves, Waterous Series 500 or equal, with a minimum pressure rating of 200 psi, and shall conform to the latest revision of AWWA specification C509. Valves shall be installed along the water main at intervals not to exceed 500 feet within the

Industrial zone and not to exceed 800 feet within commercial and residential zones. Valves shall be placed on each main at all junction points.

Fire hydrants shall be Clow Medallion fitted with a five-inch Stortz connection on the steamer port, secured to the hydrant with aircraft cable. Fire hydrants shall be installed at intervals of 600 feet within commercial and residential zone districts and intervals of 500 feet within the Industrial zone.

3.2 Water Quality Analysis

Raw water withdrawn at the two City wellfields is of excellent quality with respect to drinking water standards. The only parameter of concern is nitrate, which is present in elevated concentrations in all wells. At the Sumas Wellfield (which comprises sources SO6 and SO7), nitrate concentrations are below the MCL of 10 mg/l, whereas at the May Road Wellfield (#1 now used for domestic supply) nitrate levels are at times slightly above the MCL.

The graphs in Figures 11a through 11e indicate the trend in nitrate concentration over time at each well. Generally, the trend is toward higher values over time, but the rate of degradation varies from well to well. Wells 1, 2, and 3 (SO1, SO2, and SO3 respectively) are older artesian wells completed at a depth of 57 feet below ground level. Among the five wells at the Sumas Wellfield, these three wells show the fastest rate of degradation and the highest nitrate concentrations. The three graphs also reveal that nitrate concentrations increase as one progresses further up-gradient (and uphill) within the wellfield. Well 1 is the furthest down-gradient and shows the lowest concentrations, while Well 3, with the highest concentrations, is the furthest up-gradient. Wells 4 and 5, which are completed at depths of 80+ feel below ground level, contain the lowest nitrate concentrations. The graphs suggest that nitrate contamination is most prevalent near the top of the water table.

Figure 11. a through g Nitrate Concentration at Wells

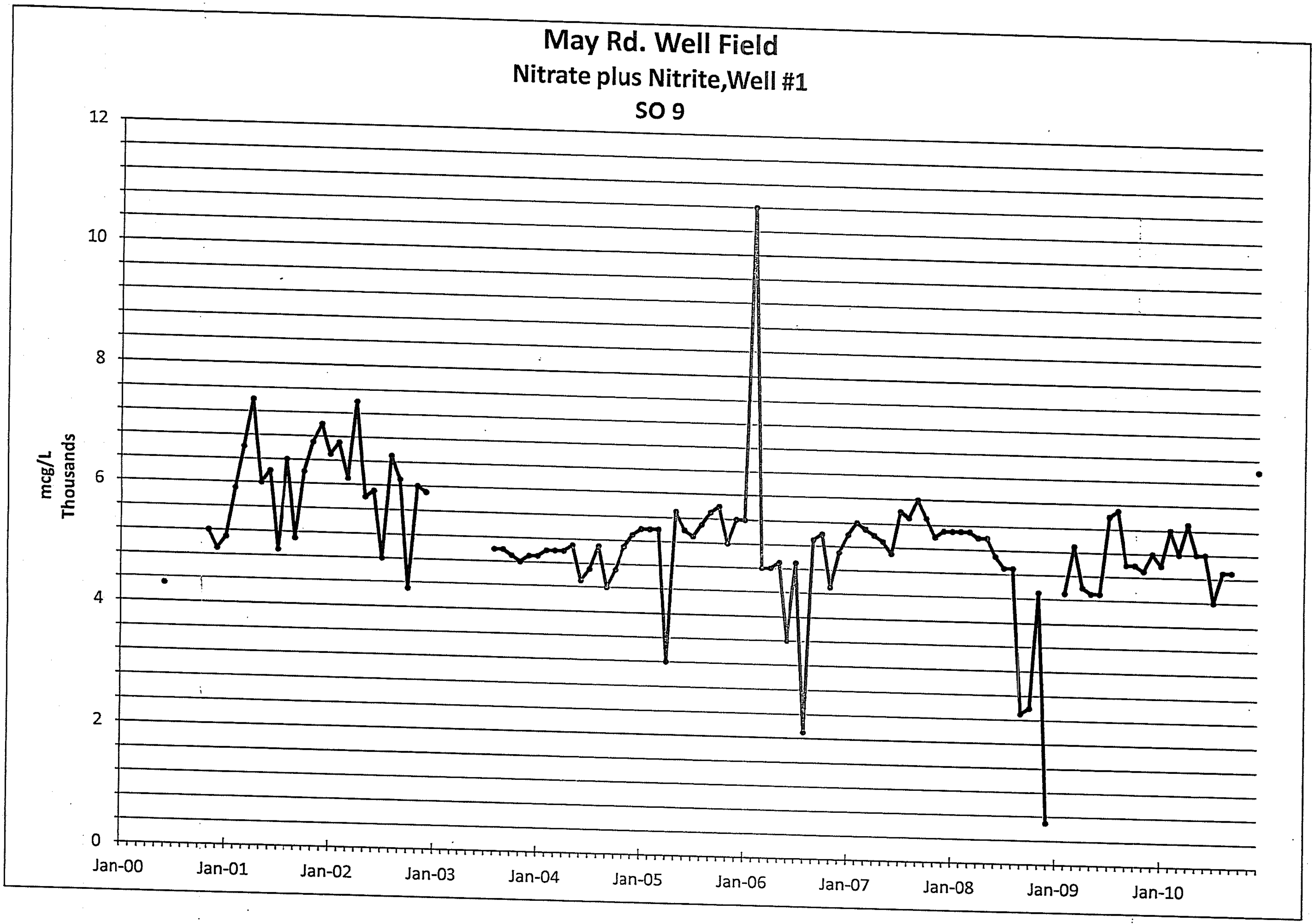

May Rd. Well Field
Nitrate plus Nitrite,Well #1
SO 9
mcg/L
Thousands
0
2
4
6
8
10
12
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10

Figure 11a

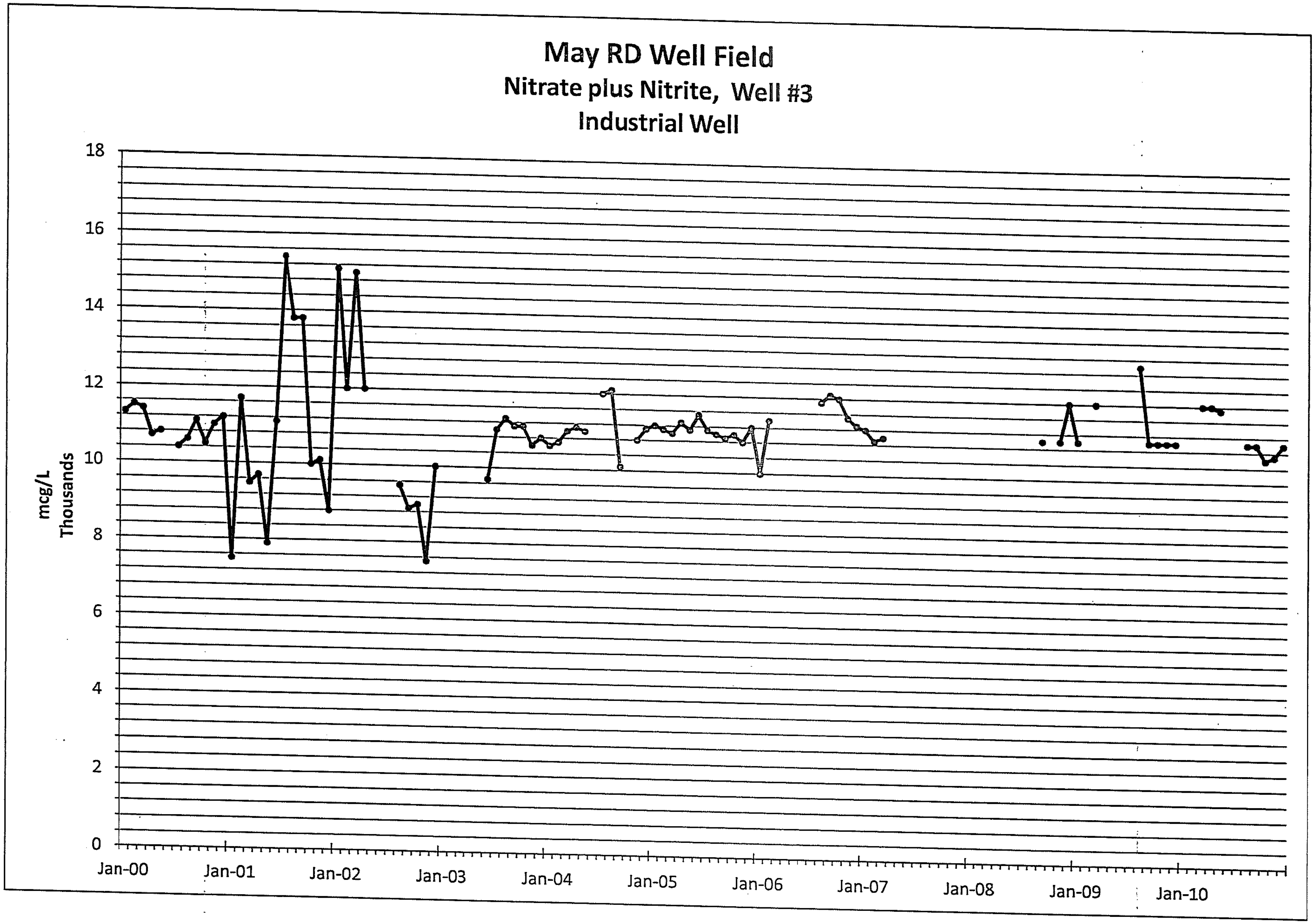

May RD Well Field
Nitrate plus Nitrite, Well #3
Industrial Well
mcg/L
Thousands
0
2
4
6
8
10
12
14
16
18
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10

Figure 11b

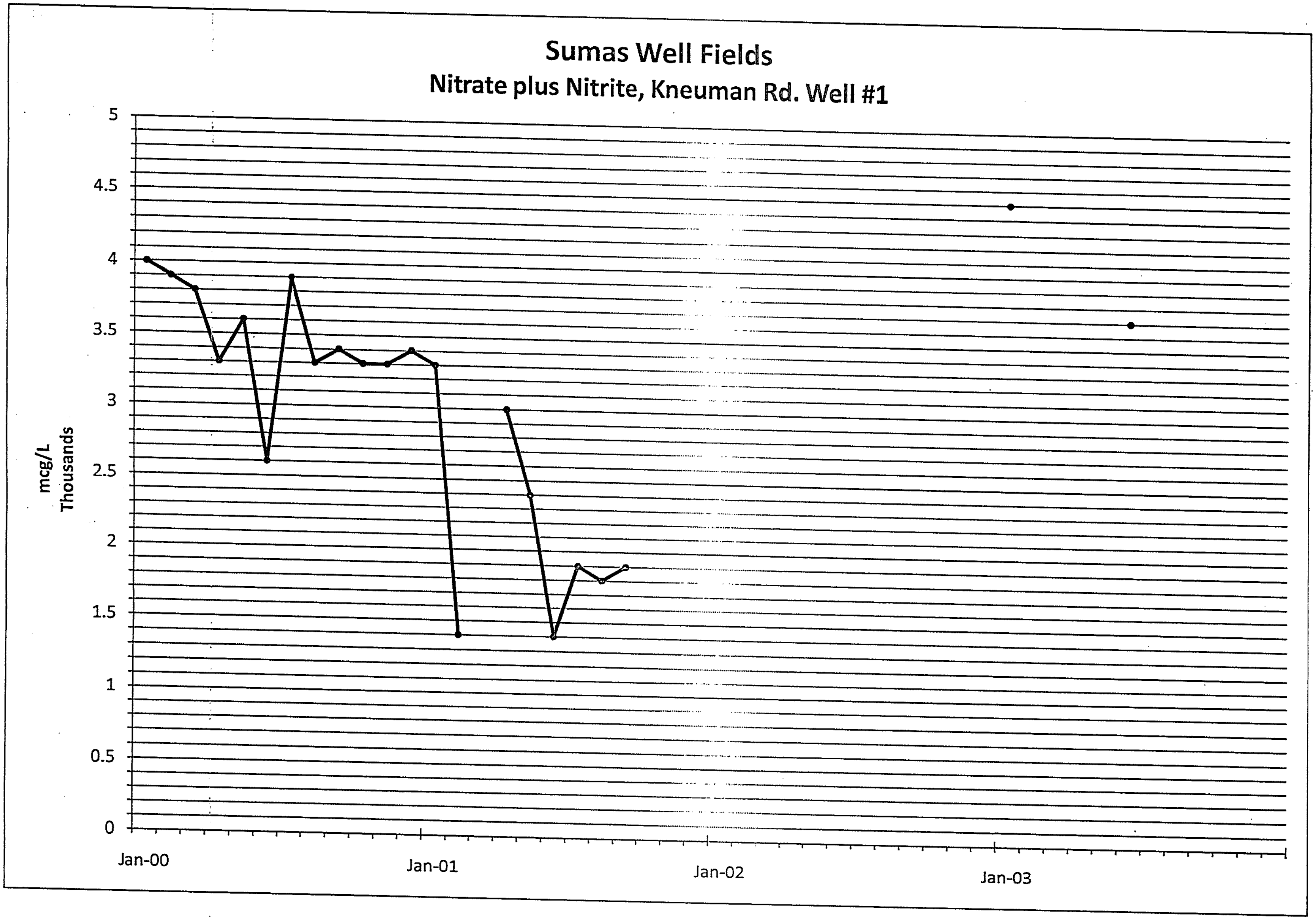

Sumas Well Fields
Nitrate plus Nitrite, Kneuman Rd. Well #1
mcg/L
Thousands
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Jan-00
Jan-01
Jan-02
Jan-03

Figure 11c

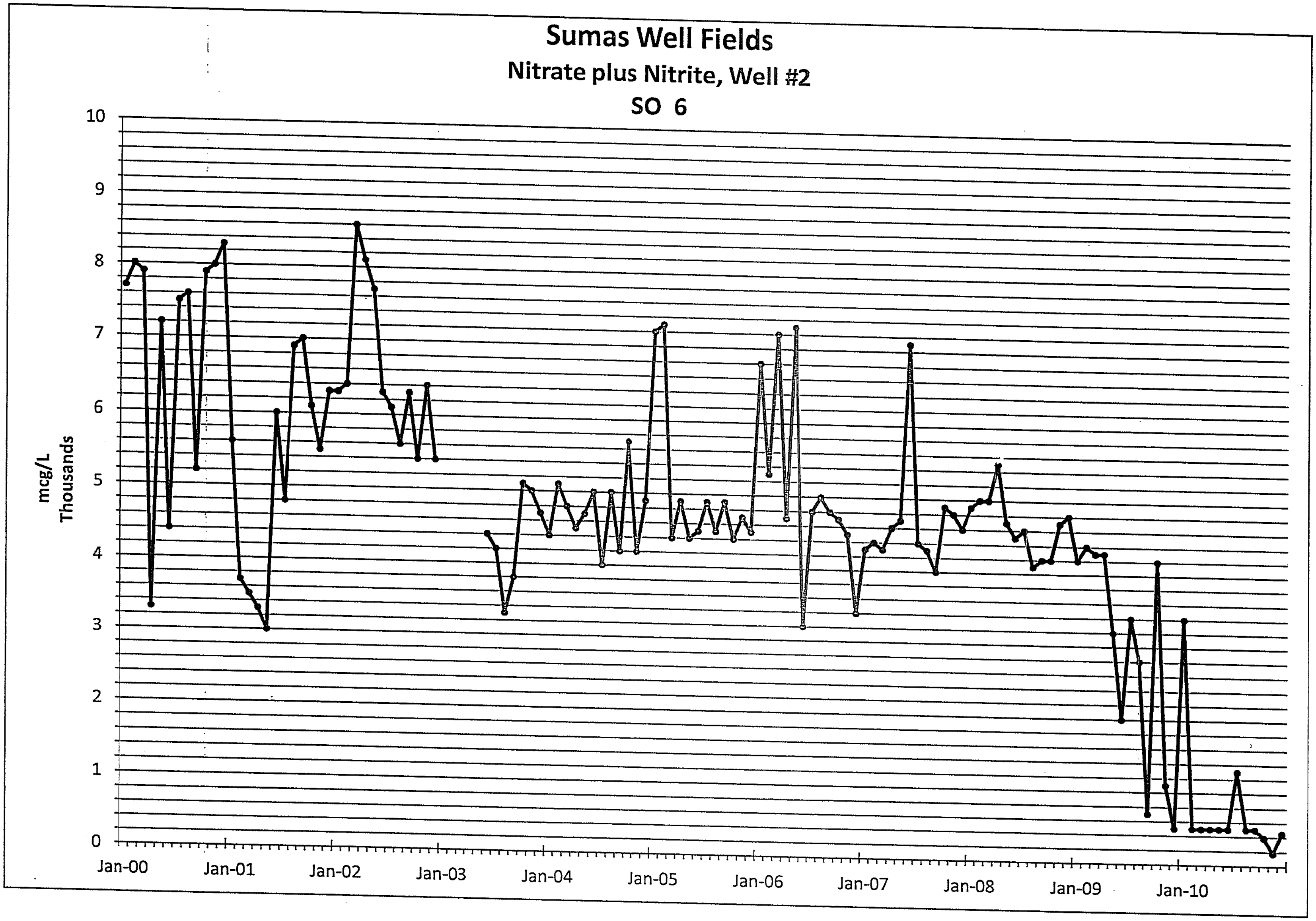


Figure 11d

pa

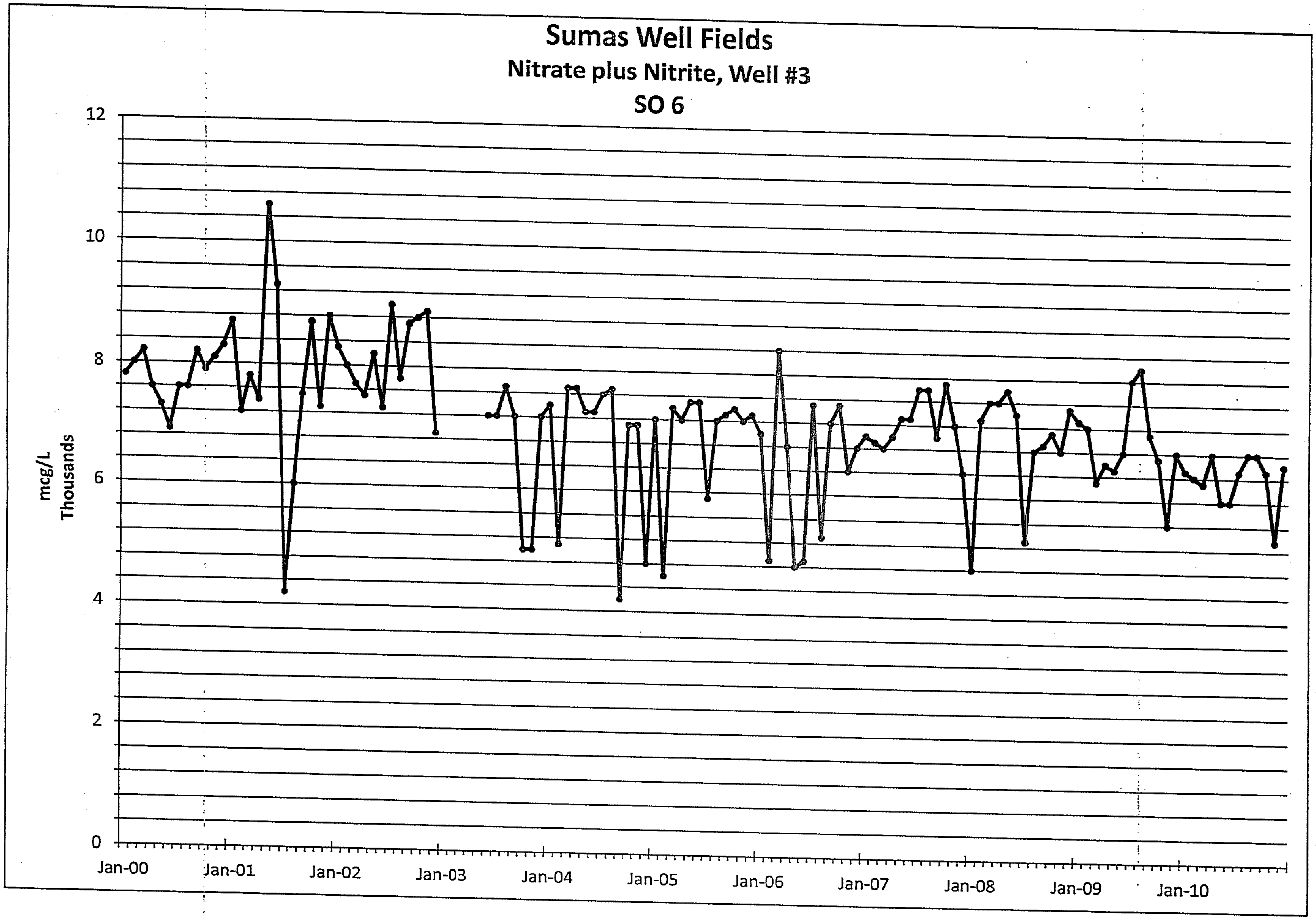

Sumas Well Fields
Nitrate plus Nitrite, Well #3
SO 6
mcg/L
Thousands
0
2
4
6
8
10
12
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10

Figure 11e

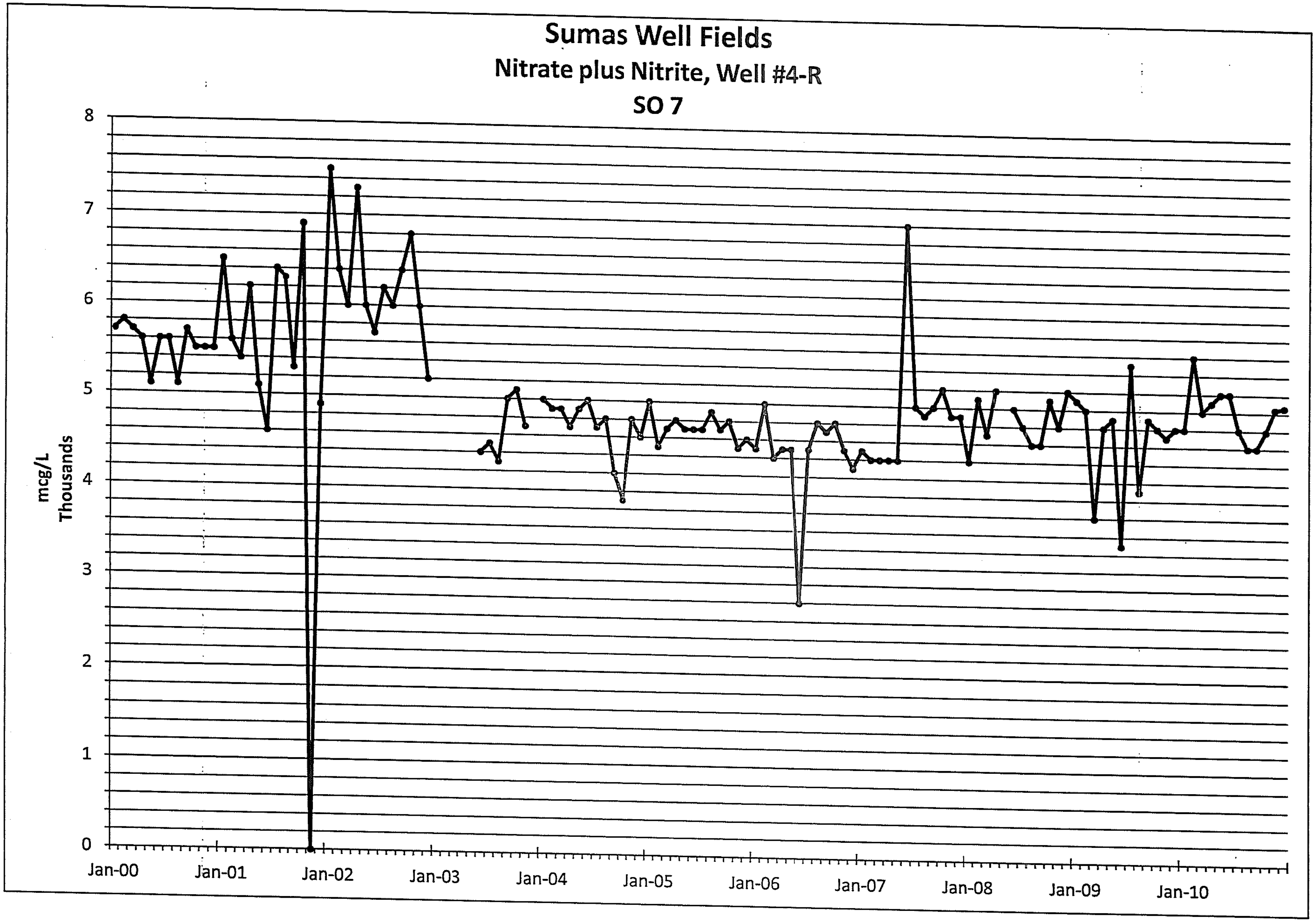
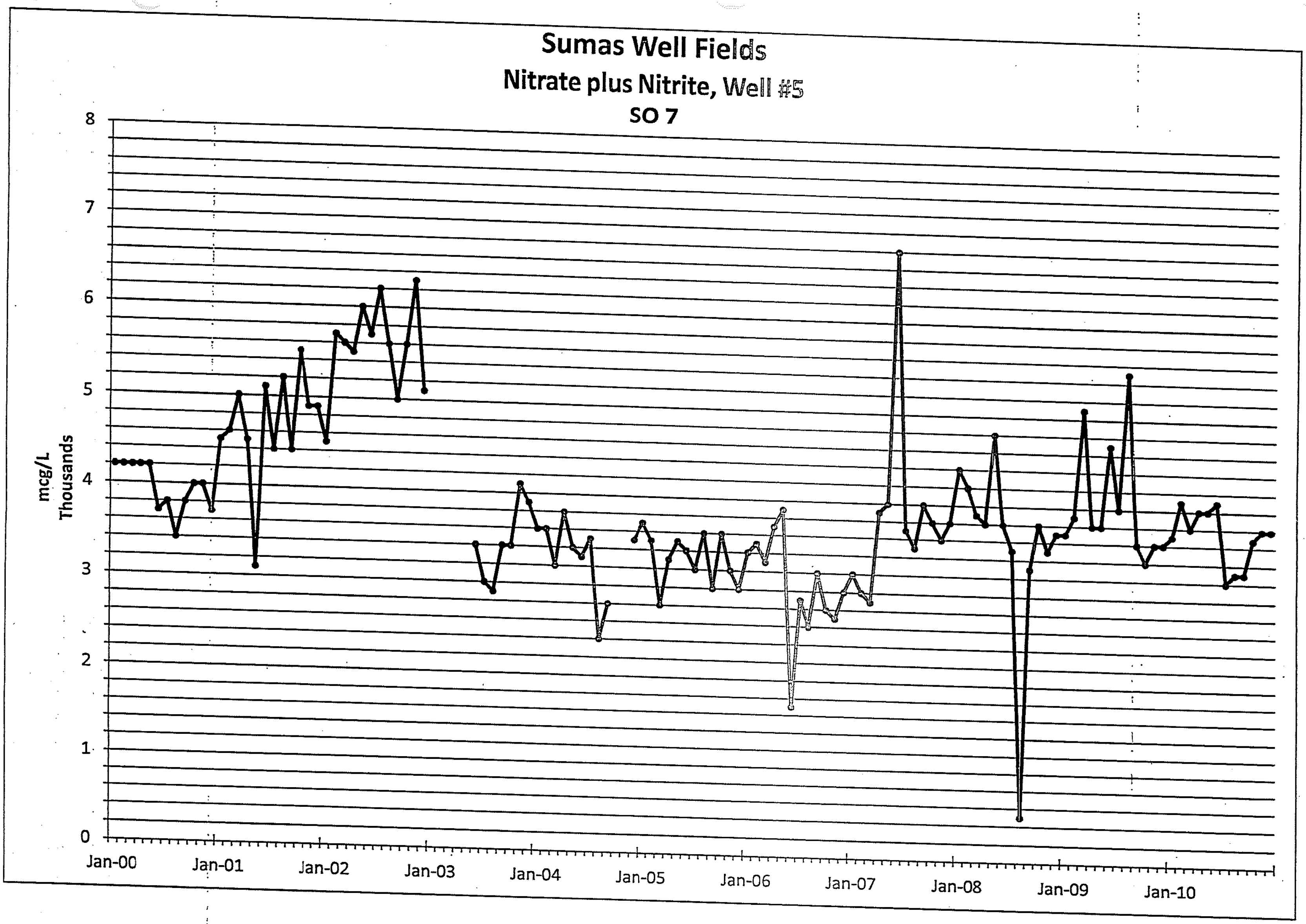


Figure 11f

pa



Sumas Well Fields
Nitrate plus Nitrite, Well #5
SO 7
mcg/L
Thousands
8
7
6
5
4
3
2
1
0
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08
Jan-09
Jan-10

Figure 11g

3.3 System Description and Analysis

3.3.1 Source

General Description and Condition

The sources are best discussed as follows, broken down by the particular wells in question. Figures 13 and 14 are schematic drawings of the Sumas and May Road Wellfields, showing the relative locations of the various wells. Appendix F contains well logs and pump specifications for each well.

- *Sumas Wellfield Wells 1, 2, 3 (SO6).* These three wells flow freely through a manifold to the pump house pressurizing the Nooksack/NVWA system. They are the oldest and shallowest wells at this field, all drilled to a depth of about 57 feet in the period from 1959 to 1971. A group of three submersible pumps is used to regulate the rate of withdrawal from the wells. The maximum sustainable pumping rate is 500 gpm. If pumped at a greater rate, the cone of depression becomes so deep as to allow excessive air to enter the perforated portions of the casings. Although the wells are 30 to 40 years old, they show no signs of deterioration (e.g., no increase in sanding). The HDPE manifold pipe and the pump house are in good condition and are readily accessible for repair and replacement, so there is no expected date of obsolescence of this source.

- *Sumas Wellfield Well 4R (SO8).* This is the newest well in the field, drilled in 1997. A pump test conducted by Robinson & Noble indicates that the well can sustain a yield of 1,200 gpm, presuming all other wells in the field are operating under normal production conditions. The well is outfitted with a submersible pump capable of pumping 810 gpm against the prevailing head (i.e., reservoir almost full). The submersible pump is 18 years old but was completely rebuilt in 1997, when it was moved from well 4 to well 4R. Well 4, the predecessor to this well, exhibited sand buildup after 28 years of use. This well has a life expectancy of 20+ years.

- *Sumas Wellfield Well 5 (SO7).* This well was drilled in 1992. A pump test conducted by Robinson & Noble indicates that the well can sustain a yield of 1,100 gpm, presuming all other wells in the field are operating under normal production conditions. The well is outfitted with a submersible pump capable of pumping 860 gpm against the prevailing head (i.e., reservoir almost full). The submersible pump was new in 1992. All components of this well are in good shape, and it has a life expectancy of 20+ years.

- *May Road Wellfield Well 1.* This well was drilled in 1992. A pump test conducted by Robinson & Noble indicates that the well can sustain a yield of 200 gpm, not accounting for interference with other wells. The well is outfitted with a submersible pump capable of pumping 200 gpm against the prevailing head. The submersible pump was new in 1992. All components of this well are in good shape, and it has a life expectancy of 20+ years.

- *May Road Wellfield Well 2.* This well was drilled in 1987. A pump test conducted by Golder indicates that the well can sustain a yield of 500 gpm, not accounting for interference with other wells. There is currently no pump installed in the well. The 8-inch casing is just capable of accommodating a submersible pump rated at 500 gpm. Robinson & Noble anticipate that a maximum of 900 gpm can be withdrawn from wells 2 and 3 in combination, due to interference effects.

- *May Road Wellfield Well 3.* This well was drilled in 1992. A pump test conducted by Robinson & Noble indicates that the well can sustain a yield of 800 gpm, not accounting for interference with other wells. The well is outfitted with a submersible pump capable of pumping 800 gpm against the prevailing head. The submersible pump was new in 1992. All components of this well are in good shape, and it has a life expectancy of 20+ years. Robinson & Noble anticipate that a maximum of 900 gpm can be withdrawn from wells 2 and 3 in combination, due to interference effects.

Long-term monitoring of water table elevation and stream level at the May Road Wellfield reveals no hint of reduction in capacity of the aquifer. The springs at each wellfield continue to flow freely year round.

On February 12, 2010 the Department of Ecology approved a transfer of the G1-26398 water right from May Road wellfield to the Knueman Road wellfield. This transfer of withdrawal point allows 860 gpm and 1,376 acre-ft per year from the May Road wellfield to be used for municipal use.

<u>*Source Capacity Analysis*</u>

The water rights analysis in Chapter 4, see also Table 2-1 and Table 2-2, reveals that Sumas has adequate water rights for annual maximum withdrawal in acre-ft per year for the coming 20-year planning period. Based on estimated and contractual instantaneous flow rates Sumas has enough well capacity but does not have enough pumping capacity to meet the peak hourly demand estimated for 2016. By 2030 Sumas has also reached its well capacity and water right limit with respect to meeting the estimated peak hourly demand and maximum withdrawal rate. The estimated 2030 annual withdrawal volume is within the water right limit.

A discussion of each wellfield is presented below:

- *Sumas (Knueman Road) Wellfield*

  In the existing configuration, the five wells operating together can produce approximately 2,200 gpm, slightly less than the water right allowable peak of 2,250 gpm. This wellfield is the primary source of water for Sumas, SRWA, Nooksack, and NVWA. In the past, the wells and pumps could reliably provide enough water to meet the peak hourly demand for these four water systems. Wells 4R and 5 would provide enough water to both Sumas and SRWA and provide additional flow to Nooksack & NVWA during their peak demand periods.

  Based on Sumas' current peak hourly demand and the current allocations to the other systems (see Table 2-2), the operation of both Pumps 4R and 5, with Wells 1-3, are required to meet the peak demand. By 2016, the combined peak hourly demand of these four systems will be greater than the pumping capacity, but less than the well capacity. In order to satisfy this demand, the first option will be to utilize the equalizing storage capacity of each tank to store the difference between the pumping capacity and the peak hourly demand. Other options include retrofitting Well 4R and Well 5 with pumps that match the well capacity – i.e., 1,100 gpm each and installing a third well.

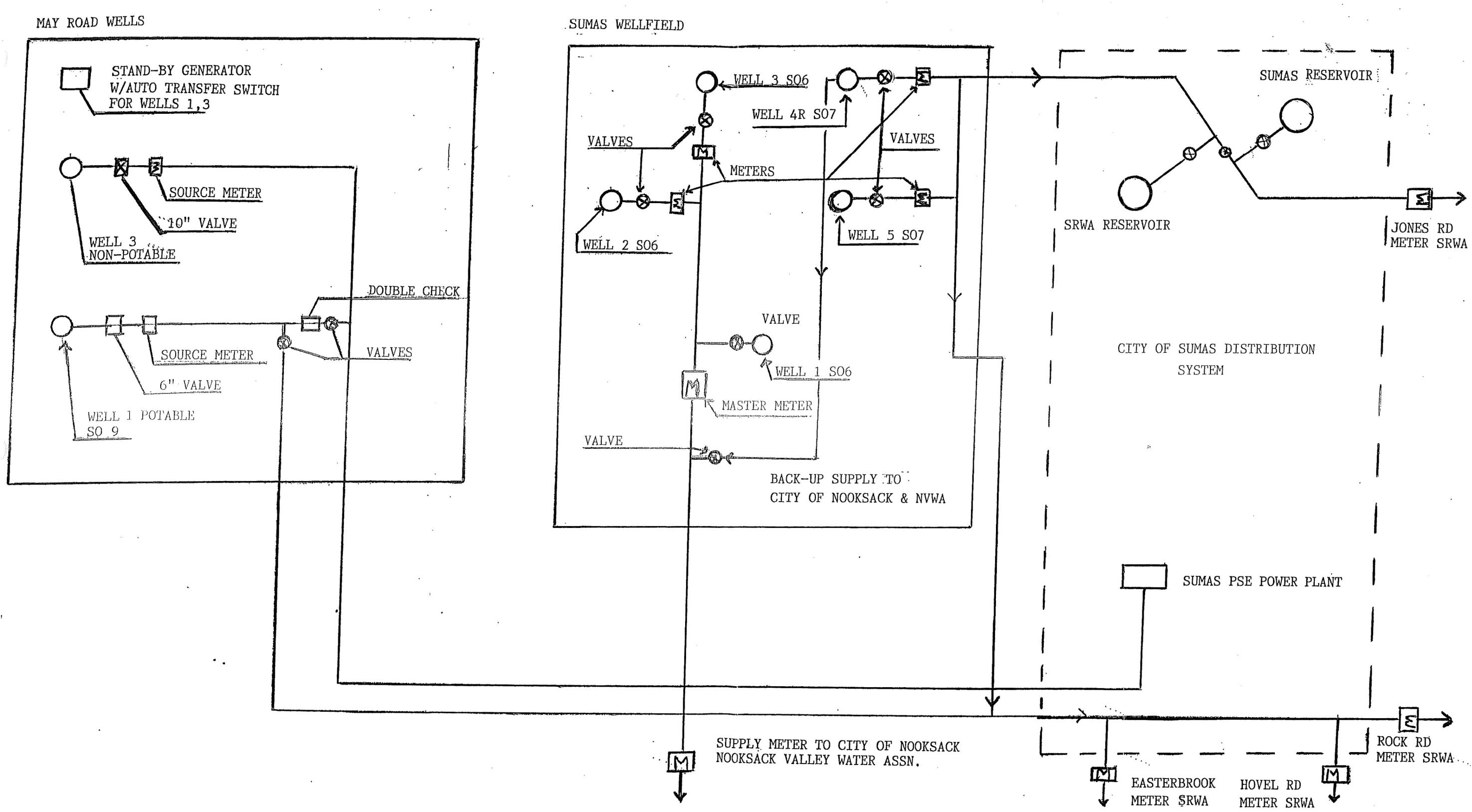
By 2030, the estimated peak hourly demand (3,033 gpm) will reach the well capacity of the Knueman wellfield plus the addition of 200 gpm from May Rd 1 wellfield (totaling 3,000 gpm). This is also approximately equal to the municipal water right maximum withdrawal rate (3,050 gpm). Since the estimated 2030 annual usage (2,785 acre-ft) is still less than the water right (3,744 acre-ft) any additional increase in future peak hourly demand can be met by increasing the equalizing storage in the reservoirs.

- *May Road Wellfield*

  In the existing configuration with minimal usage of Well 2, the two remaining wells operating together can produce about 1,100 gpm, approximately one-third less than the allowable peak of 1,660 gpm. May Rd Well 3, with a water right of 860 gpm and 1,376 acre-ft, is used to supply the PSE congen plant, which is allocated 800 gpm and 969 acre-ft per year.

  With the 2010 water right point of transfer change for May Rd 1 to the Knueman Rd wellfield, the 800 gpm maximum flow rate can be used to supplement the demand for Sumas, SRWA, Nooksack, and NRWA. Although this well capacity is only 200 gpm, the remaining 600 gpm (the difference between the 800 gpm water right and the 200 gpm well capacity) can be reserved for the Pumps 4R and 5. These pumps can then pump the additional 600 gpm from their wells without exceeding the overall water right of 3,050 gpm.

Figure 13. Schematic Drawings of May Rd. and Sumas Wellfield



CITY OF SUMAS WATER SYSTEM SCHEMATIC

FIGURE 13

Figure 14. Storage Tank Piping Details

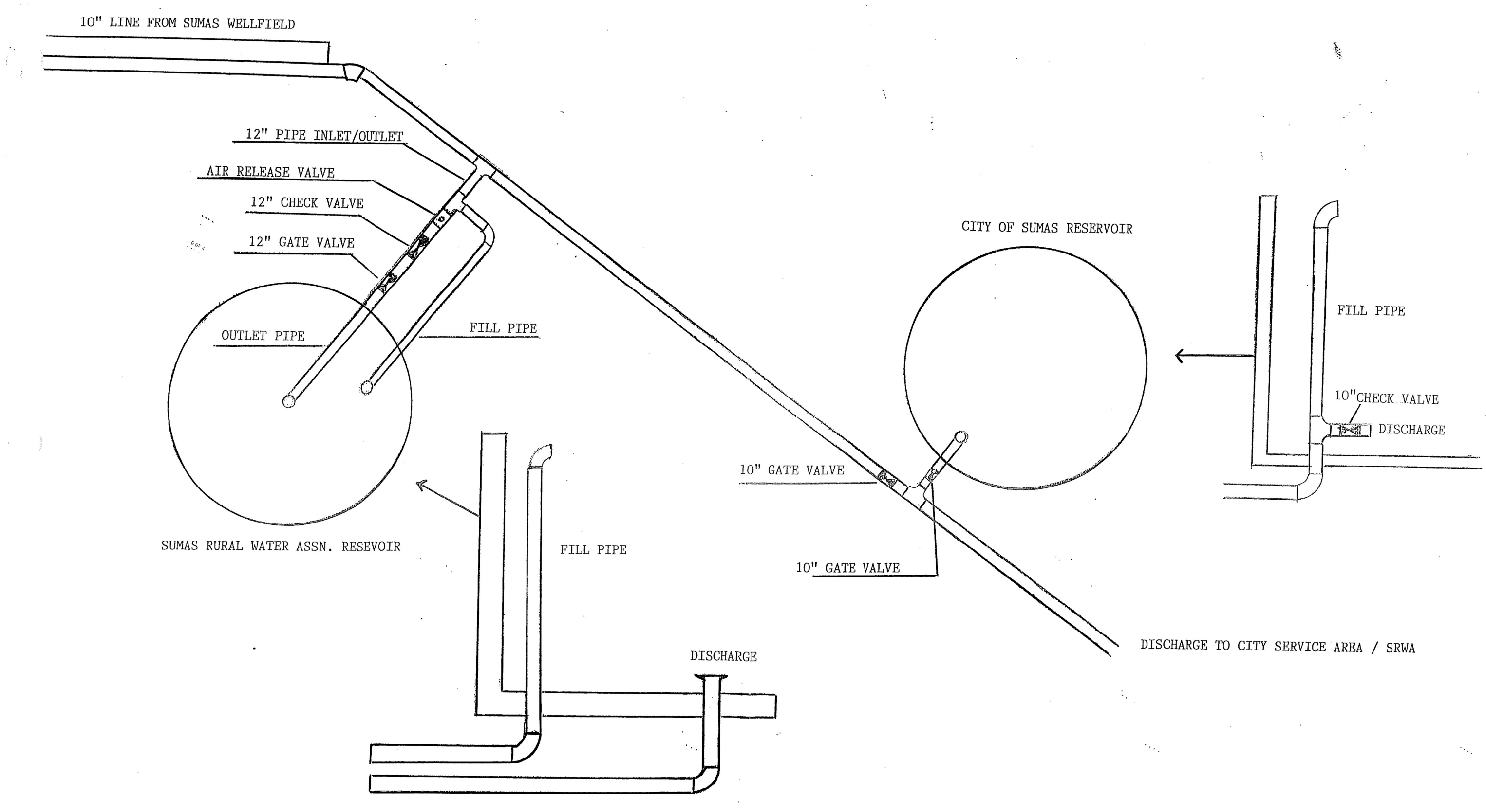


FIGURE 14. STORAGE TANK PIPING DETAIL

3.3.2 Water Treatment

As described in 1.3 page 1-5 chlorination is normally not performed on a continuous basis. When it is the following equipment and procedure is used. Chlorine injection facilities are present in both the Nooksack pump house and the well 4R pump house. In each case, liquid sodium hypochlorite (12.5% solution) is injected into transmission mains using small pumps. The pumps automatically adjust the rate of injection to achieve the proper residual. A residual chlorine concentration of 1.00 mg/l is typical, even at the extreme southern end of the NVWA system. The condition of each injection pump is good. Each is a minor piece of equipment and easily replaced. The existing treatment method could be used on a continuous basis should constant disinfection become necessary.

3.3.3 Storage

The City of Sumas has a single 500,000 gallon reservoir which is utilized to provide all of the storage requirements for the city of Sumas. The reservoir is a concrete tank 60 feet in diameter and 24 feet high (21,149 gallons per ft. of tank height). The reservoir has a base elevation of 186 feet. The source for the reservoir is the Sumas Wellfield which contains two pumps: Pump #4R-810 gpm at 155 ft. of head, and Pump #5 - 866 gpm at 155 ft. of head. These pumping rates are substantially lower than the instantaneous water rights for the wellfield.

In 2001 the Sumas Rural Water Association, a wholesale customer of the City of Sumas, constructed an identical 500,000 gallon reservoir adjacent to the City of Sumas' concrete tank. This tank is used by SRWA and provides their required equalizing and standby storage. The two tanks are hydraulically connected such that the two tanks respond together and equally to changes in water level. The inlet and outlet are designed to fill from the top and drain from the bottom to eliminate any chance of stagnant water, each thank has it own separate inlet and outlet Figure (14) shows the design and location of the piping of each tank. The water level is controlled by a float system that is hard wired to the pump controls since the tanks are the same elevation only one float system is needed. The tanks are in good condition and are inspected quarterly we also have an aggressive cleaning schedule of every (5) years using divers with a vacuum system, the last year they were cleaned was in 2010. While hydraulically connected, the two tanks are considered to be individual tanks when estimating the respective storage and fire flow requirements for each system. Only the Sumas tank was used to evaluate the Sumas system requirements and performance.

<u>Operation storage</u> for the system is minimal. The city's operational and maintenance personnel are not aware of any pump manufacturer's requirements regarding excessive cycling times. Under normal operating condition with two cycling pumps, once a pump is activated it will operate for a few hours. This will allow each pump to remain out of service for more than the common 15 minute downtime requirement. No other operational storage requirements are considered.

<u>Equalizing storage</u> has been calculated in accordance with the DOH *Water System Design Manual* (Design Manual), December 2009 and ADD, MDD, and PHD calculations based on the

However, in 2030, equalizing storage of 34, 950 gallons is required because the City of Sumas' supplied flow rate of 700 gpm is less than the estimated peak hourly demand of 933 gpm.

Fire suppression storage has been calculated in accordance with the Design Manual and the *Whatcom County Coordinated Water System Plan*, February 2000. These guidelines are followed by the City of Sumas. The maximum fire flow is in industrial areas with a fire flow requirement of 1,000 gpm for 120 minutes. This requirement is not anticipated to change over the next 20 years. Fire suppression storage volumes are provided in the Table 3-3 below.

Standby Storage has been calculated in accordance with the Design Manual and ADD, MDD, and PHD calculations based on the Design Manual requirements (see Appendix D). As discussed above, this system has two source pumps and standby storage requirements are based on multiple source criteria. Standby storage volumes are provided in Table 3-3 below.

Table 3-3 Sumas Storage Requirements in Gallons

	2010	*2016*	*2030*
I. Operational Storage	0	0	0
II. Equalizing Storage	0	0	34,950
III. Fire Suppression Storage	120,000	120,000	120,000
III. Standby Storage	125,400	174,200	263,800
TOTAL ($I+II+III_{max}$)	**125,400**	**174,200**	**418,750**

Based on the information presented in this table, the existing 500,000 gallon reservoir appears to provide adequate storage capacity for the City of Sumas for the next 20 years. With the 2001 addition of a 500,000 gallon reservoir, SRWA appears to have sufficient storage capacity for their needs.

3.3.4 Distribution System

NOOKSACK AND NVWA SYSTEM

The city of Nooksack and the NVWA receive their potable water from Wells 1, 2, and 3 of the Sumas (Knueman Rd.) Wellfield through a distribution system independent of the Sumas system. Water from the wells is routed southeast through a new eight-inch PVC pipe installed along Knueman Road then south on the west side of Barbo Road. The pipe continues south and is connected to the existing asbestos cement eight-inch line at the north side of the BNR railroad tracks. The eight-inch asbestos cement line continues to Garrison's Corner (the intersection of Halverstick Road and Garrison Road) and then south along the former SR9 to Nooksack.

There are two existing interties between the Sumas and the Nooksack/NVWA systems: at the wellfield (to allow water from Wells 4R and 5 to supplement Wells 1-3) and at Garrison's Corner.

As outlined in the latest Sumas and NVWA & Nooksack agreement (*Second Amendment to Agreement to Supply Water,* dated August 28, 2009) the City of Sumas' responsibility consists of operating and maintaining the distribution system from the wellfield to Garrison's Corner, from which Nooksack and NVWA take responsibility. In accordance with this agreement Sumas agrees to provide a total maximum annual volume of water equal to 768.6 acre-ft and a maximum instantaneous flow of 971.5 gpm.

SUMAS AND SRWA SYSTEM

City of Sumas and the SRWA receive their potable water from Wells 4R and 5 of the Sumas (Knueman Rd.) Wellfield and Well 1 of the May Road Wellfield through a distribution system independent of the Nooksack and NVWA system. The following system discussion and analysis deals specifically with this system.

General Description and Condition

Pipe Inventory:

The existing water distribution system has the following breakdown of pipes and lengths:

1"	898 ft.
2"	9,613 ft.
4"	14,114 ft.
6"	18,320 ft.
8"	27,824 ft.
10"	21,216 ft.
12"	1,038 ft.
TOTAL	93,023 ft.

In general, distribution lines are in good condition. The exception tends to be the 2-inch lines, which are typically older galvanized iron pipe. Listed below are pipe segments considered to be in poor condition. These segments are scheduled for replacement within the improvement program.

Segment	Length	Cost
First St. (Sumas to Lawson)	600'	$12,000
Alley between 3rd & 2nd (Sumas west to NAPA)	275'	$5,500
Victoria Ct. (Kneuman up hill)	300'	$9,000
Lawson St. (3rd to Vancouver)	800'	$22,000
Mitchell St. (Sumas to Cost Cutter)	200'	$6,000
Alley bet. Mitchell & Morton (Sumas to Cherry)	500'	$10,000

3.3.5 Hydraulic Capacity Analysis

System ADD, MDD, and PHD calculations are included in Appendix D. The following is a summary of these results.

Table 3-4: Summary of ADD, MDD, and PHD

	2009	2008	2010		2016		2030	
	Sumas	SRWA						
	Base Line	Base Line	Sumas	SRWA	Sumas	SRWA	Sumas	SRWA
	Information	Information						
# of Users	496		496		636		843	
System Annual Consumption (ft^3)	8,633,787		8,633,787		11,972,487		18,140,401	
System Annual Consumption (acre-ft)	198		198		275		416	
System ADD (gpd)	176,933		176,933		245,340		371,958	
System ADD/Users (gpd/user)	357		357				441	
System MDD (gpd)	353,866		353,866		490,680		743,916	
System MDD/ERU (gpd/ERU)	564		564		564		564	
# of Residential and Small Users	475		475		612		812	
Residential Annual Consumption (ft^3)	6,546,726		6,546,726		8,421,545		11,173,684	
Residential ADD (gpd)	134,163		134,163		172,584		228,984	
Residential ADD/User (gpd/user)	282		282		282		282	
ERU (gpd/user)	282		282		282		282	
Residential MDD (gpd)	268,326		268,326		345,168		457,968	
Residential MDD/ERU (gpd/ERU)	564		564		564		564	
# of Large Users	21		21		24		31	
Large User Annual Consumption (ft^3)	2,087,061		2,087,061		3,550,942		6,966,717	
Large User ADD (gpd)	42,770		42,770		72,770		142,770	
# of ERU 's for Large Users	152		152		258		506	
Large User MDD (gpd)	85,540		85,540		145,540		285,540	
Large User MDD/ERU (gpd/ERU)	564		564		564		564	
Total ERU's	627		627		870		1,319	
PHD (gpm)	499	1,000	499	1,010	651	1,040	933	1,110
PHD for Combined System (gpm)			1,509		1,691		2,043	
PHD Used in Models (gpm)			1,680		1,873		2,278	

A map of the Sumas water distribution system is provided in Appendix H. The water system was analyzed using the computer program "Pipe2010" (version 5.012e) by KYPipe. "KYPIPE4" is the hydraulic calculation engine behind the Pipe2010: KYPipe hydraulic model. KYPIPE4 was developed by Civil Engineering professors from the University of Kentucky and has been continually updated and maintained for over 35 years. The KYPipe engine is an industry standard for analyzing pressurized water distribution systems.

For modeling purposes, system elements are organized into junction nodes, pipes, pumps, and a storage tank. Junction nodes are specific points identified in the system where pipes intersect and elevations and system water demand are identified. Node elevations were obtained from the 1993 digitized aerial map *Lower Nooksack River and Flood Plain*, prepared by the Whatcom County Public Works Department. Information on the pipe size, location, material, and age, as well as tank, pump, and wellfield information was provided by the city's water department personnel. Pipe roughness coefficients were estimated based on material type, age, and water department personnel's evaluation of the pipe condition.

Two modes of analysis are used to evaluate the water system: steady state and extended period simulation. The steady state analysis is used to determine the operating behavior at a specific point in time, or under steady (unchanging) conditions. This analysis is used to evaluate the point at which the system is operating under its worst case scenario, that is, the point of maximum system demand, no pumps operating, and the water level in the tank at the bottom of the standby storage section.

The extended period simulation is used to examine the effects on the system with water demands varying over time. This mode of analysis is useful for examining how a tank will drain and fill, or how pressure and flow rates will vary throughout the day. Based on discussions with Sumas and SRWA large and small users, the following multipliers were used to estimate the hourly demand as a percentage of the maximum demand:

Time From Start (hr)	Multiplier	Time From Start (hr)	Multiplier
2.0	0.46	14.0	0.75
4.0	0.62	16.0	0.84
6.0	0.51	18.0	0.62
8.0	0.54	20.0	0.24
10.0	0.54	22.0	0.10
12.0	0.54	24.0	0.14

The 2010 Sumas water system hydraulic model was created by estimating the peak hourly demand at each system node based on the number of residential and large users in the vicinity of the respective node. A 2009 aerial map of Sumas was used to identify the location and the number of service connections associated with each node. The value of the residential peak hour demand was estimated based on the DOH's Peak Hourly Demand equation (See Section 3.1). Demands at dead end nodes where estimated based on the Maximum Instantaneous Demand (MID) methodology outlined the DOH's *Sizing Guidelines for Public Water Supplies*, September, 1983.

Monthly meter records were used to identify 21 large users in the city's system. Based on these records, the ADD was calculated. The MDD was estimated at 2.0 times the average daily demand (ADD). PHD was conservatively estimated at four times the MDD.

Based on the similarity between the population and large users, the 2009 usage information is assumed to be the same for the 2010 condition. Conservative assumptions were made regarding the number of service connections and their associated demand. Existing services that are presently not being used, such as homes and business not operating at this time, have been included in the model. The total number of service connections for the Existing Condition 2010 model is 521, as compared to the actual 496 users. The resulting peak hourly demand used in the hydraulic modeling is therefore higher than the PHD calculated through the DOH equation based on the actual number of service connections.

The peak hourly demands in the 2010, 2016, and 2030 models were calculated by summing the following: the residential demand (based on the DOH PHD methodology), the large user demand (see Table 3-1), and SRWA demand distributed as discussed below. The total PHD used on the model resulted in a value higher than what is estimated using the PHD DOH methodology (for 2010, the model used 1,681 gpm as compared to 1,508 gpm (see Table 3-4)).

A single 500,000 gallon tank was used for all three analyses.

The peak hourly demand for the SRWA system was taken from their technical memorandums *System Future Demand Estimates for Use in Water Sale Agreement with the City of Sumas,* dated January 15, 2009. 2010, 2016, and 2030 values were interpolated from their table. Meter records at the SRWA interties were reviewed to determine the distribution of the supplied water at each of the four interties. Based on the 2009 meter records the following percentages were assumed to distribute the SRWA demand at the four interties. This same distribution was assumed for the 2016 and 2030 models.

SRWA meters	**2009 Total Usage** (ft3)	**% of Total Usage**	**Node**
Jones Rd.	2,531,457	16.6%	174
Rock Rd.	5,863,080	38.4%	349
Hovel Rd.	2,635,635	17.2%	715
Ball Park (Easterbook Rd.)	4,252,870	27.8%	267
TOTAL	**15,283,042**		
(acre-ft)	**351**		

Table 3-5: Estimated Demand and Pressure at SRWA Interties

Node #	Location	2010		2016		2030	
		PHD (gpm)	Pressure (psi)	PHD (gpm)	Pressure (psi)	PHD (gpm)	Pressure (psi)
174	Jones Rd	167	60	172	58	184	52
349	Rock Rd	387	54	399	50	426	40
715	Hovel Rd	174	54	179	50	191	39
267	Easterbrook Rd	281	51	289	48	309	37
	TOTAL	1,010		1,040		1,100	

<u>*Results of Hydraulic Analysis*</u>

Appendix D contains the supporting documentation of the hydraulic analysis. This information includes the modeling results for a series of scenarios, all based on the existing pipe distribution system. The analyses include the steady state condition using peak hourly demand, fire flow analysis, and extended period simulations for refilling the storage tank for the existing 2010 and future 2016 and 2030 conditions. Based on the results of these analyses, the existing system appears to be able to meet the anticipated future demands and no improvements to the distribution system are proposed to 2030. Likewise not improvements to the transmission lines to SRWA and Nooksack and NVWA are anticipated to 2030.

Existing 2010 Condition
Various modifications of the hydraulic model were run to provide an overall evaluation of the existing system. Worst case scenarios, such as both pumps being out of service and tank water levels at less than full conditions, were assumed for the system evaluation. Improvements to the water system in the past ten years have remedied most of the past system deficiencies identified in the previous Water Plan.

- Steady State: Using the full peak hourly demands, the steady state model shows the system is capable of maintaining pressures between 30 psi to 65 psi throughout the system with neither pump running and as little as two feet of water in the tank, except for the deficiencies noted below.
- Fire Flow: Using the full peak hourly demands the steady state model shows the system is capable of delivering the required fire flow with neither pump operating, the tank water level at the bottom of the standby storage level, and 20 psi residual pressure except as noted below.
- Extended Period Simulation: Using the hourly demand multipliers listed above, the model shows that Pump 5, the stronger of the two pumps, is able to refill the tank fully each day when it is the sole pump in operation. The model also shows that Pump 4, when the sole pump in operation, does not fill the tank each day but has a slight decrease in the water level. The present pump controls alternates the pump in operation. During extreme events when both bumps are operating, the tank is easily filled.

System Deficiencies

1. Junction nodes in the Moe's Hill area experience pressures less than the required 30 psi in the steady state model. This area, which includes the system's ground level storage tank, has a ground elevation between 140 feet and 190 feet, while the majority of the Sumas system is at elevation 40 feet. Presently there are 27 homes in this area. Each of these homes needs its own booster pumps for their individual service and a backflow preventer to protect the home in the event line pressure drops below 20 psi (see below).

2. The fire flow analysis indicates that the required 500 gpm fire flow cannot be delivered to any of the three hydrants located on Moe's Hill. In order for these hydrants to deliver the 500 gpm residential fire flow, the fire truck will need to provide suction to obtain the flow from the line and nearby tank. This will result in reduced or negative pressures in this section of pipe. Backflow protection will be required at each home and pipe line and joint integrity must be maintained to prevent potential groundwater intrusion into the system.

3. The hydrant located at the north end of Victoria Street in the southeast corner of town is served by a 300 ft. long, four-inch diameter pipe with two services downstream of the hydrant. Under the existing system with peak hourly demands, the maximum deliverable fire flow to this hydrant is 270 gpm, while maintaining a minimum of 20 psi at all system nodes.

See Appendix D for a copy of the analysis input information and output results.

Future Condition: 2016

Anticipated growth in the city of Sumas over the next six years is estimated to include the addition of approximately 116 new residential service connections and three large industrial users. Figure 6 identifies the anticipated location of these new services. Water consumption in SRWA is also expected to remain relatively constant with only a slight increase in the estimated PHD.

- Steady State: Using the full peak hourly demands, the steady state model shows the system is capable of maintaining pressures between 30 psi to 62 psi throughout the system with neither pump running and as little as two feet of water in the tank, except for the deficiencies noted below.
- Fire Flow: Using the full peak hourly demands the steady state model shows the system is capable of delivering the required fire flow with neither pump operating, the tank water level at the bottom of the standby storage level, and 20 psi residual pressure except as noted below.
- Extended Period Simulation: Using the hourly demand multipliers listed above, the model shows that a single pump is not able to able to refill the tank fully each day. A second pump is required to operate for a approximately five to six hours each day to keep the water level above the standby storage level.

System Deficiencies

1. In general the existing system responded the same way as the 2010 analysis. See comments for 2010 above.
2. By 2016 the peak hourly demand of the combined Sumas, SRWA, Nooksack, and NVWA systems may exceed the combined capacity of the existing pumps. This deficiency can be remedied by utilizing the equalizing storage capabilities of each system's respective storage tank or upsizing the existing pumps as an option to replacing the pumps with larger capacity.

See Appendix D for a copy of the analysis input information and output results.

Future Condition: 2030

Anticipated growth in the city of Sumas over the next 20 years is estimated to include the addition of approximately 316 new residential service connections and ten large industrial users (compared to the 2010 system). Figure 7 identifies the anticipated location of these new services. SRWA is also expected to remain relatively constant with only a slight increase on their estimated PHD.

New infrastructure, including pipe, hydrants, valves, and meters, will be required to provide service to the anticipated growth areas. The 2030 hydraulic model assumes the demands for these new services are applied at the adjacent existing nodes and that the new infrastructure will not significantly reduce pressure and flows at the point of future usage.

- Steady State: Using the full peak hourly demands, the steady state model shows the system is capable of maintaining pressures between 30 psi to 55 psi throughout the system with neither pump running and the water level in the tank at the bottom of the Standby Storage (Elev. 196 ft.), except for the same deficiencies noted in the 2010 analysis.

- Fire Flow: Using the full peak hourly demands the steady state model shows the existing system is not capable of delivering the required fire flow to more than half the system without a pump operating, with the tank water level at the bottom of the standby storage level, and 20 psi residual pressure. Various pipe modifications to the system were investigated but the majority of the hydrants did not reach the required fire flow. However, when either the Wellfield 4R or 5 pumps are turned on, the required fire flow is obtained except at the four hydrants previously discussed in the 2010 analysis. Two other hydrants near the old ball field (at the south end of Sumas Avenue and across from the RV park) are estimated to be only able to provide between 300 gpm and 500 gpm with Pump 4R running.

  As required by WAC 246-290-230 (6), the distribution system does not have to provide the peak hourly flow (PHD) with fire flow, but the maximum day demand (MDD) while maintaining a pressure of at least 20 psi (140 kPa) at all points throughout the distribution system, and under the condition where the designed volume of fire suppression and equalizing storage has been depleted. The MDD for the Sumas system is approximately 55% of the PHD. Using the MDD, the 2030 fire flow analysis shows that all the hydrants are capable of meeting their required fire flow except for the three hydrants on Moe's Hill and the hydrant at the north end of Victoria Street (estimated flow rate of 342 gpm).

- Extended Period Simulation: Using the hourly demand multipliers listed above, the model shows that a single pump is not able to able to refill the tank fully each day. However, when two pumps are operating, the tank is easily filled.

System Deficiencies

1. See comments for 2010 and 2016 above.
2. As Sumas anticipates its future growth in the southeast corner of the city, by 2030 the overall pressure in this area is estimated to drop 10-15 psi below existing levels. While the estimated pressure in this area is still above the 30 psi minimum requirement, the delivery pressure to SRWA will need to be monitored.
3. By 2030 the peak hourly demand of the combined Sumas, SRWA, Nooksack, and NVWA systems may exceed the existing well capacity and water right allocation. Future monitoring will be required to assess potential alternatives for meeting future demands. Since the estimated annual withdrawal volume is estimated to be lower than the water right allocation, increasing the equalizing storage capacity will likely be required.

3.4 Summary of System Deficiencies & Proposed Improvements

The following is a summary of the system deficiencies and proposed remedial action.

Deficiency	Remedial Action
Existing 2010 System	
1. Pressures less than the required 30 psi in the Moe's Hill area.	• Existing homeowners have booster pumps. No additional action planned at this time.
2. Fire flow at 500 pm to the three hydrants on Moe's Hill cannot be provided by tanks and wellfield pumps. All fire flow must be provided by fire trucks and/or tank suction at the hydrants.	• Annual inspection and monitoring of the pipes and service connections on Moe's Hill is recommended to ensure pipe joint integrity to prevent potential groundwater intrusion into the system.
3. Fire flow to hydrant at the north end of Victoria Street is below 500 gpm requirement.	• Install an orifice plate on the hydrant to limit flow to 250 gpm and mark hydrant as such, or the pipe can be replaced with a minimum six-inch diameter.
Future 2016 System	
1. See 2010 deficiencies.	• See remedial action outlined for 2010.
2. No existing infrastructure in proposed growth areas.	• Loop the new infrastructure improvements to the existing main distribution lines.
3. Based on estimated and contractual instantaneous flow rates Sumas may not have enough pumping capacity to meet the estimated peak hourly demand.	• Continue monitoring PHD. Utilizing existing equalizing storage capacity in tanks to make up the difference between peak flow and pump capacity. Install larger pumps, or a new well and pump, if equalizing storage is inadequate.
Future 2030 System	
1. Future development in the Moe's Hill area may be in areas where pressures are less than the required 30 psi.	• Monitor development. Continue with remedial actions outlined in 2010.
2. No existing infrastructure in proposed growth areas.	• Loop the new infrastructure improvements to the existing main distribution lines.
3. Insufficient pumping capacity at wellfield, peak demand nearing water right allocation.	• Future monitoring will be required to assess potential alternatives for meeting future demands. Increasing the equalizing storage capacity in the systems tanks will likely be required.