93-e14

Water Body No. 10-23-1010GW
10-23-1020GW
10-23-1100GW

DEPARTMENT OF ECOLOGY

June 29, 1993

TO: Paul Pickett, WAS

THROUGH: Bill Yake, TCGWIS BY

FROM: Denis Erickson, TCGWIS DE

SUBJECT: Chehalis River TMDL, Ground Water Reconnaissance and Estimated Inflows

SUMMARY

The Chehalis River between the Thurston/Lewis County border (River Mile 60) and Adna (River Mile 86) hydraulically interacts with an extensive surficial aquifer and serves as a regional ground water sink. Ground water inflows to the Chehalis River are estimated using readily available existing information. Minimum and maximum ground water inflows range from 0.1 to 10.3 cubic feet per second per mile (cfs/mi). Estimated mean ground water inflows for six subaquifers range from 0.5 to 4.5 cfs/mi. Samples from 28 wells in the study area show that ground water quality is highly variable. The water quality results are presented in this memorandum. Chloride and organic loading via ground water is highest along the reach between River Miles (RM) 72 to 77.5.

INTRODUCTION

This technical document describes the results of the ground water reconnaissance for the Chehalis River Total Maximum Daily Load (TMDL) study. The study area extends along the Chehalis River from Bunker Creek at RM 86 (about three miles west of Adna) downstream to the Thurston/Lewis County border at RM 60. This final technical document addresses your comments to my March 30 draft memorandum and includes the five well elevations surveyed by Lewis County Conservation District/SCS. The ground water inflow results in this memo should be considered as rough estimates. They are based on numerous assumptions and approximations described in the following section.

METHODS

I used an aquifer characterization approach to estimate ground water interaction with the Chehalis River. Aquifer characterization included mapping (definition of aquifer lateral and vertical boundaries) and defining hydrologic properties that determine rates of ground water

movement. For this project I used hydraulic conductivity and hydraulic gradients to estimate ground water flux (discharge per unit area). The ground water inflow to the river was estimated by combining ground water flux with the aquifer thickness interacting with the river. The methods used to define these properties are described below.

Aquifer Mapping

Surficial aquifer lateral boundaries were mapped from a geologic map by Weigle and Foxworthy (1962). Geologic units included in the surficial aquifer were alluvial deposits, glacial outwash, and terrace deposits. The aquifer boundaries were digitized in ARC/INFO format.

In addition, the Chehalis Surficial Aquifer was further divided in six subaquifers based on similar lithology and thickness. These subaquifers are designated by geographic location as:

		River Miles
I.	Bunker Hill - Adna	86 to 82
II.	Adna - Claquato	82 to 77.5
III.	Claquato - Golf Course	77.5 to 72
IV.	Golf Course - Mellen Street	72 to 67.5
V.	Centralia/Fords Prairie	67.5 to 62
VI.	Galvin/North of Fords Prairie	62 to 60

Aquifer thickness was estimated from cross sections constructed using well logs from Weigle and Foxworthy (1962) and sampled wells on file with Department of Ecology. In many cases no wells were located near the river therefore I had to extrapolate subsurface data long distances. Also, without detailed studies I can only estimate the aquifer thickness that interacts with the river.

Hydraulic Conductivity

I estimated hydraulic conductivity for each subaquifer from well specific capacity data using the method described by Bradbury and Rothschild (1985). This method is an iterative solution to the Theis equation with a modification for partial penetration. Specific capacity data, the ratio of discharge rate and drawdown, was obtained from well logs on file with the Department of Ecology and from Weigle and Foxworthy (1962). The number of wells with specific capacity data in each subaquifer was highly variable, ranging from 66 wells in the Centralia/Fords Prairie subaquifer to no wells in the Adna-Claquato subaquifer. For the Adna-Claquato subaquifer I estimated hydraulic conductivity based on lithology. Because hydraulic conductivity is generally thought to be log-normally distributed (Freeze, 1986), the geometric mean is considered to be more representative of central tendency than the arithmetic mean. I used geometric means of hydraulic conductivity results to calculate ground water flux.

Hydraulic Gradients

I estimated hydraulic gradients using surface water expression (from topographic maps the elevation of topographic contours and surface water intersections) and water level measurements obtained during sampling. Because elevations were estimated from topographic maps, the data is probably accurate to within ± 5 feet. The Lewis County Conservation District surveyed wellhead elevations for five wells. The accuracy of these elevations is about ± 0.1 feet. Water elevations were also available for Centralia Landfill wells. A water-table contour map was prepared with a ten-foot contour interval. Hydraulic gradients were estimated by measuring the change of hydraulic potential (head) over a measured distance.

Ground Water Flux

Ground water flux (discharge per unit area) was estimated using Darcy's Law:

$$q = -K_h \frac{dh}{dL}$$

where,

q = ground water flux (discharge per unit area, ft/day)
K_h = hydraulic conductivity, horizontal (ft/day)
dh/dL = hydraulic gradient (ft/ft, dimensionless)

Flux values were used to estimate ground water inflow rates by multiplying the flux by the aquifer thickness interacting with the river. No adjustments were made for river bed sediments. The geometric mean for hydraulic conductivity combined with maximum, minimum and mean hydraulic gradients and a range of aquifer thicknesses provided a range of estimated ground water inflow rates.

Ground Water Sampling

Twenty eight wells were sampled; 27 private wells and one monitoring well. The well locations are shown on Figure 1. To accommodate sample loading at the laboratory, samples were obtained in three episodes: November 17-18, December 1-2, and December 8, 1992. Samples from private wells were obtained from taps as close to the well head as possible. Prior to sampling, I purged the wells until a minimum of three well volumes were removed and specific conductance, pH, and temperature readings had stabilized. Ortho-phosphate samples were field-filtered using in-line 0.45 micron filters.

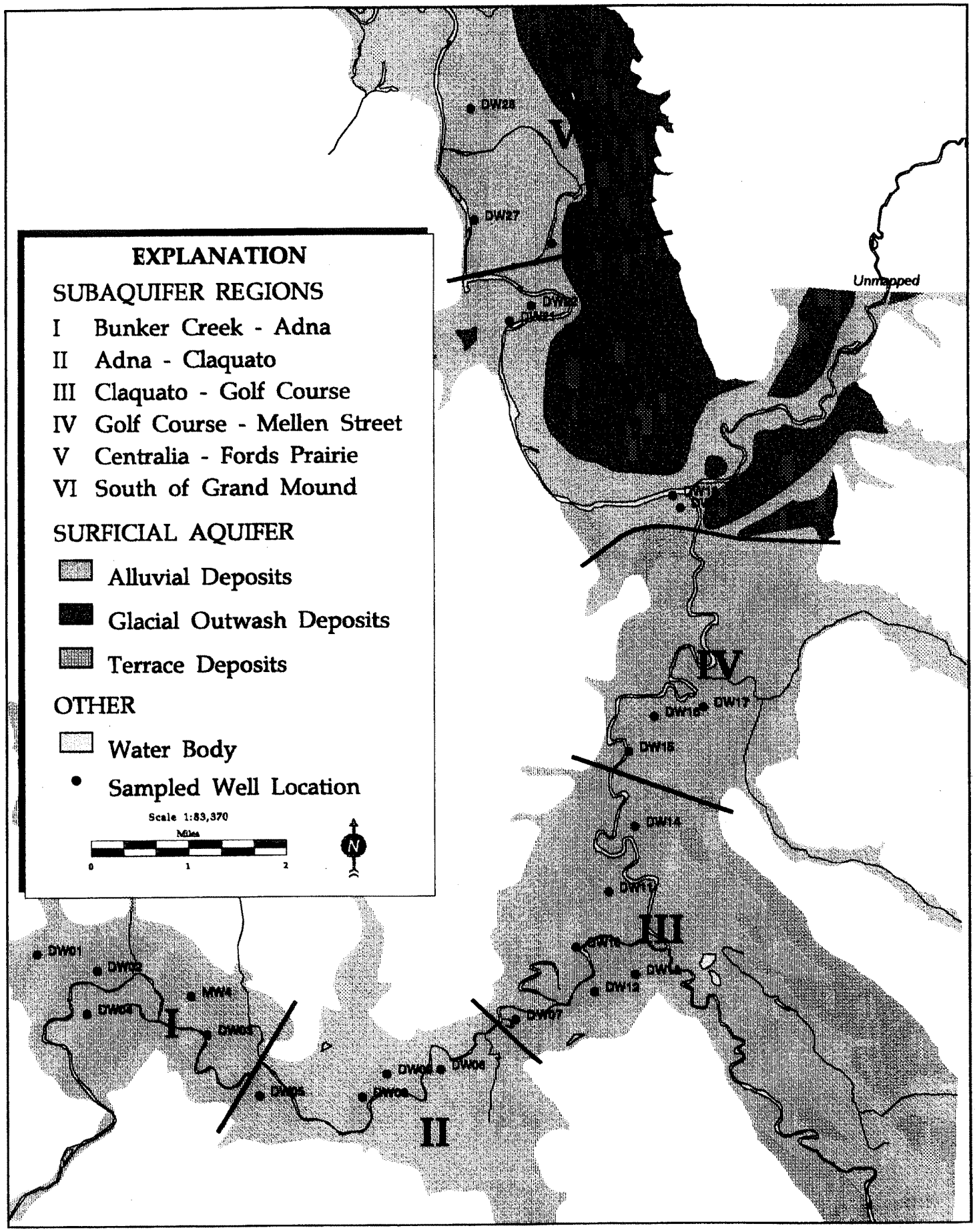

FIGURE 1. Surficial Aquifer and Well Location Map, Chehalis River TMDL

The sampled monitoring well (MW4) was the upgradient well for a monitoring network installed at Sheridan Dairy Lagoon by Ecology (Erickson, 1992). MW4 was sampled using a peristaltic pump equipped with silastic tubing.

One well, DW16, was inadvertently sampled after water treatment and results are not reported. Field parameters at this well were obtained prior to treatment and are valid.

The target analytes, test methods, and method detection limits are listed in Table 1. All water quality testing was conducted by the Ecology/EPA Manchester Laboratory. Individual water quality results were sent to well owners on February 11.

Sixteen of the sampled wells had access for water level measurements. Water levels were obtained using a commercial electric well probe. The probe was decontaminated between wells using a 10% bleach solution and a deionized water rinse.

Quality Assurance

All data are considered acceptable for use except as qualified and discussed below. In addition to method blanks and lab duplicates, field quality assurance samples consisted of two duplicate and two replicate samples. Quality assurance results are shown in Table 2. Duplicate samples were collected simultaneously from the same well but submitted to the laboratory with different identification. Replicate samples were obtained at different times from the same well using identical sampling procedures. Relative percent differences were generally less than 15%. Two exceptions were a TDS duplicate (RPD=51%) and total phosphorus replicate (RPD=67%). The cause of the poor precision for these two samples is not known. Because the other QA samples for TDS and total phosphorus were within acceptable ranges of precision the data are not qualified. Ortho-phosphate as P substantially exceeded the total phosphorus concentrations in 4 of 27 samples. The cause of this inconsistency is not known. Two ortho-phosphate analyses were not completed prior to established holding times and are qualified.

RESULTS

The surficial aquifer and well locations are shown in Figure 1. The aquifer appears to be hydraulically connected to the Chehalis River for its entire length in the study area. In the upstream portions of the study area the surficial aquifer consists mostly of alluvial deposits of interlayered gravel, sand, silt, and clay. The gravel and sand layers are water-bearing. Near Centralia and northward, the surficial aquifer consists mostly of sandy gravel outwash deposits. In general, the aquifer thickens from upstream to downstream, ranging from four to ten feet thick west of Adna up to 90 feet thick near Fords Prairie. Regionally, the river serves as a ground water sink, *i.e.* ground water from the surficial aquifer is flowing toward and into the river.

Table 1. Chehalis River TMDL, Ground Water Reconnaissance Parameters, Test Methods, and Detection Limits.

Parameter	Method of Analysis	Reference	Detection Limit
Water Level	Electric Well Probe	NA	0.01 feet
pH	Orion pH Meter	NA	0.1 Std Units
Specific Conductance	YSI Conductance Meter	NA	10 umhos/cm
Temperature	Orion Temperature Probe	NA	0.1°C
Ammonia-N	EPA Method 350.1	EPA (1983)	0.01 mg/L
Nitrate+Nitrite-N	EPA Method 353.2	EPA (1983)	0.01 mg/L
Total Persulfate Nitrogen	EPA Method 353.2	EPA (1983)	0.1 mg/L
Total Phosphorus	EPA Method 365.3	EPA (1983)	0.01 mg/L
Ortho-Phosphate	EPA Method 365.3	EPA (1983)	0.01 mg/L
Chloride	EPA Method 330.0	EPA (1983)	0.1 mg/L
Total Dissolved Solids	EPA Method 160.1	EPA (1983)	1 mg/L
Biological Oxygen Demand	EPA Method 405.1	EPA (1983)	2 mg/L
Total Organic Carbon	EPA Method 415.1	EPA (1983)	1.0 mg/L

NA= Not Applicable

Table 2. Chehalis River TMDL Ground Water Reconnaissance, Field Quality Assurance Results.

Site ID	TDS	TOC	BOD	Ammonia-N	NO3+NO2-N	TPN	Total Phosphorus	Ortho-PO4 as P	Chloride
DW11(11/18/92)	181	1.1	2 U	0.514	0.01 U	0.662	0.637	0.788	16.1
(Duplicate)	305	1.0	2 U	0.552	0.01 U	0.643	0.623	0.823	16.0
RPD(%)=	51	10	--	7	--	3	2	4	1
DW11(11/18/92)	193	1 U	2 U	0.517	0.01 U	0.666	0.316	0.816	15.6
(Replicate)									
RPD(%)=	6	--	--	1	--	1	67	3	3
DW11(12/02/92)	203	1 U	2 U	0.545	0.01 U	0.643	0.573	0.701	16.8
(Replicate)1									
RPD(%)=	11	--	--	6	--	3	11	12	4
DW22	121	1 U	2 U	0.01 U	0.437	0.493	0.022	0.026	6.5
(Duplicate)	100	1 U	2 U	0.01 U	0.43	0.47	0.024	0.024	6.5
RPD(%)=	19	--	--	--	2	5	9	8	0

U= Analyte not detected at or above listed value.

RPD= Relative percent difference. ((x-y)/((x+y)/2))*100

1 RPD calculated using the mean of duplicate sample results for 11/18/92.

Ground Water Inflow Estimates

The locations of the six subaquifers are shown on Figure 1 and are designated by Roman Numerals. The ground water inflow estimates for each of the six subaquifers are listed in Table 3. The minimum and maximum estimated inflows ranged from 0.1 to 10.3 cubic feet per second per mile (cfs/mi). The mean ground water inflow estimates ranged from 0.5 to 4.5 cubic feet per second per mile (cfs/mi). Inflows to the Chehalis River were lowest in the upstream areas near Adna and highest in the downstream areas near Centralia. The higher inflows are due to higher mean hydraulic conductivities and increased aquifer thickness.

Ground Water Quality

Results of field measurements are shown in Table 4. The results are arranged by subaquifer and are listed upstream to downstream. The ranges for pH, temperature, and specific conductance were 6.1 to 8.5 standard units, 10.1 to 13.1°C, and 46 to 920 micromhos/cm, respectively.

Laboratory results are shown in Table 5. The results are listed by subaquifer, upstream to downstream. The river reach believed to be downgradient of the sampled well is also shown.

In general the ground water quality results are highly variable. Chloride, organic (TOC and BOD) and ammonia-N concentrations are highest in the Claquato-Golf Course area. Four of six chloride concentrations are greater than 120 mg/L, four of six BOD concentrations are five or greater and ammonia-N concentrations ranged from 0.057 to 2.1 mg/L. Reducing conditions are likely responsible for inorganic-N appearing as ammonia-N rather than nitrate+nitrite-N. Note that one of these wells (DW10) was reportedly completed at a depth of 200 feet and sample results may not represent the quality of water entering the river. Nitrate+nitrite-N concentrations were generally higher in the downstream subaquifers ranging from 0.38 to 7.5 mg/L. Phosphorus concentrations are generally higher in the upstream portions of the study area ranging from 0.031 to 1.2 mg/L.

Other Ground Water Quality Data

Three other sources of ground water quality information in the study area are summarized below. These sources are listed as follows:

1) Lewis County Health District Ford's Prairie Study
2) National Frozen Foods
3) Centralia Landfill

National Frozen Foods and the Centralia Landfill are located in the Golf Course-Mellen Street subaquifer where there were few domestic wells to sample. The information from

Table 3. Chehalis River TMDL Ground Water Reconnaissance, Ground Water Inflow Estimates.

Aquifer Designation	River Mile		Hydraulic Gradient (ft/ft)	Hydraulic Conductivity (ft/day)	Flux (ft/day)	Aquifer Thickness (ft)	Number Inflow Banks (1 or 2)	Estimated Ground Water Inflow (cfs/mi)
1. Bunker Creek-Adna	86-82	Min=	0.0026	69	0.2	4	2	0.1
		Max=	0.014	69	1.0	10	2	1.2
		Mean=	0.0083	69	0.6	7	2	0.5
2. Adna-Claquato	82-77.5	Min=	0.0011	150	0.2	4	2	0.1
		Max=	0.0025	150	0.3	45	2	1.9
		Mean=	0.0018	150	0.2	20	2	0.6
3. Claquato-Golf Course	77.5-72	Min=	0.003	138	0.5	10	2	0.6
		Max=	0.005	138	0.8	50	2	5.0
		Mean=	0.004	138	0.6	30	2	2.4
4. Golf Course-	72-67.5	Min=	0.0016	162	0.3	10	2	0.3
Mellen Street		Max=	0.0042	162	0.7	70	2	5.8
		Mean=	0.0029	162	0.5	30	2	1.7
5. Centralia/Fords Prairie	67.5-64.2	Min=	0.0019	283	0.5	30	1	1.0
		Max=	0.0033	283	0.9	90	1	5.1
		Mean=	0.0026	283	0.7	50	1	2.2
(Lincoln Creek)	64.2-62	Min=	0.0019	283	0.5	30	2	2.0
		Max=	0.0033	283	0.9	90	2	10.3
		Mean=	0.0026	283	0.7	50	2	4.5
6. South of Grand Mound	62-60	Min=	0.0022	213	0.5	30	1	0.9
		Max=	0.0038	213	0.8	90	1	4.5
		Mean=	0.003	213	0.6	50	1	2.0

Table 4. Chehalis River TMDL Ground Water Reconnaissance, Field Measurement Results.

Aquifer Designation	Site ID	Depth (feet)	Date	pH (Std. Units)	Temperature (C)	Specific Conductance (micromhs/cm)
Bunker Creek-Adna	DW04	130	11/17/92	7.1	11.0	190
	DW01	40	11/17/92	6.1	10.9	192
	DW02	Shallow	11/17/92	6.2	12.7	216
	MW4	27.6	11/17/92	6.4	12.1	920
	DW03	90	11/17/92	7.1	10.8	238
Adna-Claquato	DW05	70	11/17/92	6.2	13.1	186
	DW06	30	11/17/92	7.4	11.3	245
	DW08	37	11/18/92	6.7	11.0	168
	DW09	65	11/18/92	6.7	12.5	125
Claquato-Golf Course	DW07	90	11/18/92	7.5	11.3	825
	DW12	60	11/18/92	8.2	11.2	770
	DW10	200	11/18/92	8.5	12.2	700
	DW13	69	11/18/92	7.5	11.1	430
	DW11	64	11/18/92	7.5	10.7	175
	DW11	64	12/02/92	7.2	10.2	182
	DW14	39	12/01/92	6.9	10.2	168
Golf Course-Mellen Street	DW15	50	12/01/92	7.5	10.3	258
	DW16	50	12/01/92	7.3	11.2	770
	DW17	20	12/01/92	6.5	11.3	77
Centalia/Fords Prairie	DW18	Shallow	12/01/92	6.7	10.4	118
	DW19	37	12/01/92	6.7	10.1	121
	DW20	47	12/01/92	6.8	11.0	46
	DW21	35	12/02/92	6.4	13.0	112
	DW22	30	12/02/92	6.8	11.8	92
	DW23	59	12/02/92	6.6	11.0	195
	DW24	40	12/02/92	6.8	11.3	132
	DW25	63	12/02/92	6.4	11.7	110
South of Grand Mound	DW26	60	12/02/92	6.4	11.3	109
	DW27	36	12/08/92	6.5	10.6	Not Tested
	DW28	40	12/08/92	6.5	10.6	Not Tested
			Minimum	6.1	10.1	46
			Maximum	8.5	13.1	920
			Mean=	6.9	11.3	281

Table 5. Chehalis River TMDL Ground Water Reconnaissance, Laboratory Results (Units = mg/L)

Subaquifer Designation	Site ID	TDS	TOC	BOD	Ammonia as N	NO3+NO2 as N	TPN	Total Phos-phorous	Ortho-Phos-phate	Chloride	Down-gradient Reach(RM)	Distance From River(ft)	Well Depth (ft)
Bunker Creek -	DW04	148	1 U	2 U	0.078	0.01 U	0.11	0.070	0.032	4.0	84.6-84.2	750-1500	130
Adna	DW01	183	1 U	2 U	0.01 U	2.1	2.1	0.042	0.031	9.7	84.3	2300	40
"	DW02	184	1.1	2 U	0.01 U	9.3	10.0	0.15	0.13	12.7	84.2	700	Shallow
"	MW4	612	5.8	2	0.67	0.01 U	1.5	0.21	0.50	44.2	82.8	1700	27.6
"	DW03	167	1.3	2 U	0.083	0.17	0.34	0.33	0.15	11.1	82.7	200	90
Adna-Claquato	DW05	140	1.5	2 U	0.011	2.1	2.3	0.064	0.033	10.6	81.8-81.2	1250-1850	70
"	DW06	179	1.1	2 U	0.57	0.01 U	0.62	1.2	1.2	16.0	78.9-78.6	700-1450	30
"	DW08	245	1 U	2 U	0.01 U	0.94	1.1	0.016	0.014	3.5	79.8	300	37
"	DW09	117	1 U	2 U	0.01 U	0.74	0.82	0.029	0.019	3.4	79.7	700	65
Claquato-	DW07	466	2	5	0.74	0.01 U	0.90	0.32	0.40	164	77.5	600	90
Golf Course	DW12	675	2.3	6	0.96	0.01 U	1.3	0.19	0.19	294	76.7	900	60
"	DW10	700	3.7	8	0.77	0.01 U	1.1	0.95	0.92	233	76.2	100	200
"	DW13	588	11.8	7	2.1	0.01 U	2.6	0.38	0.53	120	75.6-75.3	1600	69
"	DW11	226	1	2 U	0.53	0.01 U	0.66	0.63	0.81	15.9	74.1	1100	64
"	DW14	195	1 U	2 U	0.057	0.01 U	0.058	0.072	0.080	3.7	73.6-72.8	600-1000	39
Golf Course-	DW15	367	4.8	5	0.56	0.01 U	0.75	1.2	1.3	27.9	71.8	150	50
Mellen St.	DW16	--	--	--	--	--	--	--	--	--	--	--	50
"	DW17	106	1.2	2 U	0.01 U	2.6	3.0	0.038	0.022	4.5	70.4-70.3	800	20
Centralia/Ford	DW18	130	1 U	2 U	0.01 U	1.5	1.6	0.043	0.044	5.6	66.8	200	Shallow
Prairie	DW19	139	1 U	2 U	0.01 U	0.38	0.40	0.047	0.051	6.0	66.8	700	37
"	DW20	136	1 U	2 U	0.01 U	3.2	3.4	0.025	0.020	7.1	65.2-64.8	4000	47
"	DW21	114	1 U	2 U	0.01 U	1.6	1.7	0.043	0.045	7.9	63.6	200	35
"	DW22	110	1 U	2 U	0.01 U	0.43	0.48	0.023	0.025	6.5	63.3-62.7	600-2100	30
"	DW23	149	1 U	2 U	0.01 U	6.0	6.2	0.013	0.012	8.2	63.6-63.4	3000	59
"	DW24	148	1 U	2 U	0.14	3.5	3.8	0.027	0.026	7.3	63.1	600	40
"	DW25	145	1 U	2 U	0.01 U	2.9	3.2	0.024	0.024	13.1	63	2100	63
South of Grand	DW26	124	1 U	2 U	0.01 U	2.2	2.4	0.023	0.023	8.4	61.5-61.3	4000	60
Mound	DW27	171	1 U	2 U	0.01 U	4.4	4.3	0.030	0.014 H	8.7	61.3	300	36
"	DW28	208	1 U	2 U	0.012	7.5	7.2	0.028	0.023 H	16.6	60	1500	40

U = Analyte not detected above listed value. H = Analysis completed after established holding time. RM = River Mile.

these sources may be useful for supplementing the sample results. The water quality information from each of these sources is discussed below.

Lewis County Ford's Prairie Study

Lewis County Health District sampled 97 domestic wells in Ford's Prairie in 1990 to determine if ground water quality had deteriorated since previous sampling events in 1972 and 1974 (Lewis County Health District, 1990). Wells were sample for nitrate, nitrite, chloride, phosphate, and bacteria. The Health District concluded that ground water quality had deteriorated between 1974 and 1990. The mean concentration for nitrate in 1990 was 2.8 mg/L. Nine of the 97 wells had concentrations greater than 5 mg/L. Phosphate concentrations were generally less than 0.02 mg/L. The maximum phosphate concentration was 0.36 mg/L. The chloride data was unusual; chloride concentrations were described in 5 mg/L increments. This suggests the data may have been obtained using a nonconventional method, possibly field test kits. Most chloride concentrations were less than 15 mg/L. The maximum chloride concentration was 40 mg/L.

National Frozen Foods

National Frozen Foods has three monitoring wells at a land application field (Field 3) located adjacent to the Chehalis River in the Golf Course-Mellen Street subaquifer. These wells are sampled quarterly for total dissolved solids, biochemical oxygen demand, ammonia-N, nitrate-N, nitrite-N, and sodium. Concentrations in downgradient wells (MW2 and MW3) are generally elevated relative to the upgradient well (MW1). In 1992 ammonia-N and BOD concentrations in well MW3, the well with the highest concentrations, ranged from 0.7 to 1.1 mg/L and <4 to 9 mg/L, respectively. Two samples from MW3 by EILS in October 1991 showed ammonia-N at 1.1 to 1.2 mg/L and BOD at 14 to 15 mg/L (Carey, 1992). MW3 chloride concentrations in EILS samples ranged from 187 to 200 mg/L. The chloride concentrations for the two domestic wells sampled in this subaquifer were much lower at 4.5 and 27.9 mg/L. Carey, based on the EILS sample results, concluded that the ground water represented a potential increased oxygen demand for the Chehalis River and that ammonia concentrations in MW3 could be high enough to be chronically toxic to salmonids.

Centralia Landfill

Thirteen monitoring wells around the Centralia Landfill, located in the Golf Course-Mellen Street subaquifer region and about 1000 feet east of the Chehalis River, are sampled quarterly for a broad range of parameters. The site is underlain by two aquifers: a shallow aquifer consisting of sand, silty sand and silt and deeper regional aquifer consisting of sand and gravel (Shannon and Wilson, 1975). The two aquifers are separated by a silt layer that ranges in thickness from 20 to 30 feet. The ground water flow direction in the shallow aquifer is toward the west and south. The shallow aquifer likely discharges to Salzer Creek on the south and to the Chehalis River to the west. The relationship of the deep aquifer to the Chehalis River is less clear. Two monitoring wells completed in the shallow aquifer,

downgradient and west (MW2S) and south (B3S) of the landfill, show elevated concentrations of ammonia, chloride, total dissolved solids, iron, manganese, and total organic carbon (City of Centralia, 1991). The chloride concentration in MW2S has been steadily increasing since December 1990 and as of September 1991 was 110 mg/L. Likewise, the chloride concentration in B3S has been increasing since September 1988 and as of October 1991 was also 110 mg/L. Nitrate+nitrite-N concentrations have been low and in October 1991 were <0.01 mg/L. It appears that a potential exists for contaminants from the landfill to affect water quality in Salzer Creek and the Chehalis River.

CONCLUSIONS

The conclusions of the ground water reconnaissance for the Chehalis River TMDL are discussed below.

1. The Chehalis River is hydraulically connected to an extensive surficial aquifer and serves as a regional ground water sink for the study area. The minimum and maximum estimated ground water inflows to the Chehalis River range from 0.1 to a 10.3 cubic feet per second per mile (cfs/mi). The estimated mean ground water inflow for six subaquifers ranges from 0.5 to 4.5 cfs/mi. In general, ground water inflow is higher in the north part of the study area where thick outwash deposits predominate.

2. Based on the water quality results, ground water quality within each subaquifer is highly variable. Organic (TOC and BOD) and chloride loading via ground water to the Chehalis River is highest in the Claquato-Golf Course subaquifer area.

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