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**CHEHALIS RESERVATION  
2001 GROUNDWATER MONITORING REPORT**

*Prepared for:*

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The Chehalis Reservation  
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Chehalis Reservation  
2001 groundwater  
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## 1.0 Project Description

This Groundwater Monitoring Report has been prepared for the Confederated Tribes of the Chehalis Indian Reservation of Washington State. The Reservation is situated both in Grays Harbor and Thurston counties along State Route 12 (SR 12) between the cities of Rochester and Oakville (Figure 1). There are currently 97 private domestic wells on the Reservation and two public water systems with well sources. The reservation relies solely on these wells as its source of drinking water.

The Reservation comprises 6.6 square miles of the flood plain between the Chehalis and Black Rivers. The topography is generally flat, with surface elevations ranging from about 65 to 100 ft above sea level.

The reservation is underlain by alluvial material and outwash deposits from the Black and Chehalis Rivers. The alluvium consists of coarse sand and gravel and extends to a depth of approximately 100 feet. The alluvium is underlain by consolidated sedimentary and volcanic bedrock through which little groundwater flows.

Groundwater is shallow and flows generally westward, parallel to the flow of the Chehalis and Black rivers. Depth to groundwater ranges from 10 to 30 feet. Domestic wells on the reservation are completed in the alluvium and range in depth from 20 to 80 feet. These wells typically produce 50 to 500 gpm. Groundwater on the reservation is very susceptible to contamination because the aquifer lacks overlying confining layers that would prohibit the downward movement of pollutants.

The purpose of this monitoring project is to collect data necessary for the protection of the groundwater resources of the Chehalis Reservation. Specific objectives include:

- ▶ Assess seasonal variability and regional trends in groundwater quality, including nitrate.
- ▶ Assess the presence of pesticides and herbicides in water supply wells.
- ▶ Assess the contribution of nitrate and herbicides from agriculture.

## 2.0 Previous Investigations

Four previous reports address water resources on the Chehalis Reservation. The USGS Open File Report titled *Water Resources of the Chehalis Indian Reservation, Washington* (OFR 77-708, 1979) covers the availability and quality of groundwater and surface water as well as flooding analysis. Relevant conclusions from the USGS report include the following:

- ▶ Groundwater discharges to the Chehalis and Black Rivers during both summer and winter months.
- ▶ Total groundwater use during 1975 was estimated to be 48 million gallons. Estimates

- of seasonally available groundwater are 20 to 60 times the annual withdrawal in 1975.
- ▶ Coliform bacteria were detected in 2 out of 25 wells sampled.
  - ▶ Average discharge from the Chehalis River near Grand Mound is 2,850 ft<sup>3</sup>/sec.

A groundwater monitoring project plan for the Chehalis Reservation was produced in 1996. In this study, 96 wells were monitored annually for two years. One sample was collected during the wet season and one sample was collected during the dry season. Each sample was analyzed for pH, conductivity, temperature, turbidity, nitrate, nitrite, and ammonia. Analytical data from one sample event is included in Appendix A. Data from other sample events are not available. The 1996 program sampled 96 wells twice in contrast to the present study, which focuses on a smaller number of wells with long term quarterly sampling. Longer-term sampling will identify trends and seasonal variation in groundwater quality.

David Evans and Associates prepared a report titled *Aquifer Evaluation for Confederated Tribes of the Chehalis Reservation* (January 1998). This report includes well logs for domestic wells on the Reservation and aquifer test results. This report presented hydraulic conductivity estimates of 500 to 1,000 gpd/ft<sup>2</sup> for the upper portion of the aquifer and 10,000 to 15,000 gpd/ft<sup>2</sup> for the lower portion. Recommendations of the David Evans report included:

- ▶ Perform spatially distributed aquifer tests to assess hydraulic conductivity regions.
- ▶ Perform aquifer tests using higher capacity wells.
- ▶ Update database with new water level measurement data.
- ▶ Prepare water table contour maps for various seasons.
- ▶ Develop a computer model for wellhead protection purposes.

Many of these recommendations are currently being pursued, although not necessarily in conjunction with this report. Higher capacity testing was performed at the Icy Fresh Fish company. Water level and water quality data are being added to the Chehalis Tribe Environmental database. Water table contour maps have been prepared and are included in this report. A computer model is planned for completion over the next year.

PGG published the first Groundwater Monitoring Report in September 2000. This report documented groundwater samples collected up to the publication date. The current 2001 Groundwater Monitoring Report supersedes the September 2000 report.

### 3.0 Project Organization

This study was authorized by Dr. C. S. Sodhi, Director of the Department of Natural Resources, the Confederated Tribes of the Chehalis Reservation. This study was performed under contract between the Washington State Department of Ecology (Centennial Grant) and the Chehalis Tribe. The project manager at the Chehalis Reservation is:

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Groundwater samples were collected and analyzed by Harry Pickernell, lab supervisor of the Chehalis Tribe Water Quality Laboratory and Tom Hayden, Senior Water Quality Technician. Pacific Groundwater Group organized data collection and reporting, and observed Synthetic Organic Compound (SOC) sampling.

## **4.0 Sampling Program**

The groundwater-sampling program consisted of collecting groundwater samples from both existing domestic water supply wells and temporary push probes.

### **4.1 Domestic Well Sampling**

The purpose of the water supply well sampling program was to assess concentrations of groundwater constituents posing health risks. In the rural setting of the Chehalis Reservation, the sources of risk are likely septic systems and agricultural practices. Therefore, constituents were selected to detect contamination from these sources. The following constituents were analyzed as part of this study:

Wells to be sampled were initially selected based on spatial distribution and probable access. Although access was not initially granted for all of the initial selections, access increased as the program progressed. The number of sample locations increased from 15 to a maximum of 36 as access was granted by additional private well owners.

#### **4.1.1 Domestic Well Field Sampling Methods**

Field water quality instruments (Hydrolab Minisonde with Surveyor 4 datalogger) were

calibrated at the beginning (prior to sampling) and end of each day. Calibration data were recorded in a field notebook.

Groundwater samples were collected from a sampling port on the well or the nearest tap to the wellhead and upstream of any tank or treatment device where possible. If the sampling port is upstream of any storage tanks or treatment systems, the well was operated for at least 5 minutes before collecting the sample. If a storage tank existed upstream of the sampling port, the well was operated for at least 20 minutes before collecting a sample.

Clean, disposable, latex gloves were worn when filling bottles for analyses and gloves were changed between sampling locations. Water samples were collected directly from the spigot into sample containers. Sample bottles were placed in a clean, insulated ice chest containing frozen gel or ice, and delivered to the water quality laboratory at the end of the day.

#### **4.2 Push-Probe Sampling**

Push probe samples were attempted to collect data in areas where domestic wells were not available. Push probe sampling was accomplished by advancing small diameter casing through direct pressure on the casing. No rotary drilling methods were used. Once the desired depth was reached, the probe was retracted and water was pumped out of the casing using a peristaltic pump. Detailed push probe methodology is presented in the approved Groundwater Monitoring Plan (PGG, 1999). Push probe sampling was performed by Cascade Drilling of Woodinville, WA on April 10, 2000.

Sample collection was attempted at three locations, on the east and west sides of Briarwood Farms, and along Moon Road. Multiple attempts were made at each location. However, the drill rig was unable to penetrate deeper than 8 feet in all 6 borings attempted. Depth to groundwater is approximately 20 feet. The push probe was unable to reach the depth of groundwater likely because of the coarseness of the aquifer material.

#### **4.3 Laboratory Analytical Methods**

Nitrate, coliform, and E. Coli samples were collected for the ten quarters between second quarter 1999 and third quarter 2001. All samples were analyzed by the Chehalis Reservation Water Quality Laboratory. Split samples were collected the first quarter and sent to the EPA's Manchester Lab for nitrate analysis. In addition, six high frequency rounds of nitrate samples were collected in the eastern half of the site between August 23 and September 27, 2001. These samples were split with Thurston County Department of Health. Nitrate was analyzed using a specific ion probe. Coliform samples were analyzed using the Colilert Method 9223A. Analytical methods and QA/QC procedures are included in Appendices B and C.

Dissolved oxygen, conductivity, percent oxygen saturation, temperature and pH were measured for four quarters (second, third, and fourth quarter 2000, and third quarter 2001).

Pesticide and herbicide samples were collected during the fourth quarter of 1999 and analyzed by Analytical Resources Inc. of Seattle, WA using EPA methods 8081 and 8051. The ten sample locations were selected to cover collected were distributed to cover a wide area of the Reservation.

The Tribal water quality lab is planning will likely receive chemistry certification from the EPA this year.

## **5.0 Map Specifications**

The base map used to generate all of the figures in this report was produced by David C. Smith and Associates, Inc. of Portland, OR. The mapping control is based on the Thurston County High Precision Control Network using the following specifications:

Horizontal Datum: NAD '83/ '91  
Vertical Datum: NGVD '29 Mean Sea Level  
Units: U.S. Survey Foot  
Projection: Lambert Conical, Washington State Plane South Zone

The base map was compiled to meet the following accuracy standards:

Horizontal Accuracy: +/- 2.5 feet horizontal accuracy for 90% of well-defined points  
Vertical Accuracy: +/- 1.25 feet vertical accuracy for 90% of well-defined points

## **6.0 Data Management**

All data collected has been entered into the Chehalis Environmental Data Management System, which resides on the Chehalis Tribe computer network. The Data Management System was programmed using the Microsoft Access database program and is designed to manage water quality, water level, air quality, and meteorological data. The database allows immediate access to all of the Tribe's monitoring data. The Data Management System produces both tabular and GIS map output. The GIS interface uses the base maps described above. The tabular reports include event and time series reports for each of the data types. Data is added to the system at the completion of each sampling event.

## **7.0 Groundwater Elevations**

Groundwater elevations measured on November 7, 2001 are presented in Table 1. Access was only granted for nine wells. Static water level tests were performed by Chehalis Tribe personnel from August 1994 to August 1995. The tests involved measuring the

depth to water in a domestic well twice, approximately one half hour apart. Two measurements were taken to assess whether water levels were in fact static.

Groundwater elevation maps for two of the static tests are presented in Figures 1 and 2. The water level elevations presented are from February and August, which represent high and low water conditions. Groundwater flow on a regional scale is from southeast to northwest with a gradient of approximately 0.001. Local scale flow near the Chehalis and Black Rivers may vary significantly and is likely towards the rivers. Groundwater flow directions and gradient do not vary greatly between wet and dry seasons although the amount of water flowing towards the rivers is likely greater during the wet season.

## 8.0 Sampling Results

Ten quarters of groundwater samples were collected between June 1999 and September 2001. In addition, six rounds of samples were collected in the eastern half of the site between August 23 and September 27, 2001. Nitrate, coliform, and E. Coli were analyzed each sampling event. Dissolved oxygen, conductivity, percent oxygen saturation, temperature and pH were recorded for four quarters during 2000 and 2001. The sample results are presented in Tables 2 through 16. Sample data from 1996 are presented in Appendix A for documentation purposes. Nitrate concentrations detected during the monitoring program ranged from less than 0.05 mg/l (detection limit) to 7.86 mg/l (in AAD730). Nitrate was not detected at concentrations over the MCL of 10 mg/L.

Total coliform was detected in 26 wells on the Reservation. Coliform was detected most frequently in AAD727 where coliform was detected nine times. This well is adjacent to Briarwood Farms and the Casino. Other wells with high frequency coliform detections include AAD704, AAD705, and AAD703, which had five, four, and three detections respectively. These wells are located in the northeast corner of the site near the intersection of Anderson and Moon roads. Coliform was detected four times in AAD792, which is located in the northwest corner of the site south of Oakville. E. Coli was detected once in well AAD704.

Pesticide and herbicides were not detected in any of the samples collected (Table 5).

### 8.1 Spatial Distribution

Figures 3 through 18 present nitrate concentrations for the sixteen sampling events. In general, nitrate concentrations were higher in the eastern half of the reservation compared to the western half. Samples collected from domestic wells AAD727, AAD730, and IH124D consistently had the highest concentrations of nitrate on the Reservation. Concentrations for these three wells ranged from 3.53 to 7.86 mg/L, which are likely above natural background. All three wells are located on Anderson Road adjacent to Briarwood Farms and the Casino. Groundwater flow directions are not well known in this area so the source of the nitrate cannot be assessed. See Section 10 for recommendations

regarding groundwater flow assessment. Domestic well AAD730 consistently has the highest nitrate concentration and is likely closest to the center of the plume. Nitrate concentrations are also elevated in nearby wells AAD725 and AAD732 although they have a shorter monitoring record.

Figure 19 presents the spatial distribution of the number of coliform detections per well. The highest number of detections occurred in AAD727, which is down gradient of Briarwood Farms and the Casino. Other high detection counts were distributed over the Reservation. Coliform was detected four and five times in domestic wells AAD705 and AAD704, which are located in the north east corner of the Reservation. Coliform was detected four times in AAD792, which is located in the north west corner of the Reservation, south of Oakville.

## **8.2 Time Series Analysis**

Figures 20 through 23 present nitrate time series plots. The plots have been divided into five groups based on the nitrate concentration trend. The locations of wells included in the time series plots along with their respective groups have been plotted in Figure 24. The groups fall into rough geographic clusters with the highest concentration group 1 located downgradient of the Casino and Briarwood Farms.

Wells in Group 1 have the highest consistent nitrate concentrations ranging from 3.03 to 7.86 mg/L. Until the third quarter of 2000, nitrate concentrations in Group 1 wells generally peaked in September 1999 and again in March 2000. Subsequently, nitrate concentrations increased consistently from the third quarter of 2000 through August 2001 at which point concentrations decreased sharply by approximately 1 mg/L. However, the change in the sampling frequency at the end of 2000 may be affecting the interpretation of these results. Sharp decreases may have occurred before August 2001 but would not have been detected because of the greater sampling frequency. Group 1 wells are located downgradient of the Casino and Briarwood Farms.

Wells in Group 2 generally follow the same pattern as Group 1, except the concentrations are generally lower. Nitrate concentrations in Group 2 range from 0.5 to 5 mg/L. One difference is that nitrate concentrations are stable after August 2001 instead of exhibiting the sharp decrease seen in Group 1 wells. Consequently, these wells show an increasing trend of nitrate concentrations. However, only one of the wells in Group 2 (AAD747) was sampled past August 8<sup>th</sup>. So this conclusion is based on the samples from that well only. The same decrease seen in Group 1 could have been seen in Group 2 if more wells had been sampled. Group 2 wells are located in the central part of the Reservation.

Wells in Group 3 are characterized by consistent nitrate concentrations until October 2000 followed by a sharp increase peaking in March of 2001. Group 3 wells are located in the western quarter of the reservation.

Group 4 consists of wells with peak nitrate concentrations in January 2000, September 2000, and August 2001. Group 4 wells are located in the northeast corner of the site.

Wells that did not fit in any of the other groups were included in Group 5. These wells are located on Briarwood Farms and north of the Casino.

## 9.0 Split Sample Comparison

During the second quarter of 1999, nitrate samples were split between the EPA and the Chehalis Tribe's lab. Samples were split with the Thurston County Department of Health during the seven sampling events between August 8 and September 27, 2001. Comparison plots are presented in Figure 25. The plot includes an "equivalency line," which is the line on which the plots would fall if concentrations measured were equivalent.

Figure 25 indicates good correlation between the Chehalis Tribe data and data analyzed by the two other agencies. Correlation coefficients were 0.98 and 0.96 between the Chehalis Tribe and the EPA and Thurston County respectively.

The EPA measured concentrations were biased approximately 0.5 mg/L higher than the Chehalis Tribe data. Concentrations measured by Thurston County were biased approximately 0.1 mg/L below concentrations measured by the Chehalis Tribe. These differences are likely due to differences in analytical methods.

## 10.0 Summary of Findings and Recommendations

The following bullets summarize the findings of this study:

- ▶ Pesticides and herbicides were not detected in any of the samples collected.
- ▶ Nitrate concentrations were highest immediately downgradient of Briarwood Farms and the Casino. Concentrations were detected up to 7.86 mg/l. Increasing trends were observed in some wells.
- ▶ Total coliform was detected in 26 wells on the Reservation. Coliform was detected nine times in well AAD727.
- ▶ Regional groundwater flow is from southeast to northwest at a gradient of 0.001.
- ▶ There is good correlation between EPA and Chehalis Tribe analytical results.

We recommend the following actions be taken to further evaluate water quality at the Chehalis Reservation.

- ▶ Continue to collect and analyze groundwater samples quarterly for nitrate.
- ▶ Measure groundwater elevations as part of groundwater sampling events.
- ▶ Investigate groundwater flow directions and nitrate concentrations near Briarwood

Farms and the Lucky Eagle Casino through the installation of monitoring wells. A minimum of three wells is required to assess groundwater flow directions.

- ▶ Connect wells near Briarwood Farms and the Lucky Eagle Casino to the distribution system once it is constructed.
- ▶ Assess the source of increasing nitrate concentrations in Group 2 wells.
- ▶ Define individual well capture zones through development and use of a computer model.

## **11.0 References**

David Evans and Associates. 1988. Aquifer Evaluation for Confederated Tribes of the Chehalis Reservation. Consultants Report.

Pacific Groundwater Group. 1999. Chehalis Reservation Groundwater Monitoring Plan. Consultants Report prepared for the Chehalis Tribe.

Pacific Groundwater Group. 2000. Chehalis Reservation Groundwater Monitoring Report. Consultants Report prepared for the Chehalis Tribe.

Pearson, H.E., and Higgins, G. T. 1979. Water Resources of the Chehalis Indian Reservation, Washington. USGS Open File Report 77-704.

**Table 1. Groundwater Levels Measured November 7, 2001**

<b>Well ID</b>	<b>System Owner</b>	<b>Time</b>	<b>Casing Diameter</b>	<b>Casing Height</b>	<b>Measuring Point Elev</b>	<b>Depth to Water</b>	<b>Groundwater Elevation</b>
AAD704	Shirley Montoya	10:11 AM	6 inch	2"	104.00	15.00	89.00
AAD709	Jack Garden	10:04 AM	6 inch	8"	112.80	17.04	95.76
AAD716	Mary Secena	10:30 AM	6 inch	10"	121.60	36.29	85.31
AAD727	Sam Secena	1:45 PM	6 inch	10 1/2"	120.30	35.63	84.68
AAD736	Shaker Church	2:20 PM	6 inch	2' 1"	116.30	31.98	84.32
AAD740	Tribal System (IH124D-#2)	2:37 PM	6 inch	3'	Not Avail	32.92	
AAD749	Youckton System	11:42 AM	6 inch	5'	92.40	15.15	77.25
AAD763	Helen Sanders	11:18 AM	6 inch	1' 6 1/2"	91.00	16.21	74.79
AAD797	Starr System	11:06 AM	6 inch	1' 6 1/2"	93.40	30.23	63.17

*All elevations in feet, NGVD '29 Mean Sea Level*

**Table 2. Groundwater Sampling Results, Second Quarter 1999**

Well ID	System		Sample		CTWQ	EPA	Total	
	Owner	Sample ID	Number	Date	NO <sub>3</sub> <sup>-</sup> (mg/l)	NO <sub>3</sub> <sup>-</sup> (mg/l)	Coliform	E.Coli
AAD707	Stanley Johnson	99250001	1	6/23/99	1.800	---	A	A
AAD709	Jack Garden	99250002	2	6/23/99	0.020	0.402	A	A
AAD716	Mary Secena	99250004	4	6/23/99	0.592	1.132	A	A
AAD727	Roberta Secena	99250006	6	6/23/99	4.640	5.372	A	A
AAD728	Sam Secena	99250007	7	6/23/99	3.340	4.678	A	A
AAD730	Marie Francis	99250005	5	6/23/99	5.260	6.194	A	A
AAD746	Ida Rosander	99250008	8	6/23/99	1.860	2.842	A	A
AAD747	Jimmy/Elaine	99250009	9	6/23/99	1.600	2.077	A	A
AAD749	Youckton System	99250010	10	6/23/99	2.050	2.187	A	A
AAD768	Icy Fresh	99250015	15	6/23/99	0.909	1.432	A	A
AAD781	Frank Cayenne Jr.	99250014	14	6/23/99	0.644	1.022	A	A
AAD792	Jim Young	99250013	13	6/23/99	0.000	0.518	A	A
AAD797	Starr System	99250012	12	6/23/99	0.563	1.152	A	A
AAD800	Al Brown	99250011	11	6/23/99	0.884	1.418	A	A
IH713L	Lucky Eagle Casino	99250003	3	6/23/99	0.402	0.972	A	A

CTWQ: Chehalis Tribal Water Quality Laboratory

P = Present, A = Absent

**Table 3. Groundwater Sampling Results, Third Quarter 1999**

Well ID	System		Sample			Total		
	Owner	Sample ID	Number	Date	Time	NO <sub>3</sub> <sup>-</sup> (mg/l)	Coliform	E.Coli
AAD707	Stanley Johnson	99380001	1	9/21/99	1515	2.02	A	A
AAD708	Jimmy Jack Trailer	99380017	17	9/22/99	1545	0.03	A	A
AAD709	Jack Garden	99380016	16	9/22/99	1512	0.07	A	A
AAD716	Mary Secena	99380020	20	9/22/99	1642	0.19	A	A
AAD717	Chuck Palmer	99380006	6	9/22/99	0945	0.51	A	A
AAD727	Sam Secena	99380005	5	9/22/99	0916	5.10	A	A
AAD728	Roberta Secena	99380004	4	9/22/99	0903	4.52	A	A
AAD730	Marie Francis	99380003	3	9/22/99	0848	6.42	A	A
AAD746	Ida Rosander	99380007	7	9/22/99	1003	2.73	A	A
AAD747	Jimmy/Elaine	99380008	8	9/22/99	1025	1.39	A	A
AAD749	Youckton System	99380009	9	9/22/99	1043	2.34	A	A
AAD758	Harvey Hamilton	99380019	19	9/22/99	1628	1.45	A	A
AAD767	Sue Sanders	99380015	15	9/22/99	1412	2.31	A	A
AAD769	Icy Fresh	99380014	14	9/22/99	1358	0.15	A	A
AAD781	Frank Cayenne Jr.	99380013	13	9/22/99	1205	0.04	A	A
AAD792	Jim Young	99380012	12	9/22/99	1145	0.04	A	A
AAD797	Starr System	99380011	11	9/22/99	1130	0.32	A	A
AAD798	Lillian Young	99380018	18	9/22/99	1603	0.30	A	A
AAD800	Al Brown	99380010	10	9/22/99	1103	0.09	A	A
IH124D	Tribal System	99380021	21	9/22/99	1656	3.62	A	A
IH713L	Lucky Eagle Casino	99380002	2	9/22/99	0821	0.17	A	A

*P = Present, A = Absent*

**Table 4. Groundwater Sampling Results, Fourth Quarter 1999**

Well ID	System		Sample			Total		
	Owner	Sample ID	Number	Date	Time	NO <sub>3</sub> <sup>-</sup> (mg/l)	Coliform	E.Coli
AAD703	Neil Marvin	99520001	1	12/29/99	8:23 AM	1.27	A	A
AAD704	Shirley Montoya	99520002	2	12/29/99	8:38 AM	0.88	P	P
AAD705	Phil Anderson	99520003	3	12/29/99	8:53 AM	0.76	P	A
AAD706	Bill Johnson	99520004	4	12/29/99	9:05 AM	1.52	P	A
AAD707	Stanley Johnson	99520005	5	12/29/99	9:18 AM	1.31	A	A
AAD708	Jimmy Jack	99520007	7	12/29/99	9:52 AM	0.25	A	A
AAD709	Jack Garden	99520006	6	12/29/99	9:32 AM	0.20	P	A
AAD716	Mary Secena	99520009	9	12/29/99	10:14 AM	0.62	P	A
AAD717	Chuck Palmer	99520010	10	12/29/99	10:27 AM	0.93	A	A
AAD727	Sam Secena	99520013	13	12/29/99	11:05 AM	3.67	P	A
AAD728	Roberta Secena	99520012	12	12/29/99	10:54 AM	3.20	P	A
AAD730	Marie Francis	99520011	11	12/29/99	10:40 AM	3.92	P	A
AAD746	Ida Rosander	99520023	23	12/29/99	2:02 PM	1.31	P	A
AAD747	Hayden System	99520022	22	12/29/99	1:47 PM	1.75	A	A
AAD749	Youckton System	99520021	21	12/29/99	1:16 PM	1.50	A	A
AAD767	Sue Sanders	99520020	20	12/29/99	12:56 PM	1.53	P	A
AAD768	Icy Waters	99520019	19	12/29/99	12:45 PM	0.85	A	A
AAD781	Frank Cayenne	99520018	18	12/29/99	12:29 PM	1.09	A	A
AAD792	Jim Young	99520017	17	12/29/99	12:15 PM	0.39	A	A
AAD797	Starr System	99520016	16	12/29/99	12:06 PM	0.72	A	A
AAD798	Lillian Young	99520015	15	12/29/99	11:55 AM	1.02	A	A
AAD800	Alfred Brown	99520014	14	12/29/99	11:42 AM	0.52	A	A
IH128D	Tribal System	99520024	24	12/29/99	2:14 PM	2.46	A	A
IH713L	Lucky Eagle Casino	99520008	8	12/29/99	10:03 AM	0.52	A	A

P = Present, A = Absent

**Table 5. Groundwater Sampling Results, Pesticides and Herbicides, Fourth Quarter 1999**

Constituent	AAD706		AAD747	AAD730	AAD728	AAD727	AAD704	AAD707	AAD767	AAD749	
	GWQC	B. Johnson	B. Reiber	Hayden Sys	M. Francis	R. Secena	S. Secena	S. Montoya	S. Johnson	S. Sanders	Youckton Sys.
2,4,5-T		0.6U	0.6U	0.6U	0.6U	0.6U	0.6U	0.6U	0.6U	0.6U	0.6U
2,4,5-TP (Silvex)		0.28U	0.28U	0.28U	0.28U	0.28U	0.28U	0.28U	0.28U	0.28U	0.28U
2,4-D		1.5U	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U	1.5U
2,4-DB		10U	10U	10U	10U	10U	10U	10U	10U	10U	10U
4,4'-DDD	0.3	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
4,4'-DDE	0.3	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
4,4'-DDT	0.3	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Aldrin	0.0005	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
alpha Chlordane	0.06	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
alpha-BHC		0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
beta-BHC		0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
Dalapon		2U	2U	2U	2U	2U	2U	2U	2U	2U	2U
delta-BHC		0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
Dicamba		0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U	0.7U
Dichloroprop		3.1U	3.1U	3.1U	3.1U	3.1U	3.1U	3.1U	3.1U	3.1U	3.1U
Dieldrin	0.005	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Dinoseb		0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Endosulfan I		0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
Endosulfan II		0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Endosulfan Sulfate		0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Endrin		0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Endrin Aldehyde		0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
Endrin Ketone		0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U	0.1U
gamma Chlordane	0.06	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
gamma-BHC (Lindane)	0.06	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
Heptachlor	0.02	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
Heptachlor Epoxide	0.009	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U	0.05U
MCPA		1200U	1200U	1200U	1200U	1200U	1200U	1200U	1200U	1200U	1200U
Methoxychlor		0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U	0.5U
Toxaphene	0.08	5U	5U	5U	5U	5U	5U	5U	5U	5U	5U

All concentrations in ug/L

Samples analyzed by ARI of Seattle, WA

**Table 6. Groundwater Sampling Results, First Quarter 2000**

Well ID	System		Sample			Total			Comments
	Owner	Sample ID	Number	Date	Time	NO <sub>3</sub> <sup>-</sup> (mg/l)	Coloform	E Coli	
AAD703	Neil Marvin	00130001	1	3/27/00	9:30	1.79	A	A	
AAD704	Shirley Montoya	00130002	2	3/27/00	9:42	1.15	A	A	
AAD705	Phil Anderson	00130003	3	3/27/00	9:50	1.07	A	A	
AAD706	Bill Johnson	00130004	4	3/27/00	10:00	1.75	A	A	
AAD707	Stanley Johnson	00130005	5	3/27/00	10:11	1.66	A	A	
AAD708	Jimmy Jack	00130030	30	3/30/00	14:01	0.27	A	A	
AAD709	Jack Garden	00130006	6	3/27/00	10:25	0.37	A	A	
AAD714	Sonya Sanders	00130008	8	3/27/00	11:04	6.63	A	A	
AAD714	Sonya Sanders	00130036	36	3/30/00	15:57	3.01	---	---	Resample
AAD716	Mary Secena	00130029	29	3/30/00	13:47	0.63	A	A	
AAD717	Chuck Palmer	00130009	9	3/27/00	11:16	1.69	A	A	
AAD721	Jerry Dorsch	00130010	10	3/27/00	11:28	0.44	A	A	
AAD723	Briarwood 1	00130033	33	3/30/00	15:02	1.92	A	A	
AAD724	Briarwood 2	00130034	34	3/30/00	15:23	1.15	A	A	
AAD725	Briarwood 3	00130035	35	3/30/00	15:37	3.03	A	A	
AAD727	Sam Secena	00130011	11	3/27/00	11:38	5.66	A	A	
AAD728	Roberta Secena	00130012	12	3/27/00	11:46	4.63	A	A	
AAD730	Marie Francis	00130013	13	3/27/00	11:54	6.46	A	A	
AAD732	Hazel Pete	00130031	31	3/30/00	14:20	3.41	A	A	
AAD746	Ida Rosander	00130027	27	3/27/00	14:45	2.42	A	A	
AAD747	Hayden System	00130026	26	3/27/00	14:38	1.54	A	A	
AAD749	Youckton System	00130025	25	3/27/00	14:20	1.72	A	A	
AAD758	Harvey Hamilton	00130023	23	3/27/00	13:57	2.09	A	A	
AAD763	Helen Sanders	00130024	24	3/27/00	14:07	1.99	A	A	
AAD767	Sue Sanders	00130022	22	3/27/00	13:43	1.62	A	A	
AAD768	Icy Waters	00130021	21	3/27/00	13:34	1.25	A	A	
AAD777	Murv Stayton	00130018	18	3/27/00	12:59	0.25	A	A	
AAD779	Patricia Stayton	00130019	19	3/27/00	13:12	0.21	A	A	
AAD781	Frank Cayenne	00130020	20	3/27/00	13:21	0.55	A	A	
AAD791	Housing Rental	00130032	32	3/30/00	14:39	0.34	A	A	
AAD792	Jim Young	00130017	17	3/27/00	12:45	0.62	A	A	
AAD797	Starr System	00130016	16	3/27/00	12:37	1.21	A	A	
AAD798	Lillian Young	00130015	15	3/27/00	12:29	1.46	A	A	
AAD800	Alfred Brown	00130014	14	3/27/00	12:19	0.81	A	A	
IH124D	Tribal System	00130028	28	3/27/00	15:39	5.26	A	A	
IH713L	Lucky Eagle Casino	00130007	7	3/27/00	10:47	1.03	A	A	

P = Present, A = Absent

**Table 7. Groundwater Sampling Results, Second Quarter 2000**

Well ID	System Owner	Sample		Coliform	E. Coli	Saturation		EC umhos/cm	DO mg/L	pH Std Units	Temp C
		Date	NO3 (mg/l)			Percent					
AAD703	Neil Marvin	8/1/00	1.69	P	A	27.1	117.3	2.89	6.45	12.64	
AAD704	Shirley Montoya	8/1/00	1.39	P	A	47.1	88.3	4.97	6.3	12.46	
AAD705	Randy Hurst	8/1/00	1.82	P	A	50.1	90.5	4.83	6.28	16.25	
AAD706	Bill Johnson	8/1/00	3.05	A	A	39.1	109.4	3.84	6.46	16.36	
AAD707	Stanley Johnson	8/1/00	1.51	A	A	38	108.1	4.02	6.51	11.74	
AAD708	Jimmy Jack	8/1/00	0.69	A	A						
AAD709	Jack Garden	8/1/00	0.08	A	A	44.8	75.6	4.57	6.75	14.9	
AAD714	Sonya Sanders	8/1/00	2.98	P	A	59.8	130.7	6.31	6.37	12.98	
AAD716	Mary Secena	8/1/00									
AAD717	Chuck Palmer	8/1/00	0.57	A	A	36.8	93	4.1	6.51	10.85	
AAD721	Jerry Dorsch	8/1/00	ND	A	A	55.8	101.6	6.08	6.98	11.43	
AAD723	Briarwood 1	8/2/00	1.48	A	A						
AAD724	Briarwood 2	8/2/00	0.97	A	A						
AAD725	Briarwood 3	8/2/00	3.88	A	A						
AAD727	Sam Secena	8/1/00	3.53	P	A	43.8	141.2	4.62	6.6	12.77	
AAD728	Roberta Secena	8/1/00	3.74	A	A	44.3	133.1	4.72	6.68	12.32	
AAD730	Marie Francis	8/1/00	4.21	A	A	61.4	143.1	6.72	6.56	11.94	
AAD732	Hazel Pete	8/1/00	0.71	A	A	56.4	109.6	5.18	6.89	19.32	
AAD746	Ida Rosander	8/1/00	1.19	P	A	50.3	112.2	5.5	6.75	11.41	
AAD747	Hayden System	8/1/00	0.76	A	A	43.2	110.2	4.19	7.26	15.48	
AAD749	Youckton System	8/1/00	1.16	A	A	53.6	110.9	5.51	7.38	13.98	
AAD758	Harvey Hamilton	8/1/00	0.85	P	A	12.1	148.5	1.24	6.84	12.93	
AAD763	Helen Sanders	8/1/00	0.96	A	A	12.1	145.1	1.26	7.16	13.35	
AAD767	Sue Sanders	8/1/00	1.45	A	A	22.6	119.3	2.38	6.96	12.94	
AAD768	Icy Fresh	8/1/00	0.19	A	A	77.4	131.4	7.73	7.16	15.11	
AAD777	Murv Stayton	8/1/00	ND	A	A	47.8	132.2	5.06	6.88	12.56	
AAD779	Patricia Stayton	8/1/00	ND	A	A	3.5	134.9	0.36	7.11	11.44	
AAD781	Mimi Cayenne	8/1/00	ND	A	A	25.8	87.1	2.81	6.84	11.5	
AAD791	Housing Rental	8/1/00	ND	A	A	49.9	91.3	5.01	7.33	14.8	
AAD792	Jim Young	8/1/00	ND	P	A	20.8	117.5	2.18	6.99	12.47	
AAD797	Starr System	8/1/00	0.36	A	A	78.8	85.4	8.63	7.01	10.99	
AAD798	Lillian Young	8/1/00	0.42	A	A	76.4	89.2	8.51	7.05	10.81	
AAD800	Alfred Brown	8/1/00	0.19	A	A	57.5	69.5	5.9	6.72	13.37	
IH124D	Tribal System	8/1/00	3.81	A	A	67.9	126.6	7.5	6.83	10.67	
IH713L	Lucky Eagle Casino	8/1/00	1.03	A	A	65.9	102.1	6.62	6.8	15.05	

P = Present, A = Absent

**Table 8. Groundwater Sampling Results, Second Quarter 2000, Resample**

<b>Well ID</b>	<b>Owner</b>	<b>Date</b>	<b>Coliform</b>	<b>E. Coli</b>
AAD703	Neil Marvin	8/15/00	A	A
AAD704	Shirley Mon	8/15/00	P	A
AAD705	Randy Hurst	8/15/00	P	A
AAD714	Sonya Sande	8/15/00	P	A
AAD727	Sam Secena	8/15/00	P	A
AAD758	Harvey Ham	8/15/00	A	A
AAD792	Jim Young	8/15/00	P	A

*P = Present, A = Absent*

**Table 9. Groundwater Sampling Results, Third Quarter 2000**

Well ID	System Owner	Sample Date	NO3 (mg/l)	Coliform	E. Coli	Saturation	EC	DO	pH	Temp C
						Percent	umhos/cm	mg/L	Std Units	
AAD703	Neil Marvin	9/27/00	1.93	A	A	45.7	131.1	4.73	6.42	11.9
AAD704	Shirley Montoya	9/27/00	2.73	A	A	59.7	103.8	7.42	5.81	11.2
AAD705	Randy Hurst	9/27/00	2.84	A	A	56.3	112.1	5.86	5.61	12.7
AAD706	Bill Johnson	9/27/00	3.08	A	A	46.7	129.6	4.87	5.81	12.26
AAD707	Stanley Johnson	9/27/00	2.33	A	A	36.6	120.3	3.94	5.79	11.22
AAD708	Jimmy Jack	9/27/00	1.45	A	A	22.4	125.8	2.33	6.13	12.38
AAD709	Jack Garden	9/27/00	2.01	A	A	81.5	88.5	8.4	6.08	11.78
AAD714	Sonya Sanders	9/27/00	2.35	A	A	69.7	132.4	7.35	6.08	11.98
AAD721	Jerry Dorsch	9/27/00	1.22	A	A	62	113.2	6.59	6.35	11.51
AAD723	Briarwood 1	9/28/00	2.74	A	A					
AAD724	Briarwood 2	9/28/00	1.58	A	A					
AAD725	Briarwood 3	9/28/00	4.03	A	A					
AAD727	Sam Secena	9/27/00	5.04	A	A	49.9	158.7	5.32	6.26	11.35
AAD728	Roberta Secena	9/27/00	4.42	A	A	47.2	149.7	4.97	6.27	11.88
AAD730	Marie Francis	9/27/00	4.99	A	A	62.3	167.1	6.74	6.16	10.68
AAD732	Pete System	9/27/00	3.81	A	A	67.6	148.5	6.24	6.33	17.79
AAD746	Ida Rosander	9/27/00	1.95	A	A	50.9	132	5.34	6.11	11.8
AAD747	Hayden System	9/27/00	1.91	A	A	48.1	126.8	4.93	6.14	13.23
AAD749	Youckton System	9/27/00	2.06	A	A	51	129.1	5.09	6.4	14.32
AAD758	Harvey Hamilton	9/27/00	1.98	A	A	18.5	164.9	1.98	6.05	11.04
AAD763	Helen Sanders	9/27/00	1.84	A	A	16.3	169.2	1.7	6.25	11.95
AAD767	Sue Sanders	9/27/00	2.17	A	A	59.3	136	6.55	5.96	11.36
AAD768	Icy Fresh	9/27/00	1.47	A	A	74.2	150.8	7.81	6.67	11.66
AAD777	Murv Stayton	9/27/00	0.962	A	A	51.1	151.1	5.64	6.33	10.34
AAD779	Patricia Stayton	9/27/00	1.19	A	A	11.6	149.9	1.16	6.43	10.92
AAD781	Mimi Cayenne	9/27/00	1.02	A	A	41.9	101.4	3.79	6.51	11.73
AAD792	Jim Young	9/27/00	1.86	A	A	24.3	134.1	2.55	5.96	11.92
AAD797	Starr System	9/27/00	1.93	A	A	78.4	96.5	8.65	6.15	10.71
AAD798	Lillian Young	9/27/00	1.79	A	A	76.4	101.6	8.21	5.76	10.88
AAD800	Alfred Brown	9/27/00	1.87	A	A	51.3	78.8	5.35	6.37	12.53
IH124D	Tribal System	9/27/00	3.83	A	A	70.6	151.5	7.24	6.12	13.02
IH713L	Lucky Eagle Casino	9/27/00	1.18	A	A	63	114.5	6.42	6.49	13.61

P = Present, A = Absent

**Table 10. Groundwater Sampling Results, Fourth Quarter 2000**

Well ID	System Owner	Sample Date	NO3 (mg/l)	Coliform	E. Coli	Saturation	EC	DO	pH	Temp
						Percent	umhos/cm	mg/L	Std Units	C
AAD703	Neil Marvin	1/3/01	1.82	A	A	32.2	136.9	3.62	6.4	9.69
AAD704	Shirley Montoya	1/3/01	2.62	A	A	49.3	114.4	5.49	6.27	10.7
AAD705	Randy Hurst	1/3/01	2.75	A	A	46.4	113.4	5.37	6.12	9.16
AAD706	Bill Johnson	1/3/01	2.97	A	A	42.3	131.2	4.97	6.28	8.34
AAD707	Stanley Johnson	1/3/01	2.26	A	A	35.7	124.9	3.8	6.37	10.63
AAD708	Jimmy Jack	1/3/01	1.33	A	A	16.9	115.6	1.76	6.63	12.55
AAD709	Jack Garden	1/3/01	1.9	A	A	80.2	91.3	8.6	6.73	12.03
AAD714	Sonya Sanders	1/3/01	2.33	A	A	70.9	120.8	7.95	6.49	9.89
AAD717	Chuck Palmer	1/3/01	1.98	A	A	43.9	112.8	4.94	6.35	9.95
AAD721	Jerry Dorsch	1/3/01	1.36	A	A	55.7	121.1	6.22	6.52	10.9
AAD723	Briarwood 1	1/17/01	2.6	A	A					
AAD724	Briarwood 2	1/17/01	1.6	A	A					
AAD725	Briarwood 3	1/17/01	4.2	A	A					
AAD727	Sam Secena	1/3/01	4.84	A	A	45.1	158.7	5.09	6.36	10.19
AAD728	Roberta Secena	1/3/01	4.24	A	A	41.5	152.3	4.71	6.42	10.45
AAD730	Marie Francis	1/3/01	4.74	A	A	56.8	174.7	6.4	6.29	10.21
AAD732	Pete System	1/3/01	3.89	A	A	61.4	152.7	7.51	6.39	6.73
AAD746	Ida Rosander	1/3/01	2	A	A	50.2	135.2	5.69	6.63	9.59
AAD747	Hayden System	1/3/01	1.94	A	A	44.7	127.4	5.42	6.58	7.07
AAD749	Youckton System	1/3/01	2.13	A	A	48.8	130.3	5.88	6.55	7.48
AAD758	Harvey Hamilton	1/3/01	1.95	A	A	14.8	163.9	1.69	6.36	9.36
AAD763	Helen Sanders	1/3/01	1.96	A	A	23.2	150.5	2.56	6.52	10.79
AAD767	Sue Sanders	1/3/01	2.15	A	A	26.4	139.5	2.66	6.47	11.17
AAD768	Icy Fresh	1/3/01	1.42	A	A	78.7	153.3	8.73	6.81	10.44
AAD777	Murv Stayton	1/3/01	0.895	A	A	33.8	208.2	3.66	6.62	9.6
AAD779	Patricia Stayton	1/3/01	0.976	A	A	6.1	159.2	0.65	6.63	10.18
AAD781	Mimi Cayenne	1/3/01	1.06	A	A	48	105.2	5.27	6.77	10.4
AAD796	Frank Cayenne Jr.	1/3/01	1.93	A	A	69.4	122.4	7.79	6.62	10.33
AAD797	Starr System	1/3/01	1.97	A	A	94.6	84.7	10.6	6.7	9.83
AAD798	Lillian Young	1/3/01	1.98	A	A	76.1	103.4	8.63	6.61	9.99
AAD800	Alfred Brown	1/3/01	1.82	A	A	68.8	79.6	7.62	6.54	10.81
IH124D	Tribal System	1/3/01	3.61	A	A	69.2	153.3	8.16	6.32	8.63
IH713L	Lucky Eagle Casino	1/3/01	1.25	A	A	69.5	117.4	7.48	6.71	12.21

P = Present, A = Absent

**Table 11. Groundwater Sampling Results, First Quarter 2001**

Well ID	Owner	Date	NO3 (mg/l)	Coliform	E. Coli
AAD703	Neil Marvin	3/19/01	1.54	A	A
AAD704	Shirley Montoya	3/19/01	1.06	P	A
AAD705	Randy Hurst	3/19/01	1.48	P	A
AAD706	Bill Johnson	3/19/01	1.57	A	A
AAD707	Stanley Johnson	3/19/01	1.24	P	A
AAD708	Jimmy Jack	3/19/01	0.416	P	A
AAD709	Jack Garden	3/19/01	0.591	P	A
AAD714	Sonya Sanders	3/19/01	1.45	A	A
AAD717	Chuck Palmer	3/19/01	0.776	A	A
AAD721	Jerry Dorsch	3/19/01	1.06	A	A
AAD727	Sam Secena	3/19/01	6.08	P	A
AAD728	Roberta Secena	3/19/01	5.35	A	A
AAD730	Marie Francis	3/19/01	6.51	A	A
AAD732	Pete System	3/19/01	4.53	A	A
AAD746	Ida Rosander	3/19/01	3.88	A	A
AAD747	Hayden System	3/19/01	3.07	A	A
AAD749	Youckton System	3/19/01	3.25	A	A
AAD758	Harvey Hamilton	3/19/01	3.22	A	A
AAD763	Helen Sanders	3/19/01	3.32	A	A
AAD767	Sue Sanders	3/19/01	3.69	A	A
AAD768	Icy Fresh	3/19/01	2.52	A	A
AAD777	Murv Stayton	3/19/01	3.8	A	A
AAD779	Patricia Stayton	3/19/01	2.55	P	A
AAD792	Jim Young	3/19/01	5.57	P	A
AAD796	Frank Cayenne Jr.	3/19/01	4.28	P	A
AAD797	Starr System	3/19/01	4.76	A	A
AAD798	Lillian Young	3/19/01	4.72	A	A
AAD800	Alfred Brown	3/19/01	4.15	A	A
IH124D	Tribal System	3/19/01	4.4	A	A
IH713L	Lucky Eagle Casino	3/19/01	0.823	A	A
N/A	Don Secena	3/19/01	6.32	P	A

*P = Present, A = Absent*

**Table 12. Groundwater Sampling Results, Second Quarter 2001**

Well ID	Owner	Date	NO3 (mg/l)	Coliform	E. Coli	Comment
AAD703	Neil Marvin	8/9/01	2.69	P	A	
AAD704	Shirley Montoya	8/9/01	3.7	P	A	
AAD705	Randy Hurst	8/9/01	3.98	A	A	
AAD706	Bill Johnson	8/9/01	4.37	A	A	
AAD707	Stanley Johnson	8/9/01	2.41	A	A	
AAD708	Jimmy Jack	8/9/01		A	A	
AAD709	Jack Garden	8/9/01	1.12	A	A	
AAD714	Sonya Sanders	8/9/01	7.62	A	A	
AAD716	Mary Secena	8/9/01		A	A	
AAD717	Chuck Palmer	8/9/01	2.02	A	A	
AAD721	Jerry Dorsch	8/9/01	0.376	A	A	
AAD723	Briarwood 1	8/9/01	3.75	A	A	
AAD724	Briarwood 2	8/9/01	2.09	A	A	
AAD725	Briarwood 3	8/9/01	5.71	A	A	
AAD727	Sam Secena	8/9/01	6.82	P	A	
AAD728	Roberta Secena	8/9/01	5.81	A	A	
AAD730	Marie Francis	8/9/01	7.86	P	A	
AAD732	Pete System	8/9/01	1.63	A	A	
AAD746	Ida Rosander	8/6/01	4.37	A	A	
AAD747	Hayden System	8/6/01	3.29	A	A	
AAD749	Youckton System	8/6/01	4.17	A	A	
AAD758	Harvey Hamilton	8/6/01	2.53	A	A	
AAD763	Helen Sanders	8/6/01	3.31	P	A	
AAD767	Sue Sanders	8/6/01	4.31	A	A	
AAD768	Icy Fresh	8/6/01	2.33	A	A	
AAD777	Murv Stayton	8/6/01	0.135	A	A	
AAD779	Patricia Stayton	8/6/01	0.146	A	A	
AAD781	Mimi Cayenne	8/6/01	7.36	P	A	
AAD792	Jim Young	8/6/01	0.867	P	A	
AAD796	Frank Cayenne Jr.	8/6/01	1.57	A	A	
AAD797	Starr System	8/6/01	1.63	A	A	
AAD798	Lillian Young	8/6/01	1.79	A	A	
AAD800	Alfred Brown	8/6/01	0.945	A	A	
IH124D	Tribal System	8/6/01	6.56	A	A	
IH124D	Tribal System	8/9/01	7.09	A	A	Resample
IH713L	Lucky Eagle Casino	8/9/01	1.32	A	A	
N/A	Don Secena	8/9/01	6.7	A	A	

P = Present, A = Absent

**Table 13. Groundwater Sampling Results, Third Quarter 2001**

Well ID	System		Sample			Saturation	EC	DO	pH	Temp
	Owner	Date	NO3 (mg/l)	Coliform	E. Coli	Percent	umhos/cm	mg/L	Std Units	C
AAD703	Neil Marvin	9/26/01	2.59	P	A	28.2	137	3.06	6.35	11.3
AAD704	Shirley Montoya	9/26/01	3.37	P	A	52	121.5	5.57	6.05	12.1
AAD705	Randy Hurst	9/26/01	3.4	P	A	46.1	120.7	4.67	6.03	14.43
AAD706	Bill Johnson	9/26/01	3.98	P	A	38.7	134.6	4.08	6.14	12.41
AAD707	Stan Johnson	9/26/01	2.09	P	A	30.3	127.8	3.25	6.2	11.29
AAD709	Jack Garden	9/27/01	1.01	P	A	47.7	97	4.85	7.01	14.46
AAD714	Sonya Sanders	9/27/01	4.53	P	A	73.9	166.9	7.86	6.57	12.38
AAD721	Jerry Dorsch	9/26/01	0.307	P	A	48.7	121	5.28	6.67	11.52
AAD723	Briarwood 1	9/27/01	3.02	A	A					
AAD724	Briarwood 2	9/27/01	1.83	A	A					
AAD725	Briarwood 3	9/27/01	4.86	A	A					
AAD727	Sam Secena	9/27/01	5.91	P	A	42.8	154.5	4.65	6.57	11.32
AAD728	Roberta Secena	9/27/01	4.91	A	A	46.5	142.8	5.03	6.52	11.36
AAD730	Marie Francis	9/27/01	6.31	A	A	47.3	183.1	5.21	6.37	10.79
AAD732	Pete System	9/26/01	1.39	P	A	32.2	113.3	3.44	6.49	11.99
AAD746	Ida Rosander	9/25/01	3.61	A	A	55.4	140.7	6.1	6.71	10.87
AAD747	Hayden System	9/27/01	3.3	P	A	46	131.6	4.76	6.61	13.91
AAD749	Youckton System	9/25/01	3.71	A	A	63.7	134.4	6.77	6.62	12.34
AAD758	Harvey Hamilton	9/25/01	2.02	A	A	16.6	159.6	1.73	6.46	11.79
AAD763	Helen Sanders	9/25/01	2.82	A	A	36.3	171.7	3.84	6.61	12.25
AAD767	Sue Sanders	9/25/01	3.7	A	A	27.1	141.6	2.95	6.51	11.38
AAD768	Icy Fresh	9/25/01	2.03	A	A	18.7	151.8	2.01	6.75	11.19
AAD777	Murv Stayton	9/25/01	0.148	P	A	10.1	151.7	1.09	6.67	11.14
AAD779	Patricia Stayton	9/25/01	0.142	P	A	7.5	159.1	0.8	6.67	10.88
AAD781	Mimi Cayenne	9/25/01	0.308	A	A	26.6	114	2.85	6.71	11.19
AAD792	Jim Young	9/25/01	0.869	P	A	29	137.5	3.13	6.57	11.47
AAD795	Bruce Klatush	9/25/01	1.83	A	A	65.4	133.9	7.22	6.68	10.91
AAD796	Frank Cayenne Jr.	9/25/01	1.59	A	A	68	122.8	7.53	6.67	10.72
AAD797	Starr System	9/25/01	1.61	A	A	82.1	108.8	9.02	6.48	10.88
AAD798	Lillian Young	9/25/01	1.63	P	A	77.7	106	8.55	6.63	10.8
AAD800	Alfred Brown	9/25/01	0.92	A	A	51	83.4	5.44	6.71	12.12
AAD801	Don Secena	9/27/01	5.59	P	A	36.8	149.5	3.99	6.53	11.95
IH124D	Tribal System	9/25/01	5.2	A	A	67.7	155	6.86	6.59	14.39
IH713L	Lucky Eagle Casino	9/26/01	1.1	A	A	59.6	117.9	5.85	6.52	16.16

P = Present, A = Absent

**Table 14. Groundwater Sampling Results, Third Quarter 2001, Resamples**

Well ID	System Owner	Sample Date	NO3 (mg/l)	Coliform	E. Coli	Saturation Percent	EC umhos/cm	DO mg/L	pH Std Units	Temp C
AAD703	Neil Marvin	10/1/01	0.05U	P	A					
AAD704	Shirley Mon	10/1/01	0.05U	A	A					
AAD705	Randy Hurst	10/1/01	0.05U	A	A					
AAD706	Bill Johnson	10/1/01	0.05U	A	A					
AAD707	Stan Johnson	10/1/01	0.05U	A	A					
AAD709	Jack Garden	10/1/01	0.05U	A	A					
AAD714	Sonya Sande	10/1/01	0.05U	A	A					
AAD721	Jerry Dorsch	10/1/01	0.05U	A	A					
AAD727	Sam Secena	10/1/01	0.05U	P	A					
AAD732	Pete System	10/1/01	0.05U	A	A					
AAD747	Hayden Syst	10/1/01	0.05U	A	A					
AAD777	Murv Stayto	10/1/01	0.05U	A	A					
AAD779	Patricia Stay	10/1/01	0.05U	P	A					
AAD792	Jim Young	10/1/01	0.05U	A	A					
AAD798	Lillian Youn	10/1/01	0.05U	A	A					
AAD801	Don Secena	10/1/01	0.05U	A	A					
IH124D	Tribal Syste	9/26/01	5.7	A	A	58.2	154.9	5.89	6.63	14.57
IH124D	Tribal Syste	9/27/01	6	A	A	55.6	153.4	5.54	6.58	15.45

*P = Present, A = Absent*

**Table 15. Nitrate Concentrations in Groundwater, Intensive Sampling Program**

Well ID	System Owner	August 23, 2001		August 29, 2001		September 6, 2001		September 13, 2001		September 20, 2001		September 27, 2001	
		Chehalis	Thurston	Chehalis	Thurston	Chehalis	Thurston	Chehalis	Thurston	Chehalis	Thurston	Chehalis	Thurston
AAD709	Jack Garden	0.962	0.8	0.892	0.7	0.97	0.6	0.941	0.7	0.941	0.7	1.01	0.8
AAD714	Sonya Sanders	4.98	4.7	5.46	5.1	4.76	3.8	5	3.9	4.27	3.7	4.53	3.8
AAD723	Briarwood 1	2.87	2.6	2.78	2.1	3	2.3	2.66	2.1	2.72	2.2	3.02	2.2
AAD725	Briarwood 3							4.13	3.2	4.25	3.7	4.86	3.6
AAD727	Sam Secena	5.27	4.7	5.55	4.7	5.34	4.1	5.2	4.1	5.3	4.3	5.91	4.5
AAD801	Don Secena	5.46	4.9	5.48	4.8	4.98	3.9	5.13	4.2	5.09	4.4	5.59	4.5
AAD728	Roberta Secena	4.33	3.9	4.57	4.2	4.4	3.4	4.29	3.3	4.38	3.7	4.91	3.6
AAD730	Marie Francis	5.81	5.2	6.08	5.3	5.88	4.6	5.55	4.4	5.66	4.9	6.31	4.9
AAD747	Hayden System	2.92	2.6	3.08	2.4	3.08	2.3	2.83	2.3	3.05	2.6	3.3	2.7
IHI24D	Tribal System	5.58	5.2	5.9	5.2	5.63	4.5	5.34	4.4	5.54	4.7	6	4.8

*All concentrations in mg/L*

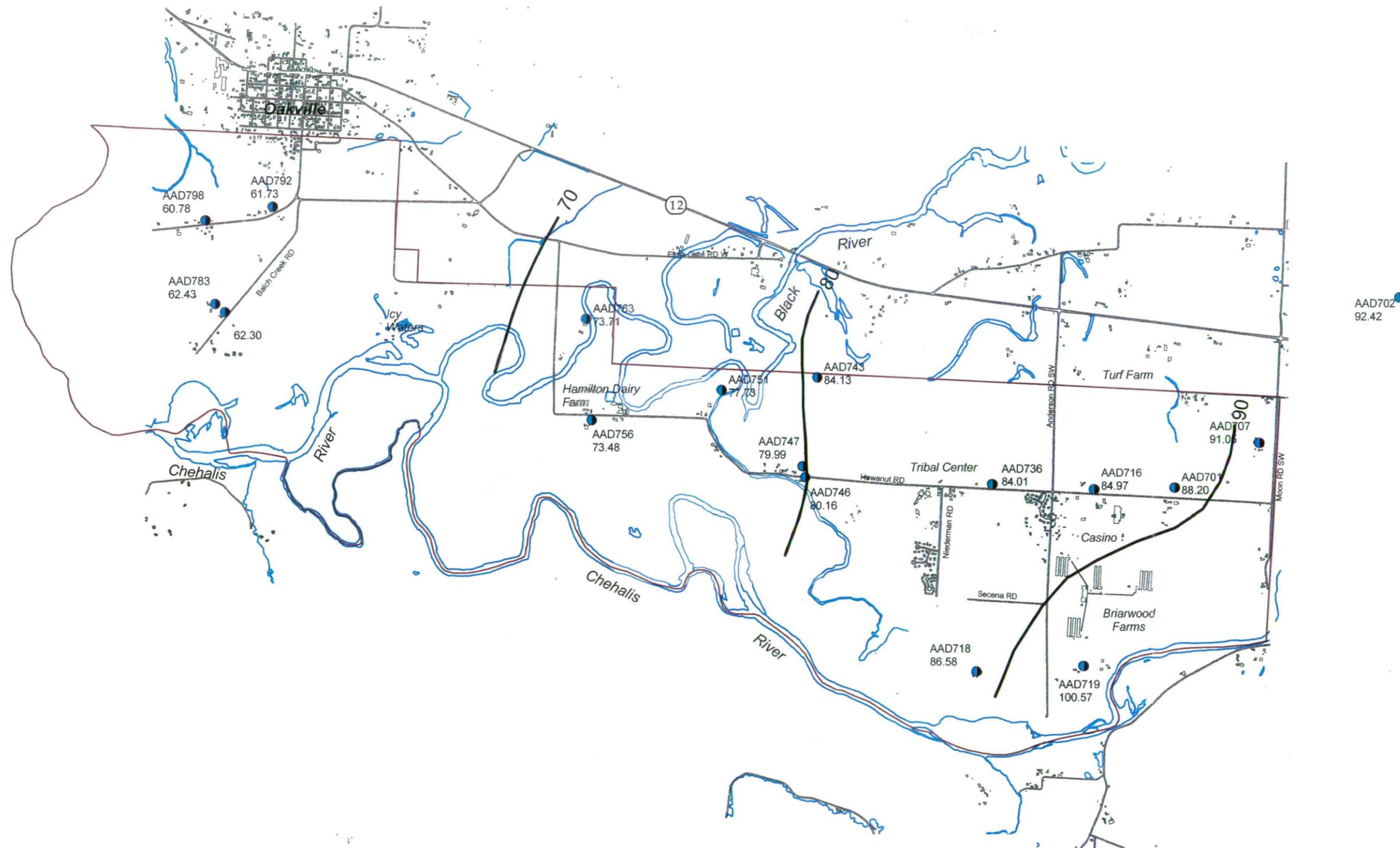
**Table 16. Coliform/E. Coli Detections in Groundwater, Intensive Sampling Program**

WELL ID	OWNER	23-Aug	29-Aug	6-Sep	13-Sep	20-Sep	27-Sep
AAD709	Jack Garden	A/A	A/A	A/A	A/A	A/A	A/A
AAD714	Sonya Sanders	A/A	A/A	A/A	A/A	A/A	A/A
AAD723	Briarwood 1	A/A	A/A	A/A	A/A	A/A	A/A
AAD725	Briarwood 3	---	---	---	A/A	A/A	A/A
AAD727	Sam Secena	P/A	P/A	P/A	A/A	A/A	P/A
AAD801	Don Secena	A/A	A/A	A/A	A/A	A/A	A/A
AAD728	Roberta Secena	A/A	A/A	A/A	A/A	A/A	A/A
AAD730	Marie Francis	A/A	A/A	A/A	A/A	A/A	A/A
AAD747	Hayden System	A/A	A/A	A/A	A/A	A/A	A/A
IH124D	Tribal System	A/A	A/A	A/A	A/A	A/A	A/A

Results are given in the form Coliform/E. Coli where P = Present and A = Absent

*Well # AAD709 is located 1/2 mile east of the Casino/Briarwood farm facilities. This well is considered as a background well.*

*Well # AAD747 is located 1 1/4 miles west of the Anderson Road. This well is also considered as background well.*



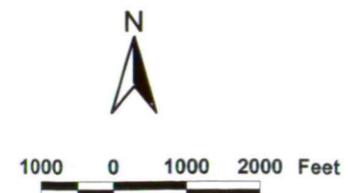
**Legend**

AAD716 Well ID#  
77.49 ● 1994 Q3 Water Level Elevation

— Reservation Boundary

*Groundwater contours reflect the regional hydrologic regime. Local groundwater flow, especially in the vicinity of the surface water bodies, may vary significantly.*

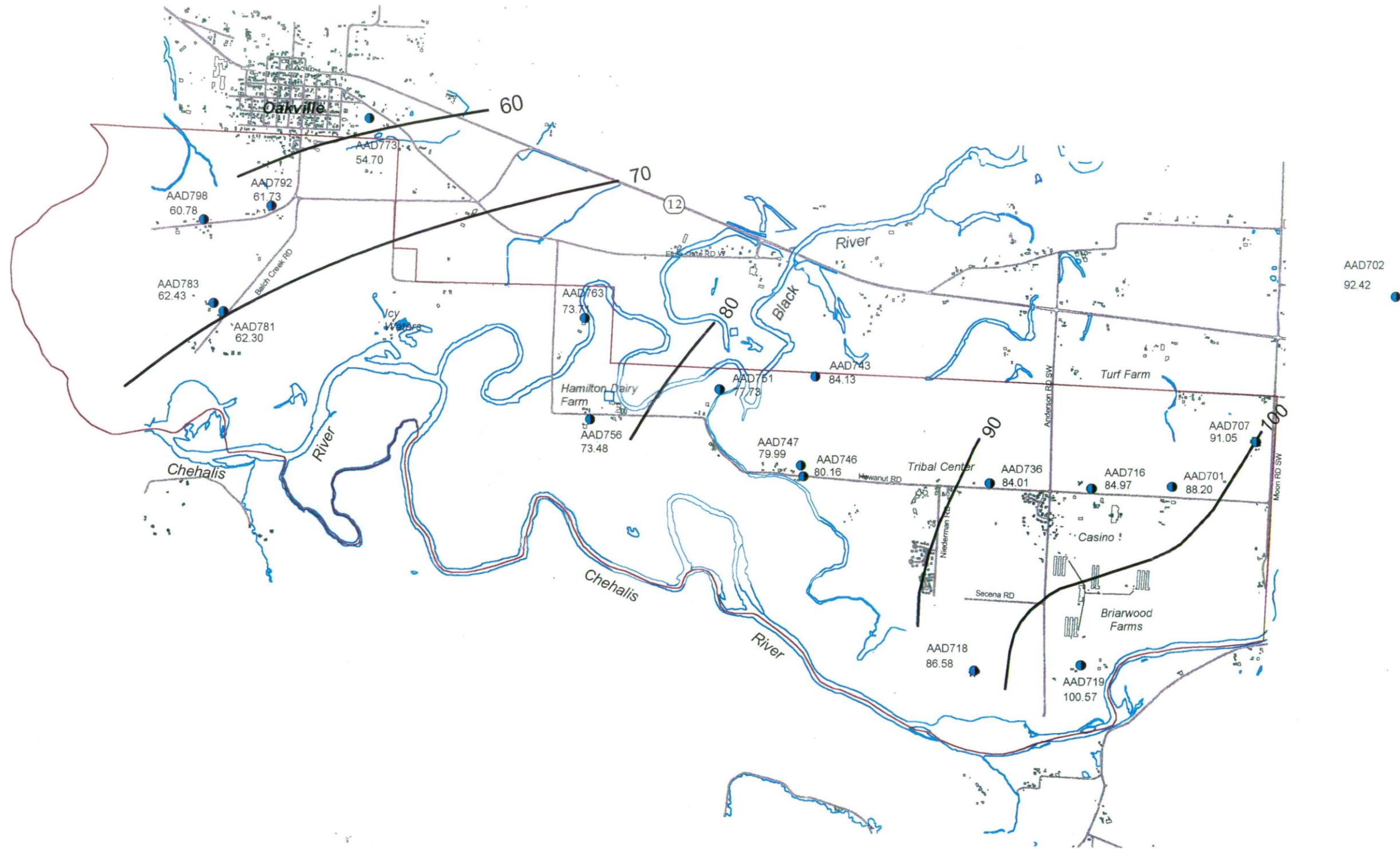
*Water level data from Chehalis Tribe static well tests 1994 - 1995.*



**Figure 1**  
**Groundwater Elevations and Contours, 1994 Q3**

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12/2001





**Legend**

AAD716 Well ID#  
77.49 ● 1995 Q1 Water Level Elevation

Reservation Boundary

Groundwater contours reflect the regional hydrologic regime. Local groundwater flow, especially in the vicinity of the surface water bodies, may vary significantly.

Water level data from Chehalis Tribe static well tests 1994 - 1995.

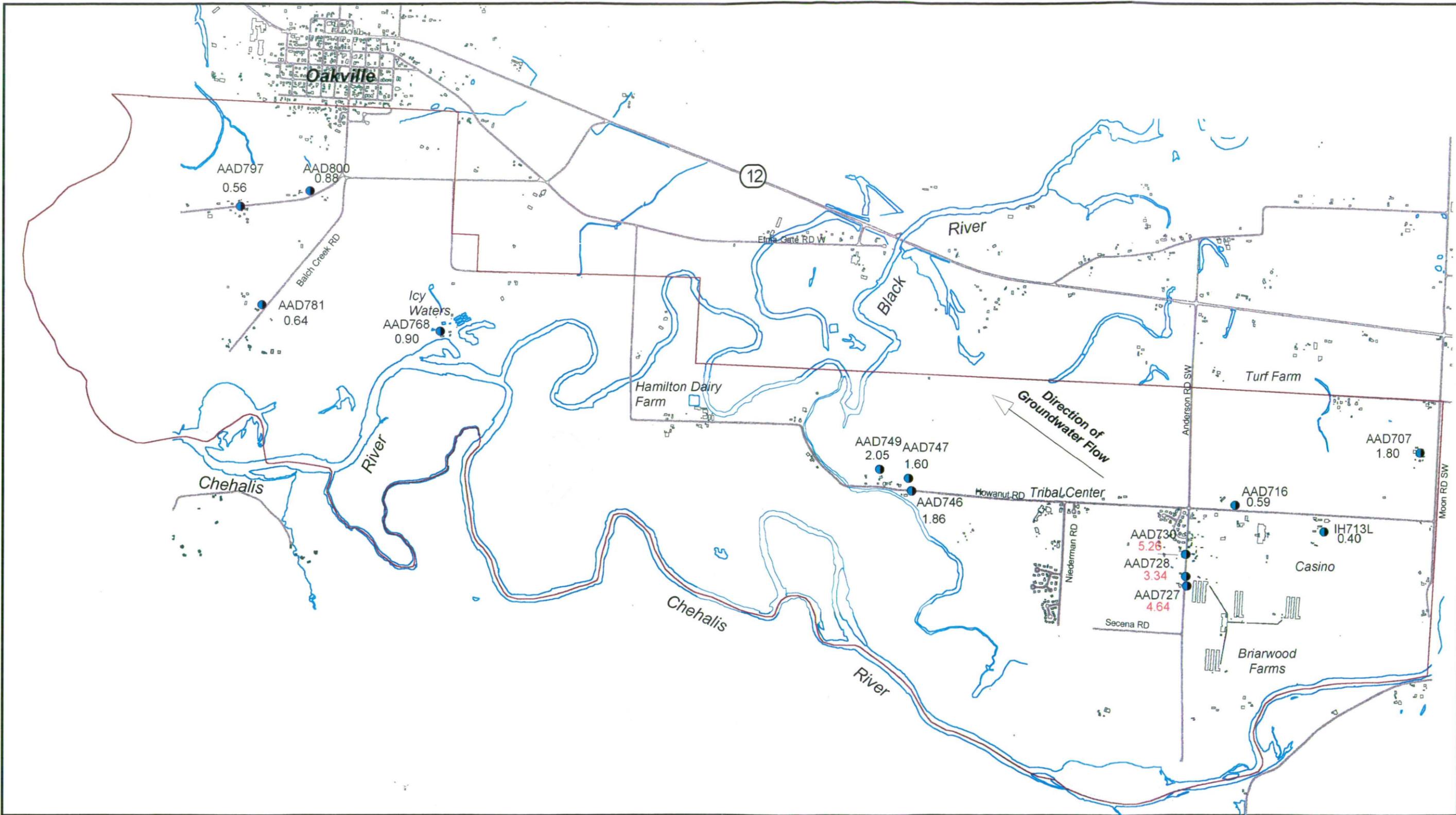


1000 0 1000 2000 Feet

**Figure 2**  
Groundwater Elevations  
and Contours, 1995 Q1

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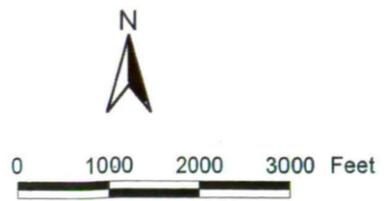


**Legend**

AAD716 ● Well ID#

1.12 ● 1999 Q2 Nitrate Concentration, mg/L

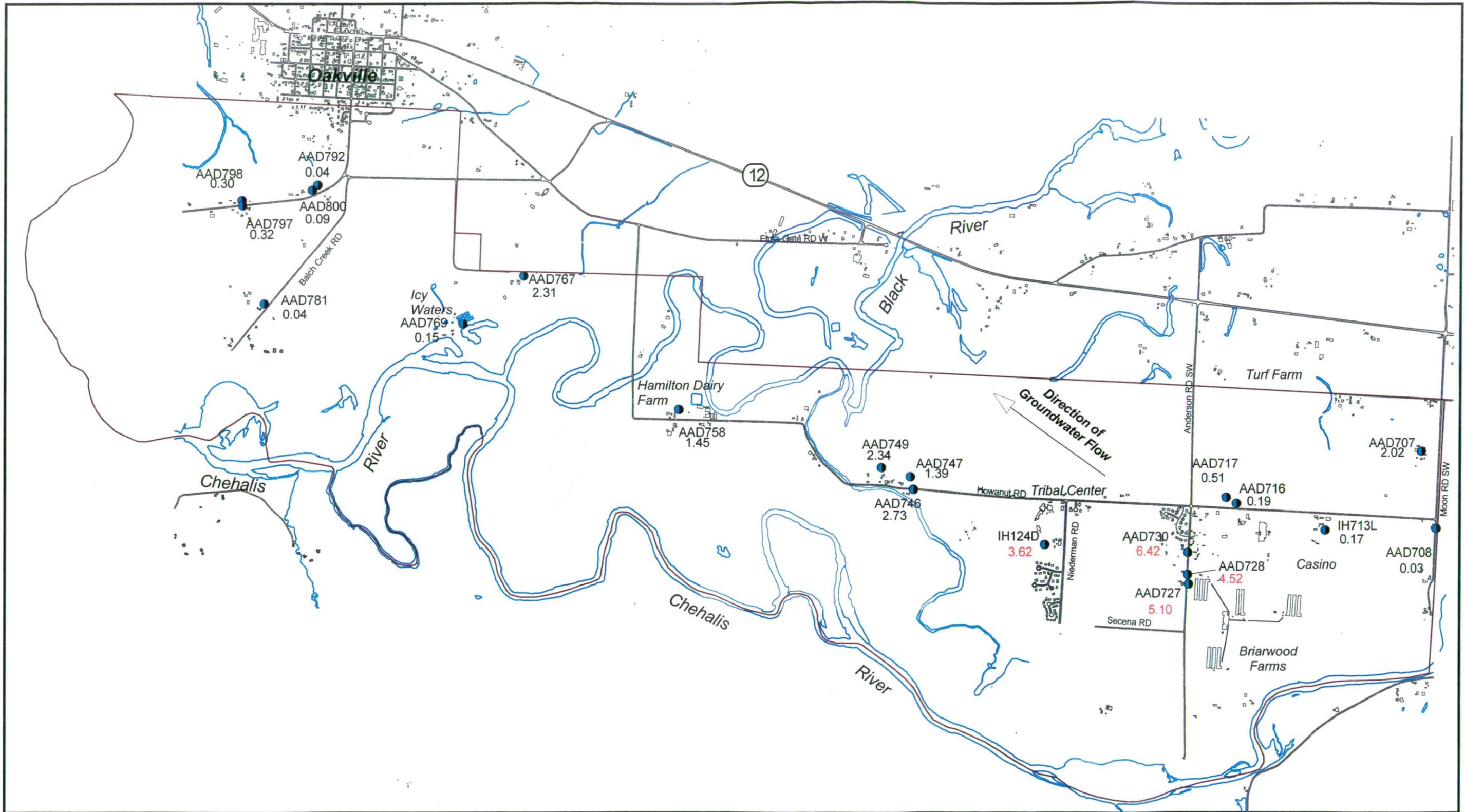
— Reservation Boundary



**Figure 3**  
Nitrate Concentrations in  
Groundwater, 1999 Q2

Chehalis Reservation  
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01/2/2001



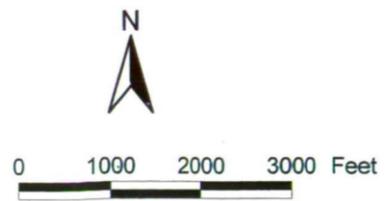


**Legend**

AAD716 ● Well ID#

1.12 ● 1999 Q3 Nitrate Concentration, mg/L

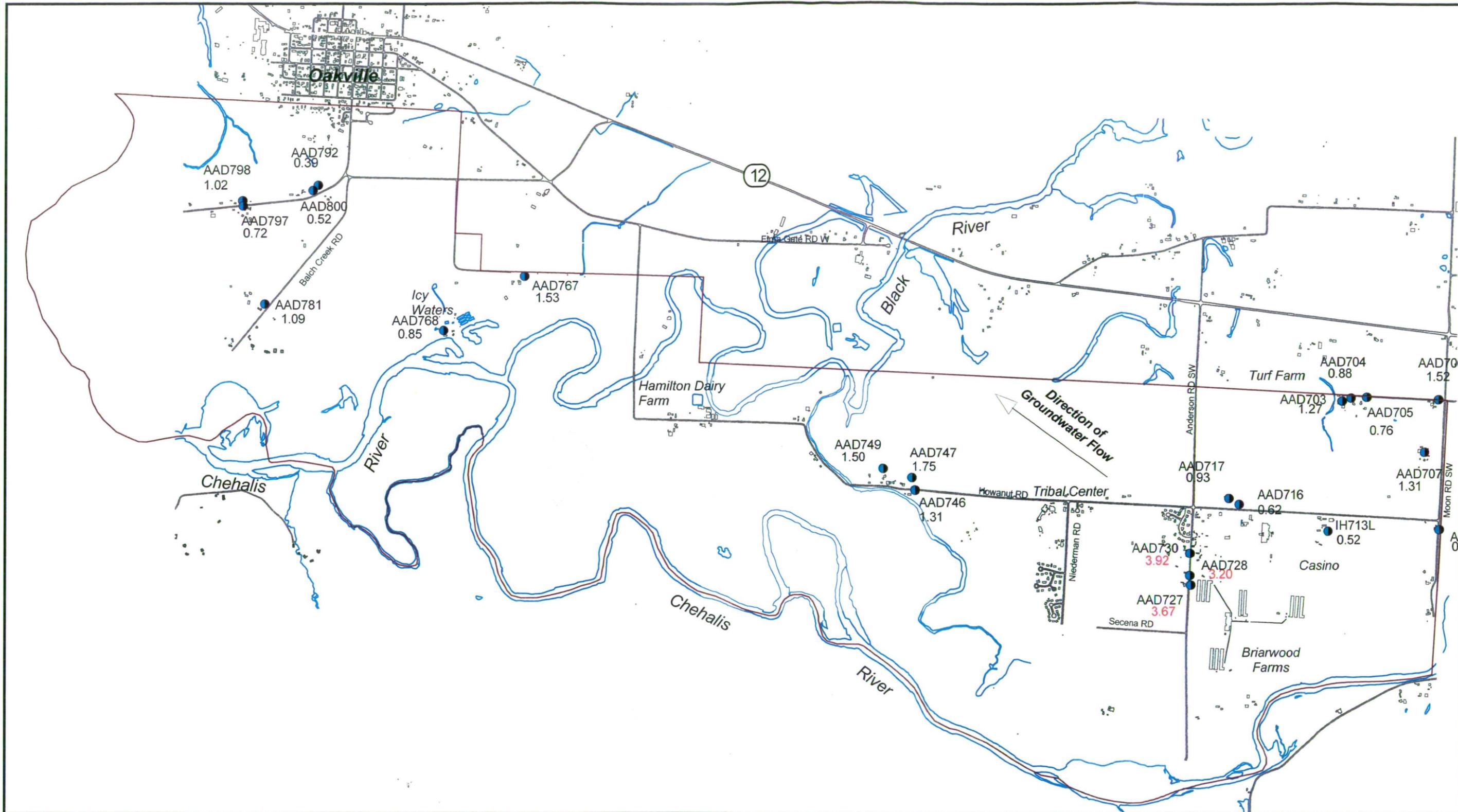
⎓ Reservation Boundary



**Figure 4**  
Nitrate Concentrations in Groundwater, 1999 Q3

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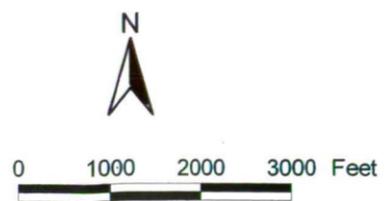




**Legend**

AAD716 ● Well ID#  
 1.12 ● 1999 Q4 Nitrate Concentration, mg/L

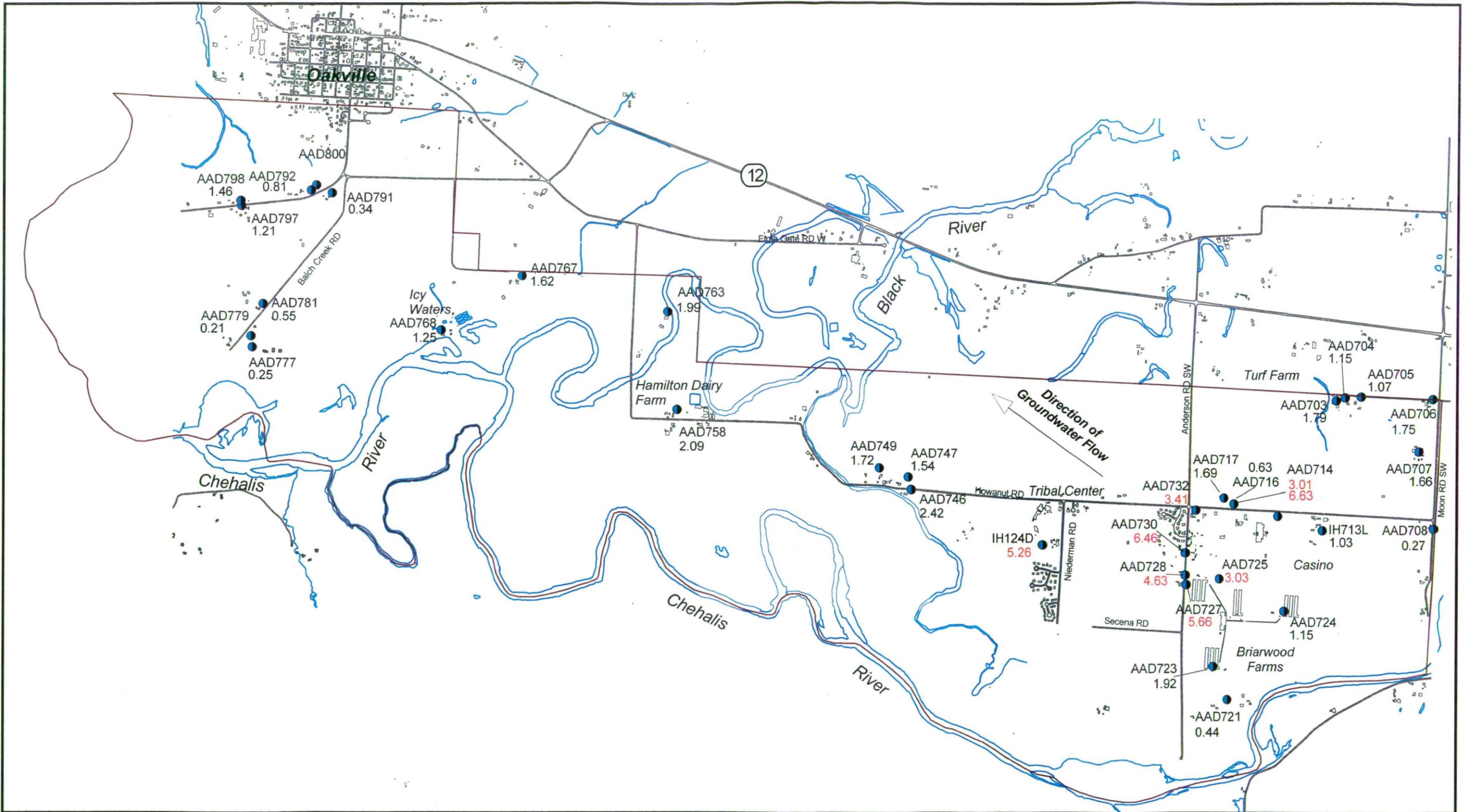
⎓ Reservation Boundary



**Figure 5**  
 Nitrate Concentrations in  
 Groundwater, 1999 Q4

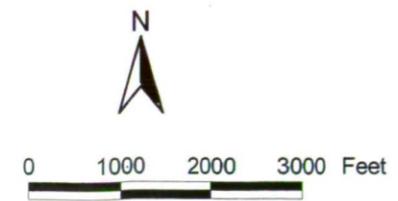
Chehalis Reservation  
 Groundwater Monitoring Report 2001  
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 012/2001





**Legend**

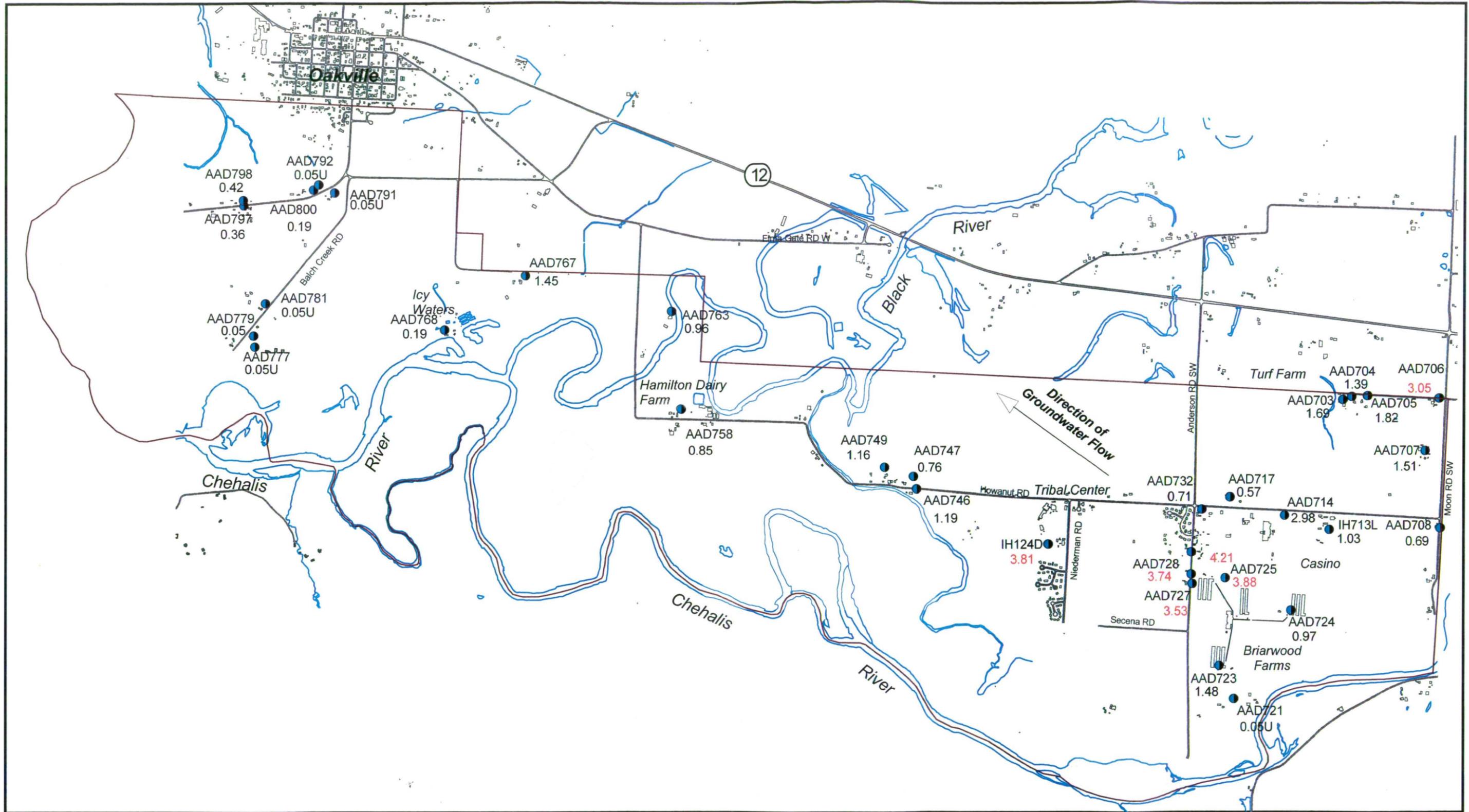
- AAD716 ● Well ID#
- 1.12 ● 2000 Q1 Nitrate Concentration, mg/L
- Reservation Boundary



**Figure 6**  
Nitrate Concentrations in  
Groundwater, 2000 Q1

Chehalis Reservation  
Groundwater Monitoring Report 2001  
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12/2001



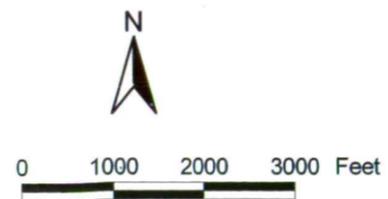


**Legend**

AAD716 ● Well ID#

1.12 ● 2000 Q2 Nitrate Concentration, mg/L

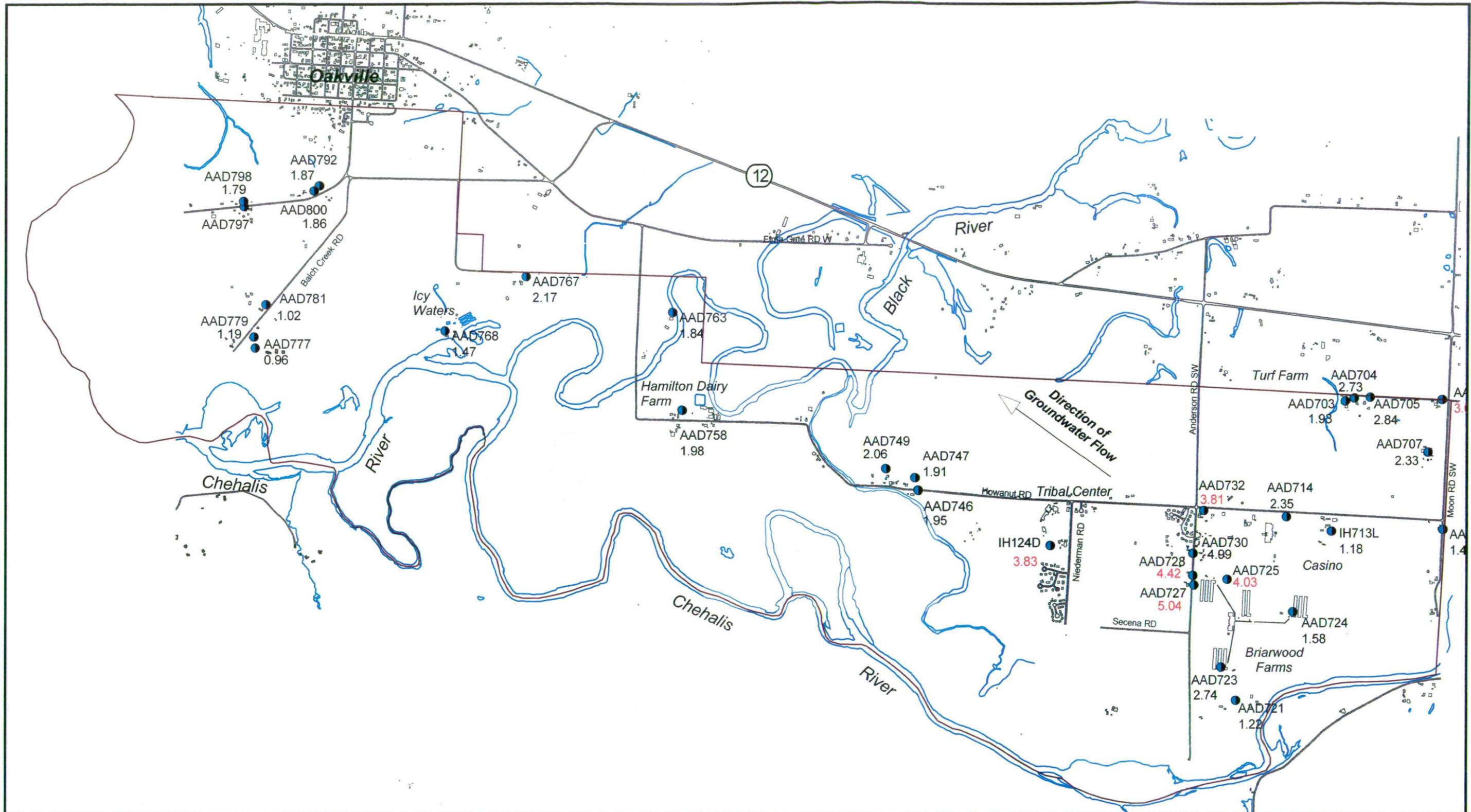
⎓ Reservation Boundary



**Figure 7**  
Nitrate Concentrations in Groundwater, 2000 Q2

Chehalis Reservation  
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12/2001



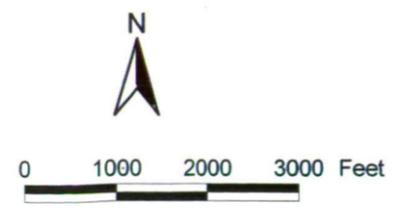


**Legend**

AAD716 ● Well ID#

1.12 ● 2000 Q3 Nitrate Concentration, mg/L

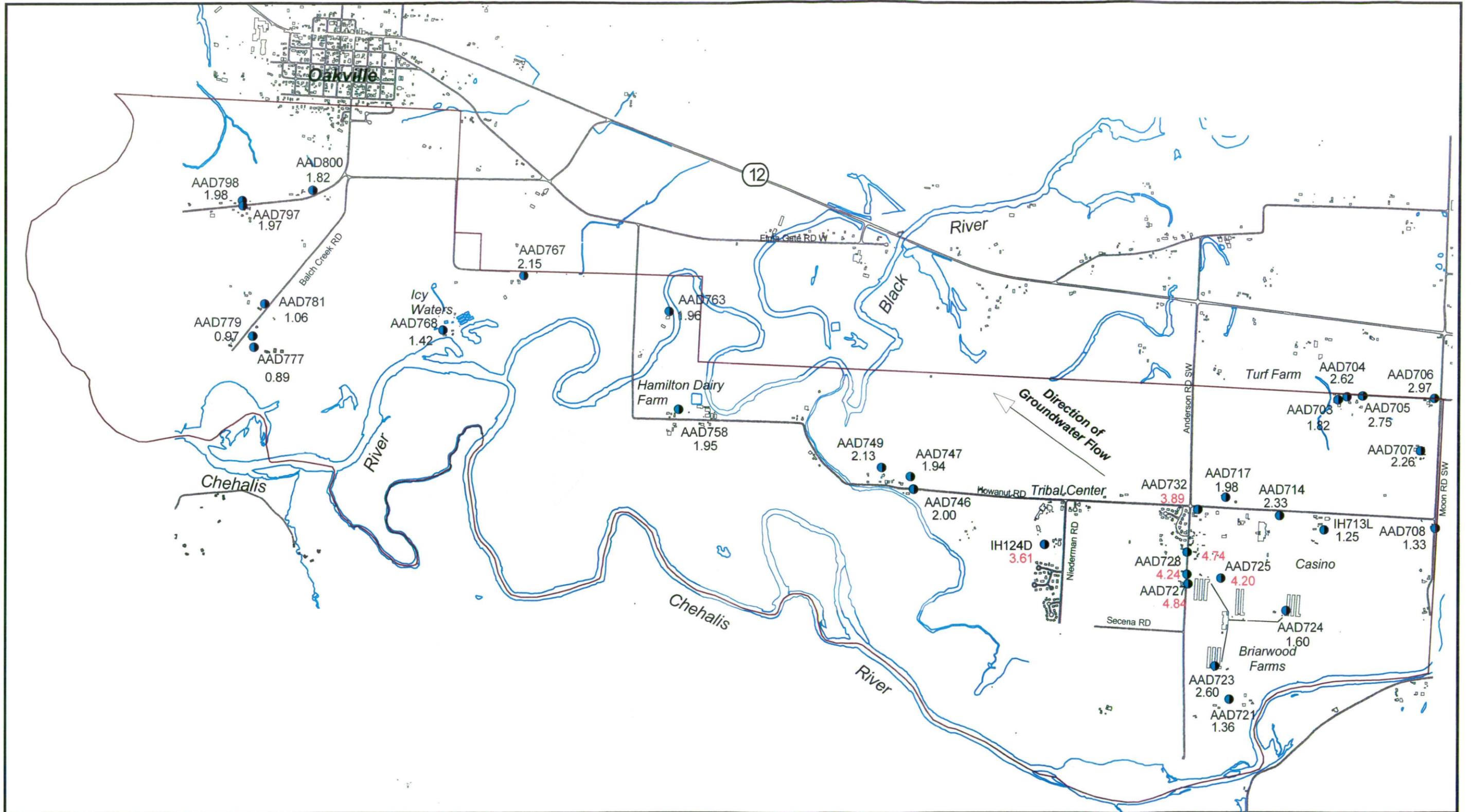
⎓ Reservation Boundary



**Figure 8**  
Nitrate Concentrations in Groundwater, 2000 Q3

Chehalis Reservation  
Groundwater Monitoring Report 2001  
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12/2001



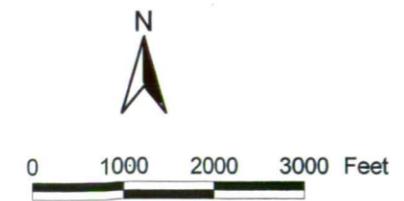


**Legend**

AAD716 ● Well ID#

1.12 ● 2000 Q4 Nitrate Concentration, mg/L

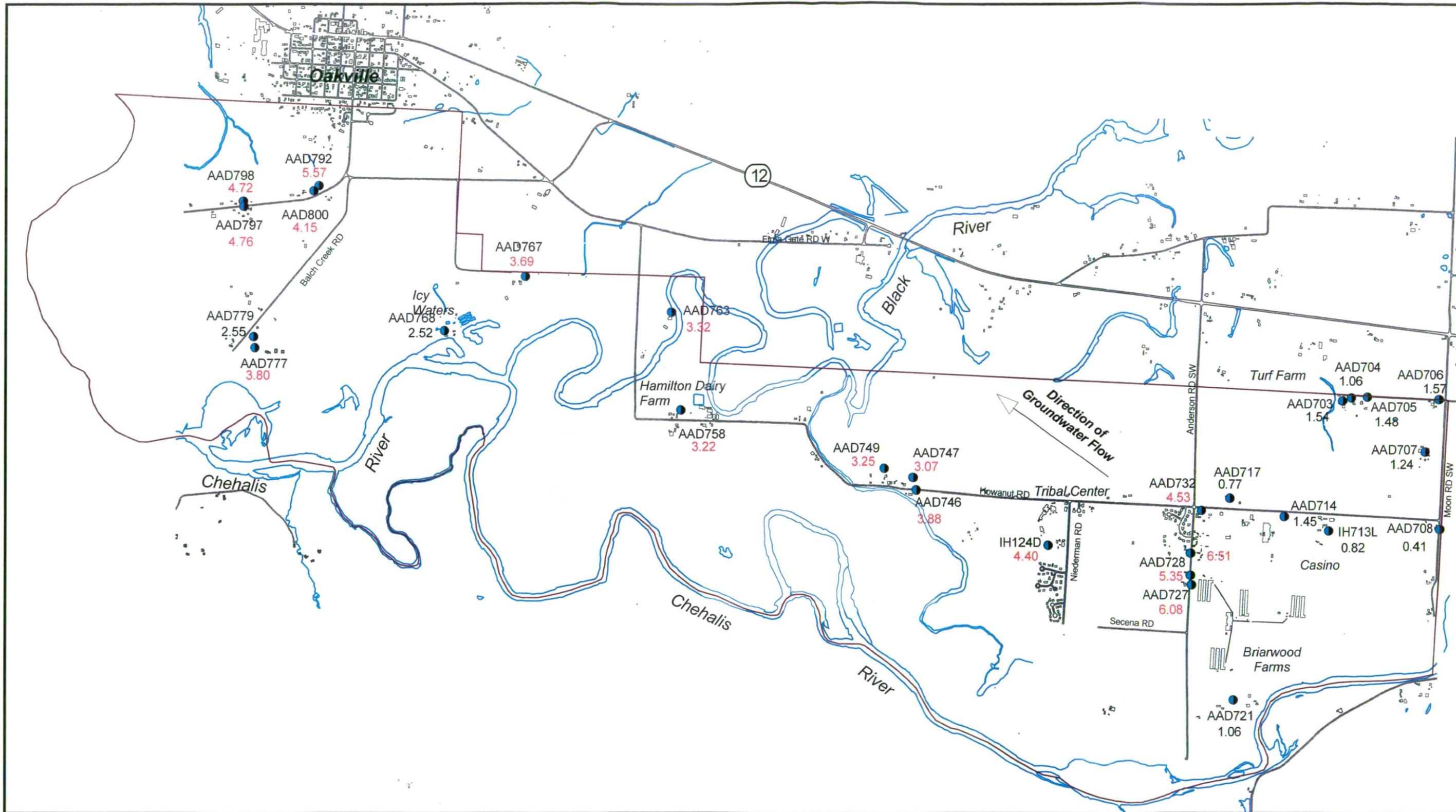
▭ Reservation Boundary



**Figure 9**  
Nitrate Concentrations in Groundwater, 2000 Q4

Chehalis Reservation  
Groundwater Monitoring Report 2001  
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12/2001



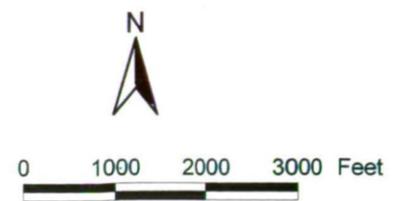


**Legend**

AAD716 ● Well ID#

1.12 ● 2001 Q1 Nitrate Concentration, mg/L

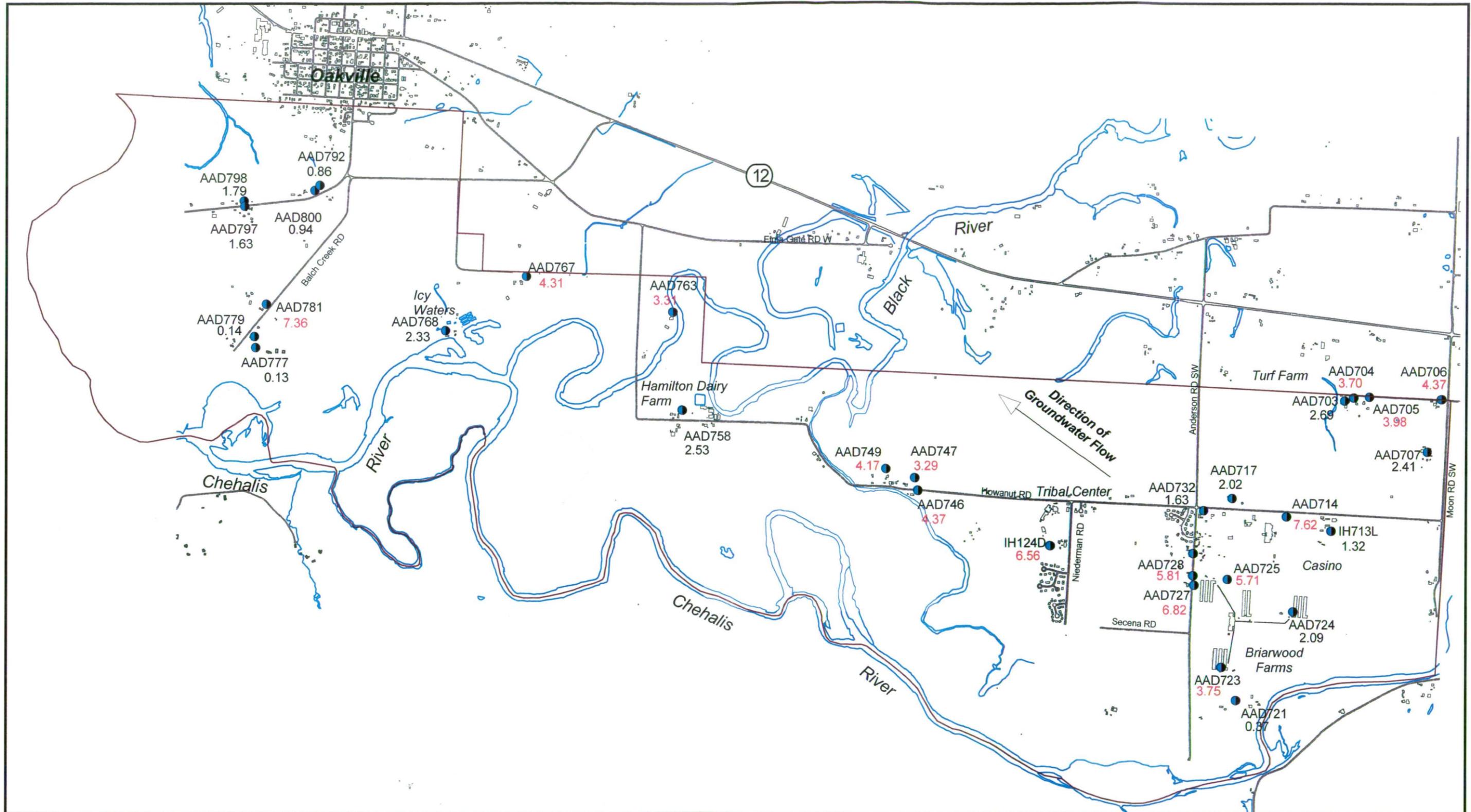
⎓ Reservation Boundary



**Figure 10**  
Nitrate Concentrations in Groundwater, 2001 Q1

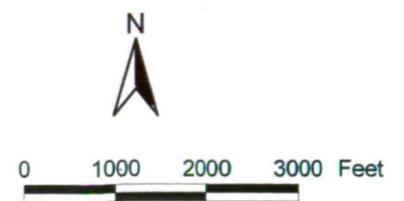
Chehalis Reservation  
Groundwater Monitoring Report 2001  
JOB JS9802, K:\OTHERS\Steve\Chehalis\GIS\chehalis\_mp  
12/2001





**Legend**

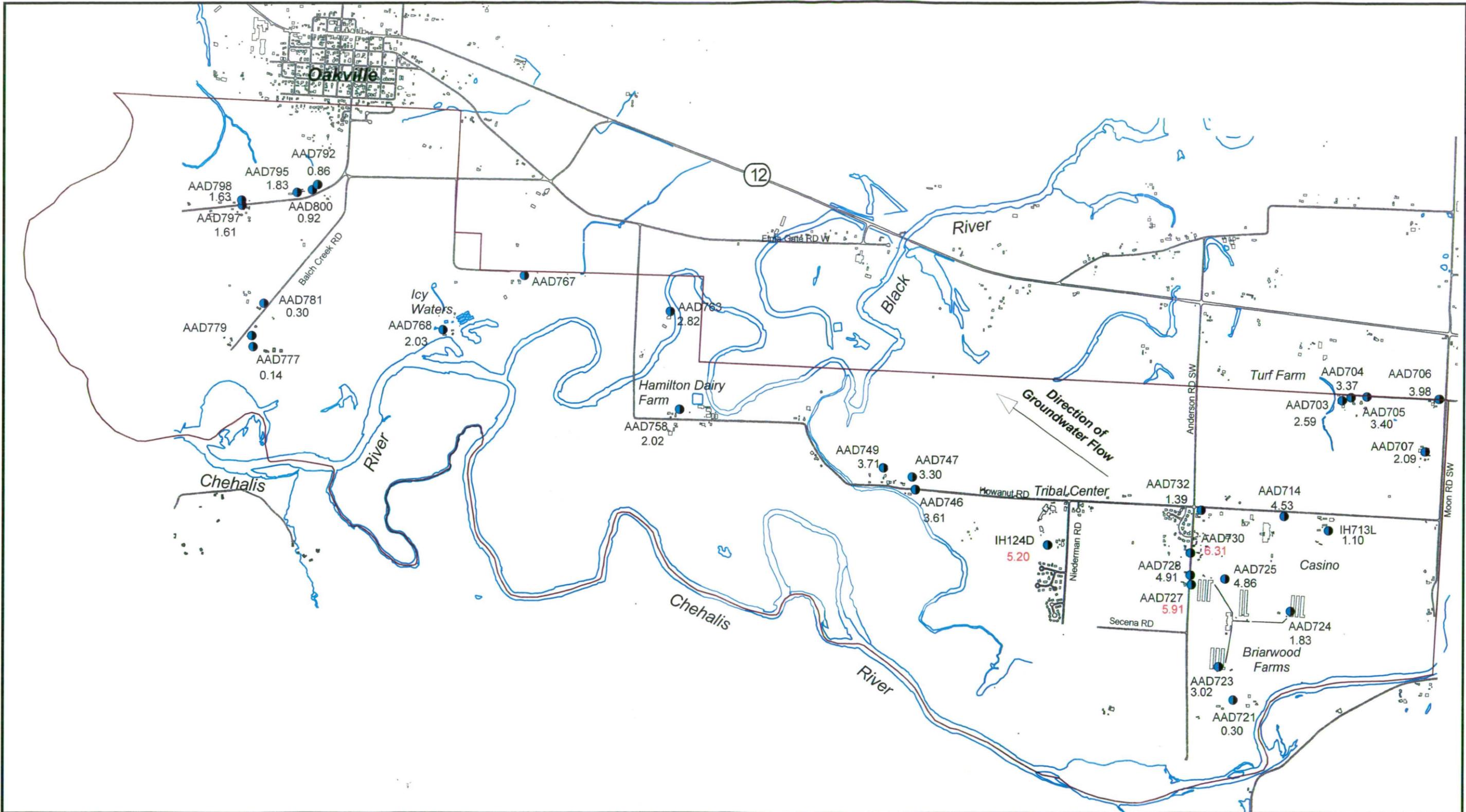
- AAD716 ● Well ID#
- 1.12 ● 2001 Q2 Nitrate Concentration, mg/L
- ▭ Reservation Boundary



**Figure 11**  
Nitrate Concentrations in  
Groundwater, 2001 Q2

Chehalis Reservation  
Groundwater Monitoring Report 2001  
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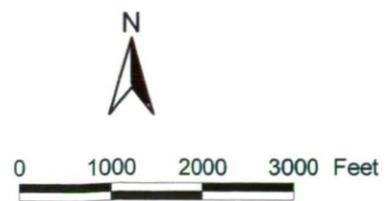


**Legend**

AAD716 ● Well ID#

1.12 ● 2001 Q3 Nitrate Concentration, mg/L

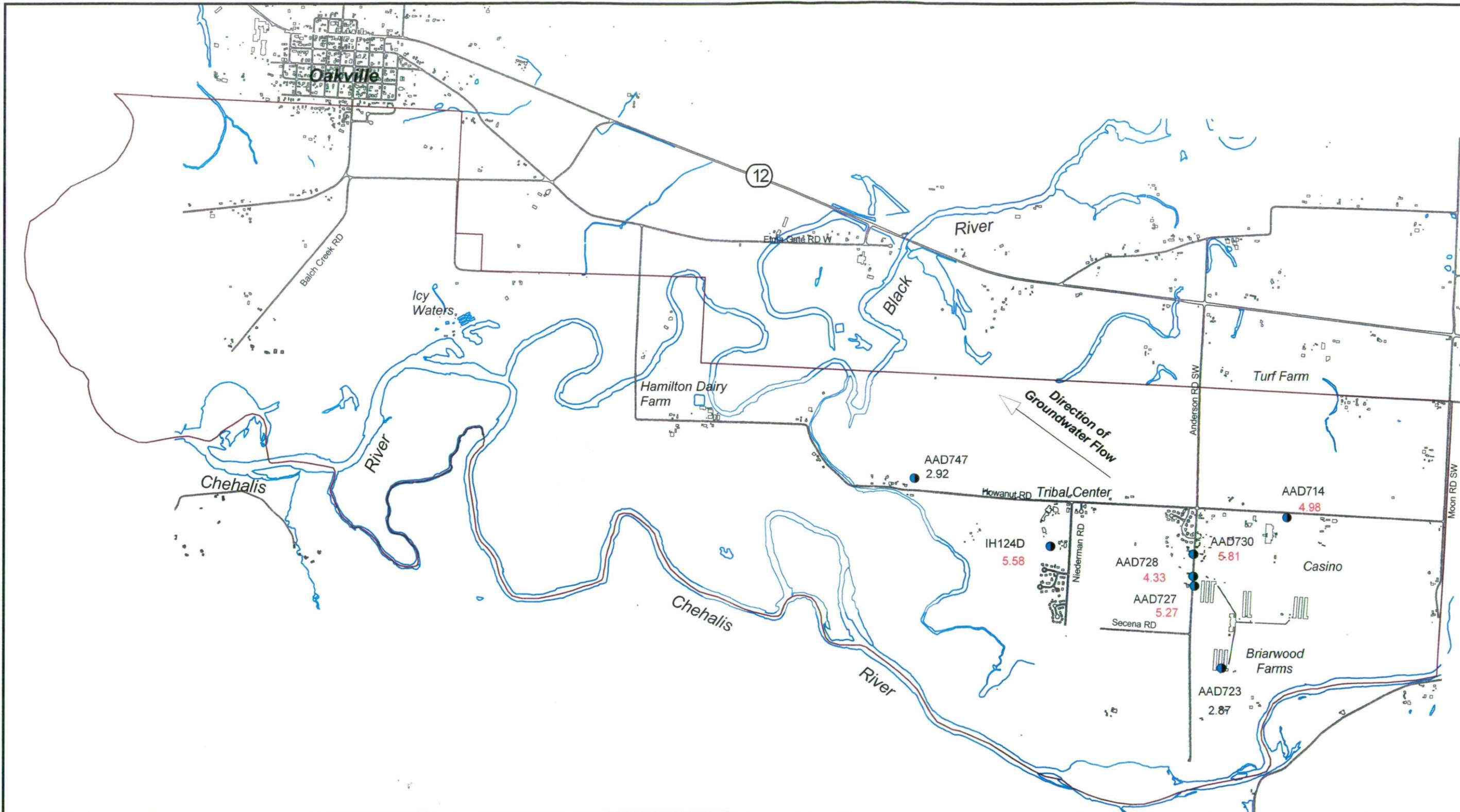
⎓ Reservation Boundary



**Figure 12**  
Nitrate Concentrations in Groundwater, 2001 Q3

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12/2001



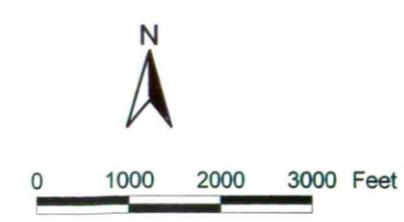


**Legend**

AAD716 ● Well ID#

1.12 ● 8-23-2001 Nitrate Concentration, mg/L

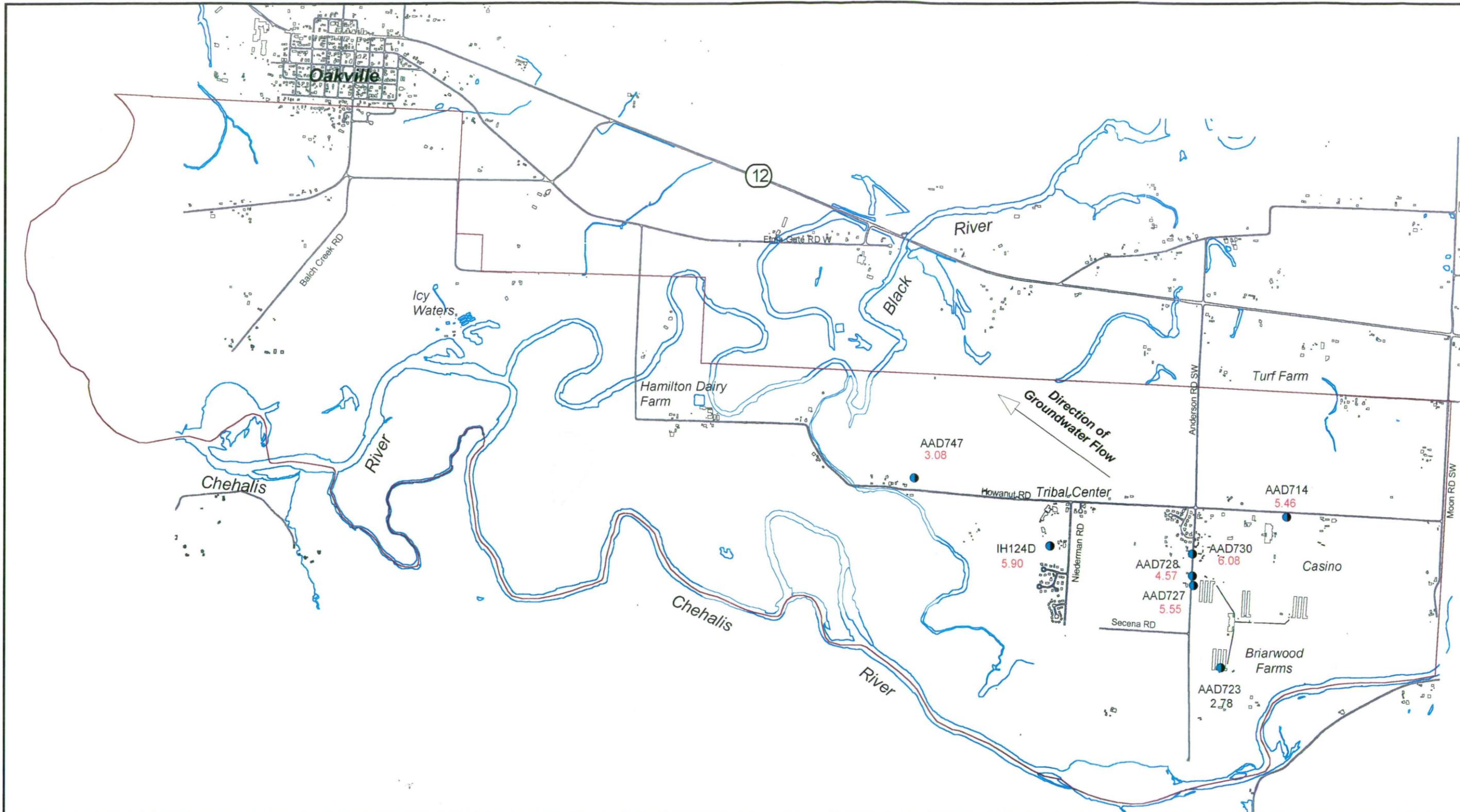
— Reservation Boundary



**Figure 13**  
**Nitrate Concentrations in**  
**Groundwater, 8-23-2001**  
**6-Week Intensive Sampling Program**

Chehalis Reservation  
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 12/2001



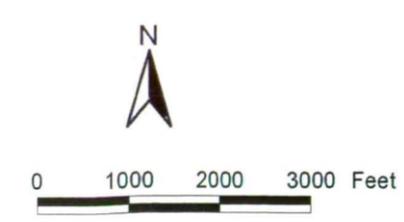


**Legend**

AAD716 ● Well ID#

1.12 ● 8-29-2001 Nitrate Concentration, mg/L

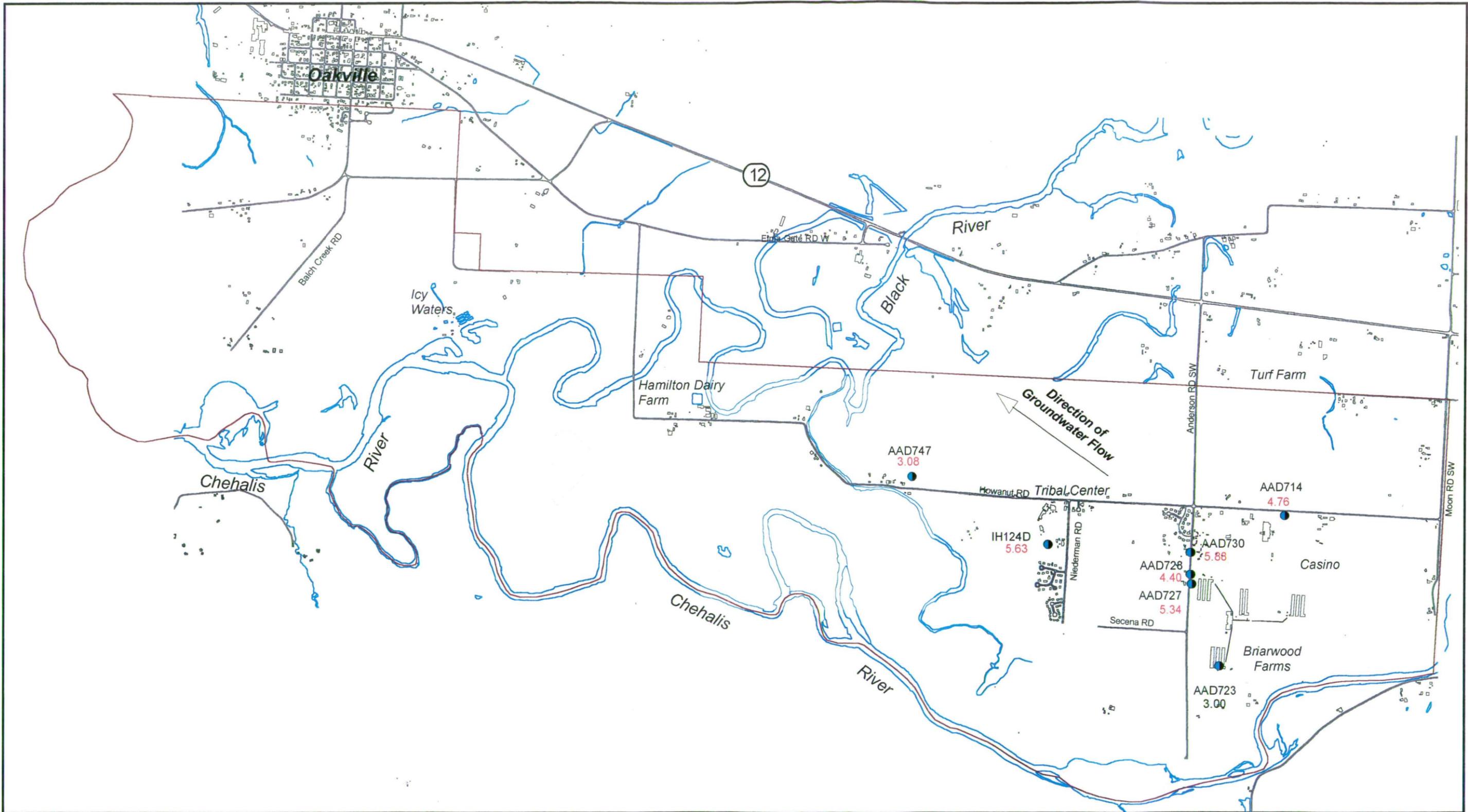
— Reservation Boundary



**Figure 14**  
**Nitrate Concentrations in**  
**Groundwater, 8-29-2001**  
**6-Week Intensive Sampling Program**

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 12/2001



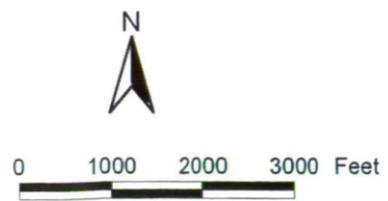


**Legend**

AAD716 ● Well ID#

1.12 ● 9-6-2001 Nitrate Concentration, mg/L

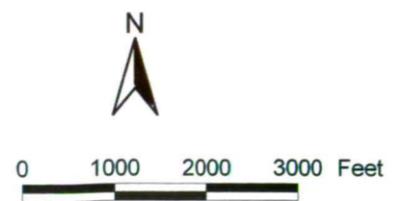
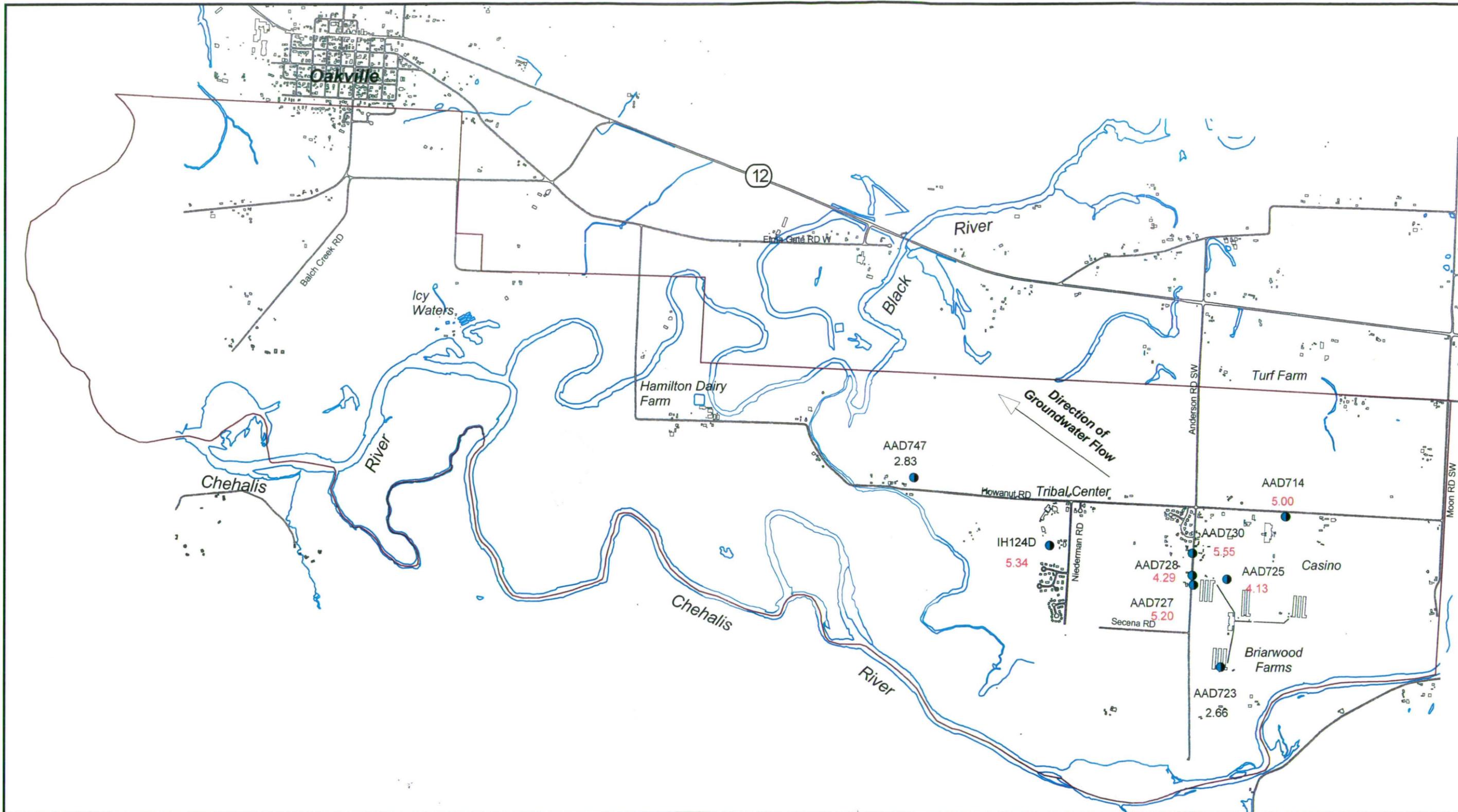
— Reservation Boundary



**Figure 15**  
**Nitrate Concentrations in**  
**Groundwater, 9-6-2001**  
**6-Week Intensive Sampling Program**

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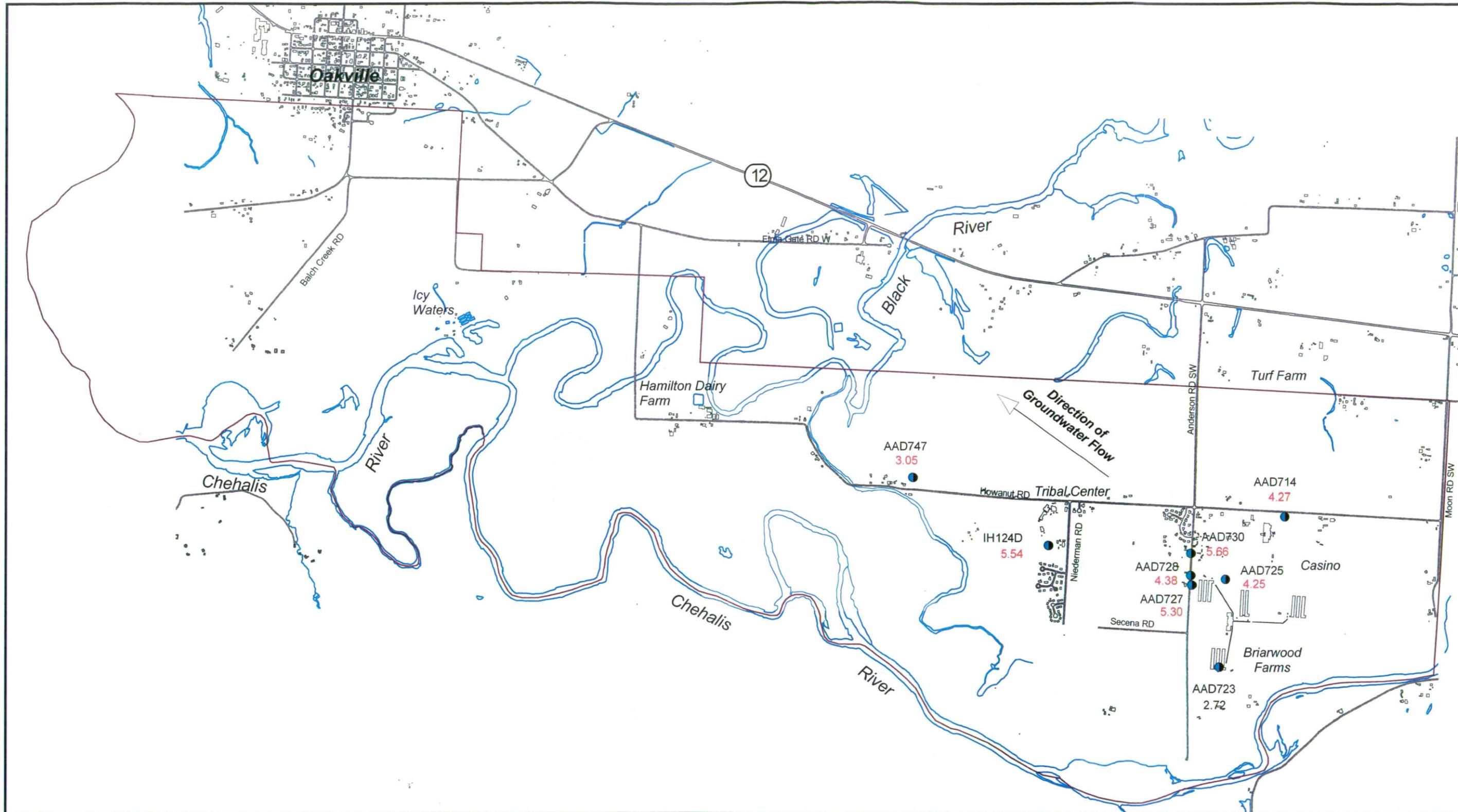




**Figure 16**  
**Nitrate Concentrations in**  
**Groundwater, 9-13-2001**  
**6-Week Intensive Sampling Program**

Chehalis Reservation  
 Groundwater Monitoring Report 2001  
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 12/2001



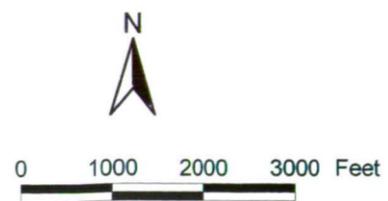


**Legend**

AAD716 ● Well ID#

1.12 ● 9-20-2001 Nitrate Concentration, mg/L

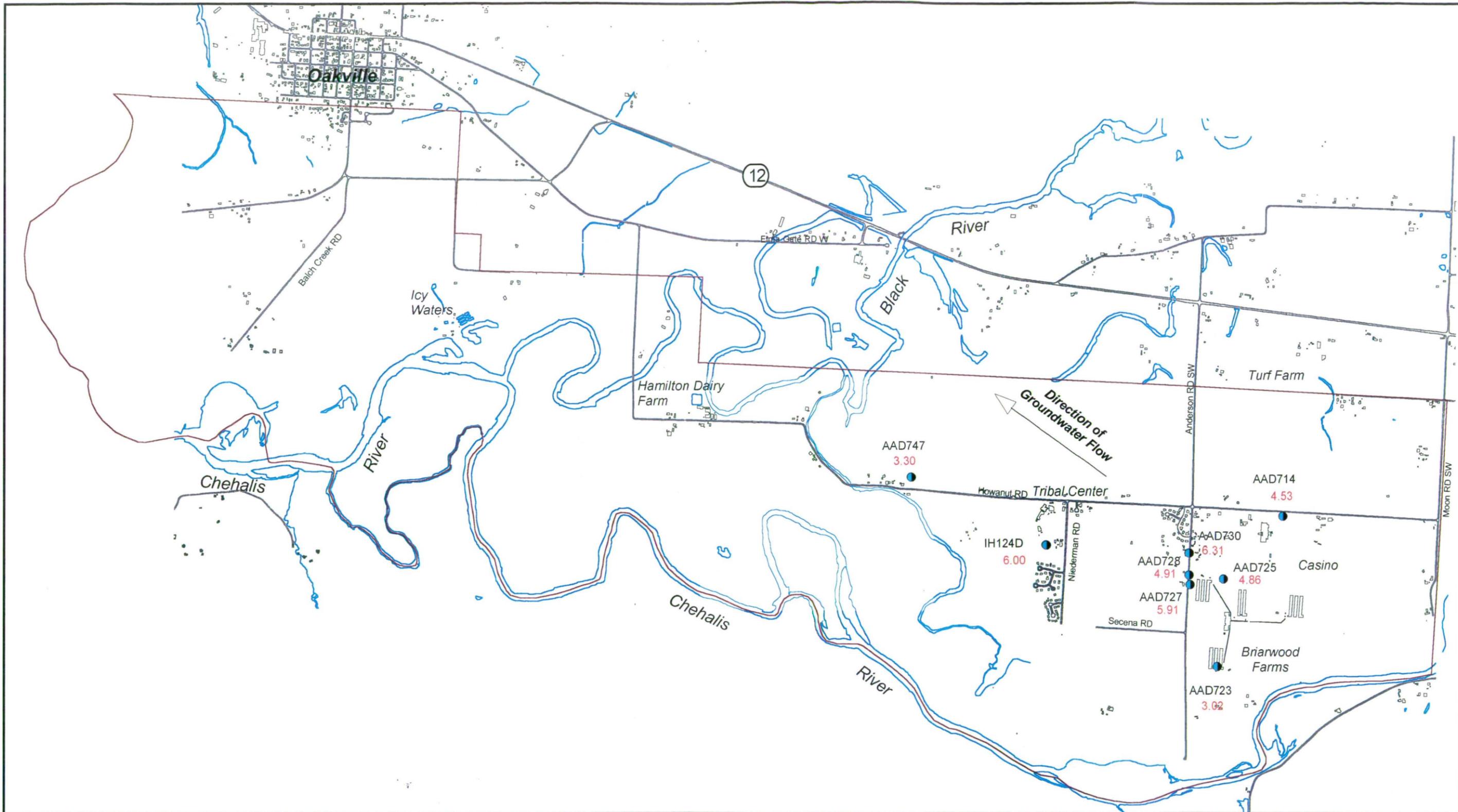
— Reservation Boundary



**Figure 17**  
**Nitrate Concentrations in**  
**Groundwater, 9-20-2001**  
**6-Week Intensive Sampling Program**

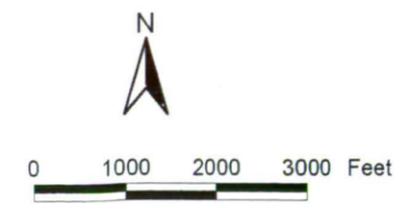
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**Legend**

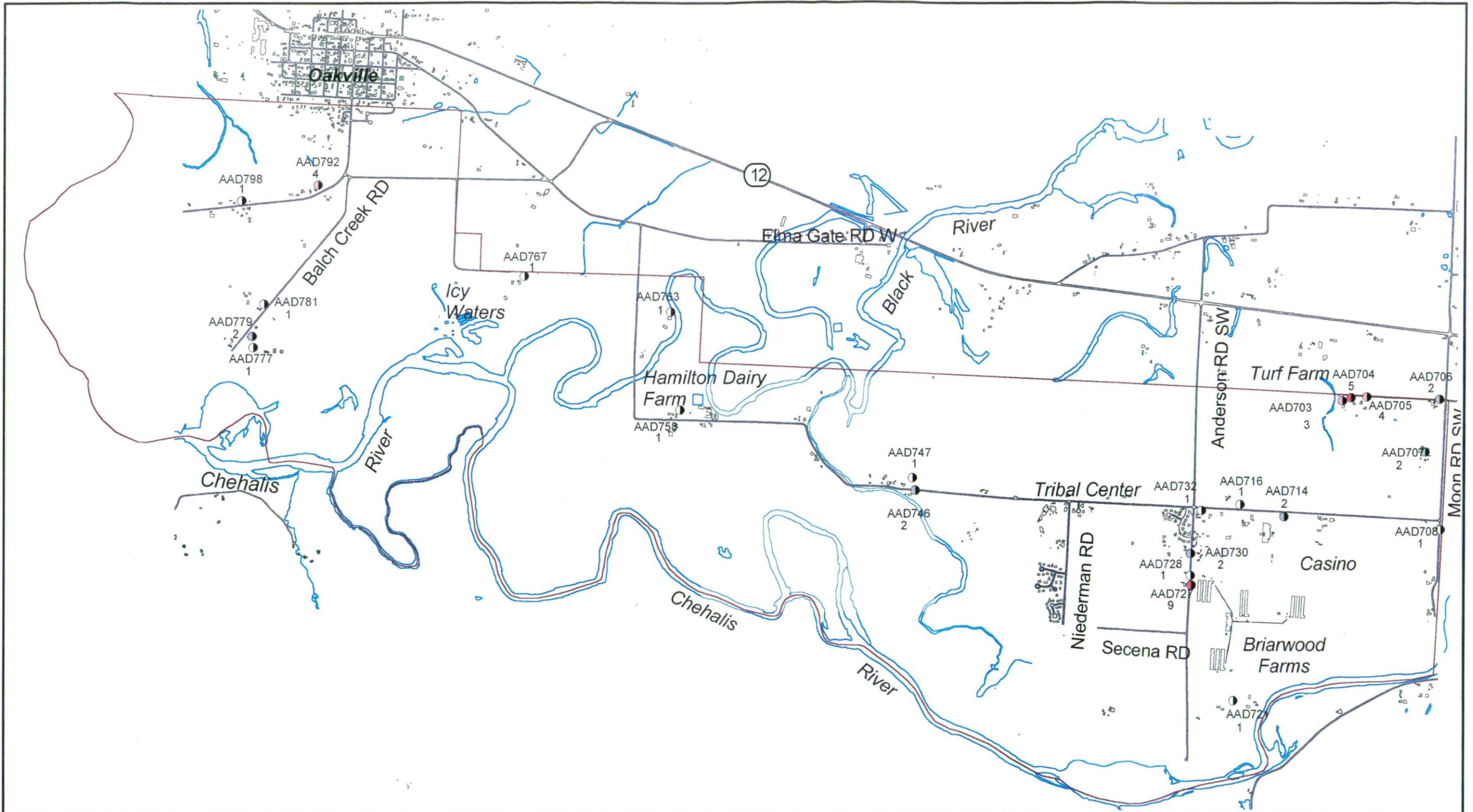
- AAD716 ● Well ID#
- 1.12 ● 9-27-2001 Nitrate Concentration, mg/L
- Reservation Boundary



**Figure 18**  
**Nitrate Concentrations in**  
**Groundwater, 9-27-2001**  
**6-Week Intensive Sampling Program**

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 12/2001



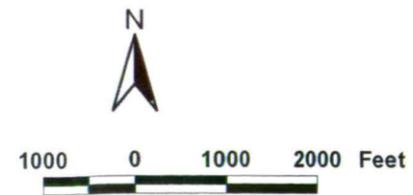


**Legend**

- AAD716 ● Well ID#
- 1 ● Number of Detections
- ~ Reservation Boundary

**Number of Detections**

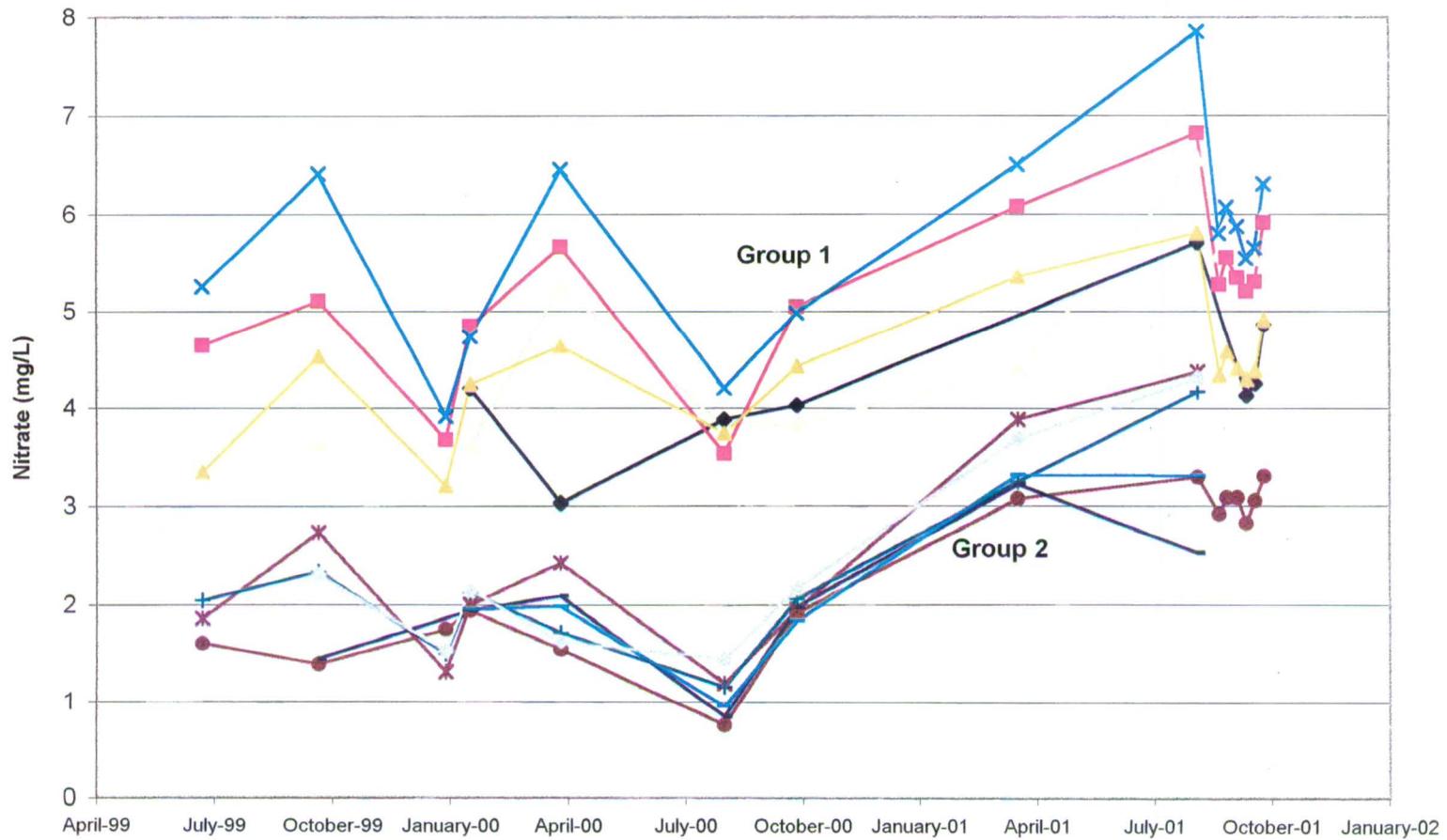
- 1
- 2
- 3 - 4
- 5 - 9



**Figure 19**  
**Coliform Detection Count**

Chehalis Reservation  
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**LEGEND**

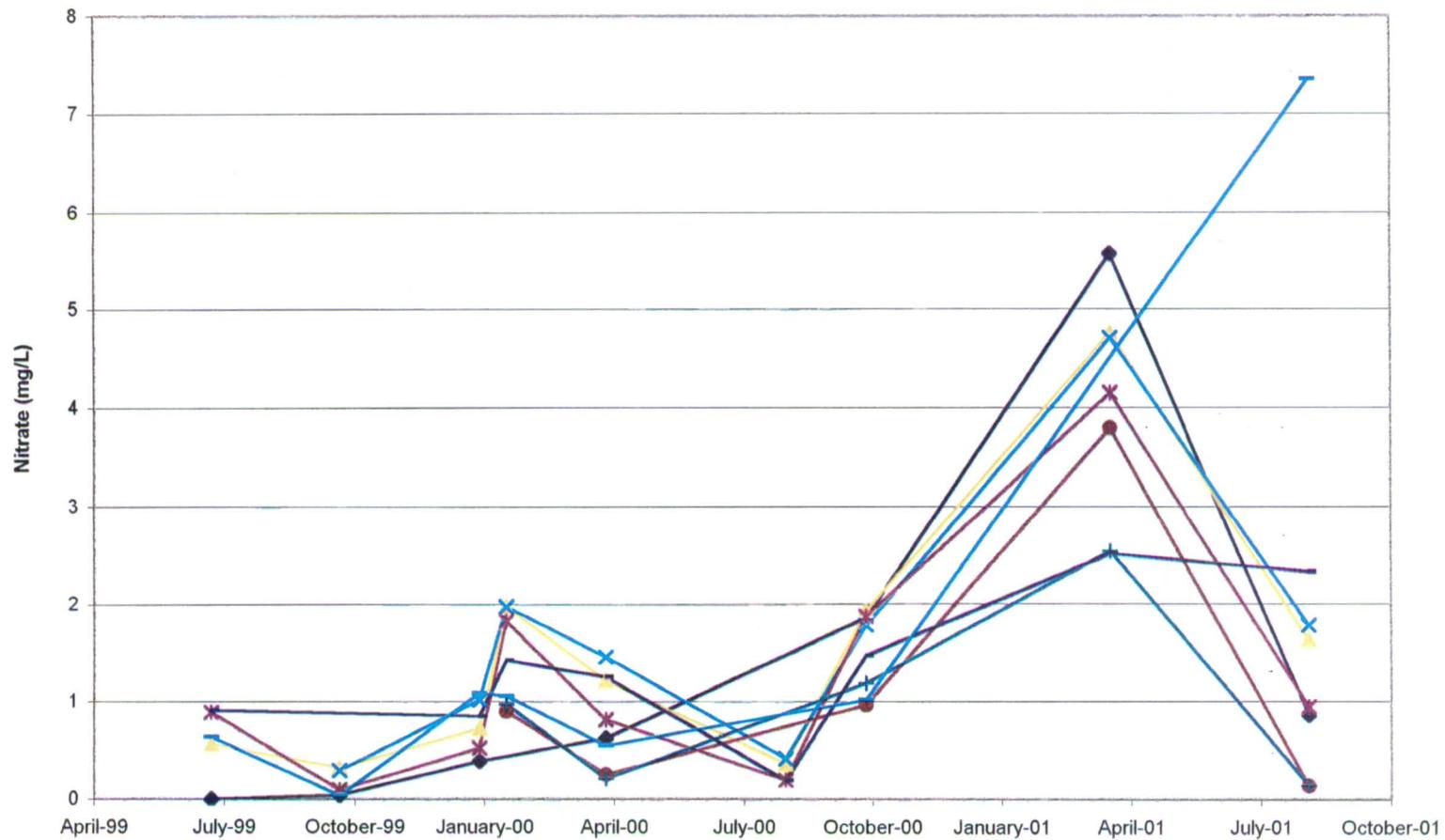
- IH124D    AAD728    AAD749    AAD725    AAD727
- AAD730    AAD746    AAD747    AAD730    AAD727
- AAD749    AAD758    AAD763    AAD725    AAD727
- AAD758    AAD767    AAD767    AAD725    AAD727

**Figure 20. Nitrate Time Series Plots, Groups 1 & 2**

Chehalis Reservation  
Groundwater Monitoring Report 2001

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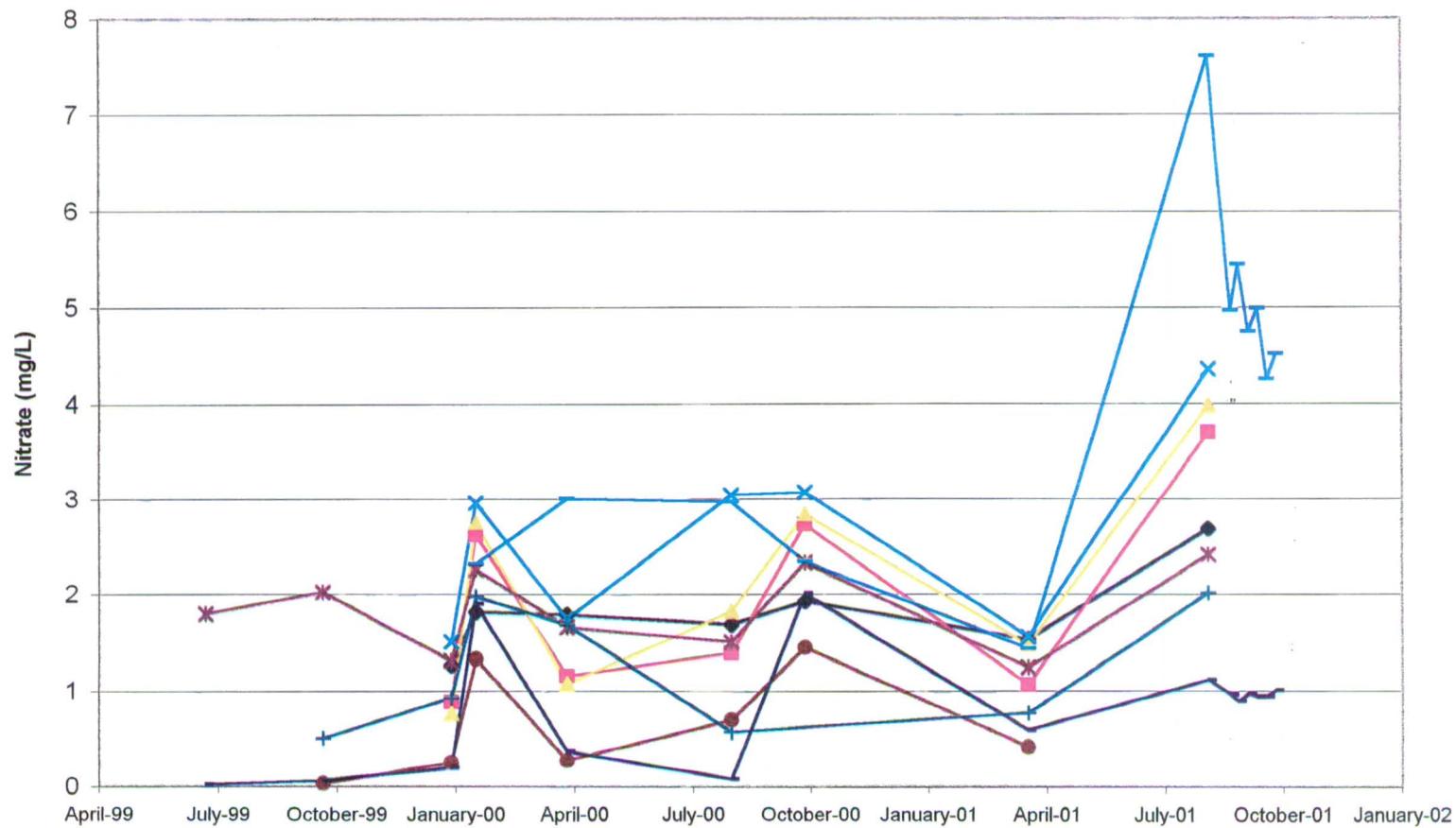
**LEGEND**

- AAD792
- AAD797
- AAD798
- AAD800
- AAD777
- AAD779
- AAD768
- AAD781

**Figure 21. Nitrate Time Series Plots, Group 3**

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 Groundwater Monitoring Report 2001  
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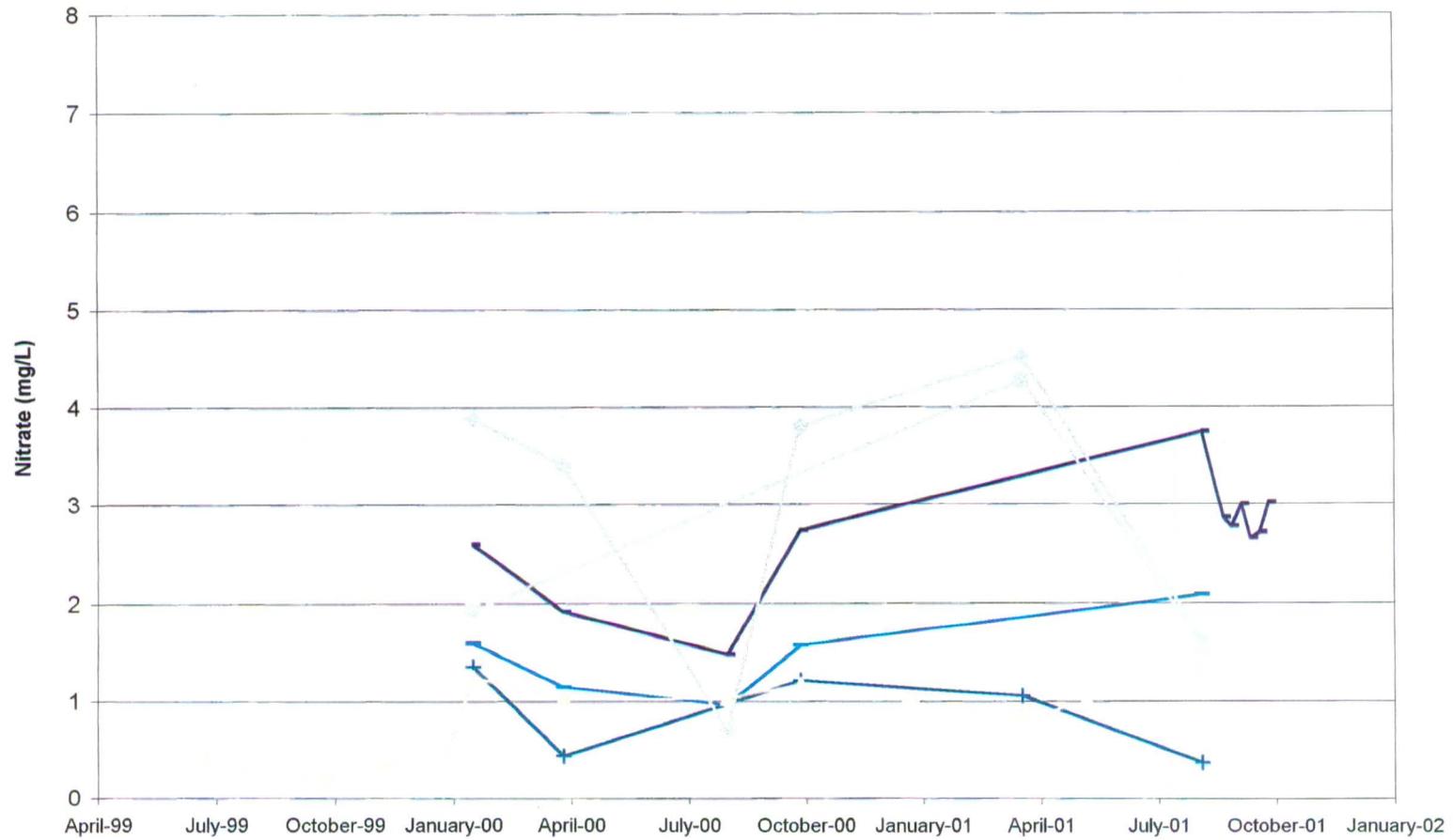
**LEGEND**

- ◆ AAD703
- ◆ AAD704
- ▲ AAD705
- ✕ AAD706
- ✕ AAD707
- AAD708
- ◆ AAD709
- ◆ AAD714
- ◆ AAD717

**Figure 22. Nitrate Time Series Plots, Group 4**

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 Groundwater Monitoring Report 2001  
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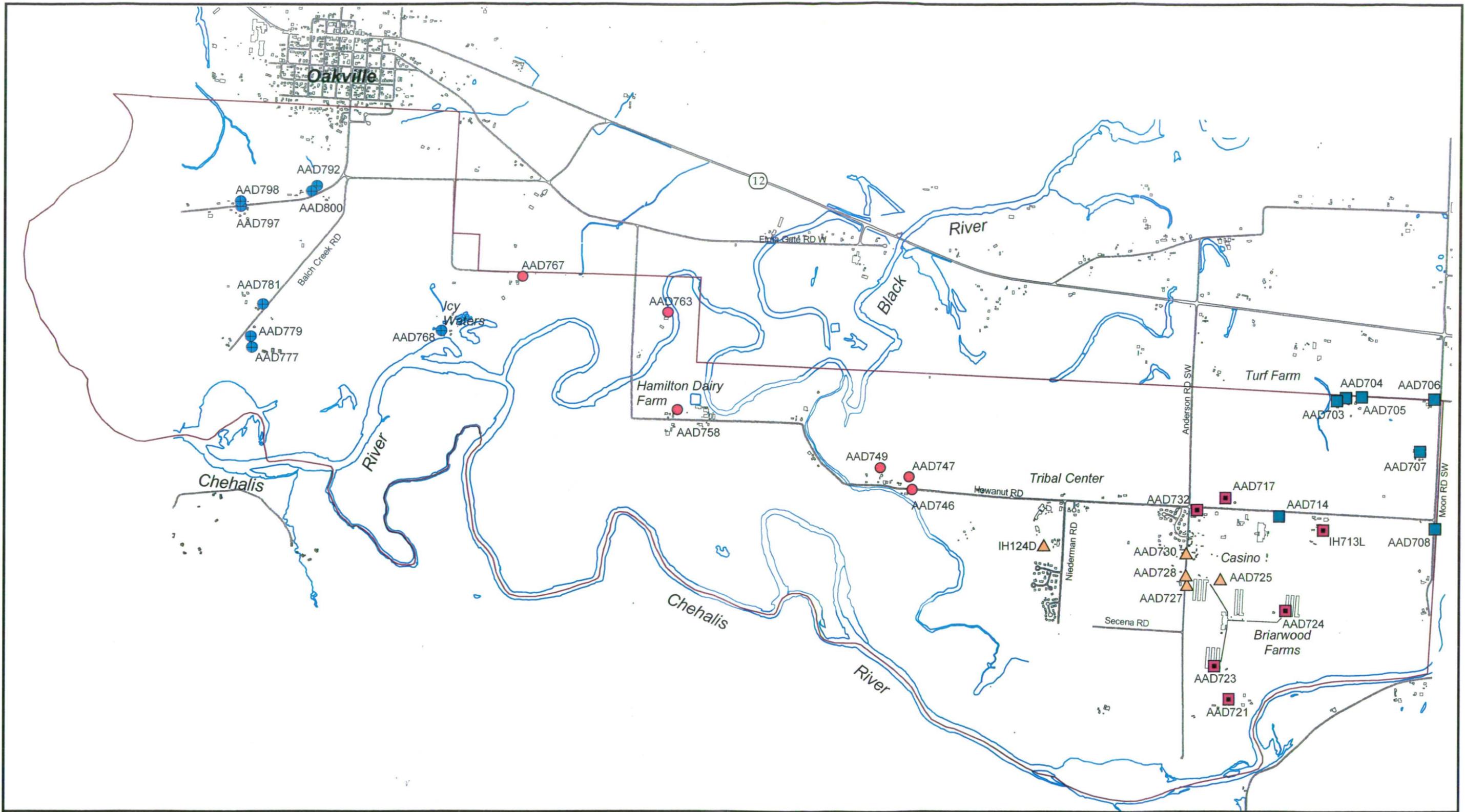
**LEGEND**

- +— AAD721
- AAD723
- AAD724
- AAD732
- AAD796
- IH713L

**Figure 23. Nitrate Time Series Plots, Group 5**

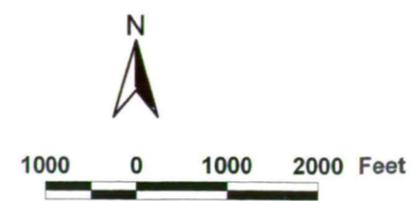
Chehalis Reservation  
 Groundwater Monitoring Report 2001  
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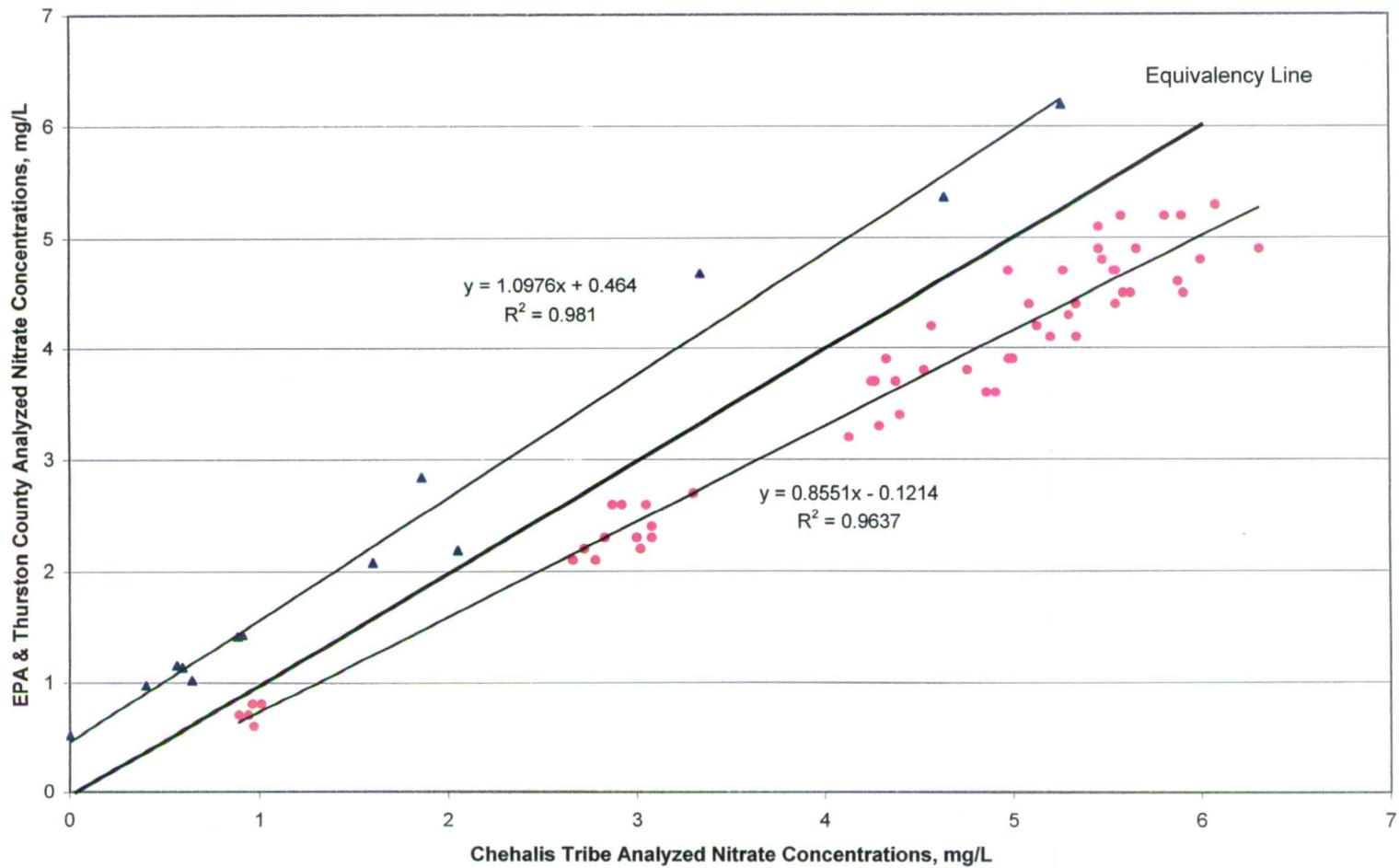


**Legend**

- |                      |         |         |  |
|----------------------|---------|---------|--|
| AAD716 Well ID#      |         |         |  |
| Reservation Boundary | Group 1 | Group 4 |  |
|                      | Group 2 | Group 5 |  |
|                      | Group 3 |         |  |



**Figure 24**  
Nitrate Time Series Groups



**Legend**

- Thurston County
- ▲ EPA

**Figure 25. Correlation of Chehalis Tribe, EPA, and Thurston County Nitrate Concentrations**

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*Appendix A. Groundwater Sampling Results 1996*

**Table A1. Groundwater Sampling Results, 1996**

Well ID	Owner	Sample Date	Temp C	pH Std Units	EC umhos/cm	Nitrate mg/L	E. Coli	Total Coliform
AAD703	BOB REIBER	8/22/96	10.9	6.4	130.9	2.1	A	A
AAD704	SHIRLEY MONTOYA	8/22/96	10.9	5.9	92.2	1.5	A	P
AAD706	LEROY JOHNSON	8/22/96	13.3	6.2	107.9	1.8	A	A
AAD707	STANLEY JOHNSON	9/10/96	11.8	6.4	111.7	1.2	A	A
AAD709	JACK GARDEN	10/30/96	11.2	6.3	0.93	0.63	A	A
AAD713	JOE PERROT	9/20/96	13.5	6.4	89.3	0.59	A	A
AAD717	CHUCK PALMER	9/16/96	9.9	6.3	95.9	1.3	A	A
AAD718	BRUCE TUTTLE	9/21/96	11.3	5.8	94.9		A	P
AAD727	SAM SECENA	9/10/96	12.6	6.3	169.0	6.1	A	A
AAD732	HAZEL PETE	9/10/96	11.9	6.3	114.9	2.1	A	A
AAD736	SHAKER CHURCH	9/10/96	11.5	6.6	103.1		A	P
AAD746	IDA ROSANDER	9/20/96	11.4	6.8	131.1	2.6	A	P
AAD747	JOHN HAYDEN	9/25/96	13.0	6.2	124.3	1.8	A	A
AAD749	YOUCKTON SYSTEM	9/20/96	12.2	6.5	130.9	2.4	A	A
AAD751	ELSIE SIMMONS	9/20/96	10.5	6.9	126.1	0.88	A	A
AAD754	FRANCIS HAMILTON	9/21/96	11.6	5.9	212.0	6.4	A	A
AAD756	VERN HAMILTON	11/6/96	9.9	6.4	137.4	0.82	A	A
AAD763	HELEN SANDERS	9/20/96	12.6	6.7	166.0	1.9	A	A
AAD767	SUE SANDERS	10/31/96	10.9	6.1	123.0	0.50	A	A
AAD768	SEA FRESH	10/31/96	11.0	6.4	142.2	1.3	A	A
AAD771	TRAVIS RYDELL	10/31/96	10.8	6.1	145.0	1.9	A	A
AAD777	MURV STAYTON	9/21/96	10.4	6.4	111.3	ND	A	A
AAD781	FRANK CAYENNE	9/24/96	10.9	6.2	102.7	0.54	A	A
AAD783	DARYL DICK	10/30/96	10.7	6.3	102.8	0.52	A	A
AAD784	SEABERG RENTAL	9/24/96	10.9	6.6	85.4	0.73	A	A
AAD791	FLOYD NELSON	10/30/96	10.9	6.6	109.6	0.41	A	A
AAD797	STARRVILLE	10/30/96	10.6	6.3	87.9	0.70	A	A
AAD800	AL BROWN	10/31/96	12.4	6.1	79.1	0.69	A	A
IH124D	TRIBAL CENTER	11/6/96	10.5	6.6	148.8	5.4	A	A
IH713L	LUCKY EAGLE CASINO	11/6/96	11.2	6.6	112.4	1.0	A	A

*P = Present, A = Absent*

*Appendix B. Lab Analytical Methods*

## 1.0 Laboratory Sampling Methods

The Chehalis Tribe's Water Quality Laboratory has been accredited by the Department of Ecology to conduct fecal coliform and turbidity analyses. Ecology's Environmental Investigations and Laboratory Services (Quality Assurance Section) conducted a system audit on June 23, 1998, as part of the continuing process of accreditation.

### 1.1 Chromogenic/Fluorogenic Substrate Tests - Colilert tests

The following describes the lab procedure for Colilert for the determination of total coliforms:

- Shake sample vigorously 25 times
- Pour 100 ml of sample from collection bottle into a ( $\cong$  125ml) sterile Colilert bottle (The colilert bottles are pre-marked with 100ml mark).
- To ascertain the water level mark in the sterile colilert bottle is within the sample range, a dummy bottle is prepared. The procedure is as follows:
  - Measure 100ml of water in a graduated cylinder graduated in 0.5ml increments
  - Pour into dummy bottle and mark water level as 100ml
  - Measure 97.5ml of water in a cylinder
  - Pour into dummy bottle and mark water level as 97.5ml
  - Measure 102.5ml of water in a cylinder
  - Pour into dummy bottle and mark water level as 102.5ml
  - A dummy bottle must be prepared for each new lot of sample bottles. The comparator is kept away from heat or other conditions that may cause evaporation.
  - The sterile colilert bottle is now compared with the dummy bottle to make sure that the 100ml mark is within the 2.5% tolerance range.
- Add contents of one Colilert media packet into sample
- Cap sample and agitate (initiates the reaction)
- Incubate at 35 ( $\pm$  0.5) $^{\circ}$ C for 24 hours

If color changes from clear to yellow and is equal or greater than the reference comparator, the sample is reported as a total coliform positive.

If the sample is yellow, but lighter than the comparator, it must be incubated for another four hours (do not incubate for more than 28 hours total). If the color is still lighter than the reference comparator at 28 hrs, the sample is reported as negative.

For E. Coli testing, the laboratory must place all total coliform-positive bottles under an ultraviolet lamp (365nm, 6-watt) in a darkened room. If sample fluoresces (blue), it is positive for E.coli

If no color change occurs and no fluorescence, sample is negative for total coliform and

E.coli. Use "Comparator" for reference.

## 1.2 Presence-Absence (P-A) Coliform test

- Shake sample lightly 25 times.
- Prepare a dummy P/A broth bottle containing an accurately measured 100ml volume mark. The procedure is as follows:
  - Measure 100ml of water in a graduated cylinder graduated in 0.5ml increments
  - Pour into dummy bottle and mark water level as 100ml
  - Measure 97.5ml of water in a cylinder
  - Pour into dummy bottle and mark water level as 97.5ml
  - Measure 102.5ml of water in a cylinder
  - Pour into dummy bottle and mark water level as 102.5ml
  - A dummy bottle must be prepared for each new lot of sample bottles. The comparator is kept away from excessive heat or other conditions that may cause evaporation.
  - Now, pour 100ml of sample into a sterile P/A culture bottle.
  - Compare the 100ml mark of the sterile bottle with the dummy bottle to make sure that volume is accurately measured.
- Add contents of one P-A ampoule into sample
- Cap the sample and agitate (initiates the reaction)
- Incubate at 35.0 ( $\pm$  0.5) $^{\circ}$ C for 24-48 hours
- Observe alterations after 24 hours:
  - **Color change** from reddish purple to yellow or yellow brown: record the test as presumptive positive for total coliform bacteria
  - **No color change:** incubate for an additional 24 hours and recheck the sample for color change. If color changes from reddish purple to yellow or yellow brown: record the test as presumptive positive for total coliform bacteria
  - If after 48 hours ( $\pm$  3 hours), no more than 51 hours of incubation, the sample still appears reddish purple (**no change**): record the test as negative for total coliform bacteria

To confirm presumptive positive samples, a culture from each total coliform-positive tube must be transferred to inoculate the appropriate media with a sterile loop:

- **Total coliform:** Brilliant green. Bile Broth incubated at 35 ( $\pm$  0.5) $^{\circ}$ C for 24 to 48 hours: if gas or turbidity is present sample is positive.
- **Fecal coliform:** EC medium tubes incubated at 44.5 ( $\pm$  0.2) $^{\circ}$ C for 24 hours: if gas or turbidity is present, sample is positive
- **E.coli:** EC medium w/ mug tubes incubated at 44.5 ( $\pm$  0.2) $^{\circ}$ C for 24 hours: if fluorescence is present, sample is positive.

### **1.3 Standard Operating Procedure for Nitrate Analysis**

Nitrate analysis will be performed using a handheld Orion pH/ISE meter (no. 290A) and an Orion nitrate test kit. The test kit converts nitrate to ammonia using an alkaline agent and a reducing agent containing titanous chloride. The ammonia is then measured with the ammonia electrode. Nitrate Analysis is conducted according to the following procedure:

#### **1.3.1 Nitrate Analysis Calibration Procedure**

Prepare two calibration standards, 10 ppm and 1 ppm NO<sub>3</sub><sup>-</sup> - N by serially diluting the 100-ppm NO<sub>3</sub><sup>-</sup> - N standard found in the test kit.

1. To prepare a 10-ppm standard, dilute 25 ml of the 100 ppm standard to 250 ml with distilled water. Prepare a 1-ppm NO<sub>3</sub><sup>-</sup> - N standard by diluting 25 ml of the 10 ppm standard to 250 ml with distilled water. Place 100 ml of each standard from a graduated cylinder into separate beakers.
2. Rinse and place the electrode in the 1-ppm solution, and stir moderately using a magnetic stirrer. Add 10ml of alkaline reagent followed by 2ml of reducing agent. After 2 minutes, record electrode potential in mV. The same procedure is conducted for the 10-ppm solution.
3. Switch the sample mode on the meter or prepare a calibration curve.

#### **1.3.2 Nitrate QA/QC Procedures**

The following laboratory QA/QC samples will be analyzed:

- One blind duplicate sample per 10 samples
- One sample spike per 10 samples.
- A blank for every 10 samples
- Nitrate Sample Preparation

For unknown levels, use 100 ml of sample and add it to a 150-ml beaker. Add 10 ml of alkaline reagent followed by 2 ml of reducing agent.

Rinse and place the ammonia electrode in the sample solution and stir moderately using a magnetic stirrer. When the reading is stable (approximately 2 minutes), read the NO<sub>3</sub><sup>-</sup> -N concentration value directly from the meter or determine from the calibration curve.

If the sample value read from the meter or calibration curve is above 20 ppm NO<sub>3</sub><sup>-</sup> - N prepare a new sample that is ten fold more dilute than the one currently measured. Repeat measurement. Further dilutions may be necessary to adjust sample values to fall within the ideal 1-10ppm calibration range of the test kit.

Nitrite, if present in the sample, is measured with nitrate. If the nitrite concentration is significant relative to the nitrate concentration, it can be eliminated by addition of 1g of

sulfamic acid in the sample and a pH adjustment to 3-4 range with HCl before the reagents are added.

### 1.3.3 Nitrate Analysis

I) Samples must be warmed to room temperature before analysis

II) Inner probe must be soaked in filling solution (951202) for at least 2 hours prior to analysis (preferably overnight)

III) Place a new membrane on the electrode tip and screw on tip cover

IV) Fill electrode with filling solution (951203) and screw electrode together

V) Rinse electrode with DI water and shake to remove bubbles and excess water. Electrode must be rinsed after every sample

VI) Attach electrode to ISE meter and perform an electrode check. The check is conducted as follows:

- In a 150ml beaker, add 100 ml of DI water, 10 ml of Alkaline Reagent and 1 ml of 1000 ppm Ammonia Standard
- Drop in stir bar and place on magnetic stirrer
- Turn ISE meter power on and read in millivolts (mV)
- Place electrode into beaker and wait for reading to stabilize (a beep and a READY message will appear on screen)
- Record as 10 ppm ammonia-N = \_\_\_\_\_ mV
- Add 10 ml of 1000 ppm Ammonia Standard to same beaker and wait for reading to stabilize
- Record as 110ppm ammonia-N = \_\_\_\_\_ mV
- The difference between the two readings is the slope of the electrode (should be between -54 and -60 mV)

VII) Perform calibration on ISE meter. The calibration procedure is done as follows:

- Set ISE meter to read in Concentration (Conc)
- Push "2nd" button and Calibration (Cal) button
- Now, in a 150ml beaker, add 100 ml of DI water and 0.1 ml of 1000 ppm Nitrate Standard (for 1ppm calibration)
- Add 10 ml of Alkaline Reagent and 2 ml of Reducing Agent
- Drop in stir bar and place on magnetic stirrer
- Place electrode in beaker and wait for reading to stabilize
- After stabilization, calibrate at 1.0 ppm.
- A fresh beaker must be used for every new sample

Repeat the same procedure for 2.5 ppm calibration using 0.25 ml of 1000 ppm Nitrate Standard (calibrate at 2.5)

Repeat for 5 ppm calibration using 0.5 ml of 1000ppm Nitrate Standard (calibrate at 5.0)

Repeat for 10 ppm calibration using 1.0 ml of 1000 Nitrate Standard (calibrate at 10.0)

- Push “Measure” button to get slope (should be between 90-100%)

VIII) Run a Laboratory Blank (reading should be less than 1.0 mg/L)

- In a 150 ml beaker combine 100 ml of DI water
- Drop in stir bar and place on magnetic stirrer
- Add 10 ml of Alkaline Reagent and 2ml of Reducing Agent
- Place electrode into beaker and wait for reading to stabilize (a beep and a READY message will appear on screen)
- If greater than 1mg/l, make a new blank in a clean beaker and repeat the procedure.
- If still greater than 1 mg/l, recalibrate and read new blank
- If it’s still greater than 1 mg/l, determine problem before continuing

IX) Run a Laboratory Control of 5 ppm (with a recovery in the range of 85-115%)

- In a 150ml beaker combine 95 ml of DI water and 5 ml of 100ppm nitrate (nitrogen) standard
- Drop in a stir bar and place on magnetic stirrer
- Add 10 ml of Alkaline Reagent and 2 ml of Reducing Agent
- Place electrode into beaker and wait for reading to stabilize (a beep and a READY message will appear on screen)

X) Run a Laboratory Check with 5 ppm calibration sample (with a recovery of 85-115%)

- This step must be run after every 10th sample and after the final sample has been analyzed
- Record the result

XI) Run first sample

- In a 150 ml beaker combine 100 ml of sample
- Drop in a stir bar and place on magnetic stirrer
- Add 10ml of Alkaline Reagent and 2 ml of Reducing Agent
- Place electrode into beaker and wait for reading to stabilize (a beep and a READY message will appear on screen)
- Record the result

XII) Run a spike of sample (with a recovery of 85-115%). The spike should be run on one per ten samples

- In a 150 ml beaker combine 100 ml of sample and 0.2 ml of 1000 ppm nitrate (nitrogen) standard
- Drop in a stir bar and place on magnetic stirrer
- Add 10 ml of Alkaline Reagent and 2 ml of Reducing Agent
- Place electrode into beaker and wait for reading to stabilize (a beep and a READY message will appear on screen)
- Record Result

XIII) Run a duplicate of sample (with a recovery of 20%)

The duplicate should be run on the 1st, and subsequently (n+1), (2n+1), where n = 10.

- Same as step XII with new aliquot of sample
- Record result

XIV) Run remaining samples

- A spike sample and a duplicate sample must be run for every 10 samples
- 5ppm Laboratory check sample must be read after every 10th sample and after final sample has been analyzed
- Record result

*Appendix C. Quality Assurance/Quality Control*

## **1.0 Field Quality Assurance/Quality Control**

A Hydrolab multiparameter instrument will be used to collect field data including temperature, pH, dissolved oxygen, specific conductivity, and turbidity. The instrument will be calibrated prior to data collection. Calibration is performed for pH, specific conductivity and turbidity using laboratory prepared standards. Calibration of pH is performed using two standards (pH=4 and pH=7). Conductivity is calibrated using a 10uS or 100uS solution. An air saturation calibration, at the appropriate barometric pressure, is performed on the dissolved oxygen meter.

Samples will be collected directly from a sampling port in the wellhead where possible. A Hydrolab meter with a flow cell will be used to prevent dissolved oxygen concentration changes during data collection. Before a sample is drawn or parameters measured, the system will be purged until the temperature, pH, specific conductivity and dissolved oxygen stabilizes. After stabilization, the flow will be reduced to collect the sample. Care will be taken to assure that there is no contact between bottles and sampling port.

## **2.0 Laboratory Quality Assurance/Quality Control**

The Chehalis Tribe's Water Quality Laboratory has been accredited by the Department of Ecology to conduct fecal coliform and turbidity analyses. Ecology's Environmental Investigations and Laboratory Services (Quality Assurance Section) conducted a system audit on June 23, 1998, as part of the continuing process of accreditation. A copy of the report is presented in Appendix 1.

Nitrate analysis will be performed using a handheld Orion pH/ISE meter (no. 290A) and an Orion nitrate test kit. The test kit converts nitrate to ammonia using an alkaline agent and a reducing agent containing titanous chloride. The ammonia is then measured with the ammonia electrode.

### **2.1 Nitrate Analysis Calibration Procedure**

Prepare two calibration standards, 10 ppm and 1 ppm  $\text{NO}_3^-$  - N by serially diluting the 100-ppm  $\text{NO}_3^-$  - N standard found in the test kit.

1. To prepare a 10-ppm standard, dilute 25 ml of the 100 ppm standard to 250 ml with distilled water. Prepare a 1-ppm  $\text{NO}_3^-$  - N standard by diluting 25 ml of the 10 ppm standard to 250 ml with distilled water. Place 100 ml of each standard into separate beakers.
2. Rinse and place the electrode in the 1-ppm solution, and stir moderately using a magnetic stirrer. Add 10ml of alkaline reagent followed by 2ml of reducing agent.

After 2 minutes, record electrode potential in mV. The same procedure is conducted for the 10-ppm solution.

3. Switch the sample mode on the meter or prepare a calibration curve.

## **2.2 Nitrate QA/QC Procedures**

The following laboratory QA/QC samples will be analyzed:

- One blind duplicate sample per 10 samples
- One sample spike per 10 samples.
- A blank for every 10 samples

## **2.3 Nitrate Sample Preparation**

For unknown levels, use 100 ml of sample and add it to a 150-ml beaker. Add 10 ml of alkaline reagent followed by 2 ml of reducing agent.

Rinse and place the ammonia electrode in the sample solution and stir moderately using a magnetic stirrer. When the reading is stable (approximately 2 minutes), read the  $\text{NO}_3^-$  -N concentration value directly from the meter or determine from the calibration curve.

If the sample value read from the meter or calibration curve is above 20 ppm  $\text{NO}_3^-$  - N prepare a new sample that is ten fold more dilute than the one currently measured. Repeat measurement. Further dilutions may be necessary to adjust sample values to fall within the ideal 1-10ppm calibration range of the test kit.

Nitrite, if present in the sample, is measured with nitrate. If the nitrite concentration is significant relative to the nitrate concentration, it can be eliminated by addition of 1g of sulfamic acid in the sample and a pH adjustment to 3-4 range with HCl before the reagents are added.

## **3.0 Decontamination Procedures**

All water supply wells have dedicated pumps and require no specific decontamination procedures. Push-probes and screens will be cleaned with alconox and deionized water. All tubing used in push-probe sampling will be replaced between each sampling location.