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**HARTCROWSER**

*Earth and Environmental Technologies*

*Ritzville Sewage Lagoons  
Groundwater Monitoring System  
Final Report  
Ritzville, Washington*

*Prepared for  
City of Ritzville  
Centennial Grant TAX 90195*

*December 28, 1990  
J-2260-02*

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**RITZVILLE SEWAGE LAGOONS  
GROUNDWATER MONITORING SYSTEM  
FINAL REPORT  
RITZVILLE, WASHINGTON**

**INTRODUCTION**

This report presents the results of the installation of a groundwater monitoring system and initial groundwater sampling for the City of Ritzville (City) Sewage Lagoons. The monitoring system was installed to provide hydraulic and water quality data on the uppermost aquifer below the lagoons as part of Washington State waste discharge permit requirements. This work was funded in part through a Centennial Fund grant (TAX 90195) provided by the Washington State Department of Ecology (Ecology).

This report is divided into three primary sections. Initially, we present a discussion of the project background followed by a summary of the major findings with recommendations for future monitoring. This is followed by the main body of the text which addresses the hydrogeology and groundwater quality data analysis. Supporting information can be found in Appendix A which presents the Field Procedures, Appendix B which presents the Water Quality Data, and Appendix C which presents the Procedures for Future Sampling and Monitoring. Appendix D presents a list of references cited in the report.

***Project Background***

The sewage lagoon facility is located in a coulee west of Ritzville as shown on Figure 1. The City sewage is composed primarily of domestic-type wastes and undergoes primary treatment prior to discharge to the lagoons. Following primary treatment the wastewater is routed through pipelines to several lagoons where it is then dissipated through evaporation and infiltration.

As part of the Washington State waste discharge permit renewal, a hydrogeologic study was required. A preliminary hydrogeologic assessment report was completed for the City with recommendations for a groundwater monitoring system (Hart Crowser, December 22, 1988). This report was reviewed by Ecology and specific modifications made to

the proposed groundwater monitoring system (Ecology letter to Dale Shaeffer dated February 17, 1989).

To assist the City in construction of the wells, a Centennial Fund grant was pursued and was awarded. A pre-construction meeting was held on July 31, 1990, at the City to finalize the work plan for the monitoring well system and to locate the wells. Dorothy Stoffel and others with Ecology, Hart Crowser, Bartholomew Brothers Drilling, and the City were present.

### *Scope of Work*

The scope of work for this project was accomplished as outlined below. A more detailed discussion of the scope of work is presented in detail in the Technical Specifications, Sewage Lagoon Monitoring System, City of Ritzville (Hart Crowser, June 29, 1990) and in the Grant Agreement. Any deviations from the scope as outlined in these documents are noted.

#### *Task 1 - Work Plan and Construction Specifications*

A work plan was developed and presented to Ecology on June 29, 1990, which detailed the well construction specifications and protocols for the field and office analyses.

#### *Task 2 - Construct and Develop Monitoring Wells*

Four monitoring wells were installed instead of the originally planned three. The first three were installed as proposed. Monitoring well MW-1 was installed as an upgradient well to provide samples representative of background water quality. Monitoring well MW-3 was installed in a presumed downgradient direction to provide samples representing the groundwater quality after it has passed beneath the lagoon. Monitoring well MW-2 was installed in an area central to the lagoons to monitor groundwater quality in the uppermost aquifer directly beneath the lagoons.

A fourth well was installed after the installation of well MW-2 because we believed MW-2 may be tapping into a shallow fracture system that is in direct connection with the "lagoon system". The lagoons are reportedly founded in abandoned rock quarries and it is possible the

rock around the lagoons is fractured from blasting associated with quarry operations. The proximity of the well to one of the largest lagoons and the coincidence of the screened depth of MW-2 (10 to 20 feet) with the reported lagoon depths (10 to 20 feet) suggested the well may be tapping lagoon water. A deeper well MW-4 was installed adjacent to MW-2 to monitor leakage to deeper groundwater zones. An added advantage of the fourth well was information on the vertical gradient in the central lagoon area. The shallower than expected depth of the wells allowed sufficient funds within the existing budget for completion of this additional well.

### Task 3 - Water Quality Sampling

Following well development and water level measurements, the wells were sampled for:

- ▶ **Field Parameters** - pH, temperature, and electrical conductivity and
- ▶ **Laboratory Analyses** - nitrates, ammonia, orthophosphorous, chloride, and fecal coliform using EPA test methods or equivalent Standard Methods.

### Task 4 - Data Analysis and Report

The data were analyzed and this report prepared to summarize our refined understanding of the hydrogeology in and around the lagoons, and to present geologic and well construction information, groundwater flow evaluation, water quality data interpretation, and recommendations for future action.

## **SUMMARY AND RECOMMENDATIONS**

The groundwater monitoring system installed will provide an early warning of any potential groundwater contamination of deeper aquifers. Well MW-1 will provide useful information on background groundwater quality. MW-2 is located so close to the lagoon water that short-distance attenuative capacity of the basalt surrounding the lagoons can be monitored. MW-3 and MW-4 provide horizontal and vertical downgradient indication of water quality impacts from the lagoons. There were no identified water wells screened in the shallow aquifer

tapped by the monitoring wells, so monitoring of these shallower wells should allow ample time to respond to any groundwater quality impacts that could occur before water supply aquifers are impacted. In particular, MW-3 and MW-4, wells completed downgradient and below the Sewage Lagoons, respectively, will provide the best indication of potential migrating contaminants.

The water quality data indicate no measurable impact to the groundwater away from the lagoons has occurred. The wells should be sampled quarterly for the next two years to develop a water quality database and observe any seasonal or long-term trends that may occur. Monitoring should also include water level measurements to verify the directions of groundwater flow identified this summer and note any seasonal or long-term changes in the groundwater flow system. We recommend monitoring all four wells during each sampling round. The data should be submitted to Ecology, and at the end of every year the data should be reviewed to note any changes in the system as described in this report. The specific procedures for conducting the water level and water quality monitoring are presented in Appendix C.

## REGIONAL SETTING

Ritzville is located on the Columbia Plateau. The plateau is comprised of a thick sequence of basaltic lava flows, known as the Columbia River Group. The basalts dip gently toward the southwest from an elevation of 2,500 feet (mean sea level - MSL) in the northeast to 400-feet in the southwest. Regional surface water drainage is toward the Columbia and Snake Rivers, to the west and south, respectively.

Wind-deposited silts blanket the Columbia Plateau surface. Subsequent glacial meltwaters scoured the silt deposits and drained toward the southwest. The resulting meltwaters channels, called coulees, represent the major topographic feature in the area today. These channels now form linear valleys that trend from northeast toward the southwest. The sewage lagoons are located in a coulee just northwest of the downtown Ritzville area.

## LOCAL HYDROGEOLOGY

Our Preliminary Assessment report identified three major aquifers believed to underlie the area based on well drilling reports. The uppermost aquifer tapped by wells was typically encountered between 120 to 175 feet below ground surface. This was the target zone for our well construction. The two deeper aquifers identified were: an intermediate aquifer between approximately 200 to 300 feet below ground (which supplies roughly half of the single domestic and irrigation wells) and a lower aquifer located approximately 300 to 450 feet below ground surface (which is tapped by the City). A perched aquifer was also indicated by drilling records as water inflow at depths as shallow as 60 feet, but there were no wells on record screened or completed this shallow.

A site reconnaissance identified basalt bedrock at or close to ground surface in the lagoon area. For this reason we drilled the wells using air rotary techniques. We expected to potentially encounter limited fracture zones at depths of roughly 60 feet and the more extensive water table aquifer as deep as 175 feet based on the available information. At all locations in the coulee area we first encountered groundwater much shallower, at depths of 10 to 18 feet. A discussion of the basalt and its water-bearing properties based on drilling and cuttings indications are presented below.

### *Drilling Observations*

The geologic sequence underlying the sewage lagoon area consists of layers of fractured and unfractured basalt. In general, the basalt intercepted within the first 10 to 20 feet of drilling was rubbly and fractured. Drilling action within this surficial basalt was highly variable and a loss in air circulation was often noted. Basalt intercepted below rubbly or fractured zones was identified as competent based on slow and steady drill action. Deeper fractured zones were interpreted by irregular drilling and/or groundwater inflows.

The shallow rubbly and fractured zone showed varying degrees of clay alteration and iron oxidation. Deeper water-bearing fracture zones were typically mottled black to gray with only minor iron oxide. The conditions encountered at each well are presented below. The boring logs with well construction diagrams are presented in Appendix A.



**MW-1 - Upgradient Well.** Basalt intercepted within the first 10 feet of borehole MW-1 was rubbly and fractured. Drilling action was variable. Eight-inch-diameter steel casing was required to a depth of 4 feet to prevent the borehole from caving. Below a depth of 10 feet, the basalt was competent and drill action was steady. A water-bearing zone was encountered at approximately 18 feet and continued to a depth of 31 feet. The basalt showed minor iron oxidation and a black-gray mottling at this depth. The well was installed with a screen at a depth of between 20 and 30 feet.

**MW-2 - Shallow Sewage Lagoon Well.** Basalt intercepted in borehole MW-2 from near surface to a depth of 21-feet was rubbly and fractured. Eight-inch-diameter steel casing was driven to a depth of 4 feet to hold the hole open. Between a depth of 10 and 21 feet the basalt was intensely altered to a clay with pervasive iron oxidation and drilling produced a considerable amount of water. Following guidelines developed during our pre-construction meeting the well was screened in this water producing zone between a depth of 10 and 20 feet.

**MW-3 - Downgradient Well.** Basalt intercepted in borehole MW-3 from ground surface to a depth of 10 feet was rubbly and fractured with minor amounts of iron oxidation. Between a depth of 10 and 38 feet the basalt appeared competent based on drill action and cuttings return, although minor water was produced and minor iron oxidation was indicated. At a depth of 38 feet the basalt indicated black-gray mottling, minor iron oxidation, and began discharging a larger volume of water. The well was screened between a depth of 38 and 48 feet.

**MW-4 - Deep Sewage Lagoon Well.** Basalt encountered in borehole MW-4 from near surface to an approximate depth of 40 feet was rubbly and fractured. This zone also produced a considerable amount of water during drilling. To seal off water from this zone, a 2-foot-thick bentonite seal was placed within the 8-inch borehole at a depth of 25 feet and 6-inch casing driven to the bottom of the seal. Drilling deeper was continued with a 6-inch bit. A second seal was placed between a depth of 38 and 40 feet to further seal off upper waters and allow us to identify deeper water-bearing fracture zones that might be encountered. Below a depth of 40 feet to approximately 50 feet, smooth, steady drill action indicated competent basalt. The basalt appeared to be fractured below 50 feet based on minor black gray mottling, and rough drilling.

As some water was being produced from this zone the well was screened between a depth of 48 and 58 feet.

### *Groundwater Flow and Gradients*

The water level elevation data indicate groundwater flows from northeast to southwest beneath the lagoon area. As anticipated, these data identify MW-1 as an upgradient well and MW-3 as downgradient of the lagoons. Water level data were obtained on August 29, 1990, and September 4, 1990, and are presented in Table 1. Figure 1 shows the relative location and water elevation of each of the wells.

The data show a relatively similar horizontal hydraulic gradient between wells MW-1, MW-2, and MW-3 suggesting these wells may be tapping into an interconnected fracture network. The gradient measured between MW-1 and MW-2 is small ranging between 0.0005 to 0.001. Between MW-2 and MW-3 the gradient was approximately 0.003 at the time of both water level measurements. Across the length of the monitoring site (from MW-1 to MW-3) a gradient of 0.006 to 0.007 was measured. Low gradient values such as these often indicate greater interconnectedness between wells.

The well pair installed adjacent the lagoon area (MW-2 and MW-4) indicate a strong downward gradient between the fractured zones screened by MW-2 and MW-4. The high gradient suggests that there is a dense, competent rock zone acting as an aquitard between a depth of roughly 40 and 50 feet beneath the lagoon system. A downward gradient is also indicated by comparison of the monitoring well groundwater elevations with the groundwater elevations in water wells in the area (see Figure 1).

The hydraulic conductivity of the zones tapped by the wells was evaluated using bail-down testing and Theis recovery analysis. It is important to note that the equations we used are for porous media rather than fracture flow. In this case we felt the methods were appropriate for the shallow groundwater zone around the lagoons because of the high apparent density of the fracturing. The rubbly nature of basalt flow tops, the drilling conditions, and the response of the wells to the testing all indicate the porous media equations may apply. Our estimates indicate hydraulic conductivities ranging from

approximately  $10^{-3}$  cm/sec (2.8 ft/day) at the MW-2 location to between  $10^{-4}$  and  $10^{-5}$  cm/sec (0.28 to 0.028 ft/day) at the other well locations.

The lateral flow rate of groundwater away from the lagoon ranges between roughly 0.014 and 0.003 feet/day as determined assuming Darcy's Law and the following parameters:

- ▶ A mean hydraulic gradient of 0.005;
- ▶ An assumed porosity of between 0.1 and 0.4 based on literature values for Columbia River Basalts (Freeze and Cherry, 1979); and
- ▶ An average hydraulic conductivity of  $10^{-4}$  cm/sec (0.28 ft/day)

## GROUNDWATER QUALITY ASSESSMENT

With the exception of one fecal coliform measurement, the first round of groundwater quality monitoring indicates that the lagoon system is in compliance with current groundwater standards. We base this conclusion on four groundwater quality samples we collected from each of the monitoring wells. In addition, a duplicate water sample was collected from well MW-3 and a field blank was prepared from deionized water for quality assurance and quality control of the field and laboratory methods. The samples were analyzed for:

- ▶ Nitrate (EPA 353.3);
- ▶ Ammonia (Standard Methods 418C);
- ▶ Orthophosphorous (EPA 365.3);
- ▶ Chloride (Standard Methods 325.3);
- ▶ Fecal coliform (Standard Methods 909C); and
- ▶ pH, electrical conductivity, and temperature.

A summary table of the laboratory results relative to Drinking Water Standards (Maximum Contaminant Levels or MCLs) and the new Groundwater Quality Standards is presented in Table 2. The full laboratory report and a quality assurance review of the laboratory results is presented in Appendix B. The following is a summary of the results:

**Nitrates.** Nitrate was detected in two out of four groundwater monitoring wells. The concentrations were low ranging from <0.01 mg/L to 0.03 mg/L. The highest level was measured in the upgradient well MW-1, but is still well below the MCL and Groundwater Quality Standard of 10 mg/L.

**Ammonia.** Ammonia was detected in all four groundwater monitoring wells. Concentrations ranged from 0.02 mg/L in MW-3 to 0.15 mg/L in MW-4. The groundwater quality standard is 28,000 mg/L.

**Orthophosphorous.** Orthophosphorous was detected in three out of the four monitoring wells sampled. Orthophosphorous ranged in concentration from a low of <0.01 mg/L in MW-1 (upgradient) to a high of 8.0 mg/L in MW-2 (near the lagoons). There are no regulatory standards for orthophosphorous.

**Chloride.** Chloride was detected in all four water samples. Concentrations ranged from a low of 16 mg/L in MW-4 to a high of 135 mg/L in the upgradient well MW-1. The groundwater quality standard is 250 mg/L.

**Fecal Coliform.** Fecal coliform was only detected in well MW-2 presumed to represent the "lagoon system" at a concentration of 3780 Colonies/100 mLs. The drinking water standard is 1 colony/100 mLs.

**pH, Electrical Conductivity, and Temperature.** pH, electrical conductivity, and temperature were measured in all four monitoring wells. pH ranged from 7.2 to 7.6. Electrical conductivity ranged from 370 to 1180  $\mu$ mhos/cm. Temperature ranged from 22° to 27° C.

### *Interpretation of Groundwater Quality Data*

In general the highest concentration of analyzed constituents occurred in well MW-2. Concentrations of nitrate, orthophosphorous, chloride and fecal coliform were elevated in MW-2 compared to the other monitoring wells. This was expected because MW-2 is believed to be indicative of the sewage lagoon water based on its shallow depth and proximity to the lagoons. Within the rubbly/fractured basalts in close proximity to the lagoons it is expected that filtering of the bacteria and adsorption of phosphorous by clays and iron oxides occur. Extensive clay alteration and iron oxidation was observed within the shallow basalt

in the MW-2/MW-4 area. The adsorption inhibits migration of these constituents to downgradient areas.

The low levels of nitrates suggest the plants in and around the sewage lagoon are depleting the sewage waters of nitrogen. In the deeper lagoon environment, anaerobic conditions may occur prohibiting the production of nitrate. It will be important to observe nitrate concentrations in the groundwater underlying the site during the winter months when vegetation is at a low. Nitrates levels may increase during the winter months. However, the lagoons have been in operation for many years and the low nitrate concentrations observed in the downgradient wells (both MW-4, which is deeper, and MW-3, which is horizontally downgradient) indicate that it is unlikely that seasonal increases are contributing to higher levels away from the lagoon area.

Chloride can often be used as a tracer of impacts to groundwaters downstream of sewage treatment facilities. However, in this case the upgradient well MW-1 had the highest level of chloride. All of the observed levels are low relative to clean-up standards.

#### IN CLOSING

The data indicate that the basalt is currently acting as an effective barrier to any potential contaminant migration. The installed monitoring wells and proposed monitoring program should provide a suitable mechanism for measuring any potential future impacts to groundwater quality.

Work for this project was performed, and this letter report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of the City of Ritzville for specific application to the referenced property. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

It should be noted that Hart Crowser relied on verbal information provided by the individuals indicated above. Hart Crowser can only relay this information and cannot be responsible for its accuracy or completeness.

Any questions regarding our work and this letter report, the presentation of the information, and the interpretation of the data are welcome and should be referred to the project manager (the undersigned).

We trust that this report meets your needs.

Sincerely,

**HART CROWSER, INC.**



**LORI J. HERMAN**

Associate

LJH:alm  
RFTZ:fr

**Table 1 - Monitoring Well and Groundwater Elevation Data**

Monitoring Well	Elevation* in Feet Top PVC Casing (TOC)	8/29/90 Depth to Water** in Feet	8/29/90 Elevation in Feet	9/4/90 Depth to Water** in Feet	9/4/90 Elevation in Feet
MW-1	1790.00	17.61	1772.39	17.58	1772.42
MW-2	1782.85	11.00	1771.85	11.57	1771.28
MW-3	1777.35	10.32	1767.03	10.36	1766.99
MW-4	1782.05	50.81	1731.24	20.89	1761.16

\* Benchmark elevation of 1,790 feet assumed for MW-1 based on USGS 7.5 minute Ritzville quadrangle map.

\*\* Depth to water is below top of PVC casing.

Table 2 - Water Quality Results - August 1990

Sample Designation	MW-1	MW-2	MW-3	MW-3D**	MW-4	Field Blank	Detection Limits	GWQ Stds
Parameters	Concentration in mg/L (ppm)							
Elect. Cond.	1180	850	480		370			
pH	7.2	7.2	7.5		7.6			
Nitrates	0.03	--	0.01	--	--	--	0.01	10
Ammonia	0.05	0.10	0.02	0.07	0.15	--	0.01	28,000
Orthophosphorous	--	8.0	0.43	0.40	0.29	--	0.01	NA
Chloride	135.0	62.0	50.0	49.0	16.0	1.0	1.0	250
Fecal Coliform*	0	3870/ 100 ml.	0	0	0	0	0	1/100

\* Fecal coliform in Colonies /100 mLs.

-- Concentration is below analytical detection limit or not detected.

\*\* Duplicate sample of MW-3.

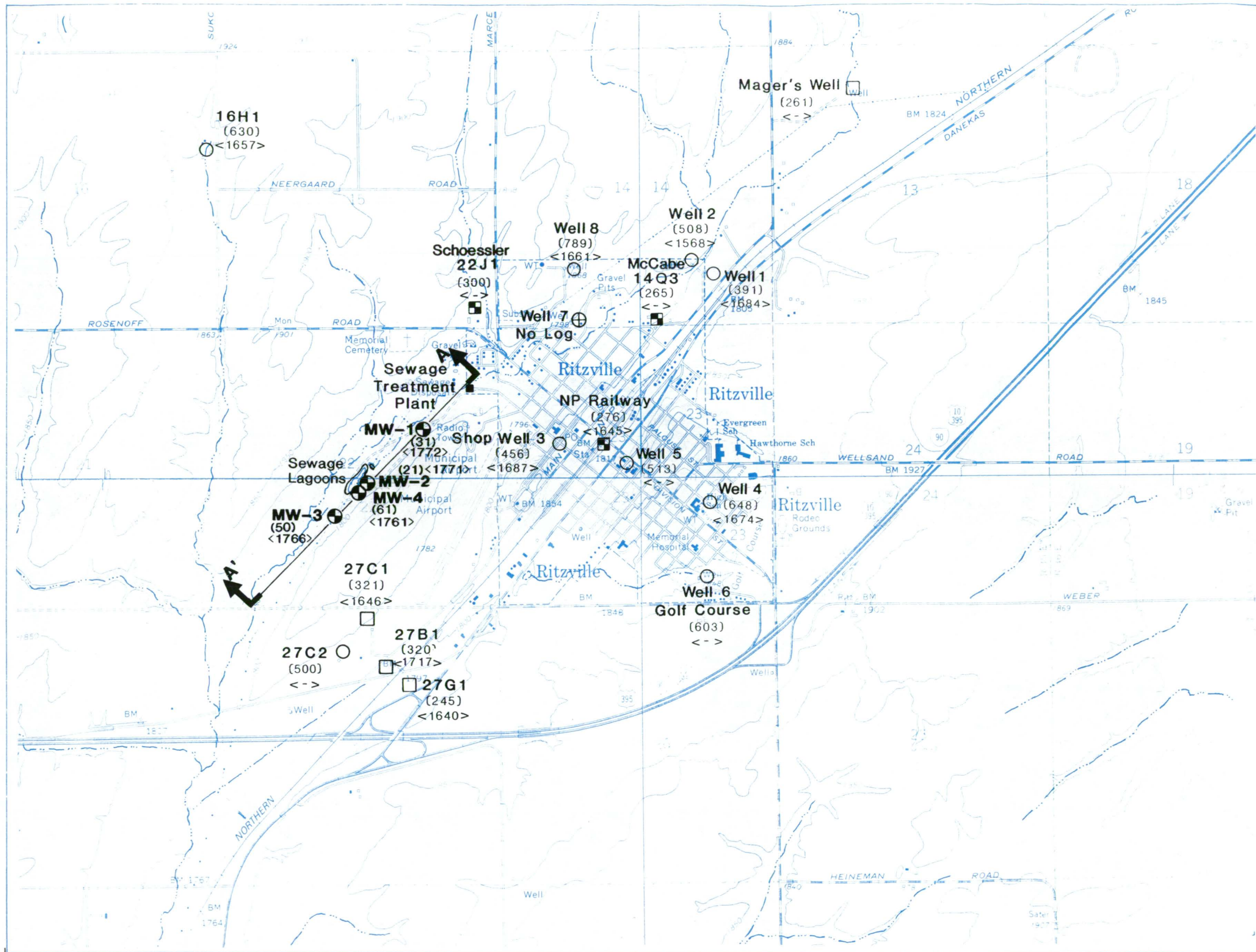
Analyses by Treclen Laboratories of Spokane, Washington.

NA No standard currently reported.

GWQ Water Quality Standards for Groundwaters of the State of Washington  
(Ecology, November 1990).



# Well and Cross Section Location Map

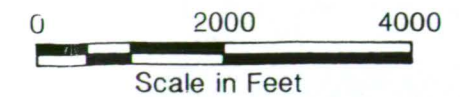


- ↑ A    A' ↑** Cross Section Location and Designation
- Well Symbols
- △ Deepest Aquifer Tapped
  - Upper
  - Intermediate
  - Lower
- McCabe** Owner or Well Name
- **27C2** Well Location and Number  
(468) Total Depth in Feet  
<1674> Water Level Elevation in Feet  
< - > No Data Available
- MW-1** Monitoring Well Location and Number (Hart Crowser 1990)
- Existing Monitoring Well Location

Note:  
Lagoon locations are approximated from observations.

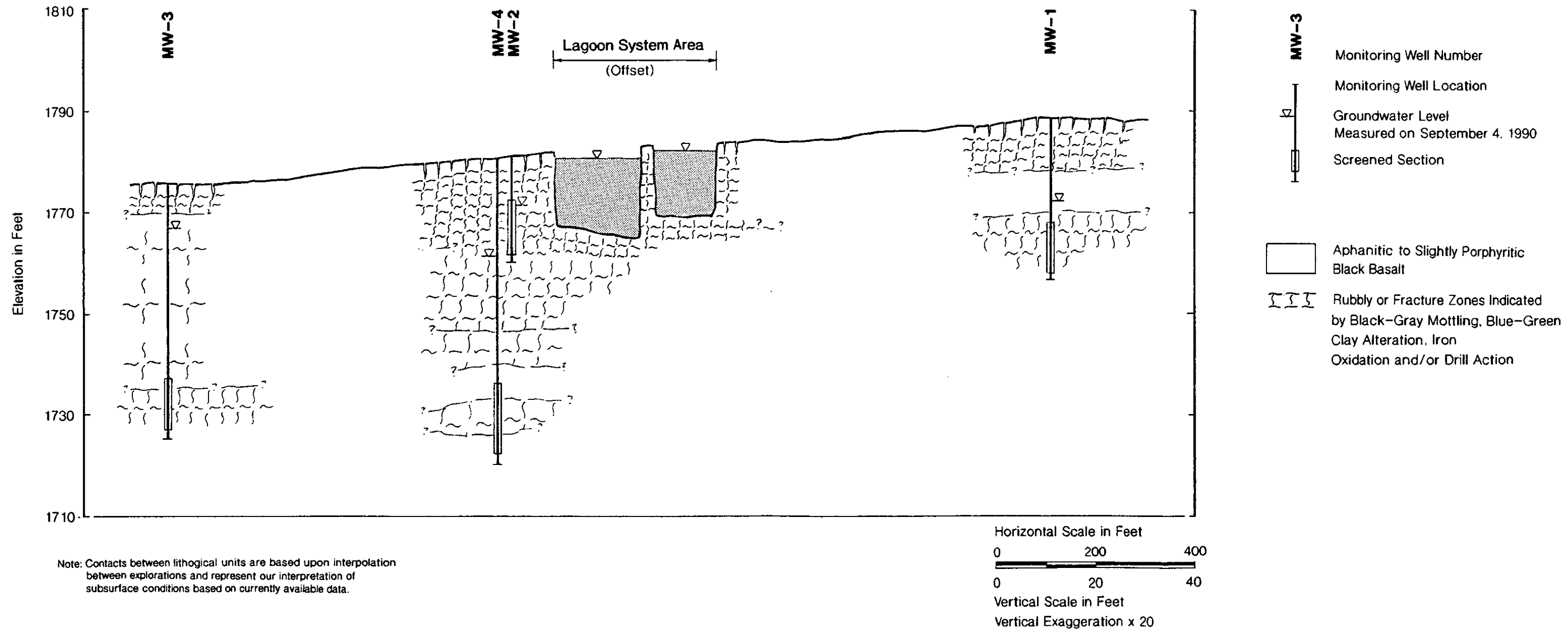


Base map prepared from 7.5-minute quadrangles of Ritzville NW, NE, SW, SE, Washington



# Generalized Subsurface Cross Section A-A'

## Ritzville Sewage Lagoon



**APPENDIX A**  
**FIELD PROCEDURES AND MONITORING WELL LOGS**

**APPENDIX A**  
**FIELD PROCEDURES AND MONITORING WELL LOGS**

*Monitoring Well Installation*

Top-drive air rotary drilling was used to advance the monitoring well borings for MW-1, MW-2, MW-3, and MW-4. An eight-inch-diameter steel casing was driven from ground surface to an average depth of 4 feet during drilling to prevent caving of the borehole, with the exception of MW-2 where a 6-inch casing was used. In the case of MW-4, the 8-inch casing was driven to 14 feet and 6-inch-diameter steel casing was driven to a depth of 38 feet in an attempt to seal off water from a shallower fractured zone.

Drill cuttings samples were collected from the discharge tube using a 5-gallon bucket. Representative samples were collected every 5 feet of drilling and were used along with drill action and other drilling indications to prepare a geological log for each well (Figures A-2 through A-5). Tom Cammarata with Hart Crowser was on site throughout the drilling to observe and record the conditions encountered.

An airlift test was conducted at each suspected aquifer during drilling to identify the nature of the water inflow -- did it have some extent or was it a very isolated zone. The test consisted of evacuating the borehole of water, then monitoring the rise in water level with time (at least 15 minutes). This was accomplished at least twice to make sure that the zone we tapped with the well screen had some extent. When a sizable zone of saturation was apparent the hole was drilled approximately 10 feet deeper to complete the well.

Wells were constructed in compliance with Minimum Functional Standards for Resource Protection Wells (WAC 173-160-500). Each well was completed with 2-inch-diameter, flush threaded, Schedule 40, PVC casing and screen (0.020-inch slot size) fitted with a threaded cap. Commercially cleaned silica sand (US sieve size 10-20) was placed as filter pack in the annular space around the screen and to approximately two feet above. One to 2 feet of bentonite chips were placed on top of the sand pack and the remaining annular space surrounding the PVC riser pipe was filled using a tremie pipe with a cement/bentonite grout. The grout consisted of Portland cement or Quickgel mixed with not

more than six gallons of water per sack of cement and up to five percent bentonite clay.

The monitoring wells were completed by placing a Readi-mix concrete pad around a 3-foot-long, 6-inch-diameter, locking steel monument which was placed over the 2-inch well. Three bollards were installed in the concrete pad surrounding the steel monument.

### *Well Development*

After completion of well construction, each well was developed to remove accumulated fine-grained materials resulting from installation procedures and to provide good hydraulic connection with the aquifer. Well development was performed using a 2-inch stainless steel bailer or a WaTerra hand pump. All equipment used for development was washed with Alconox detergent, and rinsed with tap and deionized water before use at each well (with the exception of WaTerra Polyethylene Tubing and Foot Valves). Water level measurements were taken as depth to water level from the top of casing using an electronic well sounder. Wells were pumped or bailed to remove either 10 casing volumes of groundwater or until the water cleared. The water in MW-3 and MW-1 cleared within 4 casing volumes of removal. Well MW-2 cleared within 8 casing volumes. MW-4 never cleared, but because of slow inflow of water to the well, only 6 casing volumes were removed.

### *Relative Survey*

Wells were surveyed relative to each other so that water level data could be converted to a consistent datum. An elevation was assumed from a USGS topographic map for the top of the PVC casing at MW-1 as 1,790 feet. The top of the PVC casing was then surveyed relative to the assumed MW-1 casing elevation. The top of the PVC was used as the measuring point for each well. The surveyed elevations are presented in Table 1.

### *Water Level Measurements*

Depth to water in the newly installed groundwater monitoring wells were measured using an electronic water level indicator. Water levels were measured from a fixed mark on the PVC casing. Based on the relative elevation of this referenced point, and the measured depth to

groundwater, the groundwater elevation at each well site was calculated (Well Elevation - Depth to Water = Groundwater Elevation). The water level elevation data are presented in Table 1.

### *Groundwater Sampling Procedures*

Wells were purged prior to sampling to draw fresh formation water into the wells. We purged three to five casing volumes of water from each well using a WaTerra hand pump. Polyethylene tubing was dedicated to each well during purging and sampling (and remains in the wells for future sampling). Well casing volumes were calculated from the internal casing diameter, initial depth to water, and total depth of the well prior to purging.

Groundwater samples were collected from the wells using the WaTerra hand pump. Samples were placed in laboratory-supplied jars, preserved with ice in a cooler, and submitted to the laboratory within 12 hours of collection. A duplicate sample was collected from MW-3. A field blank was also prepared from deionized water. In addition, groundwater from each monitoring well was measured for temperature, pH, and electrical conductivity during the sampling episode.

# Key to Exploration Logs

## Sample Descriptions

Classification of soils in this report is based on visual field and laboratory observations which include density/consistency, moisture condition, grain size, and plasticity estimates and should not be construed to imply field nor laboratory testing unless presented herein. Visual-manual classification methods of ASTM D 2488 were used as an identification guide.

Soil descriptions consist of the following: Density/consistency, moisture, color, minor constituents, MAJOR CONSTITUENT, additional remarks.

### Density/Consistency

Soil density/consistency in borings is related primarily to the Standard Penetration Resistance. Soil density/consistency in test pits is estimated based on visual observation and is presented parenthetically on the test pit logs.

SAND or GRAVEL	Standard Penetration Resistance in Blows/Foot	SILT or CLAY	Standard Penetration Resistance in Blows/Foot	Approximate Shear Strength in TSF
Density		Consistency		
Very loose	0 - 4	Very soft	0 - 2	<0.125
Loose	4 - 10	Soft	2 - 4	0.125 - 0.25
Medium dense	10 - 30	Medium stiff	4 - 8	0.25 - 0.5
Dense	30 - 50	Stiff	8 - 15	0.5 - 1.0
Very dense	>50	Very stiff	15 - 30	1.0 - 2.0
		Hard	>30	>2.0

### Moisture

Dry	Little perceptible moisture
Damp	Some perceptible moisture, probably below optimum
Moist	Probably near optimum moisture content
Wet	Much perceptible moisture, probably above optimum

### Minor Constituents

	Estimated Percentage
Not identified in description	0 - 5
Slightly (clayey, silty, etc.)	5 - 12
Clayey, silty, sandy, gravelly	12 - 30
Very (clayey, silty, etc.)	30 - 50

## Legends

### Sampling

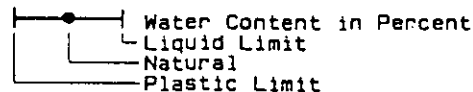
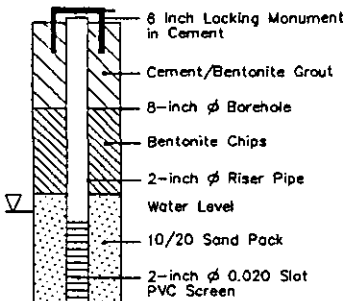
#### BORING SAMPLES

- Split Spoon
- Shelby Tube
- Cuttings
- \* No Sample Recovery
- P Tube Pushed, Not Driven

### Test Symbols

- GS Grain Size Classification
- CN Consolidation
- TUU Triaxial Unconsolidated Undrained
- TCU Triaxial Consolidated Undrained
- TCD Triaxial Consolidated Drained
- QU Unconfined Compression
- DS Direct Shear
- K Permeability
- PP Pocket Penetrometer
- Approximate Compressive Strength in TSF
- TV Torvane
- Approximate Shear Strength in TSF
- CBR California Bearing Ratio
- MD Moisture Density Relationship
- AL Atterberg Limits

### Monitoring Well Observations



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J-2260-02 11/90

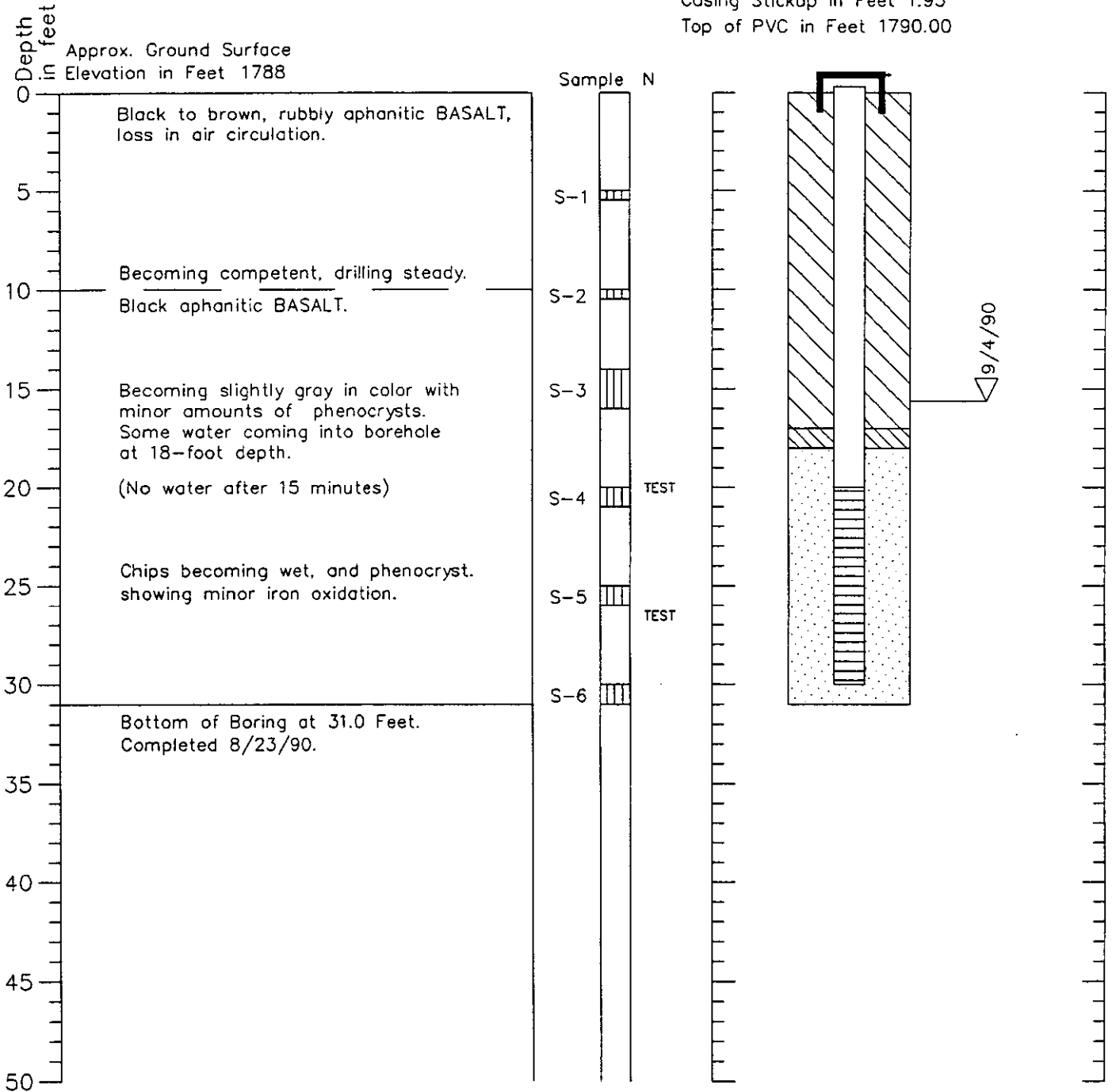
Figure A-1

# Boring Log and Construction Data for Monitoring Well MW-1

## Geologic Log

## Monitoring Well Design

Casing Stickup in Feet 1.95  
Top of PVC in Feet 1790.00



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. TEST refers to excavating casing of water with air pressure and monitoring of water level rise.



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Figure A-2

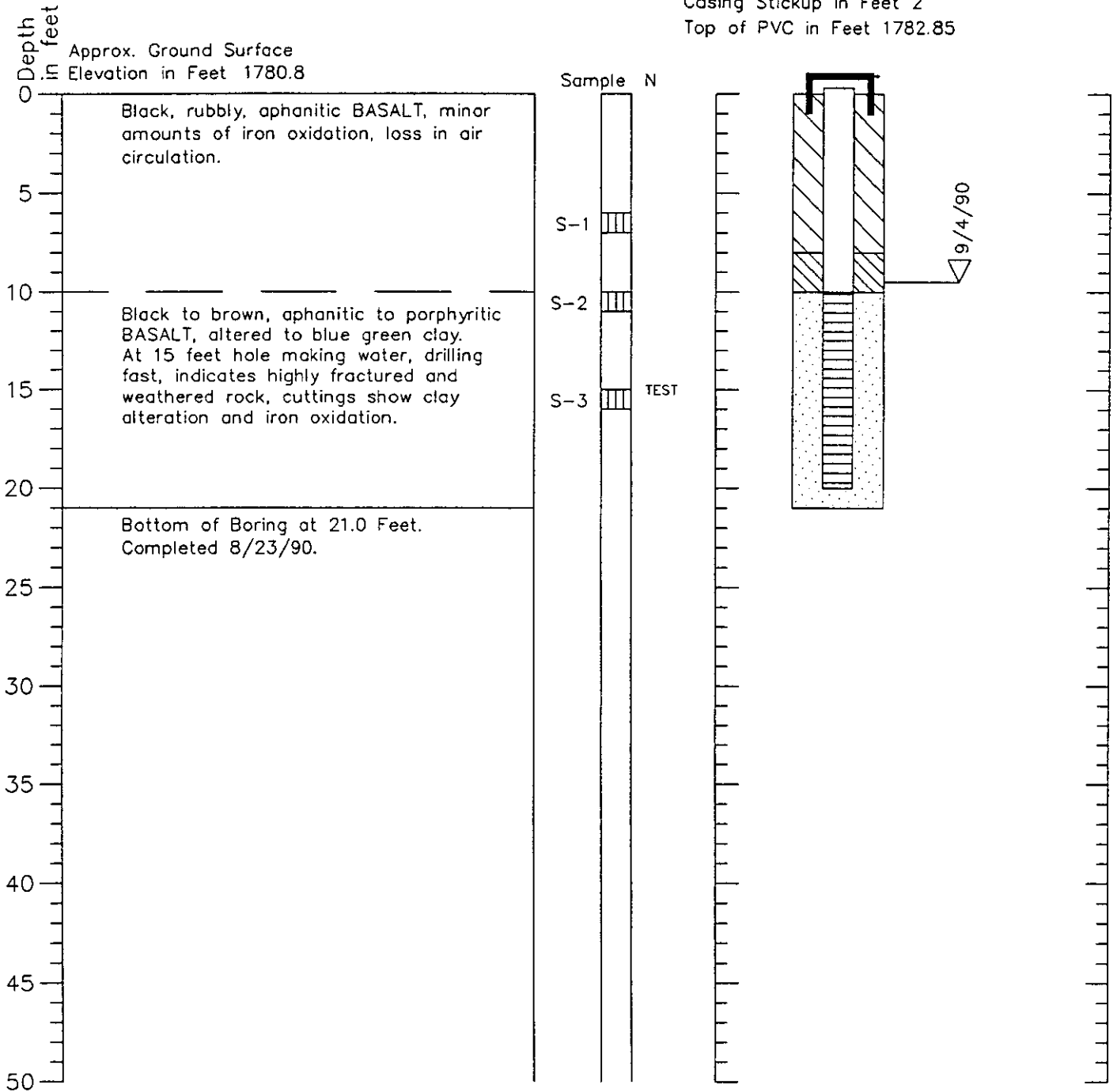


# Boring Log and Construction Data for Monitoring Well MW-2

## Geologic Log

## Monitoring Well Design

Casing Stickup in Feet 2  
Top of PVC in Feet 1782.85



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. TEST refers to excavating casing of water with air pressure and monitoring of water level rise.



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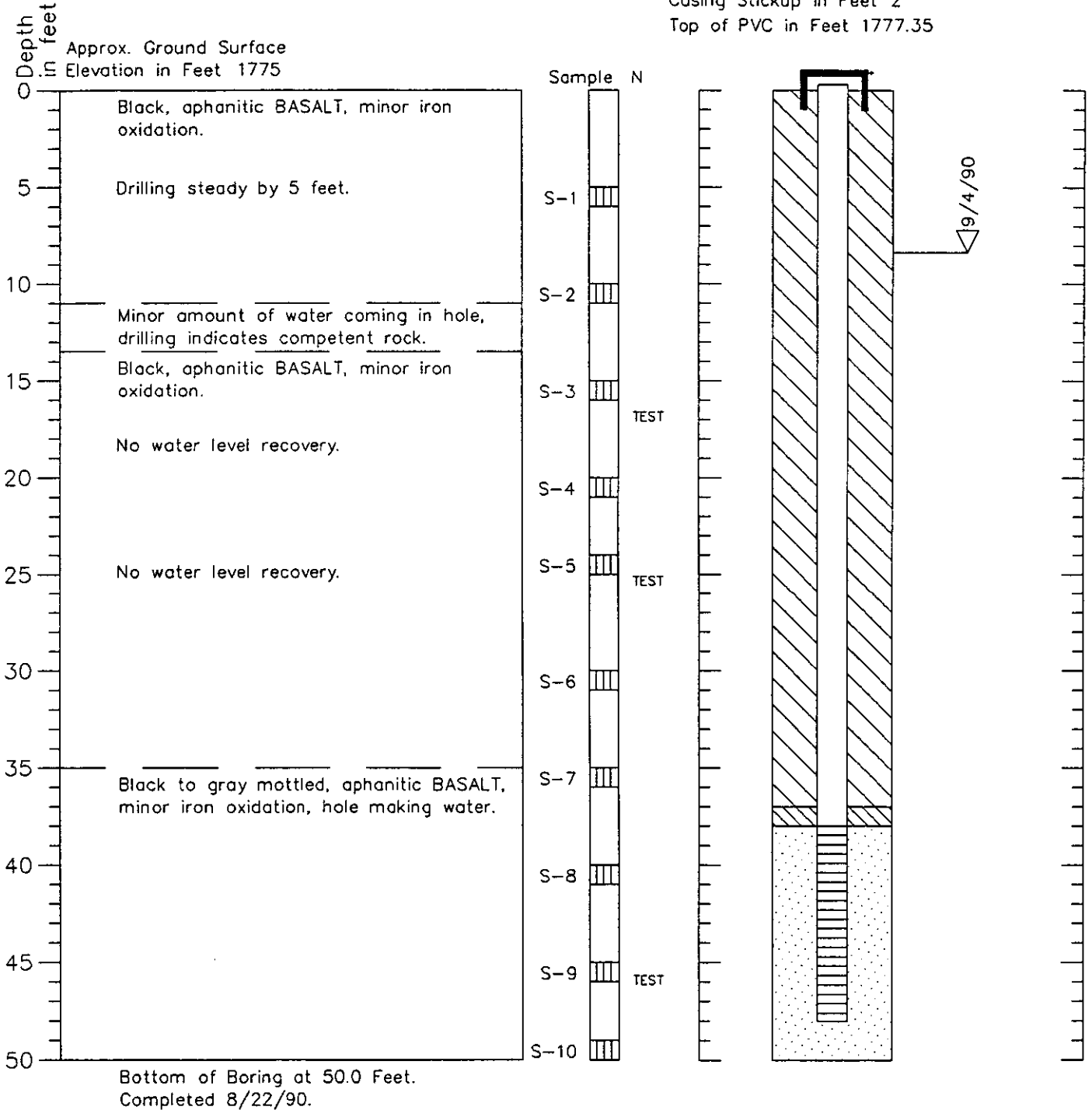
Figure A-3

# Boring Log and Construction Data for Monitoring Well MW-3

## Geologic Log

## Monitoring Well Design

Casing Stickup in Feet 2  
Top of PVC in Feet 1777.35



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. TEST refers to excavating casing of water with air pressure and monitoring of water level rise.



**HARTCROWSER**

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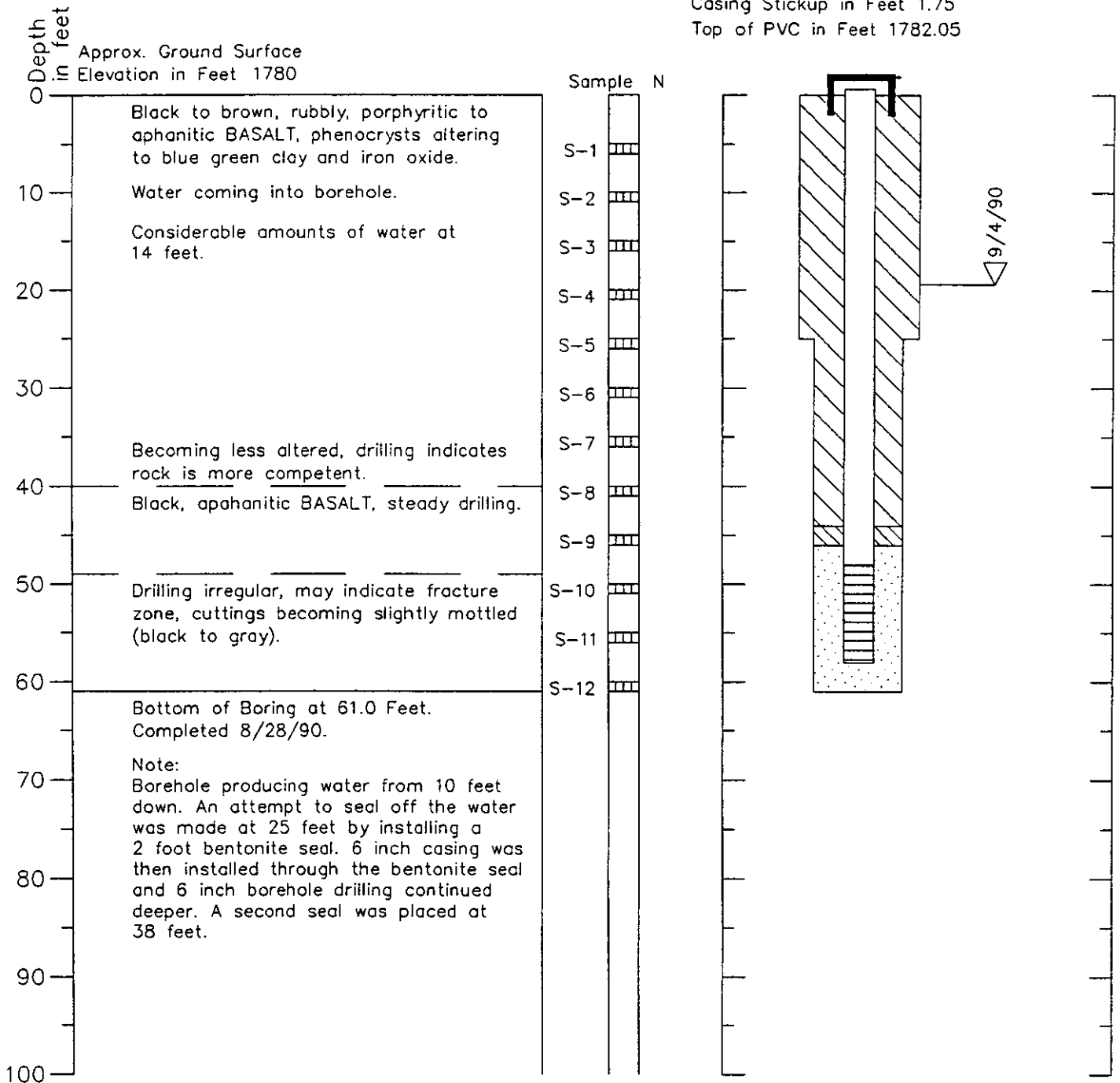
Figure A-4

# Boring Log and Construction Data for Monitoring Well MW-4

## Geologic Log

## Monitoring Well Design

Casing Stickup in Feet 1.75  
Top of PVC in Feet 1782.05



1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Ground water level, if indicated, is at time of drilling (ATD) or for date specified. Level may vary with time.
4. TEST refers to excavating casing of water with air pressure and monitoring of water level rise.



**HARTCROWSER**

J-2260-02

8/90

Figure A-5

**APPENDIX B  
LABORATORY DATA AND  
QUALITY ASSURANCE REVIEW**

**APPENDIX B  
LABORATORY ANALYTICAL DATA AND  
QUALITY ASSURANCE REVIEW**

*Quality Assurance/Quality Control Review*

Upon receipt from the laboratory, all analytical results underwent a Quality Assurance/Quality Control (QA/QC) review of laboratory and sample handling procedures. In addition to sample results, the laboratory data reports included QA/QC data for the laboratory blank, calibration data, and results of EPA blind performance QA/QC data. These data are attached and a summary of the data is presented in Table 2. In general the analytical data were deemed acceptable.

One water sample was collected for duplicate analysis (MW-3D). Duplicate analysis for all chemical parameters of interest were within acceptable limits. In addition a field blank was prepared and analyzed. Analytes of concern were not detected in the field blank, with the exception of chloride (1.0 mg/L). Chloride was detected at a concentration equal to the reported analytical method detection limit.

Hart Crowser  
J-2260-02

**CERTIFICATES OF ANALYSIS  
TRECLEN LABORATORIES**

## ANALYTICAL REPORT

Client: Hart-Crowser Inc  
 1910 Fairview East  
 Seattle, WA 98103

Ritzville Project

Report Number: 2640

Attn: Thomas Cammarata, Laurie Herman

<u>Sample Identification</u>	<u>mg/l</u> <u>NO<sub>3</sub>-N</u>	<u>mg/l</u> <u>NH<sub>4</sub>-N</u>	<u>mg/l</u> <u>Ortho P</u>	<u>mg/l</u> <u>Cl</u>	<u>Colonies/100mls</u> <u>Fecal Coliform</u>
MW-1	0.03	0.05	<0.01	135.0	0
MW-2	<0.01	0.10	8.0	62.0	3780
MW-3	0.01	0.02	0.43	50.0	0
MW-3D	<0.01	0.07	0.40	49.0	0
MW-4	<0.01	0.15	0.29	16.0	0
Field Blank	<0.01	<0.01	<0.01	1.0	0
<u>QC</u>					
Blank	<0.01	<0.01	<0.01	<1.0	0
Duplicate MW-3D	<0.01	0.07	0.40	49.0	-
Duplicate MW-4	-	-	-	-	0
Control Standard Value	0.50	1.0	1.0	-	-
Control Standard Analytical Value	0.47	0.98	1.0	-	-

Date: Sep 13, 1990

Signed: John E. TrecLen



# TrecLen Laboratories


N. 1403 Greene St., Unit 4  
Spokane, WA 99202  
(509) 535-5501

TrecLen Laboratories received 6 water samples from Tom Cammarata of Hart-Crowser Inc on Aug 29, 1990. These samples were accompanied by a chain of custody record indicating that the samples were taken on Aug 29, as well as showing the time that they were taken and the parameters to be tested for. A copy of the chain of custody has been included in this report.

The samples were analysed using EPA or equivalent methodology, within the prescribed holding times. Following is a list of the analytical methods used.

<u>Parameter</u>	<u>Description</u>	<u>Method No</u>	<u>Source</u>
Nitrate(NO <sub>3</sub> -N)	Cd Reduction	353.3	EPA Methods 1979
Ammonia(NH <sub>4</sub> -N)	Phenate (Manual)	418C	Standard Methods 14th Ed 1975
Phosphorous(Ortho)	Colorimetric	365.3	EPA Methods 1979
Chloride(Cl)	Mercuric Nitrate Titration	325.3	Standard Methods 14th Ed 1975
Coliform(Fecal)	Membrane Filter	909C	Standard Methods 14th Ed 1975





**Treclen Laboratories**  
 N. 1403 Greene St., Unit 4  
 Spokane, WA 99202  
 (509) 535-5501

Treclen Laboratories, as part of an ongoing QA/QC program, participates in an EPA blind performance evaluation program as well as analyzing known standards from APG on a quarterly basis. Following are the results of the most recent EPA evaluation report for Treclen Labs, dated 6/18/90.

<u>Analyte</u>	<u>Sam No</u>	<u>Report Value</u>	<u>Mg/L True Value</u>	<u>Acceptance Limits</u>	<u>Warning Limits</u>	<u>Performance Evaluation</u>
NO <sub>3</sub> -N	1	2.2	2.20	1.73-2.67	1.85-2.56	Acceptable
	2	7.0	6.50	5.34-7.67	5.62-7.39	Acceptable
NH <sub>4</sub> -N	1	3.5	3.60	2.80-4.34	2.99-4.16	Acceptable
	2	12.0	11.0	8.76-13.0	9.27-12.5	Acceptable
P(Ortho)	1	4.3	4.50	3.91-5.10	4.05-4.96	Acceptable
	2	1.0	0.95	0.779-1.12	0.820-1.08	Acceptable
C1	1	190.0	194.0	177-205	180-201	Acceptable
	2	92.0	95.0	86.4-101	88.2-99.2	Acceptable

Partial list of clients Treclen Labs performs water testing for.

- Spokane City Waste Water Treatment Plant
- City of Coeur d'Alene Waste Water Treatment Plant
- City of Moses Lake Sewage Treatment Plant
- U.S. Bureau of Indian Affairs
- Washing State University, in conjunction with U.S. Bureau of Indian Affairs
- Loon Lake Sewage Treatment Plant
- Diamond Lake Water & Sewage



United States  
 Environmental Protection  
 Agency

Region 10  
 1200 Sixth Avenue  
 Seattle WA 98101

**TOM CAMMARATA**  
**HART - CROWSER INC**  
**1910 FAIRVIEW EAST**  
**SEATTLE, WA 98103**

CHAIN OF CUSTODY RECORD

PROJECT		Lagoon		SAMPLERS: (Signature)							
Ritzville - Sewage				Thomas Cammarata							
LAB #	STATION	DATE	TIME	SAMPLE TYPE						NUMBER OF CONTAINERS	REMARKS
				WATER	SEDIMENT	ISSUE	AIR	OIL	OTHER		
	MW-1	8/29	1115	✓						2	Fecal Coliform Nitrate, Ammonia
	MW-2	8/29	1000	✓						2	"
	MW-3	8/29	1045	✓						2	"
	MW-3D	8/29	1045	✓						2	"
	MW-4	8/29	1300	✓						2	"
	<del>MW-4</del>	8/29		✓						2	"
	FIELD BLK	8/29	0900	✓						2	"
RELINQUISHED BY: (Signature)				RECEIVED BY: (Signature)				DATE/TIME			
Thomas Cammarata				John T. ...				8/29 1558 hrs			
RELINQUISHED BY: (Signature)				RECEIVED BY: (Signature)				DATE/TIME			
RELINQUISHED BY: (Signature)				RECEIVED BY: (Signature)				DATE/TIME			
RELINQUISHED BY: (Signature)				REC'D BY MOBILE LAB FOR FIELD ANAL: (Signature)				DATE/TIME			
DISPATCHED BY: (Signature)		DATE/TIME		RECEIVED FOR LAB BY: (Signature)		DATE/TIME					
METHOD OF SHIPMENT:											
HART - CROWSER Delivered.											

Using STATE LASH OR EPA Method

Distribution Original - Accompany Shipment  
 One Copy - Survey Coordinator Field Files

FIGURE 2  
 Chain Of Custody Record



**TrecLen Laboratories**

N. 1403 Greene St., Unit 4  
Spokane, WA 99202  
(509) 535-5501

TRECLLEN LABORATORIES IS A BROAD SERVICE LABORATORY SERVING THE CHEMICAL ANALYTICAL NEEDS OF INDUSTRY FOR OVER SIX YEARS. WITH SERVICES RANGING FROM ASSAY AND GEOCHEMICAL TESTING FOR THE MINING INDUSTRY, TO MEAT TESTING FOR THE REAL MEAT INDUSTRY, TO INDUSTRIAL AND HAZARDOUS WASTE TESTING FOR ALL INDUSTRIES, TRECLLEN LABORATORIES CAN ACCOMODATE MANY OF THE ANALYTICAL NEEDS IN THE INDUSTRIAL COMMUNITY. TRECLLEN LABORATORIES ATTEMPTS TO ACCOMODATE THE SPECIFIC NEEDS OF EACH CLIENT WITH RESPECT TO ANALYTICAL REQUIREMENTS AS WELL AS TIMELY REPORTING OF TEST RESULTS, FACILITATED BY FAXING RESULTS IF REQUIRED.

JOHN TRECHTER, OWNER AND CHIEF CHEMIST, IS A DEGREED CHEMIST WITH OVER 17 YEARS EXPERIENCE IN ANALYTICAL CHEMISTRY. WITH EXPERIENCE IN THE FIELDS OF ASSAYING AND GEOCHEMISTRY, AGRICULTURAL SOIL, WATER, COAL, NATURAL GAS, CRUDE PETROLEUM, PLANT TISSUE, MINE RECLAMATION AND INDUSTRIAL WASTE ANALYSIS, JOHN POSSESS A VARIED AND HIGHLY TECHNICAL BACKGROUND WHICH IS AN ASSET IN HELPING TO DEAL WITH CLIENTS PROBLEMS.

IN THE EVENT THAT TRECLLEN LABORATORIES MAY BE OF SERVICE TO YOU, PLEASE FEEL FREE TO CONTACT US.



# TrecLen Laboratories

N. 1403 Greene St., Spokane, WA 99202 (509) 535-5501  
 P.O. Box 14642, Spokane, WA 99214

## ENVIRONMENTAL SERVICES

### NON-METALLIC DETERMINATIONS

Total Coliform Bacteria	\$20.00	Settleable Solids	\$ 5.00
Fecal Coliform Bacteria	20.00	Total Dissolved Solids	10.00
Nitrate Nitrogen	12.00	Total Suspended Solids	10.00
Nitrate Nitrogen	8.00	Volatile Suspended Solids	15.00
Ammonia Nitrogen	10.00	pH	6.00
Phosphate Total	10.00	Specific Conductivity	6.00
Phosphate Ortho	10.00	Turbidity	8.00
Sulfate	10.00	Tannin/Lignin	30.00
Cyanide Total	20.00	Phenol	25.00
Cyanide Amenable to Chlorination	30.00	Oil & Grease	20.00
Cyanate	35.00	Chemical Oxygen Demand	20.00
Chloride	10.00	Biological Oxygen Demand	20.00
Fluoride	10.00	Dissolved Oxygen	10.00
Alkalinity	10.00	Color	10.00
Total Hardness	10.00	Boron	10.00
		Hexavalent Chromium	20.00

### METALLIC DETERMINATIONS

Aluminum (Al)	Copper (Cu)	Potassium (K)	This group of Metals priced at \$10.00 ea.	
Barium (Ba)	Iron (Fe)	Nickel (Ni)		
Cadmium (Cd)	Lead (Pb)	Silver (Ag)		
Calcium (Ca)	Lithium (Li)	Sodium (Na)		
Chromium (Cr)	Magnesium (Mg)	Strontium (Sr)		
Cobalt (Co)	Manganese (Mn)	Tin (Sn)		
	Molybdenum (Mo)	Zinc (Zn)		
Arsenic (As)	Mercury (Hg)	Selenium (Se)		\$15.00 ea.

**Quantity price discounts available upon request.**

Extraction Procedure Toxicity (EP Toxicity) priced at \$20.00/extraction, plus the prices listed above for each element tested.

Hazardous waste and industrial chemical consulting available on an individual basis.

Additional charges may be made on samples other than natural or waste water.

A minimum charge of \$25.00 per order may be charged on orders that total less than this amount.

All procedures used are EPA approved or, when no EPA procedure exists, Standard Methods for Water & Waste Water is used.

**APPENDIX C  
CITY OF RITZVILLE  
GROUNDWATER MONITORING AND SAMPLING PROCEDURES**

**APPENDIX C  
CITY OF RITZVILLE  
GROUNDWATER MONITORING AND SAMPLING PROCEDURES**

Groundwater sampling of wells MW-1, MW-2, MW-3, and MW-4 should proceed in the following manner:

Prior to going into the field;

- ▶ Obtain appropriate sample bottles from the laboratory,
- ▶ Bring a dedicated field notebook with you during all sampling events. Use it to record all of the sampling activities. An example Groundwater Sampling Form is attached which you should use during each sampling event to trigger your data collection activities. Always record each of the items listed on this form for each well.

In the field;

- ▶ Measure the water level in each well using a well sounder and record on the field notebook. Measure the water level from the top of the 2-inch PVC casing to the nearest hundredth (0.01) of an inch);
- ▶ Calculate the casing volume using the following equations:
  - ▶  $\text{Depth of Well in Feet} - \text{Water Level in Feet} = \text{Height of Water Column in Feet}$
  - ▶  $\text{Height of Water Column} \times 0.16 = \text{Volume of Water in Casing in Gallons}$
- ▶ Remove 3 casing volumes of water from the well (3 x volume of water in casing determined as above) before placing water in sample jars

Note: Well MW-4 should be purged first and sampled last due to the slow inflow of water into the well;

- ▶ Using the WaTerra hand pump - fill laboratory supplied bottles with groundwater (two bottles for each well - plastic bottles for nutrients and glass for fecal coliform). Collect a duplicate sample at one of the wells for QA/QC purposes.
- ▶ At each well, fill a clean glass jar with additional groundwater and measure pH, temperature and electrical conductivity; Record the measurements on the field notebook dedicated to the monitoring program.
- ▶ Prepare a field blank by running deionized water through a piece of clean WaTerra tubing - fill both the plastic and glass bottles; and
- ▶ All samples should be placed in a cooler with ice immediately after collection and delivered to the laboratory within 24 hours after collection.

# Groundwater Sampling Data

Project \_\_\_\_\_ Job No. \_\_\_\_\_

Field Rep. \_\_\_\_\_ Date \_\_\_\_\_

WELL NUMBER	DATE SAMPLED	WELL DEPTH IN FEET	DEPTH TO WATER IN FEET	DEPTH TO SEDIMENT IN FEET	SEDIMENT THICKNESS IN FEET	METHOD OF SAMPLING	COMMENTS	T °C	pH	EC IN $\mu$ MHOS	CASING VOLUME IN GALLONS	PURGE VOLUME IN GALLONS



**APPENDIX D  
REFERENCES**

**APPENDIX D  
REFERENCES**

City of Ritzville Grant Application for Ground Water Activities --  
Centennial Clean Water Fund, dated May 30, 1990.

Department of Ecology letter, dated February 17, 1989. Re:  
Compliance with Schedule of Compliance Condition S6.(b), State  
Waste Discharge Permit No. 8028.

Department of Ecology Grant Agreement: TAX 90195 between  
Ecology and City of Ritzville, approved June 13, 1990.

Freeze, R.A., and J.A. Cherry, 1979. Groundwater. Prentice-Hall,  
Inc., Publ. Englewood Cliffs, NJ. 604 p.

Hart Crowser, 1988. Hydrogeological Assessment and Groundwater  
Monitoring Recommendations for the City of Ritzville Sewage  
Lagoons, Ritzville, Washington, J-2260, December 22, 1988.

Hart Crowser, June 29, 1990. Work Plan for Sewage Lagoon  
Groundwater Monitoring Well System.



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**HARTCROWSER**

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