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Golder Associates Inc.
CONSULTING ENGINEERS

INSTALLATION AND PUMP-TESTING OF TEST WELLS AND RECOMMENDATIONS FOR FURTHER GROUND WATER EXPLORATION

BLAINE GROUND WATER MANAGEMENT AREA

DRAFT

Prepared for the
City of Blaine, Washington

Funded In Part by the
Washington State Department of Ecology
Through the Centennial Clean Water Fund

By
Golder Associates Inc.

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1. INTRODUCTION

This report summarizes the test well drilling and pump testing work completed to date, as part of the Blaine Ground Water Management Program (GWMP), and presents recommendations to further explore for additional sources of ground water within the Blaine Ground Water Management Area (GWMA). The work described in this report was carried out as part of the Data Collection and Analysis Plan (DCAP)[1] for the Blaine Ground Water Management Program. The overall purpose of the data collection program is to better understand the hydrogeology and availability of ground water in the area.

The work outlined in the DCAP, includes the following:

- Drilling and completion of three test wells;
- Test-pumping of each test well, and analysis of the results to determine the hydraulic characteristics of the water-bearing zones;
- Collection and analysis of ground-water-quality samples from each test well;
- Collection and analysis of ground-water-quality samples from wells throughout the GWMA;
- Measurement of stream flows in Dakota Creek and an unnamed the stream draining from the Blaine Watershed;
- Measurement of precipitation on the Boundary Uplands area near the Blaine Watershed.

The work completed to date includes the drilling and pump-testing of the three test wells, and the collection of ground-water-quality samples from these wells. Stream gages have also been installed in Dakota Creek and in a stream draining from the Blaine Watershed. Sufficient data has yet to be collected from the gaging stations for analysis. A precipitation gaging station has not yet been installed in the Boundary Uplands region, and regional ground water quality sampling has yet to be conducted.

This report presents an interim evaluation of the hydrogeologic conditions based on the three test wells, and presents recommendations for further hydrogeologic investigations to better define the ground water resources of the GWMA.

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[1] *Blaine Ground Water Management Area- Data Collection and Analysis Plan, Prepared by Golder Associates, dated November,1990.*

2. FIELD WORK

2.1 Drilling and Well Installation

Three test wells (GWMP-1, GWMP-2, and GWMP-3) were drilled and constructed by Hayes Well Drilling of Bow, Washington under the observation of a Golder Associates hydrogeologist. The boreholes were drilled at eight-inch diameter with an air-rotary rig, using drill-drive methods to advance the eight-inch steel casing into the subsurface. Well locations are shown on Figure 2-1.

Drill cuttings were collected every five feet, except when advancing through potential water-bearing zones, where samples were collected every 2.5 feet. The drill cuttings were visually inspected and described, and then the samples were archived for future reference.

Each well was completed with a type 304 stainless-steel continuous wire-wound telescoping well screen, fitted with a mild-steel riser pipe and neoprene "K" packer. Each screen assembly was lowered into the borehole to the desired depth, and then the casing was pulled back to expose the screen to the aquifer. Screen slot-sizes were chosen based on the grain-size of the aquifer materials. Each well was developed by bailing and air lifting ground water from the well. Each well has a sanitary seal of cement-bentonite to a depth of 18 feet, and is equipped with a locking well cap. Borehole logs and completion details for each well are presented in Appendix A.

2.1.1 Test Well GWMP-1

Test well GWMP-1 was drilled and completed between August 27 and August 31, 1990 to a total depth of 278 feet below ground surface (bgs). Fine sand with a trace of silt was encountered from the surface to a depth of 64 feet. Groundwater was encountered at a depth of between 45 and 60 feet. Air lift water flows were generally less than five gallons per minute (gpm) from this zone. Silt with a trace of fine sand was encountered between 64 and 120 feet. Fine sand was encountered at a depth of between 120 and 150 feet, and alternating layers of fine sand with silt, and silt were encountered between 150 and 161 feet. Fine to coarse sand with silt and gravel was encountered between 161 and 188 feet. Air lift water flows from this zone were estimated at between 10 and 20 gpm. Fine sand was encountered at 188 feet, which graded downward to sandy clay at a depth of 237 feet. Silty clay was encountered from 237 to 278 feet where the borehole was terminated.

The most productive water-bearing zone was encountered at a depth of between 161 and 188 feet bgs. The casing was cut at 195 feet bgs, and the bottom section of the casing was back-filled with bentonite and pea-gravel. Ten feet of 40-slot well screen was then installed at a depth of 176 to 186 feet, and the eight-inch casing was pulled back to expose the screen to the aquifer. The well was developed for approximately two hours, at which time, the water was slightly cloudy. The air lift water flow rate at the end of the two-hour development period was approximately 14 gpm.

2.1.2 Test Well GWMP-2

Test well GWMP-2 was drilled and completed between September 4 and September 10, 1990 to a total depth of 303 feet bgs. Sand and gravel was encountered from the surface to a depth of 17 feet. Silty clay and clayey silt were encountered between 17 and 55 feet. Water-bearing fine to coarse sand and gravel was encountered between 55 and 90 feet. Air lift water flows from this zone were approximately 33 gpm. Peat was encountered between 90 and 94 feet, and fine sand was encountered between 94 and 101 feet. Silty clay was encountered between 101 and 228 feet; silty fine sand was encountered between 228 and 240 feet; and silty clay was encountered between 240 and 303 feet, where the borehole was terminated.

Ground water was first encountered at a depth of 55 feet. However, as the borehole was advanced into the zone between 70 and 90 feet, the static water level dropped to approximately 70 feet bgs. This suggests that the upper ground water was probably perched above a thin silty layer within the sand and gravel and thought to exist at a depth of about 70 feet (based on the drilling action). The aquifer at a depth of between 70 and 90 feet was targeted for testing since this represented the most promising water-bearing material encountered in the borehole.

The casing was cut at 92 feet bgs, and the lower section of casing was backfilled with bentonite and pea gravel. Five feet of 60-slot screen was installed between 83.5 and 88.5 feet bgs, and the remaining eight-inch casing was pulled back to expose the screen to the aquifer. The well developed quickly, and the water was clear by the end of development. The air lift flow at the end of development was approximately 60 gpm.

2.1.3 Test Well GWMP-3

Test well GWMP-3 was drilled and completed between September 10 and September 14, 1990 to a total depth of 299 feet bgs. Silty clay was encountered from the surface to 23 feet bgs. Clay and sandy gravel were encountered between 23 and 35 feet bgs, and sand and gravel was encountered between 35 and 53 feet bgs. No water was encountered within this zone. Clayey fine sand was encountered between 53 and 100 feet. Water-bearing fine to medium sand was encountered at 100 feet bgs, which graded downward to sand and gravel at a depth of 145 feet. Sand and gravel was encountered between 145 and 161 feet bgs, and graded downward to fine sand with silt at a depth of 220 feet. Air lift water flows ranged from 60 gpm to over 200 gpm while drilling through the sand and gravel encountered between 100 and 220 feet. Sandy silt and clayey silt were encountered between 220 and 247 feet bgs, and clay and gravel was encountered between 247 and 255 feet bgs. Water-bearing fine sand was encountered between 255 and 299 feet bgs, where the borehole was terminated. Air lift water flows from this zone were about 30 gpm.

The most productive water-bearing zone was found at a depth of between 143 to 163 feet bgs, although the full thickness of this aquifer extends from 100 feet to 220 feet bgs. A second potentially productive aquifer is also present at this location, extending from 255 feet to at least 299 feet (where the borehole was terminated). To complete the well, the casing was cut at 164 feet bgs and the bottom casing was back-filled with bentonite and pea gravel. Ten feet of 60-slot screen was installed between 148 and 158 feet bgs, and then the eight-inch casing was pulled back to expose the screen to the aquifer. The well developed quickly, and the water from the well was clear by end of development. The air lift flow at the end of development was approximately 200 gpm.

2.2 Pump Tests

Test wells GWMP-2 and GWMP-3 were pump tested, and well GWMP-1 was slug-tested to estimate the hydraulic properties of the water-bearing zones. The testing was carried out from October 2 to October 8, 1990, by Hayes Drilling Company, and observed by a Golder Associates hydrogeologist.

2.2.1 Test Well GWMP-1

Test well GWMP-1 was slug tested on October 2, 1990 by rapidly drawing the water level in the well down by 36 feet using a submersible pump, and then measuring the water-level recovery to within 95% of the original static water-level. GWMP-1 was not pump tested because of the poor air lift water flows (14 gpm) observed during well development.

2.2.2 Test Well GWMP-2

Test well GWMP-2 was step-tested on October 8, 1990. The test consisted of four 30-minute steps at pumping rates of approximately 17 gpm, 75 gpm, 145 gpm, and 205 gpm. The pump was then turned off and the water-level recovery was measured to within 99% of the original static water level.

A 24-hour constant-rate test, at a rate of 149 gpm, was initiated on October 8, 1990. During the test, water levels were also measured in a nearby domestic well and in City of Blaine Well No.7. The ground water levels in these wells were not influenced by the pump test. The maximum drawdown in the pumping well at the end of the test was 6.75 feet.

2.2.3 Test Well GWMP-3

Test well GWMP-3 was step-tested on October 4, 1990. The test consisted of five 30-minute steps at pumping rates of approximately 61 gpm, 150 gpm, 250 gpm, 350 gpm, and 375 gpm. The pump was turned off after the fifth step and the water-level recovery was measured to within 96% of the original static water level.

A 24-hour constant-rate test, at a rate of 490 gpm, was initiated on October 4, 1990. After 720 minutes of pumping, the flow rate was cut back to 396 gpm because the water level in the well was approaching the pump intake. The pumping rate was maintained at 396 gpm for the remainder of the test. The drawdown in the well at the end of the test was 44.77 feet.

2.3 Water Quality Sampling

Ground water samples were collected from all test wells for analysis. The samples were collected and preserved according to the technical procedure in the Quality Assurance Project Plan. The samples were submitted to Analytical Technologies in Renton for analysis.

The sample from GWMP-1 was collected following the slug test by pumping the well at a steady rate of about 7 gpm for thirty minutes. At the time of sampling the physical parameters of the water were measured as follows: temperature 54°F, specific conductance 210μS/cm, and pH 8.4.

Two ground water samples were collected from test wells GWMP-2 and GWMP-3; the first after one hour of pumping, and the second at the end of the test. Only the second sample was submitted for analysis. At the time of sampling the physical parameters of the ground water from GWMP-2 were as follows: temperature 50°F, specific conductance 180 μS/cm and pH 7.65. Ground water from GWMP-3 was measured as follows: temperature 52°F, specific conductance 210μS/cm and pH 7.86.

3. RESULTS

3.1 Geology

3.1.1 Overview

The geology of the GWMA consists of Quaternary glacial deposits of the Fraser Glaciation and Pre-Fraser glacial and non-glacial sediments. Little is known about Pre-Fraser glacial and non-glacial sediments in the vicinity of the GWMA. The Fraser Glaciation consisted of the Vashon and Sumas Stades, two major periods of glacial advance, which were separated by a period of glacial retreat, named the Everson Interstade. The Vashon deposits consist of a sand and gravel unit of fluvial origin, named the Esperance Sand, and a till unit consisting of unsorted gravel, sand, silt, and clay, named the Vashon Drift. As the Vashon Stade glaciers retreated, the area was invaded by the sea, and Everson Interstade sediments were deposited, which consisted of the Kulshan glaciomarine drift, the Deming sand and the Bellingham glaciomarine drift. The deposits include interbedded fossiliferous stony clays, stony silt, till-like mixtures, marine clay, deltaic sand and gravel, fluvial and lacustrine clay, silt, sand, gravel, and peat. During the waning stages of the last glacial period, a small glacial re-advance (Sumas Stade), deposited glacial outwash in the Sumas region[2,3].

3.1.2 Interpretation of New Borehole Logs

Geologic logging of the test wells has refined our understanding of the geology within the GWMA. The material encountered in the boreholes differed substantially, indicating the complexity of the geology within the GWMA. Identification of the geologic materials has allowed us to develop preliminary stratigraphic correlations, and to refine our conceptual geologic model of the GWMA. Geologic cross-sections, and a more detailed discussion of the geology of the GWMA, will be presented in the area characterization report.

Borehole GWMP-1 encountered fine-grained materials thought to be Bellingham Drift, from the surface to a depth of approximately 150 feet. This material consisted of fine sand with occasional gravel, fine sand with silt, silt, and clayey silt. Fine to coarse sand with gravel, which is thought to be Deming Sand, was encountered between 150 and approximately 190 feet. Fine sand, grading to sandy clay, and silty clay, thought to be Kulshan Drift, was encountered between 190 and 278 feet where the borehole was terminated.

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[2] *Easterbrook, D. J. (1976). Geologic Map of Western Whatcom County, USGS Miscellaneous Investigations Series Map I-854-B, Scale 1:62,500.*

[3] *Armstrong, J.F., Crandell, D.R. Easterbrook, D.J., and Noble, J.B., 1965. Late Pleistocene Stratigraphy and Chronology on Southwestern British Columbia and Northwestern Washington. Geological Society of America Bulletin, Volume 76, p. 321-330.*

Borehole GWMP-2 encountered sandy clay and gravel, and fine to coarse sand, believed to be Recent colluvium and Sumas glacial deposits, from the surface to a depth of 17 feet. Silty clay and clayey silt, thought to be Bellingham Drift, was encountered between 17 and 55 feet. Sand and gravel, and peat, thought to be Deming Sand was then encountered between 55 and 100 feet. Silty-clay, thought to be Kulshan Drift, was encountered from 100 to 303 feet where the borehole was terminated.

Borehole GWMP-3 encountered silty clay, clay and gravel, and sandy gravel, thought to be recent colluvium and Sumas glacial deposits, from the surface to a depth of 53 feet. Clayey fine sand with occasional gravel, thought to be Bellingham Drift, was encountered from 53 to 100 feet. Sand and gravel, thought to be Deming Sand, was encountered between 100 and 220 feet. Silty sand and clayey silt, thought to be Kulshan Drift was encountered between 220 and 255 feet. Fine sand with occasional gravel thought to be Vashon glacial fluvial deposits were encountered from 255 to 299 feet, where the borehole was terminated.

3.2 Hydrogeology

One potentially productive aquifer was encountered in borehole GWMP-2, and two potentially productive aquifers were encountered in borehole GWMP-3. The aquifer encountered in GWMP-2 consists of sand and gravel, and occurs at a depth of between 70 and 90 feet. The shallow aquifer in borehole GWMP-3 was encountered at a depth of between 100 and 220 feet, and consists of sand with some gravel. Test well GWMP-3 was installed within this aquifer. The second and deeper aquifer was encountered at a depth of between 255 and 299 feet (where the borehole was terminated), and consists of fine sand. The full thickness of this deeper aquifer is unknown.

3.2.1 Pump-Test Analysis

The pump tests were analyzed using an analytical well hydraulics program. This program is capable of incorporating complex aquifer conditions much better than conventional curve-matching or straight-line pump test interpretation methods. Results of the slug-test conducted in well GWMP-1 were analyzed using the methods of Hvorslev[4] and Papadapolous et al[5].

The well hydraulics program is used to simulate the drawdown and recovery of a well based on a set of user specified hydraulic parameters (transmissivity, storativity, well loss coefficient, etc.). The parameters are manually adjusted until the simulated drawdown and recovery closely matches the observed drawdown and recovery data. The well hydraulics

[4] *Hvorslev, M.J., 1951. Time Lag and Soil Permeability in Groundwater Observations. U.S. Army Corps of Engineers Waterways Exp. Sta. Bull. 36, Vickburg, Miss.*

[5] *Papadapolous, I.S., J.D. Bredehoeft and H.H. Cooper, 1973. On the Analysis of Slug Test Data, Water Resources Res., Vol. 9, PP. 1087-1089.*

program is capable of incorporating complex aquifer conditions such as boundaries and also well performance parameters (such as well loss constant and borehole skin effects). However, as with conventional analysis methods, storativity cannot be determined based only on the drawdown and recovery from the pumping well. Thus, we assumed storativity values based on our knowledge of the hydrogeologic conditions.

3.2.1.1 GWMP-1

The slug test indicates that the hydraulic conductivity of the screened material is relatively low, between 1.5 and 3.0 ft/day. This translates into a transmissivity of between 60 and 120 ft^2/day for the saturated thickness of 40 feet. This aquifer, at this location, is not capable of producing large enough quantities of groundwater to warrant further investigation.

3.2.1.2 GWMP-2

Analysis of the pump test of test well GWMP-2 indicates that the aquifer is very permeable with an estimated transmissivity of 14,000 ft^2/d. We have assumed that the aquifer is unconfined to slightly confined, because the static water level is below the top of the aquifer. Thus, we assumed a storativity of 0.01, which is typical of unconfined to slightly confined aquifers. Our analysis indicates that the aquifer is limited laterally by possibly two low-permeability boundaries. The exact location and orientation of these boundaries cannot be determined without additional wells. Assuming that the storativity of the aquifer is 0.01, the boundaries appear parallel to sub-parallel, and located within 400 feet of the well. This model is consistent with glacial-fluvial sediments deposited within a channel cut into less permeable material. A comparison of the observed and simulated drawdown and recovery data (based on the interpreted aquifer conditions) is shown in Figure 3-1.

Our analysis indicates that the test well is relatively inefficient at the pumping rate of 149 gpm. Of the drawdown in the well of 6.75 feet at the end of the test, only about 2.5 to 3.0 feet was due to aquifer drawdown. The additional drawdown was the result of well losses due to turbulent flow of water into the well, and possibly non-laminar flow within the aquifer immediately outside the well screen. The test well is about 40% efficient at the tested pumping rate of 149 gpm.

The estimated distance from the test well to the low-permeability boundaries is very sensitive to the value of storativity used in our simulations. Storativity cannot be accurately determined from the drawdown and recovery data from the pumping well alone, and water-level data from additional monitoring wells are required. The boundaries could be as close as 50 to 100 feet from the test well if a lower storativity is assumed.

Although the aquifer is very permeable, the saturated thickness of the aquifer at the time of testing was only about 20 feet. Thus, the available drawdown in the test well or any future wells is limited to 10 feet or less. The limited drawdown correspondingly limits the pumping rate of any future production wells installed in this aquifer. Assuming a maximum drawdown of 10 feet, we believe that an efficient production well could yield approximately 200 gpm on a short-term basis (i.e., one to three months).

The potential long-term yield of this aquifer is dependent on the extent of the aquifer and the long-term recharge to the aquifer. The 24-hour test did not show any evidence of recharge from leakage. The aquifer is, however, likely recharged by precipitation in the winter months and possibly leakage from adjacent sediments. A more accurate estimate of the potential long-term yield of the aquifer and hence long-term pumping rate from any future production wells would require the following:

- Long-term monitoring of water levels to identify seasonal ground water-level fluctuations.
- Installation of an additional monitoring well adjacent to the test well and a longer pump-test (three to seven days) of the test well.

The longer pump test would provide a better estimate of storativity and could identify more distant low-permeability or recharge boundaries that would influence long-term aquifer behavior.

3.2.1.3 GWMP-3

Analysis of the pump test of GWMP-3 indicates that the shallow aquifer at this location is moderately permeable, with an estimated transmissivity of 4,000 ft^2/day. We assumed that the aquifer is confined to semi-confined aquifer, because the static water level was about 15 feet above the top of the aquifer, and that even during pumping the water-level in the aquifer may not have been drawn down more than 15 feet during the pump test. We assumed a storativity of 2.0×10^{-4}, which is typical of confined to semi-confined aquifers. Our analysis using the well hydraulic program indicates that the aquifer may be limited laterally by two low-permeability boundaries. Based on the assumed storativity value, the boundaries appear to be located approximately 2,000 feet on either side of the well, and are thought to be parallel to sub-parallel. The exact location and orientation of these boundaries, however, cannot be determined without additional observation wells. A comparison of the observed and simulated drawdown and recovery data (based on the interpreted aquifer conditions) is shown in Figure 3-2.

As discussed in Section 3.2.1.2, the estimated distance from the well to the low-permeability boundaries is very sensitive to the value of storativity used in our simulations. Storativity cannot be accurately determined from the drawdown and recovery data from the pumping well alone. For example, if this aquifer behaved more as an unconfined aquifer rather than a confined aquifer, with a storativity of 0.015, the distance to the low-permeability boundaries, would be reduced to within 250 feet of the well. Accurate determination of storativity and, subsequently, the location of the boundaries is important with regard to the placement of possible future production wells within the aquifer.

Our analysis indicates that the test well is relatively efficient at the tested pumping rate. Of the drawdown in the well of 44 feet at the end of the test, approximately 30 feet appears to be due to aquifer drawdown. The additional drawdown was the combined result of partial penetration of the aquifer by the well and well losses due to turbulent flow of water into the well, and possibly non-laminar flow within the aquifer immediately outside the well screen. The test well is estimated to be about 70% efficient at the tested pumping rate.

Based on our present understanding of this aquifer, the maximum potential short-term yield (one to three months), for a 100% efficient well, is expected to be between 350 to 450 gpm, assuming an allowable drawdown in the well of 40 feet. The potential long-term yield of the aquifer is dependent on the amount of recharge to the aquifer either from leakage from adjacent or underlying sediments or from infiltration of precipitation in the winter months. We have made a preliminary estimate for long-term well yield of between 150 and 250 gpm. However, the actual yield of the aquifer is dependent on its extent and amount of recharge.

A better estimate of the potential long-term yield of the aquifer and hence the potential pumping rate(s) of individual production wells, would require further ground water level monitoring, the installation of an additional monitoring well(s), and a longer pump-test. The pump test is required to determine the presence of more distant low-permeability or recharge boundaries/leakage, and to obtain a better estimate of aquifer storativity.

3.2.2 Water Quality

Analysis of the ground water samples collected from the test wells indicates that the quality of the ground water is good. The ground water meets the primary and secondary drinking water standards for the analyzed constituents, except for manganese and iron. Manganese concentrations are at or above the secondary standard of 0.05 mg/L in the samples collected from all three wells (0.05, 0.1, and 0.05 mg/L in GWMP-1, GWMP-2, and GWMP-3, respectively). Iron concentrations are above the secondary standard of 0.3 mg/L in the sample collected from well GWMP-1 (0.48 mg/L). Similar iron and manganese concentrations are present in the ground water being pumped from some of the City production wells. These concentrations have been low enough such that no adverse consequences have resulted. Water quality data are presented in Appendix C.

4. SUMMARY AND RECOMMENDATIONS

4.1 Summary

The installation and pump testing of the three test wells has identified three moderately productive aquifers capable of supplying ground water in quantities required for municipal supply purposes. One of the aquifers was encountered in borehole GWMP-2, and the other two were encountered in borehole GWMP-3.

The aquifer encountered in well GWMP-2 at a depth of between 55 and 90 feet consists of sand and gravel. This aquifer is very permeable, but well yields are limited because of the available drawdown (about 10 feet), and the limited extent of the aquifer. The long-term aquifer yield is unknown at this time until additional data including aquifer extent and recharge are collected. We estimate that short-term well yields of between 100 and 200 gpm are possible from this aquifer.

The shallow aquifer encountered in well GWMP-3 at a depth of between 100 and 220 feet consists mostly of sand and gravel. This aquifer is moderately permeable, and appears to be capable of yielding between 350 and 450 gpm to a properly installed well on a short-term basis. The aquifer appears to be limited by low-permeability boundaries. The long-term yield of the shallow aquifer will be dependent on the extent of the aquifer and recharge from either leakage from the materials surrounding the aquifer, or from infiltration of precipitation. The potential long-term yield of an efficient production well is presently estimated at between 150 and 250 gpm, based on a maximum allowable drawdown of 65 feet. This estimate assumes that the aquifer is not receiving leakage from overlying or underlying sediments. Greater yields would be possible if recharge occurs.

The deeper aquifer encountered in well GWMP-3 at a depth of between 255 and at least 299 feet consists of fine sand. The thickness of this aquifer is unknown because the borehole was terminated before penetrating the full thickness of the aquifer. This aquifer has not been pump-tested, and represents a promising prospect for future ground water exploration. Although this aquifer is somewhat finer grained than the overlying shallow aquifer, it still may be capable of yielding several hundred gallons a minute of groundwater to a properly installed well. The greater depth of the aquifer offers the advantage of a potentially greater available drawdown for pumping. In addition, the aquifer may have a greater lateral extent than the overlying aquifer, and may be receiving recharge from adjacent aquifers, which would reduce the long-term drawdown and increase long-term yield.

The estimated aquifer parameters determined from the pump tests of test wells GWMP-2 and GWMP-3 are based on the analysis of a single pumping well without benefit of adjacent observation wells. Thus, the storativity of the aquifers is uncertain. The extent of the aquifers is also uncertain because no observation wells were available during the tests. Aquifer extent controls the amount of recharge which is able to enter the aquifer (i.e., potential long-term yield), and also governs the location(s) of additional production wells.

4.2 Recommendations

Based on the work carried out to date, we have developed the following recommendations (in order of priority) to pursue further evaluation of the ground water resources in the vicinity of the Blaine Watershed.

1) Objective: **Evaluate Ground Water Supply Potential of the Deeper Aquifer at GWMP-3 Site**

Approach: A test/production well should be installed in the deep aquifer adjacent to well GWMP-3. The well should be pump-tested for a period of between three and seven days to determine the hydraulic properties of the aquifer and to identify potential leakage/recharge. We recommend that this well should be completed as follows: Twelve-inch diameter casing should be installed using drill-drive methods to the final depth of between 300 and 400 feet. The well should be gravel packed, and completed with eight-inch diameter casing and an eight-inch pipe-size well screen of appropriate slot-size. In addition, a one-inch diameter piezometer should then be installed within the shallow aquifer, to allow for additional monitoring of the water levels within this aquifer.

2) Objective: **Further Evaluation of the Shallow Aquifer at GWMP-3 Site**

Approach: Test well GWMP-3 should be pump tested for three to seven days, while monitoring the response in both the well and in the piezometer installed in the shallow aquifer as part of the proposed new well. Monitoring of the response to pump-testing in the piezometer will permit a better estimate of storativity and aquifer boundaries. The pump-test should be continued for at least three days in order to determine if the aquifer is receiving leakage from overlying or underlying aquifers. Leakage from other aquifers could substantially reduce the long-term drawdown and allow for increased production of the aquifer.

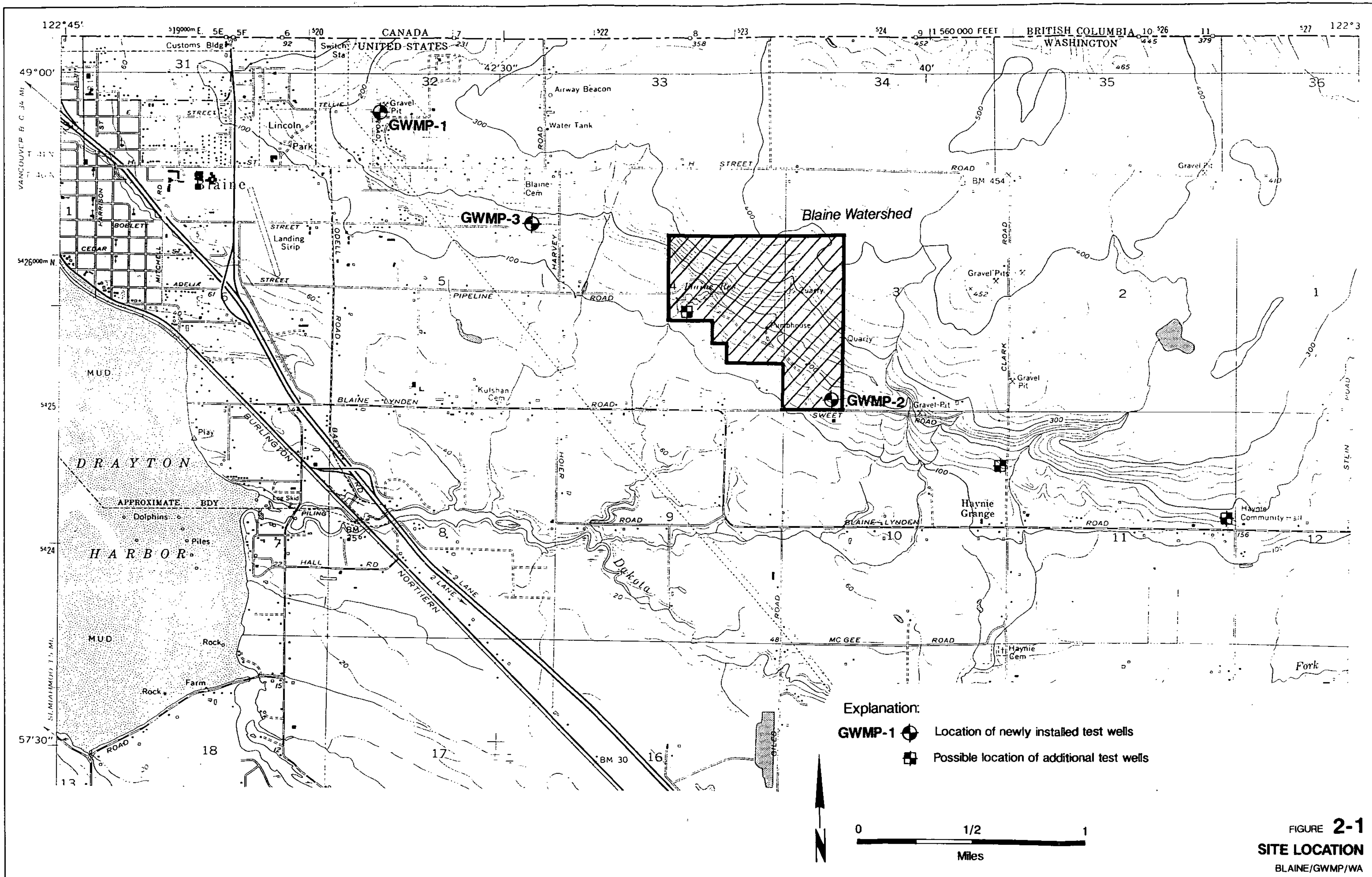
3) Objective: **Evaluate the Ground Water Supply Potential East of the Blaine Watershed.**

Approach: Two or three additional exploratory wells should be drilled at the locations shown on Figure 2-1. Following drilling, each well should be pump tested to determine whether the water-bearing materials are suitable for development as a municipal supply. We estimate that each well could be between 300 and 400 feet deep.

We recommend exploring the area east of the Blaine Watershed, because this is an area where few deep wells have previously been drilled, and where we believe there is a good possibility of encountering similar sediments to those encountered by the Watershed wells and by the GWMP-3 test well. The southwestern corner of the Blaine Watershed may also offer a promising location for exploration, if the deep aquifer in the vicinity of GWMP-3 appears to be extensive and worth developing for municipal purposes.

Figures

FIGURES



Explanation:

GWMP-1 ⊕ Location of newly installed test wells

⊞ Possible location of additional test wells

0 1/2 1
Miles

FIGURE **2-1**

SITE LOCATION

BLAINE/GWMP/WA

PROJECT NO 903-1060-303 DWG NO 23555 DATE 11/2/90 DRAWN HP

Golder Associates

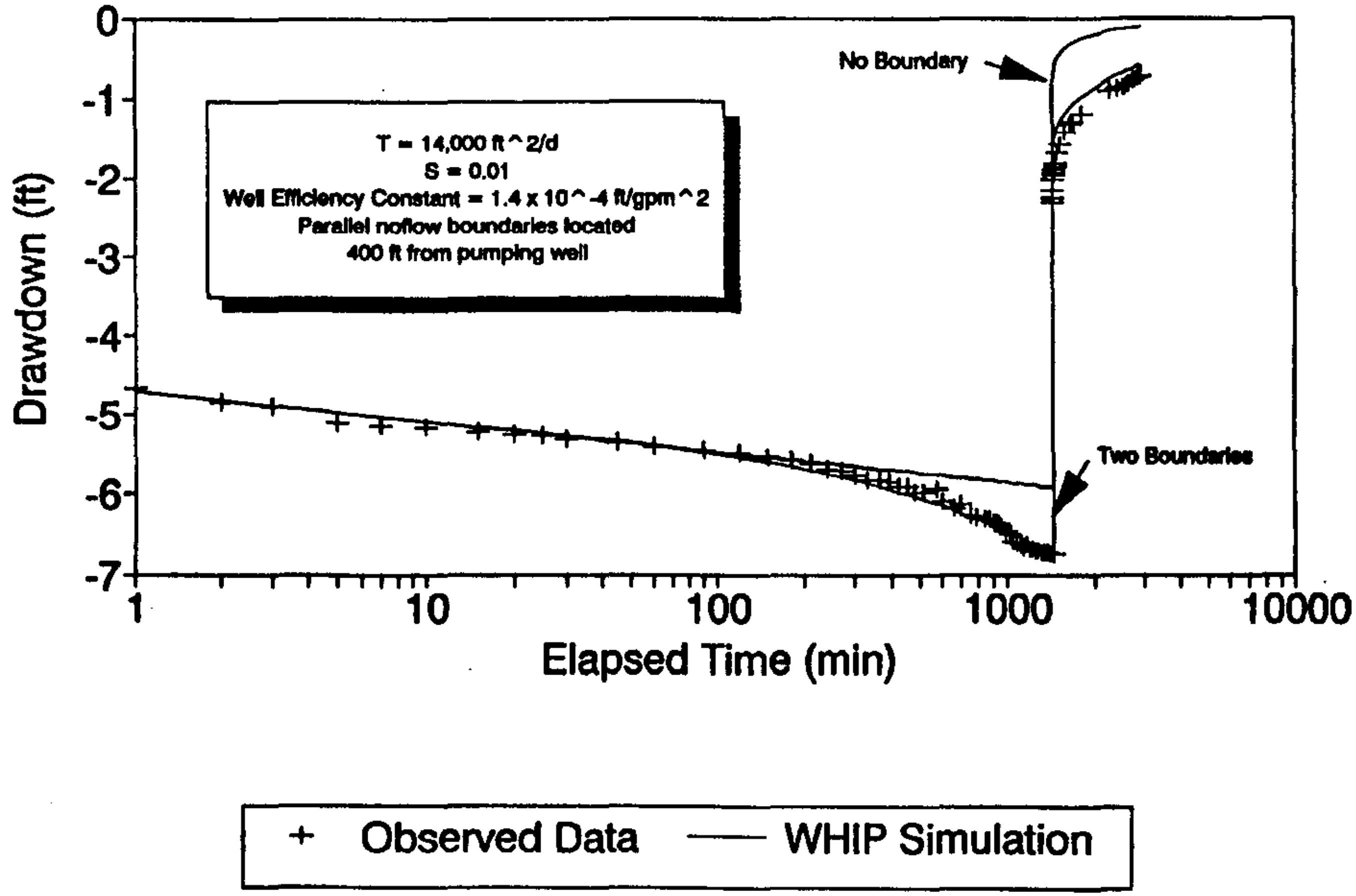


FIGURE **3-1**

PUMP-TEST ANALYSIS: GWMP-2

BLAINE/GEOPHYS REPORT/WA

PROJECT NO. 903-1060.303 DRAWING NO. 24316 DATE 11/13/90 DRAWN BY CB

Golder Associates

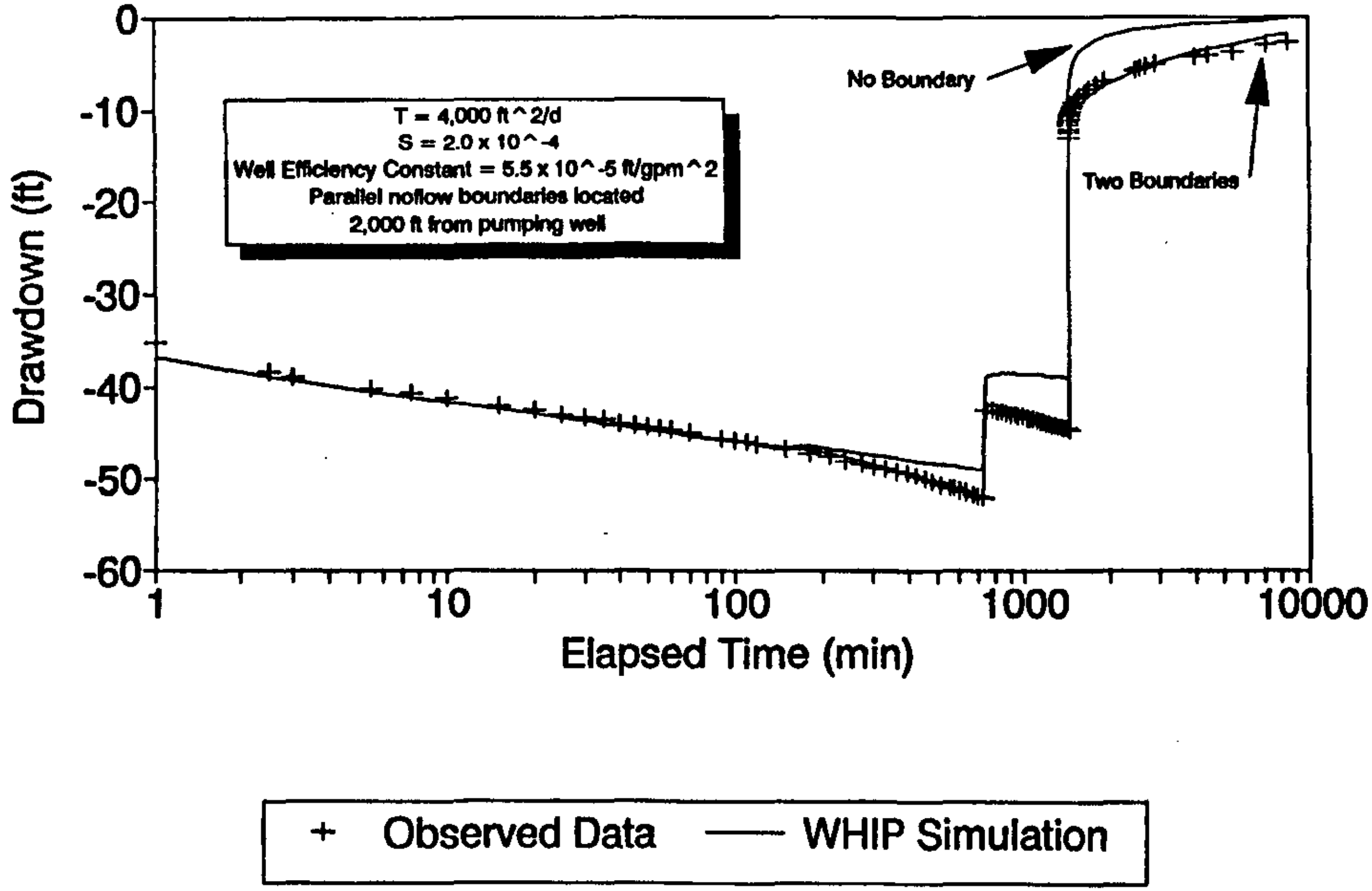


FIGURE **3-2**

PUMP-TEST ANALYSIS: GWMP-3

BLAINE/GEOPHYS REPORT/WA

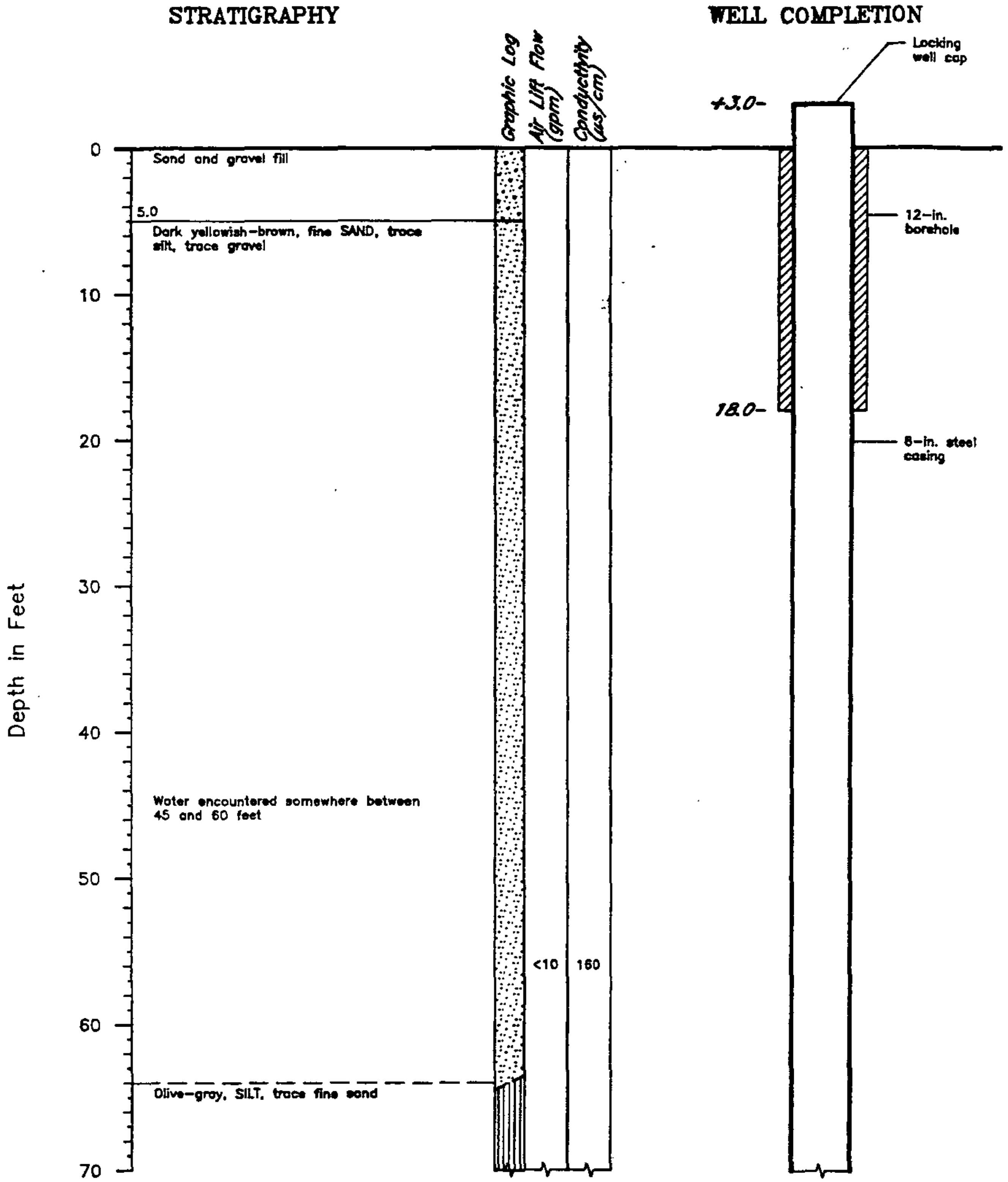
PROJECT NO. 903-1060.303 DRAWING NO. 24317 DATE 11/13/90 DRAWN BY CB

Golder Associates

Appendix A

APPENDIX A

WELL LOGS



WELL COMPLETION LEGEND:

- Bentonite Grout
- Bentonite Chips
- Pea Gravel
- Water Level
- 8" Steel Casing
- 8-in., telescopic stainless steel wellscreen

NOT TO SCALE

Date: 8/27/90-8/31/90
Ground Elevation: -
T.O.C. Elevation: -
Drill Rig: Speed Star
Drill Method: Air rotary

FIGURE **A-1**
SHEET 1 OF 4

GWMP-1
RECORD OF BOREHOLE

BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34343 DATE 11/1/90 DRAWN JSS APPROVED ____

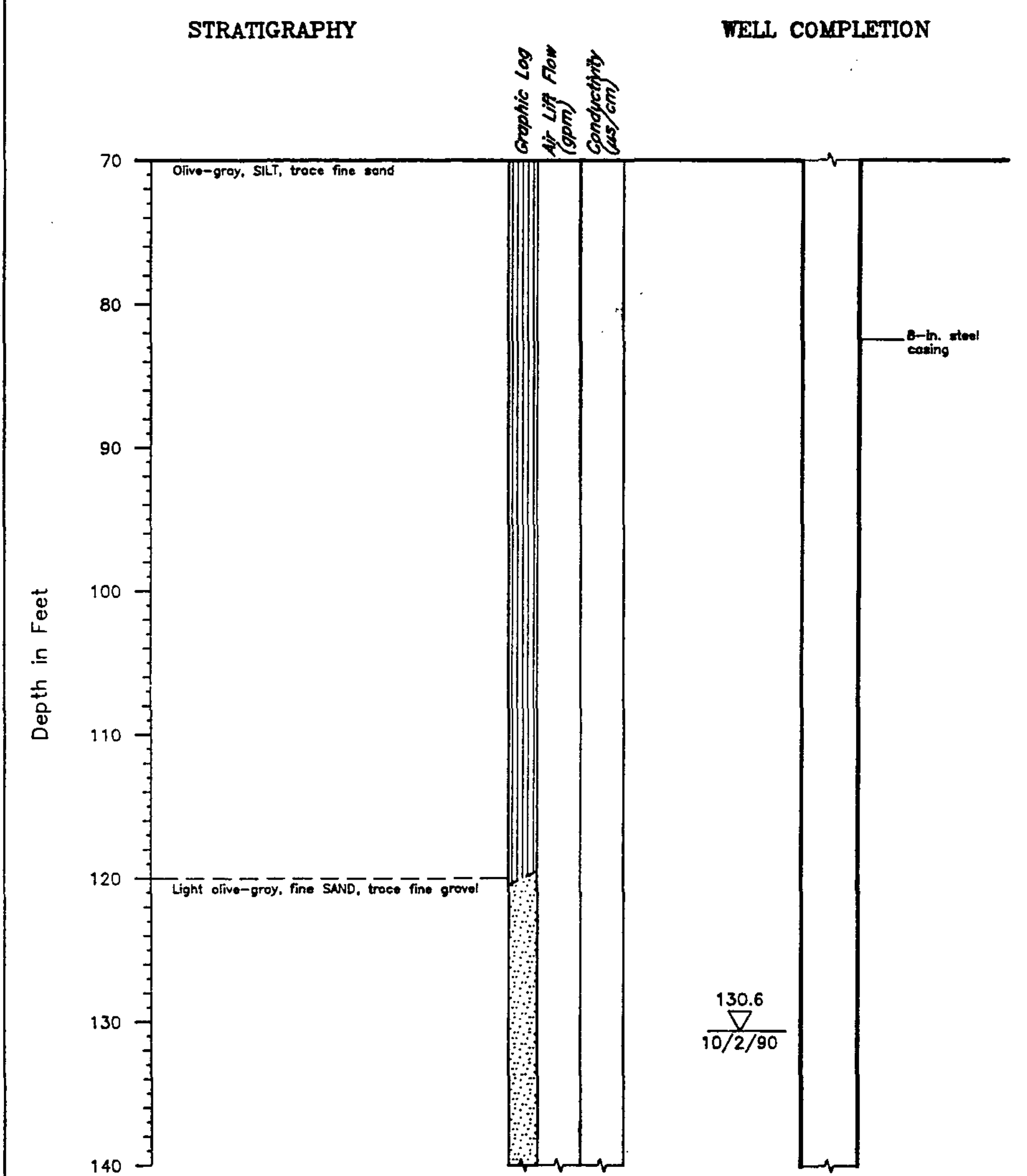


FIGURE **A-1**
SHEET 2 OF 4

GWMP-1

RECORD OF BOREHOLE

BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34344 DATE 11/1/90 DRAWN JSS APPROVED ____

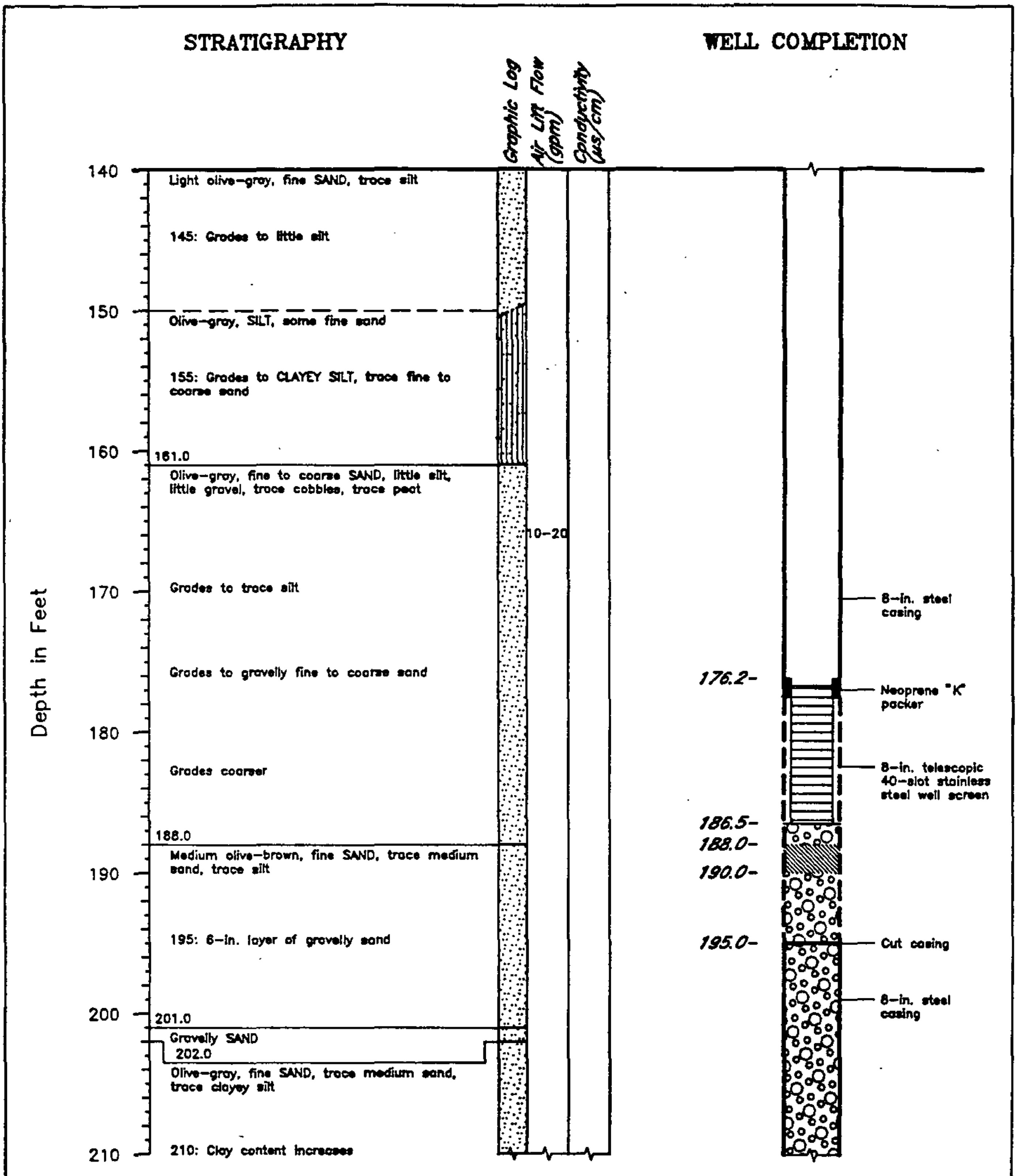


FIGURE **A-1**
SHEET 3 OF 4

GWMP-1

RECORD OF BOREHOLE

BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34345 DATE 11/1/90 DRAWN JSS APPROVED ____

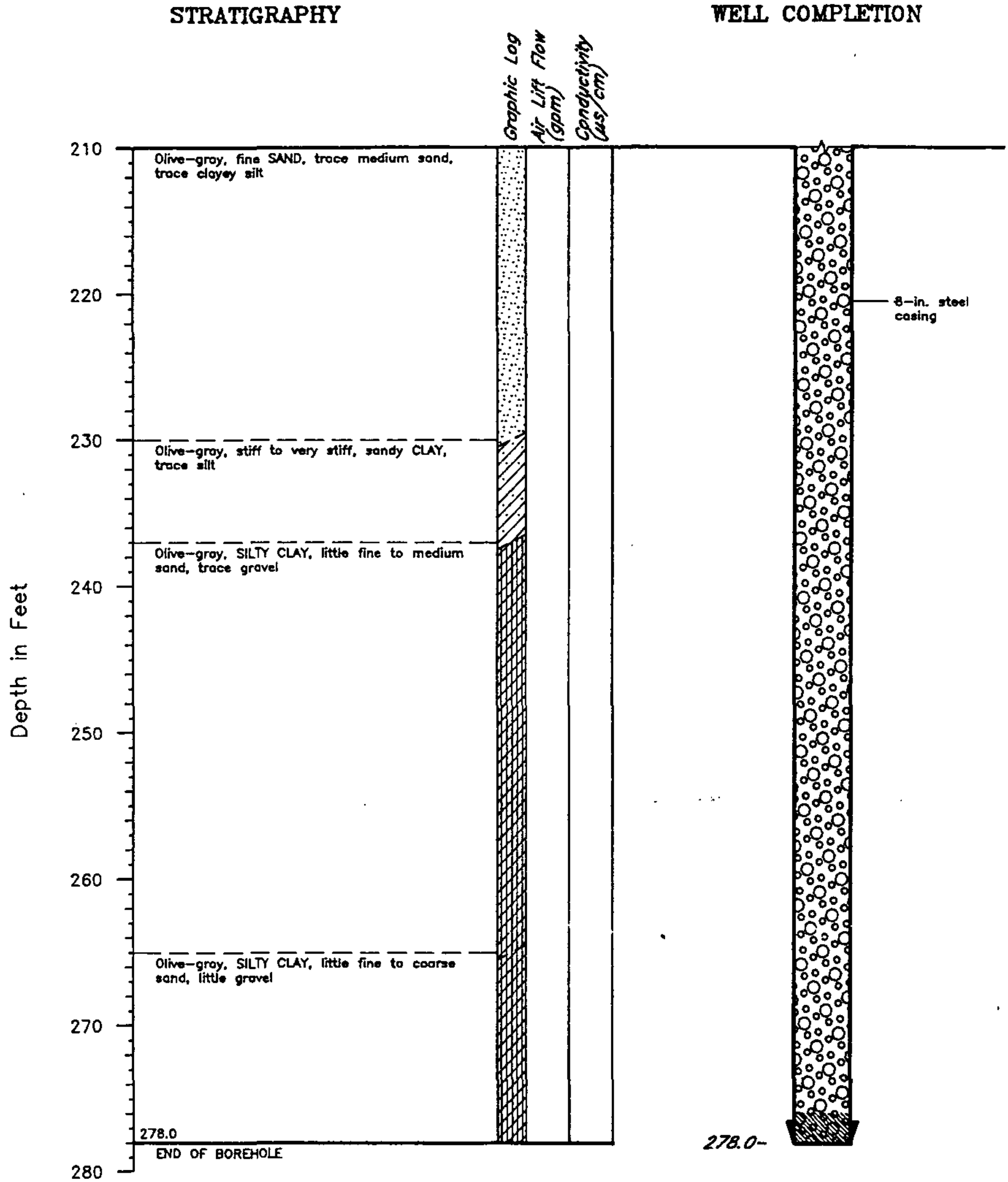
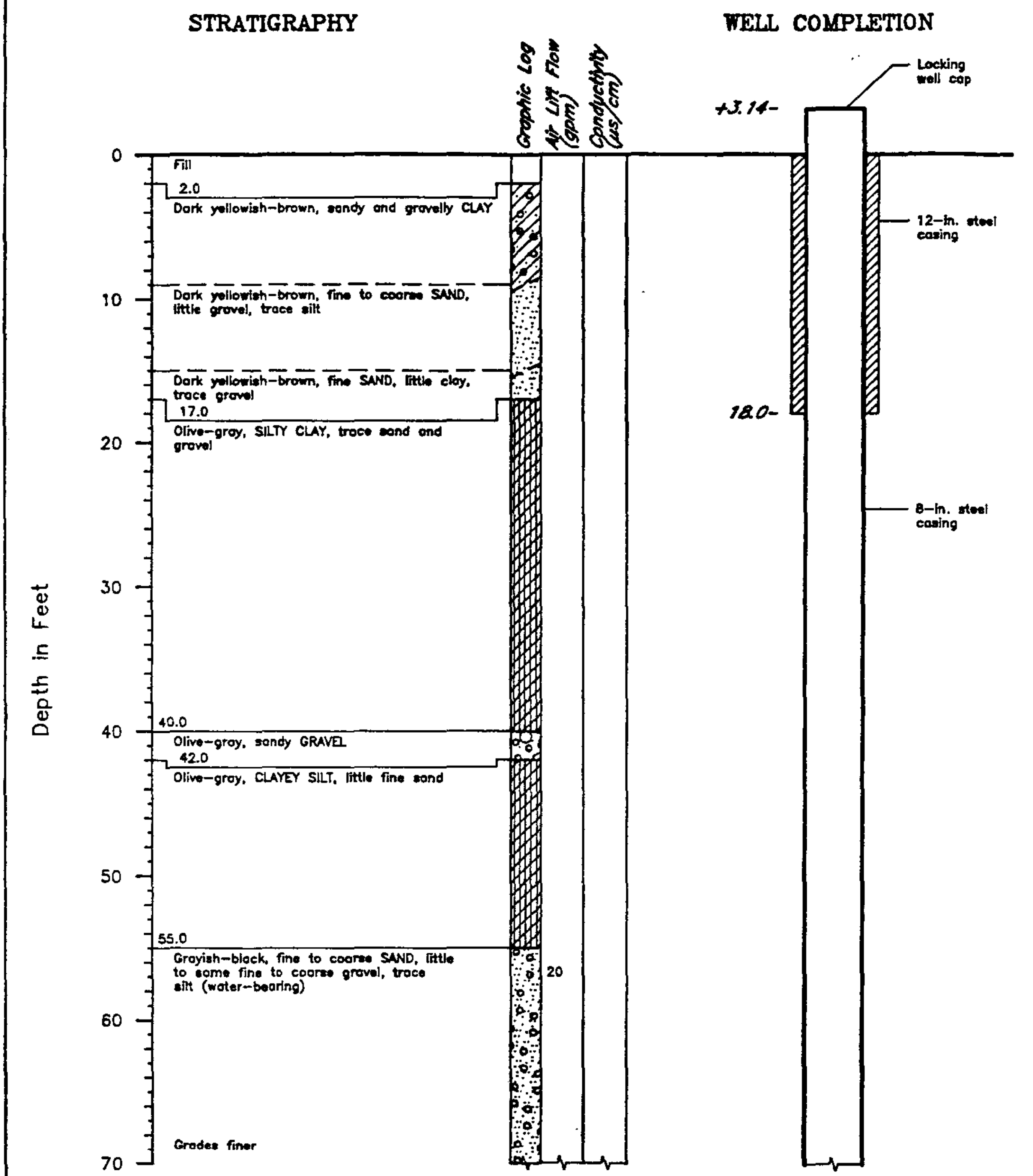


FIGURE **A-1**
SHEET 4 OF 4
GWMP-1
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34343 DATE 11/1/90 DRAWN JSS APPROVED ___



WELL COMPLETION LEGEND:

- Bentonite Grout
- Bentonite Chips
- Pea Gravel
- Water Level
- 8" Steel Casing
- 8-in., telescopic stainless steel wellscreen

NOT TO SCALE

Date: 9/4/90-9/10/90
Ground Elevation: -
T.O.C. Elevation: -
Drill Rig: Speed Star
Drill Method: Air rotary

FIGURE **A-2**
SHEET 1 OF 5

GWMP-2
RECORD OF BOREHOLE

BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34333 DATE 11/1/90 DRAWN JSS APPROVED ___

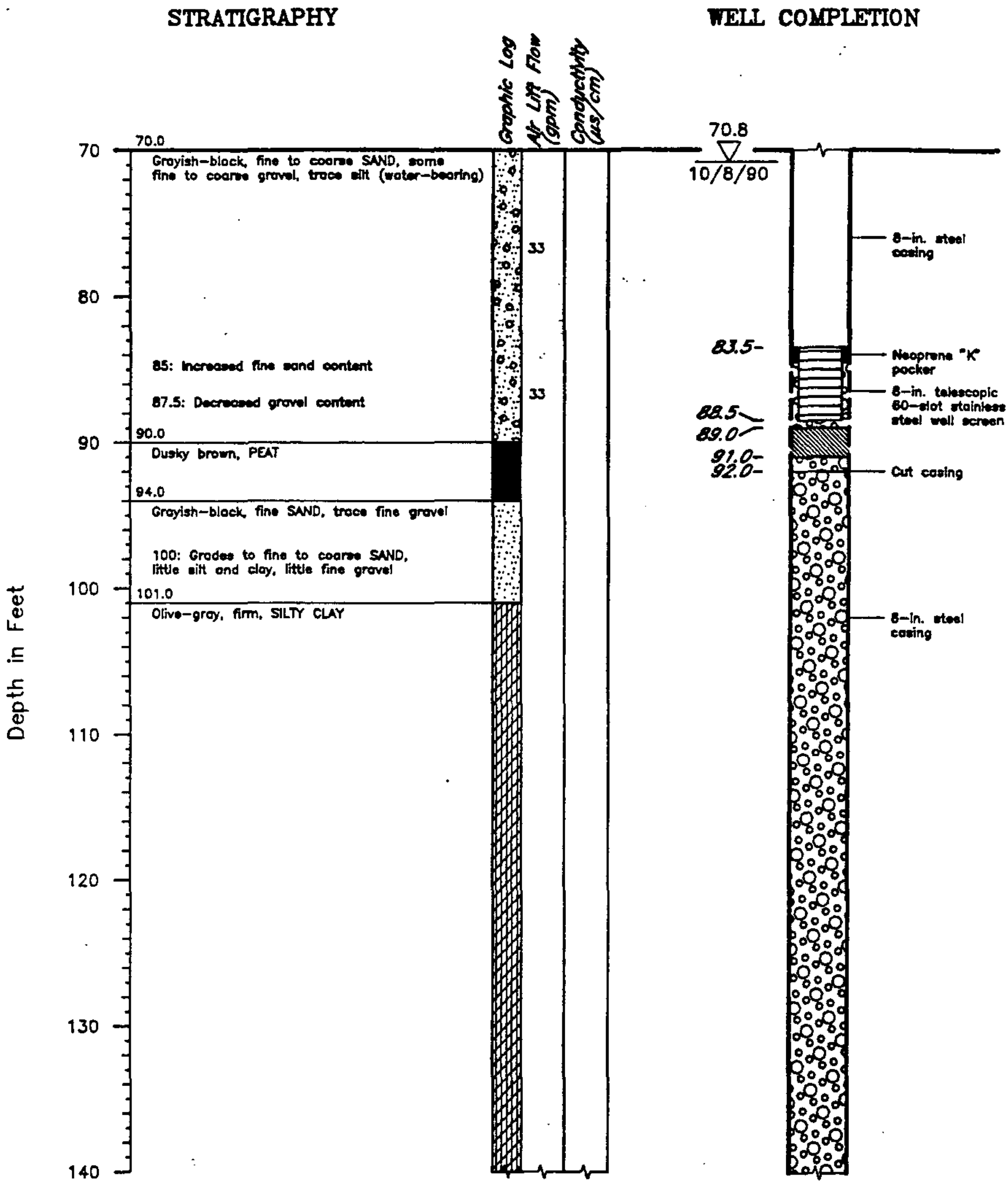


FIGURE **A-2**
SHEET 2 OF 5
GWMP-2
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34334 DATE 11/1/90 DRAWN JSS APPROVED ____

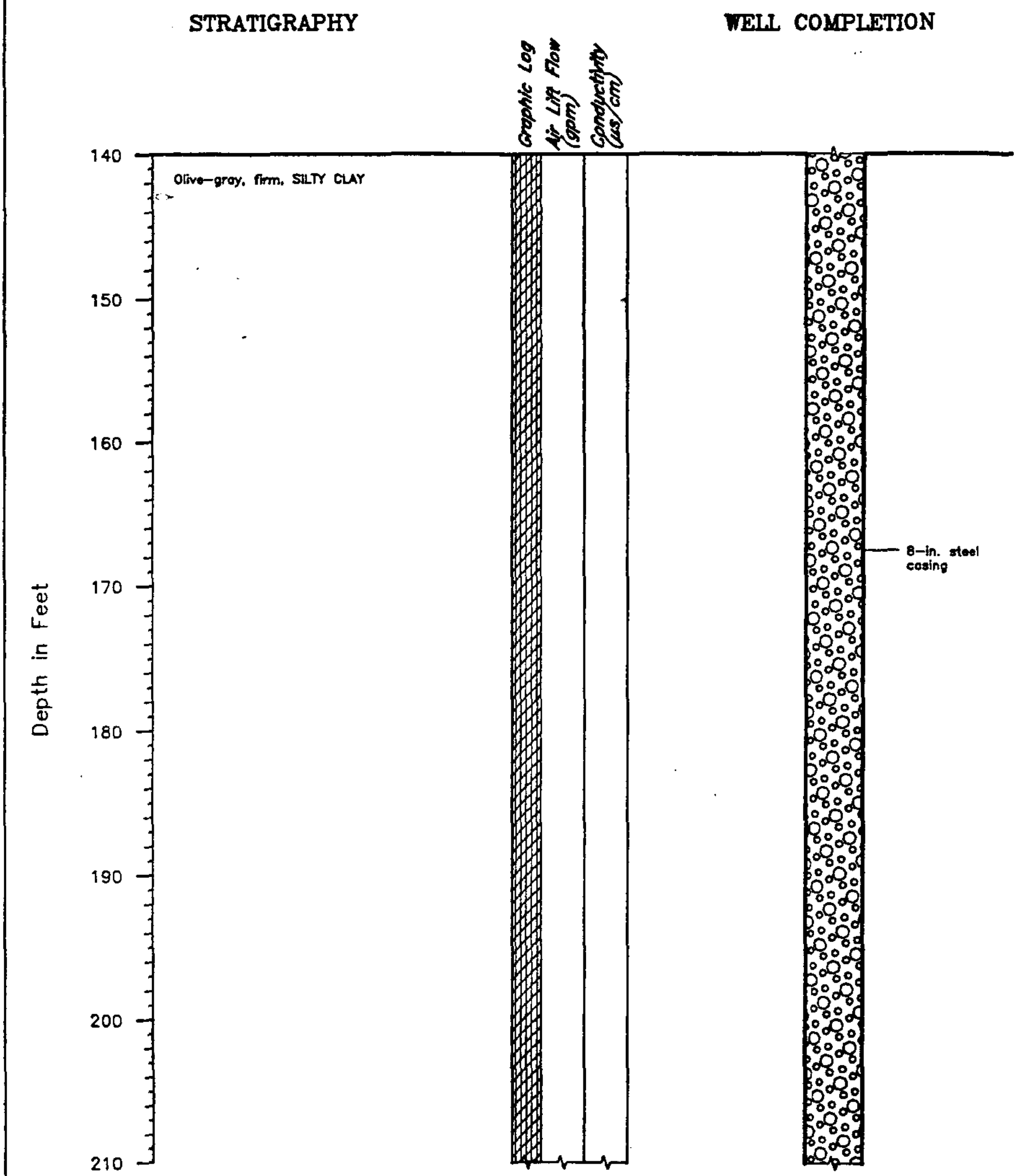


FIGURE **A-2**
SHEET 3 OF 5
GWMP-2
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34335 DATE 11/1/90 DRAWN JSS APPROVED ___

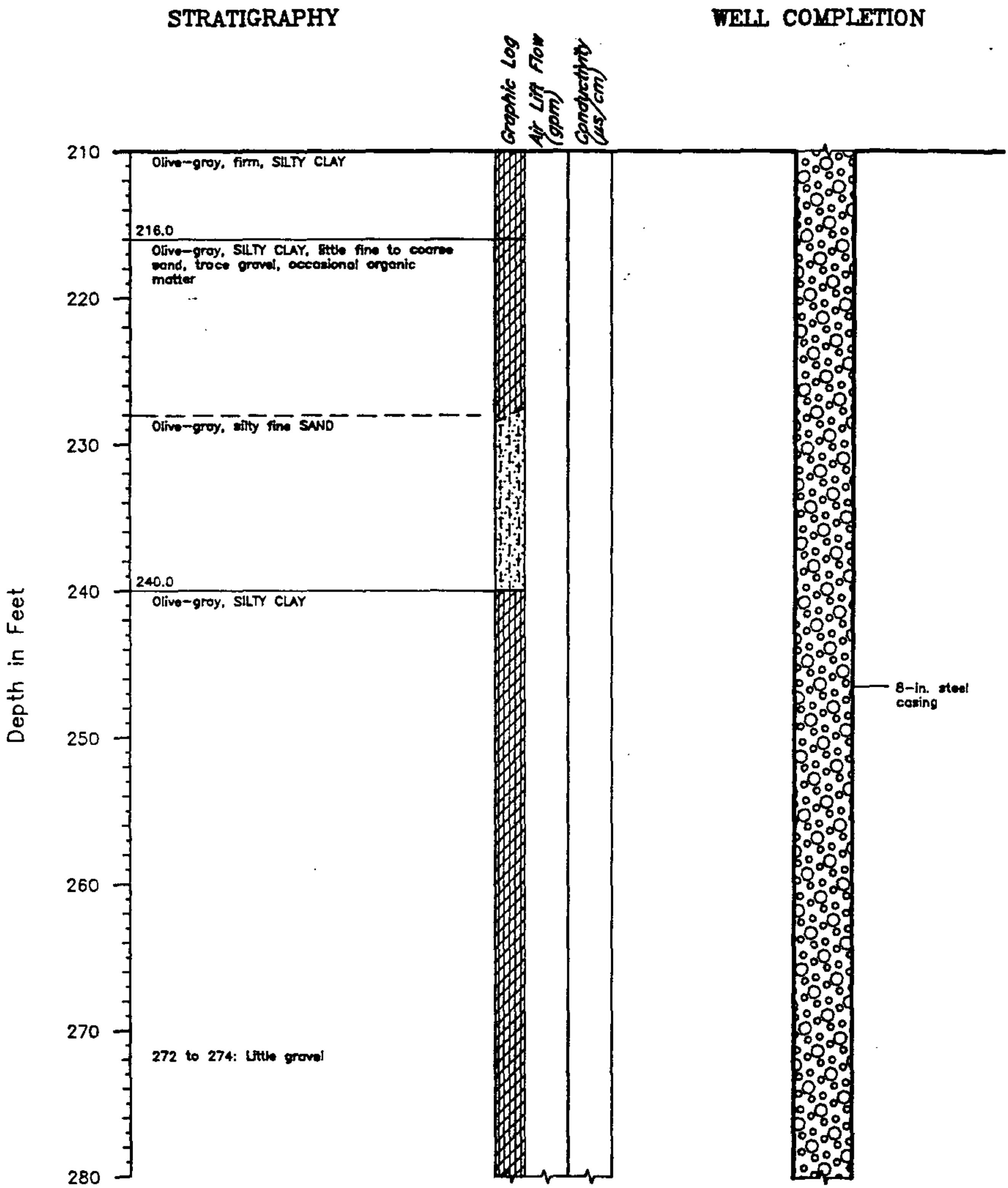


FIGURE **A-2**
SHEET 4 OF 5
GWMP-2
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34336 DATE 11/1/90 DRAWN JSS APPROVED ___

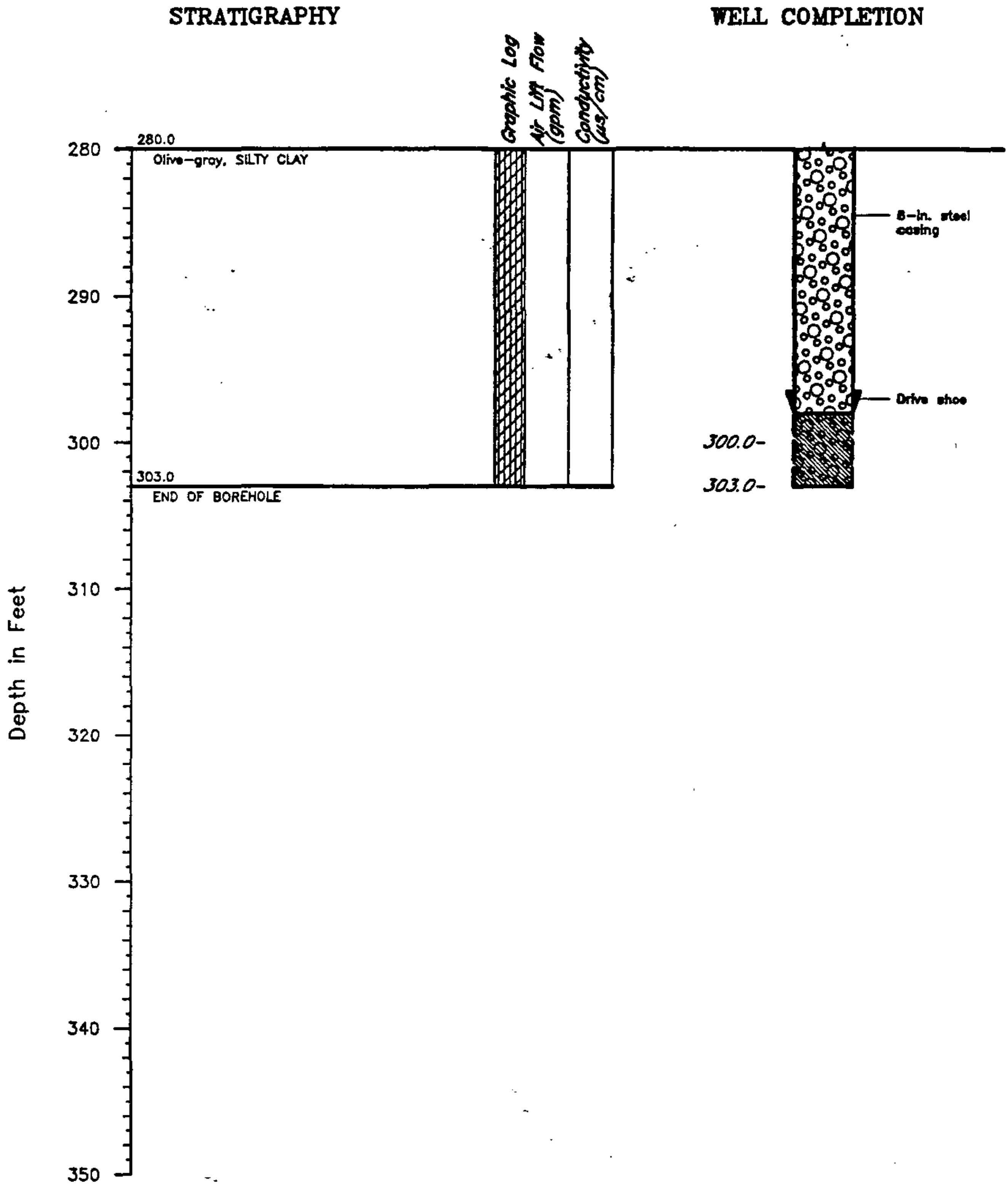
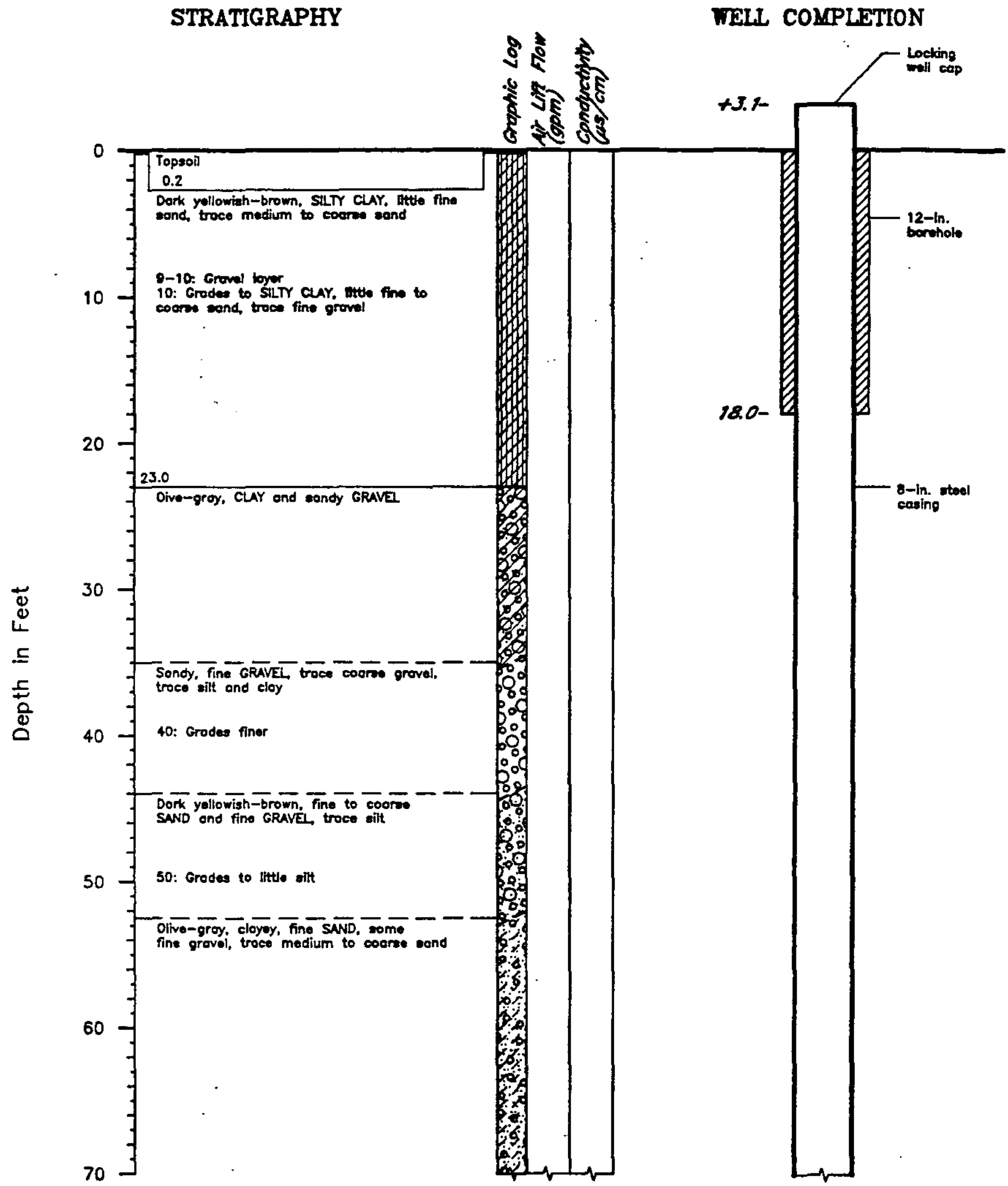


FIGURE **A-2**
SHEET 5 OF 5
GWMP-2
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34337 DATE 10/29/90 DRAWN JSS APPROVED ___



WELL COMPLETION LEGEND:

- Bentonite Grout
- Bentonite Chips
- Pea Gravel
- Water Level
- 8" Steel Casing
- 8-in., telescopic stainless steel wellscreen

NOT TO SCALE

Date: 9/10/90-9/14/90
Ground Elevation: –
T.O.C. Elevation: –
Drill Rig: Speed Star
Drill Method: Air rotary

FIGURE **A-3**
SHEET 1 OF 5
GWMP-3
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34338 DATE 11/1/90 DRAWN JSS APPROVED ___

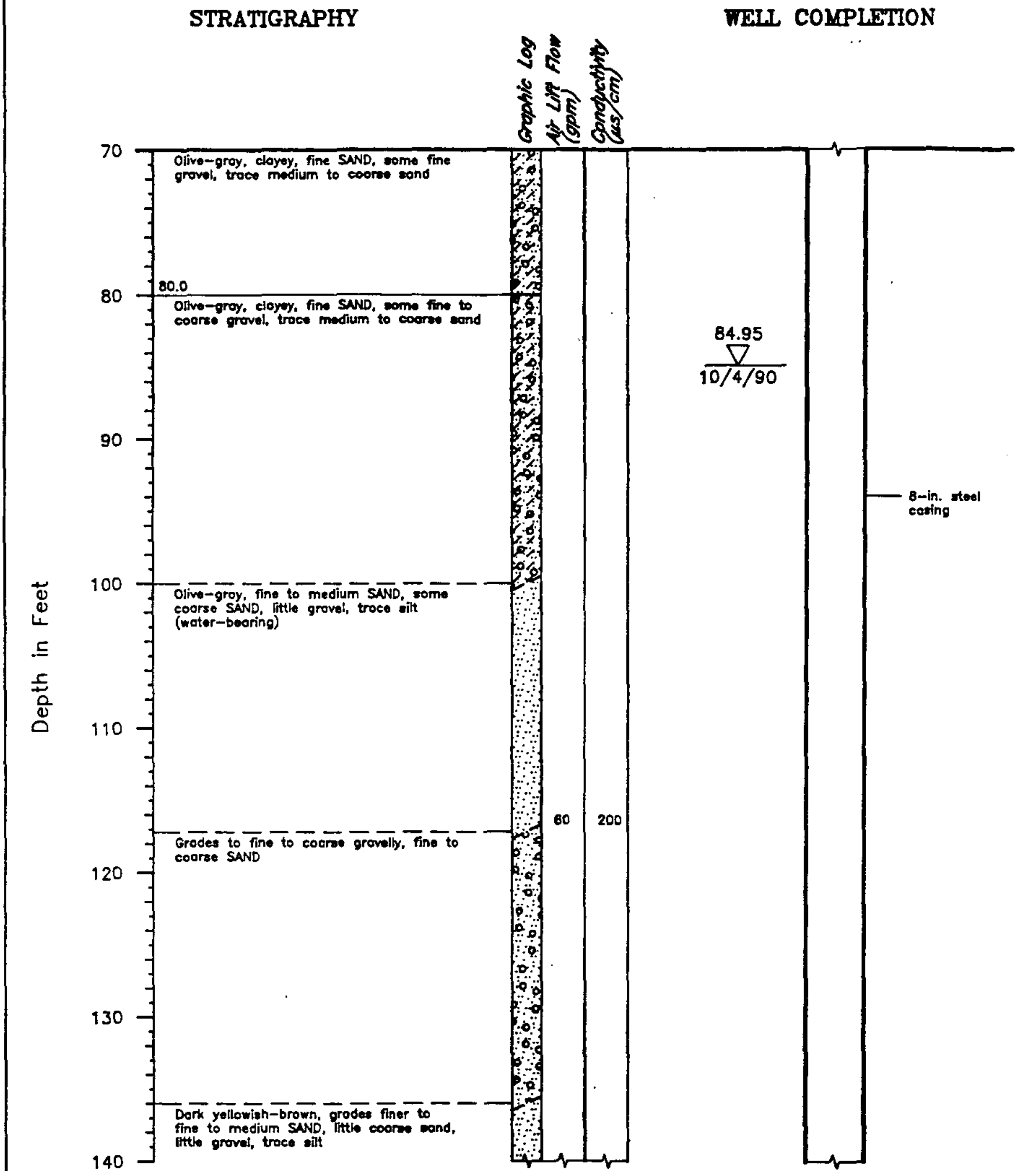


FIGURE **A-3**
SHEET 2 OF 5
GWMP-3
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34339 DATE 11/1/90 DRAWN JSS APPROVED ___

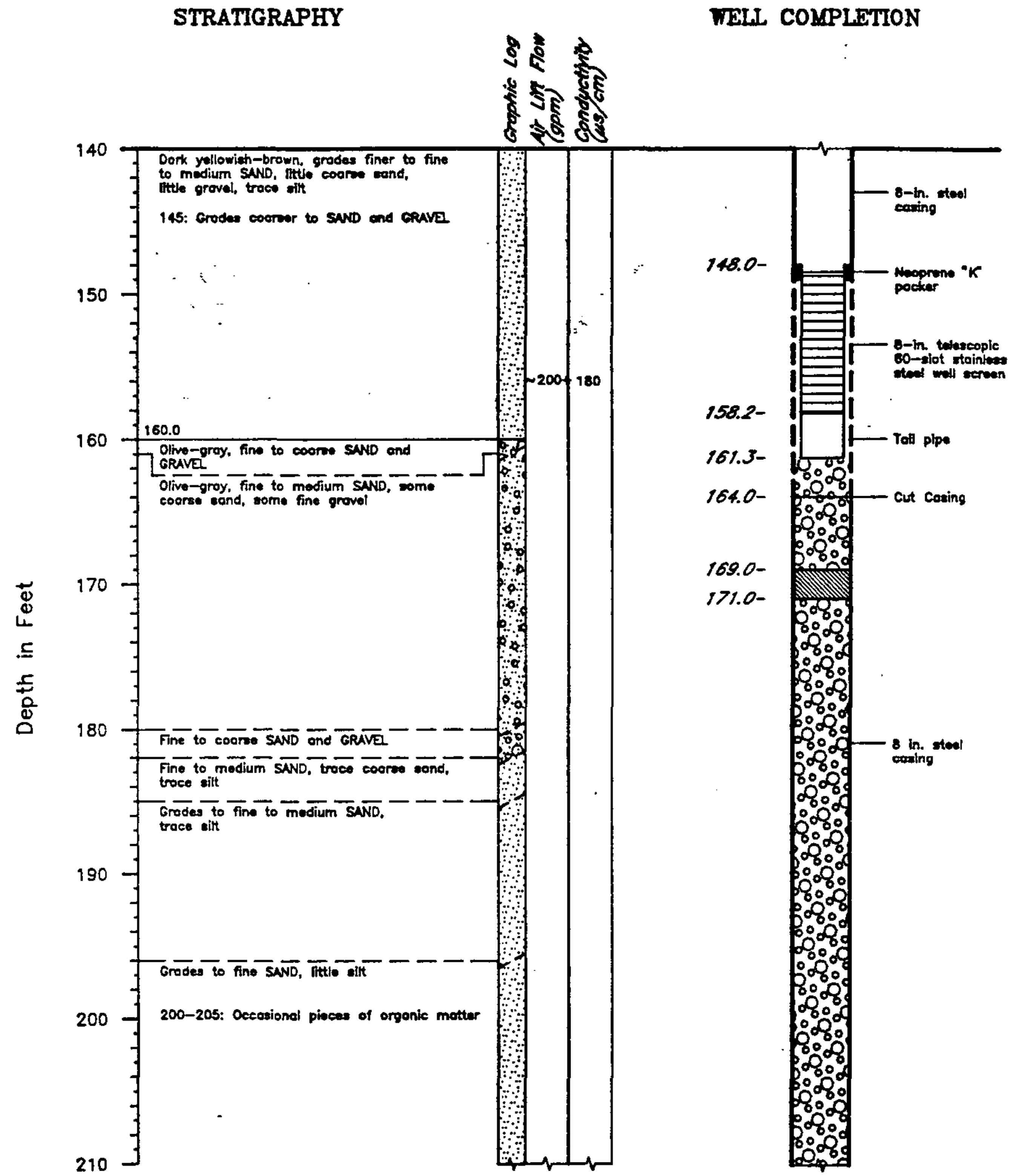


FIGURE **A-3**
SHEET 3 OF 5
GWMP-3
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34340 DATE 11/1/90 DRAWN JSS APPROVED ____

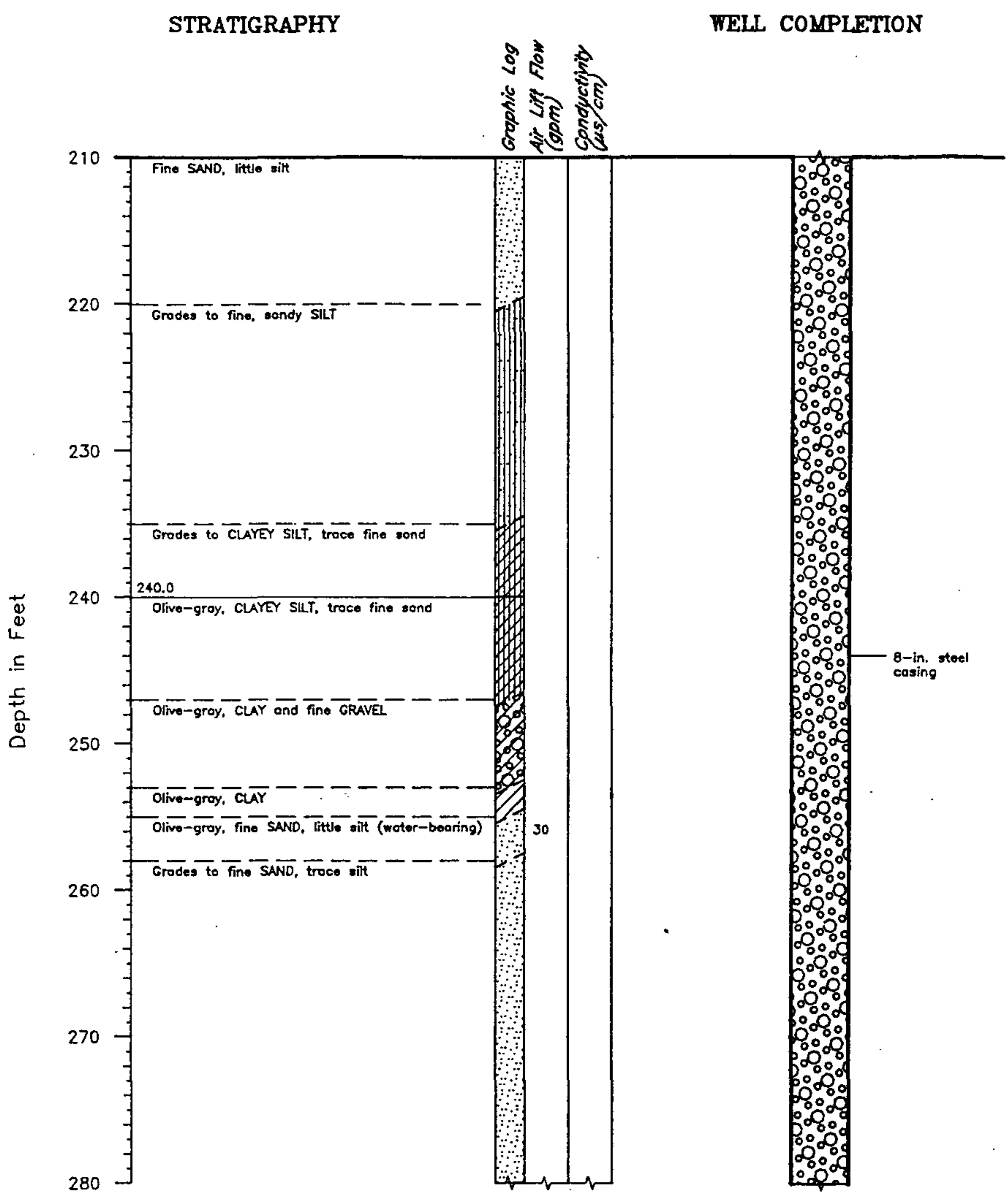


FIGURE **A-3**
SHEET 4 OF 5
GWMP-3
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34341 DATE 11/1/90 DRAWN JSS APPROVED ____

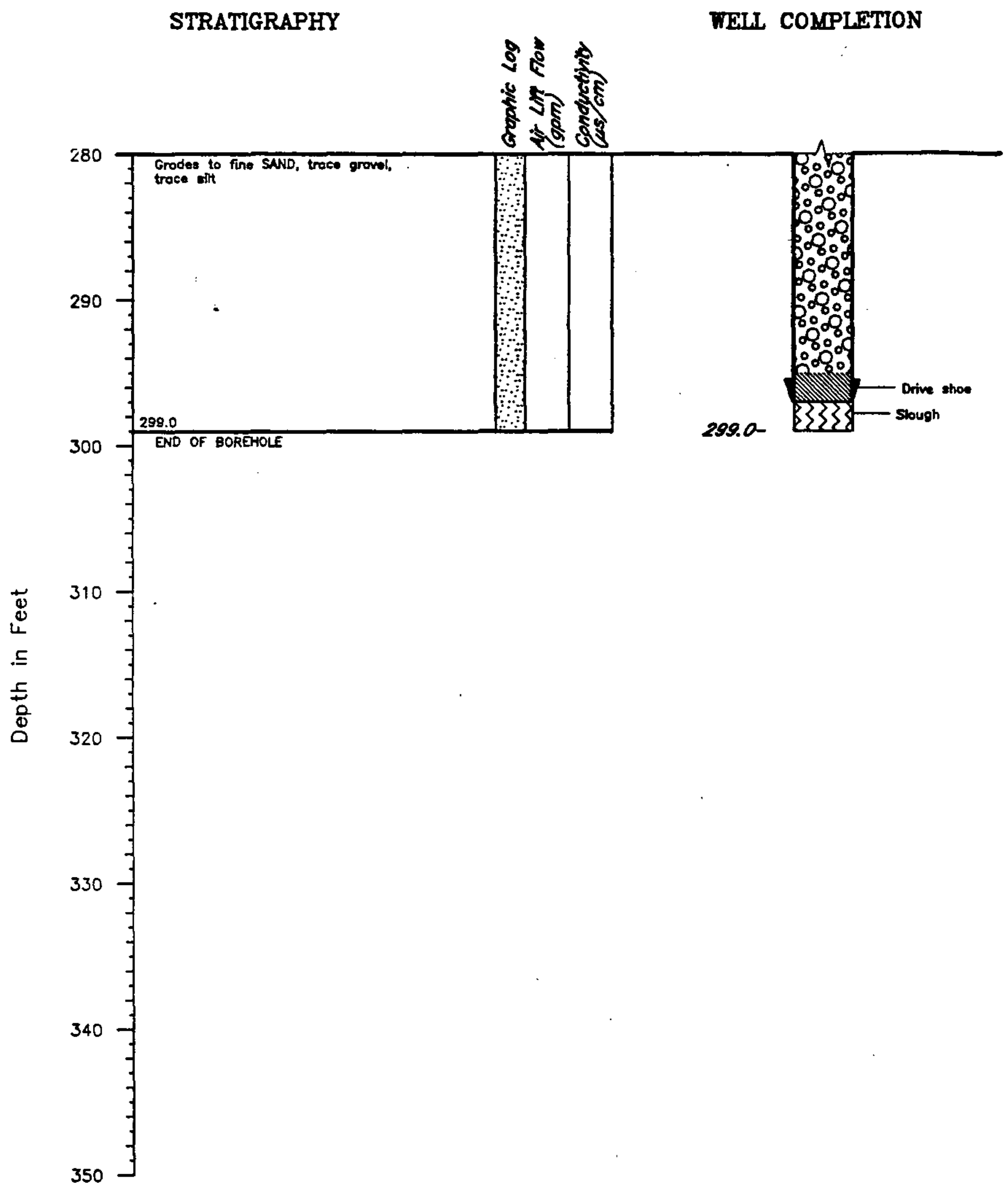


FIGURE **A-3**
SHEET 5 OF 5
GWMP-3
RECORD OF BOREHOLE
BLAINE/GWMP/WA

PROJECT NO 903-1060.303 DWG NO 34342 DATE 11/1/90 DRAWN JSS APPROVED ____

Appendix B

APPENDIX B

PUMP TEST DATA

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-1 – SLUG TEST

WELL SCREEN INTERVAL= 176.2 to 186.2 ft

COMPLETION DEPTH= 186.5 ft START TEST= 12:36 10/2/90

MEASURING POINT= TOC

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	COMMENTS
	02–Oct	<0.0	133.60	0.00	STATIC WATER LEVEL
		0.0	169.67	36.07	START SLUG TEST
		1.0	165.50	31.90	
		2.0	162.20	28.60	
		3.0	159.20	25.60	
		5.0	154.00	20.40	
		8.0	149.10	15.50	
		10.0	145.60	12.00	
		15.0	140.50	6.90	
		20.0	137.60	4.00	
		25.0	136.00	2.40	
		30.0	135.20	1.60	

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-2 - STEP-TEST

WELL SCREEN INTERVAL=	83.5 to 88.5 ft	START TEST=	12:43 10/8/90
COMPLETION DEPTH=	88.5 ft	START RECOVERY=	14:43 10/8/90
MEASURING POINT=	TOC		

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
	01–Oct	0.0	73.70	0.00		
	03–Oct	0.0	73.83	0.00		
	05–Oct	0.0	74.00	0.00		
	08–Oct	0.0	73.93	0.00		START STEP 1
		1.0	74.45	0.52		
		2.0	74.45	0.52		
		3.0	74.45	0.52	20	
		5.0	74.46	0.53		
		7.0	74.42	0.49	16	
		11.0	74.43	0.50	19	
		17.0	74.45	0.52	16	
		20.0	74.43	0.50	17	
		25.0	74.41	0.48	18	
		30.0	74.43	0.50	18	START STEP 2
		31.0	75.00	1.07		
		32.0	75.70	1.77	71	
		33.0	75.90	1.97	75	
		37.5	75.96	2.03	75	
		42.0	76.07	2.14	75	
		45.0	76.06	2.13	77	
		50.0	76.10	2.17	76	
		56.0	76.13	2.20		
		60.0	76.15	2.22	76	START STEP 3
		61.0	78.70	4.77		
		62.0	78.65	4.72	142	
		64.0	78.75	4.82	150	
		66.5	78.73	4.80	143	
		70.0	78.76	4.83	146	
		75.0	78.79	4.86	144	

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-2 - STEP-TEST

WELL SCREEN INTERVAL=	83.5 to 88.5 ft	START TEST=	12:43 10/8/90
COMPLETION DEPTH=	88.5 ft	START RECOVERY=	14:43 10/8/90
MEASURING POINT=	TOC		

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		80.0	78.83	4.90	145	
		85.0	78.83	4.90	146	
		90.0	78.81	4.88	143	START STEP 4
		91.0	82.18	8.25		
		92.0	81.90	7.97	211	
		93.5	81.90	7.97	202	
		96.0	81.89	7.96	205	
		98.0	81.90	7.97	205	
		100.0	81.90	7.97		
		105.0	81.95	8.02	204	
		110.5	81.99	8.06	205	
		115.0	82.01	8.08	204	
		120.0	82.04	8.11	205	START RECOVERY
		121.0	74.63	0.70		
		122.0	74.40	0.47		
		123.0	74.35	0.42		
		129.0	74.30	0.37		
		133.5	74.27	0.34		
		135.0	74.27	0.34		
		144.0	74.18	0.25		
		152.0	74.17	0.24		
		167.0	74.09	0.16		
		182.0	74.06	0.13		
		197.0	74.03	0.10		
		212.0	73.98	0.05		

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-2 - CONSTANT-RATE TEST

WELL SCREEN INTERVAL=	83.5 TO 88.5 ft	START TEST=	16:30 10/8/90
COMPLETION DEPTH=	88.5 ft	START RECOVERY=	16:30 10/9/90
MEASURING POINT=	TOC		

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
	08-Oct	0.0	73.93	0		START TEST
		1.0	78.61	4.68	140	
		2.0	78.77	4.84	147	
		3.0	78.83	4.90	150	
		5.0	79.03	5.10	150	
		7.0	79.08	5.15	149	
		10.0	79.10	5.17	150	
		15.0	79.15	5.22	151	
		20.0	79.18	5.25	150	
		25.0	79.21	5.28	150	
		30.0	79.24	5.31	150	pH=7.70 C=230 μS/cm T=11°C
		45.0	79.29	5.36	149	pH=7.50 C=190 μS/cm T=10°C
		60.0	79.34	5.41	150	pH=7.54 C=200 μS/cm T=10°C
		90.0	79.38	5.45	150	
		120.0	79.42	5.49	149	pH=7.04 C=200 μS/cm T=10°C
		150.0	79.47	5.54	149	
		180.0	79.51	5.58	149	pH=7.02 C=200 μS/cm T=10°C
		210.0	79.54	5.61	149	
		240.0	79.63	5.70	150	pH=6.50 C=200 μS/cm T=10°C
		270.0	79.65	5.72	149	
		300.0	79.70	5.77	149	pH=6.56 C=200 μS/cm T=10°C
		330.0	79.76	5.83	149	
		360.0	79.75	5.82	149	pH=6.61 C=200 μS/cm T=10°C
		390.0	79.78	5.85	149	
		420.0	79.82	5.89	149	pH=6.84 C=200 μS/cm T=10°C
	09-Oct	450.0	79.83	5.90	149	
		480.0	79.90	5.97	149	pH=7.02 C=200 μS/cm T=10°C
		510.0	79.90	5.97	149	
		570.0	79.87	5.94	150	
		600.0	80.02	6.09	149	pH=6.92 C=200 μS/cm T=10°C

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-2 - CONSTANT-RATE TEST

WELL SCREEN INTERVAL= 83.5 TO 88.5 ft START TEST= 18:30 10/8/90

COMPLETION DEPTH= 88.5 ft START RECOVERY= 18:30 10/9/90

MEASURING POINT= TOC

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		660.0	80.11	6.18	149	pH=7.25 C=200 µS/cm T=10°C
		690.0	80.06	6.13	149	
		750.0	80.20	6.27	149	
		780.0	80.22	6.29	149	pH=7.35 C=200 µS/cm T=10°C
		840.0	80.24	6.31	149	pH=7.30 C=200 µS/cm T=10°C
		870.0	80.24	6.31	149	
		900.0	80.28	6.35	149	
		930.0	80.30	6.37	149	
		960.0	80.34	6.41	149	pH=7.53 C=200 µS/cm T=10°C
		990.0	80.39	6.46	149	
		1025.0	80.43	6.50	149	
		1050.0	80.52	6.59	149	
		1080.0	80.54	6.61	149	pH=7.60 C=180 µS/cm T=10°C
		1110.0	80.57	6.64	149	
		1140.0	80.60	6.67	149	
		1170.0	80.56	6.63	149	
		1200.0	80.62	6.69	149	pH=7.40 C=180 µS/cm T=10°C
		1230.0	80.62	6.69	149	
		1260.0	80.63	6.70	149	
		1290.0	80.64	6.71	149	
		1320.0	80.65	6.72	149	pH=7.65 C=180 µS/cm T=10°C
		1350.0	80.65	6.72	149	
		1380.0	80.66	6.73	149	
		1410.0	80.67	6.74	149	
	09-Oct	1440.0	80.68	6.75	149	START RECOVERY
		1441.0	76.24	2.31		
		1442.0	76.17	2.24		
		1443.0	76.08	2.15		
		1445.0	75.94	2.01		
		1449.0	75.95	2.02		

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-2 - CONSTANT-RATE TEST

WELL SCREEN INTERVAL=	83.5 TO 88.5 ft	START TEST=	16:30 10/8/90
COMPLETION DEPTH=	88.5 ft	START RECOVERY=	16:30 10/9/90
MEASURING POINT=	TOC		

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		1450.0	75.96	2.02		RECOVERY CONT.
		1455.0	75.90	1.97		
		1460.0	75.85	1.92		
		1465.0	75.83	1.90		
		1470.0	75.79	1.86		
		1485.0	75.75	1.82		
		1500.0	75.62	1.69		
		1530.0	75.50	1.57		
		1587.0	75.35	1.42		
		1662.0	75.25	1.32		
		1707.0	75.22	1.29		
		1833.0	75.13	1.20		
		2297.0	74.84	0.91		
		2430.0	74.81	0.88		
		2530.0	74.78	0.85		
		2563.0	74.78	0.85		
		2624.0	74.75	0.82		
		2656.0	74.74	0.81		
		2747.0	74.71	0.78		
		2785.0	74.69	0.76		
		2844.0	74.68	0.75		
		2910.0	74.65	0.72		

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-3 - STEP-TEST

WELL SCREEN INTERVAL= 148 to 158 ft START TEST= 8:05 10/4/90
COMPLETION DEPTH= 161.3 ft START RECOVERY= 10:35 10/4/90
MEASURING POINT= TOC

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
	02–Oct	0.0	88.66	0.00		
	03–Oct	0.0	88.20	0.00		
	04–Oct	0.0	88.05	0.00		START STEP 1
		1.0	90.35	2.30	61	
		2.0	90.46	2.41	61	
		3.0	90.57	2.52	61	
		5.0	90.63	2.58	61	
		7.0	90.67	2.62	61	
		10.0	90.67	2.62	61	
		15.0	90.70	2.65	61	
		20.0	90.75	2.70	61	
		25.0	90.75	2.70	61	
		30.0	90.77	2.72		START STEP 2
		31.0	93.90	5.85	150	
		33.5	93.23	5.18	150	
		35.0	94.57	6.52	150	
		37.0	94.70	6.65	150	
		40.0	94.70	6.65	150	
		45.0	94.85	6.80	150	
		51.0	94.95	6.90	150	
		55.0	95.03	6.98	150	
		60.0	95.05	7.00		START STEP 3
		61.5	101.10	13.05	250	
		62.5	101.33	13.28	250	
		63.5	101.40	13.35	250	
		65.0	100.97	12.92	250	
		67.0	101.10	13.05	250	
		70.0	101.25	13.20	250	
		75.0	101.40	13.35	250	
		80.0	101.60	13.55	250	

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-3 - STEP-TEST

WELL SCREEN INTERVAL= 148 to 158 ft
COMPLETION DEPTH= 161.3 ft
MEASURING POINT= TOC
START TEST= 8:05 10/4/90
START RECOVERY= 10:35 10/4/90

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		85.0	101.72	13.67	250	
		90.0	101.72	13.67		START STEP 4
		91.0	104.95	16.90	350	
		92.0	105.64	17.59	350	
		93.0	106.05	18.00	350	
		95.0	106.42	18.37	350	
		97.0	106.60	18.55	350	
		100.0	106.78	18.73	350	
		105.0	107.03	18.98	350	
		110.0	107.18	19.13	350	
		115.0	107.28	19.23	350	
		120.0	107.40	19.35		START STEP 5
		121.0	109.86	21.81	375	
		122.0	110.14	22.09	375	
		123.5	110.37	22.32	375	
		125.0	110.47	22.42	375	
		127.0	110.66	22.61	375	
		130.0	110.80	22.75	375	
		135.0	111.00	22.95	375	
		140.0	111.20	23.15	375	
		145.0	111.32	23.27	375	
		150.0	111.43	23.38		START RECOVERY
		151.0	92.65	4.60		
		152.0	92.04	3.99		
		153.0	91.70	3.65		
		154.0	91.40	3.35		
	04–Oct	155.0	91.23	3.18		
		157.0	90.95	2.90		
		160.0	90.60	2.55		
		165.0	90.25	2.20		

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-3 - STEP-TEST

WELL SCREEN INTERVAL= 148 to 158 ft
COMPLETION DEPTH= 161.3 ft
MEASURING POINT= TOC
START TEST= 8:05 10/4/90
START RECOVERY= 10:35 10/4/90

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		170.0	89.98	1.93		RECOVERY CONT.
		175.0	89.80	1.75		
		180.0	89.70	1.65		
		185.0	89.55	1.50		
		213.0	89.21	1.16		
		273.0	88.90	0.85		
		285.0	88.90	0.85		
		295.0	88.87	0.82		
		305.0	88.83	0.78		

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-3 - CONSTANT-RATE TEST

WELL SCREEN INTERVAL=	148 TO 156 ft	START TEST=	13:30 10/4/90
COMPLETION DEPTH=	161.3 ft	START RECOVERY=	13:35 10/5/90
MEASURING POINT=	TOC		

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
	04-Oct	0.0	88.05	0		START TEST
		1.0	123.25	35.20		
		2.5	126.50	38.45		
		3.0	127.00	38.95	510	
		5.5	128.25	40.20		
		7.5	128.80	40.75	504	
		10.0	129.48	41.43	499	
		15.0	130.22	42.17	497	
		20.0	130.75	42.70	494	
		25.0	131.20	43.15	497	
		30.0	131.50	43.45	495	
		35.0	131.75	43.70	496	
		40.0	132.10	44.05	497	
		45.0	132.30	44.25		
		50.0	132.50	44.45	496	
		55.0	132.68	44.63		
		60.0	132.85	44.80	495	
		70.0	133.20	45.15	494	pH=6.99 C=210 μS/cm T=10°C
		90.0	133.70	45.65	494	
		100.0	133.98	45.93		
		110.0	134.15	46.10	493	
		120.0	134.40	46.35	494	pH=7.31 C=210 μS/cm T=10°C
		150.0	134.90	46.85	491	
		180.0	135.36	47.31	494	pH=7.96 C=210 μS/cm T=10°C
		210.0	135.77	47.72		
		240.0	136.15	48.10	491	
		273.0	136.48	48.43	493	pH=7.68 C=230 μS/cm T=10°C
		300.0	136.77	48.72	490	
		330.0	137.02	48.97	489	pH=7.77 C=200 μS/cm T=11°C
		360.0	137.30	49.25	489	pH=7.78 C=190 μS/cm T=11°C

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-3 - CONSTANT-RATE TEST

WELL SCREEN INTERVAL=	148 TO 158 ft	START TEST=	13:30 10/4/90
COMPLETION DEPTH=	181.3 ft	START RECOVERY=	13:35 10/5/90
MEASURING POINT=	TOC		

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		390.0	137.56	49.51	491	
		420.0	137.88	49.83	489	pH=7.79 C=190 μS/cm T=11°C
		450.0	138.10	50.05	489	
		480.0	138.45	50.40	486	pH=7.93 C=190 μS/cm T=10°C
		510.0	138.72	50.67	489	
		546.0	139.04	50.99	485	pH=7.89 C=200 μS/cm T=10°C
		570.0	139.14	51.09	492	
		600.0	139.50	51.45		pH=7.80 C=200 μS/cm T=10°C
	05–Oct	630.0	139.60	51.55	486	
		663.0	139.88	51.83	490	pH=7.81 C=200 μS/cm T=10°C
		690.0	140.08	52.03	485	
		720.0	140.23	52.18	487	REDUCED FLOW RATE BECAUS
		737.0	130.70	42.65	486	WAS APPROACHING PUMP INTA
		750.0	130.66	42.61	396	
		780.0	130.76	42.71	396	pH=7.80 C=200 μS/cm T=10°C
		810.0	130.81	42.76	396	
		840.0	130.81	42.76	399	
		870.0	130.97	42.92	396	pH=7.80 C=200 μS/cm T=10°C
		904.0	131.14	43.09	399	pH=7.80 C=200 μS/cm T=10°C
		930.0	131.25	43.20	396	
		960.0	131.35	43.30	399	pH=7.81 C=200 μS/cm T=10°C
		990.0	131.39	43.34	399	
		1030.0	131.46	43.41		pH=7.81 C=200 μS/cm T=10°C
		1050.0	131.64	43.59	396	
	05–Oct	1080.0	131.70	43.65	396	
		1110.0	131.84	43.79	396	
		1140.0	131.97	43.92	395	
		1170.0	132.04	43.99	395	pH=7.83 C=210 μS/cm T=10°C
		1200.0	132.12	44.07		
		1230.0	132.24	44.19	395	

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-3 - CONSTANT-RATE TEST

WELL SCREEN INTERVAL= 148 TO 158 ft
START TEST= 13:30 10/4/90
COMPLETION DEPTH= 161.3 ft
START RECOVERY= 13:35 10/5/90
MEASURING POINT= TOC

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		1260.0	132.33	44.28	395	
		1290.0	132.38	44.33	395	
		1320.0	132.45	44.40	394	
		1350.0	132.55	44.50	393	pH=7.87 C=210 µS/cm T=11°C
		1380.0	132.70	44.65	394	
		1410.0	132.72	44.67	393	pH=7.86 C=210 µS/cm T=11°C
		1440.0	132.82	44.77	392	
		1445.0	132.82	44.77	393	START RECOVERY
		1446.0	101.23	13.18		
		1447.0	100.56	12.51		
		1448.0	100.25	12.20		
		1450.0	99.80	11.75		
		1452.0	99.38	11.33		
		1455.0	99.10	11.05		
		1460.0	98.72	10.67		
		1465.0	98.65	10.60		
		1470.0	98.37	10.32		
		1490.0	97.93	9.88		
		1505.0	97.69	9.64		
		1535.0	97.26	9.21		
		1565.0	96.92	8.87		
		1596.0	96.70	8.65		
		1655.0	96.30	8.25		
		1715.0	95.90	7.85		
		1838.0	95.45	7.40		
		1945.0	94.95	6.90		
		2524.0	93.75	5.70		
		2608.0	93.62	5.57		
		2727.0	93.45	5.40		
		2931.0	93.20	5.15		

GROUND WATER MANAGEMENT PROGRAM PUMPING TEST

Well GWMP-3 - CONSTANT-RATE TEST

WELL SCREEN INTERVAL= 148 TO 158 ft
COMPLETION DEPTH= 161.3 ft
MEASURING POINT= TOC

START TEST= 13:30 10/4/90
START RECOVERY= 13:35 10/5/90

	DATE	ELAPSED TIME (min)	DEPTH TO WATER (ft)	DRAW-DOWN (ft)	FLOW RATE (gpm)	COMMENTS
		4024.0	92.40	4.35		
		4480.0	92.10	4.05		
		5450.0	91.87	3.82		
		7185.0	90.99	2.94		
		8525.0	90.80	2.75		

Appendix C

APPENDIX C

WATER QUALITY DATA

AnalyticalTechnologies,Inc.

ATI I.D. # 9010-092

SAMPLE CROSS REFERENCE SHEET

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

ATI #	CLIENT DESCRIPTION	DATE SAMPLED	MATRIX
9010-092-1	GOLDER/CCY-GWMP-1-A	10/02/90	WATER
9010-092-2	GOLDER/CCY-GWMP-3-A	10/04/90	WATER
9010-092-3	GOLDER/CCY-GWMP-3-B	10/05/90	WATER

----- TOTALS -----

MATRIX	# SAMPLES
WATER	3

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

AnalyticalTechnologies,Inc.

ATI I.D. # 9010-092

ANALYTICAL SCHEDULE

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

ANALYSIS	TECHNIQUE	REFERENCE	LAB
ARSENIC	AA/GF	EPA 7060	R
BARIUM	AA/F	EPA 7080	R
CADMIUM	AA/GF	EPA 7131	R
CALCIUM	AA/F	EPA 7140	R
CHROMIUM	AA/F	EPA 7190	R
COPPER	AA/F	EPA 7210	R
IRON	AA/F	EPA 7380	R
LEAD	AA/GF	EPA 7421	R
MAGNESIUM	AA/F	EPA 7450	R
MANGANESE	AA/F	EPA 7460	R
MERCURY	AA/COLD VAPOR	EPA 7470	R
POTASSIUM	AA/F	EPA 7610	R
SELENIUM	AA/GF	EPA 7740	R
SILVER	AA/F	EPA 7760	R
SODIUM	AA/F	EPA 7770	R
ZINC	AA/F	EPA 7950	R
ALKALINITY	TITRIMETRIC	EPA 310.1	R
BICARBONATE	TITRIMETRIC	EPA 310.1	R
CARBONATE	TITRIMETRIC	EPA 310.1	R
CATION/ANION BALANCE	CALCULATION	SM 104C	R

CONTINUED NEXT PAGE

ATI I.D. # 9010-092

ANALYTICAL SCHEDULE
CONTINUED

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

ANALYSIS	TECHNIQUE	REFERENCE	LAB
CHLORIDE	TITRIMETRIC	EPA 325.3	R
COLOR	COLORIMETRIC	EPA 110.2	SD
CONDUCTIVITY	ELECTRODE	EPA 9050	R
FLUORIDE	ELECTRODE	EPA 340.2	SD
TOTAL HARDNESS	CALCULATION	SM 314A	R
HYDROXIDE	TITRIMETRIC	EPA 310.1	R
NITRATE-NITRITE AS NITROGEN	COLORIMETRIC	EPA 353.1	SD
SILICA	COLORIMETRIC	EPA 370.1	SD
SULFATE	TURBIMETRIC	EPA 375.4	R
TOTAL DISSOLVED SOLIDS	GRAVIMETRIC	EPA 160.1	R
TURBIDITY	NEPHELOMETRIC	EPA 180.1	R

R = ATI - Renton
SD = ATI - San Diego
T = ATI - Tempe
PNR = ATI - Pensacola
FC = ATI - Fort Collins
SUB = Subcontract

METALS RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER

UNITS : mg/L

PARAMETER	GOLDER/CCY-GWMP-1-A -1	GOLDER/CCY-GWMP-3-B -3
ARSENIC	<0.005	0.008
BARIUM	<0.06	<0.06
CADMIUM	<0.0003	<0.0003
CALCIUM	16	14
CHROMIUM	<0.03	<0.03
COPPER	<0.02	<0.02
IRON	0.48	<0.03
LEAD	<0.005	<0.005
MAGNESIUM	7.6	6.2
MANGANESE	0.05	0.05
MERCURY	<0.0005	<0.0005
POTASSIUM	3.3	3.0
SELENIUM	<0.005	<0.005
SILVER	<0.02	<0.02
SODIUM	8.2	8.7
ZINC	0.22	0.02

METALS QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER

UNITS : mg/L

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED SAMPLE	SPIKE CONC	% REC
ARSENIC	9010-088-4	<0.005	<0.005	0	0.044	0.050	88
BARIUM	9010-088-4	<0.06	<0.06	0	20.1	20.0	101
CADMIUM	9010-088-4	<0.0003	<0.0003	0	0.0023	0.0020	115
CALCIUM	9010-088-4	31	32	3	51	20	100
CHROMIUM	9010-088-4	<0.02	<0.02	0	2.04	2.00	102
COPPER	9010-088-4	<0.02	<0.02	0	0.95	1.00	95
IRON	9010-088-4	0.39	0.39	0	2.35	2.00	98
LEAD	9010-088-4	<0.005	<0.005	0	0.058	0.050	116
MAGNESIUM	9010-088-4	29	29	0	48	20	95
MANGANESE	9010-088-4	0.69	0.68	1	2.48	2.00	90
MERCURY	9010-108-1	<0.0005	<0.0005	0	0.0019	0.0020	95
POTASSIUM	9010-088-4	8.9	8.9	0	21.5	12.0	105
SELENIUM	9010-088-4	<0.005	<0.005	0	0.038	0.050	76
SILVER	9010-088-4	<0.02	<0.02	0	0.94	1.00	94
SODIUM	9010-088-4	44	44	0	N/A	N/A	N/A
SODIUM	BLANK SPIKE	N/A	N/A	N/A	21.9	20.0	110
ZINC	9010-088-4	<0.01	<0.01	0	0.48	0.50	96

$$\text{\% Recovery} = \frac{\text{(Spike Sample Result - Sample Result)}}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{\text{(Sample Result - Duplicate Result)}}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER
UNITS : mg/L

PARAMETER	GOLDER/CCY-GWMP-1-A -1	GOLDER/CCY-GWMP-3-B -3
ALKALINITY	52	84
BICARBONATE	52	84
CARBONATE	<5	<5
CHLORIDE	<5	6
FLUORIDE	<0.5	<0.5
TOTAL HARDNESS	71	60
HYDROXIDE	<5	<5
NITRATE-NITRITE as NITROGEN	<0.05	<0.05
SILICA	22.2	25.3
SULFATE	6	<5
TOTAL DISSOLVED SOLIDS	130	130

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER

UNITS : mg/L

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
ALKALINITY	9010-092-3	84	88	5	276	200	96
CHLORIDE	9010-108-1	5	5	0	212	200	104
FLUORIDE	9010-092-3	<0.5	<0.5	0	4.97	5.00	99
TOTAL HARDNESS	9010-088-4	196	199	2	N/A	N/A	N/A
NITRATE-NITRITE as NITROGEN	01016601	<0.05	<0.05	0	1.9	2.0	95
SILICA	01016601	25.7	26.6	3	68.0	40.0	105
SULFATE	9010-108-1	<5	<5	0	9.7	10	97
TOTAL DISSOLVED SOLIDS	9010-092-3	130	120	8	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER

UNITS : -

PARAMETER	GOLDER/CCY-GWMP-1-A -1	GOLDER/CCY-GWMP-3-B -3
COLOR	<5	<5
CATION/ANION BALANCE	1.21	0.76

ATI I.D. # 9010-092

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER
UNITS : -

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
COLOR	9010-092-3	<5	<5	0	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

ATI I.D. # 9010-092

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER

UNITS : umhos/cm

PARAMETER	GOLDER/CCY-GWMP-1-A -1	GOLDER/CCY-GWMP-3-B -3
CONDUCTIVITY	200	160

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER
UNITS : umhos/cm

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
CONDUCTIVITY	9010-108-1	130	150	14	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

ATI I.D. # 9010-092

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER
UNITS : NTU

PARAMETER	GOLDER/CCY-GWMP-1-A -1	GOLDER/CCY-GWMP-3-B -3
TURBIDITY	18	<0.5

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903 1060.900
PROJECT NAME : CITY OF BLAINE, WA.

MATRIX : WATER
UNITS : NTU

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
TURBIDITY	9010-108-1	<0.5	<0.5	0	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

AnalyticalTechnologies,Inc.

ATI I.D. # 9010-108

SAMPLE CROSS REFERENCE SHEET

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

ATI #	CLIENT DESCRIPTION	DATE SAMPLED	MATRIX
9010-108-1	CCY-GWMP-2-B	10/09/90	WATER

----- TOTALS -----

MATRIX	# SAMPLES
WATER	1

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

ANALYTICAL SCHEDULE

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

ANALYSIS	TECHNIQUE	REFERENCE	LAB
ARSENIC	AA/GF	EPA 7060	R
BARIUM	AA/F	EPA 7080	R
CADMIUM	AA/GF	EPA 7131	R
CALCIUM	AA/F	EPA 7140	R
CHROMIUM	AA/F	EPA 7190	R
COPPER	AA/F	EPA 7210	R
IRON	AA/F	EPA 7380	R
LEAD	AA/GF	EPA 7421	R
MAGNESIUM	AA/F	EPA 7450	R
MANGANESE	AA/F	EPA 7460	R
MERCURY	AA/COLD VAPOR	EPA 7470	R
POTASSIUM	AA/F	EPA 7610	R
SELENIUM	AA/GF	EPA 7740	R
SILVER	AA/F	EPA 7760	R
SODIUM	AA/F	EPA 7770	R
ZINC	AA/F	EPA 7950	R
ALKALINITY	TITRIMETRIC	EPA 310.1	R
BICARBONATE	TITRIMETRIC	EPA 310.1	R
CARBONATE	TITRIMETRIC	EPA 310.1	R
CATION/ANION BALANCE	CALCULATION	SM 104C	R

CONTINUED NEXT PAGE

ANALYTICAL SCHEDULE
CONTINUED

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

ANALYSIS	TECHNIQUE	REFERENCE	LAB
CHLORIDE	TITRIMETRIC	EPA 325.3	R
COLOR	COLORIMETRIC	EPA 110.2	SD
CONDUCTIVITY	ELECTRODE	EPA 9050	R
FLUORIDE	ELECTRODE	EPA 340.2	SD
HARDNESS	CALCULATION	SM 314A	R
HYDROXIDE	TITRIMETRIC	EPA 310.1	R
NITRATE -NITRITE AS NITROGEN	COLORIMETRIC	EPA 353.1	SD
SILICA	COLORIMETRIC	EPA 370.1	SD
SULFATE	TURBIMETRIC	EPA 375.4	R
TOTAL DISSOLVED SOLIDS	GRAVIMETRIC	EPA 160.1	R
TURBIDITY	NEPHELOMETRIC	EPA 180.1	R

R = ATI - Renton
SD = ATI - San Diego
T = ATI - Tempe
PNR = ATI - Pensacola
FC = ATI - Fort Collins
SUB = Subcontract

METALS RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : mg/L

PARAMETER	CCY-GWMP-2-B -1
ARSENIC	<0.005
BARIUM	<0.06
CADMIUM	<0.0003
CALCIUM	13
CHROMIUM	<0.02
COPPER	<0.02
IRON	0.11
LEAD	<0.005
MAGNESIUM	5.3
MANGANESE	0.10
MERCURY	<0.0005
POTASSIUM	2.2
SELENIUM	<0.005
SILVER	<0.02
SODIUM	9.5
ZINC	0.04

METALS QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : mg/L

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED SAMPLE	SPIKE CONC	% REC
ARSENIC	9010-088-4	<0.005	<0.005	0	0.044	0.050	88
BARIUM	9010-088-4	<0.06	<0.06	0	20.1	20.0	101
CADMIUM	9010-088-4	<0.0003	<0.0003	0	0.0023	0.0020	115
CALCIUM	9010-088-4	31	32	3	51	20	100
CHROMIUM	9010-088-4	<0.02	<0.02	0	2.04	2.00	102
COPPER	9010-088-4	<0.02	<0.02	0	0.95	1.00	95
IRON	9010-088-4	0.39	0.39	0	2.35	2.00	98
LEAD	9010-088-4	<0.005	<0.005	0	0.058	0.050	116
MAGNESIUM	9010-088-4	29	29	0	48	20	95
MANGANESE	9010-088-4	0.69	0.68	1	2.48	2.00	90
MERCURY	9010-108-1	<0.0005	<0.0005	0	0.0019	0.0020	95
POTASSIUM	9010-088-4	8.9	8.9	0	21.5	12.0	105
SELENIUM	9010-088-4	<0.005	<0.005	0	0.038	0.050	76
SILVER	9010-088-4	<0.02	<0.02	0	0.94	1.00	94
SODIUM	9010-088-4	44	44	0	N/A	N/A	N/A
SODIUM	BLANK SPIKE	N/A	N/A	N/A	21.9	20.0	110
ZINC	9010-088-4	<0.01	<0.01	0	0.48	0.50	96

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : mg/L

PARAMETER	CCY-GWMP-2-B -1
ALKALINITY	80
BICARBONATE	80
CARBONATE	<5
CHLORIDE	5
FLUORIDE	<0.5
TOTAL HARDNESS	54
HYDROXIDE	<5
NITRATE-NITRITE as NITROGEN	<0.05
SILICA	25.7
SULFATE	<5
TOTAL DISSOLVED SOLIDS	130

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : mg/L

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
ALKALINITY	9010-092-3	84	88	5	276	200	96
CHLORIDE	9010-108-1	5	5	0	212	200	104
FLUORIDE	01016003	0.6	0.6	0	5.17	5.00	103
TOTAL HARDNESS	9010-088-4	196	199	2	N/A	N/A	N/A
NITRATE-NITRITE as NITROGEN	9010-108-1	<0.05	<0.05	0	1.9	2.0	95
SILICA	9010-108-1	25.7	26.6	3	68.0	40.0	105
SULFATE	9010-108-1	<5	<5	0	9.7	10	97
TOTAL DISSOLVED SOLIDS	9010-108-1	130	150	14	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : -

PARAMETER	CCY-GWMP-2-B -1
COLOR	<5
CATION/ANION BALANCE	0.74

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : -

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
COLOR	01016502	<5	<5	0	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

AnalyticalTechnologies,Inc.

ATI I.D. # 9010-108

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : umhos/cm

PARAMETER	CCY-GWMP-2-B -1
CONDUCTIVITY	130

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : umhos/cm

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
CONDUCTIVITY	9010-108-1	130	150	14	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY RESULTS

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : NTU

PARAMETER	CCY-GWMP-2-B -1
TURBIDITY	<0.5

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : GOLDER ASSOCIATES
PROJECT # : 903-1060
PROJECT NAME : BLAINE/PUMP TESTING/WA

MATRIX : WATER
UNITS : NTU

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
TURBIDITY	9010-108-1	<0.5	<0.5	0	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$