CITY OF WHITTIER, ALASKA

WHITTIER WELL FIELD UPGRADE

ADDENDUM NO. 2

February 12, 2024

The changes, additions, deletions, and clarifications reflected in this addendum are hereby made a part of the Whittier Well Field Upgrade Specifications and Contract Documents.

SPECIFICATIONS AND CONTRACT DOCUMENTS

III. SPECIAL PROVISIONS

SECTION 60.09 CONSTRUCT WELL FIELD UPGRADE

Article 9.8 Construction, Item P.

Add the following after the second sentence: "The water reservoir will not be allowed to be taken offline prior to September 15, 2024."

Article 9.10 Basis of Payment

Add the following after the second paragraph: "In addition, the Work shall include cleaning and disinfecting the water reservoir after installation of the transducer."

SECTION 60.11 DECOMMISSION MUNICIPAL WATER WELL

Article 11.4 Basis of Payment

Delete this sentence: "Furnishing and installing line stop shall be paid under the appropriate bid items."

Add new section to MASTER INDEX, along with the attached report which includes Well A and Well B well logs:

XIII. WHITTIER AQUIFER EVALUATION REPORT

BIDDER QUESTIONS

1. The manufacturer of the spool pitless adapter does not recognize the X at the end of the part number. Please provide clarification.

   Response: The X at the end of the part number for the Pitless Unit System denotes an NSF61 Epoxy powder coating which meets the requirement of the specifications for the Pitless Unit System to be NSF 61 certified.

2. Door schedule calls for insulated fiberglass exterior doors, but they are drawn as thermally broken hollow metal. Please confirm these are to be HM not FG.

   Response: Please provide fiberglass doors and frames at exterior man doors. Reference specification Section 08 16 10.

3. Please confirm that the hardware called out is to set a standard and we can substitute for equal or better items.

   Response: Equal or better will be reviewed for acceptance when a substitution request form is submitted to the owner/architect.

4. Door E9 is on the door schedule but not on the floor plan, please confirm this door does not exist.

   Response: Door schedule on Sheet A401 indicates door numbers 101A, 101B, and 102.

5. Are there any fire ratings required?

   Response: No fire ratings are required in the project.

6. Do we have to disinfect the water reservoir and is it part of the contract?

   Response: Yes, since we are going into the reservoir to install the water level transducer the reservoir must be cleaned and disinfected in accordance with AWWA Standard C652 Disinfection of Water-Storage Facilities.

7. Are the existing well pumps in Well Houses No. 2 and No. 3 submersible turbine pumps?

   Response: Yes.

8. Are there any pictures of the existing well houses?

   Response: Yes, see Sheet C301 for photos of the well houses. Also, the record drawings have photos inside the well houses from the RE-POWER WELL HOUSES #1, 2 & 3 project.

9. What are the depths of the existing wells and the new wells?

   Response: The new well elevations are shown on Sheet C204, Detail 1, Well Detail. The Special Provisions, Section 60.11 Decommission Municipal Water Well, Article 1.1 General provides existing well depths and casing sizes.

BIDDER MUST ACKNOWLEDGE RECEIPT OF THIS ADDENDUM IN THE APPROPRIATE SPACE ON THE BID FORM. FAILURE TO DO SO WILL SUBJECT THE BIDDER TO DISQUALIFICATION.

* * * END OF ADDENDUM NO. 2 * * *

CITY OF WHITTIER, ALASKA

WHITTIER WELL FIELD UPGRADE

SECTION XIII

WHITTIER AQUIFER EVALUATION REPORT

SUBMITTED TO:
CRW Engineering
3940 Arctic Boulevard, #300
Anchorage, Alaska 99503

BY:
Shannon & Wilson, Inc.
5430 Fairbanks Street, Suite 3
Anchorage, Alaska 99518

907-561-2120
www.shannonwilson.com

FINAL

AQUIFER EVALUATION REPORT

Whittier Well Rehabilitation

WHITTIER, ALASKA

December 2020

Shannon & Wilson No: 104786-003

SHANNON & WILSON

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Submitted To: CRW Engineering
3940 Arctic Boulevard, #300
Anchorage, Alaska 99503
Attn: Pete Bellezza, P.E.

Subject: FINAL AQUIFER EVALUATION REPORT, WHITTIER WELL REHABILITATION, WHITTIER, ALASKA

Shannon & Wilson prepared this report and participated in this project as a subconsultant to CRW Engineering. Our scope of services was specified our Professional Services Agreement with you dated April 28, 2020. This work was conduct in accordance with our February 5, 2020 proposal. Our scope was modified by your October 6, 2020 letter. The modifications included removing Task 2 from our scope, increasing the test well diameter to 12-inches, and adding a second test well. Our scope was further modified to advance the wells deeper than planned and to provide additional discharge hose in your December 14, 2020 letter.

This report presents the results of the aquifer evaluation that was conducted and was prepared by the undersigned. We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON, INC.

AECC125

Stafford Glashan, P.E.
Senior Engineer III

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1 INTRODUCTION

This report presents the results of our investigation of the Whittier aquifer. Two test wells (Wells A and B) were installed, developed, and test pumped. The purpose of this study was to collect data to perform an aquifer evaluation.

2 SITE AND PROJECT DESCRIPTION

The Whittier wellfield is located to the south of the Whittier Harbor as shown in Figure 1. Three existing wells, installed by the U.S. Army during World War II, are located to the southwest of the intersection of Whittier Street and Glacier Avenue as shown in Figure 2. Well 1 is a 10-inch diameter well with a reported capacity of 530 gallons per minute (gpm). Wells 2 and 3 are 8-inch diameter wells with reported capacities between 220 and 250 gpm (Golder 2004). The wells are reportedly 75 to 80 feet deep. No well logs, prior pumping tests, or camera inspections were identified in publicly available data.

The City of Whittier desires a wellfield with the capacity of 500 to 750 gpm per well. Given the age and diameter of the existing wells it was determined that new, larger diameter wells were preferred. As part of this project, two test wells were installed, and an aquifer evaluation was performed using pumping tests.

3 LOCAL GEOLOGY

Whittier lies on an alluvial fan near the head of Passage Canal. Bedrock in the Whittier area consists of a complex mixture of marine sedimentary rocks and igneous rocks. These rocks have been intensely deformed and metamorphosed by high temperature and pressure during the Chugach Mountain building processes and earlier tectonic activity. Depth to bedrock ranges from surface exposure in the mountains to over several hundred feet below the ground surface in local areas. The entire sequence is known as the Valdez Group, and represents shallow to deep marine environments. Shales, slate, argillite and greywackes characterize the Valdez Group.

Overlying the Valdez Group is a package of unconsolidated sediments of glacial and fluvial origin. Several streams, including Whittier Creek, have created a package of alluvium that is complexly interrelated with the glacial deposits. The depth of these deposits is unknown but extends to at least 100 feet near Wellhouse 3. The thickness of these deposits likely decreases towards the head and sides of the valley.

A test well was advanced about 850 feet south of Wellhouse 3 in 2007. The well was advanced to a depth of 134 feet below ground surface (bgs) and completed with 20 feet of wire-wound screen beginning at a depth of 122 feet bgs. The soil encountered consisted of gavel and cobbles with variable amounts of fines. A 12-hour pumping test at 700 gallons per minute (gpm) resulted in about 79 feet of drawdown from the static level of 51 feet bgs (CRW 2007).

4 TEST WELL INSTALLATION

Two, 12-inch diameter test wells (Wells A and B) were installed in November 2020 by Wheaton Water Wells (Wheaton). The well locations were selected by others and staked in the field by CRW. The wells were advanced using air-rotary drilling and a casing hammer. A 14-inch diameter surface casing was advanced to 20 feet bgs to allow installation of a surface seal. The subsurface conditions were logged by Wheaton and consisted of sands and gravels with variable amounts of silt. Zones of cobbles were encountered in both wells. At the original target depth of 85 feet bgs it appeared that the production would be less than the desired production of 500 to 750 gpm. Because the apparent production rate was increasing with depth, it was decided to advance the wells deeper.

When pulling tooling from Well B it was suspected that the casing had been damaged during installation. A camera inspection confirmed that the deepest weld had broken during installation. The upper 80 feet of casing was removed from Well B and a new well was drilled about 10 feet from the original location. The original Well B borehole was abandoned with a combination of allowing the formation to collapse and backfilling with drill cuttings. A five-foot-thick layer of hydrated bentonite chips was installed from 13 to 18 feet bgs.

Select soil samples were transported to our Anchorage soils laboratory to evaluate subsurface conditions for screen sizing and placement. Grain size classification (gradation) testing was performed to estimate the particle size distribution of the aquifer materials. The gradation testing generally followed the procedures described in ASTM C117/C136 and D422. Based on gradation results, a target zone for the screen from approximately 85 to 100 feet bgs was selected for both wells. Driller's logs and the results of gradation testing are included in Appendix A.

Each well was completed with 15 feet of stainless-steel, wire wound screen manufactured by Alloy Screen Works. Screen slot sizes of 0.080 and 0.060 inches were selected for Wells A and B, respectively. The screens were 10-inch pipe size, equipped with a k-packer at the top and a 2-foot tail of well casing at the bottom. The screened intervals are 86 to 101 feet bgs in Well A and 84 to 99 feet bgs in Well B

The surface seal was installed by pumping neat cement into the annulus between the surface casing and the well casing as the surface casing was removed. The well casings were cutoff about three feet above the ground surface. At the completion of the pumping test described below, steel plates were welded to the top of the casing to secure them.

5 AQUIFER EVALUATION

The City of Whittier desires a wellfield with a capacity of 500 to 750 gpm per well. The following sections describe our evaluation of the pumping tests conducted and our interpretations of the aquifer properties.

5.1 Pumping Tests

The procedures for conducting the pumping tests in Wells A and B were similar. Wheaton installed a submersible pump in the well with 4-inch riser piping. At the surface the riser piping was connected to a control valve, 25 feet of steel pipe, a flow meter, and discharge hose. The discharge hose was routed so that flows discharged to the west and away from the rail yard. The discharge was periodically checked for erosion; none was observed during the pumping tests.

The pump used was a Berkeley 8T-750, submersible turbine pump powered by a 40-horsepower motor. Power was supplied to the motor from a generator provided by the City of Whittier.

Pressure transducers were deployed in Wells A and B by Shannon & Wilson personnel prior to each test and recovered about 30 minutes after each test. The transducers were set to record water levels at one-minute intervals. A barologger was placed at the site so that the data from the pumping test could be compensated for changes in barometric pressure. Each long-term pumping test was preceded by brief step-rate pumping tests. The purpose of the step-rate pumping tests was to determine a pumping rate for the steady-state pumping test and each step was 10 to 15 minutes long.

The Well A pumping test was begun at about 1700 hours on December 15, 2020 and ran for 24 hours (including step-rate pumping tests). The step-rate pumping tests were conducted at rates of about 420, 595 and 760 gpm. The average flow during the long-term pumping test was 775 gpm.

The Well B pumping test was begun at about 1300 hours on December 14, 2020 and ran for 24 hours (including step-rate pumping tests). The step-rate pumping tests were conducted at rates of about 360, 420 and 525 gpm. The average flow during the long-term pumping test was 565 gpm.

5.2 Aquifer Properties

Charts 1 and 2 present the drawdown recorded during the pumping tests on Wells A and B, respectively. A review of the pumping test data plotted on these charts indicates that the test data appears reasonable and that problems with data collection were not encountered. With the test wells located approximately 1,000 feet from Passage Canal it was anticipated that the tidal influence would be minimal. However, as can be seen on Charts 1 and 2, there was a significant tidal influence on water levels in the wells. Water levels in the wells changed by up to four feet during a tide cycle or about 25-percent of the tide height.

The raw data was compensated for the effects of the tide by using the non-pumping well to cancel out the changes in water level caused by the tide. The recovery observed in the non-pumping well was then used to adjust the water levels in the pumping well by applying the observed recovery over the length of the pumping test in a linear manner. In our opinion this results in a reasonable approximation of the water levels in the pumping well.

The data from the pumping tests was evaluated in several ways. The data was first manually plotted on a semi-log graph to calculate initial aquifer transmissivity values using the Cooper-Jacob method. The data from the pumping tests was imported into a commercial groundwater software program (Aqtesolv). This program was used to evaluate the data with several methods including the Cooper-Jacob (1946) and Neuman (1974) equations for an unconfined aquifer. The data was also evaluated for delayed-yield effects (common in highly stratified deposits) using the Tartakovsky-Neuman (2007) method.

5.2.1 Well A

Based on this evaluation, we calculated the transmissivity of the aquifer near Well A to range from about 14,800 to 38,000 feet squared per day (ft^2/day) when modeled as an unconfined aquifer. In evaluated curve fitting, it is our opinion that the average transmissivity is on the order of 24,000 ft^2/day

Based on the well log and length of pumping test, we estimate the aquifer thickness contributing to the flow during the pumping test as 90 feet. A hydraulic conductivity value of 260 feet per day (ft/day) was calculated for the aquifer. This is consistent with a clean, coarse sand to fine gravel aquifer.

5.2.2 Well B

Based on this evaluation, we calculated the transmissivity of the aquifer near Well B to range from about 4,400 to 9,300 ft^2/day when modeled as an unconfined aquifer. In evaluated curve fitting, it is our opinion that the average transmissivity is on the order of 6,800 ft^2/day

Based on the well log and length of pumping test, we estimate the aquifer thickness contributing to the flow during the pumping test as 90 feet. A hydraulic conductivity value of 75 ft/day was calculated for the aquifer. This is consistent with a clean, medium to coarse sand aquifer.

5.3 Saltwater Intrusion

When developing a drinking water supply in a coastal area the potential for saltwater intrusion needs to be evaluated. Because saltwater is heavier than fresh water, the fresh water tends to 'float' above the denser salt water. The weight of the fresh water on top of the salt water depresses the interface between fresh and salt water such that the further inland you are the deeper the interface.

The Ghyben-Herzberg relation states that the slope of the saltwater/freshwater interface is dependent on the density of the two fluids and the height of fresh water above sea level.

$$Z = \frac{pf}{(ps - pf)} hf$$

Where z is the depth below sea level to a point on the interface, *hf* is freshwater depth above the sea level, *pf* is the density of fresh water, and *ps* is the density of the salt water. For average fresh and saltwater densities, the density term is approximately 40.

Based on static water levels measured on December 14, 2020 and the above relationship, there is about 10 feet of fresh water above sea level and approximately 400 feet of fresh water below sea level. However, the interface between fresh water and salt water is not abrupt. A zone of brackish water exists on either side of this interface due to natural diffusion, changes in water levels (tides, large storm events, droughts, etc.) and the interface should be considered to be the mid-point of the brackish zone.

The upwelling of salt water into fresh water due to the effects of groundwater withdrawals can be estimated using the relationship developed by Dagan & Bear:

$$Qmax < 0.6\pi K d^2 \frac{(ps - pf)}{pf}$$

Where K is the hydraulic conductivity of the aquifer materials and d is the distance from the saltwater interface to the bottom of the well intake. For this evaluation we assumed that the well was completed with 15 feet of casing at a bottom elevation of -64 MSL. Based on this configuration, d would be 336 feet and the maximum constant-rate pumping without saltwater upwelling into the screen would be greater than 2,000 gpm. Note that there is no factor of safety on this estimate and this estimate is for a single well. Based on the distance between the test wells it is our opinion that this is applicable to the wells individually and together if pumped simultaneously.

Note that these relationships are very reliant on the elevation of the static water level. If the static water level drops to 7 feet above sea level, the depth to the saltwater interface drops to 275 feet and the maximum pumping rate drops to 1,500 gpm.

Note that in alluvial deposits saltwater intrusion can occur from horizontal intrusion due to reducing the amount of fresh water discharging into the ocean. An evaluation of this phenomena would require a robust numerical model and is beyond the scope of this study.

6 DISCUSSION/RECOMMENDATIONS

The following sections summarize our conclusions and recommendations for the Whittier Wellfield.

6.1 Aquifer Evaluation

Analysis of the pumping tests indicates aquifer properties that are similar but slightly more favorable to groundwater production at Well A. This is not unusual in a complex, alluvial fan deposit. The specific capacity (flow rate divide by drawdown) was between 38 and 130 gpm/foot (gpm/ft) with Well A having the higher capacity. For comparison, specific capacity in the prior test well was 8 gpm/ft (CRW 2007) and drew the water level to the bottom of the well when pumping at 700 gpm.

The aquifer near Wells A and B is strongly influenced by tide cycles. Water levels were observed to change at a magnitude of nearly 25-percent of the tide height with a lag time of about 70 minutes. This indicates a highly transmissive aquifer.

Boundary conditions (changes in the ability of the aquifer to produce water) were not observed during the pumping test. However, they could have been masked by the data manipulation to remove the impact of the tide on the water level data.

6.2 Aquifer Yield

Well yield must carefully balance aquifer production, potential for saltwater intrusion (discussed below), and physical construction of the wells. Our recommendations for well operations are discussed below. Note that if both Wells A and B are operating at the same time, we expect to see 1 to 3 feet of additional drawdown at each well and the pumping rates may need to be reduced.

These pumping tests were conducted during freezing and thawing conditions in December. It is likely that aquifer conditions change significantly seasonally. The lowest aquifer levels are expected when freezing conditions persist. Longer term pumping tests, or monitoring during regular operation, should be used to confirm the conclusions below.

6.2.1 Well A Production

We recommend operating Well A in a manner that does not cause the average daily drawdown to be below sea level. Based on the pumping test data it appears that a pumping rate of about 750 gpm would likely meet this criterion for periods of about one week of continuous pumping. The maximum short-term (six hours) pumping rate should be limited to about 850 gpm as this is near the maximum, laminar transmissivity of the well screen.

The transmissivity of the well screen will go down over time. To track this, we recommend periodically calculating the specific capacity of the well and comparing it to the baseline value of 130 gpm/ft. The well should be evaluated for rehabilitation if specific capacity drops by 10 percent.

6.2.2 Well B Production

Because the aquifer conditions near Well B are not as favorable, it may not be possible to operate Well B in a manner that does not cause the average daily drawdown to be below sea level unless the pumping rate is limited to about 500 gpm for continuous pumping durations of one day to one week. The maximum short-term (six hours) pumping rate should be limited to about 700 gpm as this is near the maximum, laminar transmissivity of the well screen.

The transmissivity of the well screen will go down over time. To track this, we recommend periodically calculating the specific capacity of the well and comparing it to the baseline value of 38 gpm/ft. The well should be evaluated for rehabilitation if specific capacity drops by 10 percent.

6.3 Saltwater Intrusion

Based on our evaluation, saltwater intrusion into the aquifer from upwelling does not appear to be a significant risk to Wells A and B if they are pumped at the rates recommended in this report. The horizontal intrusion of saltwater is a more complex evaluation and beyond the scope of this study.

One indication that horizontal saltwater intrusion may not be a risk to the wellfield is the historical data from Wells 1 through 3. The existing wells have been operated for decades without saltwater impact. Well 1, the primary production well, is located about 200 feet closer to the shoreline than Wells A and B.

If production from Wells A and B is greater than the historical production from Wells 1 through 3, the potential for horizontal saltwater intrusion should be further studied or monitored. If monitored, instruments could be installed in Wells 1 and 2 to serve as sentential wells. A 10 percent increase in salinity should be used as a criterion to conduct further studies or change production rates. If the combined production from Wells A and B and existing Wells 2 and 3 exceeds 2,000 gpm additional evaluation for upwelling of saltwater should be conducted.

7 CLOSURE/LIMITATIONS

This report was prepared for the exclusive use of our client and their representatives for evaluating the site as it relates to the hydrogeological aspects discussed herein. The conclusions presented are only applicable to the pumping rate during the test and the aquifer/climatic conditions at the time of the test. Different conclusions may be reached for different pumping rates or duration or different aquifer/climatic conditions. Groundwater levels and recharge vary by season and from year to year. The available water in the aquifer could vary substantially from what was observed during this study.

Shannon & Wilson has prepared the attachments in Appendix B Important Information About Your Geotechnical/Environmental Report to assist you and others in understanding the use and limitations of the reports.

Copies of documents that may be relied upon by our client are limited to the printed copies (also known as hard copies) that are signed or sealed by Shannon & Wilson with a wet, blue ink signature. Files provided in electronic media format are furnished solely for the convenience of the client. Any conclusion or information obtained or derived from such electronic files shall be at the user's sole risk.

8 REFERENCES

CRW Engineering Group LLC (CRW) 2007, Exploratory Well Drilling Program, for City of Whittier, November 12, 70p.

Golder Associates (Golder) 2004, Whittier Water Well Siting, for CRW Engineering Group LLC, September 27, 20p.

CHART 1 - WELL A PUMPING TEST

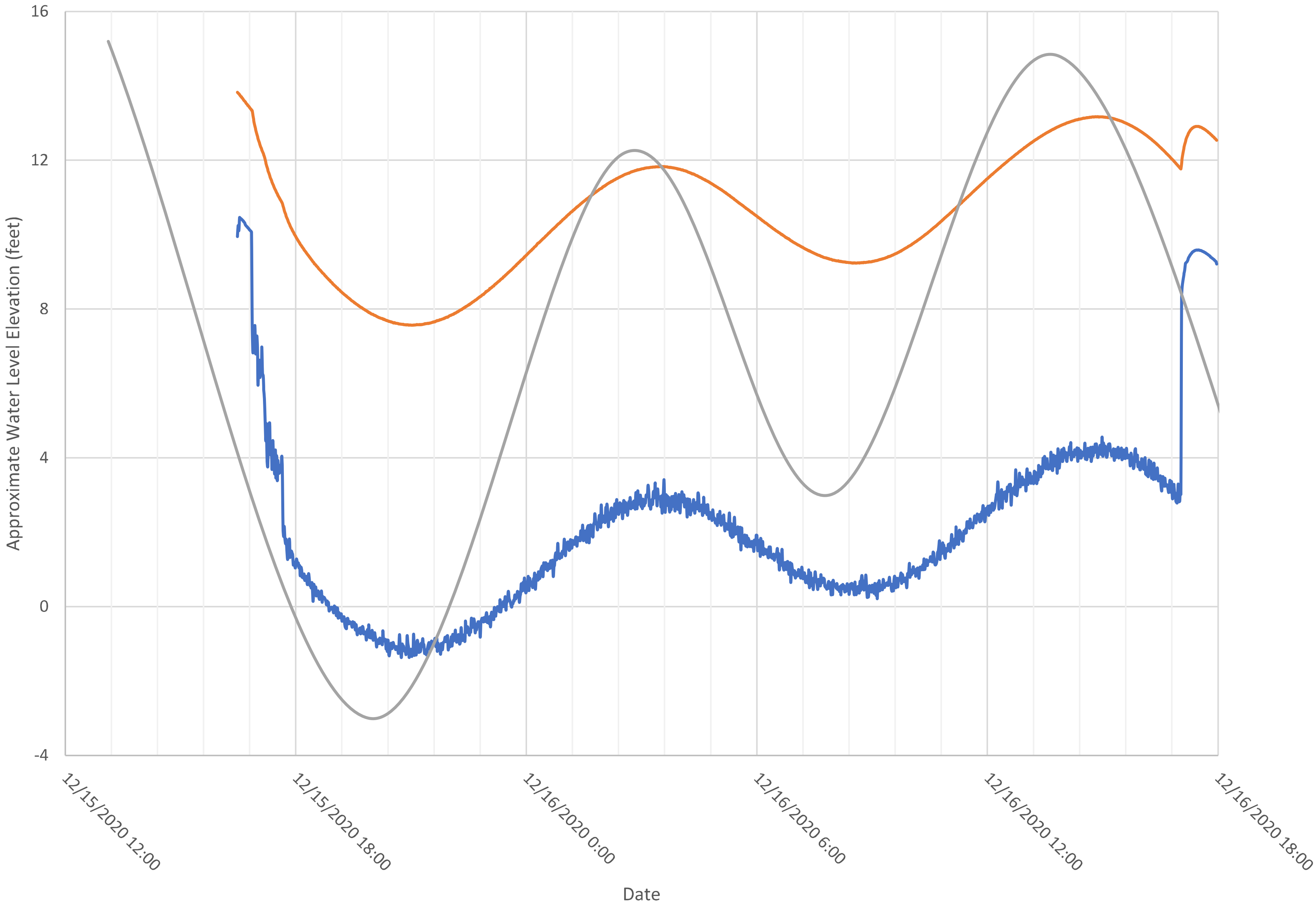
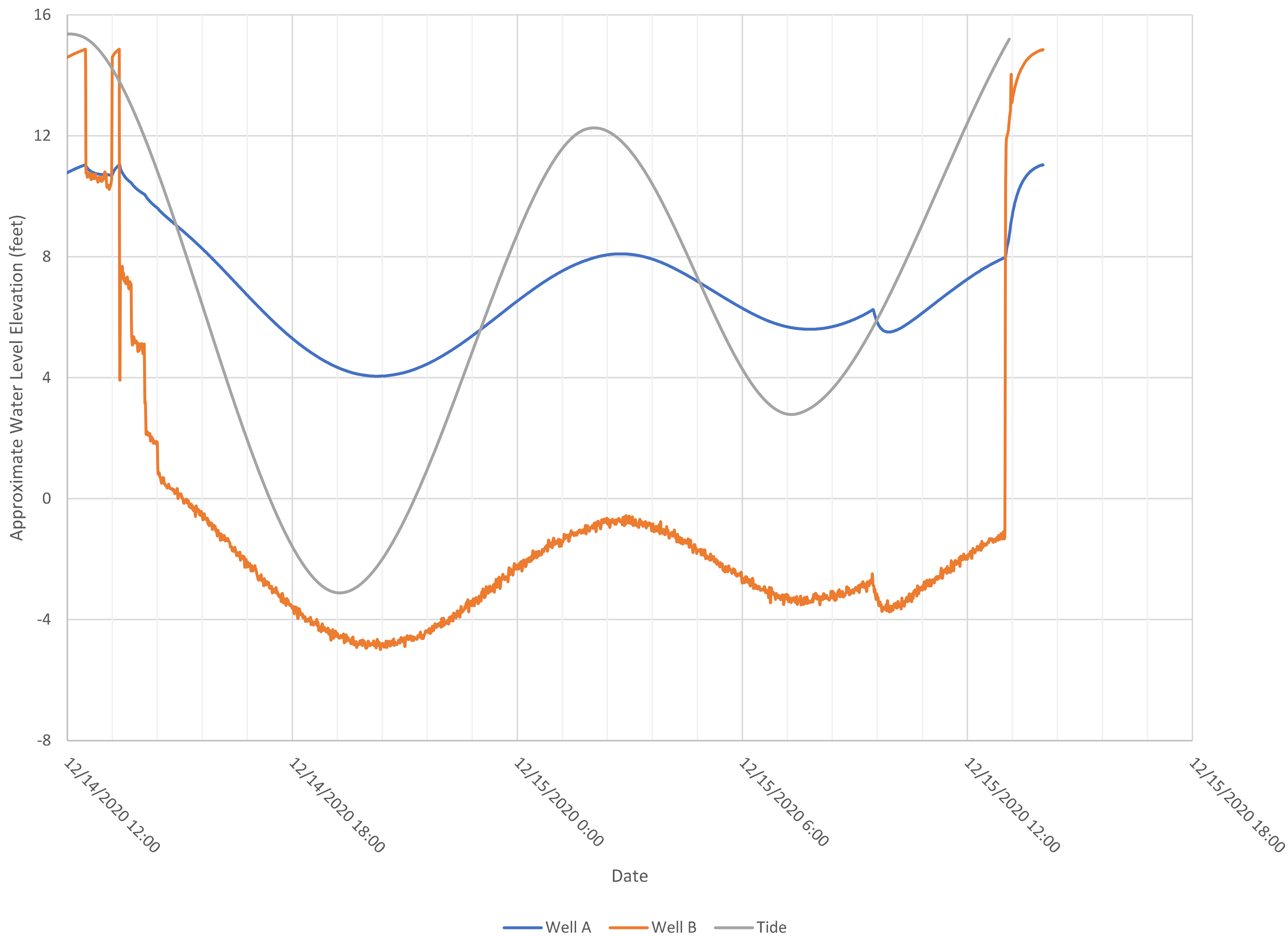


CHART 2 - WELL B PUMPING TEST



Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth™ Mapping Service.

Wellfield Aquifer Evaluation
Whittier, Alaska

VICINITY MAP

December 2020 | 104786-003

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FIG. 1

Map adapted from aerial imagery provided by Google Earth Pro, reproduced by permission granted by Google Earth™ Mapping Service.

LEGEND

Test Well A — Approximate Location of Test Well A installed November 2020.

0 100 200
APPROXIMATE SCALE IN FEET

N

Wellfield Aquifer Evaluation
Whittier, Alaska

SITE PLAN

December 2020 104786-003

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FIG. 2

APPENDIX A: WELL LOGS AND LAB RESULTS

Appendix A
Well Logs and Lab Results

Wheaton Water Well, Inc.

1190 N. Wasilla-Fishhook Road
Wasilla, AK 99654
(907)376-2041

Name:	Shannon and Wilson				
Address:	5430 Fairbanks St. #3				
City:	Anchorage	**State:** AK		**Zip Code:**	99518
Well Site:	City of Whittier			**Lot/Block:**	
Additional:	Well A				

		From:	**To:**	**Formation:**
Well Depth:	103 ft.	0	14	sand/gravel/cobble/silty grey
Below Ground:	101 ft.	14	38	damp sand/gravel/silt
Above Ground:	2 ft.	38	86	gravel/sand/silt/wet/few cobble
Gal/Min:	TBD	86	89	cobble/water
		89	103	gravel/sand/water
Static Level:	27 ft.			
Casing:	86ft. of 12 in. x .25 in. steel"			
Liner Pipe:	N/A			
Screened:	2' tail, 15' of .080 slot from 103'-86'			
Perforated:	N/A			
Grouted:	TBD- Surface Seal			
Depth:	TBD			
Develop. Method:	Air			
Use of Well:	Residential			
Drilling Method:	Rotary			
Misc:				
Other:				

The well was pumped 5' off the bottom with 100% draw down for 2 hours and recovered at TBD .

Date Drilled: 12.11.2020 **Driller:** Ben Mattson

Wheaton Water Well, Inc.

1190 N. Wasilla-Fishhook Road

Wasilla, AK 99654

(907)376-2041

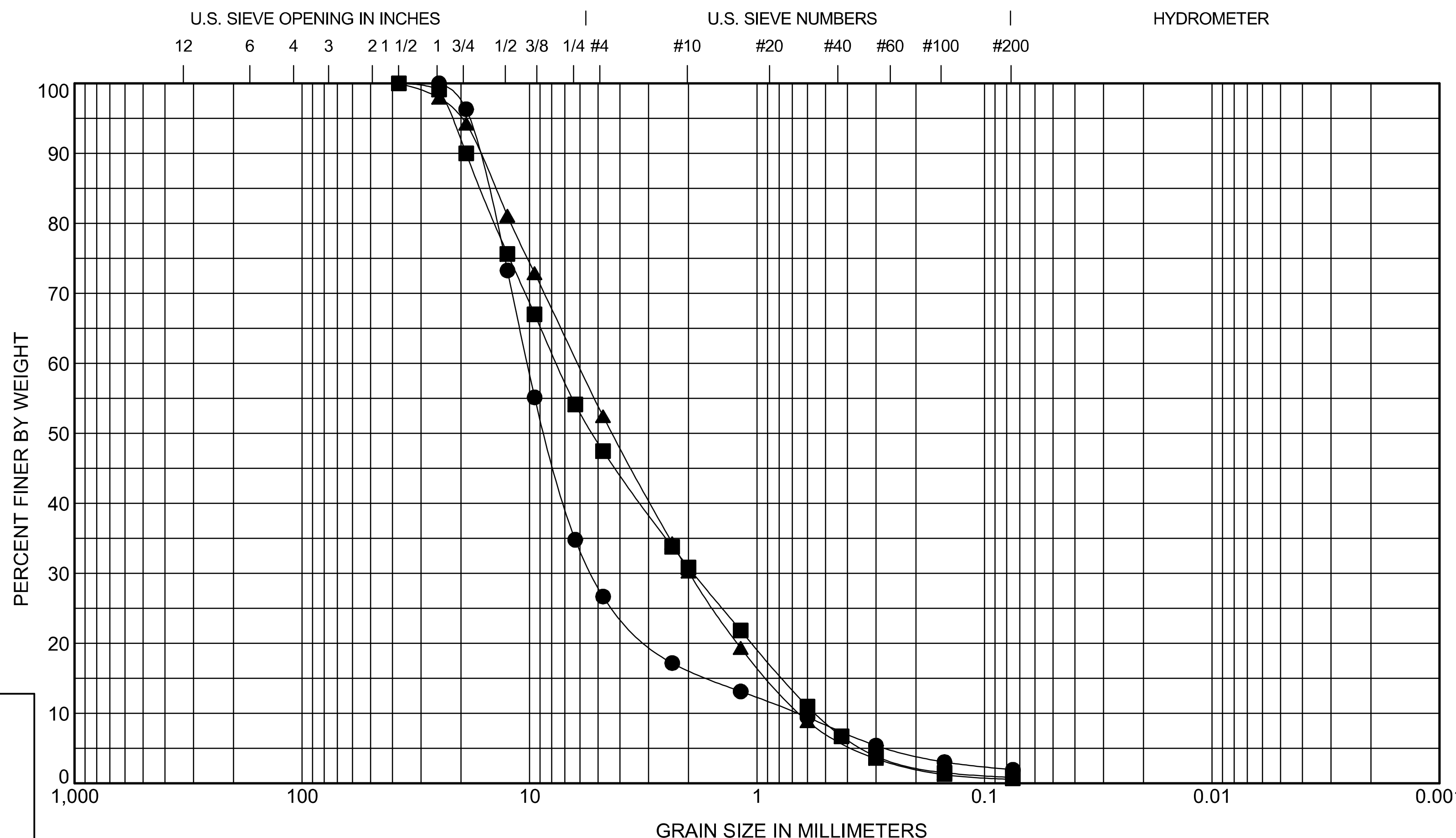
Name:	Shannon and Wilson		
Address:	5430 Fairbanks St. #3		
City:	Anchorage	**State:** AK	**Zip Code:** 99518
Well Site:	City of Whittier		**Lot/Block:**
Additional:	Well B		

Well Depth:	101 ft.
Below Ground:	99 ft.
Above Ground:	2 ft.
Gal/Min:	TBD
Static Level:	27'
Casing:	84ft. of 12 in. x .25 in. steel"
Liner Pipe:	N/A
Screened:	2' tail and 15' of .060 slot screen 101-84'
Perforated:	N/A
Grouted:	Neat Cement Surface Seal
Depth:	20'
Develop. Method:	Air
Use of Well:	Residential
Drilling Method:	Rotary
Misc:	
Other:	

From:	To:	Formation:
0	7	silt/gravel/organics
7	23	silt/sand/gravel
23	34	cobble/gravel/silt
34	46	gravel/sand/silt/water
46	58	gravel/cobble/silt/sand/water
58	68	gravel/sand/silt/water
68	78	gravel/cobble/silt/water
78	96	gravel/cobble/sand/silt/water
96	101	gravel/sand/water/silty

The well was pumped 5’ off the bottom with 100% draw down for 2 hours and recovered at TBD .

Date Drilled:	12.11.2020	**Driller:**	Ben Mattson



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	Well A S1	87.0 - 88.5	**GRAVEL with Sand (GP)**				**4.2**	**15.4**
■	Well A S2	90.0 - 91.5	**GRAVEL with Sand (GP)**				**0.9**	**13.7**
▲	Well A S3	100.0 - 101.5	**Well-graded SAND with Gravel (SW)**				**1.0**	**9.5**

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	Well A S1	87.0 - 88.5	**25**	**10.23**	**5.33**	**0.67**	**73**	**25**	**2**	
■	Well A S2	90.0 - 91.5	**37.5**	**7.6**	**1.91**	**0.55**	**53**	**47**	**1**	
▲	Well A S3	100.0 - 101.5	**37.5**	**6.14**	**1.98**	**0.65**	**48**	**52**	**1**	

Wellfield Evaluation
Whittier, Alaska

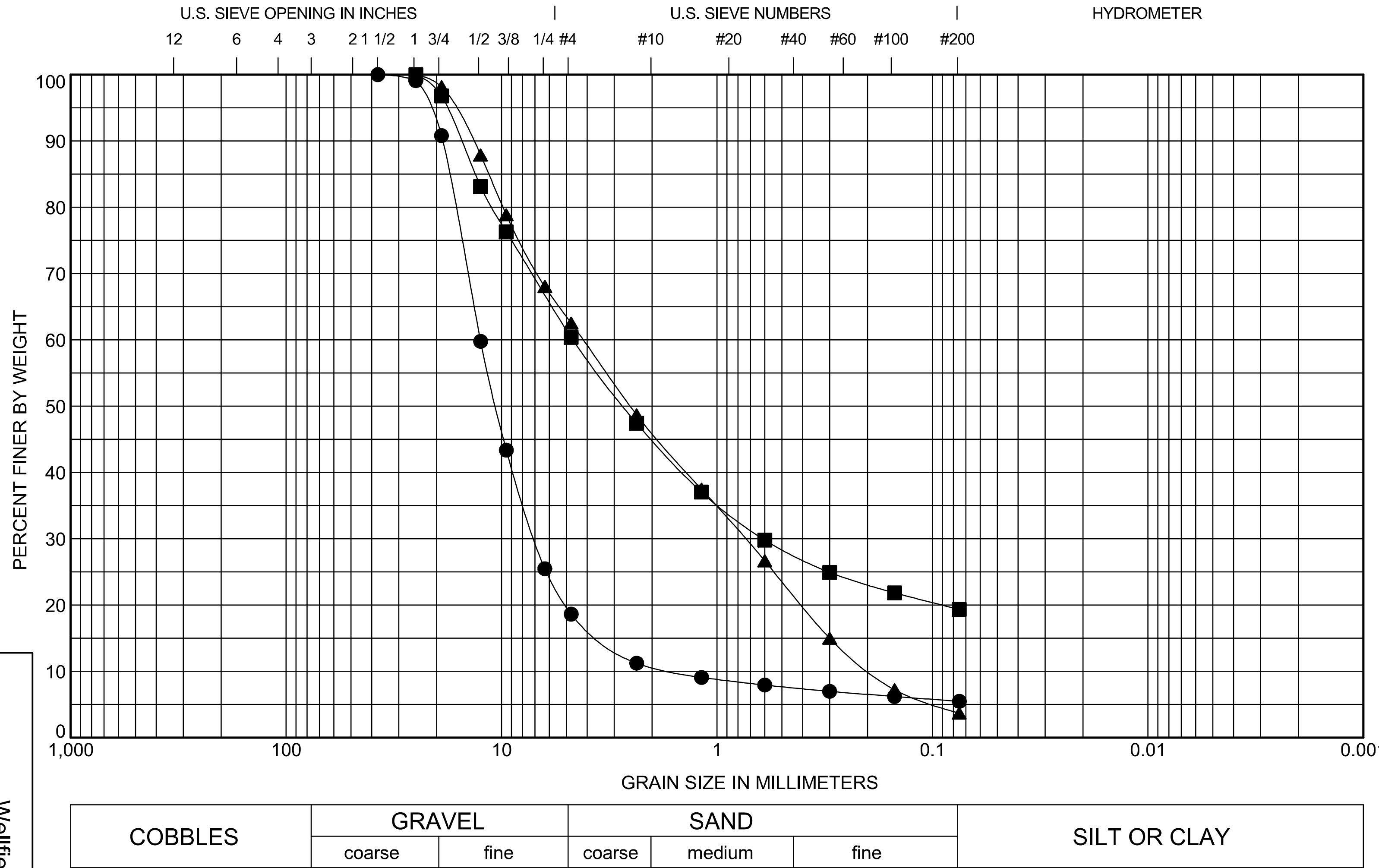
GRAIN SIZE CLASSIFICATION

December 2020

104786-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 1 of 3



	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**Well B S1**	**75.0 - 76.5**	**Well-graded GRAVEL (GW)**				**2.5**	**7.9**
■	**Well B S2**	**80.0 - 81.5**	**Silty SAND with Gravel (SM)**					
▲	**Well B S3**	**90.0 - 91.5**	**Poorly graded SAND with Gravel (SP)**				**0.7**	**21.8**

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**Well B S1**	**75.0 - 76.5**	**37.5**	**12.54**	**6.99**	**1.59**	**81**	**13**	**5**	
■	**Well B S2**	**80.0 - 81.5**	**25**	**4.65**	**0.61**		**40**	**41**	**19**	
▲	**Well B S3**	**90.0 - 91.5**	**25**	**4.18**	**0.74**	**0.19**	**37**	**59**	**4**	

Wellfield Evaluation
Whittier, Alaska

GRAIN SIZE CLASSIFICATION

December 2020

104786-003

SHANNON & WILSON, INC.
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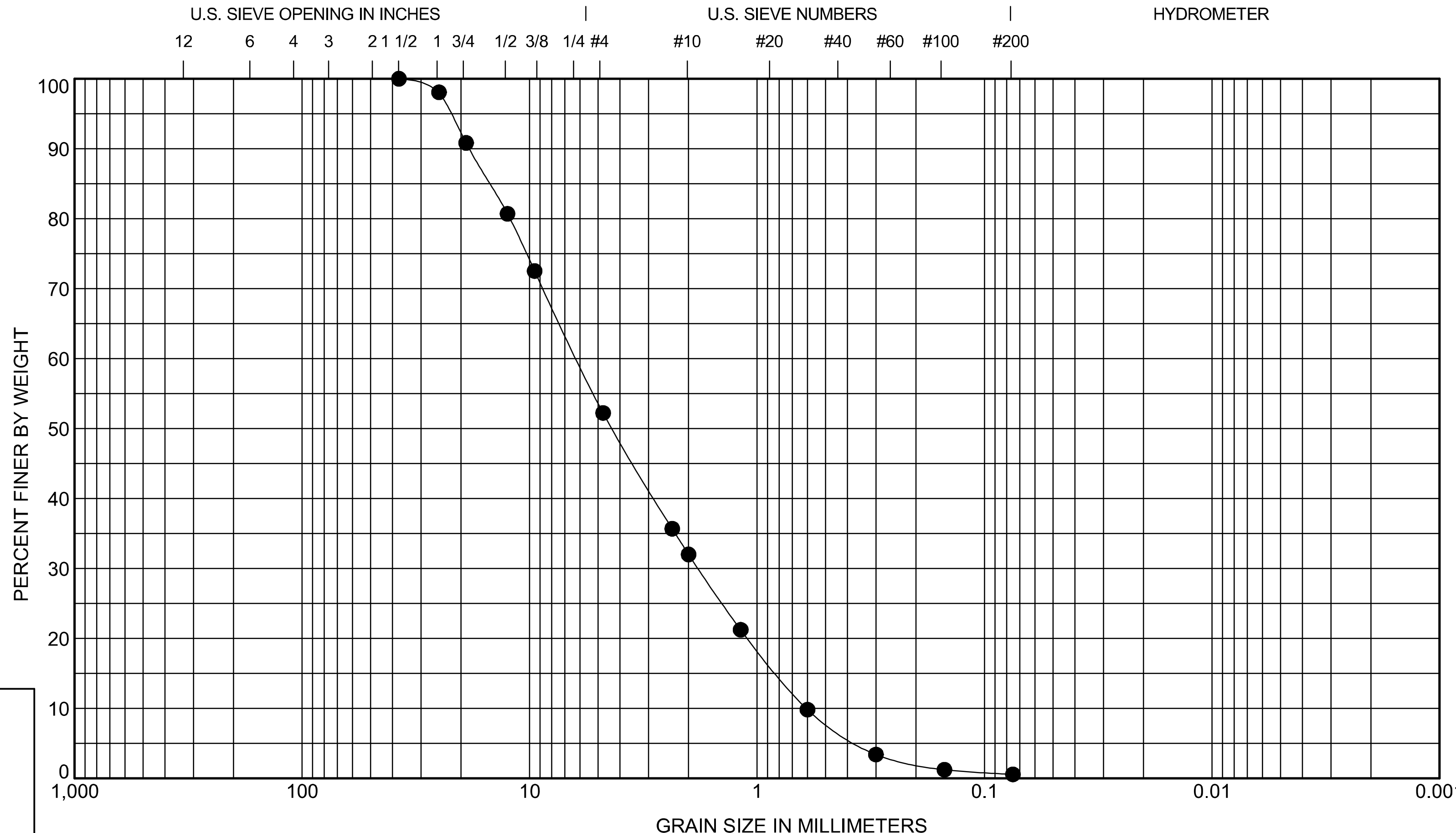
FIG. A-1
Sheet 2 of 3



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	**Well B S4**	**95.0 - 96.5**	**Poorly graded SAND with Gravel (SP)**				**0.9**	**10.2**

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**Well B S4**	**95.0 - 96.5**	**37.5**	**6.19**	**1.81**	**0.61**	**48**	**52**	**1**	

Wellfield Evaluation
Whittier, Alaska

GRAIN SIZE CLASSIFICATION

December 2020 104786-003

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 3 of 3

IMPORTANT INFORMATION

Appendix B

Important Information about your Geotechnical/Environmental Report

IMPORTANT INFORMATION

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should

IMPORTANT INFORMATION

retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland