RECEIVED
By Brianna Uy at 1:14 pm, Apr 05, 2021

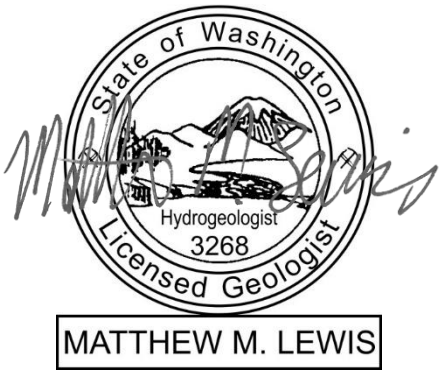
MEMORANDUM

Project No. 190559

March 1, 2020

To: Meredith Cambre, YMCA of Seattle

From:



Matthew M. Lewis, LHG
Project Hydrogeologist
mlewis@aspectconsulting.com

Jill Van Hulle, CWRE
Associate Water Rights Specialist
jvanhulle@aspectconsulting.com

Re: **YMCA: Mineral Lake Pumping Test Methods and Results**

An existing well (Well 1) on the YMCA property was tested by Aspect Consulting, LLC (Aspect) to assess aquifer feasibility in supplying future water needs for the camp. The testing supports Lewis County Department of Environmental Health source approval and the Washington State Department of Ecology (Ecology) water right permitting. This technical memo details the field methods, data analysis, and findings from the aquifer testing.

Aquifer Characterization

Well 1 is in the NW ¼ NE ¼ Section 4, Township 14 N., Range 5 E.W.M (Ecology ID BBN-866; see Figure 1). Based on review of the Ecology well log, the well is 249 feet deep and interpreted to be completed in a fractured bedrock aquifer. A 6-inch-diameter steel casing extends from the surface to 54 feet below ground surface (bgs). A 4-inch-diameter PVC liner was installed from 29 to 249 feet bgs with perforations between 239 and 249 feet bgs. The static water level was reported at 26 ft bgs at the time of completion in June 2010. The well log is included as Attachment A.

A step-rate pumping test was conducted by an Aspect hydrogeologist to estimate aquifer parameters and assess the efficiency of the well. The testing method, analysis, and results are described below.

Test Procedure

Aquifer testing at each well included installing a 3-inch-diameter Grundfos submersible pump and a downhole pressure transducer to monitor and record water levels. Prior to testing, the test well

was initially sounded to establish static depth to groundwater before placing the pressure transducer and pump near the bottom of the well (within the well screen). After stabilization of the groundwater level (from the displacement of the pressure transducer and pump), the pump was started and the pumping rate adjusted to produce a continuous flow. Water produced during pumping was discharged 400 feet away from the well to avoid potential interference.

The pressure transducer monitored and recorded drawdown during pumping and a totalizing flow meter was read periodically to determine pumping rates. The pump discharge line was equipped with a check valve to prevent water from flowing back down the line and into the well after pump shut-off. Manual water level measurements were also collected using a sounding tape and recorded on field sheets. Once water levels in the well stabilized on the final step, the pump was stopped, and water level recovery was recorded by the pressure transducer. However, the transducer cable was severed during pump removal and was not able to be retrieved from the well. Therefore, manual water level measurements were relied upon for aquifer analysis. Once the groundwater level was nearly fully recovered to static pre-test conditions, the pump and testing equipment were removed from the well.

Pumping rates were gradually increased in four steps: 7.8 gallons per minute (gpm), 11.2 gpm, 15.5 gpm, and the final step at 19.3 gpm. The water level drawdown at the end of the test was 19.5 ft below static after about 4 hours of pumping. Each step lasted between 35 minutes and 2 hours to ensure stabilization before moving to the next step. A hydrograph for the test is shown as Figure 2.

A pressure transducer was also installed in the closest nearby well about 350 feet southwest to evaluate aquifer response. No response was noted in the observation well during pumping; this is consistent with the low yield of the test well and suggests low transmissivity (the ability of the aquifer to transmit water per unit width) within the aquifer.

Test Results

The Cooper-Jacob method (1946) was used to analyze drawdown data from the final step of the pumping test, as shown on Figure 3. Aquifer transmissivity was estimated to be about 310 square feet per day (ft^2/d), which is consistent with the lithology described in the well log.

Well efficiency and long-term drawdown was estimated by applying the well and aquifer metrics described in the preceding sections to the Theis equation (Krusemann and de Ridder, 2001). Specific capacity is a measure of the pumping rate (gpm) divided by the drawdown measured after continuously pumping for a certain period (often 30 minutes) and is a useful metric for estimating the capacity of a well. The specific capacity and well efficiency estimates are presented in Table 1.

Table 1. Step-Rate Test Summary of Results

Step #	Pumping Rate (gpm)	Drawdown (feet)	Specific Capacity (gpm/ft)	Well Efficiency (%)
1	7.8	5.5	1.4	69%
2	11.2	8.5	1.3	61%
3	15.5	13.8	1.1	53%
4	19.3	19.5	1.0	48%

Estimated water levels during long-term continuous pumping at the test well is shown on Figure 4. The predicted drawdown for the test well assumes that the well screen remains fully saturated and that pump assemblies are not installed within the screen assemblies in a manner that restricts flow. The drawdown from pumping at 40 gpm is predicted to be approximately 79 feet, which places the pumping level at about 100 feet bgs. This leaves about 100 feet above the assumed pump intake, suggesting that the well has some additional capacity not utilized in this pumping test. However, pumping this additional capacity may be limited by the 4-inch-diameter liner in the well which restricts the size of pump that may be installed.

For the primary Phase 1 buildout of the camp, the YMCA assumes water will be required for 500 people (400 campers and 100 staff members.) If an average demand of 45 gallons per day (gpd) is assumed per person, a total of 22,500 gpd will be needed. A constant pumping rate of 40 gpm (or up to 58,000 gpd) from the well will provide sufficient supply for the camp at the Phase 1 buildout. Based on our evaluation of the site, and assuming the wells are sufficiently spaced, we anticipate that any additional wells needed for the project can be expected to produce similar quantities as the camp continues to expand into full buildout.

References

Cooper, H.H. and C.E. Jacob, 1946, A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Wellfield History, Am. Geophys. Union Trans., Vol. 27, pp 526-534.

Kruseman, G.P., and N.A. de Ridder, 2001, Analysis and Evaluation of Pumping Test Data, ILRI Publication 47, 2nd addition, ISBN 90 70754 207.K-D, 2000.

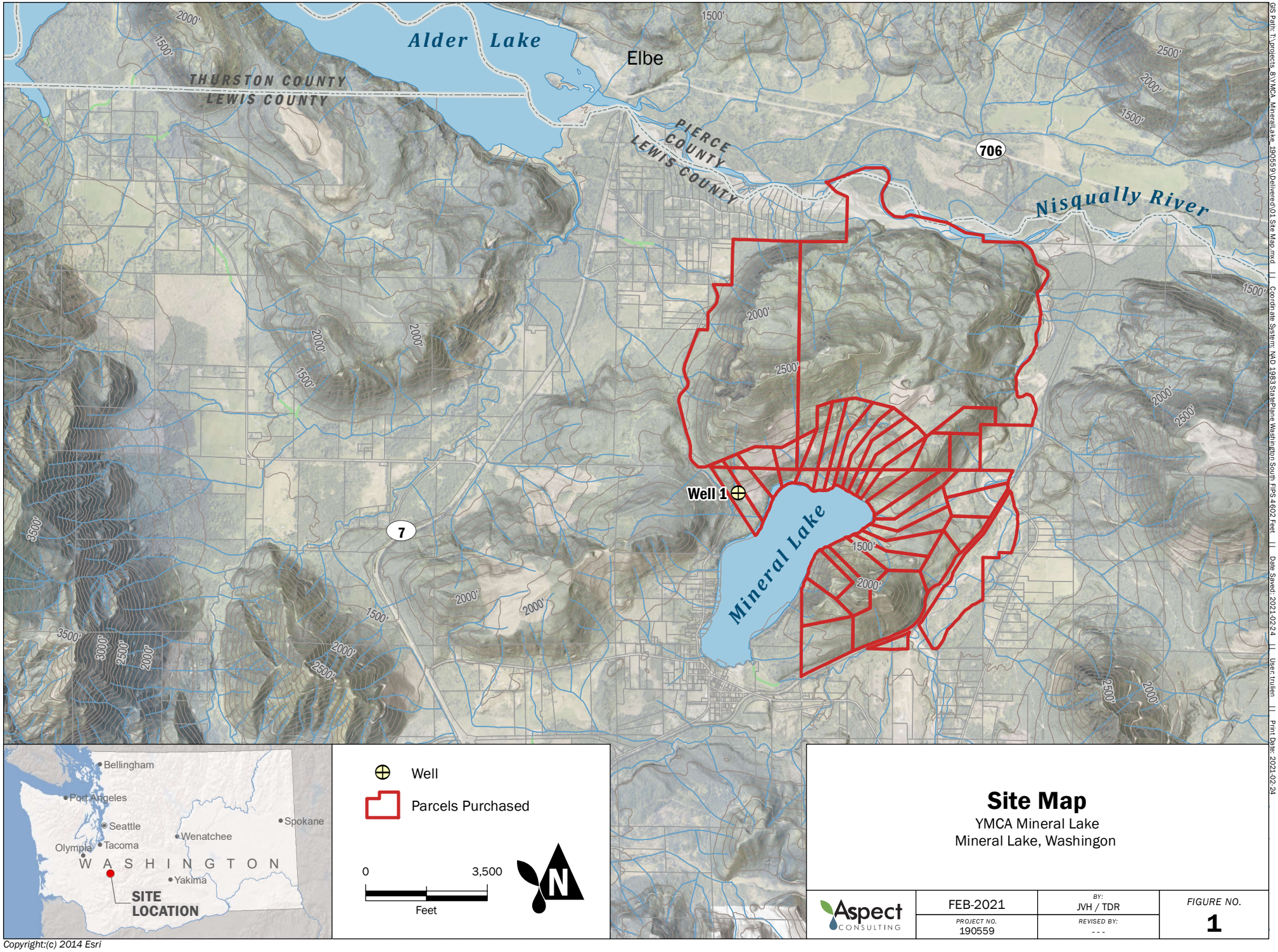
Limitations

Work for this project was performed for the YMCA of Seattle (Client), and this memorandum was prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

All reports prepared by Aspect Consulting for the Client apply only to the services described in the Agreement(s) with the Client. Any use or reuse by any party other than the Client is at the sole risk of that party, and without liability to Aspect Consulting. Aspect Consulting's original files/reports shall govern in the event of any dispute regarding the content of electronic documents furnished to others.

Attachments:
Figure 1 – Site Map
Figure 2 – Step-Rate Test Hydrograph
Figure 3 – Transmissivity Analysis Hydrograph
Figure 4 – Long Term Pumping Rates
Attachment 1 – Well Log

FIGURES



Site Map

YMCA Mineral Lake
Mineral Lake, Washingon

Aspect Consulting	FEB-2021	BY: JVH / TDR	FIGURE NO. 1
	PROJECT NO. 190559	REVISED BY: ---	

GIS Path: T:\projects_8\YMCA_MineralLake_190559\Delivered\01 Site Map.mxd | | Coordinate System: NAD 1983 StatePlane Washington South FIPS 4602 Feet | | Date Saved: 2021-02-24 | | User: truelen | | Print Date: 2021-02-24

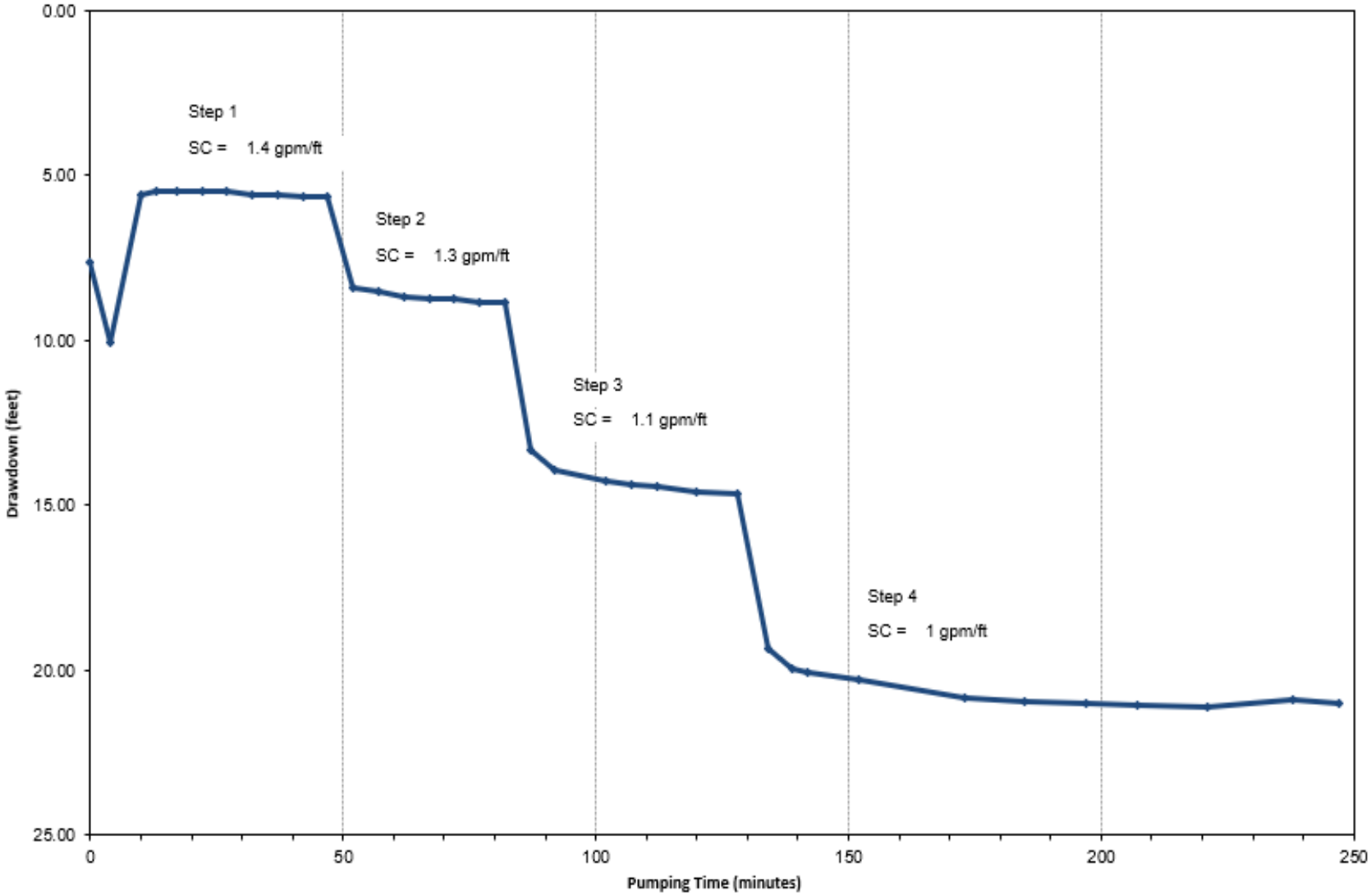


Figure 2
Step-Rate Test Hydrograph
YMCA: Mineral Lake Pumping Test Methods and Results
YMCA: Mileral Lake, King County, WA

Aspect Consulting
2/23/2021
S:\YMCA of Seattle\Report Drafts\Draft\Figures\YMCA_Hantush-Bierschenk_Solution_DRAFT

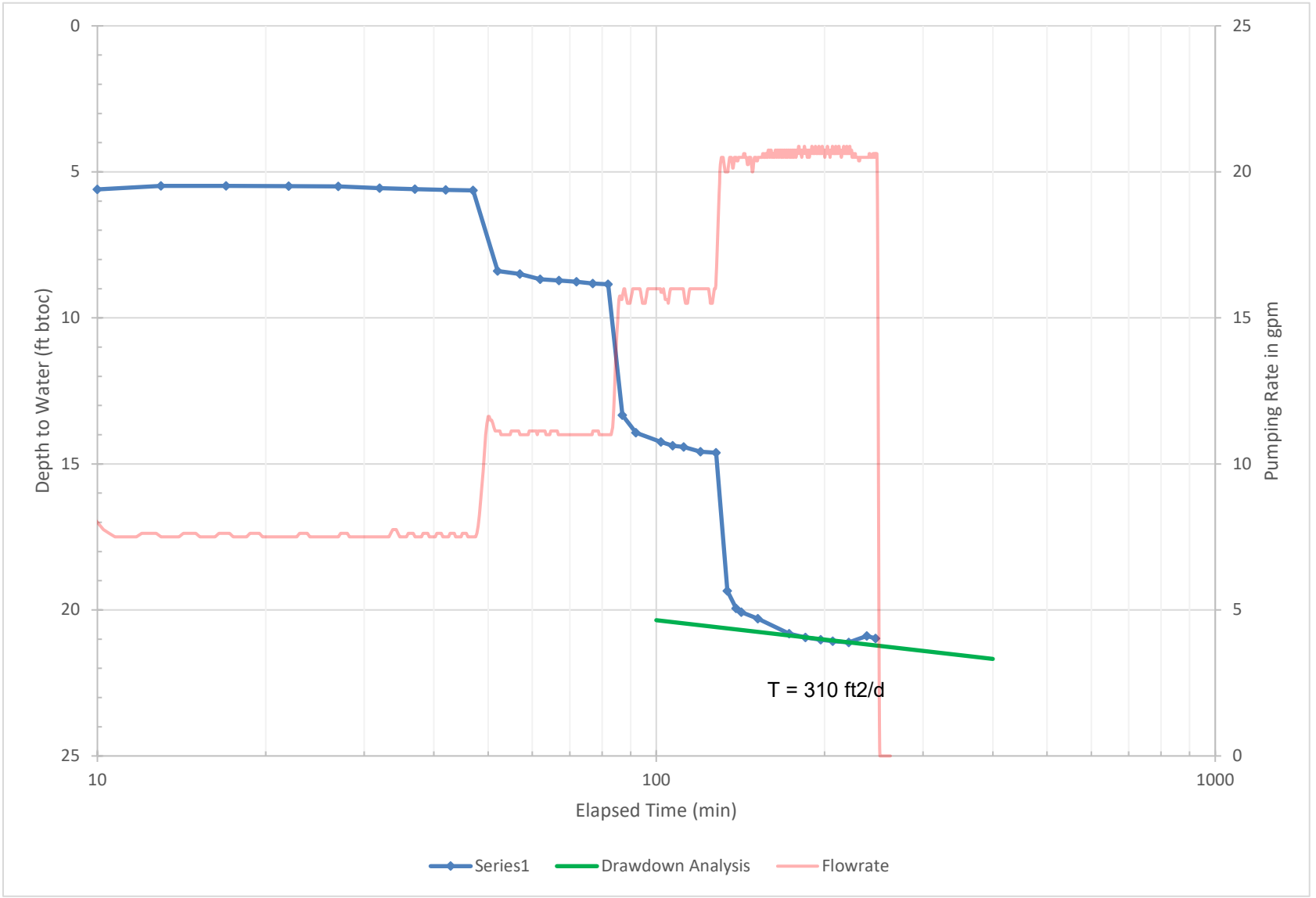


Figure 3
Transmissivity Analysis Hydrograph
YMCA: Mineral Lake Pumping Test Methods and Results
YMCA: Mileral Lake, King County, WA

Aspect Consulting
2/23/2021
S:\YMCA of Seattle\Data\Analyses\PumpingTest032020_repair

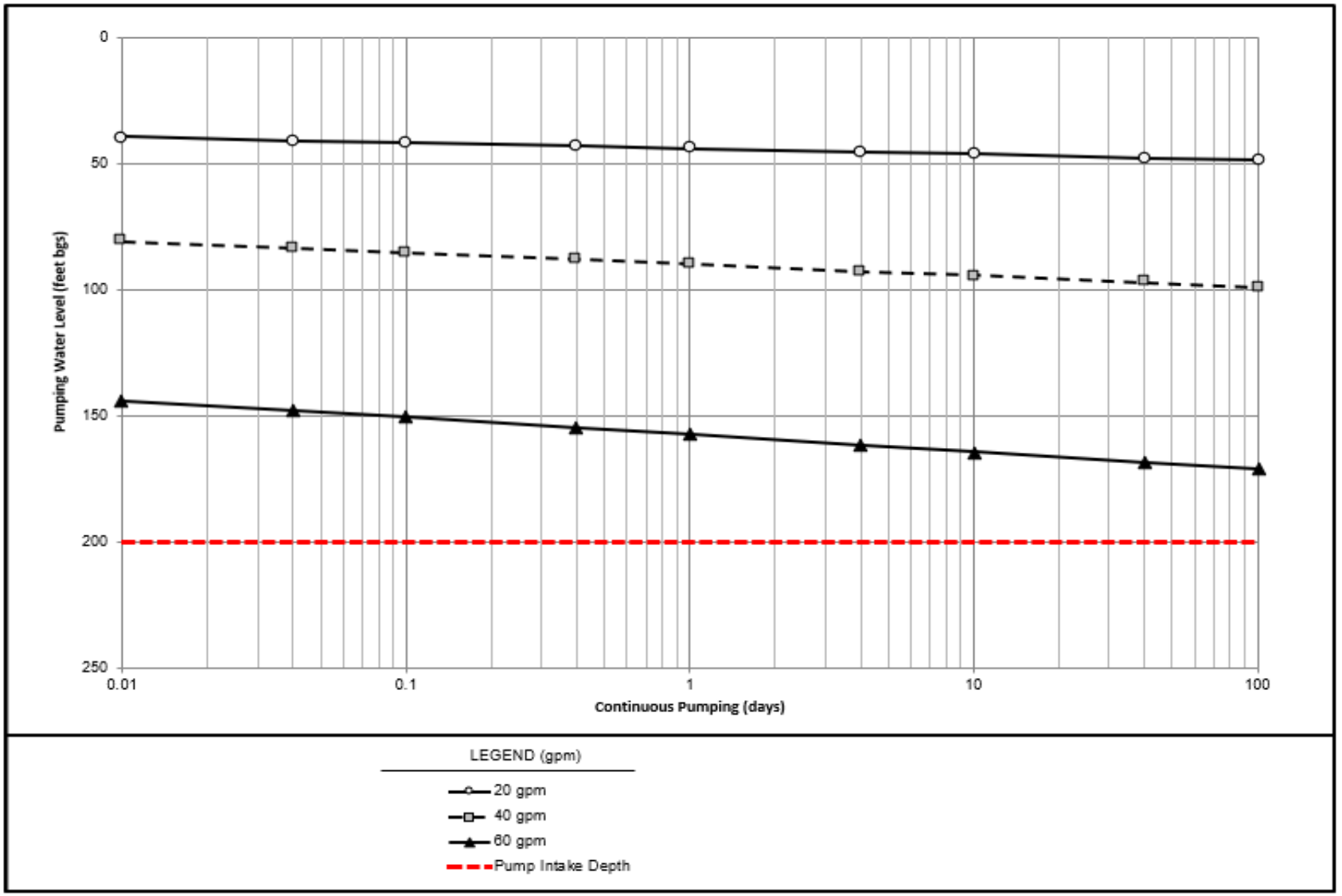


Figure 4
Long Term Pumping Rates
YMCA: Mineral Lake Pumping Test Methods and Results
YMCA: Mileral Lake, King County, WA

Aspect Consulting
2/23/2021
S:\YMCA of Seattle\Report Drafts\Draft\Figures\YMCA_Hantush-Bierschenk_Solution_DRAFT

Attachment 1

Well Log

WATER WELL REPORT

DEPARTMENT OF ECOLOGY State of Washington

Original & 1st copy - Ecology, 2nd copy - owner, 3rd **copy - driller**

Construction/Decommission *("x" in circle)* 376984
- [x] Construction
- [ ] Decommission *ORIGINAL INSTALLATION*

Notice of Intent Number _____

PROPOSED USE: [x] Domestic [ ] Industrial [ ] Municipal [ ] DeWater [ ] Irrigation [ ] Test Well [ ] Other _____

TYPE OF WORK: Owner's number of well (if more than one) _____
[x] New well [ ] Reconditioned *Method:* [ ] Dug [ ] Bored [ ] Driven [ ] Deepened [ ] Cable [x] Rotary [ ] Jetted

DIMENSIONS: Diameter of well 6 inches, drilled 251 ft.
Depth of completed well 249 ft.

CONSTRUCTION DETAILS
Casing Installed: [x] Welded 6 " Diam. from +2 ft. to 54 ft.
[x] Liner installed 4 " Diam. from 29 ft. to 249 ft.
[ ] Threaded _____ " Diam. From _____ ft. to _____ ft.

Perforations: [x] Yes [ ] No
Type of perforator used Grinder cut
SIZE of perfs 1/4 in. by 2 in. and no. of perfs 40 from 239 ft. to 249 ft.

Screens: [ ] Yes [x] No [ ] K-Pac Location _____
Manufacturer's Name _____
Type _____ Model No. _____
Diam. _____ Slot size _____ from _____ ft. to _____ ft.
Diam. _____ Slot size _____ from _____ ft. to _____ ft.

Gravel/Filter packed: [ ] Yes [x] No Size of gravel/sand _____
Materials placed from _____ ft. to _____ ft.

Surface Seal: [x] Yes [ ] No To what depth? 18 ft.
Material used in seal Bentonite
Did any strata contain unusable water? [ ] Yes [x] No
Type of water? _____ Depth of strata _____
Method of sealing strata off _____

PUMP: Manufacturer's Name _____
Type: _____ H.P. _____

WATER LEVELS: Land-surface elevation above mean sea level 1555 ft.
Static level 28 ft. below top of well Date 6/2/10
Artesian pressure _____ lbs. per square inch Date _____
Artesian water is controlled by _____ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? [ ] Yes [x] No If yes, by whom? _____
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.
Yield: _____ gal./min. with _____ ft. drawdown after _____ hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____
Bailer Test _____ gal./min. with _____ ft. drawdown after _____ hrs.
Airtest 45 gal./min. with stem set at 248 ft. for 1 hrs.
Artesian flow _____ g.p.m. Date 6/2/10
Temperature of water _____ Was a chemical analysis made? [ ] Yes [x] No

CURRENT

Notice of Intent No. W 270539
Unique Ecology Well ID Tag No. BBN 866
Water Right Permit No. Exempt well
Property Owner Name Mineral Lake Forest LLC
Well Street Address Off Mineral Hill Road Lot #3
City Mineral County Lewis
Location NW 1/4-1/4 NE 1/4 Sec 4 Twn 14 R 5 EWM [x] Check Or WWM [ ] One
(s, t, r Still REQUIRED)

Lat/Long Lat Deg 46 Lat Min/Sec 43' 41"
Long Deg 122 Long Min/Sec 10' 59"

Tax Parcel No. (Required) 038931001103

CONSTRUCTION OR DECOMMISSION PROCEDURE
Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO
Top soil	0	3
Clay Brown Hard	3	15
Sandy clay Gray Soft	15	23
Clay & gravel Brown Hard	23	36
Rock-crumbly Gray Semi-hard	36	47
Rock Gray Hard	47	163
Basalt Gray Very hard	163	241
Rock-crumbly Gray Soft	241	245
Rock-crumbly, caving-wb Gray Soft	245	251

RECEIVED
JUN 15 2010
WA State Department of Ecology (SWRO)

Start Date 6/1/10 Completed Date 6/2/10

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

[x] Driller [ ] Engineer [ ] Trainee Name (Print) Chris Jones
Driller/Engineer/Trainee Signature Chris Jones
Driller or trainee License No. 2253
IF TRAINEE: Driller's License No: _____
Driller's Signature: _____

Drilling Company Moerke & Sons Pump & Drilling, Inc.
Address 1162 NW State Avenue
City, State, Zip Chehalis , WA , 98532
Contractor's Registration No. MOERKSP072N5 Date 6/3/10