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DEWATERING DESIGN - 2401 NW MARKET STREET, SEATTLE, WASHINGTON

Dear Brandon:

This letter presents our dewatering design recommendations for construction dewatering at your 2401 NW Market Street development in Seattle, Washington. This letter is intended to provide the basis of design, and design recommendations for site groundwater control. This letter does not detail the specific equipment intended for construction of the system, specific dewatering component cut sheets, layout, or schedule. This plan has been prepared based on the project geotechnical report, the plans, our experience, and our conversations with you.

PROJECT DESCRIPTION

The site is located at 2401 NW Market Street in Seattle, Washington. The site is located between NW Market Street on the north, 24th Avenue NW on the east, NW 54th Street on the south, and an existing building to the west. The site is located north of the Ship Canal and slopes from north to south with the highest existing site grades about elevation 48 feet sloping down to about elevation 29 feet in the south.

The shoring design was prepared by Terracon, dated August 12, 2022. The top of slab for the PL2 floor will be elevation 18.5 feet; we assume a base of excavation elevation of 16.5 feet. The excavation will be shored by a soldier pile and lagging walls along the north and east sides of the excavation. We understand that the base of excavation elevations for the elevator pits and crane pad excavations will be about 5 feet lower, or to about elevation 11.5 feet.

We understand that the work will begin in early 2023.

SOIL CONDITIONS

The soil conditions for the site are provided in a March 30, 2022 geotechnical report provided by Aspect Consulting titled Geotechnical Engineering Report, 2401 NW Market St, Seattle Washington. This report provides geotechnical recommendations, groundwater level monitoring data, a number of boring logs performed by Aspect, and a number of boring logs performed by others on and in the vicinity of the project site.

Based on the geotechnical report and explorations, the soil conditions appear to consist of fill over weathered till, and then till. The fill and the weathered till have essentially the same soil classifications and Aspect has lumped these into one unit. The underlying till is composed primarily of silty sand.

Till is traditionally a very low permeability soil. This soil was formed at the base of a glacier and as such is very dense, and typically has a sufficient amount of fines (soil that passes through the No. 200 sieve) that it will exhibit low permeability; till is traditionally not capable of transmitting significant quantities of groundwater.

At and in the vicinity of this site the till does not appear to have the gravels and cobbles that are typically associated with a classic till. We get the impression that the till is more of a diamict, and these types of (more uniform finer-grained) tills can often form on the lee side of traditional till ridge. In many cases a diamict can have coarser lenses of soil that contains sand, and therefore may be capable of transmitting groundwater at higher rates; however, since it often is a lens of sand, high seepage rates to the excavation will only be for a limited time period. In review of all of the logs provided in the geotechnical report, we get the impression that the soils tend to get slightly coarser at elevations of less than, say roughly 5 feet. North of the site Golder Associates tended to call the unit Advance Outwash Sand; this may be due to a coarsening of the soil in those locations or that it can be very difficult to discern between silts and fine sands in a boring sample, and different firms may classify soils such as this differently. The point here is that the soils encountered at the site are near the silt content transition point between what may be slightly pervious soils or low permeability aquitards.

Aspect points out that trenches and sumps were required during construction of the building immediately to the west of the site, and that a wellpoint system was required for the excavation of the elevator pit excavations. That building is slightly shallower than the subject site.

Aspect installed dataloggers in select monitoring wells and measured groundwater elevations for about four months. Groundwater levels peaked during the monitoring period in January of 2022 at an elevation of about 25.5 feet. Since the monitoring wells used for the data collection were located in the middle and southern parts of the site, and indicate a fairly significant gradient, we use a design groundwater elevation of 28 feet at the north end of the site.

Based on our interpretation of the boring logs, where groundwater levels were often encountered much lower during drilling versus those measured, it appears that groundwater is under confined conditions deeper in the soil profile, say roughly less than elevation 5 feet. If this is true, then recharge to the excavation will be from the deeper more pervious soil.

DESIGN APPROACH AND CALCULATIONS

This section presents our interpretation of the soil and groundwater conditions, our approach to groundwater control, and design calculations for the excavation.

After review of all of the boring logs provided in the geotechnical report, it is our impression that the site soils will exhibit low permeabilities to and below the base of excavation elevation; trenches and sumps will largely be effective in collecting and removing groundwater from the excavation. Near elevation 5 feet or so, the soil may be slightly coarser or have thin seems of sand with silt or poorly graded sands; these soils may provide a source of water to the shallower silty sands near the base of excavation, and may have silt contents near the limit where an active dewatering system, such as a well point system can be used to reduce groundwater pressures and seepage rates to the excavation. We note that this summary of the soil conditions is based on our review of the boring logs; gradations of soil samples were not provided.

Based on these data and assessments we believe that groundwater control for the mass excavation can be performed using trenching and sumps. The base of excavation will be to elevation 16 feet or so, and there will likely be enough lower permeability soils above the coarser soils near elevation 5 feet to prevent higher seepage rates. The sumps and trenches will be located and operated as necessary according to the means and methods of the excavation contractor. There may be areas where coarser soils are encountered and higher seepage rates occur, the seepage rates from these soils should reduce shortly after being exposed as it is likely that the seepage is only from a lens of coarse sand. If seepage rates persist and are high enough, then it may be that a vacuum well point system will need to be installed.

Aspect performed rising head tests at two of the monitoring wells installed at the site. Their analysis yielded an inflow estimate to the excavation of 10 gpm using a bulk hydraulic conductivity of 0.2 feet per day or $1.4x10^{-4}$ feet per minute. Based on the soil descriptions near subgrade elevation we would largely agree with this estimate.

That estimate is based on the entire soil mass having a very low permeability. To provide you with some understanding of a possible upper discharge rate limit for groundwater control at the site, for instance if the suspected higher permeability sand below elevation 5 feet were higher, we performed analytical dewatering calculations assuming the entire site was dewatered at once using a well point system. This estimate should be considered as very conservative as it assumes the entire excavation is dewatered at once, and the soil permeabilities used in the calculations are likely too high. Using soil permeabilities between 0.002 and 0.005 ft/min the likely maximum discharge rate for the site would be about 50 gpm.

If seepage rates for the elevator pit and crane pad excavations are above those that can be tolerated or controlled by sumps and trenches, we would then recommend the use of well points to dewater those excavations. Vacuum-based well points are closely spaced small diameter wells that remove groundwater from the soils using vacuum pressures. They work well in soils with varying permeability such as at this site. One issue with well points is that since they operate under vacuum pressures generated from a single pump, any break in any component (main header, well point, vacuum hoses, valving) will immediately terminate operation of the entire system; as such, the dewatering components should be protected from damage.

Analytical calculations were performed to estimate the performance of well point systems for the elevator pits and crane pad excavations. The calculations performed were for dewatering all of these at one time, however individual excavations can be dewatered based on the conditions encountered. Sheet 1 provides a potential layout of such well point systems, and indicates that the yield from the systems (assuming all are dewatered at once) may be on the order of 20 to 40 gpm.

DESIGN RECOMMENDATIONS

Groundwater control for the building excavation at the 24012 NW Market Street project will be performed primarily using sumps and trenches. As a contingency for the excavations and possibly for the elevator pit and crane pad excavations, a vacuum-based well point system can be used.

We would anticipate that trenches would be excavated along the walls of the excavation, and where seepage is encountered inside the excavation, the seepage would then be routed to sumps. Sumps should be cased in a perforated housing or well screen surrounded by a washed, rounded gravel pack to avoid pumping of fines. Sumps may need to be removed and the filter pack replaced periodically to keep them functional. Trenches may be excavated into the native soil and filled with free draining gravel as conditions require. The discharge from the sumps should be routed to one or more settlement tanks before discharge to the system outfall. Note that due to the fine soil conditions, some filtration of the water may be required to meet local discharge requirements.

We recommend that the sump systems be run without interruption for maximum performance.

Should a well point system be required the following provides specific recommendations for construction and operation of the system. We should be consulted for the final well point design and layout prior to system installation.

Well Points: The well points may be drilled at an angle (60-degrees below horizontal) or vertical near soldier pile and lagging walls or vertical near the west and south walls and elevator pit and crane pad locations. The well points should be installed on 7-foot centers. They should be drilled to a depth of 21 feet (from original grade, or to a similar elevation if the site has been cut down) using a Klemm or similar. Well points should be constructed of 2-inch-diameter PVC and have a 3-foot long 30-slot screen section and interior suction pipe to the bottom of the well point.

A Colorado Product 12-20, or equivalent, washed, rounded sand filter pack should be placed in the annular space between the borehole wall and well point casing up to the static water table. A bentonite pellet seal should be placed between the top of the sand pack and ground surface. The seal should be hydrated.

Well point swing hoses should be new or clean enough that the operator and site staff can clearly see the amount of air and water passing through the hose.

All well points should have valves placed in-line to control vacuum pressure and flow at each well point.

Well points should be installed in accordance with WAC 173-160.

Vacuum Pump: Vacuum pumps capable of creating at least 22-inches (Hg) of vacuum across each well point should be provided. The pumps should have a continuous power supply and be capable of providing continuous vacuum in the system throughout the length of the project.

Provide a vacuum gage on the end of the header pipe furthest from the pump. Vacuum pressures should be above 18-inches at the gage at all times.

Development: The well points should be developed immediately upon completion. Development methods should utilize flow surging. Development will improve the hydraulic connection with the aquifer and should provide a clean dewatering effluent with time. Development water should be discharged to a settling tank.

Piping and Discharge: The discharge piping from the pump should be minimum 6-inch diameter HDPE or PVC. The discharge piping will be routed to the discharge outfall. Air leaks in the piping and components must be minimized such that there is greater than 18-inches of vacuum at each well point at all times.

Flowmeter: A flowmeter should be installed on the mainline discharge from the dewatering system. The flowmeter should be installed such that there is a full pipe of water and that some backpressure is exerted on the meter. Flowmeters should be installed according to manufacturer's recommendations on distances to joints, elbows, etc.

Power: We understand that power will be supplied by line power or diesel driven pumps.

Well Decommissioning: The well points should be decommissioned according to WAC 173-160.

Operation: The system should be operated continuously. Dewatering should commence a minimum of 2 to 4 days prior to excavation below the water table, depending on the nature and location of the seepage. The system(s) should be regularly inspected for piping leaks and pump malfunctions. Frequent tuning of the system may be required in the first week of operation.

Monitoring: We recommend that select monitoring wells, such as AMW-2, -4, and -7 be retained until the dewatering requirements at the site are fully understood and that complete dewatering of the site is assured. The static water levels in the monitoring wells (and the well points if installed) should be measured and recorded prior to excavation, and then daily after the water table has been intercepted. Once dewatering has been assured the monitoring wells should be decommissioned according to WAC 173-160.

Discharge rates from sump collection and/or well point systems should be monitored daily and recorded in the project log.

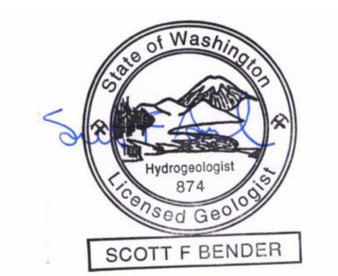
Monitoring of subgrade conditions for piping and boils should be performed at all times.

<u>Closure:</u> The dewatering design recommendations provided herein have been oriented to the various soil conditions observed at the site, further variations may exist. As such, we recommend that our staff be present during initial system installation and startup. Should well discharge rates and groundwater level drawdown not be similar than presented herein, we should be contacted so that we may observe the system performance and revise our design recommendations as necessary.

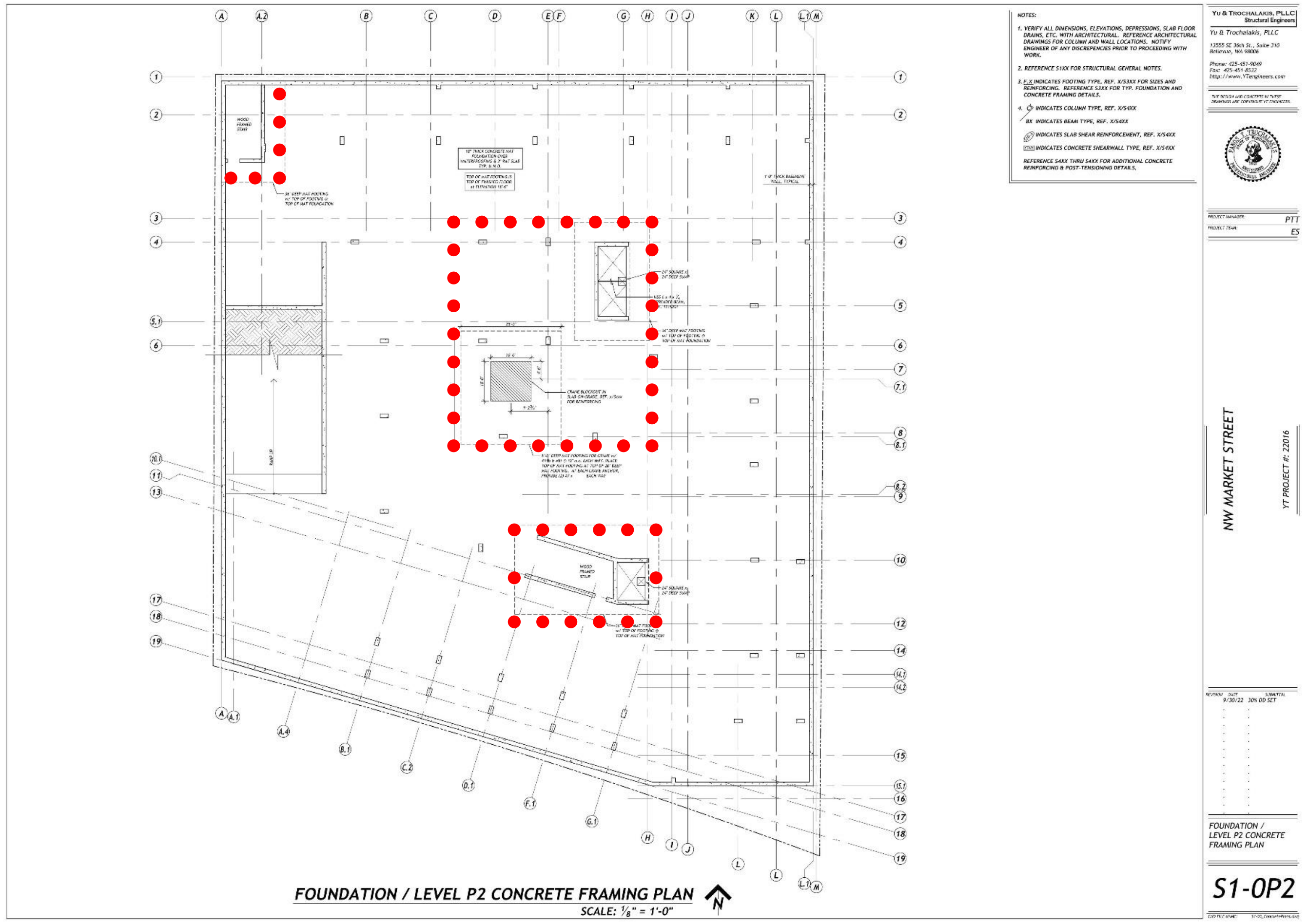
This design has been prepared to meet the groundwater drawdown levels required by the work. Potential impacts to off-site structures or facilities have not been considered as part of this work. If there are potential affects to structures, such as groundwater drawdown inducing ground settlement, then the Geotechnical Engineer should be contacted to identify these risks and what constraints they may have on operation of the dewatering system. This design has not considered the effects or liabilities associated with pumping or migration of contaminated groundwater; as stated above, the design has been provided only to meet the specified drawdown criteria and we hold no liability for adverse effects related to groundwater drawdown and soil contamination.

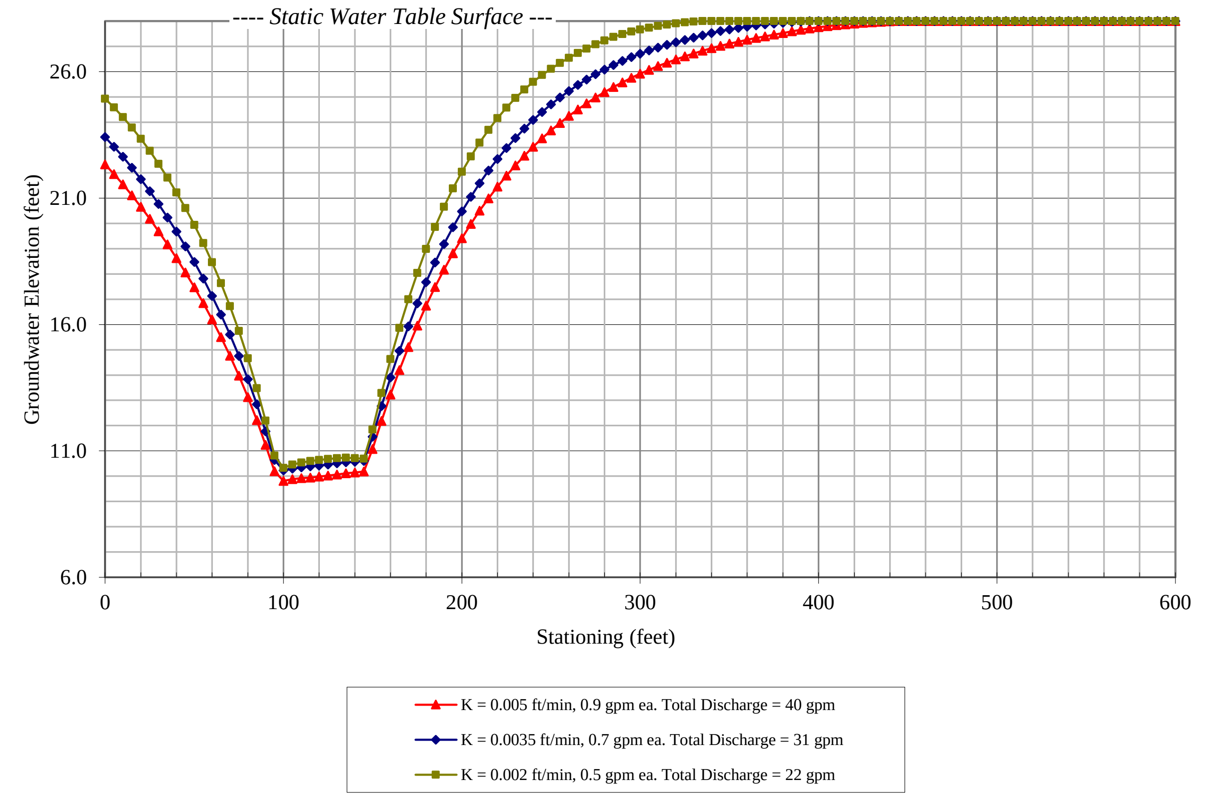
Thank you for the opportunity to be of service. Please call us at (360) 631-5600 should you have any questions or comments.

Sincerely,



Scott F. Bender L.H.G., P.G., C.G.W.P.





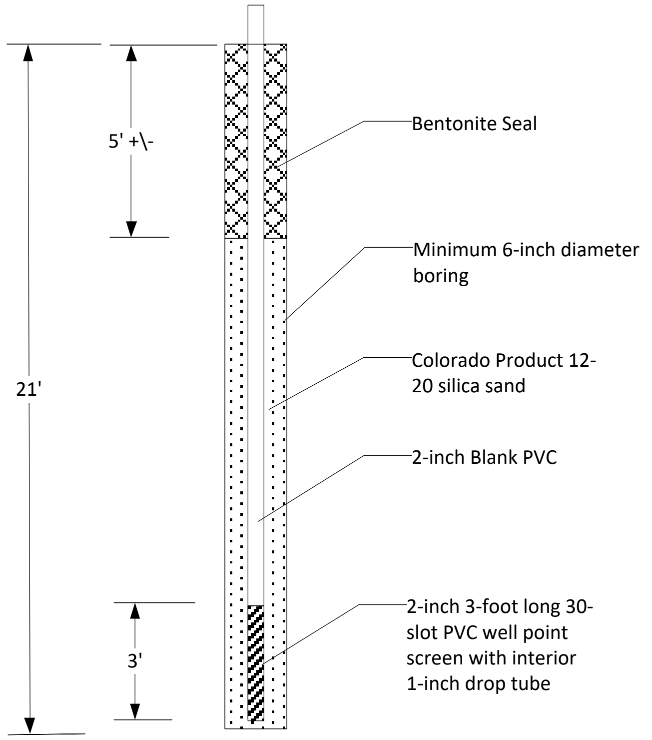
Notes (see October 2022 design report for full description):

1) Place well points for excavations requiring seepage control beyond sumps

2) Calculation example for all well points operating as shown in plan view, rates may vary depending on the number of excavations dewatered and total number of well points installed

BENDER CONSULTING, LLC Applied Groundwater Solutions	2401 NW Market Street Dewatering Design Recommendations Deal Investments	Schematic Dewatering Well Point Locations and Calculations	Project Number 2226-01 Sheet 1

Well Point Construction



Notes (see October 2022 design report for full description):

1) Place well points for excavations requiring seepage control beyond sumps

2) place well points on approximate 7-foot centers

3) develop all well points after completion

4) connect well points to main header with minimum 6" HPDE or PVC pipe

5) use vacuum pump capable of 22" of vacuum, place gauge at end of system to ensure 18" of vacuum at each well point

6) provide sumps to capture residual seepage and/or perched water

7) provide flowmeter

8) operate system continuously, without interruption, inspect for piping leaks

9) record flow rates and groundwater levels daily until drawdown phase complete, three times per week thereafter

10) observe subgrade conditions for piping and boils, stop excavation and contact designer should these occur

11) terminate dewatering only upon authorization of Engineer

12) decommission well points and monitoring wells upon completion of dewatering and upon authorization of Engineer

Notes:

Install interior suction pipe to bottom of well point

Depths may vary according to site conditions

All well points to be constructed according to WAC 173-160

BENDER CONSULTING, LLC Applied Groundwater Solutions	2401 NW Market Street Dewatering Design Recommendations Deal Investments	Well Point Design and Dewatering System Notes	Project Number 2226-01 Sheet 2