Dennis M. Bruce, P.E.

M.S.C.E., M.B.A. Geotechnical / Civil Engineer

June 2, 2016

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City of Lake Forest Park

City of Lake Forest Park
c/o NorWes Construction, Inc.

norweslee@aol.com

Subject: **Geotechnical Evaluation**
Foundation Recommendations, Infiltration Criteria
Proposed New Home
190xx 40th Place NE, Lake Forest Park, Washington

This engineering report presents the results of a geotechnical evaluation of the overall property at 190xx 40th Place NE, Lake Forest Park, Washington. This evaluation was required due to owner / contractor concerns, as well as City of Lake Forest Park requirements for Environmentally Critical Area (ECA) -- Steep Slopes Hazard Areas.

REFERENCES:

- Property Survey by ABA dated March 8, 2016
- Site Plan depicting one new residence (northern portion)
- Representative Site photographs by D. Bruce, P.E.

FILE COPY

BACKGROUND:

The overall property at 190xx 40th Place NE, Lake Forest Park, Washington is irregular in shape with approximately 200' of width, and depth that varies from 128' to 200'. See survey map.

Currently, the overall property is not developed and contains slopes. A portion of the overall site (northeast corner) contains slopes greater than 40%, thus are defined as a "Steep Slope Hazard Area". The steep slopes do not exceed twenty feet (20.0') in height from top to toe.

This designation requires the evaluation and investigation by a licensed geotechnical engineer.

This engineer understands that NorWes Construction, Inc., proposes to construct a new single family residence in the northern portion of the property (see Site Plan).

Visual evaluation of the existing residence at 19038 40th Place NE, reveals no evidence of any geotechnical distress: no slides, no soil tension cracks, nor any evidence of erosional degradation.

EVALUATION:

In order to augment the existing site geotechnical information, three soil test holes were dug under this engineer's observation on January 21, 2016.

Additional test holes were dug in May of 2016, to verify site conditions. See Site Plan for test hole locations.

All test holes revealed the following similar sub-grade conditions, namely:

0" to 6"	Roots, vegetation and organic silt
6" to 44" (bottom of test holes)	Dense native clean **sands**

No groundwater was encountered in any of the two test holes (six test holes overall). All test hole walls remained vertical and stable. No sloughing or caving occurred.

CONCLUSIONS / RECOMMENDATIONS:

Based on the findings of this investigation, and experience with similar sites in the area, the property at 190xx 40th Place NE, Lake Forest Park, Washington is **geotechnically approved** for the proposed house, subject to the following:

- Setback distance: City of Lake Forest Park Code presents the need for a designated setback distance from designated steep slope areas.

  This engineer **declares** that the designated steep slope area (See Site Plan for cross-hatched portion at northeast corner) is **not** geotechnically significant. Hence, **no setback distance is geotechnically required.**

  Currently, the Site Plan depicts the new residence in the central portion of the lot. However, there is no geotechnical reason to impose any setback distance from the designated "steep slope area".

- Standard reinforced continuous and spread footings. Allowable bearing pressure: **2,000 p.s.f.**

- Equivalent fluid pressure of 35 p.c.f. is recommended for any retaining wall design provided drainage zone is inspected and verified by this engineer.

- For retaining wall design, use friction factor of 0.55 and passive pressure of 350 p.c.f.

- Geotechnical inspections by this engineer are required prior to any foundation concrete placement.

The proposed structure can be supported on conventional continuous and spread footings bearing on undisturbed native soils or on structural fill placed above native soils. See the later sub-section entitled General Earthwork and Structural Fill for structural fill placement and compaction recommendations. Continuous and individual spread footings should have **minimum** widths of eighteen (18) and twenty-four (24) inches, respectively, and should be bottomed at least eighteen (18) inches below the lower adjacent finish ground surface.

Depending on the final site grades, some over-excavation may be required below footings to expose competent native soils. Unless lean concrete is used to fill the over excavated hole, the width of the over-excavation at the bottom must be at least as wide as the sum of two times the depth of the over-excavation and the footing width. For example, an over-excavation extending two feet below the bottom of a three-foot wide footing must be at least seven feet wide at the base of the excavation.

Footings constructed according to the above recommendations may be designed for an allowable soil bearing pressure of two thousand (2,000) pounds per square foot (p.s.f.). A one-third increase in this design bearing pressure may be used when considering short-term wind or seismic loads. For the above design criteria, it is anticipated that total post-construction settlement of footings founded on competent, native soils (or on structural fill up to five (5) feet in thickness) will be about one-half inch, with differential settlements on the order of one-quarter inch.

NOTE: The bearing capacity of 3,000 p.s.f. applies to over-excavated and backfill conditions. Footings placed on native soils may be designed for 2,000 p.s.f.

Lateral loads due to wind or seismic forces may be resisted by friction between the foundations and the bearing soils, or by passive earth pressure acting on the vertical, embedded portions of the foundations. For the latter condition, the foundations must either be poured directly against undisturbed soil or the backfill placed around the outside of the foundation must be level structural fill. We recommend the following design values be used for the foundation's resistance to lateral loading:

Parameter	Design Value
Coefficient of Friction	0.55
Passive Earth Pressure	350 p.c.f.

Where:

(1) p.c.f. is pounds per cubic foot.
(2) Passive earth pressure is computed using the equivalent fluid density.

We recommend that a safety factor of at least 1.5 be used for design of the foundation's resistance to lateral loading.

SLABS-ON-GRADE:

Slab-on-grade floors may be supported on undisturbed, competent native soils or on structural fill. The slabs may be supported on the existing soils provided these soils can be re-compacted prior to placement of the free-draining sand or gravel underneath the slab. This sand and gravel layer should be a minimum of four (4) inches thick. We also recommend using a vapor barrier such as 6-mil. plastic membrane beneath the slab with minimum overlaps of 12 inches for sealing purposes.

PERMANENT FOUNDATION AND RETAINING WALLS:

Retaining walls backfilled on one side only should be designed to resist lateral earth pressures imposed by the soils retained by these structures. The following recommended design parameters are for walls less than twelve (12) feet in height, which restrain level backfill:

Parameter	Design Value
Active Earth Pressure*	35 p.c.f.
Passive Earth Pressure	350 p.c.f.
Coefficient of Friction	0.55
Soil Unit Weight	125 p.c.f.

Where:

(1) p.c.f. is pounds per cubic foot
(2) Active and passive earth pressures are computed using equivalent fluid densities.

* For restrained walls which cannot deflect at least 0.002 times the wall height, a uniform lateral pressure of one hundred (100 p.s.f. should be added to the active equivalent fluid pressure).

The values given above are to be used for design of permanent foundation and retaining walls only. An appropriate safety factor should be applied when designing the walls. We recommend using a safety factor of at least 1.5 for overturning and sliding.

The above design values do not include the effects of any hydrostatic pressures behind the walls and assume that no surcharge slopes or loads will be placed above the walls. If these conditions exist, then those pressures should be added to the above lateral pressures. Also, if sloping backfill is desired behind the walls, then we will need to be given the wall dimensions and slope of the backfill in order to provide the appropriate design earth pressures.

Heavy construction equipment should not be operated behind retaining and foundation walls within a distance equal to the height of the wall, unless the walls are designed for the additional lateral pressures resulting from the equipment. Placement and compaction of retaining wall backfill should be accomplished with hand-operated equipment.

Retaining Wall Backfill

Backfill placed within eighteen (18) inches of any retaining or foundation walls should be free-draining structural fill containing no organics. This backfill should contain no more than five (5) percent silt or clay particles and have no particles greater than four (4) inches in diameter. The percentage of particles passing the No. 4 sieve should be between twenty-five (25) and seventy (70) percent. Due to their high silt content, if the native soils are used as backfill, a drainage composite, such as Mirafi and Enkadrain, should be placed against the retaining walls. The drainage composites should be hydraulically connected to the foundation drain system. The purpose of these backfill requirements is to assure that the design criteria for the retaining wall is not exceeded because of a build-up of hydrostatic pressure behind the wall. The subsection entitled General Earthwork and Structural Fill contains recommendations regarding placement and compaction of structural fill behind retaining and foundation walls.

EXCAVATION AND SLOPES:

At the time of this investigation and report, it is understood that the proposed house will entail excavation depths greater than five feet (5.0'). Hence, temporary shoring **is required** during the excavation phase.

See typical eco block shoring design (attached).

In no case should excavation slopes be greater than the limits specified in local, state and national government safety regulations. Temporary cuts up to a height of four (4) feet deep in unsaturated soils may be vertical. For temporary cuts having a height greater than four (4) feet, the cut should have an inclination no steeper than 1:1 (Horizontal:Vertical) from the top of the slope to the bottom of the excavation. Under **specific recommendations by the geotechnical engineer**, excavation cuts **may** be modified for site conditions. All permanent cuts into native soils should be inclined no steeper than 2:1 (H:V). Fill slopes should not exceed 2H:1V. It is important to note that sands do cave suddenly, and without warning. The contractors should be made aware of this potential hazard.

Water should not be allowed to flow uncontrolled over the top of any temporary or permanent slope. All permanently exposed slopes should be seeded with an appropriate species of vegetation to reduce erosion and improve stability of the surficial layer of soil.

DRAINAGE CONSIDERATIONS:

Footing drains are recommended at the base of all footings and retaining walls. These drains should be surrounded by at least six (6) inches of one-inch-minus washed rock wrapped in non-woven geotextile filter fabric (Mirafi 140N, Supac 4NP, or similar material). At the highest point, the perforated pipe invert should be at least as low as the bottom of the footing and it should be sloped for drainage. All roof and surface water drains must be kept separate from the foundation drain system.

No groundwater was observed in any of the six test holes during the fieldwork. Seepage into the planned excavation is possible, and likely if excavation occurs during winter months, and if encountered should be drained away from the site by use of drainage ditches, perforated pipe, French drains, or by pumping from sumps interconnected by shallow connector trenches at the bottom of the excavation.

The excavation of the site should be graded so that surface water is directed off the site and away from the tops of slopes. Water should not be allowed to stand in any area where foundations, slabs, or pavements are to be constructed. Any exposed slopes to be covered with plastic to minimize erosion. Final site grading in areas adjacent to buildings should be sloped at least two (2) percent away from the building, except where the area adjacent to the building is paved.

GENERAL EARTHWORK AND STRUCTURAL FILL:

The proposed building and pavement areas should be stripped and cleared of all surface vegetation, all organic matter, and other deleterious material. The stripped or removed materials should not be mixed with any materials to be used as structural fill.

NOTE: Specific clearing limits to be established at pre-construction meeting with City of Lake Forest Park building officials.

Structural fill is defined as any fill placed under the building, behind permanent retaining or foundation walls, or in other areas where the underlying soils needs to support loads. This engineer should observe site conditions during and after excavation prior to placement of any structural fill.

All structural fill should be placed in horizontal lifts with a moisture content at or near the optimum moisture content. The optimum moisture content is that moisture content which results in the greatest compacted dry density. The moisture content of fill soils is very important and must be closely controlled during the filling and compaction process.

The allowable thickness of the fill lift will depend on the material type, compaction equipment, and the number of passes made to compact the lift. In no case should the lifts exceed twelve (12) inches in loose thickness. The following table presents recommended relative compaction for structural fill:

Location of Fill Placement	Minimum Relative Compaction
Beneath footings, slabs or walkways	95%
Behind retaining walls	90%
Beneath pavements	95% for upper 12 inches of Sub-grade, 90% below that level

Where: Minimum relative compaction is the ratio, expressed in percentages, of the compacted dry density to the maximum dry density, as determined in accordance with ASTM Test Designation D-1557-78 (Modified Proctor).

Use of On-Site Soils

If grading activities take place during wet weather, or when the sandy, on-site soils are extremely wet, site preparation costs may be higher because of delays due to

rains and the potential need to import granular fill. The on-site soils are generally sandy and thus are not highly moisture sensitive. Grading operations will be difficult when the moisture content of these soils greatly exceeds the optimum moisture content.

Moisture sensitive soils will also be susceptible to excessive softening and "pumping" from construction equipment traffic when the moisture content is greater than the optimum moisture content.

Ideally, structural fill, which is to be placed in wet weather, should consist of a granular soil having no more than five (5) percent silt or clay particles. The percentage of particles passing the No. 200 sieve should be measured from that portion of the soil passing the three-quarter-inch sieve.

The use of "some" on-site soils for fill material **may be acceptable** if the upper organic materials are segregated and moisture contents are monitored by engineering inspection.

DRAINAGE CONTROLS:

No drainage problems were evident with the overall lot. Obviously, the clean subgrade sands allow for infiltration.

At the time of this report (subject to follow up verification when specific house plans are available, this engineer recommends **on-site infiltration** for storm water management.

The actual infiltration rate of the clean sands exceeds thirty inches (30") per hour. However, experience has recommended a **design rate** of ten inches (10") per hour.

This engineer will provide a specific on-site infiltration layout and design, once final house plans are available.

At this point in time, the owner / developer may use twenty (20) lineal feet of infiltration trench per 1,000 square feet of impervious surface.

This "general guideline" **must** be verified by this engineer prior to construction.

INFILTRATION DESIGN – DRYWELL:

See attached design sketch for an effective drywell design for the project.

Specifically, three locations are noted for a standard drywell (an excavation filled with gravel). Dimensions 6.0' x 6.0' x 4.0' deep.

This engineer to perform on-site geotechnical inspections for the construction of all three drywells.

CONCRETE:

All foundation concrete (footings, stem walls, slabs, any retaining walls, etc.) shall have a minimum cement content of 5-1/2 sacks per cubic yard of concrete mix.

STEEP SLOPE HAZARD AREA:

As stated, the designated steep slope area is not an actual geotechnical hazard.

This engineer recommends a **full exemption** to the Steep Slope Hazard Areas review constraints.

The overall slopes are less than twenty feet (20') in height.

As stated earlier, a **zero** buffer is justified, based on the stability of the slope.

The elimination of the buffer will adequately protect the proposed development, adjacent developments, and adjacent uses, and the designated Steep Slope Hazard Area itself.

Currently, the developer proposes no alteration to the small segment of the site that exceeds 40% in declination.

If desired, this area could be modified, landscaped, or graded, with no adverse impacts to overall slope integrity.

SEISMIC HAZARD AREA:

Geotechnical investigation has verified dense stable granular subgrade soils (sands with occasional gravels). These soils do not pose an excessive seismic hazard. These stable soils, combined with the gentle slopes of the property, result in a declaration of, "**No significant seismic hazard**" for the property.

EROSION HAZARD:

The geotechnical investigation has verified dense stable soils, combined with the moderate slopes on the property, to conclude "**There are no significant erosion hazards**" for this property.

Further, the construction of the new residence with reinforced concrete foundation walls, footing drains, controlled storm water collection systems and engineering infiltration, will **improve** the overall slope stability.

INSPECTIONS:

The recommendations of this report are **only valid** when key geotechnical aspects are inspected by this engineer during construction:

- Soil cuts
- Temporary shoring – if required
- Foundation sub-grade verification
- Any retaining wall, or rockery placement
- Any fill placement
- Subsurface drainage installation, including on-site infiltration
- Temporary and permanent erosion control measures

SUMMARY:

The proposed two new residence at 190xx 40th Place NE, Lake Forest Park, Washington is **geotechnically viable** when constructed in accordance with the recommendations herein, compliance with City of Lake Forest Park approved plans and requirements, and key geotechnical inspections during construction.

STATEMENT OF MINIMAL RISK:

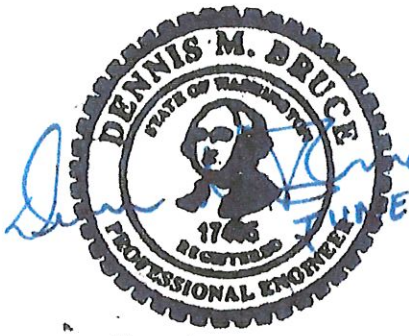
The plans dated June 29, 2016, and specifications for the new home at 190xx 40th Place NE, Lake Forest Park, Washington have been reviewed by this engineer and conform to the recommendations of the analysis and report and, provided that those conditions and recommendations are satisfied during the construction and use, and inspected and verified by this engineer, the area disturbed by construction will be stabilized and remain stable and will not increase the potential for soil movement, and the risk of damage to the proposed development and from the development to adjacent properties from soil instability will be minimal.

CLOSURE:

The findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. No other warranty, either express or implied, is made. The conclusions are based on the results of the field exploration and interpolation of subsurface conditions between explored

locations. If conditions are encountered during construction that appear to be different than those described in this report, this engineer should be notified to observe the situation and review and verify or modify the recommendations.

If there are any questions, do not hesitate to call.



Dennis M. Bruce, P.E.
Geotechnical / Civil Engineer

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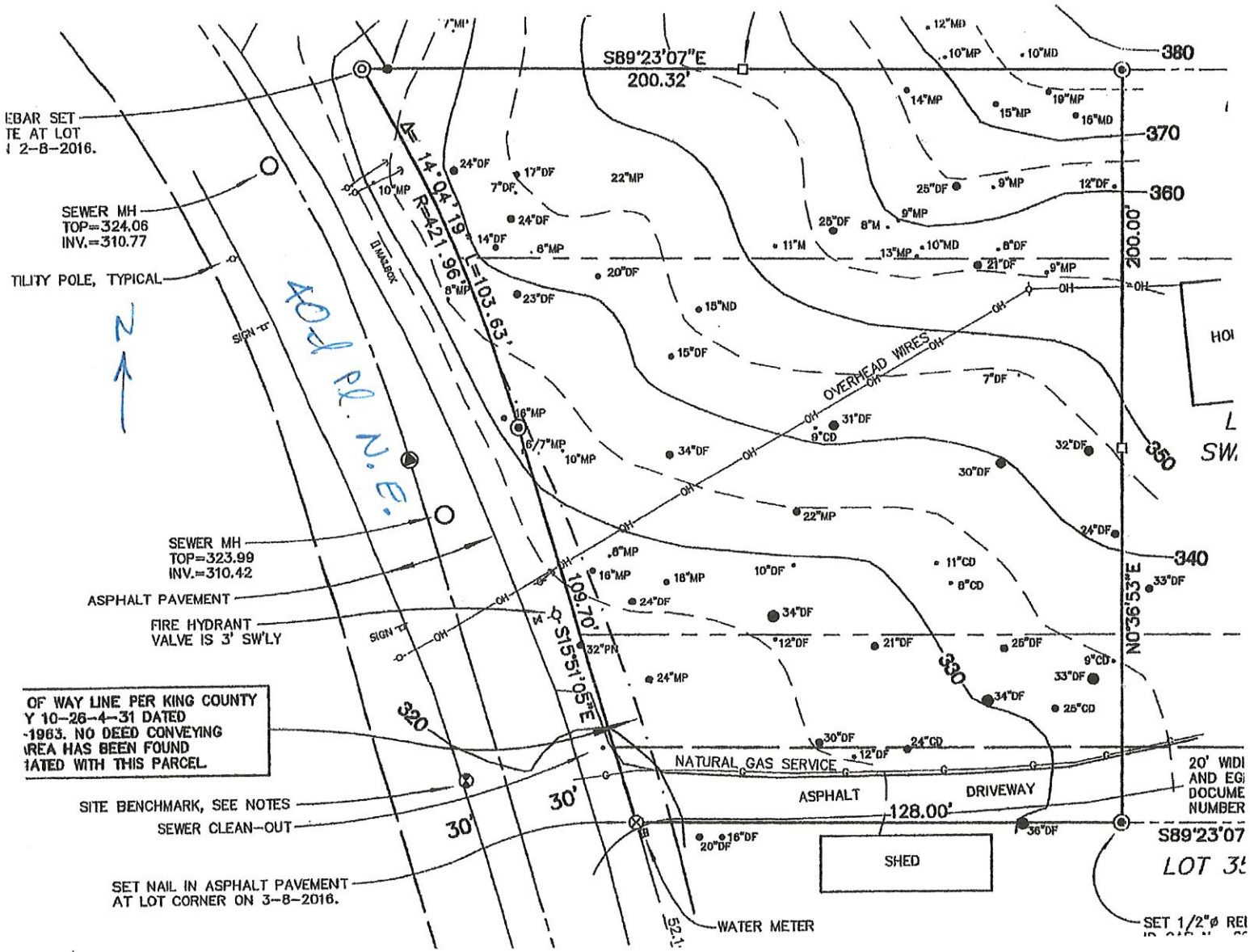
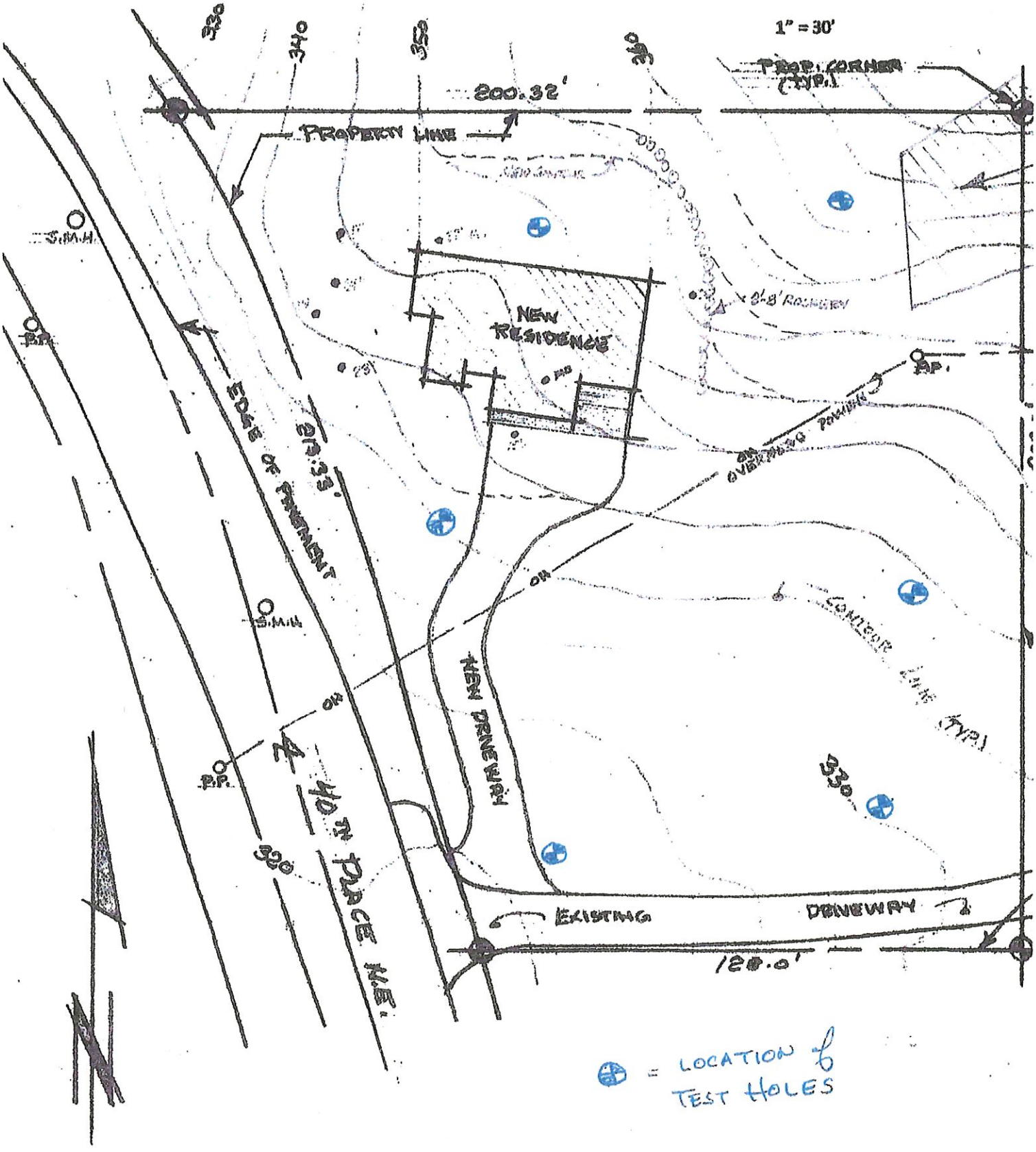

S89°23'07"E
200.32'
380
370
360
350
340
330
320
200.00'
N0°36'53"E
Δ= 14°04'19"
R=421.96'
L=103.63'
S15°51'05"E
109.70'
40th PL. N.E.
SEWER MH
TOP=324.06
INV.=310.77
SEWER MH
TOP=323.99
INV.=310.42
ASPHALT PAVEMENT
FIRE HYDRANT
VALVE IS 3' SW'LY
SITE BENCHMARK, SEE NOTES
SEWER CLEAN-OUT
SET NAIL IN ASPHALT PAVEMENT
AT LOT CORNER ON 3-8-2016.
OF WAY LINE PER KING COUNTY
Y 10-26-4-31 DATED
-1963. NO DEED CONVEYING
REA HAS BEEN FOUND
IATED WITH THIS PARCEL
OVERHEAD WIRES
NATURAL GAS SERVICE
ASPHALT
DRIVEWAY
128.00'
SHED
WATER METER
S89°23'07
LOT 3
SET 1/2"ø RE
20' WIDI
AND EG
DOCUME
NUMBER
30'
30'

SITE PLAN


1" = 30'
330
340
350
360
PROP. CORNER (TYP.)
200.32'
PROPERTY LINE
S.M.H.
B.F.
NEW RESIDENCE
8'-8' ROADWAY
P.P.
OVERHANG PARKING
EDGE OF PAVEMENT
210.33'
S.M.H.
OH
NEW DRIVEWAY
CONTOUR LINE (TYP.)
330
P.P.
OH
410 TH PLACE N.E.
330
EXISTING
DRIVEWAY
120.0'
= LOCATION of TEST HOLES

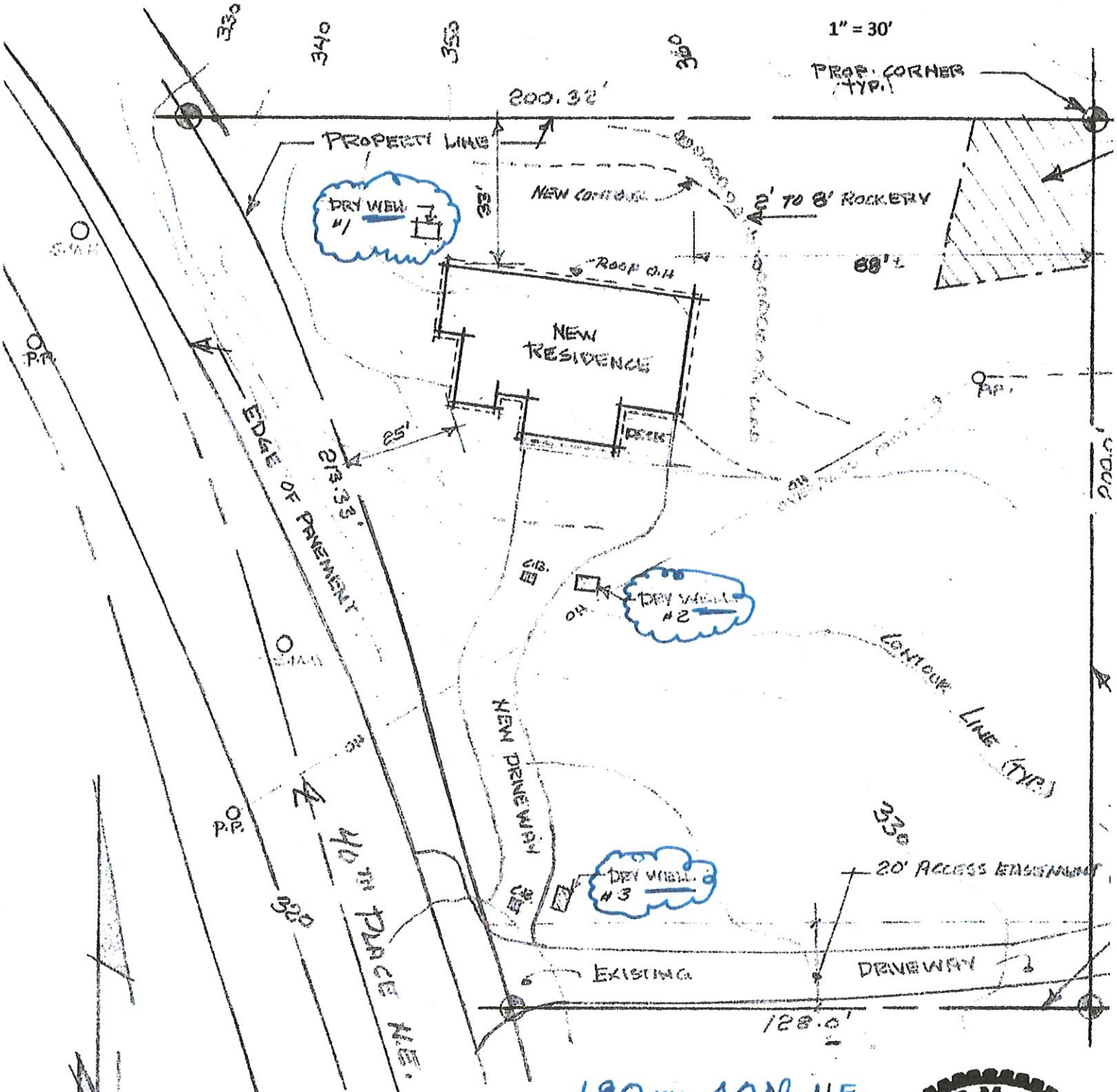
19038 40th Pl. N.E. Stable slopes.

Existing slopes are geotechnically **stable.**

Dense native **sands.**

Excellent soil for on-site infiltration ,per geotechnical engineering designs and inspections.

SITE PLAN

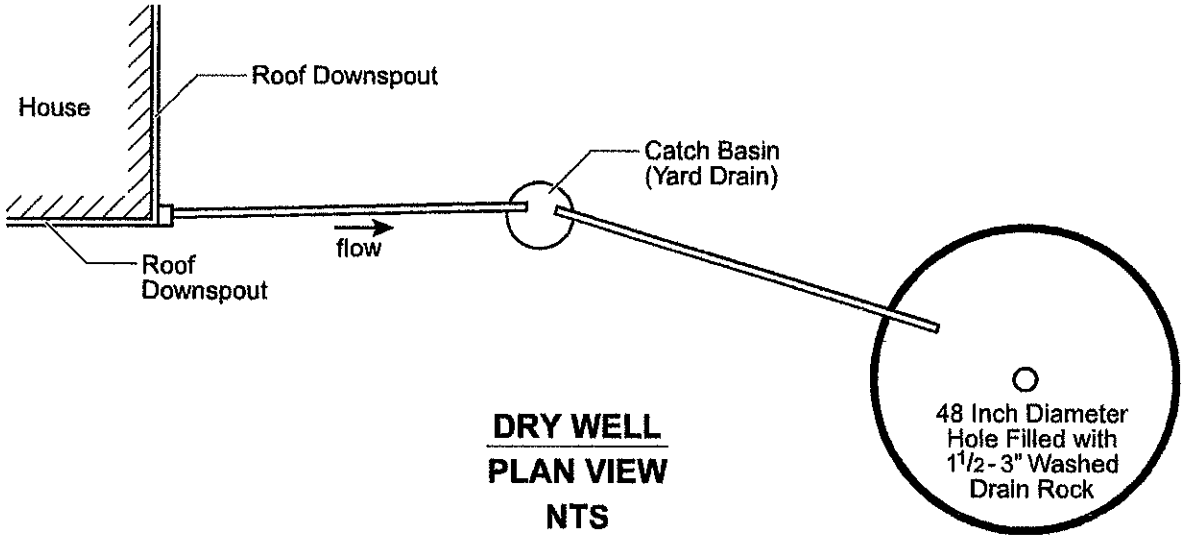


- CONSTRUCT 3 DRYWELLS (LOCATION AS SHOWN)
- EACH DRYWELL 6 FT. x 6 FT. x 4 FT. DEEP
- INSPECTIONS BY THIS ENGR. REQUIRED.

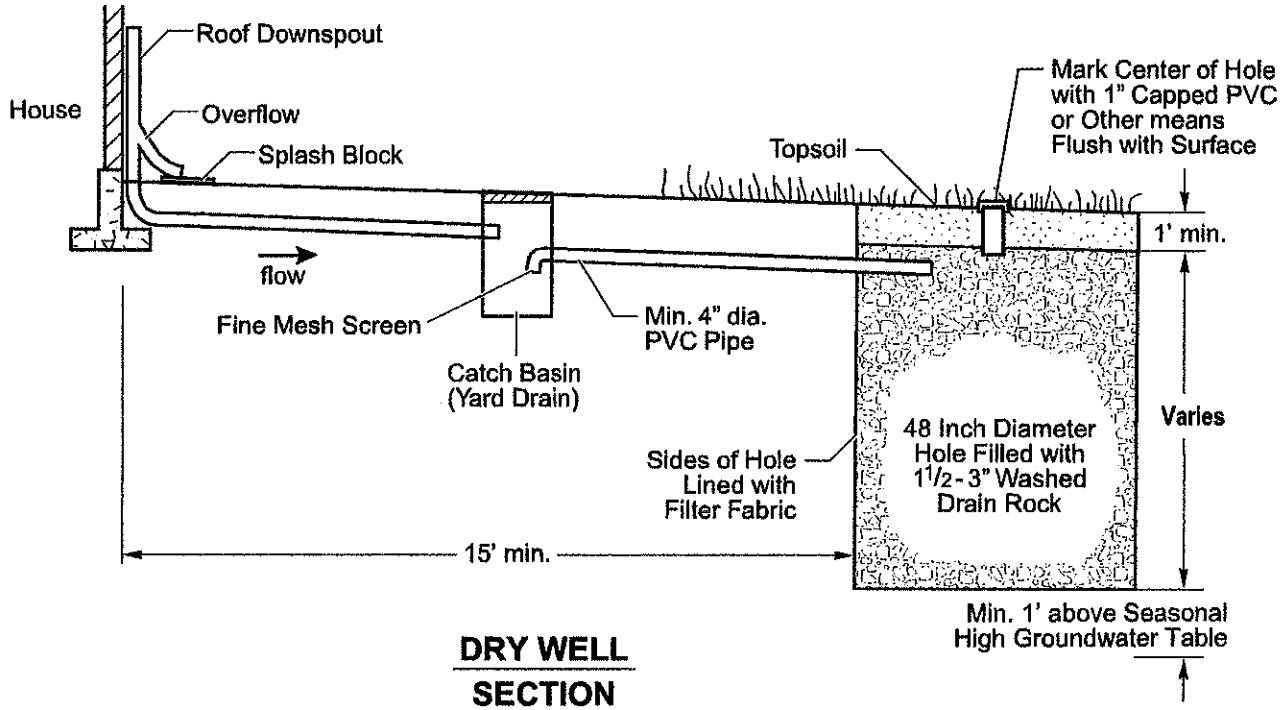
DENNIS M. BRUCE
STATE OF WASHINGTON
17406
REGISTERED
PROFESSIONAL ENGINEER

7-14-16

FIGURE C.2.2.C TYPICAL DRYWELL INFILTRATION SYSTEM



DRY WELL
PLAN VIEW
NTS



DRY WELL
SECTION
NTS

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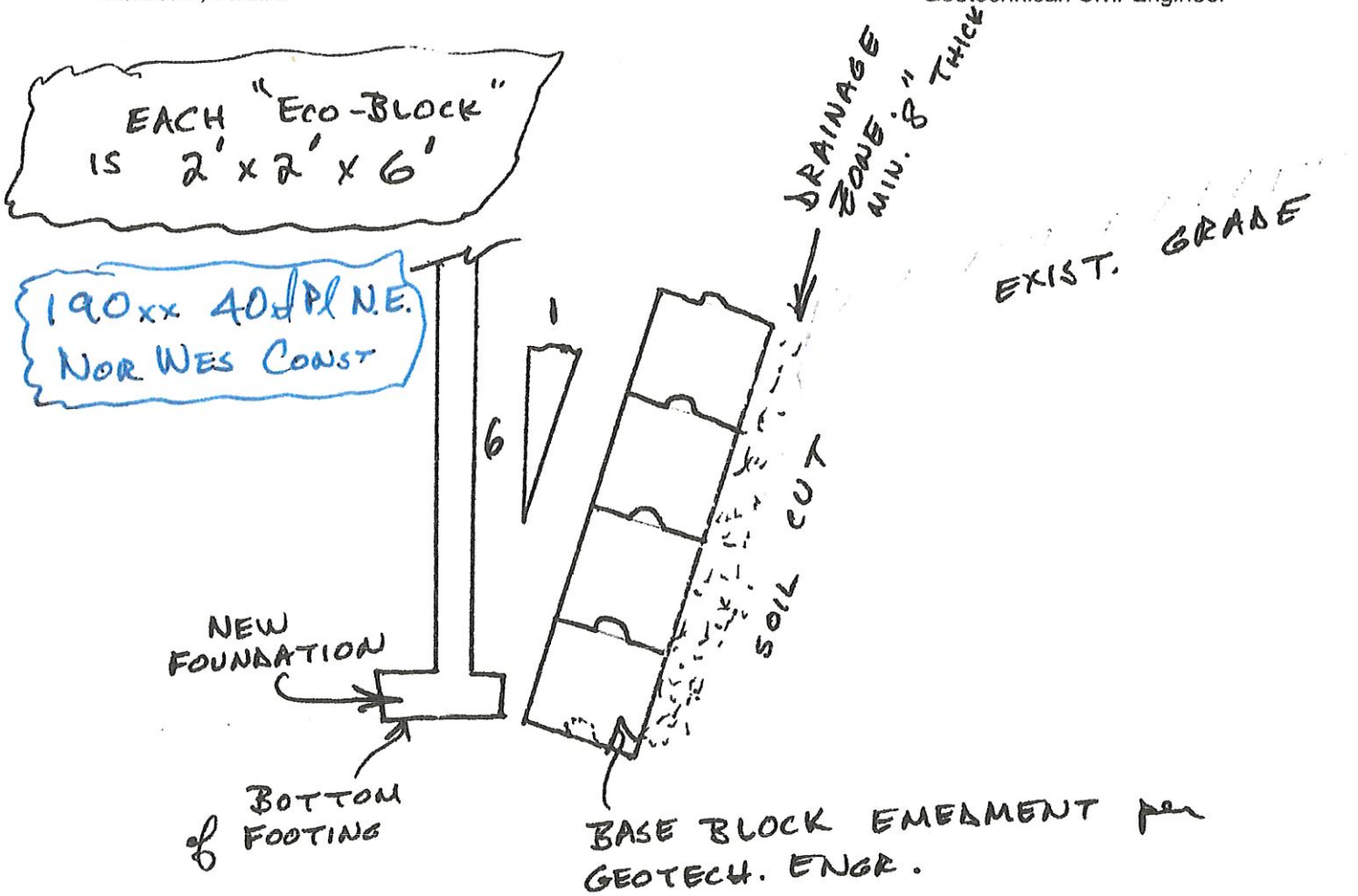
M.S.C.E., M.B.A. Geotechnical / Civil Engineer



TYPICAL 8 FT. DEEP CUT WITH TEMPORARY ECO-BLOCK SHORING

NOTE: ADDING ONE MORE BLOCK (5 HIGH) WILL ALLOW FOR A 10 FT CUT IF THIS ENGR. APPROVES.

INSPECTIONS BY THIS ENGR. REQUIRED.

DENNIS M. BRUCE STATE OF WASHINGTON 17405 REGISTERED PROFESSIONAL ENGINEER

P.E. 7-14-2016

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P.O. Box 55502 • Shoreline, WA 98155 • (206) 546-9217 • ~~FAX (206) 546-8442~~