Broad Mountain Power Project

Input to DEP Public Meeting December 4, 2019

Stephen J. Daderko, PE

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Education, Licenses, and Experience

- BS Mining Engineering – Penn State University-1979
- MBA-Indiana University of PA-1986
- Licensed Professional Engineer Pennsylvania (active) and Virginia (inactive)
- 30+ years of experience in the operation, maintenance, siting, and construction of power generation projects (none wind power), including three years on the siting and licensing team for a proposed new nuclear power plant
- 1-1/2 years as a geotechnical engineer for the US Bureau of Mines

Declarations

- I am not being paid for this analysis or input
- I am not presenting as an "expert witness"
- The analysis and input is based solely on my education and experience

Impact Considerations

- Broad Mountain is being presented as an environmentally beneficial project
- 290 acres of standing trees clear-cut at the headwaters of five Exceptional Value Watersheds
- USACE identified 15 wetlands locations totaling 8.18 acres
- E&S Notes Sheet (CE-002 and CS-002) identify 25 seeps or springs
- Lansford-Coaldale Water Authority well field directly below the project on the south side (See Attachment 1)
- Tamaqua Water Authority Still Creek Reservoir located on north side
- Installation of 16 wind turbines with 353 ft hub height and 5 wind turbines with 262 ft hub height
- Turbines will require massive reinforced concrete foundations which require excavations

Observations

- Submitted E&S plan does not appear to consider the significant amount of water likely to be present in foundation excavations
- Only mention of excavation in E&S with no quantification is ***"Unwanted water present in excavations should be pumped through filter bag to a well-vegetated gently sloping surface."*** Section 3.2.3 Erosion & Sedimentation Control Plan Narrative/Report
- Appendix A Planner Designer Qualifications Erosion & Sedimentation Control Plan Narrative/Report sample projects
  - Pentagon – CNG terminal
  - 2 Walmart projects
- None of the referenced projects involved significant sub-grade excavation

Turbine Foundation Construction

- Turbine foundation construction will require excavating very large holes for each foundation
- Foundation configuration requested from Broad Mountain, no reply
- Used design information from Crocker Wind Project in South Dakota (See Attachment 2)
- Crocker wind turbines approximately the size of small wind turbines at Broad Mountain (262 ft hub height)
- Foundations for 353 ft hub height wind turbines will be significantly larger, so analysis understates impact
- Crocker foundations 10 ft deep, discussions indicate that foundations for larger turbines at Broad Mountain could be 30 ft deep

Turbine Foundation Construction

- Excavation for turbine foundations will be a significant source of water to be managed during construction, likely to significantly exceed stormwater runoff
- Presence of wetlands, seeps, and springs throughout the project site indicates groundwater is present at relatively shallow depths, data not available so assume 5 ft BGL
- Foundation excavations will require dewatering to remove groundwater to allow construction activities
- Data not available for groundwater flow so analysis based on initial dewatering only, actual will likely require constant dewatering during construction

Turbine Foundation Construction

- Based on Crocker design, foundation is 62 ft x 62 ft x 10 ft deep
- Excavation add 20 ft to each horizontal dimension for construction (See Attachment 3)
- Total excavation volume/foundation 2,490 cu yd (in-place volume)
- Total amount of excavated material to be disposed of/foundation 2,490 cu yd x swell factor
- Total amount of water to be pumped to dewater total excavation volume one time/foundation 251,478 gal (static analysis assumes no further in-flow)

Turbine Foundation Construction

- Broad Mountain 353 ft hub turbines will require significantly larger and deeper foundations
- Assume same horizontal dimensions (conservative)
- Increase depth to 30 ft
- Total excavation volume/foundation 7,471 cu yd (in-place volume)
- Total amount of excavated material to be disposed of/foundation 7,471 cu yd x swell factor
- Total amount of water to be pumped to dewater total excavation volume one time/foundation 1,257,388 gal (static analysis assumes no further in-flow)

Turbine Foundation Construction Sequence

- Excavate hole (any required blasting will significantly impact schedule duration)
- Place forms
- Place rebar
- Pour concrete
- Cure concrete
- Strip forms
- Backfill
- Water must be pumped from excavation until forms are stripped

Comparisons

- Crocker foundation excavations are 6,724 sq ft, Broad Mountain excavations likely to be significantly larger
- Based on US Census Bureau average home size was 2,598 sq ft (See Attachment 4)
- Two average houses could fit in each foundation excavation
- Depending on depth of excavation and assuming no continued inflow of water each Broad Mountain turbine foundation could contain between 251,478 gal and 1,257,388 gal
- An Olympic swimming pool contains 660,000 gal

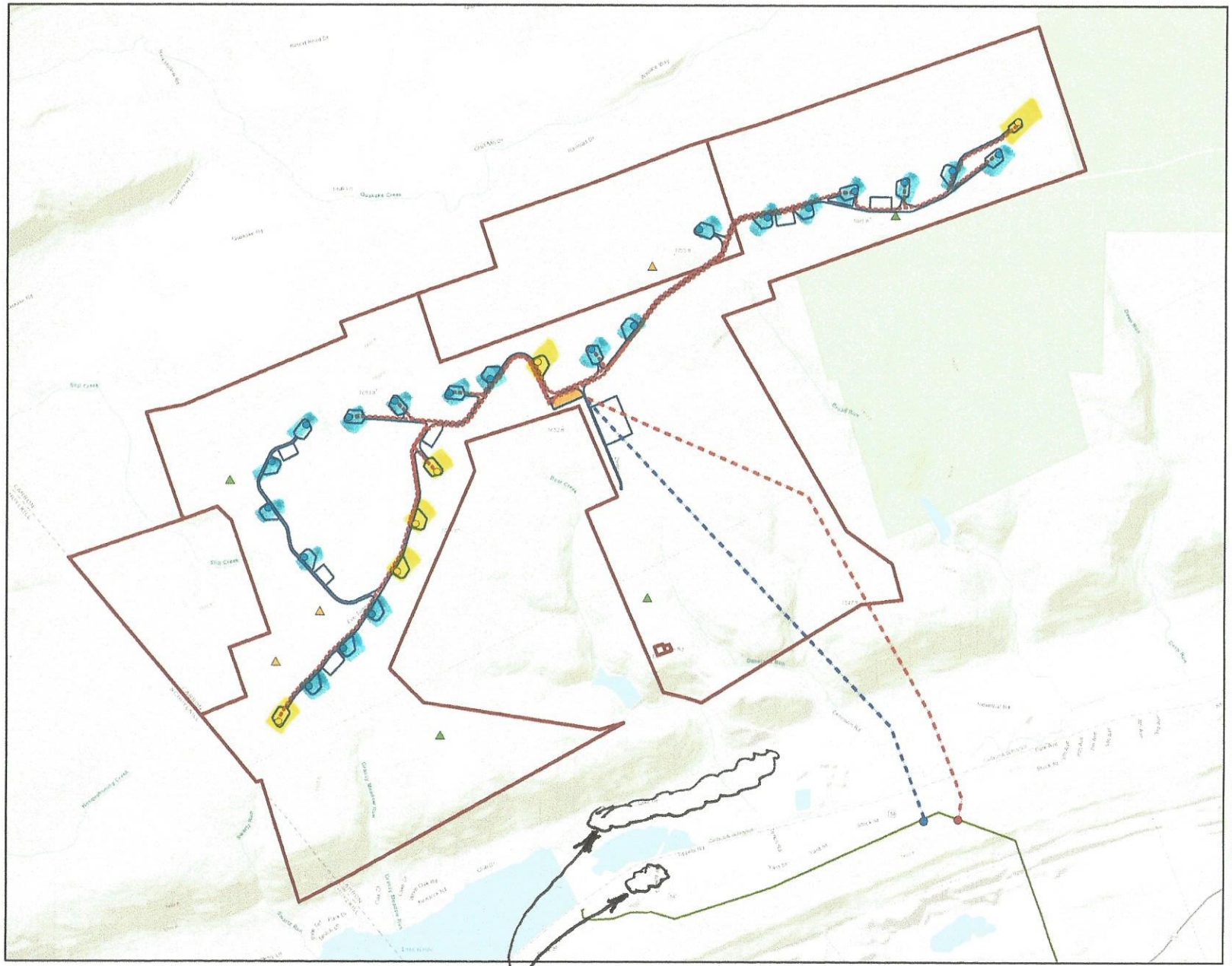
Items to Resolve Pre-construction

- Actual foundation design dimensions
- Construction sequencing i.e. series (one excavation at a time) or parallel (multiple foundations simultaneously)
- Depth to groundwater (requires drilling)
- Groundwater inflow rate (requires drilling)
- Quantify amount of water to be used for permit application
- Identify potential impact on wetlands, streams, seeps, and streams due to localized drawdown of groundwater to dewater foundation excavations. Blasting has potential to fracture bedrock increasing negative impact on groundwater

Post Construction Items to Consider

- What is the impact on groundwater of deforestation, compaction due to construction activities, and replacement of the native soil with the massive impermeable reinforced concrete foundations
- Based on twenty-one 62 ft by 62 ft reinforced concrete foundations native soil will be replaced by 1.9 acres of impervious concrete, potentially 30 ft deep. What is the long-term impact on the wetlands and EV watersheds of replacing the native soil with the massive impermeable reinforced concrete foundations

6 - 80.0 m hub height (262 ft)
20 - 107.5 m hub height (353 ft)



Legend

- Proposed Preliminary MET Tower, 127.5m[1]
- Existing MET Tower, 60m

Proposed Preliminary Turbines[2]

- G114 2.625MW hub: 80.0 m
- SG145 4.2MW hub: 107.5

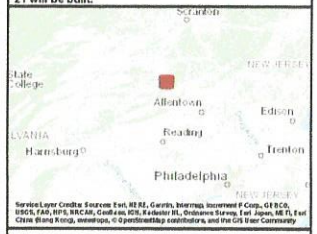
Proposed Preliminary Transmission Line

- Option 6
- Option 8

Proposed Preliminary Line Tap

- Option 6
- Option 8
- Proposed Preliminary Collector Line
- Existing Transmission Line
- Proposed Preliminary Access Roads and Laydown
- Participating Property Lines/Leased Boundary
- Proposed Preliminary Substation

[1]: Turbines 3B, 2D, 3D, 5D, 5D, ALT1 & ALT5 are potential locations of a temporary MET tower to be in place prior to construction.
[2]:This map presents 26 potential pad locations, of which 21 will be built.



0 400 800 Meters
0 1,375 2,750 Feet

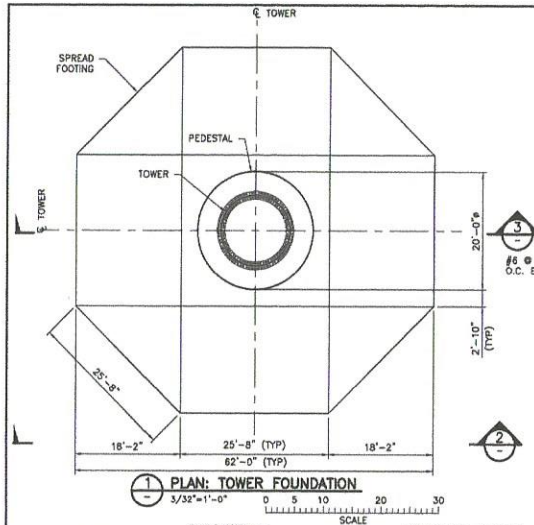
BROAD MOUNTAIN POWER LLC

TITLE: General Layout 80MW

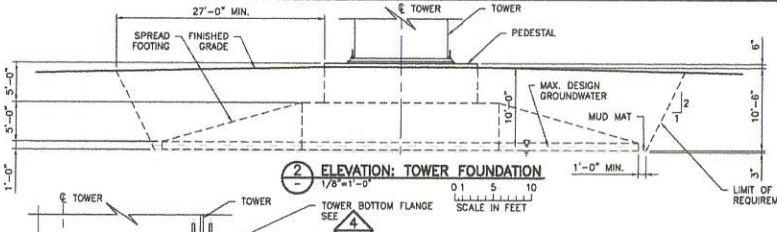
DATUM/PROJECTION: NAD83/UTM 18N	SCALE: 1:25,000
DRAWN BY: D THOMPSON	DATE: FEB 13, 2019
DRAWING No. BROAD - 100	REVISION No. 19

Lansford - Coaldale Water Authority Well Fields

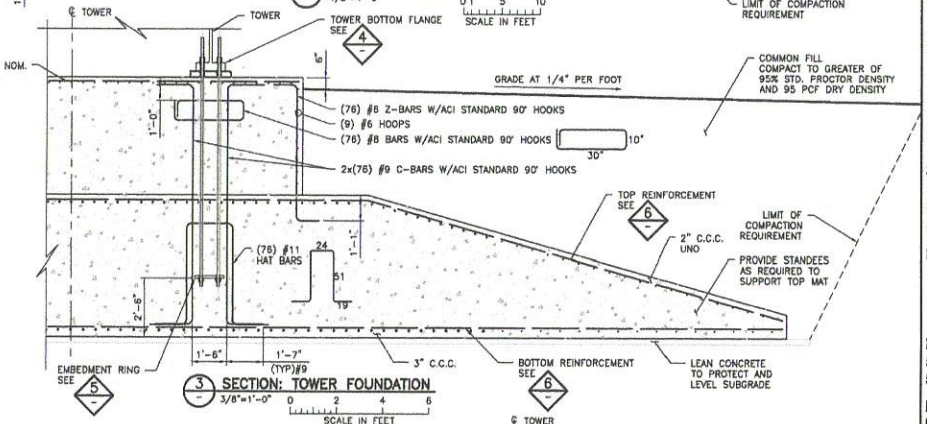
Attachment 1



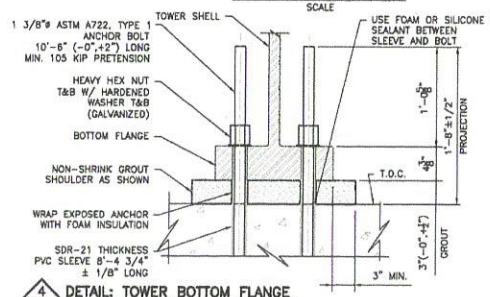
1 PLAN: TOWER FOUNDATION
3/32"=1'-0"
SCALE 0 5 10 20 30



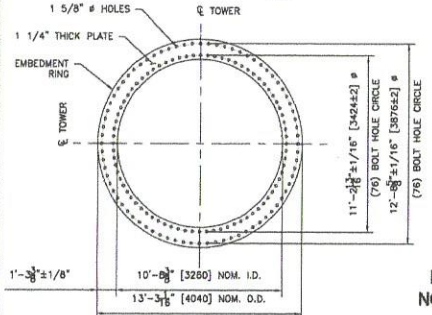
2 ELEVATION: TOWER FOUNDATION
1/8"=1'-0"
SCALE IN FEET 0 1 5 10



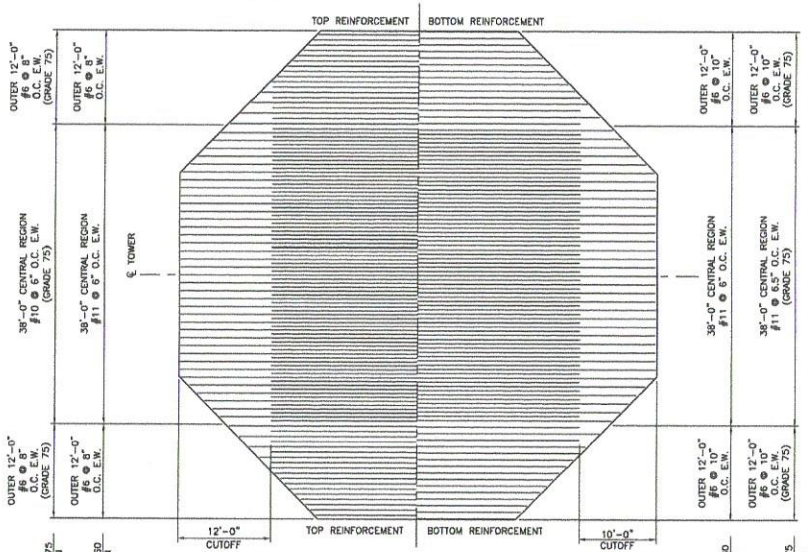
3 SECTION: TOWER FOUNDATION
3/8"=1'-0"
SCALE IN FEET 0 2 4 6



4 DETAIL: TOWER BOTTOM FLANGE
1 1/2"=1'-0"
SCALE 0 3" 6" 9" 1' 2'



5 DETAIL: EMBEDMENT RING
1/4"=1'-0"
SCALE IN FEET 0 1 5



6 DETAIL: TOP & BOTTOM REINFORCEMENT
1/8"=1'-0"
SCALE IN FEET 0 1 5 10

FOR PERMITTING ONLY
NOT FOR CONSTRUCTION

CONFIDENTIAL

BUILDING AND DESIGN CODES:

INTERNATIONAL BUILDING CODE 2012, INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS.

BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE, ACI 318, 2011, AMERICAN CONCRETE INSTITUTE.

WIND TURBINE AND TOWER:

MANUFACTURER: VESTAS
MODEL: V136-3.45
POWER OUTPUT: 3.45 MW
TURBINE HUB HEIGHT: 82m
ROTOR DIAMETER: 136m

DESIGN SERVICE LOADS:

UNFACTORED SERVICE LOADS DUE TO NORMAL EXTREME WIND CONDITION IEC CLASS IIIB/S (APPLY 1.35 LOAD FACTOR TO LOADS SHOW BELOW TO OBTAIN FACTORED LOADS)
OVERTURNING MOMENT, MSY = 76,590 KN-M
HORIZONTAL BASE SHEAR, HXY = 916.0 KN
VERTICAL TOWER LOAD, WZ = 4,221 KN

UNFACTORED SERVICE LOADS DUE TO ABNORMAL EXTREME WIND CONDIION IEC CLASS IIIB/S (APPLY 1.10 LOAD FACTOR TO LOADS SHOWN BELOW TO OBTAIN FACTORED LOADS)
OVERTURNING MOMENT, MXY = 92,220 KN-M
HORIZONTAL BASE SHEAR, HXY = 1,111 KN
VERTICAL TOWER LOAD, WZ = 4,301 KN

FOUNDATION DESIGN DATA:

MIN. FACTOR OF SAFETY AGAINST OVERTURNING: >1.5
MIN. FACTOR OF SAFETY AGAINST SLIDING: >1.5
MIN. FACTOR OF SAFETY AGAINST BEARING CAPACITY FAILURE: >2.26 ON EXTREME

FATIGUE LIFE: 30 YEARS BASED ON FATIGUE LOADING PROVIDED IN REFERENCE 1

REFERENCE DOCUMENTS:

1. VESTAS, "FOUNDATION LOADS, V136-3.45 MW, MK3, IEC3A, 82 M (TOWER T3III520)," DOCUMENT NO. 0068-6938 VER 00, ISSUED NOT FOR CONSTRUCTION, DATED AUGUST 14, 2017, PRELIMINARY LOADING.
2. BARR ENGINEERING CO, "PRELIMINARY GEOTECHNICAL ENGINEERING REPORT, CROCKER WIND PROJECT, CLARK COUNTY, SOUTH DAKOTA", DATED TBD.

MIN. 28-DAY COMPRESSIVE STRENGTH CONCRETE:
5,000 PSI (FOOTING)
5,500 PSI (PEDESTAL)

MIN. YIELD POINT STRENGTH OF REINFORCING BAR:
60 KSI UNO

MIN. STRENGTH OF ANCHOR BOLTS:
TENSILE STRENGTH **150 KSI** YIELD STRENGTH **120 KSI**

MIN. 28-DAY COMPRESSIVE STRENGTH OF NON-SHRINK GROUT:
13,000 PSI

MIN. YIELD POINT STRENGTH OF EMBEDMENT PLATE:
36 KSI

VOLUME OF CONCRETE IN FOUNDATION:
505 CUBIC YARDS

ESTIMATED WEIGHT OF STEEL REINFORCING:
GRADE 60 OPTION: 54 TONS
GRADE 75 OPTION: 39.0 TONS GRADE 75
9.0 TONS GRADE 60

COARSE AGGREGATE GRADATION:
ASTM C33 (SIZE NUMBER 5, 56, OR 57) WITH A MINIMUM OF 2% RETAINED ON THE 1-INCH SIEVE.

MIN. REQUIRED ALLOWABLE NET BEARING CAPACITY:
2000 PSF

ABBREVIATIONS:

B.O.	BOTTOM OF	O.C.	ON CENTER
C.C.C.	CLEAR CONCRETE COVER	O.D.	OUTSIDE DIAMETER
℄	CENTER LINE	R	RADIUS
EL.	ELEVATION	T&B	TOP AND BOTTOM
E.W.	EACH WAY	T.O.C.	TOP OF CONCRETE
EX.	EXISTING	TYP	TYPICAL
I.D.	INSIDE DIAMETER	U.N.O.	UNLESS NOTED OTHERWISE
MIN.	MINIMUM	MAX.	MAXIMUM
NOM.	NOMINAL	W/	WITH
ø	DIAMETER		

NO.	BY	CHK	APP.	DATE	REVISION DESCRIPTION
A	JMW	ARC2	MBJ	10/6/2017	PRELIMINARY

RELEASED TO/FOR: CLIENT, BID, CONSTRUCTION (10/06)
DATE RELEASED: A B C 0 1 2 3

BARR ENGINEERING CO.
3005 BOARDWALK STREET
SUITE 100
ANN ARBOR, MI 48108
Corporate Headquarters: Minneapolis, Minnesota
Ph: 1-800-632-2277
Ph: 1-800-270-5017
Fax: (732) 922-4401
www.barr.com

Scale	AS SHOWN
Date	9/14/2017
Drawn	JMW
Checked	CMM3
Designed	ARC2
Approved	MBJ

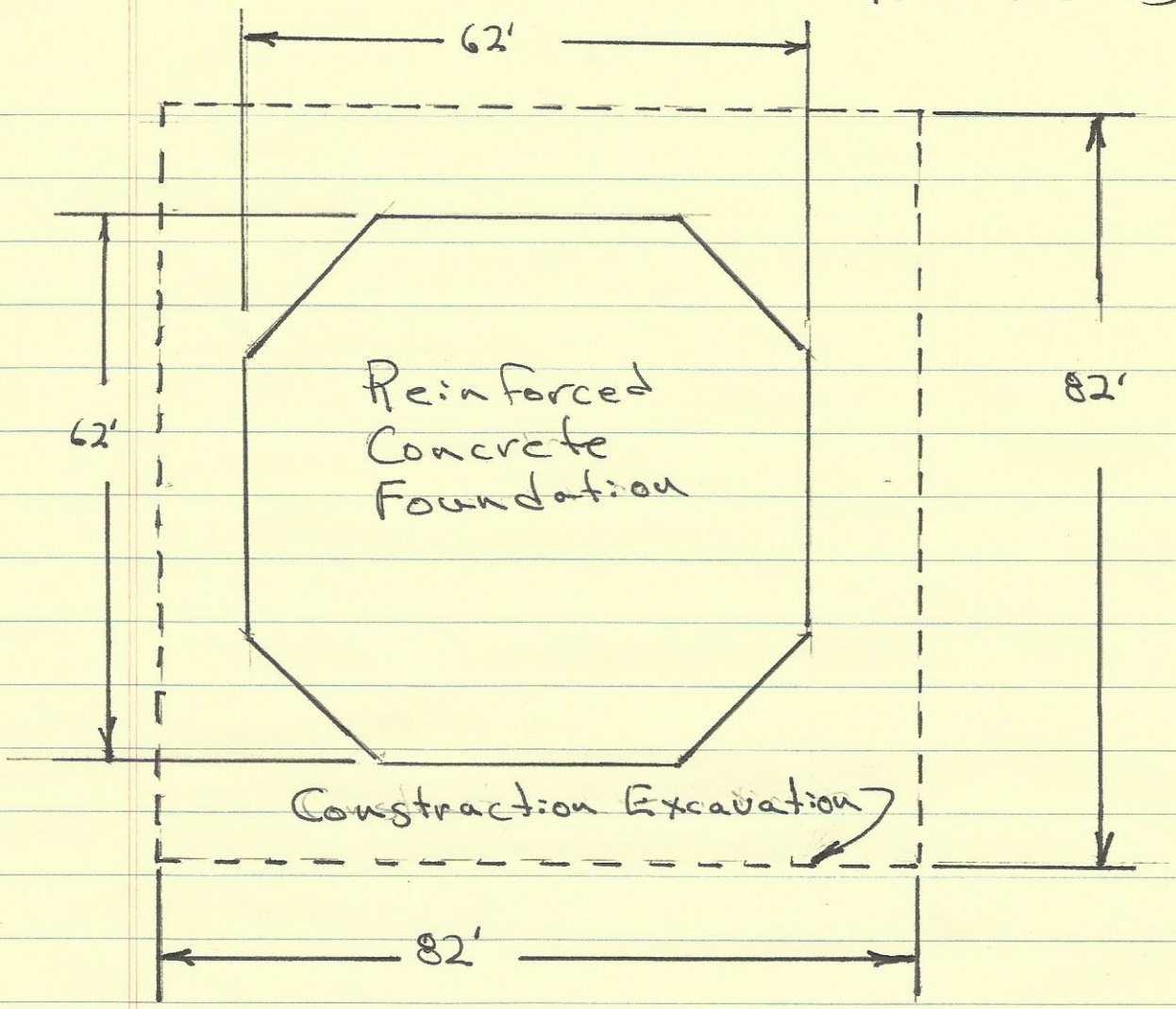
GERONIMO ENERGY
MINNEAPOLIS, MINNESOTA

CROCKER WIND PROJECT
CLARK COUNTY, SOUTH DAKOTA

SPREAD FOOTING FOUNDATION
PLAN, ELEVATION, SECTION & DETAILS

BARR PROJECT No. 41/12-1001.01
CLIENT PROJECT No.
DWG. No. S-01
REV. No. A

Attachment 2



Area of excavation/foundation
82ft x 82ft = 6,724 ft²

Volume of foundation @ 10 ft deep
6,724 ft² x 10 ft = 67,240 ft³ = 2,490 yd³

Volume of foundation @ 30 ft deep
6,724 ft² x 30 ft = 201,720 ft³ = 7,471 yd³

Based on Attachment 2

Assuming ground water 5ft BGL

Volume of water @ 10ft deep foundation
$6{,}724\ ft^2 \times 5\ ft = 33{,}620\ ft^3 = 251{,}478\ gal$
$1\ ft^3 = 7.48\ gal$

Volume of water @ 30ft deep foundation
$6{,}724\ ft^2 \times 25\ ft = 168{,}100\ ft^3 = 1{,}257{,}388\ gal$

Based on "static" analysis. Excavate hole, fills to 5ft BGL with no refill.
Actual situation will be pump throughout excavation and continuing pumping until removal of forms. Likely much more significant than "static" analysis

Attachment A

Average home size

SOURCE: CENSUS BUREAU

footprint = 1,300 Ft²

McMansion
4,000 ft²
footprint = 3000 Ft²