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# *CONCRETE BLOCK WALL - GRAVITY ENGINEERING ANALYSIS*

# MEADOW LANE PLAT

**Glade Ct.**
**Tax Parcel No.: 5593-000-018-0002**

*located in:*
KITSAP COUNTY

*prepared for:*
**JWJ Group**
**3599 Carlton St., Ste 201**
**Silverdale, WA 98383**
**(360) 626-1146**

*date:*
***July 14, 2016***

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MICHAEL F. WNEK
STATE OF WASHINGTON
07-14-16
023660
REGISTERED
PROFESSIONAL ENGINEER

**MFW Project Number: 689 (previous 540)**

*By the seal and signature here affixed, I certify that the enclosed report was accomplished under my direct supervision and that I am currently a registered engineer of good standing in the State of Washington.*

## OVERVIEW

This retaining wall has had a "history" from a permitting perspective; however the pertinent issue is that it has remained stable throughout its life. This history is sufficiently documented in the Building Permit files, and will not be repeated here.

On May 27th & 31st, 2016, I provided a visual examination of the subject retaining wall. I found no evidence of instability, foundation or backfill settlement, block movement, or structural deterioration.

The originally constructed wall was 7 blocks in height. This office provided an after-the-fact analysis of the wall, since there was no documentation of the original construction ("Concrete Block Wall - Gravity Engineering Analysis, Meadow Lane Plat, 05/01/2012), showing the wall met stability criteria in the as-constructed condition. During final construction of the street & pond, the top block was removed and backfill was placed on the forward side of the base block (50% minimum); resulting in a wall of basically 5.5 blocks in height maximum. Additionally, the slope down from the cul-de-sac to the back-of-wall was shaped to 1.5:1 (H:V) allowing the slope to daylight at the bottom of the top block. The 1.5:1 slope is steeper than typical grading slopes, however since the native material is clean & fine sand, this slope is also stable. Vegetation has not had a problem becoming established on this slope.

The top row of blocks is not required to support the slope above, neither is it providing stability to the retaining wall from its weight. This row of blocks can be removed without a detrimental effect on the stability of the wall or slope. This will reduce the wall height from the original 7 blocks, down to a maximum of 4.5 blocks.

The attached analysis documents the stability of the wall in this proposed condition. Soil & geotechnical factors used in this analysis are the same as used in the 05/01/2012 analysis, as field conditions observed recently showed no reason to adjust any values.

Once the top-block row is removed, the wall and slope should otherwise <u>not</u> be disturbed, except for vegetation management. The surplus concrete blocks should be hauled off the site. Furthermore no fill material or clearing debris shall be allowed to placed within the retention pond limits and decrease its capacity.

Note that the project address and tax parcel number has been updated for this report, reflecting the final-plat recorded condition.

**DESIGN DATA**

SITE DATA:

Concrete block retaining wall, 10-ft height, foundation in native soils.

GEOTECHNICAL DATA:

Soils conditions on-site were examined most recently on 05-27-2016, and were found to be identical with soils observed on various previous dates for the general plat construction. Native soils are consistent: fine sand with minimal fines & classified as "SM" (Sand with silt).

Soils data for design is readily apparent from investigation of the site; soil values are assigned based on accepted engineering values. No conditions exist as outlined in IBC 1803.5 that warrant further geotechnical investigation.

SOILS DATA:

| PROPERTY | SYMBOL | VALUE | COMMENT |
| --- | --- | --- | --- |
| Unit Weight of Soils | $\gamma_S$ | 118 pcf | REF. A. |
| Soil Friction | $\phi$ | 45° | REF. A. |
| Wall Friction | $\delta$ | 35° | REF. D, (3/4 * $\phi$) |
| Coefficient of Friction | $\mu$ | 0.543 | REF. A. |
| Soil Bearing Capacity | $q_{soil}$ | 3,000 psf | REF. B. |

STRUCTURAL DATA:

| PROPERTY | SYMBOL | VALUE | COMMENT |
| --- | --- | --- | --- |
| Batter | $\psi$ | 1:6.3 | Average |
| Backfill Slope | $\beta$ | 1.5:1 | Maximum condition |
| Surcharge (maximum) | $q_s$ | 0 | No surcharge exists. |

ANALYSIS:

Minimum Design Safety Factors

| | |
| --- | --- |
| Overturning | 1.5 |
| Sliding | 1.5 |
| Bearing Capacity | 2 |
| Internal Stability | 2 |
| Seismic | Not Applicable |

REFERENCES (REF.):

A. Soil Mechanics in Engineering Practice, Terzaghi/Peck, 1967
B. Engineering Manual, Perry, 1976
C. Rockery Design and Construction Guidelines, FHWA-CFL/TD-06-006, November 2006
D. Engineering Design Manual for Ultrablock Gravity Wall Systems, White/Noonan, 2008

**STRUCTURAL NOTES:**

| | |
| --- | --- |
| 1. Floor Live Load: | N/A |
| 2. Roof Live Load: | N/A |
| 3. Roof Snow Load: | N/A |
| 4. Wind Design Data: | N/A |
| 5. Earthquake Design Data: | N/A |
| 6. Geotechnical Information: | |
| a. Soil Bearing Pressure = | 3000 psf |
| b. Soil Friction Interface Angle = | 45° |
| c. Unit Weight of Soil = | 118 pcf |
| 7. Flood Design Data: | N/A |
| 8. Special Loads: | |
| a. Highway Surcharge = | N/A |
| b. Driveway Surcharge = | N/A |
| c. Pedestrian Surcharge = | N/A |
| d. Foundation Loading = | N/A |

| MEADOW LANE POND WALL | | | | WNEK ENGINEERING |
|---|---|---|---|---|
| **Block Wall Calculations** | | | | **July 14, 2016** |
| Friction Factor | $\mu$= | 0.543 | unitless | =tan($\phi$) |
| Soil Friction Interface Angle | $\phi$ = | 45 | deg | input |
| Interface Friction Angle | $\delta$ = | 33.75 | deg | =(2/3)$\phi$ |
| Unit Weight of Soil | $\gamma_S$ = | 118 | pcf | input |
| Unit Weight of Rock | $\gamma_R$ = | 150 | pcf | input |
| Retained Soil Angle | $\psi$ = | 9.02 | deg | input |
| Fill Slope Angle | $\beta$ = | 33.69 | deg | input |
| Earth Pressure Coeff. | $K_A$ | 0.165 | unitless | =A/{B[1+SQRT{C/D}]$^2$} |
| Passive Pressure Coeff. | $K_p$ | 3.886 | unitless | =tan$^2$(45°+[$\phi$/2]) / $FS_{sliding}$ |
| Soil Capacity | $q_{soil}$ | 3000 | psf | input |
| Friction Force | $F_\mu$ | 2502 | lb | =$\mu$(W+$F_V$) |
| Surcharge | $q_s$ | 0 | lb/ft | input |
| Soil Force | $F_A$ | 973 | lb/ft | =½($K_A\gamma_S H^2$) |
| Lateral Earth Force | $F_{A,H}$ | 884 | lb | =$F_A$cos($\delta-\psi$) |
| Vertical Soil Force | $F_{A,V}$ | 407.2 | lb | =$F_A$sin($\delta-\psi$) |
| Surcharge Force | $F_S$ | 0 | lb | =$K_A H q_s$ |
| Toe Force | $F_p$ | 229.3 | lb | =½($K_p\gamma_S$(D-d)$^2$) |
| Block Base Width | B | 2 | ft | input |
| Footing Bottom Width | bw | 5 | ft | input |
| Footing Depth | bd | 0.67 | ft | input |
| Wall Height | H | 10 | ft | input |
| Face Height | Hr | 9.00 | ft | =H-D |
| Embedment depth | D | 1.00 | ft | input |
| Neglected Soil Depth | d | 0.00 | ft | input |
| Weight | W | 4200 | lb | =W1+W2+W3 |
| Distance from Block to OT point | $\bar{y}$ | 1.53 | ft | =x dist to centroid of block wall |
| Distance Toe Force to Moment | $\bar{y}_t$ | 0.33 | ft | =(D-d)/3 |
| Total Weight | W | 4200 | lb | =Wt |
| Resisting Moments, Rock Weight | $M_{r,t}$ | 6426 | lb*ft | =E($W_i$*$x_i$) |
| Overturn Moments | $M_o$ | 2947 | lb*ft | =$F_{A,H}$(H/3)+$F_s$(H/2) |
| Resisting Moments | $M_r$ | 7532 | lb*ft | =E$w_i x_i$+½$\gamma_s K_A H^2$sin($\delta-\psi$)([H/3]tan($\psi$)+B)+½$\gamma_s K_p$(D-d)$^2$([D-d]/3) |
| Eccentricity | e | 0.005 | ft | =B/2-([$M_r$-$M_o$]/{W+½$\gamma_s K_A H^2$sin($\delta-\psi$)}) |
| Max Pressure | $q_{max}$ | 927 | lb/ft | =({W+½$\gamma_s K_A H^2$sin($\delta-\psi$)}/B){1+[6e/B]} |
| Moment Overturning, Int. | $M_{O,int.}$ | 368 | lb*ft | =½$\gamma_s K_A$(H-H')$^2$cos($\delta-\psi$)([H-H']/3)+$q_s K_A$(H-H')([H-H']/3) |
| Moment Resisting, Int | $M_{r,int.}$ | 1837 | lb*ft | =E$w_{i_top}$($x_i$-x')+½$\gamma_s K_A$(H-H')$^2$sin($\delta-\psi$)({[H-H']/3}tan($\psi$)+B') |
| | | | Minimum | |
| FS, Overturning | | 2.56 | 1.5 | |
| FS, Sliding | | 3.09 | 1.5 | |
| FS, Bearing Capacity | | 3.24 | 2 | |
| FS, Internal Stability | | 4.99 | 2 | |

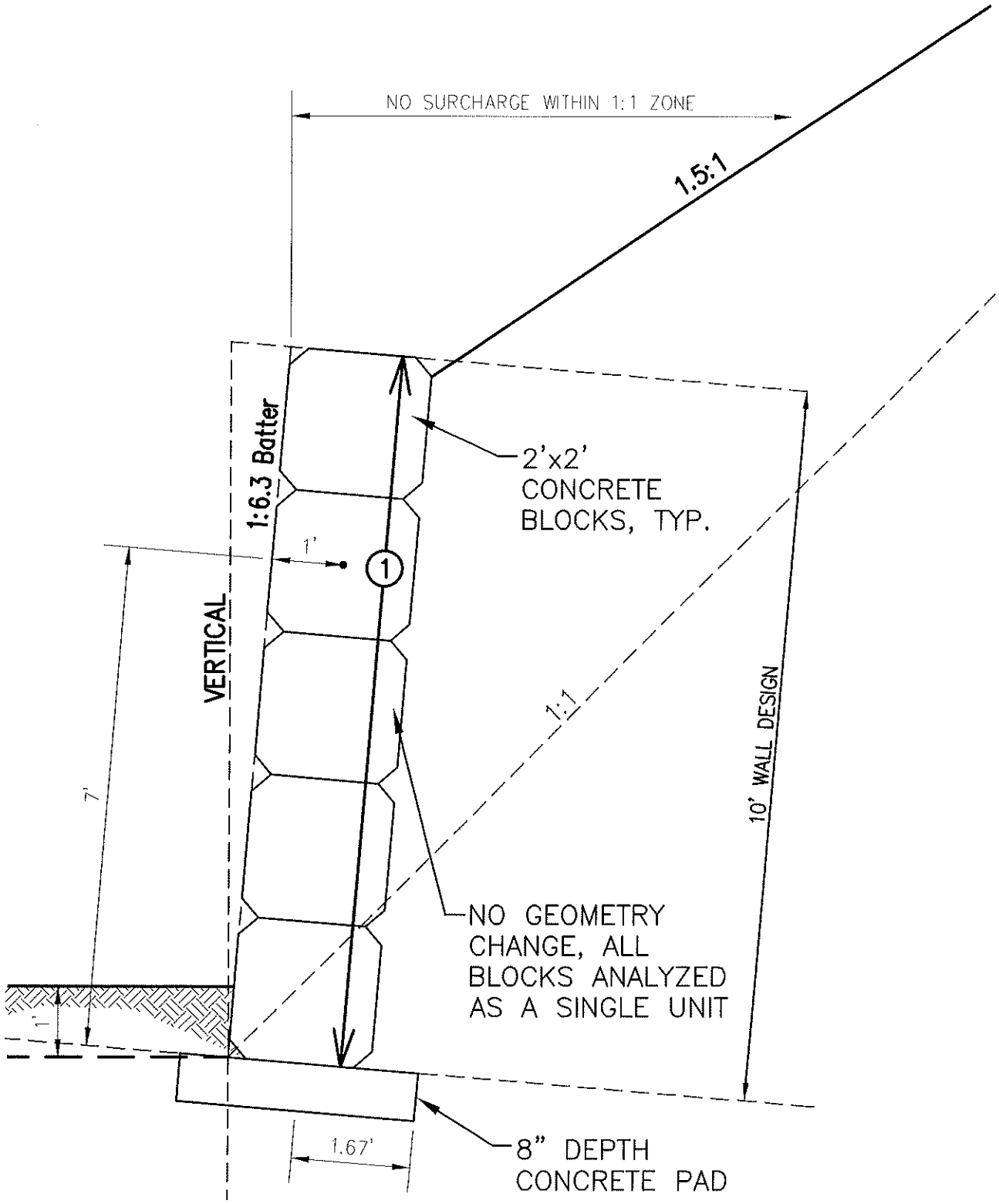
Additional Calculations and Input

| | | | | | | |
|---|---|---|---|---|---|---|
| Cos^2 G+P | 0.345 | "A" | | Retained Soil Angle | 9.02 | degrees |
| Cos^2G*Cos(g-G) | 0.886 | "B" | | H | 1 | |
| sin(p+g)*sin(p-B) | 0.192 | "C" | | V | 6.3 | |
| cos(g-G)*cos(-G-B) | 0.667 | "D" | | Fill Slope Angle | 33.69 | degrees |
| | | | | H | 1.5 | |
| | Weights | x distance | Resisting Moments | V | 1 | |
| Wt | 4200 | 1.53 | 6426 | | | |

## 10' WALL DIAGRAM

SCALE 1" = 2'

NOTE: THIS SCHEMATIC IS INTENDED TO SHOW THE RELATIONSHIP BETWEEN BLOCK SIZE AND HEIGHT OF WALL FOR ANALYSIS CALCULATIONS. REFER TO THE CONSTRUCTION PLANS & DETAILS FOR CONSTRUCTION REQUIREMENTS.



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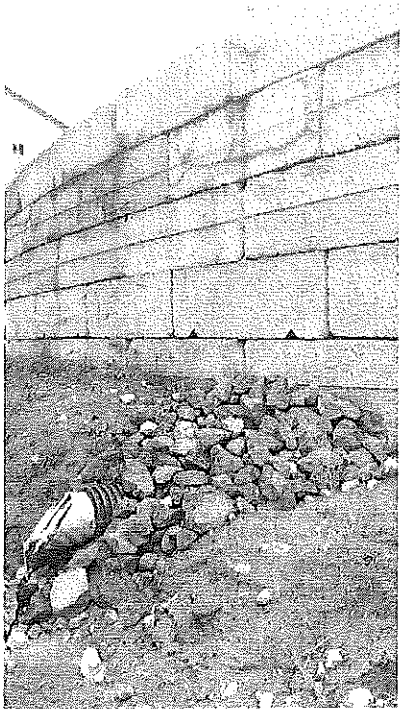
2012-04-17

A-1

2012-01-03



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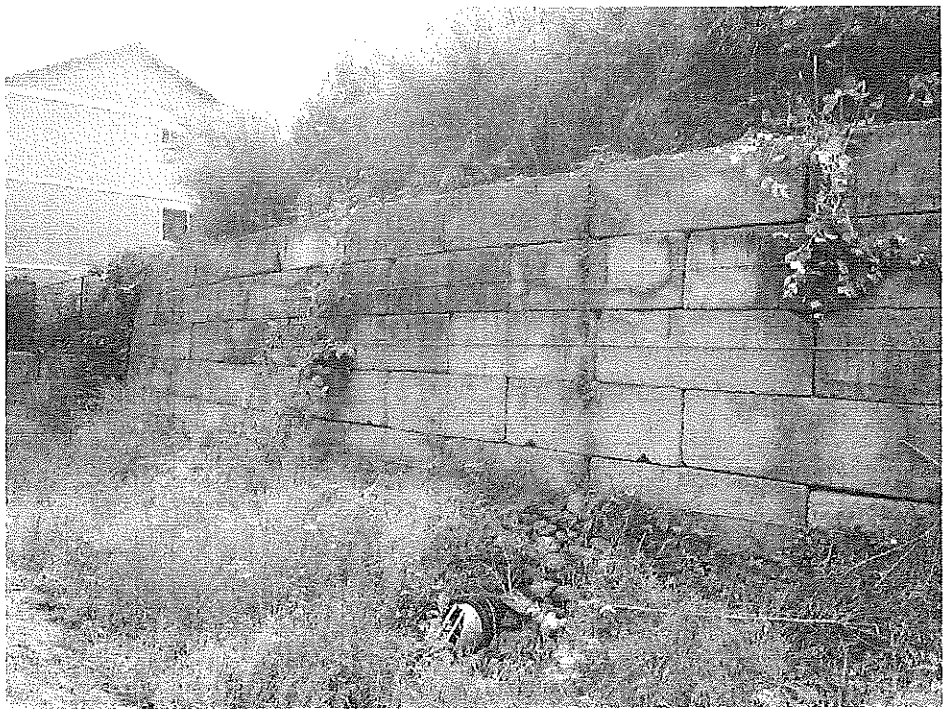

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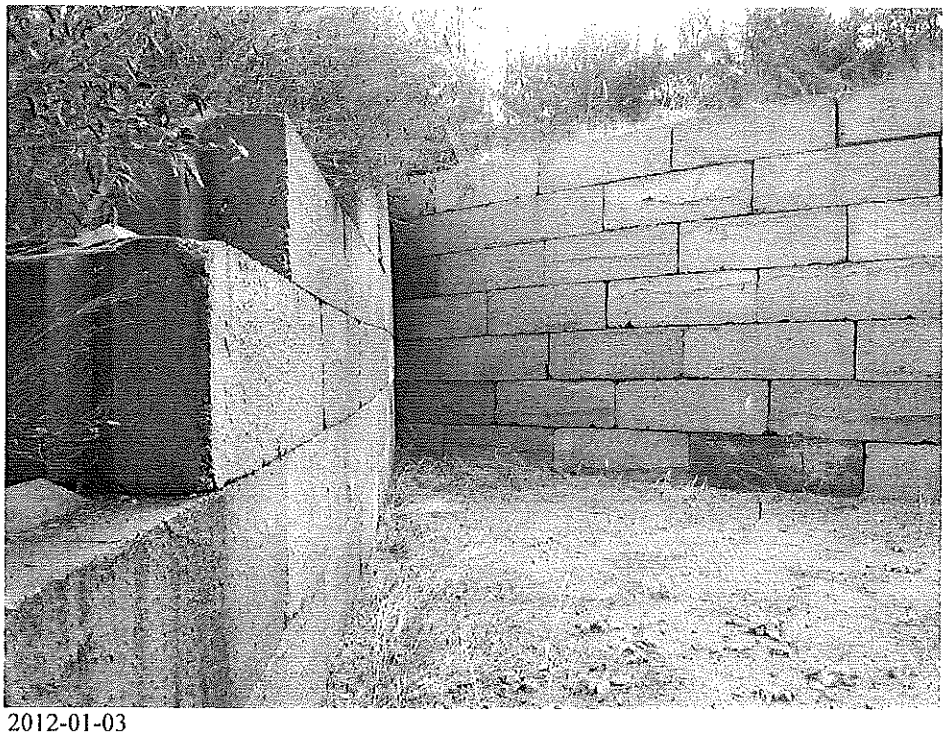

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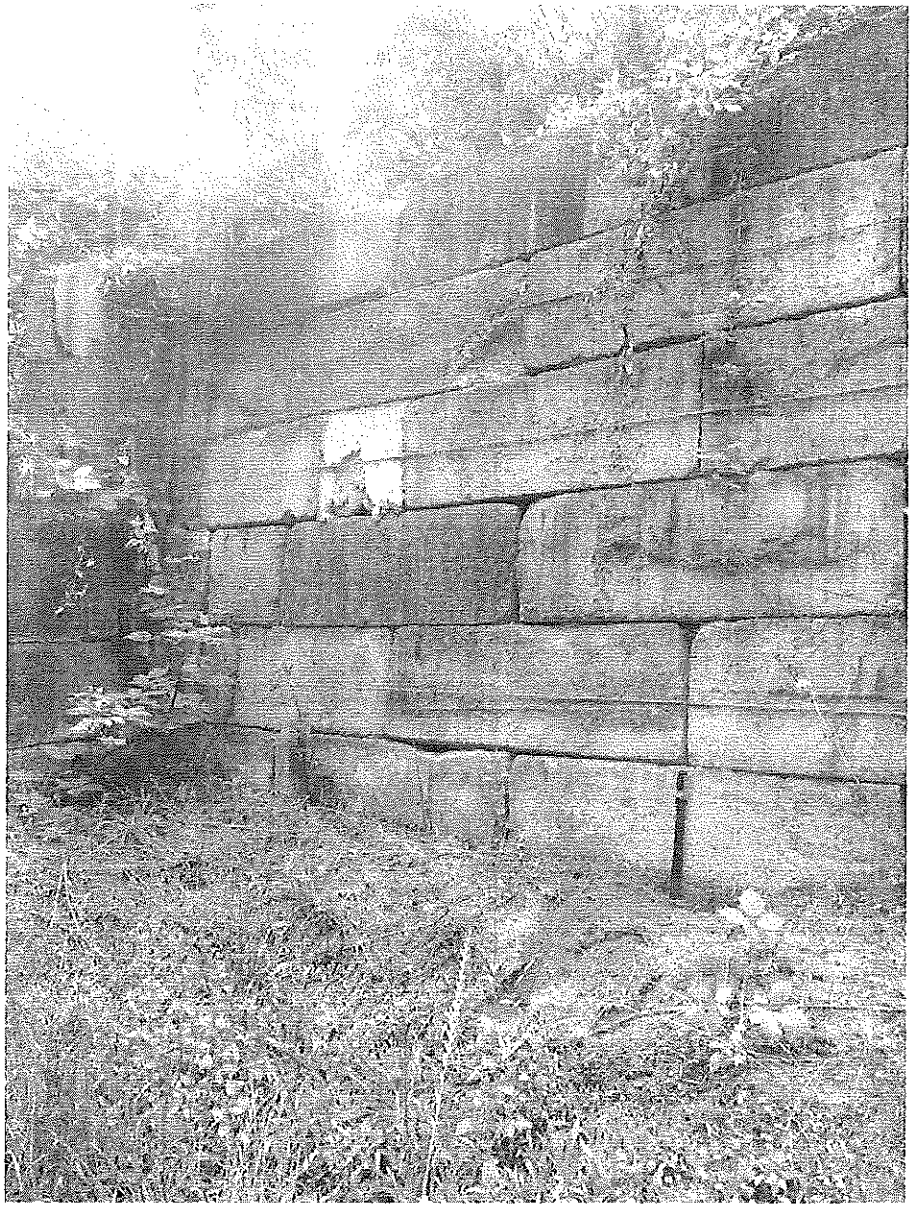

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