# FINAL DRAINAGE REPORT
# FOR
# RK SUBDIVISION
# PART OF THE SW ¼ SEC 19, T2N, R63W
# KEENESBURG, COLORADO
# WELD COUNTY

# CASE NO.


**RICHARD ROBERTSON AND AARON KAISER**

**ROBERTSON'S: 8357 WCR 51**

**KEENESBURG, CO 80643**

**KAISER'S: 39673 E. 160TH AVENUE**

**KEENESBURG, CO 80643**

Western Engineering Consultants inc LLC
127 South Denver Avenue
Fort Lupton, CO 80621



Revised: May 19, 2020
Revised: October 09, 2019
Original: March 27, 2019

# FINAL DRAINAGE REPORT
# FOR
# RK SUBDIVISION
# PART OF THE SW ¼ SEC 19, T2N, R63W
# KEENESBURG, COLORADO

Prepared For:

RICHARD ROBERTSON & AARON KAISER
Contact: Richard Robertson - Owner
8537 County Road 51
Keenesburg, CO 80643
303-961-0031

Contact: Aaron Kaiser - Owner
39673 E 160th Ave
Keenesburg, CO 80643
303-994-7947

Prepared By:

WESTERN ENGINEERING CONSULTANTS inc LLC
127 South Denver Avenue
Fort Lupton, CO 80621
(720) 685-9951
Contact: Chadwin F. Cox, P.E.

Revised: May 19, 2020
Revised: October 09, 2019
Original: March 27, 2019

CERTIFICATIONS

I hereby certify that this report and plan for the drainage design of Town of Keenesburg RK Subdivision was prepared by me, or under my direct supervision, for the owners thereof, in accordance with the provisions of Colorado Floodplain and Stormwater Criteria Manual, and Urban Drainage and Flood Control District Design and Technical Criteria, and approved variances and exceptions hereto. I understand that Town of Keenesburg does not and will not assume liability for drainage facilities designed by others.

_____
Chadwin F. Cox, P.E.
Registered Professional Engineer
State of Colorado No. 33802

*Richard Robertson and Aaron Kaiser hereby certify that the drainage facilities for RK Subdivision design shall be constructed according to the design presented in this report. I understand that the Town of Keenesburg does not and will not assume liability for the drainage facilities designed and/or certified by my engineer, and that the Town of Keenesburg reviews drainage plans pursuant to Colorado revised Statutes Title 30, Article 28, but cannot, on behalf of RK Subdivision, guarantee that final drainage design review will absolve RK Subdivision and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat, Final Development Plan, and/or Subdivision Development Plan does not imply approval of my engineer's drainage design.*

_____
**RK Subdivision**
**Richard Robertson or Owner's Representative**

_____
**RK Subdivision**
**Aaron Kaiser or Owner's Representative**

**TABLE OF CONTENTS**

# APPENDICES

**APPENDIX A**

Vicinity Map (USGS)
Key Map (Google Earth)
FEMA Firmette
Soil Survey Map & Soil Legend
Geotechnical Study

**APPENDIX B**

UDFCD Runoff & Rational Method References
NOAA Atlas 14 Rainfall - Point Precipitation Frequency

**APPENDIX C**

Infiltration Pond Design, and Channel Capacities, etc.

**APPENDIX D**

Drainage Plan – (full size – 24 x 36)

## INTRODUCTION

This study provides the final design for the construction of RK Subdivision. The overall site is an approximate 15.06 acre property as defined by the Final Plat prepared by American West Land Surveying Co. dated July 28, 2019.

The proposed RK Subdivision site is proposed on an undeveloped site. The existing site is predominantly bare except for some piled materials near the middle of the site.

The project shall include approximately seven (7) Commercial Lots. A 60 foot right-of-way is proposed to be constructed from County Road 398 north between the lots.

RK Subdivions lies approximately two miles northeast of the I-76 interchange with Market St. County Road 398 is the south border.

The entire RK Subdivision site and all adjacent and surrounding properties are historically tributary to Lost Creek which lies approximately 2 miles southeast of the site, which ultimately flows into the South Platte River which lies approximately 16 miles northeast of Lost Creek.

Based on the initial coordination with the Town, no Final Drainage Studies for any property north of Interstate 76 including adjacent properties were known to exist.

RK Subdivision does not lie within a Master Flood or Drainage Planned Study. The entire subdivision is within Zone X "Area of Minimal Flood Hazard" and not within the 100 year floodplain per FEMA FIRM 08123C2180E – effective January 20, 2016.

## I. GENERAL LOCATION AND DESCRIPTION

A. Site Location

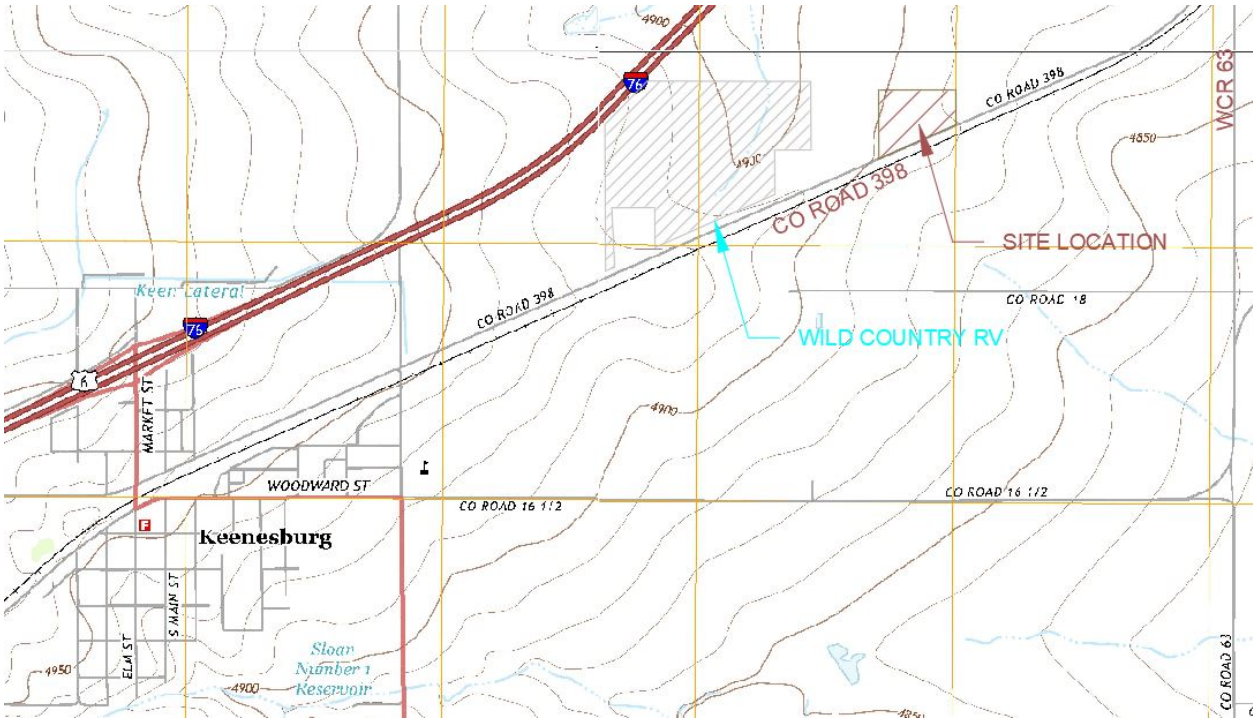
The property lies in the Southwest ¼ of Section 19, Township 2 North, Range 63 West of the 6th P.M.

The overall property nets 15.06 acres +/-. County Road 398 lies along the southern border.

A vicinity and key map of the site are included in Appendix A of this study as well as on the following page.

The scales below are not accurate since the maps included herein are for exhibit purposes only.


The Google Earth Exhibit above shows the site and the adjacent properties and their relationship to I-76 and Weld County Roads in the Town of Keenesburg.




The USGS Exhibit above details historic topography of project site, Interstate 76, Weld County Roads and their proximity to the Town of Keenesburg.

B. Description of Property

The metes and bounds legal description for the property is included in Appendix A.

Currently this parcel has slight to moderate topographical relief – 17 feet from the northwest edge (4904 elevation) to the southeast edge (4887 elevation). Ultimately the site does slope generally in one direction – to the southeast corner of the site to the County Road 398 ditch which runs adjacent to the property. Existing slopes average at 1.55%. The historic slopes appear to be 1.0% based on the USGS Quad from west to east.

The existing grades in general match the historical direction per USGS Quad maps.

The approximate grade at the four corners of the property are as follows – 4904.69 NW corner, 4891.50 NE corner, 4886.85 SE corner, and 4898.70 SW corner of RK Subdivision.

The subdivision is made up of multiple soil types, all NRCS classified B soils. The subdivision consists of 18 (Colby-Adena Loams) and 47 (Olney Fine Sandy Loam).

The adjacent R.O.W. basin to the south as well as the off-site basin to the west are the same NRCS soil types (Type B). The off-site basin to the northwest is a different NRCS soil type (Type C). All soil types are noted as well drained. Soils classifications were taken from Hydrologic Soil Type Map (Appendix A) USDA Soil Survey.

## II. DRAINAGE BASINS AND SUB-BASINS

A. Major Drainage Basins

The RK Subdivision Site is solely located in the South Platte River basin and all existing and developed drainage is ultimately tributary to the South Platte River. The historic and existing basins are shown on sheet 04 and 05.

### HISTORIC

**Basin H** (15.06 ac) includes everything but the off-site basins (OFF N, OFF W) to the north and west. As noted above, the historic grades (1.0%) drained off-site to the northeast. As noted previously, the entirety of the site and this basin is (100%) NRCS Soil Type B.

All runoff values presented herein have been prepared with the recently updated method of check for time of concentration – the UDFCD 2017 equation of: (26-17i) + [$L_{travel}$ / (60*(14i + 9)*($S_o$)^.5)]. *All values provided in this study are as determined by the 2017 time of concentration check.*

The Historic effective imperviousness value used was 2.0%. The minor (5yr) storm runoff is approximately 0.17 cfs, and the major storm runoff is approx. 17.28 cfs at Design Point H1.

**EXISTING**

**Basin E** (15.06 ac) includes everything but the off-site basins (OFF N, OFF W) to the north and west. As noted previously the topography slopes at 1.55% throughout the basin. The entirety of the site and this basin is (100%) NRCS Soil Type B.

The existing effective imperviousness value used was modeled at 2.0% since the overall basin (primarily undeveloped) includes the developed gas station, convenience store, and asphalt parking lot. The minor (5yr) storm runoff is approximately 0.29 cfs, and the major storm runoff is approximately 30.27 cfs at Design Point E1.

**OFFSITE BASINS**

**Basin OFF-N** includes part of the existing Parcels 130319000003 and 130524000026 to the north and northwest of the site. The basin is uphill from the site and drains on-site at approximately 1.0%. The Basin is predominantly NRCS Soil Type B.

The effective imperviousness value used is 3.66% as the basin is bare ground with some existing buildings. The minor (5yr) storm-runoff is approximately 0.39 cfs, and the major storm runoff is approximately 17.17 cfs at Design Point OFF N.

Proposed grading is designed to capture the runoff from this basin and send it to either Pond 4 or Pond 5-7 through swale 4N or swale 5N, respectively.

**Basin OFF-W** includes part of the existing Parcels 130319000011, 130524400042, and 13052400026 to the west and northwest of the site. The basin is uphill from the site and drains on-site at approximately 1.3%. The Basin is predominantly NRCS Soil Type B.

The effective imperviousness value used is 6.00% as the basin is predominately bare ground with existing asphalt parking and an existing building. The minor (5yr) storm-runoff is approximately 1.15 cfs, and the major storm runoff is approximately 28.93 cfs at Design Point OFF W.

Proposed grading is designed to capture the runoff from this basin and send it to one of the drainage ponds on the west half of the site (Pond 1, 2-3, or 4) through on-site drainage swales.

B. Minor Developed Drainage Basins

The Developed sub-basins related to this project are shown on sheet 07.

This study provides the final developed drainage characteristics for the ~ 15.06 acre site.

The developed basins for the RK Subdivision site are defined as Basins Lot 1, Lot 2, Lot 3, Lot 4, Lot 5, Lot 6, Lot 7, and ROW RK. Basin Lot 1 includes the designed Subdivision Infiltration Pond 1. Basins Lot 2 and Lot 3 share the designed Subdivision Infiltration Pond 2-3. Basin Lot 4 includes the designed Subdivision Infiltration Pond 4. Basins Lot 5, Lot 6, and Lot 7 share the designed Subdivision Infiltration Pond 5-7.

The weighted average imperviousness for the entire site (All Basins without 100 year pond water surfaces is 39.85%).

Each minor storm event referred to below is the 5 year event and each major storm event referred to below is the 100 year event. The 10 year event has also been calculated.

Calculations are carried out to the hundredths for consistency purposes only.

1. Basin Lot 1 (1.96 acres)

Basin Lot 1 is the developed lot in the southwest corner of the site. Although this basin is currently undeveloped bare ground, it has been modeled to receive a 6,300 square foot concrete building pad in the future.

Runoff from Basin Lot 1 begins at the west edge of the building pad and will be directed overland west to Swale 1W then south towards Swale 1S and ultimately east to the proposed concrete rundown to Forebay 1 in Infiltration Pond 1. The release from Basin Lot 1 occurs at Design Point 1 where Swale 1S meets Pond 1.

The developed effective imperviousness value calculated for Basin Lot 1 is 43.65% and the Rational runoff calculations were based on said existing conditions. NRCS Soil Type for this basin is solely Type B. The minor (5yr) storm runoff is approximately 1.34 cfs, and the major storm runoff approximately 5.45 cfs.

2. Basin Lot 2 (1.70 acres)

Basin Lot 2 is one of the center lots on the west half of the site, located directly north of Lot 1. Although this Basin is currently undeveloped bare ground, it has been modeled to receive a 6,300 square foot concrete building pad in the future.

Runoff from Basin Lot 2 begins at the west edge of the building pad and is directed overland west towards Swale 2W then south towards Swale 2S and ultimately east and northeast to the proposed concrete rundown to Forebay 2/3 S in Infiltration Pond 2-3. The release from Basin Lot 2 occurs at Design Point 2 where Swale 2S meets Pond 2-3.

The developed effective imperviousness value calculated for Basin Lot 2 is 43.03%. NRCS Soil Type for this basin is solely Type B. The minor storm runoff is 2.27 cfs, and the major storm runoff is 9.39 cfs. Calculations were carried out to the hundredths for consistency purposes only.

3. Basin Lot 3 (1.65 acres)

Basin Lot 3 is one of the center lots on the west half of the site, located directly north of Lot 2. Although this Basin is currently undeveloped bare ground, it has been modeled to receive a 6,300 square foot concrete building pad in the future.

Runoff from Basin Lot 3 begins in the northeast corner of the building pad and is directed overland west towards Swale 3W then south towards Swale 3S and ultimately east and northeast to the proposed concrete rundown to Forebay 2/3 N in Infiltration Pond 2-3. The release from Basin Lot 3 occurs at Design Point 3 where Swale 3S meets Pond 2-3.

The developed effective imperviousness value calculated for Basin Lot 3 is 31.37%. NRCS Soil Type for this basin is solely Type B. The minor storm runoff is 0.80 cfs, and the major storm runoff is 4.16 cfs. Calculations were carried out to the hundredths for consistency purposes only.

4. Basin Lot 4 (2.00 acres)

Basin Lot 4 is located in the northwest corner of the site. Although this Basin is currently undeveloped bare ground, it has been modeled to receive a 5,400 square foot concrete building pad in the future.

Runoff from Basin Lot 4 begins in the northeast corner of the building pad and is directed overland northeast towards Swale 4N then east towards Swale 4E and ultimately south to the proposed concrete rundown to Forebay 4 in Infiltration Pond 4. The release from Basin Lot 4 occurs at Design Point 4 where Swale 4E meets Pond 4.

The developed effective imperviousness value calculated for Basin Lot 4 is 41.34%. NRCS Soil Type for this basin is solely Type B. The minor storm runoff is 1.50 cfs, and the major storm runoff is 6.38 cfs. Calculations were carried out to the hundredths for consistency purposes only.

5. Basin Lot 5 (1.95 acres)

Basin Lot 5 is located in the northeast corner of the site. Although this Basin is currently undeveloped bare ground, it has been modeled to receive a 6,300 square foot concrete building pad in the future.

Runoff from Basin Lot 5 begins in the northwest corner of the building pad and is directed overland north towards Swale 5N then east and ultimately to the proposed concrete rundown to Forebay 5/6/7 N in Infiltration Pond 5-7. The release from Basin Lot 5 occurs at Design Point 5 where Swale 5N meets Pond 5-7.

The developed effective imperviousness value calculated for Basin Lot 5 is 43.65%. NRCS Soil Type for this basin is solely Type B. The minor storm runoff is 1.95 cfs, and the major storm runoff is 7.96 cfs. Calculations were carried out to the hundredths for consistency purposes only.

6. Basin Lot 6 (2.32 acres)

Basin Lot 6 is the center lot on the east half of the site. Although this Basin is currently undeveloped bare ground, it has been modeled to receive a 6,300 square foot concrete building pad in the future.

Runoff from Basin Lot 6 begins in the southwest corner of the building pad and is directed overland south towards Swale 6-7 then east ultimately to the proposed concrete rundown to Forebay 5/6/7 N in Infiltration Pond 5-7. The release from Basin Lot 6 occurs at Design Point 6 where Swale 6-7 meets Pond 5-7.

The developed effective imperviousness value calculated for Basin Lot 6 is 43.03%. NRCS Soil Type for this basin is solely Type B. The minor storm runoff is 1.77 cfs, and the major storm runoff is 7.31 cfs. Calculations were carried out to the hundredths for consistency purposes only.

7. Basin Lot 7 (2.18 acres)

Basin Lot 7 is located on the southeast corner of the site. Although this Basin is currently undeveloped bare ground, it has been modeled to receive a 6,300 square foot concrete building pad in the future.

Runoff from Basin Lot 7 begins in the south side of the building pad and is directed overland south to Swale 7S then northeast and ultimately to the proposed concrete rundown to Forebay 5/6/7 S in Infiltration Pond 5-7. The release from Basin Lot 7 occurs at Design Point 7 where Swale 7S meets Pond 5-7.

The developed effective imperviousness value calculated for Basin Lot 7 is 31.37%. NRCS Soil Type for this basin is solely Type B. The minor storm runoff is 1.14 cfs, and the major storm runoff is 5.96 cfs. Calculations were carried out to the hundredths for consistency purposes only.

8. Basin ROW RK (0.73 acres)

Basin ROW RK includes the proposed RK Drive to the middle of the site. This basin was mapped from the north end of the proposed cul-de-sac south to the south property line of the site.

The 500 foot length of Road has a low point at the south property line, sloping at 0.5% from the north. The Basin is NRCS Soil Type B.

The effective imperviousness value used is 41.34% and was based on the 32 foot wide asphalt section and four (4) foot gravel shoulder. The minor (5yr) storm runoff is approximately 0.59 cfs, and the major storm runoff is approximately 2.51 cfs at Design Point 8.

## III. DRAINAGE DESIGN CRITERIA

A. Regulations

The calculations provided in this letter report have been prepared in conformance with the Town of Keenesburg Development Standards and Regulations (Ref 1) – per Professional Engineering Consultants direction that the Town has adopted the Colorado Water Conservation Board and Colorado Department of Natural Resources "*Colorado Floodplain and Stormwater Criteria Manual Volumes 1 and 2*" (Ref 3), and "*Urban Drainage Flood Control District (UDFCD) Urban Storm Drainage Criteria Manual, Volumes I thru III*" (Ref 2), latest release unless otherwise noted.

All design elements outlined in this report, and illustrated in the construction plans, are proposed as final conditions (as directed, assumed, or otherwise prepared) in order to complete the development of this Project.

B. Drainage Studies, Outfall Systems Plans, Site Constraints

No apparent Final Drainage Study appears to have been prepared as part of this property in the past. The Town of Keenesburg falls just outside of the Urban Drainage boundary.

Coordination with Town staff confirmed no Final Drainage Report is known to exist for this property or any Town limit property north of Interstate 76.

No significant constraint was identified as part of the design of this project beyond the flat nature of the area and existing encroachment of the Senior Center to the east.

C. Hydrology

The rainfall intensity information was obtained from the NOAA Atlas 14 using 1 hour rainfall depths as taken from UDSDC Manual Vol 1 (Ref 2).

Town of Keenesburg adopted the Colorado Water Conservation Board and Colorado Department of Natural Resources "*Colorado Floodplain and Stormwater Criteria Manual Volumes 1 and 2*" (Ref 3), and "*Urban Drainage Flood Control District (UDFCD) Urban Storm Drainage Criteria Manual, Volumes I thru III*" (Ref 2), latest release unless otherwise noted were utilized for confirmation of 100 year and 10 year event storm rainfall data.

Upon review of the aforementioned references, the NOAA Atlas 14 was referenced and data derived for 1 hour rainfall depths at 2, 5, 10, and 100 year events are as follows:

| DESIGN STORM | WEC Derived from USDCM NOAA Atlas 14 1-hr Event (inches) |
|---|---|
| 2 | 0.87 |
| 5 | 1.14 |
| 10 | 1.42 |
| 100 | 2.66 |

The precipitation depth derived from the NOAA Atlas 14 by WEC for the 1-hour design storm was 2.66 inches rainfall depth for the 100-year storm, 1.42 inches rainfall depth for the 10-year storm, and 1.14 inches rainfall depth for the 5 year storm.

The Rational Method for storm-water runoff calculations, using the Equations as described in the UDFCD (Reference 2) Criteria Manual Chapter 5 Runoff was used to calculate stormwater flows within this study. The run-off coefficient 'C' values were obtained from the UDFCD (Reference 2) Criteria Manual as well based on the predominate NRCS Soil Type.

It appears no on site water quality or detention has been provided or maintained for any of the adjacent or neighboring properties (currently primarily open space).

The use of weighted runoff coefficients is to accurately portray the proposed final conditions of the maximum build out (maximum lot coverage) for this project based on the best available information at this time. Sole use of Table RO-5 is applicable for Master Plan Drainage analysis including projects of this type – however calculation of proposed final conditions using weighted runoff coefficients provides a more thorough and accurate analysis.

The site has been modeled based on the current expected build out conditions. However, should additional paving occur the Swale conveyances have been sized to handle added runoff.

No other offsite basins have been modeled beyond those noted previously (OFF-N, OFF-W, and ROW-398) since the adjacent surveyed topography indicated adjacent runoff is not directed onto this property (nor is runoff directed from this property due to the existing grades being directed off-site to the existing WCR 398 road-side ditch).

It is the expectation of this study that any development or improvements to the property adjacent will require them to provide appropriate stormwater design(s).

This project will not negatively affect the adjacent property and will provide modern stormwater control that does not currently exist. In short, this project will be an enormous improvement to the area.

D. Hydraulics

The conveyance of onsite site stormwater occurs primarily overland across pavements and then through landscape and into swales that will ultimately convey runoff to proposed infiltration ponds. Please see Appendix C for all related swale and pond capacities.

There are no major drainage ways on this site or immediately adjacent. The South Platte River lies approximately 16 miles northeast.

E. Water Quality Enhancement

Water quality will be provided by overland runoff (gravel or vegetated native grasses) and also by the proposed grassed pond bottoms. Additional grass swales may be incorporated by the future Lots.

F. Groundwater

Project Geotechnical Reports have been completed at each proposed pond location by High Plains Engineering & Design, LLC dated January 22, 2020 and can be found in Appendix A.

No groundwater was encountered during the subsurface investigations.

Developed runoff is not anticipated to increase groundwater levels but will be infiltrated into the subsurface soils.

Should groundwater levels surface (above the design bottom) at any time for more than 24 hours the Engineer of Record should be contacted and plans to mitigate said groundwater be undertaken (i.e. cleaning of outlet structure and/or raising of Pond bottom above groundwater).

## IV. STORMWATER MANAGEMENT FACILITY DESIGN

A. Stormwater Conveyance Facilities

Runoff analysis for stormwater management has been included and presented in this report.

No Master study exists for this area.

Capacity calculations for the proposed Swales are included in Appendix C.

B. Stormwater Storage Facilities

Traditional Stormwater storage and attenuation (water quality and infiltration) is currently proposed since this site does not currently have a source of formal outfall. Multiple Infiltration Ponds have been designed to contain the developed runoff from the site.

UDFCD Criteria Volumes (Ref 2) were referenced for determining necessary storage volumes.

Four independent volumes were calculated – (1) WQCV, (2) Required EURV, (3) required 100 yr, (4) Available volume @ Emergency Overflow. UDFCD UD spreadsheet version 3.07 was utilized to calculate said volumes;

Pond 1: (1) 1,540 cubic feet, (2) 5,042 cubic feet, (3) 34,010 cubic feet, and (4) 34,811 cubic feet.

Pond 2-3: (1) 2,595 cubic feet, (2) 8,186 cubic feet, (3) 61,482 cubic feet, and (4) 66,313 cubic feet.

Pond 4: (1) 2,316 cubic feet, (2) 7,58 cubic feet, (3) 36,320 cubic feet, and (4) 36,543 cubic feet.

Pond 5-7: (1) 5,747 cubic feet, (2) 18,382 cubic feet, (3) 194,887 cubic feet, and (4) 200,402 cubic feet.

The current RK Subdivision Pond 1 storage/grading design provides volume for proposed Lot 1 (maximized imperviousness of 43.65%). Pond 2-3 storage/grading design provides volume for the proposed Lots 2 and 3 (maximized imperviousness of 43.03%). Pond 4 storage/design provides volume for proposed Lot 4 (maximized imperviousness of 41.34%). Pond 5-7 storage/design provides volume (1.5x100yr Storm) for proposed Lots 5, 6, and 7 (maximized imperviousness of 43.65%).

Each pond has been designed with an emergency overflow spillway wall that will allow stored water to exit the ponds into the designed spillway channels before overtopping the top of the ponds. Each spillway was designed the carry 2x100yr developed runoff with a flow depth of no more than 6". See Sheet 17D of the Construction Drawings for the spillway wall and channel details.

All calculations are included in Appendix C.

C. Water Quality BMP's

Overland runoff will provide some water quality. Infiltration Pond Forebays will treat all routed runoff. Additional BMP's in accordance with current UDFCD Volume III criteria (Ref 2) may be added in the future.

D. Floodplain

This project does not lie within a floodplain. The entire subdivision is within Zone X "Area of Minimal Flood Hazard" per FEMA FIRM 08123C2180E – effective January 20, 2016. See also the FIRMETTE map included Appendix A.

E. Groundwater

Typical Lot runoff is expected to moderately infiltrate the seeded grasses and gravel covered site under most minor events. Under multiple minor events or major events runoff is expected to sheet flow to adjacent swales and be routed to the appropriate Subdivision Infiltration Pond as designed. Minimal effect to the groundwater is expected.

F. Additional permitting

No additional permitting is anticipated.

G. Storm System Maintenance

This section defines the maintenance responsibilities for RK Subdivision:

- Swales – including but not limited to mowing, weed control, cleaning and removing debris, removing accumulated sediment, adding erosion control, and replacement of any damaged or failing improvements. Improvements for Swales include the concrete pan and adjacent grades and vegetation.

- Drainage Basins – including but not limited to mowing, weed control, cleaning and removing debris, removing accumulated sediment, adding erosion control, and replacement of any damaged or failing improvements. Improvements for each Basin beyond all Swales include the on-site grading, on site native grass, and proposed concrete curb adjacent to all proposed Buildings, parking, and access.

- Infiltration Ponds – including but not limited to mowing, weed control, cleaning and removing debris, removing accumulated sediment, adding erosion control, and replacement of any damaged or failing improvements. Improvements for the Infiltration Ponds includes 4:1 seeded slopes, forebays, trickle pan, and the pond bottoms.

Frequency of inspections and maintenance are as follows:

- Swales, Basins, and Infiltration Ponds should be inspected monthly or within 24 hours of each measureable precipitation event.
- Any damaged or lost material (riprap) should be replaced immediately
- Mowing should occur monthly or more often depending upon growth.
- Weed control should occur a minimum of two times per spring/summer/fall season
- Cleaning beyond inspections noted above should occur at a minimum of annually

## V. CONCLUSIONS

A. Compliance with standards

This Drainage Study for the RK Subdivision site is located in Town limits and was prepared in conformance with the Town of Keenesburg Development Standards and Regulations (Ref 1), the Colorado Water Conservation Board and Colorado Department of Natural Resources "*Colorado Floodplain and Stormwater Criteria Manual Volumes 1 and 2*" (Ref 3), and the Urban Drainage Flood Control District Storm Drainage Design and Technical Criteria (Ref 2).

This drainage design and concept quantifies the requirements to manage stormwater runoff.

B. Variances

No variance is proposed or requested.

C. Drainage concept

The intent of this design is to provide the drainage analysis necessary for capture, routing, and infiltration of the runoff generated by the RK Subdivision property.

D. Additional Items

No additional items were considered at this time.

## VI. REFERENCES


1. Weld County Storm Drainage Design Manual "*Weld County Engineering and Construction Criteria – Chapter 5: Drainage Criteria*" Revised April 2012.

2. *Urban Storm Drainage Criteria Manual, Volumes I-III, Denver Regional Council of Governments,* 2016, Revised 2017 & 2018, and all subsequent updates

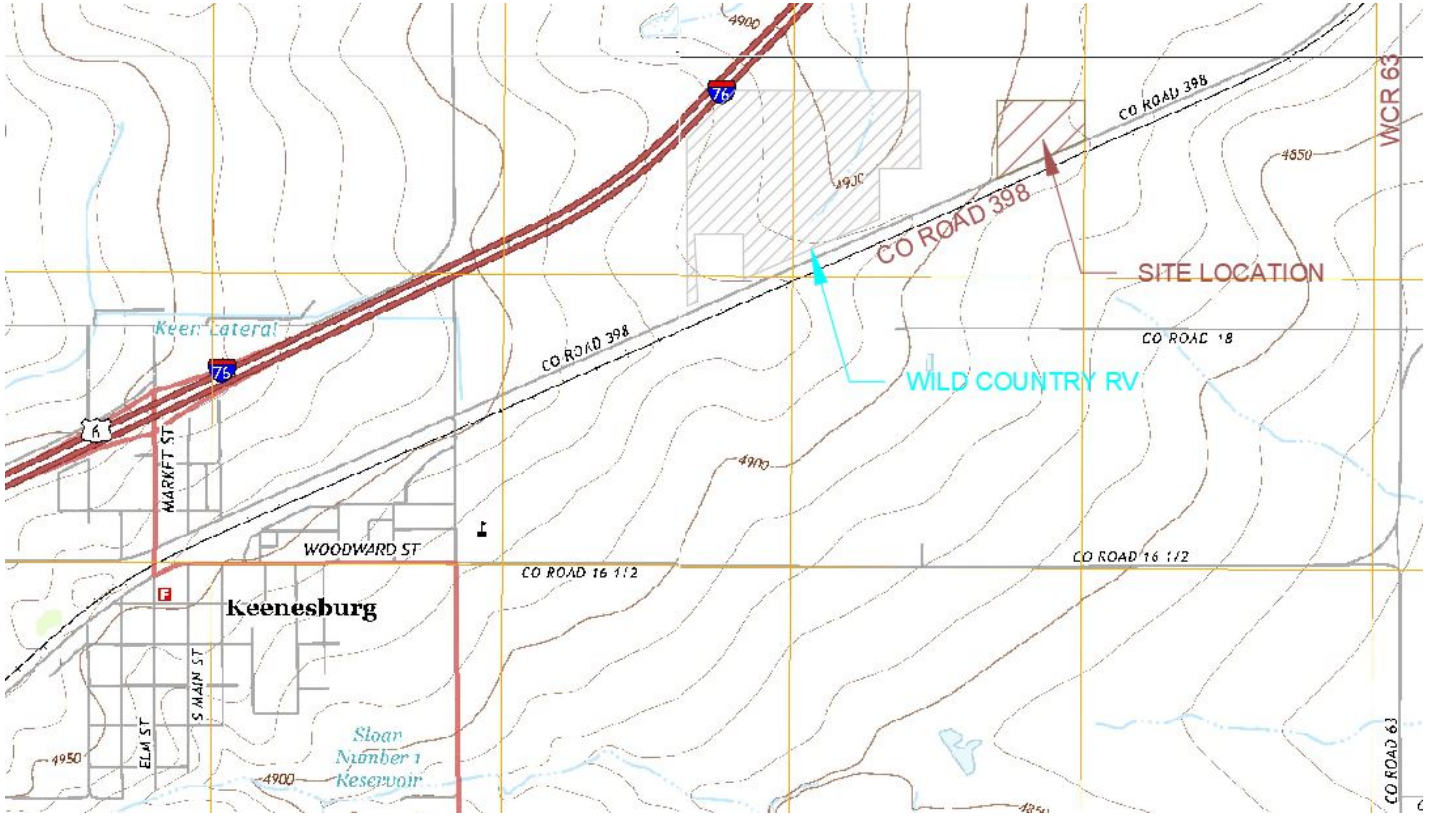
3. Colorado Water Conservation Board and Colorado department of Natural Resources "*Colorado Floodplain and Stormwater Criteria Manual Volumes 1 and 2*"


\\WECSERVER1\Share\0187_002_00-RK ANNEXATION\Docs\08 Reports\Drainage\20191009 RK FDR.docx

# APPENDIX A

**Vicinity Map (USGS) / Key Map / FEMA Flood Insurance Rate Map (FIRM), Legal Description, Soil Survey Map and Soil Legend, Geotechnical Report**


THIS PROJECT
WILD COUNTRY
RV PARK
76
76
398
398
63
18
18
18
18
18


SITE LOCATION
WILD COUNTRY RV
CO ROAD 398
CO ROAD 398
CO ROAD 398
WCR 63
CO ROAD 18
CO ROAD 16 1/2
CO ROAD 16 1/2
WOODWARD ST
MARKET ST
S MAIN ST
ELM ST
Keenesburg
Keen Lateral
Sloan Number 1 Reservoir
CO ROAD 63
4900
4950
4550

# National Flood Hazard Layer FIRMette

FEMA

40°7'34.37"N

104°29'27.16"W


104°28'49.71"W

40°7'6.86"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

**SPECIAL FLOOD HAZARD AREAS**
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

**OTHER AREAS OF FLOOD HAZARD**
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

**OTHER AREAS**
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

**GENERAL STRUCTURES**
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

**OTHER FEATURES**
- 20.2 / 17.5 Cross Sections with 1% Annual Chance / Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

**MAP PANELS**
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 3/27/2019 at 6:57:24 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

# Custom Soil Resource Report for Weld County, Colorado, Southern Part

## RK Subdivision


March 21, 2019

# Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

# Contents

# How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report
## Soil Map


Map Scale: 1:2,300 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

## MAP LEGEND

**Area of Interest (AOI)**
- Area of Interest (AOI)

**Soils**
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**Water Features**
- Streams and Canals

**Transportation**
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

**Background**
- Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Weld County, Colorado, Southern Part
Survey Area Data: Version 17, Sep 10, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 17, 2015—Oct 2, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| 18 | Colby-Adena loams, 3 to 9 percent slopes | 1.6 | 10.1% |
| 47 | Olney fine sandy loam, 1 to 3 percent slopes | 14.6 | 89.8% |
| 79 | Weld loam, 1 to 3 percent slopes | 0.0 | 0.1% |
| **Totals for Area of Interest** | | **16.2** | **100.0%** |

# Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

# Weld County, Colorado, Southern Part

## 18—Colby-Adena loams, 3 to 9 percent slopes

### Map Unit Setting

*National map unit symbol:* 361t
*Elevation:* 4,750 to 4,900 feet
*Mean annual precipitation:* 12 to 16 inches
*Mean annual air temperature:* 48 to 55 degrees F
*Frost-free period:* 120 to 160 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Colby and similar soils:* 55 percent
*Adena and similar soils:* 30 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Colby

#### Setting

*Landform:* Ridges, hills, plains
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous eolian deposits

#### Typical profile

*H1 - 0 to 7 inches:* loam
*H2 - 7 to 60 inches:* silt loam

#### Properties and qualities

*Slope:* 5 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 15 percent
*Available water storage in profile:* High (about 10.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* B
*Ecological site:* Loamy Slopes (R067BY008CO)
*Hydric soil rating:* No

### Description of Adena

#### Setting

*Landform:* Hills, plains, ridges
*Down-slope shape:* Linear
*Across-slope shape:* Linear

*Parent material:* Calcareous eolian deposits

**Typical profile**

*H1 - 0 to 6 inches:* loam
*H2 - 6 to 9 inches:* clay loam
*H3 - 9 to 60 inches:* silt loam

**Properties and qualities**

*Slope:* 3 to 7 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 15 percent
*Available water storage in profile:* High (about 10.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* C
*Ecological site:* Loamy Plains (R067BY002CO)
*Hydric soil rating:* No

**Minor Components**

**Kim**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

**Keith**

*Percent of map unit:* 4 percent
*Hydric soil rating:* No

**Weld**

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

**Wiley**

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

## 47—Olney fine sandy loam, 1 to 3 percent slopes

**Map Unit Setting**

*National map unit symbol:* 362v
*Elevation:* 4,600 to 5,200 feet
*Mean annual precipitation:* 11 to 15 inches

*Mean annual air temperature:* 46 to 54 degrees F
*Frost-free period:* 125 to 175 days
*Farmland classification:* Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60

**Map Unit Composition**

*Olney and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Olney**

**Setting**

*Landform:* Plains
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Mixed deposit outwash

**Typical profile**

*H1 - 0 to 10 inches:* fine sandy loam
*H2 - 10 to 20 inches:* sandy clay loam
*H3 - 20 to 25 inches:* sandy clay loam
*H4 - 25 to 60 inches:* fine sandy loam

**Properties and qualities**

*Slope:* 1 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 15 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 7.0 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 4c
*Hydrologic Soil Group:* B
*Ecological site:* Sandy Plains (R067BY024CO)
*Hydric soil rating:* No

**Minor Components**

**Zigweid**

*Percent of map unit:* 10 percent
*Hydric soil rating:* No

**Vona**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

## 79—Weld loam, 1 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 2x0hw
*Elevation:* 3,600 to 5,750 feet
*Mean annual precipitation:* 12 to 17 inches
*Mean annual air temperature:* 46 to 54 degrees F
*Frost-free period:* 115 to 155 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

*Weld and similar soils:* 80 percent
*Minor components:* 20 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Weld

#### Setting

*Landform:* Interfluves
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Interfluve
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous loess

#### Typical profile

*Ap - 0 to 8 inches:* loam
*Bt1 - 8 to 12 inches:* clay
*Bt2 - 12 to 15 inches:* clay loam
*Btk - 15 to 28 inches:* loam
*Bk - 28 to 60 inches:* silt loam
*C - 60 to 80 inches:* silt loam

#### Properties and qualities

*Slope:* 1 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 14 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* High (about 11.3 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 2e
*Land capability classification (nonirrigated):* 3c
*Hydrologic Soil Group:* C
*Ecological site:* Loamy Plains (R067BY002CO)
*Hydric soil rating:* No

**Minor Components**

**Adena**

*Percent of map unit:* 8 percent
*Landform:* Interfluves
*Landform position (two-dimensional):* Shoulder
*Landform position (three-dimensional):* Interfluve
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Ecological site:* Loamy Plains (R067BY002CO)
*Hydric soil rating:* No

**Colby**

*Percent of map unit:* 7 percent
*Landform:* Hillslopes
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Ecological site:* Loamy Plains (R067BY002CO)
*Hydric soil rating:* No

**Keith**

*Percent of map unit:* 3 percent
*Landform:* Interfluves
*Landform position (two-dimensional):* Summit
*Landform position (three-dimensional):* Interfluve
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* Loamy Plains (R067BY002CO)
*Hydric soil rating:* No

**Baca**

*Percent of map unit:* 2 percent
*Landform:* Interfluves
*Landform position (two-dimensional):* Shoulder, summit
*Landform position (three-dimensional):* Interfluve
*Down-slope shape:* Linear, convex
*Across-slope shape:* Linear, convex
*Ecological site:* Loamy Plains (R067BY002CO)
*Hydric soil rating:* No

# References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

# SUBSURFACE INVESTIGATION AND FOUNDATION RECOMMENDATIONS

***Prepared For:***
Platte River Investments, Inc.
8537 County Road 51
Keenesburg, CO 80643

***Job Site Located At:***
Future 1.83 Acre Parcel Currently Located within
Parcel No. 130319300014
Lot 1
A Part of the SW1/4 of Section 19
T2N, R63W of the 6th P.M.
Weld County, CO

January 22, 2020

**JOB #19-9433**


Todd M. Schroeder P.E. 33548

## AGREEMENT OF PURPOSE AND DISCLAIMER:

The parties specifically agree and contract that the purpose of the provided subsurface investigation is to test, analyze, and provide geotechnical recommendations for the foundation recommendations. This report presents a description of subsurface conditions encountered at the site, design, and construction criteria influenced by the subsurface conditions. The opinions and recommendations presented in this report are based on the data generated during this field exploration, laboratory testing, and our experience. A foundation design sealed by a Professional Engineer is required to obtain a building permit but is not included in this report.

*The parties specifically agree that High Plains Engineering & Design, LLC has not been retained nor will they render an opinion concerning environmental issues, hazardous waste or any other known and or unknown conditions that may be present on the job site, since this is not our area of expertise.*

## LOCATION AND SITE CONDITIONS:

This report represents the results of the data obtained during the subsoil investigation for the proposed steel building located at Future 1.83 Acre Parcel Currently Located within Parcel No. 130319300014, Lot 1, A Part of the SW1/4 of Section 19, T2N, R63W of the 6th P.M., Weld County, CO.

The proposed building site is a vacant lot. The site is reasonably level with approximate slopes of 1.0% to the East-Northeast. The lot appears to be well drained with no erosion evident.

The depths of the excavation are anticipated to range from two (2) to four (4) feet below grades that existed at the time of this investigation. It is anticipated that final grades may be adjusted to accommodate drainage and construction depths. It is recommended that we review the final grading plan to determine if any revisions to the recommendations presented in this report are necessary.

## SUBSOIL CONDITIONS:

Two, four-inch-diameter holes were drilled up to a depth of fifteen feet at the project site on January 7, 2020, as shown on the attached site map. Soil samples were analyzed in the field and laboratory to determine the characteristics of the soil (per Unified Soil Classification System) for identification and foundation design recommendations. In general, the soil profiles in test-holes #1 & #2 indicated Clay with Low Plasticity (CL) to a depth of 4 feet, underlain by Clay with Medium Plasticity (CL) to a final depth of 15 feet.

The Standard Penetration Test per ASTM D1586 for test-hole #1 showed 19 blows for a 12-inch penetration at a depth of 2 feet, 17 blows for a 12-inch penetration at a depth of 4 feet, and 35 blows for a 12-inch penetration at a depth of 9 feet. Please note that actual subsurface soil conditions may vary between samples and locations tested.

One-dimensional swell/consolidation tests were performed on selected samples to evaluate the expansive, compressive and collapsing nature of the soils and/or bedrock strata. These tests indicated an expansion potential of 2.7% at a depth of 2 feet, an expansion potential of 2.5% at a depth of 4 feet and an expansion potential of 1.5% at a depth of 9 feet. The soils in this report were classified using the American Society of Testing Materials (ASTM) procedures.

The geotechnical practice in the State of Colorado utilizes a relative scale to evaluate swelling (expansion) potentials. When a sample is wetted under a surcharge pressure of 500 pounds per square foot (psf), the measured swell is classified as low, moderate, high, or very high. The following table represents the relative classification criteria. Please note that the measured swell is not the only criteria for slab-on-grade recommendations and additional factors are considered by the engineer when evaluating the risk for slab-on-grade construction.

| TABLE 1 | |
|---|---|
| SLAB PERFORMANCE RISK CATEGORY | REPRESENTATIVE PERCENT SWELL (500 PSF SURCHARGE) |
| LOW | 0 TO <3 |
| MODERATE | 3 TO <5 |
| HIGH | 5 TO <8 |
| VERY HIGH | ≥8 |

Source: Colorado Association of Geotechnical Engineers, Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area), 1996

## GROUNDWATER:

Groundwater levels were not recorded at the time of our field investigation; however, it may be possible for groundwater to exist at construction depths at a later date. The groundwater can be expected to fluctuate throughout the year depending on variations in precipitation, surface drainage and irrigation on the site. The possible presence of shallow bedrock/dense clays beneath the surface is favorable for the formation of "perched" groundwater. We recommend that the bottom of the basement or crawlspace excavations be maintained at least 4 feet above the free groundwater level.

The ground water levels recorded represent the free, static water levels after equalization of hydrostatic pressures in the test-hole borings. It is possible that the groundwater levels recorded in the test-hole borings may not be present at those levels in the foundation excavations. Flow rates, seepage paths, hydrostatic pressures, seasonal groundwater fluctuations, water quality and other factors were not determined in this investigation. A program, which may include special well construction, test procedures, long-term monitoring, and analysis, would be necessary to determine these factors.

## FOUNDATION RECOMMENDATIONS:

The Clay with Low Plasticity (CL) and Clay with Medium Plasticity (CL) material has a bearing strength of 2000 pounds per square foot (psf) and an equivalent liquid pressure of 55 pcf. We recommend the use of a continuous spread footing, due to the low expansion-consolidation potential of the analyzed soils. **The foundation must be constructed at the location in which soils investigation was performed.**

**All rebar must be fully contained within the footing/foundation and shall not have any contact with the native soils due to the known risks of soluble sulfates contained in area soils.**

All loose and disturbed soil shall be removed before placing of the concrete for the foundation. The bottom of the foundation shall be a minimum of 30" below final grade (or that required by local jurisdiction; whichever is greater) for frost protection.

Soil settlement resulting from the assumed structural loads is estimated to be one inch or less. Soil expansion at this site may be up to one inch in some areas. No foundation wall is to exceed twenty-five feet in length without utilizing buttresses or counterforts unless otherwise designed by the foundation engineer.

Engineered steel reinforcements shall be required in the footings and foundation walls. This will give walls or footing beams the strength to span or bridge over any loose or soft pockets of soil that may develop during construction.

**Owners shall be made aware of all contents of this report, and the fact that *water accumulation around foundation elements is the primary cause of distressed foundations.***

To help prevent secondary damage that could be caused by slab movement, the following construction techniques are additional recommendations for the foundation construction.

## SLAB ON GRADE CONSTRUCTION:

**Steel Building/Shop and Exterior Slab-on-grade Concrete:** The soil encountered at or below anticipated slab elevations has a low swell potential. If removal and replacement of soil below slabs is required, use a non-expansive granular soil with Plasticity Index less than 15 and Liquid Limit less than 30 and compacted to a minimum of 95% ASTM D698 (Standard Proctor Density), within 2% of the optimum moisture content.

The slabs should be constructed as "floating" slabs, which are free to move in the vertical direction. The slabs should not be attached to interior or exterior bearing members. The following design and construction details for slab-on-grade construction are recommended.

1. Floor slabs placed above potentially expansive soils will be expected to heave and crack to some degree. It is impossible to predict with certainty how much slab movement will actually occur. **When the owners cannot tolerate slab movement, we recommend to install a structural slab in place of the conventional slab on grade for floor construction.**

2. Where steel building/shop slabs and exterior slabs-on-grade are chosen, and the owners understand and accepts all the risks associated with slab movement, the following recommendations should be followed with the amount of over-excavation and replacement with imported fill determined by the owner/builder.

   a. Positive separations and/or isolation joints should be provided between slabs and all foundation walls, bearing members (columns), plumbing and utility lines. Isolation may be achieved with ½ inch expansion material or by sleeving. Vertical movement of the slabs should not be restricted. A minimum void of 3 inches should be provided with all non-bearing partition walls to allow movement without damaging the structure. Provide a minimum ½ inch space at the bottom of all doorjambs. It is the owner's responsibility to maintain these void spaces. Mechanical equipment set on the slab will require an expandable/collapsible connection to ductwork, etc.

   b. Eliminate plumbing under slabs where feasible. Where such plumbing is unavoidable, it should be thoroughly pressure tested during construction.

   c. A vapor retarder is required per IRC R506.2.3 except use 15-mil minimum thickness, located per ACI guidelines and installed per ASTM specifications. Floor slabs and footings should not be constructed on frozen subgrade. Slabs should be reinforced with rebar or wire mesh to help control crack separation.

3. Provide frequent scoring of the slabs in square dimensions (non- rectangular) to provide joints for controlled cracking of the slab. Control joints should be placed at distances equal to 24 to 30 times the slab thickness and the depth of sawed control joints should be ¼ of the slab thickness. Joints should be sawed as soon as the concrete will withstand the energy of sawing without raveling the edges of the joint. For most concrete mixtures, sawing should be completed within 6 to 18 hours after pouring, but never more than 24 hours. Install a good quality sealant (pliable/non-hardening) in these joints to prevent surface discharges of liquid from penetrating slab sub-grades.

4. The soils that will support the concrete slabs should be kept moist during construction by occasional sprinkling of water. The soils should be moistened to +/- 2 % optimum moisture within 24 hours of pouring the slabs. This procedure will help maintain the moisture content of the underlying soil. **Heavy watering or pooling of any kind next to the foundation or within the backfilled area is not recommended.**

## BACKFILL:

**The foundation and retaining walls must be well cured and well braced prior to backfilling.**

Any soil disturbed adjacent to bearing foundation components are to be **re-compacted to a minimum of 95% Standard Proctor Density (ASTM D698)**. Backfill that bears concrete slabs shall be compacted to 95% Standard Proctor Density (ASTM D698). Mechanical compaction methods shall be utilized, (water-flooding techniques are strictly prohibited). See Compaction Section for more information regarding compaction requirements and techniques.

Proper drainage away from the foundation walls shall be provided. The owners are advised to immediately fill any settled areas to eliminate water accumulation near the foundation. A minimum slope of 12 inches in the first 10 feet from the perimeter of the building is recommended. Roof downspouts and sill cocks should discharge into long concrete splash blocks (5 feet long min.) or into gutter extensions to deposit runoff water beyond the limits of the backfill soil near the foundation walls. Plastic membranes should not be used to cover the ground surface immediately surrounding the structure; geotextile fabric should be utilized for weed control. Any drainage water from uphill shall be diverted around the structure.

Sprinkling systems should not be installed or direct water to be within 10 feet of the foundation. The owner/builder is also advised that irrigation lines can leak and/or break, resulting in release of excessive amounts of water near the foundation. This can cause damage to slabs and foundation walls. **WATER ACCUMULATION AROUND FOUNDATION ELEMENTS IS THE MAIN CAUSE OF DISTRESSED FOUNDATIONS.**

## COMPACTION:

*Placing Fill*: No brush, sod, frozen material, perishable material, unsuitable material, or stones of four inches or greater in maximum dimension shall be placed in the fill. The distribution of the material on the fill shall be such as to avoid the formation of layers of materials differing substantially in characteristics from the surrounding materials.

The materials are to be delivered to the backfill surface at a uniform rate, and in such quantity as to permit a satisfactory construction procedure. Unnecessary concentration of backfill machinery travel tending to cause ruts and other hollows more than six inches in depth, are to be re-graded and compacted. After dumping of fill material on the backfill surface, the material is to be spread by approved methods in approximately 6 inches compacted thickness.

*Moisture Control*: The material in each layer shall be compacted by rolling and shall contain the optimum moisture required for maximum compaction, as nearly practicable and as determined by the soils engineer. The moisture content shall be uniform throughout all layers. If in the opinion of the soils engineer it is not possible to obtain moisture content by adding water on the fill surface, the contractor may be required to add the necessary moisture to backfill material in the borrow area.

*Compaction*: When the moisture condition and content of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer to **95% ASTM D698 (Standard Proctor Density) for slab areas, and 98% ASTM D698 for footing and/or pad areas.** A Standard Proctor test is to be performed for each typical fill material and frequent tests of the density of the fill must be taken.

In general, to compact cohesion-less free-draining materials, *the above guidelines also apply.*

When compacting cohesion-less free-draining materials such as gravel and sand, the materials shall be deposited in layers and compacted by treads of a crawler type tractor, surface of internal vibrators, pneumatic or smooth rollers, power or hand tampers, or by any other means approved by the soils engineer. The thickness of the horizontal layers after compaction is not to exceed 6 inches compacted thickness if compaction is performed by tractor treads, surface vibrators or similar equipment, or not more than penetrating length of the vibrator head if compaction is performed by internal vibrators. When the moisture content and condition of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer **to 91% ASTM D1557 (Modified Proctor Density) for slab areas, and 94% ASTM D1557 for footing and/or pad areas.**

## CONSTRUCTION DETAILS – GENERAL COMMENTS:

In any soil investigation, it is necessary to assume that the subsurface soil conditions do not vary greatly from the conditions encountered in the field and laboratory testing. The accompanying design is presented using best professional judgment based on the limits of the extent of testing commissioned by the client. Our experience has been that at times, soil conditions do change and variations do occur. These may become first apparent at the time of excavation for the foundation system.

**If soils conditions are encountered which appear different from the test borings as presented in this report, it is required that this office be called to make an observation of the open excavation prior to placing the footings. The cost of this observation is not part of this report.**

This project should be constructed by a qualified contractor with experience in similar projects. The owner/builder is advised to observe and document the construction process to ensure the construction is performed in accordance with the design drawings and technical specifications. **The foundation and retaining walls must be well cured and well braced prior to backfilling**.

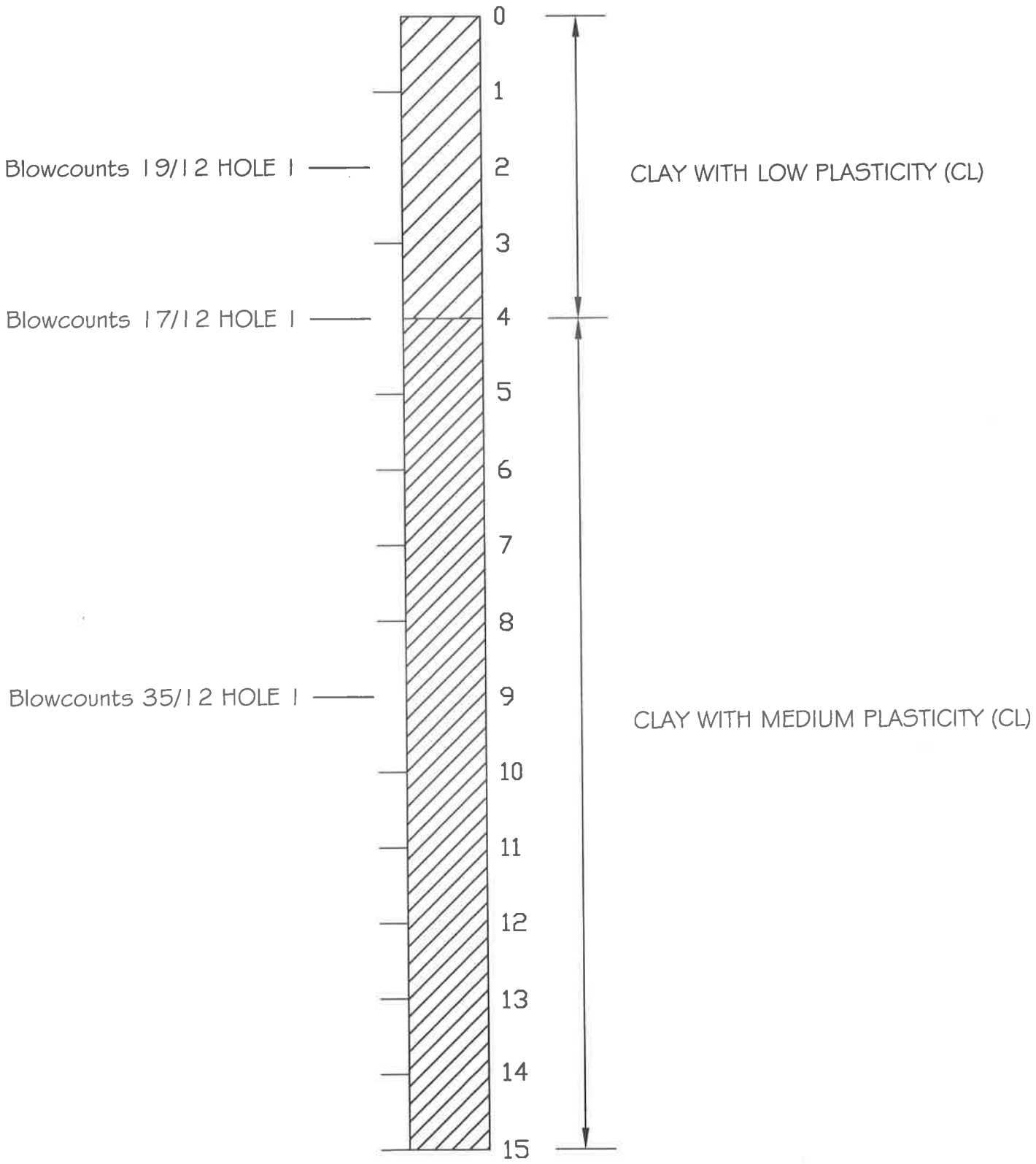
This report does not address general hillside stability, landslide potential, and/or other natural hazards. Several areas in the Colorado Front Range have known geologic hazards associated with them. We recommend that readers of this report educate themselves further as to the existence of geologic hazards on or around their specific property of interest. The Colorado Geologic Survey {www.geosurvey.state.co.us or 303-866-2611} is a good source for publications (maps, reports, etc.) dealing with specific geologic issues and/or issues related to specific geographic areas.

## DISCLAIMER:

We do not guarantee the performance of the project in any respect, but only that our engineering work and judgments rendered meet the standard care of our profession. The presence of underground workings (e.g. coal mines) and subsidence potential from any workings was not part of this investigation. The owner should contact the State and County agencies to determine if mining has been conducted in the area and if any precautions are recommended.

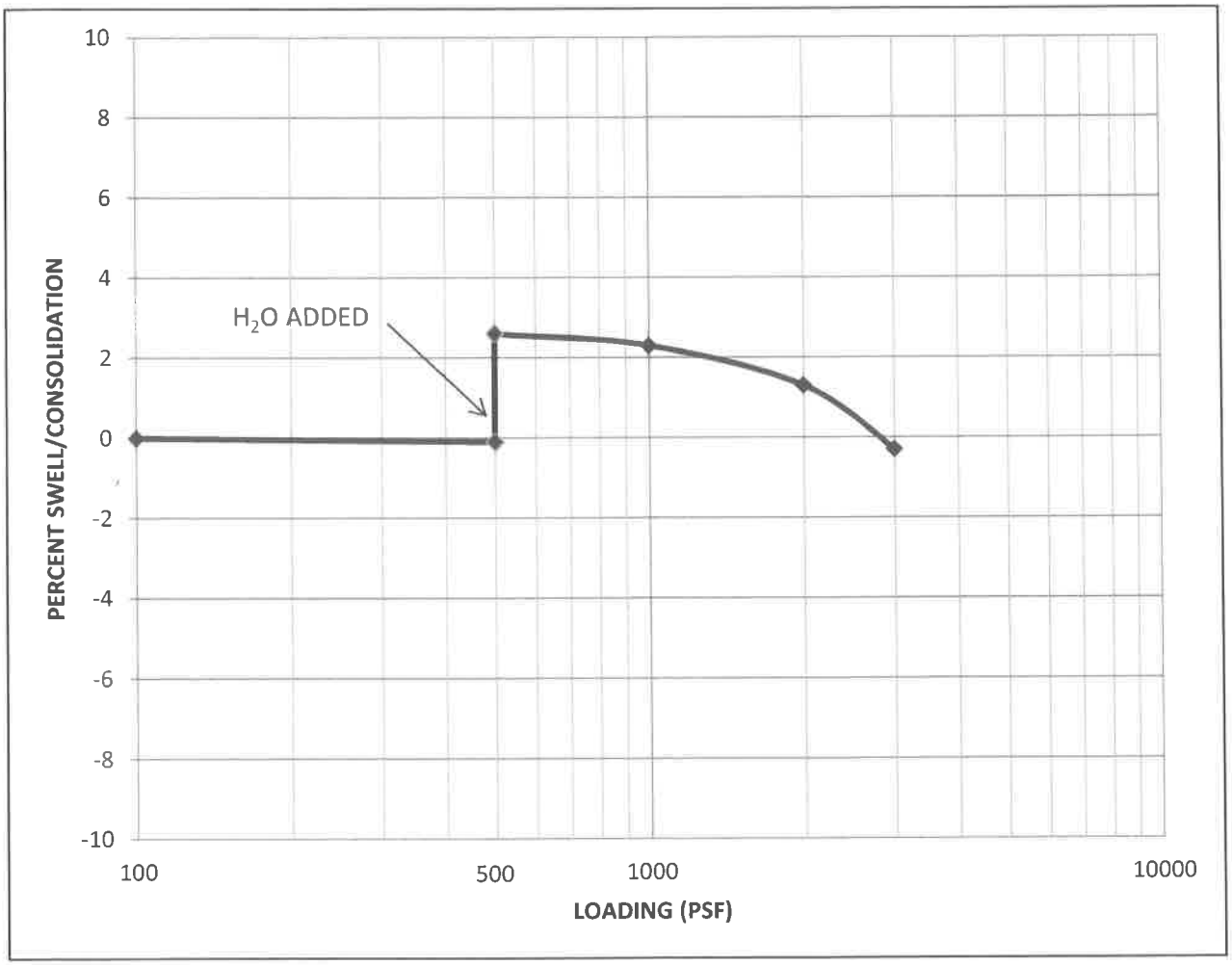
THE PARTIES SPECIFICALLY AGREE THAT *HIGH PLAINS ENGINEERING & DESIGN, LLC.* HAS NOT BEEN RETAINED NOR WILL THEY RENDER AN OPINION CONCERNING ANY ENVIRONMENTAL ISSUES, HAZARDOUS WASTE OR ANY OTHER KNOWN OR UNKNOWN CONDITIONS THAT MAY BE PRESENT ON SITE.

**DUE TO CHANGING TECHNOLOGY, BUILDING CODES AND CITY/COUNTY REQUIREMENTS, THIS SOIL REPORT MUST BE USED WITHIN ONE YEAR OF THE DATE ON THE FRONT OF THE REPORT OR MUST BE REVISED.**




TEST HOLE(S) 1 & 2

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

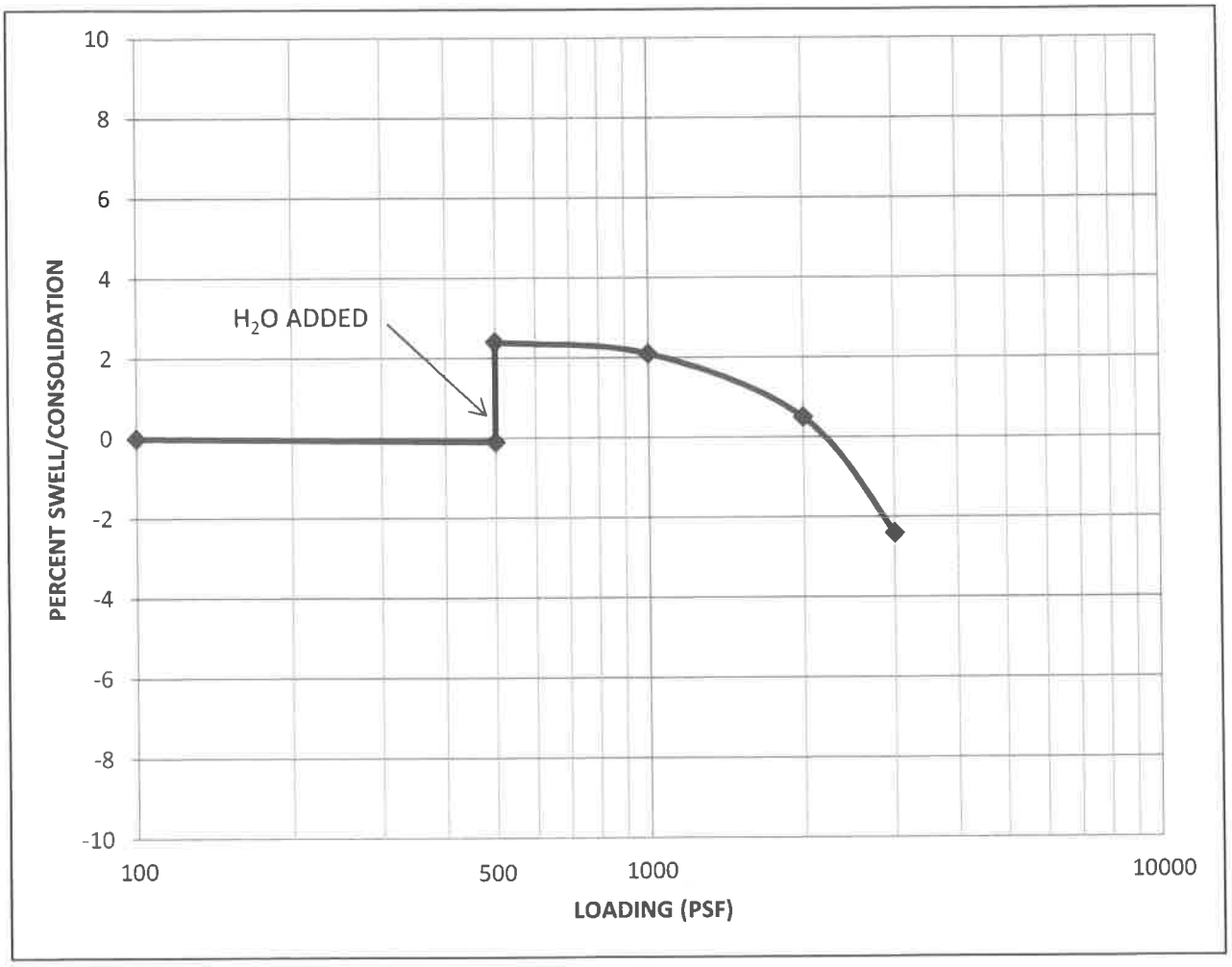



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 2' BC | 35.33 | 22.25 | 13.09 | 2.7 | | 9.96 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH LOW PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9433 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.83 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 1, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

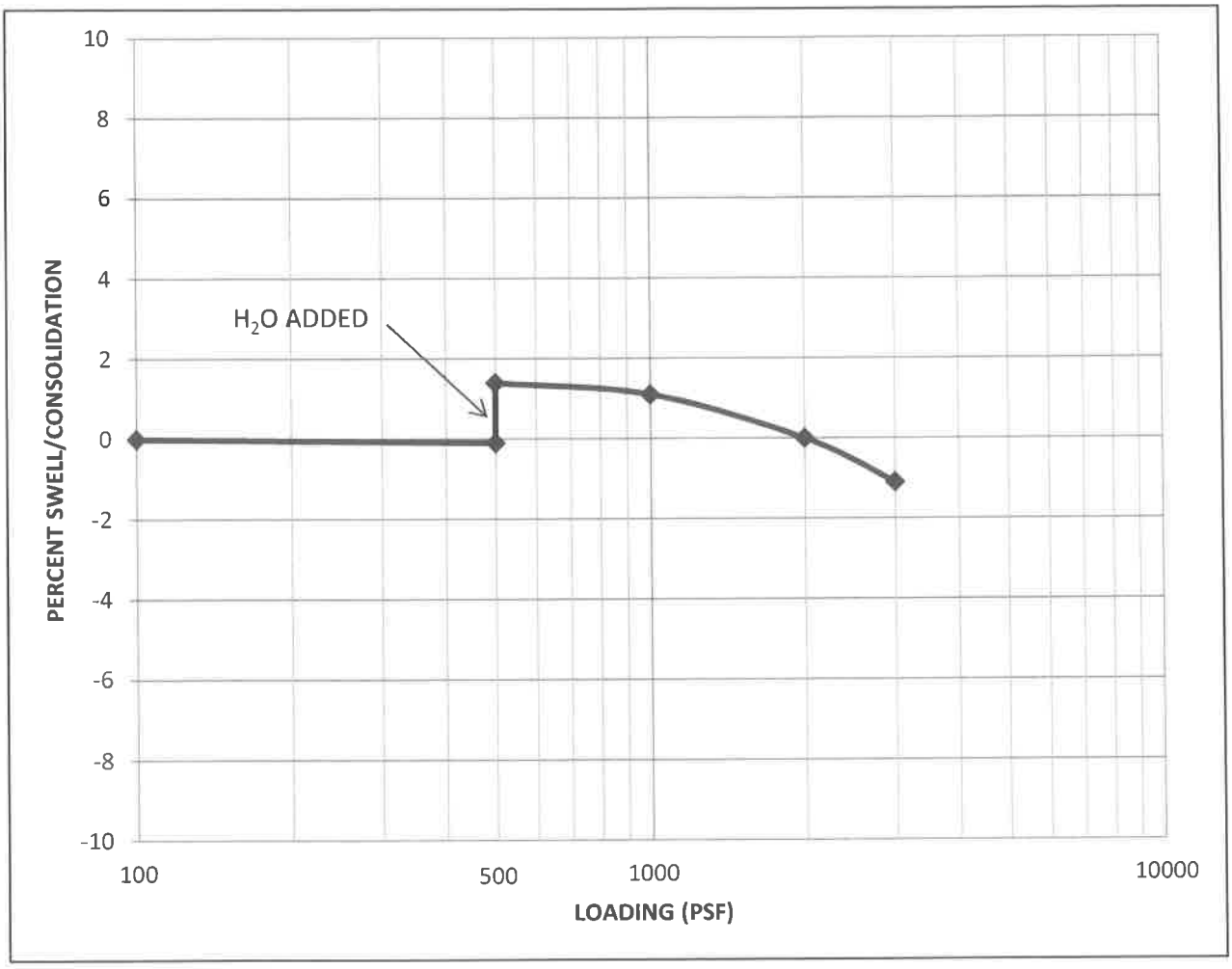



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 4' BC | 37.95 | 21.95 | 16.00 | 2.5 | | 9.5 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9433 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.83 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 1, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238



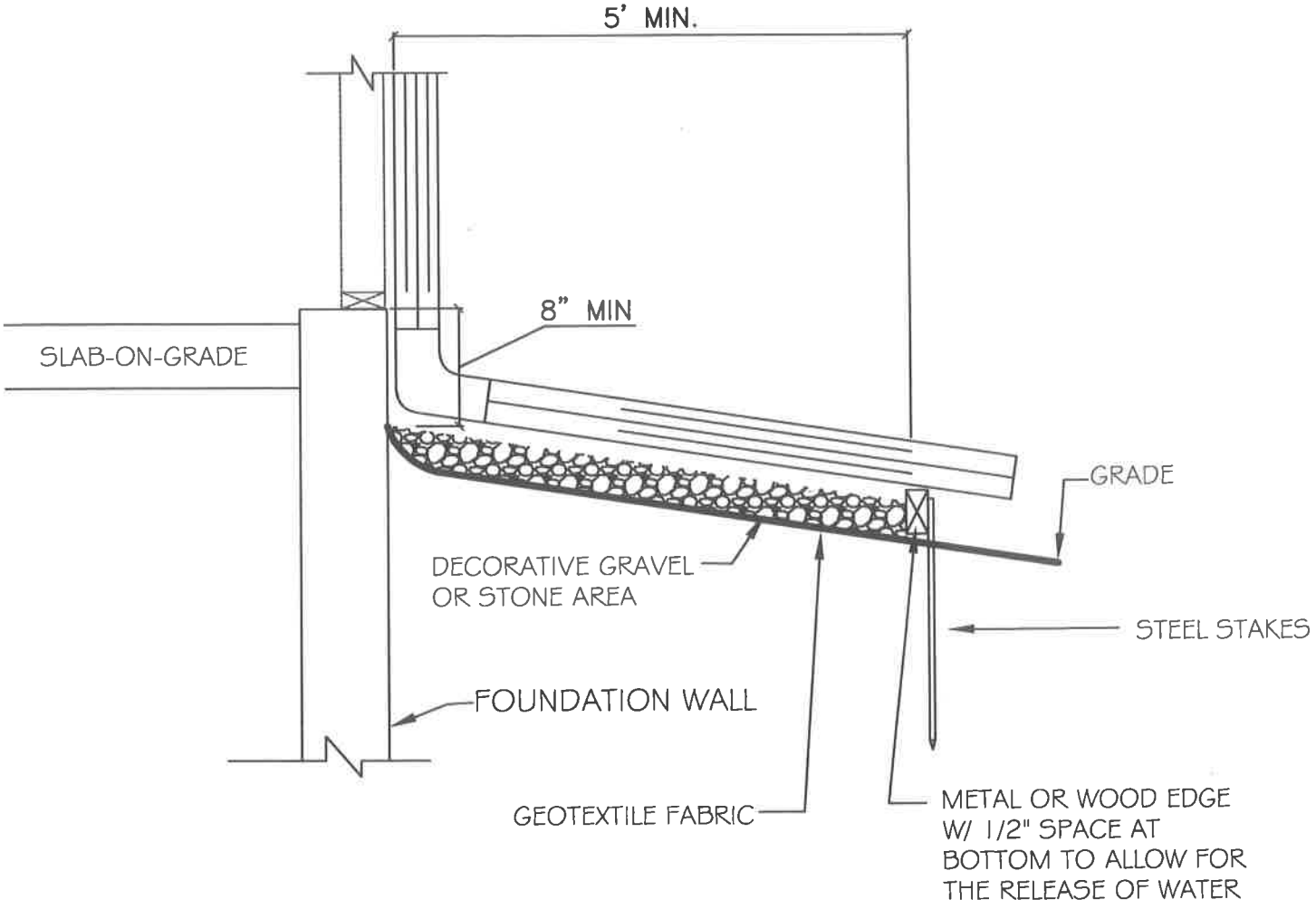

| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 9' BC | 42.63 | 22.62 | 20.01 | 1.5 | | 13.43 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9433 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.83 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 1, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 806420 PHONE (303) 857-9280 FAX (303) 857-923

# FOUNDATION GRADING DETAIL

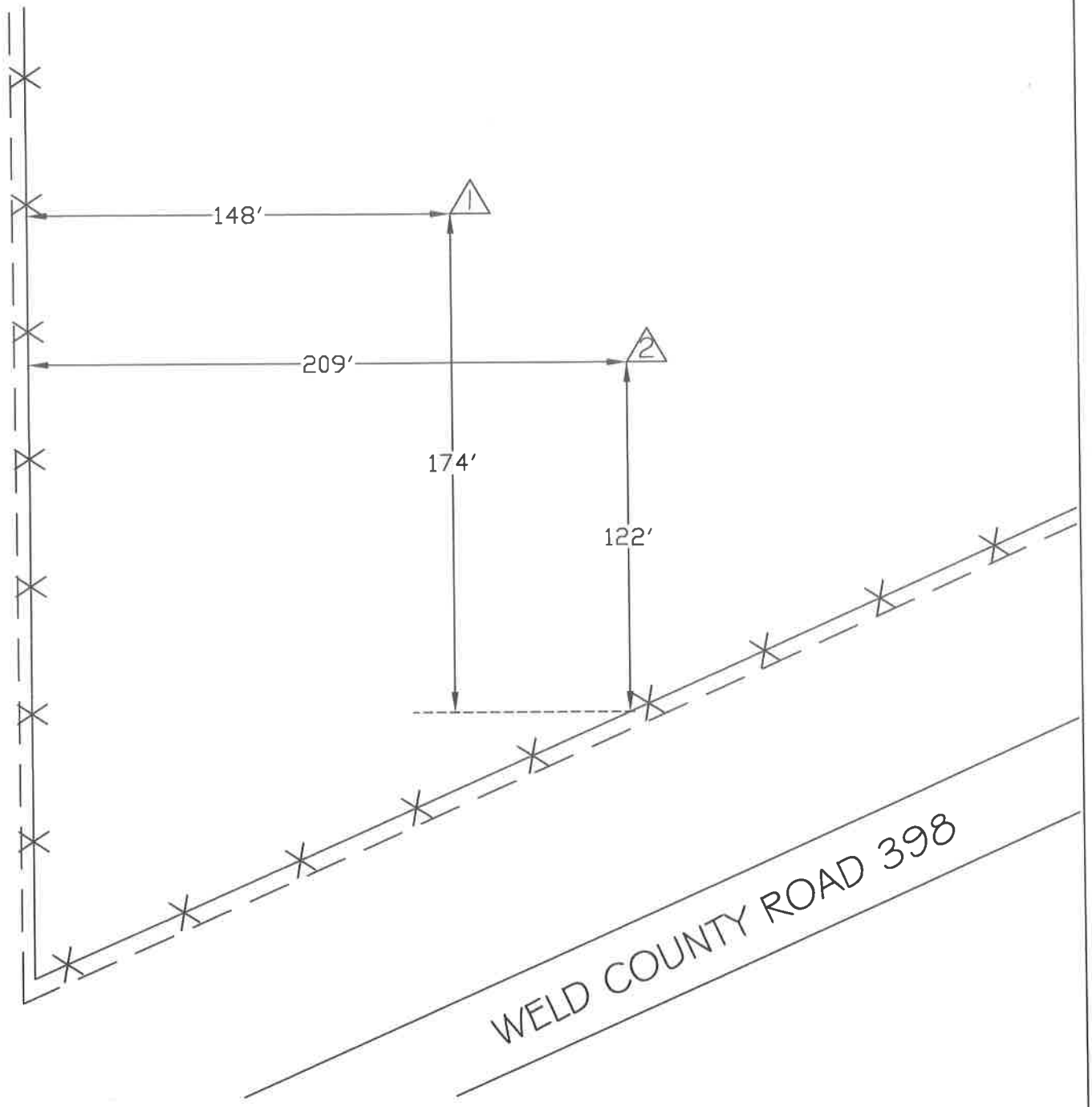



NOTE

1. PROVIDE A MINIMUM SLOPE OF 12" IN THE FIRST 10'-0" FROM FOUNDATION (10%)
2. DOWNSPOUTS AND EXTENSIONS SHOULD EXTEND BEYOND THE GRAVEL OR STONE AREA
3. HARDSCAPING NEXT TO FOUNDATION SHOULD SLOPE AWAY AT 2% SLOPE

# SITE MAP

FUTURE 1.83 ACRE PARCEL CURRENTLY LOCATED WITHIN PARCEL 130319300014
LOT 1 A PART OF THE SW1/4 OF SECTION 19, T2N, R63W OF THE 6TH P.M.
WELD COUNTY, CO




LEGEND

- o - Percolation Test Hole
- X - Percolation Profile Hole
- △ - Soil Profile Hole
- XX - Fence
- ☆ - Bench Mark
- ▯ - Soil Pit

All locations shown above are based on specific information furnished by others or estimates made in the field by High Plains Engineering & Design personnel. The locations, distances, directions, etc. are not the result of a property survey but are approximations and are not warranted to be exact. It is the owner/builder's responsibility to define property - boundaries and ensure all onsite improvements are located within the platted site and out of inappropriate easements. All distances are to be verified prior to excavation.

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

# SUBSURFACE INVESTIGATION AND FOUNDATION RECOMMENDATIONS

***Prepared For:***
Platte River Investments, Inc.
8537 County Road 51
Keenesburg, CO 80643

***Job Site Located At:***
Future 1.66 Acre Parcel Currently Located within
Parcel No. 130319300014
Lot 2
A Part of the SW1/4 of Section 19
T2N, R63W of the 6th P.M.
Weld County, CO

January 22, 2020

**JOB #19-9434**


Todd M. Schroeder P.E. 33548

## AGREEMENT OF PURPOSE AND DISCLAIMER:

The parties specifically agree and contract that the purpose of the provided subsurface investigation is to test, analyze, and provide geotechnical recommendations for the foundation recommendations. This report presents a description of subsurface conditions encountered at the site, design, and construction criteria influenced by the subsurface conditions. The opinions and recommendations presented in this report are based on the data generated during this field exploration, laboratory testing, and our experience. A foundation design sealed by a Professional Engineer is required to obtain a building permit but is not included in this report.

*The parties specifically agree that High Plains Engineering & Design, LLC has not been retained nor will they render an opinion concerning environmental issues, hazardous waste or any other known and or unknown conditions that may be present on the job site, since this is not our area of expertise.*

## LOCATION AND SITE CONDITIONS:

This report represents the results of the data obtained during the subsoil investigation for the proposed steel building located at the Future 1.66 Acre Parcel currently located within Parcel No. 130319300014, Lot 2, A Part of the SW1/4 of Section 19, T2N, R63W of the 6th P.M., Weld County, CO.

The proposed building site is a vacant lot. The site is reasonably level with approximate slopes of 1.5% to the East. The lot appears to be well drained with no erosion evident.

The depths of the excavation are anticipated to range from two (2) to four (4) feet below grades that existed at the time of this investigation. It is anticipated that final grades may be adjusted to accommodate drainage and construction depths. It is recommended that we review the final grading plan to determine if any revisions to the recommendations presented in this report are necessary.

## SUBSOIL CONDITIONS:

Two, four-inch-diameter holes were drilled up to a depth of fifteen feet at the project site on January 7, 2020, as shown on the attached site map. Soil samples were analyzed in the field and laboratory to determine the characteristics of the soil (per Unified Soil Classification System) for identification and foundation design recommendations. In general, the soil profiles in test-holes #1 & #2 indicated Clay with Medium Plasticity (CL) to a final depth of 15 feet.

The Standard Penetration Test per ASTM D1586 showed 25 blows for a 12-inch penetration at a depth of 2 feet, 18 blows for a 12-inch penetration at a depth of 4 feet, and 25 blows for a 12-inch penetration at a depth of 7 feet. Please note that actual subsurface soil conditions may vary between samples and locations tested.

One-dimensional swell/consolidation tests were performed on selected samples to evaluate the expansive, compressive and collapsing nature of the soils and/or bedrock strata. These tests indicated an expansion potential of 1.5% at a depth of 2 feet, an expansion potential of 2.8% at a depth of 4 feet and an expansion potential of 4.3% at a depth of 7 feet. The soils in this report were classified using the American Society of Testing Materials (ASTM) procedures.

The geotechnical practice in the State of Colorado utilizes a relative scale to evaluate swelling (expansion) potentials. When a sample is wetted under a surcharge pressure of 500 pounds per square foot (psf), the measured swell is classified as low, moderate, high, or very high. The following table represents the relative classification criteria. Please note that the measured swell is not the only criteria for slab-on-grade recommendations and additional factors are considered by the engineer when evaluating the risk for slab-on-grade construction.

TABLE 1

| SLAB PERFORMANCE RISK CATEGORY | REPRESENTATIVE PERCENT SWELL (500 PSF SURCHARGE) |
|---|---|
| LOW | 0 TO <3 |
| MODERATE | 3 TO <5 |
| HIGH | 5 TO <8 |
| VERY HIGH | ≥8 |

Source: Colorado Association of Geotechnical Engineers, Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area), 1996

## GROUNDWATER:

Groundwater levels were not recorded at the time of our field investigation; however, it may be possible for groundwater to exist at construction depths at a later date. The groundwater can be expected to fluctuate throughout the year depending on variations in precipitation, surface drainage and irrigation on the site. The possible presence of shallow bedrock/dense clays beneath the surface is favorable for the formation of "perched" groundwater. We recommend that the bottom of the basement or crawlspace excavations be maintained at least 4 feet above the free groundwater level.

The ground water levels recorded represent the free, static water levels after equalization of hydrostatic pressures in the test-hole borings. It is possible that the groundwater levels recorded in the test-hole borings may not be present at those levels in the foundation excavations. Flow rates, seepage paths, hydrostatic pressures, seasonal groundwater fluctuations, water quality and other factors were not determined in this investigation. A program, which may include special well construction, test procedures, long-term monitoring, and analysis, would be necessary to determine these factors.

## FOUNDATION RECOMMENDATIONS:

The Clay with Low Plasticity (CL) material has a bearing strength of 2000 pounds per square foot (psf) and an equivalent liquid pressure of 55 pcf. We recommend the use of a continuous spread footing, due to the low expansion-consolidation potential of the analyzed soils. **The foundation must be constructed at the location in which soils investigation was performed.**

**All rebar must be fully contained within the footing/foundation and shall not have any contact with the native soils due to the known risks of soluble sulfates contained in area soils.**

Unmonitored moisture content in foundation excavations over an extended period of time can create foundation stress and potential damage after backfilling operations are complete. Foundation excavations left open for a period greater than 7 days will require moisture monitoring and/or moisture augmentation. High Plains Engineering & Design, LLC cannot be held responsible for foundation damage as a result of the failure to monitor moisture content after a period of 7 days. If it's anticipated that the foundation excavation will be left open for an extended period of time, the general contractor/owner shall contact High Plains Engineering & Design, LLC for further recommendations.

All loose and disturbed soil shall be removed before placing of the concrete for the foundation. The bottom of the foundation shall be a minimum of 30" below final grade (or that required by local jurisdiction; whichever is greater) for frost protection.

Soil settlement resulting from the assumed structural loads is estimated to be one inch or less. Soil expansion at this site may be up to one inch in some areas. No foundation wall is to exceed twenty-five feet in length without utilizing buttresses or counterforts unless otherwise designed by the foundation engineer.

Engineered steel reinforcements shall be required in the footings and foundation walls. This will give walls or footing beams the strength to span or bridge over any loose or soft pockets of soil that may develop during construction.

**Owners shall be made aware of all contents of this report, and the fact that *water accumulation around foundation elements is the primary cause of distressed foundations.***

To help prevent secondary damage that could be caused by slab movement, the following construction techniques are additional recommendations for the foundation construction.

## SLAB ON GRADE CONSTRUCTION:

**Steel Building/Shop and Exterior Slab-on-grade Concrete:** The soil encountered at or below anticipated slab elevations has a low/moderate swell potential. If removal and replacement of soil below slabs is required, use a non-expansive granular soil with Plasticity Index less than 15 and Liquid Limit less than 30 and compacted to a minimum of 95% ASTM D698 (Standard Proctor Density), within 2% of the optimum moisture content.

The slabs should be constructed as "floating" slabs, which are free to move in the vertical direction. The slabs should not be attached to interior or exterior bearing members. The following design and construction details for slab-on-grade construction are recommended.

1. Floor slabs placed above potentially expansive soils will be expected to heave and crack to some degree. It is impossible to predict with certainty how much slab movement will actually occur. **When the owners cannot tolerate slab movement, we recommend to install a structural slab in place of the conventional slab on grade for floor construction.**

2. Where steel building/shop slabs and exterior slabs-on-grade are chosen, and the owners understand and accepts all the risks associated with slab movement, the following recommendations should be followed with the amount of over-excavation and replacement with imported fill determined by the owner/builder.

   a. Positive separations and/or isolation joints should be provided between slabs and all foundation walls, bearing members (columns), plumbing and utility lines. Isolation may be achieved with ½ inch expansion material or by sleeving. Vertical movement of the slabs should not be restricted. A minimum void of 3 inches should be provided with all non-bearing partition walls to allow movement without damaging the structure. Provide a minimum ½ inch space at the bottom of all doorjambs. It is the owner's responsibility to maintain these void spaces. Mechanical equipment set on the slab will require an expandable/collapsible connection to ductwork, etc.

   b. Eliminate plumbing under slabs where feasible. Where such plumbing is unavoidable, it should be thoroughly pressure tested during construction.

   c. A vapor retarder is required per IRC R506.2.3 except use 15-mil minimum thickness, located per ACI guidelines and installed per ASTM specifications. Floor slabs and footings should not be constructed on frozen subgrade. Slabs should be reinforced with rebar or wire mesh to help control crack separation.

3. Provide frequent scoring of the slabs in square dimensions (non- rectangular) to provide joints for controlled cracking of the slab. Control joints should be placed at distances equal to 24 to 30 times the slab thickness and the depth of sawed control joints should be ¼ of the slab thickness. Joints should be sawed as soon as the concrete will withstand the energy of sawing without raveling the edges of the joint. For most concrete mixtures, sawing should be completed within 6 to 18 hours after pouring, but never more than 24 hours. Install a good quality sealant (pliable/non-hardening) in these joints to prevent surface discharges of liquid from penetrating slab sub-grades.

4. The soils that will support the concrete slabs should be kept moist during construction by occasional sprinkling of water. The soils should be moistened to +/- 2 % optimum moisture within 24 hours of pouring the slabs. This procedure will help maintain the moisture content of the underlying soil. **Heavy watering or pooling of any kind next to the foundation or within the backfilled area is not recommended.**

## BACKFILL:

**The foundation and retaining walls must be well cured and well braced prior to backfilling.**

Any soil disturbed adjacent to bearing foundation components are to be **re-compacted to a minimum of 95% Standard Proctor Density (ASTM D698)**. Backfill that bears concrete slabs shall be compacted to 95% Standard Proctor Density (ASTM D698). Mechanical compaction methods shall be utilized, (water-flooding techniques are strictly prohibited). See Compaction Section for more information regarding compaction requirements and techniques.

Proper drainage away from the foundation walls shall be provided. The owners are advised to immediately fill any settled areas to eliminate water accumulation near the foundation. A minimum slope of 12 inches in the first 10 feet from the perimeter of the building is recommended. Roof downspouts and sill cocks should discharge into long concrete splash blocks (5 feet long min.) or into gutter extensions to deposit runoff water beyond the limits of the backfill soil near the foundation walls. Plastic membranes should not be used to cover the ground surface immediately surrounding the structure; geotextile fabric should be utilized for weed control. Any drainage water from uphill shall be diverted around the structure.

Sprinkling systems should not be installed or direct water to be within 10 feet of the foundation. The owner/builder is also advised that irrigation lines can leak and/or break, resulting in release of excessive amounts of water near the foundation. This can cause damage to slabs and foundation walls. **WATER ACCUMULATION AROUND FOUNDATION ELEMENTS IS THE MAIN CAUSE OF DISTRESSED FOUNDATIONS.**

## COMPACTION:

*Placing Fill*: No brush, sod, frozen material, perishable material, unsuitable material, or stones of four inches or greater in maximum dimension shall be placed in the fill. The distribution of the material on the fill shall be such as to avoid the formation of layers of materials differing substantially in characteristics from the surrounding materials.

The materials are to be delivered to the backfill surface at a uniform rate, and in such quantity as to permit a satisfactory construction procedure. Unnecessary concentration of backfill machinery travel tending to cause ruts and other hollows more than six inches in depth, are to be re-graded and compacted. After dumping of fill material on the backfill surface, the material is to be spread by approved methods in approximately 6 inches compacted thickness.

*Moisture Control*: The material in each layer shall be compacted by rolling and shall contain the optimum moisture required for maximum compaction, as nearly practicable and as determined by the soils engineer. The moisture content shall be uniform throughout all layers. If in the opinion of the soils engineer it is not possible to obtain moisture content by adding water on the fill surface, the contractor may be required to add the necessary moisture to backfill material in the borrow area.

*Compaction*: When the moisture condition and content of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer to **95% ASTM D698 (Standard Proctor Density) for slab areas, and 98% ASTM D698 for footing and/or pad areas.** A Standard Proctor test is to be performed for each typical fill material and frequent tests of the density of the fill must be taken.

In general, to compact cohesion-less free-draining materials, *the above guidelines also apply.*

When compacting cohesion-less free-draining materials such as gravel and sand, the materials shall be deposited in layers and compacted by treads of a crawler type tractor, surface of internal vibrators, pneumatic or smooth rollers, power or hand tampers, or by any other means approved by the soils engineer. The thickness of the horizontal layers after compaction is not to exceed 6 inches compacted thickness if compaction is performed by tractor treads, surface vibrators or similar equipment, or not more than penetrating length of the vibrator head if compaction is performed by internal vibrators. When the moisture content and condition of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer **to 91% ASTM D1557 (Modified Proctor Density) for slab areas, and 94% ASTM D1557 for footing and/or pad areas.**

## CONSTRUCTION DETAILS – GENERAL COMMENTS:

In any soil investigation, it is necessary to assume that the subsurface soil conditions do not vary greatly from the conditions encountered in the field and laboratory testing. The accompanying design is presented using best professional judgment based on the limits of the extent of testing commissioned by the client. Our experience has been that at times, soil conditions do change and variations do occur. These may become first apparent at the time of excavation for the foundation system.

**If soils conditions are encountered which appear different from the test borings as presented in this report, it is required that this office be called to make an observation of the open excavation prior to placing the footings. The cost of this observation is not part of this report.**

This project should be constructed by a qualified contractor with experience in similar projects. The owner/builder is advised to observe and document the construction process to ensure the construction is performed in accordance with the design drawings and technical specifications. **The foundation and retaining walls must be well cured and well braced prior to backfilling**.

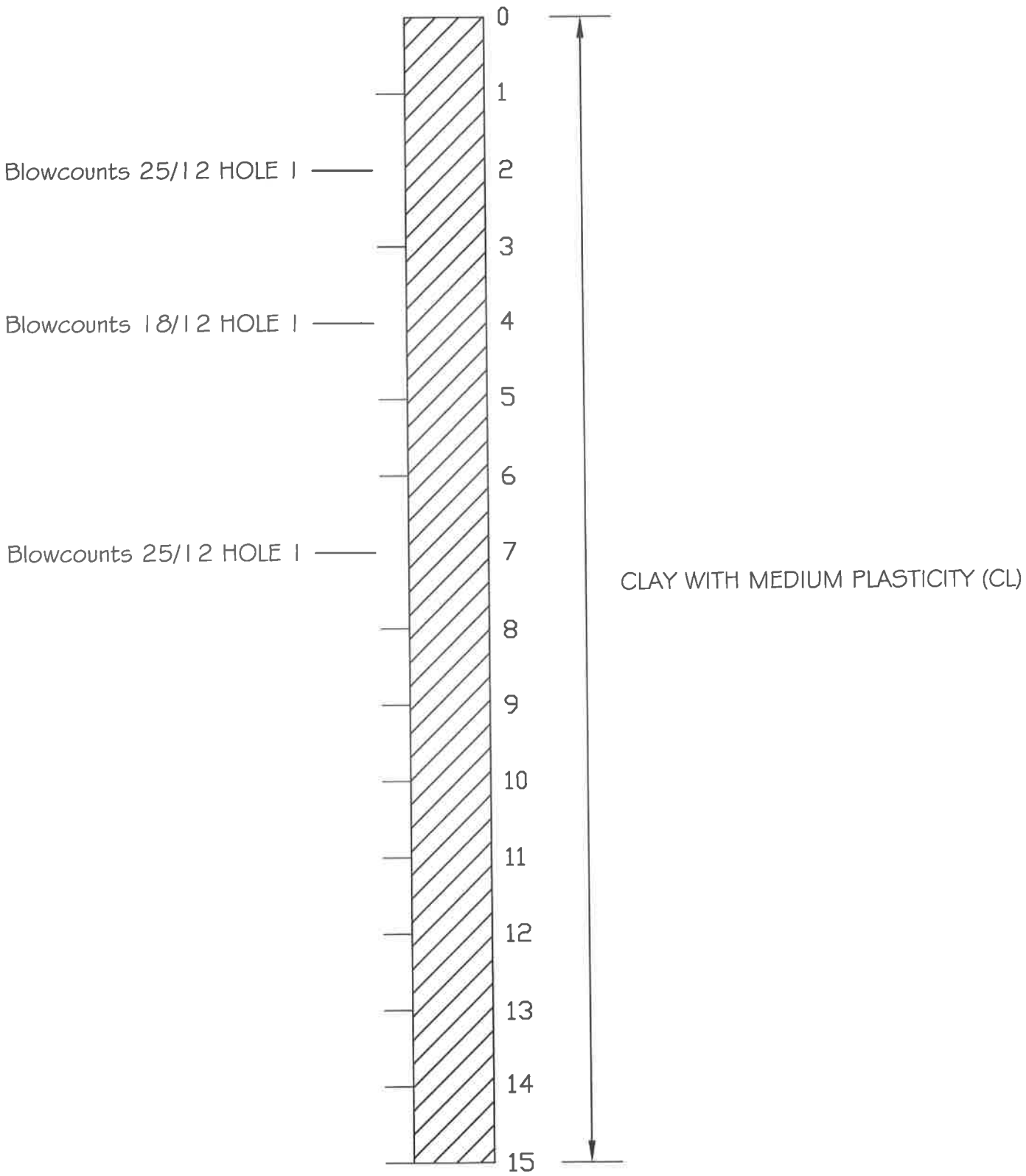
This report does not address general hillside stability, landslide potential, and/or other natural hazards. Several areas in the Colorado Front Range have known geologic hazards associated with them. We recommend that readers of this report educate themselves further as to the existence of geologic hazards on or around their specific property of interest. The Colorado Geologic Survey {www.geosurvey.state.co.us or 303-866-2611} is a good source for publications {maps, reports, etc.} dealing with specific geologic issues and/or issues related to specific geographic areas.

## DISCLAIMER:

We do not guarantee the performance of the project in any respect, but only that our engineering work and judgments rendered meet the standard care of our profession. The presence of underground workings (e.g. coal mines) and subsidence potential from any workings was not part of this investigation. The owner should contact the State and County agencies to determine if mining has been conducted in the area and if any precautions are recommended.

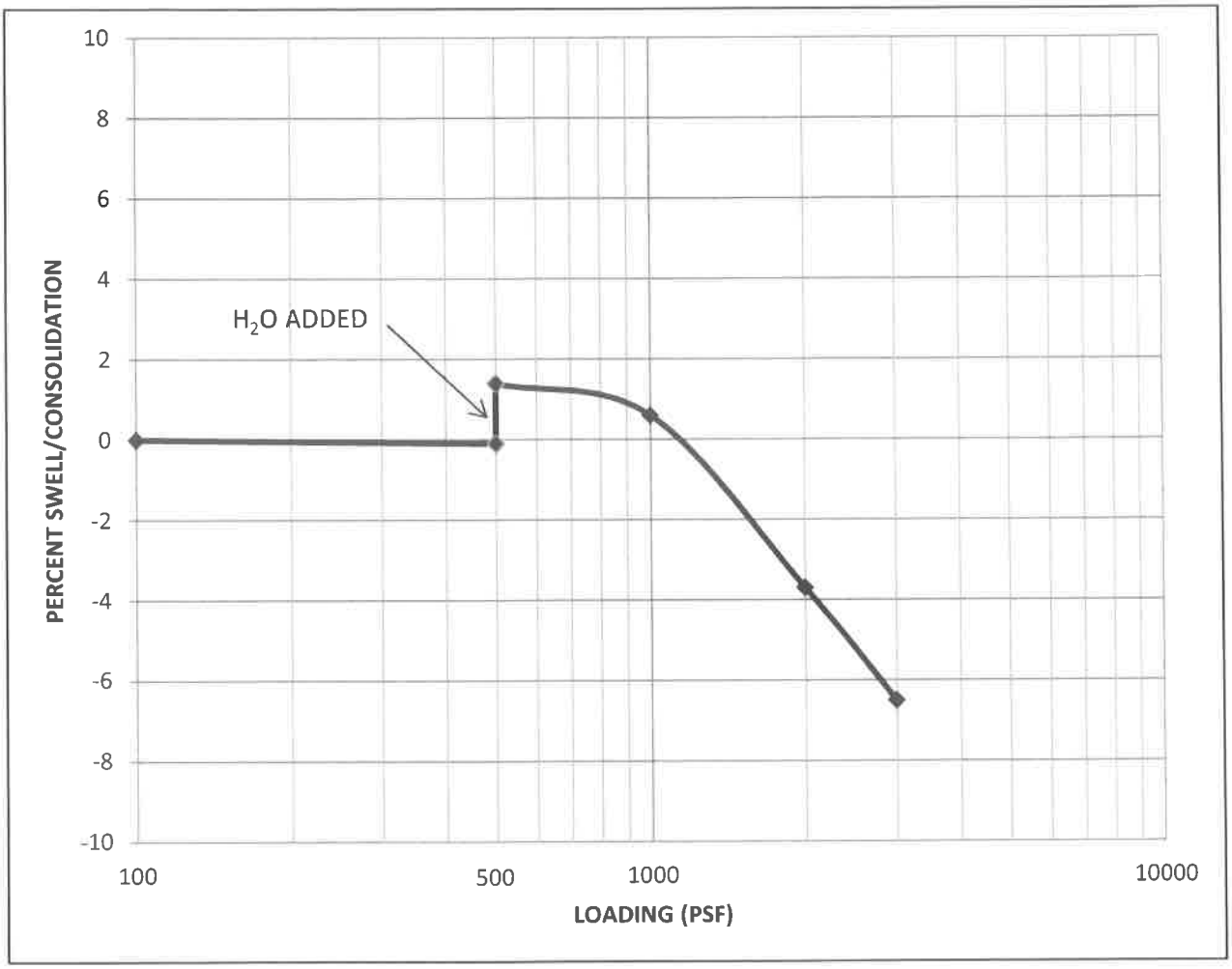
THE PARTIES SPECIFICALLY AGREE THAT *HIGH PLAINS ENGINEERING & DESIGN, LLC.* HAS NOT BEEN RETAINED NOR WILL THEY RENDER AN OPINION CONCERNING ANY ENVIRONMENTAL ISSUES, HAZARDOUS WASTE OR ANY OTHER KNOWN OR UNKNOWN CONDITIONS THAT MAY BE PRESENT ON SITE.

**DUE TO CHANGING TECHNOLOGY, BUILDING CODES AND CITY/COUNTY REQUIREMENTS, THIS SOIL REPORT MUST BE USED WITHIN ONE YEAR OF THE DATE ON THE FRONT OF THE REPORT OR MUST BE REVISED.**




TEST HOLE(S) 1 & 2

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

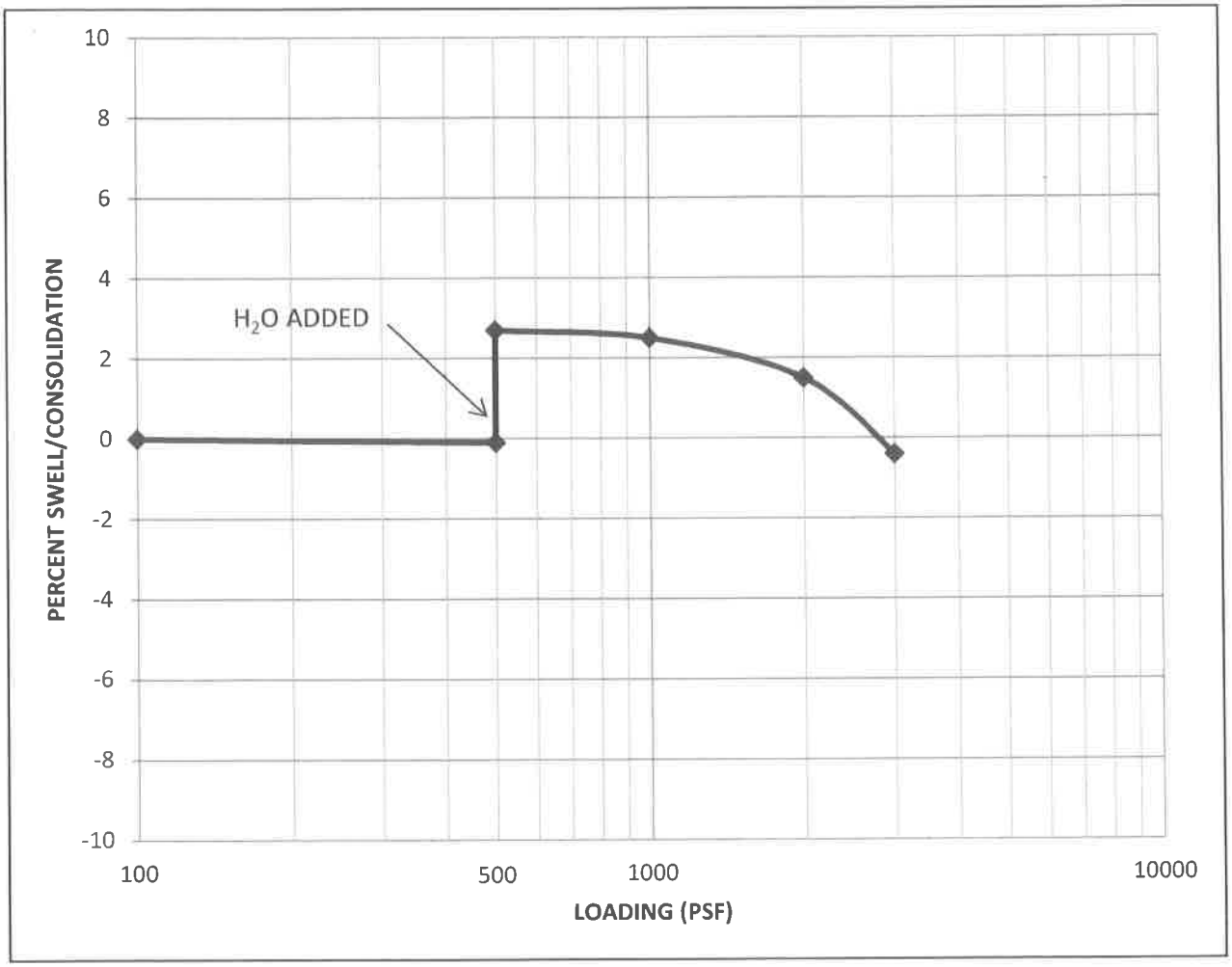



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 2' BC | 35.99 | 20.58 | 15.41 | 1.5 | | 8.81 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9434 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.66 ACRE PARCEL LOCATED WITHIN PARCEL 13031900014 |
| **DRAWN:** | KELSEY | LOT 2, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

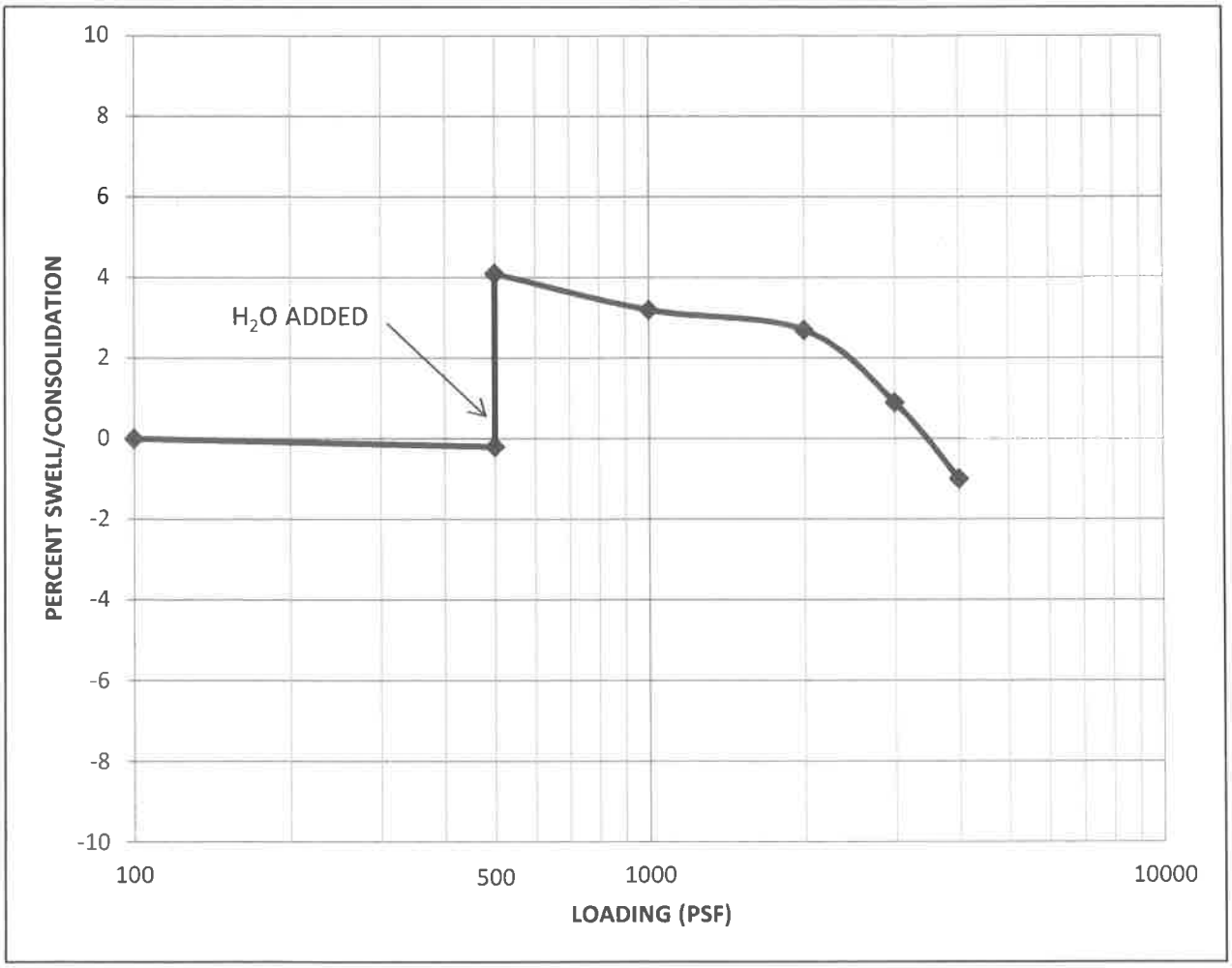



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 4' BC | 39.86 | 22.12 | 17.74 | 2.8 | | 8.76 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9434 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.66 ACRE PARCEL LOCATED WITHIN PARCEL 13031900014 |
| **DRAWN:** | KELSEY | LOT 2, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238



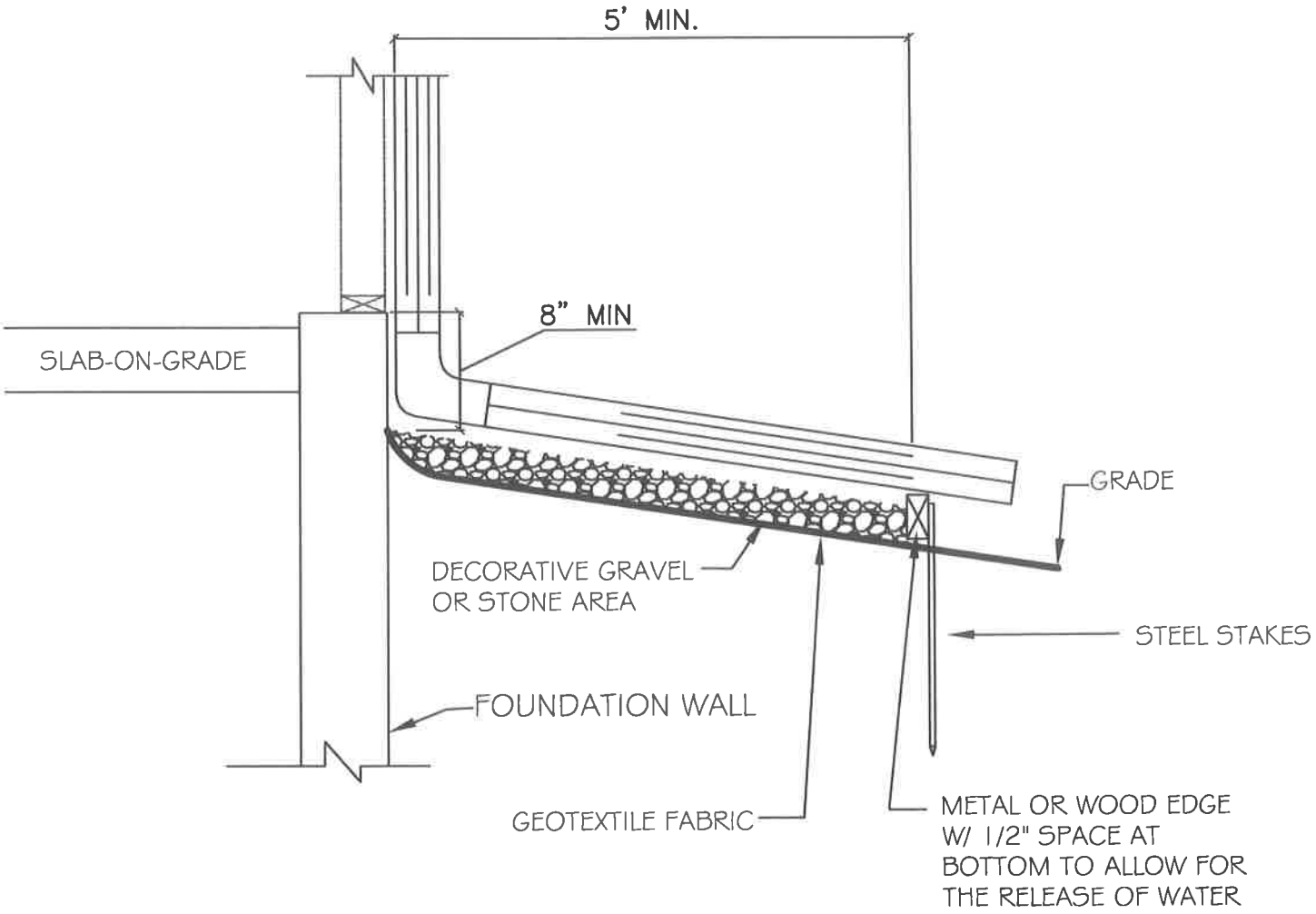

| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 7' BC | 43.00 | 23.51 | 19.49 | 4.3 | | 13.73 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9434 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.66 ACRE PARCEL LOCATED WITHIN PARCEL 13031900014 |
| **DRAWN:** | KELSEY | LOT 2, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 806420 PHONE (303) 857-9280 FAX (303) 857-923

# FOUNDATION GRADING DETAIL

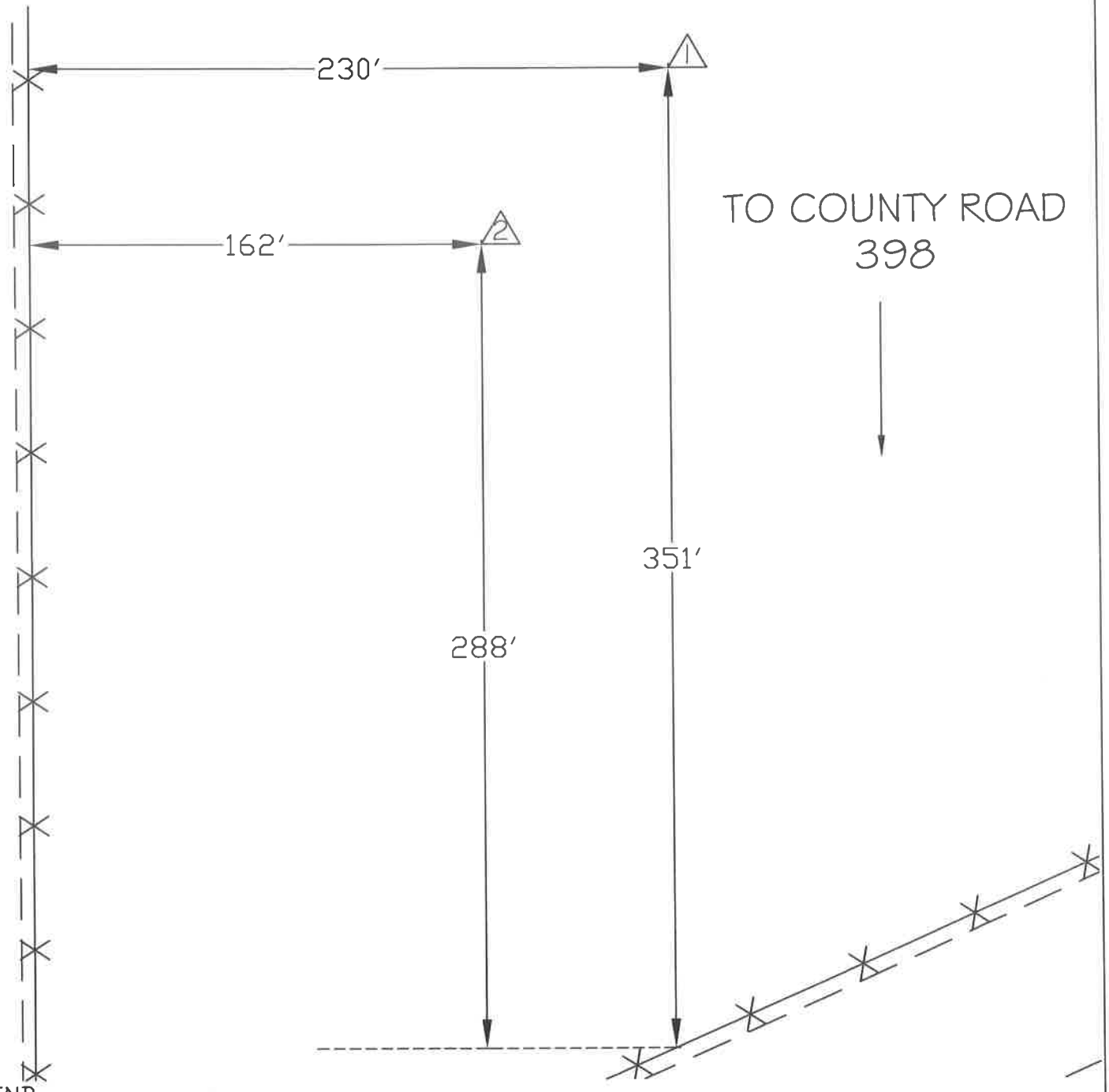



NOTE

1. PROVIDE A MINIMUM SLOPE OF 12" IN THE FIRST 10'-0" FROM FOUNDATION (10%)
2. DOWNSPOUTS AND EXTENSIONS SHOULD EXTEND BEYOND THE GRAVEL OR STONE AREA
3. HARDSCAPING NEXT TO FOUNDATION SHOULD SLOPE AWAY AT 2% SLOPE

# SITE MAP

FUTURE 1.66 ACRE PARCEL CURRENTLY LOCATED WITHIN PARCEL 130319300014
LOT 2, A PART OF THE SW1/4 OF SECTION 19, T2N, R63W OF THE 6TH P.M.
WELD COUNTY, CO




LEGEND

- o – Percolation Test Hole
- X – Percolation Profile Hole
- △ – Soil Profile Hole
- ✳✳ – Fence
- ☆ – Bench Mark
- ▯ – Soil Pit

All locations shown above are based on specific information furnished by others or estimates made in the field by High Plains Engineering & Design personnel. The locations, distances, directions, etc. are not the result of a property survey but are approximations and are not warranted to be exact. It is the owner/builder's responsibility to define property - boundaries and ensure all onsite improvements are located within the platted site and out of inappropriate easements. All distances are to be verified prior to excavation.

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

# SUBSURFACE INVESTIGATION AND FOUNDATION RECOMMENDATIONS

***Prepared For:***
Platte River Investments, Inc.
8537 County Road 51
Keenesburg, CO 80643

***Job Site Located At:***
Future 1.65 Acre Parcel Currently Located within
Parcel No. 130319300014
Lot 3
A Part of the SW1/4 of Section 19
T2N, R63W of the 6th P.M.
Weld County, CO

January 22, 2020

**JOB #19-9435**


Todd M. Schroeder P.E. 33548

## AGREEMENT OF PURPOSE AND DISCLAIMER:

The parties specifically agree and contract that the purpose of the provided subsurface investigation is to test, analyze, and provide geotechnical recommendations for the foundation recommendations. This report presents a description of subsurface conditions encountered at the site, design, and construction criteria influenced by the subsurface conditions. The opinions and recommendations presented in this report are based on the data generated during this field exploration, laboratory testing, and our experience. A foundation design sealed by a Professional Engineer is required to obtain a building permit but is not included in this report.

*The parties specifically agree that High Plains Engineering & Design, LLC has not been retained nor will they render an opinion concerning environmental issues, hazardous waste or any other known and or unknown conditions that may be present on the job site, since this is not our area of expertise.*

## LOCATION AND SITE CONDITIONS:

This report represents the results of the data obtained during the subsoil investigation for the proposed steel building located at the Future 1.65 Acre Parcel currently located within Parcel No. 130319300014, Lot 3, A Part of the SW1/4 of Section 19, T2N, R63W of the 6th P.M., Weld County, CO.

The proposed building site is a vacant lot. The site is reasonably level with approximate slopes of 1.5% to the East-Southeast. The lot appears to be well drained with no erosion evident.

The depths of the excavation are anticipated to range from two (2) to four (4) feet below grades that existed at the time of this investigation. It is anticipated that final grades may be adjusted to accommodate drainage and construction depths. It is recommended that we review the final grading plan to determine if any revisions to the recommendations presented in this report are necessary.

## SUBSOIL CONDITIONS:

Two, four-inch-diameter holes were drilled up to a depth of fifteen feet at the project site on January 7, 2020, as shown on the attached site map. Soil samples were analyzed in the field and laboratory to determine the characteristics of the soil (per Unified Soil Classification System) for identification and foundation design recommendations. In general, the soil profiles in test-holes #1 & #2 indicated Clay with Low Plasticity (CL) to a depth of 4 feet, underlain by Clay with Medium Plasticity (CL) to a final depth of 15 feet.

The Standard Penetration Test per ASTM D1586 showed 15 blows for a 12-inch penetration at a depth of 2 feet, 17 blows for a 12-inch penetration at a depth of 4 feet, and 21 blows for a 12-inch penetration at a depth of 7 feet. Please note that actual subsurface soil conditions may vary between samples and locations tested.

One-dimensional swell/consolidation tests were performed on selected samples to evaluate the expansive, compressive and collapsing nature of the soils and/or bedrock strata. These tests indicated an expansion potential of 1.9 % at a depth of 2 feet, an expansion potential of 3.1% at a depth of 4 feet and an expansion potential of 3.9% at a depth of 7 feet. The soils in this report were classified using the American Society of Testing Materials (ASTM) procedures.

The geotechnical practice in the State of Colorado utilizes a relative scale to evaluate swelling (expansion) potentials. When a sample is wetted under a surcharge pressure of 500 pounds per square foot (psf), the measured swell is classified as low, moderate, high, or very high. The following table represents the relative classification criteria. Please note that the measured swell is not the only criteria for slab-on-grade recommendations and additional factors are considered by the engineer when evaluating the risk for slab-on-grade construction.

| TABLE 1 | |
|---|---|
| SLAB PERFORMANCE RISK CATEGORY | REPRESENTATIVE PERCENT SWELL (500 PSF SURCHARGE) |
| LOW | 0 TO <3 |
| MODERATE | 3 TO <5 |
| HIGH | 5 TO <8 |
| VERY HIGH | ≥8 |

Source: Colorado Association of Geotechnical Engineers, Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area), 1996

## GROUNDWATER:

Groundwater levels were not recorded at the time of our field investigation; however, it may be possible for groundwater to exist at construction depths at a later date. The groundwater can be expected to fluctuate throughout the year depending on variations in precipitation, surface drainage and irrigation on the site. The possible presence of shallow bedrock/dense clays beneath the surface is favorable for the formation of "perched" groundwater. We recommend that the bottom of the basement or crawlspace excavations be maintained at least 4 feet above the free groundwater level.

The ground water levels recorded represent the free, static water levels after equalization of hydrostatic pressures in the test-hole borings. It is possible that the groundwater levels recorded in the test-hole borings may not be present at those levels in the foundation excavations. Flow rates, seepage paths, hydrostatic pressures, seasonal groundwater fluctuations, water quality and other factors were not determined in this investigation. A program, which may include special well construction, test procedures, long-term monitoring, and analysis, would be necessary to determine these factors.

## FOUNDATION RECOMMENDATIONS:

The Clay with Low Plasticity (CL) and Clay with Medium Plasticity (CL) material has a bearing strength of 2000 pounds per square foot (psf) and an equivalent liquid pressure of 55 pcf. We recommend the use of a continuous spread footing, due to the low/moderate expansion-consolidation potential of the analyzed soils. **The foundation must be constructed at the location in which soils investigation was performed.**

**All rebar must be fully contained within the footing/foundation and shall not have any contact with the native soils due to the known risks of soluble sulfates contained in area soils.**

Unmonitored moisture content in foundation excavations over an extended period of time can create foundation stress and potential damage after backfilling operations are complete. Foundation excavations left open for a period greater than 7 days will require moisture monitoring and/or moisture augmentation. High Plains Engineering & Design, LLC cannot be held responsible for foundation damage as a result of the failure to monitor moisture content after a period of 7 days. If it's anticipated that the foundation excavation will be left open for an extended period of time, the general contractor/owner shall contact High Plains Engineering & Design, LLC for further recommendations.

All loose and disturbed soil shall be removed before placing of the concrete for the foundation. The bottom of the foundation shall be a minimum of 30" below final grade (or that required by local jurisdiction; whichever is greater) for frost protection.

Soil settlement resulting from the assumed structural loads is estimated to be one inch or less. Soil expansion at this site may be up to one inch in some areas. No foundation wall is to exceed twenty-five feet in length without utilizing buttresses or counterforts unless otherwise designed by the foundation engineer.

Engineered steel reinforcements shall be required in the footings and foundation walls. This will give walls or footing beams the strength to span or bridge over any loose or soft pockets of soil that may develop during construction.

**Owners shall be made aware of all contents of this report, and the fact that *water accumulation around foundation elements is the primary cause of distressed foundations.***

To help prevent secondary damage that could be caused by slab movement, the following construction techniques are additional recommendations for the foundation construction.

## SLAB ON GRADE CONSTRUCTION:

**Steel Building/Shop and Exterior Slab-on-grade Concrete:** The soil encountered at or below anticipated slab elevations has a low/moderate swell potential. If removal and replacement of soil below slabs is required, use a non-expansive granular soil with Plasticity Index less than 15 and Liquid Limit less than 30 and compacted to a minimum of 95% ASTM D698 (Standard Proctor Density), within 2% of the optimum moisture content.

The slabs should be constructed as "floating" slabs, which are free to move in the vertical direction. The slabs should not be attached to interior or exterior bearing members. The following design and construction details for slab-on-grade construction are recommended.

1. Floor slabs placed above potentially expansive soils will be expected to heave and crack to some degree. It is impossible to predict with certainty how much slab movement will actually occur. **When the owners cannot tolerate slab movement, we recommend to install a structural slab in place of the conventional slab on grade for floor construction.**

2. Where steel building/shop slabs and exterior slabs-on-grade are chosen, and the owners understand and accepts all the risks associated with slab movement, the following recommendations should be followed with the amount of over-excavation and replacement with imported fill determined by the owner/builder.

   a. Positive separations and/or isolation joints should be provided between slabs and all foundation walls, bearing members (columns), plumbing and utility lines. Isolation may be achieved with ½ inch expansion material or by sleeving. Vertical movement of the slabs should not be restricted. A minimum void of 3 inches should be provided with all non-bearing partition walls to allow movement without damaging the structure. Provide a minimum ½ inch space at the bottom of all doorjambs. It is the owner's responsibility to maintain these void spaces. Mechanical equipment set on the slab will require an expandable/collapsible connection to ductwork, etc.

   b. Eliminate plumbing under slabs where feasible. Where such plumbing is unavoidable, it should be thoroughly pressure tested during construction.

   c. A vapor retarder is required per IRC R506.2.3 except use 15-mil minimum thickness, located per ACI guidelines and installed per ASTM specifications. Floor slabs and footings should not be constructed on frozen subgrade. Slabs should be reinforced with rebar or wire mesh to help control crack separation.

3. Provide frequent scoring of the slabs in square dimensions (non- rectangular) to provide joints for controlled cracking of the slab. Control joints should be placed at distances equal to 24 to 30 times the slab thickness and the depth of sawed control joints should be ¼ of the slab thickness. Joints should be sawed as soon as the concrete will withstand the energy of sawing without raveling the edges of the joint. For most concrete mixtures, sawing should be completed within 6 to 18 hours after pouring, but never more than 24 hours. Install a good quality sealant (pliable/non-hardening) in these joints to prevent surface discharges of liquid from penetrating slab sub-grades.

4. The soils that will support the concrete slabs should be kept moist during construction by occasional sprinkling of water. The soils should be moistened to +/- 2 % optimum moisture within 24 hours of pouring the slabs. This procedure will help maintain the moisture content of the underlying soil. **Heavy watering or pooling of any kind next to the foundation or within the backfilled area is not recommended.**

## BACKFILL:

**The foundation and retaining walls must be well cured and well braced prior to backfilling.**

Any soil disturbed adjacent to bearing foundation components are to be **re-compacted to a minimum of 95% Standard Proctor Density (ASTM D698)**. Backfill that bears concrete slabs shall be compacted to 95% Standard Proctor Density (ASTM D698). Mechanical compaction methods shall be utilized, (water-flooding techniques are strictly prohibited). See Compaction Section for more information regarding compaction requirements and techniques.

Proper drainage away from the foundation walls shall be provided. The owners are advised to immediately fill any settled areas to eliminate water accumulation near the foundation. A minimum slope of 12 inches in the first 10 feet from the perimeter of the building is recommended. Roof downspouts and sill cocks should discharge into long concrete splash blocks (5 feet long min.) or into gutter extensions to deposit runoff water beyond the limits of the backfill soil near the foundation walls. Plastic membranes should not be used to cover the ground surface immediately surrounding the structure; geotextile fabric should be utilized for weed control. Any drainage water from uphill shall be diverted around the structure.

Sprinkling systems should not be installed or direct water to be within 10 feet of the foundation. The owner/builder is also advised that irrigation lines can leak and/or break, resulting in release of excessive amounts of water near the foundation. This can cause damage to slabs and foundation walls. **WATER ACCUMULATION AROUND FOUNDATION ELEMENTS IS THE MAIN CAUSE OF DISTRESSED FOUNDATIONS.**

## COMPACTION:

*Placing Fill*: No brush, sod, frozen material, perishable material, unsuitable material, or stones of four inches or greater in maximum dimension shall be placed in the fill. The distribution of the material on the fill shall be such as to avoid the formation of layers of materials differing substantially in characteristics from the surrounding materials.

The materials are to be delivered to the backfill surface at a uniform rate, and in such quantity as to permit a satisfactory construction procedure. Unnecessary concentration of backfill machinery travel tending to cause ruts and other hollows more than six inches in depth, are to be re-graded and compacted. After dumping of fill material on the backfill surface, the material is to be spread by approved methods in approximately 6 inches compacted thickness.

*Moisture Control*: The material in each layer shall be compacted by rolling and shall contain the optimum moisture required for maximum compaction, as nearly practicable and as determined by the soils engineer. The moisture content shall be uniform throughout all layers. If in the opinion of the soils engineer it is not possible to obtain moisture content by adding water on the fill surface, the contractor may be required to add the necessary moisture to backfill material in the borrow area.

*Compaction*: When the moisture condition and content of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer to **95% ASTM D698 (Standard Proctor Density) for slab areas, and 98% ASTM D698 for footing and/or pad areas.** A Standard Proctor test is to be performed for each typical fill material and frequent tests of the density of the fill must be taken.

In general, to compact cohesion-less free-draining materials, *the above guidelines also apply.*

When compacting cohesion-less free-draining materials such as gravel and sand, the materials shall be deposited in layers and compacted by treads of a crawler type tractor, surface of internal vibrators, pneumatic or smooth rollers, power or hand tampers, or by any other means approved by the soils engineer. The thickness of the horizontal layers after compaction is not to exceed 6 inches compacted thickness if compaction is performed by tractor treads, surface vibrators or similar equipment, or not more than penetrating length of the vibrator head if compaction is performed by internal vibrators. When the moisture content and condition of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer **to 91% ASTM D1557 (Modified Proctor Density) for slab areas, and 94% ASTM D1557 for footing and/or pad areas.**

## CONSTRUCTION DETAILS – GENERAL COMMENTS:

In any soil investigation, it is necessary to assume that the subsurface soil conditions do not vary greatly from the conditions encountered in the field and laboratory testing. The accompanying design is presented using best professional judgment based on the limits of the extent of testing commissioned by the client. Our experience has been that at times, soil conditions do change and variations do occur. These may become first apparent at the time of excavation for the foundation system.

**If soils conditions are encountered which appear different from the test borings as presented in this report, it is required that this office be called to make an observation of the open excavation prior to placing the footings. The cost of this observation is not part of this report.**

This project should be constructed by a qualified contractor with experience in similar projects. The owner/builder is advised to observe and document the construction process to ensure the construction is performed in accordance with the design drawings and technical specifications. **The foundation and retaining walls must be well cured and well braced prior to backfilling**.

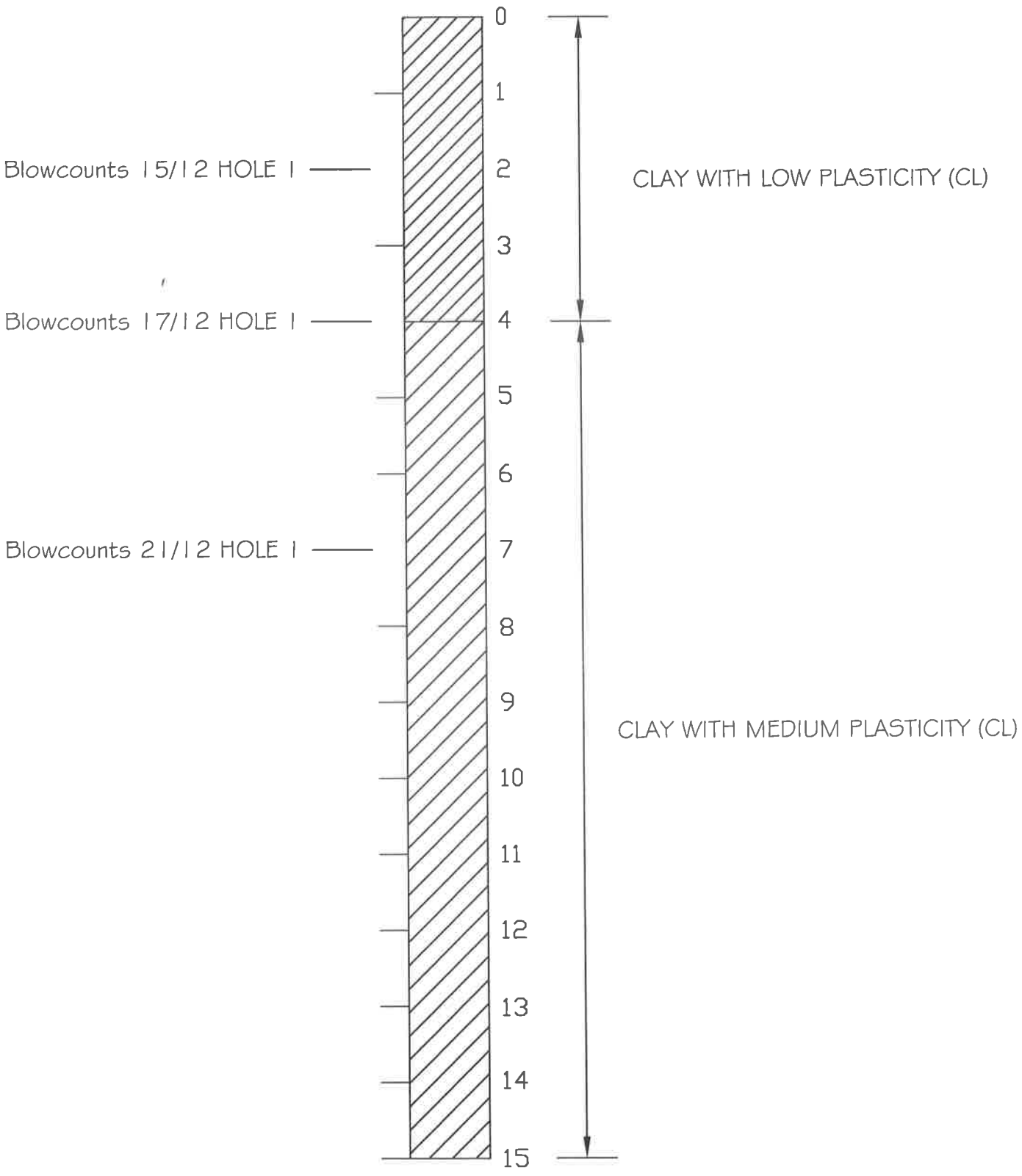
This report does not address general hillside stability, landslide potential, and/or other natural hazards. Several areas in the Colorado Front Range have known geologic hazards associated with them. We recommend that readers of this report educate themselves further as to the existence of geologic hazards on or around their specific property of interest. The Colorado Geologic Survey {www.geosurvey.state.co.us or 303-866-2611} is a good source for publications (maps, reports, etc.) dealing with specific geologic issues and/or issues related to specific geographic areas.

## DISCLAIMER:

We do not guarantee the performance of the project in any respect, but only that our engineering work and judgments rendered meet the standard care of our profession. The presence of underground workings (e.g. coal mines) and subsidence potential from any workings was not part of this investigation. The owner should contact the State and County agencies to determine if mining has been conducted in the area and if any precautions are recommended.

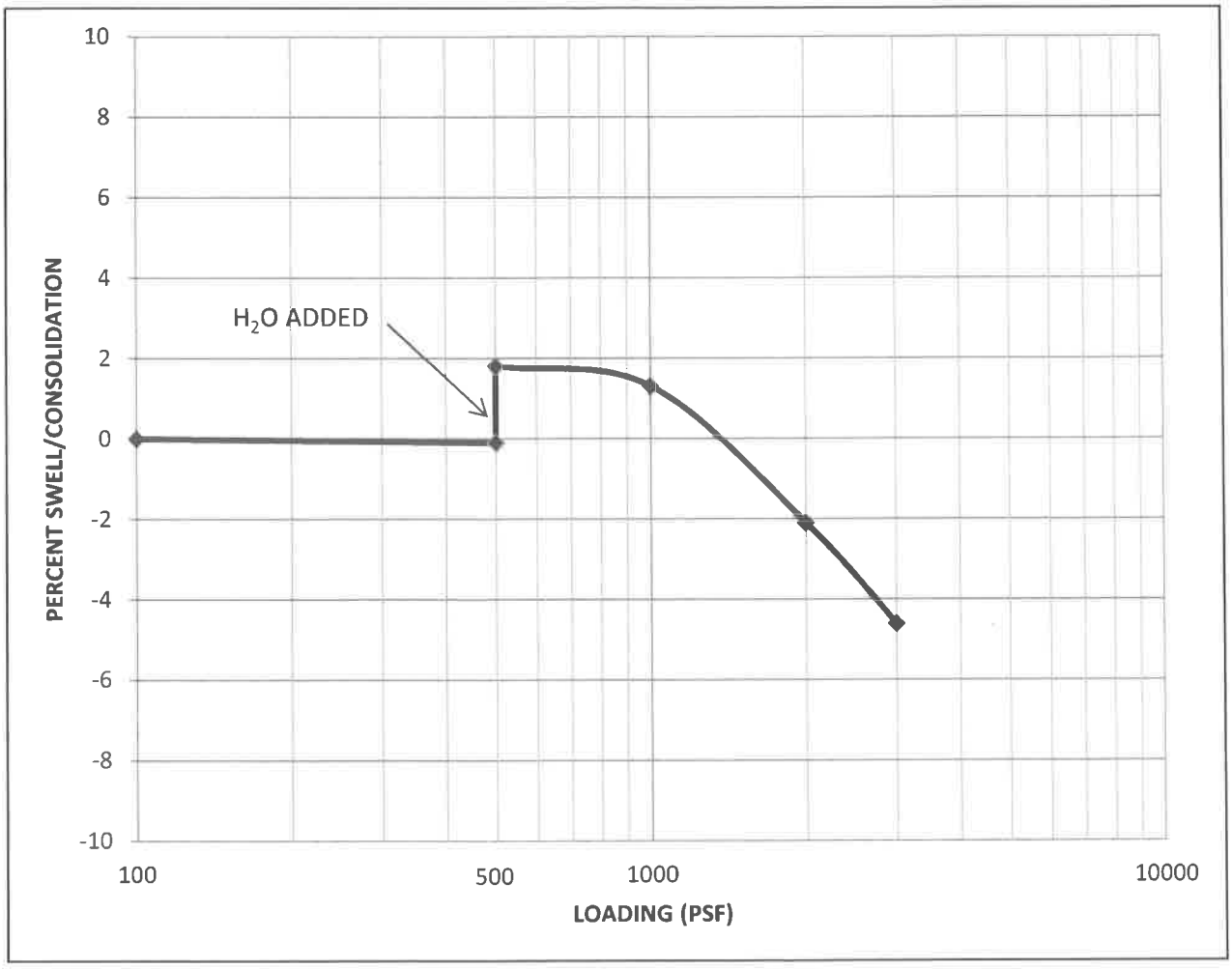
THE PARTIES SPECIFICALLY AGREE THAT *HIGH PLAINS ENGINEERING & DESIGN, LLC.* HAS NOT BEEN RETAINED NOR WILL THEY RENDER AN OPINION CONCERNING ANY ENVIRONMENTAL ISSUES, HAZARDOUS WASTE OR ANY OTHER KNOWN OR UNKNOWN CONDITIONS THAT MAY BE PRESENT ON SITE.

**DUE TO CHANGING TECHNOLOGY, BUILDING CODES AND CITY/COUNTY REQUIREMENTS, THIS SOIL REPORT MUST BE USED WITHIN ONE YEAR OF THE DATE ON THE FRONT OF THE REPORT OR MUST BE REVISED.**




TEST HOLE(S) 1 & 2

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

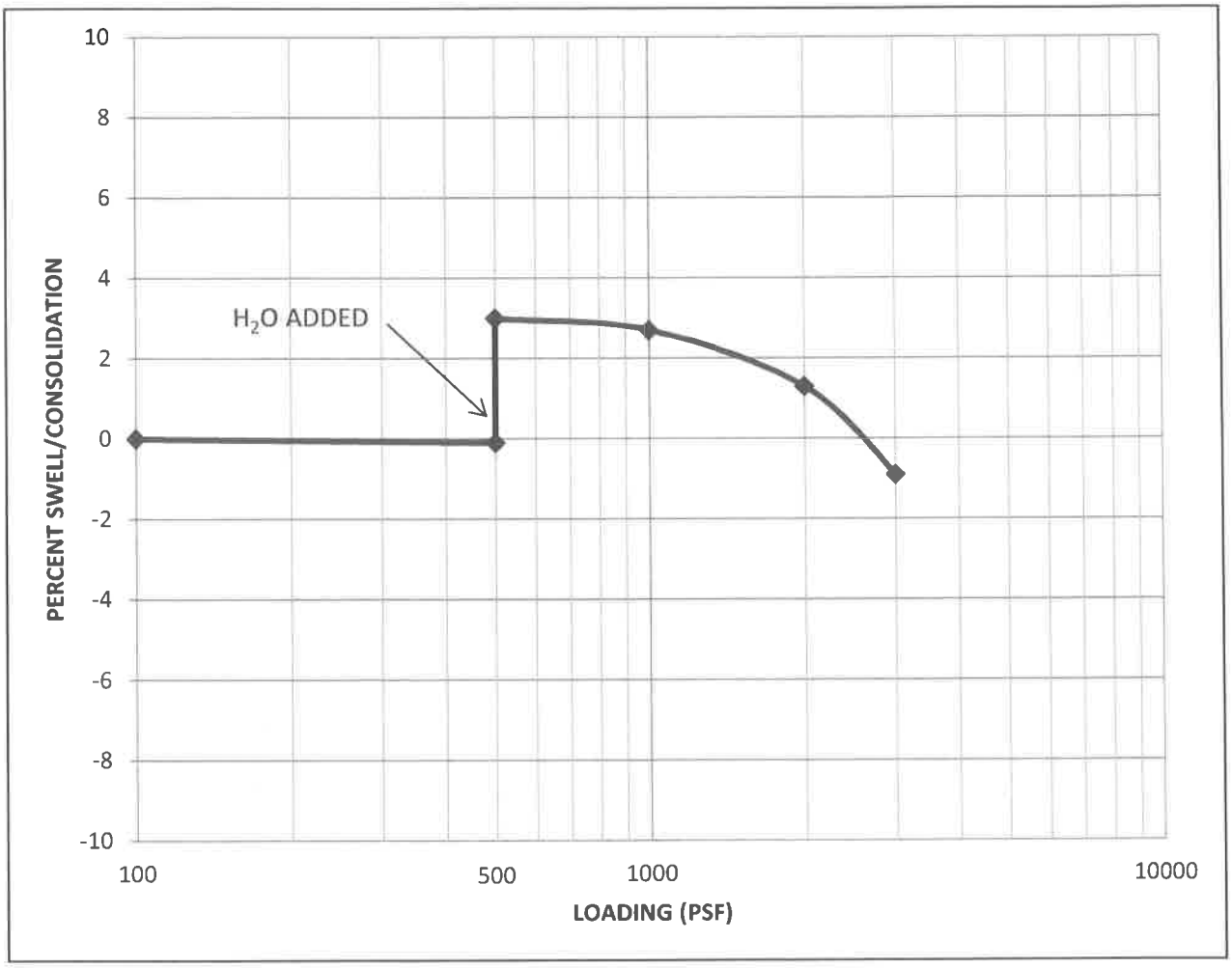



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 2' BC | 36.48 | 21.92 | 14.57 | 1.9 | | 9.65 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH LOW PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9435 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.65 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 3, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

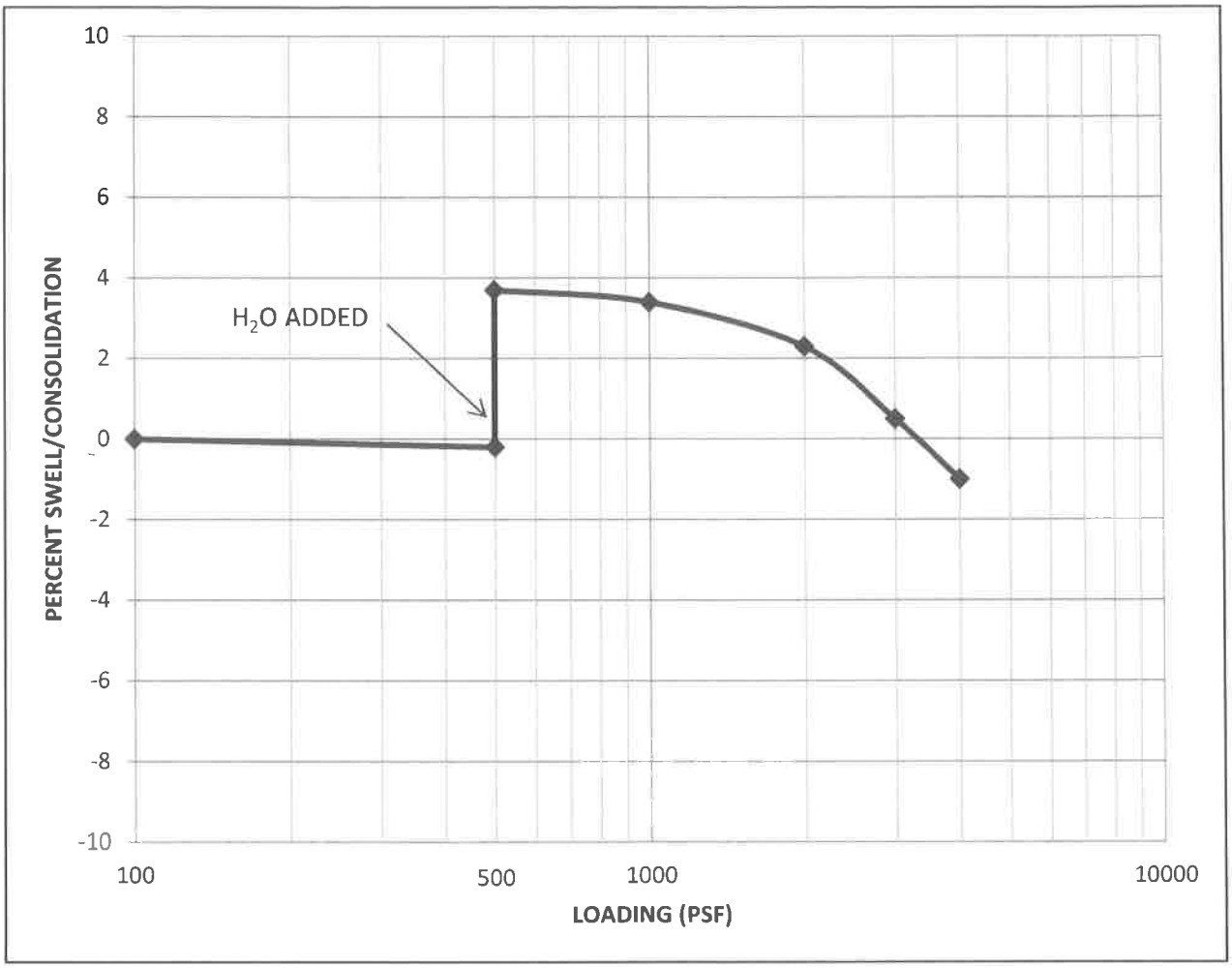



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 4' BC | 38.66 | 21.34 | 17.32 | 3.1 | | 9.46 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9435 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.65 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 3, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238



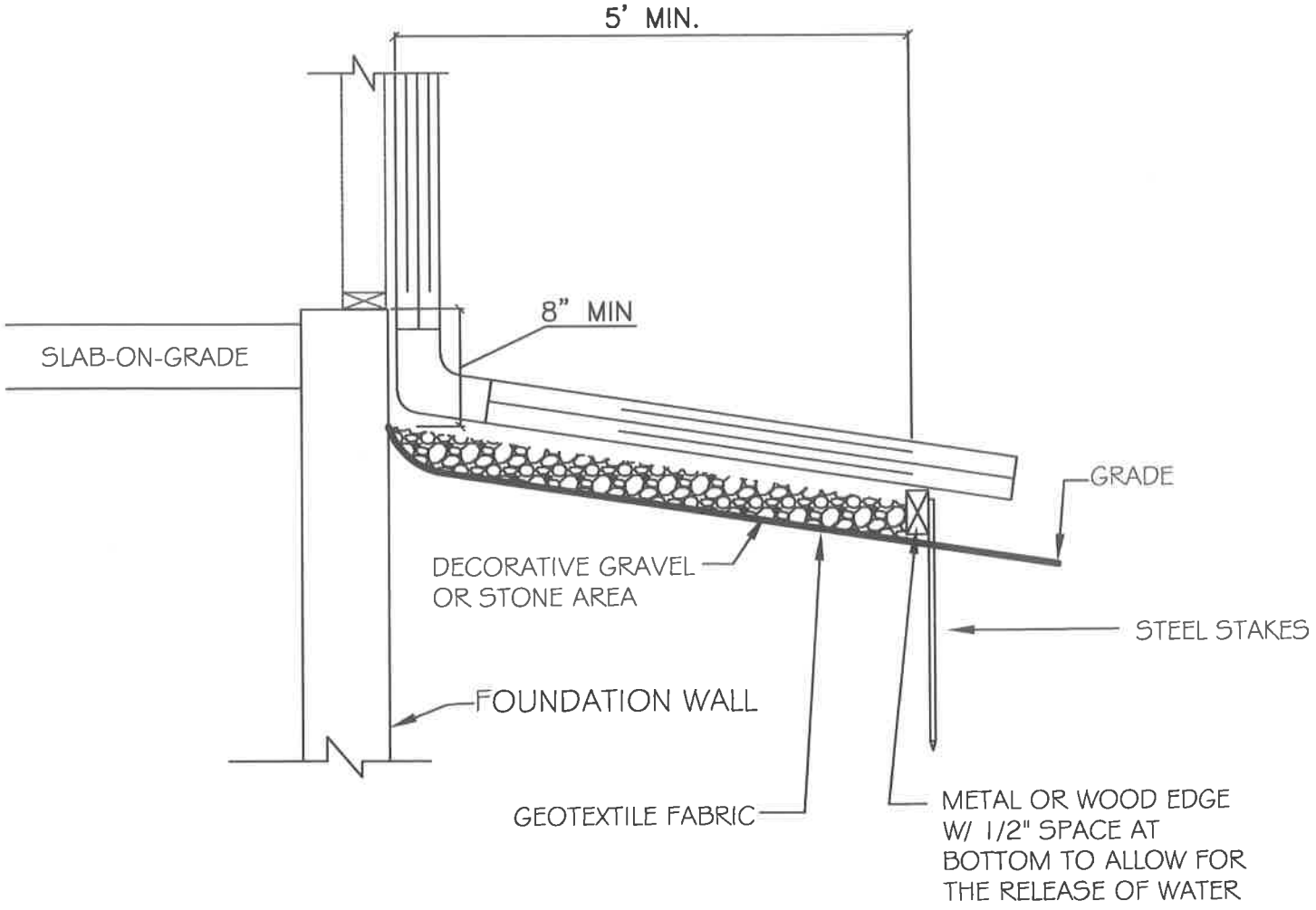

| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 7' BC | 39.82 | 22.22 | 17.60 | 3.9 | | 11.41 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9435 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 1.65 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 3, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 806420 PHONE (303) 857-9280 FAX (303) 857-923

# FOUNDATION GRADING DETAIL

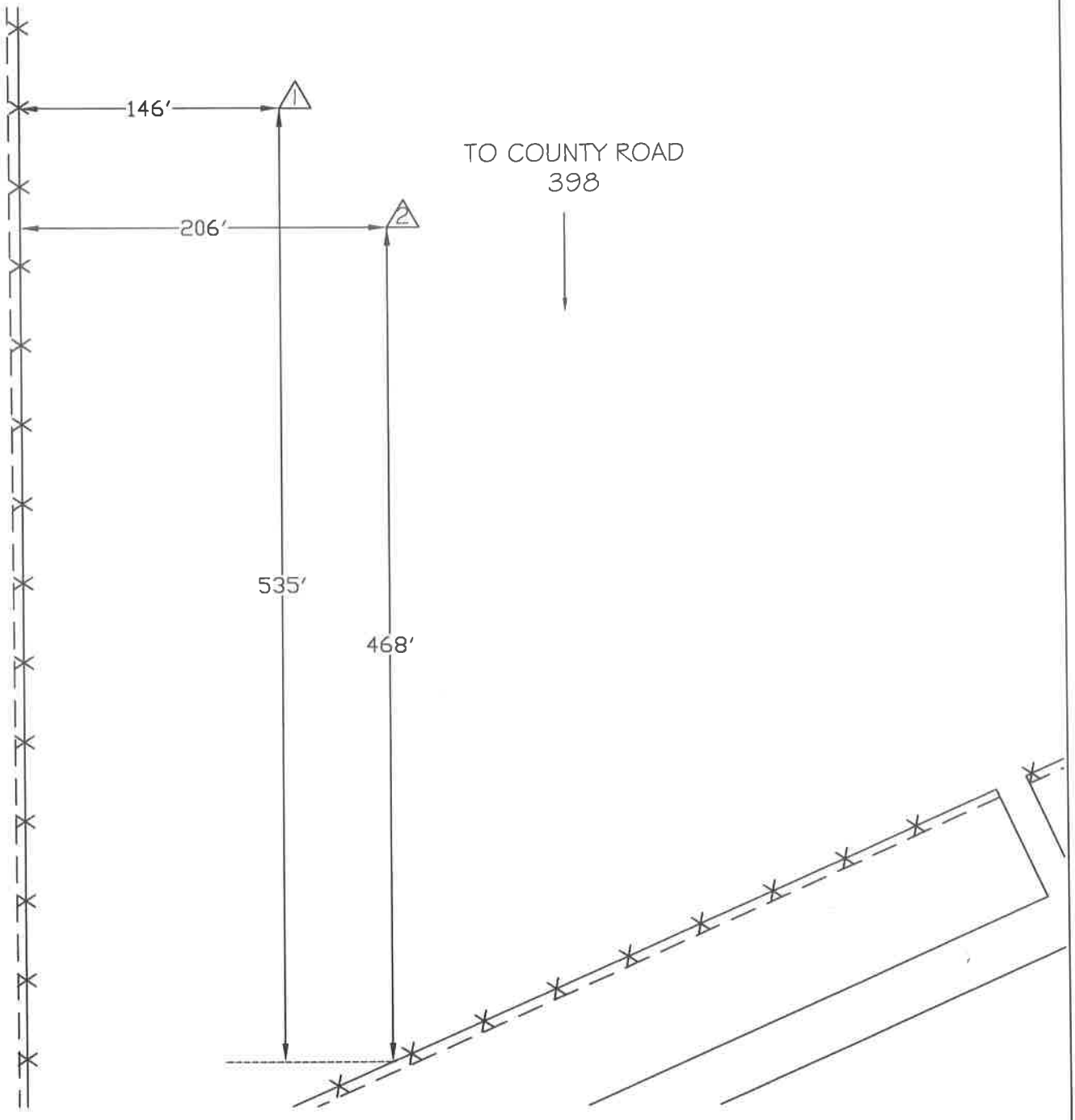



## NOTE

1. PROVIDE A MINIMUM SLOPE OF 12" IN THE FIRST 10'-0" FROM FOUNDATION (10%)
2. DOWNSPOUTS AND EXTENSIONS SHOULD EXTEND BEYOND THE GRAVEL OR STONE AREA
3. HARDSCAPING NEXT TO FOUNDATION SHOULD SLOPE AWAY AT 2% SLOPE

# SITE MAP

FUTURE 1.65 ACRE PARCEL CURRENTLY LOCATED WITHIN PARCEL 130319300014
LOT 3, A PART OF THE SW1/4 OF SECTION 19, T2N, R63W OF THE 6TH P.M.
WELD COUNTY, CO




LEGEND

- o - Percolation Test Hole
- X - Percolation Profile Hole
- △ - Soil Profile Hole
- ✕✕ - Fence
- ☆ - Bench Mark
- ▯ - Soil Pit

All locations shown above are based on specific information furnished by others or estimates made in the field by High Plains Engineering & Design personnel. The locations, distances, directions, etc. are not the result of a property survey but are approximations and are not warranted to be exact. It is the owner/builder's responsibility to define property - boundaries and ensure all onsite improvements are located within the platted site and out of inappropriate easements. All distances are to be verified prior to excavation.

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

# SUBSURFACE INVESTIGATION AND FOUNDATION RECOMMENDATIONS

***Prepared For:***
Platte River Investments, Inc.
8537 County Road 51
Keenesburg, CO 80643

***Job Site Located At:***
Future 2.00 Acre Parcel Currently Located within
Parcel No. 130319300014
Lot 4
A Part of the SW1/4 of Section 19
T2N, R63W of the 6th P.M.
Weld County, CO

January 22, 2020

**JOB #19-9436**


Todd M. Schroeder P.E. 33548

## AGREEMENT OF PURPOSE AND DISCLAIMER:

The parties specifically agree and contract that the purpose of the provided subsurface investigation is to test, analyze, and provide geotechnical recommendations for the foundation recommendations. This report presents a description of subsurface conditions encountered at the site, design, and construction criteria influenced by the subsurface conditions. The opinions and recommendations presented in this report are based on the data generated during this field exploration, laboratory testing, and our experience. A foundation design sealed by a Professional Engineer is required to obtain a building permit but is not included in this report.

*The parties specifically agree that High Plains Engineering & Design, LLC has not been retained nor will they render an opinion concerning environmental issues, hazardous waste or any other known and or unknown conditions that may be present on the job site, since this is not our area of expertise.*

## LOCATION AND SITE CONDITIONS:

This report represents the results of the data obtained during the subsoil investigation for the proposed steel building located at the Future 2.00 Acre Parcel currently located within Parcel No. 130319300014, Lot 4, A Part of the SW1/4 of Section 19, T2N, R63W of the 6th P.M., Weld County, CO.

The proposed building site is a vacant lot. The site is reasonably level with approximate slopes of 2.0% to the Southeast. The lot appears to be well drained with no erosion evident.

The depths of the excavation are anticipated to range from two (2) to four (4) feet below grades that existed at the time of this investigation. It is anticipated that final grades may be adjusted to accommodate drainage and construction depths. It is recommended that we review the final grading plan to determine if any revisions to the recommendations presented in this report are necessary.

## SUBSOIL CONDITIONS:

Two, four-inch-diameter holes were drilled up to a depth of fifteen feet at the project site on January 7, 2020, as shown on the attached site map. Soil samples were analyzed in the field and laboratory to determine the characteristics of the soil (per Unified Soil Classification System) for identification and foundation design recommendations. In general, the soil profiles in test-holes #1 & #2 indicated Clay with Low Plasticity (CL) to a depth of 4 feet, underlain by Clay with Medium Plasticity (CL) to a final depth of 15 feet.

The Standard Penetration Test per ASTM D1586 showed 20 blows for a 12-inch penetration at a depth of 2 feet, 13 blows for a 12-inch penetration at a depth of 4 feet, and 20 blows for a 12-inch penetration at a depth of 7 feet. Please note that actual subsurface soil conditions may vary between samples and locations tested.

One-dimensional swell/consolidation tests were performed on selected samples to evaluate the expansive, compressive and collapsing nature of the soils and/or bedrock strata. These tests indicated an expansion potential of 1.5% at a depth of 2 feet, an expansion potential of 1.9% at a depth of 4 feet and an expansion potential of 1.3% at a depth of 7 feet. The soils in this report were classified using the American Society of Testing Materials (ASTM) procedures.

The geotechnical practice in the State of Colorado utilizes a relative scale to evaluate swelling (expansion) potentials. When a sample is wetted under a surcharge pressure of 500 pounds per square foot (psf), the measured swell is classified as low, moderate, high, or very high. The following table represents the relative classification criteria. Please note that the measured swell is not the only criteria for slab-on-grade recommendations and additional factors are considered by the engineer when evaluating the risk for slab-on-grade construction.

| TABLE 1 | |
|---|---|
| SLAB PERFORMANCE RISK CATEGORY | REPRESENTATIVE PERCENT SWELL (500 PSF SURCHARGE) |
| LOW | 0 TO <3 |
| MODERATE | 3 TO <5 |
| HIGH | 5 TO <8 |
| VERY HIGH | ≥8 |

Source: Colorado Association of Geotechnical Engineers, Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area), 1996

## GROUNDWATER:

Groundwater levels were not recorded at the time of our field investigation; however, it may be possible for groundwater to exist at construction depths at a later date. The groundwater can be expected to fluctuate throughout the year depending on variations in precipitation, surface drainage and irrigation on the site. The possible presence of shallow bedrock/dense clays beneath the surface is favorable for the formation of "perched" groundwater. We recommend that the bottom of the basement or crawlspace excavations be maintained at least 4 feet above the free groundwater level.

The ground water levels recorded represent the free, static water levels after equalization of hydrostatic pressures in the test-hole borings. It is possible that the groundwater levels recorded in the test-hole borings may not be present at those levels in the foundation excavations. Flow rates, seepage paths, hydrostatic pressures, seasonal groundwater fluctuations, water quality and other factors were not determined in this investigation. A program, which may include special well construction, test procedures, long-term monitoring, and analysis, would be necessary to determine these factors.

## FOUNDATION RECOMMENDATIONS:

The Clay with Low Plasticity (CL) and Clay with Medium Plasticity (CL) material has a bearing strength of 2000 pounds per square foot (psf) and an equivalent liquid pressure of 55 pcf. We recommend the use of a continuous spread footing, due to the low/moderate expansion-consolidation potential of the analyzed soils. **The foundation must be constructed at the location in which soils investigation was performed.**

**All rebar must be fully contained within the footing/foundation and shall not have any contact with the native soils due to the known risks of soluble sulfates contained in area soils.**

Unmonitored moisture content in foundation excavations over an extended period of time can create foundation stress and potential damage after backfilling operations are complete. Foundation excavations left open for a period greater than 7 days will require moisture monitoring and/or moisture augmentation. High Plains Engineering & Design, LLC cannot be held responsible for foundation damage as a result of the failure to monitor moisture content after a period of 7 days. If it's anticipated that the foundation excavation will be left open for an extended period of time, the general contractor/owner shall contact High Plains Engineering & Design, LLC for further recommendations.

All loose and disturbed soil shall be removed before placing of the concrete for the foundation. The bottom of the foundation shall be a minimum of 30" below final grade (or that required by local jurisdiction; whichever is greater) for frost protection.

Soil settlement resulting from the assumed structural loads is estimated to be one inch or less. Soil expansion at this site may be up to one inch in some areas. No foundation wall is to exceed twenty-five feet in length without utilizing buttresses or counterforts unless otherwise designed by the foundation engineer.

Engineered steel reinforcements shall be required in the footings and foundation walls. This will give walls or footing beams the strength to span or bridge over any loose or soft pockets of soil that may develop during construction.

**Owners shall be made aware of all contents of this report, and the fact that *water accumulation around foundation elements is the primary cause of distressed foundations.***

To help prevent secondary damage that could be caused by slab movement, the following construction techniques are additional recommendations for the foundation construction.

## SLAB ON GRADE CONSTRUCTION:

**Steel Building/Shop and Exterior Slab-on-grade Concrete:** The soil encountered at or below anticipated slab elevations has a low swell potential. If removal and replacement of soil below slabs is required, use a non-expansive granular soil with Plasticity Index less than 15 and Liquid Limit less than 30 and compacted to a minimum of 95% ASTM D698 (Standard Proctor Density), within 2% of the optimum moisture content.

The slabs should be constructed as "floating" slabs, which are free to move in the vertical direction. The slabs should not be attached to interior or exterior bearing members. The following design and construction details for slab-on-grade construction are recommended.

1. Floor slabs placed above potentially expansive soils will be expected to heave and crack to some degree. It is impossible to predict with certainty how much slab movement will actually occur. **When the owners cannot tolerate slab movement, we recommend to install a structural slab in place of the conventional slab on grade for floor construction.**

2. Where steel building/shop slabs and exterior slabs-on-grade are chosen, and the owners understand and accepts all the risks associated with slab movement, the following recommendations should be followed with the amount of over-excavation and replacement with imported fill determined by the owner/builder.

   a. Positive separations and/or isolation joints should be provided between slabs and all foundation walls, bearing members (columns), plumbing and utility lines. Isolation may be achieved with ½ inch expansion material or by sleeving. Vertical movement of the slabs should not be restricted. A minimum void of 3 inches should be provided with all non-bearing partition walls to allow movement without damaging the structure. Provide a minimum ½ inch space at the bottom of all doorjambs. It is the owner's responsibility to maintain these void spaces. Mechanical equipment set on the slab will require an expandable/collapsible connection to ductwork, etc.

   b. Eliminate plumbing under slabs where feasible. Where such plumbing is unavoidable, it should be thoroughly pressure tested during construction.

   c. A vapor retarder is required per IRC R506.2.3 except use 15-mil minimum thickness, located per ACI guidelines and installed per ASTM specifications. Floor slabs and footings should not be constructed on frozen subgrade. Slabs should be reinforced with rebar or wire mesh to help control crack separation.

3. Provide frequent scoring of the slabs in square dimensions (non- rectangular) to provide joints for controlled cracking of the slab. Control joints should be placed at distances equal to 24 to 30 times the slab thickness and the depth of sawed control joints should be ¼ of the slab thickness. Joints should be sawed as soon as the concrete will withstand the energy of sawing without raveling the edges of the joint. For most concrete mixtures, sawing should be completed within 6 to 18 hours after pouring, but never more than 24 hours. Install a good quality sealant (pliable/non-hardening) in these joints to prevent surface discharges of liquid from penetrating slab sub-grades.

4. The soils that will support the concrete slabs should be kept moist during construction by occasional sprinkling of water. The soils should be moistened to +/- 2 % optimum moisture within 24 hours of pouring the slabs. This procedure will help maintain the moisture content of the underlying soil. **Heavy watering or pooling of any kind next to the foundation or within the backfilled area is not recommended.**

## BACKFILL:

**The foundation and retaining walls must be well cured and well braced prior to backfilling.**

Any soil disturbed adjacent to bearing foundation components are to be **re-compacted to a minimum of 95% Standard Proctor Density (ASTM D698)**. Backfill that bears concrete slabs shall be compacted to 95% Standard Proctor Density (ASTM D698). Mechanical compaction methods shall be utilized, (water-flooding techniques are strictly prohibited). See Compaction Section for more information regarding compaction requirements and techniques.

Proper drainage away from the foundation walls shall be provided. The owners are advised to immediately fill any settled areas to eliminate water accumulation near the foundation. A minimum slope of 12 inches in the first 10 feet from the perimeter of the building is recommended. Roof downspouts and sill cocks should discharge into long concrete splash blocks (5 feet long min.) or into gutter extensions to deposit runoff water beyond the limits of the backfill soil near the foundation walls. Plastic membranes should not be used to cover the ground surface immediately surrounding the structure; geotextile fabric should be utilized for weed control. Any drainage water from uphill shall be diverted around the structure.

Sprinkling systems should not be installed or direct water to be within 10 feet of the foundation. The owner/builder is also advised that irrigation lines can leak and/or break, resulting in release of excessive amounts of water near the foundation. This can cause damage to slabs and foundation walls. **WATER ACCUMULATION AROUND FOUNDATION ELEMENTS IS THE MAIN CAUSE OF DISTRESSED FOUNDATIONS.**

## COMPACTION:

*Placing Fill*: No brush, sod, frozen material, perishable material, unsuitable material, or stones of four inches or greater in maximum dimension shall be placed in the fill. The distribution of the material on the fill shall be such as to avoid the formation of layers of materials differing substantially in characteristics from the surrounding materials.

The materials are to be delivered to the backfill surface at a uniform rate, and in such quantity as to permit a satisfactory construction procedure. Unnecessary concentration of backfill machinery travel tending to cause ruts and other hollows more than six inches in depth, are to be re-graded and compacted. After dumping of fill material on the backfill surface, the material is to be spread by approved methods in approximately 6 inches compacted thickness.

*Moisture Control*: The material in each layer shall be compacted by rolling and shall contain the optimum moisture required for maximum compaction, as nearly practicable and as determined by the soils engineer. The moisture content shall be uniform throughout all layers. If in the opinion of the soils engineer it is not possible to obtain moisture content by adding water on the fill surface, the contractor may be required to add the necessary moisture to backfill material in the borrow area.

*Compaction*: When the moisture condition and content of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer to **95% ASTM D698 (Standard Proctor Density) for slab areas, and 98% ASTM D698 for footing and/or pad areas.** A Standard Proctor test is to be performed for each typical fill material and frequent tests of the density of the fill must be taken.

In general, to compact cohesion-less free-draining materials, *the above guidelines also apply.*

When compacting cohesion-less free-draining materials such as gravel and sand, the materials shall be deposited in layers and compacted by treads of a crawler type tractor, surface of internal vibrators, pneumatic or smooth rollers, power or hand tampers, or by any other means approved by the soils engineer. The thickness of the horizontal layers after compaction is not to exceed 6 inches compacted thickness if compaction is performed by tractor treads, surface vibrators or similar equipment, or not more than penetrating length of the vibrator head if compaction is performed by internal vibrators. When the moisture content and condition of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer **to 91% ASTM D1557 (Modified Proctor Density) for slab areas, and 94% ASTM D1557 for footing and/or pad areas.**

## CONSTRUCTION DETAILS – GENERAL COMMENTS:

In any soil investigation, it is necessary to assume that the subsurface soil conditions do not vary greatly from the conditions encountered in the field and laboratory testing. The accompanying design is presented using best professional judgment based on the limits of the extent of testing commissioned by the client. Our experience has been that at times, soil conditions do change and variations do occur. These may become first apparent at the time of excavation for the foundation system.

**If soils conditions are encountered which appear different from the test borings as presented in this report, it is required that this office be called to make an observation of the open excavation prior to placing the footings. The cost of this observation is not part of this report.**

This project should be constructed by a qualified contractor with experience in similar projects. The owner/builder is advised to observe and document the construction process to ensure the construction is performed in accordance with the design drawings and technical specifications. **The foundation and retaining walls must be well cured and well braced prior to backfilling**.

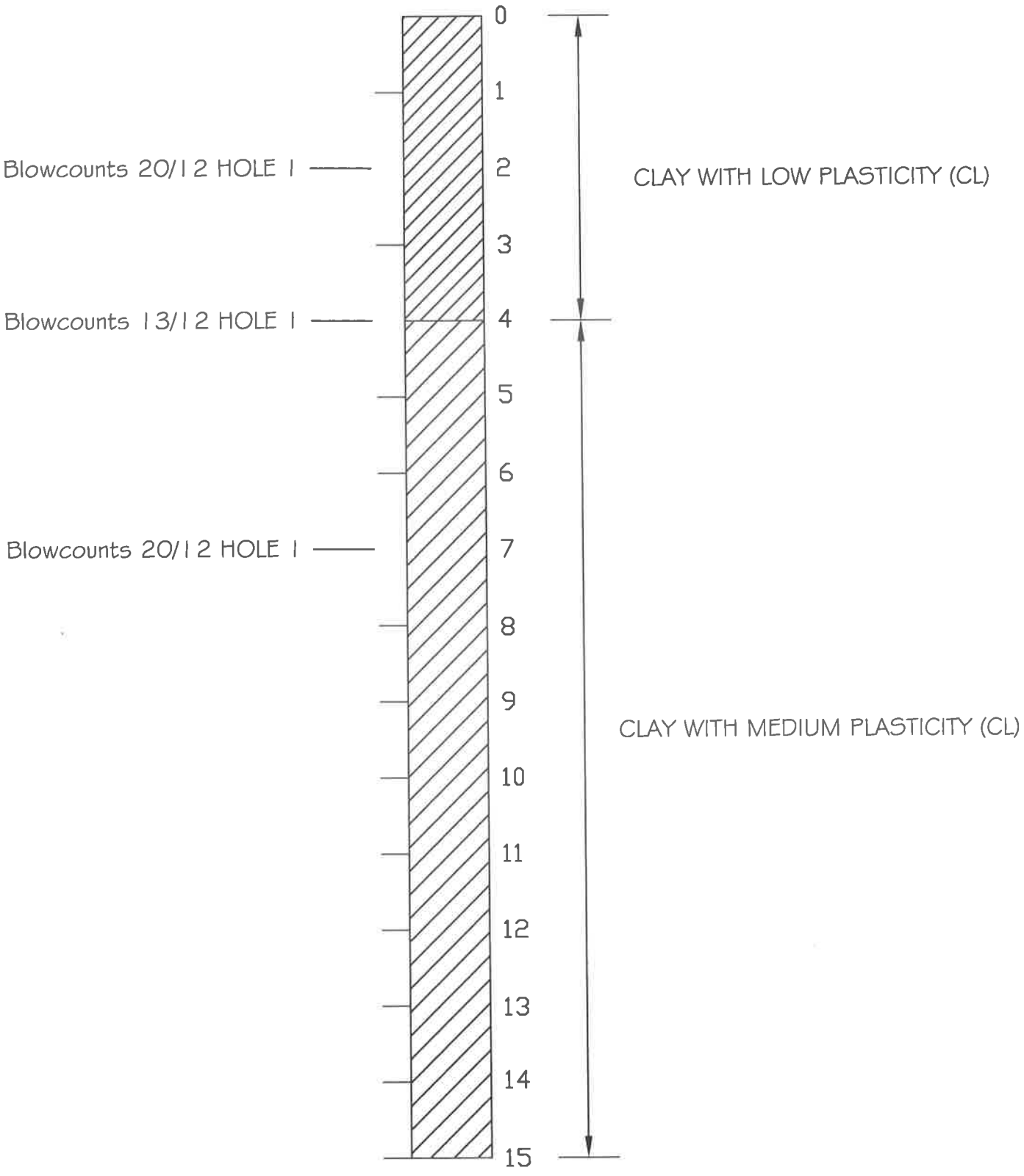
This report does not address general hillside stability, landslide potential, and/or other natural hazards. Several areas in the Colorado Front Range have known geologic hazards associated with them. We recommend that readers of this report educate themselves further as to the existence of geologic hazards on or around their specific property of interest. The Colorado Geologic Survey {www.geosurvey.state.co.us or 303-866-2611} is a good source for publications (maps, reports, etc.) dealing with specific geologic issues and/or issues related to specific geographic areas.

## DISCLAIMER:

We do not guarantee the performance of the project in any respect, but only that our engineering work and judgments rendered meet the standard care of our profession. The presence of underground workings (e.g. coal mines) and subsidence potential from any workings was not part of this investigation. The owner should contact the State and County agencies to determine if mining has been conducted in the area and if any precautions are recommended.

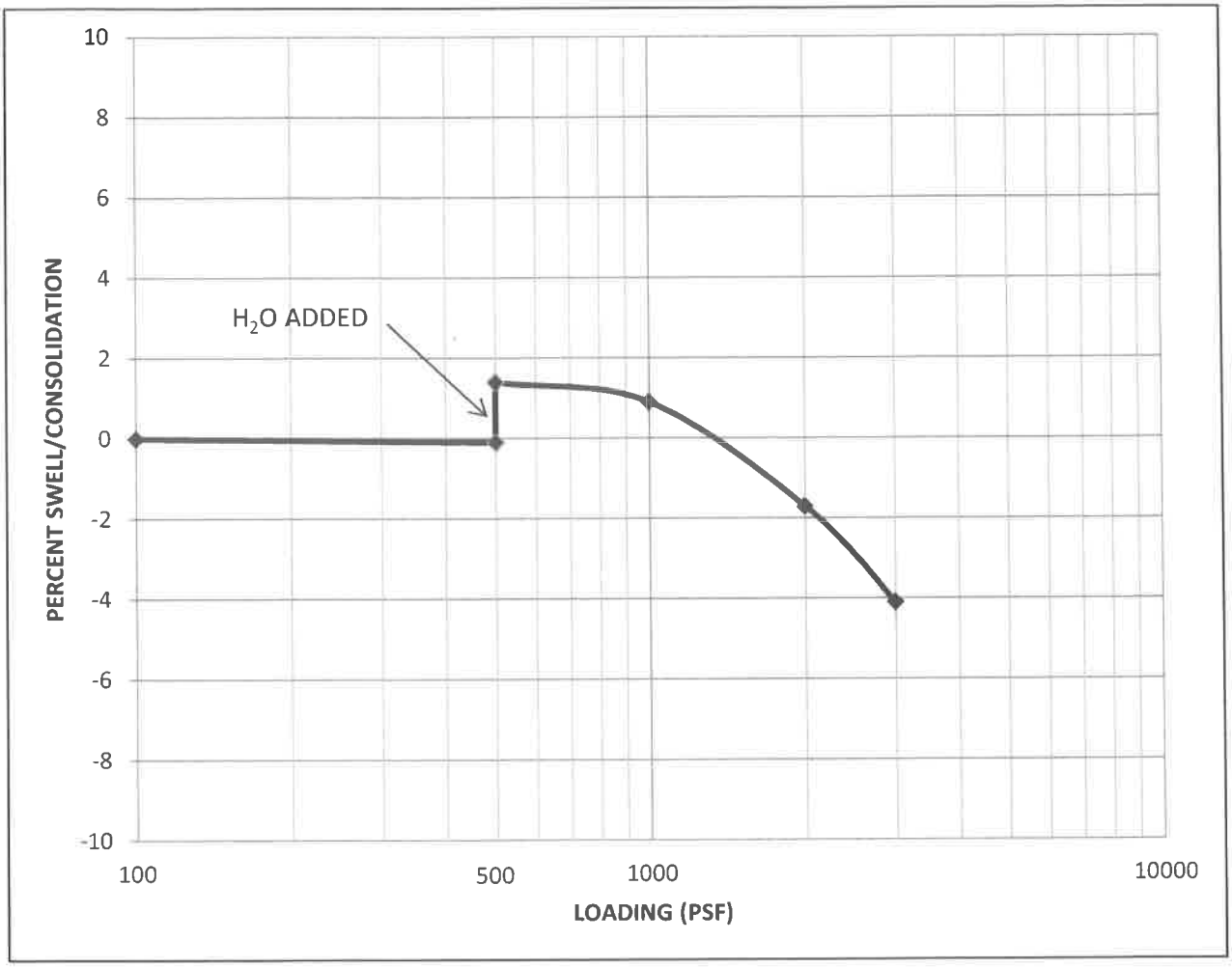
THE PARTIES SPECIFICALLY AGREE THAT *HIGH PLAINS ENGINEERING & DESIGN, LLC.* HAS NOT BEEN RETAINED NOR WILL THEY RENDER AN OPINION CONCERNING ANY ENVIRONMENTAL ISSUES, HAZARDOUS WASTE OR ANY OTHER KNOWN OR UNKNOWN CONDITIONS THAT MAY BE PRESENT ON SITE.

**DUE TO CHANGING TECHNOLOGY, BUILDING CODES AND CITY/COUNTY REQUIREMENTS, THIS SOIL REPORT MUST BE USED WITHIN ONE YEAR OF THE DATE ON THE FRONT OF THE REPORT OR MUST BE REVISED.**




TEST HOLE(S) 1 & 2

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

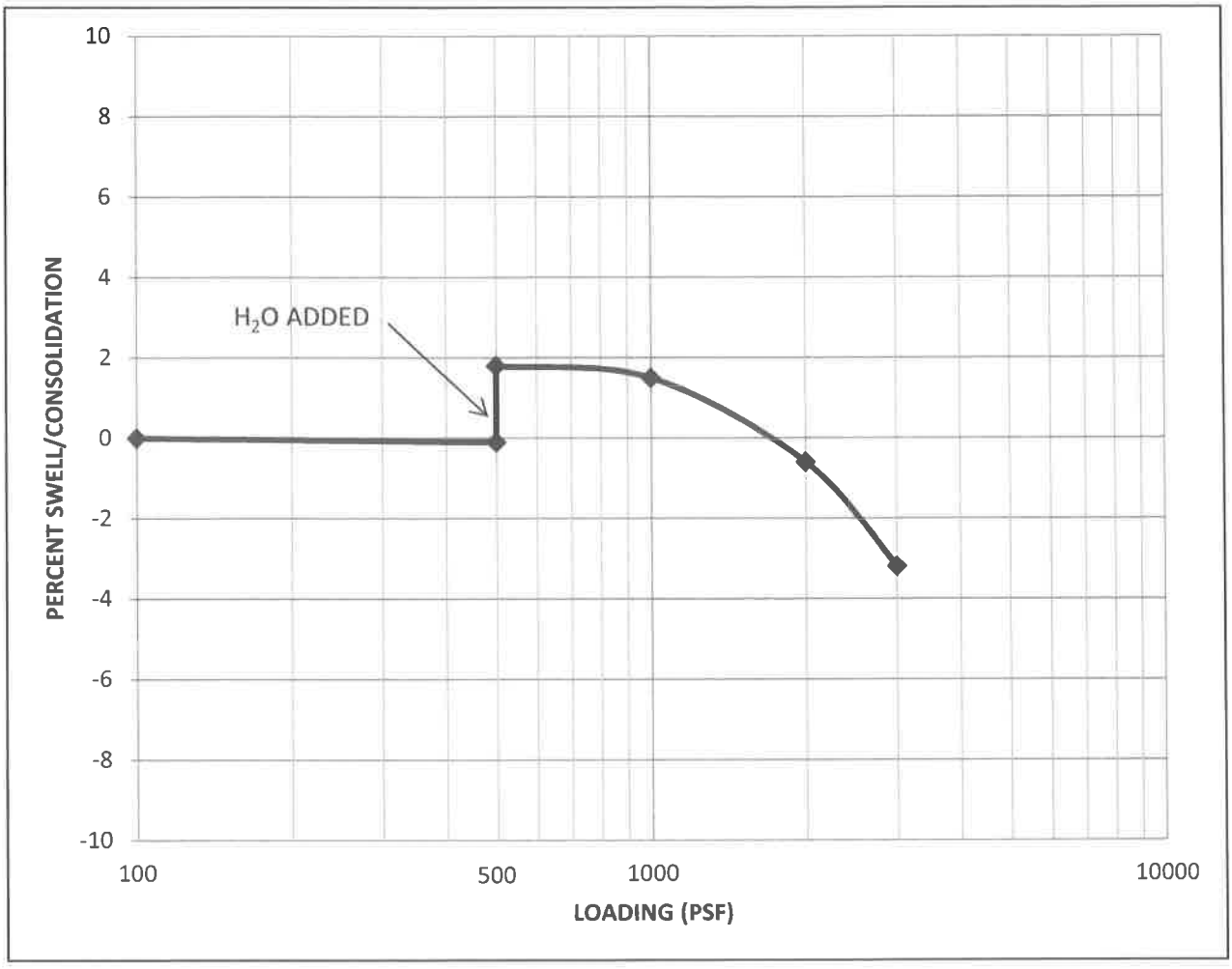



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 2' BC | 36.07 | 21.13 | 14.93 | 1.5 | | 7.97 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH LOW PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9436 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 2.00 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 4, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

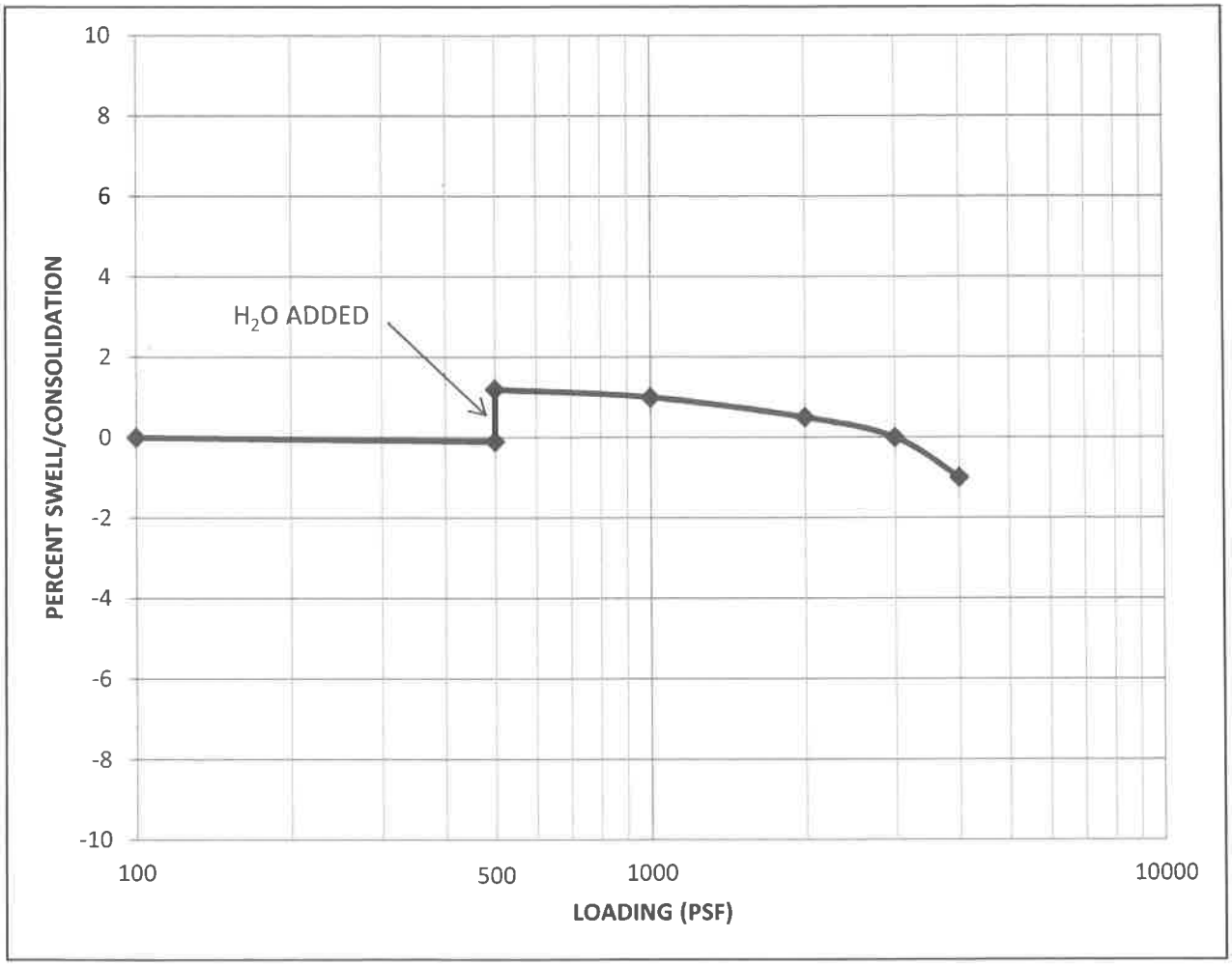



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 4' BC | 38.82 | 22.11 | 16.71 | 1.9 | | 9.53 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9436 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 2.00 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 4, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238



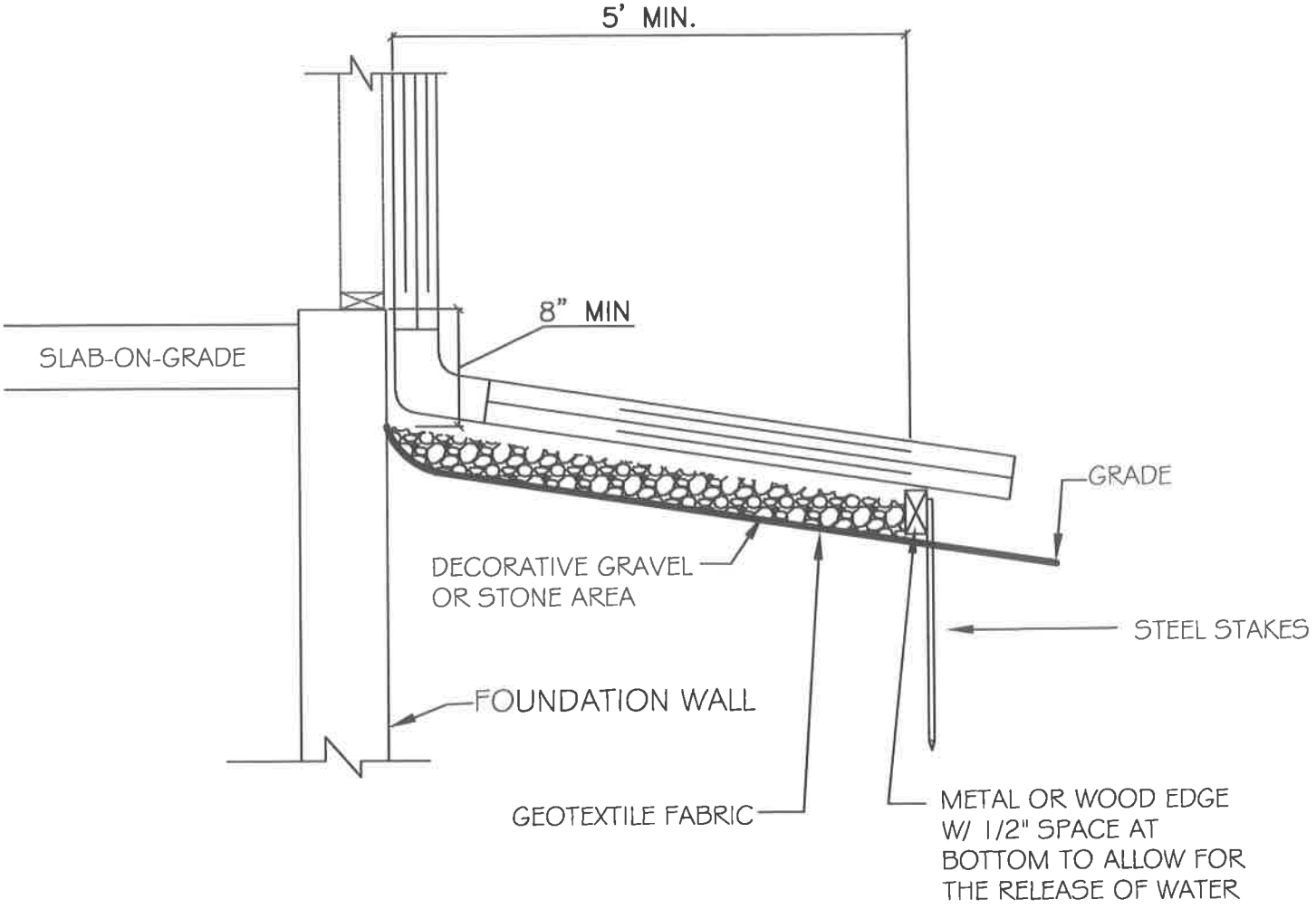

| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 7' BC | 37.11 | 21.93 | 15.18 | 1.3 | | 14.21 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9436 | **JOB LOCATION:** |
| **DATE:** | 1/22/20 | FUTURE 2.00 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 4, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 806420 PHONE (303) 857-9280 FAX (303) 857-923

# FOUNDATION GRADING DETAIL

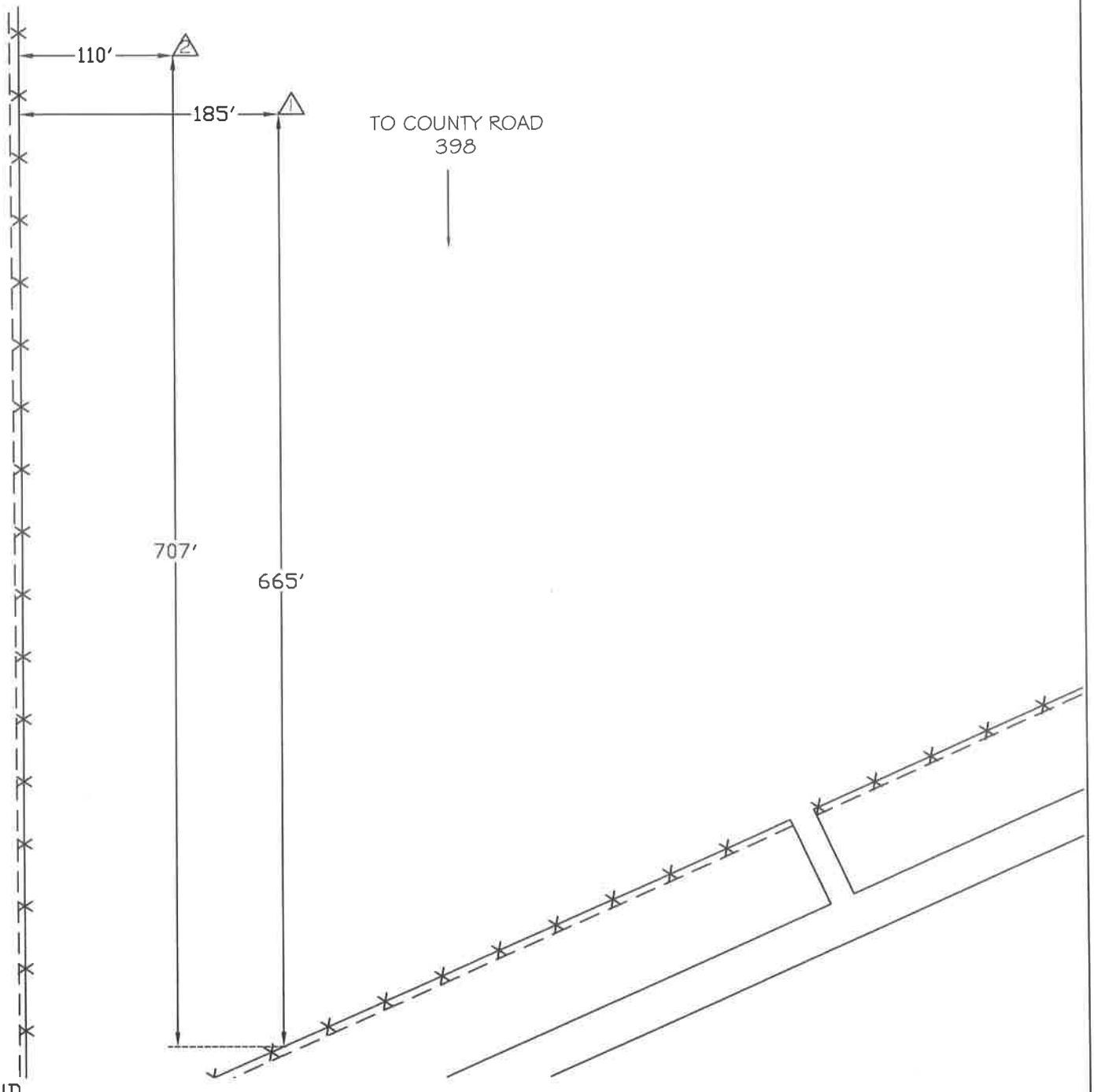



NOTE

1. PROVIDE A MINIMUM SLOPE OF 12" IN THE FIRST 10'-0" FROM FOUNDATION (10%)
2. DOWNSPOUTS AND EXTENSIONS SHOULD EXTEND BEYOND THE GRAVEL OR STONE AREA
3. HARDSCAPING NEXT TO FOUNDATION SHOULD SLOPE AWAY AT 2% SLOPE

# SITE MAP

FUTURE 2.00 ACRE PARCEL CURRENTLY LOCATED WITHIN PARCEL 130193000014
LOT 4, A PART OF THE SW1/4 OF SECTION 19, T2N, R63W OF THE 6TH P.M.
WELD COUNTY, CO




LEGEND

- o – Percolation Test Hole
- X – Percolation Profile Hole
- △ – Soil Profile Hole
- ✳✳ – Fence
- ☆ – Bench Mark
- ▯ – Soil Pit

All locations shown above are based on specific information furnished by others or estimates made in the field by High Plains Engineering & Design personnel. The locations, distances, directions, etc. are not the result of a property survey but are approximations and are not warranted to be exact. It is the owner/builder's responsibility to define property - boundaries and ensure all onsite improvements are located within the platted site and out of inappropriate easements. All distances are to be verified prior to excavation.

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

# SUBSURFACE INVESTIGATION AND FOUNDATION RECOMMENDATIONS

***Prepared For:***
Platte River Investments, Inc.
8537 County Road 51
Keenesburg, CO 80643

***Job Site Located At:***
Future 7.16 Acre Parcel Currently Located within
Parcel No. 130319300014
Lot 7
A Part of the SW1/4 of Section 19
T2N, R63W of the 6th P.M.
Weld County, CO

February 13, 2020

**JOB #19-9437**

Todd M. Schroeder P.E. 33548

## AGREEMENT OF PURPOSE AND DISCLAIMER:

The parties specifically agree and contract that the purpose of the provided subsurface investigation is to test, analyze, and provide geotechnical recommendations for the foundation recommendations. This report presents a description of subsurface conditions encountered at the site, design, and construction criteria influenced by the subsurface conditions. The opinions and recommendations presented in this report are based on the data generated during this field exploration, laboratory testing, and our experience. A foundation design sealed by a Professional Engineer is required to obtain a building permit but is not included in this report.

*The parties specifically agree that High Plains Engineering & Design, LLC has not been retained nor will they render an opinion concerning environmental issues, hazardous waste or any other known and or unknown conditions that may be present on the job site, since this is not our area of expertise.*

## LOCATION AND SITE CONDITIONS:

This report represents the results of the data obtained during the subsoil investigation for the proposed steel building located at the Future 7.16 Acre Parcel currently located within Parcel No. 130319300014, Lot 7, A Part of the SW1/4 of Section 19, T2N, R63W of the 6th P.M., Weld County, CO.

The proposed building site is a vacant lot. The site is reasonably level with approximate slopes of 1.0% to the East. The lot appears to be well drained with no erosion evident.

The depths of the excavation are anticipated to range from two (2) to four (4) feet below grades that existed at the time of this investigation. It is anticipated that final grades may be adjusted to accommodate drainage and construction depths. It is recommended that we review the final grading plan to determine if any revisions to the recommendations presented in this report are necessary.

## SUBSOIL CONDITIONS:

Two, four-inch-diameter holes were drilled up to a depth of fifteen feet at the project site on January 7, 2020, as shown on the attached site map. Soil samples were analyzed in the field and laboratory to determine the characteristics of the soil (per Unified Soil Classification System) for identification and foundation design recommendations. In general, the soil profiles in test-holes #1 & #2 indicated Clay with Low Plasticity (CL) to a final depth of 15 feet.

The Standard Penetration Test per ASTM D1586 showed 17 blows for a 12-inch penetration at a depth of 2 feet, 17 blows for a 12-inch penetration at a depth of 4 feet, and 18 blows for a 12-inch penetration at a depth of 7 feet. Please note that actual subsurface soil conditions may vary between samples and locations tested.

One-dimensional swell/consolidation tests were performed on selected samples to evaluate the expansive, compressive and collapsing nature of the soils and/or bedrock strata. These tests indicated an expansion potential of 1.5% at a depth of 2 feet, an expansion potential of 2.1% at a depth of 4 feet and an expansion potential of 2.5% at a depth of 7 feet. The soils in this report were classified using the American Society of Testing Materials (ASTM) procedures.

The geotechnical practice in the State of Colorado utilizes a relative scale to evaluate swelling (expansion) potentials. When a sample is wetted under a surcharge pressure of 500 pounds per square foot (psf), the measured swell is classified as low, moderate, high, or very high. The following table represents the relative classification criteria. Please note that the measured swell is not the only criteria for slab-on-grade recommendations and additional factors are considered by the engineer when evaluating the risk for slab-on-grade construction.

| TABLE 1 | |
|---|---|
| SLAB PERFORMANCE RISK CATEGORY | REPRESENTATIVE PERCENT SWELL (500 PSF SURCHARGE) |
| LOW | 0 TO <3 |
| MODERATE | 3 TO <5 |
| HIGH | 5 TO <8 |
| VERY HIGH | ≥8 |

Source: Colorado Association of Geotechnical Engineers, Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area), 1996

## GROUNDWATER:

Groundwater levels were not recorded at the time of our field investigation; however, it may be possible for groundwater to exist at construction depths at a later date. The groundwater can be expected to fluctuate throughout the year depending on variations in precipitation, surface drainage and irrigation on the site. The possible presence of shallow bedrock/dense clays beneath the surface is favorable for the formation of "perched" groundwater. We recommend that the bottom of the basement or crawlspace excavations be maintained at least 4 feet above the free groundwater level.

The ground water levels recorded represent the free, static water levels after equalization of hydrostatic pressures in the test-hole borings. It is possible that the groundwater levels recorded in the test-hole borings may not be present at those levels in the foundation excavations. Flow rates, seepage paths, hydrostatic pressures, seasonal groundwater fluctuations, water quality and other factors were not determined in this investigation. A program, which may include special well construction, test procedures, long-term monitoring, and analysis, would be necessary to determine these factors.

## FOUNDATION RECOMMENDATIONS:

The Clay with Low Plasticity (CL) material has a bearing strength of 2000 pounds per square foot (psf) and an equivalent liquid pressure of 55 pcf. We recommend the use of a continuous spread footing, due to the low/moderate expansion-consolidation potential of the analyzed soils. **The foundation must be constructed at the location in which soils investigation was performed.**

**All rebar must be fully contained within the footing/foundation and shall not have any contact with the native soils due to the known risks of soluble sulfates contained in area soils.**

Unmonitored moisture content in foundation excavations over an extended period of time can create foundation stress and potential damage after backfilling operations are complete. Foundation excavations left open for a period greater than 7 days will require moisture monitoring and/or moisture augmentation. High Plains Engineering & Design, LLC cannot be held responsible for foundation damage as a result of the failure to monitor moisture content after a period of 7 days. If it's anticipated that the foundation excavation will be left open for an extended period of time, the general contractor/owner shall contact High Plains Engineering & Design, LLC for further recommendations.

All loose and disturbed soil shall be removed before placing of the concrete for the foundation. The bottom of the foundation shall be a minimum of 30" below final grade (or that required by local jurisdiction; whichever is greater) for frost protection.

Soil settlement resulting from the assumed structural loads is estimated to be one inch or less. Soil expansion at this site may be up to one inch in some areas. No foundation wall is to exceed twenty-five feet in length without utilizing buttresses or counterforts unless otherwise designed by the foundation engineer.

Engineered steel reinforcements shall be required in the footings and foundation walls. This will give walls or footing beams the strength to span or bridge over any loose or soft pockets of soil that may develop during construction.

**Owners shall be made aware of all contents of this report, and the fact that *water accumulation around foundation elements is the primary cause of distressed foundations.***

To help prevent secondary damage that could be caused by slab movement, the following construction techniques are additional recommendations for the foundation construction.

# SLAB ON GRADE CONSTRUCTION:

**Steel Building/Shop and Exterior Slab-on-grade Concrete:** The soil encountered at or below anticipated slab elevations has a low swell potential. If removal and replacement of soil below slabs is required, use a non-expansive granular soil with Plasticity Index less than 15 and Liquid Limit less than 30 and compacted to a minimum of 95% ASTM D698 (Standard Proctor Density), within 2% of the optimum moisture content.

The slabs should be constructed as "floating" slabs, which are free to move in the vertical direction. The slabs should not be attached to interior or exterior bearing members. The following design and construction details for slab-on-grade construction are recommended.

1. Floor slabs placed above potentially expansive soils will be expected to heave and crack to some degree. It is impossible to predict with certainty how much slab movement will actually occur. **When the owners cannot tolerate slab movement, we recommend to install a structural slab in place of the conventional slab on grade for floor construction.**

2. Where steel building/shop slabs and exterior slabs-on-grade are chosen, and the owners understand and accepts all the risks associated with slab movement, the following recommendations should be followed with the amount of over-excavation and replacement with imported fill determined by the owner/builder.

   a. Positive separations and/or isolation joints should be provided between slabs and all foundation walls, bearing members (columns), plumbing and utility lines. Isolation may be achieved with ½ inch expansion material or by sleeving. Vertical movement of the slabs should not be restricted. A minimum void of 3 inches should be provided with all non-bearing partition walls to allow movement without damaging the structure. Provide a minimum ½ inch space at the bottom of all doorjambs. It is the owner's responsibility to maintain these void spaces. Mechanical equipment set on the slab will require an expandable/collapsible connection to ductwork, etc.

   b. Eliminate plumbing under slabs where feasible. Where such plumbing is unavoidable, it should be thoroughly pressure tested during construction.

   c. A vapor retarder is required per IRC R506.2.3 except use 15-mil minimum thickness, located per ACI guidelines and installed per ASTM specifications. Floor slabs and footings should not be constructed on frozen subgrade. Slabs should be reinforced with rebar or wire mesh to help control crack separation.

3. Provide frequent scoring of the slabs in square dimensions (non- rectangular) to provide joints for controlled cracking of the slab. Control joints should be placed at distances equal to 24 to 30 times the slab thickness and the depth of sawed control joints should be ¼ of the slab thickness. Joints should be sawed as soon as the concrete will withstand the energy of sawing without raveling the edges of the joint. For most concrete mixtures, sawing should be completed within 6 to 18 hours after pouring, but never more than 24 hours. Install a good quality sealant (pliable/non-hardening) in these joints to prevent surface discharges of liquid from penetrating slab sub-grades.

4. The soils that will support the concrete slabs should be kept moist during construction by occasional sprinkling of water. The soils should be moistened to +/- 2 % optimum moisture within 24 hours of pouring the slabs. This procedure will help maintain the moisture content of the underlying soil. **Heavy watering or pooling of any kind next to the foundation or within the backfilled area is not recommended.**

## BACKFILL:

**The foundation and retaining walls must be well cured and well braced prior to backfilling.**

Any soil disturbed adjacent to bearing foundation components are to be **re-compacted to a minimum of 95% Standard Proctor Density (ASTM D698).** Backfill that bears concrete slabs shall be compacted to 95% Standard Proctor Density (ASTM D698). Mechanical compaction methods shall be utilized, (water-flooding techniques are strictly prohibited). See Compaction Section for more information regarding compaction requirements and techniques.

Proper drainage away from the foundation walls shall be provided. The owners are advised to immediately fill any settled areas to eliminate water accumulation near the foundation. A minimum slope of 12 inches in the first 10 feet from the perimeter of the building is recommended. Roof downspouts and sill cocks should discharge into long concrete splash blocks (5 feet long min.) or into gutter extensions to deposit runoff water beyond the limits of the backfill soil near the foundation walls. Plastic membranes should not be used to cover the ground surface immediately surrounding the structure; geotextile fabric should be utilized for weed control. Any drainage water from uphill shall be diverted around the structure.

Sprinkling systems should not be installed or direct water to be within 10 feet of the foundation. The owner/builder is also advised that irrigation lines can leak and/or break, resulting in release of excessive amounts of water near the foundation. This can cause damage to slabs and foundation walls. **WATER ACCUMULATION AROUND FOUNDATION ELEMENTS IS THE MAIN CAUSE OF DISTRESSED FOUNDATIONS.**

## COMPACTION:

*Placing Fill*: No brush, sod, frozen material, perishable material, unsuitable material, or stones of four inches or greater in maximum dimension shall be placed in the fill. The distribution of the material on the fill shall be such as to avoid the formation of layers of materials differing substantially in characteristics from the surrounding materials.

The materials are to be delivered to the backfill surface at a uniform rate, and in such quantity as to permit a satisfactory construction procedure. Unnecessary concentration of backfill machinery travel tending to cause ruts and other hollows more than six inches in depth, are to be re-graded and compacted. After dumping of fill material on the backfill surface, the material is to be spread by approved methods in approximately 6 inches compacted thickness.

*Moisture Control*: The material in each layer shall be compacted by rolling and shall contain the optimum moisture required for maximum compaction, as nearly practicable and as determined by the soils engineer. The moisture content shall be uniform throughout all layers. If in the opinion of the soils engineer it is not possible to obtain moisture content by adding water on the fill surface, the contractor may be required to add the necessary moisture to backfill material in the borrow area.

*Compaction*: When the moisture condition and content of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer to **95% ASTM D698 (Standard Proctor Density) for slab areas, and 98% ASTM D698 for footing and/or pad areas.** A Standard Proctor test is to be performed for each typical fill material and frequent tests of the density of the fill must be taken.

In general, to compact cohesion-less free-draining materials, *the above guidelines also apply.*

When compacting cohesion-less free-draining materials such as gravel and sand, the materials shall be deposited in layers and compacted by treads of a crawler type tractor, surface of internal vibrators, pneumatic or smooth rollers, power or hand tampers, or by any other means approved by the soils engineer. The thickness of the horizontal layers after compaction is not to exceed 6 inches compacted thickness if compaction is performed by tractor treads, surface vibrators or similar equipment, or not more than penetrating length of the vibrator head if compaction is performed by internal vibrators. When the moisture content and condition of each spread layer is satisfactory, it shall be compacted by a method approved by the soils engineer **to 91% ASTM D1557 (Modified Proctor Density) for slab areas, and 94% ASTM D1557 for footing and/or pad areas.**

## CONSTRUCTION DETAILS – GENERAL COMMENTS:

In any soil investigation, it is necessary to assume that the subsurface soil conditions do not vary greatly from the conditions encountered in the field and laboratory testing. The accompanying design is presented using best professional judgment based on the limits of the extent of testing commissioned by the client. Our experience has been that at times, soil conditions do change and variations do occur. These may become first apparent at the time of excavation for the foundation system.

**If soils conditions are encountered which appear different from the test borings as presented in this report, it is required that this office be called to make an observation of the open excavation prior to placing the footings. The cost of this observation is not part of this report.**

This project should be constructed by a qualified contractor with experience in similar projects. The owner/builder is advised to observe and document the construction process to ensure the construction is performed in accordance with the design drawings and technical specifications. **The foundation and retaining walls must be well cured and well braced prior to backfilling**.

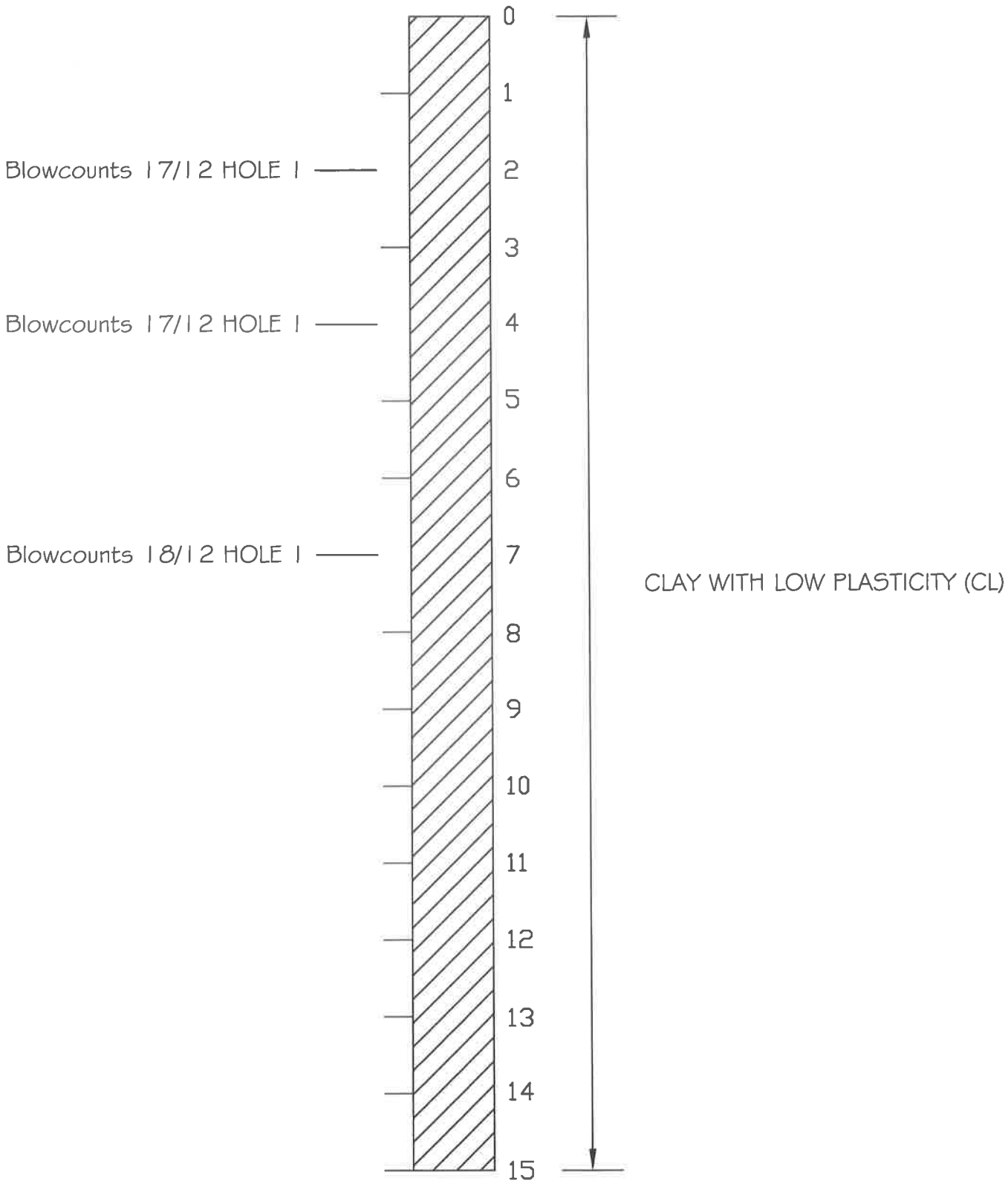
This report does not address general hillside stability, landslide potential, and/or other natural hazards. Several areas in the Colorado Front Range have known geologic hazards associated with them. We recommend that readers of this report educate themselves further as to the existence of geologic hazards on or around their specific property of interest. The Colorado Geologic Survey {www.geosurvey.state.co.us or 303-866-2611} is a good source for publications (maps, reports, etc.) dealing with specific geologic issues and/or issues related to specific geographic areas.

## DISCLAIMER:

We do not guarantee the performance of the project in any respect, but only that our engineering work and judgments rendered meet the standard care of our profession. The presence of underground workings (e.g. coal mines) and subsidence potential from any workings was not part of this investigation. The owner should contact the State and County agencies to determine if mining has been conducted in the area and if any precautions are recommended.

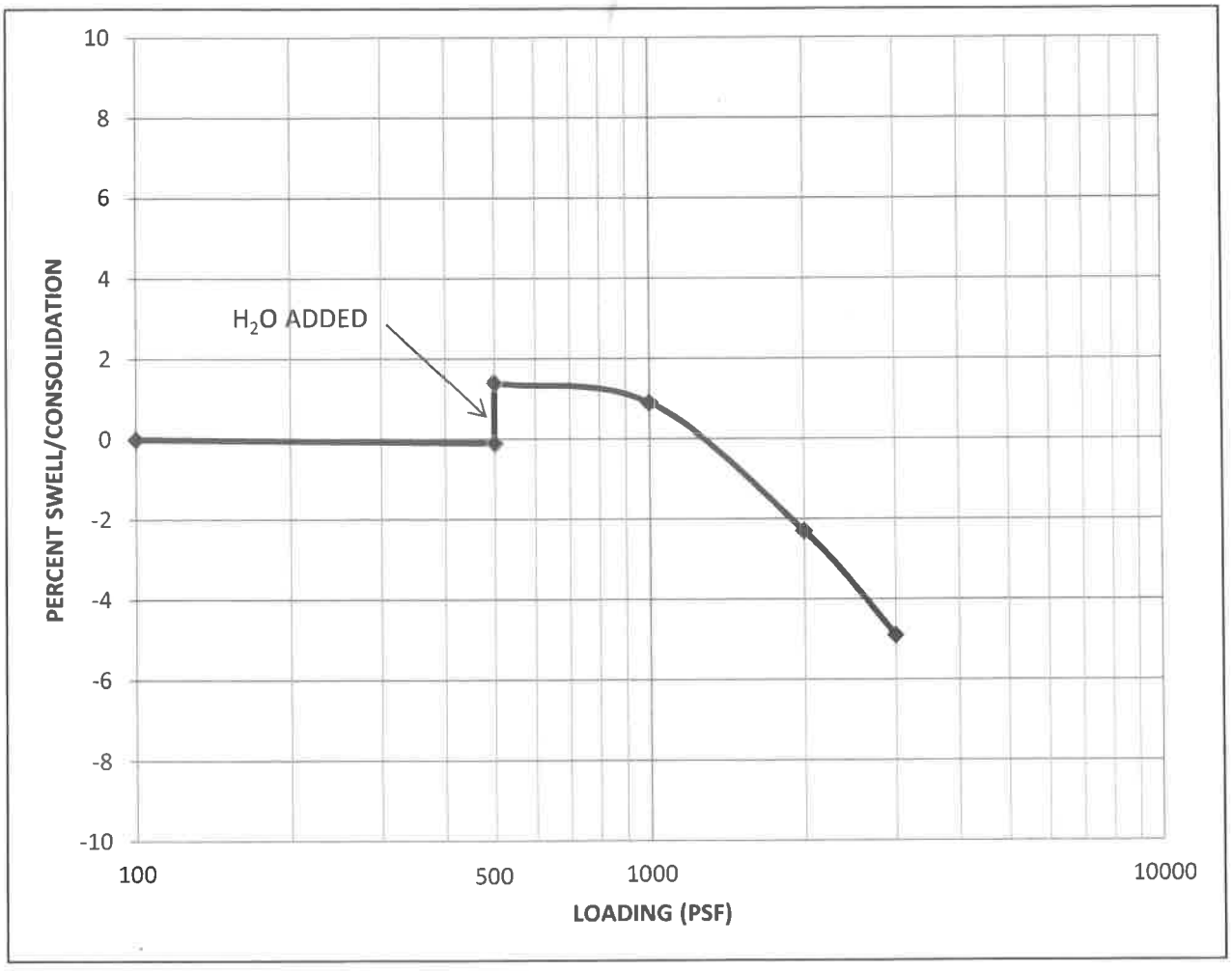
THE PARTIES SPECIFICALLY AGREE THAT *HIGH PLAINS ENGINEERING & DESIGN, LLC*. HAS NOT BEEN RETAINED NOR WILL THEY RENDER AN OPINION CONCERNING ANY ENVIRONMENTAL ISSUES, HAZARDOUS WASTE OR ANY OTHER KNOWN OR UNKNOWN CONDITIONS THAT MAY BE PRESENT ON SITE.

**DUE TO CHANGING TECHNOLOGY, BUILDING CODES AND CITY/COUNTY REQUIREMENTS, THIS SOIL REPORT MUST BE USED WITHIN ONE YEAR OF THE DATE ON THE FRONT OF THE REPORT OR MUST BE REVISED.**




TEST HOLE(S) 1 & 2

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

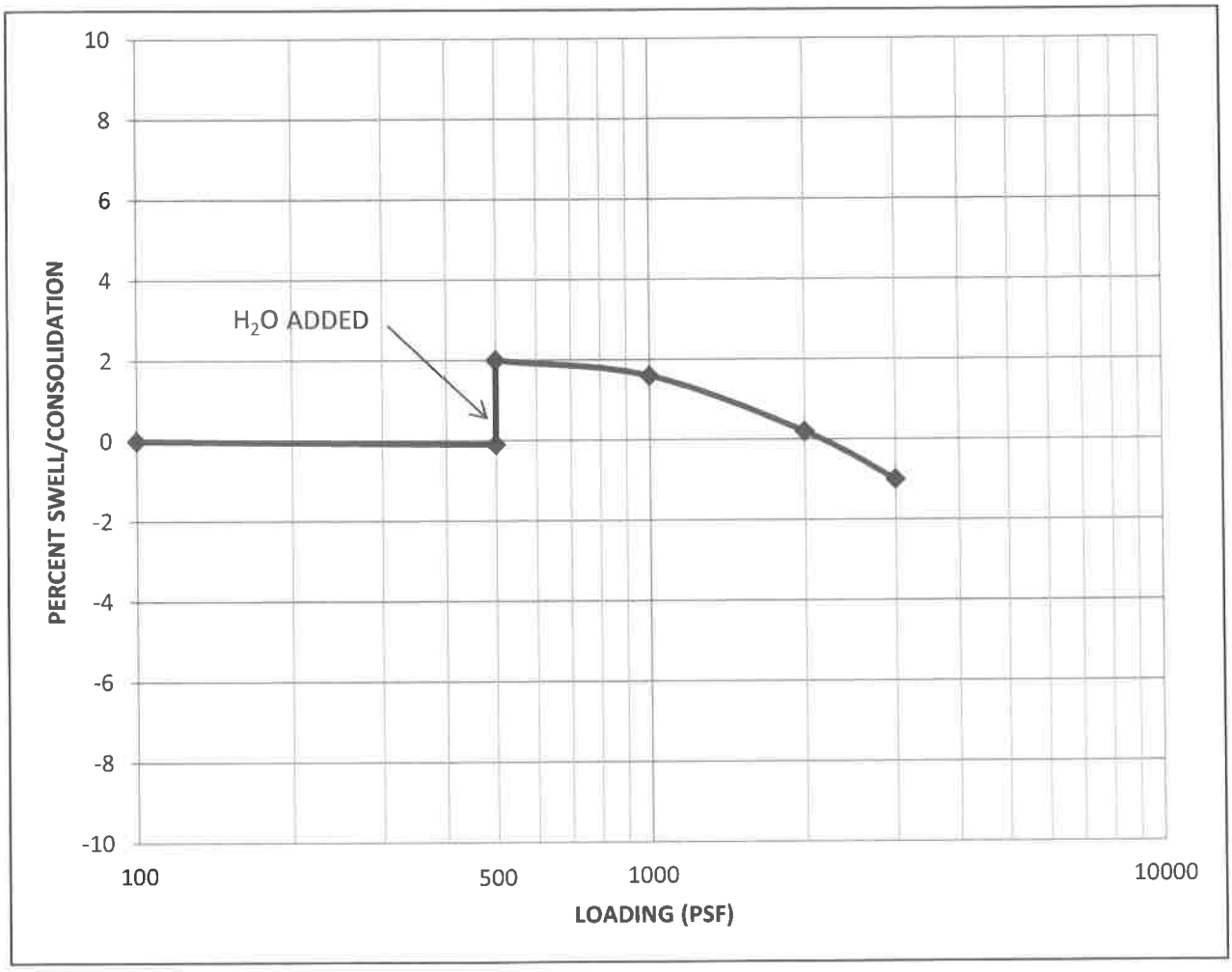



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 2' BC | 37.81 | 24.14 | 13.67 | 1.5 | | 9.94 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH LOW PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9437 | **JOB LOCATION:** |
| **DATE:** | 1/29/20 | FUTURE 7.16 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 7, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238

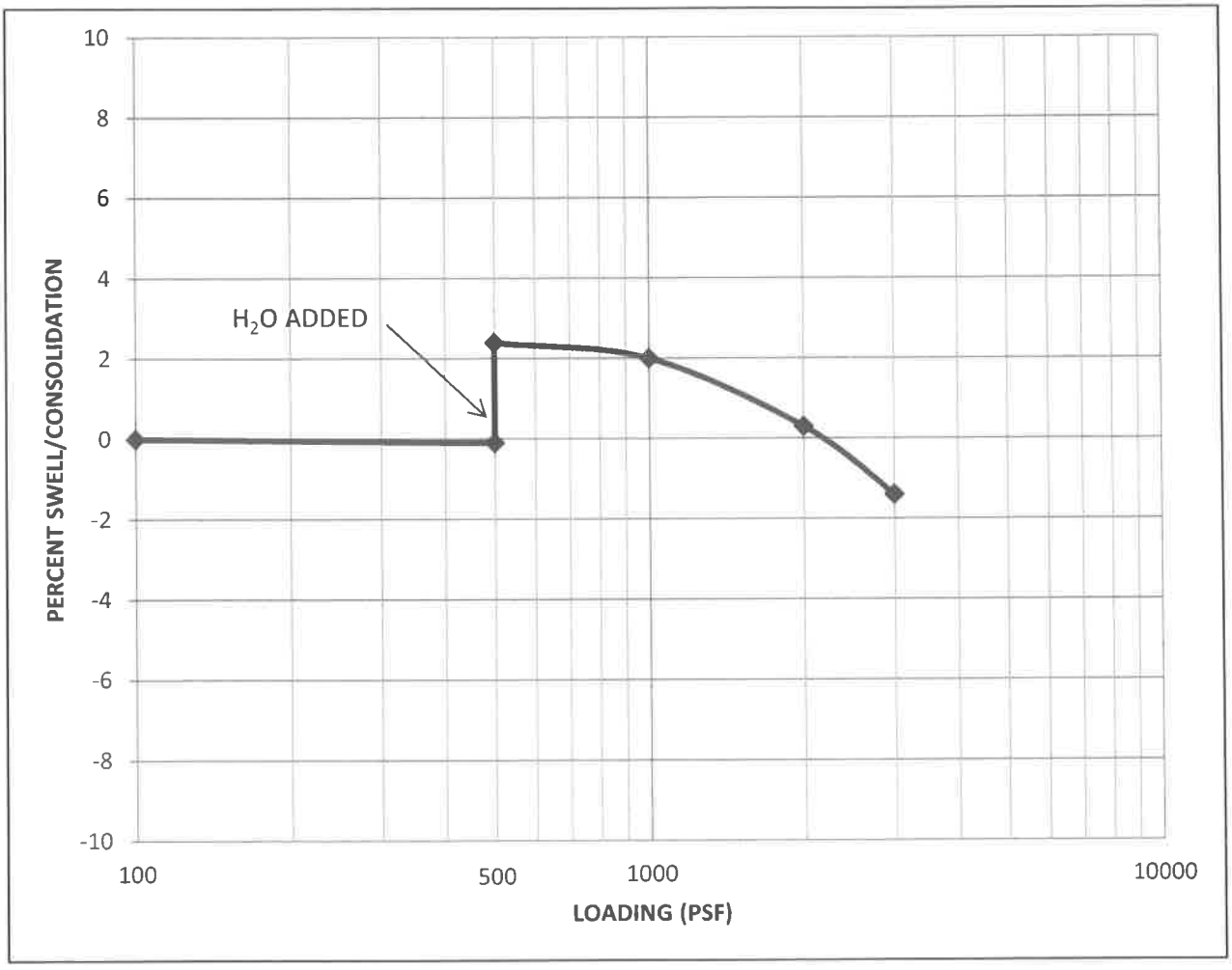



| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 4' BC | 35.53 | 21.68 | 13.85 | 2.1 | | 9.38 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH LOW PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9437 | **JOB LOCATION:** |
| **DATE:** | 1/29/20 | FUTURE 7.16 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 7, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 80642 • PHONE: 303-857-9280 • FAX: 303-857-9238



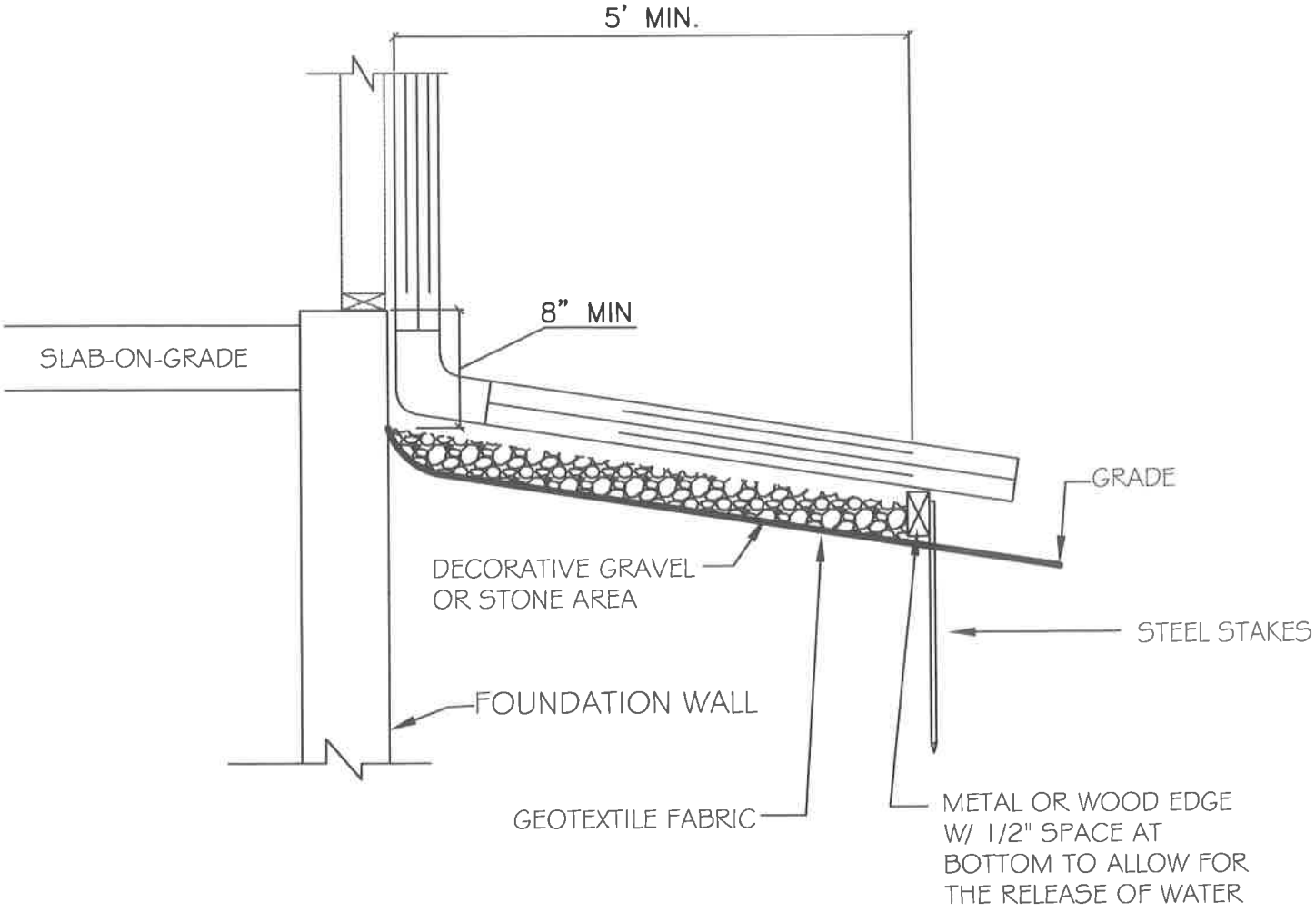

| HOLE # | DEPTH | L.L. | P.L. | P.I. | % EXPANSION | % CONSOLIDATION | % MOISTURE |
|---|---|---|---|---|---|---|---|
| 1 | 7' BC | 36.07 | 21.74 | 14.33 | 2.5 | | 10.31 |

| | |
|---|---|
| SOIL TYPE: | CLAY WITH MEDIUM PLASTICITY (CL) |

| | | |
|---|---|---|
| **JOB NO:** | 19-9437 | **JOB LOCATION:** |
| **DATE:** | 1/29/20 | FUTURE 7.16 ACRE PARCEL LOCATED WITHIN PARCEL 130319300014 |
| **DRAWN:** | KELSEY | LOT 7, A PART OF THE SW1/4 OF SEC. 19, T2N, R63W OF THE 6TH P.M. |
| **CHECKED:** | TMS | WELD COUNTY, CO |

HIGH PLAINS ENGINEERING & DESIGN, LLC
555 MAIN STREET, P.O. BOX 1077, HUDSON, CO 806420 PHONE (303) 857-9280 FAX (303) 857-9238

# FOUNDATION GRADING DETAIL

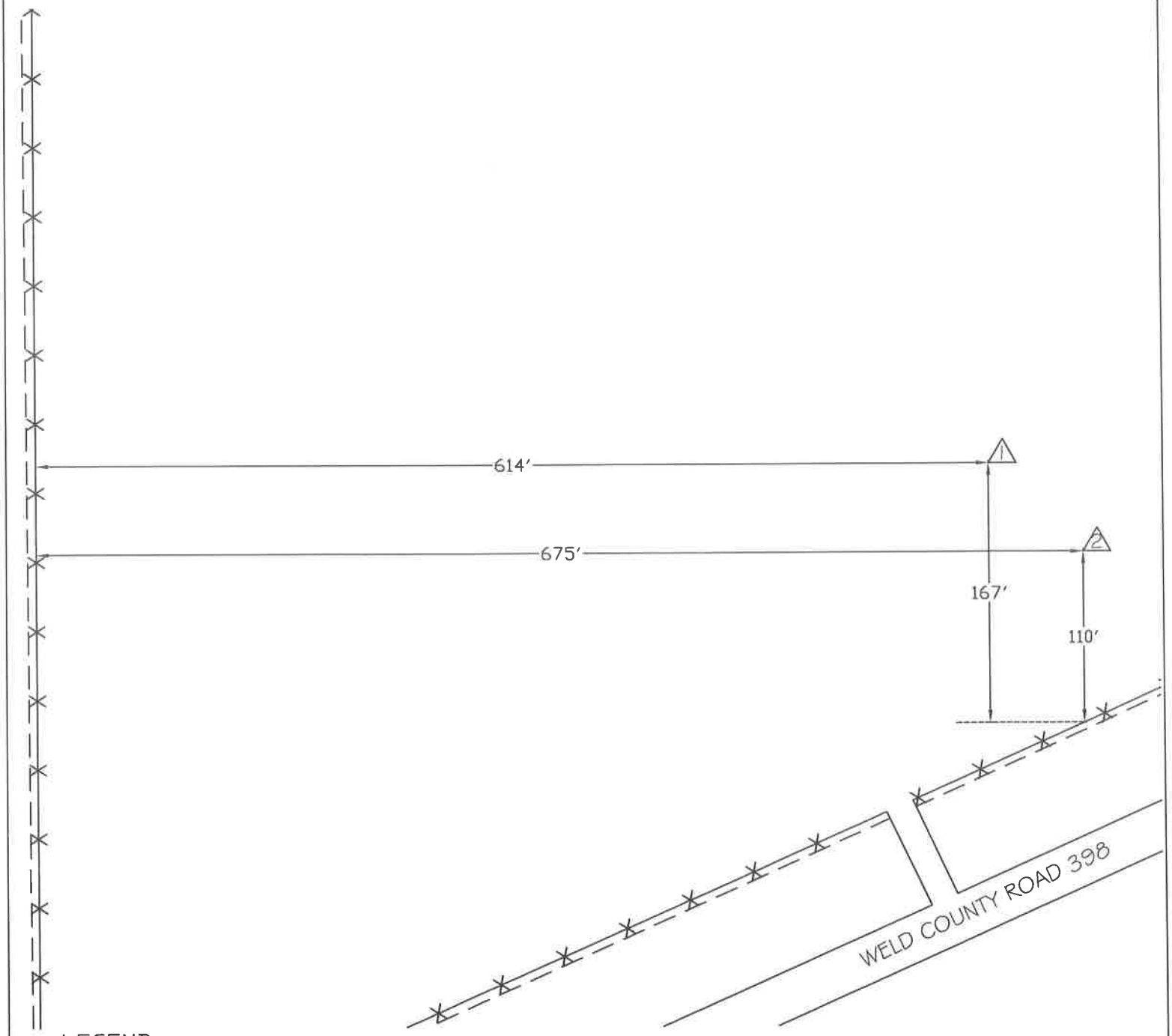



## NOTE

1. PROVIDE A MINIMUM SLOPE OF 12" IN THE FIRST 10'-0" FROM FOUNDATION (10%)
2. DOWNSPOUTS AND EXTENSIONS SHOULD EXTEND BEYOND THE GRAVEL OR STONE AREA
3. HARDSCAPING NEXT TO FOUNDATION SHOULD SLOPE AWAY AT 2% SLOPE

# SITE MAP

FUTURE 7.16 ACRE PARCEL CURRENTLY LOCATED WITHIN PARCEL 1303193000014
LOT 7, A PART OF THE SW1/4 OF SECTION 19, T2N, R63W OF THE 6TH P.M.
WELD COUNTY, CO




LEGEND

- o – Percolation Test Hole
- X – Percolation Profile Hole
- △ – Soil Profile Hole
- ✳✳ – Fence
- ☆ – Bench Mark
- ▯ – Soil Pit

All locations shown above are based on specific information furnished by others or estimates made in the field by High Plains Engineering & Design personnel. The locations, distances, directions, etc. are not the result of a property survey but are approximations and are not warranted to be exact. It is the owner/builder's responsibility to define property - boundaries and ensure all onsite improvements are located within the platted site and out of inappropriate easements. All distances are to be verified prior to excavation.

# APPENDIX B

**Rational Method Runoff Calculations**

| HISTORIC RUNOFF TABLE (RK Annexation) | | | | | | | |
|---|---|---|---|---|---|---|---|
| BASIN | Impervious | C-YR | I | A | CIA(YR-historic) | Flow | DESIGN POINT |
| H | | | | | | | |
| **$C_5$ (UDFCD 2017)** | 2.00 | 0.01 | 1.96 | 15.06 | 0.29 | cfs | HE1 |
| | | | | | | | |
| **$C_{100}$** | 2.00 | 0.44 | 4.57 | 15.06 | 30.27 | cfs | |
| | | | | | | | |

# RK ANNEX - HISTORIC RUNOFF CALCS

for D soils - $C_5$ $C_{10}$ $C_{100}$ = from Table RO-5

**for Ti calculations - only $C_5$ is used

**Ti= (.395*(1.1-$C_{yr}$)*($L^{.5}$)) / $(S)^{.333}$**
From UDFCD 2016, Equation 6-3

| | 5 | 10 | 100 |
|---|---|---|---|
| 1-Hour Point Rainfall | **1.14** | **1.42** | **2.66** |

2017 UDFCD >>> Tc Check = (26-17i) + [Ltravel / (60*(14i + 9)(So)^.5)]

**H** — **Existing - 5, 10, 100 yr** — **15.060** acres

100% NCS TYPE B

| | | Length | Slope | $C_{yr}$ - see frequency left | Ti** | Velocity | Tt | Tc | check | Use Tc | I | A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | initial | 989 | 0.010 | 0.01 | 62.75 | 1.00 | 0.00 | 62.75 | 25.66 | 25.66 | 1.96 | 15.06 | **$CIA_{5\ existing}$** 0.29 **cfs** |
| | travel | 0 | 0.010 | | | | | | | | | | |
| **10yr** | | 989 | | 0.07 | 62.75 | 1.00 | 0.00 | 62.75 | 25.66 | 25.66 | 2.44 | 15.06 | **$CIA_{10\ existing}$** 2.57 **cfs** |
| | Overland flow only | | | | | | | | | | | | |
| | Overland distance 1049 ft, limited to 500 ft per UDFCD RO 2.4.1 | | | | | | | | | | | | |
| **100yr** | Remainder carried as travel | Cv= | 10 | 0.44 | 62.75 | 1.00 | 0.00 | 62.75 | 25.66 | 25.66 | 4.57 | 15.06 | **$CIA_{100\ existing}$** 30.27 **cfs** |

15.060 acres

| **H** | **Undeveloped** | **Building** | **Asphalt** | **Concrete** | **Gravel (packed)** | **EFFECTIVE** |
|---|---|---|---|---|---|---|
| 100% NCS TYPE B | | | | | | |
| Imperviousness % | 2 | 90.00 | 100.00 | 90.00 | 40.00 | **2.00** |
| **C5** | 0.01 | 0.76 | 0.86 | 0.76 | 0.32 | **0.01** |
| C10 | 0.07 | 0.78 | 0.86 | 0.78 | 0.38 | **0.07** |
| **C100** | 0.44 | 0.84 | 0.89 | 0.84 | 0.61 | **0.44** |
| AREA | 15.060 | 0.00 | 0.00 | 0.00 | 0.00 | 15.06 |

0.000 acres

| **H-I76** | **Undeveloped** | **Building** | **Asphalt** | **Concrete** | **Gravel (packed)** | **EFFECTIVE** |
|---|---|---|---|---|---|---|
| Use NCS Type C | | | | | | |
| I | 2 | 90.00 | 100.00 | 90.00 | 40.00 | **#DIV/0!** |
| **C5** | 0.07 | 0.83 | 0.92 | 0.83 | 0.40 | **#DIV/0!** |
| C10 | 0.22 | 0.87 | 0.94 | 0.87 | 0.50 | **#DIV/0!** |
| **C100** | 0.52 | 0.91 | 0.96 | 0.91 | 0.69 | **#DIV/0!** |
| AREA | 0.000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

TABLE RO-2 (taken from UDFCD Manual - Vol. I)

| Type of Land Surface | Conveyance coefficient, Cv |
|---|---|
| Heavy Meadow | 2.5 |
| Tillage/field | 5 |
| Short pasture/Lawns | 7 |
| Nearly Bare Ground | 10.00 |
| Grassed Waterway | 15.00 |
| Paved areas and shallow paved swales | 20.00 |

| EXISTING RUNOFF TABLE (RK Annexation) | | | | | | | |
|---|---|---|---|---|---|---|---|
| BASIN | Impervious | C-YR | I | A | CIA(YR-existing) | Flow | DESIGN POINT |
| E | | | | | | | |
| **C5 (UDFCD 2017)** | 2.00 | 0.01 | 1.96 | 15.06 | 0.29 | cfs | E1 |
| | | | | | | | |
| **$C_{100}$** | 2.00 | 0.44 | 4.57 | 15.06 | 30.27 | cfs | |
| | | | | | | | |
| OFF N | | | | | | | |
| **C5 (UDFCD 2017)** | 3.66 | 0.02 | 0.83 | 19.74 | 0.39 | cfs | O1 |
| | | | | | | | |
| **$C_{100}$** | 3.66 | 0.45 | 1.94 | 19.74 | 17.17 | cfs | |
| | | | | | | | |
| OFF W | | | | | | | |
| **C5 (UDFCD 2017)** | 6.00 | 0.04 | 1.05 | 25.84 | 1.15 | cfs | O2 |
| | | | | | | | |
| **$C_{100}$** | 6.00 | 0.46 | 2.44 | 25.84 | 28.93 | cfs | |
| | | | | | | | |

# RK ANNEX - EXISTING RUNOFF CALCS

for D soils - $C_5$ $C_{10}$ $C_{100}$ = from Table RO-5

**for Ti calculations - only $C_5$ is used

**Ti= (.395*(1.1-$C_{yr}$)*($L^{.5}$)) / $(S)^{.333}$**
From UDFCD 2016, Equation 6-3

| | 5 | 10 | 100 |
|---|---|---|---|
| 1-Hour Point Rainfall | **1.14** | **1.42** | **2.66** |

2017 UDFCD >>> Tc Check = (26-17i) + [Ltravel / (60*(14i + 9)(So)^.5)]

**E** — **Existing - 5, 10, 100 yr** — **15.060** acres

100% NCS TYPE B

| | | Length | Slope | $C_{yr}$ - see frequency left | Ti** | Velocity | Tt | Tc | check | Use Tc | I | A | $CIA_{5\ existing}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | | | | 0.01 | 56.54 | 1.24 | 0.00 | 56.54 | 25.66 | 25.66 | 1.96 | 15.06 | 0.29 | **cfs** |
| | initial | 1,075 | 0.016 | | | | | | | | | | | |
| | travel | 0 | 0.016 | | | | | | | | | | $CIA_{10\ existing}$ | |
| **10yr** | | 1075 | | 0.07 | 56.54 | 1.24 | 0.00 | 56.54 | 25.66 | 25.66 | 2.44 | 15.06 | 2.57 | **cfs** |
| | Overland distance 960 ft, limited to 500 ft per UDFCD RO 2.4.1 | | | | | | | | | | | | | |
| | Remainder carried as travel | | | | | | | | | | | | $CIA_{100\ existing}$ | |
| **100yr** | | Cv= | 10 | 0.44 | 56.54 | 1.24 | 0.00 | 56.54 | 25.66 | 25.66 | 4.57 | 15.06 | 30.27 | **cfs** |

---

**OFF N** — **Existing - 5, 10, 100 yr** — **19.739** acres

100% NCS TYPE B

| | | Length | Slope | $C_{yr}$ - see frequency left | Ti** | Velocity | Tt | Tc | check | Use Tc | I | A | $CIA_{5\ existing}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | | | | 0.02 | 95.76 | 1.14 | 0.00 | 95.76 | 25.38 | 95.76 | 0.83 | 19.74 | 0.39 | **cfs** |
| | initial | 2,203 | 0.009 | | | | | | | | | | | |
| | travel | 0 | 0.009 | | | | | | | | | | $CIA_{10\ existing}$ | |
| **10yr** | | 2203 | | 0.08 | 95.76 | 1.14 | 0.00 | 95.76 | 25.38 | 95.76 | 1.04 | 19.74 | 1.71 | **cfs** |
| | | | | | | | | | | | | | $CIA_{100\ existing}$ | |
| **100yr** | | Cv= | 12 | 0.45 | 95.76 | 1.14 | 0.00 | 95.76 | 25.38 | 95.76 | 1.94 | 19.74 | 17.17 | **cfs** |

---

**OFF W** — **Existing - 5, 10, 100 yr** — **25.844** acres

100% NCS TYPE B

| | | Length | Slope | $C_{yr}$ - see frequency left | Ti** | Velocity | Tt | Tc | check | Use Tc | I | A | $CIA_{5\ existing}$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | | | | 0.04 | 69.00 | 1.37 | 0.00 | 69.00 | 24.98 | 69.00 | 1.05 | 25.84 | 1.15 | **cfs** |
| | initial | 1,513 | 0.013 | | | | | | | | | | | |
| | travel | 0 | 0.013 | | | | | | | | | | $CIA_{10\ existing}$ | |
| **10yr** | | 1513 | | 0.10 | 69.00 | 1.37 | 0.00 | 69.00 | 24.98 | 69.00 | 1.31 | 25.84 | 3.46 | **cfs** |
| | | | | | | | | | | | | | $CIA_{100\ existing}$ | |
| **100yr** | | Cv= | 12 | 0.46 | 69.00 | 1.37 | 0.00 | 69.00 | 24.98 | 69.00 | 2.44 | 25.84 | 28.93 | **cfs** |

---

15.060 acres

| **E** | **Undeveloped** | **Building** | **Asphalt** | **Concrete** | **Gravel (packed)** | |
|---|---|---|---|---|---|---|
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| Imperviousness % | 2 | 90.00 | 100.00 | 90.00 | 40.00 | **2.00** |
| C5 | 0.01 | 0.76 | 0.86 | 0.76 | 0.32 | **0.01** |
| **C10** | 0.07 | 0.78 | 0.86 | 0.78 | 0.38 | **0.07** |
| **C100** | 0.44 | 0.84 | 0.89 | 0.84 | 0.61 | **0.44** |
| AREA | 15.060 | 0.00 | 0.00 | 0.00 | 0.00 | 15.06 |

19.739 acres

| **OFF N** | **Undeveloped** | **Building** | **Asphalt** | **Concrete** | **Gravel (packed)** | |
|---|---|---|---|---|---|---|
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| I | 2 | 90.00 | 100.00 | 90.00 | 40.00 | **3.66** |
| C5 | 0.01 | 0.76 | 0.86 | 0.76 | 0.32 | **0.02** |
| **C10** | 0.07 | 0.78 | 0.86 | 0.78 | 0.38 | **0.08** |
| **C100** | 0.44 | 0.84 | 0.89 | 0.84 | 0.61 | **0.45** |
| AREA | 19.122 | 0.18 | 0.00 | 0.00 | 0.43 | 19.74 |

25.844 acres

| **OFF W** | **Undeveloped** | **Building** | **Asphalt** | **Concrete** | **Gravel (packed)** | |
|---|---|---|---|---|---|---|
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| Imperviousness % | 2 | 90.00 | 100.00 | 90.00 | 40.00 | **6.00** |
| C5 | 0.01 | 0.76 | 0.86 | 0.76 | 0.32 | **0.04** |
| **C10** | 0.07 | 0.78 | 0.86 | 0.78 | 0.38 | **0.10** |
| **C100** | 0.44 | 0.84 | 0.89 | 0.84 | 0.61 | **0.46** |
| AREA | 23.123 | 0.00 | 0.00 | 0.00 | 2.72 | 25.84 |

0.275 acres

| **ROW 398** | **Undeveloped** | **Building** | **Asphalt** | **Concrete** | **Gravel (packed)** | |
|---|---|---|---|---|---|---|
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| I | 2 | 90.00 | 100.00 | 90.00 | 40.00 | **2.00** |
| C5 | 0.01 | 0.76 | 0.86 | 0.76 | 0.32 | **0.01** |
| **C10** | 0.07 | 0.78 | 0.86 | 0.78 | 0.38 | **0.07** |
| **C100** | 0.44 | 0.84 | 0.89 | 0.84 | 0.61 | **0.44** |
| AREA | 0.275 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 |

25.844 acres

| **OFF W** | **Undeveloped** | **Building** | **Asphalt** | **Concrete** | **Gravel (packed)** | |
|---|---|---|---|---|---|---|
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| Imperviousness % | 2 | 90 | 100 | 90 | 40 | **6.00** |
| **C5** | 0.01 | 0.76 | 0.86 | 0.76 | 0.32 | **0.04** |
| **C10** | 0.07 | 0.78 | 0.86 | 0.78 | 0.38 | **0.10** |
| **C100** | 0.44 | 0.84 | 0.89 | 0.84 | 0.61 | **0.46** |
| AREA | 23.123 | 0 | 0 | 0 | 2.72 | 25.84 |

| TABLE RO-2 (taken from UDFCD Manual - Vol. I) | |
|---|---|
| Type of Land Surface | Conveyance coefficient, Cv |
| Heavy Meadow | 2.5 |
| Tillage/field | 5 |
| Short pasture/Lawns | 7 |
| Nearly Bare Ground | 10.00 |
| Grassed Waterway | 15.00 |
| Paved areas and shallow paved swales | 20.00 |

| DEVELOPED (RK Annexation) | | | | | | | |
|---|---|---|---|---|---|---|---|
| BASIN | Impervious | C-YR | I | A | CIA(YR-DEVELOPED) | cfs | DESIGN POINT |
| LOT 1 | | | | | | | |
| **C5 (UDFCD 2017)** | 40.92 | 0.34 | 2.00 | 1.96 | 1.32 | cfs | 1 |
| | | | | | | | |
| **$C_{100}$** | 40.92 | 0.62 | 4.68 | 1.96 | 5.65 | cfs | 1 |
| | | | | | | | |
| LOT 2 | | | | | | | |
| **$C_5$** | 42.16 | 0.35 | 3.87 | 1.70 | 2.28 | cfs | 2 |
| | | | | | | | |
| **$C_{100}$** | 42.16 | 0.62 | 9.02 | 1.70 | 9.53 | cfs | 2 |
| | | | | | | | |
| LOT 3 | | | | | | | |
| **$C_5$** | 31.37 | 0.26 | 1.89 | 1.65 | 0.80 | cfs | 3 |
| | | | | | | *cfs* | |
| **$C_{100}$** | 31.37 | 0.57 | 4.40 | 1.65 | 4.16 | cfs | 3 |
| | | | | | | *cfs* | |
| LOT 4 | | | | | | | |
| **$C_5$** | 41.34 | 0.34 | 2.21 | 2.00 | 1.50 | cfs | 4 |
| | | | | | | *cfs* | |
| **$C_{100}$** | 41.34 | 0.62 | 5.16 | 2.00 | 6.38 | cfs | 4 |
| | | | | | | *cfs* | |
| LOT 5 | | | | | | | |
| **$C_5$** | 40.92 | 0.34 | 2.12 | 1.95 | 1.39 | cfs | 5 |
| | | | | | | *cfs* | |
| **$C_{100}$** | 40.92 | 0.62 | 4.95 | 1.95 | 5.95 | cfs | 5 |
| | | | | | | *cfs* | |
| LOT 6 | | | | | | | |
| **$C_5$** | 42.16 | 0.35 | 2.15 | 2.32 | 1.73 | cfs | 6 |
| | | | | | | | |
| **$C_{100}$** | 42.16 | 0.62 | 5.03 | 2.32 | 7.23 | cfs | 6 |
| | | | | | | | |
| LOT 7 | | | | | | | |
| **$C_5$** | 31.37 | 0.26 | 1.92 | 2.18 | 1.07 | cfs | 7 |
| | | | | | | | |
| **$C_{100}$** | 31.37 | 0.57 | 4.48 | 2.18 | 5.60 | cfs | 7 |
| | | | | | | | |
| ROW RK | | | | | | | |
| **$C_5$** | 41.34 | 0.34 | 2.30 | 0.73 | 0.57 | cfs | 8 |
| | | | | | | | |
| **$C_{100}$** | 41.34 | 0.62 | 5.38 | 0.73 | 2.43 | cfs | 8 |
| | | | | | | | |

# RK ANNEX - DEVELOPED RUNOFF CALCS (25.5% Max Bldg-Pavement)

See below for effective C values as calculated from Table RO-5

**for Ti calculations - only $C_5$ is used

**Ti= (.395*(1.1-$C_{yr}$)*(L^.5)) / (S)^.333**
From UDFCD 2016, Equation 6-3

| | **5** | **10** | **100** |
|---|---|---|---|
| **Point Rainfall** | **1.14** | **1.42** | **2.66** |

2017 UDFCD >>> Tc Check = (26-17i) + [Ltravel / (60*(14i + 9)(So)^.5)]

**LOT 1** — **Developed -5, 10, 100 yr** — **1.96** acres — 100% NCS TYPE B

| | | Length | Slope | $C_5$ | Ti | Velocity | Tt | Tc | check | Use Tc | $C_{yr}$ - see above | I | A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | initial | 99 | 0.004 | 0.34 | 17.90 | 1.08 | 6.71 | 24.60 | 25.87 | 24.60 | 0.34 | 2.00 | 1.96 | **$CIA_{5\ developed}$** 1.32 **cfs** |
| | travel | 435 | 0.005 | | | | | | | | | | | |
| **10yr** | | | | 0.34 | 17.90 | 1.08 | 6.71 | 24.60 | 25.87 | 24.60 | 0.39 | 2.50 | 1.96 | **$CIA_{10\ developed}$** 1.89 **cfs** |
| | | Cv= | 15.00 | | | | | | | | | | | |
| **100yr** | | | | 0.34 | 17.90 | 1.08 | 6.71 | 24.60 | 25.87 | 24.60 | 0.62 | 4.68 | 1.96 | **$CIA_{100\ developed}$** 5.65 **cfs** |

**LOT 2** — **Developed -5, 10, 100 yr** — **1.70** acres — 100% NCS TYPE B

| | | Length | Slope | $C_5$ | Ti | Velocity | Tt | Tc | check | Use Tc | $C_{yr}$ - see above | I | A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | initial | 130 | 0.003 | 0.35 | 24.61 | 0.64 | 13.71 | 38.32 | 32.63 | 5.00 | 0.35 | 3.87 | 1.70 | **$CIA_{5\ developed}$** 2.28 **cfs** |
| | travel | 523 | 0.002 | | | | | | | | | | | |
| **10yr** | | | | 0.35 | 24.61 | 0.64 | 13.71 | 38.32 | 32.63 | 5.00 | 0.40 | 4.82 | 1.70 | **$CIA_{10\ developed}$** 3.24 **cfs** |
| | | Cv= | 15.00 | | | | | | | | | | | |
| **100yr** | | | | 0.35 | 24.61 | 0.64 | 13.71 | 38.32 | 32.63 | 5.00 | 0.62 | 9.02 | 1.70 | **$CIA_{100\ developed}$** 9.53 **cfs** |

**LOT 3** — **Developed -5, 10, 100 yr** — **1.65** acres — 100% NCS TYPE B

| | | Length | Slope | $C_5$ | Ti | Velocity | Tt | Tc | check | Use Tc | $C_{yr}$ - see above | I | A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | initial | 120 | 0.005 | 0.26 | 20.68 | 1.12 | 6.00 | 26.68 | 27.39 | 27.39 | 0.26 | 1.89 | 1.65 | **$CIA_{5\ developed}$** 0.80 **cfs** |
| | travel | 404 | 0.006 | | | | | | | | | | | |
| **10yr** | Overland distance 1790 ft, limited to 500 ft per UDFCD RO 2.4.1 Remainder carried as travel | | | 0.26 | 20.68 | 1.12 | 6.00 | 26.68 | 27.39 | 27.39 | 0.31 | 2.35 | 1.65 | **$CIA_{10\ developed}$** 1.20 **cfs** |
| | | Cv= | 15.00 | | | | | | | | | | | |
| **100yr** | | | | 0.26 | 20.68 | 1.12 | 6.00 | 26.68 | 27.39 | 27.39 | 0.57 | 4.40 | 1.65 | **$CIA_{100\ developed}$** 4.16 **cfs** |

**LOT 4** — **Developed -5, 10, 100 yr** — **2.00** acres — 100% NCS TYPE B

| | | Length | Slope | C5 | Ti | Velocity | Tt | Tc | check | Use Tc - see above | | I | A | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **5yr** | initial | 184 | 0.028 | 0.34 | 15.31 | 1.44 | 1.57 | 16.88 | 20.57 | 20.57 | 0.34 | 2.21 | 2.00 | **CIA5 developed** 1.50 **cfs** |
| | travel | 136 | 0.009 | | | | | | | | | | | |
| **10yr** | | | | 0.34 | 15.31 | 1.44 | 1.57 | 16.88 | 20.57 | 20.57 | 0.39 | 2.75 | 2.00 | **CIA10 developed** 2.14 **cfs** |
| | | Cv= | 15.00 | | | | | | | | | | | |
| **100yr** | | | | 0.34 | 15.31 | 1.44 | 1.57 | 16.88 | 20.57 | 20.57 | 0.62 | 5.16 | 2.00 | **CIA100 developed** 6.38 **cfs** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LOT 5** | | **Developed -5, 10, 100 yr** | | | **1.95** acres | | | | | | | | | | | |
| | | 100% NCS TYPE B | | C5 | Ti | Velocity | Tt | Tc | check | Use Tc | - see above | | I | A | **CIA5 developed** | |
| | **5yr** | Length | Slope | 0.34 | 8.60 | 1.89 | 3.06 | 11.66 | 22.16 | 22.16 | 0.34 | | 2.12 | 1.95 | 1.39 | **cfs** |
| | initial | 91 | 0.059 | | | | | | | | | | | | | |
| | travel | 347 | 0.016 | | | | | | | | | | | | **CIA10 developed** | |
| | **10yr** | | | 0.34 | 8.60 | 1.89 | 3.06 | 11.66 | 22.16 | 22.16 | 0.39 | | 2.64 | 1.95 | 1.99 | **cfs** |
| | | Cv= | 15.00 | | | | | | | | | | | | **CIA100 developed** | |
| | **100yr** | | | 0.34 | 8.60 | 1.89 | 3.06 | 11.66 | 22.16 | 22.16 | 0.62 | | 4.95 | 1.95 | 5.95 | **cfs** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LOT 6** | | **Developed -5, 10, 100 yr** | | | **2.32** acres | | | | | | | | | | | |
| | | 100% NCS TYPE B | | $C_5$ | Ti | Velocity | Tt | Tc | check | Use Tc | $C_{yr}$ - see above | | I | A | **$CIA_{5\ developed}$** | |
| | **5yr** | Length | Slope | 0.35 | 5.46 | 2.35 | 2.73 | 8.19 | 21.58 | 21.58 | 0.35 | | 2.15 | 2.32 | 1.73 | **cfs** |
| | initial | 31 | 0.031 | | | | | | | | | | | | | |
| | travel | 385 | 0.025 | | | | | | | | | | | | **$CIA_{10\ developed}$** | |
| | **10yr** | | | 0.35 | 5.46 | 2.35 | 2.73 | 8.19 | 21.58 | 21.58 | 0.40 | | 2.68 | 2.32 | 2.46 | **cfs** |
| | | Cv= | 15.00 | | | | | | | | | | | | **$CIA_{100\ developed}$** | |
| | **100yr** | | | 0.35 | 5.46 | 2.35 | 2.73 | 8.19 | 21.58 | 21.58 | 0.62 | | 5.03 | 2.32 | 7.23 | **cfs** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **LOT 7** | | **Developed -5, 10, 100 yr** | | | **2.18** acres | | | | | | | | | | | |
| | | 100% NCS TYPE B | | $C_5$ | Ti | Velocity | Tt | Tc | check | Use Tc | $C_{yr}$ - see above | | I | A | **$CIA_{5\ developed}$** | |
| | **5yr** | Length | Slope | 0.26 | 9.22 | 1.42 | 5.24 | 14.46 | 26.54 | 26.54 | 0.26 | | 1.92 | 2.18 | 1.07 | **cfs** |
| | initial | 104 | 0.091 | | | | | | | | | | | | | |
| | travel | 445 | 0.009 | | | | | | | | | | | | **$CIA_{10\ developed}$** | |
| | **10yr** | | | 0.26 | 9.22 | 1.42 | 5.24 | 14.46 | 26.54 | 26.54 | 0.31 | | 2.39 | 2.18 | 1.61 | **cfs** |
| | | Cv= | 15.00 | | | | | | | | | | | | **$CIA_{100\ developed}$** | |
| | **100yr** | | | 0.26 | 9.22 | 1.42 | 5.24 | 14.46 | 26.54 | 26.54 | 0.57 | | 4.48 | 2.18 | 5.60 | **cfs** |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ROW RK** | | **Developed -5, 10, 100 yr** | | | **0.73** acres | | | | | | | | | | | |
| | | 100% NCS TYPE B | | $C_5$ | Ti | Velocity | Tt | Tc | check | Use Tc | $C_{yr}$ - see above | | I | A | **$CIA_{5\ developed}$** | |
| | **5yr** | Length | Slope | 0.34 | 38.31 | 1.46 | 0.00 | 38.31 | 18.97 | 18.97 | 0.34 | | 2.30 | 0.73 | 0.57 | **cfs** |
| | initial | 497 | 0.005 | | | | | | | | | | | | | |
| | travel | 0 | 0.005 | | | | | | | | | | | | **$CIA_{10\ developed}$** | |
| | **10yr** | | | 0.34 | 38.31 | 1.46 | 0.00 | 38.31 | 18.97 | 18.97 | 0.39 | | 2.87 | 0.73 | 0.82 | **cfs** |
| | | Cv= | 20.00 | | | | | | | | | | | | **$CIA_{100\ developed}$** | |
| | **100yr** | | | 0.34 | 38.31 | 1.46 | 0.00 | 38.31 | 18.97 | 18.97 | 0.62 | | 5.38 | 0.73 | 2.43 | **cfs** |

| | TOTAL AREA | **1.960** | acres | | | |
|---|---|---|---|---|---|---|
| **LOT 1** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **40.92** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.34** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.39** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.62** |
| AREA | 0.54 | 1.03 | 0.00 | 0.14 | 0.25 | 1.960 |

| | TOTAL AREA | **1.700** | acres | | **Water /** | |
|---|---|---|---|---|---|---|
| **LOT 2** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **42.16** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.35** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.40** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.62** |
| AREA | 0.40 | 0.96 | 0.00 | 0.14 | 0.19 | 1.700 |

| | TOTAL AREA | **2.316** | acres | | | |
|---|---|---|---|---|---|---|
| **LOT 3** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **31.37** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.26** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.31** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.57** |
| AREA | 1.02 | 0.96 | 0.00 | 0.14 | 0.19 | 2.316 |

| | TOTAL AREA | **2.001** | acres | | **Water /** | |
|---|---|---|---|---|---|---|
| **LOT 4** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 100% NCS TYPE B | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **41.34** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.34** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.39** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.62** |
| AREA | 0.55 | 1.03 | 0.00 | 0.12 | 0.29 | 2.001 |

| | TOTAL AREA | **1.950** | acres | | | |
|---|---|---|---|---|---|---|
| **LOT 5** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 119.5 | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **40.92** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.34** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.39** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.62** |
| AREA | 0.12 | 1.26 | 0.00 | 0.14 | 0.43 | 1.950 |

| | TOTAL AREA | **2.316** | acres | | **Water /** | |
|---|---|---|---|---|---|---|
| **LOT 6** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 183.8 | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **42.16** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.35** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.40** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.62** |
| AREA | 0.41 | 1.45 | 0.00 | 0.14 | 0.30 | 2.316 |

| | TOTAL AREA | **2.180** | acres | | | |
|---|---|---|---|---|---|---|
| **LOT 7** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 497.1597 | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **31.37** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.26** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.31** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.57** |
| AREA | 0.35 | 1.68 | 0.00 | 0.14 | 0.00 | 2.180 |

| | TOTAL AREA | **0.730** | acres | | **Water /** | |
|---|---|---|---|---|---|---|
| **ROW RK** | **Landscaping** | **Gravel** | **Building** | **Concrete** | **Asphalt** | |
| 2.315610652 | | | | | | **EFFECTIVE** |
| I | 2 | 40.00 | 90.00 | 90.00 | 100.00 | **41.34** |
| C5 | 0.01 | 0.32 | 0.76 | 0.76 | 0.86 | **0.34** |
| **C10** | 0.07 | 0.38 | 0.78 | 0.78 | 0.86 | **0.39** |
| **C100** | 0.44 | 0.61 | 0.84 | 0.84 | 0.89 | **0.62** |
| AREA | 0.13 | 0.11 | 0.00 | 0.00 | 0.48 | 0.730 |

| TABLE RO-2 (taken from UDFCD Manual - Vol. I) | |
|---|---|
| Type of Land Surface | Conveyance coefficient, Cv |
| Heavy Meadow | 2.5 |
| Tillage/field | 5 |
| Short pasture/Lawns | 7 |
| Nearly Bare Ground | 10.00 |
| Grassed Waterway | 15.00 |
| Paved areas and shallow paved swales | 20.00 |

# APPENDIX C

**Empirical Detention Calculations, ACSDCM, CFSCM, & UDFCD Retention Calculations, Design Pond Volumes, Channel Capacities, etc**

## OVERALL REQUIRED INFILTRATION (EMPIRICAL) per CFSCM & UDFCD

Per NOAA Atlas - 24 hr 100 yr rate of 5 inches (conservatively - value interpolated = 4.7)

Per Colorado Floodplain & Stormwater Criteria Manual (CFSCM) - retention is Tributary area X rainfall depth

Per UDFCD Volume II - Storage - 3.3.4 Retention Facilities - factor by 2.0

| | Tributary Area (ac) | Tributary Area (ft) | Noaa Rainfall (in) | CFSCM Ret Volume (cft) | UDFCD Factored 2.0 Ret Volume (cft) | Ret Volume (ac-ft) |
|---|---|---|---|---|---|---|
| **POND 1** | 1.83 | 79,776 | 5 | 33,240 | 66,480 | 1.53 |
| **POND 2-3** | 3.32 | 144,441 | 5 | 60,184 | 120,367 | 2.76 |
| **POND 4** | 2.00 | 87,167 | 5 | 36,320 | 72,639 | 1.67 |
| **POND 5-7** | 7.16 | 311,819 | 5 | 129,925 | 259,849 | 5.97 |

### WATER QUALITY CALCULATIONS

from Figure EDB-2, 40 hr drain @ I, WQCV= noted below

| BASIN | A acres | WQ (in/watershed) | WQCV ac-ft | WQCV cubic feet | TOTAL w/ 10 yr acre ft | TOTAL w/ 100 yr acre ft | TOTAL w/ 10 yr cubic feet | TOTAL w/ 100 yr cubic feet** |
|---|---|---|---|---|---|---|---|---|
| **LOT 1** | 1.96 | 0.19 | 0.04 | 1,647.4 | 0.12 | 0.20 | 5,135 | 7,700 |
| **LOT 2** | 1.70 | 0.19 | 0.03 | 1,428.8 | 0.10 | 0.17 | 4,454 | 6,679 |
| **LOT 3** | 1.65 | 0.17 | 0.03 | 1,196.1 | 0.08 | 0.13 | 3,452 | 5,098 |
| **LOT 4** | 2.00 | 0.19 | 0.04 | 1,681.9 | 0.12 | 0.20 | 5,243 | 7,862 |
| **LOT 5** | 1.95 | 0.19 | 0.04 | 1,638.9 | 0.12 | 0.19 | 5,109 | 7,661 |
| **LOT 6** | 2.32 | 0.19 | 0.04 | 1,949.9 | 0.14 | 0.23 | 6,070 | 9,099 |
| **LOT 7** | 2.18 | 0.17 | 0.04 | 1,578.6 | 0.10 | 0.17 | 4,556 | 6,729 |
| **ROW RK** | 0.73 | 0.19 | 0.01 | 613.6 | 0.04 | 0.07 | 1,913 | 2,868 |
| **TOTAL** | **14.49** | **1.49** | **0.27** | **11,735** | **0.82** | **1.37** | **35,930.55** | **53,695.95** |

** only includes 50% of WQCV

| FOREBAY | A acres | WQCV cubic feet | Min Reqd Vol % of WQCV | Min Reqd Vol cubic feet | Max Depth (in) | Forebay Dimensions | Forebay Volume (ft^3) | Release Rate 2% of Dev Q (cfs) | Weir (in) |
|---|---|---|---|---|---|---|---|---|---|
| **POND 1** | 1.96 | 1,647.4 | 2% | 32.9 | 12 | 8' * 8' | 32 | 0.11 | 1.1" |
| **POND 2/3 S** | 1.70 | 1,428.8 | 2% | 28.6 | 12 | 8' * 8' | 32 | 0.19 | 2" |
| **POND 2/3 N** | 1.65 | 1,196.1 | 2% | 23.9 | 12 | 7'*7' | 25 | 0.08 | 0.8" |
| **POND 4** | 2.00 | 1,681.9 | 2% | 33.6 | 12 | 9' * 9' | 41 | 0.13 | 1.4" |
| **POND 5/6/7 N** | 4.27 | 3,588.9 | 2% | 71.8 | 12 | 13' * 13' | 85 | 0.26 | 3.3" |
| **POND 5/6/7 N** | 2.18 | 1,578.6 | 2% | 31.6 | 12 | 9' * 9' | 41 | 0.11 | 1.3" |

# POND 1 - LOT BUILDOUT Imp = 43.65%

## 100 YEAR INFILTRATION VOLUME - WATER SURFACE

## ESTIMATED POND (TYPICAL) VOLUME vs ELEVATION

| | | | |
|---|---|---|---|
| **WQCV:** | **1,647.4 ft^3** | **4886.66** | **ELEVATION** |
| **REQUIRED 10 yr per MODIFIED FAA:** | **5,149.4 ft^3** | **4888.26** | **ELEVATION** |
| **REQUIRED 100 yr per MODIFIED FAA:** | **34,063.7 ft^3** | **4893.51** | **ELEVATION** |
| **Avail Vol @ Emer Overflow:** | **34,810.9 ft^3** | **4893.60** | **ELEVATION** |

43560

| | ELEV | AREA | t | VOL | ACCUM | ACUM (ac-ft) |
|---|---|---|---|---|---|---|
| | 4,884.80 | 534.0 | | | | |
| | | | 0.20 | 114.7 | 114.7 | 0.00 |
| | 4,885.00 | 613.5 | | | | |
| 881.36 | | | 1.00 | 841.3 | 955.9 | 0.02 |
| | 4,886.00 | 1,091.8 | | | | |
| | | | 1.00 | 1,386.6 | 2,342.6 | 0.05 |
| | 4,887.00 | 1,704.1 | | | | |
| 2,338.57 | | | 1.00 | 2,066.1 | 4,408.6 | 0.10 |
| | 4,888.00 | 2,450.5 | | | | |
| | | | 1.00 | 2,879.5 | 7,288.2 | 0.17 |
| | 4,889.00 | 3,331.0 | | | | |
| | | | 1.00 | 3,827.1 | 11,115.3 | 0.26 |
| | 4,890.00 | 4,345.6 | | | | |
| | | | 1.00 | 4,908.7 | 16,024.0 | 0.37 |
| | 4,891.00 | 5,494.3 | | | | |
| | | | 1.00 | 6,124.4 | 22,148.4 | 0.51 |
| | 4,892.00 | 6,777.0 | | | | |
| | | | 1.00 | 7,474.2 | 29,622.7 | 0.68 |
| | 4,893.00 | 8,193.9 | | | | |
| | | | 0.60 | 5,188.2 | 34,810.9 | 0.80 |
| | 4,893.60 | 9,108.3 | | | | |

**Infiltration Rates:**

| | | | | | |
|---|---|---|---|---|---|
| Using 46 min per inch >> | 4888.26 | 5 yr W/S ELEV | Using 46 min per inch >> | 4893.51 | 100 yr W/S ELEV |
| | 4,884.80 | Bottom ELEV | | 4,884.80 | Bottom ELEV |
| | 3.46 | Head (ft) | | 8.71 | Head (ft) |
| 46 min per inch = | 0.109 | ft/hour percolation | 46 min per inch = | 0.109 | ft/hour percolation |
| | 31.8 | hrs to drain 5 yr W/S | | 80.2 | hrs to drain 100 yr W/S |

# POND 2-3 - LOT BUILDOUT Imp = 32.23%

## 100 YEAR INFILTRATION VOLUME - WATER SURFACE
## ESTIMATED POND (TYPICAL) VOLUME vs ELEVATION

| | | | |
|---|---|---|---|
| **WQCV:** | **2,624.9 ft^3** | **4887.26** | **ELEVATION** |
| **REQUIRED 10 yr per MODIFIED FAA:** | **8,215.9 ft^3** | **4888.74** | **ELEVATION** |
| **REQUIRED 100 yr per MODIFIED FAA:** | **61,496.4 ft^3** | **4894.65** | **ELEVATION** |
| **Avail Vol @ Emer Overflow:** | **66,312.5 ft^3** | **4895.00** | **ELEVATION** |

43560

| ELEV | AREA | t | VOL | ACCUM | ACUM (ac-ft) |
|---|---|---|---|---|---|
| 4,886.00 | 990.0 | | | | |
| | | 1.00 | 1,776.9 | 1,776.9 | 0.04 |
| 4,887.00 | 2,704.4 | | | | |
| 3,303.43 | | 1.00 | 3,224.4 | 5,001.3 | 0.11 |
| 4,888.00 | 3,774.1 | | | | |
| | | 1.00 | 4,357.9 | 9,359.2 | 0.21 |
| 4,889.00 | 4,969.1 | | | | |
| 6,091.35 | | 1.00 | 5,616.3 | 14,975.5 | 0.34 |
| 4,890.00 | 6,289.4 | | | | |
| | | 1.00 | 6,999.7 | 21,975.3 | 0.50 |
| 4,891.00 | 7,735.0 | | | | |
| | | 1.00 | 8,508.3 | 30,483.6 | 0.70 |
| 4,892.00 | 9,305.9 | | | | |
| | | 1.00 | 10,142.1 | 40,625.8 | 0.93 |
| 4,893.00 | 11,002.1 | | | | |
| | | 1.00 | 11,901.2 | 52,527.0 | 1.21 |
| 4,894.00 | 12,823.6 | | | | |
| | | 1.00 | 13,785.5 | 66,312.5 | 1.52 |
| 4,895.00 | 14,770.4 | | | | |

**Infiltration Rates:**

| | | | | | |
|---|---|---|---|---|---|
| Using 46 min per inch >> | 4888.74 | 5 yr W/S ELEV | Using 46 min per inch >> | 4894.65 | 100 yr W/S ELEV |
| | 4,886.00 | Bottom ELEV | | 4,886.00 | Bottom ELEV |
| | 2.74 | Head (ft) | | 8.65 | Head (ft) |
| 46 min per inch = | 0.109 | ft/hour percolation | 46 min per inch = | 0.109 | ft/hour percolation |
| | 25.2 | hrs to drain 5 yr W/S | | 79.6 | hrs to drain 100 yr W/S |

# POND 4 - LOT BUILDOUT Imp = 41.34%

## 100 YEAR INFILTRATION VOLUME - WATER SURFACE

## ESTIMATED POND (TYPICAL) VOLUME vs ELEVATION

| | | | |
|---|---|---|---|
| **WQCV:** | **2,295.4 ft^3** | **4888.87** | **ELEVATION** |
| **REQUIRED 10 yr per MODIFIED FAA:** | **7,563.4 ft^3** | **4890.78** | **ELEVATION** |
| **REQUIRED 100 yr per MODIFIED FAA:** | **36,320.0 ft^3** | **4894.98** | **ELEVATION** |
| **Avail Vol @ Emer Overflow:** | **36,542.5 ft^3** | **4895.00** | **ELEVATION** |

43560

| ELEV | AREA | t | VOL | ACCUM | ACUM (ac-ft) |
|---|---|---|---|---|---|
| 4,887.00 | 653.1 | | | | |
| | | 1.00 | 922.7 | 922.7 | 0.02 |
| 4,888.00 | 1,221.7 | | | | |
| 1,634.75 | | 1.00 | 1,576.0 | 2,498.8 | 0.06 |
| 4,889.00 | 1,959.3 | | | | |
| | | 1.00 | 2,403.6 | 4,902.4 | 0.11 |
| 4,890.00 | 2,877.3 | | | | |
| 3,820.81 | | 1.00 | 3,417.2 | 8,319.6 | 0.19 |
| 4,891.00 | 3,987.3 | | | | |
| | | 1.00 | 4,623.0 | 12,942.6 | 0.30 |
| 4,892.00 | 5,289.3 | | | | |
| | | 1.00 | 6,020.9 | 18,963.5 | 0.44 |
| 4,893.00 | 6,783.4 | | | | |
| | | 1.00 | 7,675.3 | 26,638.8 | 0.61 |
| 4,894.00 | 8,603.2 | | | | |
| | | 1.00 | 9,903.7 | 36,542.5 | 0.84 |
| 4,895.00 | 11,263.7 | | | | |

**Infiltration Rates:**

| | | | | | |
|---|---|---|---|---|---|
| Using 46 min per inch >> | 4890.78 | 5 yr W/S ELEV | Using 46 min per inch >> | 4894.98 | 100 yr W/S ELEV |
| | 4,887.00 | Bottom ELEV | | 4,887.00 | Bottom ELEV |
| | 3.78 | Head (ft) | | 7.98 | Head (ft) |
| 46 min per inch = | 0.109 | ft/hour percolation | 46 min per inch = | 0.109 | ft/hour percolation |
| | 34.8 | hrs to drain 5 yr W/S | | 73.4 | hrs to drain 100 yr W/S |

# POND 5-7 - LOT BUILDOUT Imp = 34.01%

## 100 YEAR INFILTRATION VOLUME - WATER SURFACE

## ESTIMATED POND (TYPICAL) VOLUME vs ELEVATION

| | | | |
|---|---|---|---|
| **WQCV:** | **5,167.5 ft^3** | **4876.89** | **ELEVATION** |
| **REQUIRED 10 yr per MODIFIED FAA:** | **17,802.5 ft^3** | **4878.41** | **ELEVATION** |
| **REQUIRED 100 yr per MODIFIED FAA:** | **132,508.8 ft^3** | **4884.84** | **ELEVATION** |
| **REQUIRED 1.5x100 yr per MODIFIED FAA:** | **194,887.0 ft^3** | **4886.84** | **ELEVATION** |
| **Avail Vol @ Emer Overflow:** | **200,401.9 ft^3** | **4887.00** | **ELEVATION** |

43560

| | ELEV | AREA | t | VOL | ACCUM | ACUM (ac-ft) |
|---|---|---|---|---|---|---|
| | 4,876.00 | 5,161.4 | | | | |
| | | | 1.00 | 5,997.5 | 5,997.5 | 0.14 |
| | 4,877.00 | 6,874.6 | | | | |
| 7,937.03 | | | 1.00 | 7,804.0 | 13,801.5 | 0.32 |
| | 4,878.00 | 8,771.8 | | | | |
| | | | 1.00 | 9,809.1 | 23,610.6 | 0.54 |
| | 4,879.00 | 10,884.3 | | | | |
| 12,862.77 | | | 1.00 | 12,029.3 | 35,639.9 | 0.82 |
| | 4,880.00 | 13,211.9 | | | | |
| | | | 1.00 | 14,464.7 | 50,104.6 | 1.15 |
| | 4,881.00 | 15,754.7 | | | | |
| | | | 1.00 | 17,115.2 | 67,219.7 | 1.54 |
| | 4,882.00 | 18,512.7 | | | | |
| | | | 1.00 | 19,980.8 | 87,200.5 | 2.00 |
| | 4,883.00 | 21,485.8 | | | | |
| | | | 1.00 | 23,061.6 | 110,262.2 | 2.53 |
| | 4,884.00 | 24,674.2 | | | | |
| | | | 1.00 | 26,357.6 | 136,619.7 | 3.14 |
| | 4,885.00 | 28,077.6 | | | | |
| | | | 1.00 | 29,868.7 | 166,488.4 | 3.82 |
| | 4,886.00 | 31,696.3 | | | | |
| | | | 1.00 | 33,913.4 | 200,401.9 | 4.60 |
| | 4,887.00 | 36179.96 | | | | |

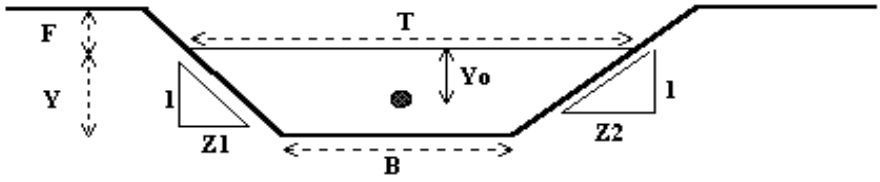
**Infiltration Rates:**

| | | | | | |
|---|---|---|---|---|---|
| Using 46 min per inch >> | 4878.41 | 5 yr W/S ELEV | Using 46 min per inch >> | 4886.84 | 1.5x100 yr W/S ELEV |
| | 4,876.00 | Bottom ELEV | | 4,876.00 | Bottom ELEV |
| | 2.41 | Head (ft) | | 10.84 | Head (ft) |
| 46 min per inch = | 0.109 | ft/hour percolation | 46 min per inch = | 0.109 | ft/hour percolation |
| | 22.2 | hrs to drain 5 yr W/S | | 99.7 | hrs to drain 1.5x100 yr W/S |

# Normal Flow Analysis - Trapezoidal Channel

**Project:** RK Annexation

**Channel ID:** Lot 1 Spillway Wall

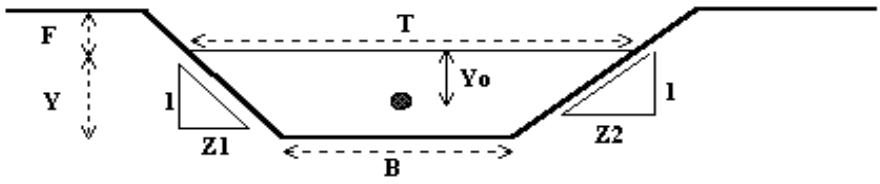



| **Design Information (Input)** | | | |
|---|---|---|---|
| Channel Invert Slope | So = | 0.0050 | ft/ft |
| Manning's n | n = | 0.030 | |
| Bottom Width | B = | 15.00 | ft |
| Left Side Slope | Z1 = | 0.01 | ft/ft |
| Right Side Slope | Z2 = | 0.01 | ft/ft |
| Freeboard Height | F = | 0.00 | ft |
| Design Water Depth | Y = | **0.40** | ft |

| **Normal Flow Condtion (Calculated)** | | | |
|---|---|---|---|
| **Discharge** | **Q =** | **11.05** | cfs |
| **Froude Number** | **Fr =** | **0.51** | |
| **Flow Velocity** | **V =** | **1.84** | fps |
| Flow Area | A = | 6.00 | sq ft |
| Top Width | T = | 15.01 | ft |
| Wetted Perimeter | P = | 15.80 | ft |
| Hydraulic Radius | R = | 0.38 | ft |
| Hydraulic Depth | D = | 0.40 | ft |
| Specific Energy | Es = | 0.45 | ft |
| Centroid of Flow Area | Yo = | 0.20 | ft |
| Specific Force | Fs = | 0.11 | kip |

# Normal Flow Analysis - Trapezoidal Channel

| | |
|---|---|
| **Project:** | **RK Annexation** |
| **Channel ID:** | **Lot 2/3 Spillway Wall** |



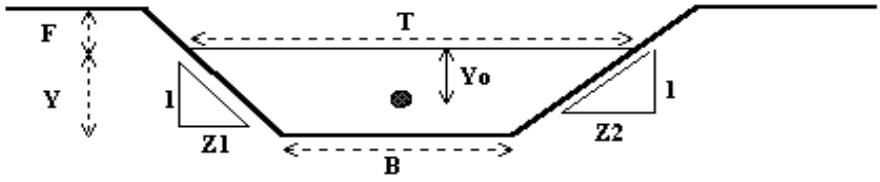

| **Design Information (Input)** | | | |
|---|---|---|---|
| Channel Invert Slope | So = | 0.0050 | ft/ft |
| Manning's n | n = | 0.030 | |
| Bottom Width | B = | 25.00 | ft |
| Left Side Slope | Z1 = | 0.01 | ft/ft |
| Right Side Slope | Z2 = | 0.01 | ft/ft |
| Freeboard Height | F = | 0.00 | ft |
| Design Water Depth | Y = | **0.51** | ft |

| **Normal Flow Condtion (Calculated)** | | | |
|---|---|---|---|
| **Discharge** | **Q =** | **27.39** | cfs |
| **Froude Number** | **Fr =** | **0.54** | |
| **Flow Velocity** | **V =** | **2.17** | fps |
| Flow Area | A = | 12.63 | sq ft |
| Top Width | T = | 25.01 | ft |
| Wetted Perimeter | P = | 26.01 | ft |
| Hydraulic Radius | R = | 0.49 | ft |
| Hydraulic Depth | D = | 0.50 | ft |
| Specific Energy | Es = | 0.58 | ft |
| Centroid of Flow Area | Yo = | 0.25 | ft |
| Specific Force | Fs = | 0.31 | kip |

# Normal Flow Analysis - Trapezoidal Channel

**Project:** RK Annexation

**Channel ID:** Lot 4 Spillway Wall

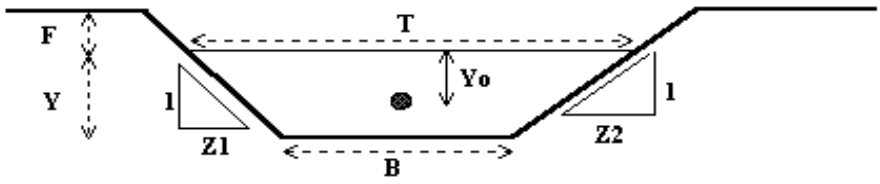



| **Design Information (Input)** | | | |
|---|---|---|---|
| Channel Invert Slope | So = | 0.0050 | ft/ft |
| Manning's n | n = | 0.030 | |
| Bottom Width | B = | 15.00 | ft |
| Left Side Slope | Z1 = | 0.01 | ft/ft |
| Right Side Slope | Z2 = | 0.01 | ft/ft |
| Freeboard Height | F = | 0.00 | ft |
| Design Water Depth | Y = | **0.45** | ft |

| **Normal Flow Condtion (Calculated)** | | | |
|---|---|---|---|
| **Discharge** | **Q =** | **13.40** | cfs |
| **Froude Number** | **Fr =** | **0.52** | |
| **Flow Velocity** | **V =** | **1.98** | fps |
| Flow Area | A = | 6.75 | sq ft |
| Top Width | T = | 15.01 | ft |
| Wetted Perimeter | P = | 15.90 | ft |
| Hydraulic Radius | R = | 0.42 | ft |
| Hydraulic Depth | D = | 0.45 | ft |
| Specific Energy | Es = | 0.51 | ft |
| Centroid of Flow Area | Yo = | 0.22 | ft |
| Specific Force | Fs = | 0.15 | kip |

# Normal Flow Analysis - Trapezoidal Channel

| | |
|---|---|
| **Project:** | **RK Annexation** |
| **Channel ID:** | **Lot 5/6/7 Spillway Wall** |



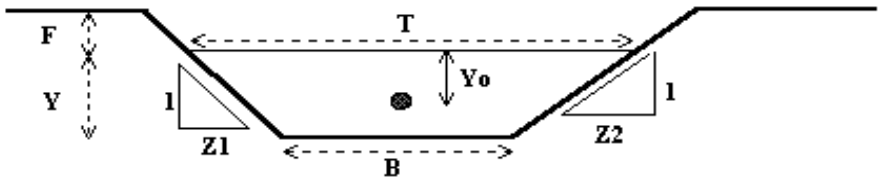

| **Design Information (Input)** | | | |
|---|---|---|---|
| Channel Invert Slope | So = | 0.0050 | ft/ft |
| Manning's n | n = | 0.030 | |
| Bottom Width | B = | 40.00 | ft |
| Left Side Slope | Z1 = | 0.01 | ft/ft |
| Right Side Slope | Z2 = | 0.01 | ft/ft |
| Freeboard Height | F = | 0.00 | ft |
| Design Water Depth | Y = | **0.50** | ft |

| **Normal Flow Condtion (Calculated)** | | | |
|---|---|---|---|
| **Discharge** | **Q =** | **43.53** | cfs |
| **Froude Number** | **Fr =** | **0.54** | |
| **Flow Velocity** | **V =** | **2.18** | fps |
| Flow Area | A = | 20.00 | sq ft |
| Top Width | T = | 40.01 | ft |
| Wetted Perimeter | P = | 41.00 | ft |
| Hydraulic Radius | R = | 0.49 | ft |
| Hydraulic Depth | D = | 0.50 | ft |
| Specific Energy | Es = | 0.57 | ft |
| Centroid of Flow Area | Yo = | 0.25 | ft |
| Specific Force | Fs = | 0.50 | kip |

# Normal Flow Analysis - Trapezoidal Channel

**Project:** RK Annexation

**Channel ID:** West Spillway Channel

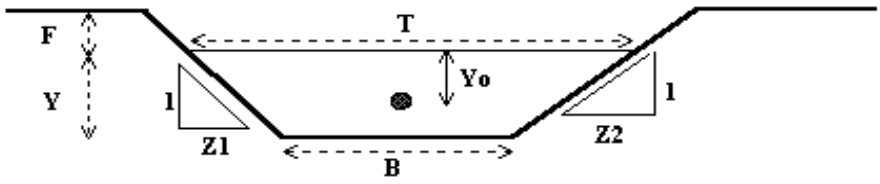



| **Design Information (Input)** | | | |
|---|---|---|---|
| Channel Invert Slope | So = | 0.0050 | ft/ft |
| Manning's n | n = | 0.029 | |
| Bottom Width | B = | 9.00 | ft |
| Left Side Slope | Z1 = | 10.00 | ft/ft |
| Right Side Slope | Z2 = | 10.00 | ft/ft |
| Freeboard Height | F = | 0.00 | ft |
| Design Water Depth | Y = | **1.00** | ft |

| **Normal Flow Condtion (Calculated)** | | | |
|---|---|---|---|
| **Discharge** | **Q =** | **51.95** | cfs |
| **Froude Number** | **Fr =** | **0.60** | |
| **Flow Velocity** | **V =** | **2.73** | fps |
| Flow Area | A = | 19.00 | sq ft |
| Top Width | T = | 29.00 | ft |
| Wetted Perimeter | P = | 29.10 | ft |
| Hydraulic Radius | R = | 0.65 | ft |
| Hydraulic Depth | D = | 0.66 | ft |
| Specific Energy | Es = | 1.12 | ft |
| Centroid of Flow Area | Yo = | 0.41 | ft |
| Specific Force | Fs = | 0.76 | kip |

# Normal Flow Analysis - Trapezoidal Channel

| | |
|---|---|
| **Project:** | **RK Annexation** |
| **Channel ID:** | **East Spillway Channel** |

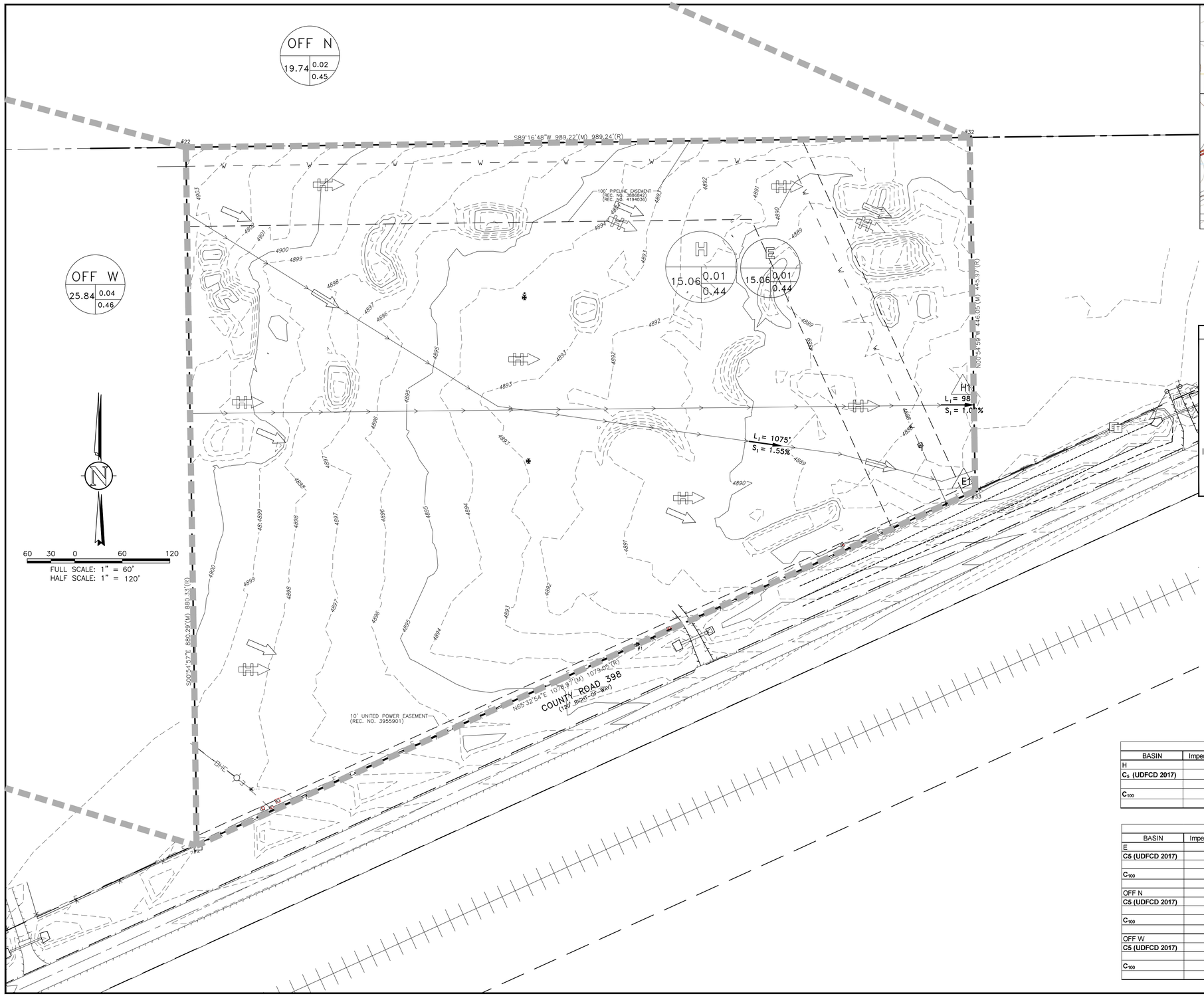


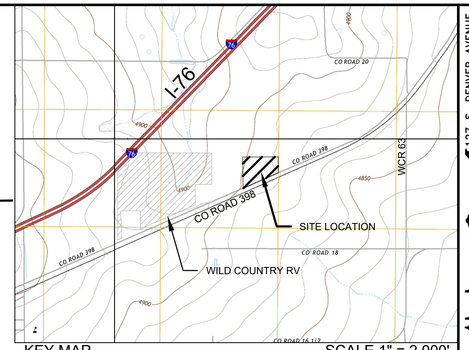

| **Design Information (Input)** | | | |
|---|---|---|---|
| Channel Invert Slope | So = | 0.0050 | ft/ft |
| Manning's n | n = | 0.030 | |
| Bottom Width | B = | 10.00 | ft |
| Left Side Slope | Z1 = | 25.00 | ft/ft |
| Right Side Slope | Z2 = | 25.00 | ft/ft |
| Freeboard Height | F = | 0.00 | ft |
| Design Water Depth | Y = | **1.00** | ft |

| **Normal Flow Condtion (Calculated)** | | | |
|---|---|---|---|
| **Discharge** | **Q =** | **85.78** | cfs |
| **Froude Number** | **Fr =** | **0.57** | |
| **Flow Velocity** | **V =** | **2.45** | fps |
| Flow Area | A = | 35.00 | sq ft |
| Top Width | T = | 60.00 | ft |
| Wetted Perimeter | P = | 60.04 | ft |
| Hydraulic Radius | R = | 0.58 | ft |
| Hydraulic Depth | D = | 0.58 | ft |
| Specific Energy | Es = | 1.09 | ft |
| Centroid of Flow Area | Yo = | 0.38 | ft |
| Specific Force | Fs = | 1.23 | kip |

# APPENDIX D

WEC Drainage Sheets




KEY MAP SCALE 1" = 2,000'

SE 1/4, S24, T2N, R64W, 6th P.M.

SHOWN KEY MAP TAKEN FROM USGS QUAD MAPS - KEENESBURG 40104-A5, PROSPECT VALLEY 40104-A5, KLUG RANCH 40104-B5 & TAMPA 40104-B4

## HISTORIC & EXISTING DRAINAGE LEGEND

- E — EXISTING SUB-BASIN DESIGNATION
- H — HISTORIC SUB-BASIN DESIGNATION
- 1.12 / .73 / .83 — C5 / C100 — AREA IN ACRES
- EXISTING BASIN
- EXISTING DRAINAGE PATTERN
- HISTORICAL DRAINAGE PATTERN

| | |
|---|---|
| $L_I$ - INITIAL LENGTH | $L_I$ = 72.5 |
| $S_I$ - INTIAL SLOPE | $S_I$ = 6.0% |
| $L_t$ - TRAVEL LENGTH | $L_t$ = 160' |
| $S_t$ - TRAVEL SLOPE | $S_t$ = 0.75% |

*** AVERAGE SLOPE INCLUDES ROOF SLOPE OF 8.33%**

HISTORIC RUNOFF TABLE (RK Annexation)

| BASIN | Impervious | C-YR | I | A | CIA(YR-historic) | Flow | DESIGN POINT |
|---|---|---|---|---|---|---|---|
| H | | | | | | | |
| **$C_5$ (UDFCD 2017)** | 2.00 | 0.01 | 1.96 | 15.06 | 0.29 | cfs | HE1 |
| | | | | | | | |
| **$C_{100}$** | 2.00 | 0.44 | 4.57 | 15.06 | 30.27 | cfs | |
| | | | | | | | |

EXISTING RUNOFF TABLE (RK Annexation)

| BASIN | Impervious | C-YR | I | A | CIA(YR-existing) | Flow | DESIGN POINT |
|---|---|---|---|---|---|---|---|
| E | | | | | | | |
| **C5 (UDFCD 2017)** | 2.00 | 0.01 | 1.96 | 15.06 | 0.29 | cfs | E1 |
| | | | | | | | |
| **$C_{100}$** | 2.00 | 0.44 | 4.57 | 15.06 | 30.27 | cfs | |
| | | | | | | | |
| OFF N | | | | | | | |
| **C5 (UDFCD 2017)** | 3.66 | 0.02 | 0.83 | 19.74 | 0.39 | cfs | O1 |
| | | | | | | | |
| **$C_{100}$** | 3.66 | 0.45 | 1.94 | 19.74 | 17.17 | cfs | |
| | | | | | | | |
| OFF W | | | | | | | |
| **C5 (UDFCD 2017)** | 6.00 | 0.04 | 1.05 | 25.84 | 1.15 | cfs | O2 |
| | | | | | | | |
| **$C_{100}$** | 6.00 | 0.46 | 2.44 | 25.84 | 28.93 | cfs | |
| | | | | | | | |


127 S. DENVER AVENUE
FT. LUPTON, CO 80621
www.westernec.com
email@westernec.com
(720) 685-9951
FAX (720) 294-1330
Western Engineering Consultants, inc LLC


| No. | REVISION | DATE | BY |
|---|---|---|---|
| 0 | INITIAL RELEASE | 03/19/19 | CFC |
| 1 | RESUBMITAL PER TOWN COMMENTS | 05/19/20 | CFC |

ROBERTSON-KAISER SUBDIVISION

CONTACT: RICK ROBERTSON
50531 E. 60th AVENUE
BENNETT, CO 80102
(303)961-0037

HISTORIC DRAINAGE PLAN
ROBERTSON -KAISER ANNEX
PRELIMINARY PLAT
TOWN of KEENESBURG, WELD COUNTY, COLORADO

Dig Safely.
CALL UNCC
THREE WORKING DAYS BEFORE YOU DIG
1-800-922-1987
www.uncc.org
UTILITY NOTIFICATION CENTER OF COLORADO

FOR REVIEW

ONLY VALID FOR CONSTRUCTION IF SEAL & ORIGINAL SIGNATURE ARE ON EACH SHEET

INITIAL PLAN RELEASE: 03/19/19
DESIGNED BY: CFC
DRAWN BY: CFC
CHECKED BY: CFC
PROJECT NO. 01-0187.002.00
DOC CON # 0015-HISDRNG
SHEET 15 OF 27

MAINTENANCE OF ALL PRIVATE STORMWATER TREATMENT AND DRAINAGE IMPROVEMENTS IS A CONTINUING OBLIGATION OF THE LAND OWNER, ITS SUCCESSORS, AND ASSIGNS, TO ENSURE THE FACILITIES FUNCTION AS DESIGNED AND CONTINUE SERVING THE INTENDED FUNCTIONS IN PERPETUITY UNLESS THE CITY EXPRESSLY ACCEPTS THE RESPONSIBILITY IN WRITING. A NON-EXCLUSIVE ACCESS AND DRAINAGE EASEMENTS ARE HEREBY GRANTED TO CITY OF BRIGHTON FOR THE PURPOSE OF ACCESSING, INSPECTING, MAINTAINING, AND REPAIRING PRIVATE DRAINAGE FACILITIES IN THE EVENT THE LAND OWNER, ITS SUCCESSORS, AND ASSIGNS FAILS TO SATISFACTORILY MAINTAIN OR REPAIR SAID FACILITIES

$L_I$ - INITIAL LENGTH — $L_I$ = 72.5
$S_I$ - INTIAL SLOPE — $S_I$ = 6.0%
$L_t$ - TRAVEL LENGTH — $L_t$ = 160'
$S_t$ - TRAVEL SLOPE — $S_t$ = 0.75%
* AVERAGE SLOPE INCLUDES ROOF SLOPE OF 8.33%

DEVELOPED DRAINAGE LEGEND

B1 | 3.20 | 58 / 88 — SUB-BASIN DESIGNATION; C5; C100; AREA IN ACRES
EXISTING DRAINAGE PATTERN
DEVELOPED BASIN
PROPOSED DRAINAGE PATTERN
INTERNAL EMERGENCY OVERFLOW
OFFSITE EMERGENCY OVERFLOW

60 30 0 60 120
FULL SCALE: 1" = 60'
HALF SCALE: 1" = 120'

OFF N | 19.74 | 0.02 / 0.45
OFF W | 25.84 | 0.04 / 0.46

PARCEL NO. 130319000003
GARY DOUGLAS MYERS (1/2 INT)
ARTHUR W. BERGLUND
ROBERT KENT BERGLUND REVOCABLE TRUST
ARNITA M. TUDOR
JANET B. WARDA
Acres (Calculated) 302.0659
Legal 7233 THAT PT N2/SE4 19 2 63 LYING N & W OF RR R/W
N89°53'18"E 2756.96' (BASIS OF BEARINGS)

NW COR. SW 1/4, SEC. 19, T 2 N, R 63 W, FOUND 3/4" REBAR WITH 3 1/4" ALUMINUM CAP, PLS 23027.

NE COR. SW 1/4, SEC. 19, T 2 N, R 63 W, FOUND 3/4" REBAR WITH 3 1/4" ALUMINUM CAP, PLS 23027.

S89°16'48"W 989.19'(M) 989.24'(R)

S00°54'57"E 880.33'(R)

LOT 1 | 1.96 | 0.36 / 0.63
LOT 2 | 2.32 | 0.35 / 0.63
LOT 3 | 1.65 | 0.26 / 0.57
LOT 4 | 2.00 | 0.34 / 0.62
LOT 5 | 1.95 | 0.36 / 0.63
LOT 6 | 2.32 | 0.35 / 0.63
LOT 7 | 2.18 | 0.26 / 0.57
ROWRK | 0.73 | 0.34 / 0.62

FB 1 — $L_I$= 99.1' $S_I$ = 0.42%
FB 2/3 N — $L_I$= 404.2' $S_I$ = 0.56%
FB 2/3 S — $L_I$= 129.7' $S_I$ = 0.34%
FB 4 — $L_I$= 183.8' $S_I$ = 2.42%
FB 5/6/7 N — $L_I$= 347.9' $S_I$ = 1.39%
FB 5/6/7 S — $L_I$= 364.9' $S_I$ = 2.19%
FH RK #1 — $L_I$= 435.5' $S_I$ = 0.52%
FH RK #2 — $L_I$= 523.4' $S_I$ = 0.18%
FH RK #3 — $L_I$= 104.0' $S_I$ = 9.12%

50' X 70' SEPTIC FIELD
70' X 50' SEPTIC FIELD
CONCEPT BLDG 6,300 SF
CONCEPT BLDG 23,400 SF
100' PIPELINE EASEMENT (REC. NO. 3886642) (REC. NO. 4194935)
10' UNITED POWER EASEMENT (REC. NO. 3955901)
COUNTY ROAD NO. 398
FWS ANNEXATION NO. 3 (REC. NO. 4268974)
RAILROAD

KEY MAP — SCALE 1" = 2,000'
SE 1/4, S24, T2N, R64W, 6th P.M.
SHOWN KEY MAP TAKEN FROM USGS QUAD MAPS - KEENESBURG 40104-A5, PROSPECT VALLEY 40104-A5, KLUG RANCH 40104-B5 & TAMPA 40104-B4

I-76, CO ROAD 20, CO ROAD 398, CO ROAD 18, WCR 63, N, W, SITE LOCATION, WILD COUNTRY RV

INFILTRATION PONDS - 100yr STORM

| POND | REQUIRED VOLUME | DESIGN VOLUME | INFILTRATION RATE* |
|---|---|---|---|
| 1 | 34,010 | 34,811 | 80.1 HRS |
| 2-3 | 61,481 | 66,313 | 79.6 HRS |
| 4 | 36,320 | 36,543 | 73.4 HRS |
| 5-7 | 194,887 | 200,402 | 99.7 HRS |

* USING PERCOLATION RATE FROM ROBERTSON RV PARK DATED JANUARY 14, 2014 PER CRS 37-92-602(8) - 100yr STORM IS REQUIRED TO DRAIN WITHIN 120 HOURS.

INFILTRATION PONDS - 5yr STORM

| POND | REQUIRED VOLUME | DESIGN VOLUME | INFILTRATION RATE* |
|---|---|---|---|
| 1 | 5,041 | 34,811 | 31.5 HRS |
| 2-3 | 8,186 | 66,313 | 25.1 HRS |
| 4 | 7,583 | 36,543 | 34.8 HRS |
| 5-7 | 18,382 | 200,402 | 22.7 HRS |

* USING PERCOLATION RATE FROM ROBERTSON RV PARK DATED JANUARY 14, 2014 PER CRS 37-92-602(8) - 5yr STORM IS REQUIRED TO DRAIN WITHIN 72 HOURS.

DEVELOPED (RK Annexation)

| BASIN | Impervious | C-YR | I | A | CIA(YR-DEVELOPED) | | DESIGN POINT |
|---|---|---|---|---|---|---|---|
| LOT 1 | | | | | | | |
| **$C_5$ (UDFCD 2017)** | 43.65 | 0.36 | 2.03 | 1.83 | 1.34 | cfs | 1 |
| | | | | | | | |
| **$C_{100}$** | 43.65 | 0.63 | 4.74 | 1.83 | 5.45 | cfs | 1 |
| LOT 2 | | | | | | | |
| **$C_5$** | 43.03 | 0.35 | 3.87 | 1.66 | 2.27 | cfs | 2 |
| | | | | | | | |
| **$C_{100}$** | 43.03 | 0.63 | 9.02 | 1.66 | 9.39 | cfs | 2 |
| | | | | | | | |
| LOT 3 | | | | | | | |
| **$C_5$** | 31.37 | 0.26 | 1.89 | 1.65 | 0.80 | cfs | 3 |
| | | | | | | cfs | |
| **$C_{100}$** | 31.37 | 0.57 | 4.40 | 1.65 | 4.16 | cfs | 3 |
| | | | | | | cfs | |
| LOT 4 | | | | | | | |
| **$C_5$** | 41.34 | 0.34 | 2.21 | 2.00 | 1.50 | cfs | 4 |
| | | | | | | cfs | |
| **$C_{100}$** | 41.34 | 0.62 | 5.16 | 2.00 | 6.38 | cfs | 4 |
| | | | | | | cfs | |
| LOT 5 | | | | | | | |
| **$C_5$** | 43.65 | 0.36 | 2.15 | 2.52 | 1.95 | cfs | 5 |
| | | | | | | cfs | |
| **$C_{100}$** | 43.65 | 0.63 | 5.02 | 2.52 | 7.96 | cfs | 5 |
| | | | | | | cfs | |
| LOT 6 | | | | | | | |
| **$C_5$** | 43.03 | 0.35 | 2.16 | 2.32 | 1.77 | cfs | 6 |
| | | | | | | | |
| **$C_{100}$** | 43.03 | 0.63 | 5.05 | 2.32 | 7.31 | cfs | 6 |
| | | | | | | | |
| LOT 7 | | | | | | | |
| **$C_5$** | 31.37 | 0.26 | 1.92 | 2.32 | 1.14 | cfs | 7 |
| | | | | | | | |
| **$C_{100}$** | 31.37 | 0.57 | 4.48 | 2.32 | 5.96 | cfs | 7 |
| | | | | | | | |
| ROW RK | | | | | | | |
| **$C_5$** | 41.34 | 0.34 | 2.21 | 0.75 | 0.57 | cfs | 8 |
| | | | | | | | |
| **$C_{100}$** | 41.34 | 0.62 | 5.15 | 0.75 | 2.40 | cfs | 8 |


127 S. DENVER AVENUE
FT. LUPTON, CO 80621
www.westernec.com
email@westernec.com
(720) 685-9951
FAX (720) 294-1330
Western Engineering Consultants, inc LLC


| No. | REVISION | DATE | BY |
|---|---|---|---|
| 0 | INITIAL RELEASE | 03/19/19 | CFC |
| 1 | RESUBMITAL PER TOWN COMMENTS | 05/19/20 | CFC |

ROBERTSON-KAISER SUBDIVISION
CONTACT: RICK ROBERTSON
50531 E. 60th AVENUE
BENNETT, CO 80102
(303)961-0032

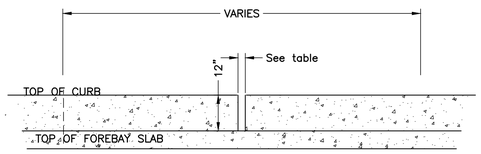
DEVELOPED DRAINAGE PLAN
ROBERTSON -KAISER ANNEX
PRELIMINARY PLAT
TOWN of KEENESBURG, WELD COUNTY, COLORADO

Dig Safely.
CALL UNCC
THREE WORKING DAYS BEFORE YOU DIG
1-800-922-1987
www.uncc.org
UTILITY NOTIFICATION CENTER OF COLORADO

FOR REVIEW

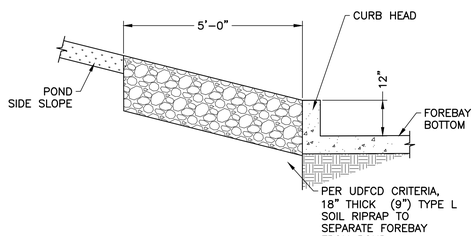
ONLY VALID FOR CONSTRUCTION IF SEAL & ORIGINAL SIGNATURE ARE ON EACH SHEET

INITIAL PLAN RELEASE: 03/19/19
DESIGNED BY: CFC
DRAWN BY: CFC
CHECKED BY: CFC
PROJECT NO. 01-0187.002.00
DOC CON # 0016-DEVDRNG
SHEET 16 OF 27

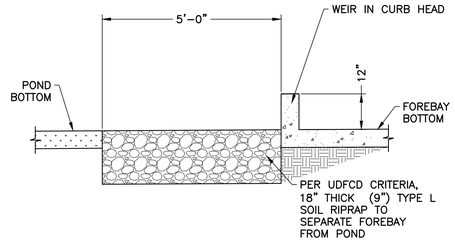



SEE TABLE FOR RELEASE FROM FOREBAY PER UDFCD EQN. SO-13 SEE DRAINAGE REPORT APPENDIX FOR CALCULATIONS

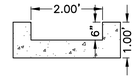
**TYPICAL FOREBAY WEIR**
SCALE 1" = 2'



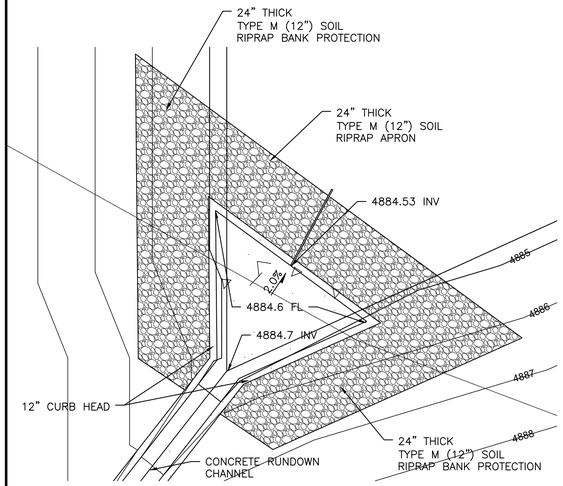

**TYPICAL FOREBAY BANK PROTECTION CROSS SECTION**
SCALE 1" = 2'



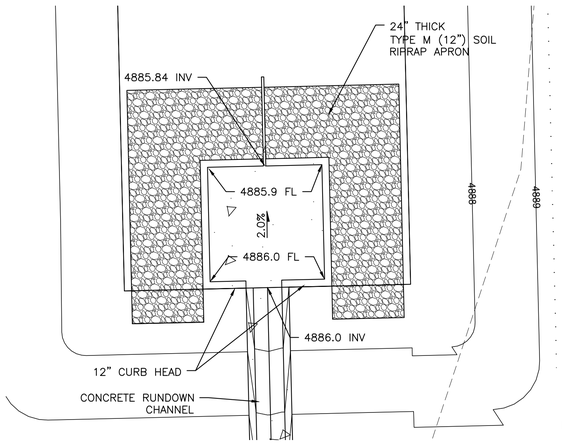

**TYPICAL FOREBAY APRON CROSS SECTION**
SCALE 1" = 2'



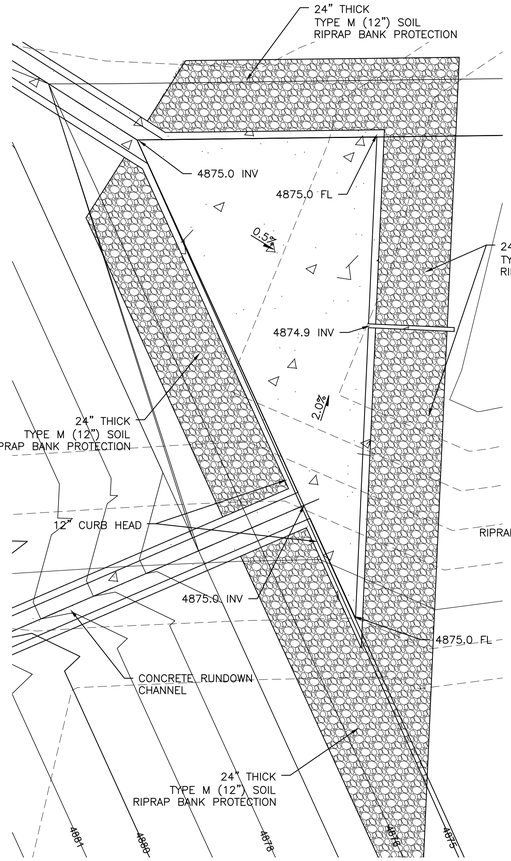

**CONC RUNDOWN SECTION**
SCALE 1" = 2'



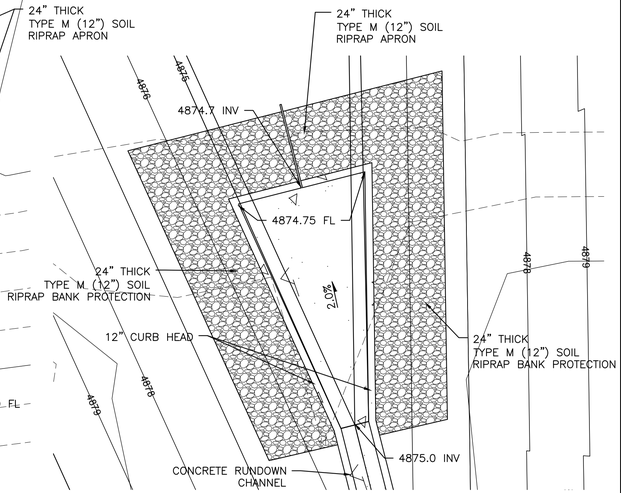

**FOREBAY 1 DETAIL**
SCALE 1" = 5'




**FOREBAY 2/3 S DETAIL**
SCALE 1" = 5'

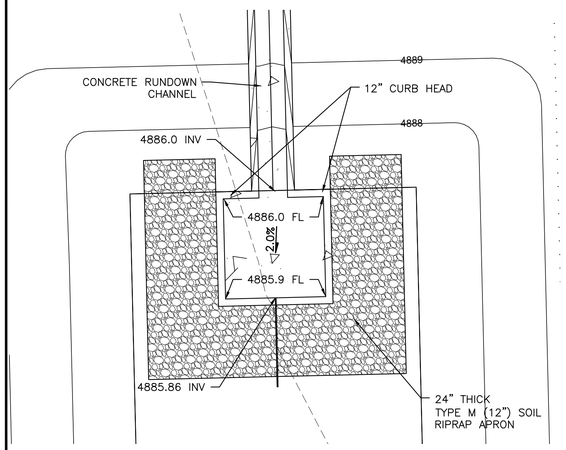



**FOREBAY 5/6/7 N DETAIL**
SCALE 1" = 5'

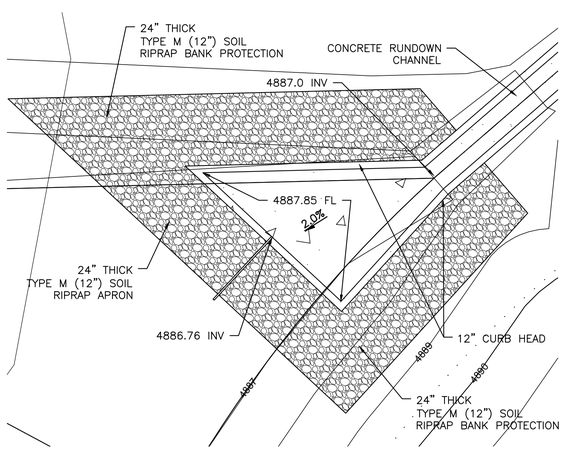



**FOREBAY 5/6/7 S DETAIL**
SCALE 1" = 5'

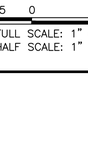
| FOREBAY DATA TABLE | | | | |
|---|---|---|---|---|
| FOREBAY | FOREBAY AREA (SF) | BASINS TREATED | 2% RELEASE Q (CFS) | WEIR WIDTH (IN) |
| 1 | 64 | LOT 1 | 0.11 | 1.1 |
| 2/3 S | 64 | LOT 2 | 0.19 | 2 |
| 2/3 N | 49 | LOT 3 | 0.08 | 0.8 |
| 4 | 81 | LOT 4 | 0.13 | 1.4 |
| 5/6/7 N | 169 | LOTS 5 & 6 | 0.31 | 3.3 |
| 5/6/7 S | 81 | LOT 7 | 0.12 | 1.3 |




**FOREBAY 2/3 N DETAIL**
SCALE 1" = 5'




**FOREBAY 4 DETAIL**
SCALE 1" = 5'




5 2.5 0 5 10
FULL SCALE: 1" = 5'
HALF SCALE: 1" = 10'


127 S. DENVER AVENUE
FT. LUPTON, CO 80621
www.westernec.com
email@westernec.com
(720) 685-9951
FAX (720) 294-1330
Western Engineering Consultants, inc LLC


| No. | REVISION | DATE | BY |
|---|---|---|---|
| 0 | INITIAL RELEASE | 03/19/19 | CFC |
| 1 | RESUBMITAL PER TOWN 05/02/19 COMMENTS | 05/19/20 | CFC |

ROBERTSON-KAISER SUBDIVISION
CONTACT: RICK ROBERTSON
50531 E. 60th AVENUE
BENNETT, CO 80102
(303)961-0033

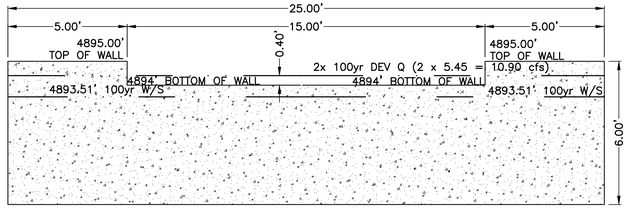
POND DETAILS
ROBERTSON-KAISER ANNEX
PRELIMINARY PLAT
TOWN of KEENESBURG, WELD COUNTY, COLORADO

Dig Safely.
CALL UNCC
THREE WORKING DAYS BEFORE YOU DIG
1-800-922-1987
www.uncc.org
UTILITY NOTIFICATION CENTER OF COLORADO

FOR REVIEW

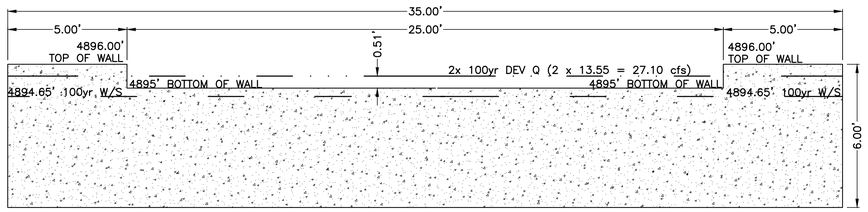
ONLY VALID FOR CONSTRUCTION IF SEAL & ORIGINAL SIGNATURE ARE ON EACH SHEET

INITIAL PLAN RELEASE:03/19/19
DESIGNED BY: CFC
DRAWN BY: CFC
CHECKED BY: CFC
PROJECT NO.
01-0187.002.00
DOC CON #
0017-POND DTL
SHEET
17 OF 27



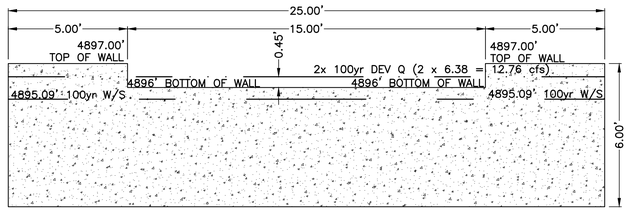

**POND '1' EMERGENCY SPILLWAY WALL**

SCALE 1" = 3'



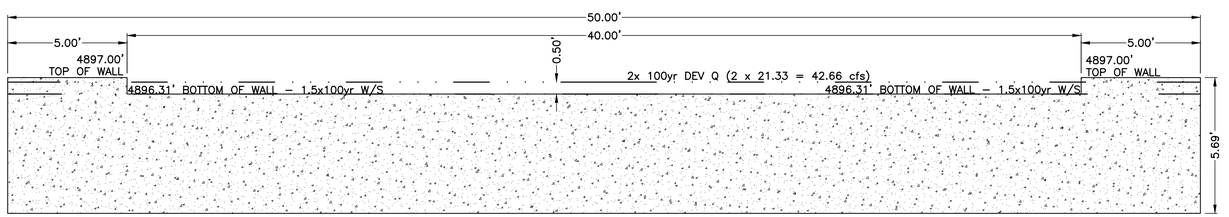

**POND '2/3' EMERGENCY SPILLWAY WALL**

SCALE 1" = 3'



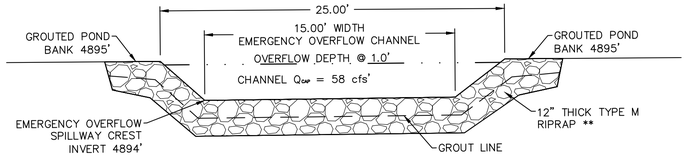

**POND '4' EMERGENCY SPILLWAY WALL**

SCALE 1" = 3'




**POND '5/6/7' EMERGENCY SPILLWAY WALL**

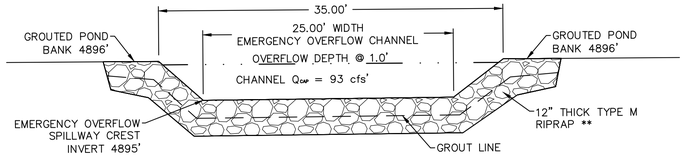
SCALE 1" = 3'




** GROUTED RIPRAP SHALL NOT HAVE GROUT LEVEL ABOVE 1/2 THE TOTAL RIPRAP DEPTH (i.e. 12" OF TYPE M RIPRIP TO HAVE GROUT UP TO 6").

## EMERGENCY OVERFLOW CHANNEL @ SPILLWAY WALL DETAIL - POND 1

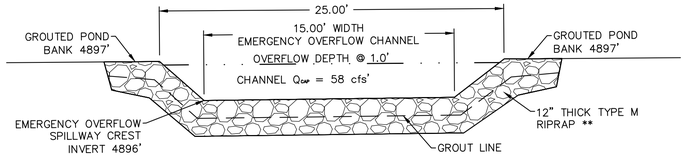
SCALE 1" = 2.0'




** GROUTED RIPRAP SHALL NOT HAVE GROUT LEVEL ABOVE 1/2 THE TOTAL RIPRAP DEPTH (i.e. 12" OF TYPE M RIPRIP TO HAVE GROUT UP TO 6").

## EMERGENCY OVERFLOW CHANNEL @ SPILLWAY WALL DETAIL - POND 2/3

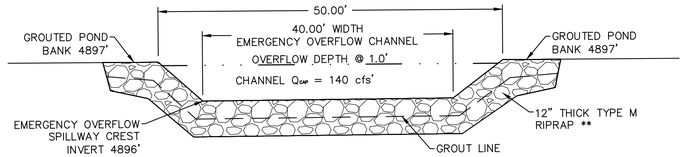
SCALE 1" = 2.0'




** GROUTED RIPRAP SHALL NOT HAVE GROUT LEVEL ABOVE 1/2 THE TOTAL RIPRAP DEPTH (i.e. 12" OF TYPE M RIPRIP TO HAVE GROUT UP TO 6").

## EMERGENCY OVERFLOW CHANNEL @ SPILLWAY WALL DETAIL - POND 4

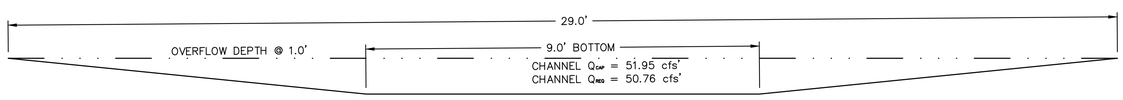
SCALE 1" = 2.0'




** GROUTED RIPRAP SHALL NOT HAVE GROUT LEVEL ABOVE 1/2 THE TOTAL RIPRAP DEPTH (i.e. 12" OF TYPE M RIPRIP TO HAVE GROUT UP TO 6").

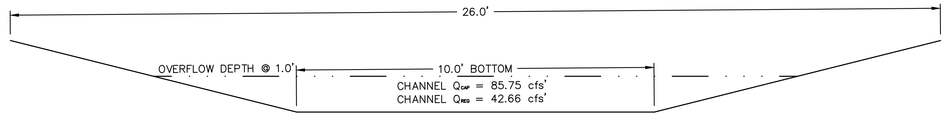
## EMERGENCY OVERFLOW CHANNEL @ SPILLWAY WALL DETAIL - POND 5/6/7

SCALE 1" = 2.0'




## SPILLWAY CHANNEL DETAIL - PONDS 1, 2/3, 4

SCALE 1" = 2.0'




## SPILLWAY CHANNEL DETAIL - POND 5/6/7

SCALE 1" = 2.0'


127 S. DENVER AVENUE
FT. LUPTON, CO 80621
www.westernec.com
email@westernec.com
(720) 685-9951
FAX (720) 294-1330
Western Engineering Consultants, inc LLC


| No. | REVISION | DATE | BY |
|---|---|---|---|
| 1 | RESUBMITTAL PER TOWN 05/02/19 COMMENTS | 05/19/20 | CFC |

ROBERTSON-KAISER SUBDIVISION
CONTACT: RICK ROBERTSON
50531 E. 60th AVENUE
BENNETT, CO 80102
(303)961-0031

POND SPILLWAY DETAILS
ROBERTSON -KAISER ANNEX
PRELIMINARY PLAT
TOWN of KEENESBURG, WELD COUNTY, COLORADO

Dig Safely.
CALL UNCC
THREE WORKING DAYS BEFORE YOU DIG
1-800-922-1987
www.uncc.org
UTILITY NOTIFICATION CENTER OF COLORADO

FOR REVIEW

ONLY VALID FOR CONSTRUCTION IF SEAL & ORIGINAL SIGNATURE ARE ON EACH SHEET

INITIAL PLAN RELEASE: 05/19/20
DESIGNED BY: CFC
DRAWN BY: CFC
CHECKED BY: CFC
PROJECT NO. 01-0187.002.00
DOC CON # 017D-POND DTL
SHEET 17D OF 27