Final Drainage Report
Hanover School District – Prairie Heights Elementary School
7930 Indian Village Heights
Lot 110 Midway Ranches Fil No 7
El Paso County, Colorado

Prepared for:

Hanover School District – Prairie Heights Elementary School
17050 S. Peyton Hwy,
Colorado Springs, Colorado
(719) 683-2247

Prepared by:

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
Ph: (719)630-7342

Kiowa Project No. 24047

EPC Project Number: PPR254

June 9, 2025

Revised: 3/10/26

Table of Contents

Design Engineer's Statement:

The attached drainage plan and letter were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage letter has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Kiowa Engineering Corporation, 1604 South 21st Street, Colorado Springs, Colorado 80904

COLORADO LICENSED TODD A. CARTWRIGHT 06/10/2025 33365 PROFESSIONAL ENGINEER

COLORADO LICENSED TODD A. CARTWRIGHT 03/10/2026 33365 PROFESSIONAL ENGINEER

Signature: ______________________________ ____________

Todd Cartwright, P.E. No. 33365 Date

School District Statement:

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

Signed by: Mark McPherson
7B1631F3FB854DF...

Signature of Owner or Representative

Date: 4/27/2025 | 6:17 PM PDT

El Paso County Statement:

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 & 2, El Paso County Engineering Criteria Manual, and Land Development Code, as amended.

Daniel Torres, P.E. Digitally signed by Daniel Torres, P.E. Reason: Authorized signatory as County Engineer designee Date: 2025.09.08 16:52:12-06'00'

9/8/2025

Joshua Palmer, P.E. Date
El Paso County Engineer/ECM Administrator

Conditions: Daniel Torres, P.E. Digitally signed by Daniel Torres, P.E. Reason: Authorized signatory as County Engineer designee Date: 2026.05.12 10:27:41-06'00'

I. GENERAL LOCATION AND DESCRIPTION

The purpose of this Drainage Letter is to identify on-site and off-site drainage patterns, storm sewers, culvert and inlet locations, areas tributary to the site, and to safely route developed storm water to adequate outfalls for Prairie Heights Elementary School.

A vicinity map showing the general location of the site is presented in Appendix A. Prairie Heights Elementary School is comprised of 38.56 acres, located in southwest El Paso County. The street address for the site is 7930 Indian Village Heights. The platted name is Lot 110 Midway Ranches Fil No 7. The property is primarily located in Sections 28, Township 17 South, Range 65 West of the 6th Principal Meridian, in El Paso County, Colorado. The site also extends into sections 29, 32 and 33. The school itself is primarily in section 33. The expansion will extend into section 28.

The vegetation on the site consists of native grass. There are no proposed developments within a designated floodplain, as indicated on FEMA panel 08041C1170G, effective 12/7/2018. A FEMA firmette for the site is located in Appendix A. There is a type A floodplain along the north edge of the property where Sand Creek Crosses the property.

95 % of the site consists of hydrologic group 'C' soils Kimera Loam and Wilid Silt Loam and less than 5% hydrologic group 'A' soils Schamber-Razor Complex. A copy of the USDA Custom Soil Resource Report is located in Appendix A.

The school is located in the southwest corner of the site. The area of disturbance for this project will be 3.22 acres. The outline of the area of disturbance encompasses 3.68 acres, however the portion of existing school to remain has a 0.46 acre footprint resulting in the 3.22 acres of disturbance. The portable buildings (modulars) will be removed with this project.

II. GENERAL CONCEPT

A. EXISTING DRAINAGE PATTERNS

In the existing condition, the site generally drains from south to the north to Sand Creek at the north property line. Sand Creek flows across the north end of the property. Sand Creek flows east to Fountain Creek

The following is a description of the existing drainage sub-basins.

Sub-basin E-1: Sub-basin E-1 is 19.71 acres, with 5 and 100-year runoff of 7.7 and 40 CFS respectively. The runoff from this sub-basin flows north down overland to sand creek as mostly unconcentrated flow. The design point is depicted as Design Point E1. Sand creek flows through the site.

Sub-basin E-2: Sub-basin E-2 is 16.77 acres, with 5 and 100-year runoff of 14 and 61 CFS respectively. It is not expected to receive any offsite flow. The flows around the school generally flow around the school on the surface starting at the southeast corner of the school and flowing around the south or the east side as appropriate. The design point is depicted as Design Point E2.

Sub-basin E-3: Sub-basin E-3 is 0.72 acres, with 5 and 100-year runoff of 0.5 and 2.5 CFS respectively. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north and off site to sand creek as mostly unconcentrated flow. The design point is depicted as Design Point E3.

Sub-basin E-4: Sub-basin E-4 is 0.23 acres, with 5 and 100-year runoff of 0.2 and 1.0 CFS respectively. It is not expected to receive any offsite flow. The runoff from this sub-basin flows south as mostly unconcentrated flow. The design point is depicted as Design Point E4.

Sub-basin E-5: Sub-basin E-5 is 0.35 acres, with 5 and 100-year runoff of 0.9 and 2.0 CFS respectively. It is not expected to receive any offsite flow. The runoff from this sub-basin flows south as mostly unconcentrated flow. The design point is depicted as Design Point E5.

B. PROPOSED DRAINAGE PATTERNS

Similar to the existing conditions, the proposed drainage will generally travel to the North into Sand Creek, then ultimately flow into the Fountain creek drainage basin.

The runoff in the developed condition will be basically the same as the existing condition.

The following is a description of the proposed drainage sub-basins.

Sub-basin P-1: Sub-basin P-1 is 19.71 acres, with 5 and 100-year runoff of 7.7 and 40 CFS respectively. This basin consists of undisturbed open space. The runoff from this sub-basin flows north down overland to sand creek as mostly unconcentrated flow. The design point is depicted on the attached map as Design Point P1. Sand creek flows through the site.

Sub-basin P-2: Sub-basin P-2 is 11.93 acres, with 5 and 100-year runoff of 5.5 and 29 CFS respectively. This basin consists of undisturbed open space. It is not expected to receive any offsite flow. The runoff flows from north of the school on the surface to the northwest and off the property before getting to sand creek. The design point is depicted on the attached map as Design Point P2.

Sub-basin P-3: Sub-basin P-3 is 0.72 acres, with 5 and 100-year runoff of 0.5 and 2.5 CFS respectively. This basin consists of undisturbed open space. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north and off site to sand creek as mostly unconcentrated flow. The design point is depicted as Design Point on the attached map P3. P-6 & P-7 areas and runoff are included in the runoff for basin P-3.

Sub-basin P-4: Sub-basin P-4 is 0.95 acres, with 5 and 100-year runoff of 1.9 and 4.7 CFS respectively. This basin consists of school buildings, drives, landscaping and open space. It is not expected to receive any offsite flow. The runoff from this sub-basin flows around the east side of the school as mostly concentrated flow. The runoff from this basin will be treated in the East Sand Filter located north of the site. The design point is depicted as Design Point P4.

Sub-basin P-5: Sub-basin P-5 is 0.05 acres, with 5 and 100-year runoff of 0.1 and 0.3 CFS respectively. This basin consists of the school building roof. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north as mostly concentrated flow to a roof drain storm sewer. The runoff from this basin will be treated in the East Sand Filter located north of the site. The design point is depicted as Design Point P5.

Sub-basin P-6: Sub-basin P-6 is 0.22 acres, with 5 and 100-year runoff of 0.6 and 1.3 CFS respectively. This basin consists of the school building roof. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north as mostly concentrated flow to a roof drain storm sewer. The runoff from this basin will be treated in the East Sand Filter located north of the site. The design point is depicted as Design Point P6.

<u>Sub-basin P-7</u>: Sub-basin P-7 is 0.15 acres, with 5 and 100-year runoff of 0.4 and 1.0 CFS respectively. This basin consists of the school building roof. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north as mostly concentrated flow to a roof drain storm sewer. The runoff from this basin will be treated in the East Sand Filter located north of the site. The design point is depicted as Design Point P7.

<u>Sub-basin P-8</u>: Sub-basin P-8 is 0.04 acres, with 5 and 100-year runoffs of 0.1 and 0.2 CFS respectively. This basin consists of a school playground. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north as mostly concentrated flow to a storm sewer. The runoff from this basin will be treated in the West Sand Filter located north of the site. The design point is depicted as Design Point P8.

<u>Sub-basin P-9</u>: Sub-basin P-9 is 0.24 acres, with 5 and 100-year runoff of 0.2 and 1.1 CFS respectively. This basin consists of school landscaping and open space. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north as unconcentrated and concentrated flow. The runoff from this basin will be treated in the East Sand Filter located north of the site. The design point is depicted as Design Point P9.

<u>Sub-basin P-10</u>: Sub-basin P-10 is 0.12 acres, with 5 and 100-year runoff of 0.3 and 0.7 CFS respectively. This basin was used to identify the flow in the curb chase. This basin consists of school landscaping and drives. It is not expected to receive any offsite flow. The runoff from this sub-basin flows west as concentrated flow to Basin 11. The runoff from this basin will be treated in the West Sand Filter located north of the site. The design point is depicted as Design Point P10.

<u>Sub-basin P-11</u>: Sub-basin P-11 is 0.47 acres, with 5 and 100-year runoff of 1.0 and 2.4 CFS respectively. This basin was used to identify the flow in the storm pipe culvert at Design Point 11. This basin consists of school playgrounds, landscaping and drives. It is not expected to receive any offsite flow, however, it receives the runoff from Basin 10. The runoff from this sub-basin flows west as concentrated flow to Basin 13. The runoff from this basin will be treated in the West Sand Filter located north of the site. The design point is depicted as Design Point P11.

<u>Sub-basin P-12</u>: Sub-basin P-12 is 0.15 acres, with 5 and 100-year runoff of 0.2 and 0.7 CFS respectively. This basin consists of school landscaping and open space. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north as unconcentrated and concentrated flow. The runoff from this basin will be treated in the West Sand Filter located north of the site. The design point is depicted as Design Point P12.

<u>Sub-basin P-13</u>: Sub-basin P-13 is 0.67 acres, with 5 and 100-year runoff of 1.0 and 2.9 CFS respectively. This basin consists of school, playgrounds, drives, landscaping and open space. It is not expected to receive any offsite flow. The runoff from this sub-basin flows north as unconcentrated and concentrated flow. The runoff from this basin will be treated in the West Sand Filter located north of the site. The design point is depicted as Design Point P13.

<u>Design Points 14 & 15</u> are used to identify the runoff flow into the East and West Sand Filter. These design points do not have unaccounted for basin area. The calculations for the design of these sand filters are included in appendix C. These sand filters provide permanent water quality for 87% of the disturbed area.

<u>Sub-basin P-16</u>: Sub-basin P-16 is 1.87 acres, with 5 and 100-year runoff of 1.0 and 5.7 CFS respectively. This basin consists of undisturbed open space. It is not expected to receive any offsite flow. The school runoff flows into Basin 16 from the two sand filters and Basin 12. The runoff flows from north of the school on the surface to the northwest to Basin 2 and Design Point 2. The design point is depicted as Design Point P16.

Sub-basin P-21: Sub-basin P-21 is 0.29 acres, with 5 and 100-year runoff of 0.8 and 1.8 CFS respectively. It is not expected to receive any offsite flow. The runoff from this sub-basin flows south as mostly unconcentrated flow. The runoff from this basin will be treated in the East Sand Filter located north of the site. The design point is depicted as Design Point P21.

Sub-basin P-22: Sub-basin P-22 is 0.23 acres, with 5 and 100-year runoff of 0.2 and 1.0 CFS respectively. It is not expected to receive any offsite flow. The runoff from this sub-basin flows south as mostly unconcentrated flow. The runoff from this basin will be treated in the East Sand Filter located north of the site. The design point is depicted as Design Point P22.

III. DRAINAGE DESIGN CRITERIA

This report followed the criteria and format included in "Colorado Springs Drainage Criteria Manual (DCM) Volume 1", "Volume 2" and "Colorado Springs Engineering Criteria Manual".

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *Colorado Springs Drainage Criteria Manual*. Topography for the site was compiled using a one-foot contour interval and is presented on the Drainage Plan.

The hydrologic calculations were made for the historic and developed site conditions. The Drainage Plan presents the drainage patterns for the site, including the sub-basins. The peak flow rates for the sub-basins were estimated using the Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The one-hour rainfall depth was determined from Table 6-2 of the Drainage Criteria Manual. These depths are shown in the runoff calculations spreadsheet.

I. OFF-SITE RUNOFF CONSIDERATION

No significant off-site flows are expected to enter the site.

Flows leave the site in Sand Creek.

II. HYDROLOGIC AND HYDRAULIC CALCULATIONS

Hydrologic and hydraulic calculations for the site were performed using the methods outlined in the *Colorado Springs Drainage Criteria Manual*. Topography for the site was compiled using a one-foot contour interval and is presented on the Drainage Plan. Detailed topography is not available for the northern portion of the site in a CADD format.

The hydrologic calculations were made for the historic and developed site conditions. The Drainage Plan presents the drainage patterns for the site, including the sub-basins. The peak flow rates for the sub-basins were estimated using the Rational Method. The 5-year (Minor Storm) and 100-year (Major Storm) recurrence intervals were determined. The one-hour rainfall depth was determined from Table 6-2 of the *Drainage Criteria Manual*. These depths are shown in the runoff calculations spreadsheet.

III. SOILS CONSIDERATIONS

The onsite soils were considered to be Hydrologic Soil Group C, based on the *Soil Survey*. 95 % of the site consists of hydrologic group 'C' soils Kimera Loam and Wilid Silt Loam and less than 5% hydrologic group 'A' soils Schamber-Razor Complex. A copy of the USDA Custom Soil Resource Report is located in Appendix A

A Grading and Erosion Control plan is required for this project since the area of disturbance is greater than 1.0 acres. The area of disturbance is 3.27 acre. A Grading and Erosion Control plan will be submitted to EPC or review and approval with the development of the construction drawings.

IV. WATER QUALITY METHODOLOGY (4-STEP PROCESS):

The Four Step Process is a method of mitigating the impact of new development on receiving waters by reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls. The Four Step Process primarily focuses on smaller, frequently occurring storm events, as opposed to larger storms for which the drainage facilities are sized.

The Grading and Erosion Control Plan will be submitted for review and approval prior to construction.

STEP 1: RUNOFF REDUCTION PRACTICES

~~The runoff from the site will primarily be directed to two proposed sand filters for water quality treatment. The two sand filters will treat 87% of the site runoff. The site has a had a percolation test that indicated a 10 minute per inch or 6 inch per hour infiltration rate. The infiltration rate is documented in the attached geotechnical investigation in Appendix A. With this high infiltration rate the sand filters will have no liner or underdrain, allowing most of the frequent storm runoff to infiltrate to provide water quality. The area tributary to the PBMP's is illustrated in Appendix D on map DM3. A summary of the area's tributary to the PMBP's is included in appendix C.~~

Updated - The runoff from the site will primarily be directed to two proposed sand filters for water quality treatment. The two sand filters will treat 87% of the site runoff. The site has had an updated percolation test that indicated a 0.40 minute per inch and 0.78 inch per hour infiltration rate. The updated infiltration rate is documented in the attached updated geotechnical investigation in Appendix E. The sand filters will have no liner. With this infiltration rate the sand filters will have 4" perf pipe underdrains to collect the filtered runoff. The area tributary to the PBMP's is illustrated in Appendix D on map DM3. A summary of the area's tributary to the PMBP's is included in appendix C.

STEP 2: IMPLEMENT CM'S THAT SLOWLY RELEASE THE WATER QUALITY CAPTURE VOLUME

The proposed sand filters are designed per current criteria to slowly release the water quality capture volume. The total area of disturbance for all construction activities is 3.22 acres. The total percentage of disturbed areas receiving water quality treatment is 87% of the disturbed area. This is well in excess of the 80% requirement. The remaining 13% is the area at the south end of the site that drains to the south and to Indian Hills Road. and the road.

STEP 3: STABILIZE DRAINAGEWAYS

At the north end of the site is Sand Creek. This end of the site is undisturbed, and no improvements are proposed for Sand Creek. The swales around the school will be lined with cobble or rip rap. This will prevent the swale from eroding.

STEP 4: IMPLEMENT SITE SPECIFIC & SOURCE CONTROL MEASURES

There are no potential sources of contaminants that could be introduced to the County's MS4 that will not be controlled by temporary construction CMs. Construction CMs in the form of vehicle tracking control, concrete washout area, inlet protection, rock socks, and silt fences will be utilized during construction activities to protect receiving waters.

V. DRAINAGE BASIN FEES

The site is already plated and will not be required to pay drainage fees.

VI. PCM COST ESTIMATE

The site includes 2 sand filter PCM's. Below is the PCM cost estimate.

	Description	*Qty*	*Unit*	*Unit Cost*		*Cost*	
1	**Sand Filter East**					$17,316.00	
2	Rip Rap	100	SF	$7.00		$700.00	
3	Sand	1958	CF	$6.00		$11,748.00	
4	Forebay	2	EA	$600.00		$1,200.00	
5	Wall	124	LF	$23.00		$2,852.00	
6	Outlet pipe	12	LF	$68.00		$816.00	
8	**Sand Filter West**					$14,597.00	
9	Rip Rap	100	SF	$7.00		$700.00	
10	Sand	1438	CF	$6.00		$8,628.00	
11	Forebay	2	EA	$600.00		$1,200.00	
12	Wall	103	LF	$23.00		$2,369.00	
13	Outlet pipe	25	LF	$68.00		$1,700.00	
							Avg Cost
					SUB-TOTAL	***$31,913.00***	$15,956.50

VII. SUMMARY

The site runoff proposed for Prairie Heights Elementary School expansion will increase the runoff by approximately 1% and not adversely affect the downstream and surrounding developments.

Runoff Summary

Design Point	**Existing**		**Proposed**	
	5 yr Flow (cfs)	100-yr Flow (cfs)	5 yr Flow (cfs)	100 yr flow (cfs)
E-1 / P-1	7.7	40	7.7	40
E-2 / P-2	8.9	41	10	42
E-3 / P-3	0.5	2.5	0.5	2.5
E-21 / P-21	0.9	2.0	0.8	1.8
E-22 / P-22	0.2	1.0	0.1	1.0

A. AGENCY REQUIREMENTS

I. FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

The subject property limits are shown on Flood Insurance Rate Map (FIRM) 08041C1170G with effective dates of December 7, 2018, that are included in Appendix A. The FIRMs also show that the property to be developed is located outside of the FEMA regulated floodplain.

VIII. REFERENCES

1) El Paso County Drainage Criteria Manual Volume 1, dated July 2014, Revised January 2021.
2) El Paso County Drainage Criteria Manual Volume 2, dated July 2014, revised December 2020.
3) El Paso County Engineering Criteria Manual, dated July 2019.
4) National Flood Insurance Hazard layer FIRMette portion of panel 08041C1170G, Federal Emergency Management Agency, Effective Date 12/7/2018.

APPENDIX A

Figure 1: Vicinity Map

Figure 2: Soils Report

Figure 3: FEMA Flood Insurance Rate Map

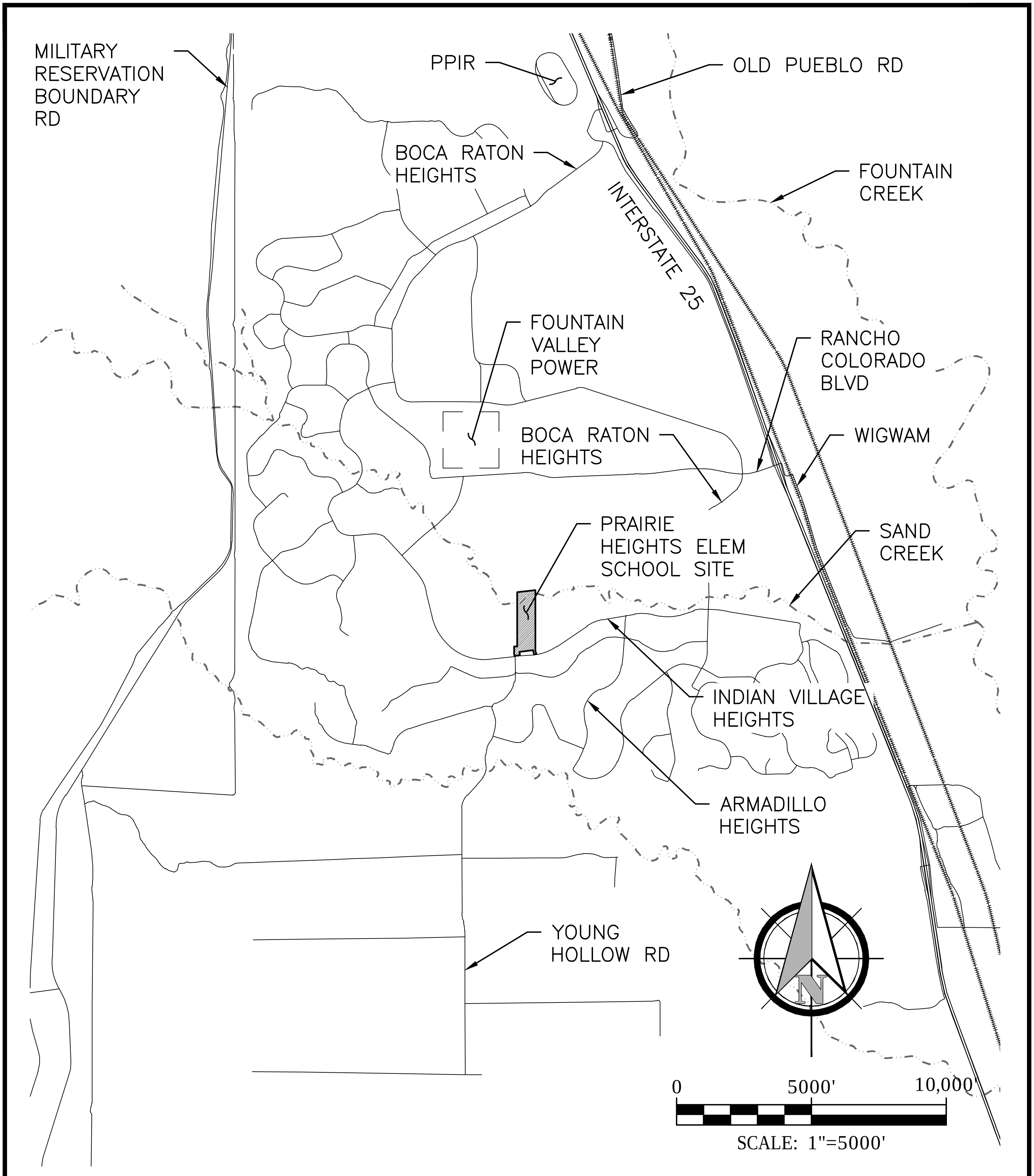


FIGURE 1

Kiowa Engineering Corporation

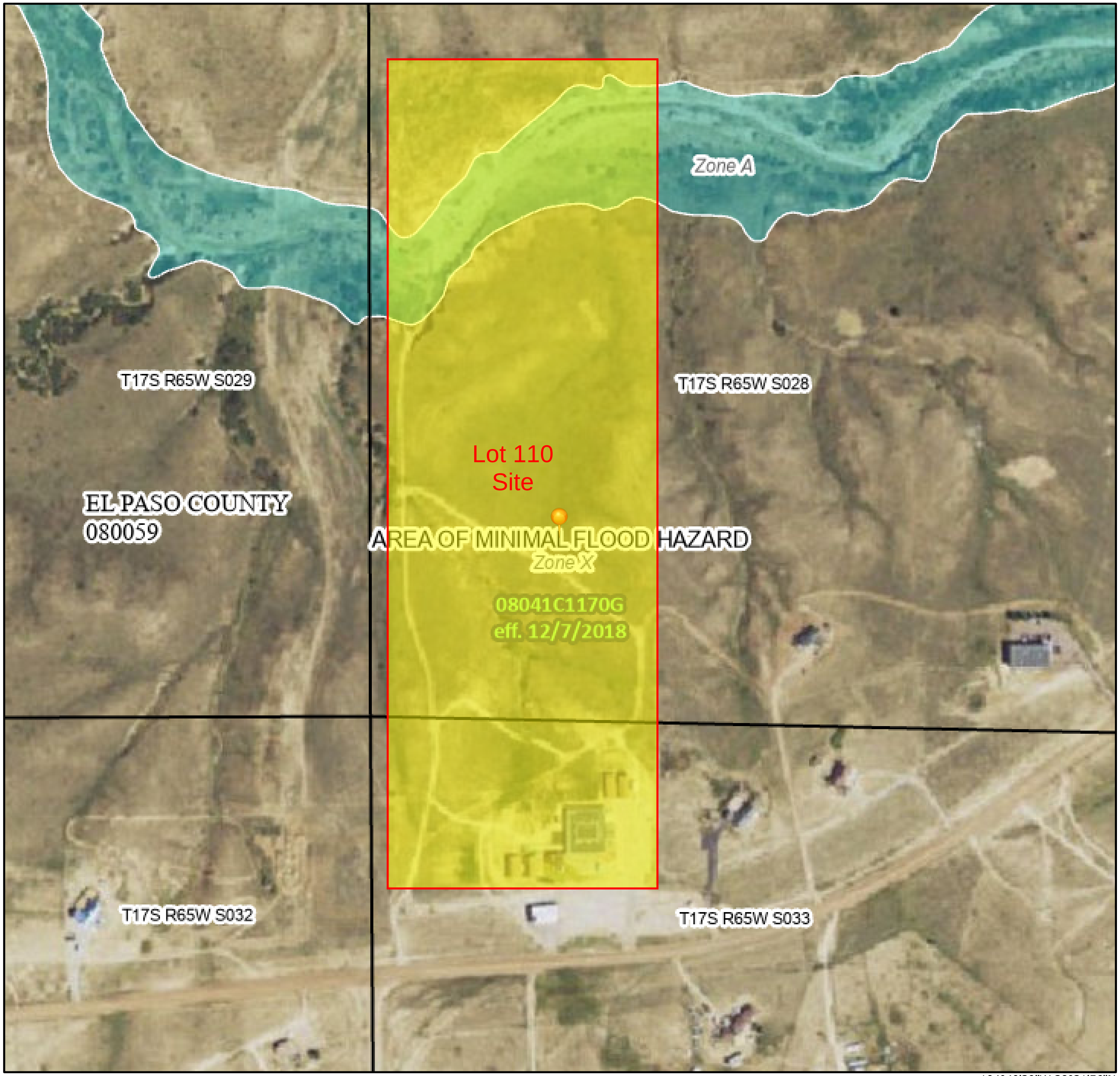
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

Vicinity Map
Prairie Heights Elementary School
7930 Indian Village Heights, Fountain, CO 80817

National Flood Hazard Layer FIRMette

FEMA

104°41'7"W 38°32'24"N



104°40'30"W 38°31'56"N

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

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 1/27/2025 at 3:57 AM 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

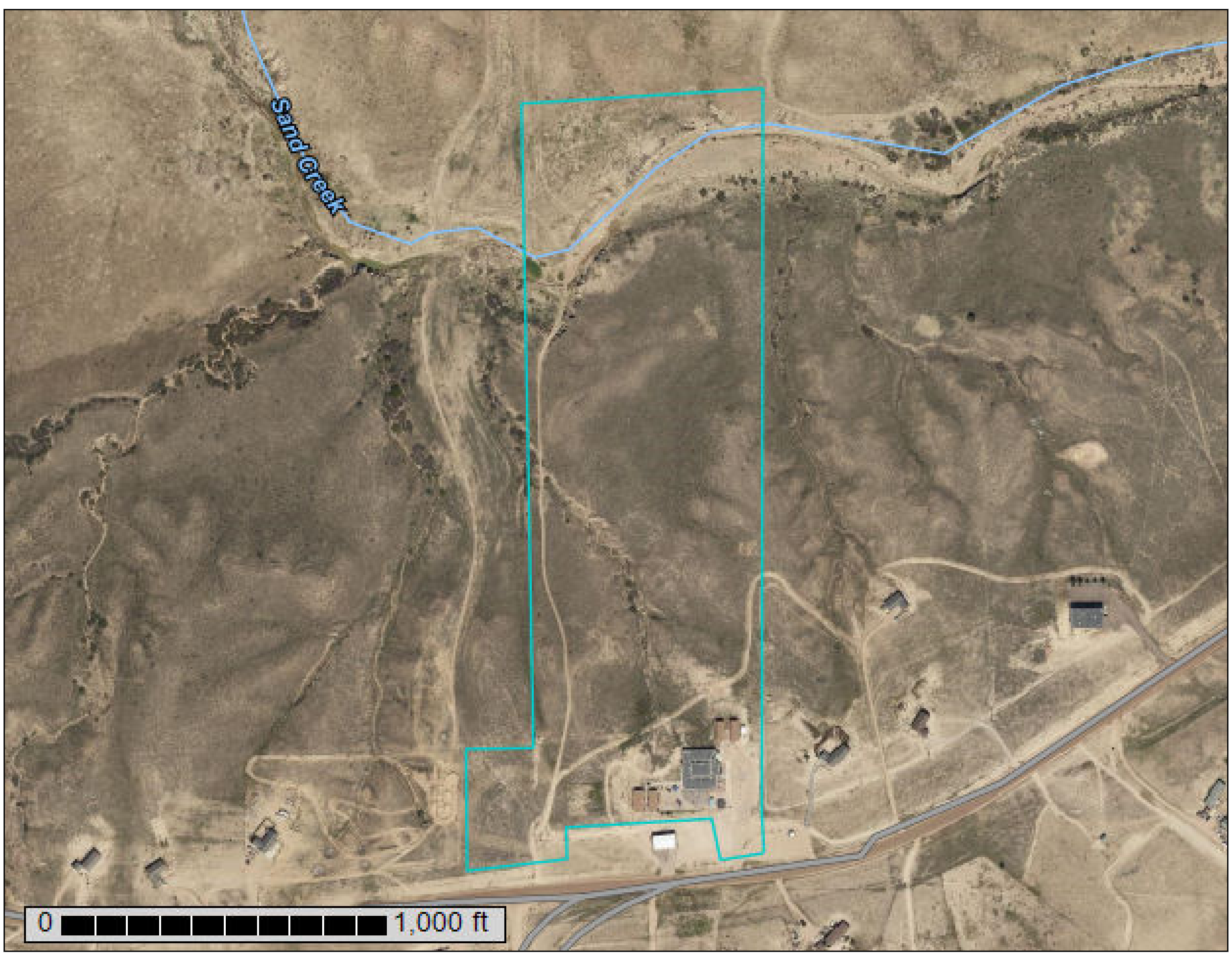
NRCS

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

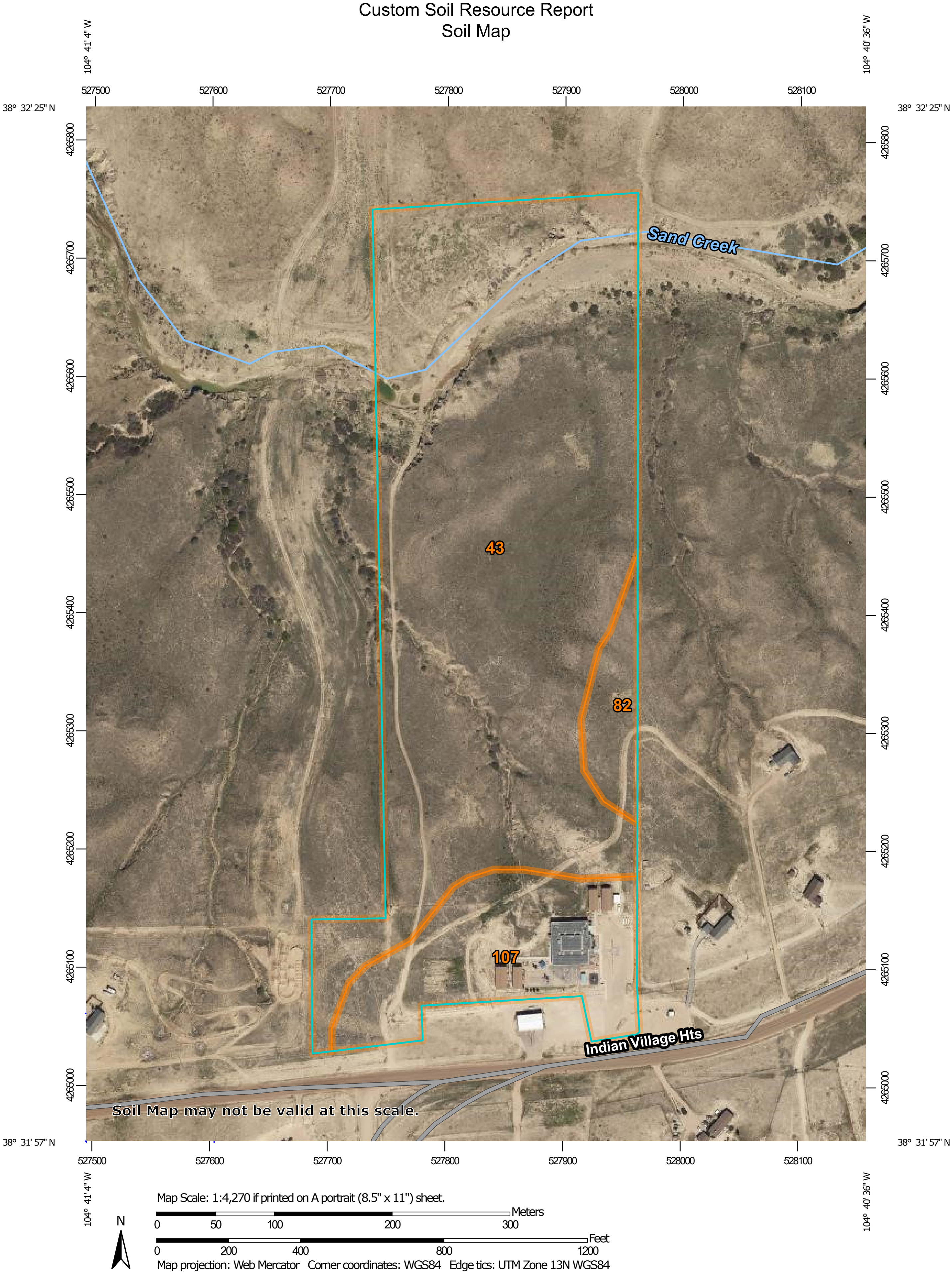
Custom Soil Resource Report for

El Paso County Area, Colorado



January 26, 2025

Soil Map


104° 41' 4" W
104° 40' 36" W
38° 32' 25" N
38° 31' 57" N
527500
527600
527700
527800
527900
528000
528100
4265800
4265700
4265600
4265500
4265400
4265300
4265200
4265100
4265000
Sand Creek
43
82
107
Indian Village Hts
Soil Map may not be valid at this scale.
Map Scale: 1:4,270 if printed on A portrait (8.5" x 11") sheet.
Meters
0 50 100 200 300
Feet
0 200 400 800 1200
N
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: El Paso County Area, Colorado
Survey Area Data: Version 22, Sep 3, 2024

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

Date(s) aerial images were photographed: Aug 14, 2018—Sep 23, 2018

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
43	Kimera loam, 0 to 5 percent slopes	31.1	79.5%
82	Schamber-Razor complex, 8 to 50 percent slopes	1.7	4.3%
107	Wilid silt loam, 0 to 3 percent slopes	6.3	16.1%
Totals for Area of Interest		**39.1**	**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.

El Paso County Area, Colorado

43—Kimera loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2t51v
Elevation: 3,700 to 6,400 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 130 to 170 days

Map Unit Composition

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

Description of Kimera

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Old alluvium and/or eolian deposits

Typical profile

A - 0 to 6 inches: loam
Bw - 6 to 16 inches: loam
Bk1 - 16 to 28 inches: clay loam
Bk2 - 28 to 38 inches: loam
Bk3 - 38 to 79 inches: loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.71 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Very slightly saline (2.0 to 3.9 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: R069XY006CO - Loamy Plains
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)

Hydric soil rating: No

Minor Components

Wilid

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Oterodry

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY026CO - Sandy Plains
Hydric soil rating: No

Fort

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Travessilla

Percent of map unit: 5 percent
Landform: Scarps
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R069XY053CO - Sandstone Breaks
Other vegetative classification: Needs Field Review (G069XW050CO), Sandstone Breaks #53 (069XY053CO_2)
Hydric soil rating: No

82—Schamber-Razor complex, 8 to 50 percent slopes

Map Unit Setting

National map unit symbol: 369y
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 135 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Schamber and similar soils: 55 percent
Razor and similar soils: 43 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Schamber

Setting

Landform: Breaks
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite and/or colluvium derived from granite and/or eolian deposits derived from granite

Typical profile

A - 0 to 5 inches: gravelly loam
AC - 5 to 15 inches: very gravelly loam
C - 15 to 60 inches: very gravelly sand

Properties and qualities

Slope: 8 to 50 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: R069XY064CO - Gravel Breaks
Hydric soil rating: No

Description of Razor

Setting

Landform: Breaks
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey slope alluvium over residuum weathered from shale

Typical profile

A - 0 to 3 inches: clay loam
Bw - 3 to 9 inches: clay loam
Bk - 9 to 31 inches: clay
Cr - 31 to 35 inches: weathered bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
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 content: 15 percent
Gypsum, maximum content: 5 percent
Maximum salinity: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 15.0
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R069XY047CO - Alkaline Plains
Other vegetative classification: ALKALINE PLAINS (069AY047CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

107—Wilid silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2qnmq
Elevation: 4,000 to 6,200 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 48 to 54 degrees F
Frost-free period: 125 to 175 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Wilid

Setting

Landform: Interfluves
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess and/or eolian deposits

Typical profile

A - 0 to 6 inches: silt loam
Bt - 6 to 10 inches: silty clay loam
Btk - 10 to 30 inches: silty clay loam
Bk1 - 30 to 44 inches: silty clay loam
Bk2 - 44 to 79 inches: silt loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
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 content: 40 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.5 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 4.0
Available water supply, 0 to 60 inches: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: C
Ecological site: R069XY006CO - Loamy Plains
Forage suitability group: Loamy (G069XW017CO)
Other vegetative classification: Loamy (G069XW017CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

Minor Components

Minnequa

Percent of map unit: 5 percent
Landform: Ridges, pediments
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains
Other vegetative classification: Loamy (G069XW017CO)
Hydric soil rating: No

Almagre

Percent of map unit: 5 percent
Landform: Interfluves
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains
Other vegetative classification: Loamy Plains #6 (069XY006CO_2), Loamy (G069XW017CO)
Hydric soil rating: No

Manzanola

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Talf
Down-slope shape: Concave, linear
Across-slope shape: Linear
Ecological site: R069XY006CO - Loamy Plains
Other vegetative classification: Clayey (G069XW001CO), Loamy Plains #6 (069XY006CO_2)
Hydric soil rating: No

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GEOTECHNICAL INVESTIGATION

PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION

7930 INDIAN VILLAGE HEIGHTS
FOUNTAIN, COLORADO

Prepared for:

HANOVER SCHOOL DISTRICT NO. 28
17050 SOUTH PEYTON HIGHWAY
FOUNTAIN, COLORADO 80928

Attention: Mr. Mark McPherson, Superintendent

Project No. CS19910.000-125

January 28, 2025

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SCOPE

This report presents the results of our Geotechnical Investigation for the proposed Prairie Heights Elementary School building addition located at 7930 Indian Village Heights in Fountain, Colorado. The purpose of our investigation was to evaluate subsurface conditions at the site in order to develop geotechnical design criteria for the proposed addition and associated site improvements. This report summarizes the results of our field and laboratory investigation, and presents our design and construction recommendations for foundations, floor systems, pavement section alternatives, as well as other details influenced by subsurface conditions and site improvements. We believe the investigation was completed in accordance with our proposal (CTL|T Proposal No. CS-24-0203) dated October 24, 2024. Evaluation of the property for the possible presence of potentially hazardous materials (environmental site assessment) is not included in the scope.

The report was prepared based on conditions disclosed by our exploratory borings, results of laboratory tests, engineering analyses, and our experience. The design criteria presented in the report were based on our understanding of the planned construction. The following section summarizes the report. More detailed descriptions of subsurface conditions, as well as our design and construction recommendations, are presented in the report.

SUMMARY OF CONCLUSIONS

1. Subsurface conditions were explored by advancing five (5) exploratory borings within the approximate footprint of the proposed building addition. Soils encountered within the exploratory borings consisted of suspect quality sand and clay fill underlain by natural, clayey sand, silty sand, and sandy clay extending to the maximum depths explored of 20 to 30 feet. The natural sand and clay are judged to be slightly expansive or non-expansive. Bedrock was not encountered in our exploratory borings.

2. Groundwater was not encountered in our exploratory borings during our drilling operations. Groundwater levels may rise in response to seasonal precipitation and irrigation.

3. The proposed addition to the school building can be constructed using a spread footing foundation system. Footings should be underlain by properly moisture conditioned and densely compacted fill. Existing suspect quality fills cannot be relied upon as a reliable support stratum; therefore, existing fills may not remain in place below new foundations.

4. We believe a low risk of poor slab-on-grade performance will exist for a slab-on-grade floor when underlain by new, properly constructed fill. Suspect quality fills cannot be relied upon for new construction.

5. Surface drainage should be designed and maintained to provide for the rapid removal of runoff away from the proposed building addition to reduce potential subsurface wetting. Water should not be allowed to pond adjacent to the building.

6. The design and construction criteria for foundations and slabs-on-grade included in this report were compiled with the expectation that all recommendations will be incorporated into the project and that the property manager/owner will maintain the structure, use prudent irrigation practices, and maintain surface drainage. It is critical that all recommendations in this report are followed.

SITE CONDITIONS

The school property is located at 7930 Indian Village Heights in Fountain, Colorado. The overall property contains 38.5 acres of land; however, the immediate project area contains about 4 acres of land. The existing school is a single-story building with no below grade construction. Two modular buildings are located to the northeast of the school building. A dirt and gravel surface parking lot, bus lane, and access road are located east of the school building. Indian Village Heights is present adjacent to the south. Large plot residences are present to the east, and vacant lots are present in the immediate vicinity to the north and west. The Hanover Volunteer Fire Department is located immediately south of the school.

The ground surface in the vicinity of the project site and within the immediate area of the proposed building addition are generally graded flat and level. Areas to the north and west, beyond the approximate project site, are slightly to moderately sloping downward and to the north at grades of about 5 to 7 percent. Elevations at the school and proposed addition are approximately 5,420 feet above mean sea level, based on available United States Geological Survey mapping of the area. Areas to the east and south are generally flat and level to slightly sloping toward the north at grades of 1 to 3 percent. The ground surface at the project area is generally covered with weeds and native grasses. The general vicinity of the property and approximate location of the proposed building addition is presented in Fig. 1.

PROPOSED CONSTRUCTION

A building addition is planned to be constructed on the east side of the existing Prairie Heights Elementary School, at the approximate location shown on Fig. 1. The addition is planned as a single-story structure, and will likely be constructed using light gauge metal framing with metal, block veneer, composite exterior finishes, or other similar construction. The structure is planned to contain nearly 18,400 square feet of interior floor space. No below grade construction is planned. Our understanding of the proposed construction is based on discussions with the client, a Geotechnical Engineering Scope of Services prepared by HSD (dated October 17, 2024), and a conceptual site plan prepared by MOA Architecture, October 10, 2024.

INVESTIGATION

Subsurface conditions at the site were investigated by drilling five (5) exploratory borings for the proposed building addition and two (2) shallow subgrade borings in the proximity of the proposed parking lot improvements. A percolation test was performed near the existing leach field, west of the school building. The exploratory borings were drilled at the approximate locations shown on Fig. 1 and advanced to depths of 20 and 30 feet using 4-inch diameter, continuous-flight auger and a truck-mounted drill rig. Subgrade borings were advanced to depths of 4 feet.

Samples of the soil were obtained at 5 to 10-foot intervals using a 2.5-inch diameter (O.D.) modified California barrel sampler driven by blows from a 140-pound hammer falling 30 inches. Subgrade samples consisted of the upper 4 feet of the borings, obtained from two exploratory borings and two subgrade borings. A representative of CTL|Thompson, Inc. was present during drilling to observe drilling operations, log the subsurface conditions encountered in the borings, and obtain samples for laboratory tests.

Samples were returned to our laboratory where they were examined by our engineer and laboratory tests were assigned. Laboratory tests included dry density, moisture content, Atterberg limits, gradation analysis, swell-consolidation testing, and water-soluble sulfate concentration. Swell-consolidation testing was performed by wetting samples under estimated overburden pressures (weight of the overlying soils). Summary logs of the exploratory borings, including results of field penetration resistance tests and a portion of the laboratory data, are presented in Fig. 2. Swell-consolidation test results are presented in Figs. 3 through 7 and gradation test results are presented in Figs. 8 through 10. The laboratory results are summarized on Table 1.

SURFACE CONDITIONS

Subsurface soils encountered in the five (5) borings advanced within the area of the addition consisted of suspect quality, sandy to very sandy clay and very clayey sand fill underlain by natural, sand and clay soils to the maximum depths explored of 25 and 30 feet. Subsurface soils encountered in the two (2) shallow parking lot subgrade borings consisted of about 4 feet of natural, very sandy clay. Bedrock and groundwater were not encountered in our borings. Pertinent engineering characteristics of the soils encountered are described in the following paragraphs.

Fill

Sandy to very sandy clay and very clayey sand fill was encountered at the ground surface in four of the five borings located within the building footprint and extended to depths of between 4 and 10 feet below existing grades. The fill is judged to be loose to medium dense (sand) and stiff to very stiff (clay) based on field penetration resistance testing. Four samples of the fill were subjected to laboratory testing and contained 38 to 75 percent silt and clay-sized particles (percent passing the No. 200 sieve). Two samples of the fill were subjected to Atterberg limits testing resulting in Liquid Limits of 33 and 36 and Plasticity Indices of 15 and 16. Based on the laboratory test results and our experience, we judge the fill to be non-expansive to slightly expansive when wetted.

Natural Soils

Natural, slightly sandy to very sandy clay as well as clayey to very clayey and silty sand were encountered at the ground surface and underlying the existing fill within the building footprint. Near surface materials encountered within the parking lot consisted of sandy and very sandy clay. The natural soils extended to depths of up to 30 feet below existing grades.

Clay soils were encountered at the site and judged to be stiff to very stiff based on field penetration resistance testing. Clay was found at the ground surface and underlying the existing fills in 5 borings. Clays were also encountered underlying the natural, clayey and silty sands at depths of between 16 and 23 feet in three of the borings. Five samples of the clay were subjected to laboratory testing and contained 64 to 92 percent silt and clay-sized particles. Five samples were subjected to swell-consolidation testing. One sample exhibited 0.2 percent measured swell. Three samples compressed between 0.1 and 1.4 percent, and one sample exhibited no movement when wetted under estimated overburden pressures.

Sand soils encountered at the site are judged to be loose to very dense, based on field penetration resistance testing. The sands were encountered underlying the existing fills and natural clays at depths ranging from 6 to 18 feet. Seven samples were tested in our laboratory and contained 15 to 48 percent silt and clay-sized particles. Three samples were subjected to swell-consolidation testing resulting in 0.8 and 0.5 percent compression and 0.2 percent swell when wetted under estimated overburden pressures. Based on the laboratory test results and our experience, we judge the natural soils to be slightly expansive or non-expansive when wetted.

Groundwater

Groundwater was not encountered in the exploratory borings during our drilling operations. The borings were drilled in the late fall season when groundwater depths typically become deeper. Water levels may rise in response to seasonal precipitation and irrigation.

Seismicity

According to the USGS, Colorado's Front Range and eastern plains are considered low seismic hazard zones. The earthquake hazard exhibits higher risk in western Colorado compared to other parts of the state. The Denver Metropolitan area has experienced earthquakes within the past 100 years, shown to be related to deep drilling, liquid injection, and oil/gas extraction. Naturally occurring earthquakes along faults due to tectonic shifts are rare in this area.

The soil and bedrock at this site are not expected to respond unusually to seismic activity. The 2021 International Building Code (Section 1613.2.2) defers the estimation of Seismic Site Classification to ASCE 7-16, as outlined in the table below.

ASCE 7-16 SITE CLASSIFICATION CRITERIA

Seismic Site Class	$\bar{s}_u$, Average Undrained Shear Strength (lb/ft^2)	$\bar{N}$, Average Standard Penetration Resistance (blows/ft)	$\bar{v}_s$, Average Shear Wave Velocity (ft/s)
A. Hard Rock	N/A	N/A	>5,000
B. Rock	N/A	N/A	2,500 to 5,000
C. Very Dense Soil and Soft Rock	>2,000	>50 blows/ft	1,200 to 2,500
D. Stiff Soil	1,000 to 2,000	15 to 50 blows/ft	600 to 1,200
E. Very Loose Sand or Soft Clay Soil	<1,000	<15 blows/ft	<600
F. Soils requiring Site Response Analysis	See Section 20.3.1	See Section 20.3.1	See Section 20.3.1

Based on the results of our investigation, we judge a Seismic Site Classification of D (Stiff Soil). The subsurface conditions indicate low susceptibility to liquefaction from a materials and groundwater perspective. If desired, we can provide shear wave velocity testing to evaluate the site classification; however, we believe it is unlikely to result in an improved seismic site classification.

SITE GEOLOGY

Geology of the site generally consists of Verdos Alluvium (Qv) originating from the Pleistocene Geologic Era and includes a granular mix of silty to clayey sand with weathered gravels. The geologic unit is considered to be underlain by Pierre Shale, which generally weathers to claystone and clay. Bedrock was not encountered in the exploratory borings. Geologic conditions at the site were identified following our review of the Pueblo 1° X 2° Quadrangle, South-Central Colorado, prepared by Glen R. Scott, Richard B. Taylor, Rudy C. Epis, and Reinhard A. Wobus, dated 1976.

SITE DEVELOPMENT

The location of the proposed building addition is relatively flat and level to slightly sloping toward the northwest. Materials encountered in the vicinity of the proposed school building addition consist of suspect quality fills and natural, slightly expansive or non-expansive sandy clay and clayey sand. Based on the existing site grading, we expect cuts and fills of less than about 2 to 3 feet will be needed to establish a building pad. Grading plans have not been provided for our review.

Excavation

We believe the near-surface soils can be excavated with conventional, heavy-duty excavation equipment. Based on our investigation and Occupational Safety and Health Administration (OSHA) standards, we believe the fills, clays, and granular materials identified at the site classify as Type C soil. Type C soil requires a maximum slope inclination of 1.5:1 (horizontal to vertical) for dry conditions. Excavation slopes specified by OSHA are dependent upon the types of soil and groundwater conditions encountered. The contractor's "competent person" should identify the soils encountered in the excavation and refer to OSHA standards to determine appropriate slopes. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to one-half the excavation depth, from the edge of the excavation.

Over-Excavation and Building Pad Improvement

Existing fill was identified in 4 of the 5 borings located within the building addition footprint. The fill extended to depths of 4 to 10 feet below existing ground surface elevations. Documentation for the placement of the existing fill was not available for review and zones of loose materials and relatively low densities were identified in our boring logs. These conditions pose a risk of differential movement and associated damages to foundations and the structure. A reliable approach to reduce the risk of differential movement associated with variations of the existing fill includes removal of the fills within the building footprint; however, this may not be feasible adjacent to existing structures. We recommend over-excavation of the existing soils, fill and native, to a depth of at least 4 feet below the lowest bottom of footing elevation and throughout the building footprint. Excavations should extend 5 feet laterally beyond the outside edges of the footings. Over-excavation will improve bearing capacity and establish a more uniform layer of support for shallow foundations. Where existing fills extend deeper than 4 feet below bottom of foundations, our personnel should evaluate the exposed materials within the excavations at the time of construction to determine if removal to more competent materials is necessary. Evaluation may include visual observation, probing, potholing, and field density testing.

Excavations immediately adjacent to the existing building should be sloped away from the foundations at a 1:1 slope. Care should be taken not to undermine existing foundations and excavations should not remain open as long as necessary to complete the excavation and backfill process, especially adjacent to existing foundations.

Over-excavated soils can be reused given they are free of organics and debris. The materials should be reconstructed as moisture conditioned and densely compacted fill. The materials placed as over-excavation backfill should be moisture conditioned and densely compacted as discussed in the following Fill Placement Section.

Fill Placement

New fill placed at the site will be required to establish a building pad for the building addition and as over-excavation backfill. The properties of the fill will affect the performance of foundations and slabs-on-grade. The near surface soils including the existing suspect quality fills are expected to be suitable to re-use as fill and over-excavation backfill material given the materials are free from vegetation and organics, topsoil, debris, building remnants, and other deleterious materials.

Our experience suggests shrinkage factors of about 10 to 15 percent will exist for the on-site materials. Many variables affect the actual shrinkage-swelling factors of soils and include sample disturbance actual percent compaction of the fill, subsoil profile, compression of the natural soils below the new fill, compression of the deeper fill, rebound of materials cut during site grading, swell after excavated materials are moisture conditioned, etc. The effects of these variables on the shrinkage-swelling factor are difficult to quantify. The actual shrinkage-swelling factor will vary from the estimated percentages.

If imported fill is necessary, it should ideally consist of granular material with 100 percent passing the 2-inch sieve and less than 40 percent passing the No. 200 sieve. The import soil should exhibit low plasticity with a Liquid Limit less than 30 and a Plasticity Index less than 10. Import soils similar to the on-site natural soils may be suitable. A sample of the import material should be submitted to our office for approval before stockpiling at the site.

Prior to fill placement, vegetation, topsoil, and other deleterious material should be removed. Areas to receive fill should be scarified to a depth of 8 inches, moisture conditioned to near optimum moisture content and compacted to high densities.

Fill and backfill should be placed in thin, loose lifts of 8 inches or less. Cohesive materials placed as fill should be moisture conditioned to within 2 percent of optimum moisture contents and compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D

698). Granular materials placed as fill should be moisture conditioned to within 2 percent of optimum moisture contents and compacted to at least 95 percent of maximum modified Proctor dry density (ASTM D 1557). We estimate maximum dry densities for the on-site clay soils to range from 105 to 120 pcf with estimated optimum moisture contents of 12 to 18 percent. A Proctor should be conducted by our laboratory at the time of construction to determine the actual maximum Proctor dry density and optimum moisture content for materials placed as fill. Compaction of backfill should be observed and tested by a representative of our firm during construction.

Water and sewer lines are often constructed beneath slabs and pavements. Compaction of utility trench backfill can have a significant effect on the life and serviceability of floor slabs, pavements, and exterior flatwork. We recommend utility trench backfill in non-building areas be moisture conditioned to within 2 percent of optimum moisture content and compacted to at least 95 percent of maximum standard Proctor dry density (ASTM D 698). Our experience indicates the use of a self-propelled compactor results in more reliable performance compared to trench backfill compacted by a sheepsfoot wheel attachment on a backhoe or trackhoe. The upper portion of the trenches should be widened to allow the use of a self-propelled compactor. The placement and compaction of utility trench backfill should be observed and tested by a representative of our firm during construction.

Fill should not be placed when frozen and should not be placed over top of frozen soils. Once fill is placed, it is important that measures be planned to reduce drying of the near-surface materials. If the fill dries excessively prior to building construction, it may be necessary to rework (scarify, moisture condition, and compact) the upper, drier materials prior to the placement of concrete and forms for the new foundations or floor slabs.

FOUNDATIONS

We understand the desired foundations for the building addition includes the use of spread footings. Based on our exploratory borings and understanding of the proposed construction, we anticipate suspect quality fill and natural, slightly expansive and non-expansive clays and sands are present at elevations that will influence the performance of shallow foundations. Existing fills are considered suspect in quality, as no records of the placement are available for review and zones of loose soils were identified during drilling. New foundations cannot be underlain by suspect quality fill. Additionally, the natural materials present across the building addition footprint exhibit variability such as loose soils, slight expansion and consolidation when wetted, resulting in risk of movement and potential structure damage. To reduce risk and establish a layer of reliable foundation support, new foundations should be underlain by new over-excavation backfill as described in the Over-Excavation and Building Pad Improvement section. Design and construction criteria for the spread footing foundations are presented in the following section.

Spread Footing Foundations

The following presents our design and construction recommendations for the spread footing foundation option.

1. Existing fill cannot be relied upon and must be over-excavated and reconstructed as moisture conditioned and densely compacted fill per the Fill Placement section of this report. Spread footings for the proposed building addition should be underlain by a minimum 4-foot-thick layer of properly constructed over-excavation fill.

2. Spread footings can be designed for a maximum allowable soil bearing pressure of 3,000 psf when underlain by a layer of properly constructed over-excavation fills.

3. We recommend footings beneath continuous foundation walls be at least 16 inches wide. Footings beneath isolated column pads should be at least 24 inches square. Larger footing sizes may be required to accommodate the anticipated foundation loads.

4. Foundation walls should be well-reinforced. We recommend reinforcement sufficient to span an unsupported distance of at least 10 feet.

5. We recommend designs consider total movement of 1-inch and differential movement of 1/2-inch.

6. Foundations subject to lateral loading may be designed using a coefficient of friction of 0.3.

7. Exterior footings must be protected from frost action. Normally, 30 inches of frost cover is required in the area, according to the Pikes Peak Regional Building Department.

8. A representative of our firm should observe the completed foundation excavation prior to the placement of over-excavation backfill to confirm the exposed conditions are similar to those encountered in our exploratory borings. The placement and compaction of below-footing fill and footing subgrade preparation should be observed and tested by a representative of our firm during construction.

9. Excessive wetting of foundation soils during and after construction can cause softening and settlement of foundation soils and result in footing and slab movements. Proper surface drainage around the building is critical to control wetting.

FLOOR SYSTEMS

We understand a slab-on-grade floor is the preferred floor system of the proposed school building addition. The anticipated building addition finished floor elevation will likely match the elevation of the existing building floor slab-on-grade. We estimate less than about 2 to 3 feet of new fill may be required to establish a finished floor slab-on-grade elevation. Based on our understanding of the proposed construction and near surface materials encountered in our exploratory borings, we anticipate suspect quality fill will impact the proposed slabs. We believe an undefined risk of differential settlement exists due to the presence of suspect quality fill, loose sands, and inconsistent material types (clay and sand) found within the borings at or near anticipated floor slab-on-grade elevations. We recommend mitigation efforts be performed to reduce risk of settlement as described in the Site Development section and the following section. Design and construction recommendations for slabs-on-grade are presented below.

Slab-on-Grade

Where conventional slabs-on-grade are used and the owner accepts the risks, we recommend the following design and construction criteria. These recommendations will not prevent movement. Rather, they tend to reduce damage if movement occurs.

1. Slabs should be separated from exterior walls and interior bearing members with a slip joint that allows free vertical movement of the slabs. This detail can reduce cracking when movement occurs.

2. Use of slab-supported partition walls should be minimized. Slip-joints in slab-bearing partitions should allow for at least 1-1/2 inches of free vertical movement. If the “float” is provided at the tops of partitions, the connection between interior, slab-supported partitions and exterior, foundation-supported walls should be detailed to allow differential movement. These architectural connections are critical to help reduce cosmetic damage when foundations and floor slabs move relative to each other. We have seen instances where these architectural connections were not designed and constructed properly and resulted in moderate cosmetic damage, even though the movement experienced was well within the anticipated range. The architect should pay special attention to these issues and detail the connections accordingly.

3. Underslab plumbing should be eliminated where feasible. Where such plumbing is unavoidable, it should be pressure tested for leaks prior to slab construction

and provided with flexible couplings. Pressurized water supply lines should be brought above the floors as quickly as possible.

4. Plumbing and utilities that pass through the slabs should be isolated from the slabs and constructed with flexible couplings. Utilities, as well as electrical and mechanical equipment, should be constructed with sufficient flexibility to allow for movement.

5. HVAC or other mechanical systems supported by the slabs (if any) should be provided with flexible connections capable of withstanding at least 1-inch of movement.

6. Slabs should be placed directly on properly moisture conditioned, well-compacted fill. The 2021 International Building Code (IBC) requires a vapor retarder between the base course or subgrade soils and the concrete slab-on-grade floor. The merits of installation of a vapor retarder below floor slabs depend on the sensitivity of floor coverings and building use to moisture. A properly installed vapor retarder (6 mil minimum) is more beneficial below concrete slab-on-grade floors where floor coverings, painted floor surfaces or products stored on the floor will be sensitive to moisture. The vapor retarder is most effective when concrete is placed directly on top of it, rather than placing a sand or gravel leveling course between the vapor retarder and the floor slab. The placement of concrete on the vapor retarder may increase the risk of shrinkage cracking and curling. Use of concrete with reduced shrinkage characteristics including minimized water content, maximized coarse aggregate content, and reasonably low slump will reduce the risk of shrinkage cracking and curling. Considerations and recommendations for the installation of vapor retarders below concrete slabs are outlined in Section 5.2.3.2 of the 2015 report of American Concrete Institute (ACI) Committee 302, "Guide for Concrete Floor and Slab Construction (ACI 302.1R-15)".

7. Slab-on-grade floors can be designed considering a modulus of subgrade reaction of 100 pci for slabs supported on at least 4 feet of new fill.

8. The American Concrete Institute (ACI) recommends frequent control joints be provided in slabs to reduce problems associated with shrinkage cracking and curling. To reduce curling, the concrete mix should have a high aggregate content and a low slump. If desired, a shrinkage compensating admixture could be added to the concrete to reduce the risk of shrinkage cracking. We can perform a mix design or assist the design team in selecting a pre-existing mix.

Exterior Flatwork

We recommend exterior flatwork and sidewalks be isolated from the foundations to reduce the risk of transferring heave, settlement, or freeze-thaw movement to the structures. One alternative would be to construct the inner edges of the flatwork on haunches or steel angles bolted to the foundation walls and detail the connections such that movement will cause less distress to the building, rather than tying the slabs directly into the building foundation. Construction on haunches or steel angles and reinforcing the sidewalks and other exterior flatwork will reduce the potential for differential settlement and better allow them to span across wall backfill. Frequent control joints should be provided to reduce problems associated with shrinkage cracking. Panels that are approximately square perform better than rectangular areas.

BELOW-GRADE CONSTRUCTION

It is our understanding that no below-grade construction (habitable or mechanical such as elevator pits) is planned for the proposed school building addition. If plans change and habitable or mechanical, below-grade areas will be included in the structure, our office should be contacted to assess our shallow foundation recommendations as well as provide design criteria for lateral earth pressures and subsurface drain systems.

PAVEMENTS

We understand the proposed building addition will include the construction of new asphalt and/or concrete paved drive lanes and parking lots. The new parking lot will be located east of the school building and will contain about 21 parking stalls. A pickup and drop-off drive lane as well as a bus lane will be located along the west side of the parking lot. An access drive lane will be constructed to the south, providing access to the parking lot from Indian Village Heights.

Our exploratory borings and understanding of the proposed construction suggest the subgrade soils in the vicinity of the proposed parking lot and access drive consist of sandy to very sandy clay fill and natural sandy to very sandy clay. Subgrade samples of the near surface soils were obtained from two exploratory borings (TH-4 and TH-5) and two subgrade borings (S-1 and S-2) during drilling. The subgrade samples were returned to our laboratory, combined, and assigned laboratory classification testing. Classification testing included gradation analysis and Atterberg Limits. Samples contained 50 to 55 percent silt and clay-sized particles (passing the No. 200 sieve). Atterberg limits testing resulting was performed, resulting in a Liquid Limit of 33 and a Plasticity Index of 15. The pavement subgrade sample classified as CL soils using the Unified Soil Classification System (USCS). According to the American Association of State Highway Transportation Officials (AASHTO) classification system, the subgrade soils present within the proposed parking lots and drive lanes classify as A-6 soils. These types of materials generally exhibit fair to poor pavement support characteristics. For design purposes, an estimated Hveem Stabilometer ("R") value of 20 was assigned for the existing subgrade materials, based on our laboratory classification testing.

We anticipate the parking lot will be subjected to passenger pick-up trucks, automobiles, school busses, and occasional delivery trucks. We considered a daily traffic number (DTN) of 2 for the automobile parking stalls which correspond to an 18-kip Equivalent Single-Axle Loads (ESAL) of 14,600 for a 20-year flexible pavement design life (asphalt pavement). We considered a DTN of 10 for the drive lanes and access road which corresponds to an 18-kip ESAL of 73,000 for a 20-year flexible pavement design life. We calculated an 18-kip ESAL for rigid pavement (concrete), considering a 50-year design life of 36,500 and 182,500 for the parking stalls and drive lanes, respectively. Parking lot pavement alternatives are presented in the following table. If the estimated DTN values are significantly different, we should be contacted to revise our calculations to reflect the different values.

RECOMMENDED PAVEMENT DESIGN SECTION ALTERNATIVES

Street/Parking Lot	ESAL Asphalt/Concrete	Asphalt Section (AC) Inches	Asphalt Pavement + Aggregate Base Course (AC + ABC) Inches	Plain Portand Cement Concrete (PCC) Inches
Automobile Parking Stalls	14,600 / 36,500	4.5	3 + 6	6
Drive Lanes/Access Drive	73,000 / 182,500	5.5	4 + 6	6

We recommend a concrete pad be provided at the trash dumpster site, if included in the proposed construction. The pad should be at least 8 inches thick and long enough to support the entire length of the trash truck and dumpster. Joints between concrete and asphalt pavements should be sealed with a flexible compound.

Our design considers pavement construction will be completed in accordance with the City Fountain or El Paso County Specifications. The specifications contain requirements for the pavement materials (asphalt, base course, and concrete) as well as the construction practices used (compaction, materials sampling, and proof-rolling). Of particular importance are those recommendations directed toward subgrade and basecourse compaction and proof-rolling. During proof-rolling, attention should be directed toward the areas of confined backfill compaction such as utility trenches. Soft or loose subgrade or areas that pump excessively should be stabilized prior to pavement construction. Subgrade areas that pass the proof-roll should be stable enough to pave. A representative of our office should be present at the site during placement of fill and construction of pavements to perform density testing.

PEROLATION TESTING

We understand the existing leach field may be expanded to accommodate a larger on-site wastewater system. The location of the existing on-site wastewater system is located west of the existing school building. Our office performed field percolation testing at the site to assess the percolation rate of the near surface soils in the vicinity of the proposed leach field expansion. A profile hole was advanced to a depth of 10 feet near the center of the test location and samples were obtained for classification. A total of three, six-inch diameter holes were advanced to depths of about 3 feet below existing grades using a truck mounted drill rig and continuous flight auger at the location indicated on Fig. 1. Slotted PVC pipe was installed into the three holes and the holes were presoaked. We returned on the following day to perform the percolation test by taking measurements of the water depth on a periodic basis. Measurements were taken and recorded in the field. A design infiltration rate of 10 minutes per inch was determined for percolation test location P-1. Test results are summarized in the table presented in Fig. 11 of this report.

CONCRETE

Concrete in contact with soil can be subject to sulfate attack. We measured water-soluble sulfate concentration of less than 0.1 percent in a sample obtained from the site. As indicated in our tests and ACI 318-19, the sulfate exposure class is *not applicable* or S0.

SULFATE EXPOSURE CLASSES PER ACI 318-19

Exposure Classes		Water-Soluble Sulfate (SO_4) in Soil [A] (%)
Not Applicable	S0	< 0.10
Moderate	S1	0.10 to 0.20
Severe	S2	>0.20 to 2.00
Very Severe	S3	> 2.00

A) Percent sulfate by mass in soil determined by ASTM C1580

For this level of sulfate concentration, ACI 318-19, *Building Code Requirements for Structural Concrete*, indicates there are no special cement type requirements for sulfate resistance as indicated in the table below.

CONCRETE DESIGN REQUIREMENTS FOR SULFATE EXPOSURE PER ACI 318-19

Exposure Class		Maximum Water/ Cement Ratio	Minimum Compressive Strength (psi)	Cementitious Material Types [A]			Calcium Chloride Admixtures
				ASTM C150/ C150M	ASTM C595/ C595M	ASTM C1157/ C1157M	
S0		N/A	2500	No Type Restrictions	No Type Restrictions	No Type Restrictions	No Restrictions
S1		0.50	4000	II [B]	Type with (MS) Designation	MS	No Restrictions
S2		0.45	4500	V [B]	Type with (HS) Designation	HS	Not Permitted
S3	Option 1	0.45	4500	V + Pozzolan or Slag Cement [C]	Type with (HS) Designation plus Pozzolan or Slag Cement [C]	HS + Pozzolan or Slag Cement [C]	Not Permitted
S3	Option 2	0.4	5000	V [D]	Type with (HS) Designation	HS	Not Permitted

A) Alternate combinations of cementitious materials shall be permitted when tested for sulfate resistance meeting the criteria in section 26.4.2.2(c).
B) Other available types of cement such as Type III or Type I are permitted in Exposure Classes S1 or S2 if the C3A contents are less than 8 or 5 percent, respectively.
C) The amount of the specific source of pozzolan or slag to be used shall not be less than the amount that has been determined by service record to improve sulfate resistance when used in concrete containing Type V cement. Alternatively, the amount of the specific source of the pozzolan or slab to be used shall not be less than the amount tested in accordance with ASTM C1012 and meeting the criteria in section 26.4.2.2(c) of ACI 318.
D) If Type V cement is used as the sole cementitious material, the optional sulfate resistance requirement of 0.040 percent maximum expansion in ASTM C150 shall be specified.

Superficial damage may occur to the exposed surfaces of highly permeable concrete. To control this risk and to resist freeze-thaw deterioration, the water-to-cementitious materials ratio should not exceed 0.50 for concrete in contact with soils that are likely to stay moist due to surface drainage or high-water tables. Concrete should have a total air content of 6 percent ± 1.5 percent. We advocate damp-proofing of all foundation walls and grade beams in contact with the subsoils.

SURFACE DRAINAGE

Performance of the foundation system, floor slabs, pavements, and concrete flatwork to be constructed at this site will be influenced by the moisture conditions existing within the near-surface soils. Overall surface drainage patterns must be planned to provide for the rapid removal of storm runoff. Water should not be allowed to pond adjacent to foundations or over pavements or concrete flatwork. We recommend the following precautions be observed during construction and maintained at all times after the building is completed.

1. Excessive wetting or drying of the open foundation excavation should be avoided.

2. Foundation wall backfill should be graded to provide for the rapid removal of runoff. We recommend a slope equivalent to at least 6 inches in the first 10 feet. In flatwork areas adjacent to the structure, the slope may be reduced to comply with ADA requirements.

3. Backfill around foundations should be moistened and compacted to 95 percent of standard Proctor dry density, according to criteria presented in Fill Placement.

4. Roof downspouts and drains should discharge well away from the building. Downspout extensions and/or splash blocks should be provided to help reduce infiltration into the backfill adjacent to the structure.

5. Landscaping concepts should concentrate on use of plantings that require little or no supplemental irrigation after the vegetation is established. Irrigated sod, if it is included in the landscaping plan, should not be located within 6 feet of the foundation walls. Irrigation should be limited to the minimum amount sufficient to maintain vegetation. Application of more water will increase likelihood of slab and foundation movements.

6. Backfill around foundations should be moistened and compacted according to criteria presented in Fill Placement.

CONSTRUCTION OBSERVATIONS

We recommend that CTL|Thompson, Inc. provide construction observation services to allow us the opportunity to confirm subsurface conditions are consistent with those found during this investigation. If others perform these observations, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

GEOTECHNICAL RISK

The concept of risk is an important aspect with any geotechnical evaluation primarily because the methods used to develop geotechnical recommendations do not comprise an exact science. We never have complete knowledge of subsurface conditions. Our analysis must be tempered with engineering judgment and experience. Therefore, the recommendations presented in any geotechnical evaluation should not be considered risk-free. Our recommendations represent our judgment of those measures that are necessary to increase the chances that the structures will perform satisfactorily. It is critical that all recommendations in this report are followed during construction. The owner must assume responsibility for maintaining the structure and use appropriate practices regarding drainage.

LIMITATIONS

This report has been prepared for the exclusive use of the Hanover School District No. 28 and NV5 for the purpose of providing geotechnical design and construction criteria for the proposed Prairie Heights Elementary School building addition and associated site improvements located at 7930 Indian Village Heights in Fountain, Colorado. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of structure proposed, the geologic setting, and the subsurface conditions encountered. The conclusions and recommendations contained in the report are not valid for use by others. Standards of practice continuously evolve in the area of geotechnical engineering. The recommendations provided are appropriate for about three years. If the project is not constructed within about three years, we should be contacted to determine if we should update this report.

Our borings were spaced to obtain a reasonably accurate picture of foundation conditions below the proposed building addition area. The data are representative of conditions encountered only at the exact boring locations. Variations in the subsurface conditions not indicated by our borings are possible. Representatives of our firm should periodically visit the site during construction to perform observation and testing services.

We believe this investigation was conducted in a manner consistent with that level of skill and care normally used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made.

If we can be of further service in discussing the contents of this report or in the analysis of the influence of the subsoil conditions on design of the building, please call.

CTL|THOMPSON, INC.

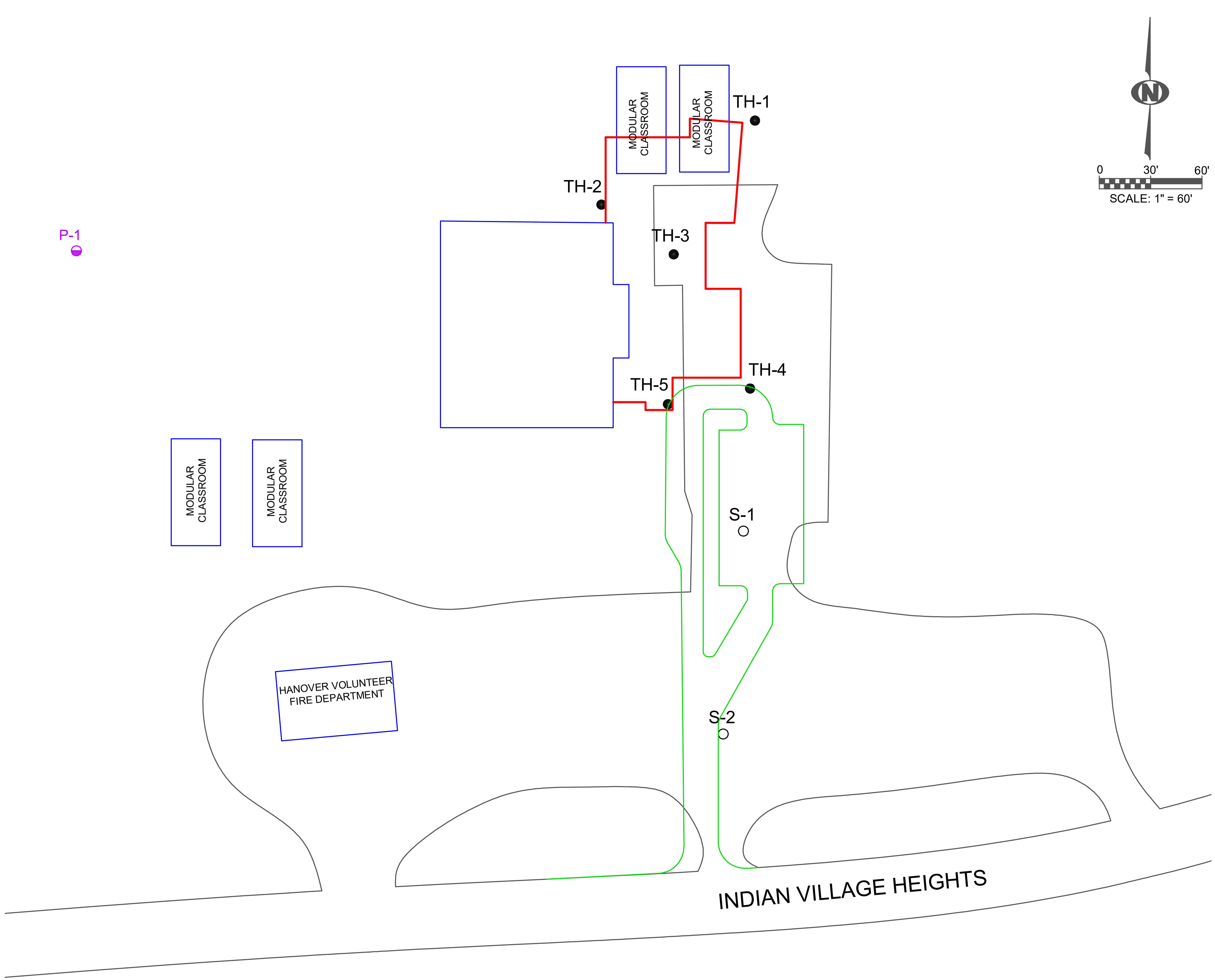
Patrick Foley, E.I.
Staff Engineer

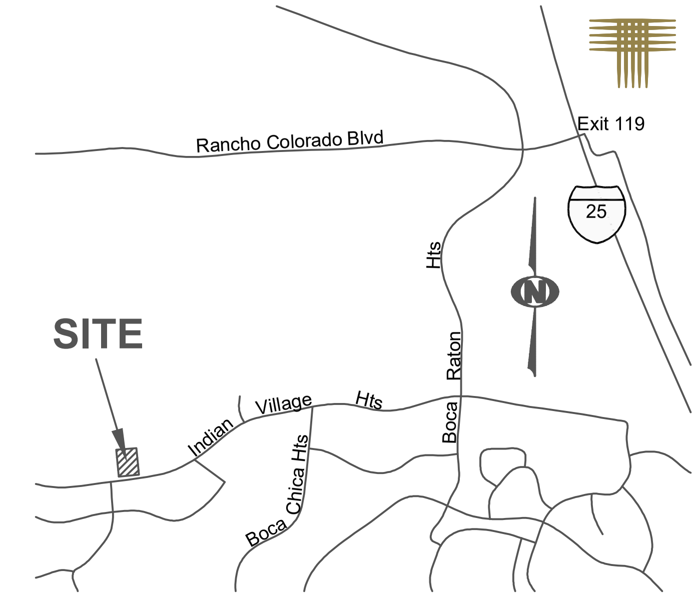
Reviewed by:

COLORADO LICENSED JEFFREY MARK JONES 47539 1/28/25 PROFESSIONAL ENGINEER

Jeffrey M. Jones, P.E.
Principal Engineer

PF:JMJ:cw
Via e-mail: Steve.Horn@nv5.com





VICINITY MAP

(NOT TO SCALE)

LEGEND:

TH-1 ●	APPROXIMATE LOCATION OF EXPLORATORY BORING.
S-1 ○	APPROXIMATE LOCATION OF SUBGRADE SAMPLE.
P-1 ◒	APPROXIMATE LOCATION OF PERCOLATION TEST.
(blue line)	LOCATION OF EXISTING BUILDING FOOTPRINT.
(red line)	LOCATION OF PROPOSED BUILDING ADDITION FOOTPRINT.
(grey line)	LOCATION OF EXISTING STREETS, PARKING LOT, AND DRIVE LANES.
(green line)	LOCATION OF PROPOSED PARKING LOT AND DRIVE LANES.

NOTE:
BASE DRAWING WAS PROVIDED BY NV5 (PREPARED BY MOA ARCHITECTURE, DATED OCTOBER 10, 2024).

HANOVER SCHOOL DISTRICT NO. 28
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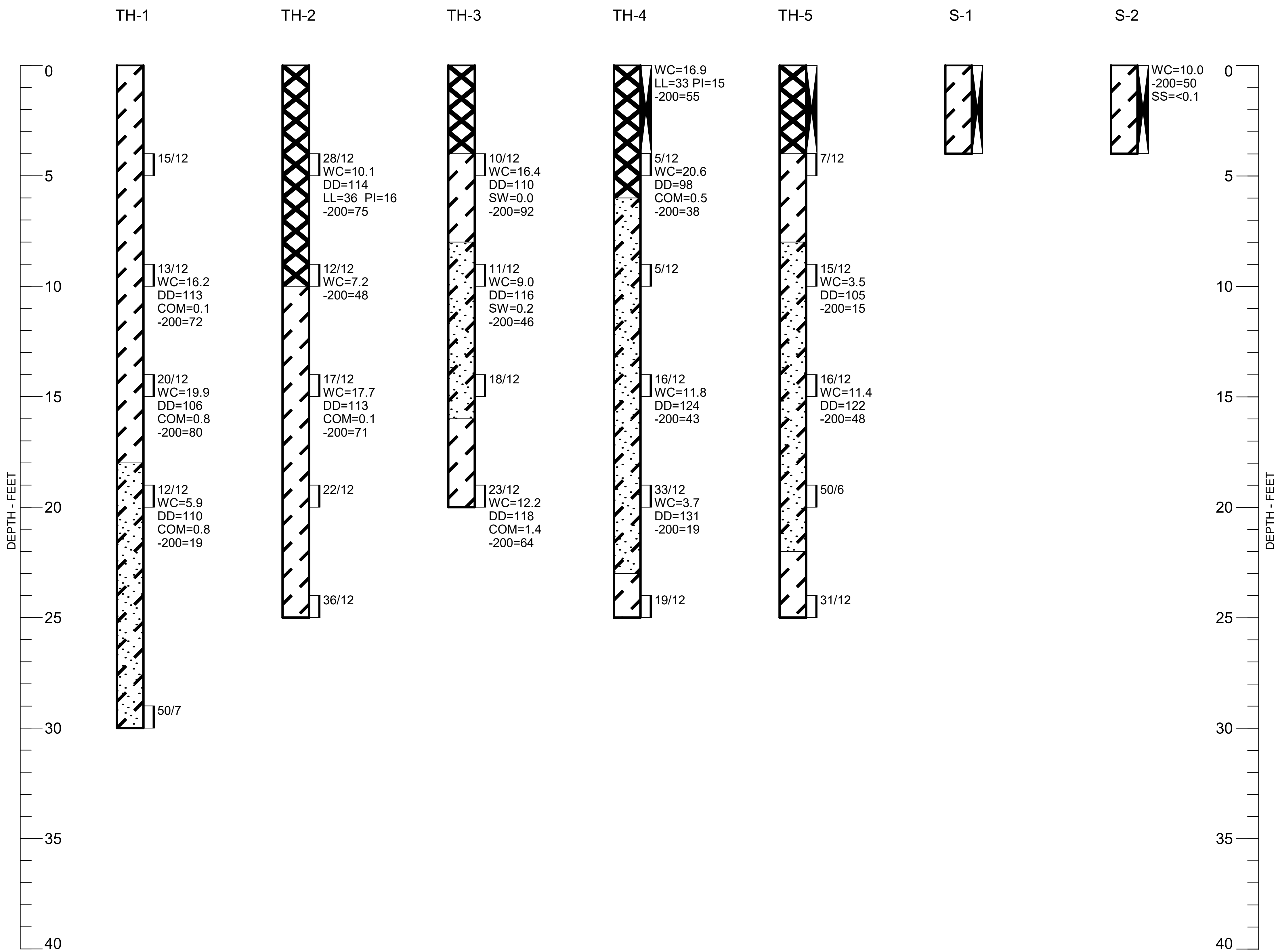
Location of Exploratory Borings

FIG. 1



LEGEND:

FILL, CLAY, SANDY TO VERY SANDY AND SAND, VERY CLAYEY, VERY STIFF (CLAY), SLIGHTLY GRAVELLY, MEDIUM DENSE (SAND), MOIST, BROWN.

CLAY, SLIGHTLY SANDY TO VERY SANDY, STIFF TO VERY STIFF, MOIST TO VERY MOIST, BROWN, OCCASIONAL GRAVELS (CL).

SAND, CLAYEY TO VERY CLAYEY AND SILTY, SLIGHTLY GRAVELLY TO GRAVELLY, LOOSE TO VERY DENSE, LIGHT BROWN TO BROWN (SC, SM).

DRIVE SAMPLE. THE SYMBOL 15/12 INDICATES 15 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

INDICATES BULK SAMPLE OBTAINED FROM AUGER CUTTINGS.

NOTES:

1. THE BORINGS WERE DRILLED NOVEMBER 18, 2024 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-55, TRUCK-MOUNTED DRILL RIG.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. GROUNDWATER WAS NOT ENCOUNTERED IN THE EXPLORATORY BORINGS DURING THIS INVESTIGATION.
4. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   SW - INDICATES SWELL WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
   COM - INDICATES COMPRESSION WHEN WETTED UNDER APPROXIMATE OVERBURDEN PRESSURE. (%)
   LL - INDICATES LIQUID LIMIT. (NV : NO VALUE)
   PI - INDICATES PLASTICITY INDEX. (NP : NON-PLASTIC)
   -200 - INDICATES PASSING NO. 200 SIEVE. (%)
   SS - INDICATES WATER-SOLUBLE SULFATE CONTENT. (%)

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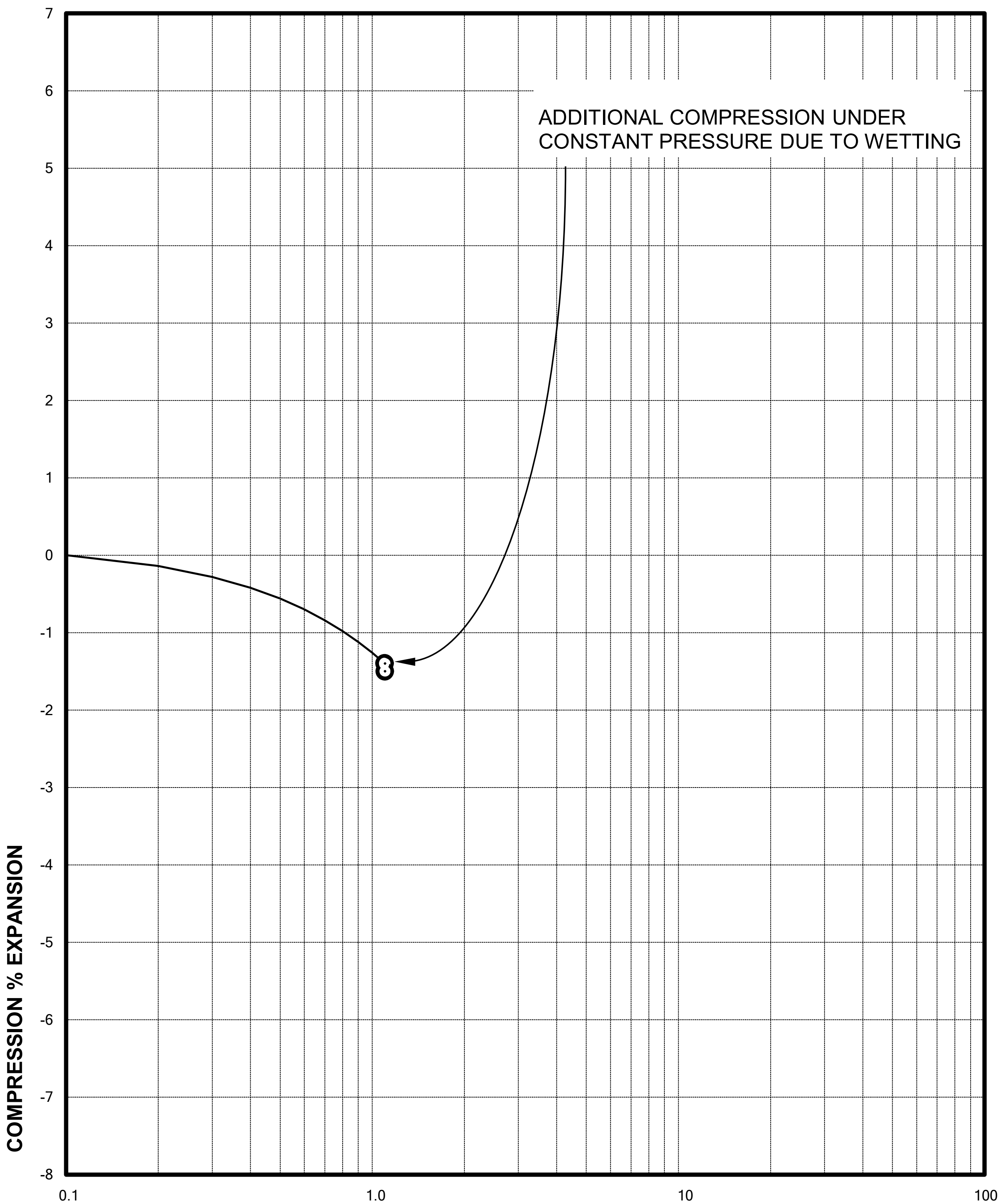
Summary Logs of Exploratory Borings

FIG. 2



APPLIED PRESSURE - KSF

Sample of CLAY, SANDY (CL)
From TH-1 AT 9 FEET

DRY UNIT WEIGHT= 113 PCF
MOISTURE CONTENT= 16.2 %

HANOVER SCHOOL DISTRICT NO. 28
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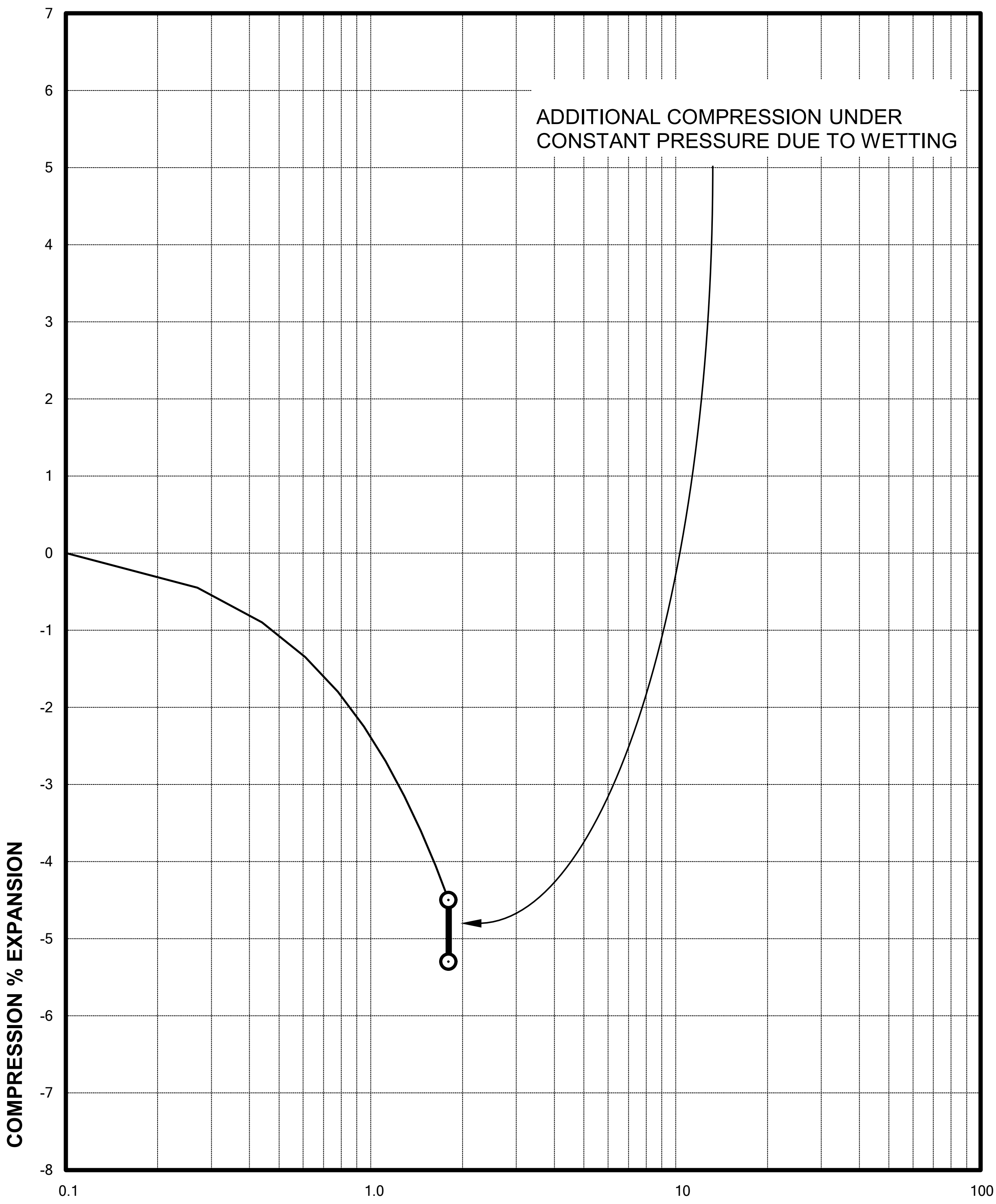
Swell Consolidation Test Results

FIG. 3



Sample of CLAY, SANDY (CL)
From TH-1 AT 14 FEET

DRY UNIT WEIGHT= 106 PCF
MOISTURE CONTENT= 19.9 %

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
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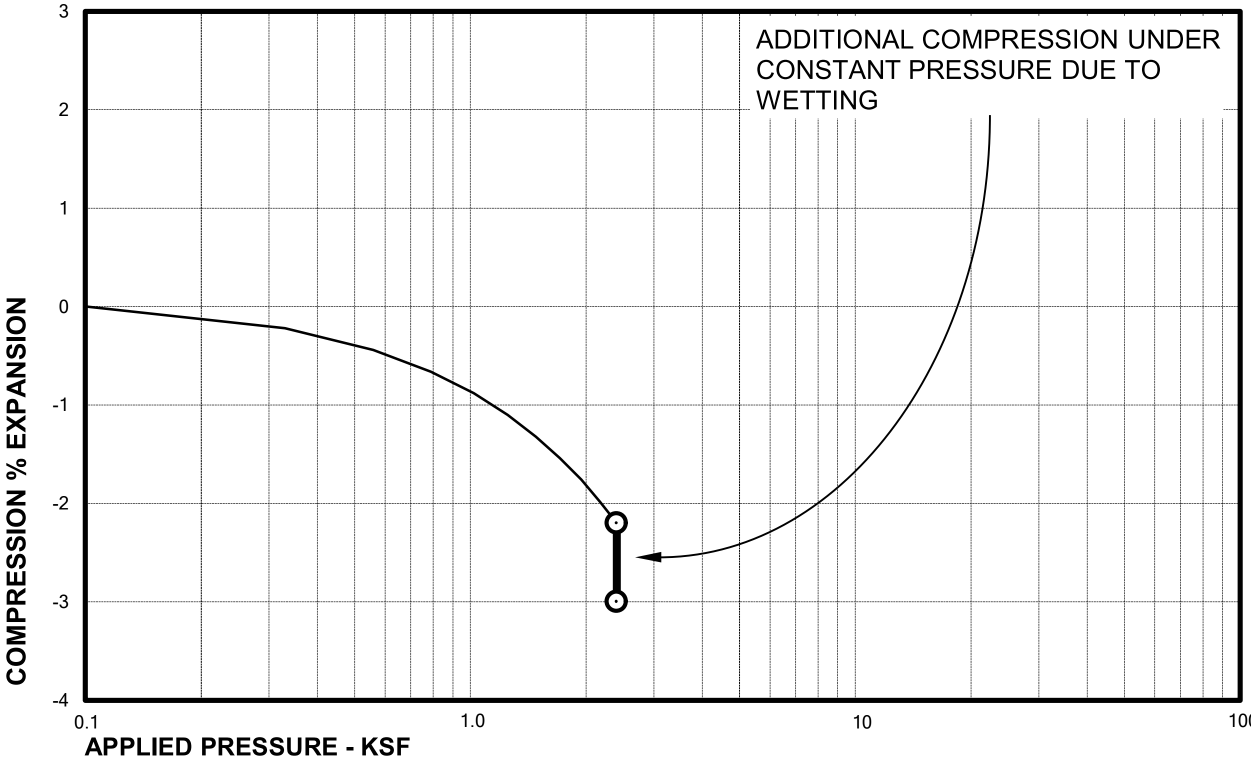
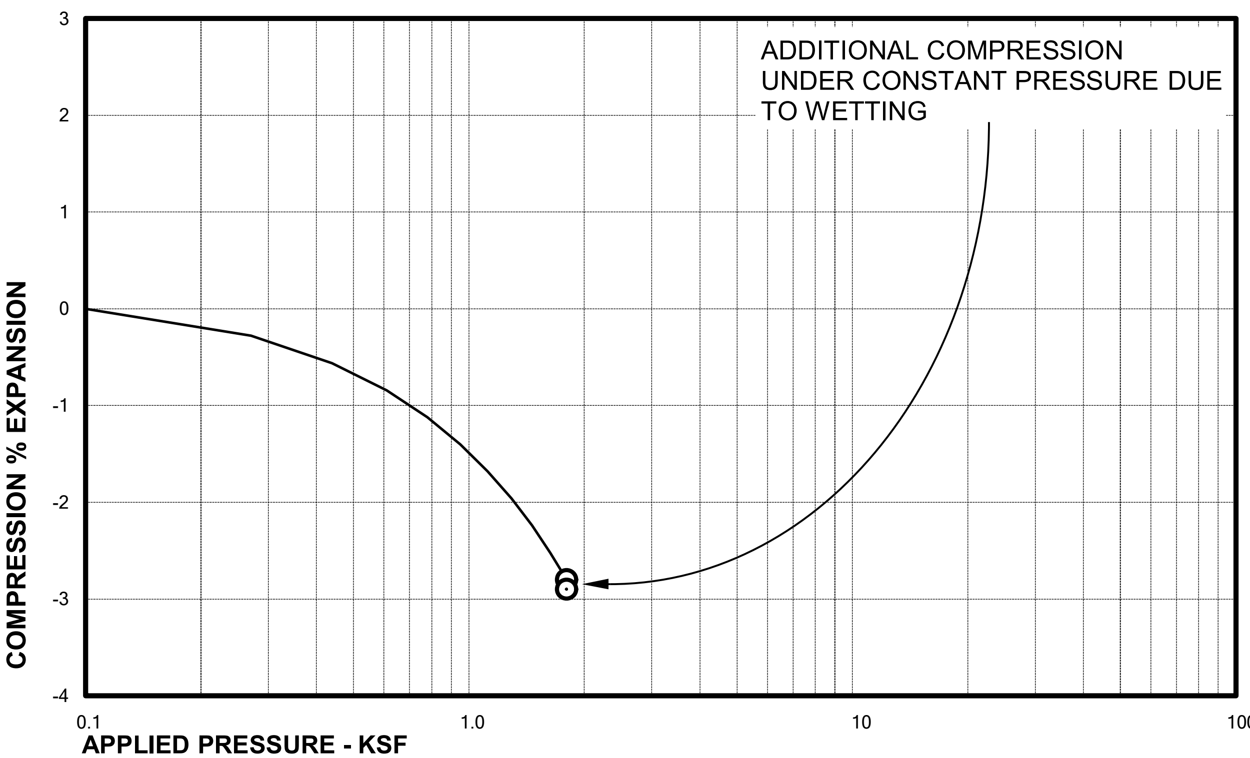
Swell Consolidation Test Results

FIG. 4



Sample of SAND, SILTY (SM)
From TH-1 AT 19 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 5.9 %



Sample of CLAY, SANDY (CL)
From TH-2 AT 14 FEET

DRY UNIT WEIGHT= 113 PCF
MOISTURE CONTENT= 17.7 %

HANOVER SCHOOL DISTRICT NO. 28
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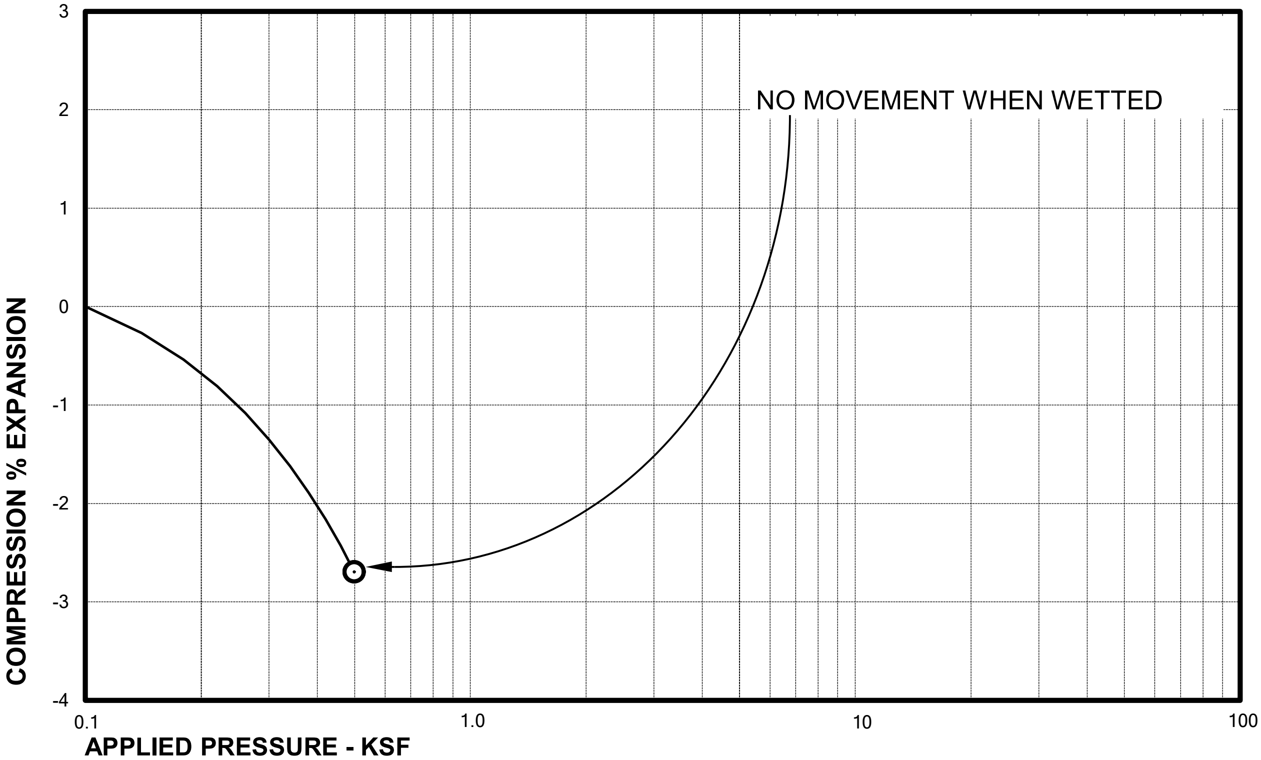
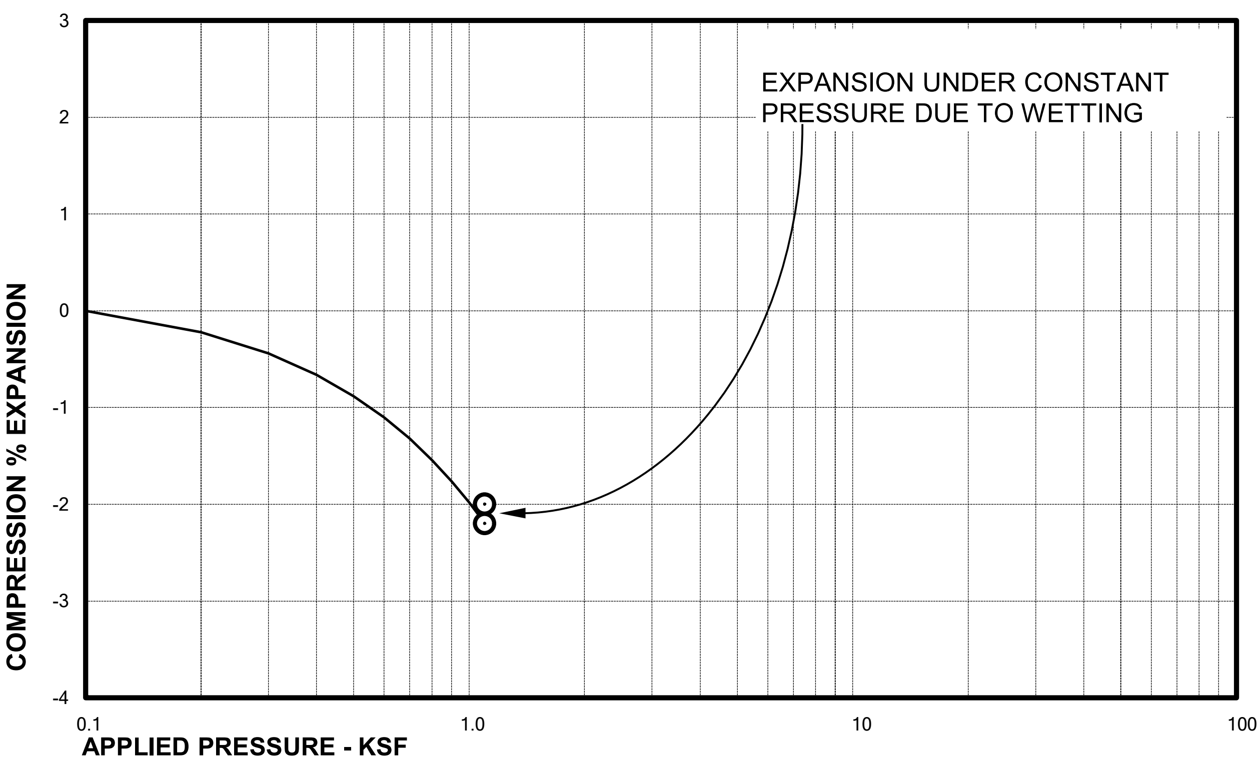
Swell Consolidation Test Results

FIG. 5



Sample of CLAY, SLIGHTLY SANDY (CL)
From TH-3 AT 4 FEET

DRY UNIT WEIGHT= 110 PCF
MOISTURE CONTENT= 16.4 %



Sample of SAND, VERY CLAYEY (SC)
From TH-3 AT 9 FEET

DRY UNIT WEIGHT= 116 PCF
MOISTURE CONTENT= 9.0 %

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
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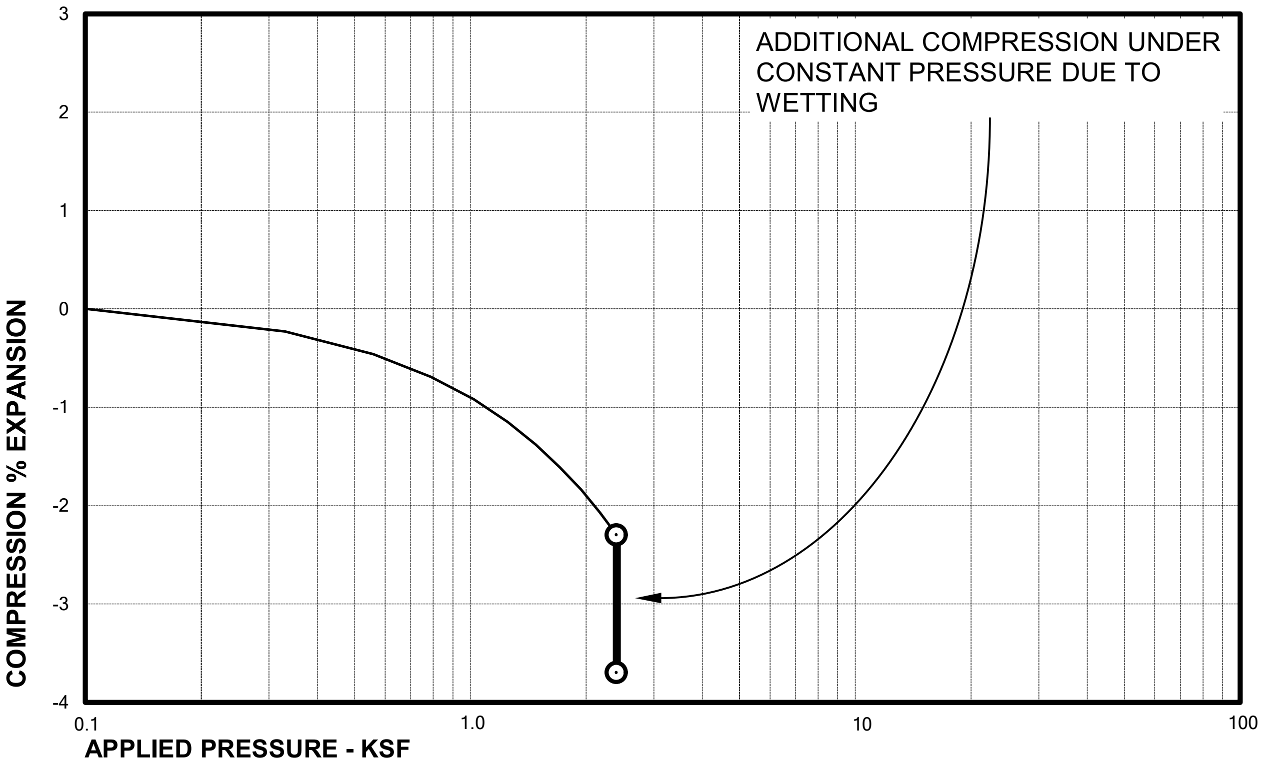
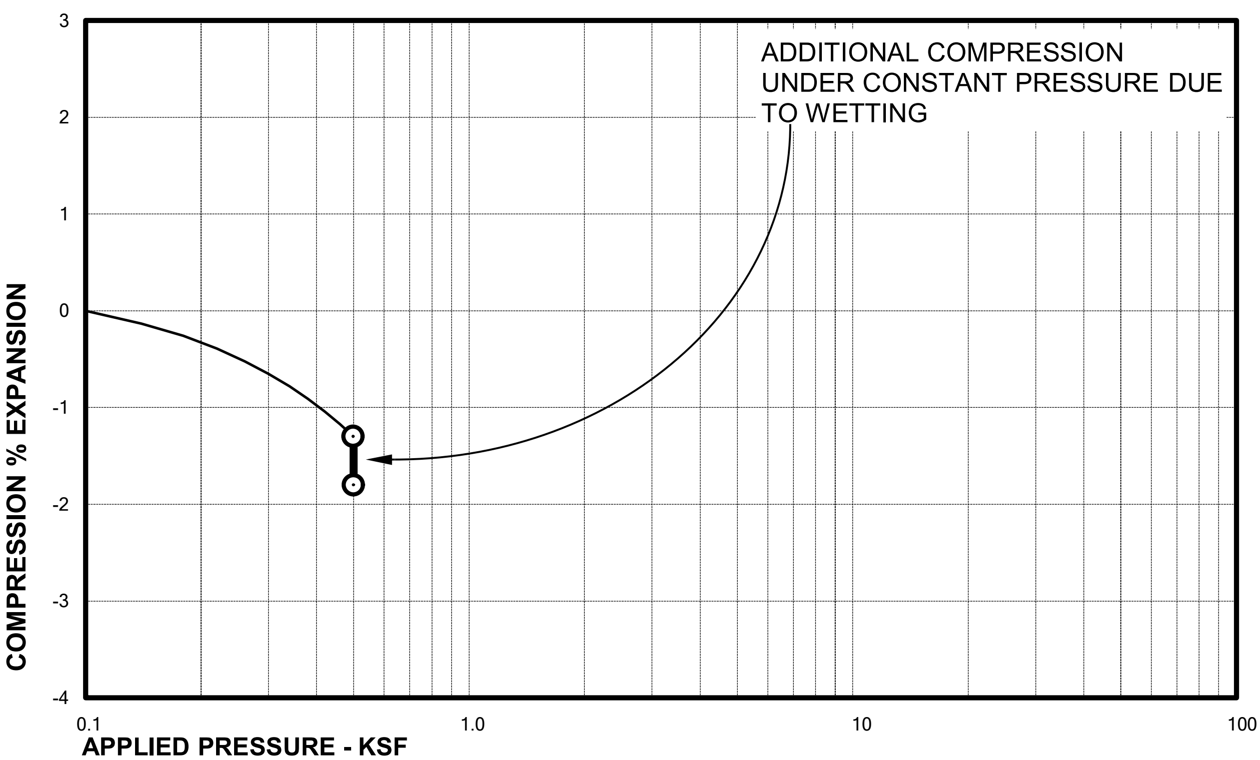
Swell Consolidation Test Results

FIG. 6



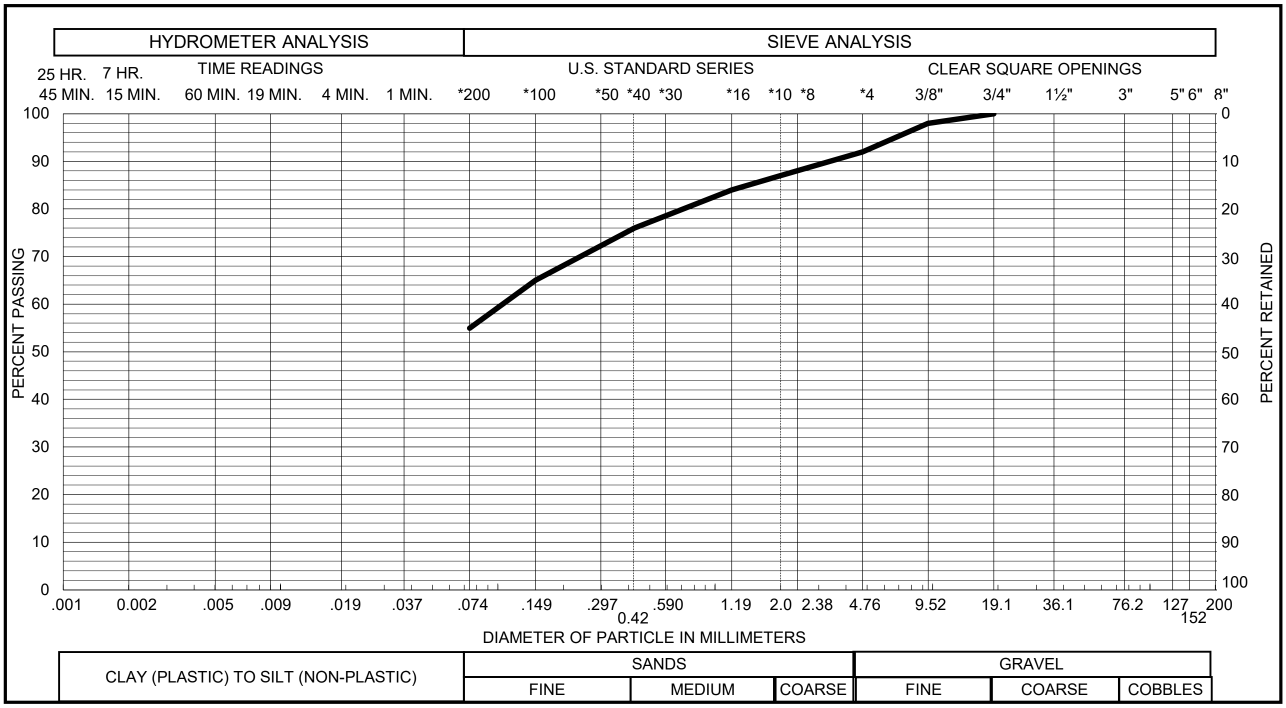
Sample of	CLAY, VERY SANDY (CL)	DRY UNIT WEIGHT=	118	PCF
From	TH-3 AT 19 FEET	MOISTURE CONTENT=	12.2	%



Sample of	SAND, VERY CLAYEY (SC)	DRY UNIT WEIGHT=	98	PCF
From	TH-4 AT 4 FEET	MOISTURE CONTENT=	20.6	%

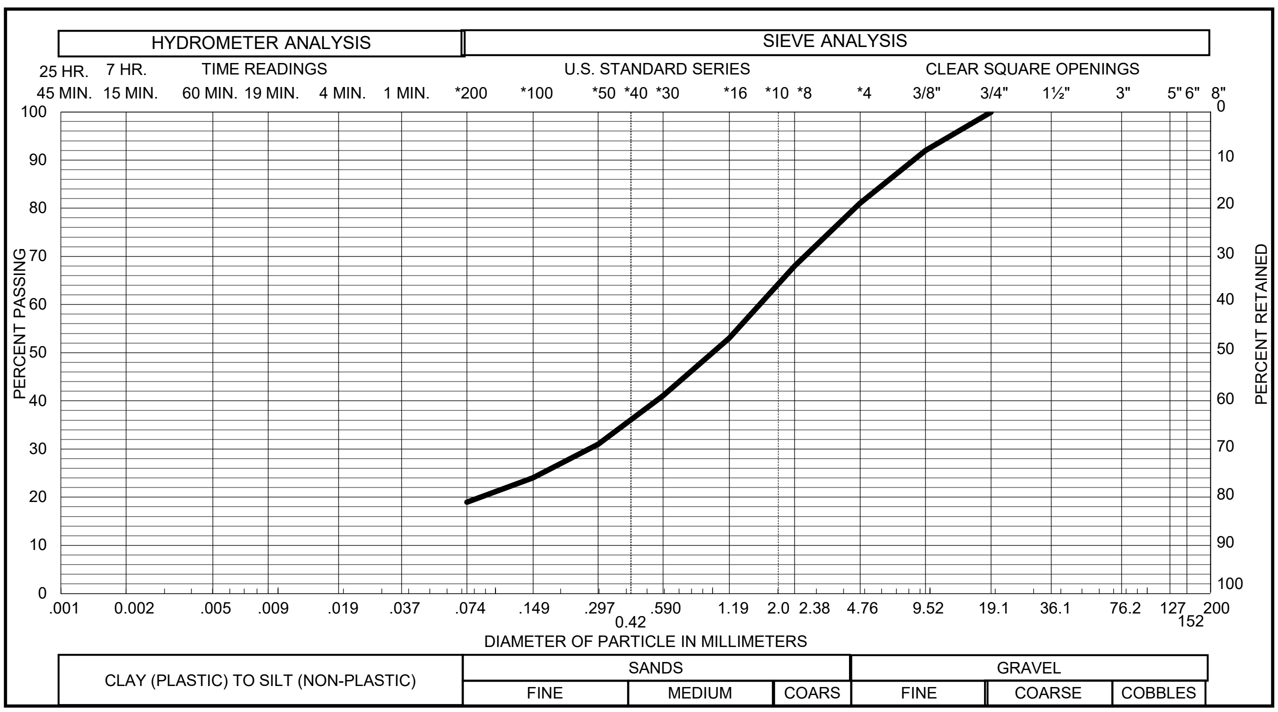
Swell Consolidation Test Results

FIG. 7



Sample of FILL, SAND, SILTY
From TH - 4 AT 0 FEET

GRAVEL 8 % SAND 37 %
SILT & CLAY 55 % LIQUID LIMIT 33
PLASTICITY INDEX 15



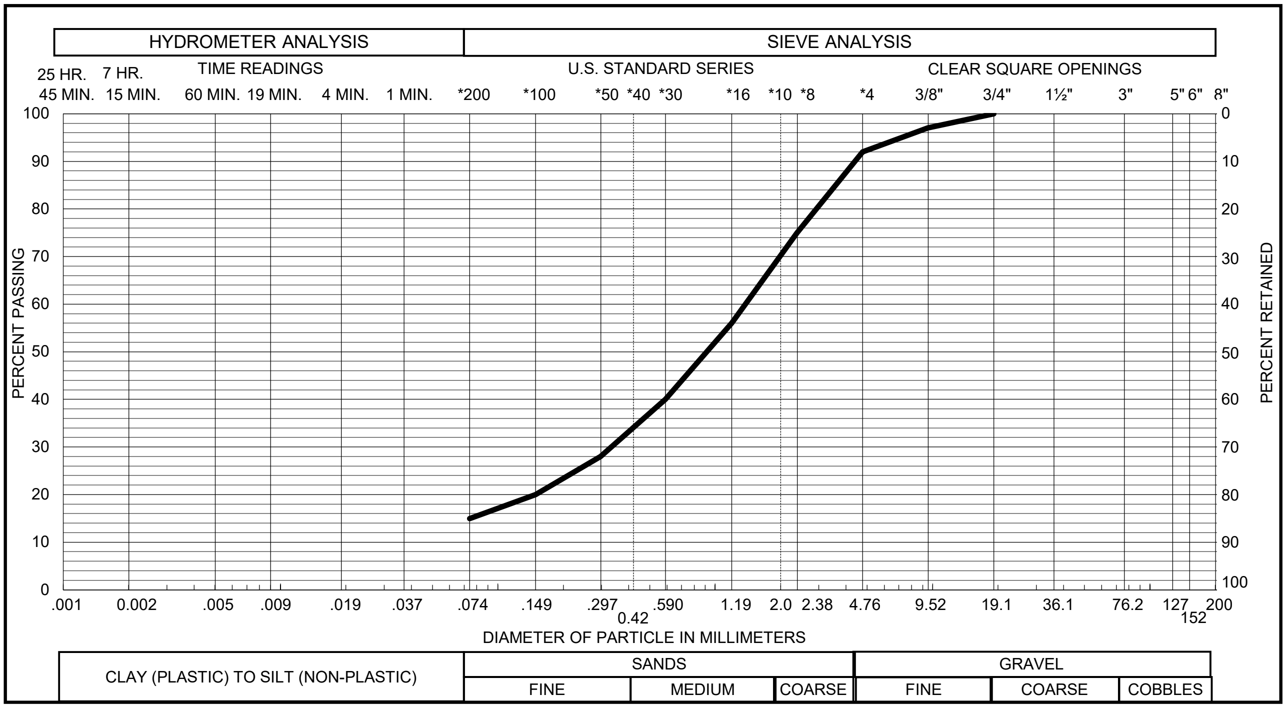
Sample of SAND, SILTY (SM)
From TH - 4 AT 19 FEET

GRAVEL 19 % SAND 62 %
SILT & CLAY 19 % LIQUID LIMIT
PLASTICITY INDEX

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
CTL|T PROJECT NO. CS19910.000-125

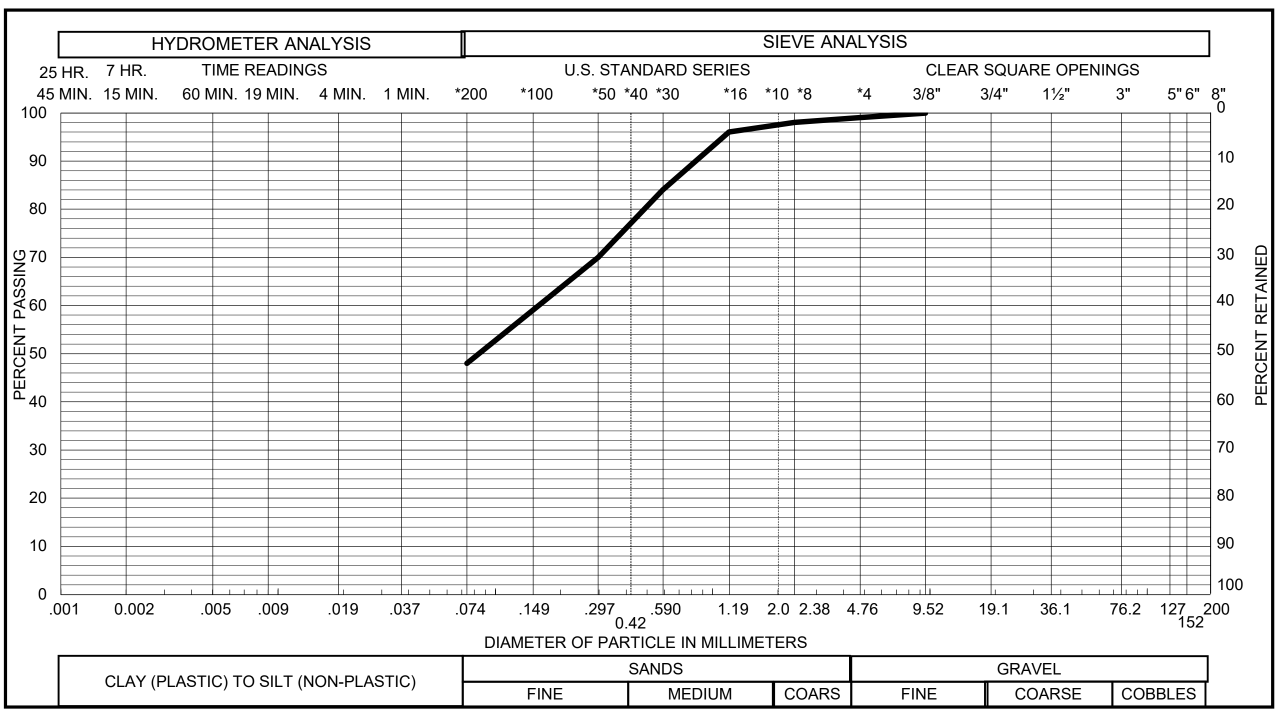
Gradation Test Results

FIG. 8



Sample of SAND, SILTY (SM)
From TH - 5 AT 9 FEET

GRAVEL 8 % SAND 77 %
SILT & CLAY 15 % LIQUID LIMIT
PLASTICITY INDEX



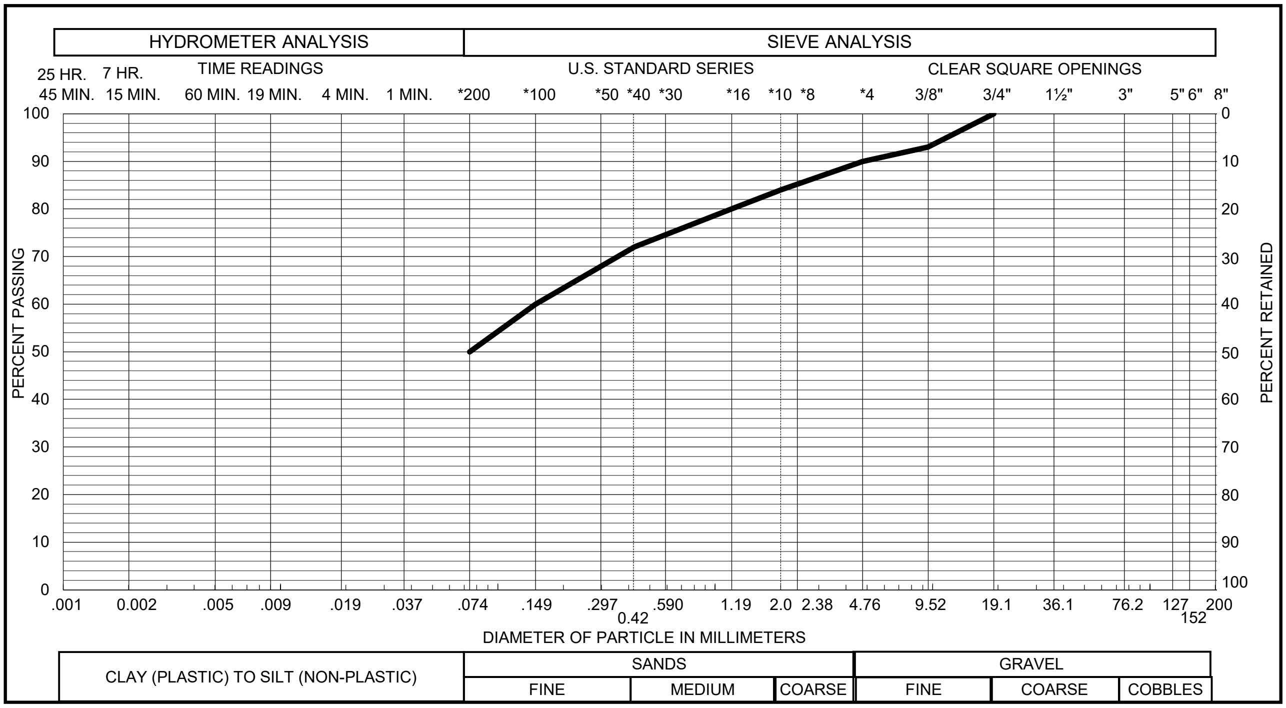
Sample of SAND, VERY CLAYEY (SC)
From TH - 5 AT 14 FEET

GRAVEL 1 % SAND 51 %
SILT & CLAY 48 % LIQUID LIMIT
PLASTICITY INDEX

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
CTL|T PROJECT NO. CS19910.000-125

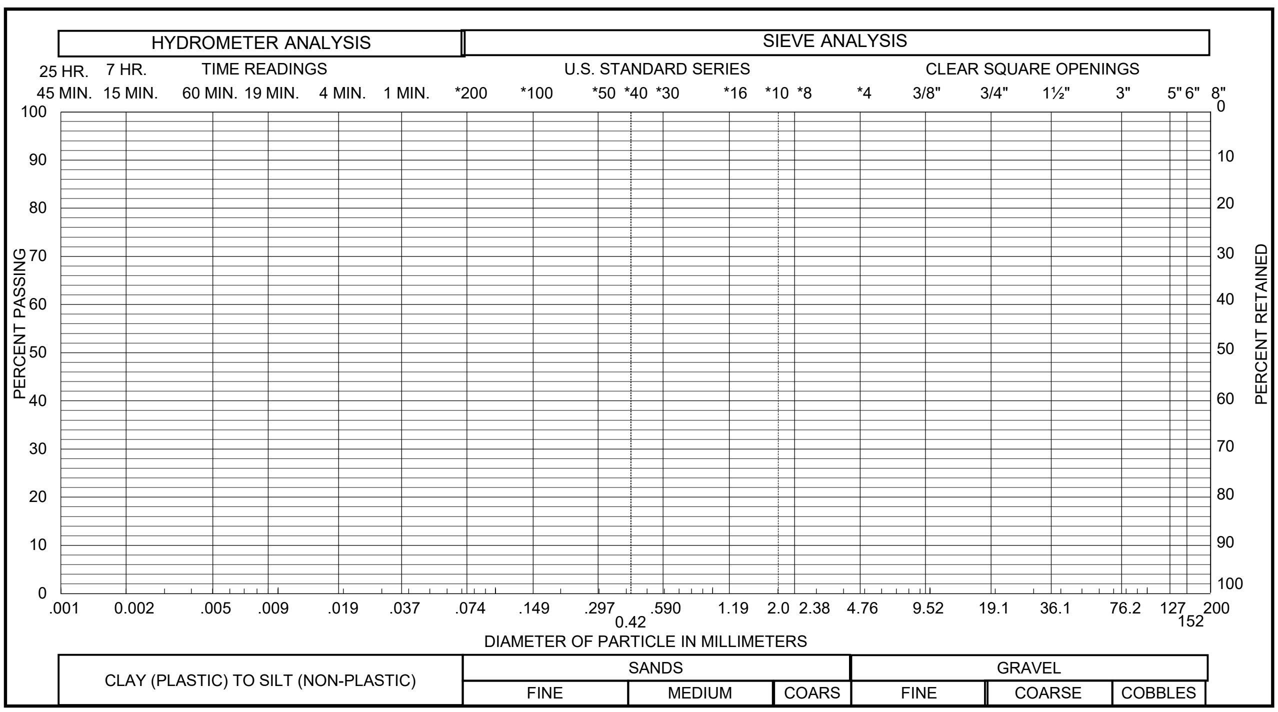
Gradation Test Results

FIG. 9



Sample of CLAY, VERY SANDY (CL)
From S - 2 AT 0 FEET

GRAVEL 10 % SAND 40 %
SILT & CLAY 50 % LIQUID LIMIT
PLASTICITY INDEX



Sample of
From

GRAVEL % SAND %
SILT & CLAY % LIQUID LIMIT
PLASTICITY INDEX

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
CTL|T PROJECT NO. CS19910.000-125

Gradation Test Results

FIG. 10

CTL | THOMPSON

PERCOLATION TEST DATA

Project: Prairie Heights Elementary School Addition
Location: 7930 Indina Village Heights
Pre-Soaked Date: November 18, 2024 **Time:** 1 PM

Project #: CS19910.000-125
Technician/Engineer: KD
Date of Test: November 19, 2024

Percolation Test Hole: 1
Depth of Hole: 36 inches **Pipe Length: 60 inches**

Time (hrs:min)	Time Interval (hrs:min)	Depth to Water* (in)	Change in Water Depth (in)	Perc. Rate (min/in)
10:28 AM	-------	28		
10:38 AM	0:10	29 1/2	1 1/2	7
10:48 AM	0:10	31	1 1/2	7
10:58 AM	0:10	32 1/8	1 1/8	9
11:08 AM	0:10	32 7/8	3/4	13
11:18 AM	0:10	33 5/8	3/4	13
11:28 AM	0:10	34 3/8	3/4	13

Rate = 10

Percolation Test Hole: 2
Depth of Hole: 36 inches **Pipe Length: 61 inches**

Time (hrs:min)	Time Interval (hrs:min)	Depth to Water* (in.)	Change in Water Depth (in)	Perc. Rate (min/in)
10:38 AM	-------	26 1/2		
10:48 AM	0:10	27 1/2	1	10
10:58 AM	0:10	28 3/8	7/8	11
11:08 AM	0:10	29 1/8	3/4	13
11:18 AM	0:10	29 7/8	3/4	13
11:28 AM	0:10	30 5/8	3/4	13

Rate = 12

Percolation Test Hole: 3
Depth of Hole: 36 inches **Pipe Length: 59 inches**

Time (hrs:min)	Time Interval (hrs:min)	Depth to Water* (in.)	Change in Water Depth (in)	Perc. Rate (min/in)
12:12 PM	---------	26		
12:22 PM	0:10	27 3/4	1 3/4	6
12:32 PM	0:10	29 1/2	1 3/4	6
12:42 PM	0:10	31	1 1/2	7
12:52 PM	0:10	32 1/2	1 1/2	7
1:02 PM	0:10	34	1 1/2	7

Rate = 6

Average Calculated Percolation Rate = 10 min/in

*Note: The depth to water was measured from the top of pipe.

Fig. 11

TABLE I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19910.000-125

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS LIQUID LIMIT	ATTERBERG LIMITS PLASTICITY INDEX	SWELL TEST RESULTS* SWELL (%)	SWELL TEST RESULTS* SWELL PRESSURE (PSF)	PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
TH-1	9	16.2	113			-0.1		72		CLAY, SANDY (CL)
TH-1	14	19.9	106			-0.8		80		CLAY, SANDY (CL)
TH-1	19	5.9	110			-0.8		19		SAND, SILTY (SM)
TH-2	4	10.1	114	36	16			75		FILL, CLAY, SANDY
TH-2	9	7.2						48		FILL, SAND, VERY CLAYEY
TH-2	14	17.7	113			-0.1		71		CLAY, SANDY (CL)
TH-3	4	16.4	110			0.0		92		CLAY, SLIGHTLY SANDY (CL)
TH-3	9	9.0	116			0.2		46		SAND, VERY CLAYEY (SC)
TH-3	19	12.2	118			-1.4		64		CLAY, VERY SANDY (CL)
TH-4	0	16.9		33	15			55		FILL, CLAY, VERY SANDY
TH-4	4	20.6	98			-0.5		38		SAND, VERY CLAYEY (SC)
TH-4	14	11.8	124					43		SAND, VERY CLAYEY (SC)
TH-4	19	3.7	131					19		SAND, SILTY (SM)
TH-5	9	3.5	105					15		SAND, SILTY (SM)
TH-5	14	11.4	122					48		SAND, VERY CLAYEY (SC)
S-2	0	10.0						50	<0.1	CLAY, VERY SANDY (CL)
P-1	4	7.7	106	27	11			64		CLAY, VERY SANDY (CL)

* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.
NEGATIVE VALUE INDICATES COMPRESSION.

APPENDIX B
Rational and Hydraulic Calculations

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Area Runoff Coefficient Summary - EXISTING

			DEVELOPED				UNDEVELOPED				WEIGHTED		
BASIN	*TOTAL AREA*		*AREA*	C_5	C_{100}	*% Imp*	*AREA*	C_5	C_{100}	*% Imp*	C_5	C_{100}	*% Imp*
	(SF)	*(Acres)*	*(Acres)*				*(Acres)*						
E-1	859,316	19.73	0.00	0.53	0.68	70%	19.73	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
E-2	519,516	11.93	0.00	0.53	0.68	70%	11.93	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
E-3	31,395	0.72	0.00	0.53	0.68	70%	0.72	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
E-4													
E-5													
E-6	5,568	0.13	0.13	0.53	0.68	70%	0.00	0.16	0.51	2%	***0.54***	***0.68***	***0.71***
E-7	6,712	0.15	0.15	0.53	0.68	70%	0.00	0.16	0.51	2%	***0.52***	***0.68***	***0.68***
E-8													
E-9													
E-10													
E-11													
E-12													
E-13	198,753	4.56	1.15	0.53	0.68	70%	3.41	0.16	0.51	2%	***0.25***	***0.55***	***0.19***
E-21	15,045	0.35	0.35	0.53	0.68	70%	0.00	0.16	0.51	2%	***0.53***	***0.68***	***0.71***
E-22	10,231	0.23	0.00	0.53	0.68	70%	0.23	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
Total	1,646,536	37.8											

Calculated by: TAC

Date: 4/2/2025

Checked by: TAC

Hanover School District - Prairie Heights Elementary School
Final Drainage Report
Area Runoff Coefficient Summary - PROPOSED

			DEVELOPED				***UNDEVELOPED***				***WEIGHTED***		
BASIN	***TOTAL AREA***		***AREA***	C_5	C_{100}	***% Imp***	***AREA***	C_5	C_{100}	***% Imp***	C_5	C_{100}	***% Imp***
	(SF)	***(Acres)***	***(Acres)***				***(Acres)***						
P-1	859,316	19.73	0.00	0.53	0.68	70%	19.73	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
P-2	519,516	11.93	0.00	0.53	0.68	70%	11.93	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
P-3	31,395	0.72	0.00	0.53	0.68	70%	0.72	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
P-4	41,539	0.95	0.75	0.53	0.68	70%	0.20	0.16	0.51	2%	***0.45***	***0.64***	***0.55***
P-5	2,186	0.05	0.05	0.53	0.68	70%	0.00	0.16	0.51	2%	***0.53***	***0.68***	***0.70***
P-6	9,400	0.22	0.22	0.53	0.68	70%	0.00	0.16	0.51	2%	***0.53***	***0.68***	***0.70***
P-7	6,736	0.15	0.16	0.53	0.68	70%	0.00	0.16	0.51	2%	***0.53***	***0.68***	***0.70***
P-8	1,566	0.04	0.02	0.53	0.68	70%	0.02	0.16	0.51	2%	***0.37***	***0.60***	***0.40***
P-9	10,292	0.24	0.00	0.53	0.68	70%	0.24	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
P-10	5,259	0.12	0.12	0.53	0.68	70%	0.00	0.16	0.51	2%	***0.53***	***0.68***	***0.70***
P-11	20,443	0.47	0.36	0.53	0.68	70%	0.11	0.16	0.51	2%	***0.44***	***0.64***	***0.54***
P-12	6,439	0.15	0.03	0.53	0.68	70%	0.12	0.16	0.51	2%	***0.24***	***0.54***	***0.16***
P-13	29,350	0.67	0.34	0.53	0.68	70%	0.33	0.16	0.51	2%	***0.35***	***0.60***	***0.36***
P-14	***70153***												***0.53***
P-15	***56618***												***0.50***
P-16	81,602	1.87	0.00	0.53	0.68	70%	1.87	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
P-21	12,833	0.29	0.35	0.53	0.68	70%	-0.06	0.16	0.51	2%	***0.60***	***0.71***	***0.83***
P-22	10,231	0.23	0.00	0.53	0.68	70%	0.23	0.16	0.51	2%	***0.16***	***0.51***	***0.02***
Total	1,648,103	37.8											

Calculated by:	TAC
Date:	4/2/2025
Checked by:	TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Area Drainage Summary - EXISTING

		WEIGHTED		*OVERLAND*				*STREET / CHANNEL FLOW*					*T_t*	*CA*		*INTENSITY*		*TOTAL FLOW*	
BASIN	***AREA TOTAL***	***C_5***	***C_{100}***	***C_5***	***Length***	***Height***	***T_C***	***Grass/ Paved***	***Length***	***Slope***	***Velocity***	***T_t***	***TOTAL***	***CA_5***	***CA_{100}***	***I_5***	***I_{100}***	***Q_5***	***Q_{100}***
	(Acres)	* For Calcs See Runoff Summary			***(ft)***	***(ft)***	***(min)***		***(ft)***	***(%)***	***(fps)***	***(min)***	***(min)***			***(in/hr)***	***(in/hr)***	***(c.f.s.)***	***(c.f.s.)***
E-1	19.73	0.16	0.51	0.16	75	4.0	8.8	Grass Grass	560 1300	2.0% 6.0%	1.3 1.4	7.1 15.2	31.0	3.16	10.06	2.4	4.0	***7.7***	***40***
E-2	11.93	0.16	0.51	0.16	100	4.0	11.1	Grass Grass	400 500	6.0% 2.0%	1.4 1.3	4.7 6.3	22.1	1.91	6.08	2.9	4.8	***5.5***	***29***
E-3	0.72	0.16	0.51	0.16	50	2.0	7.9	Grass	250	2.0%	1.3	3.2 0.0	11.0	0.12	0.37	3.9	6.8	***0.5***	***2.5***
E-4	0.00																		
E-5	0.00																		
E-6	0.13	0.54	0.68	0.16	5	0.5	1.8	Paved	120	1.0%	1.4	1.4 0.0	5.0 MIN 5 USED	0.07	0.09	5.0	9.1	***0.3***	***0.8***
E-7	0.15	0.52	0.68	0.16	5	0.5	1.8	Paved	120	1.0%	1.4	1.4 0.0	5.0 MIN 5 USED	0.08	0.10	5.0	9.1	***0.4***	***0.9***
E-8	0.00																		
E-9	0.00																		
E-10	0.00																		

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Area Drainage Summary - EXISTING

		WEIGHTED		OVERLAND				STREET / CHANNEL FLOW					T_t	CA		INTENSITY		TOTAL FLOW	
BASIN	AREA TOTAL (Acres)	C_5	C_{100}	C_5	Length (ft)	Height (ft)	T_C (min)	Grass/ Paved	Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	TOTAL (min)	CA_5	CA_{100}	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)
		* For Calcs See Runoff Summary																	
E-11	0.00																		
E-12	0.00																		
E-13	4.56	0.25	0.55	0.16	25	1.0	5.6	Paved Grass	230 240	2.0% 5.0%	1.4 1.4	2.7 2.8	11.1	1.16	2.52	3.9	6.8	**4.5**	**17**
E-21	0.35	0.53	0.68	0.16	15	0.5	4.6	Paved	125	2.0%	1.4	1.4 0.0	6.0	0.18	0.24	4.8	8.5	**0.9**	**2.0**
E-22	0.23	0.16	0.51	0.16	25	1.0	5.6	Grass	45	2.0%	1.3	0.6 0.0	6.1	0.04	0.12	4.7	8.5	**0.2**	**1.0**

Calculated by: TAC
Date: 4/2/2025
Checked by: TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Area Drainage Summary - PROPOSED

		WEIGHTED		OVERLAND				STREET / CHANNEL FLOW					T_t	CA		INTENSITY		TOTAL FLOW	
BASIN	AREA TOTAL (Acres)	C_5	C_{100}	C_5	Length (ft)	Height (ft)	T_C (min)	Grass/ Paved	Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	TOTAL (min)	CA_5	CA_{100}	I_5 (in/hr)	I_{100} (in/hr)	Q_5 (c.f.s.)	Q_{100} (c.f.s.)
		* For Calcs See Runoff Summary																	
P-1	19.73	0.16	0.51	0.16	75	4.0	8.8	Grass Grass	560 1300	2.0% 6.0%	1.3 1.4	7.1 15.2	31.0	3.16	10.06	2.4	4.0	7.7	40
P-2	11.93	0.16	0.51	0.16	100	4.0	11.1	Grass Grass	400 500	6.0% 2.0%	1.4 1.3	4.7 6.3	22.1	1.91	6.08	2.9	4.8	5.5	29
P-3	0.72	0.16	0.51	0.16	50	2.0	7.9	Grass	250	2.0%	1.3	3.2 0.0	11.0	0.12	0.37	3.9	6.8	0.5	2.5
P-4	0.95	0.45	0.64	0.16	25	2.0	4.4	Grass	290	2.0%	1.3	3.7 0.0	8.1	0.43	0.61	4.4	7.7	1.9	4.7
P-5	0.05	0.53	0.68	0.16	10	0.5	3.3	Paved	100	1.0%	1.4	1.2 0.0	5.0 MIN 5 USED	0.03	0.03	5.0	9.1	0.1	0.3
P-6	0.22	0.53	0.68	0.16	10	0.5	3.3	Paved	150	1.0%	1.4	1.8 0.0	5.1	0.11	0.15	5.0	9.0	0.6	1.3
P-7	0.15	0.53	0.68	0.16	10	0.5	3.3	Paved	1.25	1.0%	1.4	0.0 0.0	5.0 MIN 5 USED	0.08	0.11	5.0	9.1	0.4	1.0
P-8	0.04	0.37	0.60	0.16	10	0.5	3.3	Paved	35	1.0%	1.4	0.4 0.0	5.0 MIN 5 USED	0.01	0.02	5.0	9.1	0.1	0.2
P-9	0.24	0.16	0.51	0.16	10	0.5	3.3	Grass Grass	30 75	2.0% 15.0%	1.3 1.6	0.4 0.8	5.0 MIN 5 USED	0.04	0.12	5.0	9.1	0.2	1.1
P-10	0.12	0.53	0.68	0.16	10	0.5	3.3	Paved	75	1.0%	1.4	0.9 0.0	5.0 MIN 5 USED	0.06	0.08	5.0	9.1	0.3	0.7
P-11	0.47	0.44	0.64	0.16	10	0.5	3.3	paved Grass	55 236	1.0% 1.5%	1.4 1.3	0.7 3.0	6.9	0.21	0.30	4.6	8.1	1.0	2.4

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Area Drainage Summary - PROPOSED

		WEIGHTED		***OVERLAND***				***STREET / CHANNEL FLOW***					***T_t***	***CA***		***INTENSITY***		***TOTAL FLOW***	
BASIN	***AREA TOTAL (Acres)***	***C_5***	***C_{100}***	***C_5***	***Length (ft)***	***Height (ft)***	***T_C (min)***	***Grass/ Paved***	***Length (ft)***	***Slope (%)***	***Velocity (fps)***	***T_t (min)***	***TOTAL (min)***	***CA_5***	***CA_{100}***	***I_5 (in/hr)***	***I_{100} (in/hr)***	***Q_5 (c.f.s.)***	***Q_{100} (c.f.s.)***
		* For Calcs See Runoff Summary																	
P-12	0.15	0.24	0.54	0.16	10	0.5	3.3	Grass	25	2.0%	1.3	0.3 0.0	5.0 MIN 5 USED	0.03	0.08	5.0	9.1	***0.2***	***0.7***
P-13	0.67	0.35	0.60	0.16	50	2.0	7.9	Paved Grass	110 25 co	2.0% 5.0%	1.4 1.4	1.3 0.3	9.4	0.23	0.40	4.1	7.2	***1.0***	***2.9***
P-14																			
P-15																			
P-16	1.87	0.16	0.51	0.16	50	2.0	7.9	Paved Grass	230 350	2.0% 5.0%	1.4 1.4	2.7 4.2	14.7	0.30	0.96	3.5	6.0	***1.0***	***5.7***
P-21	0.29	0.60	0.71	0.16	15	0.5	4.6	Paved	125	2.0%	1.4	1.4 0.0	6.0	0.18	0.21	4.8	8.5	***0.8***	***1.8***
P-22	0.23	0.16	0.51	0.16	25	1.0	5.6	Grass	45	2.0%	1.3	0.6 0.0	6.1	0.04	0.12	4.7	8.5	***0.2***	***1.0***

Calculated by: TAC
Date: 4/2/2025
Checked by: TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

EX Surface Routing Summary

Design Points	*Contributing Basins & Design Points*	*Equivalent CA_5*	*Equivalent CA_{100}*	*Maximum T_C*	*STREET / CHANNEL FLOW Length (ft)*	*Slope (%)*	*Velocity (fps)*	*T_t (min)*	*T_t TOTAL (min)*	*INTENSITY I_5*	*I_{100}*	*FLOW Q_5*	*Q_{100}*
E-13	**E-6**	0.07	0.09	5.0	150	4.0%	4.0	0.6	5.6				
	E-7	0.08	0.10	5.0	150	4.0%	4.0	0.6	5.6				
	E-13	1.16	2.52	11.1					11.1				
		1.30	2.71						11.1	3.9	6.8	***5.1***	***18***
E-2	**E-13**	1.16	2.52	11.1	900	4.0%	4.0	3.8	14.8				
	E-2	1.91	6.08	22.1					22.1				
		3.06	8.60						22.1	2.9	4.8	***8.9***	***41***

Calculated by: TAC
Date: 4/2/2025
Checked by: TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

PR Surface Routing Summary

Design Points	Contributing Basins & Design Points	Equivalent CA_5	Equivalent CA_{100}	Maximum T_C	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	T_t (min)	T_t TOTAL (min)	INTENSITY I_5	I_{100}	FLOW Q_5	Q_{100}
P-4	**P-4**	0.43	0.61	8.1					8.1				
	P-5	0.03	0.03	5.0	75	1.0%	2.0	0.6	5.6				
		0.46	0.65						8.1	4.4	7.7	***2.0***	***5.0***
P-9	**P-6**	0.11	0.15	5.1	75	12.0%	6.9	0.2	5.2				
	P-9	0.04	0.12	5.0					5.0				
		0.15	0.27						5.2	4.9	8.9	***0.8***	***2.4***
P-14	**P-4**	***0.43***	***0.61***	***8.1***	50	2.0%	2.8	0.3	8.4				
	P-9	***0.15***	***0.27***	***5.2***	50	2.0%	2.8	0.3	5.5				
		0.58	0.88						8.4	4.3	7.6	***2.5***	***6.7***
P-11	**P-10**	0.06	0.08	5.0	240	1.0%	2.0	2.0	7.0				
	P-11	0.21	0.30	6.9					6.9				
		0.27	0.38						7.0	4.6	8.1	***1.2***	***3.1***
P-15	**P-8**	0.01	0.02	5.0	50	2.0%	2.8	0.3	5.3				
	P-11	***0.27***	***0.38***	***7.0***	50	2.0%	2.8	0.3	7.3				
	P-13	0.23	0.40	9.4	120	2.0%	2.8	0.7	10.1				
		0.52	0.81						10.1	4.0	7.0	***2.1***	***5.7***
P-16	**P-14**	***0.58***	***0.88***	***8.4***	150	4.0%	4.0	0.6	9.0				
	P-15	***0.52***	***0.81***	***10.1***	280	4.0%	4.0	1.2	11.3				
	P-16	0.30	0.96	14.7					14.7				
		1.40	2.64						14.7	3.5	6.0	***4.9***	***16***
P-2	**P-2**	1.91	6.08	22.1					22.1				
	P-16	***1.40***	***2.64***	***14.7***	900	4.0%	4.0	3.8	18.4				
		3.31	8.72						22.1	2.9	4.8	***10***	***42***

Calculated by: TAC
Date: 4/2/2025
Checked by: TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Pipe Hydraulics

PIPE SEGMENT	***Q_{max} (cfs)***	***Surf Grade (%)***	***LEN (ft)***	***$K_{(q,s)}$***	***DIA (in)***	***DIA USED (in)***	***K_{dia}***	***A (ft^2)***	***V (fps)***	***S_f (%)***
P5	**0.3**	8.2%	**55**	1.1	**6**	**12**	54.0	0.8	0.4	0.1%
P6	**1.3**	9.0%	**84**	4.4	**6**	**12**	54.0	0.8	1.7	0.1%
P7	**1.0**	7.3%	**56**	3.5	**6**	**12**	54.0	0.8	1.2	0.1%
P8	**1.1**	7.0%	**66**	4.1	**6**	**12**	54.0	0.8	1.4	0.1%
P11	**3.1**	0.7%	**85**	38.5	**12**	**18**	105.1	1.8	1.8	0.1%

Calculated by: TAC
Date: 4/2/2025
Checked by: TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Water Quality Treatment Summary Table

Basin	Basin Area (ac)	Disturbed? (Y or N)	Disturbed Area (ac)	Treated (Y, N or NA)	Treated Area Via Sand Filter (ac)	Not Treated Area (ac)
P-1	19.73	No		NA		
P-2	11.93	No		NA		
P-3	0.72	No		NA		
P-4	0.95	Yes	0.95	Yes	0.95	
P-5	0.05	Yes	0.05	Yes	0.05	
P-6	0.22	Yes	0.22	Yes	0.22	
P-7	0.15	Yes	0.15	Yes	0.15	
P-8	0.04	Yes	0.04	Yes	0.04	
P-9	0.24	Yes	0.24	Yes	0.24	
P-10	0.12	Yes	0.12	Yes	0.12	
P-11	0.47	Yes	0.47	Yes	0.47	
P-12	0.15	Yes	0.15	No		0.15
P-13	0.67	Yes	0.67	Yes	0.67	
P-14						
P-15						
P-16	1.87	No		NA		
P-21	0.29	Yes	0.29	No		0.29
P-22	0.23	No		NA		
Total	37.60		3.35		2.91	0.44
	Min Req to be Treated		2.68	***Percent***	**87%**	**13%**

Notes

No exclusions are applicable. P 452,453

Calculated by: TAC

Date: 4/2/2025

Checked by: TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

Swale Hydraulics

PIPE SEGMENT	Bottom Width	Channel Side Slope		Flow Depth	Channel Slope	Manning's "n"	Top Width	Channel Area	Wetted Perimater	Hydraulic Radius	Flow Velocity	Flow Capacity
	ft	*Left*	*Right*				*ft*	*(ft^2)*	*ft*	*ft*	ft/sec	cfs
P4	2.0 ft	3:1	3:1	0.35 ft	5.0%	0.030	4.1 ft	1.07 sf	4.2 ft	0.25 ft	4.4 ft/sec	**4.7 cfs**
P6	2.0 ft	3:1	3:1	0.18 ft	4.5%	0.030	3.1 ft	0.46 sf	3.1 ft	0.15 ft	2.9 ft/sec	**1.3 cfs**
P7	2.0 ft	3:1	3:1	0.16 ft	4.1%	0.030	3.0 ft	0.40 sf	3.0 ft	0.13 ft	2.6 ft/sec	**1.0 cfs**
P10	2.0 ft	3:1	3:1	0.19 ft	1.0%	0.030	3.1 ft	0.49 sf	3.2 ft	0.15 ft	1.4 ft/sec	**0.7 cfs**
P11	2.0 ft	3:1	3:1	0.26 ft	3.8%	0.030	3.6 ft	0.72 sf	3.6 ft	0.20 ft	3.3 ft/sec	**2.4 cfs**
											-	-

Calculated by: TAC
Date: 4/2/2025
Checked by: TAC

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

SAND FILTER FOREBAY SIZING

Presedementation / Forebay Sizing

Forebay	100 Yr Flow	Detention WQCV	Total Req'd Forebay Vol	Tributary Area	% Total Trib Area	Required Forebay Volume	Forebay Design			Discharge Design Flow	Calc'd Open Width (1" min)	**Design Width**
			3.0% WQCV				Area	Depth	Volume	2.0% 100yr		
EL	2.4cfs	786cf	24cf			24cf	64sf	1.70-ft	109 cf	0.05 cfs	4.3-inch	**4.0-inch**
ER	5.0cfs	1,595cf	48cf			48cf	64sf	1.70-ft	109 cf	0.10 cfs	4.5-inch	**4.0-inch**
WL	0.2cfs	227cf	7cf			7cf	64sf	1.70-ft	109 cf	0.00 cfs	4.1-inch	**4.0-inch**
WR	3.1cfs	2,045cf	61cf			61cf	64sf	1.25-ft	80 cf	0.06 cfs	3.4-inch	**4.0-inch**
Totals	11cf	4,653cf	140cf	0.00ac	100.0%							

Opening Width Equation for Rectangular Opening

$L = Q / (CH^{1.5}) \times 12 + 0.2xHx12$ (UD-BMP Spreadsheet -- EDB tab)

C = 3.0

Presedementation / Forebay Sizing **ALTERNATE DESIGN 1**

Forebay	100 Yr Flow	Detention WQCV	Total Req'd Forebay Vol	Tributary Area	% Total Trib Area	Required Forebay Volume	Forebay Design			Drain Time	**Opening Width (1" min)**	**Opening Flow**	Check
			3.0% WQCV				Area	Depth	Volume	5.0 min.			
EL	2.4cfs	786cf	24cf			24cf	64sf	1.70-ft	109 cf	0.21 cfs	**1.0-in**	**11.3 cfs**	OK
ER	5.0cfs	1,595cf	48cf			48cf	64sf	1.70-ft	109 cf	0.21 cfs	**1.0-in**	**11.3 cfs**	OK
WL	0.2cfs	227cf	7cf			7cf	64sf	1.70-ft	109 cf	0.21 cfs	**1.0-in**	**11.3 cfs**	OK
WR	3.1cfs	2,045cf	61cf			61cf	64sf	1.25-ft	80 cf	0.21 cfs	**1.0-in**	**7.1 cfs**	OK
Totals	11cf	4,653cf	140cf	0.00ac	100.0%								

Weir Equation:

$Q = CLH^{1.5}$

C = 3.0

Presedementation / Forebay Sizing **ALTERNATE DESIGN 2**

Forebay	100 Yr Flow	Detention WQCV	Total Req'd Forebay Vol	Tributary Area	% Total Trib Area	Required Forebay Volume	Forebay Design (30"max depth for over 25 ac)			Discharge Design Flow	**Slot Outlet Design**		**Pipe Outlet Design**			
			3.0% WQCV				Area	Depth	Volume	2.0% 100yr	Calc'd Width (1"min)	**Design Width**	Pipe Diameter	Pipe Radius	# of Pipes	Pipe Flow
EL	2.4cfs	786cf	24cf			24cf	64sf	1.70-ft	109 cf	0.05 cfs	4.3-inch	**4.0-inch**		0.00ft		**0.00cfs**
ER	5.0cfs	1,595cf	48cf			48cf	64sf	1.70-ft	109 cf	0.10 cfs	4.5-inch	**4.0-inch**		0.00ft		**0.00cfs**
WL	0.2cfs	227cf	7cf			7cf	64sf	1.70-ft	109 cf	0.00 cfs	4.1-inch	**4.0-inch**		0.00ft		**0.00cfs**
WR	3.1cfs	2,045cf	61cf			61cf	64sf	1.25-ft	80 cf	0.06 cfs	3.4-inch	**4.0-inch**		0.00ft		**0.00cfs**
Totals	11cf	4,653cf	140cf	0.0ac	100.0%											

Opening Width Equation for Rectangular Opening

$L = Q / (CH^{1.5}) \times 12 + 0.2xH$ (UD-BMP Spreadsheet -- EDB tab)

C = 3.0

Design based on Extended Detention Basin design recommendations from Volume 3, USDCM

Orifice Equation:

$Q = CA(2gH)^{0.5}$

C = Orifice coefficient

A = Area of opening (sf)

$g = 32.2$ ft/sec^2

H = Head above pipe centerline (ft)

Hanover School District - Prairie Heights Elementary School

Final Drainage Report

SAND FILTER OVERFLOW WEIR

Emergency Spillway Calculation

Detention Area	100yr Flow	Water Surf Elev	Crest Elev	Crest Length	Z	C	Flow Depth (H)	**Calc'd Flow**	Check
EAST	6.7 cfs	100.15	100.0	40 ft	1:1	3.0	0.15 ft	7.0 cfs	OK
WEST	5.7 cfs	100.15	100.0	35 ft	1:1	3.0	0.15 ft	6.1 cfs	OK

Broad Crested Weir Equation (USDCM Eqn 12-20 and 12-21):

$Q = CLH^{1.5} + 2x((2/5)CZH^{5/2})$

H = Head above weir crest, in ft

C = Weir coefficient, C = 3.0 (most cases)

Z = Side slope (horizontal:vertical)

L = Length of weir at Crest, in ft. Not including sideslopes.

Figure 13-12c. Emergency Spillway Protection

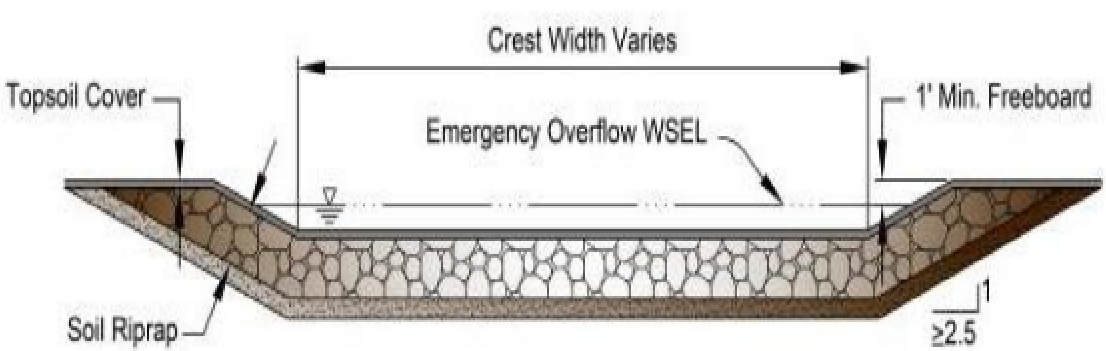
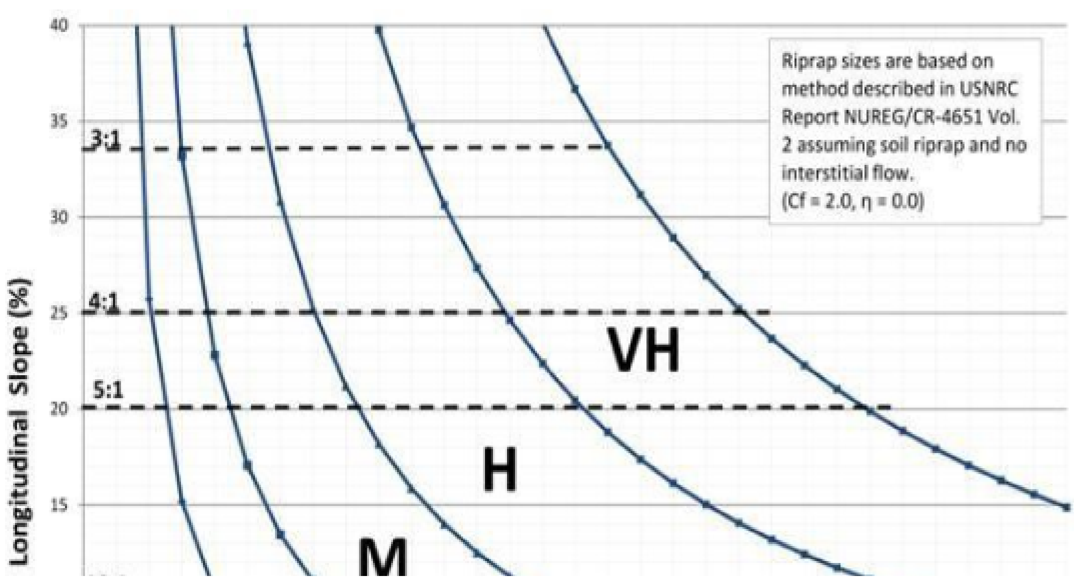
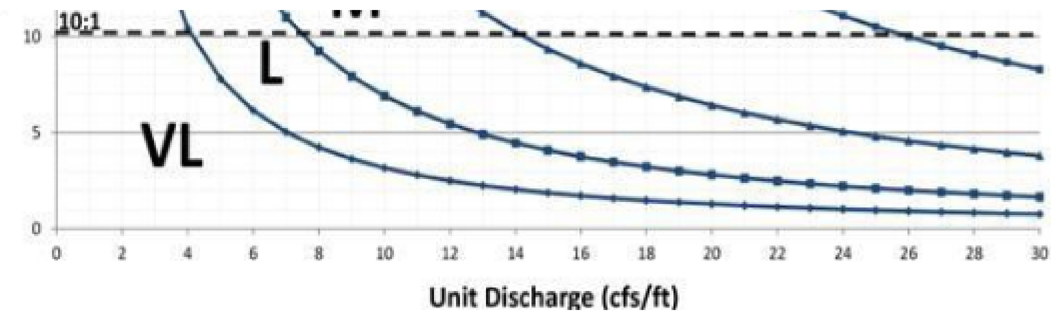


Figure 13-12d. Riprap Types for Emergency Spillway Protection




10:1
10
5
0
L
VL
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Unit Discharge (cfs/ft)

Hanover School District - Prairie Heights Elementary School
Final Drainage Report
Cost Summary

	Description	Qty	Unit	Unit Cost		Cost
1	**Sand Filter East**					$17,316.00
2	Rip Rap	100	SF	$7.00		$700.00
3	Sand	1958	CF	$6.00		$11,748.00
4	Forebay	2	EA	$600.00		$1,200.00
5	Wall	124	LF	$23.00		$2,852.00
6	Outlet pipe	12	LF	$68.00		$816.00
8	**Sand Filter West**					$14,597.00
9	Rip Rap	100	SF	$7.00		$700.00
10	Sand	1438	CF	$6.00		$8,628.00
11	Forebay	2	EA	$600.00		$1,200.00
12	Wall	103	LF	$23.00		$2,369.00
13	Outlet pipe	25	LF	$68.00		$1,700.00

		Avg Cost
SUB-TOTAL	***$31,913.00***	$15,956.50
15% ENGINEERING AND CONTINGENCIES	$4,800.00	
TOTAL	***$36,713.00***	

Calculated by: ____________________

Date: ____________________

Checked by: ____________________

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

APPENDIX C
Sand Filter PBMP Design

Design Procedure Form: Sand Filter (SF)

UD-BMP (Version 3.07, March 2018)

Designer: TAC
Company: Kiowa Engineering
Date: March 10, 2026
Project: Priaire Heights Elementary School
Location: East Basins 14 (4, 5, 6, 9)

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 49.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.490
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time WQCV= 0.8 * (0.91* i^3 - 1.19 * i^2 + 0.78 * i)	WQCV = 0.16 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 63,417 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume V_{WQCV} = WQCV / 12 * Area	V_{WQCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 1.19 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = 2,381 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WQCV} = 2.5 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 0.00 ft / ft
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 388 sq ft
D) Actual Filter Area	A_{Actual} = 978 sq ft
E) Volume Provided	V_T = 2460 cu ft
3. Filter Material	Choose One: (●) 18" CDOT Class B or C Filter Material; ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One: (●) YES; ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 0.1 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 2,381 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 2 1/16 in

Design Procedure Form: Sand Filter (SF)

Designer: TAC
Company: Kiowa Engineering
Date: March 10, 2026
Project: Priaire Heights Elementary School
Location: East Basins 14 (4, 5, 6, 9)

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	Forebay & Rip Rap

Notes:

Design Procedure Form: Sand Filter (SF)

Designer: TAC
Company: Kiowa Engineering
Date: March 10, 2026
Project: Priaire Heights Elementary School
Location: West Basins 15 (8, 10, 11, 13)

1. Basin Storage Volume	
A) Effective Imperviousness of Tributary Area, I_a (100% if all paved and roofed areas upstream of sand filter)	I_a = 54.0 %
B) Tributary Area's Imperviousness Ratio ($i = I_a/100$)	i = 0.540
C) Water Quality Capture Volume (WQCV) Based on 12-hour Drain Time $WQCV = 0.8 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i)$	WQCV = 0.17 watershed inches
D) Contributing Watershed Area (including sand filter area)	Area = 56,618 sq ft
E) Water Quality Capture Volume (WQCV) Design Volume V_{WQCV} = WQCV / 12 * Area	V_{WQCV} = cu ft
F) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm	d_6 = 1.19 in
G) For Watersheds Outside of the Denver Region, Water Quality Capture Volume (WQCV) Design Volume	$V_{WQCV\ OTHER}$ = 2,272 cu ft
H) User Input of Water Quality Capture Volume (WQCV) Design Volume (Only if a different WQCV Design Volume is desired)	$V_{WQCV\ USER}$ = cu ft
2. Basin Geometry	
A) WQCV Depth	D_{WQCV} = 2.5 ft
B) Sand Filter Side Slopes (Horizontal distance per unit vertical, 4:1 or flatter preferred). Use "0" if sand filter has vertical walls.	Z = 0.00 ft / ft
C) Minimum Filter Area (Flat Surface Area)	A_{Min} = 382 sq ft
D) Actual Filter Area	A_{Actual} = 963 sq ft
E) Volume Provided	V_T = 2408 cu ft
3. Filter Material	Choose One: (●) 18" CDOT Class B or C Filter Material; ( ) Other (Explain):
4. Underdrain System	
A) Are underdrains provided?	Choose One: (●) YES; ( ) NO
B) Underdrain system orifice diameter for 12 hour drain time	
i) Distance From Lowest Elevation of the Storage Volume to the Center of the Orifice	y = 0.1 ft
ii) Volume to Drain in 12 Hours	Vol_{12} = 2,272 cu ft
iii) Orifice Diameter, 3/8" Minimum	D_O = 2 1/16 in

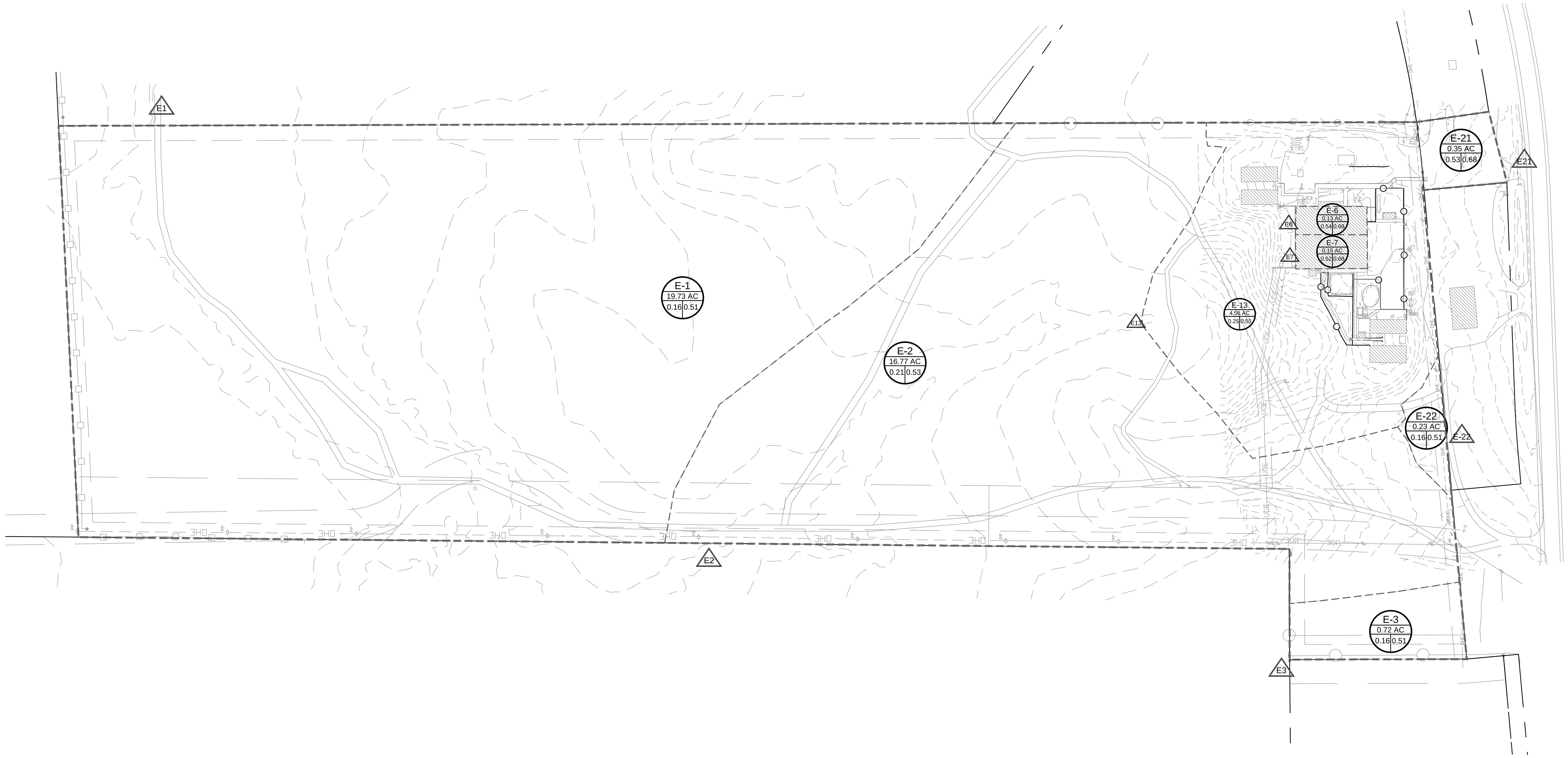
Design Procedure Form: Sand Filter (SF)

Designer: TAC
Company: Kiowa Engineering
Date: March 10, 2026
Project: Priaire Heights Elementary School
Location: West Basins 15 (8, 10, 11, 13)

5. Impermeable Geomembrane Liner and Geotextile Separator Fabric A) Is an impermeable liner provided due to proximity of structures or groundwater contamination?	Choose One ○ YES ◉ NO
6. Inlet / Outlet Works A) Describe the type of energy dissipation at inlet points and means of conveying flows in excess of the WQCV through the outlet	Forebay & Rip Rap

Notes:

APPENDIX D
Drainage Conditions Maps



DRAINAGE REPORT LEGEND

E1	DRAINAGE BASIN DESIGNATION
2.67AC	DRAINAGE BASIN ACRES
C5 RUNOFF 0.31	0.50 C100 RUNOFF
	DIRECTIONAL FLOW ARROW
	DRAINAGE BASIN BOUNDARY
1	DESIGN POINT
	TIME OF CONCENTRATION PATH
10	HYDRAULIC STRUCTURE IDENTIFIER
S10	STORM SEWER IDENTIFIER
	PROPOSED STORM SEWER PIPE
	PROPOSED STORM SEWER MANHOLE
	PROPOSED STORM DRAINAGE CURB INLET
	EXISTING CONTOURS
	PROPOSED CONTOURS
	PROPERTY BOUNDARY
	LIMIT OF CONSTRUCTION

NOTES:

1. ALL ELEVATIONS ARE FLOW LINE UNLESS OTHERWISE INDICATED.
2. ADD 4100 TO SPOT ELEVATIONS.
3.

0 100' 200'
SCALE: 1"=100'

EPC File: PPR254

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

EXISTING DRAINAGE STUDY
PRAIRIE HEIGHTS ELEMENTARY SCHOOL
EXISTING DRAINAGE MAP
FOUNTAIN, COLORADO

Project No.:	24047
Date:	4/9/25
Design:	TAC
Drawn:	JDC
Check:	-
Revisions:	

SHEET
DM1
OF _ SHEETS

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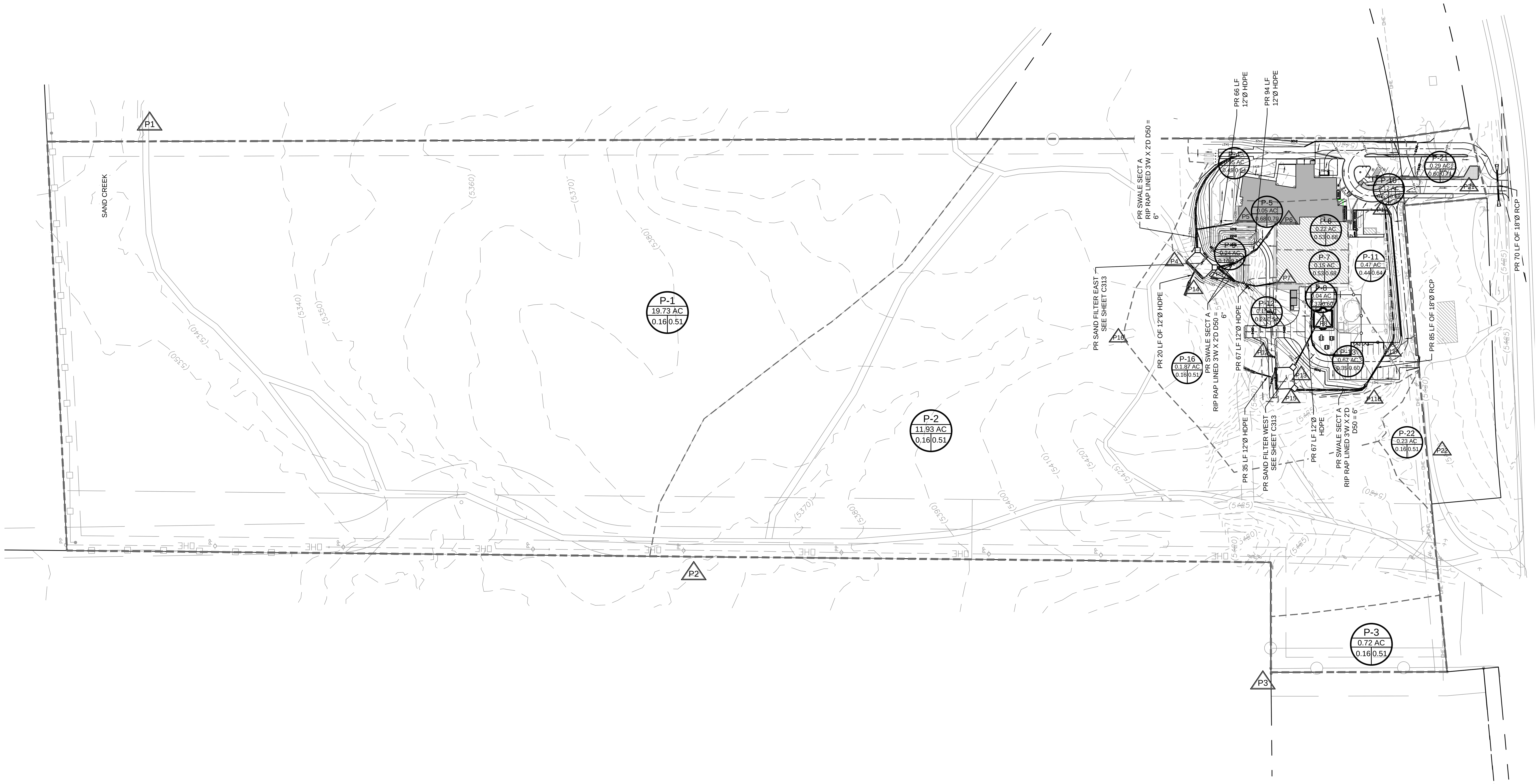

DRAINAGE REPORT LEGEND

E1	DRAINAGE BASIN DESIGNATION
2.67AC	DRAINAGE BASIN ACRES
C5 RUNOFF 0.31 / 0.50 C100 RUNOFF	
2.2 cfs / 4.3 cfs	5-YEAR RUNOFF / 100-YEAR RUNOFF
	DIRECTIONAL FLOW ARROW
	DRAINAGE BASIN BOUNDARY
1	DESIGN POINT
	TIME OF CONCENTRATION PATH
10	HYDRAULIC STRUCTURE IDENTIFIER
S10	STORM SEWER IDENTIFIER
	PROPOSED STORM SEWER PIPE
	PROPOSED STORM SEWER MANHOLE
	PROPOSED STORM DRAINAGE CURB INLET
6020	EXISTING CONTOURS
6020	PROPOSED CONTOURS
	PROPERTY BOUNDARY
	LIMIT OF CONSTRUCTION

NOTES:

1. ALL ELEVATIONS ARE FLOW LINE UNLESS OTHERWISE INDICATED.
2. ADD 4100 TO SPOT ELEVATIONS.
3.

0 100' 200'

SCALE: 1"=100'

EPC File: PPR254

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

PROPOSED DRAINAGE STUDY
PRAIRIE HEIGHTS ELEMENTARY SCHOOL
PROPOSED DRAINAGE MAP
FOUNTAIN, COLORADO

Project No.:	24047
Date:	6/9/25
Design:	TAC
Drawn:	JDC
Check:	-
Revisions:	

SHEET

DM2

OF _ SHEETS

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LEGEND

PBMP - SAND FILTER

SAND FILTER WEST TRIB AREA

SAND FILTER EAST TRIB AREA

DRAINAGE REPORT LEGEND

Symbol	Description
E1 / 2.67AC / 0.31 / 0.50	DRAINAGE BASIN DESIGNATION; DRAINAGE BASIN ACRES; C5 RUNOFF; C100 RUNOFF
2.2 cfs / 4.3 cfs	5-YEAR RUNOFF / 100-YEAR RUNOFF
	DIRECTIONAL FLOW ARROW
	DRAINAGE BASIN BOUNDARY
1	DESIGN POINT
	TIME OF CONCENTRATION PATH
10	HYDRAULIC STRUCTURE IDENTIFIER
S10	STORM SEWER IDENTIFIER
	PROPOSED STORM SEWER PIPE
	PROPOSED STORM SEWER MANHOLE
	PROPOSED STORM DRAINAGE CURB INLET
6020	EXISTING CONTOURS
6020	PROPOSED CONTOURS
	PROPERTY BOUNDARY
	LIMIT OF CONSTRUCTION

NOTES:

1. ALL ELEVATIONS ARE FLOW LINE UNLESS OTHERWISE INDICATED.
2. ADD 4100 TO SPOT ELEVATIONS.
3.

0 100' 200'

SCALE: 1"=100'

EPC File: PPR254

Kiowa Engineering Corporation
1604 South 21st Street
Colorado Springs, Colorado 80904
(719) 630-7342

PROPOSED DRAINAGE STUDY
PRAIRIE HEIGHTS ELEMENTARY SCHOOL
WQCV PBMP TREATMENT MAP
FOUNTAIN, COLORADO

Project No.:	24047
Date:	6/9/25
Design:	TAC
Drawn:	JDC
Check:	-
Revisions:	

SHEET

DM3

OF _ SHEETS

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APPENDIX E

Geotechnical Update - CTL

December 29, 2025

Hanover School District c/o NV5
17050 South Peyton Highway
Colorado Springs, Colorado 80928

Attention: Mr. Mark McPherson
Superintendent

Subject: Infiltration Testing
Prairie Heights Elementary School
7930 Indian Village Heights
Fountain, Colorado 80817
CTL|T Project No. CS19910.000-125

As requested, CTL|Thompson, Inc (CTL|T) conducted infiltration testing for the design and construction of stormwater improvements associated with the construction of the Prairie Heights Elementary School addition project, located at 7930 Indian Village Heights in Fountain, Colorado (Fig. 1). We believe the testing was performed in accordance with the scope of services presented in our contract modification dated December 2, 2025 (CTLIT Proposal No. CS-24-0203 CM2). The following summarizes the test and presents the results of the infiltration testing.

Site Conditions

Prairie Heights Elementary School is currently under construction, which includes renovation of the existing school and construction of a building addition. Site improvements include new parking lots, drive lanes, site grading as well as improvements to stormwater management. Overall grades across the site, and the general vicinity, slope downward toward the north. Shallow valleys are present toward the north and extend north, beyond the school property boundaries. Large sized lots containing single-family residences are located within the vicinity, and the Hanover Volunteer Fire Department fire station is located adjacent and south of the school. Indian Village Heights is located along the south side of the property, in an east-west direction. Vegetation within the immediate area consists of weeds and natural prairie grasses. Bare soil generally exists within the immediate vicinity of the on-going construction project. The general location and site structures are presented in Fig. 1 of this report.

Proposed Construction

We understand stormwater drainage improvements are required for the development of the site. NV5 requested soil infiltration testing be conducted at two, proposed stormwater quality ponds identified on the attached Fig. 1. The proposed detention ponds will be located to the north and downgradient of the school building. The ponds will be constructed with sand filters.

Subsurface Conditions

Subsurface conditions at each pond site were explored by drilling one centrally located infiltration profile boring. Drilling was observed by our field representative, who logged the conditions found in the boring and obtained samples. Samples obtained from each boring were returned to our laboratory where they were subjected to classification testing.

Near surface soils encountered at the site classify as natural, sandy to very sandy clay, extending to the maximum depths explored of 10 feet. Bedrock and groundwater were not encountered in the borings. Samples of the near surface clay soils were subjected to laboratory testing. The samples contained 56 and 75 percent silt and clay-sized particles. Atterberg Limits testing was conducted on two samples, resulting in Liquid Limits of 24 and 34 and Plasticity Indices of 9 and 15.

Infiltration Testing

We understand two stormwater quality ponds are planned along the north side of the school site. For design purposes, infiltration testing was conducted using percolation test procedures at each of the two locations identified in Fig. 1. Locations were established based on the site Grading and Erosion plan by Kiowa Engineering. Test locations consisted of generally undisturbed ground that had not been significantly impacted by construction traffic. Prior to our field testing, each test location was cut to near finished grades by the contractor using a front-end loader.

Each field infiltration test included a total of three, six-inch diameter holes advanced to depths of about two to three feet below existing grades using continuous flight auger and a truck mounted drill rig. Slotted PVC pipe was installed into the three holes, and the holes were presoaked approximately 24 hours prior to the test. We returned to the site on the following day to perform the infiltration tests by taking periodic measurements of the water, refilling as necessary to maintain a minimum water depth. Field reading intervals were based on the infiltration rate observed. Design percolation rates of 0.4 and 0.8 inches per hour were determined for the locations I-1 and I-2, respectively. Test results are summarized in the tables presented in Appendix A of this report.

Construction Observations

We recommend that CTL|Thompson, Inc. provide construction observation services to allow us the opportunity to confirm soil conditions are consistent with those found during this investigation. If others perform these observations, they must accept responsibility to judge whether the recommendations in this report remain appropriate.

Geotechnical Risk

The concept of risk is an important aspect with any geotechnical evaluation primarily because the methods used to develop geotechnical recommendations do not comprise an exact science. We never have complete knowledge of subsurface conditions. Our analysis must be tempered with engineering judgment and experience. Therefore, the recommendations presented in any geotechnical evaluation should not be considered risk-free. It is critical that all recommendations in this report are followed during construction.

Limitations

This report has been prepared for the exclusive use of Hanover School District No. 28, NV5, and Kiowa Engineering for the purpose of providing geotechnical design and construction criteria for the proposed stormwater improvements associated with the

Prairie Heights Elementary School Project. The information, conclusions, and recommendations presented herein are based upon consideration of many factors including, but not limited to, the type of features proposed, the geologic setting, and the subsurface conditions encountered. The conclusions and recommendations contained in the report are not valid for use by others. Standards of practice continuously evolve in the area of geotechnical engineering. The recommendations provided are appropriate for about three years. If the project is not constructed within about three years, we should be contacted to determine if we should update this report.

Our infiltration tests were located at each of the proposed pond locations as identified on the Grading and Erosion Plan, Plan Sheet C313, by Kiowa Engineering. Testing was performed at each location to obtain reasonably accurate infiltration properties at the site, representative of the subsurface materials

The data are representative of conditions encountered only at the exact locations. Variations in the subsurface conditions are possible. Placement and compaction of fill and backfill should be observed and tested by a representative of our firm during construction.

We believe this testing was conducted in a manner consistent with that level of skill and care normally used by geotechnical engineers practicing in this area at this time. No warranty, express or implied, is made.

If we can be of further service in discussing the contents of this report or in the analysis of the influence of the subsurface conditions on design of the structure, please call.

Respectfully submitted,

CTL|THOMPSON, INC.

Patrick Foley, EI
Staff Engineer

Reviewed by:

Jeffrey M. Jones, P.E.
Principal Engineer

COLORADO LICENSED
JEFFREY MARK JONES
47539
12/29/25
PROFESSIONAL ENGINEER

PF:JMJ:cw
Via email: Geoff.Graham@NV5.com
Chris.Spyke@NV5.com

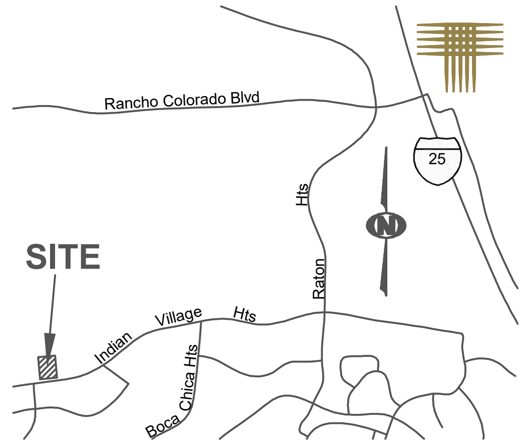
LEGEND:

I-1 ● APPROXIMATE LOCATION OF INFILTRATION PROFILE BORING.

(blue line) LOCATION OF EXISTING BUILDING FOOTPRINT.

(red line) LOCATION OF PROPOSED BUILDING FOOTPRINT.

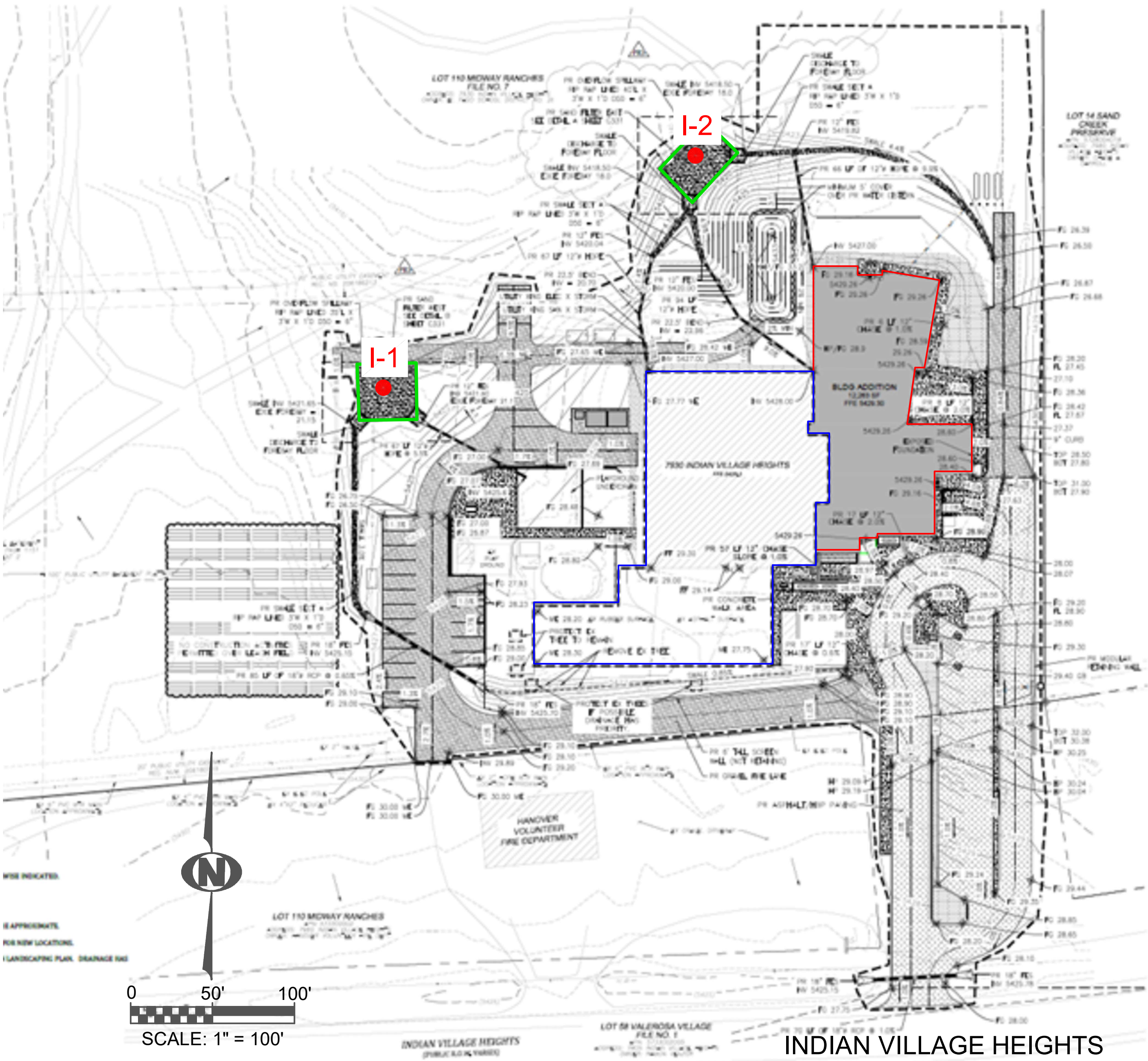
(green line) LOCATION OF PROPOSED STORMWATER QUALITY PONDS.



VICINITY MAP

(NOT TO SCALE)

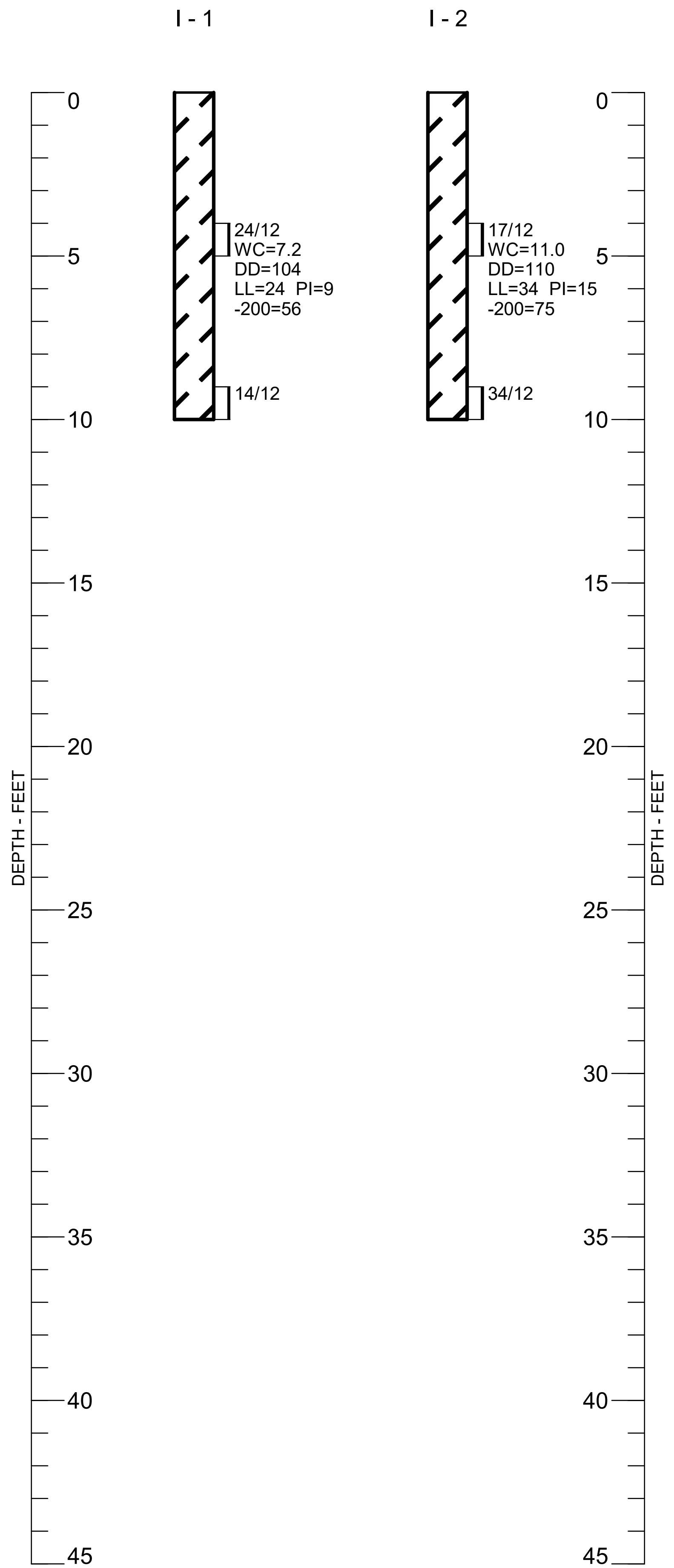
NOTE:
BASE DRAWING WAS PROVIDED BY KIOWA ENGINEERING (PROJECT NO. 24047, DATED JULY 11, 2025).



HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
CTL|T PROJECT NO. CS19910.000-125 L1

Location of Infiltration Profile Boring

FIG. 1



LEGEND:

CLAY, SANDY TO VERY SANDY, STIFF TO VERY STIFF, MOIST, LIGHT BROWN TO BROWN (CL)

DRIVE SAMPLE. THE SYMBOL 24/12 INDICATES 24 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE A 2.5-INCH O.D. SAMPLER 12 INCHES.

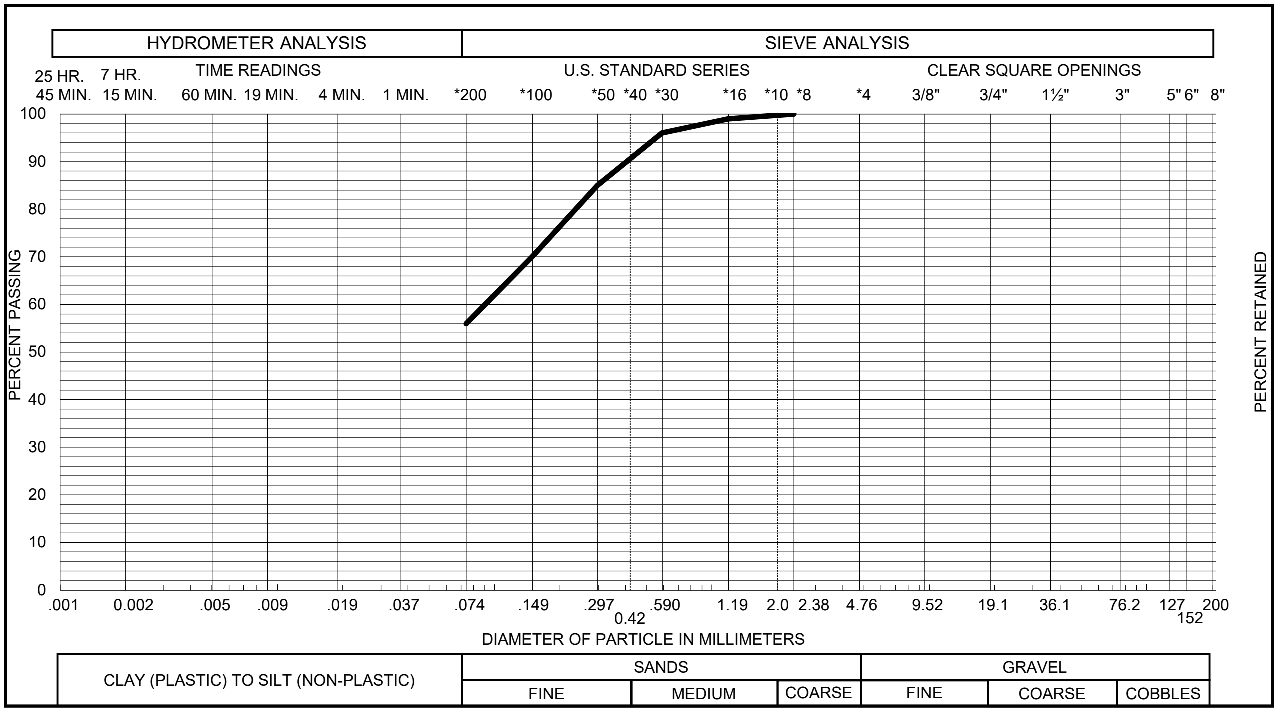
NOTES:

1. THE BORINGS WERE DRILLED DECEMBER 15, 2025 USING A 4-INCH DIAMETER, CONTINUOUS-FLIGHT AUGER AND A CME-45, TRUCK-MOUNTED DRILL RIG.
2. THESE LOGS ARE SUBJECT TO THE EXPLANATIONS, LIMITATIONS, AND CONCLUSIONS AS CONTAINED IN THIS REPORT.
3. GROUNDWATER WAS NOT ENCOUNTERED IN THE EXPLORATORY BORINGS DURING THIS INVESTIGATION.
4. WC - INDICATES MOISTURE CONTENT. (%)
   DD - INDICATES DRY DENSITY. (PCF)
   LL - INDICATES LIQUID LIMIT. (NV : NO VALUE)
   PI - INDICATES PLASTICITY INDEX. (NP : NON-PLASTIC)
   -200 - INDICATES PASSING NO. 200 SIEVE. (%)

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
CTL|T PROJECT NO. CS19910.000-125 L1

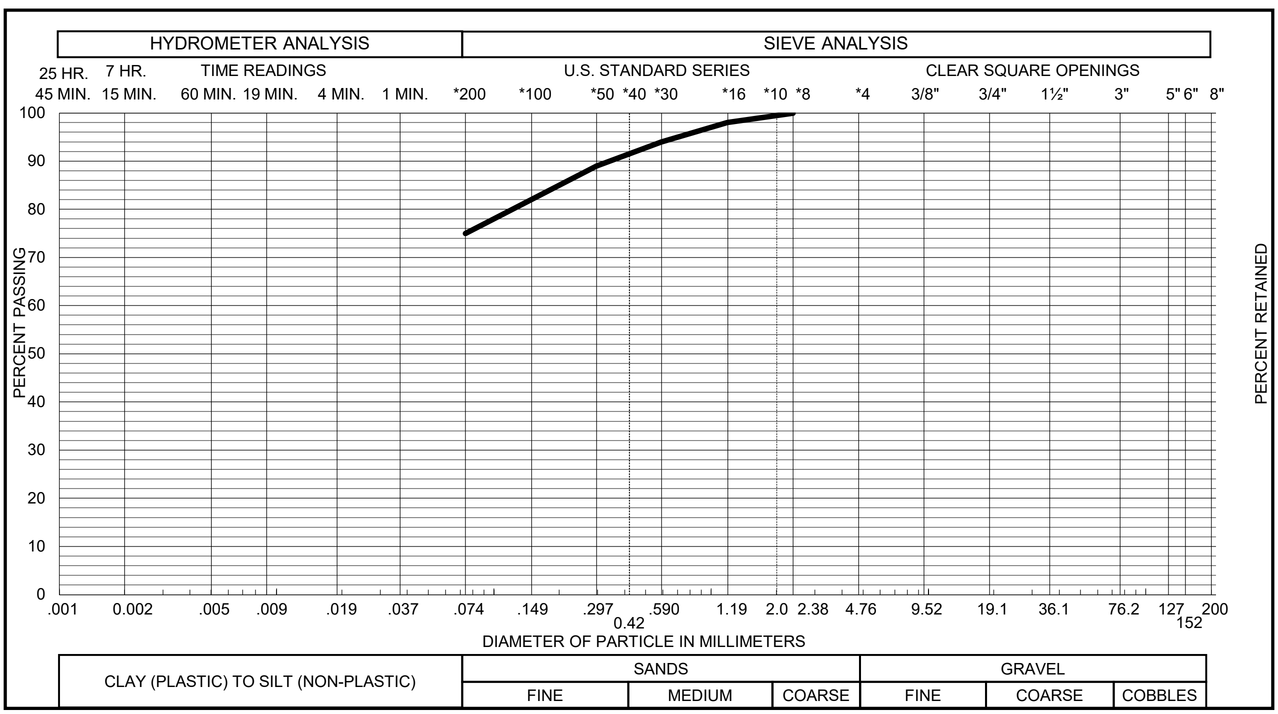
Summary Logs of Infiltration Profile Borings

FIG. 2



Sample of CLAY, VERY SANDY (CL)
From I - 1 AT 4 FEET

GRAVEL	0 %	SAND	44 %
SILT & CLAY	56 %	LIQUID LIMIT	24 %
PLASTICITY INDEX			9 %



Sample of CLAY, SANDY (CL)
From I - 2 AT 4 FEET

GRAVEL	0 %	SAND	25 %
SILT & CLAY	75 %	LIQUID LIMIT	34 %
PLASTICITY INDEX			15 %

HANOVER SCHOOL DISTRICT NO. 28
PRAIRIE HEIGHTS ELEMENTARY SCHOOL ADDITION
CTL|T PROJECT NO. CS19910.000-125 L1

Gradation Test Results

FIG. 3

TABLE I

SUMMARY OF LABORATORY TESTING
CTL|T PROJECT NO. CS19910.000-125

BORING	DEPTH (FEET)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	ATTERBERG LIMITS		SWELL TEST RESULTS*		PASSING NO. 200 SIEVE (%)	WATER SOLUBLE SULFATES (%)	DESCRIPTION
				LIQUID LIMIT	PLASTICITY INDEX	SWELL (%)	SWELL PRESSURE (PSF)			
I-1	4	7.2	104	24	9			56		CLAY, VERY SANDY (CL)
I-2	4	11.0	110	34	15			75		CLAY, SANDY (CL)

* SWELL MEASURED UNDER ESTIMATED IN-SITU OVERBURDEN PRESSURE.
NEGATIVE VALUE INDICATES COMPRESSION.

APPENDIX A
INFILTRATION TEST RESULTS

I-1
INFILTRATION TEST DATA

Project: **Prairie Heights Elementary School**
Location: **7930 Indian Village Heights**
Pre-Soaked: **12/15/2025**

Project No: **CS19910.000-125**
Technician/Engineer: **JT**
Date of Test: **12/16/2025**

Infiltraiton Test Hole: A
Hole Depth **30 in.** **Pipe Length (in.): 43**

Time (hrs:min)	Time Interval (min)	Depth to Water (in)	Change in Water Depth (in)	Infiltration Rate (in/hr)
10:10 AM	-	17 1/2		
10:20 AM	10.0	17 3/4	1/4	1 1/2
10:30 AM	10.0	18 1/2	3/4	4 1/2
10:40 AM	10.0	18 3/4	1/4	1 1/2
10:50 AM	10.0	19 1/2	3/4	4 1/2
11:00 AM	10.0	20	1/2	3
11:10 AM	10.0	20 3/4	3/4	4 1/2
11:20 AM	10.0	21 1/4	1/2	3
11:30 AM	10.0	22 1/4	1	6
11:40 AM	10.0	22 7/8	5/8	3 3/4
11:50 AM	10.0	23 3/4	7/8	5 1/4
12:00 PM	10.0	24 1/8	3/8	2 1/4
			Rate =	**3.61**

Infiltration Test Hole: B
Hole Depth **25 in.** **Pipe Length (in.): 42**

Time (hrs:min)	Time Interval (min)	Depth to Water (in)	Change in Water Depth (in)	Infiltration Rate (in/hr)
10:10 AM	-	19 3/4		
10:20 AM	10.0	20	1/4	1 1/2
10:30 AM	10.0	20 1/2	1/2	3
10:40 AM	10.0	21	1/2	3
10:50 AM	10.0	21 3/4	3/4	4 1/2
11:00 AM	10.0	22 1/2	3/4	4 1/2
11:10 AM	10.0	23 1/4	3/4	4 1/2
11:20 AM	10.0	23 3/4	1/2	3
11:30 AM	10.0	24 3/8	5/8	3 3/4
11:40 AM	10.0	24 3/4	3/8	2 1/4
11:50 AM	10.0	25 1/4	1/2	3
12:00 PM	10.0	25 3/4	1/2	3
			Rate =	**3.27**

Infiltration Test Hole: C
Hole Depth **24 in.** **Pipe Length (in.): 42**

Time (hrs:min)	Time Interval (min)	Depth to Water (in)	Change in Water Depth (in)	Infiltration Rate (in/hr)
10:10 AM	-	23 1/2		
10:20 AM	10.0	23 3/4	1/4	1 1/2
10:30 AM	10.0	24	1/4	1 1/2
10:40 AM	10.0	24 1/8	1/8	3/4
10:50 AM	10.0	24 1/4	1/8	3/4
11:00 AM	10.0	24 3/8	1/8	3/4
11:10 AM	10.0	24 1/2	1/8	3/4
11:20 AM	10.0	24 5/8	1/8	3/4
11:30 AM	10.0	24 3/4	1/8	3/4
11:40 AM	10.0	25	1/4	1 1/2
11:50 AM	10.0	25 1/8	1/8	3/4
12:00 PM	10.0	25 1/4	1/8	3/4
			Rate =	**0.95**

Average Calculated Percolation Rate	**2.61**	in/hr
Reduction Factor	**6.56**	
Infiltration Rate	**0.40**	in/hr

I-2
INFILTRATION TEST DATA

Project: Prairie Heights Elementary School
Location: 7930 Indian Village Heights
Pre-Soaked: 12/15/2025

Project No: CS19910.000-125
Technician/Engineer: JT
Date of Test: 12/16/2025

Infiltraiton Test Hole: A
Hole Depth **24 in.** **Pipe Length (in.): 24**

Time (hrs:min)	Time Interval (min)	Depth to Water (in)	Change in Water Depth (in)	Infiltration Rate (in/hr)
10:13 AM	-	10 1/2		
10:23 AM	10	10 3/4	1/4	1 1/2
10:33 AM	10	11 1/4	1/2	3
10:43 AM	10	11 1/2	1/4	1 1/2
10:53 AM	10	11 3/4	1/4	1 1/2
11:03 AM	10	12	1/4	1 1/2
11:13 AM	10	12 1/4	1/4	1 1/2
11:23 AM	10	12 1/2	1/4	1 1/2
11:33 AM	10	13	1/2	3
11:43 AM	10	13 1/4	1/4	1 1/2
11:53 AM	10	13 1/4	0	0
12:03 PM	10	13 3/4	1/2	3
			Rate =	**1.77**

Infiltration Test Hole: B
Hole Depth **30 in.** **Pipe Length (in.): 28**

Time (hrs:min)	Time Interval (min)	Depth to Water (in)	Change in Water Depth (in)	Infiltration Rate (in/hr)
10:13 AM	-	13 1/4		
10:23 AM	10	13 3/4	1/2	3
10:33 AM	10	14 1/2	3/4	4 1/2
10:43 AM	10	15 1/4	3/4	4 1/2
10:53 AM	10	15 7/8	5/8	3 3/4
11:03 AM	10	16	1/8	3/4
11:13 AM	10	16 1/2	1/2	3
11:23 AM	10	16 3/4	1/4	1 1/2
11:33 AM	10	17 1/8	3/8	2 1/4
11:43 AM	10	17 1/2	3/8	2 1/4
11:53 AM	10	17 3/4	1/4	1 1/2
12:03 PM	10	18 1/4	1/2	3
			Rate =	**2.73**

Infiltration Test Hole: C
Hole Depth **33 in.** **Pipe Length (in.): 36**

Time (hrs:min)	Time Interval (min)	Depth to Water (in)	Change in Water Depth (in)	Infiltration Rate (in/hr)
10:13 AM	-	15		
10:23 AM	10	17 1/4	2 1/4	13 1/2
10:33 AM	10	18 3/4	1 1/2	9
10:43 AM	10	20	1 1/4	7 1/2
10:53 AM	10	21	1	6
11:03 AM	10	22	1	6
11:13 AM	10	22 1/2	1/2	3
11:23 AM	10	23	1/2	3
11:33 AM	10	24	1	6
11:43 AM	10	24 5/8	5/8	3 3/4
11:53 AM	10	25 1/4	5/8	3 3/4
12:03 PM	10	25 3/4	1/2	3
			Rate =	**5.86**

Average Calculated Percolation Rate	**3.45**	in/hr
Reduction Factor	**4.42**	
Infiltration Rate	**0.78**	in/hr