

KLUG HILL RV PARK KOA® CAMPGROUND

Drainage Report

Prepared for:

Lelah Campo

Cozy Hills II Campground

1311 Bantam Road

Bantam, CT 06750

SLR #141.20174.00002.0080

November 9, 2022

Revised January 17, 2023



Drainage Report

Klug Hill RV Park
Kampgrounds of America (KOA®) Campground
232 Klug Hill Road
Torrington, Connecticut
November 9, 2022
Revised January 17, 2023
SLR #141.20174.00002.0080

This Drainage Report has been prepared in support of the proposed campground development to be constructed at 232 Klug Hill Road in the town of Torrington, Connecticut. The development proposes to construct a new KOA® Campground at the site.



Figure 1 – #215003004 and #215003016 Parcels

Table 1 – Stormwater Data

Parcel Size Total	225.9 acres
Existing Impervious Area (Property)	1.51 acres
Proposed Impervious Area (Property)	6.33 acres
Soil Types (Hydrologic Soil Group)	"B," "C," and "D"
Existing Land Use	Woods, meadow, open space, dirt, gravel, bituminous driveway, and building
Proposed Land Use	Woods, meadow, open space, dirt, gravel, bituminous driveway, and building
Design Storm for Stormwater Management (Town of Torrington)	No increases in peak rates of runoff for the 2-, 10-, 25-, 50-, and 100-year storms, Connecticut Department of Energy & Environmental Protection (CTDEEP) Water Quality Volume (WQV)
Water Quality Measures	2-foot sump catch basins, retention storage, level spreader outlets, and riprap energy dissipators
Design Storm for Storm Drainage (Town of Torrington)	10-year storm
Federal Emergency Management Agency Special Flood Hazard Areas	Area of Minimal Flood Hazard (Zone X)
Connecticut Department of Energy & Environmental Protection Aquifer Protection Areas	Not Applicable

STORMWATER MANAGEMENT APPROACH

The stormwater management system for this site has been designed utilizing Best Management Practices (BMPs) to provide water quality management while attenuating the proposed peak-flow rates from the development. The design goal is to provide water quality treatment in accordance with the CTDEEP requirements for the water quality volume (WQV) and to prevent increases in the predevelopment runoff rates from the site. Existing drainage patterns will be maintained to the maximum extent practicable, and a new stormwater treatment train proposes catch basins with 2-foot sumps, retention storage, level spreader outlets, and riprap energy dissipators.

The computer program titled *Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2019* by Autodesk, Inc., Version 2018.3, was used for designing the proposed storm drainage collection system. Storm drainage computations performed include pipe capacity and hydraulic grade line calculations. The contributing watershed to each individual catch basin inlet was delineated to determine the drainage area and land coverage. These values were used to determine the stormwater runoff to each inlet using the Rational Method. The rainfall intensities for the site were obtained from the National Oceanic and

Atmospheric Administration (NOAA) Atlas 14, Volume 10, Precipitation Frequency Data Server (PFDS). The proposed storm drainage system is designed to provide adequate capacity to convey the 10-year storm event.

WATER QUALITY MANAGEMENT

Stormwater runoff from the proposed development will be collected by a subsurface pipe and catch basin drainage system. The proposed drainage system will include catch basins with 2-foot sumps to trap sediment and debris.

Each of the proposed stormwater management basins will provide retention volume along its bottom, thus creating a water quality feature within it. This serves several purposes, including stormwater renovation and first-flush retention. The vegetation will provide pollutant removal by filtering stormwater runoff and utilizing excess nutrients that may be present in the stormwater. The CTDEEP *2004 Stormwater Quality Manual* (Chapter 7) recommends methods for sizing stormwater treatment measures with WQV computations. The WQV addresses the initial stormwater runoff, also commonly referred to as the "first-flush" runoff. The WQV provides adequate volume to store the runoff associated with the first 1 inch of rainfall, which tends to contain the highest concentration of potential pollutants. Supporting calculations have been included in the Appendix of this report.

The level spreader discharge systems are designed to release stormwater from the stormwater basins and will also help improve water quality. The design calls for a level stone berm as an overflow outlet, which will be set against a precast concrete curb. The stone level spreaders were designed to gradually release stormwater in a quiescent manner as sheet flow rather than a concentrated point discharge that results from typical storm pipe outlets or flared end sections.

HYDROLOGIC ANALYSIS

A hydrologic analysis was conducted to analyze the predevelopment and postdevelopment peak-flow rates from the site. Four analysis points that receive runoff from the site were selected. Analysis Point A represents Wetland C/E, which is located west of the campground development. Analysis Point B represents Wetland I and Goshen Road (Route 4). Analysis Point C represents Wetland K and Klug Hill Road. Analysis Point D represents Wetland B and an existing drainage swale located east of Klug Hill Road. The total watershed area delineated is approximately 89.3 acres under both existing and proposed conditions.

The method of predicting the surface water runoff rates utilized in this analysis was a computer program titled *Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2019* by Autodesk, Inc., Version 2020. The *Hydrographs* program is a computer model that utilizes the methodologies set forth in the *Technical Release No. 55* (TR-55) manual and *Technical Release No. 20* (TR-20) computer model, originally developed by the United States Department of Agriculture – Natural Resources Conservation Service (USDA-NRCS). The *Hydrographs* computer modeling program is primarily used for conducting hydrology studies such as this one.

The *Hydrographs* computer program forecasts the rate of surface water runoff based upon several factors. The input data includes information on land use, hydrologic soil type, vegetation, contributing watershed area, time of concentration, rainfall data, storage volumes, and the hydraulic capacity of structures. The

computer model predicts the amount of runoff as a function of time, with the ability to include the attenuation effect due to dams, lakes, large wetlands, floodplains, and stormwater management basins. The input data for rainfalls with statistical recurrence frequencies of 2, 10, 25, 50, and 100 years was obtained from the NOAA Atlas 14, Volume 10 database. The corresponding rainfall totals are listed below.

Storm Frequency	Rainfall (inches)
2-year	3.49
10-year	5.69
25-year	7.06
50-year	8.06
100-year	9.18

Land use for the site under existing and proposed conditions was determined from field survey and aerial photogrammetry. Land use types used in the analysis included woods, meadow, grassed or open space, dirt, gravel, building, and impervious (paved) cover. Soil types in the watershed were determined from the CTDEEP Geographic Information System (GIS) database of the USDA-NRCS soil survey for Litchfield County, Connecticut. For the analysis, the site was determined to contain hydrologic soil types "B," "C," and "D" as classified by USDA-NRCS. A composite runoff Curve Number (CN) for each subwatershed was calculated based on the different land use and soil types. The time of concentration (T_c) was estimated for each subwatershed using the TR-55 methodology and was computed by summing all travel times through the watershed as sheet flow, shallow concentrated flow, and channel flow.

The existing conditions were modeled with the *Hydrographs* program to determine the peak-flow rates for the various storm events at each analysis point. A revised model was developed incorporating the proposed site conditions and the stormwater management basins. The flows obtained with the revised model were then compared to the results of the existing conditions model.

The following peak rates of runoff were obtained from the *Hydrographs* hydrology results:

Analysis Point A – Wetland C/E					
	Peak Runoff Rate (cubic feet per second)				
Storm Frequency (years)	2	10	25	50	100
Existing Conditions	9.5	34.0	52.5	66.9	83.7
Proposed Conditions	8.6	30.0	45.4	58.3	80.7

Detention Basin 110*					
	Water Surface Elevation (feet)				
Storm Frequency (years)	2	10	25	50	100
Proposed Conditions	1137.6	1139.2	1140.1	1140.7	1141.0

*Top of Berm Elevation = 1142.0

Detention Basin 120**					
	Water Surface Elevation (feet)				
Storm Frequency (years)	2	10	25	50	100
Proposed Conditions	1134.7	1135.6	1136.4	1136.7	1136.9

**Top of Berm Elevation = 1138.0

Analysis Point B – Wetland I/Goshen Road (Route 4)					
	Peak Runoff Rate (cubic feet per second)				
Storm Frequency (years)	2	10	25	50	100
Existing Conditions	8.1	21.8	31.2	38.3	46.4
Proposed Conditions	8.1	21.7	31.0	38.0	46.1

Analysis Point C – Wetland K/Klug Hill Road					
	Peak Runoff Rate (cubic feet per second)				
Storm Frequency (years)	2	10	25	50	100
Existing Conditions	19.4	53.4	77.1	95.0	115.5
Proposed Conditions	16.7	48.7	75.8	93.5	113.1

Detention Basin 310***					
	Water Surface Elevation (feet)				
Storm Frequency (years)	2	10	25	50	100
Proposed Conditions	1152.8	1153.8	1154.2	1154.5	1154.9

***Top of Berm Elevation = 1156.0

Analysis Point D – Wetland B/East Drainage Swale					
	Peak Runoff Rate (cubic feet per second)				
Storm Frequency (years)	2	10	25	50	100
Existing Conditions	19.6	49.8	70.3	85.6	103.0
Proposed Conditions	18.6	46.4	64.5	83.1	99.9

Detention Basin 410****					
	Water Surface Elevation (feet)				
Storm Frequency (years)	2	10	25	50	100
Proposed Conditions	1129.9	1131.7	1132.3	1132.5	1133.0

****Top of Berm Elevation = 1134.0

CONCLUSION

The results of the hydrologic analysis demonstrate that there will be no increases in peak-flow rates from the proposed development. This was achieved for the storm events modeled through a planned stormwater management system with detention provided in the proposed stormwater basins. The proposed development will also introduce a new stormwater treatment train consisting of several water quality measures such as catch basins with 2-foot sumps, retention storage, level spreader outlets, and riprap energy dissipators. Additionally, the site grading is intended to disconnect the gravel surfaces over vegetated areas to the maximum extent possible. We do not anticipate that downgradient RV sites will be negatively affected by sheet flow from upgradient sites or driveways. We do anticipate that periodic maintenance and repairs to the gravel surface will be needed from time to time.

All supporting documentation and stormwater-related computations are attached to this report along with the *Hydraflow Hydrographs* model results for stormwater management and *Hydraflow Storm Sewers* model results for the proposed storm drainage system. Illustrative watershed maps for both existing and proposed conditions are also attached to this report.

Attachments

- Appendix A – United States Geological Survey Location Map
- Appendix B – Federal Emergency Management Agency Flood Insurance Rate Map
- Appendix C – Natural Resources Conservation Service Hydrologic Soil Group Map
- Appendix D – Storm Drainage Computations
- Appendix E – Water Quality Computations
- Appendix F – Hydrologic Analysis – Input Computations
- Appendix G – Hydrologic Analysis – Computer Model Results
- Appendix H – Watershed Maps

20174.00002.n922.rpt.docx

APPENDIX A

UNITED STATES GEOLOGICAL SURVEY LOCATION MAP

Drainage Report

Klug Hill RV Park

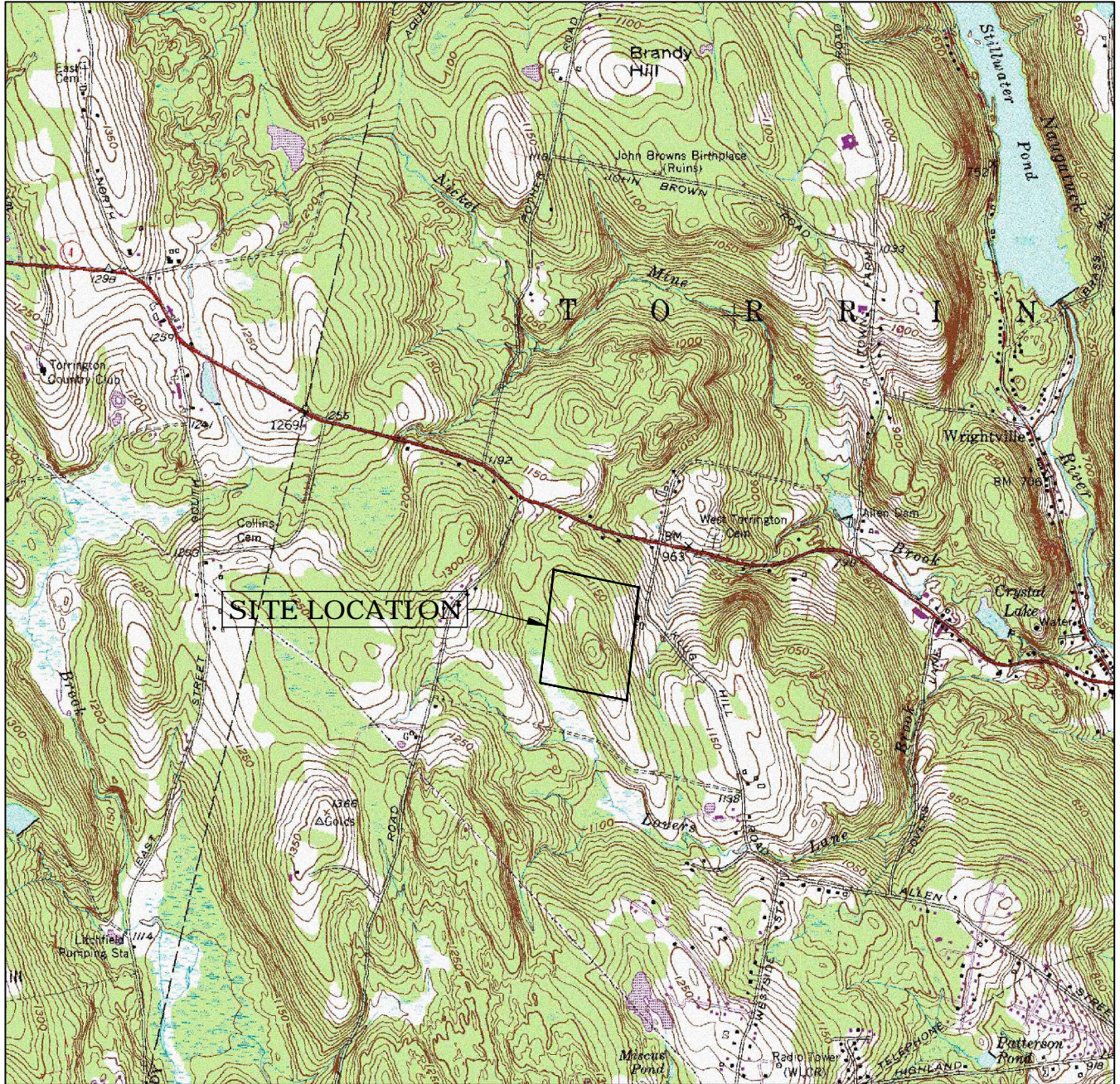
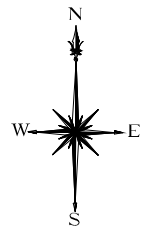
KOA® Campground

232 Klug Hill Road

Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023



99 REALTY DRIVE
CHESHIRE, CT 06410
203.271.1773
SLRCONSULTING.COM

USGS QUADRANGLE MAP, QUAD NO. 33

**KLUG HILL RV PARK
KOA CAMPGROUND**

**232 KLUG HILL ROAD
TORRINGTON, CONNECTICUT**

PROJECT PHASE:

REV: ---

DATE **OCTOBER 14, 2022**

SCALE **1"=2,400'**

PROJ. NO. **20174.00002**

DESIGNED ---	DRAWN MCB	CHECKED ---
-----------------	---------------------	----------------

DRAWING NAME:

LOC

APPENDIX B

FEDERAL EMERGENCY MANAGEMENT AGENCY FLOOD INSURANCE RATE MAP

Drainage Report

Klug Hill RV Park

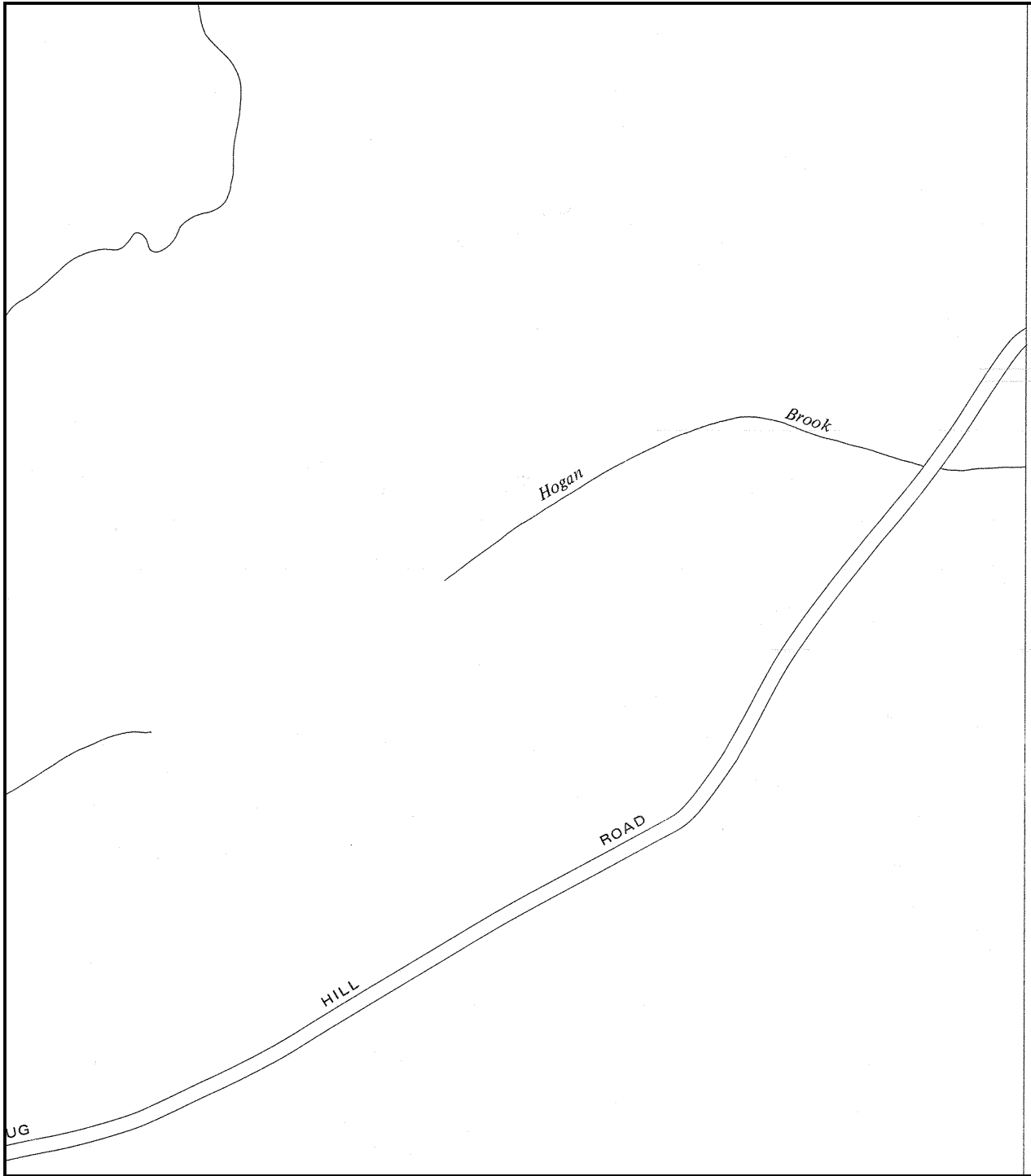
KOA® Campground

232 Klug Hill Road

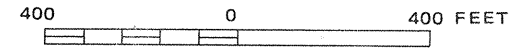
Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023



APPROXIMATE SCALE



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
TORRINGTON,
CONNECTICUT
LITCHFIELD COUNTY

PANEL 1 OF 14
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
095081 0001 B

MAP REVISED:
APRIL 4, 1983



Federal Emergency Management Agency

This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at <https://msc.fema.gov>.

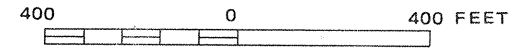
ROAD

Brook

ZONE C



APPROXIMATE SCALE



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
TORRINGTON,
CONNECTICUT
LITCHFIELD COUNTY

PANEL 1 OF 14
(SEE MAP INDEX FOR PANELS NOT PRINTED)

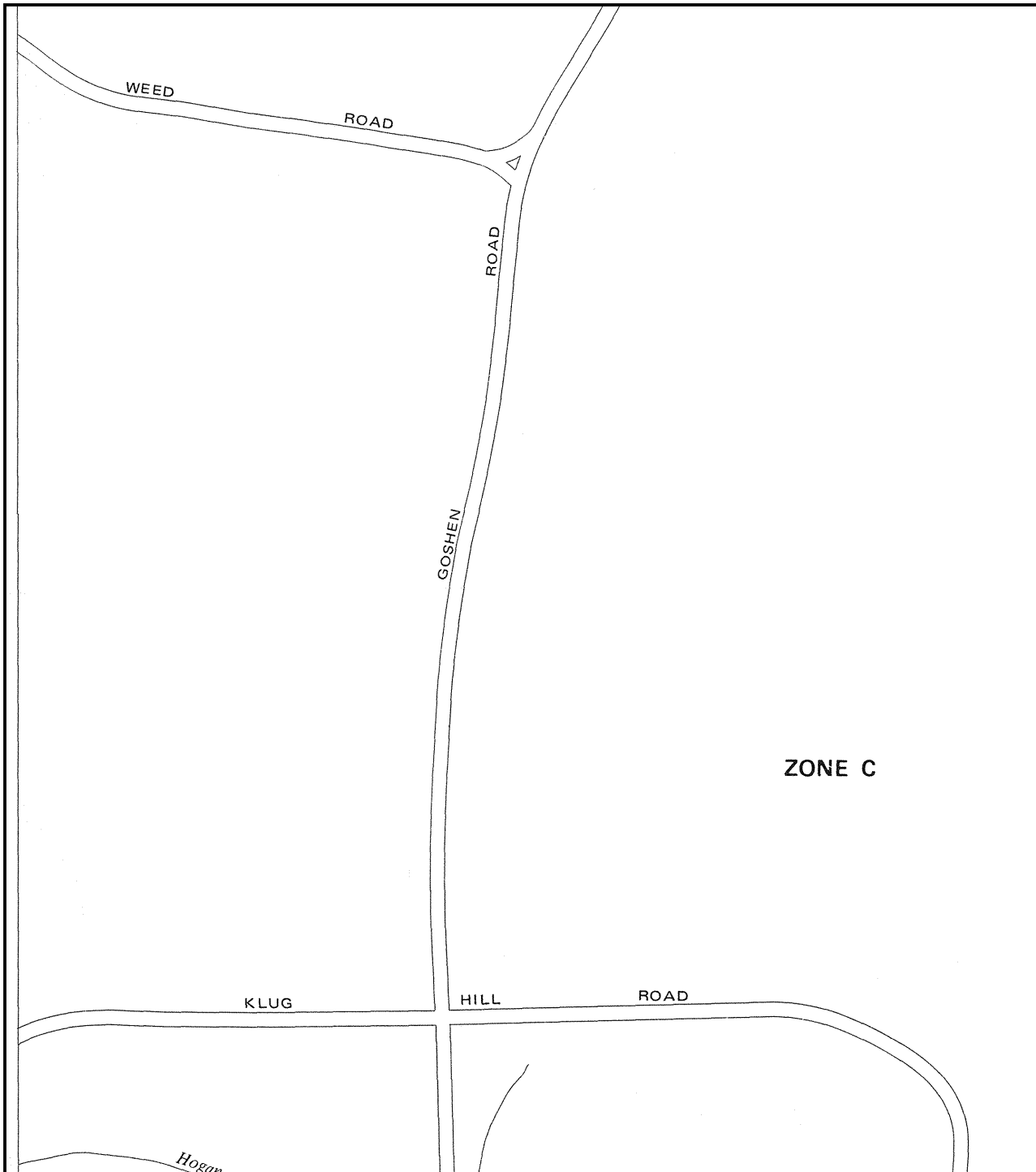
COMMUNITY-PANEL NUMBER
095081 0001 B

MAP REVISED:
APRIL 4, 1983



Federal Emergency Management Agency

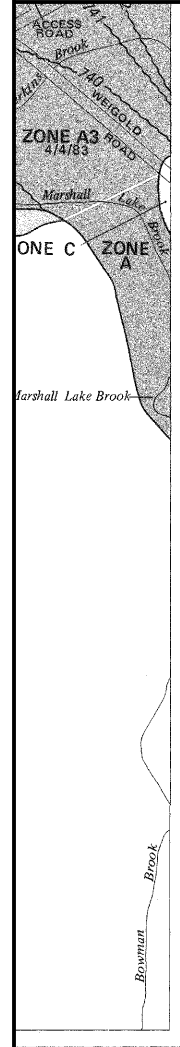
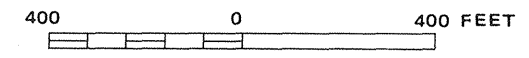
This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at <https://msc.fema.gov>.



rogram, at (800) 658-0620.



APPROXIMATE SCALE



NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

CITY OF
TORRINGTON,
CONNECTICUT
LITCHFIELD COUNTY

PANEL 2 OF 14
(SEE MAP INDEX FOR PANELS NOT PRINTED)

COMMUNITY-PANEL NUMBER
095081 0002 B

MAP REVISED:
APRIL 4, 1983



Federal Emergency Management Agency

This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at <https://msc.fema.gov>.

APPENDIX C

NATURAL RESOURCES CONSERVATION SERVICE HYDROLOGIC SOIL GROUP MAP

Drainage Report

Klug Hill RV Park

KOA® Campground

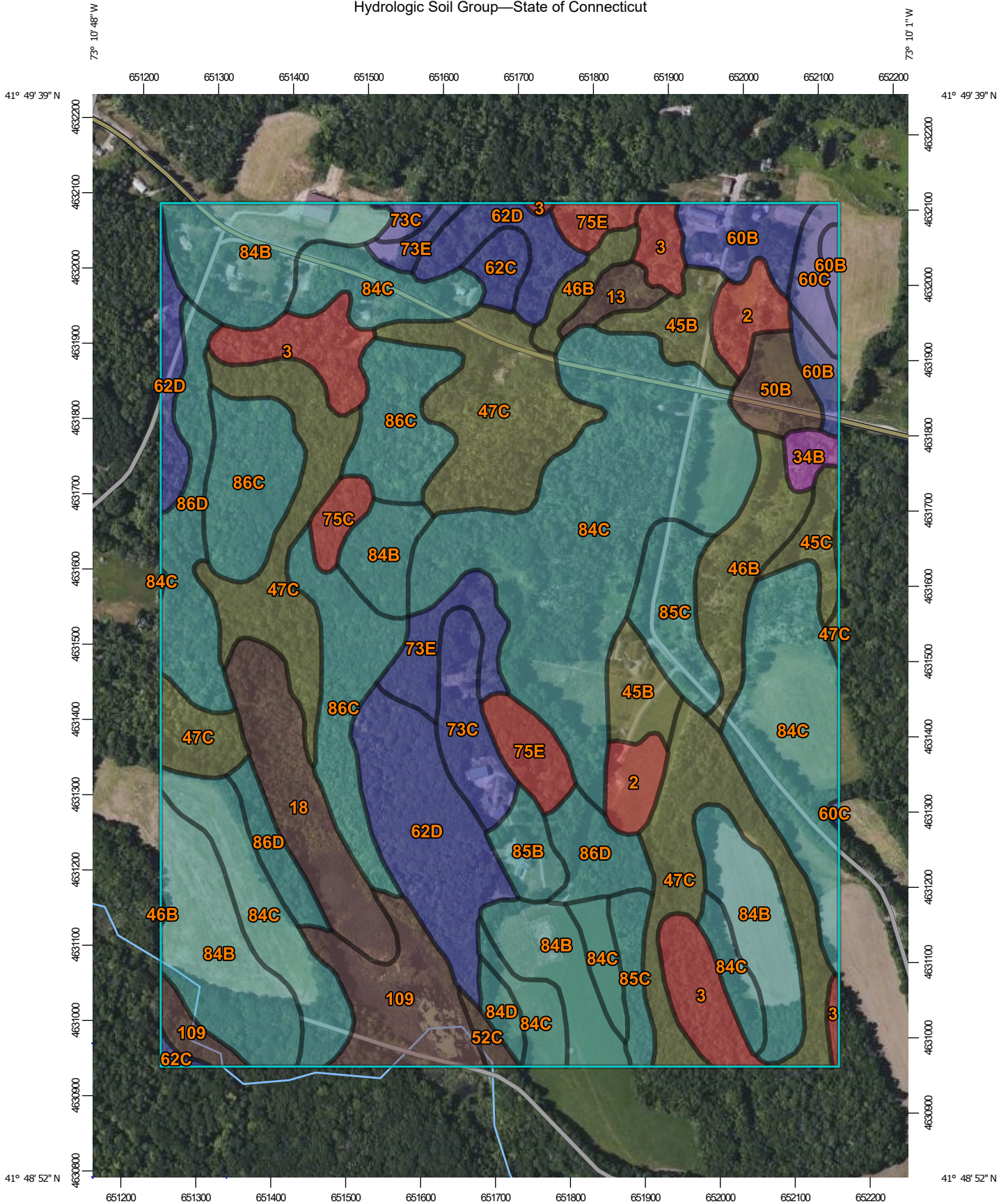
232 Klug Hill Road

Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023

Hydrologic Soil Group—State of Connecticut




Map Scale: 1:7,010 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)









 Area of Interest (AOI)

Soils

Soil Rating Polygons





 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines


 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points






 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

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 1:12,000.

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: State of Connecticut
 Survey Area Data: Version 22, Sep 12, 2022

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

Date(s) aerial images were photographed: Jun 12, 2020—Sep 15, 2020

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
2	Ridgebury fine sandy loam, 0 to 3 percent slopes	D	4.5	1.7%
3	Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony	D	9.6	3.7%
13	Walpole sandy loam, 0 to 3 percent slopes	B/D	1.5	0.6%
18	Catden and Freetown soils, 0 to 2 percent slopes	B/D	8.3	3.2%
34B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	1.1	0.4%
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	5.7	2.2%
45C	Woodbridge fine sandy loam, 8 to 15 percent slopes	C/D	2.1	0.8%
46B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	7.6	3.0%
47C	Woodbridge fine sandy loam, 3 to 15 percent slopes, extremely stony	C/D	33.1	12.9%
50B	Sutton fine sandy loam, 3 to 8 percent slopes	B/D	2.9	1.1%
52C	Sutton fine sandy loam, 2 to 15 percent slopes, extremely stony	B/D	0.7	0.3%
60B	Canton and Charlton fine sandy loams, 3 to 8 percent slopes	B	5.6	2.2%
60C	Canton and Charlton fine sandy loams, 8 to 15 percent slopes	B	2.0	0.8%
62C	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, extremely stony	B	1.8	0.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
62D	Canton and Charlton fine sandy loams, 15 to 35 percent slopes, extremely stony	B	16.7	6.5%
73C	Charlton-Chatfield complex, 0 to 15 percent slopes, very rocky	B	5.1	2.0%
73E	Charlton-Chatfield complex, 15 to 45 percent slopes, very rocky	B	4.6	1.8%
75C	Hollis-Chatfield-Rock outcrop complex, 3 to 15 percent slopes	D	1.5	0.6%
75E	Hollis-Chatfield-Rock outcrop complex, 15 to 45 percent slopes	D	3.9	1.5%
84B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes	C	30.5	11.8%
84C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes	C	58.3	22.6%
84D	Paxton and Montauk fine sandy loams, 15 to 25 percent slopes	C	1.1	0.4%
85B	Paxton and Montauk fine sandy loams, 3 to 8 percent slopes, very stony	C	2.4	0.9%
85C	Paxton and Montauk fine sandy loams, 8 to 15 percent slopes, very stony	C	6.7	2.6%
86C	Paxton and Montauk fine sandy loams, 3 to 15 percent slopes, extremely stony	C	19.1	7.4%
86D	Paxton and Montauk fine sandy loams, 15 to 35 percent slopes, extremely stony	C	12.5	4.8%
109	Fluvaquents-Udifuvents complex, frequently flooded	B/D	8.7	3.4%
Totals for Area of Interest			257.7	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX D

STORM DRAINAGE COMPUTATIONS

Drainage Report

Klug Hill RV Park

KOA® Campground

232 Klug Hill Road

Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023

Rational Method Individual Basin Calculations

Project: Klug Hill RV Park - KOA Campground
 Location: Torrington, CT

By: MCB
 Checked: _____

Date: 11/9/22
 Date: _____

Basin Name	Gravel Area C=0.75 (sf)	Grassed Area C=0.3 (sf)	Wooded Area C=0.2 (sf)	Total Area (sf)	Total Area (ac)	Weighted C	Tc (min)
System 110							
CLCB 10	6975	5646	0	12621	0.29	0.55	5.0
CLCB 11	26546	14730	0	41276	0.95	0.59	5.0
CLCB 12	22378	22301	0	44679	1.03	0.53	11.8
System 120							
CLCB 14	12937	10319	0	23256	0.53	0.55	5.0
System 310							
CLCB 6	43826	33622	0	77448	1.78	0.55	23.4
CLCB 7	6706	10282	0	16988	0.39	0.48	5.0



NOAA Atlas 14, Volume 10, Version 3
Location name: Torrington, Connecticut, USA*
Latitude: 41.8171°, Longitude: -73.1705°
Elevation: 1115.11 ft**



* source: ESRI Maps
 ** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

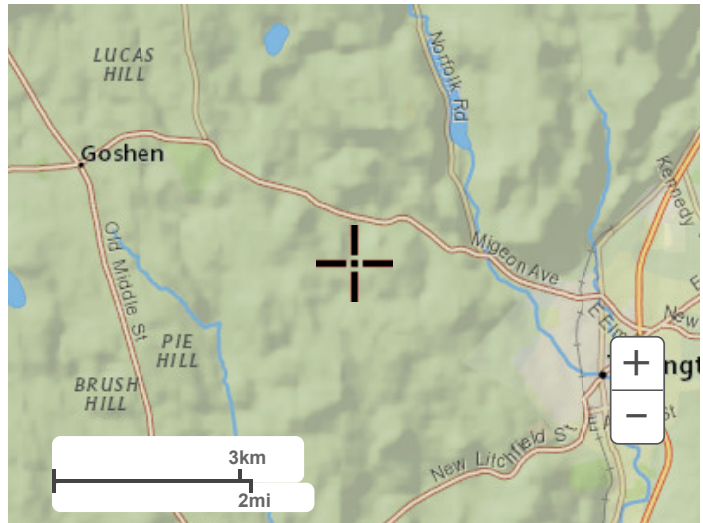
PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.26 (3.23-5.58)	5.08 (3.84-6.65)	6.41 (4.82-8.42)	7.50 (5.63-9.92)	9.01 (6.56-12.4)	10.2 (7.27-14.3)	11.3 (7.90-16.5)	12.6 (8.41-18.8)	14.3 (9.22-22.1)	15.6 (9.85-24.6)
10-min	3.02 (2.29-3.95)	3.59 (2.72-4.71)	4.54 (3.42-5.97)	5.31 (3.98-7.03)	6.38 (4.65-8.78)	7.20 (5.15-10.1)	8.03 (5.59-11.7)	8.91 (5.96-13.3)	10.1 (6.53-15.6)	11.0 (6.98-17.4)
15-min	2.37 (1.79-3.10)	2.82 (2.13-3.70)	3.56 (2.68-4.68)	4.16 (3.13-5.51)	5.00 (3.65-6.89)	5.65 (4.04-7.93)	6.30 (4.38-9.14)	6.99 (4.68-10.4)	7.92 (5.12-12.3)	8.65 (5.48-13.7)
30-min	1.62 (1.23-2.12)	1.93 (1.46-2.53)	2.43 (1.83-3.20)	2.85 (2.14-3.77)	3.42 (2.50-4.71)	3.86 (2.76-5.42)	4.31 (3.00-6.25)	4.78 (3.20-7.15)	5.42 (3.50-8.39)	5.92 (3.75-9.35)
60-min	1.03 (0.778-1.35)	1.22 (0.925-1.60)	1.54 (1.16-2.03)	1.81 (1.36-2.39)	2.17 (1.58-2.99)	2.45 (1.75-3.44)	2.74 (1.90-3.97)	3.03 (2.03-4.53)	3.44 (2.22-5.32)	3.76 (2.38-5.94)
2-hr	0.680 (0.518-0.885)	0.795 (0.604-1.04)	0.982 (0.746-1.28)	1.14 (0.858-1.50)	1.35 (0.992-1.85)	1.51 (1.09-2.12)	1.68 (1.18-2.44)	1.87 (1.25-2.78)	2.14 (1.39-3.30)	2.35 (1.49-3.71)
3-hr	0.525 (0.402-0.681)	0.613 (0.468-0.796)	0.757 (0.576-0.986)	0.876 (0.663-1.15)	1.04 (0.767-1.43)	1.16 (0.843-1.63)	1.29 (0.916-1.89)	1.45 (0.971-2.15)	1.67 (1.08-2.57)	1.85 (1.18-2.92)
6-hr	0.330 (0.253-0.425)	0.392 (0.301-0.505)	0.493 (0.377-0.637)	0.576 (0.439-0.750)	0.692 (0.514-0.947)	0.777 (0.568-1.09)	0.870 (0.624-1.27)	0.984 (0.663-1.46)	1.16 (0.756-1.79)	1.32 (0.839-2.06)
12-hr	0.198 (0.153-0.253)	0.243 (0.187-0.311)	0.317 (0.244-0.407)	0.378 (0.289-0.489)	0.463 (0.346-0.632)	0.524 (0.387-0.736)	0.593 (0.430-0.873)	0.681 (0.460-1.01)	0.820 (0.535-1.26)	0.943 (0.604-1.47)
24-hr	0.115 (0.089-0.146)	0.145 (0.113-0.185)	0.195 (0.151-0.250)	0.237 (0.182-0.304)	0.294 (0.222-0.402)	0.336 (0.250-0.471)	0.382 (0.280-0.565)	0.444 (0.301-0.654)	0.544 (0.356-0.832)	0.634 (0.407-0.988)
2-day	0.065 (0.051-0.082)	0.083 (0.065-0.105)	0.114 (0.088-0.144)	0.139 (0.107-0.177)	0.173 (0.132-0.236)	0.198 (0.149-0.278)	0.227 (0.168-0.336)	0.265 (0.180-0.390)	0.330 (0.216-0.503)	0.388 (0.250-0.602)
3-day	0.047 (0.037-0.059)	0.061 (0.048-0.077)	0.083 (0.065-0.105)	0.101 (0.079-0.129)	0.127 (0.097-0.172)	0.145 (0.109-0.203)	0.166 (0.123-0.245)	0.194 (0.132-0.285)	0.242 (0.159-0.368)	0.286 (0.184-0.443)
4-day	0.038 (0.030-0.048)	0.049 (0.038-0.062)	0.067 (0.052-0.084)	0.081 (0.063-0.103)	0.102 (0.078-0.138)	0.116 (0.088-0.162)	0.133 (0.099-0.196)	0.156 (0.106-0.228)	0.194 (0.128-0.295)	0.229 (0.148-0.355)
7-day	0.026 (0.021-0.032)	0.033 (0.026-0.041)	0.044 (0.035-0.056)	0.054 (0.042-0.068)	0.067 (0.051-0.090)	0.076 (0.058-0.106)	0.087 (0.065-0.128)	0.102 (0.070-0.148)	0.126 (0.083-0.190)	0.147 (0.095-0.228)
10-day	0.021 (0.017-0.026)	0.026 (0.021-0.033)	0.035 (0.028-0.044)	0.042 (0.033-0.053)	0.052 (0.040-0.069)	0.059 (0.044-0.081)	0.066 (0.049-0.097)	0.077 (0.053-0.112)	0.094 (0.062-0.142)	0.110 (0.071-0.169)
20-day	0.015 (0.012-0.019)	0.018 (0.014-0.022)	0.023 (0.018-0.028)	0.026 (0.021-0.033)	0.031 (0.024-0.041)	0.035 (0.026-0.047)	0.039 (0.029-0.056)	0.044 (0.030-0.064)	0.052 (0.035-0.079)	0.060 (0.039-0.092)
30-day	0.013 (0.010-0.016)	0.015 (0.012-0.018)	0.018 (0.014-0.022)	0.020 (0.016-0.025)	0.024 (0.018-0.031)	0.026 (0.020-0.035)	0.029 (0.021-0.041)	0.032 (0.022-0.046)	0.037 (0.025-0.056)	0.041 (0.027-0.063)
45-day	0.011 (0.009-0.013)	0.012 (0.010-0.015)	0.014 (0.011-0.017)	0.016 (0.013-0.020)	0.018 (0.014-0.024)	0.020 (0.015-0.026)	0.022 (0.016-0.030)	0.024 (0.017-0.034)	0.027 (0.018-0.040)	0.029 (0.019-0.044)
60-day	0.009 (0.008-0.012)	0.010 (0.008-0.013)	0.012 (0.010-0.015)	0.013 (0.011-0.017)	0.015 (0.012-0.020)	0.017 (0.012-0.022)	0.018 (0.013-0.025)	0.019 (0.013-0.028)	0.021 (0.014-0.032)	0.023 (0.015-0.035)

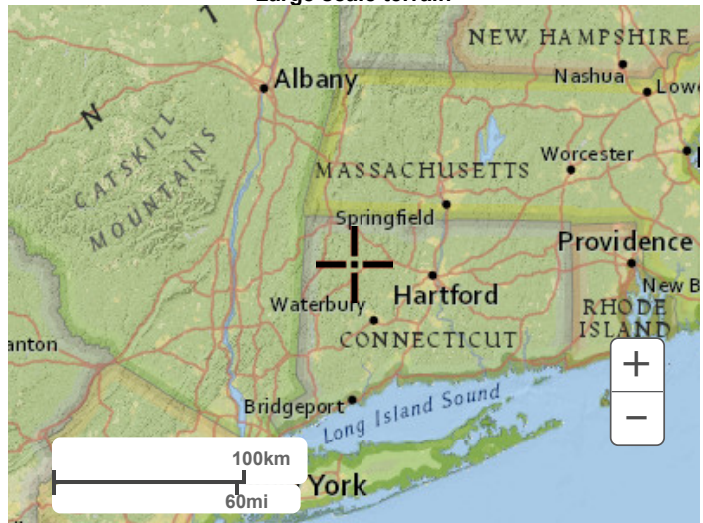
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

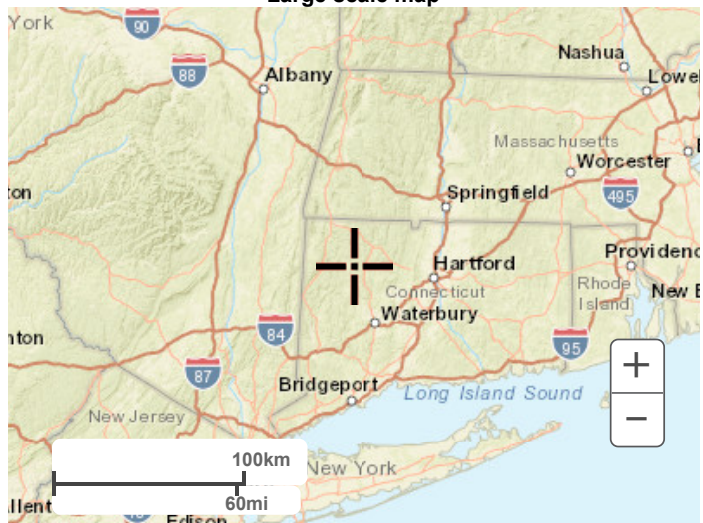
PF graphical



Large scale terrain



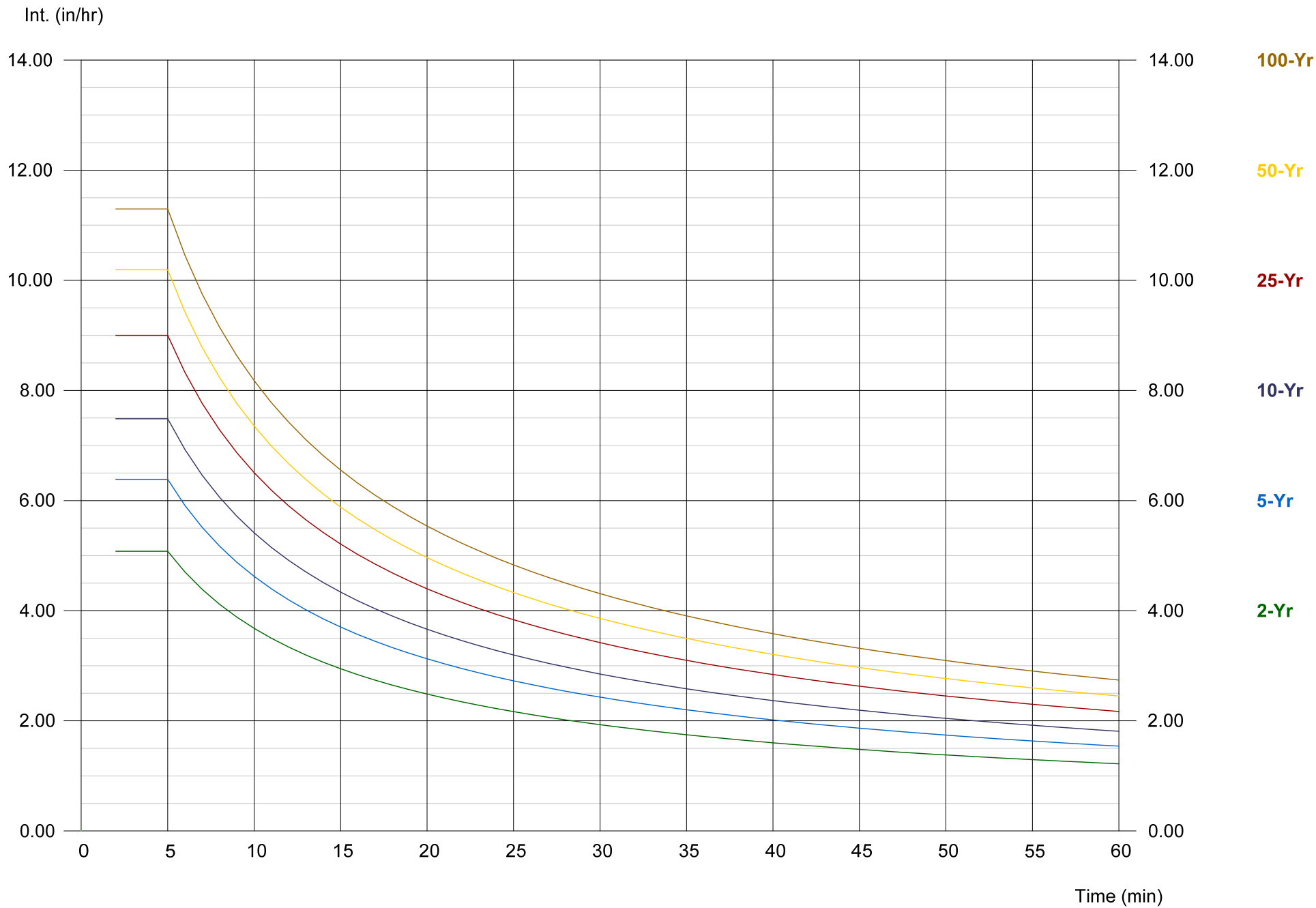
Large scale map



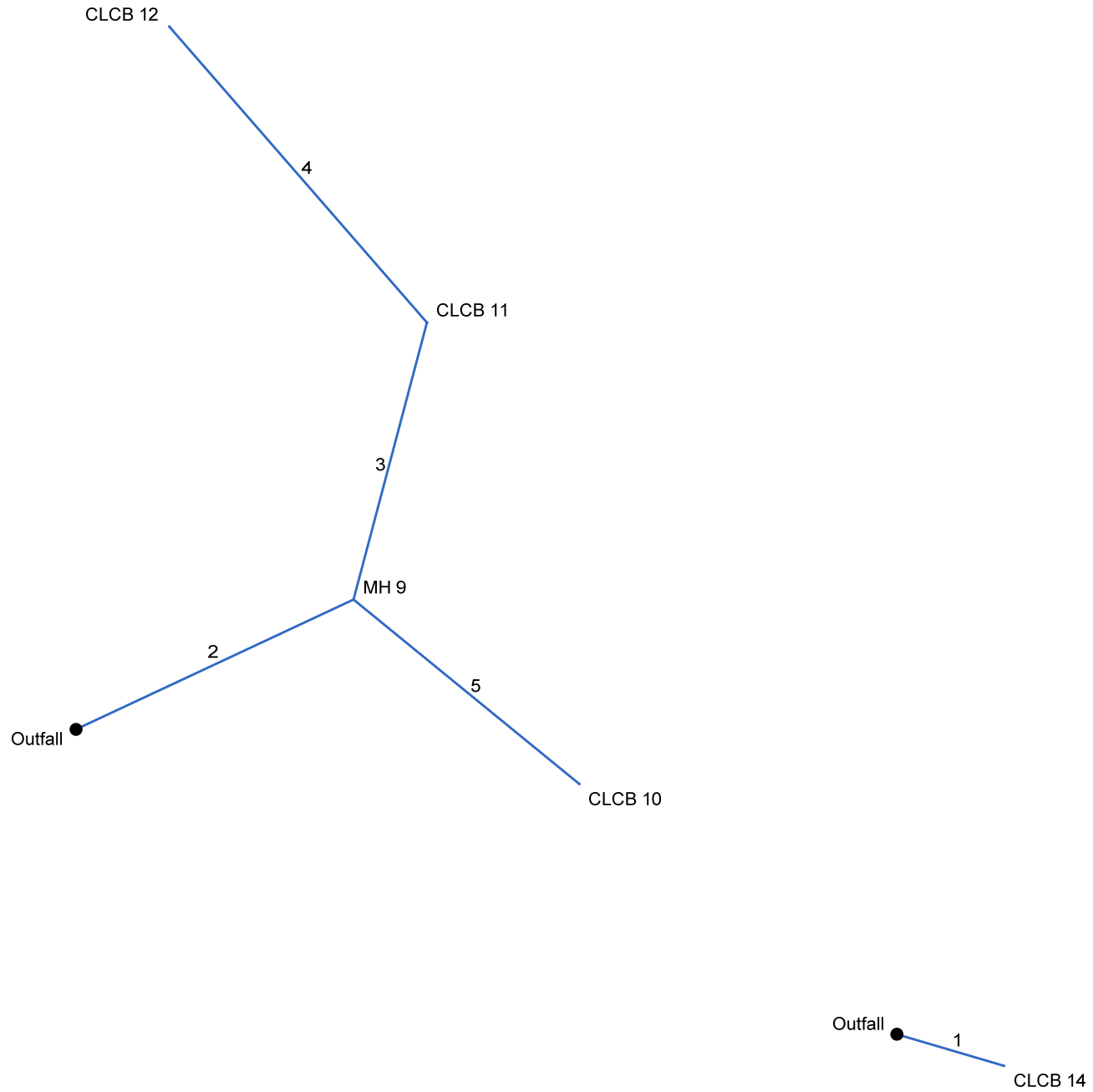
Large scale aerial

Storm Sewer IDF Curves

IDF file: Torrington.IDF



Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: System 110 + 120.stm

Number of lines: 5

Date: 11/9/2022

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	54.000	16.465	Grate	0.00	0.53	0.55	5.0	1188.00	9.26	1193.00	12	Cir	0.012	1.00	1201.00	FES 13 - CLCB 14
2	End	148.000	-25.175	MH	0.00	0.00	0.00	0.0	1142.00	8.78	1155.00	12	Cir	0.012	0.92	1168.00	FES 8 - MH 9
3	2	139.000	-50.015	Grate	0.00	0.95	0.59	5.0	1164.50	2.01	1167.30	12	Cir	0.012	1.28	1173.00	MH 9 - CLCB 11
4	3	190.000	-55.723	Grate	0.00	1.03	0.53	11.8	1167.30	0.53	1168.30	12	Cir	0.012	1.00	1171.50	CLCB 11 - CLCB 12
5	2	141.000	64.523	Grate	0.00	0.29	0.55	5.0	1164.50	7.80	1175.50	12	Cir	0.012	1.00	1178.50	MH 9 - CLCB 10

Project File: System 110 + 120.stm

Number of lines: 5

Date: 11/9/2022

Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (l) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr	Total	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	54.000	0.53	0.53	0.55	0.29	0.29	5.0	5.0	7.5	2.18	11.74	7.80	12	9.26	1188.00	1193.00	1188.29	1193.63	1189.00	1201.00	FES 13 - CLCB 1
2	End	148.000	0.00	2.27	0.00	0.00	1.27	0.0	12.9	4.7	5.97	11.43	11.22	12	8.78	1142.00	1155.00	1142.51	1155.95	1163.10	1168.00	FES 8 - MH 9
3	2	139.000	0.95	1.98	0.59	0.56	1.11	5.0	12.6	4.8	5.29	5.48	7.44	12	2.01	1164.50	1167.30	1165.29	1168.23	1168.00	1173.00	MH 9 - CLCB 11
4	3	190.000	1.03	1.03	0.53	0.55	0.55	11.8	11.8	5.0	2.71	2.80	3.83	12	0.53	1167.30	1168.30	1168.23	1169.08	1173.00	1171.50	CLCB 11 - CLCB
5	2	141.000	0.29	0.29	0.55	0.16	0.16	5.0	5.0	7.5	1.19	10.78	6.21	12	7.80	1164.50	1175.50	1164.73	1175.96	1168.00	1178.50	MH 9 - CLCB 10

Project File: System 110 + 120.stm

Number of lines: 5

Run Date: 11/9/2022

NOTES: Intensity = 35.00 / (Inlet time + 3.70) ^ 0.71; Return period = Yrs. 10 ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
1	12	2.18	1188.00	1188.29	0.29	0.19	11.43	0.27	1188.56	0.000	54.000	1193.00	1193.63	0.63**	0.52	4.18	0.27	1193.90	0.000	0.000	n/a	1.00	n/a
2	12	5.97	1142.00	1142.51	0.51*	0.41	14.71	0.93	1143.44	0.000	148.000	1155.00	1155.95	0.95**	0.77	7.73	0.93	1156.88	0.000	0.000	n/a	0.92	n/a
3	12	5.29	1164.50	1165.29	0.79*	0.67	7.94	0.75	1166.04	0.000	139.000	1167.30	1168.23	0.93**	0.76	6.94	0.75	1168.98	0.000	0.000	n/a	1.28	n/a
4	12	2.71	1167.30	1168.23	0.93	0.76	3.56	0.20	1168.43	0.426	190.000	1168.30	1169.08	0.78	0.66	4.11	0.26	1169.34	0.541	0.483	0.919	1.00	0.26
5	12	1.19	1164.50	1164.73	0.22*	0.13	9.03	0.18	1164.90	0.000	141.000	1175.50	1175.96	0.46**	0.35	3.38	0.18	1176.14	0.000	0.000	n/a	1.00	n/a

Project File: System 110 + 120.stm

Number of lines: 5

Run Date: 11/9/2022

Notes: * depth assumed; ** Critical depth. ; c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan

CLCB 7

2

CLCB 6

1

Outfall

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	94.000	167.051	Grate	0.00	1.78	0.55	23.4	1156.00	6.38	1162.00	12	Cir	0.012	1.05	1169.00	FES 5 - CLCB 6
2	1	195.000	40.859	Grate	0.00	0.39	0.48	5.0	1162.00	1.79	1165.50	12	Cir	0.012	1.00	1169.00	CLCB 6 - CLCB 7

Project File: System 310.stm

Number of lines: 2

Date: 11/9/2022

Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (l) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr	Total	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	94.000	1.78	2.17	0.55	0.98	1.17	23.4	23.4	3.3	3.88	9.75	8.62	12	6.38	1156.00	1162.00	1156.44	1162.84	1157.10	1169.00	FES 5 - CLCB 6
2	1	195.000	0.39	0.39	0.48	0.19	0.19	5.0	5.0	7.5	1.40	5.17	2.78	12	1.79	1162.00	1165.50	1162.84	1166.00	1169.00	1169.00	CLCB 6 - CLCB 7

Project File: System 310.stm

Number of lines: 2

Run Date: 11/9/2022

NOTES: Intensity = 35.00 / (Inlet time + 3.70) ^ 0.71; Return period = Yrs. 10 ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
1	12	3.88	1156.00	1156.44	0.44	0.33	11.70	0.48	1156.92	0.000	94.000	1162.00	1162.84	0.84**	0.70	5.53	0.48	1163.31	0.000	0.000	n/a	1.05	0.50
2	12	1.40	1162.00	1162.84	0.84	0.39	2.00	0.20	1163.03	0.000	195.000	1165.50	1166.00 j	0.50**	0.39	3.56	0.20	1166.20	0.000	0.000	n/a	1.00	0.20

Project File: System 310.stm

Number of lines: 2

Run Date: 11/9/2022

Notes: ; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan

DOME GRATE 110

1

● Outfall

● Outfall

2

DOME GRATE 120

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data							Line ID	
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)		Inlet/ Rim El (ft)
1	End	88.000	-115.979	None	7.38	0.00	0.00	0.0	1135.00	1.14	1136.00	15	Cir	0.012	1.00	1140.50	FES 110 - DG 110
2	End	60.000	71.803	None	7.33	0.00	0.00	0.0	1131.00	1.67	1132.00	15	Cir	0.012	1.00	1136.40	FES 120 - DG 120

Project File: Outlet 110+120.stm

Number of lines: 2

Date: 11/9/2022

Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (l) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr	Total	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	88.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	7.38	7.46	6.73	15	1.14	1135.00	1136.00	1136.01	1137.08	1136.10	1140.50	FES 110 - DG 110
2	End	60.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	7.33	9.03	6.24	15	1.67	1131.00	1132.00	1132.25	1133.08	1132.10	1136.40	FES 120 - DG 120

Project File: Outlet 110+120.stm

Number of lines: 2

Run Date: 11/9/2022

NOTES: Intensity = $127.16 / (\text{Inlet time} + 17.80)^{0.82}$; Return period = Yrs. 100 ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
1	15	7.38	1135.00	1136.01	1.01	1.07	6.93	0.66	1136.68	0.000	88.000	1136.00	1137.08	1.08**	1.13	6.54	0.66	1137.75	0.000	0.000	n/a	1.00	0.66
2	15	7.33	1131.00	1132.25	1.25*	1.13	5.97	0.55	1132.81	1.098	60.000	1132.00	1133.08 j	1.08**	1.13	6.51	0.66	1133.74	1.012	1.055	n/a	1.00	n/a

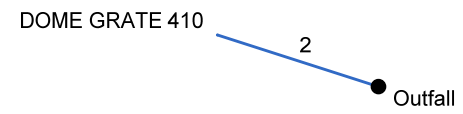
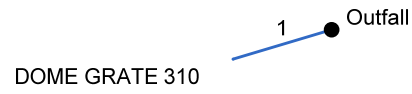
Project File: Outlet 110+120.stm

Number of lines: 2

Run Date: 11/9/2022

Notes: * depth assumed; ** Critical depth.; j-Line contains hyd. jump ; c = cir e = ellip b = box

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: Outlet 310+410.stm

Number of lines: 2

Date: 11/9/2022

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	57.000	159.770	None	10.61	0.00	0.00	0.0	1149.00	3.51	1151.00	15	Cir	0.012	1.00	1153.50	FES 310 - DG 310
2	End	94.000	-158.341	None	11.96	0.00	0.00	0.0	1125.00	3.19	1128.00	15	Cir	0.012	1.00	1131.90	FES 410 - DG 410

Project File: Outlet 310+410.stm

Number of lines: 2

Date: 11/9/2022

Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (l) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr	Total	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	57.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	10.61	13.10	8.65	15	3.51	1149.00	1151.00	1151.25	1152.56	1151.36	1153.50	FES 310 - DG 310
2	End	94.000	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	11.96	12.50	9.75	15	3.19	1125.00	1128.00	1128.25	1131.00	1128.36	1131.90	FES 410 - DG 410

Project File: Outlet 310+410.stm

Number of lines: 2

Run Date: 11/9/2022

NOTES: Intensity = $127.16 / (\text{Inlet time} + 17.80)^{0.82}$; Return period = Yrs. 100 ; c = cir e = ellip b = box

Hydraulic Grade Line Computations

Line	Size (in)	Q (cfs)	Downstream								Len (ft)	Upstream								Check		JL coeff (K)	Minor loss (ft)
			Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)		Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	Ave Sf (%)	Enrgy loss (ft)		
1	15	10.61	1149.00	1151.25	1.25	1.23	8.65	1.16	1152.41	2.301	57.000	1151.00	1152.56	1.25	1.23	8.65	1.16	1153.72	2.300	2.301	1.311	1.00	1.16
2	15	11.96	1125.00	1128.25	1.25	1.23	9.75	1.48	1129.73	2.924	94.000	1128.00	1131.00	1.25	1.23	9.75	1.48	1132.48	2.923	2.924	2.748	1.00	1.48

Project File: Outlet 310+410.stm

Number of lines: 2

Run Date: 11/9/2022

; c = cir e = ellip b = box

Outlet Protection Calculations

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
Location: Torrington, CT Checked: Date:
Outlet I.D.: **FES 5**

*Based on Connecticut DOT Drainage Manual, Section 11.13

Description:

FES 5 - DET 310

Design Criteria (10-yr Storm Event):

Q (cfs) = 3.88 R_p (ft) = 1
 D (in) = 12 S_p (ft) = 1
 V (fps) = 8.62 T_w (ft) = 0.44

Q= Flow rate at discharge point in cubic feet per second (cfs)
 D= Outlet pipe diameter (in)
 V= Flow velocity at discharge point (ft/s)
 R_p= Maximum inside pipe rise (ft)
 S_p= inside diameters for circular sections of maximum inside pipe span for non-circular sections (ft)
 T_w= Tailwater depth (ft)

Based on Table 11-12.1 use Type 'A' ---> TW < 0.5 R_p

Rip Rap Stone Size:

<u>Velocity</u>	<u>Rip Rap Specification</u>	<u>D₅₀ Stone Size</u>
8-10 fps	Intermediate	8 inches

Preformed Scour Hole Dimensions:

F(ft)=0.5(R_p) = n/a
 C(ft)=3.0(S_p)+6.0(F) = n/a
 B(ft)=2.0(S_p)+6.0(F) = n/a

Rip Rap Splash Pad Dimensions:

L_a = 10 ft
 W1 = 3.0(S_p) min. = 3 ft
 W2 = 3.0(S_p)+0.7(L_a) min. = 10 ft
 d (Depth of Stone) = 18 inches

Outlet Protection Calculations

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
Location: Torrington, CT Checked: Date:
Outlet I.D.: **FES 8**

*Based on Connecticut DOT Drainage Manual, Section 11.13

Description:

FES 8 - DET 110

Design Criteria (10-yr Storm Event):

Q (cfs) = 5.97 R_p (ft) = 1
 D (in) = 12 S_p (ft) = 1
 V (fps) = 11.22 T_w (ft) = 0.51

Q= Flow rate at discharge point in cubic feet per second (cfs)
 D= Outlet pipe diameter (in)
 V= Flow velocity at discharge point (ft/s)
 R_p= Maximum inside pipe rise (ft)
 S_p= inside diametere for circular sections of maximum inside pipe span for non-circular sections (ft)
 T_w= Tailwater depth (ft)

Based on **Table 11-13.1** use Type 'B' ---> TW ≥ 0.5 R_p

Rip Rap Stone Size:

<u>Velocity</u>	<u>Rip Rap Specification</u>	<u>D₅₀ Stone Size</u>
10-14 fps	Standard	15 inches

Preformed Scour Hole Dimensions:

F(ft)=0.5(R_p) = n/a
 C(ft)=3.0(S_p)+6.0(F) = n/a
 B(ft)=2.0(S_p)+6.0(F) = n/a

Rip Rap Splash Pad Dimensions:

L_a = 12 ft
 W1 = 3.0(S_p) min. = 3 ft
 W2 = 3.0(S_p)+0.4(L_a) min. = 8 ft
 d (Depth of Stone) = 36 inches

Outlet Protection Calculations

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
Location: Torrington, CT Checked: Date:
Outlet I.D.: **FES 13**

*Based on Connecticut DOT Drainage Manual, Section 11.13

Description:

FES 13

Design Criteria (10-yr Storm Event):

Q (cfs) = 2.18 R_p (ft) = 1
 D (in) = 12 S_p (ft) = 1
 V (fps) = 7.8 T_w (ft) = 0.29

Q= Flow rate at discharge point in cubic feet per second (cfs)
 D= Outlet pipe diameter (in)
 V= Flow velocity at discharge point (ft/s)
 R_p = Maximum inside pipe rise (ft)
 S_p = inside diameters for circular sections of maximum inside pipe span for non-circular sections (ft)
 T_w = Tailwater depth (ft)

Based on Table 11-12.1 use Type 'A' ---> $TW < 0.5 R_p$

Rip Rap Stone Size:

<u>Velocity</u>	<u>Rip Rap Specification</u>	<u>D₅₀ Stone Size</u>
0-8 fps	Modified	5 inches

Preformed Scour Hole Dimensions:

F (ft) = $0.5(R_p)$ = n/a
 C (ft) = $3.0(S_p) + 6.0(F)$ = n/a
 B (ft) = $2.0(S_p) + 6.0(F)$ = n/a

Rip Rap Splash Pad Dimensions:

L_a = 10 ft
 $W1 = 3.0(S_p)$ min. = 3 ft
 $W2 = 3.0(S_p) + 0.7(L_a)$ min. = 10 ft
 d (Depth of Stone) = 12 inches

Level Spreader Design

Level Spreader 110

Broad Crest Elevation (ft)	1136.00
Length (ft)	<u>30</u>
Discharge Coefficient	3.2
Elevation Increment	0.05
Q-100 year (cfs)	7.38 (DET 110 Discharge)

<u>Elevation (Feet)</u>	<u>Weir Discharge (cfs)</u>	<u>Area (sf)</u>	<u>Velocity (fps)</u>
1136.00	0.00	0.00	0.00
1136.05	1.07	1.50	0.72
1136.10	3.04	3.00	1.01
1136.15	5.58	4.50	1.24
1136.18	7.38	5.42	1.36
1136.20	8.59	6.00	1.43
1136.25	12.00	7.50	1.60

Level Spreader Design

Level Spreader 120

Broad Crest Elevation (ft)	1132.00
Length (ft)	<u>30</u>
Discharge Coefficient	3.2
Elevation Increment	0.05
Q-100 year (cfs)	7.33 (DET 110 Discharge)

<u>Elevation (Feet)</u>	<u>Weir Discharge (cfs)</u>	<u>Area (sf)</u>	<u>Velocity (fps)</u>
1132.00	0.00	0.00	0.00
1132.05	1.07	1.50	0.72
1132.10	3.04	3.00	1.01
1132.15	5.58	4.50	1.24
1132.18	7.33	5.40	1.36
1132.20	8.59	6.00	1.43
1132.25	12.00	7.50	1.60

Level Spreader Design

Level Spreader 310

Broad Crest Elevation (ft)	1150.00
Length (ft)	30
Discharge Coefficient	3.2
Elevation Increment	0.05
Q-100 year (cfs)	10.61 (DET 110 Discharge)

Elevation (Feet)	Weir Discharge (cfs)	Area (sf)	Velocity (fps)
1150.00	0.00	0.00	0.00
1150.05	1.07	1.50	0.72
1150.10	3.04	3.00	1.01
1150.15	5.58	4.50	1.24
1150.20	8.59	6.00	1.43
1150.23	10.61	6.91	1.54
1150.25	12.00	7.50	1.60

Level Spreader Design

Level Spreader 410

Broad Crest Elevation (ft)	1126.00
Length (ft)	<u>30</u>
Discharge Coefficient	3.2
Elevation Increment	0.05
Q-100 year (cfs)	11.96 (DET 110 Discharge)

Elevation (Feet)	Weir Discharge (cfs)	Area (sf)	Velocity (fps)
1126.00	0.00	0.00	0.00
1126.05	1.07	1.50	0.72
1126.10	3.04	3.00	1.01
1126.15	5.58	4.50	1.24
1126.20	8.59	6.00	1.43
1126.25	11.96	7.48	1.60

APPENDIX E

WATER QUALITY COMPUTATIONS

Drainage Report

Klug Hill RV Park

KOA® Campground

232 Klug Hill Road

Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023

STORMWATER QUALITY CALCULATIONS
Water Quality Volume (WQV)

Basin ID	Total Area (ac.)	Impervious Area (ac.)	Percent Impervious	Volumetric Runoff Coeff., R	WQV (ac-ft)	Total Volume Required (ac-ft)	Total Volume Provided¹ (ac-ft)
DET 110	3.50	1.30	37%	0.38	0.112	0.112	0.142
DET 120	3.62	0.65	18%	0.21	0.064	0.064	0.065
DET 310	3.79	1.40	37%	0.38	0.121	0.121	0.122
DET 410	3.56	0.68	19%	0.22	0.066	0.066	0.070

^{1.} - Volume provided below dome grate

$$\text{WQV} = \frac{(1.0 \text{ inches}) \times A \times R}{12}$$

Where:

- WQV = Water Quality Volume in acre-feet
- A = Contributing Area in acres
- R = $0.05 + 0.009 (I)$
- I = Site Imperviousness as percent

APPENDIX F

HYDROLOGIC ANALYSIS – INPUT COMPUTATIONS

Drainage Report

Klug Hill RV Park

KOA® Campground

232 Klug Hill Road

Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023

Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground
 Location: 232 Klug Hill Road
Torrington, CT

By: MCB Date: 11/9/22 Checked: _____ Date: _____
 Circle one: Present Developed Watershed: EX WS10

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area <u>Acres</u> Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Woods - Good Condition	55			12.20	670.91
B Soil	Meadow	58			0.76	44.32
B Soil	Open Space - Good Condition	61			0.80	49.03
B Soil	Gravel	85			0.17	14.39
C Soil	Woods - Good Condition	70			11.00	769.89
C Soil	Meadow	71			1.82	129.18
C Soil	Open Space - Good Condition	74			0.42	31.18
C Soil	Dirt	86			0.12	10.24
D Soil	Woods - Good Condition	77			0.44	33.95
N/A	Paved/Impervious	98			0.01	0.49
N/A	Building	98			0.14	13.50

Totals = 27.88 1767.08
 (0.04356 sq mi)

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{1767.08}{27.88} \quad \text{Use CN} = \span style="border: 2px solid black; padding: 5px;">63$$

Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground

Location: 232 Klug Hill Road
Torrington, CT

By: MCB Date: 11/9/22 Checked: _____ Date: _____

Circle one: Present Developed Watershed: EX WS40

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area Acres Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Woods - Good Condition	55			0.25	13.55
B Soil	Meadow	58			0.01	0.47
B Soil	Open Space - Good Condition	61			1.36	82.75
B Soil	Gravel	85			0.19	16.34
C Soil	Woods - Good Condition	70			5.32	372.36
C Soil	Meadow	71			3.13	222.35
C Soil	Open Space - Good Condition	74			4.64	343.10
C Soil	Dirt	86			0.02	1.53
C Soil	Gravel	89			0.04	3.38
D Soil	Woods - Good Condition	77			2.66	204.86
D Soil	Meadow	78			0.07	5.67
D Soil	Open Space - Good Condition	80			0.37	29.75
N/A	Paved/Impervious	98			0.83	81.12
N/A	Building	98			0.22	21.94
Totals =					19.10	1399.18

(0.02985 sq mi)

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{1399.18}{19.10} \text{ Use CN} = \boxed{73}$$

Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground
 Location: 232 Klug Hill Road
Torrington, CT

By: MCB Date: 11/9/22 Checked: _____ Date: _____
 Circle one: Present Developed Watershed: PR WS10

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area (Acres) Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Woods - Good Condition	55			8.33	457.97
B Soil	Meadow	58			0.04	2.58
B Soil	Open Space - Good Condition	61			0.38	22.88
B Soil	Gravel	85			0.16	13.27
C Soil	Woods - Good Condition	70			6.50	454.91
C Soil	Meadow	71			1.27	90.08
C Soil	Open Space - Good Condition	74			2.30	170.10
C Soil	Gravel	89			0.03	2.65
D Soil	Woods - Good Condition	77			0.18	13.92
D Soil	Open Space - Good Condition	80			0.10	7.68
D Soil	Gravel	91			0.001	0.11
N/A	Paved/Impervious	98			0.06	5.93
N/A	Building	98			0.12	12.02

Totals = 19.46 1254.11
 (0.03041 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{1254.11}{19.46}$ Use CN = 64

Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground
 Location: 232 Klug Hill Road
Torrington, CT

By: MCB Date: 11/9/22 Checked: _____ Date: _____
 Circle one: Present **Developed** Watershed: PR WS11

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area <u>Acres</u> Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Open Space - Good Condition	61			0.14	8.43
B Soil	Gravel	85			0.12	9.93
C Soil	Woods - Good Condition	70			0.45	31.72
C Soil	Open Space - Good Condition	74			1.54	113.61
C Soil	Gravel	89			1.08	96.48
D Soil	Open Space - Good Condition	80			0.08	6.64
D Soil	Gravel	91			0.10	8.73
Totals =					3.51	275.54

(0.00548 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{275.54}{3.51}$ Use CN = 79



Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground
 Location: 232 Klug Hill Road
Torrington, CT

By: MCB Date: 11/9/22 Checked: _____ Date: _____
 Circle one: Present **Developed** Watershed: PR WS12

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area <u>Acres</u> Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Woods - Good Condition	55			1.00	54.97
B Soil	Open Space - Good Condition	61			0.82	50.32
B Soil	Gravel	85			0.51	43.23
C Soil	Woods - Good Condition	70			0.43	30.33
C Soil	Open Space - Good Condition	74			0.53	39.47
C Soil	Gravel	89			0.06	5.08
Totals =					3.36	223.40

(0.00524 sq mi)

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{223.40}{3.36} \text{ Use CN} = \boxed{67}$$



Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground
 Location: 232 Klug Hill Road
Torrington, CT

By: MCB Date: 11/9/22 Checked: _____ Date: _____
 Circle one: Present Developed Watershed: PR WS20

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area <u>Acres</u> Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
C Soil	Woods - Good Condition	70			9.72	680.25
C Soil	Open Space - Good Condition	74			0.60	44.12
D Soil	Woods - Good Condition	77			1.24	95.78
D Soil	Open Space - Good Condition	80			0.16	12.85
N/A	Paved/Impervious	98			0.07	6.86
N/A	Building	98			0.06	5.96
Totals =					11.85	845.81

(0.01851 sq mi)

$$\text{CN (weighted)} = \frac{\text{total product}}{\text{total area}} = \frac{845.81}{11.85} \text{ Use CN} = \boxed{71}$$



Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground
 Location: 232 Klug Hill Road
Torrington, CT

By: MCB Date: 11/9/22 Checked: _____ Date: _____
 Circle one: Present **Developed** Watershed: PR WS30

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area <u>Acres</u> Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Open Space - Good Condition	61			1.45	88.48
B Soil	Gravel				0.27	0.00
C Soil	Woods - Good Condition	70			19.89	1392.00
C Soil	Meadow	71			1.01	71.74
C Soil	Open Space - Good Condition	74			3.10	229.47
C Soil	Gravel	89			0.15	13.11
D Soil	Open Space - Good Condition	80			0.12	9.34
N/A	Building	98			0.03	2.71
N/A	Paved/Impervious	98			0.00	0.26

Totals = 26.01 1807.11
 (0.04064 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{1807.11}{26.01}$ Use CN = 69



Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground

Location: 232 Klug Hill Road

Torrington, CT

By: MCB Date: 11/9/22 Checked: _____

Date: _____

Circle one: Present Developed

Watershed: PR WS40

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area Acres Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Open Space - Good Condition	61			0.40	24.63
C Soil	Woods - Good Condition	70			4.47	312.64
C Soil	Meadow	71			2.52	179.00
C Soil	Open Space - Good Condition	74			5.06	374.09
C Soil	Gravel	89			0.04	3.53
D Soil	Woods - Good Condition	77			0.98	75.38
D Soil	Meadow	78			0.07	5.67
D Soil	Open Space - Good Condition	80			0.69	54.90
D Soil	Gravel	91			0.09	7.97
N/A	Paved/Impervious	98			1.32	129.44
N/A	Building	98			0.27	26.18
Totals =					15.90	1193.42

(0.02484 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{1193.42}{15.90}$ Use CN = 75



Curve Number Calculations

Project: Klug Hill RV Park - KOA Campground

Location: 232 Klug Hill Road

Torrington, CT

By: MCB Date: 11/9/22 Checked: _____

Date: _____

Circle one: Present Developed

Watershed: PR WS41

Soil Name and Hydrologic Group (appendix A)	Cover Description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN Value ^{1.}			Area Acres Sq. Ft. %	Product of CN x Area
		Table 2-2	Figure 2-3	Figure 2-4		
B Soil	Woods - Good Condition	55			0.04	2.31
B Soil	Open Space - Good Condition	61			0.71	43.36
B Soil	Gravel	85			0.47	40.13
C Soil	Woods - Good Condition	70			0.40	28.07
C Soil	Meadow	71			0.11	7.49
C Soil	Open Space - Good Condition	74			0.36	26.49
D Soil	Woods - Good Condition	77			0.60	46.36
D Soil	Open Space - Good Condition	80			0.47	37.70
D Soil	Gravel	91			0.15	13.78
N/A	Paved/Impervious	98			0.12	11.44
N/A	Building	98			0.01	0.72
Totals =					3.44	257.85

(0.00537 sq mi)

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{257.85}{3.44}$ Use CN = 75



Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: EXWS-10
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

1. Surface description (Table 3-1)	Segment ID	A-B	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		WOODS	
3. Flow Length, L (< 300ft)	ft.	0.400	
4. Two-year 24-hr rainfall, P_2	in.	100.0	
5. Land slope, s	ft./ft.	3.49	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.010	
		0.452	= 0.452

Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description	Segment ID	B-C			
8. Manning's roughness coeff., n		WOODS			
9. Paved or unpaved		0.100			
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		UNPVD			
11. Flow Length, L	ft.	0.40			
12. Watercourse slope, s	ft./ft.	254.0			
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	0.020			
14. $T_t = \frac{L}{3600 * V}$	hr.	1.14			
		0.062	+		= 0.062

Channel flow

15. Channel Bottom width, b	Segment ID				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.				
17. Depth of flow, d	ft.				
18. Cross sectional flow area, A (assume trapazoidal)	ft. ²				
19. Wetted perimeter, P_w	ft.				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.				
21. Channel slope, s	ft./ft.				
22. Manning's roughness coeff., n					
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.				
24. Flow length, L	ft.				
25. $T_t = \frac{L}{3600 * V}$	hr.		+		= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.				0.514

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: EXWS-20
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

1. Surface description (Table 3-1)	Segment ID	A-B	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		WOODS	
3. Flow Length, L (< 300ft)	ft.	0.400	
4. Two-year 24-hr rainfall, P_2	in.	100.0	
5. Land slope, s	ft./ft.	3.49	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.025	
		0.313	= 0.313

Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description	Segment ID	B-C			
8. Manning's roughness coeff., n		WOODS			
9. Paved or unpaved		0.100			
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		UNPVD			
11. Flow Length, L	ft.	0.40			
12. Watercourse slope, s	ft./ft.	679.0			
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	0.040			
14. $T_t = \frac{L}{3600 * V}$	hr.	1.62			
		0.117	+		= 0.117

Channel flow

15. Channel Bottom width, b	Segment ID				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.				
17. Depth of flow, d	ft.				
18. Cross sectional flow area, A (assume trapazoidal)	ft. ²				
19. Wetted perimeter, P_w	ft.				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.				
21. Channel slope, s	ft./ft.				
22. Manning's roughness coeff., n					
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.				
24. Flow length, L	ft.				
25. $T_t = \frac{L}{3600 * V}$	hr.		+		= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.				0.430

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: EXWS-30
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

	Segment ID	A-B		
1. Surface description (Table 3-1)		WOODS		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.400		
3. Flow Length, L (< 300ft)	ft.	100.0		
4. Two-year 24-hr rainfall, P_2	in.	3.49		
5. Land slope, s	ft./ft.	0.050		
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.238	=	0.238

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Segment ID	B-C			
7. Surface description		WOODS			
8. Manning's roughness coeff., n		0.100			
9. Paved or unpaved		UNPVD			
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.	ft.	0.40			
11. Flow Length, L	ft.	1833.0			
12. Watercourse slope, s	ft./ft.	0.089			
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	2.41			
14. $T_t = \frac{L}{3600 * V}$	hr.	0.211	+		0.211

Channel flow

	Segment ID				
15. Channel Bottom width, b	ft.				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.				
17. Depth of flow, d	ft.				
18. Cross sectional flow area, A (assume trapazoidal)	ft. ²				
19. Wetted perimeter, P_w	ft.				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.				
21. Channel slope, s	ft./ft.				
22. Manning's roughness coeff., n					
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.				
24. Flow length, L	ft.				
25. $T_t = \frac{L}{3600 * V}$	hr.		+		0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.				0.449

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: EXWS-40
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

	Segment ID	A-B
1. Surface description (Table 3-1)		GRASS
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240
3. Flow Length, L (< 300ft)	ft.	100.0
4. Two-year 24-hr rainfall, P_2	in.	3.49
5. Land slope, s	ft./ft.	0.080
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.131 = 0.131

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Segment ID	B-C	C-D	D-E	E-F
7. Surface description		GRASS	WOODS	GRASS	BIT
8. Manning's roughness coeff., n		0.080	0.100	0.080	0.015
9. Paved or unpaved		UNPVD	UNPVD	UNPVD	PVD
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		0.40	0.40	0.40	0.20
11. Flow Length, L	ft.	132.0	393.0	287.0	55.0
12. Watercourse slope, s	ft./ft.	0.152	0.153	0.157	0.091
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	3.94	3.16	4.01	10.25
14. $T_t = \frac{L}{3600 * V}$	hr.	0.009 +	0.035 +	0.020 +	0.001 = 0.065

Channel flow

	Segment ID					
15. Channel Bottom width, b	ft.					
16. Horizontal side slope component, z (z horiz:1 vert)	ft.					
17. Depth of flow, d	ft.					
18. Cross sectional flow area, A (assume trapezoidal) ft. ²						
19. Wetted perimeter, P_w	ft.					
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.					
21. Channel slope, s	ft./ft.					
22. Manning's roughness coeff., n						
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.					
24. Flow length, L	ft.					
25. $T_t = \frac{L}{3600 * V}$	hr.					
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.					0.000
						0.196

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground

By: MCB

Date: 11/09/22

Location: Torrington, CT

Checked: _____

Date: _____

Circle one: Present Developed

Watershed: PRWS-10

Circle one: T_c T_t

Subwatershed: _____

Sheet flow (applicable to T_c only)

1. Surface description (Table 3-1)
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)
3. Flow Length, L (< 300ft)
4. Two-year 24-hr rainfall, P_2
5. Land slope, s
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$

Segment ID	A-B				
	WOODS				
	0.400				
ft.	100.0				
in.	3.49				
ft./ft.	0.010				
hr.	0.452	=			0.452

Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description
8. Manning's roughness coeff., n
9. Paved or unpaved
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.
11. Flow Length, L
12. Watercourse slope, s
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$
14. $T_t = \frac{L}{3600 * V}$

Segment ID	B-C				
	WOODS				
	0.100				
	UNPVD				
ft.	0.40				
ft./ft.	0.020				
fps.	1.14				
hr.	0.062	+			= 0.062

Channel flow

15. Channel Bottom width, b
16. Horizontal side slope component, z (z horiz:1 vert)
17. Depth of flow, d
18. Cross sectional flow area, A (assume trapazoidal)
19. Wetted perimeter, P_w
20. Hydraulic Radius, $R = \frac{A}{P_w}$
21. Channel slope, s
22. Manning's roughness coeff., n
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$
24. Flow length, L
25. $T_t = \frac{L}{3600 * V}$
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)

Segment ID					
ft.					
ft.					
ft.					
ft. ²					
ft.					
ft.					
ft./ft.					
fps.					
ft.					
hr.		+			= 0.000
hr.					= 0.514

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground

By: MCB

Date: 11/09/22

Location: Torrington, CT

Checked: _____

Date: _____

Circle one: Present Developed

Watershed: PRWS-11

Circle one: T_c T_t

Subwatershed: _____

Sheet flow (applicable to T_c only)

1. Surface description (Table 3-1)
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)
3. Flow Length, L (< 300ft)
4. Two-year 24-hr rainfall, P_2
5. Land slope, s
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$

Segment ID	A-B		
	GRASS		
	0.240		
ft.	100.0		
in.	3.49		
ft./ft.	0.050		
hr.	0.158	=	0.158

Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description
8. Manning's roughness coeff., n
9. Paved or unpaved
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.
11. Flow Length, L
12. Watercourse slope, s
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$
14. $T_t = \frac{L}{3600 * V}$

Segment ID	B-C	C-D		
	GRAVEL	GRASS		
	0.025	0.080		
	UNPVD	UNPVD		
ft.	0.40	0.40		
ft./ft.	0.045	0.045		
fps.	6.86	2.14		
hr.	0.012	+ 0.025		= 0.038

Channel flow

15. Channel Bottom width, b
16. Horizontal side slope component, z (z horiz:1 vert) ft.
17. Depth of flow, d
18. Cross sectional flow area, A (assume trapazoidal) ft.²
19. Wetted perimeter, P_w
20. Hydraulic Radius, $R = \frac{A}{P_w}$
21. Channel slope, s
22. Manning's roughness coeff., n
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$
24. Flow length, L
25. $T_t = \frac{L}{3600 * V}$
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)

Segment ID	D-E			
ft.	12" HDPE			
ft.	--			
ft.	FULL			
ft. ²	0.79			
ft.	3.14			
ft.	0.25			
ft./ft.	0.030			
	0.012			
fps.	8.57			
ft.	525.0			
hr.	0.017	+ _____		= 0.017
hr.				= 0.212

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: PRWS-12
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

	Segment ID	A-B	
1. Surface description (Table 3-1)		GRASS	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240	
3. Flow Length, L (< 300ft)	ft.	100.0	
4. Two-year 24-hr rainfall, P_2	in.	3.49	
5. Land slope, s	ft./ft.	0.065	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.142	= 0.142

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Segment ID	B-C	C-D	D-E	
7. Surface description		GRAVEL	GRASS	WOODS	
8. Manning's roughness coeff., n		0.025	0.080	0.100	
9. Paved or unpaved		UNPVD	UNPVD	UNPVD	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		0.40	0.40	0.40	
11. Flow Length, L	ft.	101.0	263.0	95.0	
12. Watercourse slope, s	ft./ft.	0.059	0.126	0.189	
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	7.86	3.59	3.52	
14. $T_t = \frac{L}{3600 * V}$	hr.	0.004	+ 0.020	+ 0.008	= 0.031

Channel flow

	Segment ID				
15. Channel Bottom width, b	ft.				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.				
17. Depth of flow, d	ft.				
18. Cross sectional flow area, A (assume trapezoidal)	ft. ²				
19. Wetted perimeter, P_w	ft.				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.				
21. Channel slope, s	ft./ft.				
22. Manning's roughness coeff., n					
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.				
24. Flow length, L	ft.				
25. $T_t = \frac{L}{3600 * V}$	hr.		+		= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.				0.174

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground

By: MCB

Date: 11/09/22

Location: Torrington, CT

Checked: _____

Date: _____

Circle one: Present Developed

Watershed: PRWS-20

Circle one: T_c T_t

Subwatershed: _____

Sheet flow (applicable to T_c only)

1. Surface description (Table 3-1)
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)
3. Flow Length, L (< 300ft)
4. Two-year 24-hr rainfall, P_2
5. Land slope, s
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$

Segment ID	A-B				
	WOODS				
	0.400				
ft.	100.0				
in.	3.49				
ft./ft.	0.025				
hr.	0.313	=			0.313

Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description
8. Manning's roughness coeff., n
9. Paved or unpaved
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.
11. Flow Length, L
12. Watercourse slope, s
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$
14. $T_t = \frac{L}{3600 * V}$

Segment ID	B-C				
	WOODS				
	0.100				
	UNPVD				
ft.	0.40				
ft./ft.	0.040				
fps.	1.62				
hr.	0.117	+			= 0.117

Channel flow

15. Channel Bottom width, b
16. Horizontal side slope component, z (z horiz:1 vert)
17. Depth of flow, d
18. Cross sectional flow area, A (assume trapazoidal)
19. Wetted perimeter, P_w
20. Hydraulic Radius, $R = \frac{A}{P_w}$
21. Channel slope, s
22. Manning's roughness coeff., n
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$
24. Flow length, L
25. $T_t = \frac{L}{3600 * V}$
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)

Segment ID					
ft.					
ft.					
ft.					
ft. ²					
ft.					
ft.					
ft./ft.					
fps.					
ft.					
hr.		+			= 0.000
hr.					= 0.430

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: PRWS-30
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

	Segment ID	A-B		
1. Surface description (Table 3-1)		WOODS		
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.400		
3. Flow Length, L (< 300ft)	ft.	100.0		
4. Two-year 24-hr rainfall, P_2	in.	3.49		
5. Land slope, s	ft./ft.	0.100		
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.180	=	0.180

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Segment ID	B-C			
7. Surface description		WOODS			
8. Manning's roughness coeff., n		0.100			
9. Paved or unpaved		UNPVD			
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.	ft.	0.40			
11. Flow Length, L	ft.	1482.0			
12. Watercourse slope, s	ft./ft.	0.089			
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	2.41			
14. $T_t = \frac{L}{3600 * V}$	hr.	0.171	+		= 0.171

Channel flow

	Segment ID				
15. Channel Bottom width, b	ft.				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.				
17. Depth of flow, d	ft.				
18. Cross sectional flow area, A (assume trapazoidal)	ft. ²				
19. Wetted perimeter, P_w	ft.				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.				
21. Channel slope, s	ft./ft.				
22. Manning's roughness coeff., n					
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.				
24. Flow length, L	ft.				
25. $T_t = \frac{L}{3600 * V}$	hr.		+		= 0.000
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.				= 0.351

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: PRWS-31
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

1. Surface description (Table 3-1)	Segment ID	A-B	
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		WOODS	
3. Flow Length, L (< 300ft)	ft.	0.400	
4. Two-year 24-hr rainfall, P_2	in.	84.0	
5. Land slope, s	ft./ft.	3.49	
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.012	
		0.366	= 0.366

Shallow concentrated flow (assume hyd. radius = depth of flow)

7. Surface description	Segment ID	B-C	C-D	D-E	E-F	
8. Manning's roughness coeff., n		GRAVEL	GRASS	GRAVEL	GRASS	
9. Paved or unpaved		0.025	0.080	0.025	0.080	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		UNPVD	UNPVD	UNPVD	UNPVD	
11. Flow Length, L	ft.	0.40	0.40	0.40	0.40	
12. Watercourse slope, s	ft./ft.	73.0	49.0	24.0	22.0	
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	0.012	0.012	0.012	0.012	
14. $T_t = \frac{L}{3600 * V}$	hr.	3.54	1.11	3.54	1.11	
		0.006	+ 0.012	+ 0.002	+ 0.006	= 0.025

Channel flow

15. Channel Bottom width, b	Segment ID	F-G				
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	12" HDPE				
17. Depth of flow, d	ft.	--				
18. Cross sectional flow area, A (assume trapezoidal) ft. ²	ft.	FULL				
19. Wetted perimeter, P_w	ft.	0.79				
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	3.14				
21. Channel slope, s	ft./ft.	0.25				
22. Manning's roughness coeff., n		0.100				
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.	0.012				
24. Flow length, L	ft.	15.65				
25. $T_t = \frac{L}{3600 * V}$	hr.	91.0				
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.	0.002	+		+	= 0.002
						0.393

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: PRWS-40
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

	Segment ID	A-B
1. Surface description (Table 3-1)		GRASS
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240
3. Flow Length, L (< 300ft)	ft.	100.0
4. Two-year 24-hr rainfall, P_2	in.	3.49
5. Land slope, s	ft./ft.	0.120
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.111 = 0.111

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Segment ID	B-C	C-D	D-E	
7. Surface description		GRASS	BIT	WOODS	
8. Manning's roughness coeff., n		0.080	0.015	0.100	
9. Paved or unpaved		UNPVD	PVD	UNPVD	
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		0.40	0.20	0.40	
11. Flow Length, L	ft.	95.0	149.0	251.0	
12. Watercourse slope, s	ft./ft.	0.274	0.027	0.159	
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	5.29	5.58	3.23	
14. $T_t = \frac{L}{3600 * V}$	hr.	0.005 +	0.007 +	0.022	= 0.034

Channel flow

	Segment ID	E-F	F-G		
15. Channel Bottom width, b	ft.	1.50	12" CPP		
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	2.00	--		
17. Depth of flow, d	ft.	0.50	FULL		
18. Cross sectional flow area, A (assume trapazoidal) ft. ²		1.25	0.79		
19. Wetted perimeter, P_w	ft.	3.74	3.14		
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.33	0.25		
21. Channel slope, s	ft./ft.	0.118	0.02		
22. Manning's roughness coeff., n		0.24	0.012		
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.	1.03	7.00		
24. Flow length, L	ft.	219.0	47.0		
25. $T_t = \frac{L}{3600 * V}$	hr.	0.059 +	0.002		= 0.061
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.				0.206

Time of Concentration (T_c) or Travel Time (T_t) Worksheet

Project: Klug Hill RV Park - KOA Campground By: MCB Date: 11/09/22
 Location: Torrington, CT Checked: _____ Date: _____
 Circle one: Present Developed Watershed: PRWS-41
 Circle one: T_c T_t Subwatershed: _____

Sheet flow (applicable to T_c only)

	Segment ID	A-B
1. Surface description (Table 3-1)		GRASS
2. Manning's roughness coeff. for sheet flow, n (Table 3-1)		0.240
3. Flow Length, L (< 300ft)	ft.	69.0
4. Two-year 24-hr rainfall, P_2	in.	3.49
5. Land slope, s	ft./ft.	0.188
6. $T_t = \frac{0.007 (nL)^{0.8}}{P_2^{0.5} (s^{0.4})}$	hr.	0.069 = 0.069

Shallow concentrated flow (assume hyd. radius = depth of flow)

	Segment ID	B-C	C-D	D-E	E-F
7. Surface description		GRAVEL	GRASS	WOODS	BIT
8. Manning's roughness coeff., n		0.025	0.080	0.100	0.015
9. Paved or unpaved		UNPVD	UNPVD	UNPVD	PVD
10. Depth of flow, d (default values: d=.4 unpaved, d=.2 paved) ft.		0.40	0.40	0.40	0.20
11. Flow Length, L	ft.	84.0	49.0	116.0	76.0
12. Watercourse slope, s	ft./ft.	0.042	0.347	0.379	0.132
13. Average velocity, $V = \frac{1.49}{n} (d^{2/3})(s^{1/2})$	fps.	6.63	5.96	4.98	12.34
14. $T_t = \frac{L}{3600 * V}$	hr.	0.004	+ 0.002	+ 0.006	+ 0.002 = 0.014

Channel flow

	Segment ID	E-F			
15. Channel Bottom width, b	ft.	12" HDPE			
16. Horizontal side slope component, z (z horiz:1 vert)	ft.	--			
17. Depth of flow, d	ft.	FULL			
18. Cross sectional flow area, A (assume trapazoidal) ft. ²		0.79			
19. Wetted perimeter, P_w	ft.	3.14			
20. Hydraulic Radius, $R = \frac{A}{P_w}$	ft.	0.25			
21. Channel slope, s	ft./ft.	0.01			
22. Manning's roughness coeff., n		0.012			
23. $V = \frac{1.49}{n} (R^{2/3})(s^{1/2})$	fps.	4.95			
24. Flow length, L	ft.	101.0			
25. $T_t = \frac{L}{3600 * V}$	hr.	0.006			= 0.006
26. Watershed or subarea T_c or T_t (add T_t in steps 6, 14 & 25)	hr.				0.069

Min TC = 0.1 hr



NOAA Atlas 14, Volume 10, Version 3
Location name: Torrington, Connecticut, USA*
Latitude: 41.8171°, Longitude: -73.1705°
Elevation: 1115.11 ft**



* source: ESRI Maps
 ** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerials](#)

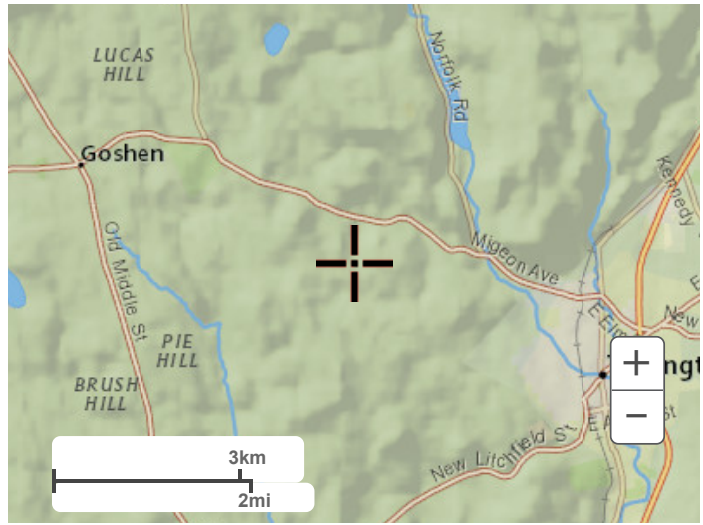
PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.355 (0.269-0.465)	0.423 (0.320-0.554)	0.534 (0.402-0.702)	0.625 (0.469-0.827)	0.751 (0.547-1.03)	0.847 (0.606-1.19)	0.945 (0.658-1.37)	1.05 (0.701-1.57)	1.19 (0.768-1.84)	1.30 (0.821-2.05)
10-min	0.503 (0.381-0.659)	0.599 (0.453-0.785)	0.756 (0.570-0.995)	0.885 (0.664-1.17)	1.06 (0.775-1.46)	1.20 (0.859-1.69)	1.34 (0.932-1.94)	1.49 (0.993-2.22)	1.68 (1.09-2.61)	1.84 (1.16-2.91)
15-min	0.592 (0.448-0.775)	0.705 (0.533-0.924)	0.889 (0.670-1.17)	1.04 (0.782-1.38)	1.25 (0.912-1.72)	1.41 (1.01-1.98)	1.58 (1.10-2.29)	1.75 (1.17-2.61)	1.98 (1.28-3.07)	2.16 (1.37-3.42)
30-min	0.810 (0.613-1.06)	0.964 (0.729-1.26)	1.22 (0.917-1.60)	1.43 (1.07-1.89)	1.71 (1.25-2.36)	1.93 (1.38-2.71)	2.15 (1.50-3.13)	2.39 (1.60-3.57)	2.71 (1.75-4.19)	2.96 (1.87-4.68)
60-min	1.03 (0.778-1.35)	1.22 (0.925-1.60)	1.54 (1.16-2.03)	1.81 (1.36-2.39)	2.17 (1.58-2.99)	2.45 (1.75-3.44)	2.74 (1.90-3.97)	3.03 (2.03-4.53)	3.44 (2.22-5.32)	3.76 (2.38-5.94)
2-hr	1.36 (1.04-1.77)	1.59 (1.21-2.07)	1.97 (1.49-2.57)	2.28 (1.72-2.99)	2.70 (1.99-3.71)	3.03 (2.18-4.24)	3.36 (2.36-4.89)	3.74 (2.51-5.57)	4.27 (2.77-6.59)	4.71 (2.99-7.42)
3-hr	1.58 (1.21-2.05)	1.84 (1.41-2.39)	2.27 (1.73-2.96)	2.63 (1.99-3.45)	3.12 (2.30-4.28)	3.49 (2.53-4.89)	3.88 (2.75-5.66)	4.34 (2.92-6.45)	5.01 (3.25-7.72)	5.57 (3.54-8.76)
6-hr	1.98 (1.52-2.54)	2.35 (1.80-3.02)	2.95 (2.26-3.82)	3.45 (2.63-4.49)	4.14 (3.08-5.67)	4.65 (3.40-6.53)	5.21 (3.73-7.64)	5.89 (3.97-8.74)	6.96 (4.53-10.7)	7.87 (5.02-12.3)
12-hr	2.38 (1.84-3.05)	2.93 (2.26-3.75)	3.82 (2.94-4.91)	4.56 (3.49-5.89)	5.57 (4.17-7.62)	6.32 (4.66-8.87)	7.14 (5.18-10.5)	8.20 (5.54-12.1)	9.88 (6.45-15.1)	11.4 (7.27-17.8)
24-hr	2.76 (2.14-3.50)	3.49 (2.71-4.44)	4.69 (3.63-5.99)	5.69 (4.38-7.31)	7.06 (5.32-9.64)	8.06 (5.99-11.3)	9.18 (6.72-13.6)	10.7 (7.22-15.7)	13.1 (8.55-20.0)	15.2 (9.76-23.7)
2-day	3.12 (2.43-3.93)	4.01 (3.13-5.06)	5.46 (4.25-6.93)	6.67 (5.16-8.51)	8.33 (6.32-11.3)	9.53 (7.14-13.4)	10.9 (8.06-16.1)	12.7 (8.66-18.7)	15.8 (10.4-24.1)	18.6 (12.0-28.9)
3-day	3.40 (2.67-4.28)	4.38 (3.43-5.51)	5.98 (4.66-7.55)	7.30 (5.67-9.28)	9.12 (6.95-12.4)	10.4 (7.85-14.6)	11.9 (8.87-17.7)	14.0 (9.52-20.5)	17.4 (11.5-26.5)	20.6 (13.3-31.9)
4-day	3.66 (2.88-4.59)	4.70 (3.69-5.90)	6.41 (5.01-8.07)	7.82 (6.09-9.91)	9.76 (7.45-13.2)	11.2 (8.41-15.6)	12.8 (9.50-18.9)	15.0 (10.2-21.9)	18.6 (12.3-28.3)	22.0 (14.2-34.0)
7-day	4.38 (3.46-5.46)	5.55 (4.38-6.93)	7.47 (5.87-9.37)	9.07 (7.09-11.4)	11.3 (8.62-15.2)	12.8 (9.70-17.8)	14.6 (10.9-21.5)	17.1 (11.7-24.9)	21.1 (13.9-32.0)	24.8 (16.0-38.3)
10-day	5.11 (4.05-6.35)	6.35 (5.02-7.90)	8.38 (6.61-10.5)	10.1 (7.89-12.6)	12.4 (9.49-16.6)	14.1 (10.6-19.4)	15.9 (11.9-23.2)	18.5 (12.7-26.8)	22.6 (15.0-34.2)	26.3 (17.1-40.6)
20-day	7.44 (5.92-9.18)	8.73 (6.94-10.8)	10.8 (8.59-13.4)	12.6 (9.92-15.7)	15.0 (11.5-19.8)	16.7 (12.7-22.8)	18.7 (13.8-26.7)	21.2 (14.6-30.6)	25.1 (16.7-37.8)	28.6 (18.6-44.0)
30-day	9.37 (7.49-11.5)	10.7 (8.52-13.1)	12.8 (10.2-15.8)	14.6 (11.5-18.1)	17.0 (13.1-22.3)	18.8 (14.2-25.3)	20.8 (15.3-29.3)	23.1 (16.0-33.3)	26.7 (17.8-40.0)	29.8 (19.4-45.7)
45-day	11.7 (9.41-14.4)	13.1 (10.5-16.0)	15.3 (12.2-18.8)	17.1 (13.6-21.2)	19.6 (15.1-25.4)	21.5 (16.2-28.6)	23.5 (17.1-32.5)	25.6 (17.8-36.7)	28.7 (19.2-42.9)	31.2 (20.4-47.8)
60-day	13.7 (11.0-16.7)	15.1 (12.1-18.4)	17.4 (13.9-21.3)	19.2 (15.3-23.8)	21.8 (16.8-28.2)	23.9 (17.9-31.5)	25.9 (18.8-35.4)	27.9 (19.4-39.8)	30.5 (20.5-45.5)	32.5 (21.2-49.7)

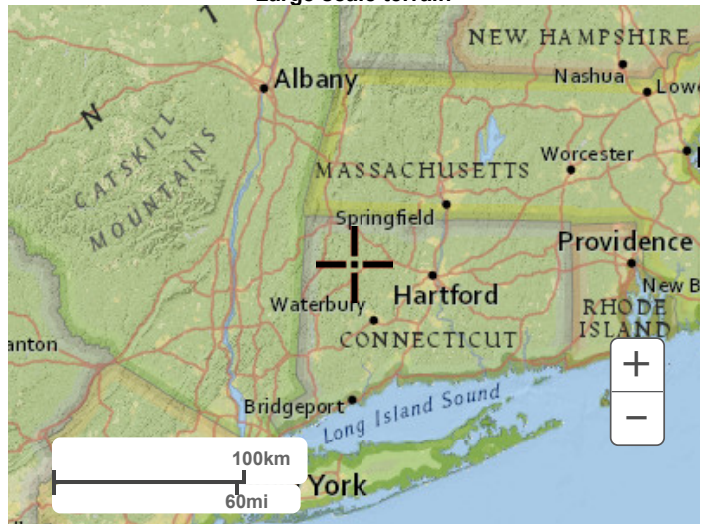
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical



Large scale terrain



Large scale map



Large scale aerial

APPENDIX G

HYDROLOGIC ANALYSIS – COMPUTER MODEL RESULTS

Drainage Report

Klug Hill RV Park

KOA® Campground

232 Klug Hill Road

Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023

Hydrographs Peak Flowrate Summary (cfs) Existing vs. Proposed

Storm Event	2yr		10yr		25yr		50yr		100yr	
	Exist	Prop	Exist	Prop	Exist	Prop	Exist	Prop	Exist	Prop
Point of Analysis A	9.5	8.6	34.0	30.0	52.5	45.4	66.9	58.3	83.7	80.7
DET 110 W.S. Elev. (ft.) Top of Berm Elev. = 1142.0	-	1137.6	-	1139.2	-	1140.1	-	1140.7	-	1141.0
DET 120 W.S. Elev. (ft.) Top of Berm Elev. = 1138.0	-	1134.7	-	1135.6	-	1136.4	-	1136.7	-	1136.9
Point of Analysis B	8.1	8.1	21.8	21.7	31.2	31.0	38.3	38.0	46.4	46.1
Point of Analysis C	19.4	16.7	53.4	48.7	77.1	75.8	95.0	93.5	115.5	113.1
DET 310 W.S. Elev. (ft.) Top of Berm Elev. = 1156.0	-	1152.8	-	1153.8	-	1154.2	-	1154.5	-	1154.9
Point of Analysis D	19.6	18.6	49.8	46.4	70.3	64.5	85.6	83.2	103.0	100.7
DET 410 W.S. Elev. (ft.) Top of Berm Elev. = 1134.0	-	1129.9	-	1131.7	-	1132.3	-	1132.5	-	1132.9

Study Area

- A
- B
- C
- D

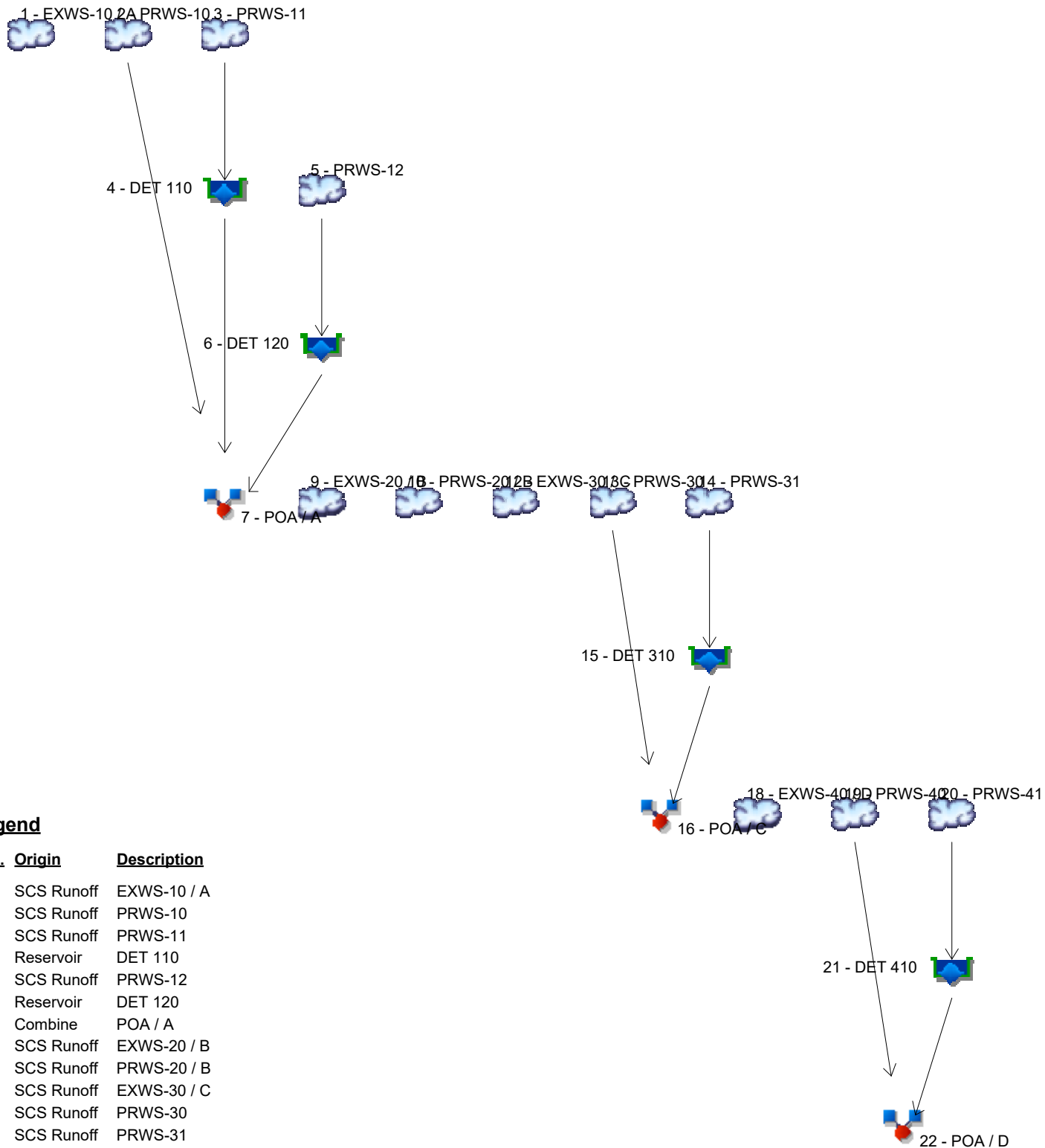
Description

- Wetland C/E
- Wetland I/Goshen Road (Route 4)
- Wetland K/Klug Hill Road
- Wetland B/East Drainage Swale

Watershed Model Schematic.....	1
Hydrograph Return Period Recap.....	2
2 - Year	
Summary Report.....	3
10 - Year	
Summary Report.....	4
25 - Year	
Summary Report.....	5
50 - Year	
Summary Report.....	6
100 - Year	
Summary Report.....	7

Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020



Legend

Hyd.	Origin	Description
1	SCS Runoff	EXWS-10 / A
2	SCS Runoff	PRWS-10
3	SCS Runoff	PRWS-11
4	Reservoir	DET 110
5	SCS Runoff	PRWS-12
6	Reservoir	DET 120
7	Combine	POA / A
9	SCS Runoff	EXWS-20 / B
10	SCS Runoff	PRWS-20 / B
12	SCS Runoff	EXWS-30 / C
13	SCS Runoff	PRWS-30
14	SCS Runoff	PRWS-31
15	Reservoir	DET 310
16	Combine	POA / C
18	SCS Runoff	EXWS-40 / D
19	SCS Runoff	PRWS-40
20	SCS Runoff	PRWS-41
21	Reservoir	DET 410
22	Combine	POA / D

Hydrograph Return Period Recap

Hydroflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	9.506	-----	-----	34.01	52.52	66.93	83.67	EXWS-10 / A
2	SCS Runoff	-----	-----	8.209	-----	-----	27.97	42.78	54.23	67.49	PRWS-10
3	SCS Runoff	-----	-----	4.989	-----	-----	11.02	14.93	17.81	21.04	PRWS-11
4	Reservoir	3	-----	0.546	-----	-----	1.305	1.608	3.061	7.382	DET 110
5	SCS Runoff	-----	-----	2.279	-----	-----	6.962	10.34	12.91	15.87	PRWS-12
6	Reservoir	5	-----	0.241	-----	-----	0.935	1.244	3.832	7.326	DET 120
7	Combine	2, 4, 6	-----	8.614	-----	-----	30.01	45.39	58.33	81.00	POA / A
9	SCS Runoff	-----	-----	8.147	-----	-----	21.79	31.20	38.28	46.42	EXWS-20 / B
10	SCS Runoff	-----	-----	8.092	-----	-----	21.65	30.99	38.02	46.11	PRWS-20 / B
12	SCS Runoff	-----	-----	19.42	-----	-----	53.43	77.11	94.98	115.49	EXWS-30 / C
13	SCS Runoff	-----	-----	16.62	-----	-----	46.93	68.42	84.83	103.61	PRWS-30
14	SCS Runoff	-----	-----	4.520	-----	-----	9.631	12.91	15.32	18.01	PRWS-31
15	Reservoir	14	-----	1.087	-----	-----	5.957	8.968	9.815	10.61	DET 310
16	Combine	13, 15	-----	16.74	-----	-----	48.68	75.84	93.48	113.06	POA / C
18	SCS Runoff	-----	-----	19.55	-----	-----	49.78	70.29	85.64	103.02	EXWS-40 / D
19	SCS Runoff	-----	-----	18.32	-----	-----	44.28	61.63	74.53	89.09	PRWS-40
20	SCS Runoff	-----	-----	4.435	-----	-----	10.63	14.76	17.82	21.28	PRWS-41
21	Reservoir	20	-----	1.137	-----	-----	2.545	6.935	10.55	11.96	DET 410
22	Combine	19, 21	-----	18.56	-----	-----	46.42	64.49	83.15	100.70	POA / D

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description
1	SCS Runoff	9.506	3	750	1.548	-----	-----	-----	EXWS-10 / A
2	SCS Runoff	8.209	3	750	1.299	-----	-----	-----	PRWS-10
3	SCS Runoff	4.989	3	729	0.456	-----	-----	-----	PRWS-11
4	Reservoir	0.546	3	813	0.313	3	1137.58	0.239	DET 110
5	SCS Runoff	2.279	3	732	0.236	-----	-----	-----	PRWS-12
6	Reservoir	0.241	3	885	0.171	5	1134.71	0.119	DET 120
7	Combine	8.614	3	753	1.782	2, 4, 6	-----	-----	POA / A
9	SCS Runoff	8.147	3	741	1.051	-----	-----	-----	EXWS-20 / B
10	SCS Runoff	8.092	3	741	1.044	-----	-----	-----	PRWS-20 / B
12	SCS Runoff	19.42	3	744	2.534	-----	-----	-----	EXWS-30 / C
13	SCS Runoff	16.62	3	738	2.003	-----	-----	-----	PRWS-30
14	SCS Runoff	4.520	3	735	0.499	-----	-----	-----	PRWS-31
15	Reservoir	1.087	3	774	0.376	14	1152.75	0.234	DET 310
16	Combine	16.74	3	741	2.380	13, 15	-----	-----	POA / C
18	SCS Runoff	19.55	3	729	1.867	-----	-----	-----	EXWS-40 / D
19	SCS Runoff	18.32	3	729	1.716	-----	-----	-----	PRWS-40
20	SCS Runoff	4.435	3	726	0.348	-----	-----	-----	PRWS-41
21	Reservoir	1.137	3	753	0.278	20	1129.89	0.132	DET 410
22	Combine	18.56	3	729	1.993	19, 21	-----	-----	POA / D
KH-Model01.gpw					Return Period: 2 Year			Wednesday, 11 / 9 / 2022	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description
1	SCS Runoff	34.01	3	747	4.641	----	----	----	EXWS-10 / A
2	SCS Runoff	27.97	3	744	3.794	----	----	----	PRWS-10
3	SCS Runoff	11.02	3	729	0.996	----	----	----	PRWS-11
4	Reservoir	1.305	3	786	0.853	3	1139.16	0.529	DET 110
5	SCS Runoff	6.962	3	729	0.644	----	----	----	PRWS-12
6	Reservoir	0.935	3	789	0.578	5	1135.63	0.295	DET 120
7	Combine	30.01	3	747	5.225	2, 4, 6	----	----	POA / A
9	SCS Runoff	21.79	3	741	2.636	----	----	----	EXWS-20 / B
10	SCS Runoff	21.65	3	741	2.618	----	----	----	PRWS-20 / B
12	SCS Runoff	53.43	3	741	6.478	----	----	----	EXWS-30 / C
13	SCS Runoff	46.93	3	738	5.226	----	----	----	PRWS-30
14	SCS Runoff	9.631	3	735	1.057	----	----	----	PRWS-31
15	Reservoir	5.957	3	753	0.934	14	1153.84	0.420	DET 310
16	Combine	48.68	3	738	6.160	13, 15	----	----	POA / C
18	SCS Runoff	49.78	3	729	4.510	----	----	----	EXWS-40 / D
19	SCS Runoff	44.28	3	729	4.001	----	----	----	PRWS-40
20	SCS Runoff	10.63	3	726	0.812	----	----	----	PRWS-41
21	Reservoir	2.545	3	750	0.741	20	1131.73	0.321	DET 410
22	Combine	46.42	3	729	4.742	19, 21	----	----	POA / D
KH-Model01.gpw					Return Period: 10 Year			Wednesday, 11 / 9 / 2022	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description	
1	SCS Runoff	52.52	3	744	6.966	-----	-----	-----	EXWS-10 / A	
2	SCS Runoff	42.78	3	744	5.652	-----	-----	-----	PRWS-10	
3	SCS Runoff	14.93	3	729	1.357	-----	-----	-----	PRWS-11	
4	Reservoir	1.608	3	792	1.214	3	1140.14	0.743	DET 110	
5	SCS Runoff	10.34	3	729	0.939	-----	-----	-----	PRWS-12	
6	Reservoir	1.244	3	792	0.874	5	1136.38	0.457	DET 120	
7	Combine	45.39	3	744	7.741	2, 4, 6	-----	-----	POA / A	
9	SCS Runoff	31.20	3	741	3.752	-----	-----	-----	EXWS-20 / B	
10	SCS Runoff	30.99	3	741	3.727	-----	-----	-----	PRWS-20 / B	
12	SCS Runoff	77.11	3	741	9.278	-----	-----	-----	EXWS-30 / C	
13	SCS Runoff	68.42	3	735	7.530	-----	-----	-----	PRWS-30	
14	SCS Runoff	12.91	3	735	1.426	-----	-----	-----	PRWS-31	
15	Reservoir	8.968	3	750	1.303	14	1154.16	0.480	DET 310	
16	Combine	75.84	3	738	8.834	13, 15	-----	-----	POA / C	
18	SCS Runoff	70.29	3	729	6.346	-----	-----	-----	EXWS-40 / D	
19	SCS Runoff	61.63	3	729	5.568	-----	-----	-----	PRWS-40	
20	SCS Runoff	14.76	3	726	1.129	-----	-----	-----	PRWS-41	
21	Reservoir	6.935	3	738	1.059	20	1132.26	0.388	DET 410	
22	Combine	64.49	3	729	6.627	19, 21	-----	-----	POA / D	
KH-Model01.gpw					Return Period: 25 Year			Wednesday, 11 / 9 / 2022		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description	
1	SCS Runoff	66.93	3	744	8.787	-----	-----	-----	EXWS-10 / A	
2	SCS Runoff	54.23	3	744	7.103	-----	-----	-----	PRWS-10	
3	SCS Runoff	17.81	3	729	1.627	-----	-----	-----	PRWS-11	
4	Reservoir	3.061	3	765	1.484	3	1140.66	0.866	DET 110	
5	SCS Runoff	12.91	3	729	1.168	-----	-----	-----	PRWS-12	
6	Reservoir	3.832	3	756	1.103	5	1136.65	0.518	DET 120	
7	Combine	58.33	3	747	9.690	2, 4, 6	-----	-----	POA / A	
9	SCS Runoff	38.28	3	741	4.604	-----	-----	-----	EXWS-20 / B	
10	SCS Runoff	38.02	3	741	4.573	-----	-----	-----	PRWS-20 / B	
12	SCS Runoff	94.98	3	741	11.421	-----	-----	-----	EXWS-30 / C	
13	SCS Runoff	84.83	3	735	9.300	-----	-----	-----	PRWS-30	
14	SCS Runoff	15.32	3	735	1.701	-----	-----	-----	PRWS-31	
15	Reservoir	9.815	3	750	1.579	14	1154.48	0.547	DET 310	
16	Combine	93.48	3	735	10.879	13, 15	-----	-----	POA / C	
18	SCS Runoff	85.64	3	729	7.740	-----	-----	-----	EXWS-40 / D	
19	SCS Runoff	74.53	3	729	6.752	-----	-----	-----	PRWS-40	
20	SCS Runoff	17.82	3	726	1.370	-----	-----	-----	PRWS-41	
21	Reservoir	10.55	3	735	1.299	20	1132.50	0.419	DET 410	
22	Combine	83.15	3	729	8.051	19, 21	-----	-----	POA / D	
KH-Model01.gpw					Return Period: 50 Year			Wednesday, 11 / 9 / 2022		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® 2019 by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (acft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (acft)	Hydrograph Description	
1	SCS Runoff	83.67	3	744	10.920	----	----	----	EXWS-10 / A	
2	SCS Runoff	67.49	3	744	8.798	----	----	----	PRWS-10	
3	SCS Runoff	21.04	3	729	1.935	----	----	----	PRWS-11	
4	Reservoir	7.382	3	750	1.792	3	1140.93	0.931	DET 110	
5	SCS Runoff	15.87	3	729	1.433	----	----	----	PRWS-12	
6	Reservoir	7.326	3	747	1.368	5	1136.87	0.568	DET 120	
7	Combine	81.00	3	747	11.958	2, 4, 6	----	----	POA / A	
9	SCS Runoff	46.42	3	738	5.586	----	----	----	EXWS-20 / B	
10	SCS Runoff	46.11	3	738	5.549	----	----	----	PRWS-20 / B	
12	SCS Runoff	115.49	3	738	13.895	----	----	----	EXWS-30 / C	
13	SCS Runoff	103.61	3	735	11.346	----	----	----	PRWS-30	
14	SCS Runoff	18.01	3	735	2.013	----	----	----	PRWS-31	
15	Reservoir	10.61	3	753	1.891	14	1154.89	0.633	DET 310	
16	Combine	113.06	3	735	13.237	13, 15	----	----	POA / C	
18	SCS Runoff	103.02	3	729	9.341	----	----	----	EXWS-40 / D	
19	SCS Runoff	89.09	3	729	8.106	----	----	----	PRWS-40	
20	SCS Runoff	21.28	3	726	1.644	----	----	----	PRWS-41	
21	Reservoir	11.96	3	735	1.574	20	1132.89	0.472	DET 410	
22	Combine	100.70	3	729	9.680	19, 21	----	----	POA / D	
KH-Model01.gpw					Return Period: 100 Year			Wednesday, 11 / 9 / 2022		

APPENDIX H

WATERSHED MAPS

Drainage Report

Klug Hill RV Park

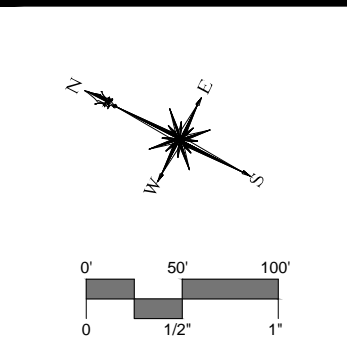
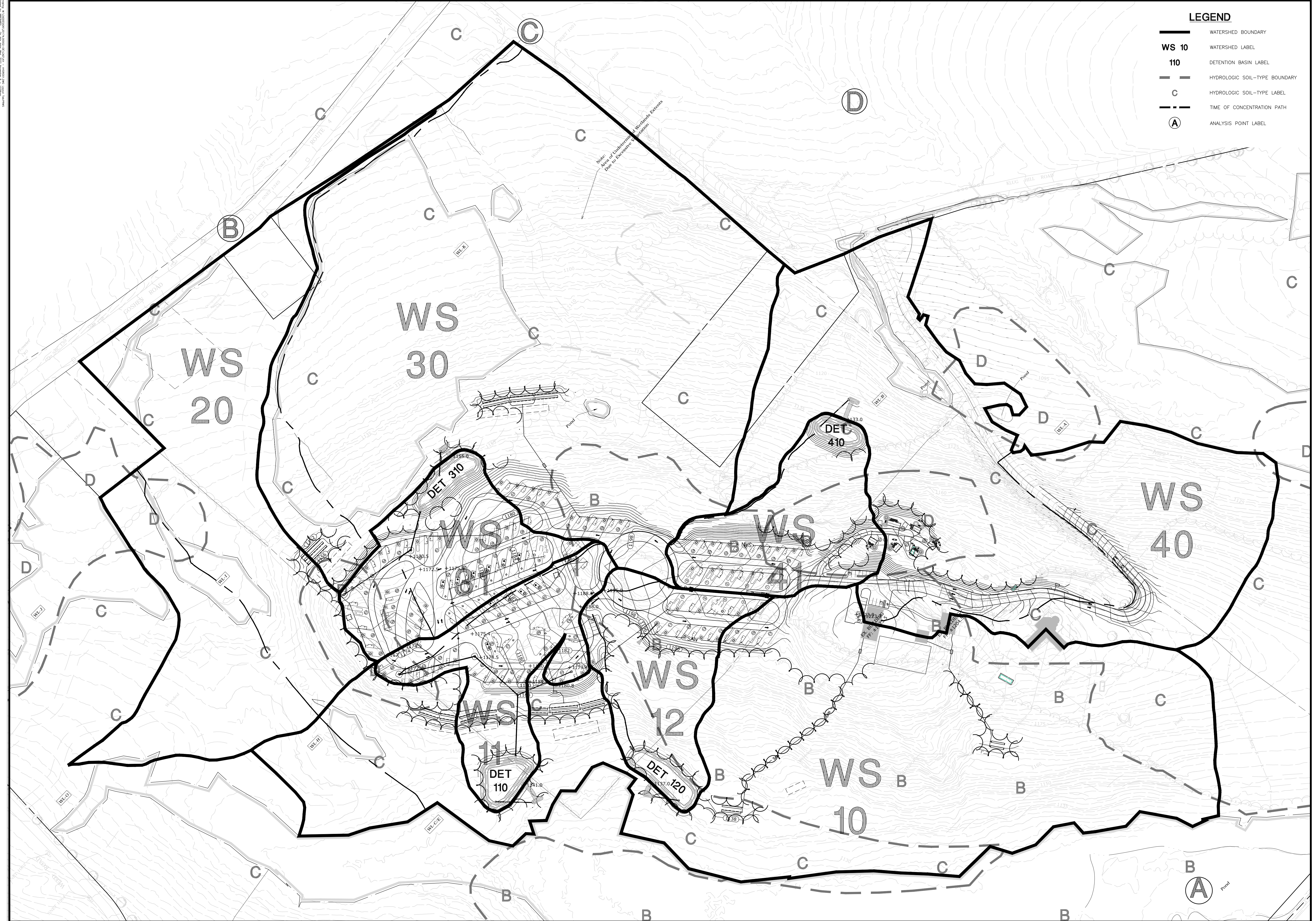
KOA® Campground

232 Klug Hill Road

Torrington, Connecticut 06790

November 9, 2022

Revised January 17, 2023



SLR
99 REALTY DRIVE
SUITE 100
TORRINGTON, CT 06460
203.771.7777
SLRCONSULTING.COM

DESCRIPTION	DATE	BY

WATERSHED MAP - PROPOSED CONDITIONS
KLUG HILL RV PARK
KOA CAMPGROUND
232 KLUG HILL ROAD
TORRINGTON, CONNECTICUT

DESIGNED	MCB	MCB	RJM
DRAWN			CHECKED
SCALE			
1"=100'			
DATE			
NOVEMBER 9, 2022			
PROJECT NO.			
20174.00002			
SHEET NO.			
2 OF 2			

PRWS