NRG – Indian River Landfill
Run-on and Run-Off Control System Plan

Indian River Landfill
Dagsboro, DE

Prepared for:

NRG Energy

SCS ENGINEERS

25221158.00 | October 2026

40 Shuman Blvd, Ste 216
Naperville, IL 60563

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PLAN REVIEW/AMENDMENT LOG

Date of Review	Reviewer Name	Amendment Required (YES/NO)	Sections Amended and Reason
October 12, 2016 (Revision 0)	Chicago Bridge and Iron	N/A	Initial Plan
October 12, 2021 (Revision 1)	SCS Engineers	YES	All sections revised / updated as part of the 5-year periodic review process.
October 12, 2026 (Revision 2)	SCS Engineers	YES	All sections revised / updated as part of the 5-year periodic review process.

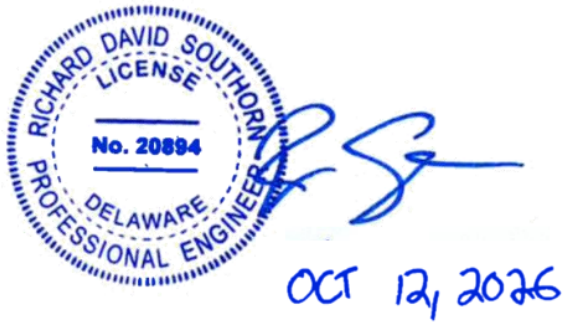
PROFESSIONAL ENGINEER CERTIFICATION

I, Richard D. Southorn, hereby certify that this periodic update to the Indian River Landfill Run-On and Run-Off Control System Plan meets the requirements of 40 CFR §257.81(c), was prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Delaware.

Richard Southorn, PE

License 20894

Expires 6/30/2028



1.0 INTRODUCTION

The Indian River Landfill, located in Dagsboro, Delaware, has been permitted by the Delaware Department of Natural Resources and Environmental Control (DNREC) for the disposal of coal combustion residuals (CCR) and other industrial wastes generated by the Indian River Generating Station. This Run-on and Run-off Control System Plan documents that the Landfill's run-on and run-off control systems have been designed and constructed to meet the applicable requirements of Title 40 Code of Federal Regulations (CFR) §257.81 of the CCR Rule.

1.1 OVERVIEW OF INDIAN RIVER LANDFILL

The Indian River Landfill is an industrial waste landfill used for disposal of coal combustion residuals (CCR) and other industrial wastes generated at the Indian River Generating Station. The landfill is permitted by the Delaware Department of Natural Resources and Environmental Control (DNREC) under Solid Waste Permit No. SW-22/02.

The landfill consists of two major phases. Phase I is a 46-acre, unlined landfill that operated from 1980 through 2014 and is now closed. Phase II is a 28-acre expansion that extends westward from Phase I and overlays portions of the western side slopes of Phase I. Phase II consists of two landfill cells, Cells 1 and 2. The eastern portions of both cells extend over the western side slopes of Phase I. Both Phase II cells, including the overlay areas, are underlain by a composite liner system.

2.0 REGULATORY REQUIREMENTS

<u>40 CFR §257.81 Run-on and run-off controls for CCR landfills.</u>

(a) The owner or operator of an existing or new CCR landfill or any lateral expansion of a CCR landfill must design, construct, operate, and maintain:

(1) A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm; and

(2) A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.

(b) Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under 40 CFR §257.3-3.

(c) Run-on and run-off control system plan

(1) Content of the plan. The owner or operator must prepare initial and periodic run-on and run-off control system plans for the CCR unit. Content requirements are provided in 40 CFR §257.81(c). These plans must document how the run-on and run-off control systems have been designed and constructed to meet the applicable requirements of this section and must be supported by appropriate engineering calculations. The owner or operator has completed the initial run-on and run-off control system plan when the plan has been placed in the facility's operating record as required by 40 CFR §257.105(g)(3).

With reference to 40 CFR §257.81(c) above, the Initial Run-On and Run-Off Control System Plan (RORO Plan) was required to be developed no later than October 17, 2016 for existing landfills (40 CFR

§257.81(c)(3)(i)). Updates to the RORO Plan are required whenever there is a change in conditions that would substantially affect the written plan in effect (40 CFR §257.81(2), or within five years of the previous plan (40 CFR §257.81(c)(4)). The most recent RORO Plan update was completed on October 12, 2021.

The owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the initial and periodic RORO Plans meet the requirements of 40 CFR §257.81.

3.0 PREVIOUS RUN-ON AND RUN-OFF CONTROL SYSTEM PLANS

The initial RORO Plan for Indian River Landfill and the corresponding updates to the Plan have been placed on a publicly available website (https://www.nrg.com/legal/coal-combustion-residuals.html). As previously stated in Section 2.0, updates to the RORO Plan are required whenever there is a change in conditions that would substantially affect the written plan in effect (40 CFR §257.81(2), or within five years of the previous plan (40 CFR §257.81(c)(4)).

The most recent periodic RORO Plan was prepared in October 2021. Since preparation of that plan, several operational and physical changes have occurred at the landfill that affect the current run-on and run-off configuration, as summarized in Section 4.1.

4.0 2026 RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN UPDATE

This document has been prepared as the five-year periodic update to the Indian River Landfill Run-On and Run-Off Control System Plan. The general run-on and run-off management approach remains consistent with the previous Plan; however, landfill operations and site conditions have changed since the 2021 update. This Plan documents the current landfill configuration and evaluates the run-on and run-off control systems under current conditions.

The 2026 evaluation also expands upon the previous analysis by evaluating the hydrologic and hydraulic performance of the stormwater conveyance and control features associated with the active portion of the landfill. The current run-on and run-off control system is depicted on Figure 1, and supporting hydrologic and hydraulic calculations are provided in Appendix B.

This Plan supersedes the previous Run-On and Run-Off Control System Plan.

4.1 CHANGES SINCE THE 2021 PLAN

Several operational and physical changes have occurred at the Indian River Landfill since preparation of the 2021 Run-On and Run-Off Control System Plan. Coal-fired electric generation at the Indian River Generating Station ceased on February 23, 2025. However, Phase II of the landfill has remained open to accommodate disposal of residual wastes generated at the Station. No portion of Phase II has received final cover meeting the requirements of §257.102(d)(3).

As landfill operations have progressed toward closure, a polyethylene tarp has been temporarily installed over portions of Phase II that are not anticipated to receive additional waste. The temporary cover limits stormwater infiltration into the underlying CCR while remaining waste disposal activities

continue. Phase II will be regraded as necessary to establish positive drainage and will receive final cover following cessation of landfill operations.

These changes are reflected in the current run-on and run-off control system configuration evaluated as part of this 2026 Periodic Run-On and Run-Off Control System Plan.

4.2 RUN-ON CONTROL SYSTEM

Grades surrounding the active disposal area slope away from the active face such that stormwater from other portions of the landfill is not directed toward the active area. In addition, the active disposal area within Phase II Cell 2 is bordered by a perimeter berm that prevents non-contact stormwater from entering the active area. The berm varies in height but is a minimum of two feet above the surrounding grade.

Portions of Phase II outside the active disposal area are covered with either a polyethylene tarp or vegetated intermediate cover to minimize stormwater infiltration and contact with the underlying CCR. Stormwater runoff from the tarp and intermediate cover is conveyed to the perimeter ditch.

4.3 RUN-OFF CONTROL SYSTEM

The perimeter berm around the active area of Phase II Cell 2 prevents water that comes in contact with CCR from leaving the active area. A low area along the northern side of the active disposal area provides sufficient storage volume to detain the 25-year storm until the contact water infiltrates into the CCR.

4.4 HYDROLOGIC AND HYDRAULIC ANALYSIS

Engineering calculations to evaluate the run-on and run-off control system at the Indian River Landfill consisted of a hydrologic and hydraulic (H&H) stormwater model prepared using HydroCAD stormwater modeling software. Information used to prepare the HydroCAD stormwater model is summarized within Appendix B.

The active area was represented in the HydroCAD model by two elements: a catchment encompassing the active disposal area and a temporary detention area representing the low area along its northern side where runoff collects and is temporarily stored. Because surrounding grades drain away from the active disposal area and the perimeter berm prevents stormwater from adjacent areas from entering the active area, no external tributary drainage area was included in the HydroCAD model.

The H&H analysis has been prepared for the 25-year, 24-hour storm event in accordance with the CCR Rule. Stormwater management calculations were performed utilizing methods outlined in the Soil Conservation Service (SCS) publication on Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55) and computed by HydroCAD software version 10.20-8a. Site conditions were modeled to reflect stormwater runoff based on runoff characteristics such as land cover, soil type, and time of concentration.

4.5 RESULTS AND CONCLUSIONS

The HydroCAD stormwater model was developed to evaluate the performance of the current run-on and run-off control systems during the 25-year, 24-hour storm event. Based on the analysis, runoff generated within the active disposal area reaches a maximum depth of approximately 0.5 foot within the temporary detention area and does not overtop the perimeter berm.

The run-on control system is designed and constructed to prevent stormwater from surrounding portions of the landfill from entering the active disposal area and meets the requirements of 40 CFR §257.81(a)(1).

The run-off control system is designed to collect and contain runoff generated within the active disposal area. Based on the HydroCAD analysis, the temporary detention area provides sufficient storage to contain the runoff volume generated by the 25-year, 24-hour storm event without overtopping the perimeter berm. Accordingly, the run-off control system meets the requirements of 40 CFR §257.81(a)(2).

5.0 CERTIFICATIONS

Richard Southorn, a licensed Professional Engineer in the State of Delaware, has overseen the preparation of this Run-On and Run-Off Control System Plan. A certification statement in accordance with 40 CFR §257.81(c)(5) is provided on **Page 2** of this plan.

6.0 RECORDKEEPING AND PERIODIC UPDATES

This Run-On and Run-Off Control System Plan, and all periodic plans, will be placed in the facility's operating record and on NRG's CCR Rule Compliance Data and Information website. Periodic Run-On and Run-Off Control System Plans will be completed every 5 years per 40 CFR §257.81(c)(4).

Notification will be provided when this Run-On and Run-Off Control System Plan, and all periodic plans, are available in the facility's operating record and on the facility's website in accordance with 40 CFR §257.105(g), §257.106(g), and §257.107(g).

7.0 REFERENCES

1. U.S. Environmental Protection Agency, Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments, Title 40 Code of Federal Regulations Part §257. Federal Register 80, Subpart D, dated April 17, 2015.
2. USDA Natural Resources Conservation Service, Web Soil Survey, dated 2026.
3. SCS Engineers, Indian River Landfill– Stormwater Calculations, Run-On and Run-Off Control System Plan, dated 2026 (Provided as **Appendix B**).

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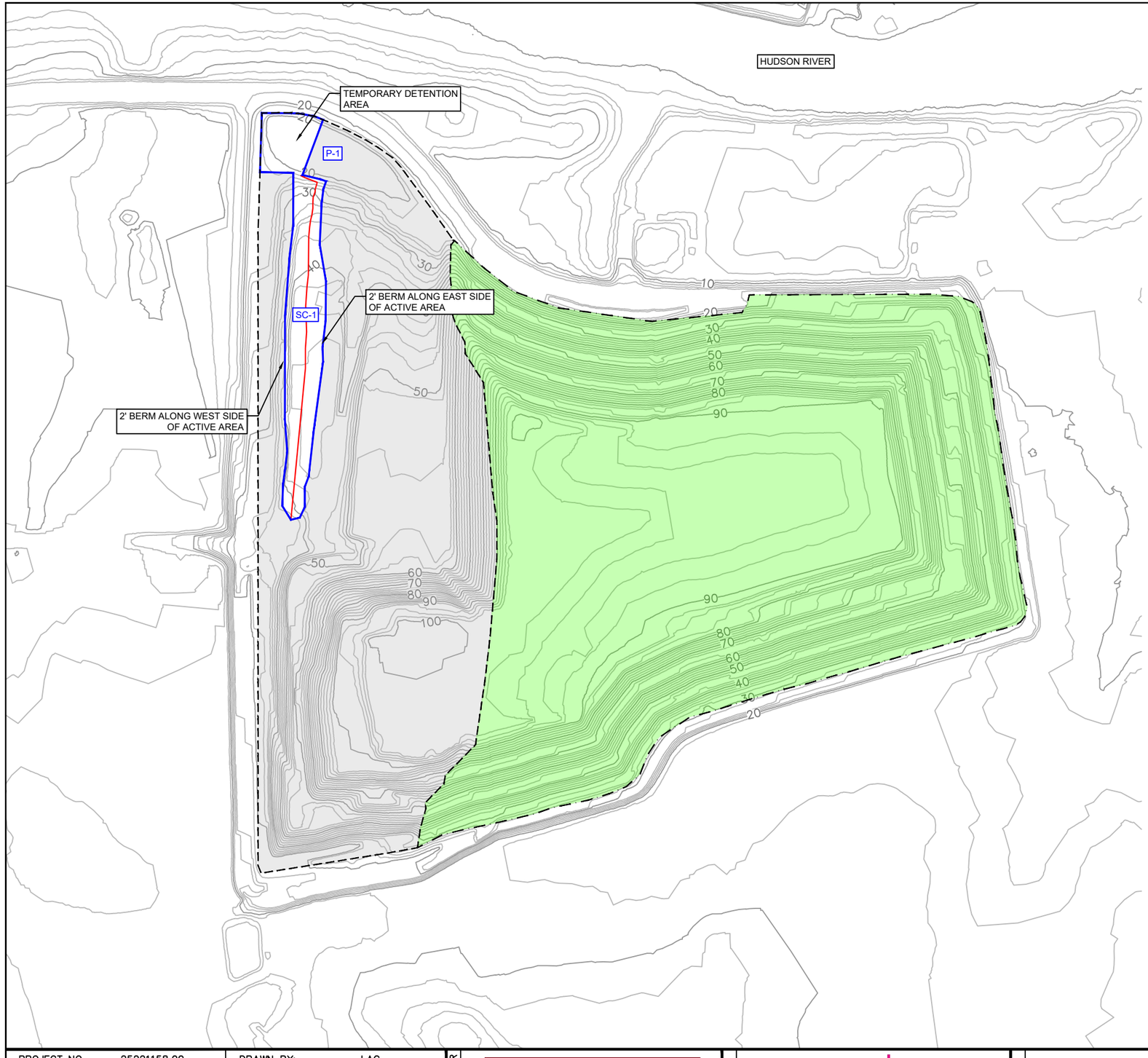
Figures

Figure 1. Indian River Landfill Run-On and Run-Off Control System



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0 300'

GRAPHIC SCALE

LEGEND

- APPROXIMATE PHASE I PERMITTED WASTE BOUNDARY
- APPROXIMATE PHASE II PERMITTED WASTE BOUNDARY
- FINAL COVER
- INTERMEDIATE COVER (TARP OR VEGETATED SOIL)
- EXISTING CONTOUR (2')
- 20 EXISTING CONTOUR (10')
- SUBCATCHMENT AREA BOUNDARY
- TIME OF CONCENTRATION FLOW PATH

NOTES

1. FOR CLARITY, NOT ALL SITE FEATURES MAY BE SHOWN.
2. EXISTING TOPOGRAPHY DEVELOPED FROM GIS DATA.

PROJECT NO.	25221158.00	DRAWN BY:	LAC
DRAWN:	08/21/26	CHECKED BY:	RDS
REVISED:	08/25/26	APPROVED BY:	

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PHONE: (608) 224-2830

CLIENT: nrg

SITE: INDIAN RIVER LANDFILL
DAGSBORO, DELAWARE

RUN-ON AND RUN-OFF PLAN
SUBCATCHMENT AREA

FIGURE
1 OF 1

Appendices

Appendix A Rainfall Totals and Distribution

Appendix B HydroCAD Output Files

Appendix A
Rainfall Totals and Distribution

State of Delaware
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF WATERSHED STEWARDSHIP
285 BEISER BOULEVARD, SUITE 102
DOVER, DELAWARE 19904

CONSERVATION PROGRAMS SECTION

PHONE (302) 608-5458

SEDIMENT & STORMWATER PROGRAM

REGULATORY GUIDANCE MEMORANDUM

RGM-1, VERSION 2

Date: November 1, 2025

Title: Adoption of NOAA Rainfall Distribution Curves

Synopsis: In May 2012, the Delaware State Office of the Natural Resources Conservation Service (NRCS) adopted the current National Oceanic & Atmospheric Administration (NOAA) Rainfall Distribution curves for the hydrologic design of conservation practices in Delaware in place of the NRCS Type II Rainfall Distribution Curves. Effective January 1, 2020, the Delaware Sediment & Stormwater Program began accepting the use of the NOAA Rainfall Distribution Curves for the hydrologic design of stormwater management practices intended to comply with the Delaware Sediment & Stormwater Regulations, while NRCS Type II Rainfall Distribution Curves remained acceptable.

Regulated entities have accepted full use of the NOAA Rainfall Distribution curves. As of the effective date of this revised Regulatory Guidance Memorandum, NOAA Rainfall Distribution curves are the only accepted rainfall distribution curves for hydrologic design to comply with the Delaware Sediment and Stormwater Regulations. NOAA Curve C should be used in New Castle and Kent Counties. NOAA Curve D should be used for Sussex County.

Effective Date: January 1, 2026

Responsible Staff Member

Elaine Z. Webb, P.E.
Engineer VI

Background

The Delaware State Office of the Natural Resources Conservation Service (NRCS) issued Engineering Field Handbook Supplement 2 (EFH-2) on May 3, 2012. This supplement provides background information and policy guidance to NRCS District Offices for adopting the NOAA Rainfall Distribution Curves in the EFH-2 Computer Program in Delaware. This computer program is the primary hydrologic model for estimating runoff and peak discharge for the design of conservation practices by NRCS. The document goes into some detail on the history of rainfall distributions and unit hydrographs used by NRCS, as well as the rationale for the decision to switch to the NOAA curves. NRCS recommends NOAA Curve C for New Castle and Kent Counties, and NOAA Curve D for Sussex County. Examples of how to incorporate the NOAA curves into the EFH-2 model along with sample screen shots are provided for users of the model. Supplement EFH-2 is attached in its entirety to this Regulatory Guidance Memorandum for further information.

Use of the NOAA Rainfall Distribution Curves

The use of the NOAA Rainfall Distribution Curves in hydrologic modeling requires software that has the capability to allow users to select different rainfall distributions or have the capability to incorporate NOAA rainfall distributions. In addition to non-proprietary hydrologic routing software used by NRCS, proprietary software most used in regulated stormwater design in Delaware has these capabilities.

Clarification

The attached EFH-2 Supplement includes a chart of 24-hour rainfall values for each of Delaware's three counties. This chart includes rainfall amounts for the 24-hour 1-year storm for each county. Note that the Resource Protection Event Volume (RPv) is defined in §5.2.2 of the Delaware Sediment and Stormwater Regulations as a 2.7" storm event. Values other than 2.7" rainfall are not acceptable for RPv computations.

ATTACHMENT

NRCS Engineering Field Handbook Supplement 2

Engineering Field Handbook Chapter 2: Estimating Runoff and Peak Discharges

Delaware EFH-2 Supplement Number 001

Introduction / Background

This Supplement to EFH-2 concerns use of rainfall data developed by the National Oceanic and Atmospheric Administration Atlas 14 (NOAA 14) and rainfall distributions based on the NOAA 14 data. These rainfall data and rainfall distributions will replace rainfall data from Weather Bureau Technical Paper 40 (TP-40) and the standard NRCS rainfall distributions Type II and Type III. This Supplement contains maps, data, and technical procedures for the state of Delaware.

This supplement will be implemented by replacing the state/county rainfall database (county.DE) and rainfall distribution types (type.rf) used with the EFH-2 computer program.

The EFH-2 computer program User Guide contains information, guidance, and examples concerning runoff curve number, average watershed slope, watershed length, input/output operations, and limitations. This supplement includes information related to rainfall data and rainfall distribution for use with the EFH-2 computer program in the state of Delaware. Additional technical information is available from the NOAA 14 web site http://hdsc.nws.noaa.gov/hdsc/pfds/ and NRCS technical directives such as National Engineering Handbook Part 630 – Hydrology, Chapter 4, Storm Rainfall Depth and Distribution.

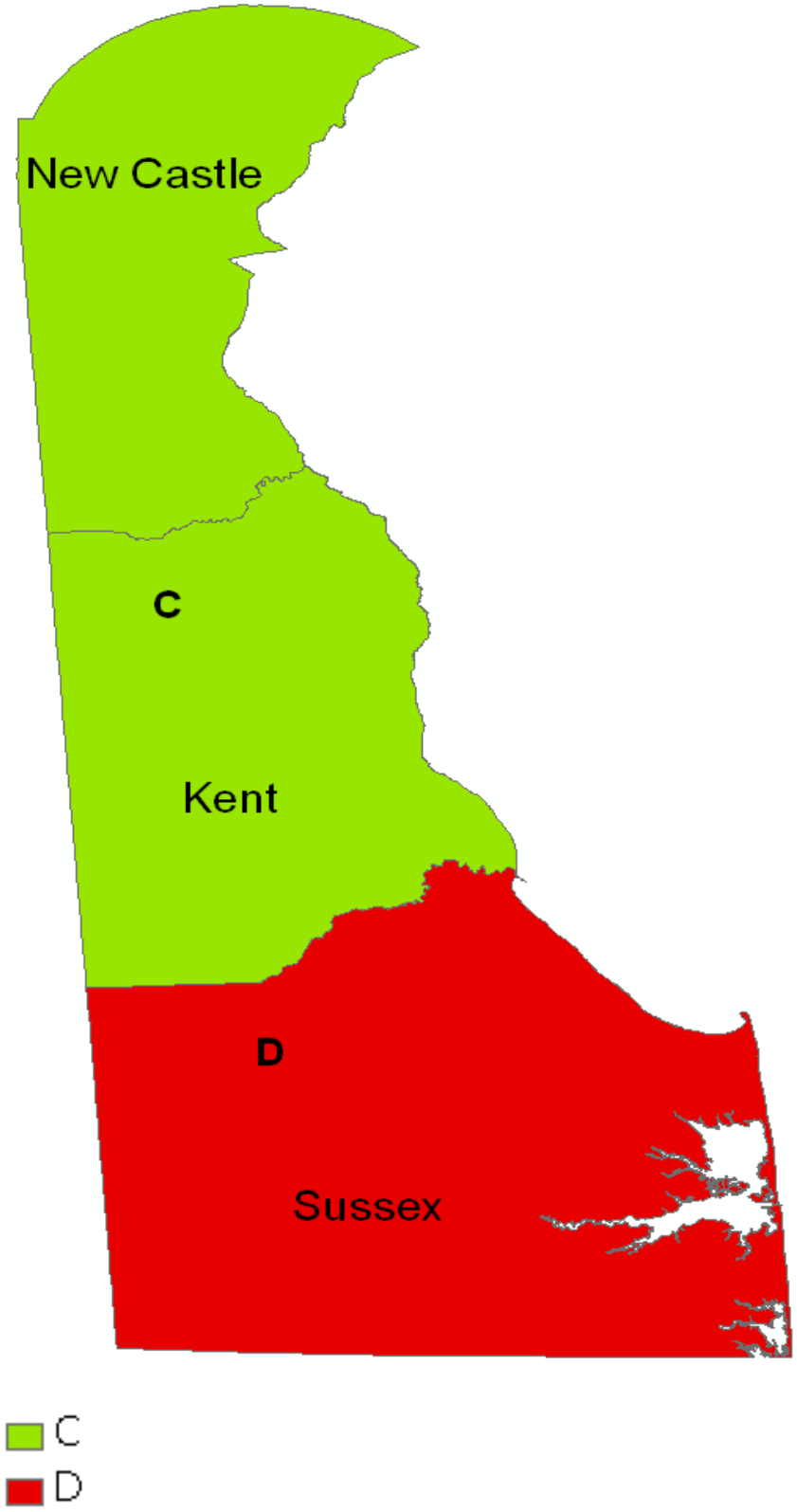
The Delmarva Dimensionless Unit Hydrograph (DMV) is used in much of Delaware and on the eastern shore of the state of Maryland, between the Chesapeake Bay and the Atlantic Ocean. When computing peak discharges in Kent and Sussex Counties, the DMV should always be used. When computing peak discharges in New Castle County, the DMV may be used in the southern portion of the county, within the Atlantic Coastal Plain Province. In northern New Castle County, within the Piedmont Province, the DMV should not be used. In this area, the Standard Dimensionless Unit Hydrograph is appropriate, and is already preset with the NOAA Region C rainfall distribution. For the purpose of simplicity, the C & D Canal is often used (while recognized this is not the geological divide) as the boundary for use of the DMV. It is recognized, however, that this is a transition area, and the DMV may or may not be appropriate immediately north or south of the canal, depending on the location of the watershed. It is recommended that a professional engineer determine which unit hydrograph to use in the transition area.

Rainfall Data

NOAA completed Volume 2 of Atlas 14 precipitation-frequency analysis in 2004. This is the first comprehensive precipitation-frequency analysis for the Ohio Valley and neighboring states since TP-40 was completed in 1961. Data are available for specific locations from an interactive web site (http://hdsc.nws.noaa.gov/hdsc/pfds/). Alternatively, data for representative locations in Delaware are included in a rainfall database **county.DE** for use with the EFH-2 computer program. The data contained in the database are included in Appendix 1 of this Supplement.

Rainfall Distributions

Four rainfall distributions have been developed for the Ohio Valley and neighboring states (DC, DE, IL, IN, KY, MD, NC, NJ, OH, PA, SC, TN, VA, and WV). These were developed based on the NOAA 14 data. Two of these extend into Delaware. The following map (next page) of the state of Delaware shows where to use the two distributions.



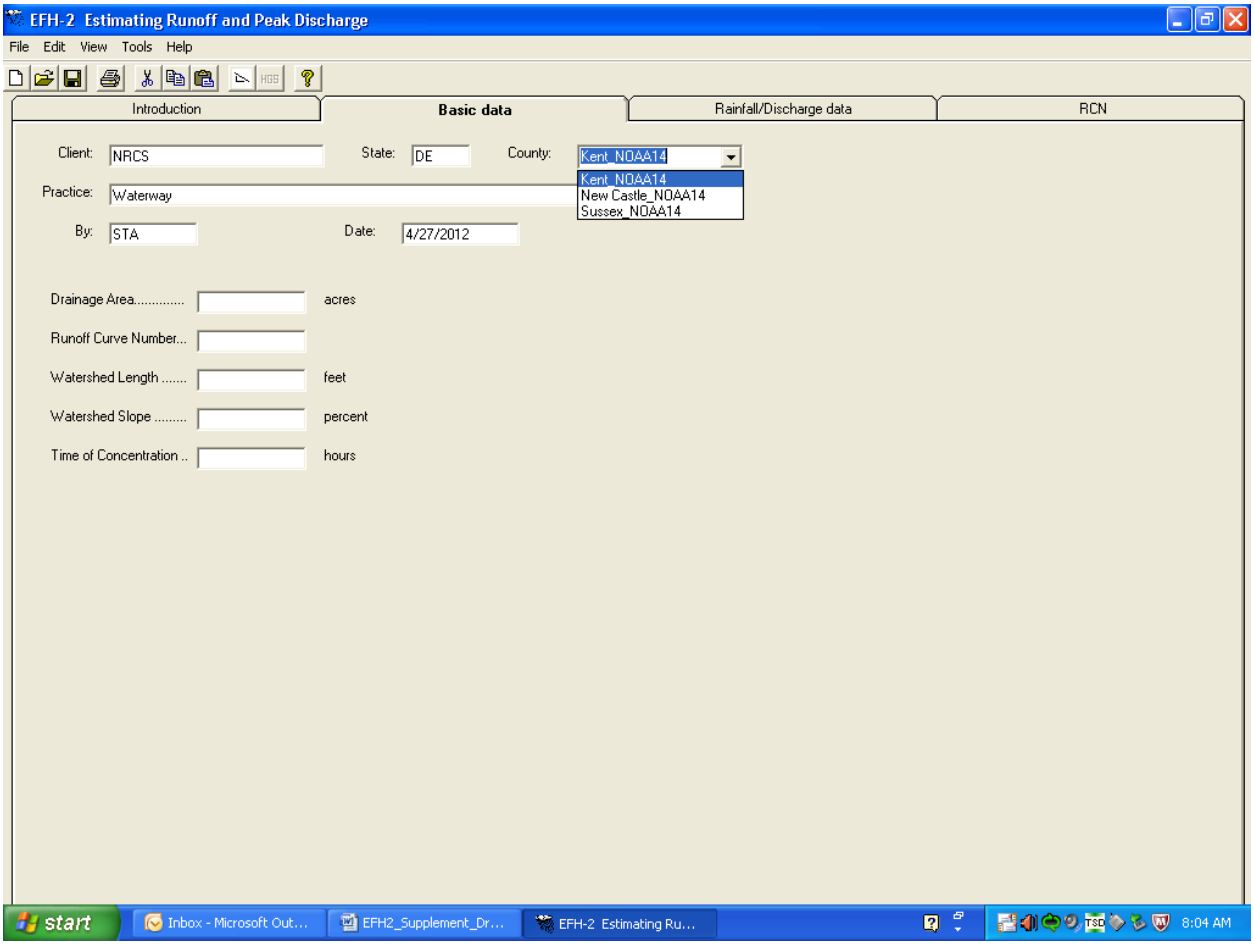
Delaware Regional Rainfall Distributions

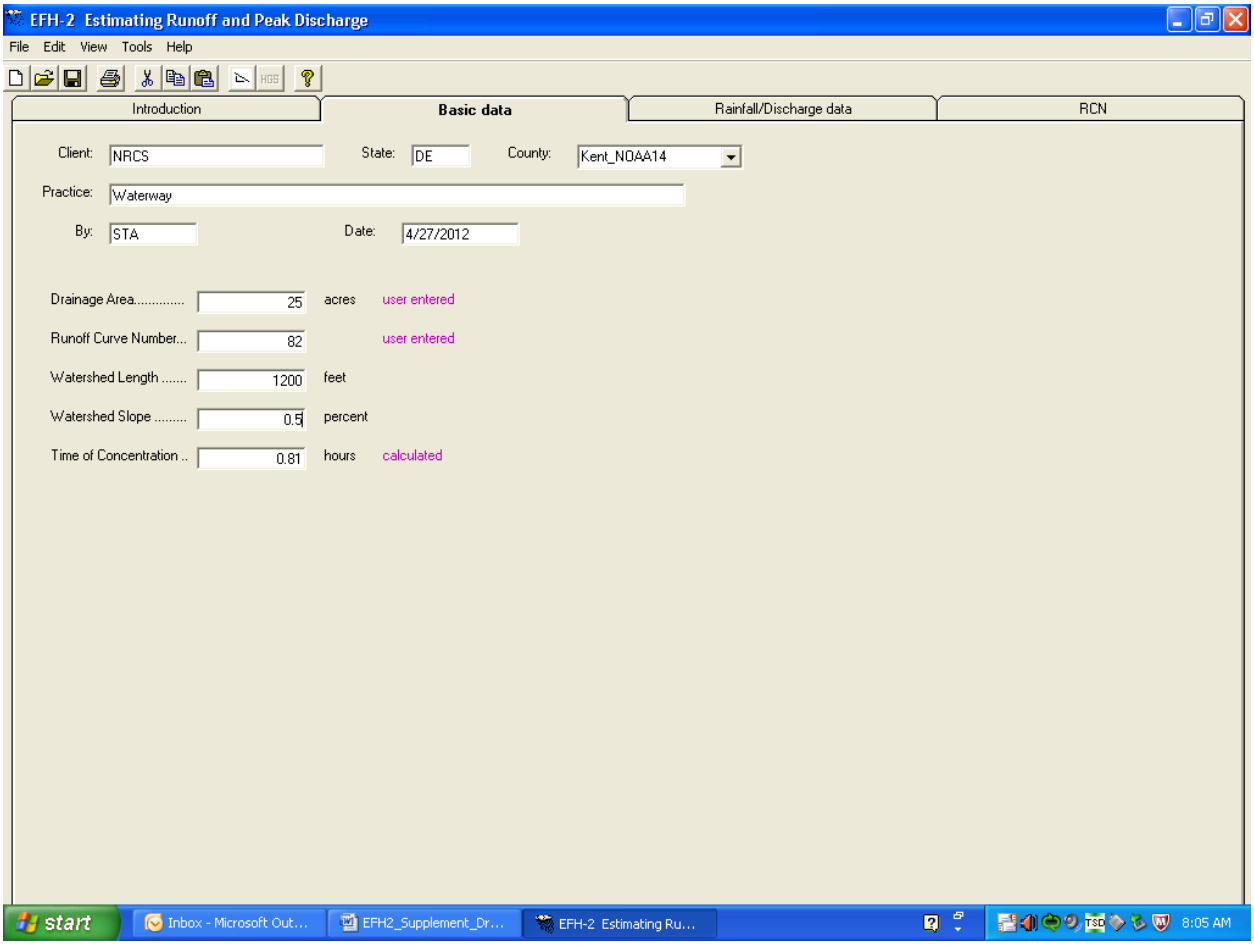
The EFH-2 computer program uses equations to relate unit peak discharge (cubic feet per second per inch of runoff per square mile of drainage area) to time of concentration in hours. The equations and coefficients for the two NOAA 14 rainfall distributions are included in Appendix 2. Plots of the two rainfall distributions are included in Appendix 3.

Example Application of the EFH-2 Computer Program in Delaware

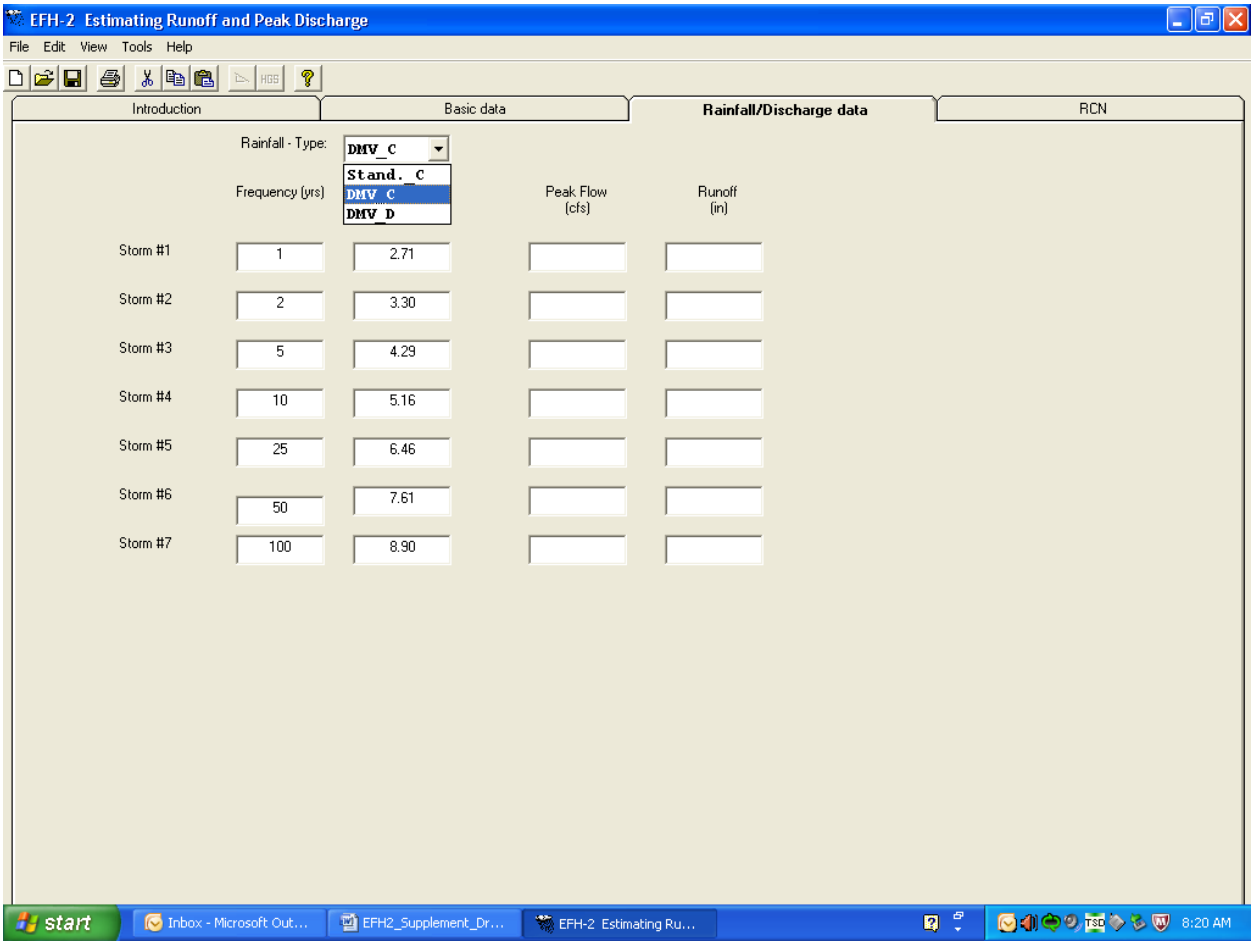
For this example, we select a small watershed in Kent County. The drainage area is 25 acres, the curve number is 82, length is 1200 feet, and average watershed slope is 0.5 percent. From the rainfall distribution map above, the rainfall distribution region is "C".

Open the EFH-2 computer program and open the Basic Data tab. Enter State: DE and use the pull-down menu to select Kent County (Kent_ NOAA14). The "NOAA14" designation indicates that the rainfall table is referenced to NOAA Atlas 14, and includes the most recent rainfall data.



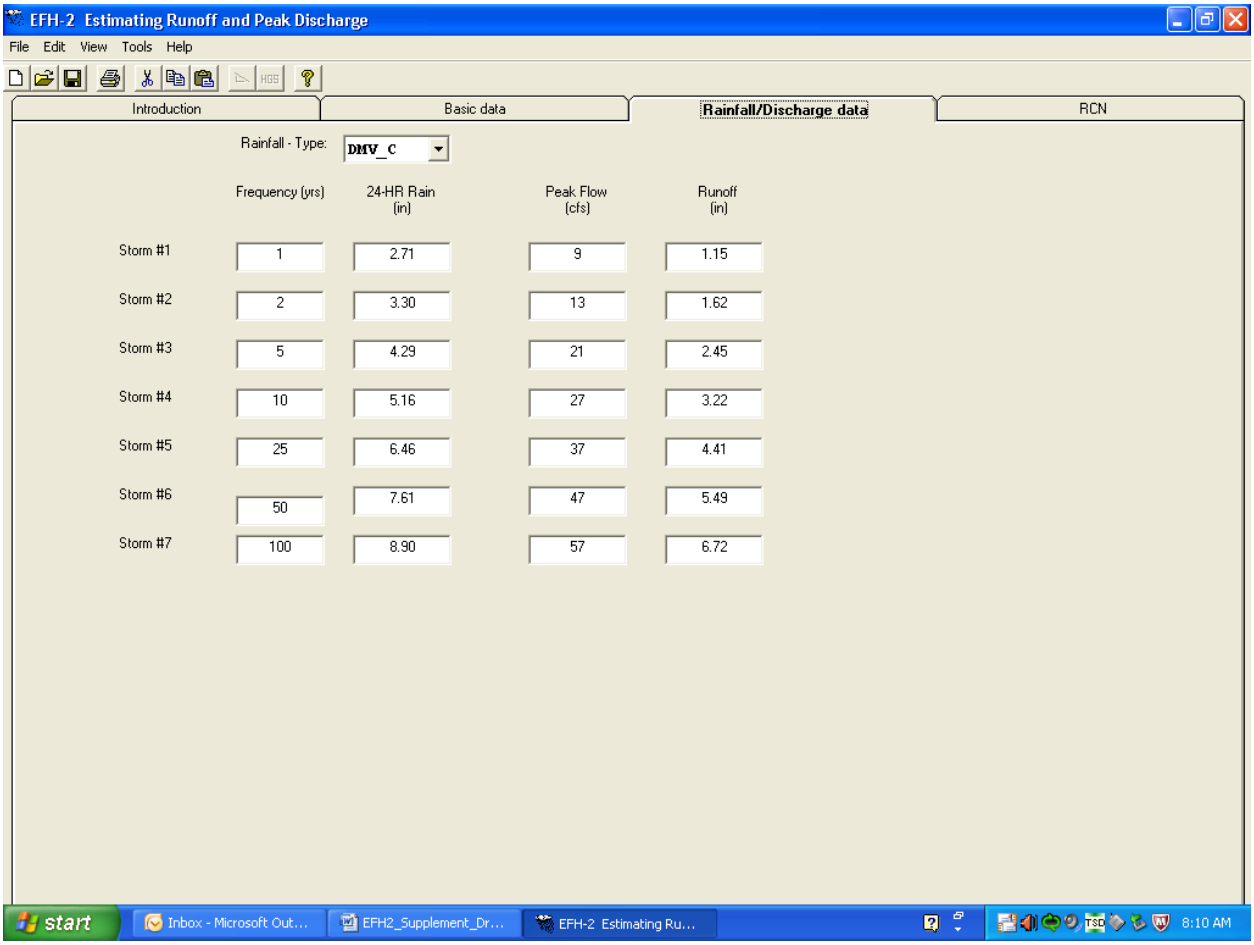


Enter the remaining data on this window. The Drainage Area and Runoff Curve Number could alternatively have been entered by opening the RCN tab (far right side of Basic data window). Open the Rainfall/Discharge data tab.

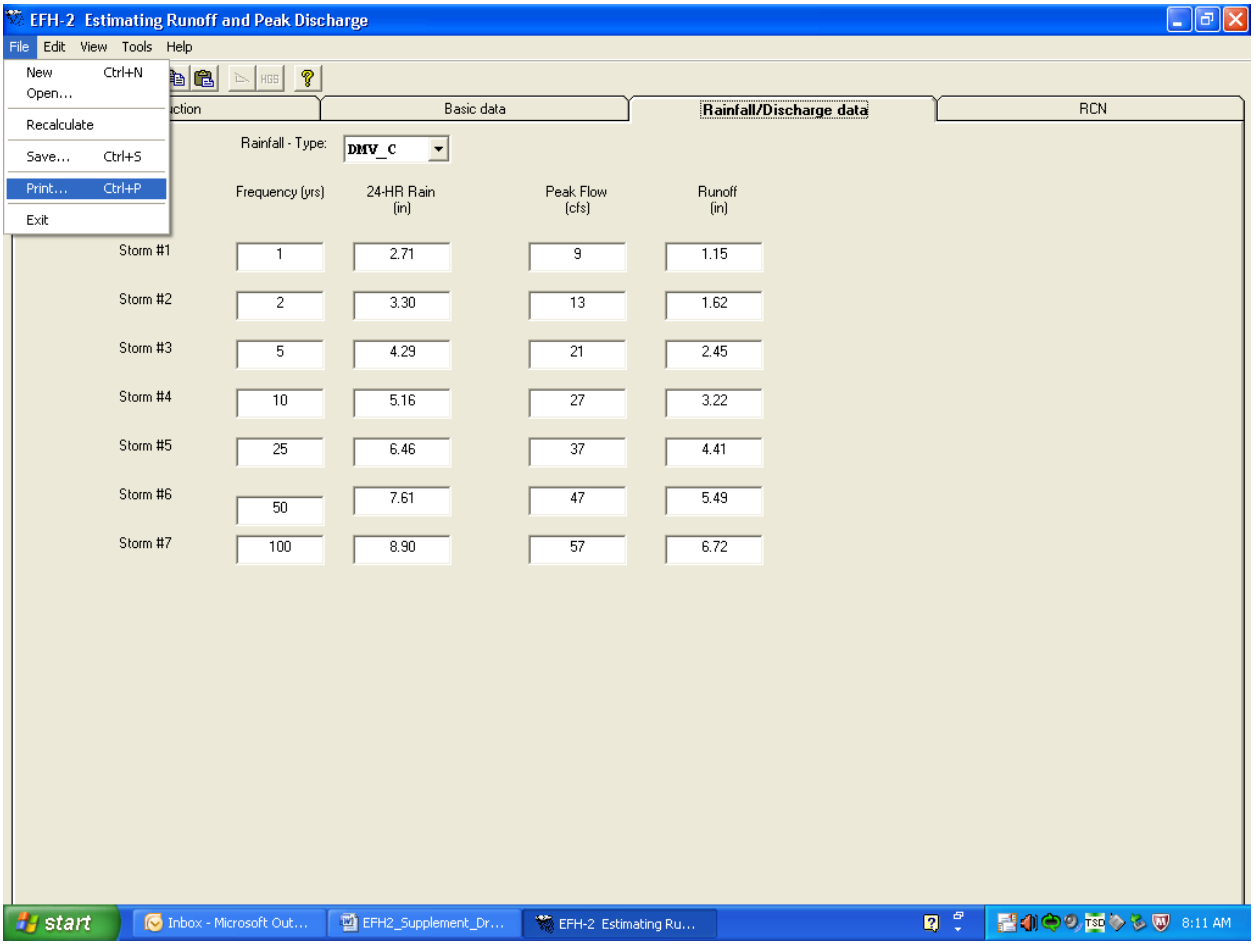


The rainfall data for Kent County have automatically been entered. Use the Rainfall Type: pull-down menu to select DMV_C. For locations in Kent or Sussex Counties, DMV_C or DMV_D should be selected, respectively, from the pull-down menu, based on the appropriate rainfall distribution for the project site (see the rainfall distribution map, above).

Note: Always use the DMV Unit Hydrograph when computing peak discharges in Kent and Sussex Counties. Use Standard _C, for northern New Castle County. Use Standard_C or DMV_C for southern New Castle County, depending on the watershed conditions.



The peak discharges and runoff volumes have been calculated.



To complete the project, click File and Save. Print output if desired. Close EFH-2.

Appendix 1. County rainfall database (county.DE) Notes: Rainfall distribution for each county and zone are shown with the county name (Region C or D). The 24-hour rainfall duration values are in units of inches.

County/Zone	1-year	2-year	5-year	10-year	25-year	50-year	100-year
New Castle NOAA-C	2.64	3.20	4.09	4.85	5.99	6.97	8.05
Kent NOAA-C	2.71	3.30	4.29	5.16	6.46	7.61	8.90
Sussex NOAA-D	2.81	3.42	4.44	5.33	6.68	7.87	9.20

Representative points for Delaware counties included in rainfall database are shown below.



The latitude and longitude of these points are included in the following table. These points were selected because they are approximately located in the center of the county, and most representative of the county rainfall.

COUNTY	Rainfall Distribution	Latitude	Longitude
New Castle Co.	C	39.5280	-75.6762
Kent Co.	C	39.0977	-75.5750
Sussex Co.	D	38.6840	-75.4192

The table above includes Latitude and Longitude for representative points for each county which are in the rainfall database. Longitude is in decimal degrees west and is a negative number. Longitude is in decimal degrees north.

Appendix 2. Rainfall distribution database (type.rf)

Peak discharge results of EFH-2 are derived from results of WinTR-20 runs. To simplify the estimation of peak discharge, WinTR-20 was run for times of concentration of 0.1 to 10.0 hours and Ia/P ratios of 0.1, 0.25, 0.3, 0.4 and 0.5. Ia is initial abstraction in units of inches. Initial abstraction includes all losses before runoff begins (interception, depression storage, early storm infiltration, etc). P is the storm rainfall with units of inches.

$$Ia = 0.2 * ((1000 / CN) - 10) \quad \text{Eq. 1}$$

where CN = NRCS runoff curve number.

Equations to relate time of concentration to unit peak discharge were then developed based on the WinTR-20 peak discharges. The equation used to compute the unit peak discharge (q) for the EFH-2 computer program is:

$$q = 10 ^ (Coeff_1 + Coeff_2 * LOG(Tc) + Coeff_3 * (LOG(Tc))^2) \quad \text{Eq. 2}$$

The coefficients to be used with each rainfall distribution are tabulated below. For example, the equation applicable to the Region C rainfall distribution of northern Delaware and Ia/P ratio of 0.1 is:

$$q = 10 ^ (2.4928 - 0.585 * LOG(Tc) - 0.137 * (LOG(Tc))^2) \quad \text{Eq. 3}$$

For a time of concentration of 0.58 hours and Ia/P ratio of 0.1, the unit peak discharge is q = 420.69 cfs / inch / sq mile.

For a drainage area of 100 acres (0.156 square miles) and runoff of 2.42 inches (rainfall is 4.15 inches, CN is 83, and Ia is 0.41 inch), the peak discharge, Q, is:

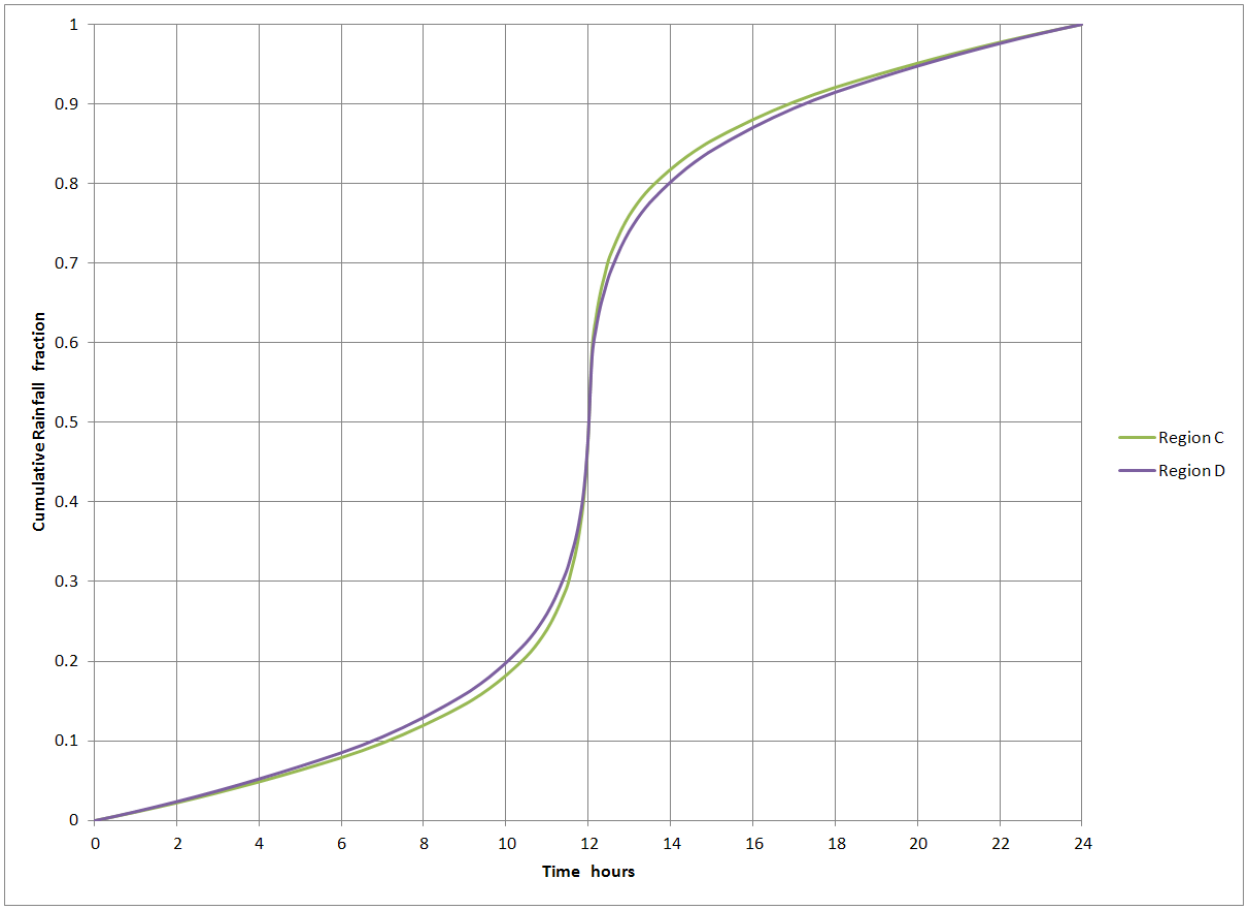
$$Q = 420.69 * 0.156 * 2.42 = 159 \text{ cfs} \quad \text{Eq. 4}$$

The peak discharge equation coefficients for each rainfall distribution are shown below.

Ia/P	Coeff_1	Coeff_2	Coeff_3
NOAA_C,5			
0.1,	2.4928,	-0.585,	-0.137
0.25,	2.4494,	-0.5928,	-0.1154
0.3,	2.4182,	-0.5857,	-0.1018
0.4,	2.3289,	-0.5381,	-0.0754
0.5,	2.1955,	-0.3952,	-0.1077
DMV_C,5			
0.1,	2.2789,	-0.6589,	-0.1045
0.25,	2.2181,	-0.6548,	-0.0745
0.3,	2.1852,	-0.64,	-0.0625
0.4,	2.1058,	-0.5758,	-0.0556
0.5,	2.0114,	-0.4671,	-0.0811
DMV_D,5			
0.1,	2.2428,	-0.638,	-0.0973
0.25,	2.1805,	-0.6327,	-0.0625
0.3,	2.146,	-0.6164,	-0.0508
0.4,	2.0604,	-0.5445,	-0.0405
0.5,	1.965,	-0.4129,	-0.0827

Appendix 3. Plots of the Ohio Valley and neighboring states rainfall distributions.

The following plots show the distribution of rainfall for the 24-hour design storm. They represent the accumulated rainfall during the 24-hour storm duration on a non-dimensional basis. The maximum accumulated rainfall in the plot is 1.0 which represents the total storm 24-hour rainfall.



These rainfall distributions are represented in WinTR-20 in tabular format at a time interval of 0.1 hour.



United States Department of Agriculture

Natural Resources Conservation Service

Conservation Engineering Division

Technical Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

Appendix B Synthetic Rainfall Distributions and Rainfall Data Sources

The highest peak discharges from small watersheds in the United States are usually caused by intense, brief rainfalls that may occur as distinct events or as part of a longer storm. These intense rainstorms do not usually extended over a large area and intensities vary greatly. One common practice in rainfall-runoff analysis is to develop a synthetic rainfall distribution to use in lieu of actual storm events. This distribution includes maximum rainfall intensities for the selected design frequency arranged in a sequence that is critical for producing peak runoff.

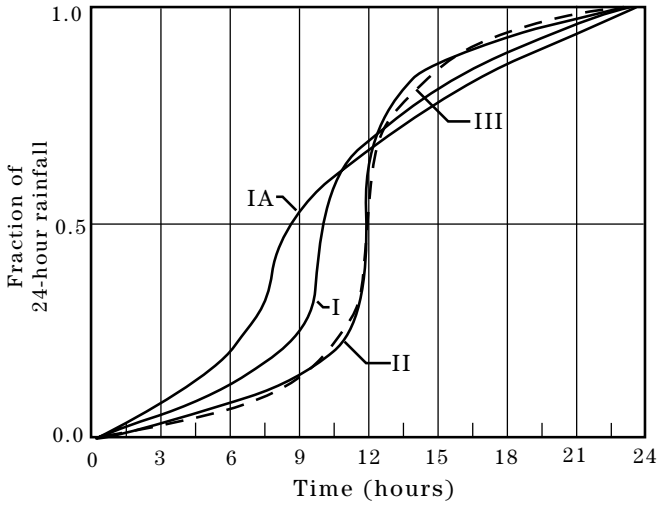
Synthetic rainfall distributions

The length of the most intense rainfall period contributing to the peak runoff rate is related to the time of concentration (T_c) for the watershed. In a hydrograph created with NRCS procedures, the duration of rainfall that directly contributes to the peak is about 170 percent of the T_c. For example, the most intense 8.5-minute rainfall period would contribute to the peak discharge for a watershed with a T_c of 5 minutes. The most intense 8.5-hour period would contribute to the peak for a watershed with a 5-hour T_c.

Different rainfall distributions can be developed for each of these watersheds to emphasize the critical rainfall duration for the peak discharges. However, to avoid the use of a different set of rainfall intensities for each drainage area size, a set of synthetic rainfall distributions having "nested" rainfall intensities was developed. The set "maximizes" the rainfall intensities by incorporating selected short duration intensities within those needed for longer durations at the same probability level.

For the size of the drainage areas for which NRCS usually provides assistance, a storm period of 24 hours was chosen the synthetic rainfall distributions. The 24-hour storm, while longer than that needed to determine peaks for these drainage areas, is appropriate for determining runoff volumes. Therefore, a single storm duration and associated synthetic rainfall distribution can be used to represent not only the peak discharges but also the runoff volumes for a range of drainage area sizes.

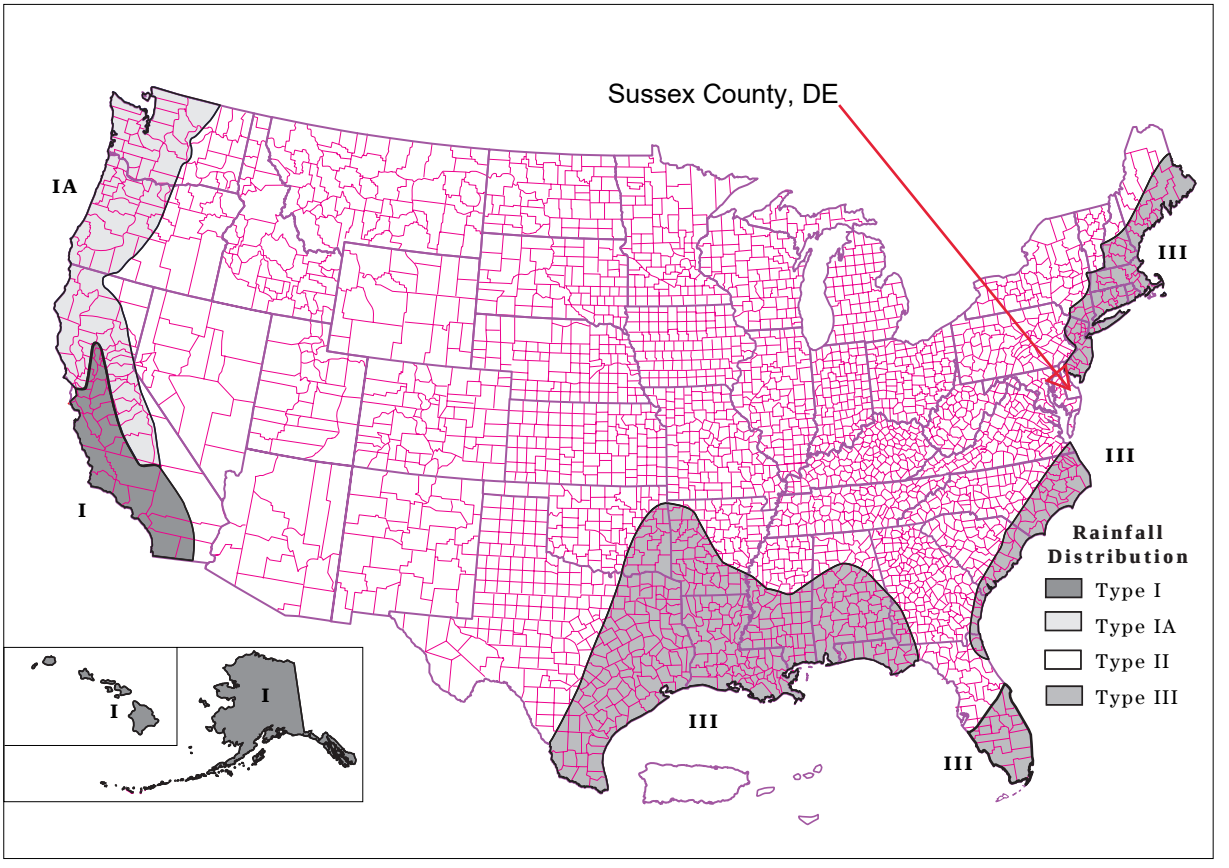
Figure B-1 SCS 24-hour rainfall distributions



The intensity of rainfall varies considerably during a storm as well as geographic regions. To represent various regions of the United States, NRCS developed four synthetic 24-hour rainfall distributions (I, IA, II, and III) from available National Weather Service (NWS) duration-frequency data (Hershfield 1061; Frederick et al., 1977) or local storm data. Type IA is the least intense and type II the most intense short duration rainfall. The four distributions are shown in figure B-1, and figure B-2 shows their approximate geographic boundaries.

Types I and IA represent the Pacific maritime climate with wet winters and dry summers. Type III represents Gulf of Mexico and Atlantic coastal areas where tropical storms bring large 24-hour rainfall amounts. Type II represents the rest of the country. For more precise distribution boundaries in a state having more than one type, contact the NRCS State Conservation Engineer.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

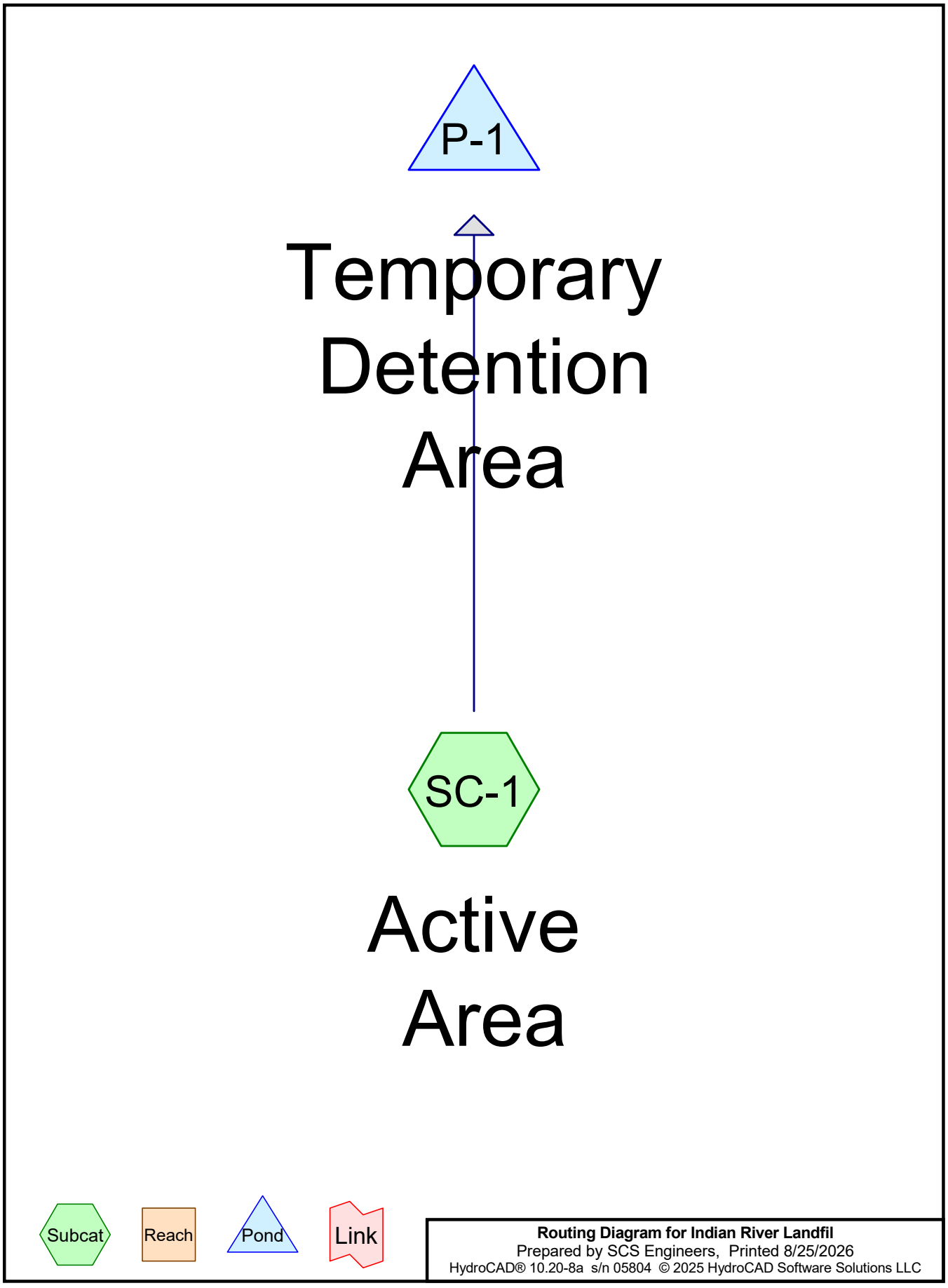
Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

Appendix B

HydroCAD Output Files



Routing Diagram for Indian River Landfil
Prepared by SCS Engineers, Printed 8/25/2026
HydroCAD® 10.20-8a s/n 05804 © 2025 HydroCAD Software Solutions LLC

Summary for Subcatchment SC-1: Active Area

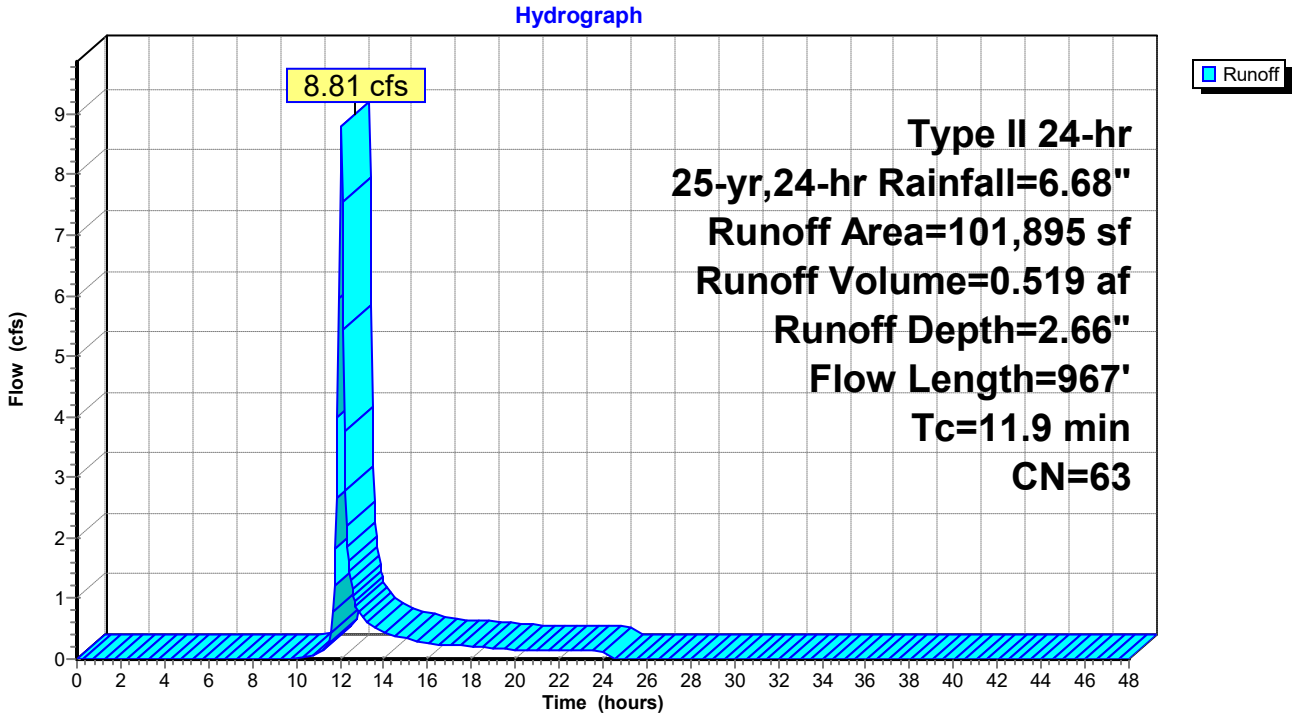
Runoff = 8.81 cfs @ 12.04 hrs, Volume= 0.519 af, Depth= 2.66"
Routed to Pond P-1 : Temporary Detention Area

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-yr,24-hr Rainfall=6.68"

	Area (sf)	CN	Description
*	101,895	63	CCR Material
	101,895		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	100	0.0223	1.48		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.40"
10.8	867	0.0180	1.34		**Shallow Concentrated Flow,** Nearly Bare & Untilled Kv= 10.0 fps
11.9	967	Total			

Subcatchment SC-1: Active Area



Summary for Pond P-1: Temporary Detention Area

Inflow Area = 2.339 ac, 0.00% Impervious, Inflow Depth = 2.66" for 25-yr,24-hr event
Inflow = 8.81 cfs @ 12.04 hrs, Volume= 0.519 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 20.50' @ 24.70 hrs Surf.Area= 46,899 sf Storage= 22,619 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	20.00'	100,913 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
20.00	43,525	0	0
21.00	50,269	46,897	46,897
22.00	57,763	54,016	100,913

Pond P-1: Temporary Detention Area

