STORMWATER MEMORANDUM

FOR

HIGHLAND AT VALE

TOWNHOME AND MULTI-FAMILY PROJECT
TECHNOLOGY AND BUSINESS OVERLAY DISTRICT (TBOD)

THE VALE
HILL STREET
(PORTIONS OF LOTS 54-05-01 & 62-01-29)
WOBURN, MA 01801

PREPARED FOR:

PULTE HOMES OF NEW ENGLAND, LLC
115 FLANDERS ROAD, SUITE 200
WESTBOROUGH, MA 01581

PREPARED BY:

CIVIL DESIGN GROUP, LLC
21 HIGH STREET, SUITE 207
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COMMONWEALTH OF MASSACHUSETTS
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No. 45641
REGISTERED PROFESSIONAL ENGINEER

DATE: APRIL 30, 2020

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1.0 INTRODUCTION

The 15.6± acre *Highland at Vale* project ("Project"), which is the subject of this memorandum, is part of a 60± acre master-planned redevelopment project known as *The Vale* located at the former Kraft Atlantic Gelatin Facility ("Kraft Plant") on Hill Street. A locus plan is included as Figure 1. *The Vale* will revitalize the former Kraft Plant into a mixed-use development consisting of office/lab/flex/research and development, retail, hotel, institutional, and residential uses comprised of townhomes, multi-family housing, and senior housing.

The Vale will be constructed in phases beginning with demolition of the existing Kraft Plant, construction of the internal roadway, environmental remediation, wetlands replication, utility infrastructure and stormwater management improvements to support the entire redevelopment. Following this initial site enabling phase, construction activities will continue to include buildout of the individual components of the development including the townhome/multi-family residential area. The *Highland at Vale* component, the subject of this memorandum, is comprised of a portion of Assessor's Parcel 54-05-01 (Hill Street) and a portion of Assessor's Parcel 62-01-29 (1 Washington Avenue). The Project includes 197 condominium units including 75 townhome dwellings and 122 will be multi-family "garden style" units contained in three multi-story buildings.

A "master" stormwater report[1] covering the entire master-planned development (including the Project site) was prepared in April 2020 by Stantec Planning and Landscape Architecture, P.C. ("Stantec") and filed with the City of Woburn by the master developer, Montvale Land LLC (hereinafter referred to as the "Master Stormwater Report"). Civil Design Group, LLC, Pulte's design engineer, has collaborated with Stantec, the master developer's design engineer, to ensure that the stormwater management program for the Project fits within and is consistent with the stormwater management program outlined in the Master Stormwater Report. This purpose of this memorandum is to document the same.

2.0 SITE DESCRIPTION

Highland at Vale is comprised of a portion of Assessor's Parcel 54-05-01 (Hill Street) and a portion of Assessor's Parcel 62-01-29 (1 Washington Avenue). It will occupy a portion of the former Kraft Plant industrial site on Hill Street, within an established commercial area of Woburn. The overall site (*The Vale*) is bounded to the north by Hill Street, to the east by Interstate 93, to the south by the Winchester town line, and to the west by the Aberjona River, which flows in a southerly direction along the western boundary of the overall site. Topography on the Project site generally slopes in a westerly direction towards the Aberjona River.

There are no wetland resource areas on the Project site but wetlands associated with the Aberjona River do exist to the west of the project site. These wetlands were delineated between June 17, 2019 and November 5, 2019 by environmental scientists with VHB in accordance with methods developed by the DEP and the U.S. Army Corps of Engineers. The resource areas were established by way of an Order of Resource Area Delineation ("ORAD") issued by the Woburn Conservation Commission on November 22, 2019 (DEP File No. 348-809).

According to the most recently available data provided by the Massachusetts Natural Heritage and Endangered Species Program (NHESP), no portion of the Project is within Priority Habitat of Rare Species or Estimated Habitat of Rare Wildlife and there are no Certified or Potential Vernal Pools in the vicinity of the Project. The most recently issued Flood Insurance Rate Map ("FIRM") for the area, produced by the Federal Emergency Management Agency ("FEMA"), indicates that no portions of the Project are within the mapped floodplain for the 100-year storm event. According to the Massachusetts

[1] *Stormwater Report, The Vale – Master Plan*, by Stantec, dated April 16, 2020.

Department of Environmental Protection ("DEP"), the Project is not located within an Area of Critical Environmental Concern (ACEC) or an area designated as an Outstanding Resource Water (ORW).

3.0 UNTREATED DISCHARGE (STANDARD 1)

As stated in the Master Stormwater Report, runoff contributing to the proposed stormwater outfalls will be treated prior to discharging and outfalls will be constructed with energy dissipating rip-rap aprons to control exiting velocities each outfall location.

4.0 PEAK RATE ATTENUATION (STANDARD 2)

4.1 Points of Analysis

The Master Stormwater Report identifies four design points that serve as comparison points for the peak discharge rates of the pre- and post-development hydrologic conditions. These design points are illustrated in Figure 1.7 of the Master Stormwater Report (Attachment A). The Project contributes flow to the following two design points:

DP3 – Aberjona River: Stormwater runoff from the majority of the undisturbed wooded area and small portion of the existing Kraft facility sheet flows directly to the Aberjona River (DP3).

DP4 – Offsite Wetland (Southeast): Stormwater runoff from a portion of the undisturbed wooded area at the southeast corner of the property sheet flows directly to an offsite wetland (DP4).

4.2 Subcatchments

The Master Stormwater Report identifies six proposed subcatchments associated with the Project as described below. These subcatchments are illustrated both in Figure 2 of this memorandum and are consistent with those evaluated in the Master Stormwater Report as shown in Figure 2.6 from the Master Stormwater Report (Attachment B).

PUL-TH1: This area is referred to as "PR-PUL-TH-1" in the Master Stormwater Report. The 10.20-acre watershed is comprised of pavement, rooftops, lawn, and water surface associated with the proposed detention basin (Pond DET-TH-1). Runoff from this subcatchment is collected via the proposed drainage system, treated, and routed through the detention basin. Outflow from the detention basin contributes to DP3.

PUL-TH2: This area is referred to as "PR-PUL-TH-2" in the Master Stormwater Report. The 1.11-acre watershed is comprised of rooftops, lawn, and brushy areas, representing the small downstream edge of the townhome area which sheet flows towards DP3.

PUL-MF1: This area is referred to as "PR-PUL-MF-1" in the Master Stormwater Report. The 3.48-acre watershed is comprised of pavement, rooftops, and lawn. Runoff from this subcatchment is collected via the proposed drainage system, treated, and routed through a subsurface detention basin (Pond DET-MF-1). Outflow from the detention basin is conveyed to the "Ring Road" drainage system which contributes to DP3.

PUL-MF2: This area is referred to as "PR-PUL-MF-2" in the Master Stormwater Report. The 0.37-acre watershed is comprised of rooftop. Runoff from this subcatchment is collected via the proposed drainage system and routed through a subsurface detention basin (Pond DET-MF-2). Outflow from the detention basin is conveyed to the "Ring Road" drainage system which contributes to DP3.

PUL-MF3: This area is referred to as “PR-PUL-MF-3” in the Master Stormwater Report. The 0.22-acre watershed is comprised of lawn, representing the small northerly downstream edge of the multi-family area. This area sheet flows to the “Ring Road” drainage system, which contributes to DP3.

PUL-MF4: This area is referred to as “PR-PUL-MF-4” in the Master Stormwater Report. The 0.20-acre watershed is comprised of woods, representing the small southerly downstream edge of the multi-family area. This area sheet flows towards DP4.

4.3 Curve Numbers

For purposes of generating the weighted Curve Numbers (CNs), the following values were utilized:

- pavement and concrete were classified as “paved parking”
- roof tops were classified as “roofs”
- wooded upland areas were classified as “woods, good”
- fallow areas were classified as “brush, good”
- lawn areas were classified as “>75% grass cover, good”
- proposed stormwater basin was classified as “water surface”

As documented in the Master Stormwater Report, the NRCS classification for Hydrologic Soil Groups (HSGs) varies between A and B/D. A majority of the property is considered Urban Land, which is not assigned a Hydrologic Soil Group. Based on the available soils data, Project areas proposed to be in a cut were classified as HSG-D due to the presence of shallow ledge and Project areas proposed to be in a fill were classified as HSG-C. This is consistent with the modeling contained in the Master Stormwater Report.

4.4 Mitigation Measures

Peak flow from the Project has been mitigated through the use of detention best management practices (BMPs) as described further below and shown in detail on the corresponding design plans. Post-development HydroCad output for the same storm events evaluated in the Master Stormwater Report is included as Attachment C. The HydroCad input and output is identical to the corresponding HydroCad modeling in the Master Stormwater Report, as Stantec and CDG coordinated and shared HydroCad modeling throughout the design process.

Pond DET-TH-1: This BMP is referred to as “INFTH” in the Master Stormwater Report. This BMP is a surface detention basin with a multi-stage outlet structure that takes the majority of runoff from the townhome area of the Project. The outflow from this BMP contributes directly to DP3.

Pond DET-MF-1: This BMP is referred to as “INFMF1” in the Master Stormwater Report. This BMP is a subsurface detention basin consisting of underground chambers with a multi-stage outlet structure that takes the majority of runoff from the multi-family area of the Project. The outflow from this BMP contributes to DP3 via the “Ring Road” drainage system, as modeled by the Master Stormwater Report.

Pond DET-MF-2: This BMP is referred to as “INFMF2” in the Master Stormwater Report. This BMP is a subsurface detention basin consisting of underground chambers with a multi-stage outlet structure that takes the rooftop of one of the multi-family buildings. The outflow from this BMP contributes to DP3 via the “Ring Road” drainage system, as modeled by the Master Stormwater Report.

4.5 Peak Flow Comparison Table

Post-development peak flow rates for the Project are consistent with the peak flow rates allotted to the Project in the Master Stormwater Report as summarized in the following table:

POINT OF ANALYSIS	2-YEAR STORM EVENT (3.30"/24-HR)		10-YEAR STORM EVENT (5.20"/24-HR)		50-YEAR STORM EVENT (7.46"/24-HR)		100-YEAR STORM EVENT (8.94"/24-HR)	
	Stantec (CFS)	**CDG (CFS)**	**Stantec (CFS)**	**CDG (CFS)**	**Stantec (CFS)**	**CDG (CFS)**	**Stantec (CFS)**	**CDG (CFS)**
DP3	*8.48*	**8.48**	*15.84*	**15.84**	*31.00*	**31.00**	*58.41*	**58.41**
DP4	*0.29*	**0.29**	*0.65*	**0.65**	*1.12*	**1.12**	*1.42*	**1.42**

The rates provided from Master Stormwater Report in the table above are those associated with Reach "PUL" (representing the Project area contributing to DP3) and Reach "PUL-3" (representing the Project area contributing to DP4). The Stantec and CDG rates are identical as Stantec and CDG coordinated and shared HydroCad modeling throughout the design process.

5.0 STORMWATER RECHARGE (STANDARD 3)

As described in the Master Stormwater Report, the stormwater recharge requirement for the *Vale* has been satisfied in areas of site where the soils are best suited to handle infiltration. None of these areas lie within the Project area due to the presence of ledge throughout much of the Project site.

6.0 WATER QUALITY (STANDARD 4)

The Master Stormwater Report states "For each site to be in compliance with the TSS calculations set forth in this report, each individual site is required to obtain 80% TSS removal on a weighted basis." By utilizing the BMPs outlined below, the Project achieves a higher level of water quality treatment than the 80% requirement. Treatment trains documenting the provided TSS removal are also provided below.

Deep Sump Hooded Catch Basins: Stormwater runoff from proposed pavement areas will be directed via curbing and site grading to catch basins with deep sumps and hooded outlets. The catch basins will trap and remove sediment and larger particles from the stormwater and will improve the performance of subsequent BMPs. The sumps will be a minimum of 4' in depth and a regular inspection and cleaning schedule has been proposed to ensure optimal effectiveness.

Proprietary Water Quality Units: The proposed proprietary water quality units (WQUs) are designed to remove heavy particles, floating debris and hydrocarbons from stormwater. Stormwater enters the system where floatables and oils are separated prior to the clarified stormwater runoff discharging to an outlet pipe.

TREATMENT TRAIN TO DETENTION BASIN DET-TH-1

BMP (A)	TSS Removal Rate (B)	Starting TSS Load (C)	Amount Removed (BxC) (D)	Remaining Load (C-D) (E)
Deep Sump CBs	0.25	1.0	0.25	0.75
WQU Unit DMH-35	0.88[2]	0.75	0.66	0.09
Total TSS Removal = Summation of (D) =			**91%**	

TREATMENT TRAIN TO DETENTION BASIN DET-MF-1, INLET 1

BMP (A)	TSS Removal Rate (B)	Starting TSS Load (C)	Amount Removed (BxC) (D)	Remaining Load (C-D) (E)
Deep Sump CBs	0.25	1.0	0.25	0.75
WQU Unit DMH-46	0.91[3]	0.75	0.68	0.07
Total TSS Removal = Summation of (D) =			**93%**	

TREATMENT TRAIN TO DETENTION BASIN DET-MF-1, INLET 2

BMP (A)	TSS Removal Rate (B)	Starting TSS Load (C)	Amount Removed (BxC) (D)	Remaining Load (C-D) (E)
Deep Sump CBs	0.25	1.0	0.25	0.75
WQU Unit DMH-47	0.88[4]	0.75	0.66	0.09
Total TSS Removal = Summation of (D) =			**91%**	

7.0 LUHPPL (STANDARD 5)

Not applicable to the Project. As stated in the Master Stormwater Report, only the commercial portion of the *Vale* constitutes a LUHPPL.

8.0 CRITICAL AREAS (STANDARD 6)

Not applicable to the Project. As stated in the Master Stormwater Report, the stormwater system does not discharge to a critical area.

9.0 REDEVELOPMENT (STANDARD 7)

As stated in the Master Stormwater Report, the *Vale* is considered a mix of new development and redevelopment. As proposed, the *Vale* complies with the new development requirements of Standards 2, 4, 5, and 6, and Standard 3 is met to the maximum extent practicable by providing recharge for the increase in impervious area from the existing to the proposed condition.

[2] See attached water quality unit sizing documentation, Attachment D

[3] See attached water quality unit sizing documentation, Attachment D

[4] See attached water quality unit sizing documentation, Attachment D

10.0 EROSION & SEDIMENT CONTROL PLAN (STANDARD 8)

As stated in the Master Stormwater Report, Sedimentation and erosion controls are proposed to be installed and maintained throughout all phases of construction. Erosion control measures for the Project are shown on the accompanying design plans. Furthermore, since the Project will entail land disturbance exceeding one acre, a Stormwater Pollution Prevention Plan (SWPPP) will be prepared for the Project prior to construction to obtain coverage under EPA's Construction General Permit.

11.0 OPERATION & MAINTENANCE PLAN (STANDARD 9)

A post-construction Operation and Maintenance (O&M) Plan for the Project is included as Attachment E.

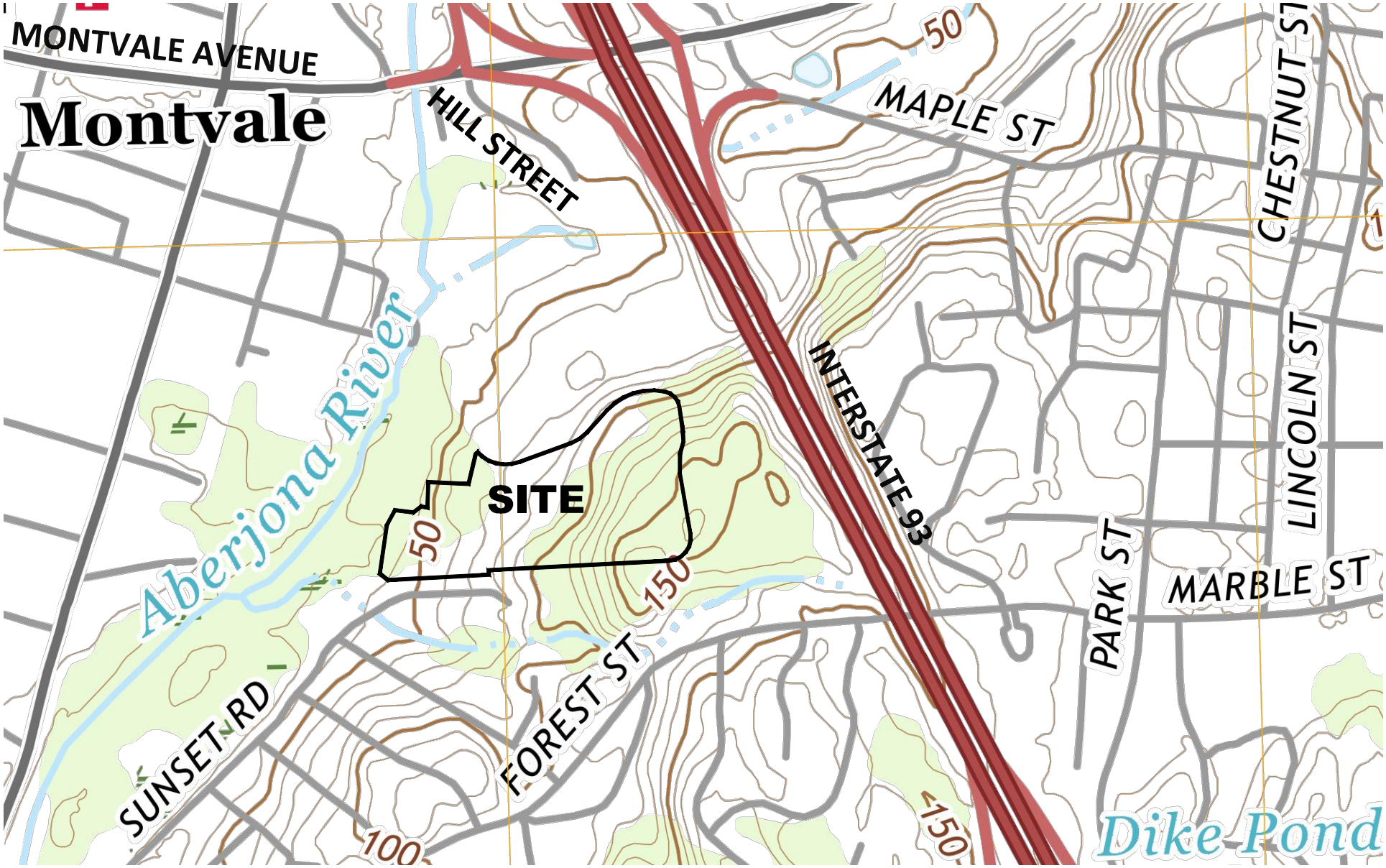
12.0 ILLICIT DISCHARGES (STANDARD 10)

The proposed stormwater management system does not include any illicit discharges. An illicit discharge statement is included as Attachment F.

13.0 DRAINAGE CONVEYANCE SYSTEM

The proposed stormwater conveyance system is designed to collect and convey runoff from developed areas to the associated stormwater management system BMPs described in this memorandum. The drainage system consists of deep-sump hooded catch basins, manholes, water quality units, and pipes. Using the rational method to determine peak runoff flows, the proposed conveyance system is designed for the 25-year storm event. Systems have been designed so as not to have any bypass from the most downstream on-grade structures, and to have a ponding depth less than the curb height for the structures in sags. Hydraflow Storm Sewers output is included in as Attachment G.

Figures



600 0 300 600 1200

GRAPHIC SCALE IN FEET

SOURCE: USGS TOPO 2019
QUADRANGLE: BOSTON NORTH

CLIENT:

Pulte HOMES

HIGHLAND AT VALE
HILL STREET
WOBURN, MA 01801

CIVIL DESIGN GROUP, LLC

21 HIGH STREET SUITE 207
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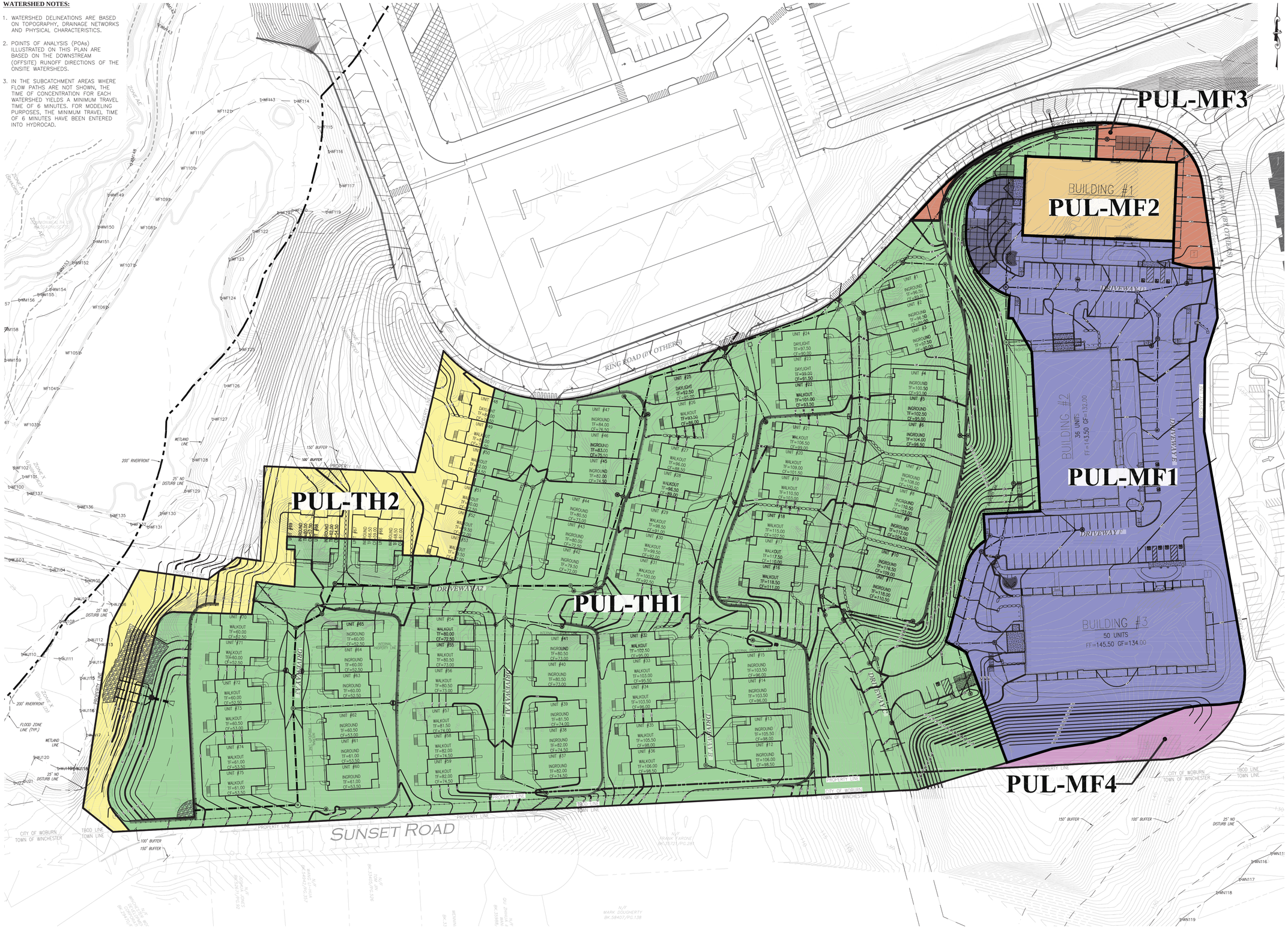
FIGURE-1
USGS PLAN

APRIL 2020

WATERSHED NOTES:

1. WATERSHED DELINEATIONS ARE BASED ON TOPOGRAPHY, DRAINAGE NETWORKS AND PHYSICAL CHARACTERISTICS.
2. POINTS OF ANALYSIS (POAs) ILLUSTRATED ON THIS PLAN ARE BASED ON THE DOWNSTREAM (OFFSITE) RUNOFF DIRECTIONS OF THE ONSITE WATERSHEDS.
3. IN THE SUBCATCHMENT AREAS WHERE FLOW PATHS ARE NOT SHOWN, THE TIME OF CONCENTRATION FOR EACH WATERSHED YIELDS A MINIMUM TRAVEL TIME OF 6 MINUTES. FOR MODELING PURPOSES, THE MINIMUM TRAVEL TIME OF 6 MINUTES HAVE BEEN ENTERED INTO HYDROCAD.



NOT FOR CONSTRUCTION

CDG PROJECT #: 19024

REVISIONS:

REV	DATE	COMMENT
1		
2		
3		
4		
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7		
8		
9		
10		

PLANNING BOARD:

SEAL:

MATTHEW A. LEIDNER, P.E.

PREPARED BY:

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PROJECT:

HIGHLAND AT VALE

HILL STREET
WOBURN, MASSACHUSETTS

SCALE:

50 0 25 50 100
GRAPHIC SCALE IN FEET

SHEET:

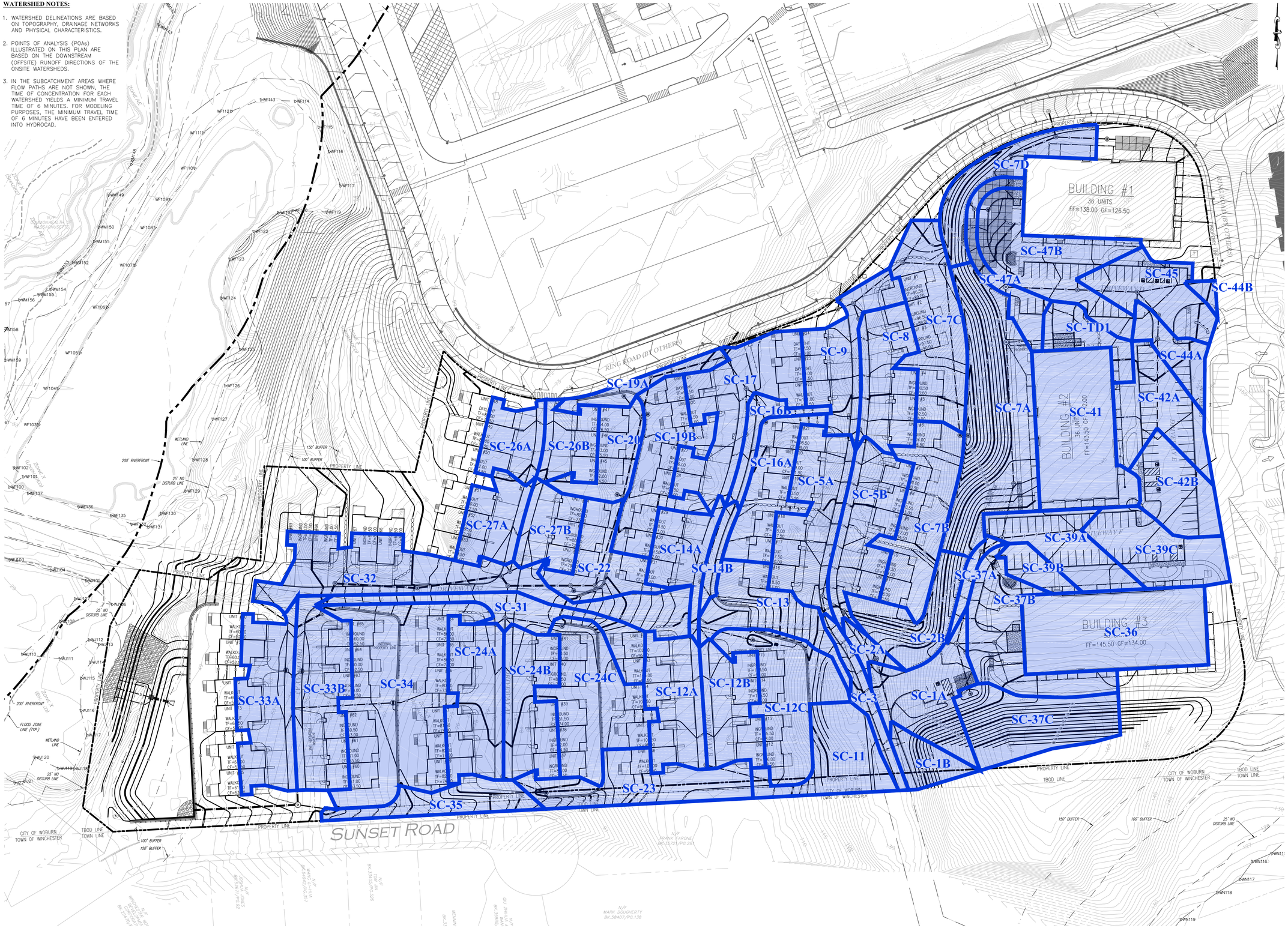
POST-DEVELOPMENT WATERSHEDS

FIGURE 2

DATE: 04/30/2020

WATERSHED NOTES:

1. WATERSHED DELINEATIONS ARE BASED ON TOPOGRAPHY, DRAINAGE NETWORKS AND PHYSICAL CHARACTERISTICS.
2. POINTS OF ANALYSIS (POAs) ILLUSTRATED ON THIS PLAN ARE BASED ON THE DOWNSTREAM (OFFSITE) RUNOFF DIRECTIONS OF THE ONSITE WATERSHEDS.
3. IN THE SUBCATCHMENT AREAS WHERE FLOW PATHS ARE NOT SHOWN, THE TIME OF CONCENTRATION FOR EACH WATERSHED YIELDS A MINIMUM TRAVEL TIME OF 6 MINUTES. FOR MODELING PURPOSES, THE MINIMUM TRAVEL TIME OF 6 MINUTES HAVE BEEN ENTERED INTO HYDROCAD.



NOT FOR CONSTRUCTION

CDG PROJECT #: 19024

REVISIONS:

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1		
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PLANNING BOARD:

SEAL:

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www.pulte.com

PROJECT:

HIGHLAND AT VALE

HILL STREET
WOBURN, MASSACHUSETTS

SCALE:

50 0 25 50 100

GRAPHIC SCALE IN FEET

SHEET:

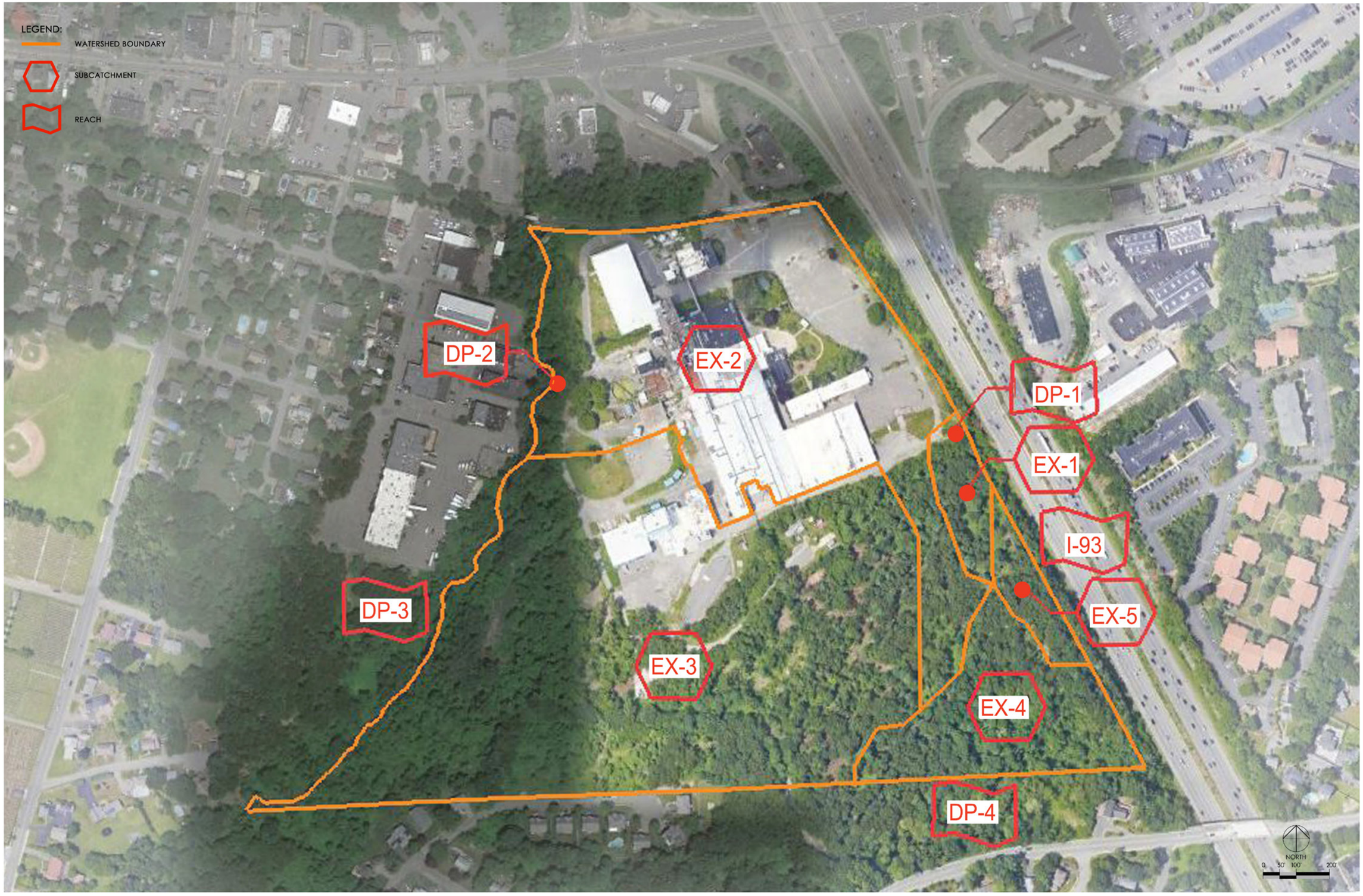
CATCH BASIN WATERSHEDS

FIGURE 3

DATE: 04/30/2020

Attachment A – Master Stormwater Report:

Figure 1.7 Existing Watershed Plan



Stantec

Planning and Landscape Architecture P.C

MONTVALE LAND LLC

WOBURN, MA

Leggat McCall PROPERTIES 50 years

Figure 1.7 - Existing Watershed Plan

Attachment B – Master Stormwater Report:

Figure 2.6 Proposed Watershed Plan

Stantec

Planning and Landscape Architecture P.C

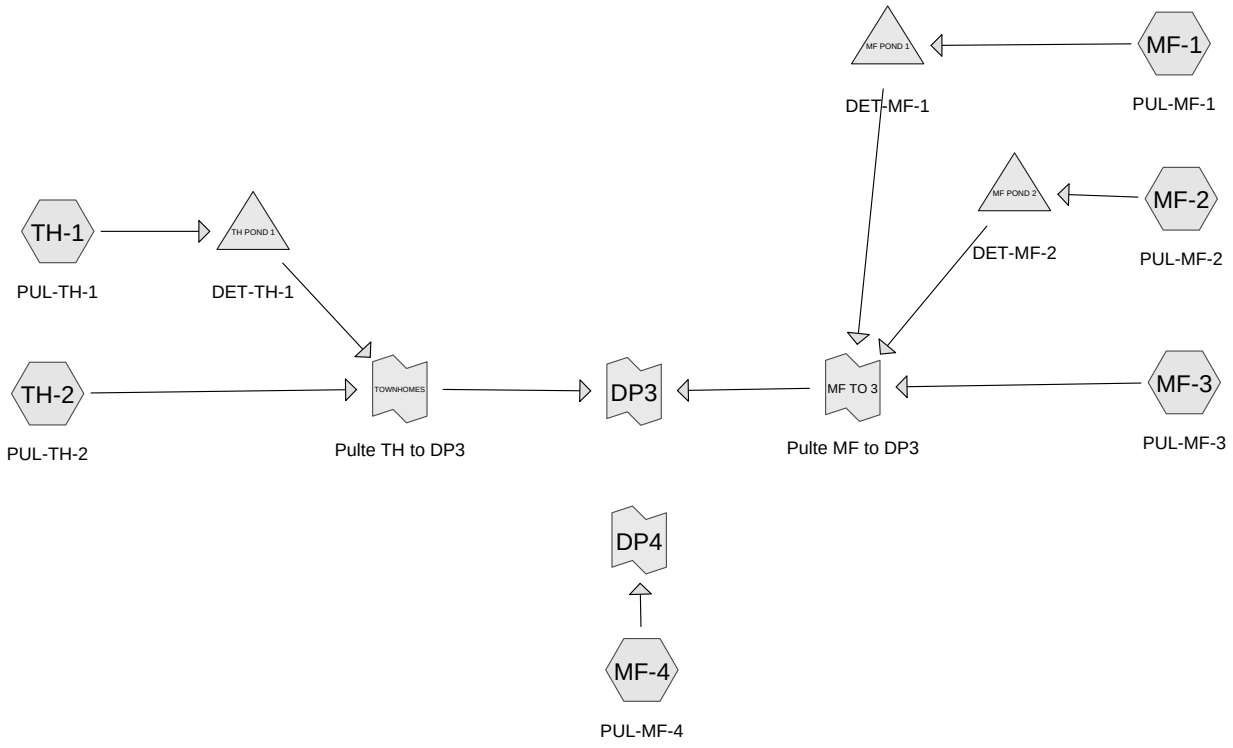
MONTVALE LAND LLC

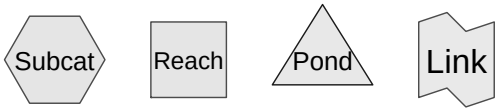
WOBURN, MA

LeggatMcCall PROPERTIES 50 years

Figure 2.6 - Proposed Watershed Plan

Attachment C – HydroCad Output





Routing Diagram for Woburn Post-Development Conditions
Prepared by Microsoft, Printed 5/5/2020
HydroCAD® 10.00-22 s/n 07576 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.028	74	>75% Grass cover, Good, HSG C (TH-1, TH-2)
4.058	80	>75% Grass cover, Good, HSG D (MF-1, MF-3, TH-1)
0.500	65	Brush, Good, HSG C (TH-2)
3.560	98	Paved parking, HSG D (MF-1, TH-1)
3.860	98	Roofs, HSG D (MF-1, MF-2, TH-1, TH-2)
0.370	98	Water Surface, 0% imp, HSG D (TH-1)
0.200	77	Woods, Good, HSG D (MF-4)
15.575	**87**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
3.528	HSG C	TH-1, TH-2
12.048	HSG D	MF-1, MF-2, MF-3, MF-4, TH-1, TH-2
0.000	Other	
15.575		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment MF-1: PUL-MF-1 Runoff Area=151,589 sf 64.08% Impervious Runoff Depth>2.44"
Tc=6.0 min CN=92 Runoff=9.73 cfs 0.709 af

Subcatchment MF-2: PUL-MF-2 Runoff Area=16,117 sf 100.00% Impervious Runoff Depth>3.06"
Tc=6.0 min CN=98 Runoff=1.19 cfs 0.094 af

Subcatchment MF-3: PUL-MF-3 Runoff Area=9,583 sf 0.00% Impervious Runoff Depth>1.48"
Tc=6.0 min CN=80 Runoff=0.38 cfs 0.027 af

Subcatchment MF-4: PUL-MF-4 Runoff Area=8,712 sf 0.00% Impervious Runoff Depth>1.28"
Tc=6.0 min CN=77 Runoff=0.29 cfs 0.021 af

Subcatchment TH-1: PUL-TH-1 Runoff Area=444,108 sf 45.61% Impervious Runoff Depth>2.00"
Tc=6.0 min CN=87 Runoff=23.91 cfs 1.700 af

Subcatchment TH-2: PUL-TH-2 Runoff Area=48,351 sf 15.32% Impervious Runoff Depth>1.10"
Tc=6.0 min CN=74 Runoff=1.37 cfs 0.102 af

Pond MF POND 1: DET-MF-1 Peak Elev=116.18' Storage=15,376 cf Inflow=9.73 cfs 0.709 af
Outflow=0.84 cfs 0.660 af

Pond MF POND 2: DET-MF-2 Peak Elev=116.86' Storage=909 cf Inflow=1.19 cfs 0.094 af
Outflow=0.51 cfs 0.094 af

Pond TH POND 1: DET-TH-1 Peak Elev=38.47' Storage=22,983 cf Inflow=23.91 cfs 1.700 af
Outflow=6.53 cfs 1.696 af

Link DP3: Inflow=8.48 cfs 2.579 af
Primary=8.48 cfs 2.579 af

Link DP4: Inflow=0.29 cfs 0.021 af
Primary=0.29 cfs 0.021 af

Link MF TO 3: Pulte MF to DP3 Inflow=1.48 cfs 0.781 af
Primary=1.48 cfs 0.781 af

Link TOWNHOMES: Pulte TH to DP3 Inflow=7.04 cfs 1.798 af
Primary=7.04 cfs 1.798 af

Total Runoff Area = 15.575 ac Runoff Volume = 2.654 af Average Runoff Depth = 2.04"
52.36% Pervious = 8.155 ac 47.64% Impervious = 7.420 ac

Summary for Subcatchment MF-1: PUL-MF-1

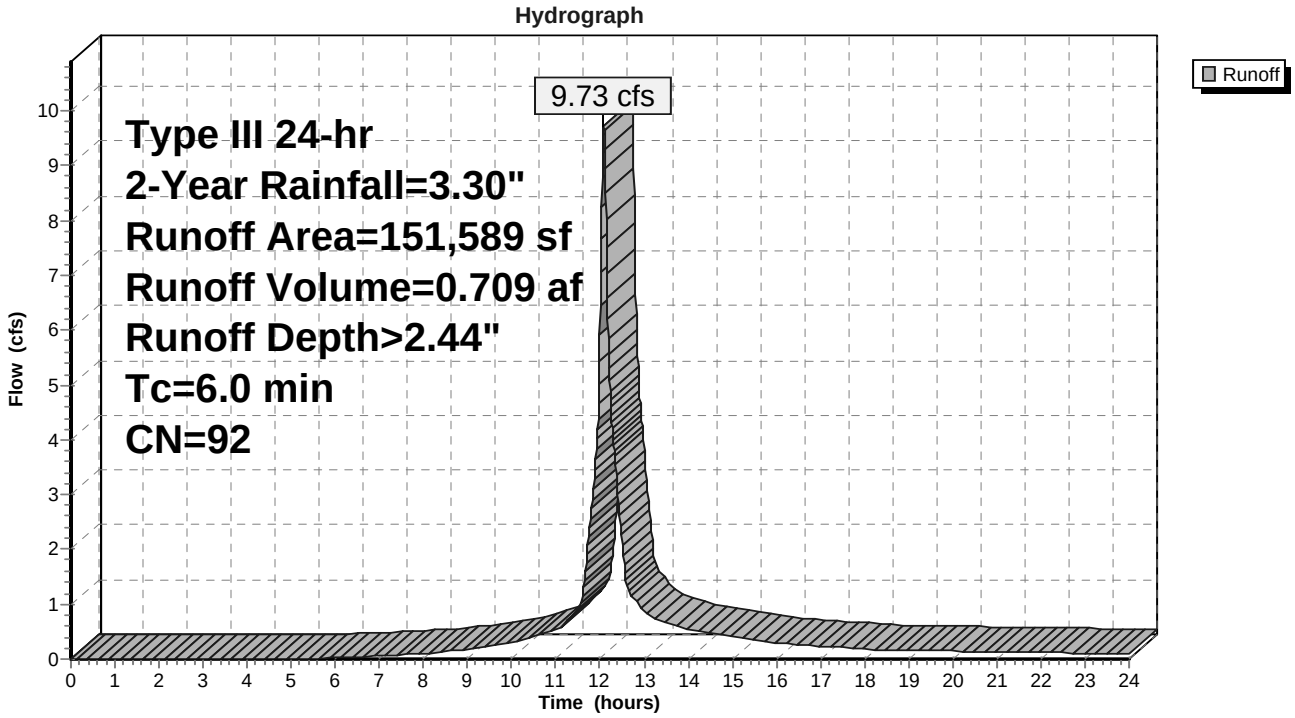
Runoff = 9.73 cfs @ 12.09 hrs, Volume= 0.709 af, Depth> 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
62,291	98	Paved parking, HSG D
34,848	98	Roofs, HSG D
54,450	80	>75% Grass cover, Good, HSG D
151,589	92	Weighted Average
54,450	80	35.92% Pervious Area
97,139	98	64.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-1: PUL-MF-1



Summary for Subcatchment MF-2: PUL-MF-2

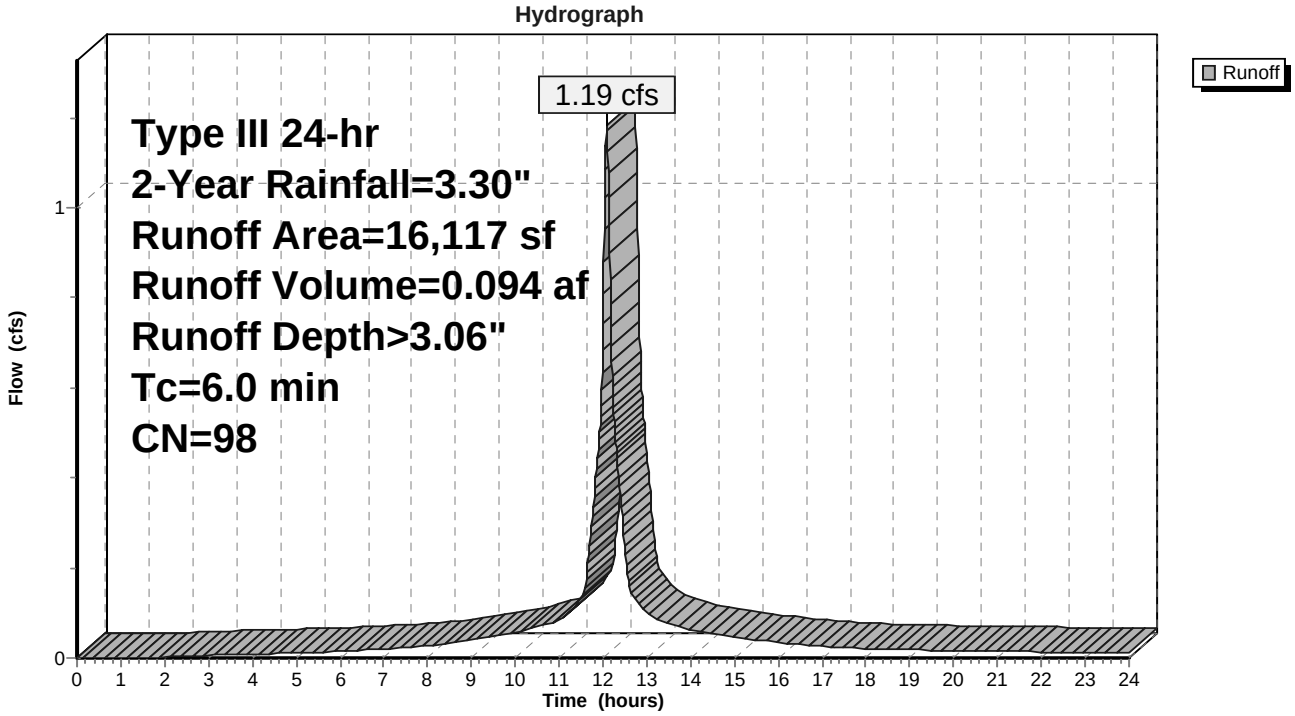
Runoff = 1.19 cfs @ 12.08 hrs, Volume= 0.094 af, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
16,117	98	Roofs, HSG D
16,117	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-2: PUL-MF-2



Summary for Subcatchment MF-3: PUL-MF-3

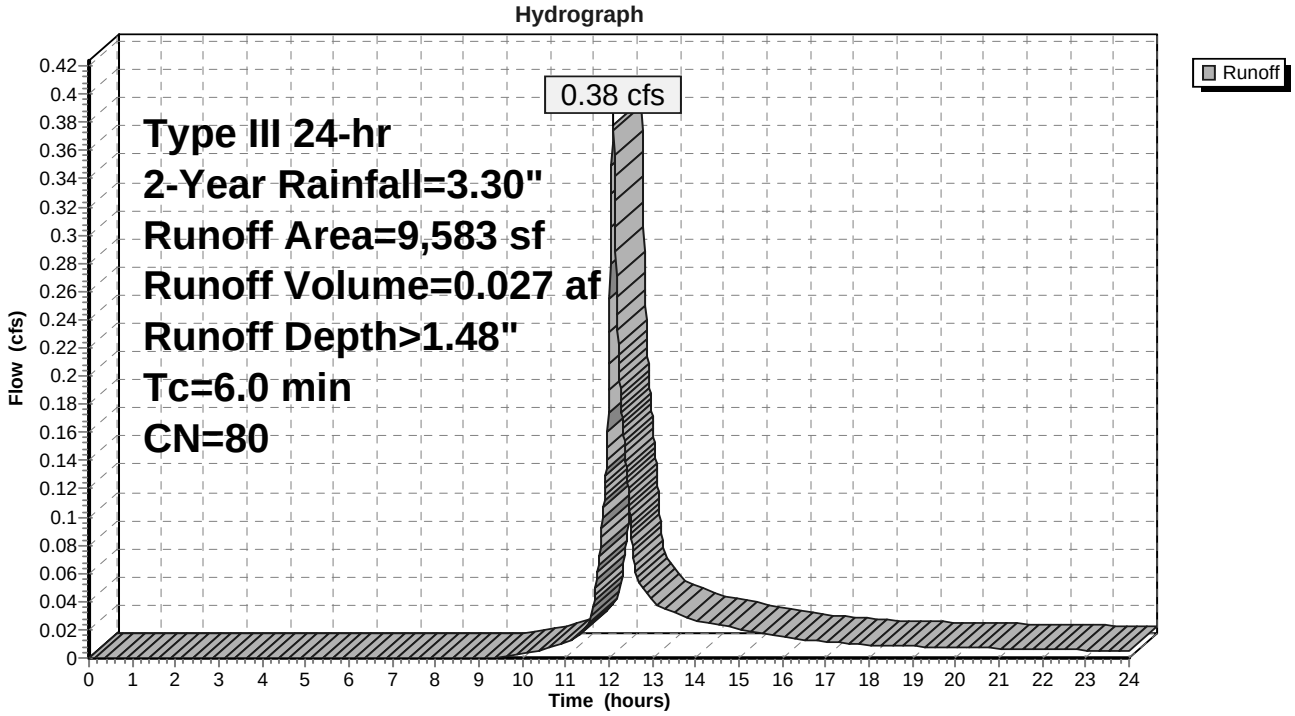
Runoff = 0.38 cfs @ 12.09 hrs, Volume= 0.027 af, Depth> 1.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
9,583	80	>75% Grass cover, Good, HSG D
9,583	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-3: PUL-MF-3



Summary for Subcatchment MF-4: PUL-MF-4

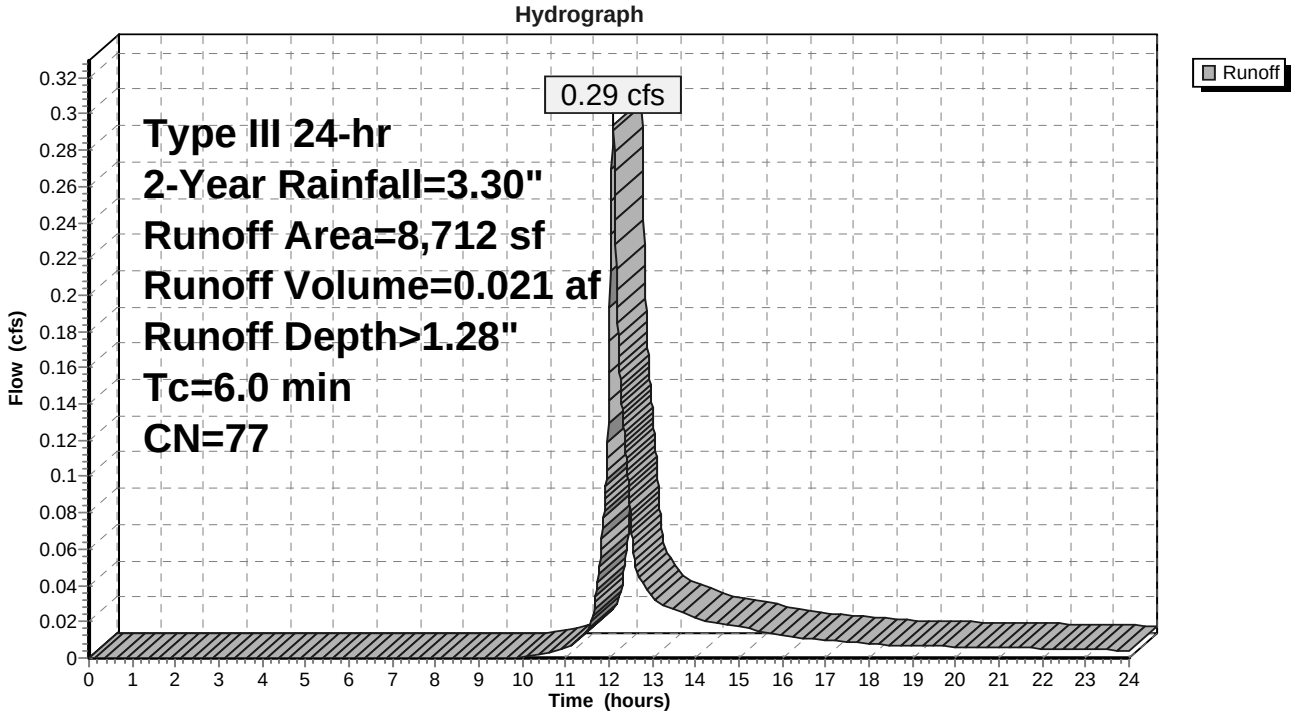
Runoff = 0.29 cfs @ 12.09 hrs, Volume= 0.021 af, Depth> 1.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
8,712	77	Woods, Good, HSG D
8,712	77	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-4: PUL-MF-4



Summary for Subcatchment TH-1: PUL-TH-1

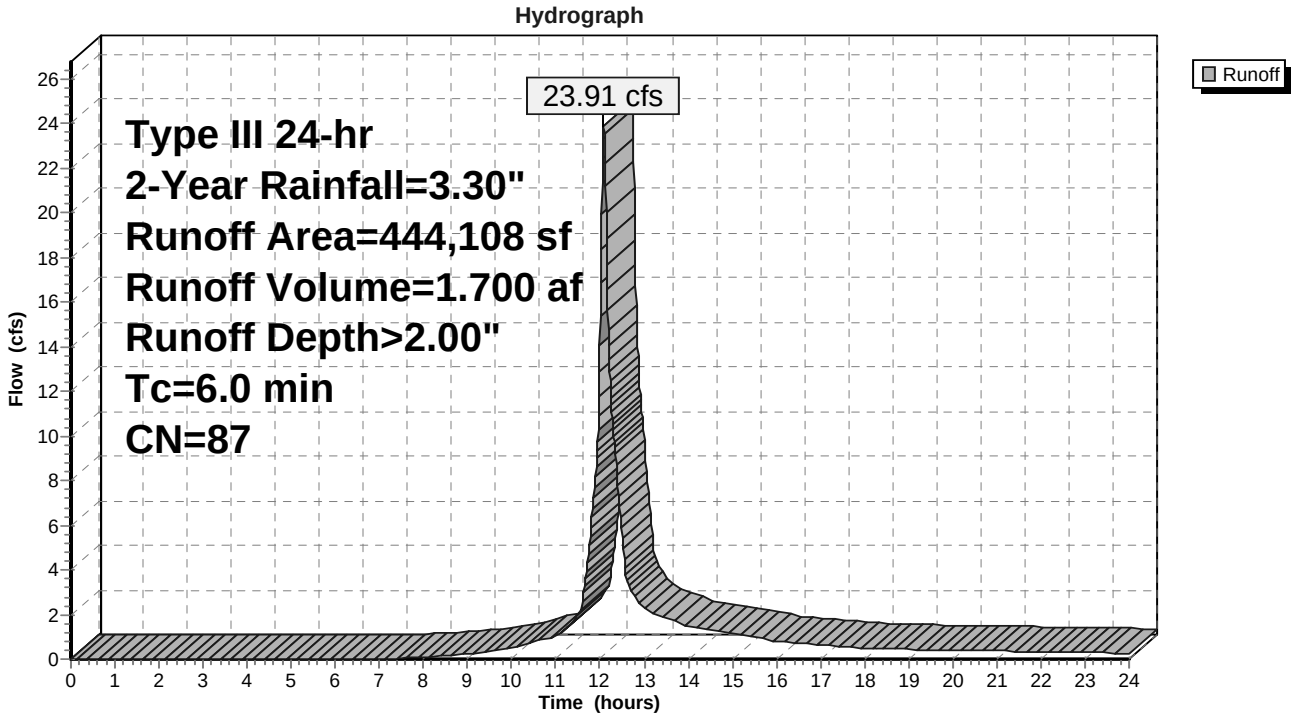
Runoff = 23.91 cfs @ 12.09 hrs, Volume= 1.700 af, Depth> 2.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
92,784	98	Paved parking, HSG D
109,771	98	Roofs, HSG D
16,117	98	Water Surface, 0% imp, HSG D
112,718	80	>75% Grass cover, Good, HSG D
112,718	74	>75% Grass cover, Good, HSG C
444,108	87	Weighted Average
241,553	78	54.39% Pervious Area
202,555	98	45.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-1: PUL-TH-1



Summary for Subcatchment TH-2: PUL-TH-2

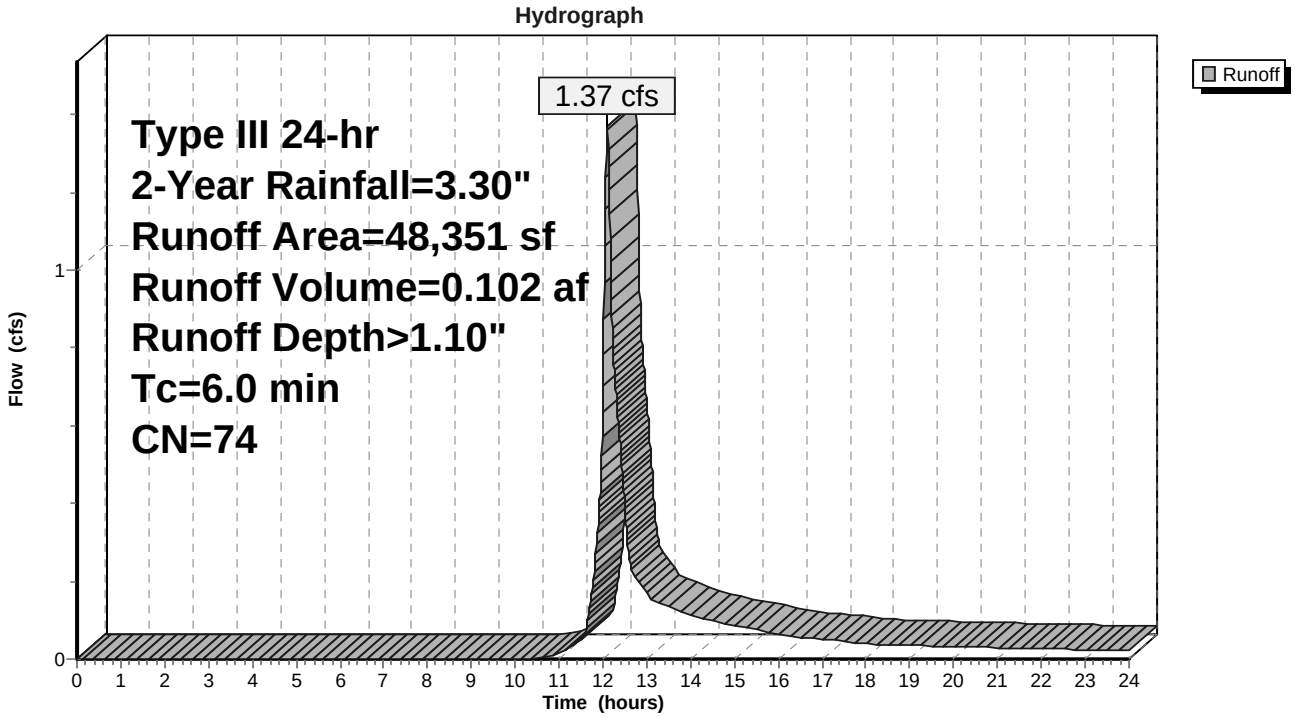
Runoff = 1.37 cfs @ 12.10 hrs, Volume= 0.102 af, Depth> 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
7,405	98	Roofs, HSG D
19,166	74	>75% Grass cover, Good, HSG C
21,780	65	Brush, Good, HSG C
48,351	74	Weighted Average
40,946	69	84.68% Pervious Area
7,405	98	15.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-2: PUL-TH-2



Summary for Pond MF POND 1: DET-MF-1

Inflow Area = 3.480 ac, 64.08% Impervious, Inflow Depth > 2.44" for 2-Year event
Inflow = 9.73 cfs @ 12.09 hrs, Volume= 0.709 af
Outflow = 0.84 cfs @ 13.03 hrs, Volume= 0.660 af, Atten= 91%, Lag= 56.7 min
Primary = 0.84 cfs @ 13.03 hrs, Volume= 0.660 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 116.18' @ 13.03 hrs Surf.Area= 3,675 sf Storage= 15,376 cf

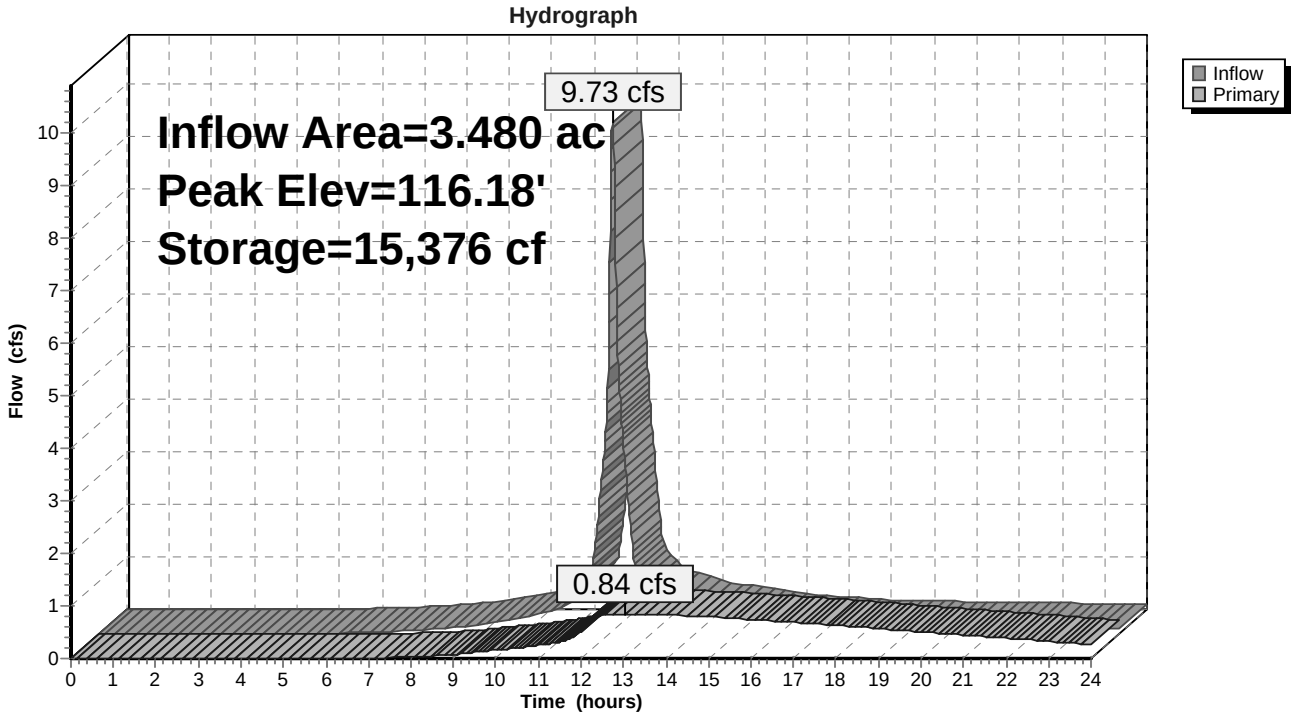
Plug-Flow detention time= 225.0 min calculated for 0.660 af (93% of inflow)
Center-of-Mass det. time= 188.9 min (984.9 - 796.0)

Volume	Invert	Avail.Storage	Storage Description
#1	112.00'	36,750 cf	**7.00'W x 7.00'L x 10.00'H Prismatoid** x 75

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**15.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	112.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	118.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	119.00'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	121.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.84 cfs @ 13.03 hrs HW=116.18' (Free Discharge)
└─**1=Culvert** (Passes 0.84 cfs of 11.15 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.84 cfs @ 9.65 fps)
  ├─**3=Orifice/Grate** (Controls 0.00 cfs)
  ├─**4=Orifice/Grate** (Controls 0.00 cfs)
  ├─**5=Orifice/Grate** (Controls 0.00 cfs)
  └─**6=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond MF POND 1: DET-MF-1



Summary for Pond MF POND 2: DET-MF-2

Inflow Area = 0.370 ac,100.00% Impervious, Inflow Depth > 3.06" for 2-Year event
Inflow = 1.19 cfs @ 12.08 hrs, Volume= 0.094 af
Outflow = 0.51 cfs @ 12.27 hrs, Volume= 0.094 af, Atten= 57%, Lag= 11.0 min
Primary = 0.51 cfs @ 12.27 hrs, Volume= 0.094 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 116.86' @ 12.27 hrs Surf.Area= 490 sf Storage= 909 cf

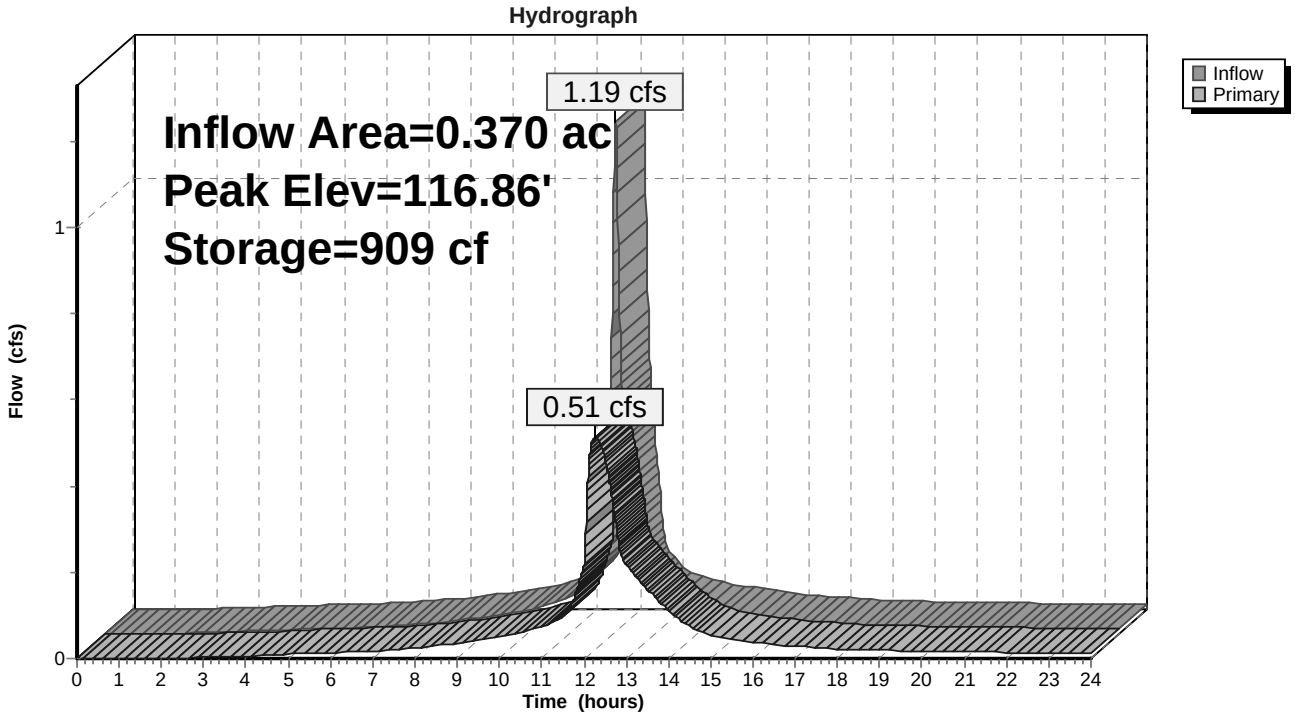
Plug-Flow detention time= 31.8 min calculated for 0.094 af (99% of inflow)
Center-of-Mass det. time= 26.2 min (781.4 - 755.2)

Volume	Invert	Avail.Storage	Storage Description
#1	115.00'	2,450 cf	**7.00'W x 7.00'L x 5.00'H Prismatoid** x 10

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**12.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	115.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#4	Device 1	119.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.51 cfs @ 12.27 hrs HW=116.86' (Free Discharge)
└─**1=Culvert** (Passes 0.51 cfs of 7.89 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.31 cfs @ 6.33 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.20 cfs @ 4.11 fps)
  └─**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond MF POND 2: DET-MF-2



Summary for Pond TH POND 1: DET-TH-1

Inflow Area = 10.195 ac, 45.61% Impervious, Inflow Depth > 2.00" for 2-Year event
Inflow = 23.91 cfs @ 12.09 hrs, Volume= 1.700 af
Outflow = 6.53 cfs @ 12.46 hrs, Volume= 1.696 af, Atten= 73%, Lag= 22.2 min
Primary = 6.53 cfs @ 12.46 hrs, Volume= 1.696 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 38.47' @ 12.46 hrs Surf.Area= 8,710 sf Storage= 22,983 cf

Plug-Flow detention time= 45.9 min calculated for 1.696 af (100% of inflow)
Center-of-Mass det. time= 44.4 min (861.3 - 816.9)

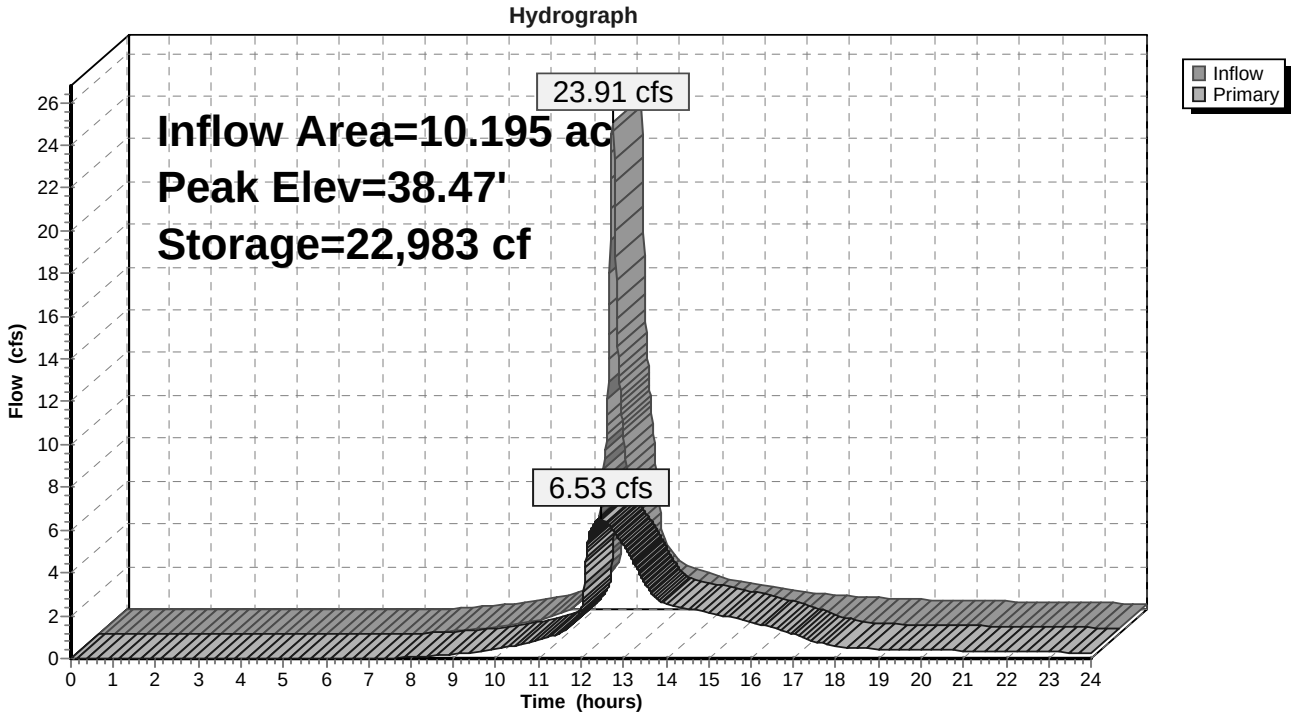
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	95,773 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
35.00	10	0	0
36.00	7,053	3,532	3,532
38.00	8,377	15,430	18,962
40.00	9,794	18,171	37,133
42.00	11,305	21,099	58,232
44.00	12,908	24,213	82,445
45.00	13,749	13,329	95,773

Device	Routing	Invert	Outlet Devices
#1	Primary	35.00'	**12.0" Round Culvert X 3.00** L= 75.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 35.00' / 34.00' S= 0.0133 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	43.25'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	35.00'	**6.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	37.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600
#5	Device 1	41.00'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Primary	43.75'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=6.53 cfs @ 12.46 hrs HW=38.47' (Free Discharge)
- **1=Culvert** (Passes 6.53 cfs of 17.94 cfs potential flow)
  - **2=Orifice/Grate** (Controls 0.00 cfs)
  - **3=Orifice/Grate** (Orifice Controls 3.39 cfs @ 8.64 fps)
  - **4=Orifice/Grate** (Orifice Controls 3.13 cfs @ 5.32 fps)
  - **5=Orifice/Grate** (Controls 0.00 cfs)
- **6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond TH POND 1: DET-TH-1

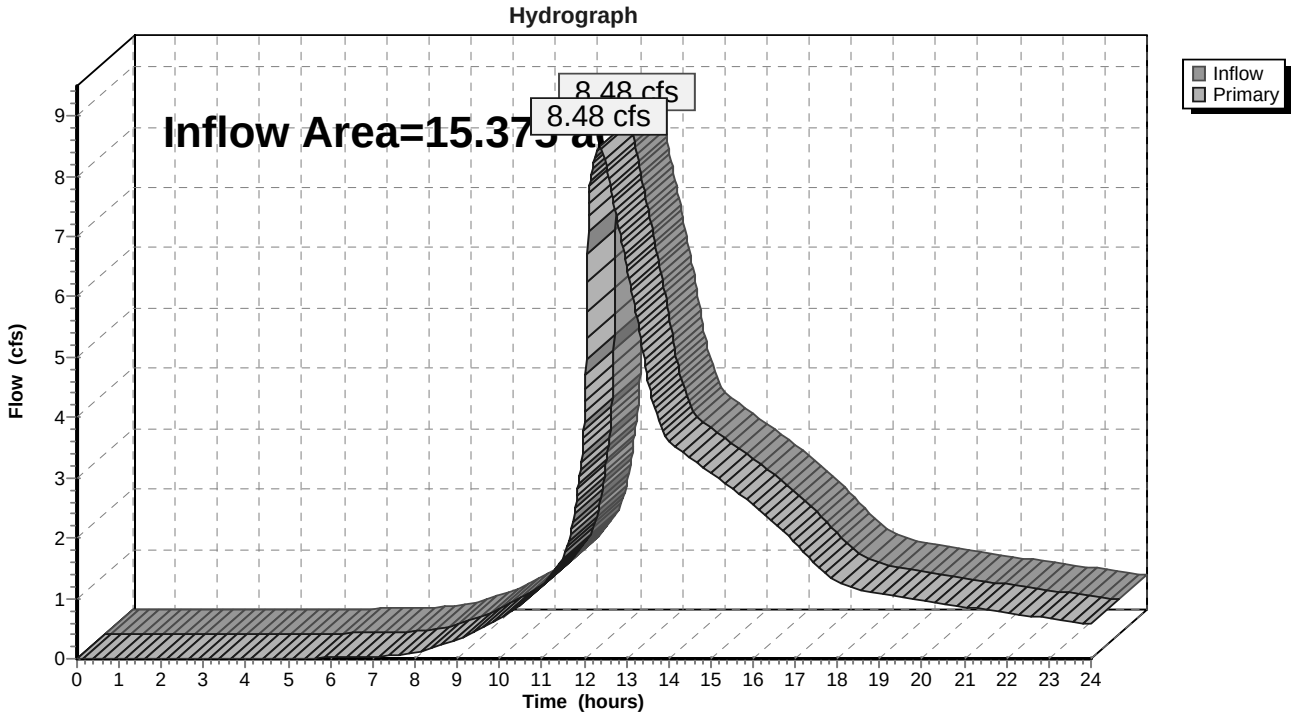


Summary for Link DP3:

Inflow Area = 15.375 ac, 48.26% Impervious, Inflow Depth > 2.01" for 2-Year event
Inflow = 8.48 cfs @ 12.37 hrs, Volume= 2.579 af
Primary = 8.48 cfs @ 12.37 hrs, Volume= 2.579 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3:

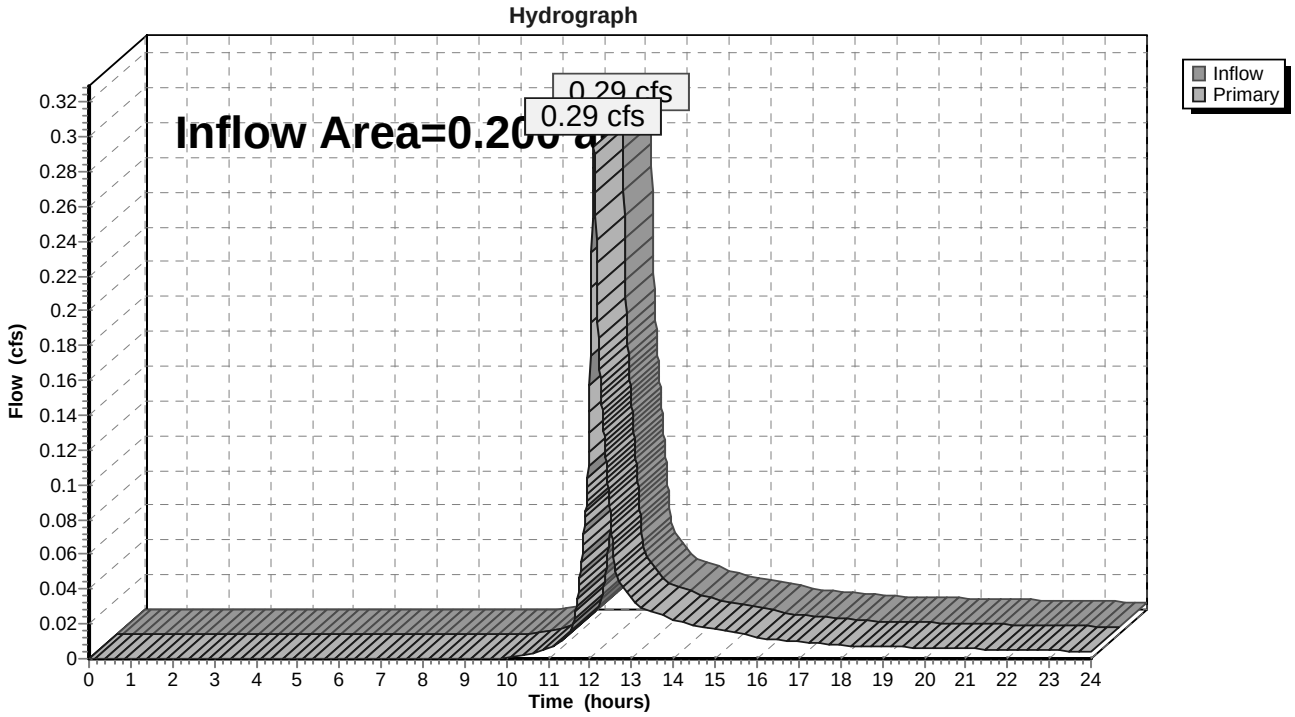


Summary for Link DP4:

Inflow Area = 0.200 ac, 0.00% Impervious, Inflow Depth > 1.28" for 2-Year event
Inflow = 0.29 cfs @ 12.09 hrs, Volume= 0.021 af
Primary = 0.29 cfs @ 12.09 hrs, Volume= 0.021 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP4:

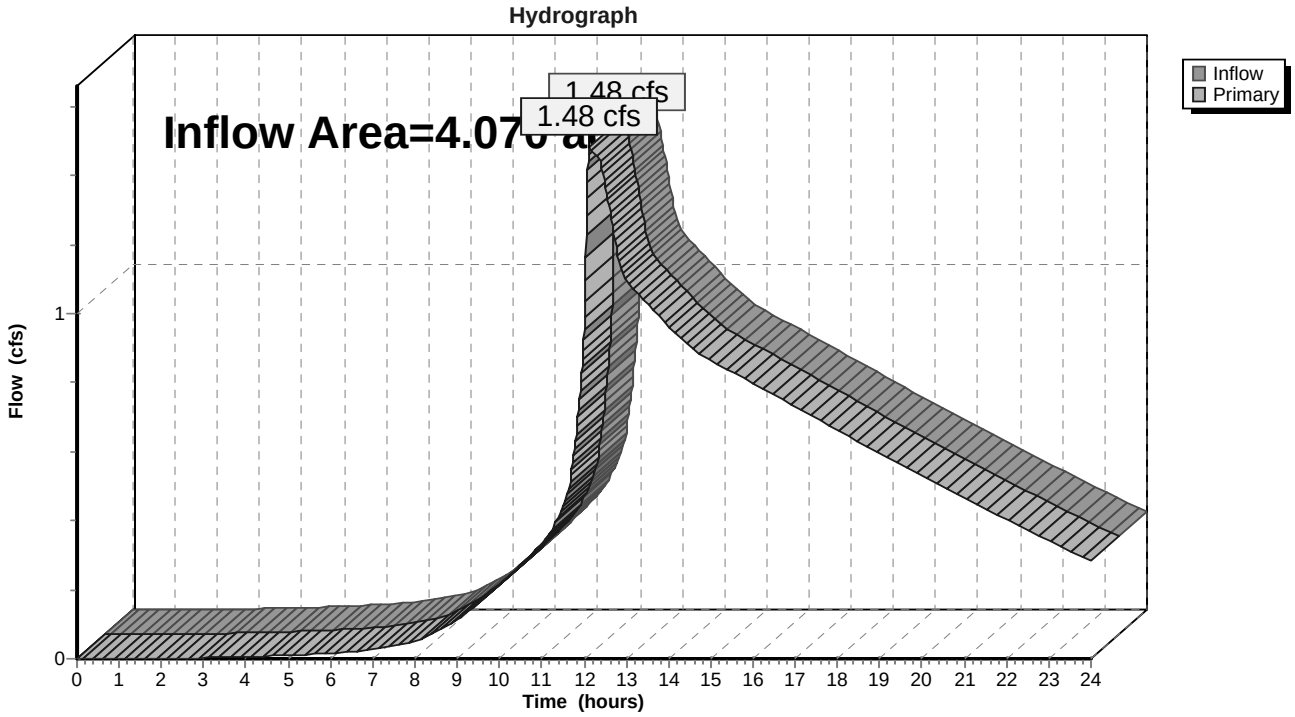


Summary for Link MF TO 3: Pulte MF to DP3

Inflow Area = 4.070 ac, 63.88% Impervious, Inflow Depth > 2.30" for 2-Year event
Inflow = 1.48 cfs @ 12.14 hrs, Volume= 0.781 af
Primary = 1.48 cfs @ 12.14 hrs, Volume= 0.781 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link MF TO 3: Pulte MF to DP3

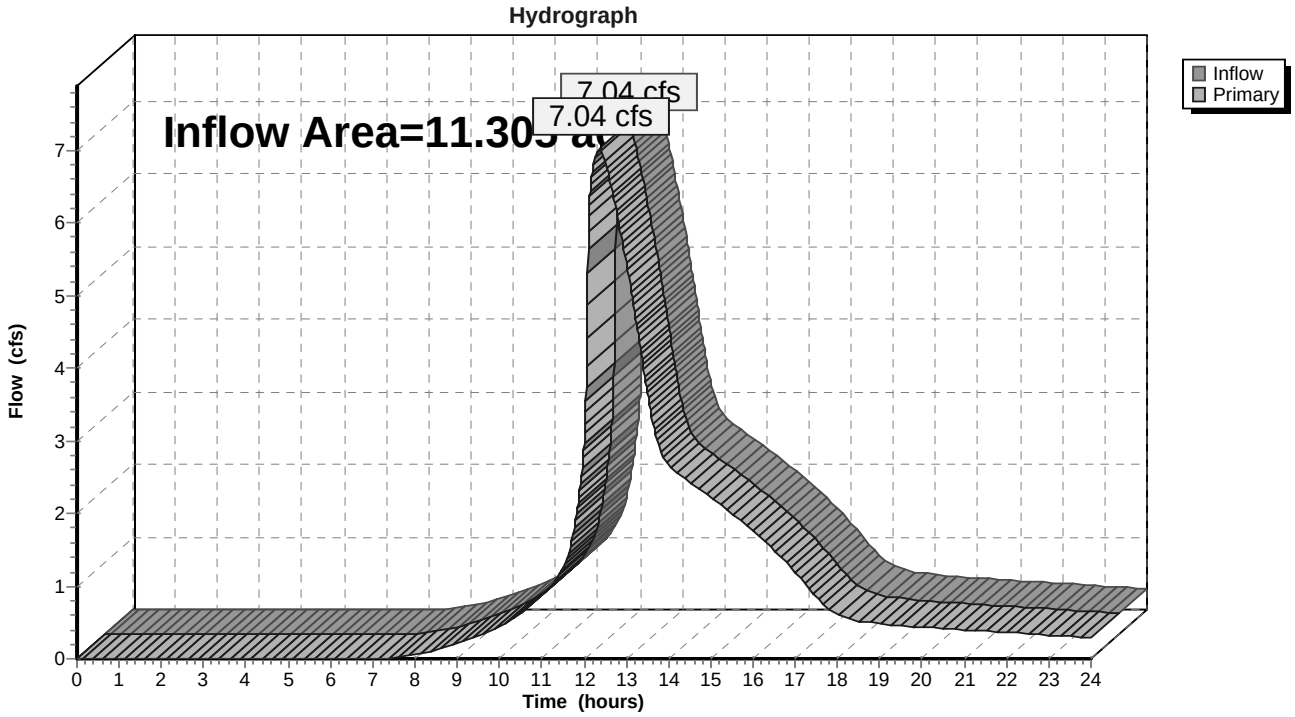


Summary for Link TOWNHOMES: Pulte TH to DP3

Inflow Area = 11.305 ac, 42.64% Impervious, Inflow Depth > 1.91" for 2-Year event
Inflow = 7.04 cfs @ 12.38 hrs, Volume= 1.798 af
Primary = 7.04 cfs @ 12.38 hrs, Volume= 1.798 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link TOWNHOMES: Pulte TH to DP3



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment MF-1: PUL-MF-1 Runoff Area=151,589 sf 64.08% Impervious Runoff Depth>4.28"
Tc=6.0 min CN=92 Runoff=16.55 cfs 1.241 af

Subcatchment MF-2: PUL-MF-2 Runoff Area=16,117 sf 100.00% Impervious Runoff Depth>4.96"
Tc=6.0 min CN=98 Runoff=1.88 cfs 0.153 af

Subcatchment MF-3: PUL-MF-3 Runoff Area=9,583 sf 0.00% Impervious Runoff Depth>3.06"
Tc=6.0 min CN=80 Runoff=0.79 cfs 0.056 af

Subcatchment MF-4: PUL-MF-4 Runoff Area=8,712 sf 0.00% Impervious Runoff Depth>2.79"
Tc=6.0 min CN=77 Runoff=0.65 cfs 0.046 af

Subcatchment TH-1: PUL-TH-1 Runoff Area=444,108 sf 45.61% Impervious Runoff Depth>3.75"
Tc=6.0 min CN=87 Runoff=43.99 cfs 3.188 af

Subcatchment TH-2: PUL-TH-2 Runoff Area=48,351 sf 15.32% Impervious Runoff Depth>2.52"
Tc=6.0 min CN=74 Runoff=3.28 cfs 0.233 af

Pond MF POND 1: DET-MF-1 Peak Elev=118.47' Storage=23,795 cf Inflow=16.55 cfs 1.241 af
Outflow=3.87 cfs 1.146 af

Pond MF POND 2: DET-MF-2 Peak Elev=118.07' Storage=1,502 cf Inflow=1.88 cfs 0.153 af
Outflow=0.73 cfs 0.152 af

Pond TH POND 1: DET-TH-1 Peak Elev=41.01' Storage=47,443 cf Inflow=43.99 cfs 3.188 af
Outflow=10.06 cfs 3.181 af

Link DP3: Inflow=15.84 cfs 4.768 af
Primary=15.84 cfs 4.768 af

Link DP4: Inflow=0.65 cfs 0.046 af
Primary=0.65 cfs 0.046 af

Link MF TO 3: Pulte MF to DP3 Inflow=4.79 cfs 1.354 af
Primary=4.79 cfs 1.354 af

Link TOWNHOMES: Pulte TH to DP3 Inflow=11.46 cfs 3.414 af
Primary=11.46 cfs 3.414 af

Total Runoff Area = 15.575 ac Runoff Volume = 4.918 af Average Runoff Depth = 3.79"
52.36% Pervious = 8.155 ac 47.64% Impervious = 7.420 ac

Summary for Subcatchment MF-1: PUL-MF-1

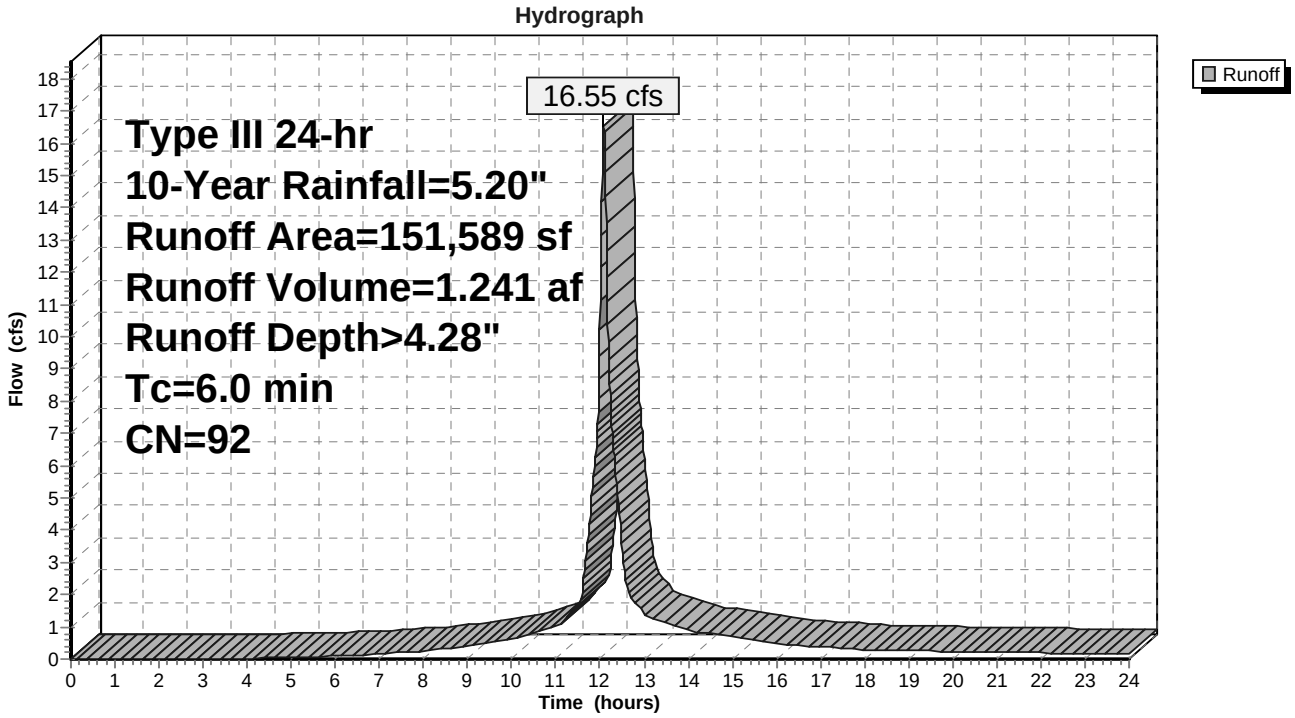
Runoff = 16.55 cfs @ 12.08 hrs, Volume= 1.241 af, Depth> 4.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
62,291	98	Paved parking, HSG D
34,848	98	Roofs, HSG D
54,450	80	>75% Grass cover, Good, HSG D
151,589	92	Weighted Average
54,450	80	35.92% Pervious Area
97,139	98	64.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-1: PUL-MF-1



Summary for Subcatchment MF-2: PUL-MF-2

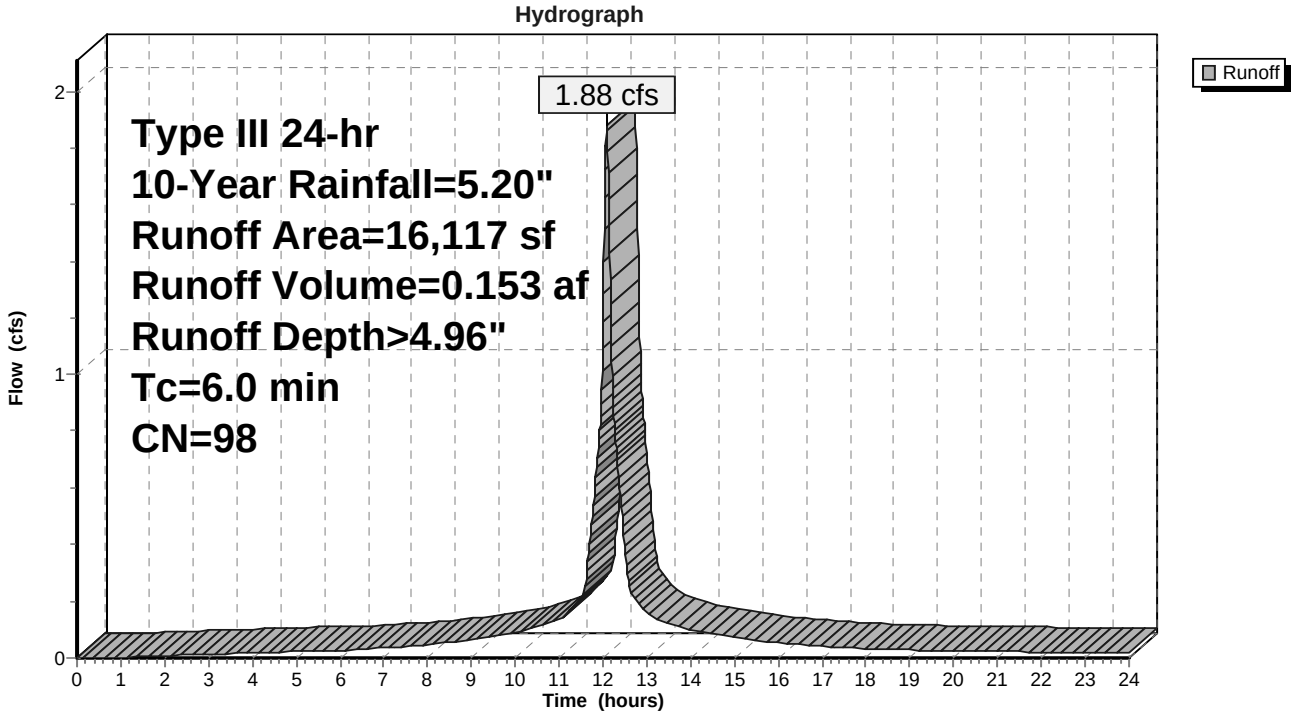
Runoff = 1.88 cfs @ 12.08 hrs, Volume= 0.153 af, Depth> 4.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
16,117	98	Roofs, HSG D
16,117	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-2: PUL-MF-2



Summary for Subcatchment MF-3: PUL-MF-3

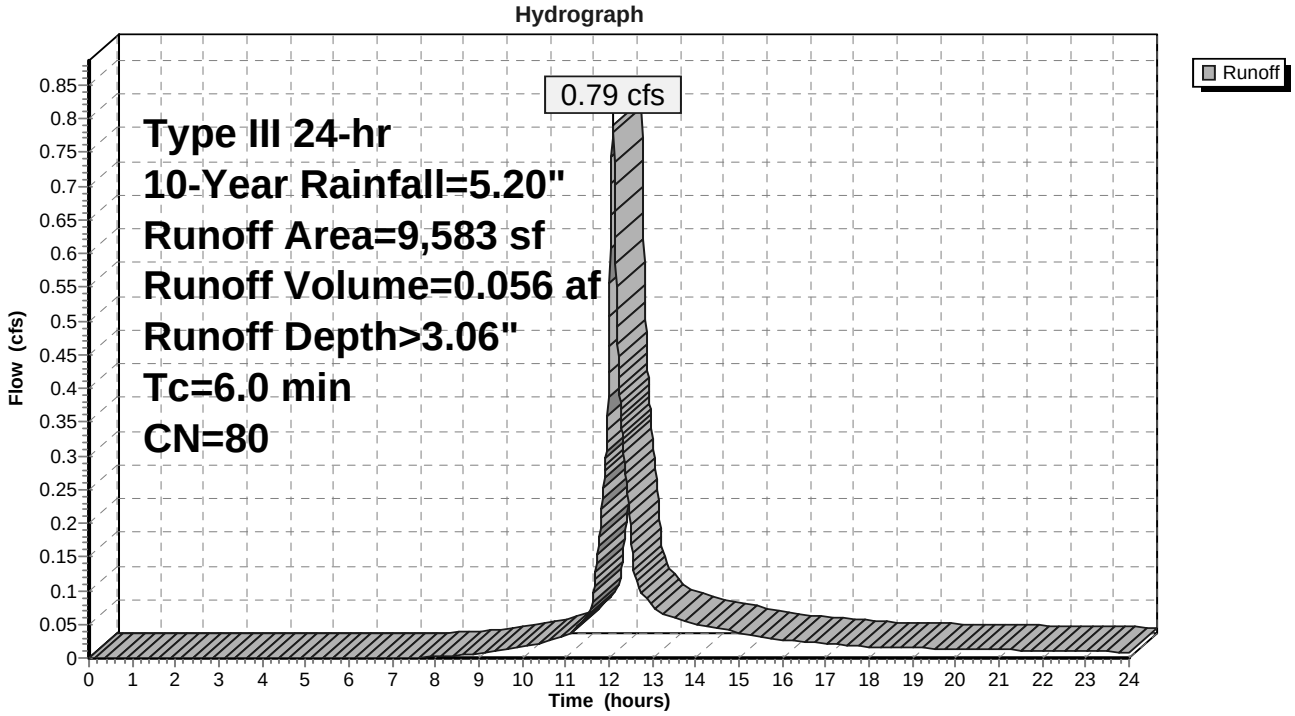
Runoff = 0.79 cfs @ 12.09 hrs, Volume= 0.056 af, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
9,583	80	>75% Grass cover, Good, HSG D
9,583	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-3: PUL-MF-3



Summary for Subcatchment MF-4: PUL-MF-4

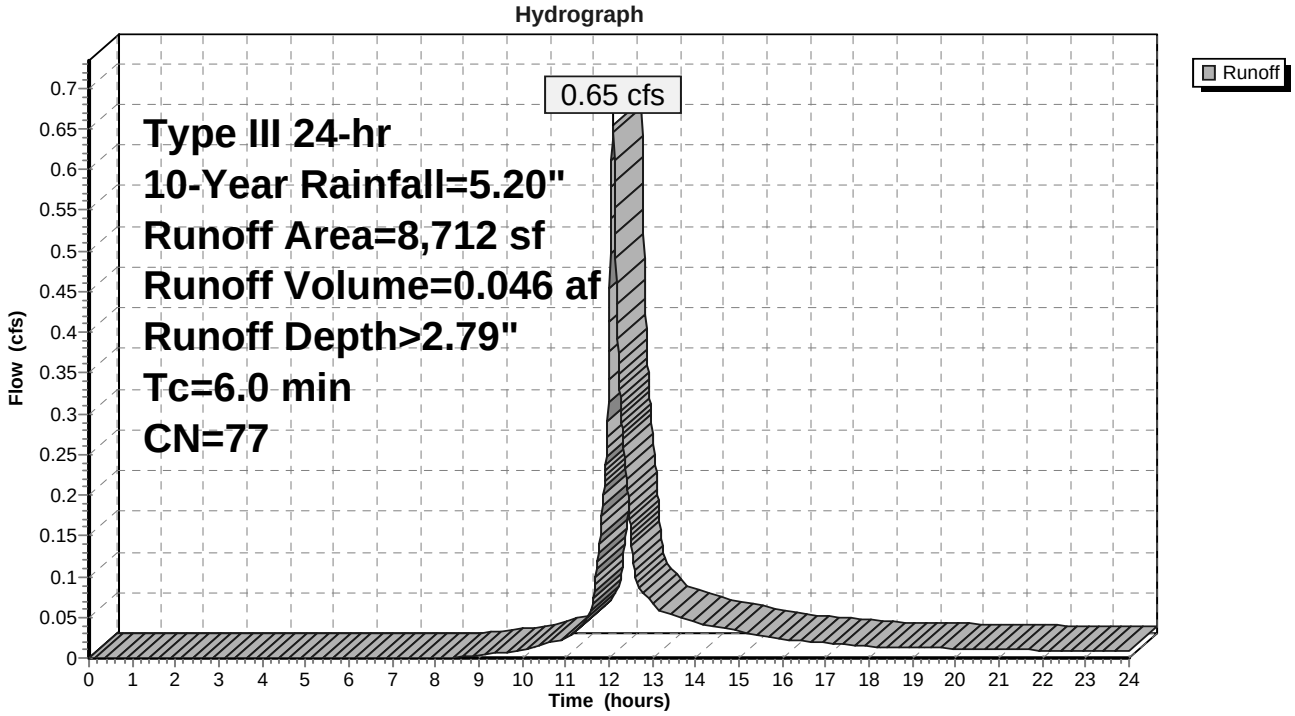
Runoff = 0.65 cfs @ 12.09 hrs, Volume= 0.046 af, Depth> 2.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
8,712	77	Woods, Good, HSG D
8,712	77	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-4: PUL-MF-4



Summary for Subcatchment TH-1: PUL-TH-1

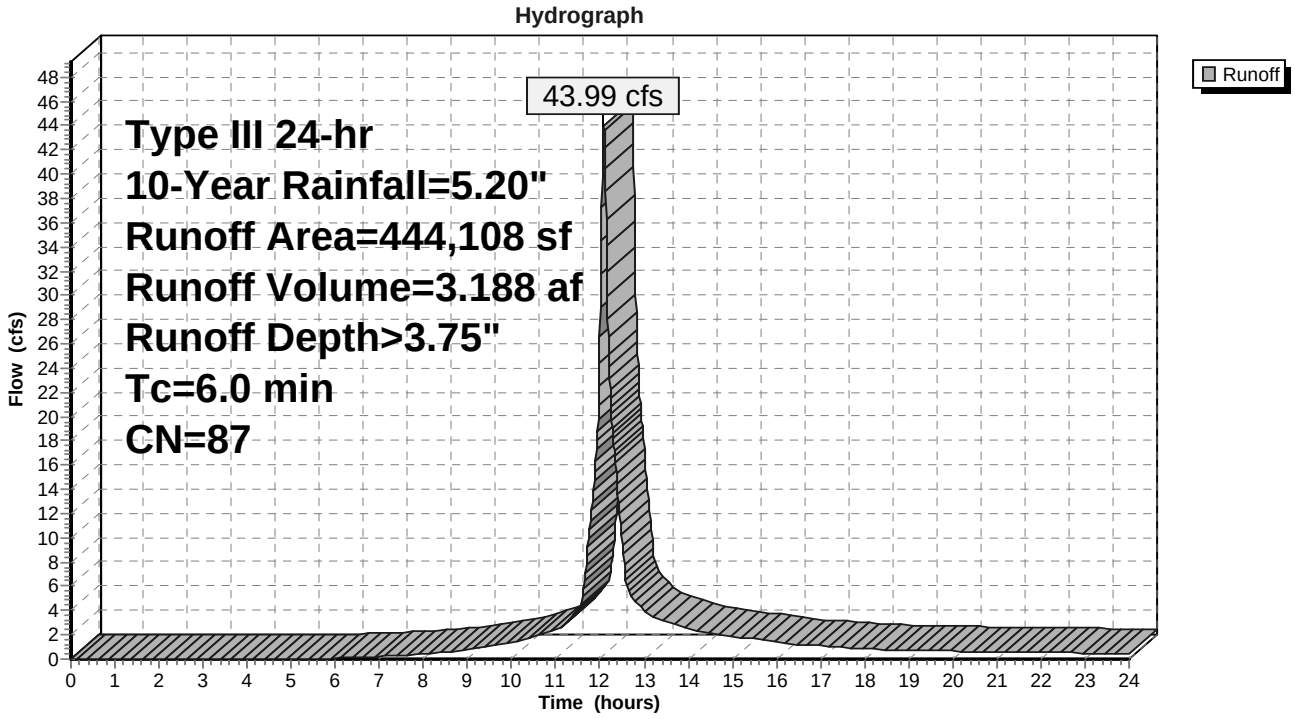
Runoff = 43.99 cfs @ 12.09 hrs, Volume= 3.188 af, Depth> 3.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
92,784	98	Paved parking, HSG D
109,771	98	Roofs, HSG D
16,117	98	Water Surface, 0% imp, HSG D
112,718	80	>75% Grass cover, Good, HSG D
112,718	74	>75% Grass cover, Good, HSG C
444,108	87	Weighted Average
241,553	78	54.39% Pervious Area
202,555	98	45.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-1: PUL-TH-1



Summary for Subcatchment TH-2: PUL-TH-2

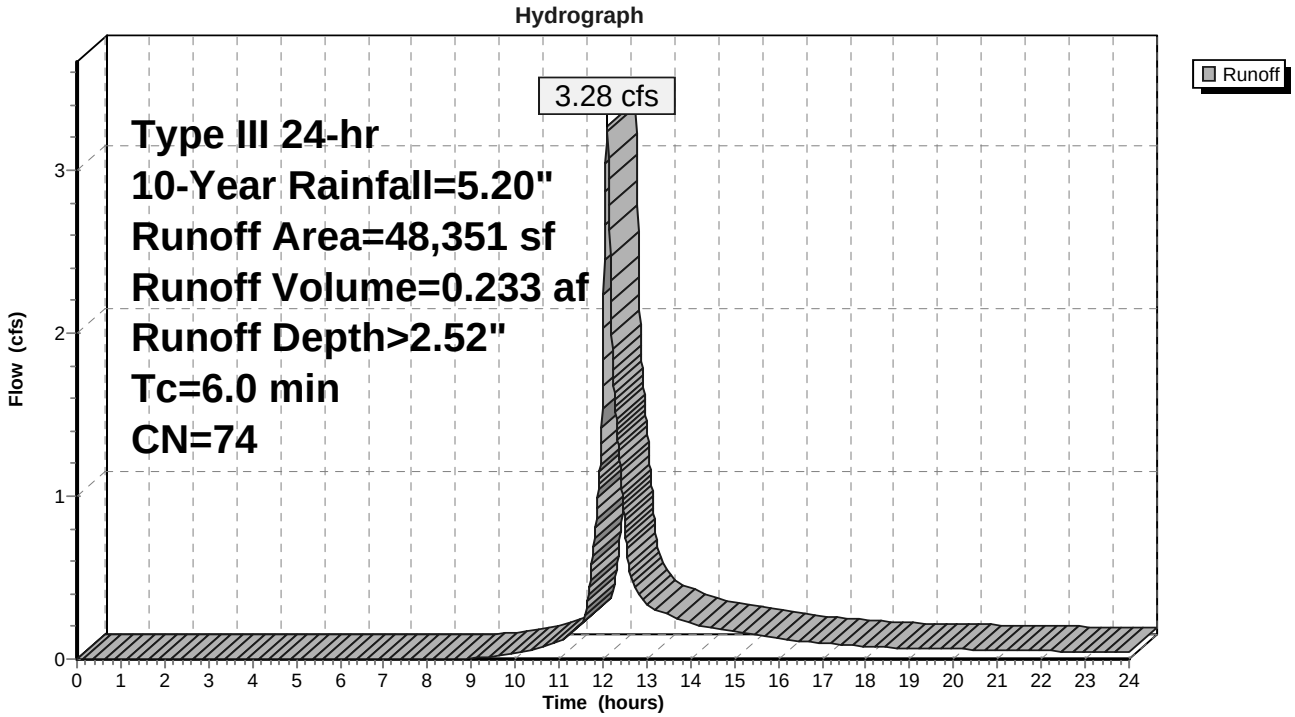
Runoff = 3.28 cfs @ 12.09 hrs, Volume= 0.233 af, Depth> 2.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=5.20"

Area (sf)	CN	Description
7,405	98	Roofs, HSG D
19,166	74	>75% Grass cover, Good, HSG C
21,780	65	Brush, Good, HSG C
48,351	74	Weighted Average
40,946	69	84.68% Pervious Area
7,405	98	15.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-2: PUL-TH-2



Summary for Pond MF POND 1: DET-MF-1

Inflow Area = 3.480 ac, 64.08% Impervious, Inflow Depth > 4.28" for 10-Year event
Inflow = 16.55 cfs @ 12.08 hrs, Volume= 1.241 af
Outflow = 3.87 cfs @ 12.48 hrs, Volume= 1.146 af, Atten= 77%, Lag= 23.5 min
Primary = 3.87 cfs @ 12.48 hrs, Volume= 1.146 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 118.47' @ 12.48 hrs Surf.Area= 3,675 sf Storage= 23,795 cf

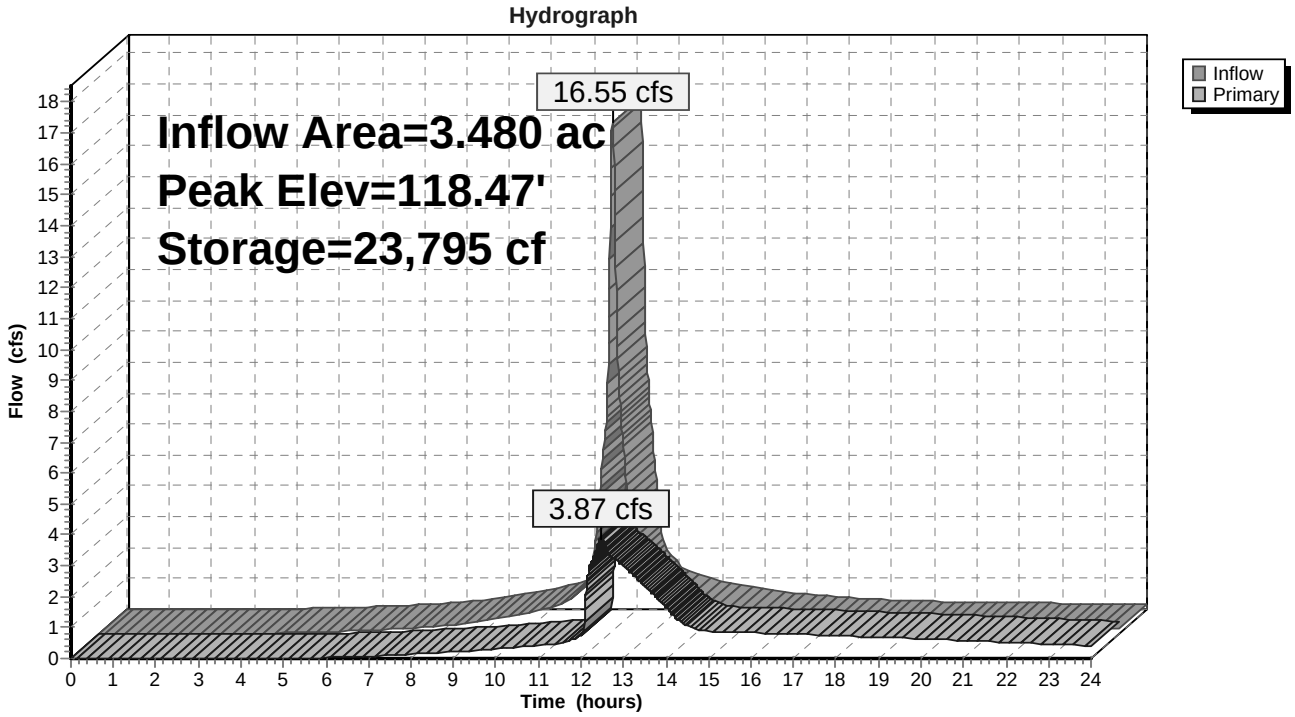
Plug-Flow detention time= 177.2 min calculated for 1.146 af (92% of inflow)
Center-of-Mass det. time= 137.4 min (918.3 - 780.9)

Volume	Invert	Avail.Storage	Storage Description
#1	112.00'	36,750 cf	**7.00'W x 7.00'L x 10.00'H Prismatoid** x 75

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**15.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	112.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	118.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	119.00'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	121.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=3.87 cfs @ 12.48 hrs HW=118.47' (Free Discharge)
└─**1=Culvert** (Passes 3.87 cfs of 14.29 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.06 cfs @ 12.09 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 2.41 cfs @ 6.91 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 0.40 cfs @ 1.61 fps)
  ├─**5=Orifice/Grate** (Controls 0.00 cfs)
  └─**6=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond MF POND 1: DET-MF-1



Summary for Pond MF POND 2: DET-MF-2

Inflow Area = 0.370 ac,100.00% Impervious, Inflow Depth > 4.96" for 10-Year event
Inflow = 1.88 cfs @ 12.08 hrs, Volume= 0.153 af
Outflow = 0.73 cfs @ 12.30 hrs, Volume= 0.152 af, Atten= 61%, Lag= 13.2 min
Primary = 0.73 cfs @ 12.30 hrs, Volume= 0.152 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 118.07' @ 12.30 hrs Surf.Area= 490 sf Storage= 1,502 cf

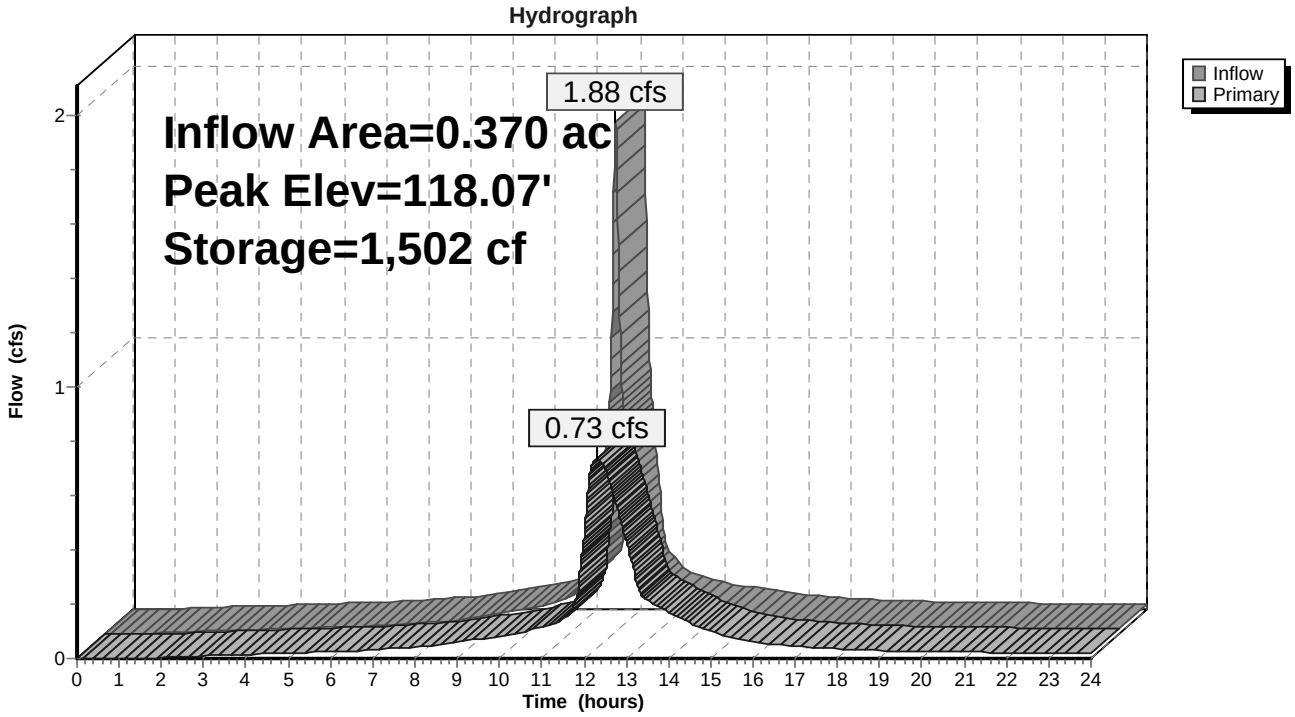
Plug-Flow detention time= 31.1 min calculated for 0.152 af (99% of inflow)
Center-of-Mass det. time= 26.5 min (773.3 - 746.8)

Volume	Invert	Avail.Storage	Storage Description
#1	115.00'	2,450 cf	**7.00'W x 7.00'L x 5.00'H Prismatoid** x 10

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**12.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	115.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#4	Device 1	119.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.73 cfs @ 12.30 hrs HW=118.06' (Free Discharge)
└─**1=Culvert** (Passes 0.73 cfs of 8.86 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.41 cfs @ 8.26 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.33 cfs @ 6.71 fps)
  └─**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond MF POND 2: DET-MF-2



Summary for Pond TH POND 1: DET-TH-1

Inflow Area = 10.195 ac, 45.61% Impervious, Inflow Depth > 3.75" for 10-Year event
Inflow = 43.99 cfs @ 12.09 hrs, Volume= 3.188 af
Outflow = 10.06 cfs @ 12.49 hrs, Volume= 3.181 af, Atten= 77%, Lag= 24.3 min
Primary = 10.06 cfs @ 12.49 hrs, Volume= 3.181 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 41.01' @ 12.49 hrs Surf.Area= 10,559 sf Storage= 47,443 cf

Plug-Flow detention time= 55.4 min calculated for 3.180 af (100% of inflow)
Center-of-Mass det. time= 54.0 min (853.1 - 799.1)

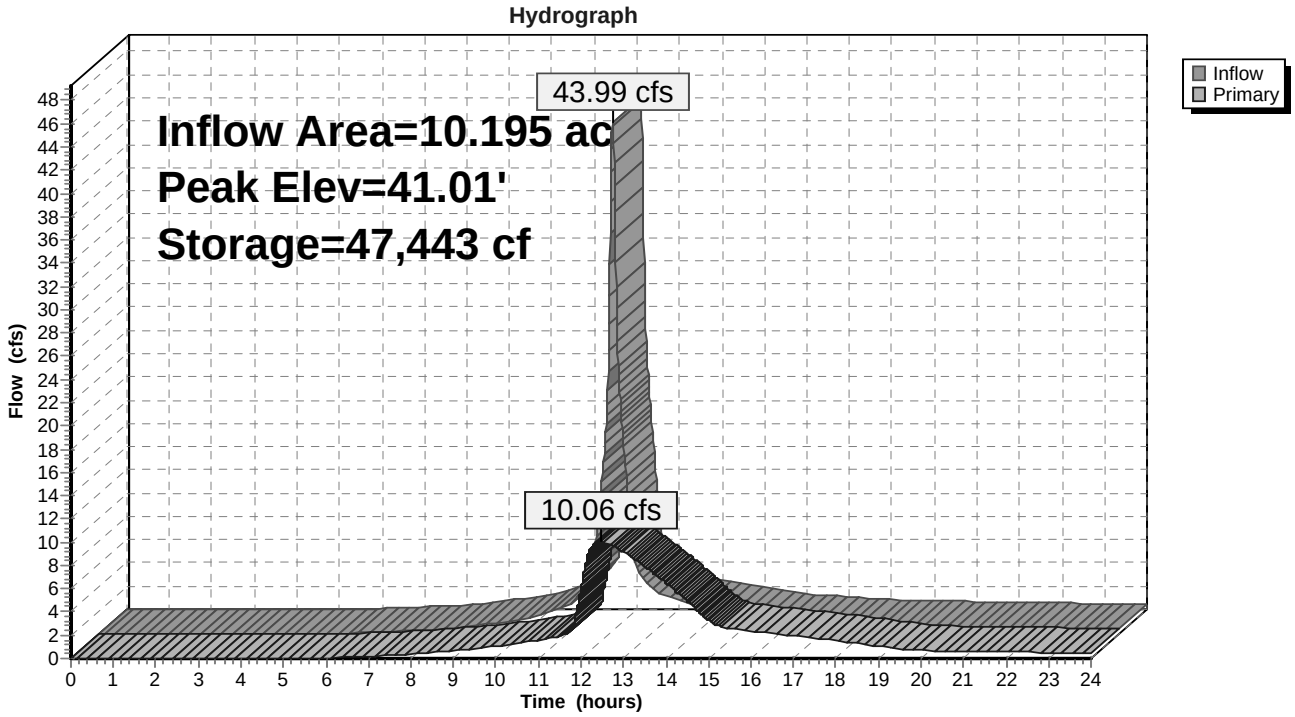
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	95,773 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
35.00	10	0	0
36.00	7,053	3,532	3,532
38.00	8,377	15,430	18,962
40.00	9,794	18,171	37,133
42.00	11,305	21,099	58,232
44.00	12,908	24,213	82,445
45.00	13,749	13,329	95,773

Device	Routing	Invert	Outlet Devices
#1	Primary	35.00'	**12.0" Round Culvert X 3.00** L= 75.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 35.00' / 34.00' S= 0.0133 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	43.25'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	35.00'	**6.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	37.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600
#5	Device 1	41.00'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Primary	43.75'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=10.04 cfs @ 12.49 hrs HW=41.01' (Free Discharge)
- **1=Culvert** (Passes 10.04 cfs of 23.62 cfs potential flow)
  - **2=Orifice/Grate** (Controls 0.00 cfs)
  - **3=Orifice/Grate** (Orifice Controls 4.54 cfs @ 11.56 fps)
  - **4=Orifice/Grate** (Orifice Controls 5.50 cfs @ 9.34 fps)
  - **5=Orifice/Grate** (Orifice Controls 0.00 cfs @ 0.39 fps)
- **6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond TH POND 1: DET-TH-1

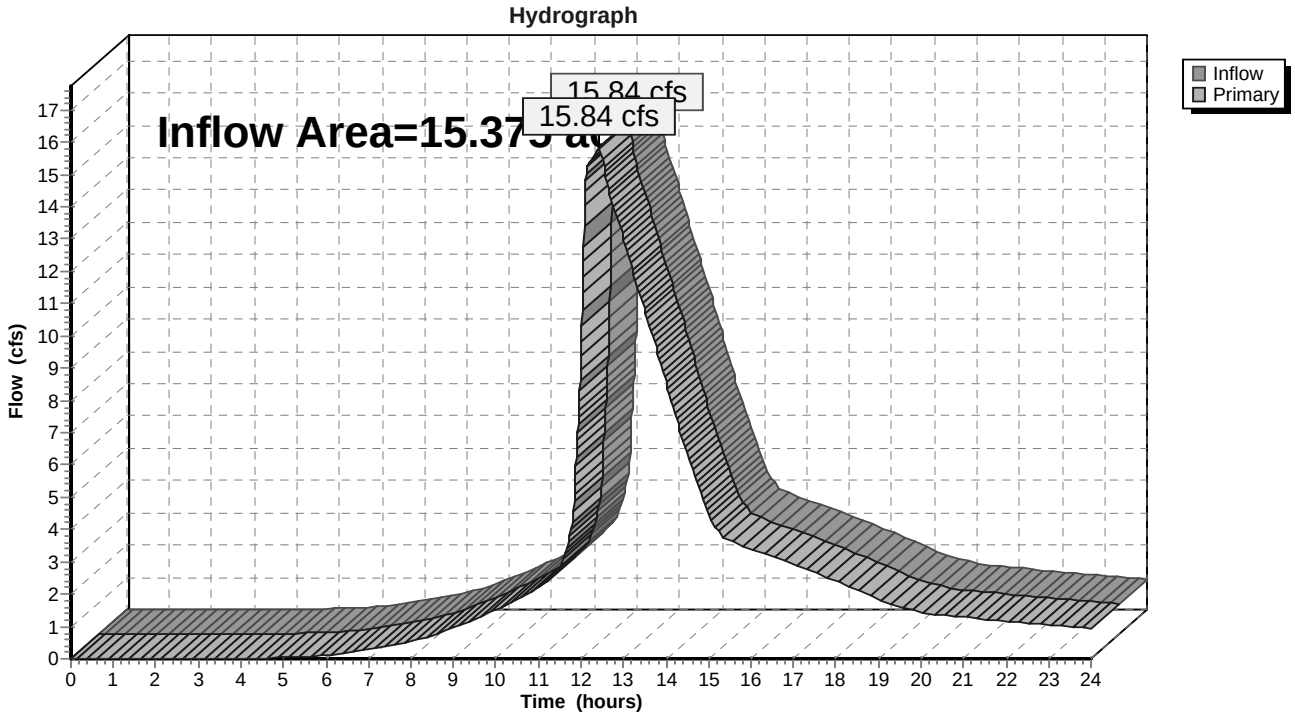


Summary for Link DP3:

Inflow Area = 15.375 ac, 48.26% Impervious, Inflow Depth > 3.72" for 10-Year event
Inflow = 15.84 cfs @ 12.42 hrs, Volume= 4.768 af
Primary = 15.84 cfs @ 12.42 hrs, Volume= 4.768 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3:

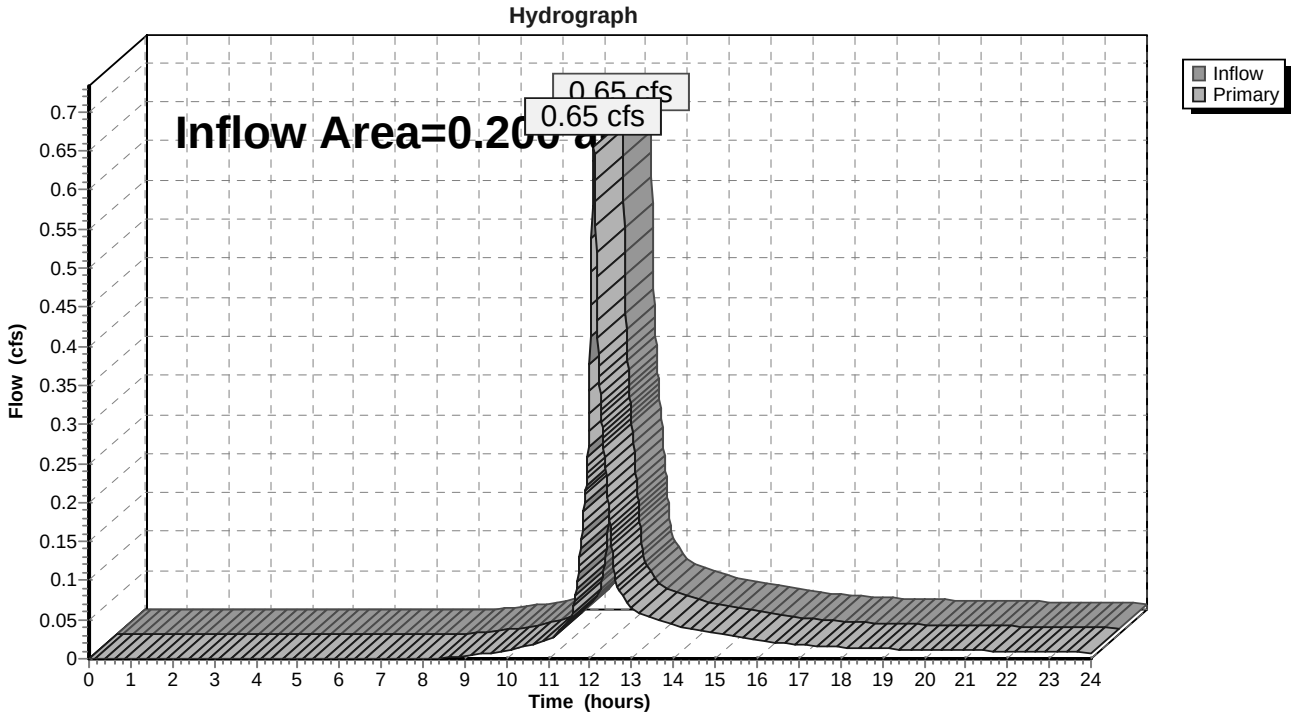


Summary for Link DP4:

Inflow Area = 0.200 ac, 0.00% Impervious, Inflow Depth > 2.79" for 10-Year event
Inflow = 0.65 cfs @ 12.09 hrs, Volume= 0.046 af
Primary = 0.65 cfs @ 12.09 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP4:

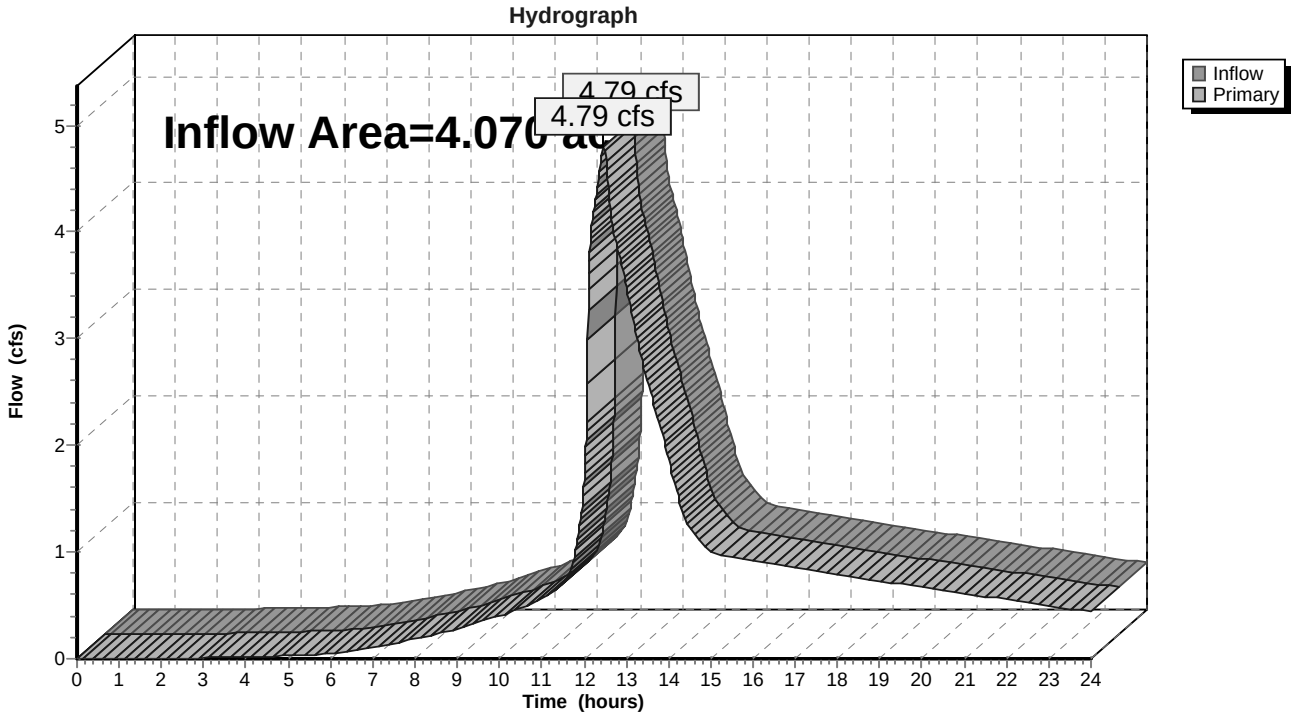


Summary for Link MF TO 3: Pulte MF to DP3

Inflow Area = 4.070 ac, 63.88% Impervious, Inflow Depth > 3.99" for 10-Year event
Inflow = 4.79 cfs @ 12.46 hrs, Volume= 1.354 af
Primary = 4.79 cfs @ 12.46 hrs, Volume= 1.354 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link MF TO 3: Pulte MF to DP3

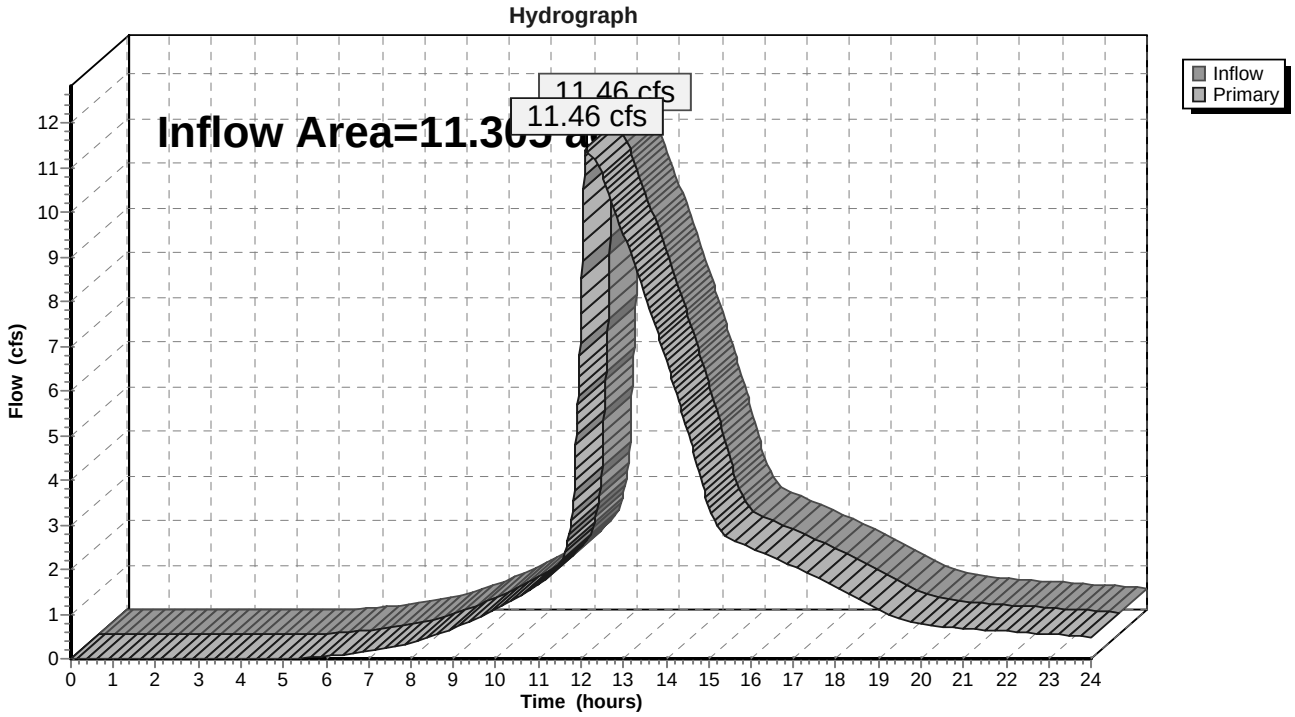


Summary for Link TOWNHOMES: Pulte TH to DP3

Inflow Area = 11.305 ac, 42.64% Impervious, Inflow Depth > 3.62" for 10-Year event
Inflow = 11.46 cfs @ 12.13 hrs, Volume= 3.414 af
Primary = 11.46 cfs @ 12.13 hrs, Volume= 3.414 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link TOWNHOMES: Pulte TH to DP3



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment MF-1: PUL-MF-1 Runoff Area=151,589 sf 64.08% Impervious Runoff Depth>6.50"
Tc=6.0 min CN=92 Runoff=24.54 cfs 1.886 af

Subcatchment MF-2: PUL-MF-2 Runoff Area=16,117 sf 100.00% Impervious Runoff Depth>7.21"
Tc=6.0 min CN=98 Runoff=2.71 cfs 0.222 af

Subcatchment MF-3: PUL-MF-3 Runoff Area=9,583 sf 0.00% Impervious Runoff Depth>5.12"
Tc=6.0 min CN=80 Runoff=1.30 cfs 0.094 af

Subcatchment MF-4: PUL-MF-4 Runoff Area=8,712 sf 0.00% Impervious Runoff Depth>4.78"
Tc=6.0 min CN=77 Runoff=1.12 cfs 0.080 af

Subcatchment TH-1: PUL-TH-1 Runoff Area=444,108 sf 45.61% Impervious Runoff Depth>5.92"
Tc=6.0 min CN=87 Runoff=67.86 cfs 5.029 af

Subcatchment TH-2: PUL-TH-2 Runoff Area=48,351 sf 15.32% Impervious Runoff Depth>4.44"
Tc=6.0 min CN=74 Runoff=5.78 cfs 0.411 af

Pond MF POND 1: DET-MF-1 Peak Elev=120.57' Storage=31,496 cf Inflow=24.54 cfs 1.886 af
Outflow=9.10 cfs 1.742 af

Pond MF POND 2: DET-MF-2 Peak Elev=119.66' Storage=2,285 cf Inflow=2.71 cfs 0.222 af
Outflow=0.95 cfs 0.221 af

Pond TH POND 1: DET-TH-1 Peak Elev=43.32' Storage=73,880 cf Inflow=67.86 cfs 5.029 af
Outflow=18.94 cfs 5.018 af

Link DP3: Inflow=31.00 cfs 7.486 af
Primary=31.00 cfs 7.486 af

Link DP4: Inflow=1.12 cfs 0.080 af
Primary=1.12 cfs 0.080 af

Link MF TO 3: Pulte MF to DP3 Inflow=10.58 cfs 2.057 af
Primary=10.58 cfs 2.057 af

Link TOWNHOMES: Pulte TH to DP3 Inflow=20.71 cfs 5.428 af
Primary=20.71 cfs 5.428 af

Total Runoff Area = 15.575 ac Runoff Volume = 7.722 af Average Runoff Depth = 5.95"
52.36% Pervious = 8.155 ac 47.64% Impervious = 7.420 ac

Summary for Subcatchment MF-1: PUL-MF-1

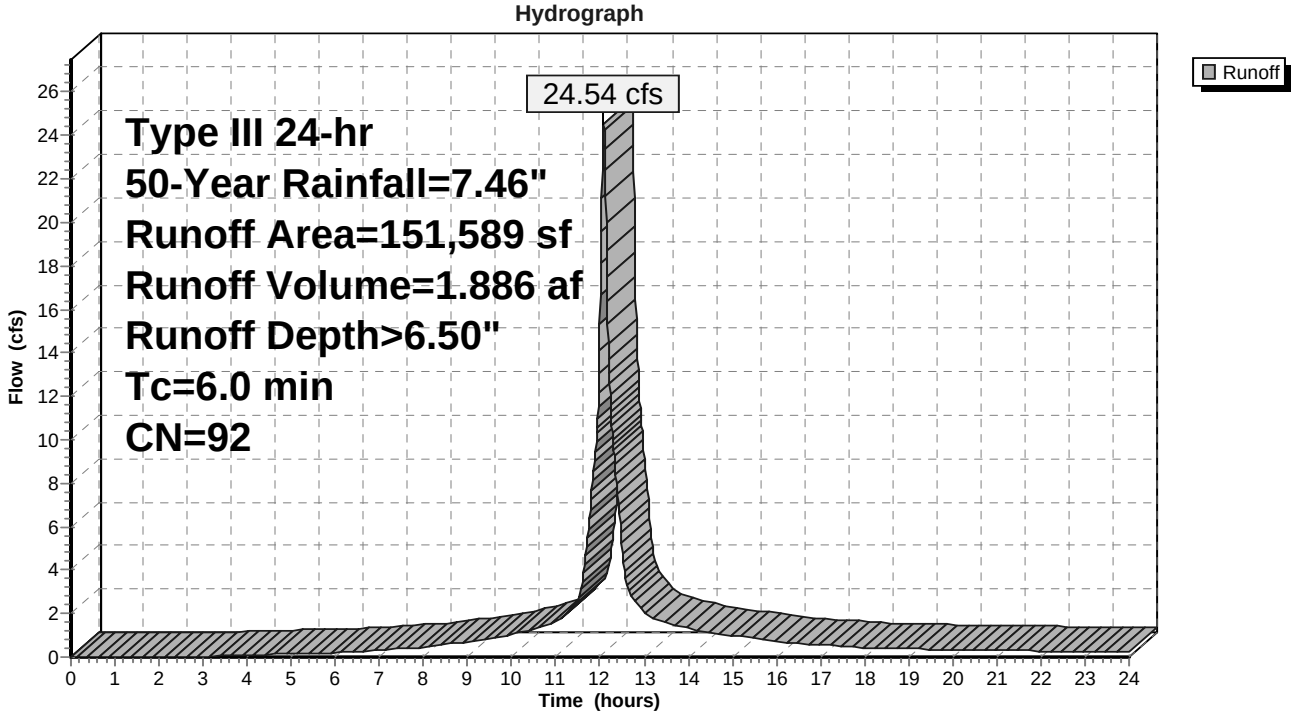
Runoff = 24.54 cfs @ 12.08 hrs, Volume= 1.886 af, Depth> 6.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=7.46"

Area (sf)	CN	Description
62,291	98	Paved parking, HSG D
34,848	98	Roofs, HSG D
54,450	80	>75% Grass cover, Good, HSG D
151,589	92	Weighted Average
54,450	80	35.92% Pervious Area
97,139	98	64.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-1: PUL-MF-1



Summary for Subcatchment MF-2: PUL-MF-2

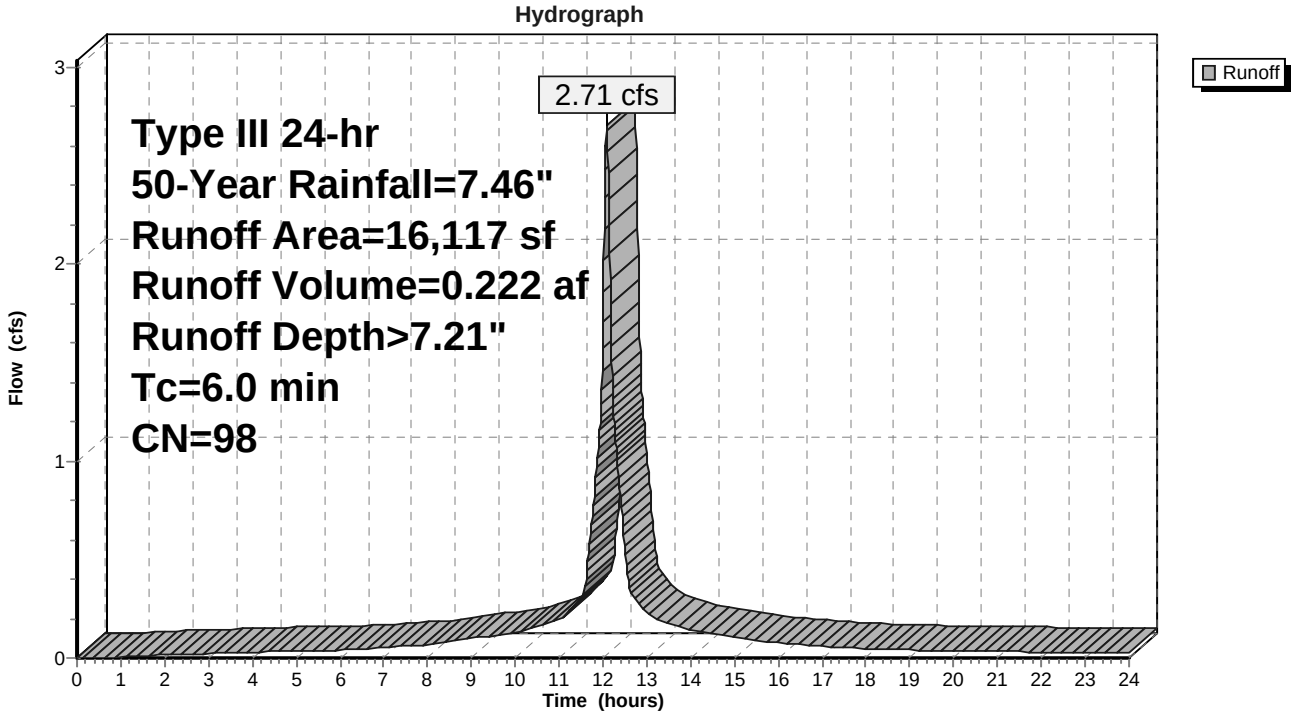
Runoff = 2.71 cfs @ 12.08 hrs, Volume= 0.222 af, Depth> 7.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=7.46"

Area (sf)	CN	Description
16,117	98	Roofs, HSG D
16,117	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-2: PUL-MF-2



Summary for Subcatchment MF-3: PUL-MF-3

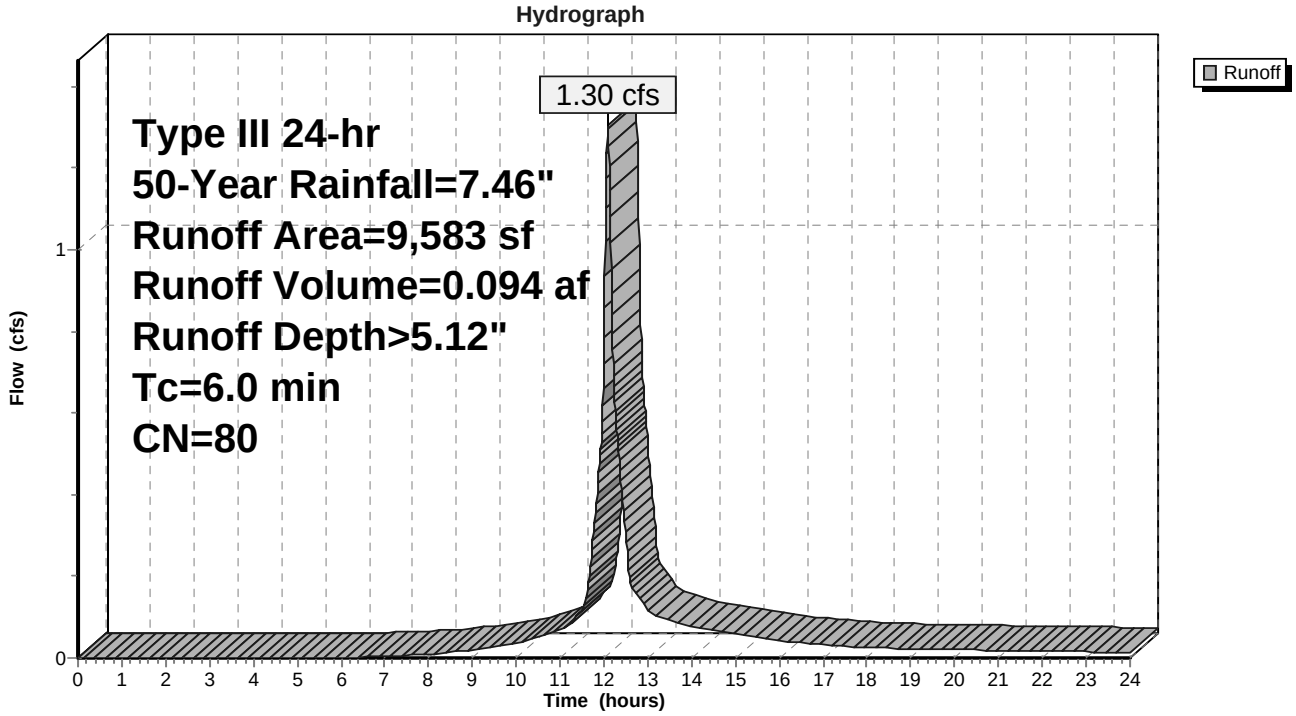
Runoff = 1.30 cfs @ 12.09 hrs, Volume= 0.094 af, Depth> 5.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=7.46"

Area (sf)	CN	Description
9,583	80	>75% Grass cover, Good, HSG D
9,583	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-3: PUL-MF-3



Summary for Subcatchment MF-4: PUL-MF-4

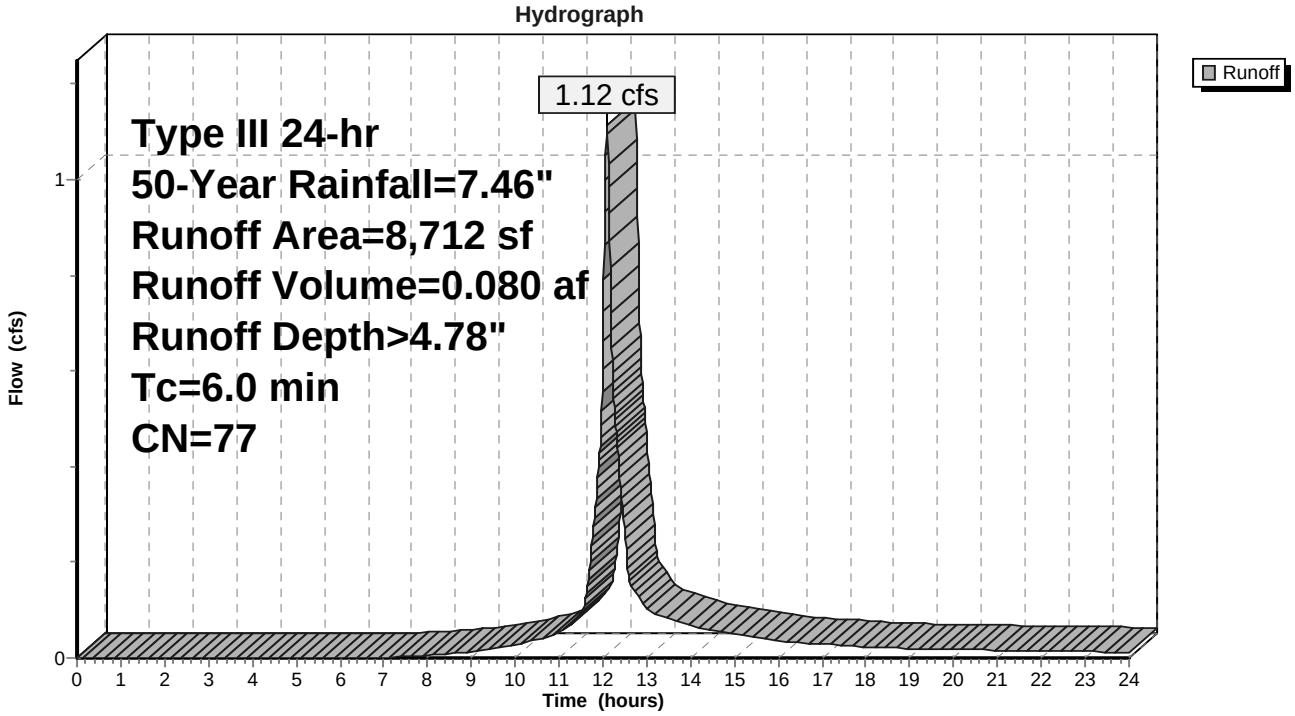
Runoff = 1.12 cfs @ 12.09 hrs, Volume= 0.080 af, Depth> 4.78"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=7.46"

Area (sf)	CN	Description
8,712	77	Woods, Good, HSG D
8,712	77	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-4: PUL-MF-4



Summary for Subcatchment TH-1: PUL-TH-1

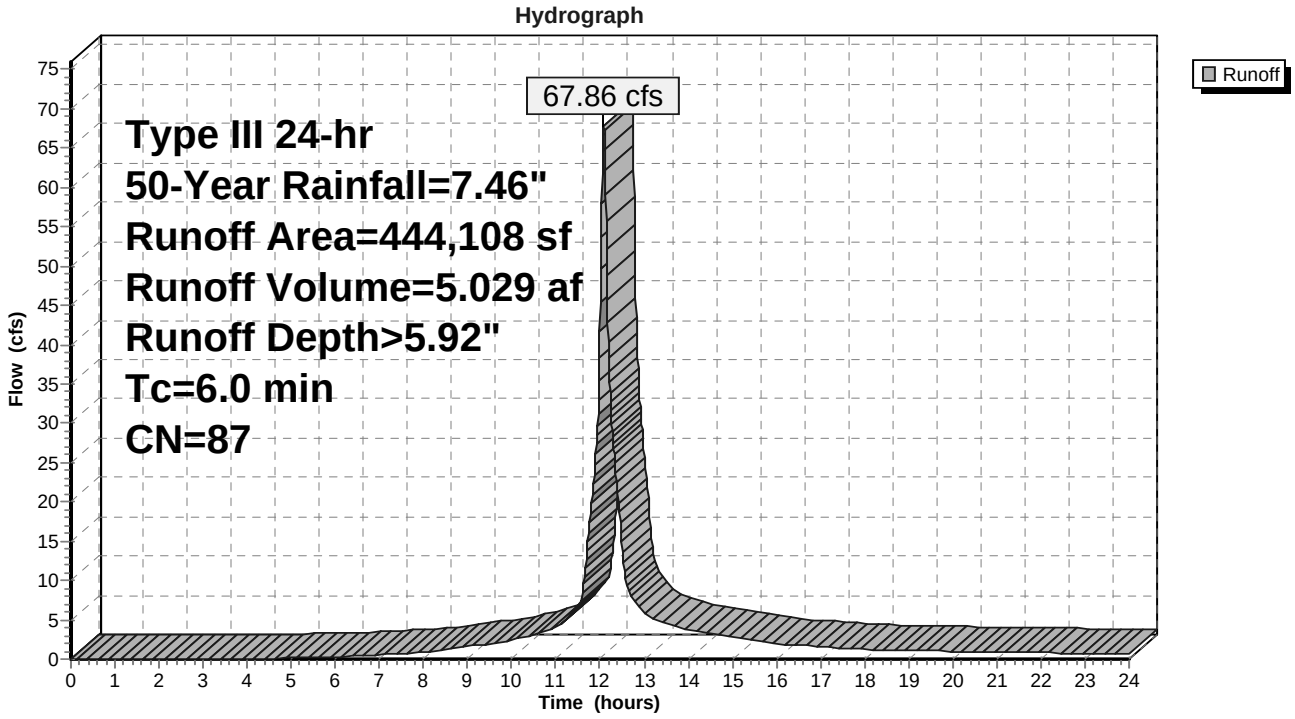
Runoff = 67.86 cfs @ 12.08 hrs, Volume= 5.029 af, Depth> 5.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=7.46"

Area (sf)	CN	Description
92,784	98	Paved parking, HSG D
109,771	98	Roofs, HSG D
16,117	98	Water Surface, 0% imp, HSG D
112,718	80	>75% Grass cover, Good, HSG D
112,718	74	>75% Grass cover, Good, HSG C
444,108	87	Weighted Average
241,553	78	54.39% Pervious Area
202,555	98	45.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-1: PUL-TH-1



Summary for Subcatchment TH-2: PUL-TH-2

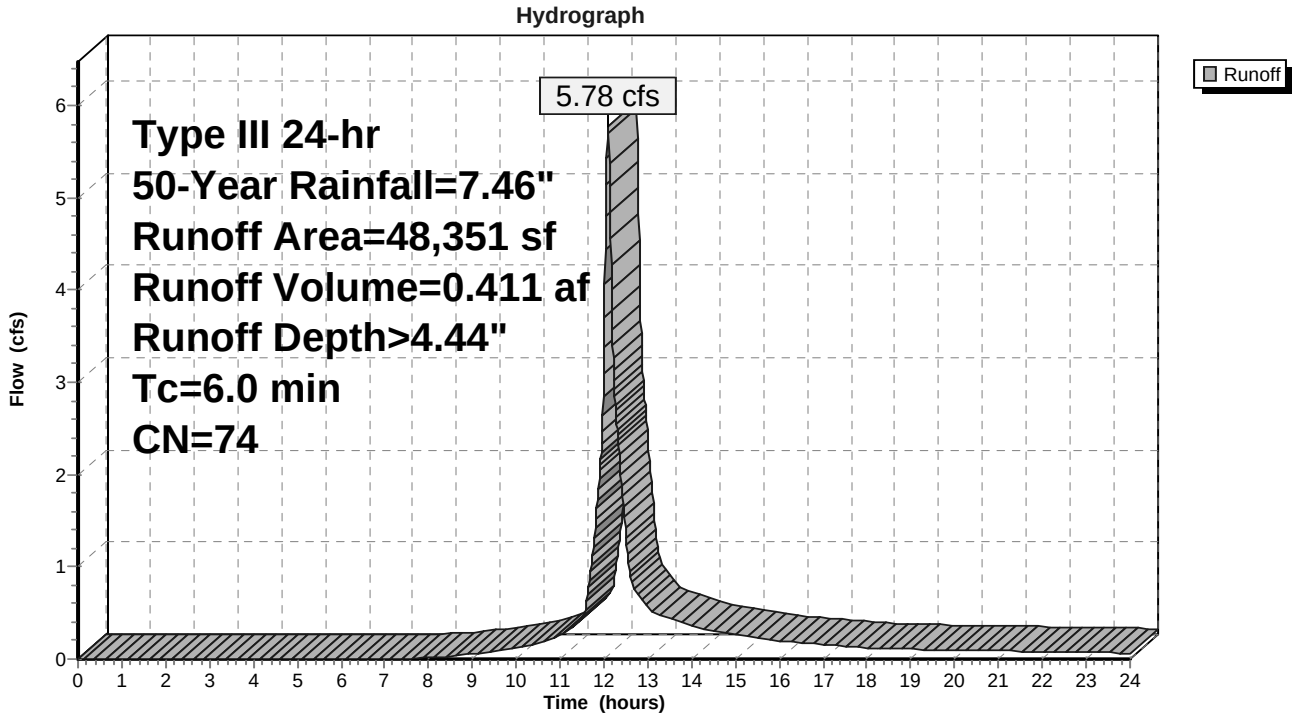
Runoff = 5.78 cfs @ 12.09 hrs, Volume= 0.411 af, Depth> 4.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Rainfall=7.46"

Area (sf)	CN	Description
7,405	98	Roofs, HSG D
19,166	74	>75% Grass cover, Good, HSG C
21,780	65	Brush, Good, HSG C
48,351	74	Weighted Average
40,946	69	84.68% Pervious Area
7,405	98	15.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-2: PUL-TH-2



Summary for Pond MF POND 1: DET-MF-1

Inflow Area = 3.480 ac, 64.08% Impervious, Inflow Depth > 6.50" for 50-Year event
Inflow = 24.54 cfs @ 12.08 hrs, Volume= 1.886 af
Outflow = 9.10 cfs @ 12.33 hrs, Volume= 1.742 af, Atten= 63%, Lag= 14.5 min
Primary = 9.10 cfs @ 12.33 hrs, Volume= 1.742 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 120.57' @ 12.33 hrs Surf.Area= 3,675 sf Storage= 31,496 cf

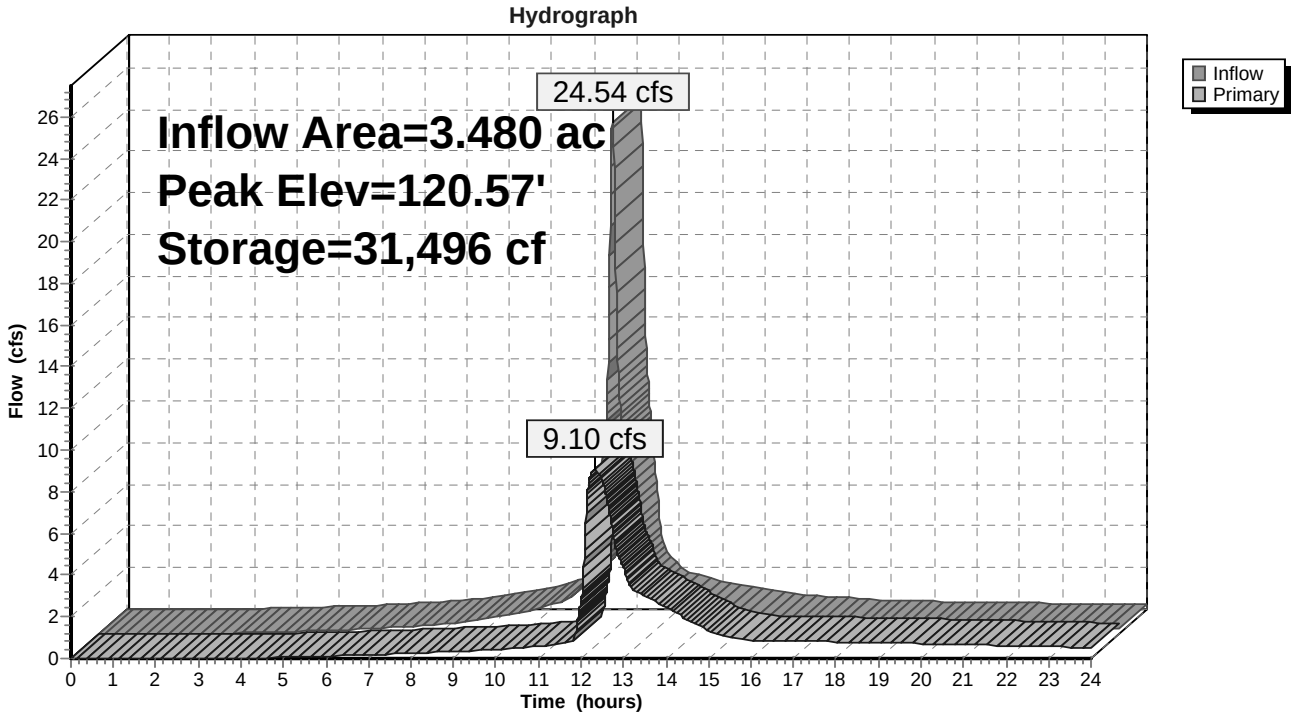
Plug-Flow detention time= 142.5 min calculated for 1.742 af (92% of inflow)
Center-of-Mass det. time= 102.6 min (873.0 - 770.4)

Volume	Invert	Avail.Storage	Storage Description
#1	112.00'	36,750 cf	**7.00'W x 7.00'L x 10.00'H Prismatoid** x 75

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**15.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	112.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	118.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	119.00'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	121.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=9.10 cfs @ 12.33 hrs HW=120.57' (Free Discharge)
└─**1=Culvert** (Passes 9.10 cfs of 16.66 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.22 cfs @ 13.96 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 3.43 cfs @ 9.81 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 2.47 cfs @ 7.07 fps)
  ├─**5=Orifice/Grate** (Orifice Controls 1.99 cfs @ 5.70 fps)
  └─**6=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond MF POND 1: DET-MF-1



Summary for Pond MF POND 2: DET-MF-2

Inflow Area = 0.370 ac,100.00% Impervious, Inflow Depth > 7.21" for 50-Year event
Inflow = 2.71 cfs @ 12.08 hrs, Volume= 0.222 af
Outflow = 0.95 cfs @ 12.34 hrs, Volume= 0.221 af, Atten= 65%, Lag= 15.5 min
Primary = 0.95 cfs @ 12.34 hrs, Volume= 0.221 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 119.66' @ 12.34 hrs Surf.Area= 490 sf Storage= 2,285 cf

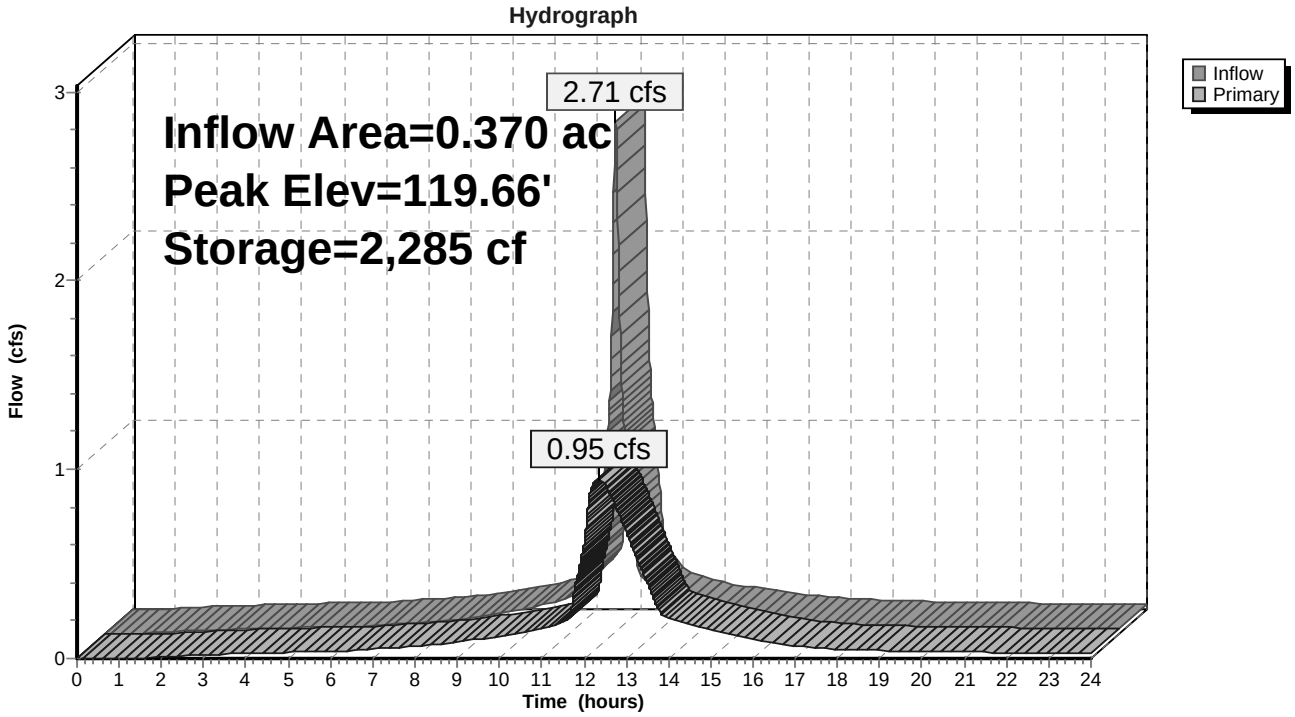
Plug-Flow detention time= 32.2 min calculated for 0.221 af (99% of inflow)
Center-of-Mass det. time= 28.3 min (769.9 - 741.6)

Volume	Invert	Avail.Storage	Storage Description
#1	115.00'	2,450 cf	**7.00'W x 7.00'L x 5.00'H Prismatoid** x 10

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**12.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	115.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#4	Device 1	119.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.95 cfs @ 12.34 hrs HW=119.66' (Free Discharge)
└─**1=Culvert** (Passes 0.95 cfs of 9.96 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.50 cfs @ 10.26 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.44 cfs @ 9.06 fps)
  └─**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond MF POND 2: DET-MF-2



Summary for Pond TH POND 1: DET-TH-1

Inflow Area = 10.195 ac, 45.61% Impervious, Inflow Depth > 5.92" for 50-Year event
Inflow = 67.86 cfs @ 12.08 hrs, Volume= 5.029 af
Outflow = 18.94 cfs @ 12.43 hrs, Volume= 5.018 af, Atten= 72%, Lag= 20.7 min
Primary = 18.94 cfs @ 12.43 hrs, Volume= 5.018 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 43.32' @ 12.43 hrs Surf.Area= 12,365 sf Storage= 73,880 cf

Plug-Flow detention time= 58.9 min calculated for 5.018 af (100% of inflow)
Center-of-Mass det. time= 57.4 min (844.1 - 786.7)

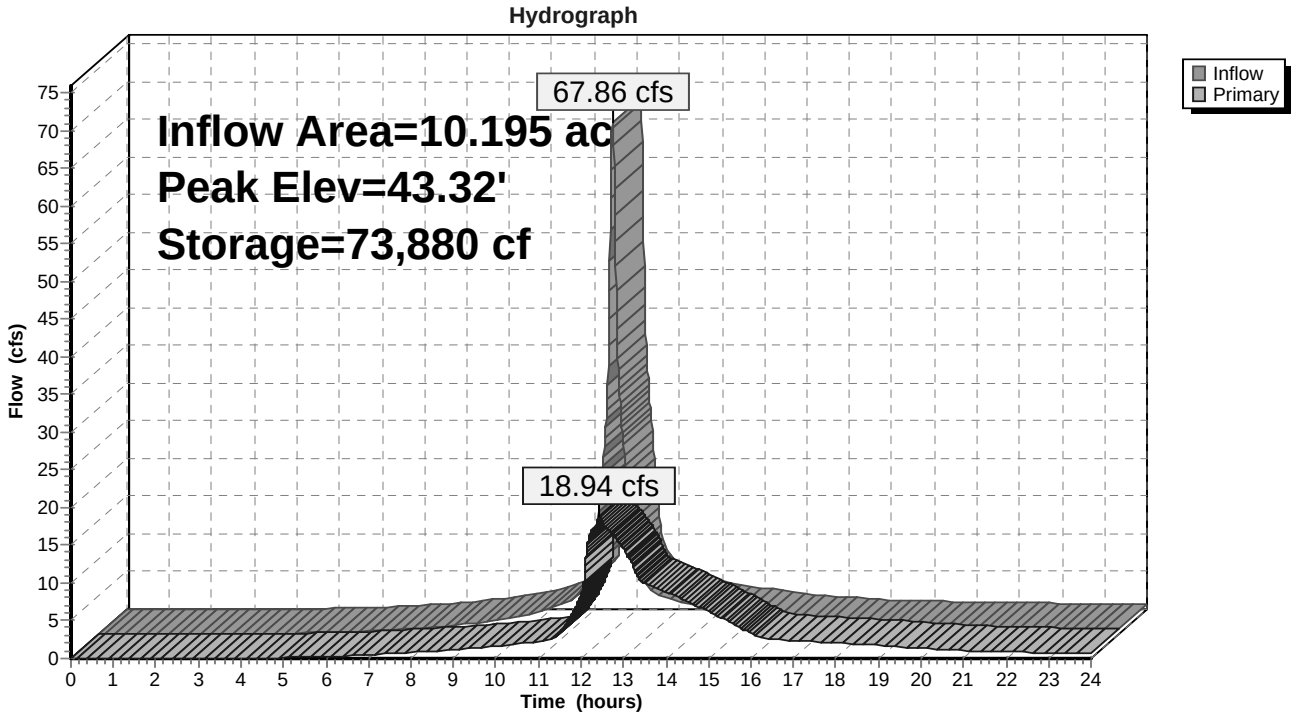
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	95,773 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
35.00	10	0	0
36.00	7,053	3,532	3,532
38.00	8,377	15,430	18,962
40.00	9,794	18,171	37,133
42.00	11,305	21,099	58,232
44.00	12,908	24,213	82,445
45.00	13,749	13,329	95,773

Device	Routing	Invert	Outlet Devices
#1	Primary	35.00'	**12.0" Round Culvert X 3.00** L= 75.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 35.00' / 34.00' S= 0.0133 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	43.25'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	35.00'	**6.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	37.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600
#5	Device 1	41.00'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Primary	43.75'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=18.82 cfs @ 12.43 hrs HW=43.32' (Free Discharge)
- **1=Culvert** (Passes 18.82 cfs of 27.78 cfs potential flow)
  - **2=Orifice/Grate** (Weir Controls 1.02 cfs @ 0.88 fps)
  - **3=Orifice/Grate** (Orifice Controls 5.37 cfs @ 13.68 fps)
  - **4=Orifice/Grate** (Orifice Controls 6.99 cfs @ 11.87 fps)
  - **5=Orifice/Grate** (Orifice Controls 5.44 cfs @ 6.93 fps)
- **6=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond TH POND 1: DET-TH-1

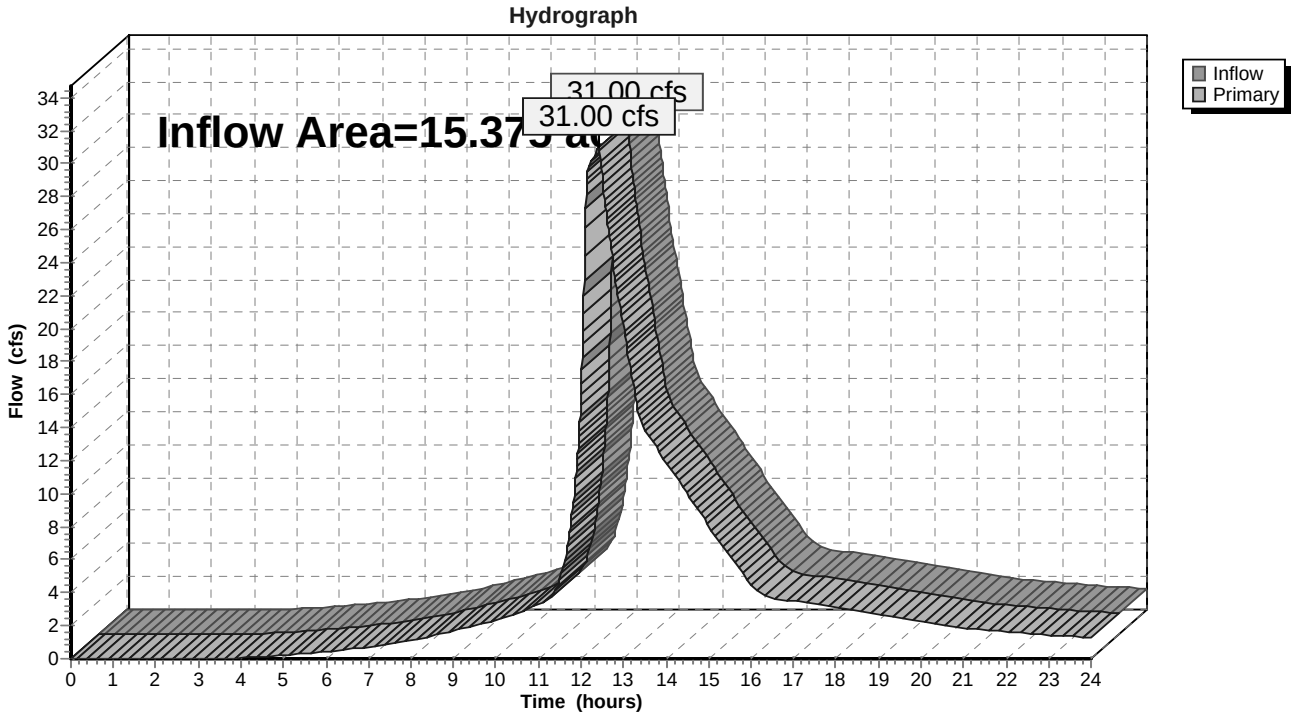


Summary for Link DP3:

Inflow Area = 15.375 ac, 48.26% Impervious, Inflow Depth > 5.84" for 50-Year event
Inflow = 31.00 cfs @ 12.41 hrs, Volume= 7.486 af
Primary = 31.00 cfs @ 12.41 hrs, Volume= 7.486 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3:

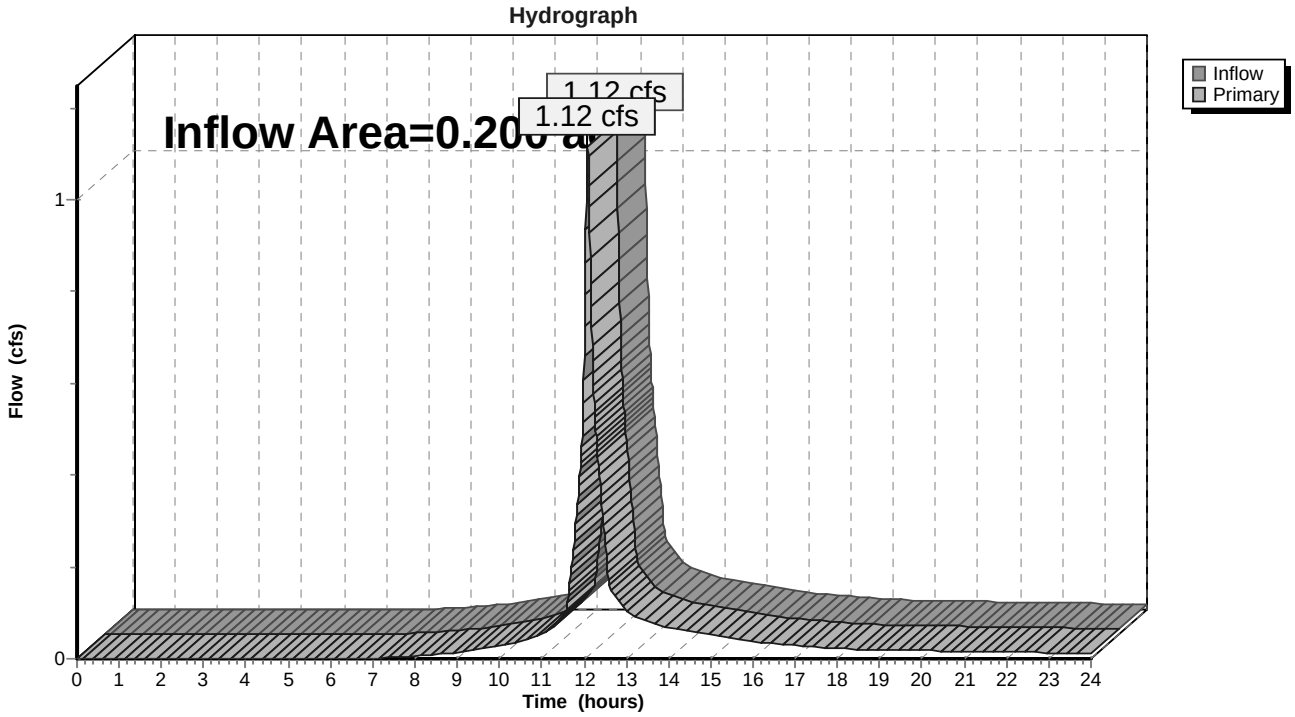


Summary for Link DP4:

Inflow Area = 0.200 ac, 0.00% Impervious, Inflow Depth > 4.78" for 50-Year event
Inflow = 1.12 cfs @ 12.09 hrs, Volume= 0.080 af
Primary = 1.12 cfs @ 12.09 hrs, Volume= 0.080 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP4:

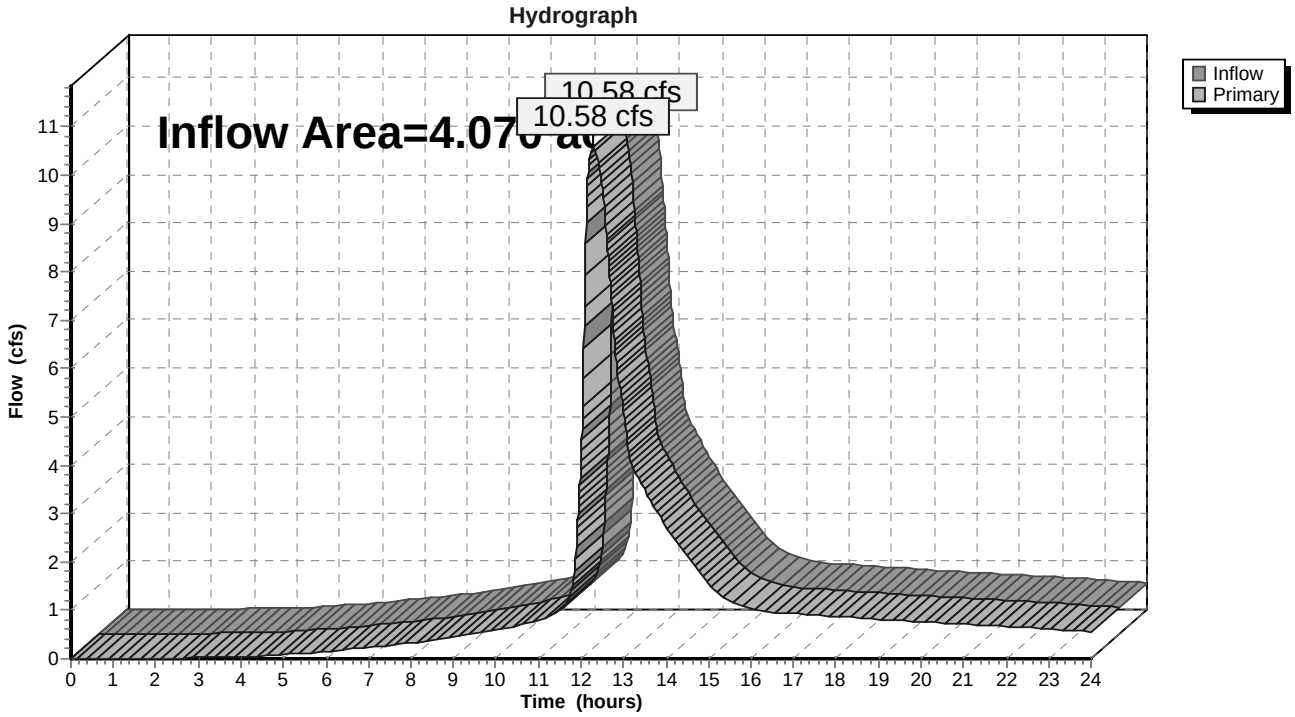


Summary for Link MF TO 3: Pulte MF to DP3

Inflow Area = 4.070 ac, 63.88% Impervious, Inflow Depth > 6.07" for 50-Year event
Inflow = 10.58 cfs @ 12.30 hrs, Volume= 2.057 af
Primary = 10.58 cfs @ 12.30 hrs, Volume= 2.057 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link MF TO 3: Pulte MF to DP3

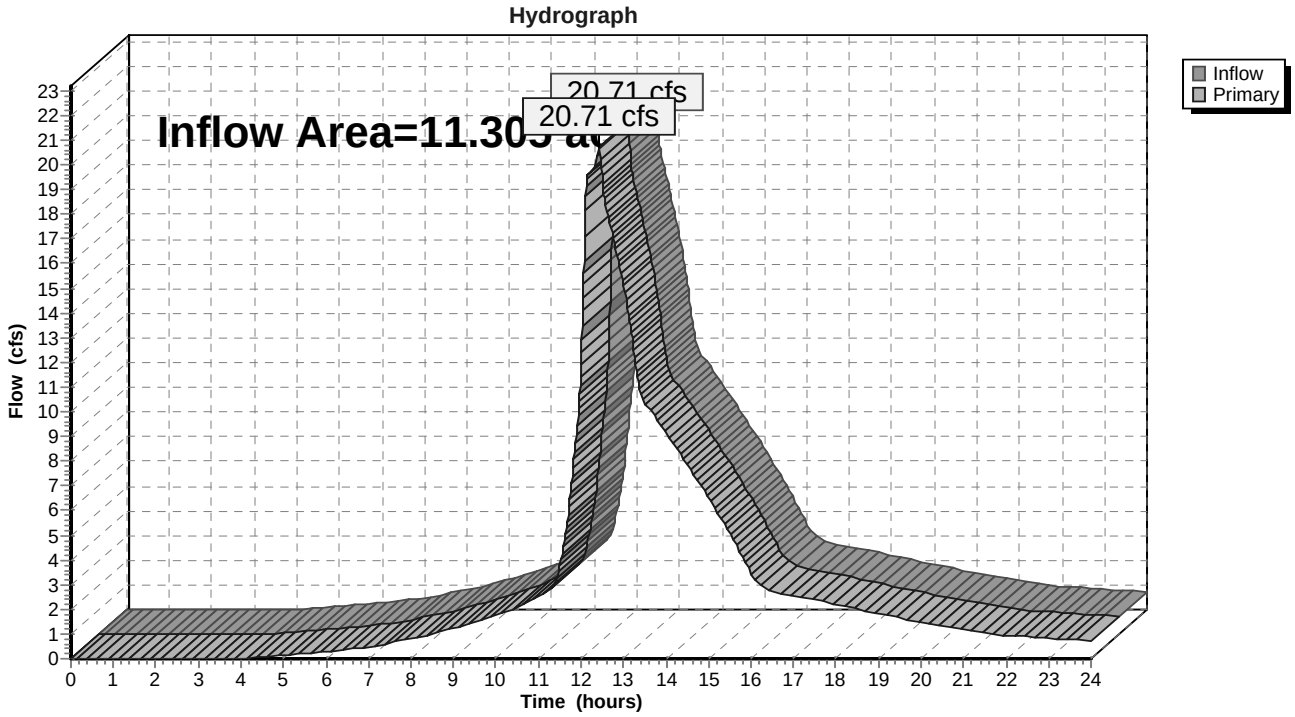


Summary for Link TOWNHOMES: Pulte TH to DP3

Inflow Area = 11.305 ac, 42.64% Impervious, Inflow Depth > 5.76" for 50-Year event
Inflow = 20.71 cfs @ 12.42 hrs, Volume= 5.428 af
Primary = 20.71 cfs @ 12.42 hrs, Volume= 5.428 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link TOWNHOMES: Pulte TH to DP3



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment MF-1: PUL-MF-1 Runoff Area=151,589 sf 64.08% Impervious Runoff Depth>7.97"
Tc=6.0 min CN=92 Runoff=29.73 cfs 2.311 af

Subcatchment MF-2: PUL-MF-2 Runoff Area=16,117 sf 100.00% Impervious Runoff Depth>8.69"
Tc=6.0 min CN=98 Runoff=3.25 cfs 0.268 af

Subcatchment MF-3: PUL-MF-3 Runoff Area=9,583 sf 0.00% Impervious Runoff Depth>6.50"
Tc=6.0 min CN=80 Runoff=1.64 cfs 0.119 af

Subcatchment MF-4: PUL-MF-4 Runoff Area=8,712 sf 0.00% Impervious Runoff Depth>6.14"
Tc=6.0 min CN=77 Runoff=1.42 cfs 0.102 af

Subcatchment TH-1: PUL-TH-1 Runoff Area=444,108 sf 45.61% Impervious Runoff Depth>7.36"
Tc=6.0 min CN=87 Runoff=83.36 cfs 6.254 af

Subcatchment TH-2: PUL-TH-2 Runoff Area=48,351 sf 15.32% Impervious Runoff Depth>5.77"
Tc=6.0 min CN=74 Runoff=7.47 cfs 0.534 af

Pond MF POND 1: DET-MF-1 Peak Elev=121.85' Storage=36,183 cf Inflow=29.73 cfs 2.311 af
Outflow=13.72 cfs 2.138 af

Pond MF POND 2: DET-MF-2 Peak Elev=119.96' Storage=2,428 cf Inflow=3.25 cfs 0.268 af
Outflow=2.20 cfs 0.267 af

Pond TH POND 1: DET-TH-1 Peak Elev=43.93' Storage=81,559 cf Inflow=83.36 cfs 6.254 af
Outflow=38.65 cfs 6.238 af

Link DP3: Inflow=58.41 cfs 9.295 af
Primary=58.41 cfs 9.295 af

Link DP4: Inflow=1.42 cfs 0.102 af
Primary=1.42 cfs 0.102 af

Link MF TO 3: Pulte MF to DP3 Inflow=16.16 cfs 2.524 af
Primary=16.16 cfs 2.524 af

Link TOWNHOMES: Pulte TH to DP3 Inflow=42.28 cfs 6.771 af
Primary=42.28 cfs 6.771 af

Total Runoff Area = 15.575 ac Runoff Volume = 9.588 af Average Runoff Depth = 7.39"
52.36% Pervious = 8.155 ac 47.64% Impervious = 7.420 ac

Summary for Subcatchment MF-1: PUL-MF-1

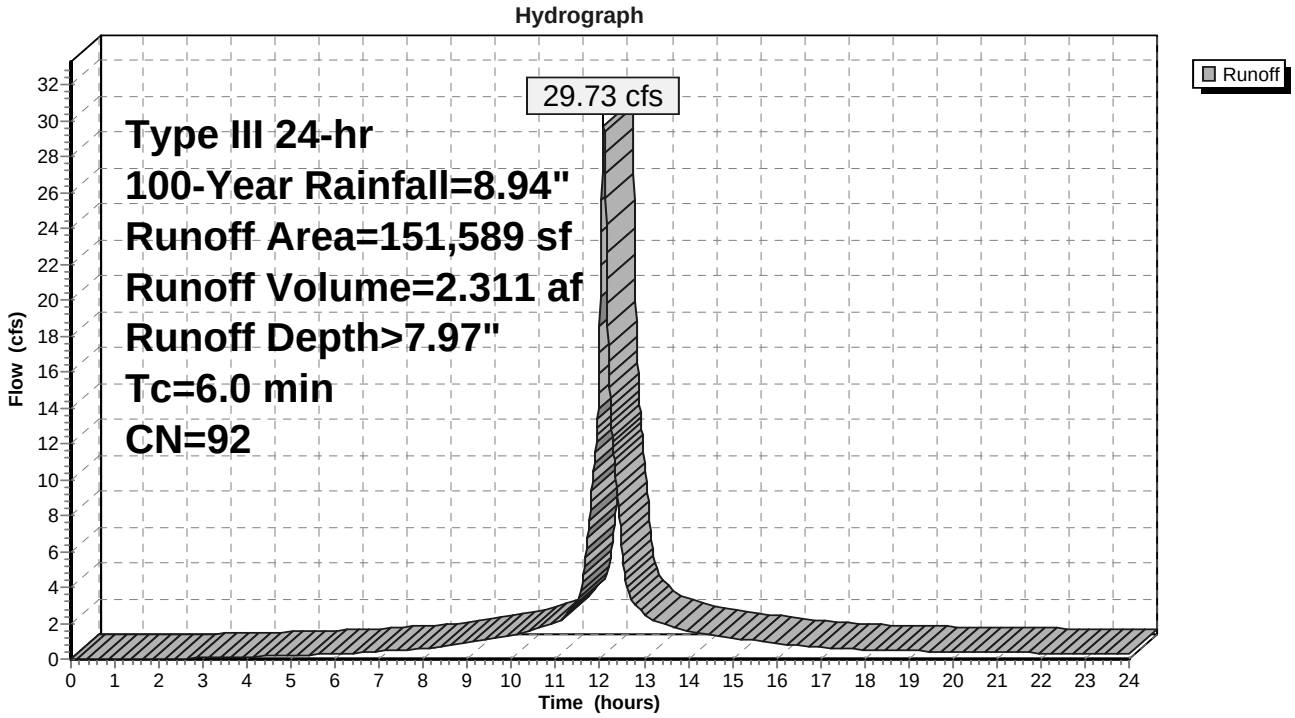
Runoff = 29.73 cfs @ 12.08 hrs, Volume= 2.311 af, Depth> 7.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
62,291	98	Paved parking, HSG D
34,848	98	Roofs, HSG D
54,450	80	>75% Grass cover, Good, HSG D
151,589	92	Weighted Average
54,450	80	35.92% Pervious Area
97,139	98	64.08% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-1: PUL-MF-1



Summary for Subcatchment MF-2: PUL-MF-2

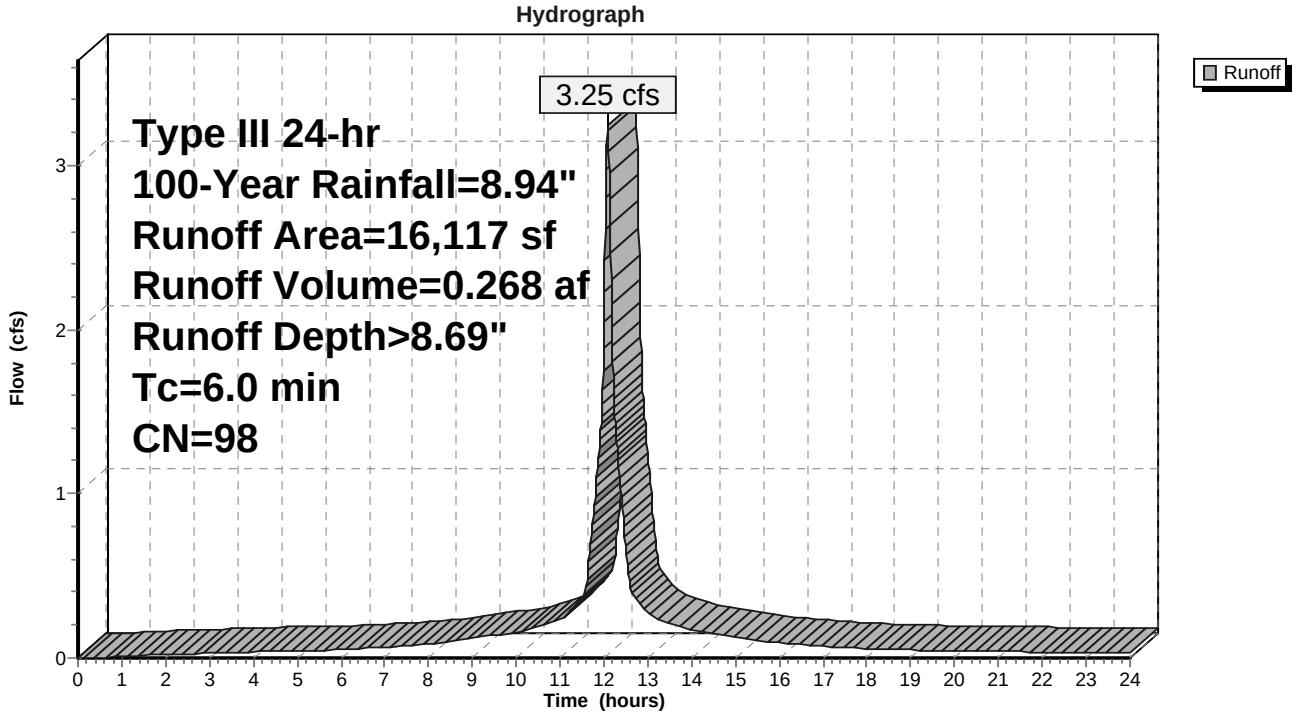
Runoff = 3.25 cfs @ 12.08 hrs, Volume= 0.268 af, Depth> 8.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
16,117	98	Roofs, HSG D
16,117	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-2: PUL-MF-2



Summary for Subcatchment MF-3: PUL-MF-3

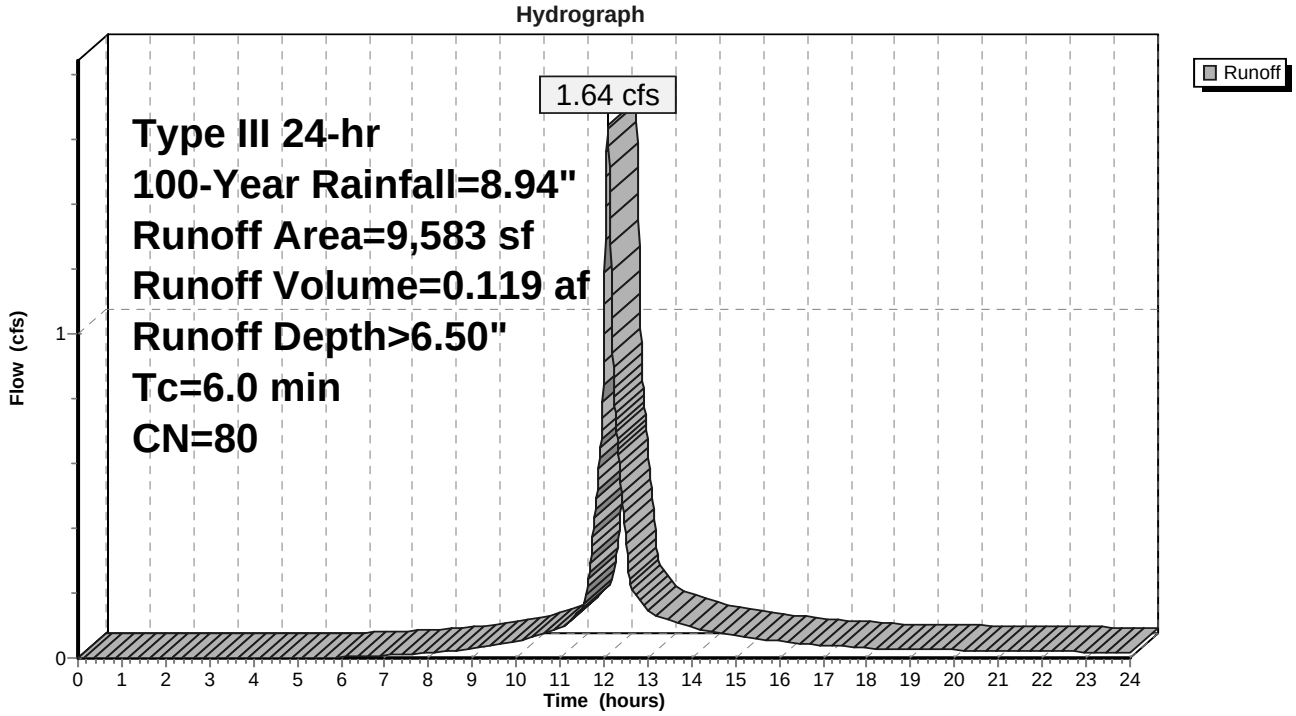
Runoff = 1.64 cfs @ 12.09 hrs, Volume= 0.119 af, Depth> 6.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
9,583	80	>75% Grass cover, Good, HSG D
9,583	80	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-3: PUL-MF-3



Summary for Subcatchment MF-4: PUL-MF-4

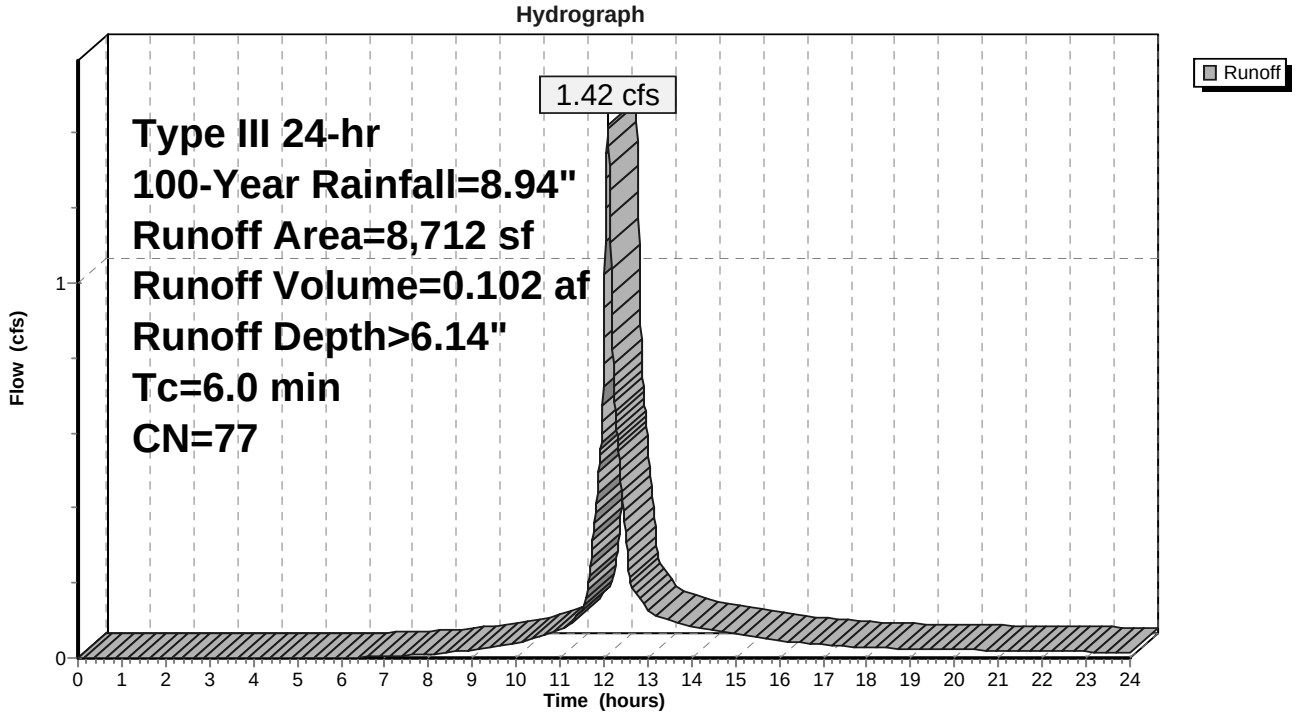
Runoff = 1.42 cfs @ 12.09 hrs, Volume= 0.102 af, Depth> 6.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
8,712	77	Woods, Good, HSG D
8,712	77	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment MF-4: PUL-MF-4



Summary for Subcatchment TH-1: PUL-TH-1

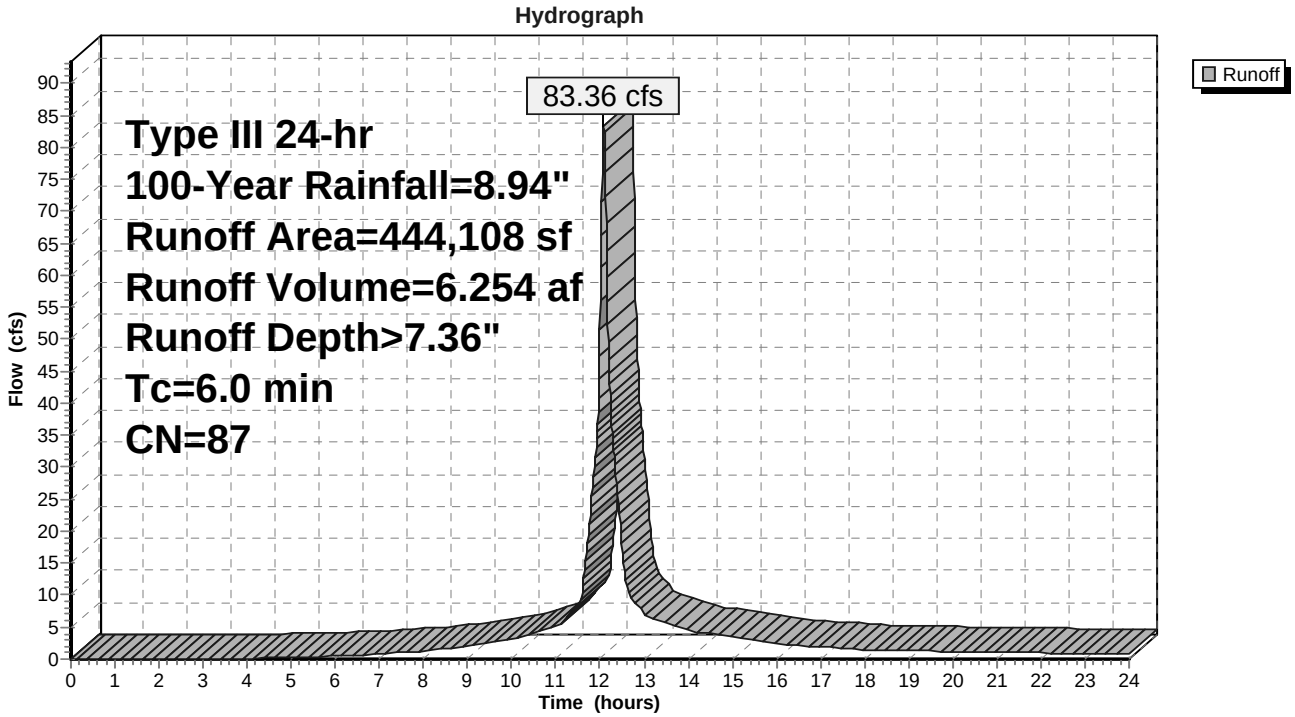
Runoff = 83.36 cfs @ 12.08 hrs, Volume= 6.254 af, Depth> 7.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
92,784	98	Paved parking, HSG D
109,771	98	Roofs, HSG D
16,117	98	Water Surface, 0% imp, HSG D
112,718	80	>75% Grass cover, Good, HSG D
112,718	74	>75% Grass cover, Good, HSG C
444,108	87	Weighted Average
241,553	78	54.39% Pervious Area
202,555	98	45.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-1: PUL-TH-1



Summary for Subcatchment TH-2: PUL-TH-2

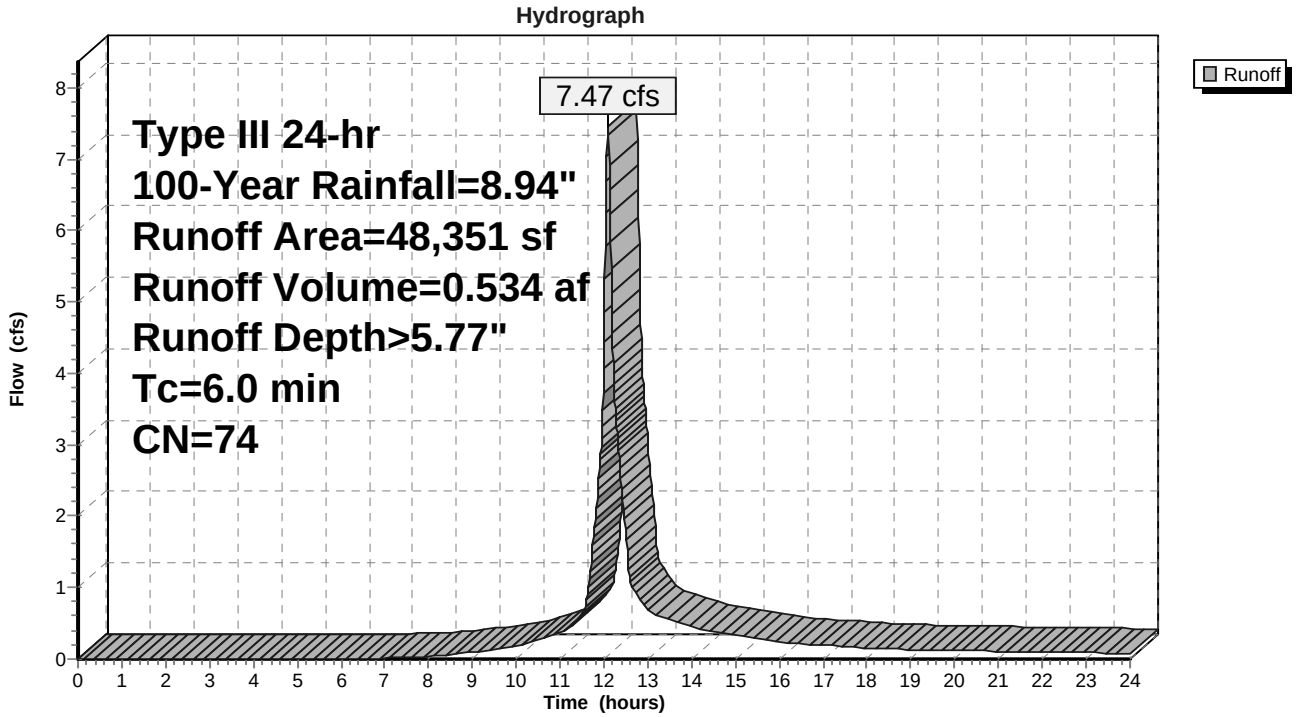
Runoff = 7.47 cfs @ 12.09 hrs, Volume= 0.534 af, Depth> 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
7,405	98	Roofs, HSG D
19,166	74	>75% Grass cover, Good, HSG C
21,780	65	Brush, Good, HSG C
48,351	74	Weighted Average
40,946	69	84.68% Pervious Area
7,405	98	15.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Subcatchment TH-2: PUL-TH-2



Summary for Pond MF POND 1: DET-MF-1

Inflow Area = 3.480 ac, 64.08% Impervious, Inflow Depth > 7.97" for 100-Year event
Inflow = 29.73 cfs @ 12.08 hrs, Volume= 2.311 af
Outflow = 13.72 cfs @ 12.25 hrs, Volume= 2.138 af, Atten= 54%, Lag= 9.9 min
Primary = 13.72 cfs @ 12.25 hrs, Volume= 2.138 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 121.85' @ 12.25 hrs Surf.Area= 3,675 sf Storage= 36,183 cf

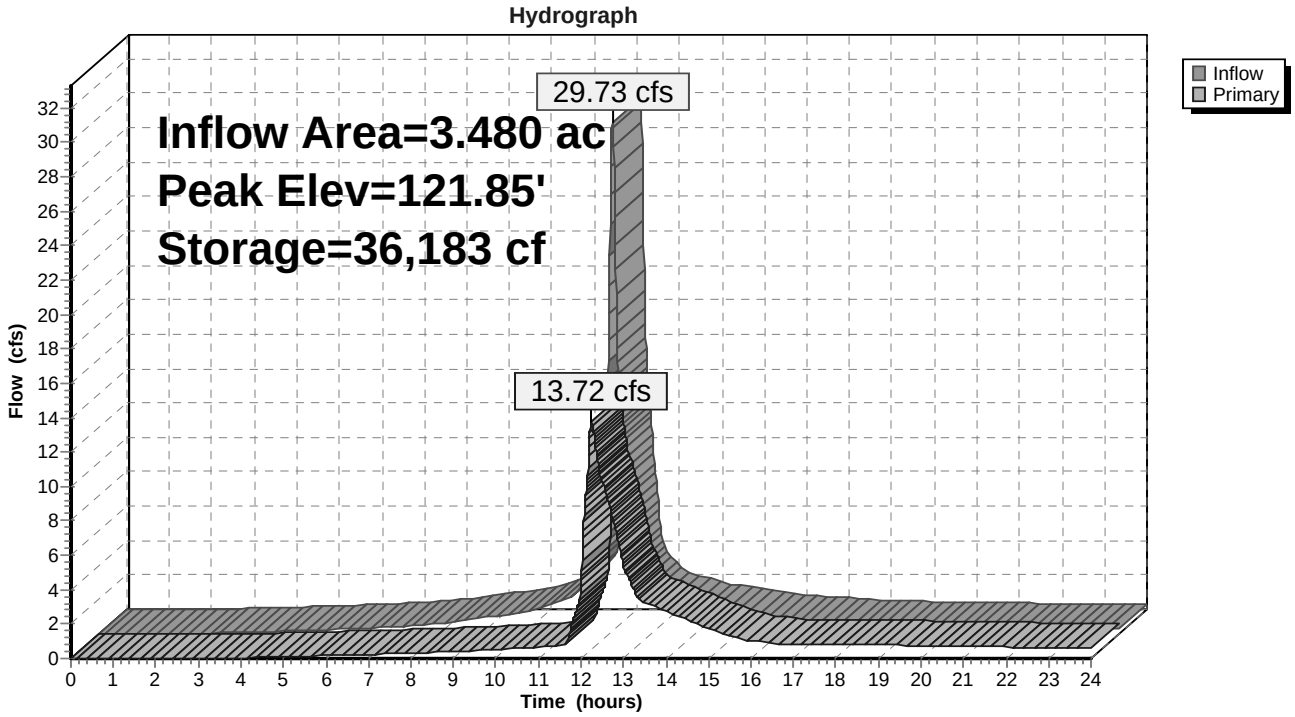
Plug-Flow detention time= 128.9 min calculated for 2.138 af (93% of inflow)
Center-of-Mass det. time= 89.3 min (855.0 - 765.6)

Volume	Invert	Avail.Storage	Storage Description
#1	112.00'	36,750 cf	**7.00'W x 7.00'L x 10.00'H Prismatoid** x 75

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**15.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	112.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	118.25'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#5	Device 1	119.00'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Device 1	121.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=13.69 cfs @ 12.25 hrs HW=121.85' (Free Discharge)
└─**1=Culvert** (Passes 13.69 cfs of 17.94 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.31 cfs @ 14.98 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 3.92 cfs @ 11.22 fps)
  ├─**4=Orifice/Grate** (Orifice Controls 3.11 cfs @ 8.92 fps)
  ├─**5=Orifice/Grate** (Orifice Controls 2.75 cfs @ 7.88 fps)
  └─**6=Sharp-Crested Rectangular Weir** (Weir Controls 2.61 cfs @ 1.92 fps)

Pond MF POND 1: DET-MF-1



Summary for Pond MF POND 2: DET-MF-2

Inflow Area = 0.370 ac,100.00% Impervious, Inflow Depth > 8.69" for 100-Year event
Inflow = 3.25 cfs @ 12.08 hrs, Volume= 0.268 af
Outflow = 2.20 cfs @ 12.17 hrs, Volume= 0.267 af, Atten= 32%, Lag= 5.1 min
Primary = 2.20 cfs @ 12.17 hrs, Volume= 0.267 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 119.96' @ 12.17 hrs Surf.Area= 490 sf Storage= 2,428 cf

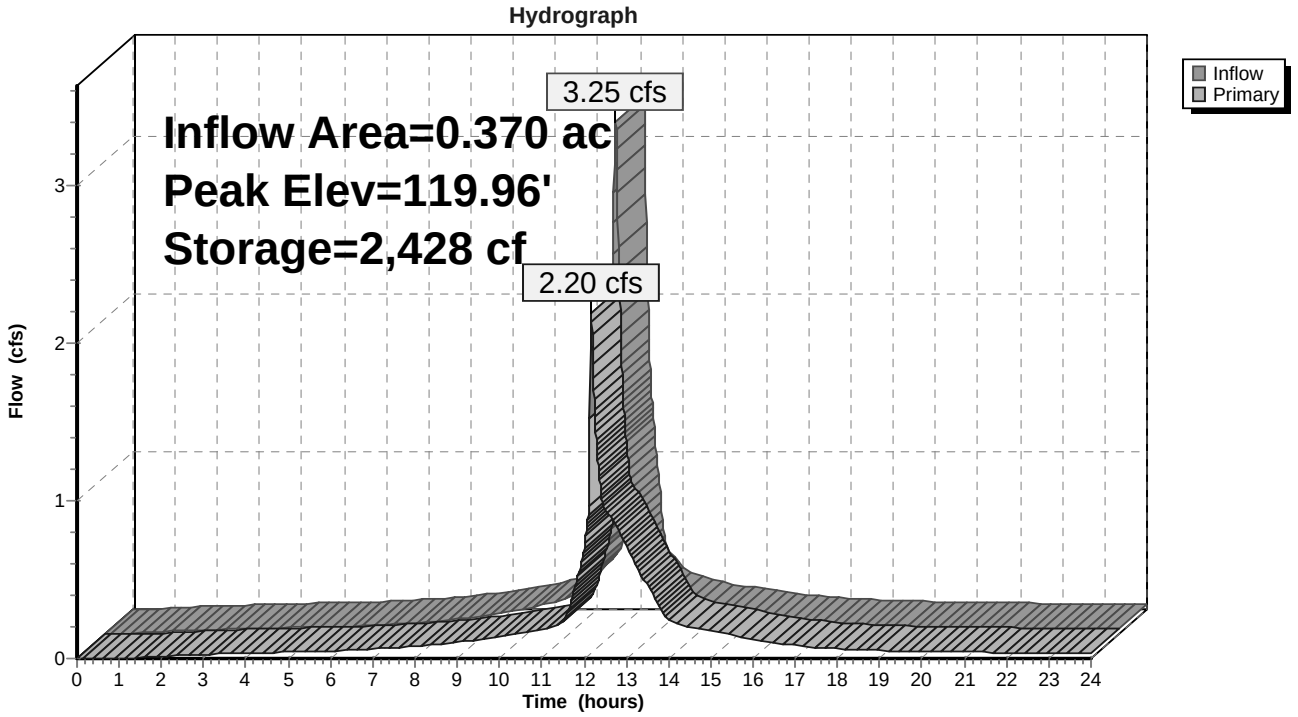
Plug-Flow detention time= 30.8 min calculated for 0.267 af (99% of inflow)
Center-of-Mass det. time= 27.3 min (766.6 - 739.3)

Volume	Invert	Avail.Storage	Storage Description
#1	115.00'	2,450 cf	**7.00'W x 7.00'L x 5.00'H Prismatoid** x 10

Device	Routing	Invert	Outlet Devices
#1	Primary	112.00'	**12.0" Round Culvert** L= 50.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 112.00' / 111.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	115.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	116.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#4	Device 1	119.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=2.19 cfs @ 12.17 hrs HW=119.96' (Free Discharge)
└─**1=Culvert** (Passes 2.19 cfs of 10.15 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.52 cfs @ 10.58 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.46 cfs @ 9.42 fps)
  └─**4=Sharp-Crested Rectangular Weir** (Weir Controls 1.21 cfs @ 1.48 fps)

Pond MF POND 2: DET-MF-2



Summary for Pond TH POND 1: DET-TH-1

Inflow Area = 10.195 ac, 45.61% Impervious, Inflow Depth > 7.36" for 100-Year event
Inflow = 83.36 cfs @ 12.08 hrs, Volume= 6.254 af
Outflow = 38.65 cfs @ 12.25 hrs, Volume= 6.238 af, Atten= 54%, Lag= 10.0 min
Primary = 38.65 cfs @ 12.25 hrs, Volume= 6.238 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 43.93' @ 12.25 hrs Surf.Area= 12,853 sf Storage= 81,559 cf

Plug-Flow detention time= 56.2 min calculated for 6.235 af (100% of inflow)
Center-of-Mass det. time= 54.5 min (835.4 - 780.9)

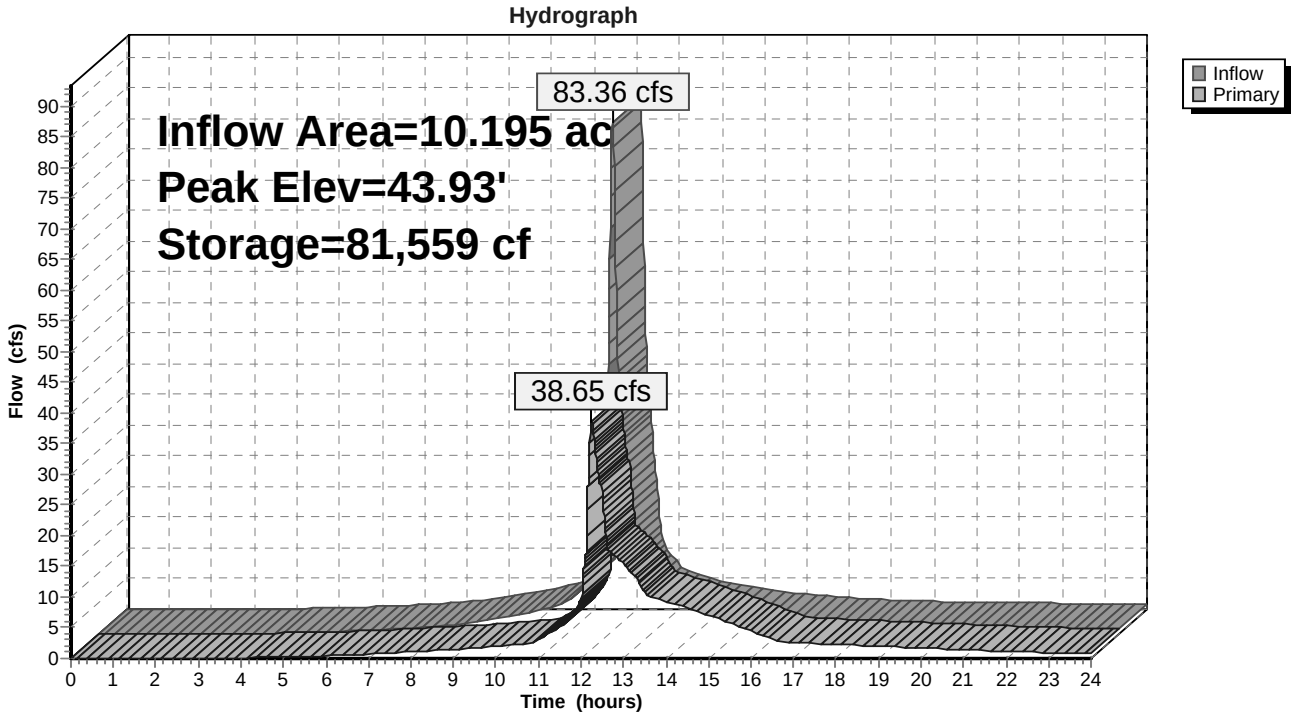
Volume	Invert	Avail.Storage	Storage Description
#1	35.00'	95,773 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
35.00	10	0	0
36.00	7,053	3,532	3,532
38.00	8,377	15,430	18,962
40.00	9,794	18,171	37,133
42.00	11,305	21,099	58,232
44.00	12,908	24,213	82,445
45.00	13,749	13,329	95,773

Device	Routing	Invert	Outlet Devices
#1	Primary	35.00'	**12.0" Round Culvert X 3.00** L= 75.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 35.00' / 34.00' S= 0.0133 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	43.25'	**48.0" x 48.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	35.00'	**6.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	37.00'	**6.0" Vert. Orifice/Grate X 3.00** C= 0.600
#5	Device 1	41.00'	**6.0" Vert. Orifice/Grate X 4.00** C= 0.600
#6	Primary	43.75'	**50.0' long x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=38.38 cfs @ 12.25 hrs HW=43.93' (Free Discharge)
- **1=Culvert** (Barrel Controls 28.78 cfs @ 12.22 fps)
  - **2=Orifice/Grate** (Passes < 29.41 cfs potential flow)
  - **3=Orifice/Grate** (Passes < 5.57 cfs potential flow)
  - **4=Orifice/Grate** (Passes < 7.33 cfs potential flow)
  - **5=Orifice/Grate** (Passes < 6.19 cfs potential flow)
- **6=Broad-Crested Rectangular Weir** (Weir Controls 9.60 cfs @ 1.06 fps)

Pond TH POND 1: DET-TH-1

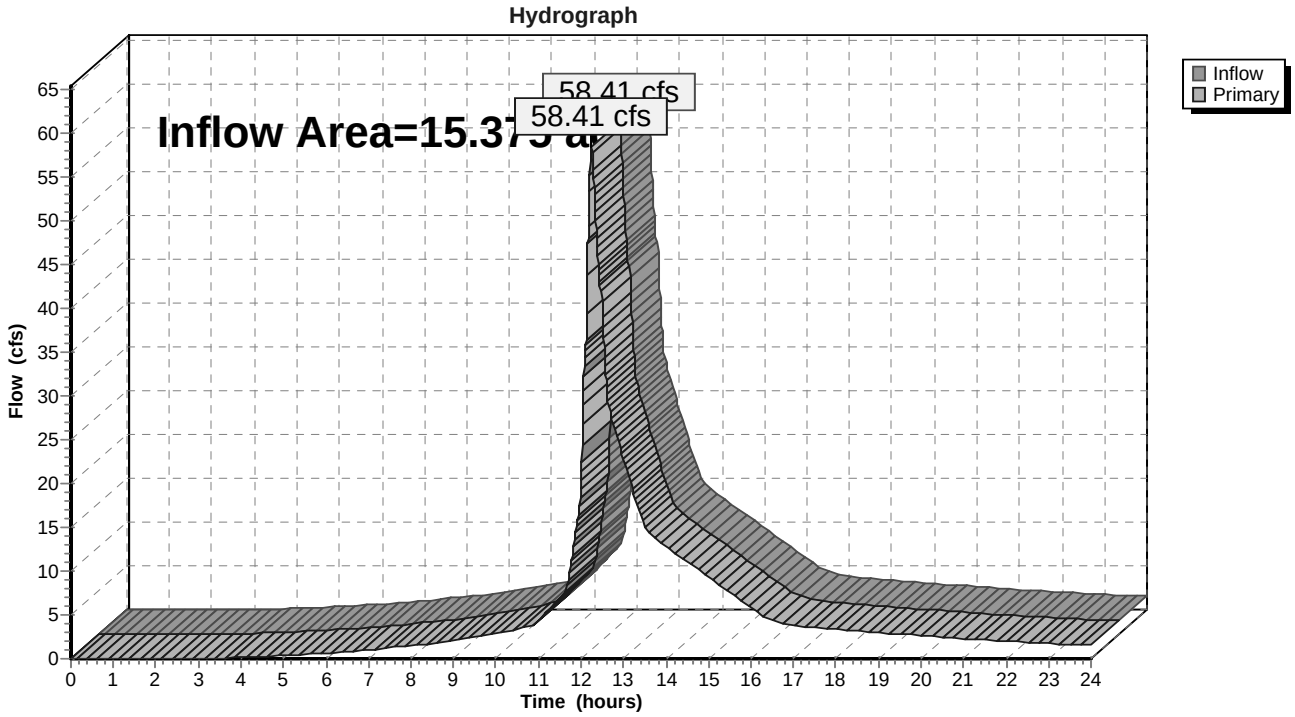


Summary for Link DP3:

Inflow Area = 15.375 ac, 48.26% Impervious, Inflow Depth > 7.25" for 100-Year event
Inflow = 58.41 cfs @ 12.24 hrs, Volume= 9.295 af
Primary = 58.41 cfs @ 12.24 hrs, Volume= 9.295 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3:

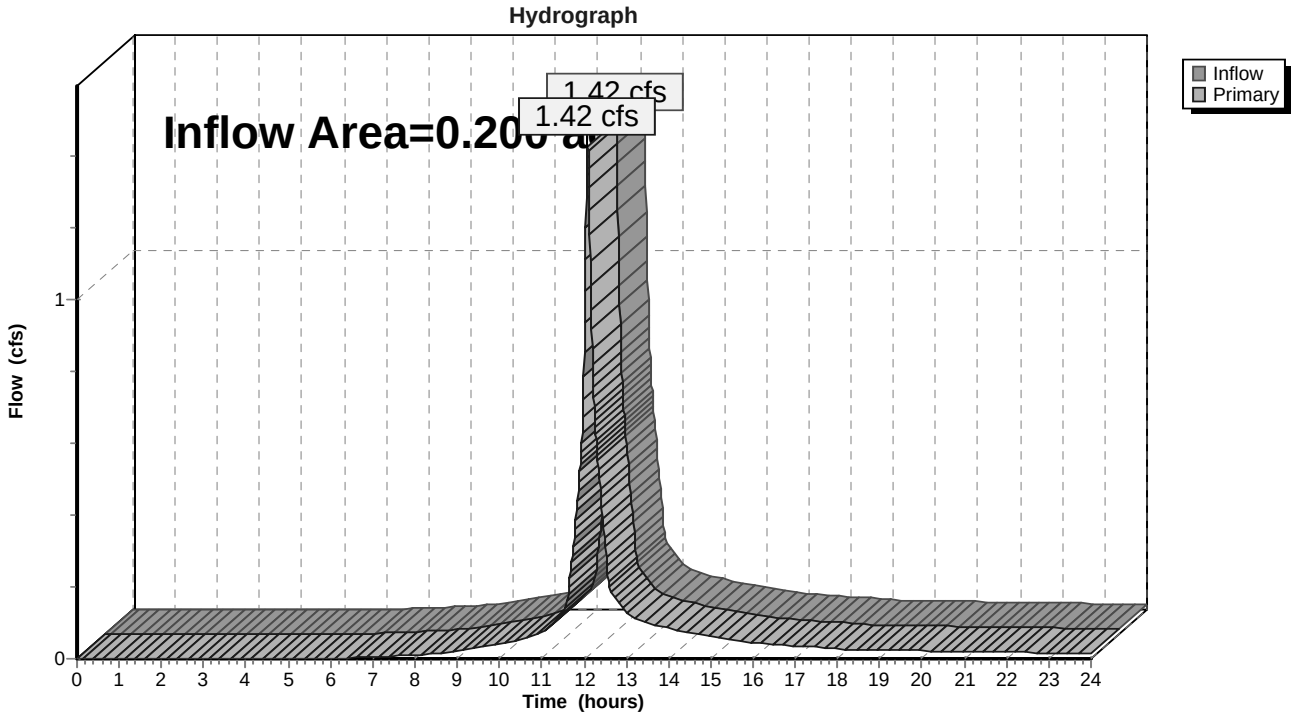


Summary for Link DP4:

Inflow Area = 0.200 ac, 0.00% Impervious, Inflow Depth > 6.14" for 100-Year event
Inflow = 1.42 cfs @ 12.09 hrs, Volume= 0.102 af
Primary = 1.42 cfs @ 12.09 hrs, Volume= 0.102 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP4:

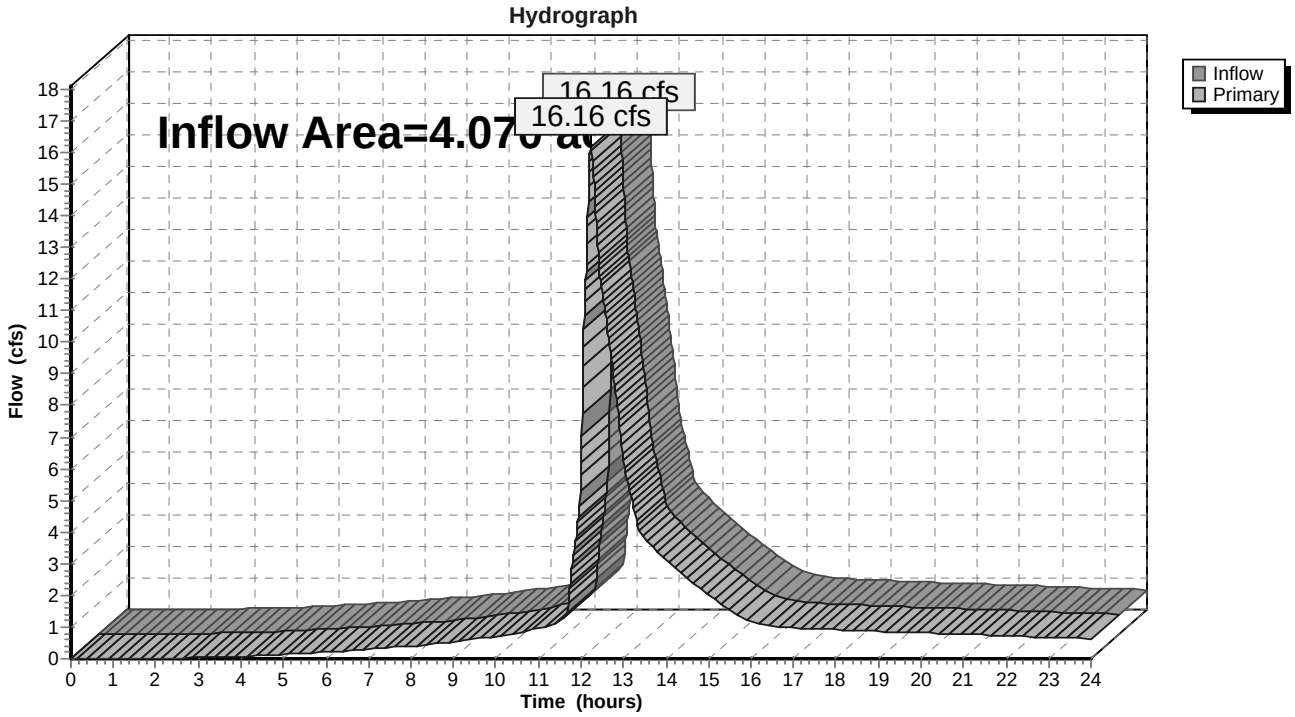


Summary for Link MF TO 3: Pulte MF to DP3

Inflow Area = 4.070 ac, 63.88% Impervious, Inflow Depth > 7.44" for 100-Year event
Inflow = 16.16 cfs @ 12.23 hrs, Volume= 2.524 af
Primary = 16.16 cfs @ 12.23 hrs, Volume= 2.524 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link MF TO 3: Pulte MF to DP3

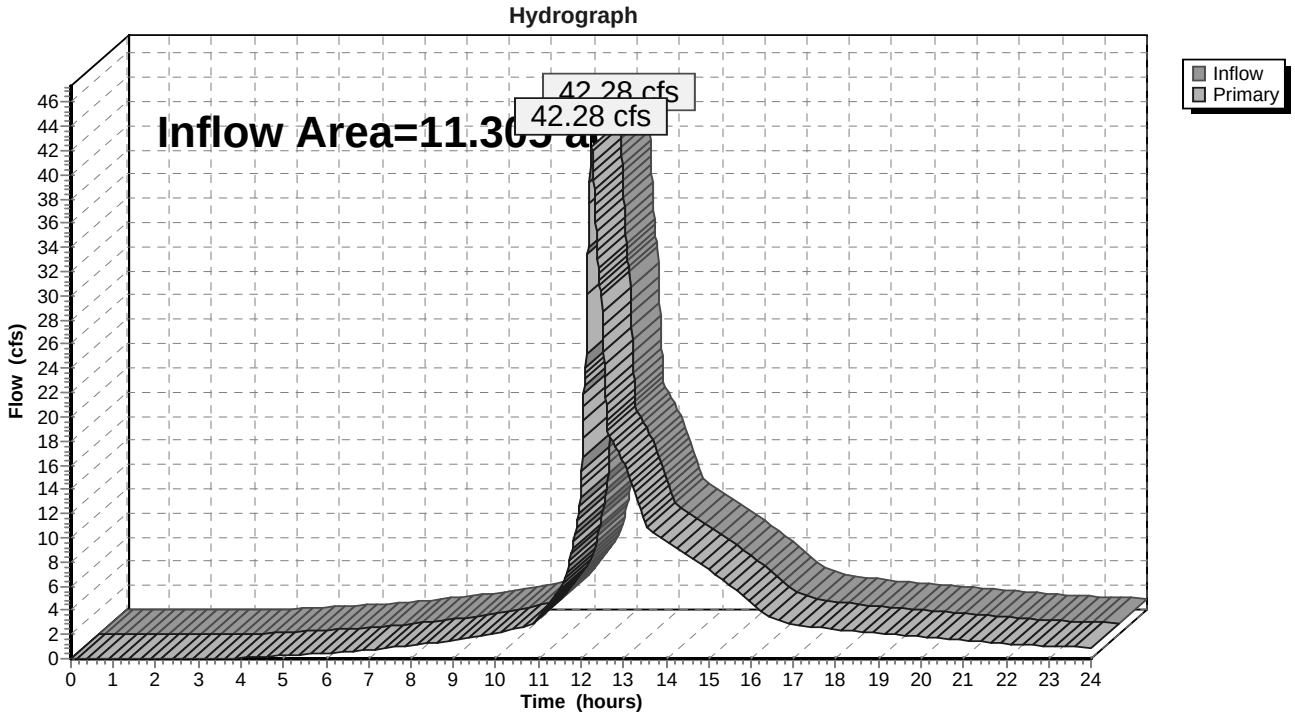


Summary for Link TOWNHOMES: Pulte TH to DP3

Inflow Area = 11.305 ac, 42.64% Impervious, Inflow Depth > 7.19" for 100-Year event
Inflow = 42.28 cfs @ 12.25 hrs, Volume= 6.771 af
Primary = 42.28 cfs @ 12.25 hrs, Volume= 6.771 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link TOWNHOMES: Pulte TH to DP3



Attachment D – Water Quality Unit Sizing

Project: Highland at Vale
Location: Woburn, MA
Prepared For: Civil Design Group

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

$$Q = (qu)\ (A)\ (WQV)$$

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
DMH-35	4.65	0.0072656	10.0	0.167	1.00	700.00	5.09
DMH-46	1.99	0.0031139	10.0	0.167	1.00	700.00	2.18
DMH-47	0.24	0.0003705	6.0	0.100	1.00	774.00	0.29

Estimated Net Annual Solids Load Reduction
Based on the Rational Rainfall Method

Highland at Vale
Woburn, MA
DMH-35

AREA	4.65	acres	CASCADE MODEL	CS-6
WEIGHTED C	0.95			
TC	10.00	minutes	RAINFALL STATION	69

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Hydraulic Loading Rate (gpm/ft2)	Removal Efficiency (%)	Incremental Removal (%)
0.02	10.2%	1.40	100.0	10.2
0.04	9.6%	2.80	100.0	9.6
0.06	9.4%	4.21	100.0	9.4
0.08	7.7%	5.61	100.0	7.7
0.10	8.6%	7.01	100.0	8.6
0.12	6.3%	8.41	100.0	6.3
0.14	4.7%	9.82	100.0	4.7
0.16	4.6%	11.22	100.0	4.6
0.18	3.5%	12.62	100.0	3.5
0.20	4.3%	14.02	98.7	4.3
0.25	8.0%	17.53	95.4	7.6
0.30	5.6%	21.04	92.1	5.2
0.35	4.4%	24.54	88.8	3.9
0.40	2.5%	28.05	85.5	2.2
0.45	2.5%	31.56	82.2	2.1
0.50	1.4%	35.06	78.9	1.1
0.75	5.0%	52.59	62.5	3.2
1.00	1.0%	70.12	46.0	0.5
1.50	0.0%	88.90	23.9	0.0
2.00	0.0%	88.90	18.0	0.0
3.00	0.5%	88.90	12.0	0.1
				94.7
			Removal Efficiency Adjustment[2] =	6.5%
			Predicted % Annual Rainfall Treated =	93.3%
			Predicted Net Annual Load Removal Efficiency =	88.2%

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Estimated Net Annual Solids Load Reduction
Based on the Rational Rainfall Method

Highland at Vale
Woburn, MA
DMH-46

AREA	1.99	acres	CASCADE MODEL	CS-5
WEIGHTED C	0.95			
TC	10.00	minutes	RAINFALL STATION	69

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Hydraulic Loading Rate (gpm/ft2)	Removal Efficiency (%)	Incremental Removal (%)
0.02	10.2%	0.86	100.0	10.2
0.04	9.6%	1.73	100.0	9.6
0.06	9.4%	2.59	100.0	9.4
0.08	7.7%	3.46	100.0	7.7
0.10	8.6%	4.32	100.0	8.6
0.12	6.3%	5.19	100.0	6.3
0.14	4.7%	6.05	100.0	4.7
0.16	4.6%	6.91	100.0	4.6
0.18	3.5%	7.78	100.0	3.5
0.20	4.3%	8.64	100.0	4.3
0.25	8.0%	10.80	100.0	8.0
0.30	5.6%	12.96	99.7	5.6
0.35	4.4%	15.13	97.7	4.3
0.40	2.5%	17.29	95.7	2.4
0.45	2.5%	19.45	93.6	2.4
0.50	1.4%	21.61	91.6	1.3
0.75	5.0%	32.41	81.4	4.1
1.00	1.0%	43.21	71.3	0.7
1.50	0.0%	64.82	51.0	0.0
2.00	0.0%	80.01	34.0	0.0
3.00	0.5%	80.01	22.6	0.1
				97.9
			Removal Efficiency Adjustment[2] =	6.5%
			Predicted % Annual Rainfall Treated =	93.4%
			Predicted Net Annual Load Removal Efficiency =	91.4%

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

HIGHLAND AT VALE
WOBURN, MA

Area	**0.24 ac**	Unit Site Designation	**DMH-47**
Weighted C	**0.9**	Rainfall Station #	**69**
t_c	**6 min**		
CDS Model	**1515-3**	CDS Treatment Capacity	**1.0 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.00	0.00	9.9
0.04	9.6%	19.8%	0.01	0.01	9.3
0.06	9.4%	29.3%	0.01	0.01	9.1
0.08	7.7%	37.0%	0.02	0.02	7.4
0.10	8.6%	45.6%	0.02	0.02	8.2
0.12	6.3%	51.9%	0.03	0.03	6.0
0.14	4.7%	56.5%	0.03	0.03	4.4
0.16	4.6%	61.2%	0.03	0.03	4.4
0.18	3.5%	64.7%	0.04	0.04	3.4
0.20	4.3%	69.1%	0.04	0.04	4.1
0.25	8.0%	77.1%	0.05	0.05	7.5
0.30	5.6%	82.7%	0.06	0.06	5.2
0.35	4.4%	87.0%	0.07	0.07	4.0
0.40	2.5%	89.5%	0.09	0.09	2.3
0.45	2.5%	92.1%	0.10	0.10	2.3
0.50	1.4%	93.5%	0.11	0.11	1.2
0.75	5.0%	98.5%	0.16	0.16	4.4
1.00	1.0%	99.5%	0.21	0.21	0.8
1.50	0.0%	99.5%	0.32	0.32	0.0
2.00	0.0%	99.5%	0.43	0.43	0.0
3.00	0.5%	100.0%	0.64	0.64	0.3
					94.2
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.5%
				Predicted Net Annual Load Removal Efficiency =	**87.8%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Attachment E – Operation & Maintenance Plan

OPERATION AND MAINTENANCE PLAN

&

LONG-TERM POLLUTION PREVENTION PLAN

FOR

HIGHLAND AT VALE

TOWNHOME AND MULTI-FAMILY PROJECT
TECHNOLOGY AND BUSINESS OVERLAY DISTRICT (TBOD)

THE VALE
HILL STREET
(PORTIONS OF LOTS 54-05-01 & 62-01-29)
WOBURN, MA 01801

PREPARED FOR:

PULTE HOMES OF NEW ENGLAND, LLC
115 FLANDERS ROAD, SUITE 200
WESTBOROUGH, MA 01581

PREPARED BY:

CIVIL DESIGN GROUP, LLC
21 HIGH STREET, SUITE 207
NORTH ANDOVER, MA 01845

DATE: APRIL 30, 2020

1.0 OPERATION AND MAINTENANCE PLAN

1.1 INTRODUCTION

In accordance with the standards set forth by the Massachusetts Department of Environmental Protection (MADEP) Stormwater Management Policy, Civil Design Group, LLC has prepared the following Operation and Maintenance (O&M) Plan for *Highland at Vale*.

PROPERTY INFORMATION

PROPERTY ADDRESS	LANDOWNER & STORMWATER MANAGEMENT SYSTEM OWNER
THE VALE HILL STREET WOBURN, MA 01801	Owner: Highland at Vale Unit Owner's Association
	Contact: TBD (interim contact Pulte Homes)
	Phone: TBD (interim phone 508-870-9999 – Pulte Homes)

The landowner shall be responsible for the long-term operation and maintenance of the site and the stormwater management system and shall be responsible for record keeping of inspections, maintenance and repairs. If the site owner changes, the new site owner shall assume all responsibilities outlined in this O&M plan. The site owner shall hire a qualified professional to conduct scheduled inspections and maintain records in accordance with the inspection schedule outline enclosed within this document.

Site Engineer: Civil Design Group, LLC
Address: 21 High Street, Suite 207, North Andover, MA 01845
Office Phone: 978-794-5400
Contact: Matthew Leidner, P.E.

The components of the stormwater management system shall be inspected, monitored and maintained in accordance with the following to ensure that the on-site stormwater management/ best management practice facilities for the project function as intended. Routine inspection and proper maintenance of these individual components is essential to providing the long-term enhancement of both the quality and quantity of the runoff from the site.

The proposed stormwater management best management practices (BMPs) have been designed to collect and convey runoff from developed areas in accordance with the Massachusetts DEP's Stormwater Management Handbook. Using the rational method to determine peak runoff flows, the onsite drainage system is designed for the 25-year storm event. The drainage system consists of deep sump hooded catch basins, manholes, water quality units, infiltration basins, and outfalls with riprap aprons.

Street Sweeping

Sweeping of the project roadways shall be performed twice a year, once in the spring and once in the fall, to reduce the amount of sediment and debris entering the catch basins.

Deep Sump Hooded Catch Basins

Stormwater runoff from proposed pavement areas is directed via curbing and site grading to catch basins with deep sumps and hooded outlets and a trench drain. Since trench drains do not contain hoods and sumps, they will be routed through manholes with deep sumps and hooded outlets. These structures are designed to trap and remove sediment and larger particles from the stormwater and improve the performance of subsequent BMP's. The sumps are a minimum of 4' in depth and a routine inspection and cleaning schedule shall be followed to ensure optimal effectiveness.

Inspection Frequency:	Quarterly
Inspection Tools:	Manhole hook; survey rod; sludge judge
Items to Inspect:	Measure sediment in sump using survey rod; visually check for floating debris or trash; visually check for oil and if more than a sheen is present, use sludge judge to measure thickness of layer; visually ensure that hood is in place; visually ensure that grate is in good condition; visually ensure that outlet pipe is unobstructed
Maintenance Threshold(s):	Annually or ≥24" sediment in sump (whichever comes first); discernible layer of oil/hydrocarbons on surface; floating trash
Maintenance Equipment:	Vactor or clamshell for sediment removal; vactor and/or oil sorbent pads for oil/hydrocarbon removal; net for floating debris or trash removal

Trench Drain

Stormwater runoff from the garage entrance to the middle low-rise building will be directed to a trench drain. As noted above, the trench drain will be routed through a manhole with deep sump and hooded outlet to provide treatment. Routine inspection and cleaning of the trench drains will help ensure optimal effectiveness of the downstream manholes.

Inspection Frequency:	Quarterly
Inspection Tools:	Manhole hook; survey rod or ruler
Items to Inspect:	Measure sediment in the trench drain using survey rod or ruler; visually check for debris or trash; visually check for oil; visually ensure that grate is in good condition; visually ensure that outlet pipe is unobstructed
Maintenance Threshold(s):	Annually or if outlet pipe begins to get blocked or appears to be at risk of getting blocked by trash or debris (whichever comes first)
Maintenance Equipment:	Hand shovel to clean

Water Quality Units

Proprietary water quality units are designed to remove heavy particles, floating debris and hydrocarbons from stormwater. Stormwater enters the system where floatables and oils are separated prior to the clarified stormwater runoff discharging to an outlet pipe. The project design proposes to use Contech model CDS1515, Cascade CS-5, and Cascade CS-6.

Inspection Frequency:	Quarterly and after storm events exceeding the 2-year, 24-hour storm (i.e. 3.22" of rain in 24 hours).

Inspection Tools:	Manhole hook; survey rod; sludge judge
Items to Inspect:	Measure sediment in sump using survey rod; use sludge judge to measure thickness of oil layer through oil port; visually ensure that insert and weir are in good condition; visually ensure that cover is in good condition
Maintenance Threshold(s):	≥8" sediment and/or a discernible layer of oil/hydrocarbons
Maintenance Equipment:	Vactor

Surface Detention Basin

The basin is designed to detain and release stormwater to an outfall. The basin is vegetated and the floor is pitched toward the outlet control structure to provide positive drainage allowing the basin to drain dry in between storms.

Inspection Frequency:	Quarterly
Inspection Tools:	Ruler or survey rod to measure sediment
Items to Inspect:	Measure any accumulated sediment using a ruler or survey rod; visually inspect for erosion on the side slopes and evidence of breaching of the berm; visually inspect outlet control structure (OCS) and associated pipes for overall condition and functionality; visually inspect integrity of emergency spillway for condition and functionality
Maintenance Threshold(s):	≥4" sediment; mow side slopes at least twice annually and remove clippings to avoid clogging of downstream structures; remove weeds, sediment, and other debris from stone routinely throughout the year and replace stone as needed to maintain a clean & neat appearance of the basin floor; repair any noted issues as required
Maintenance Equipment:	Skid steer or similar small machine for removing sediment; shovels for hand removal of sediment in tight areas such as around the outlet control structures; mower/trimmer for mowing (mow at least twice per year and remove clippings)

Subsurface Detention Systems (SDSs)

Subsurface detention systems are designed to detain and release stormwater to an outfall. These systems are comprised of concrete structures and stone. The systems are equipped with inspection/cleanout ports to facilitate inspection for standing water and sediment accumulation. There are two (2) subsurface infiltration systems in total.

Inspection Frequency:	Quarterly
Inspection Tools:	Ruler or survey rod to measure sediment
Items to Inspect:	Measure any accumulated sediment using a ruler or survey rod; inspect for standing water if more than 72 hours have elapsed since the previous rain event.
Maintenance Threshold(s):	≥1" sediment
Maintenance Equipment:	Water jet and vactor

Outfall with Riprap Apron

Outfall pipes with a riprap apron are provided for the detention basin. The riprap apron is intended to dissipate energy and spread out flow prior to discharge.

Inspection Frequency:	Quarterly
Inspection Tools:	None (all visual)

Items to Inspect:	Visually ensure that flared end section is intact; visually ensure that riprap and interspersed boulders are intact; visually inspect that pipe is unobstructed; visually inspect downgradient slope for evidence of re-concentration of sheet flow; visually inspect downgradient wetland area(s) for signs of adverse impacts such as erosion or sedimentation
Maintenance Threshold(s):	Trim vegetation around pipe annually to maintain accessibility and visibility for inspection purposes, remove sediment if present, replace any displaced stones
Maintenance Equipment:	Mower/trimmer for trimming vegetation, hand methods or equipment as required for sediment removal and stone replacement

1.2 ILLICIT DISCHARGE STATEMENT

Illicit discharges to the stormwater management system are discharges not entirely comprised of stormwater. Discharges to the stormwater management system from the following activities or facilities are permissible: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents.

There are no known illicit discharges currently at the site nor are any illicit discharges proposed as part of the project. The stormwater management system is not intended to convey any illicit discharges and or pollutants and as such, control measures that are identified within this report shall be strictly adhered to in order to minimize the risk of contamination. Any unknown existing illicit discharges that are discovered as part of the development of the subject site shall be eliminated in accordance with local, state and federal regulations.

2.0 LONG-TERM POLLUTION PREVENTION PLAN (LTPPP)

The Massachusetts DEP Stormwater Management Handbook requires that a Long-Term Pollution Prevention Plan (LTPPP) be prepared and incorporated as part of the Operation & Maintenance of the Stormwater Management System. The purpose of the LTPPP is to identify potential sources of pollution that may affect the quality of stormwater discharges, and to describe the implementation of practices to reduce the pollutants in stormwater discharges. The following items describe the source control and proper procedures for the LTPPP.

Solid Waste Storage:
There are no proposed exterior (un-covered) solid waste storage areas. Trash and recycling shall be stored either indoors or in closed containers. The homeowners association shall contract with a waste hauling company to service the development on a routine basis.

Street Sweeping
Streets shall be swept at least twice per year. Swept materials shall be disposed of in accordance with applicable local and state requirements.

Deicing and Salt Storage
Deicing methods shall be used in conjunction with snow removal to maintain safe pedestrian and vehicular access. The condominium association will be responsible for maintaining roads, driveways, sidewalks and pedestrian access onsite. To the extent practicable, snow shall be piled in areas where the snowmelt will receive maximum treatment through the proposed BMPs. Deicing products shall be stored off-site or in a covered location. Deicing products such as calcium chloride, rock salt and/or sand may be used unless otherwise restricted by the municipality.

Snow Disposal
To the extent possible, snow shall be stored on pervious surfaces in upland areas away from water resources and wells. At these locations, snow meltwater can filter in to the soil, leaving behind sand and debris, which can be removed in the springtime. Avoid disposing of snow on top of storm drain catch basins or in stormwater drainage swales or ditches. Snow combined with sand and debris may block a storm drainage system, causing localized flooding. In addition, a high volume of sand, sediment, and litter released from melting snow may be quickly transported through the drainage system into surface water. In no case shall snow be disposed of or stored in environmentally sensitive areas such as wetlands, floodplains, streams or other water bodies. If necessary to remove snow from the site, the snow shall be disposed of at an off-site location in accordance with applicable local, state and federal regulations.

Hazardous Materials Containment
Sources of potential spill hazards include vehicle fluids, liquid fuels, pesticides, paints, solvents, and liquid cleaning products. The majority of the spill hazards would likely occur within buildings and would not enter the stormwater drainage system. However, there are potential spill hazards from vehicle fluids or liquid fuels located outside of the buildings. These exterior spill hazards have the potential to enter the stormwater drainage system and shall be addressed as follows:

- Spill Hazards of pesticides, paints, and solvents shall be remediated using the manufacturers' recommended spill cleanup protocol.
- Vehicle fluids and liquid fuel spill shall be remediated according to the local and state regulations governing fuel spills.
- Any hazardous spills shall be cleaned up immediately after discovery

- Should a spill occur, this pollution prevention plan should be adjusted to include measures to prevent another spill of a similar nature. A description of the spill, along with the causes and cleanup measures should be included in the updated pollution prevention plan.

Septic System Management
Not applicable – the project utilizes a public sewer system.

Lawn, Garden, and Landscape Management:
Lawn areas shall be maintained and mowed regularly throughout the growing season. Any bare areas of lawn shall be reseeded and plants shall be pruned on an as-needed basis. Trash and debris shall be removed from landscaped and planted areas as-needed. Fertilizers, herbicides and pesticides shall be used within the amounts recommended by the manufacturer. These products shall be stored in containers indoors. Pet waste shall be disposed of properly.

APPENDIX-A

EXAMPLE
OPERATION AND MAINTENANCE
REPORT FORMS

STORMWATER DIVISION
OF CIVIL DESIGN GROUP, LLC

21 High Street, Suite 207
North Andover, MA 01845
Tel 978.794.5400
www.cdgengineering.com

QUARTERLY STORMWATER INSPECTION REPORT (1/2)

Site:	Highland at Vale	**Date:**	
Address:	The Vale, Woburn, MA	**Time:**	
Inspector:		**Weather:**	

CATCH BASINS

Unit #	Sediment (inches)	Oil (inches)	Hood/ Pipes	Grate	Last Cleaned	Attention Recommended

QUARTERLY STORMWATER INSPECTION REPORT (2/2)

Site:	Highland at Vale	**Date:**	
Address:	The Vale, Woburn, MA	**Time:**	
Inspector:		**Weather:**	

WATER QUALITY UNITS

Unit #	Sediment (inches)	Oil (inches)	Trash	Cover	Last Cleaned	Attention Recommended

SURFACE DETENTION BASIN

Unit #	Notes	Attention Recommended

OUTFALL WITH RIPRAP APRONS

Unit #	Notes	Attention Recommended

SUBSURFACE DETENTION BASINS

Unit #	Notes	Attention Recommended

APPENDIX-B

CONTECH WATER QUALITY UNIT MAINTENANCE GUIDELINES

CONTECH®
ENGINEERED SOLUTIONS

Cascade Separator™ Inspection and Maintenance Guide

CASCADE
separator™

Maintenance

The Cascade Separator™ system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects sediment and debris will depend upon on-site activities and site pollutant characteristics. For example, unstable soils or heavy winter sanding will cause the sediment storage sump to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall). However, more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment wash-down areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

A visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet chamber, flumes or outlet channel. The inspection should also quantify the accumulation of hydrocarbons, trash and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided in this Inspection and Maintenance Guide.

Access to the Cascade Separator unit is typically achieved through one manhole access cover. The opening allows for inspection and cleanout of the center chamber (cylinder) and sediment storage sump, as well as inspection of the inlet chamber and slanted skirt. For large units, multiple manhole covers allow access to the chambers and sump.

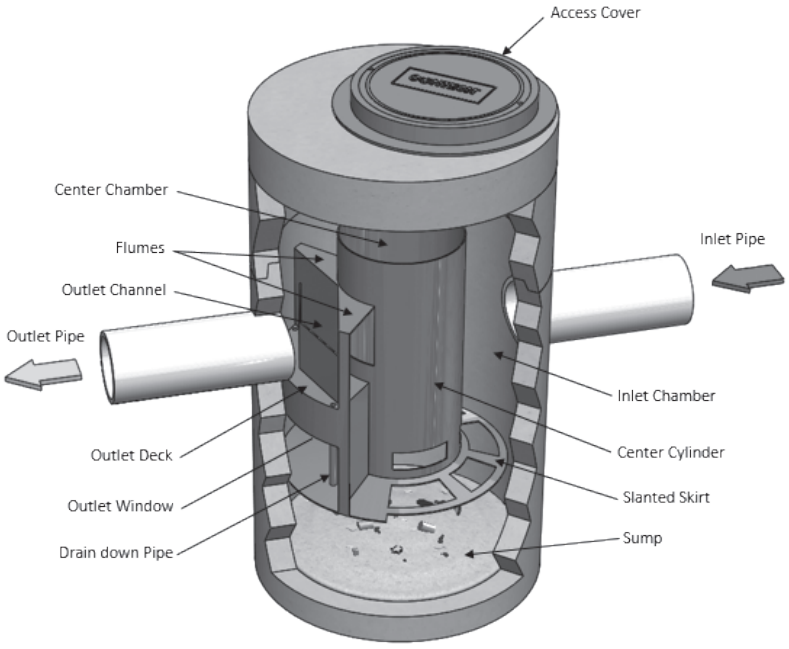
The Cascade Separator system should be cleaned before the level of sediment in the sump reaches the maximum sediment depth and/or when an appreciable level of hydrocarbons and trash has accumulated. If sorbent material is used, it must be replaced when significant discoloration has occurred. Performance may be impacted when maximum sediment storage capacity is exceeded. Contech recommends maintaining the system when sediment level reaches 50% of maximum storage volume. The level of sediment is easily determined by measuring the distance from the system outlet invert (standing water level) to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Finer, silty particles at the top of the pile typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the chart in this document to determine if the height of the sediment pile off the bottom of the sump floor exceeds 50% of the maximum sediment storage.

Cleaning

Cleaning of a Cascade Separator system should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole cover and insert the vacuum tube down through the center chamber and into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The areas outside the center chamber and the slanted skirt should also be washed off if pollutant build-up exists in these areas.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. Then the system should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and to ensure proper safety precautions. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the Cascade Separator system must be done in accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal. If any components are damaged, replacement parts can be ordered from the manufacturer.



Cascade Separator™ Maintenance Indicators and Sediment Storage Capacities

Model Number	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CS-4	4	1.2	1.5	0.5	0.7	0.5
CS-5	5	1.3	1.5	0.5	1.1	0.8
CS-6	6	1.8	1.5	0.5	1.6	1.2
CS-8	8	2.4	1.5	0.5	2.8	2.1
CS-10	10	3.0	1.5	0.5	4.4	3.3
CS-12	12	3.6	1.5	0.5	6.3	4.8

Note: The information in the chart is for standard units. Units may have been designed with non-standard sediment storage depth.

A Cascade Separator unit can be easily cleaned in less than 30 minutes.

A vacuum truck excavates pollutants from the systems.

Cascade Separator™ Inspection & Maintenance Log

Cascade Model:			Location:		
Date	Depth Below Invert to Top of Sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The depth to sediment is determined by taking a measurement from the manhole outlet invert (standing water level) to the top of the sediment pile. Once this measurement is recorded, it should be compared to the chart in the maintenance guide to determine if the height of the sediment pile off the bottom of the sump floor exceeds 50% of the maximum sediment storage. Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.
2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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CDS® Inspection and Maintenance Guide

CDS TECHNOLOGIES

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill should be cleaned out immediately. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Support

- Drawings and specifications are available at www.contechstormwater.com.
- Site-specific design support is available from our engineers.

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CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

Attachment F – Illicit Discharge Statement

ILLICIT DISCHARGE STATEMENT

FOR

HIGHLAND AT VALE

TOWNHOME AND MULTI-FAMILY PROJECT
TECHNOLOGY AND BUSINESS OVERLAY DISTRICT (TBOD)

THE VALE
(PORTIONS OF LOTS 54-05-01 & 62-01-29)
WOBURN, MA 01801

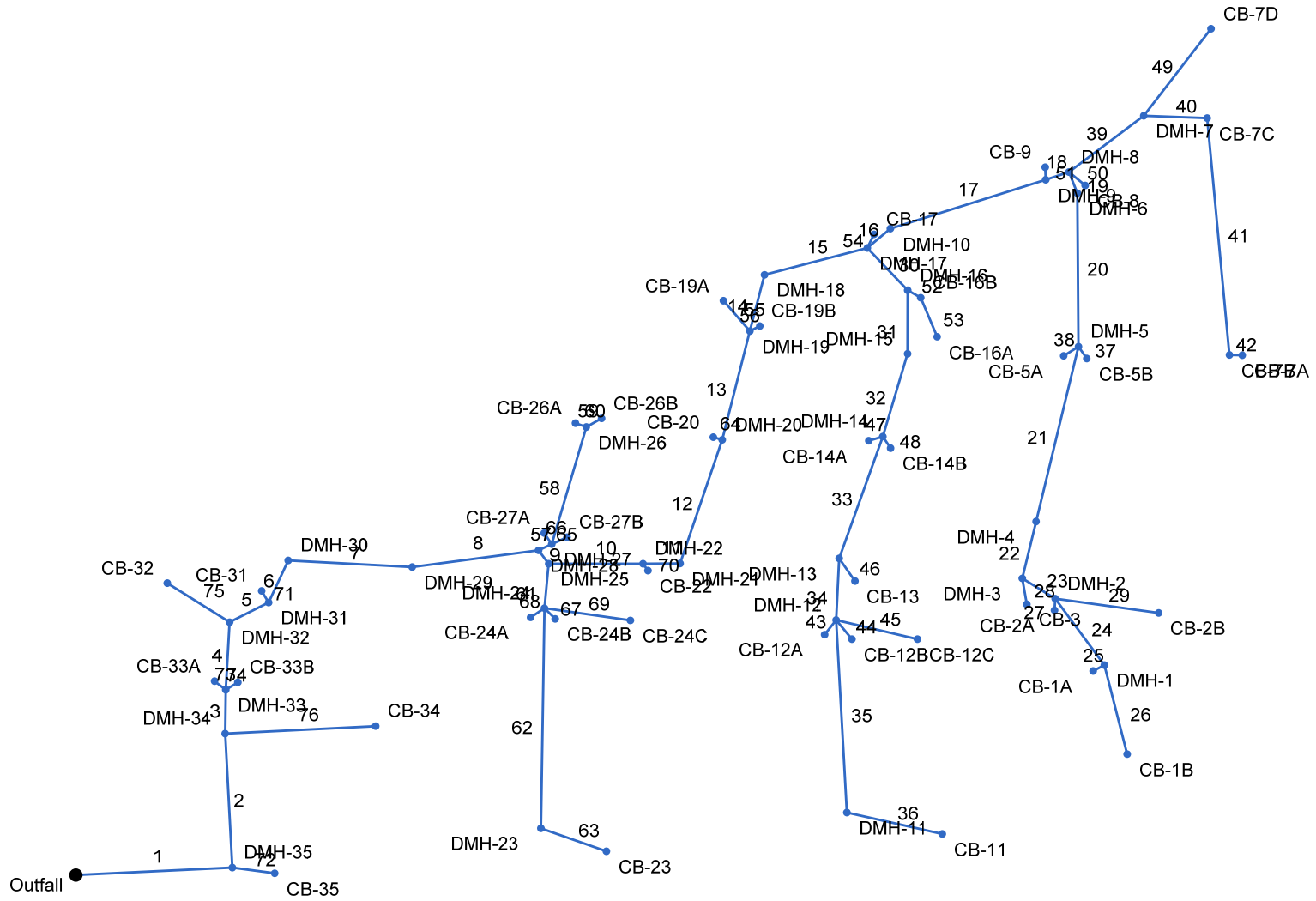
DATE: APRIL 30, 2020

Illicit discharges to the stormwater management system are discharges not entirely comprised of stormwater. Discharges to the stormwater management system from the following activities or facilities are permissible: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents.

There are no known illicit discharges currently at the site nor are any illicit discharges proposed as part of the project. The stormwater management system is *not* intended to convey any illicit discharges and/or pollutants and as such, control measures that are identified within this report shall be strictly adhered to in order to minimize the risk of contamination. Any unknown existing illicit discharges that are discovered as part of the development of the subject site shall be eliminated in accordance with local, state and federal regulations.

Attachment G – Hydraflow Storm Sewers Output

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



Project File: Woburn_System-1.stm	Number of lines: 76	Date: 4/26/2020

Storm Sewers v11.00

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	121.000	-3.003	MH	0.00	0.00	0.00	6.0	43.00	3.55	47.30	24	Cir	0.012	1.00	59.50	DMH35-OUTFALL
2	1	112.666	-89.809	MH	0.00	0.00	0.00	6.0	47.60	2.04	49.90	24	Cir	0.012	1.00	57.96	DMH34-DMH35
3	2	36.838	3.548	MH	0.00	0.00	0.00	6.0	51.40	2.04	52.15	24	Cir	0.012	0.85	57.62	DMH33-DMH34
4	3	56.704	2.234	MH	0.00	0.00	0.00	6.0	52.25	2.03	53.40	24	Cir	0.012	0.88	58.26	DMH32-DMH33
5	4	34.378	58.296	MH	0.00	0.00	0.00	6.0	53.50	8.14	56.30	24	Cir	0.012	1.00	60.75	DMH31-DMH32
6	5	38.257	-37.971	MH	0.00	0.00	0.00	6.0	56.75	2.48	57.70	24	Cir	0.012	0.95	61.80	DMH30-DMH31
7	6	95.889	69.868	MH	0.00	0.00	0.00	6.0	57.80	2.29	60.00	24	Cir	0.012	0.23	70.37	DMH29-DMH30
8	7	98.633	-11.250	MH	0.00	0.00	0.00	6.0	64.50	2.03	66.50	24	Cir	0.012	0.91	77.10	DMH28-DMH29
9	8	13.698	63.575	MH	0.00	0.00	0.00	6.0	68.20	2.19	68.50	24	Cir	0.012	0.85	77.41	DMH25-DMH28
10	9	72.892	-55.603	MH	0.00	0.00	0.00	6.0	71.35	0.55	71.75	24	Cir	0.012	0.87	76.75	DMH22-DMH25
11	10	28.701	-0.063	MH	0.00	0.00	0.00	6.0	72.25	0.52	72.40	18	Cir	0.012	0.96	76.50	DMH21-DMH22
12	11	108.731	-72.419	MH	0.00	0.00	0.00	6.0	72.50	1.52	74.15	18	Cir	0.012	1.00	78.15	DMH20-DMH21
13	12	93.833	-4.242	MH	0.00	0.00	0.00	6.0	74.65	2.93	77.40	18	Cir	0.012	0.82	81.50	DMH19-DMH20
14	13	48.530	0.326	MH	0.00	0.00	0.00	6.0	77.50	1.03	78.00	18	Cir	0.012	0.89	86.50	DMH18-DMH19
15	14	82.512	60.707	MH	0.00	0.00	0.00	6.0	80.00	2.12	81.75	18	Cir	0.012	0.92	90.00	DMH17-DMH18
16	15	24.042	-26.417	MH	0.00	0.00	0.00	6.0	81.85	0.62	82.00	18	Cir	0.012	0.45	90.16	DMH10-DMH17
17	16	126.799	23.325	MH	0.00	0.00	0.00	6.0	84.00	1.46	85.85	18	Cir	0.012	0.96	94.50	DMH9-DMH10
18	17	19.111	-1.102	MH	0.00	0.00	0.00	6.0	86.35	0.78	86.50	12	Cir	0.012	1.00	94.83	DMH8-DMH9
19	18	18.978	90.000	MH	0.00	0.00	0.00	6.0	88.50	2.11	88.90	12	Cir	0.012	0.39	95.35	DMH6-DMH8
20	19	128.723	19.602	MH	0.00	0.00	0.00	6.0	89.00	7.61	98.80	12	Cir	0.011	0.86	102.97	DMH5-DMH6
21	20	150.225	12.992	MH	0.00	0.00	0.00	6.0	98.90	8.59	111.80	12	Cir	0.011	0.15	115.00	DMH4-DMH5
22	21	48.923	0.000	MH	0.00	0.00	0.00	6.0	111.90	0.51	112.15	12	Cir	0.011	0.94	118.66	DMH3-DMH4
23	22	30.671	-68.584	MH	0.00	0.00	0.00	6.0	112.25	0.65	112.45	12	Cir	0.012	0.88	121.00	DMH2-DMH3

Project File: Woburn_System-1.stm | Number of lines: 76 | Date: 4/26/2020

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)	
24	23	67.447	21.712	MH	0.00	0.00	0.00	6.0	118.00	7.41	123.00	12	Cir	0.012	1.00	128.00	DMH1-DMH2
25	24	10.000	94.597	Grate	0.00	0.25	0.69	6.0	124.40	1.00	124.50	12	Cir	0.012	1.00	127.47	CB1A-DMH1
26	24	76.694	20.990	Grate	0.00	0.09	0.48	6.0	124.40	7.30	130.00	12	Cir	0.012	1.00	133.00	CB1B-DMH1
27	23	9.601	59.029	Grate	0.00	0.04	0.60	6.0	118.00	6.25	118.60	12	Cir	0.012	1.00	121.63	CB2A-DMH2
28	22	22.168	-21.512	Grate	0.00	0.08	0.75	6.0	115.60	8.12	117.40	12	Cir	0.012	1.00	120.42	CB3-DMH3
29	23	80.815	-25.555	Grate	0.00	0.19	0.33	6.0	112.55	0.56	113.00	12	Cir	0.012	1.00	116.00	CB2B-DMH2
30	15	47.236	64.520	MH	0.00	0.00	0.00	6.0	86.55	3.92	88.40	12	Cir	0.012	0.71	91.76	DMH16-DMH17
31	30	53.309	41.349	MH	0.00	0.00	0.00	6.0	88.50	3.19	90.20	12	Cir	0.012	0.31	93.33	DMH15-DMH16
32	31	71.896	15.361	MH	0.00	0.00	0.00	6.0	90.30	2.92	92.40	12	Cir	0.012	0.86	95.52	DMH14-DMH15
33	32	107.689	2.821	MH	0.00	0.00	0.00	6.0	92.50	2.88	95.60	12	Cir	0.012	0.81	98.71	DMH13-DMH14
34	33	51.818	-15.607	MH	0.00	0.00	0.00	6.0	95.70	0.68	96.05	12	Cir	0.012	0.98	100.30	DMH12-DMH13
35	34	161.827	-5.595	MH	0.00	0.00	0.00	6.0	97.10	2.41	101.00	12	Cir	0.012	0.97	105.13	DMH11-DMH12
36	35	75.847	-73.292	DrGrt	0.00	0.22	0.30	6.0	101.10	0.53	101.50	12	Cir	0.012	1.00	104.50	CB11-DMH11
37	20	11.833	-32.189	Grate	0.00	0.27	0.78	6.0	99.90	5.07	100.50	12	Cir	0.012	1.00	103.55	CB5B-DMH5
38	20	13.829	56.540	Grate	0.00	0.31	0.81	6.0	99.90	4.34	100.50	12	Cir	0.012	1.00	103.55	CB5A-DMH5
39	18	74.616	-19.300	MH	0.00	0.00	0.00	6.0	88.50	1.41	89.55	12	Cir	0.012	0.71	95.00	DMH7-DMH8
40	39	49.115	41.579	DrGrt	0.00	0.32	0.54	6.0	89.65	0.51	89.90	12	Cir	0.012	1.49	93.00	CB7C-DMH7
41	40	199.599	82.783	DrGrt	0.00	0.30	0.54	6.0	90.00	3.01	96.00	12	Cir	0.012	1.49	101.00	CB7B-CB7C
42	41	9.860	-83.893	DrGrt	0.00	0.54	0.36	6.0	98.00	2.54	98.25	12	Cir	0.012	1.00	105.00	CB7A-CB7B
43	34	15.212	32.987	Grate	0.00	0.22	0.81	6.0	97.35	0.99	97.50	12	Cir	0.012	1.00	100.48	CB12A-DMH12
44	34	20.273	-39.694	Grate	0.00	0.20	0.78	6.0	97.10	2.47	97.60	12	Cir	0.012	1.00	100.60	CB12B-DMH12
45	34	64.866	-78.259	DrGrt	0.00	0.31	0.51	6.0	96.15	0.54	96.50	12	Cir	0.012	1.00	99.75	CB12C-DMH12
46	33	22.604	-50.899	Grate	0.00	0.22	0.51	6.0	95.70	1.33	96.00	12	Cir	0.012	1.00	99.00	CB13-DMH13

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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)	
47	32	11.487	56.077	Grate	0.00	0.16	0.84	6.0	92.50	0.87	92.60	12	Cir	0.012	1.00	95.56	CB14A-DMH14
48	32	11.587	-46.474	Grate	0.00	0.05	0.78	6.0	92.50	0.86	92.60	12	Cir	0.012	1.00	95.55	CB14B-DMH14
49	39	89.672	-15.258	DrGrt	0.00	0.18	0.33	6.0	92.00	11.99	102.75	12	Cir	0.012	1.00	115.00	CB7D-DMH7
50	18	16.917	62.190	Grate	0.00	0.23	0.84	6.0	91.75	1.77	92.05	12	Cir	0.012	1.00	95.06	CB8-DMH8
51	17	10.501	-72.956	Grate	0.00	0.23	0.81	6.0	90.80	1.90	91.00	12	Cir	0.012	1.00	94.00	CB9-DMH9
52	30	11.845	-16.947	Grate	0.00	0.08	0.60	6.0	88.50	2.53	88.80	12	Cir	0.012	0.98	91.80	CB16B-DMH16
53	52	35.231	37.146	DrGrt	0.00	0.21	0.63	6.0	88.90	3.12	90.00	12	Cir	0.012	1.00	97.25	CB16A-CB16B
54	15	12.673	-50.267	Grate	0.00	0.35	0.75	6.0	86.55	1.97	86.80	12	Cir	0.012	1.00	89.80	CB17-DMH17
55	13	32.574	-52.021	DrGrt	0.00	0.08	0.33	6.0	77.50	1.53	78.00	12	Cir	0.012	1.00	81.00	CB19A-DMH19
56	13	8.753	47.407	DrGrt	0.00	0.28	0.57	6.0	77.50	5.71	78.00	12	Cir	0.012	1.00	84.50	CB19B-DMH19
57	8	11.440	-19.519	MH	0.00	0.00	0.00	6.0	73.95	0.87	74.05	12	Cir	0.012	1.00	77.49	DMH27-DMH28
58	57	101.701	-47.146	MH	0.00	0.00	0.00	6.0	74.15	1.43	75.60	12	Cir	0.012	0.99	79.40	DMH26-DMH27
59	58	13.910	42.864	Grate	0.00	0.13	0.87	6.0	75.70	2.52	76.05	12	Cir	0.012	1.00	79.54	CB26B-DMH26
60	58	9.023	-83.625	Grate	0.00	0.13	0.84	6.0	75.70	0.55	75.75	12	Cir	0.012	1.00	79.24	CB26A-DMH26
61	9	37.247	39.497	MH	0.00	0.00	0.00	6.0	72.75	2.01	73.50	12	Cir	0.012	1.00	77.43	DMH24-DMH25
62	61	184.831	-4.146	MH	0.00	0.00	0.00	6.0	73.65	0.78	75.10	12	Cir	0.012	0.95	81.04	DMH23-DMH24
63	62	54.208	-69.854	DrGrt	0.00	0.26	0.39	6.0	75.20	0.55	75.50	12	Cir	0.012	1.00	78.50	CB23-DMH23
64	12	7.251	-89.914	DrGrt	0.00	0.14	0.57	6.0	74.90	1.38	75.00	12	Cir	0.012	1.00	78.00	CB20-DMH20
65	57	10.845	-94.767	Grate	0.00	0.15	0.81	6.0	74.15	0.92	74.25	12	Cir	0.012	1.00	77.40	CB27A-DMH27
66	57	13.134	2.266	Grate	0.00	0.14	0.84	6.0	74.15	0.76	74.25	12	Cir	0.012	1.00	77.41	CB27B-DMH27
67	61	12.318	-47.562	Grate	0.00	0.24	0.81	6.0	74.00	2.03	74.25	12	Cir	0.012	1.00	77.30	CB24B-DMH24
68	61	13.238	48.635	Grate	0.00	0.27	0.84	6.0	73.95	2.27	74.25	12	Cir	0.012	1.00	77.25	CB24A-DMH24
69	61	67.201	-86.192	DrGrt	0.00	0.34	0.69	6.0	73.65	0.52	74.00	12	Cir	0.012	1.00	77.00	CB24C-DMH24

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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)	
70	10	7.087	57.384	DrGrt	0.00	0.19	0.60	6.0	73.45	0.71	73.50	12	Cir	0.012	1.00	76.50	CB22-DMH22
71	5	11.223	-90.000	Grate	0.00	0.19	0.72	6.0	56.40	1.78	56.60	12	Cir	0.012	1.00	59.60	CB31-DMH31
72	1	33.079	11.350	Grate	0.00	0.15	0.33	6.0	55.75	0.76	56.00	12	Cir	0.012	1.00	59.00	CB35-DMH35
73	3	11.182	55.632	Grate	0.00	0.31	0.81	6.0	54.15	2.24	54.40	12	Cir	0.012	1.00	57.42	CB33B-DMH33
74	3	11.218	-51.315	Grate	0.00	0.29	0.81	6.0	54.15	2.23	54.40	12	Cir	0.012	1.00	57.42	CB33A-DMH33
75	4	58.228	-58.697	Grate	0.00	0.51	0.63	6.0	54.00	0.52	54.30	12	Cir	0.012	1.00	57.60	CB32-DMH32
76	2	116.391	89.793	DrGrt	0.00	0.64	0.57	6.0	50.00	3.01	53.50	12	Cir	0.012	1.00	56.50	CB34-DMH34

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My Report

Line No.	Line ID	Flow Rate (cfs)	Line Length (ft)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Q Byp (cfs)	Byp Ln No	Minor Loss (ft)	HGL Jnct (ft)	DnStm Ln No	Junct Type
1	DMH35-OUTFALL	23.48	121.000	43.00	47.30	3.55	44.48	49.02	....	n/a	1.04	49.02	Outfall	MH
2	DMH34-DMH35	23.41	112.666	47.60	49.90	2.04	49.02	51.62	....	n/a	1.03	51.62	1	MH
3	DMH33-DMH34	22.03	36.838	51.40	52.15	2.04	52.55	53.83	....	n/a	n/a	53.83	2	MH
4	DMH32-DMH33	20.19	56.704	52.25	53.40	2.03	53.83	55.01	....	n/a	n/a	55.01	3	MH
5	DMH31-DMH32	18.96	34.378	53.50	56.30	8.14	55.01	57.87	....	n/a	n/a	57.87	4	MH
6	DMH30-DMH31	18.47	38.257	56.75	57.70	2.48	57.87	59.25	....	n/a	n/a	59.25	5	MH
7	DMH29-DMH30	18.58	95.889	57.80	60.00	2.29	59.25	61.55	....	n/a	n/a	61.55	6	MH
8	DMH28-DMH29	18.69	98.633	64.50	66.50	2.03	65.54	68.06	....	n/a	n/a	68.06	7	MH
9	DMH25-DMH28	16.86	13.698	68.20	68.50	2.19	69.16	69.98	....	n/a	n/a	69.98	8	MH
10	DMH22-DMH25	13.91	72.892	71.35	71.75	0.55	73.00	74.09	....	n/a	n/a	74.93	9	MH
11	DMH21-DMH22	13.47	28.701	72.25	72.40	0.52	74.93	75.33	....	n/a	n/a	76.20	10	MH
12	DMH20-DMH21	13.54	108.731	72.50	74.15	1.52	76.20	77.74	....	n/a	n/a	78.65	11	MH
13	DMH19-DMH20	13.28	93.833	74.65	77.40	2.93	78.65	79.93	....	n/a	n/a	80.65	12	MH
14	DMH18-DMH19	12.55	48.530	77.50	78.00	1.03	79.00	79.59	....	n/a	n/a	80.29	13	MH
15	DMH17-DMH18	12.60	82.512	80.00	81.75	2.12	80.98	83.09	....	n/a	n/a	83.09	14	MH
16	DMH10-DMH17	7.78	24.042	81.85	82.00	0.62	83.09	83.08	....	n/a	n/a	83.08	15	MH
17	DMH9-DMH10	7.87	126.799	84.00	85.85	1.46	84.81	86.94	....	n/a	n/a	86.94	16	MH
18	DMH8-DMH9	7.06	19.111	86.35	86.50	0.78	87.35	87.99	....	n/a	n/a	89.25	17	MH
19	DMH6-DMH8	3.63	18.978	88.50	88.90	2.11	89.25	89.71	....	n/a	n/a	89.71	18	MH
20	DMH5-DMH6	3.67	128.723	89.00	98.80	7.61	89.71	99.62	....	n/a	n/a	99.62	19	MH
21	DMH4-DMH5	1.66	150.225	98.90	111.80	8.59	99.62	112.35	....	n/a	n/a	112.35	20	MH
22	DMH3-DMH4	1.68	48.923	111.90	112.15	0.51	112.43	112.70	....	n/a	n/a	112.70	21	MH
23	DMH2-DMH3	1.41	30.671	112.25	112.45	0.65	112.72	112.95	....	n/a	n/a	112.95	22	MH

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Line No.	Line ID	Flow Rate (cfs)	Line Length (ft)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Q Byp (cfs)	Byp Ln No	Minor Loss (ft)	HGL Jnct (ft)	DnStm Ln No	Junct Type
24	DMH1-DMH2	1.03	67.447	118.00	123.00	7.41	118.21	123.43	....	n/a	n/a	123.43	23	MH
25	CB1A-DMH1	0.94	10.000	124.40	124.50	1.00	124.74	124.91	0.16	27	n/a	124.91	24	Grate
26	CB1B-DMH1	0.24	76.694	124.40	130.00	7.30	124.50	130.20	0.00	25	n/a	130.20	24	Grate
27	CB2A-DMH2	0.13	9.601	118.00	118.60	6.25	118.08	118.75	0.01	37	n/a	118.75	23	Grate
28	CB3-DMH3	0.33	22.168	115.60	117.40	8.12	115.72	117.64	0.00	38	n/a	117.64	22	Grate
29	CB2B-DMH2	0.34	80.815	112.55	113.00	0.56	112.95	113.24	0.00	Sag	n/a	113.24	23	Grate
30	DMH16-DMH17	4.20	47.236	86.55	88.40	3.92	87.08	89.26	....	n/a	n/a	89.26	15	MH
31	DMH15-DMH16	3.48	53.309	88.50	90.20	3.19	89.26	91.00	....	n/a	n/a	91.00	30	MH
32	DMH14-DMH15	3.50	71.896	90.30	92.40	2.92	91.00	93.20	....	n/a	n/a	93.20	31	MH
33	DMH13-DMH14	2.81	107.689	92.50	95.60	2.88	93.20	96.32	....	n/a	n/a	96.32	32	MH
34	DMH12-DMH13	2.35	51.818	95.70	96.05	0.68	96.34	96.71	....	n/a	n/a	96.71	33	MH
35	DMH11-DMH12	0.33	161.827	97.10	101.00	2.41	97.26	101.24	....	n/a	n/a	101.24	34	MH
36	CB11-DMH11	0.36	75.847	101.10	101.50	0.53	101.34	101.75	0.00	Sag	n/a	101.75	35	Dp-Grate
37	CB5B-DMH5	1.15	11.833	99.90	100.50	5.07	100.15	100.95	0.06	50	n/a	100.95	20	Grate
38	CB5A-DMH5	1.37	13.829	99.90	100.50	4.34	100.18	100.99	0.11	51	n/a	100.99	20	Grate
39	DMH7-DMH8	2.86	74.616	88.50	89.55	1.41	89.25	90.27	....	n/a	n/a	90.27	18	MH
40	CB7C-DMH7	2.75	49.115	89.65	89.90	0.51	90.47	90.72	0.00	Sag	n/a	91.09	39	Dp-Grate
41	CB7B-CB7C	1.93	199.599	90.00	96.00	3.01	91.09	96.59	0.00	Sag	n/a	96.59	40	Dp-Grate
42	CB7A-CB7B	1.06	9.860	98.00	98.25	2.54	98.28	98.68	0.00	Sag	n/a	98.68	41	Dp-Grate
43	CB12A-DMH12	0.97	15.212	97.35	97.50	0.99	97.69	97.91	0.10	47	n/a	97.91	34	Grate
44	CB12B-DMH12	0.85	20.273	97.10	97.60	2.47	97.35	97.99	0.06	46	n/a	97.99	34	Grate
45	CB12C-DMH12	0.86	64.866	96.15	96.50	0.54	96.71	96.89	0.00	Sag	n/a	96.89	34	Dp-Grate
46	CB13-DMH13	0.61	22.604	95.70	96.00	1.33	96.32	96.33	0.03	48	n/a	96.33	33	Grate

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Line No.	Line ID	Flow Rate (cfs)	Line Length (ft)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Q Byp (cfs)	Byp Ln No	Minor Loss (ft)	HGL Jnct (ft)	DnStm Ln No	Junct Type
47	CB14A-DMH14	0.73	11.487	92.50	92.60	0.87	93.20	92.96	0.06	54	n/a	92.96	32	Grate
48	CB14B-DMH14	0.21	11.587	92.50	92.60	0.86	93.20	92.79	0.00	52	n/a	92.79	32	Grate
49	CB7D-DMH7	0.32	89.672	92.00	102.75	11.99	92.11	102.98	0.00	Sag	n/a	102.98	39	Dp-Grate
50	CB8-DMH8	1.05	16.917	91.75	92.05	1.77	92.06	92.48	0.19	51	n/a	92.48	18	Grate
51	CB9-DMH9	1.02	10.501	90.80	91.00	1.90	91.10	91.42	0.00	Offsite	n/a	91.42	17	Grate
52	CB16B-DMH16	0.96	11.845	88.50	88.80	2.53	89.26	89.21	0.00	54	n/a	89.21	30	Grate
53	CB16A-CB16B	0.72	35.231	88.90	90.00	3.12	89.21	90.35	0.00	Sag	n/a	90.35	52	Dp-Grate
54	CB17-DMH17	1.43	12.673	86.55	86.80	1.97	86.90	87.31	0.00	Offsite	n/a	87.31	15	Grate
55	CB19A-DMH19	0.14	32.574	77.50	78.00	1.53	78.76	78.76	0.00	Sag	n/a	78.76	13	Dp-Grate
56	CB19B-DMH19	0.87	8.753	77.50	78.00	5.71	78.76	78.75	0.00	Sag	n/a	78.78	13	Dp-Grate
57	DMH27-DMH28	2.40	11.440	73.95	74.05	0.87	74.55	74.71	....	n/a	n/a	74.71	8	MH
58	DMH26-DMH27	1.20	101.701	74.15	75.60	1.43	74.71	76.06	....	n/a	n/a	76.06	57	MH
59	CB26B-DMH26	0.62	13.910	75.70	76.05	2.52	76.06	76.38	0.04	66	n/a	76.38	58	Grate
60	CB26A-DMH26	0.60	9.023	75.70	75.75	0.55	76.06	76.07	0.03	65	n/a	76.07	58	Grate
61	DMH24-DMH25	3.46	37.247	72.75	73.50	2.01	73.33	74.29	....	n/a	n/a	74.29	9	MH
62	DMH23-DMH24	0.53	184.831	73.65	75.10	0.78	74.29	75.40	....	n/a	n/a	75.40	61	MH
63	CB23-DMH23	0.55	54.208	75.20	75.50	0.55	75.50	75.81	0.00	Sag	n/a	75.81	62	Dp-Grate
64	CB20-DMH20	0.43	7.251	74.90	75.00	1.38	76.71	76.71	0.00	Sag	n/a	76.71	12	Dp-Grate
65	CB27A-DMH27	0.66	10.845	74.15	74.25	0.92	74.71	74.59	0.06	75	n/a	74.59	57	Grate
66	CB27B-DMH27	0.64	13.134	74.15	74.25	0.76	74.71	74.58	0.04	75	n/a	74.58	57	Grate
67	CB24B-DMH24	1.06	12.318	74.00	74.25	2.03	74.30	74.68	0.16	71	n/a	74.68	61	Grate
68	CB24A-DMH24	1.24	13.238	73.95	74.25	2.27	74.29	74.72	0.23	71	n/a	74.72	61	Grate
69	CB24C-DMH24	1.28	67.201	73.65	74.00	0.52	74.29	74.48	0.00	Sag	n/a	74.48	61	Dp-Grate

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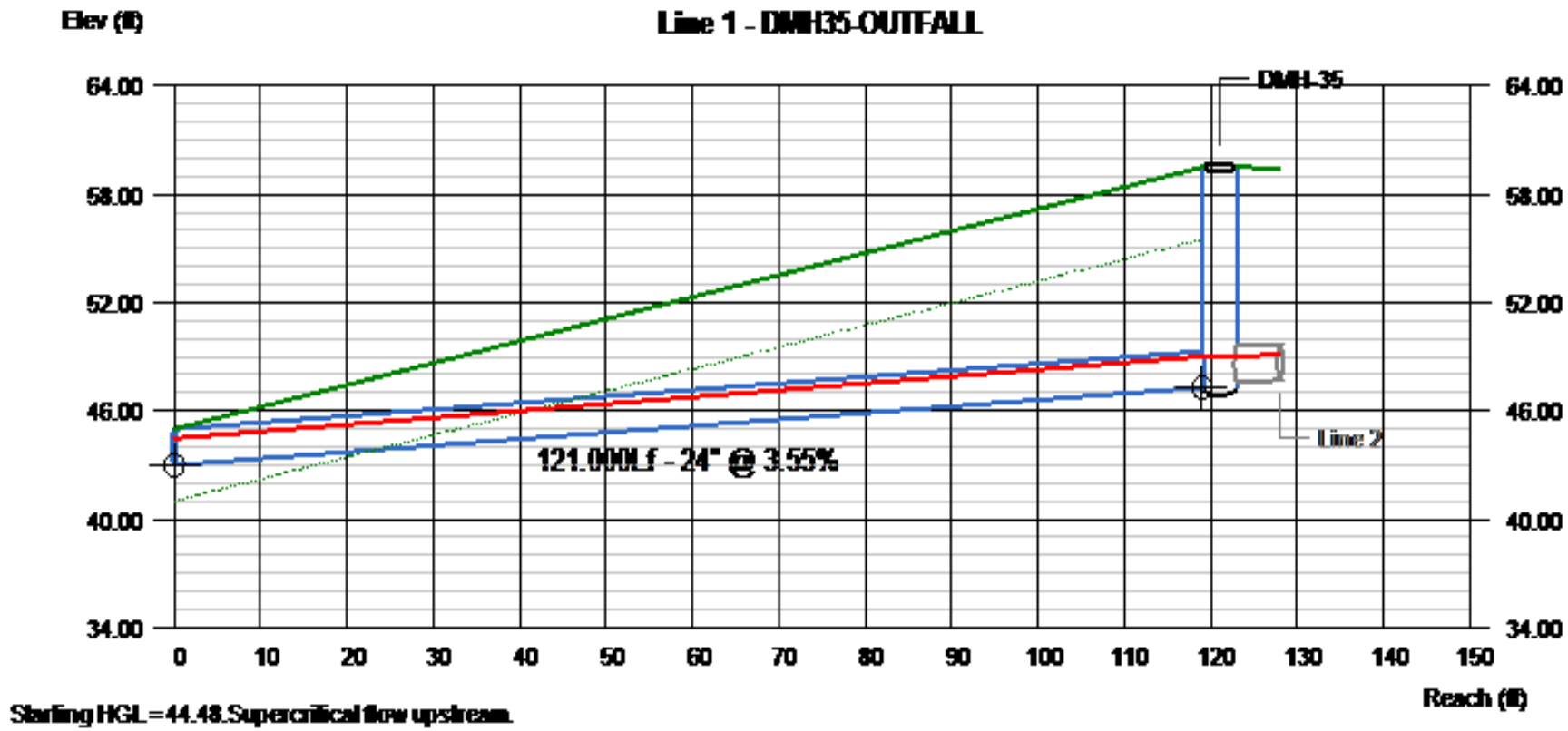
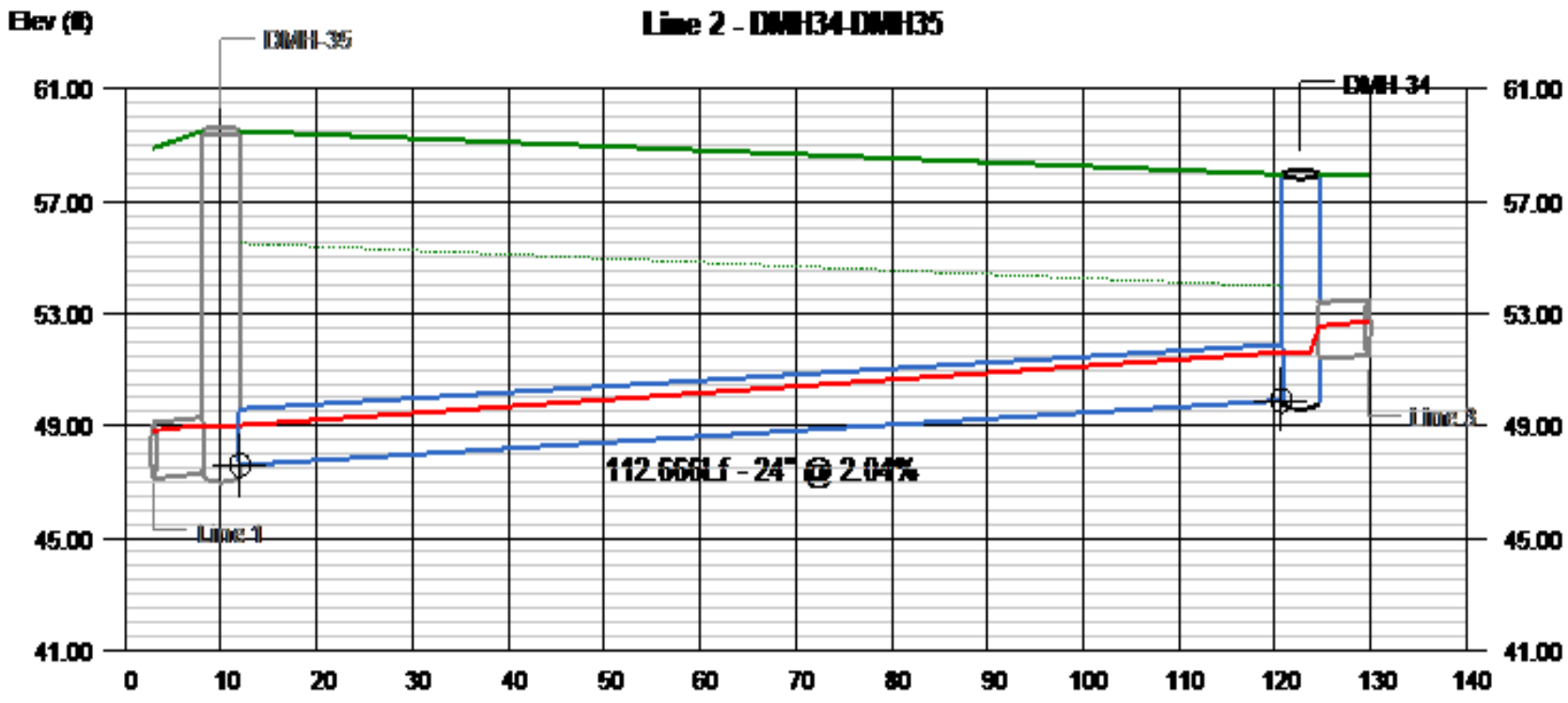
70	CB22-DMH22	0.62	7.087	73.45	73.50	0.71	74.69	74.69	0.00	Sag	n/a	74.70	10	Dp-Grate
71	CB31-DMH31	0.75	11.223	56.40	56.60	1.78	57.86	57.87	0.15	73	n/a	57.88	5	Grate
72	CB35-DMH35	0.27	33.079	55.75	56.00	0.76	55.94	56.21	0.00	Sag	n/a	56.21	1	Grate
73	CB33B-DMH33	1.37	11.182	54.15	54.40	2.24	54.48	54.89	0.00	Sag	n/a	54.89	3	Grate
74	CB33A-DMH33	1.28	11.218	54.15	54.40	2.23	54.47	54.88	0.00	Sag	n/a	54.88	3	Grate
75	CB32-DMH32	1.75	58.228	54.00	54.30	0.52	55.01	55.10	0.00	Sag	n/a	55.21	4	Grate
76	CB34-DMH34	1.99	116.391	50.00	53.50	3.01	51.61	54.10	0.00	Sag	n/a	54.10	2	Dp-Grate

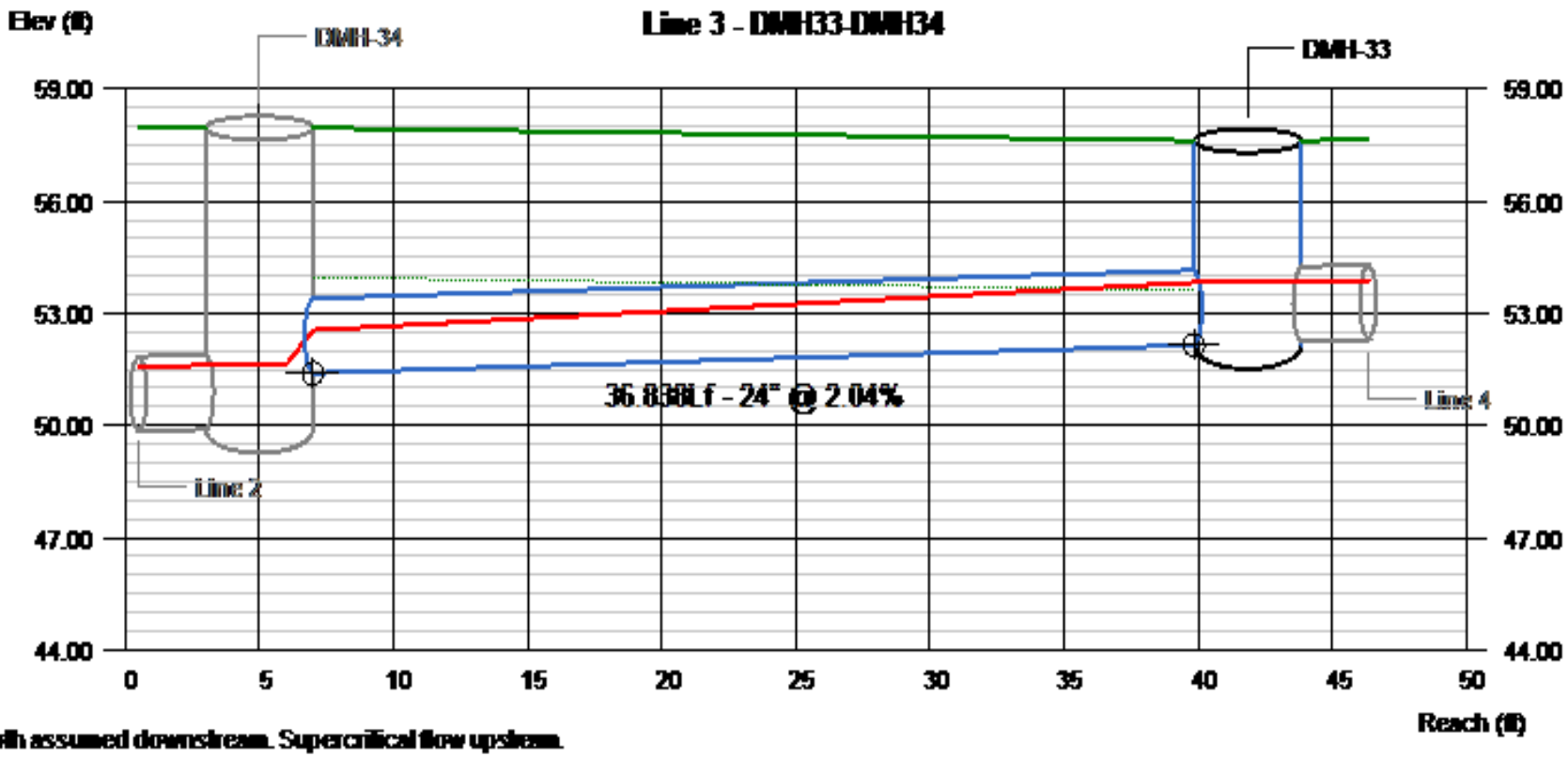
Project File: Woburn_System-1.stm | Number of lines: 76 | Date: 4/26/2020

NOTES: ** Critical depth

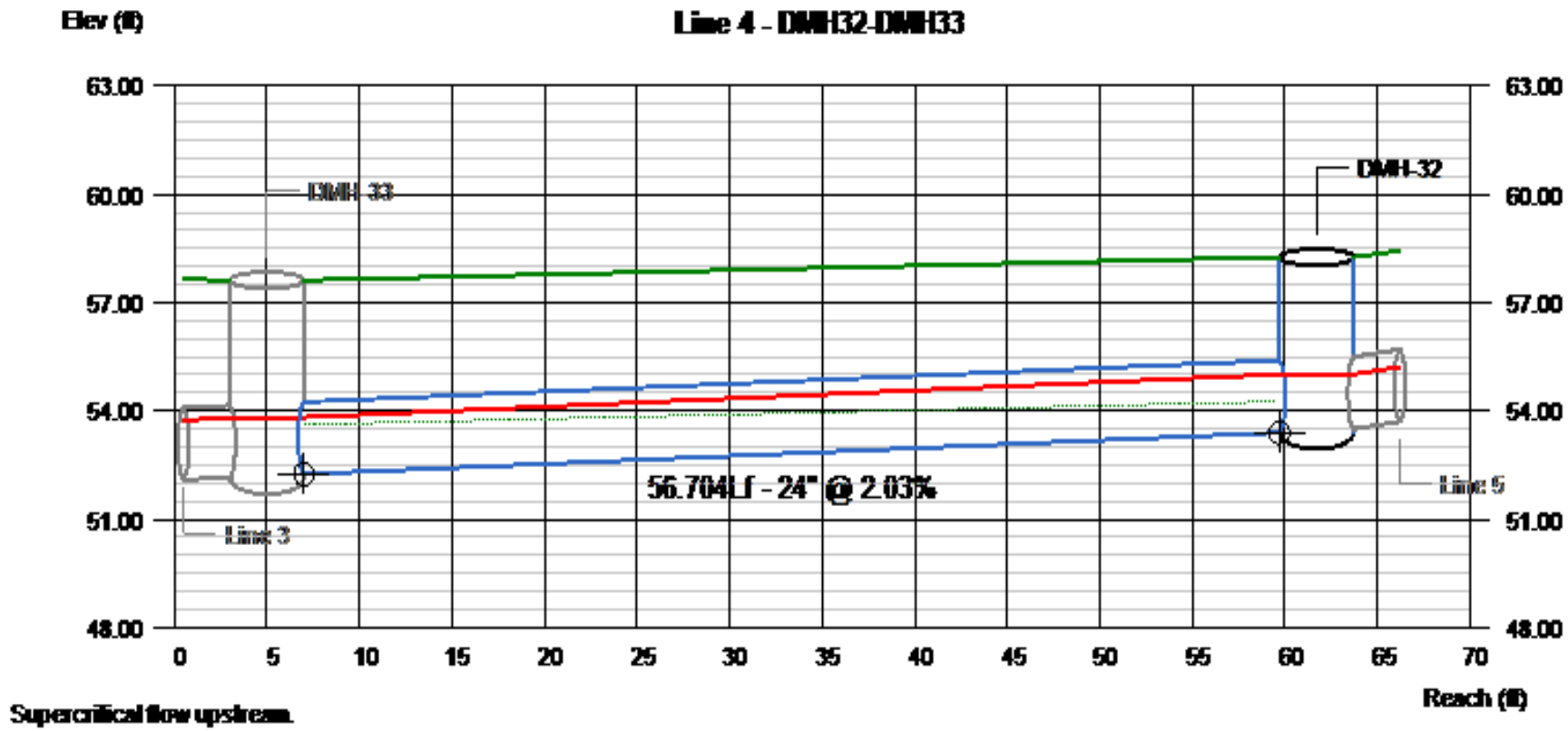

Elev (ft)
Line 1 - DMH35-OUTFALL
DMH-35
Line 2
121.000Lf - 24" @ 3.55%
64.00
58.00
52.00
46.00
40.00
34.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Reach (ft)
Starting HGL = 44.48. Supercritical flow upstream.

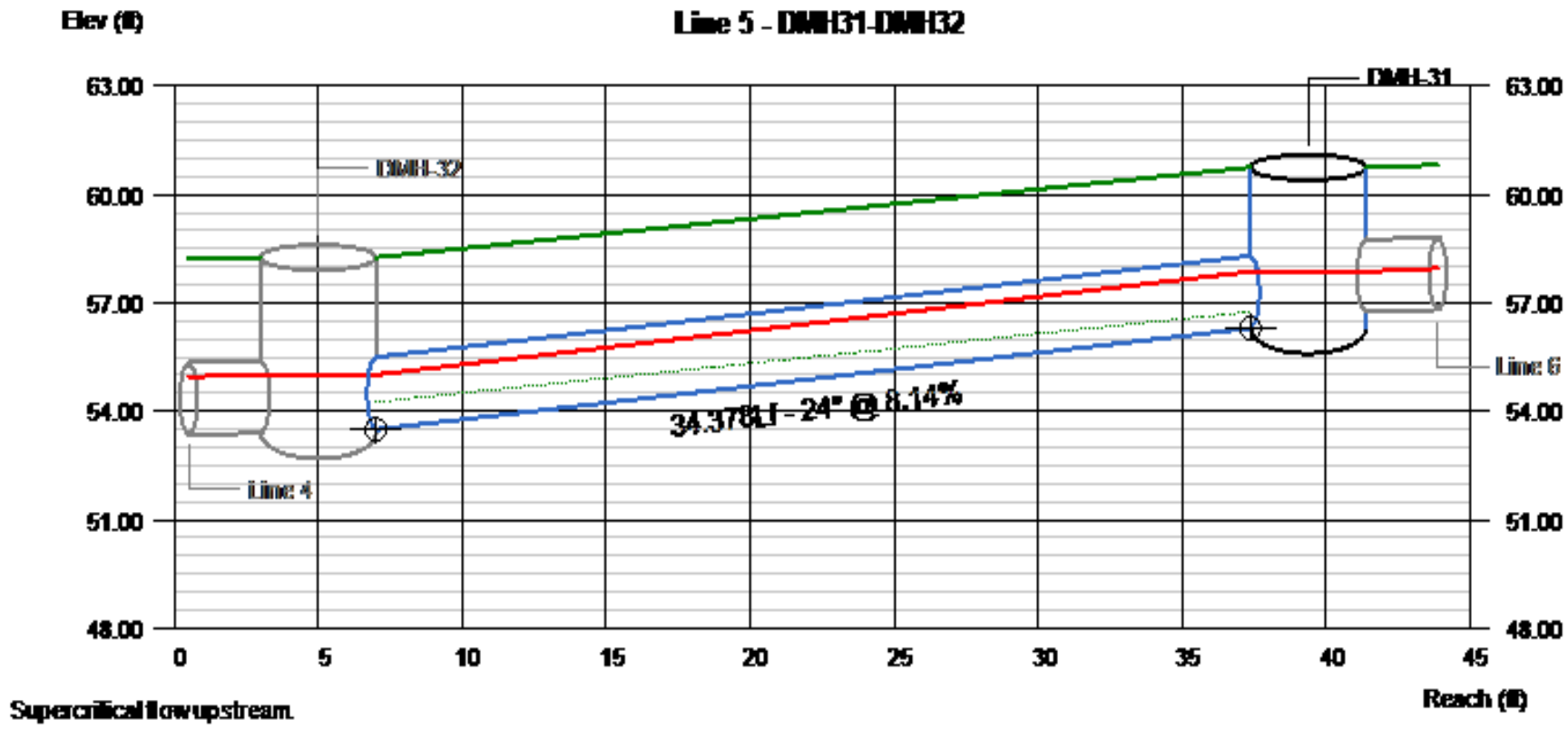


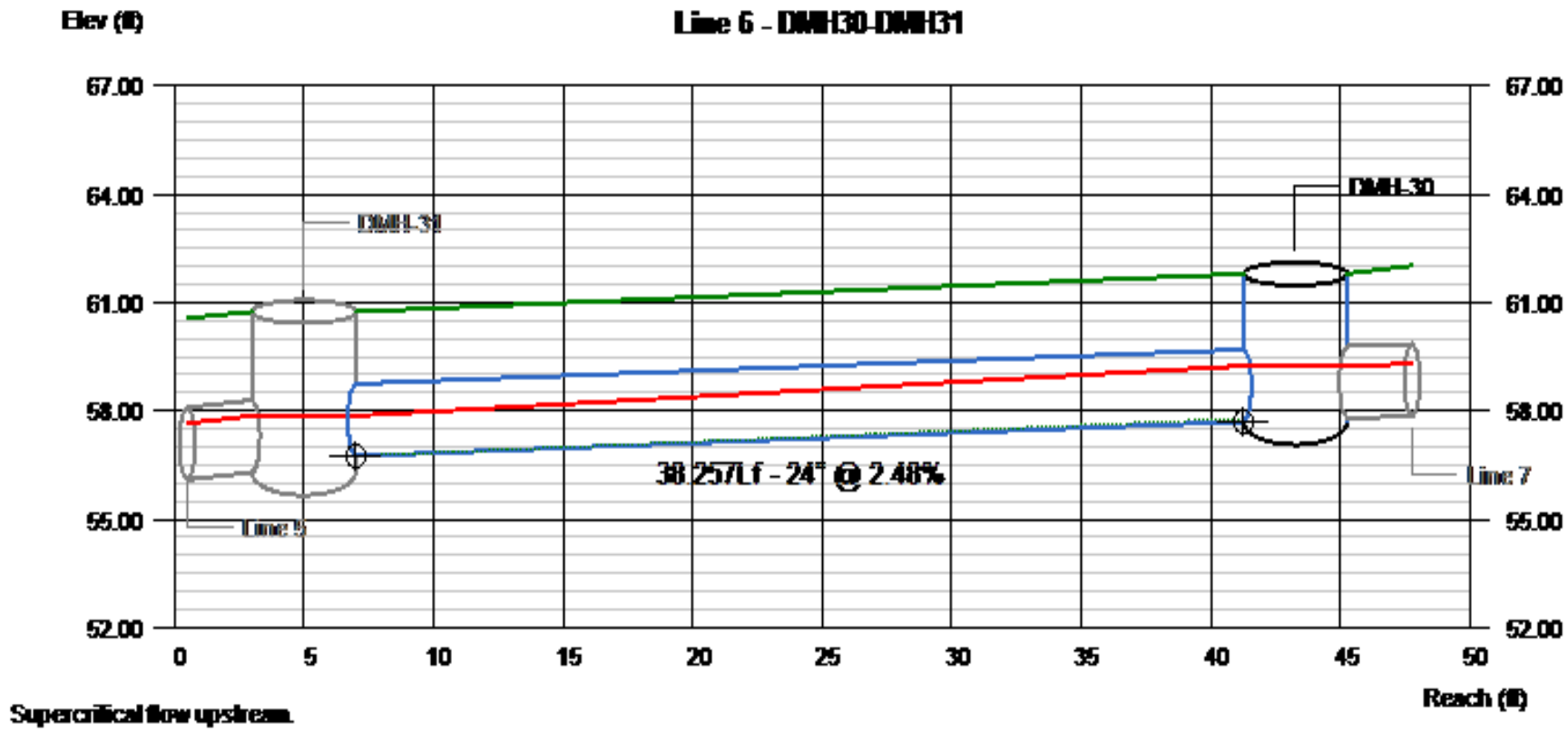
Supercritical flow upstream.

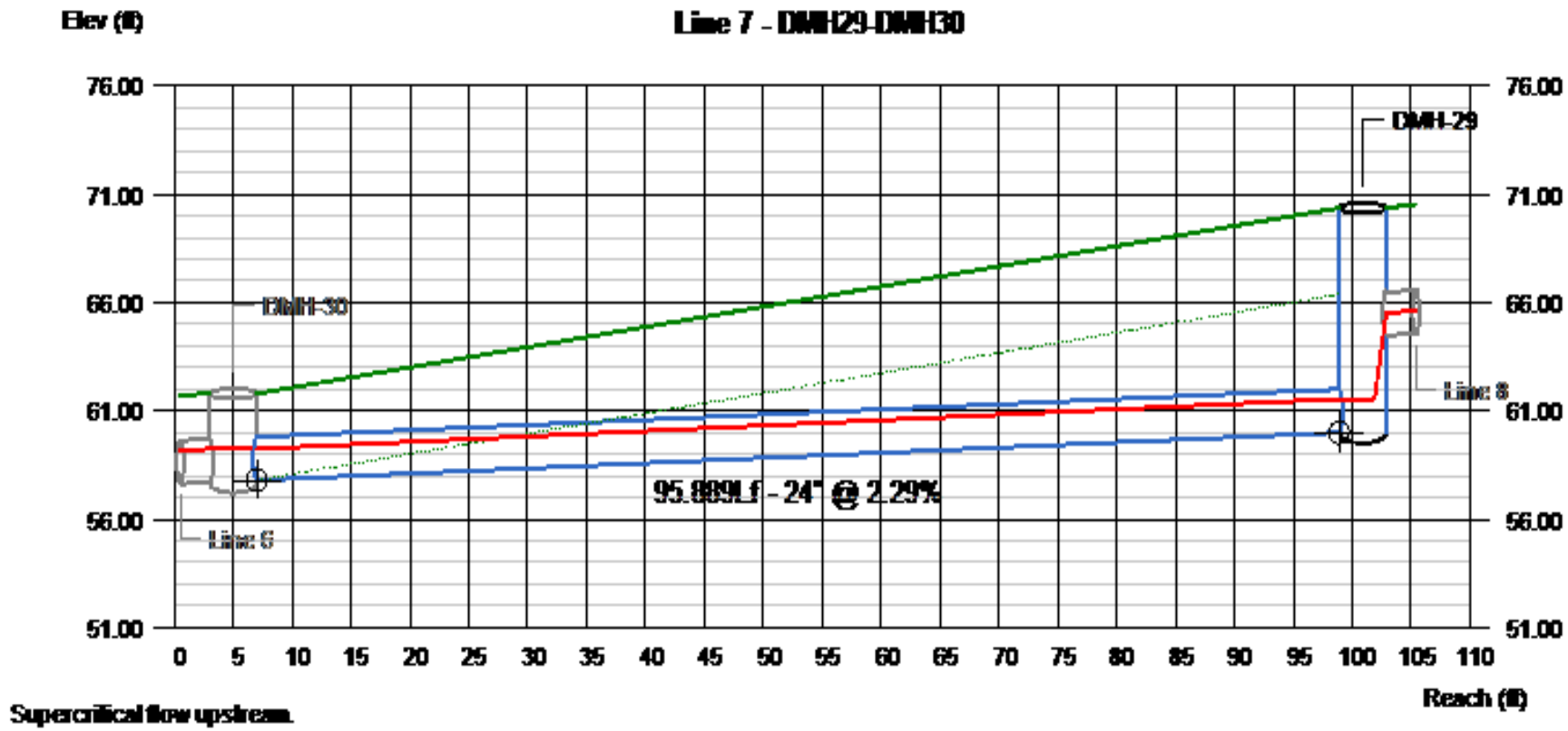


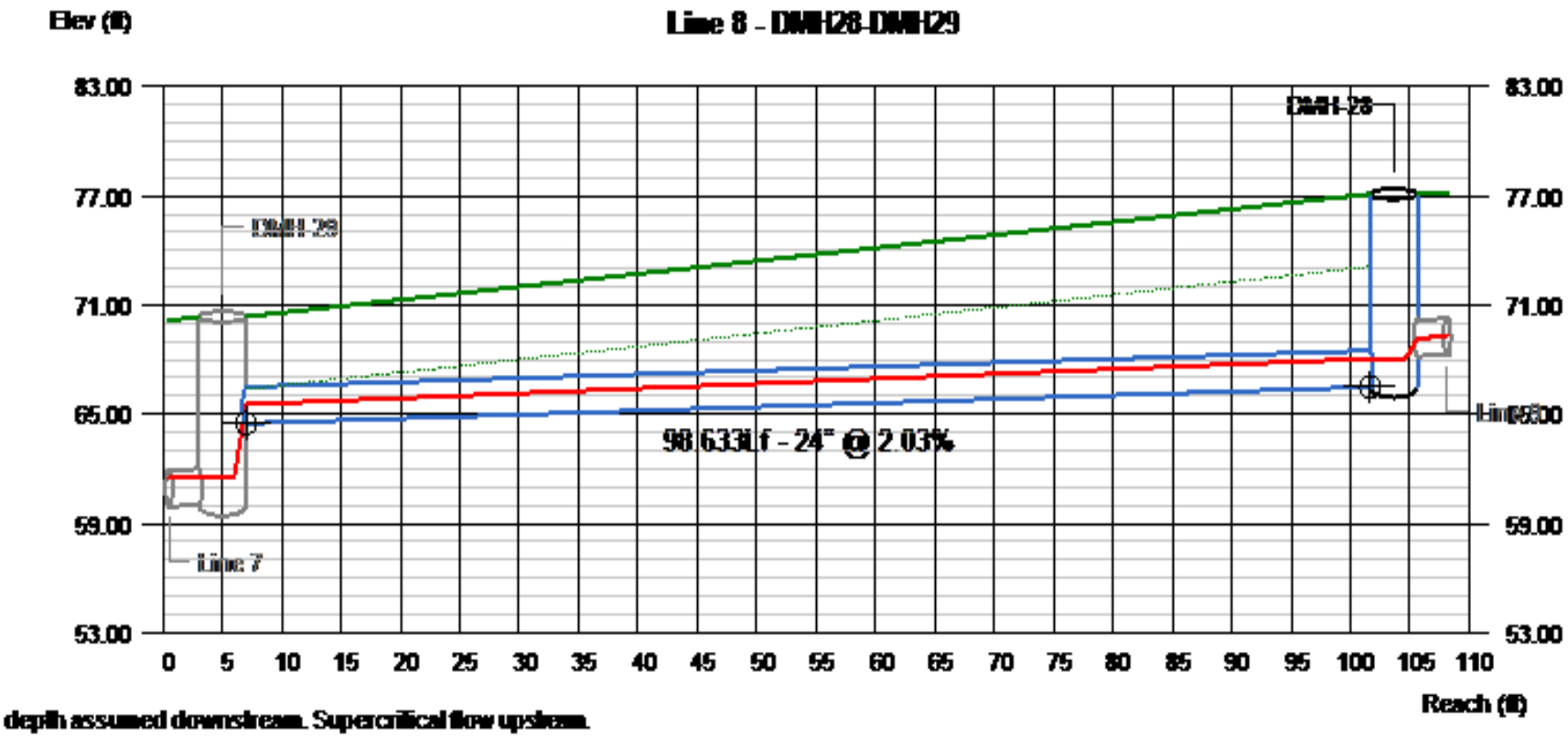
depth assumed downstream. Supercritical flow upstream.


Elev (ft)
Line 4 - DMH32-DMH33
63.00
60.00
57.00
54.00
51.00
48.00
DMH-33
DMH-32
Line 3
Line 5
56.704Lf - 24" @ 2.03%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Reach (ft)
Supercritical flow upstream.

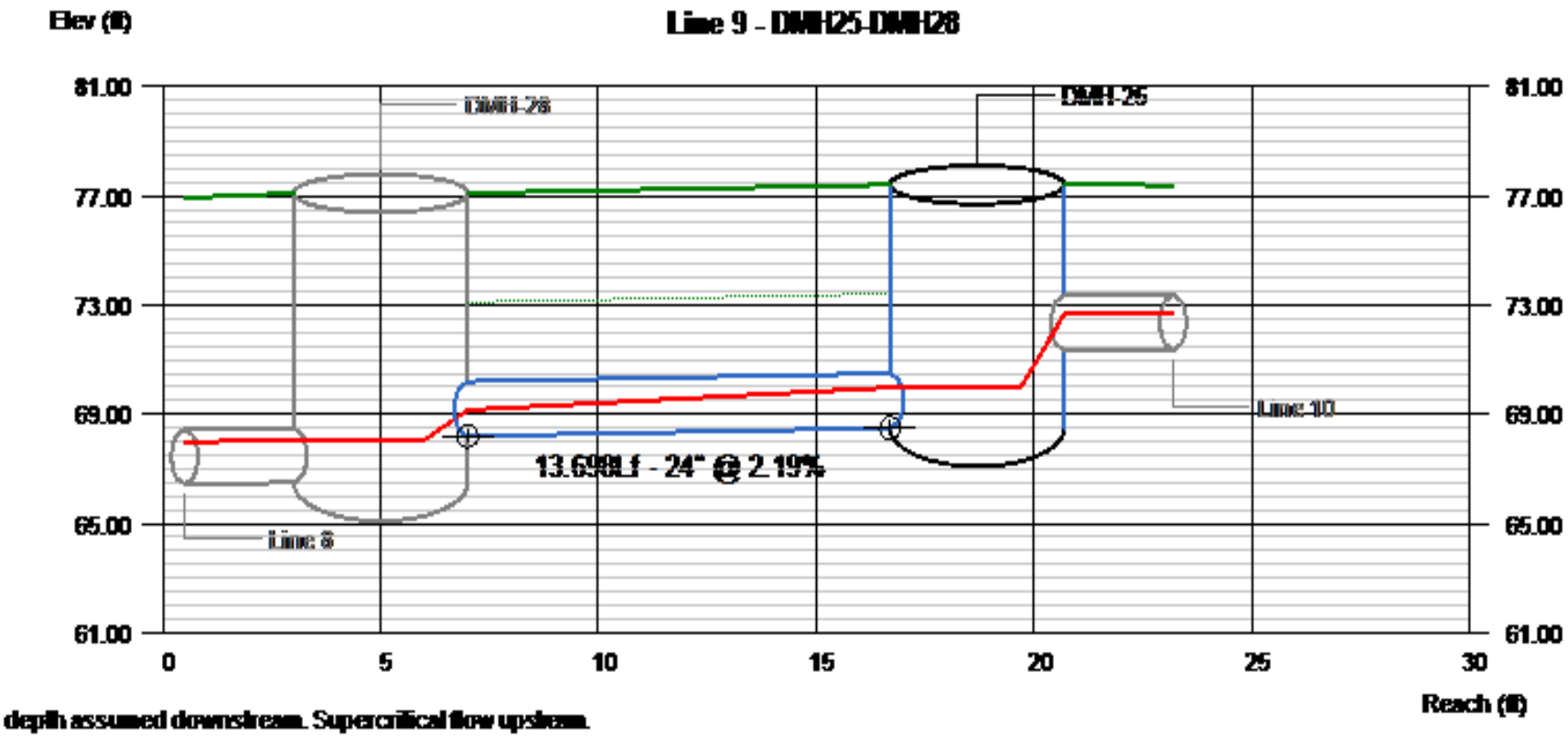

Elev (ft)
Line 5 - DMH31-DMH32
63.00
60.00
57.00
54.00
51.00
48.00
DMH-31
DMH-32
Line 6
Line 4
34.378LF - 24" @ 8.14%
0
5
10
15
20
25
30
35
40
45
Reach (ft)
Supercritical flow upstream.


Elev (ft)
Line 6 - DMH30-DMH31
67.00
64.00
61.00
58.00
55.00
52.00
DMH-31
DMH-30
38.257Lf - 24" @ 2.48%
Line 7
0
5
10
15
20
25
30
35
40
45
50
Reach (ft)
Supercritical flow upstream.

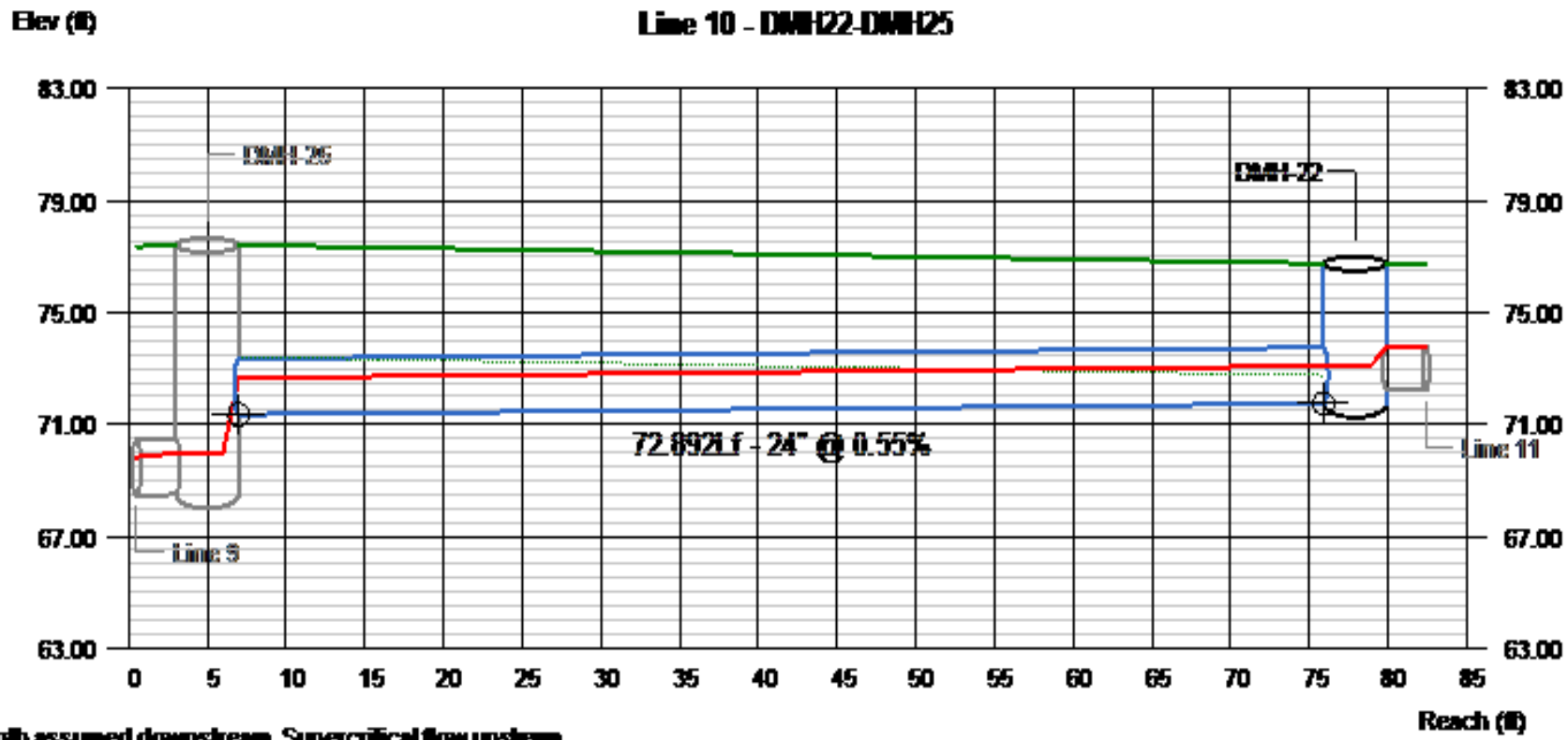

Elev (ft)
Line 7 - DMH29-DMH30
76.00
71.00
66.00
61.00
56.00
51.00
DMH-29
DMH-30
Line 8
Line 6
95.889 lf - 24" @ 2.29%
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110
Reach (ft)
Supercritical flow upstream.



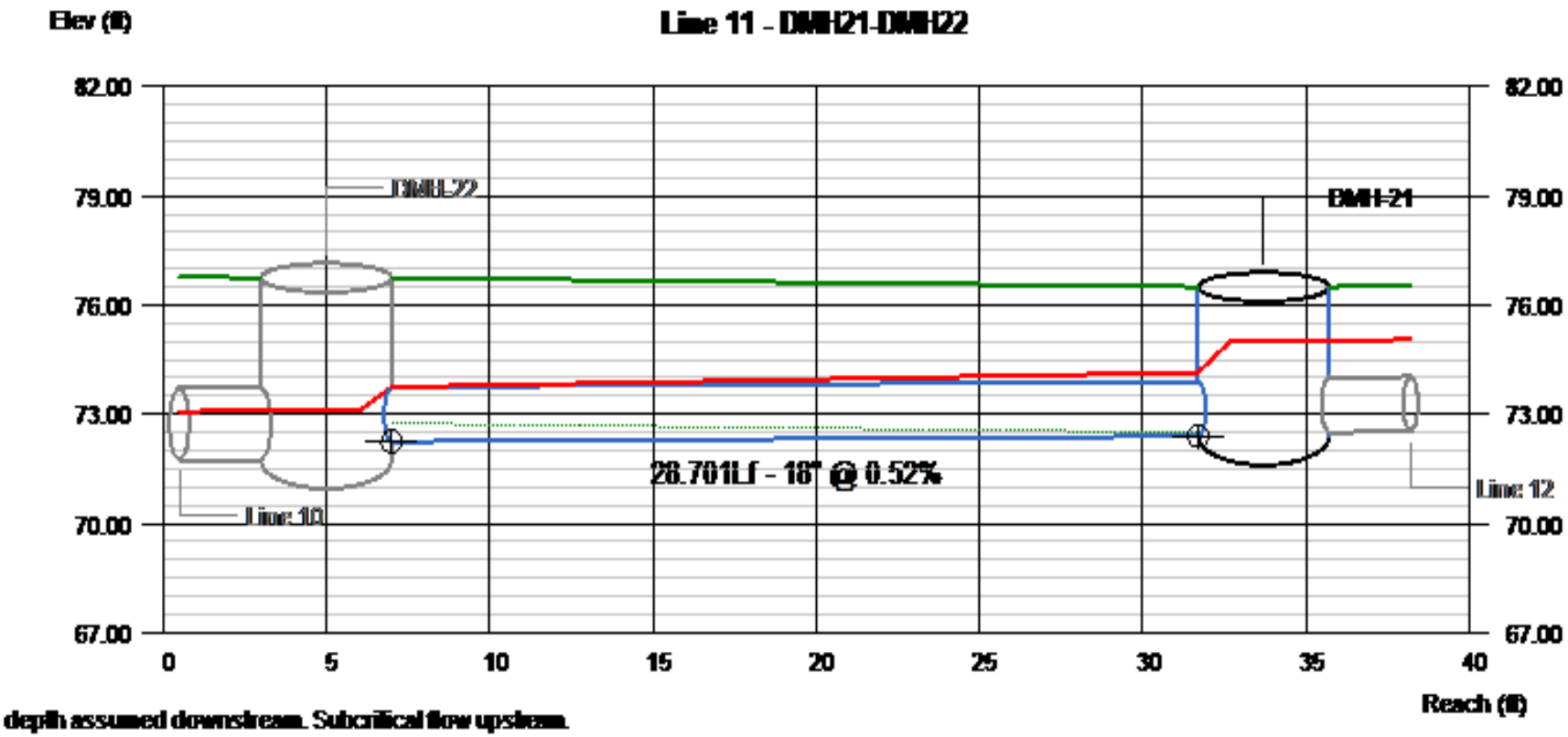
depth assumed downstream. Supercritical flow upstream.

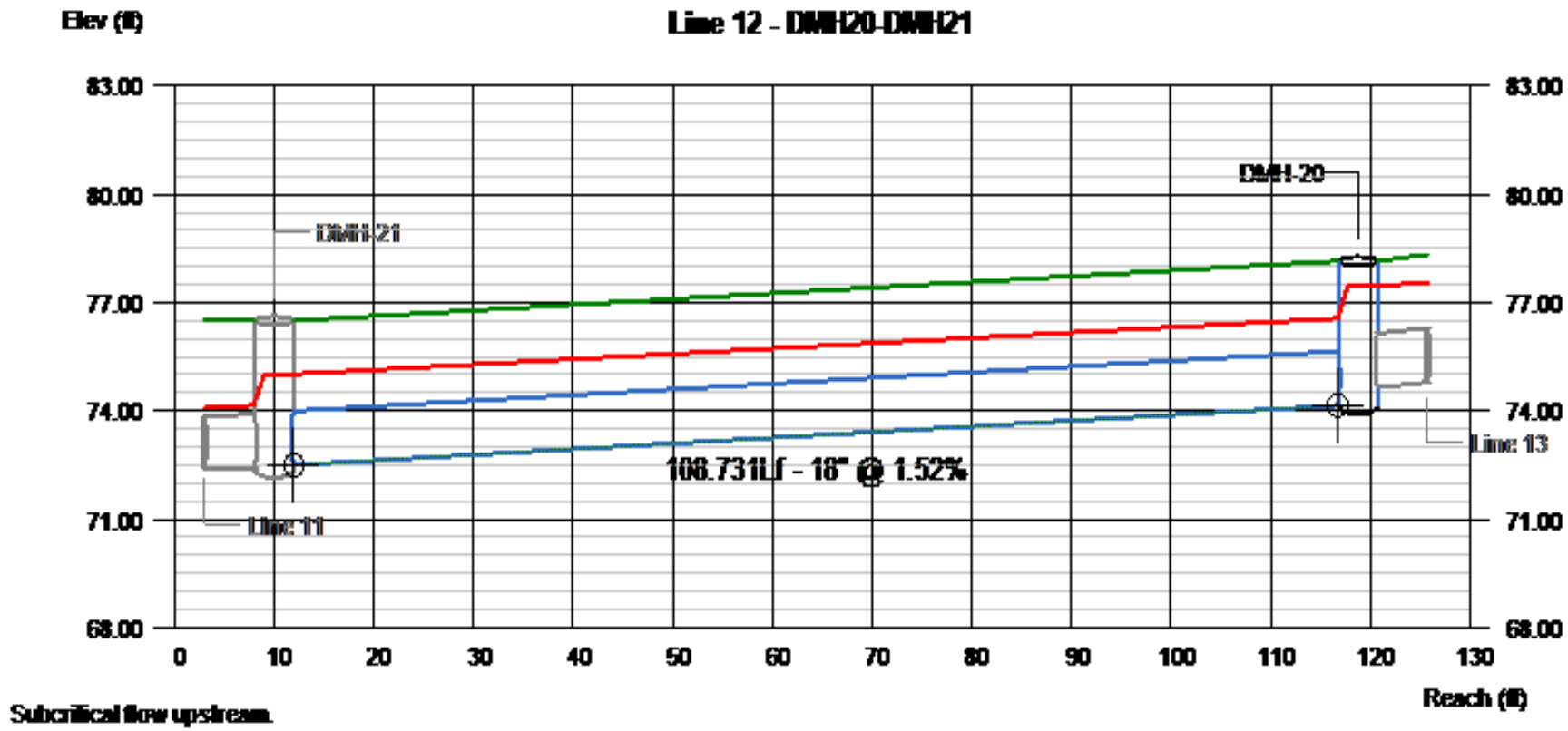


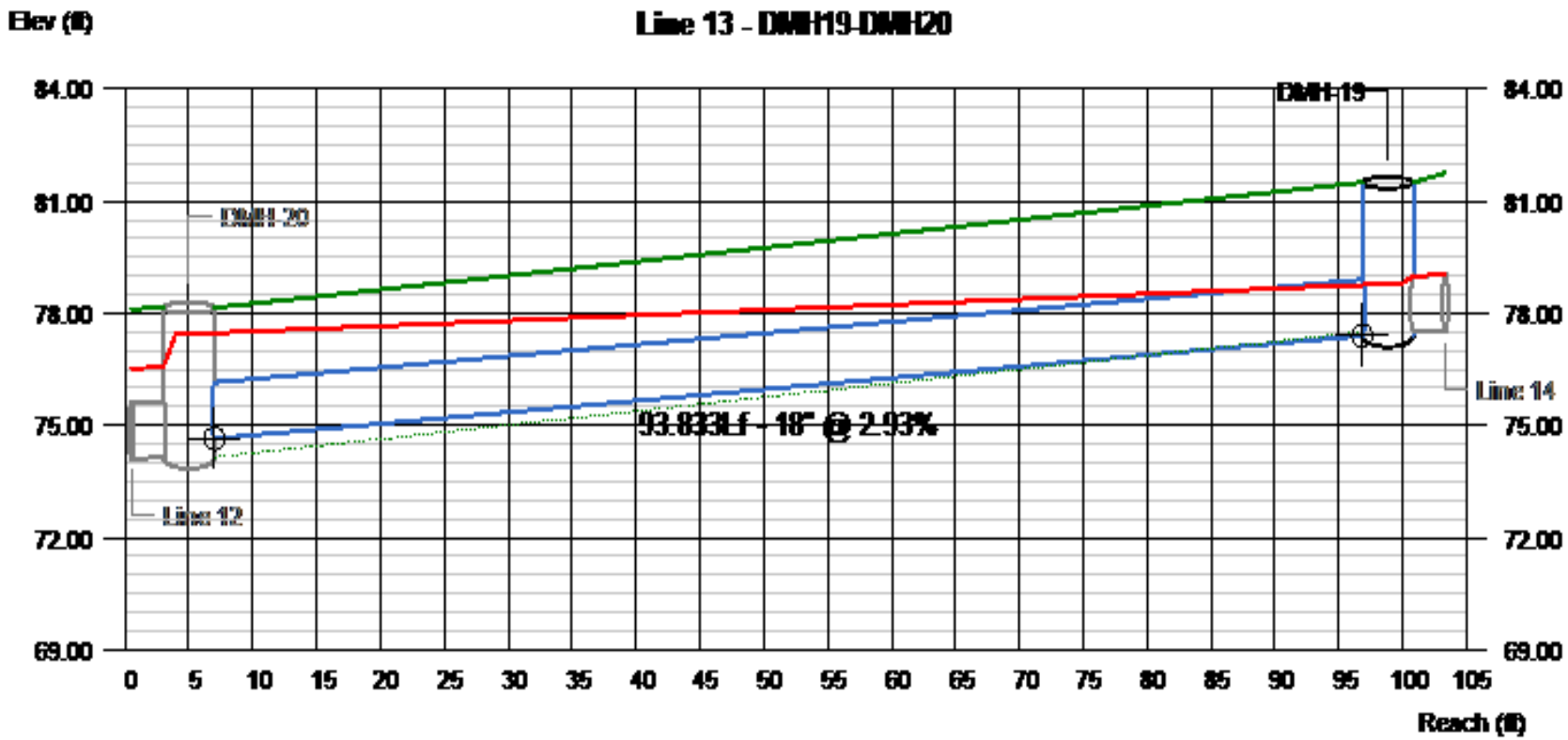
depth assumed downstream. Supercritical flow upstream.

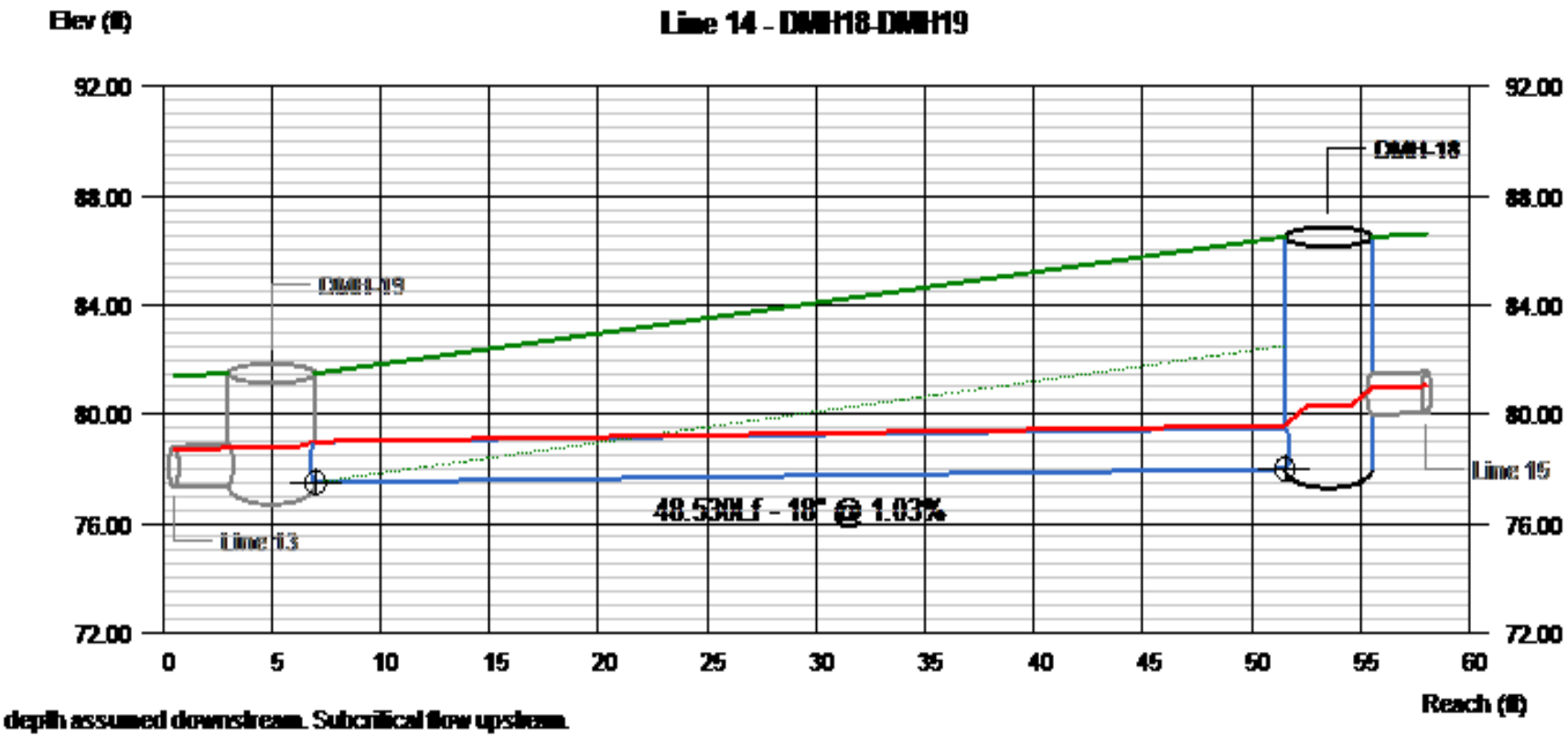


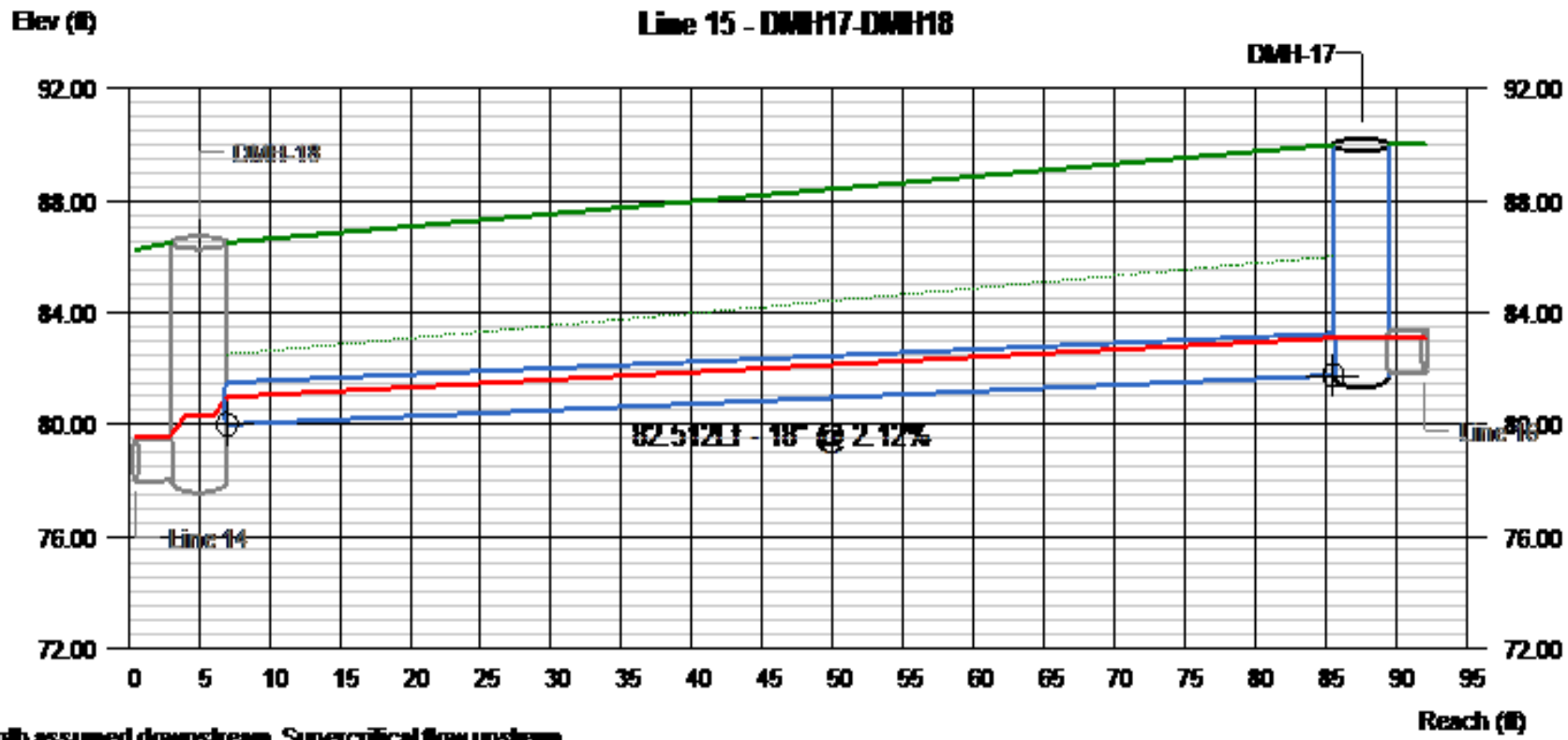
depth assumed downstream. Supercritical flow upstream.


Elev (ft)
Line 11 - DMH21-DMH22
82.00
79.00
76.00
73.00
70.00
67.00
DMH-22
DMH-21
28.701Lf - 18" @ 0.52%
Line 10
Line 12
0
5
10
15
20
25
30
35
40
Reach (ft)
depth assumed downstream. Subcritical flow upstream.

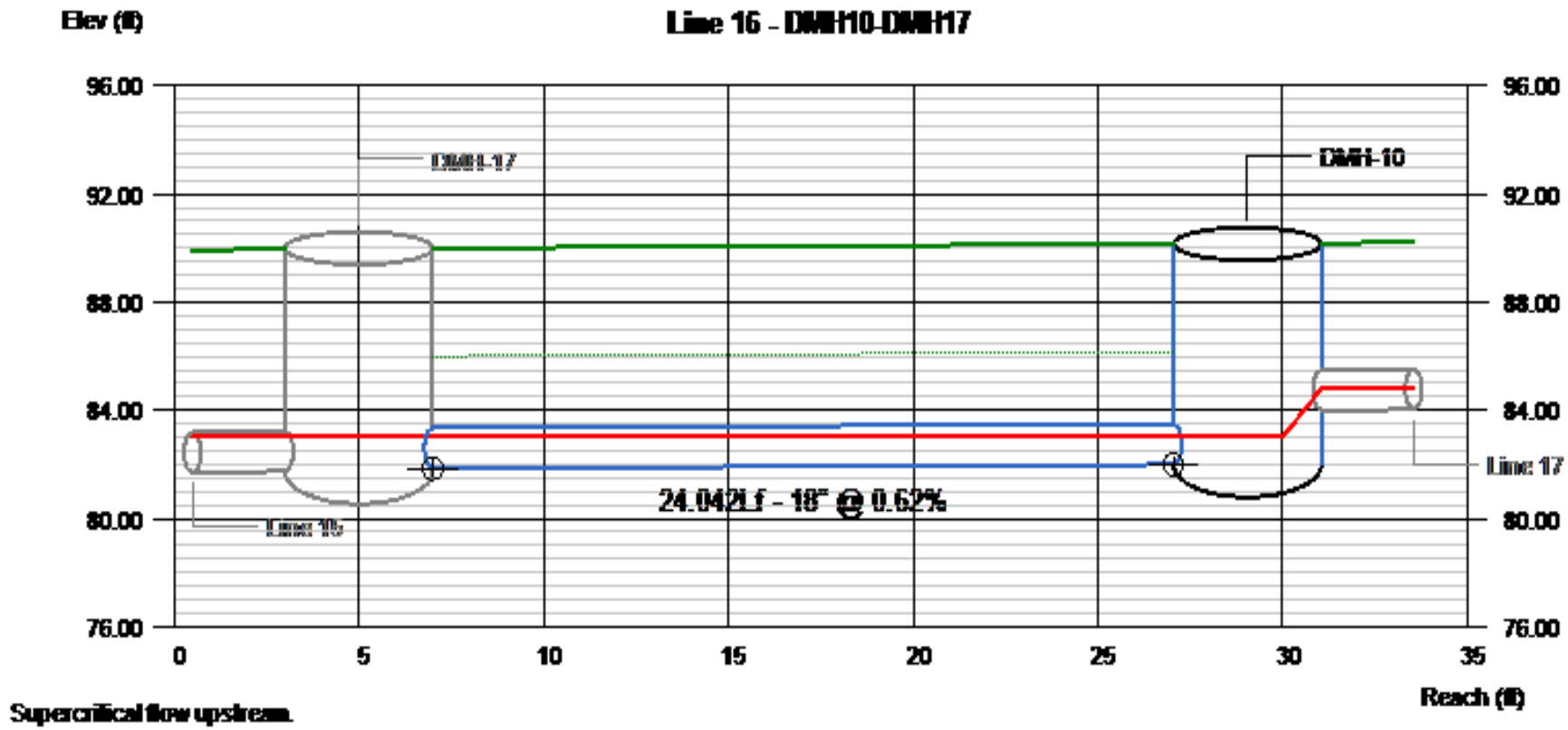

Elev (ft)
Line 12 - DMH20-DMH21
83.00
80.00
77.00
74.00
71.00
68.00
DMH-21
DMH-20
Line: 11
Line: 13
106.731Lf - 18" @ 1.52%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Reach (ft)
Subcritical flow upstream.

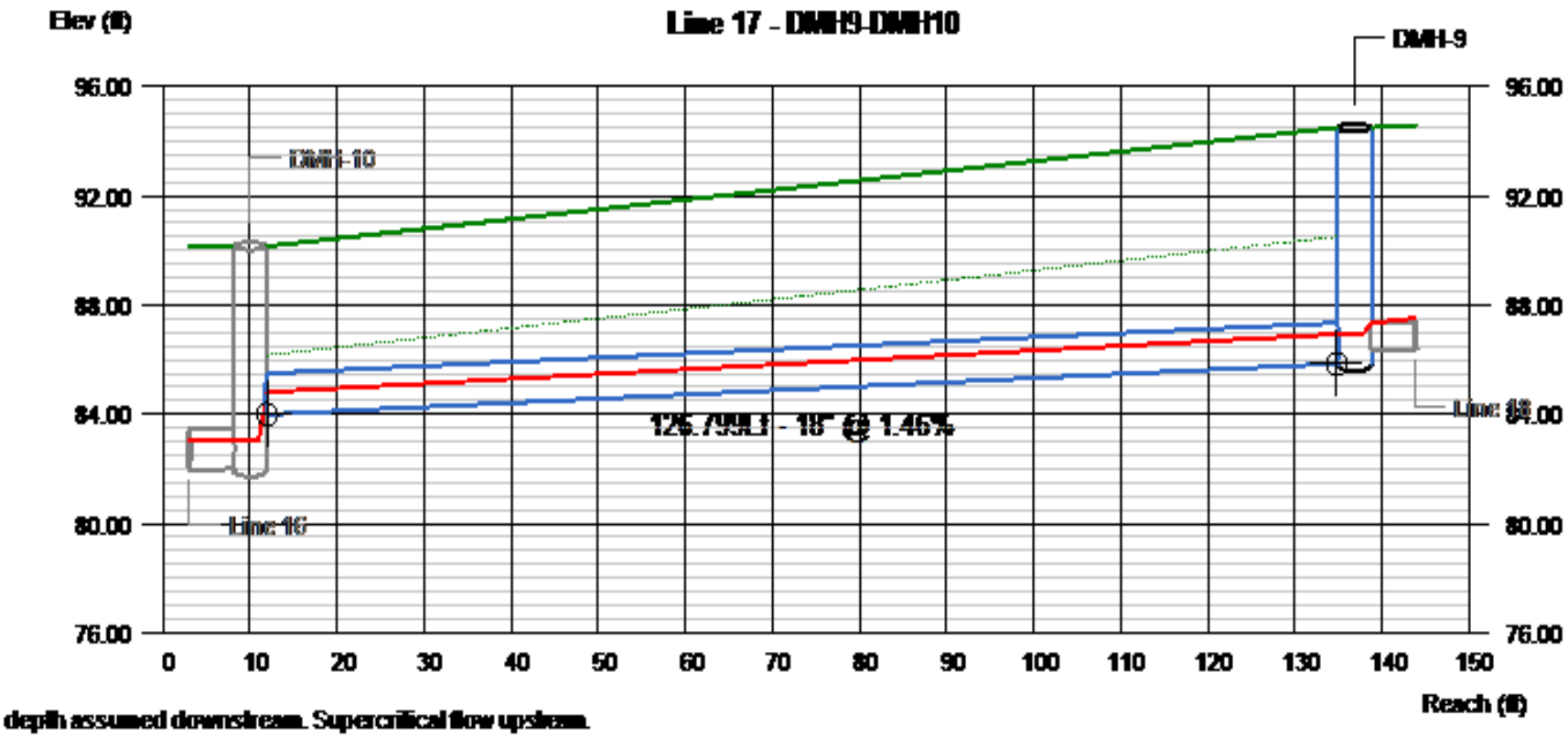

Elev (ft)
Line 13 - DMH19-DMH20
84.00
81.00
78.00
75.00
72.00
69.00
DMH-19
DMH-20
Line 14
Line 12
93.833 LF - 18" @ 2.93%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
Reach (ft)

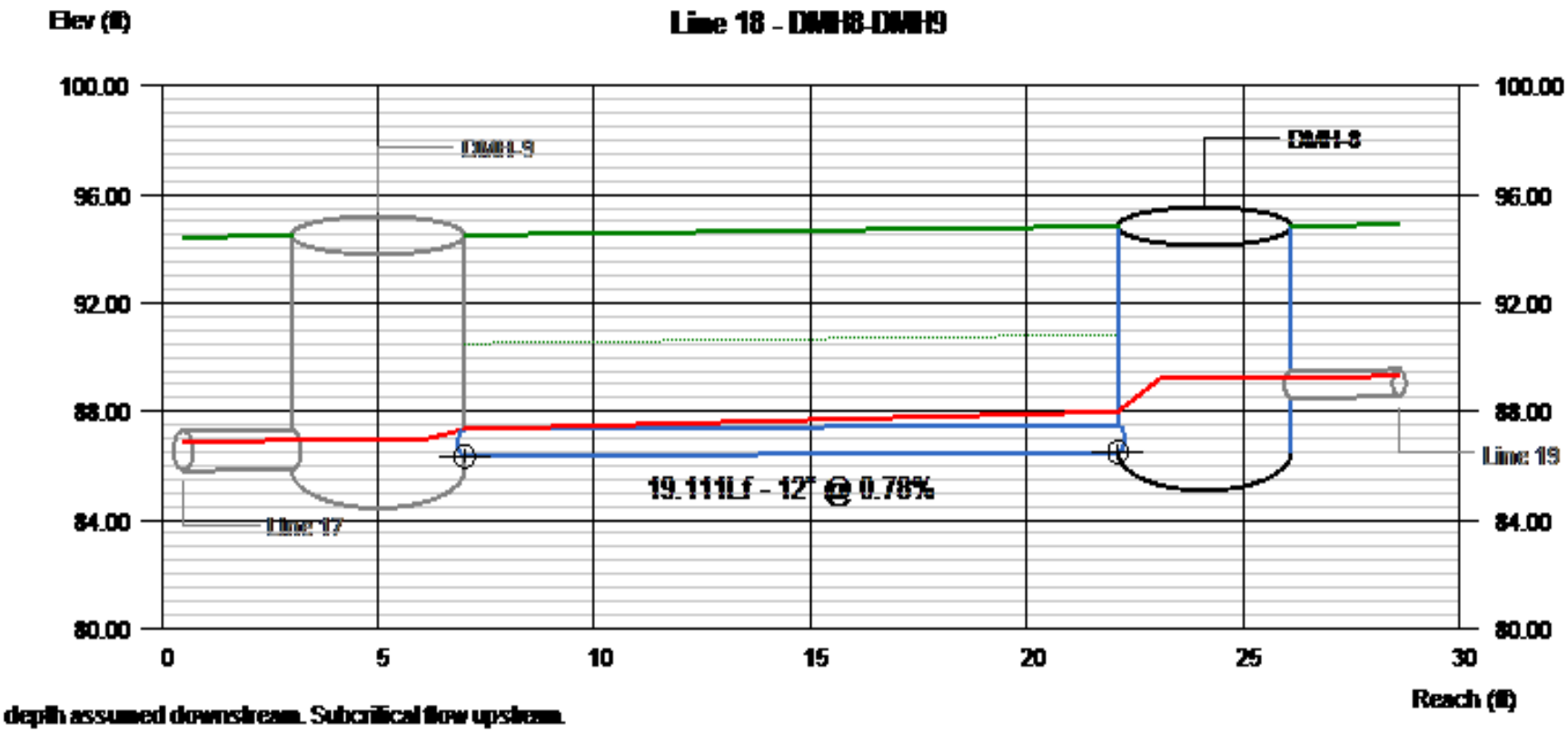

Elev (ft)
Line 14 - DMH18-DMH19
92.00
88.00
84.00
80.00
76.00
72.00
DMH-18
DMH-19
Line 15
Line 13
48.53ft - 18" @ 1.03%
0
5
10
15
20
25
30
35
40
45
50
55
60
Reach (ft)
depth assumed downstream. Subcritical flow upstream.

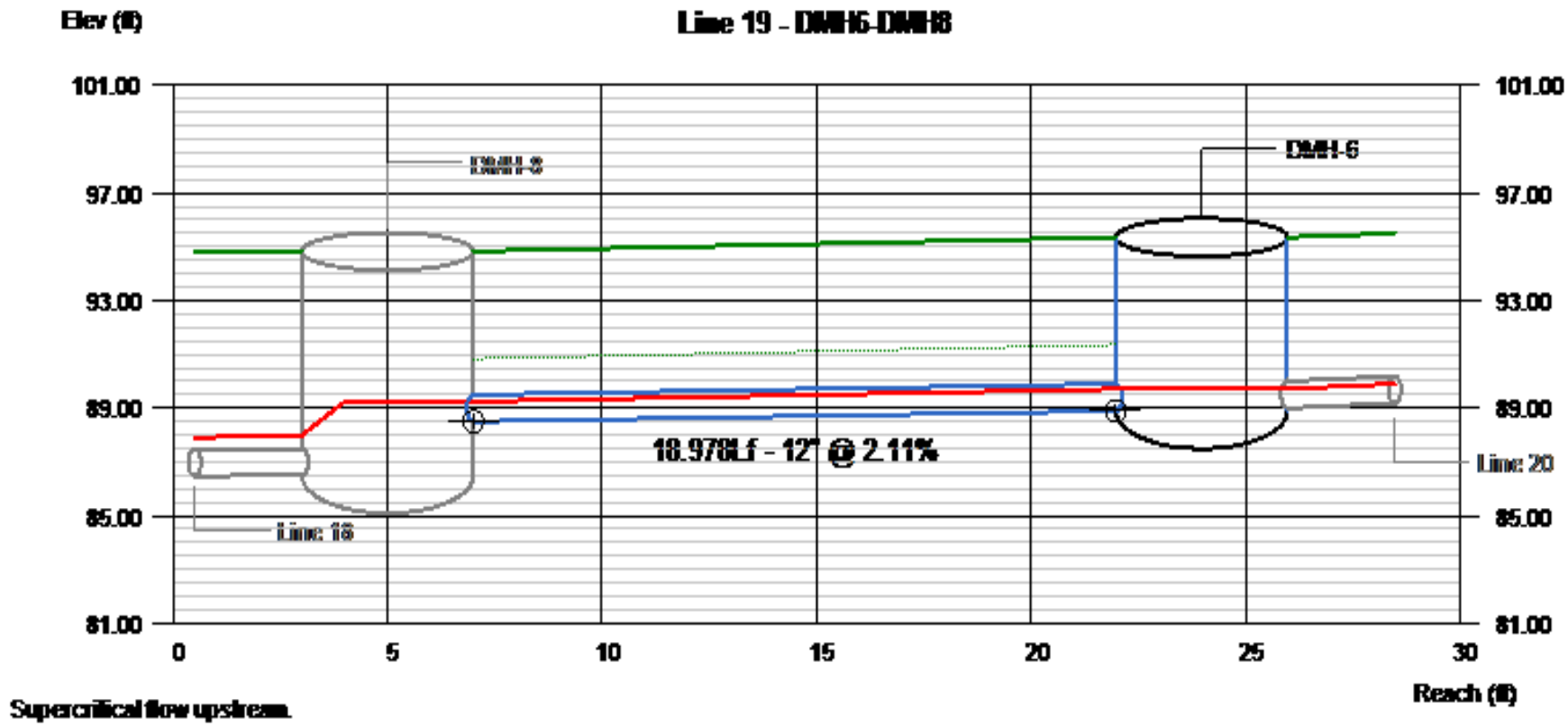


depth assumed downstream. Supercritical flow upstream.

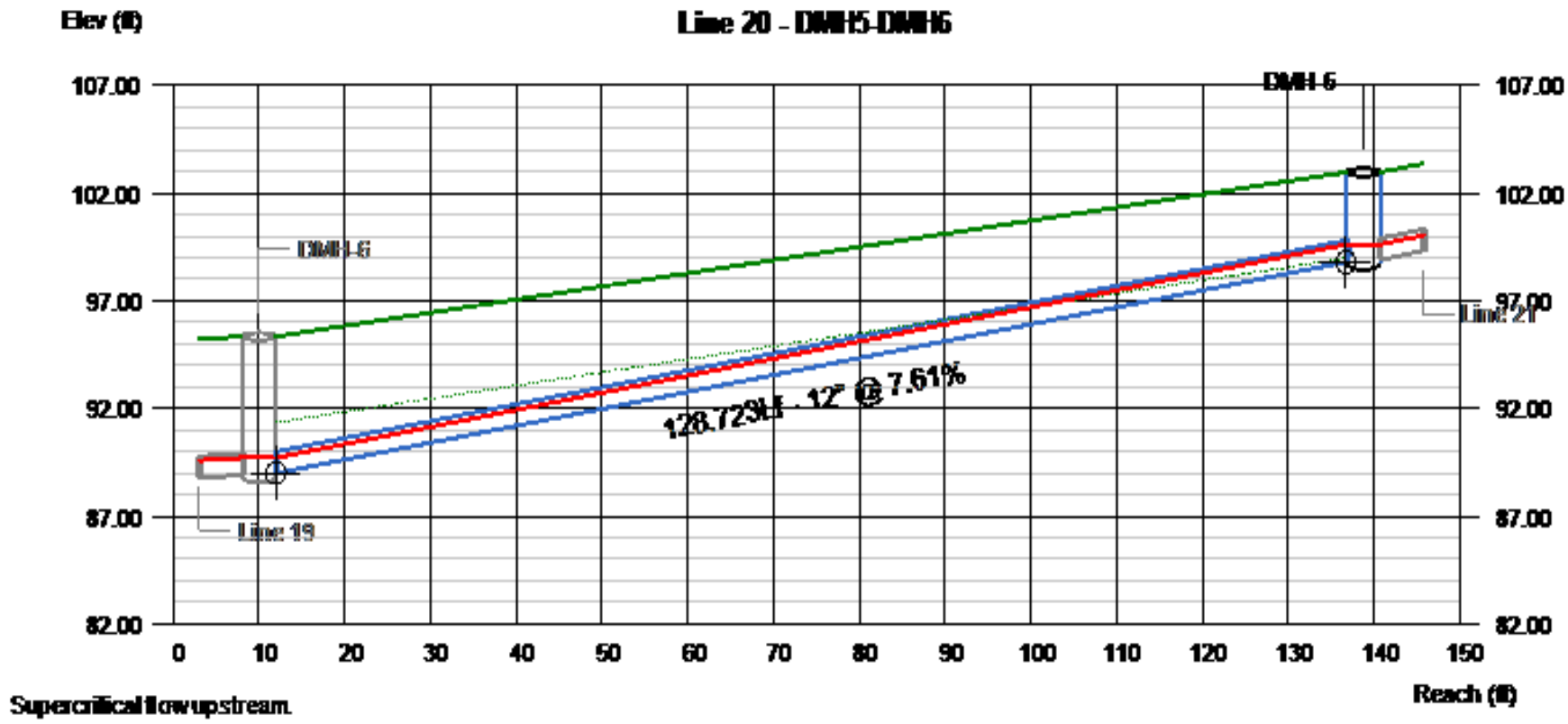

Elev (ft)
Line 16 - DMH10-DMH17
96.00
92.00
88.00
84.00
80.00
76.00
DMH-17
DMH-10
Line 17
24.0421 f - 18" @ 0.62%
0
5
10
15
20
25
30
35
Reach (ft)
Supercritical flow upstream.

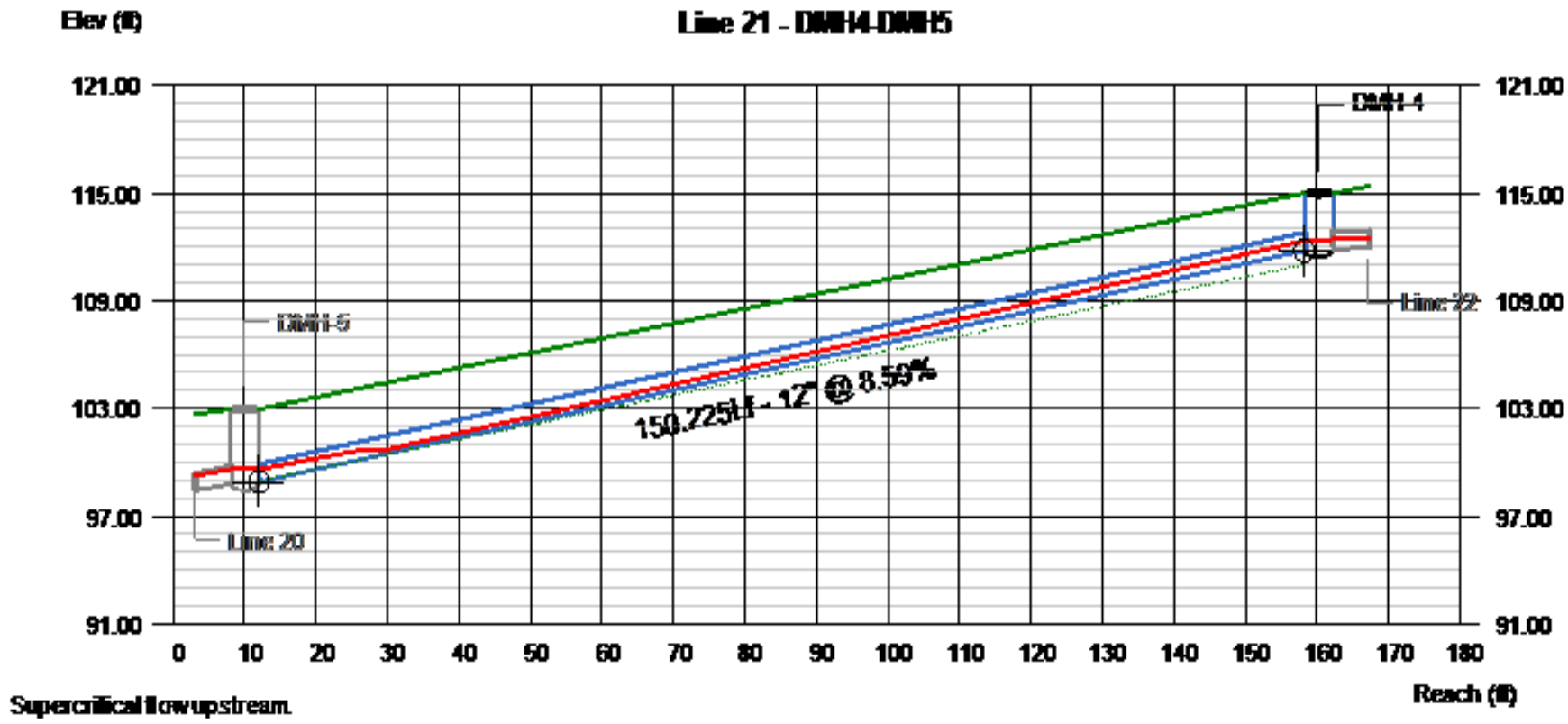

Elev (ft)
Line 17 - DMH9-DMH10
DMH-9
DMH-10
Line 16
Line 18
126.799ft - 18" @ 1.46%
96.00
92.00
88.00
84.00
80.00
76.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

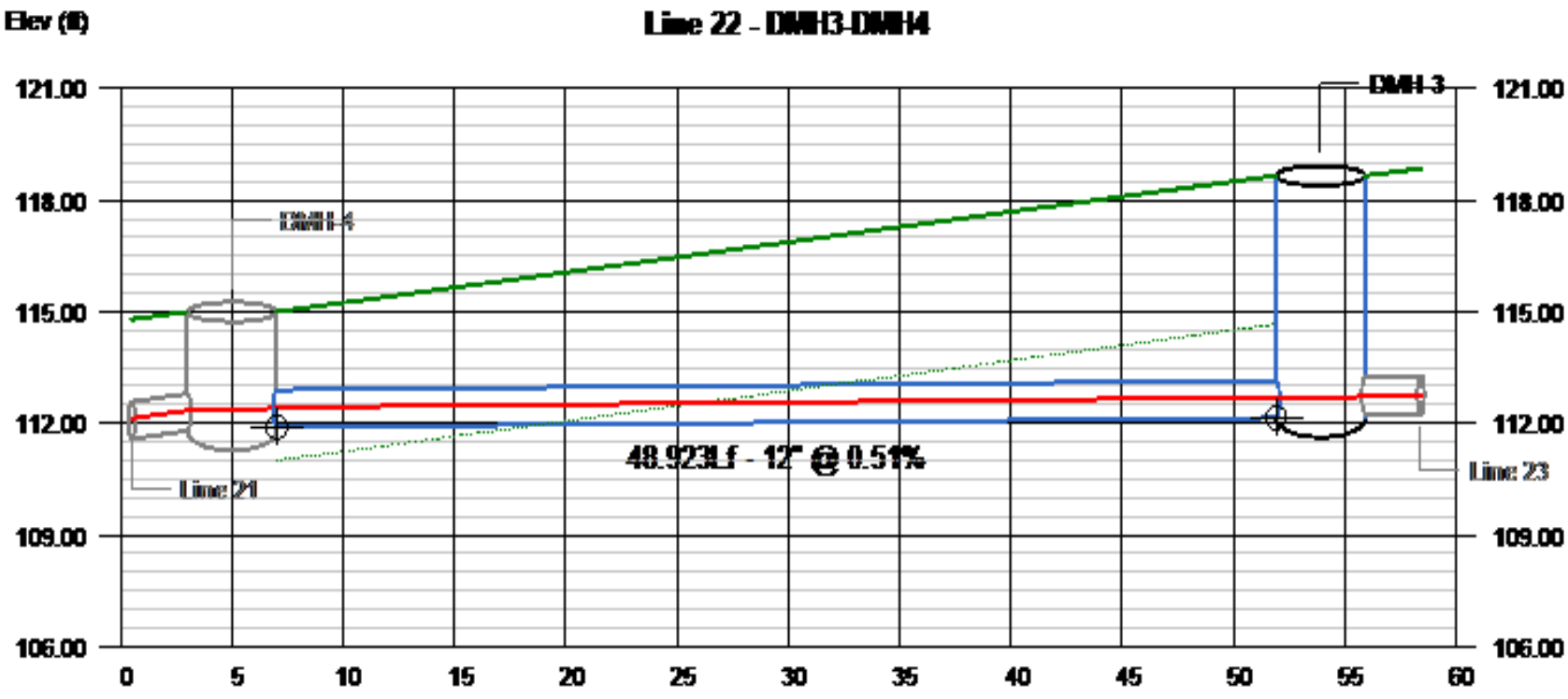

Elev (ft)
Line 18 - DMH8-DMH9
100.00
96.00
92.00
88.00
84.00
80.00
DMH-9
DMH-8
Line 17
Line 19
19.111Lf - 12" @ 0.78%
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Subcritical flow upstream.



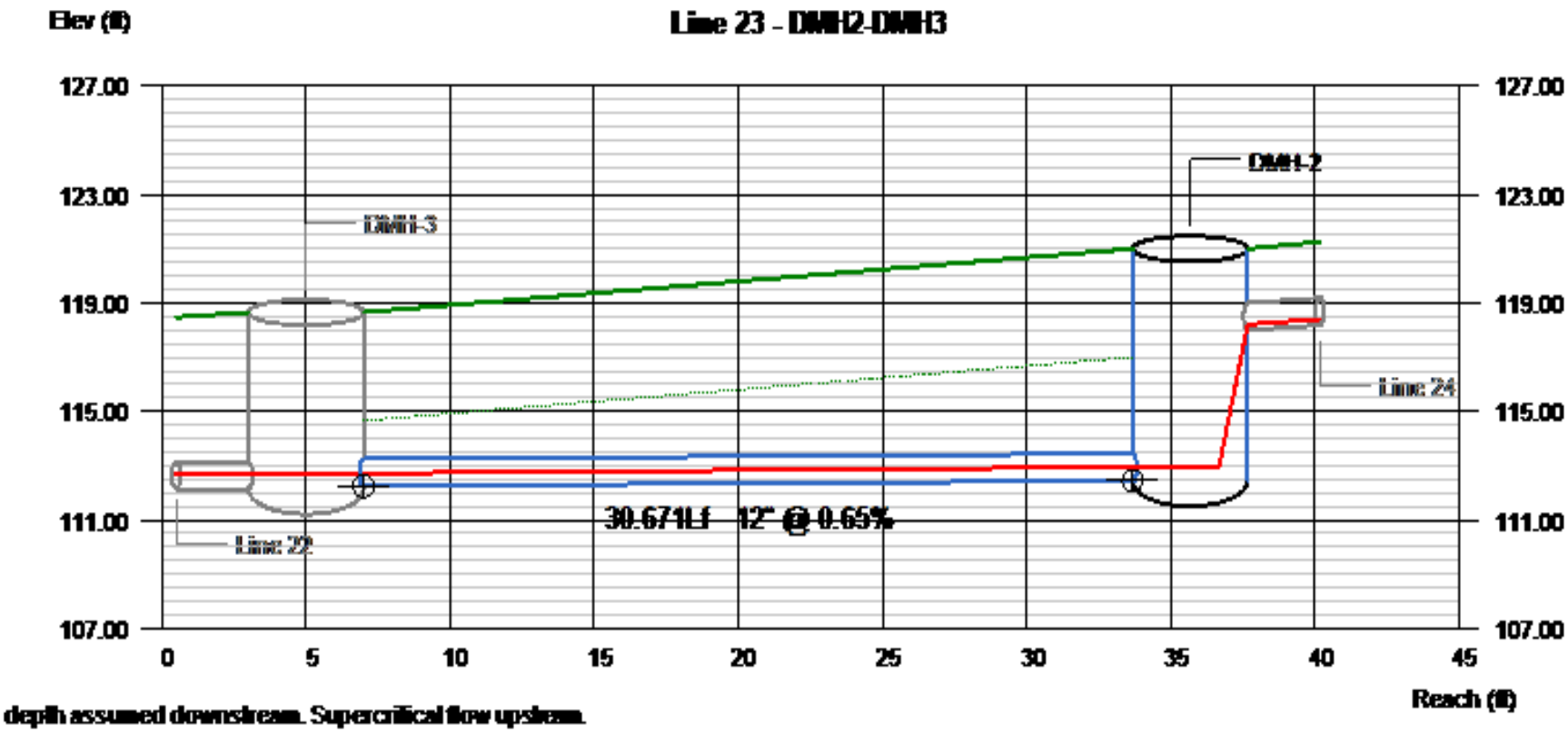
Supercritical flow upstream.

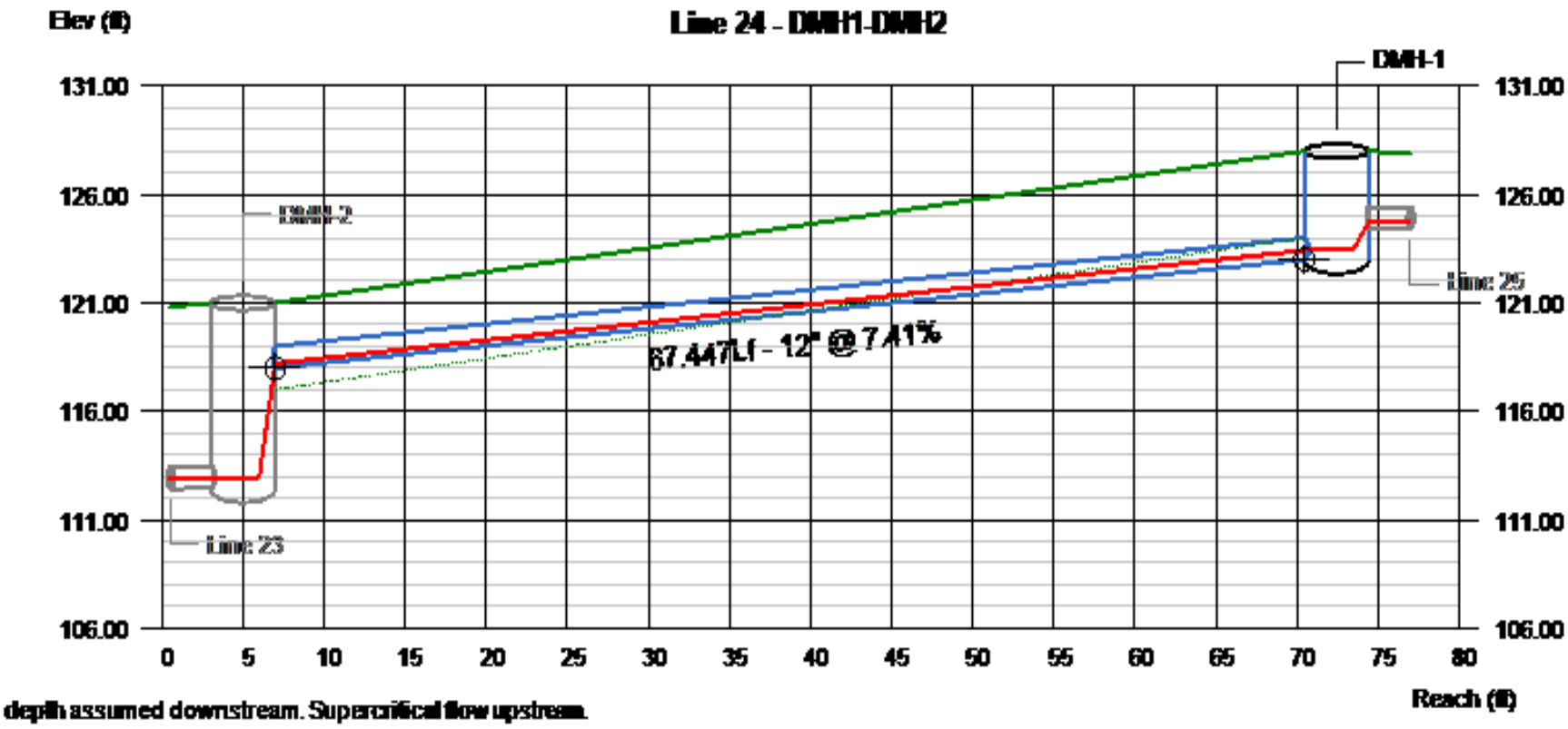

Elev (ft)
Line 20 - DMH5-DMH6
107.00
102.00
97.00
92.00
87.00
82.00
DMH-6
DMH-5
Line 21
Line 19
128.72LF - 12" @ 7.61%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Reach (ft)
Supercritical flow upstream.

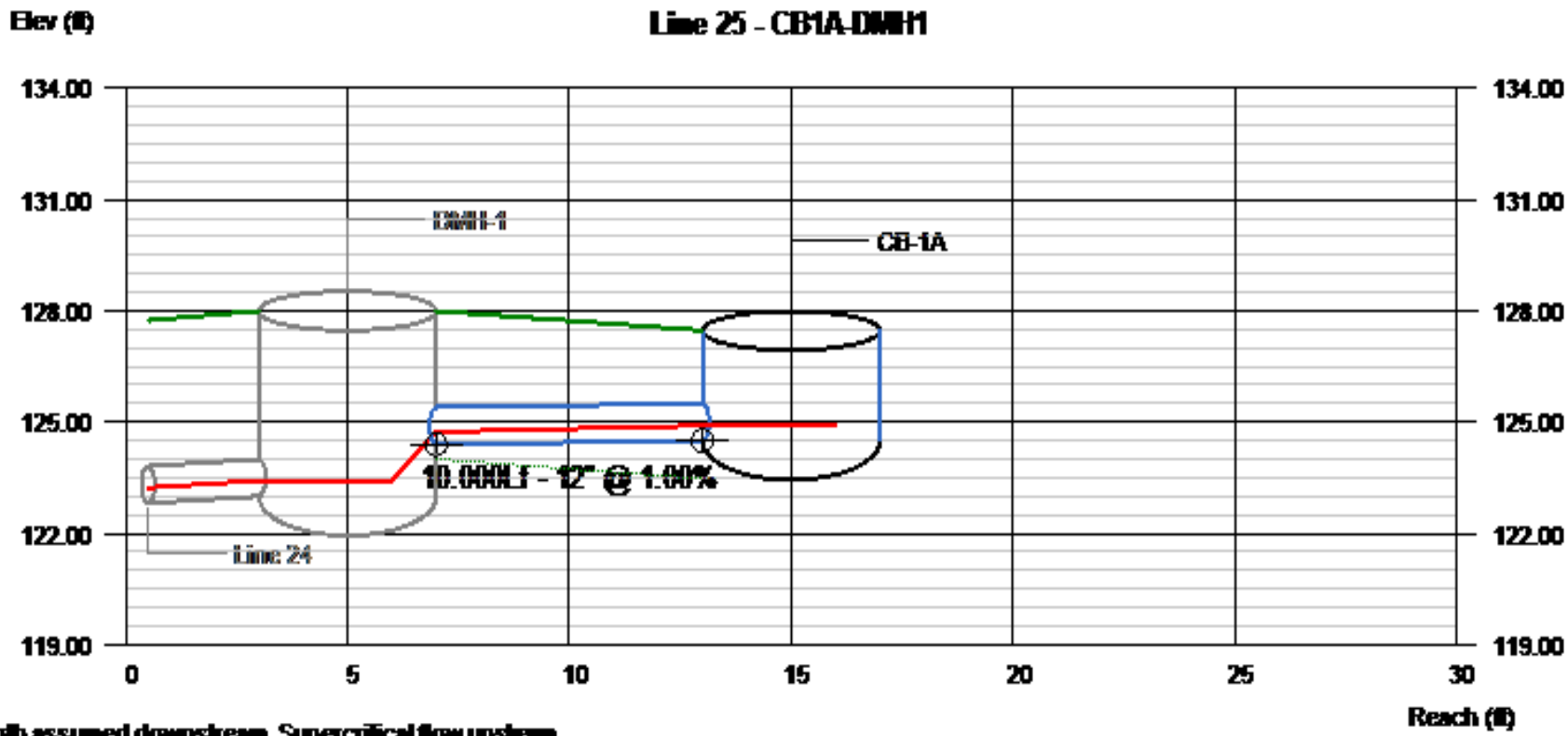

Elev (ft)
Line 21 - DMH4-DMH5
121.00
115.00
109.00
103.00
97.00
91.00
DMH-4
DMH-5
Line: 22
Line: 20
150.225ft - 12" @ 8.59%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Reach (ft)
Supercritical flow upstream.



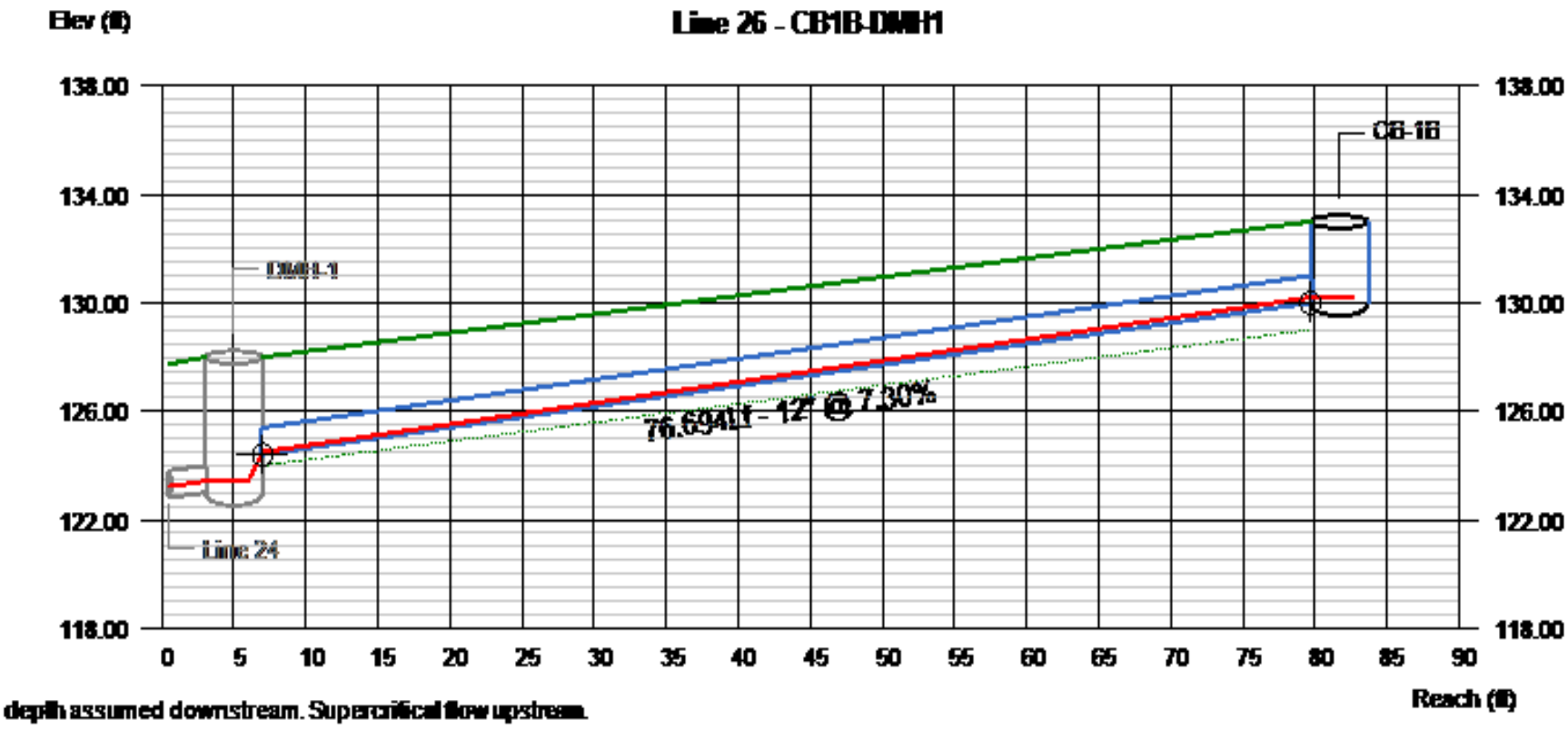
depth assumed downstream. Supercritical flow upstream.

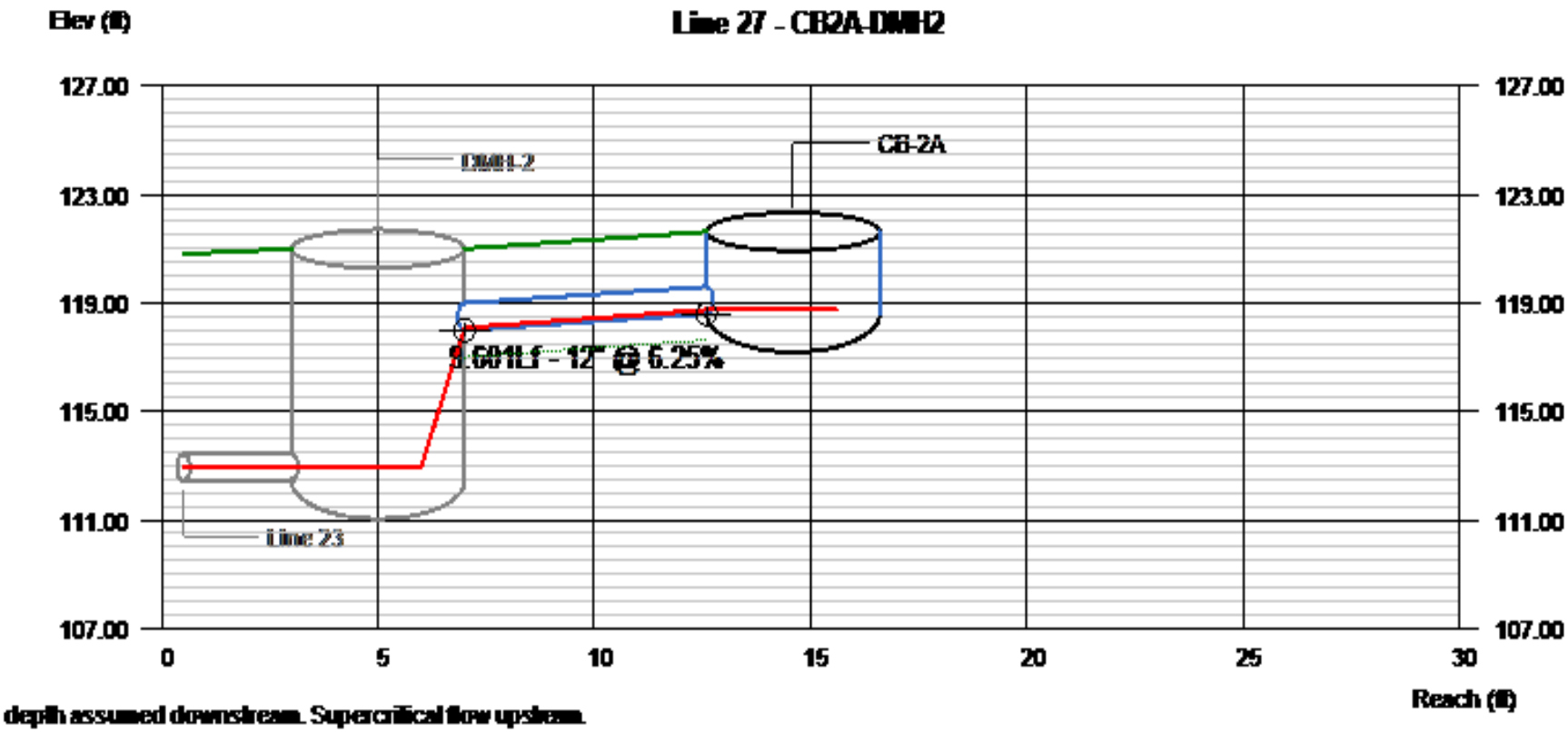

Elev (ft)
Line 23 - DMH2-DMH3
127.00
123.00
119.00
115.00
111.00
107.00
DMH-3
DMH-2
Line 24
Line 22
30.671Lf 12" @ 0.65%
0
5
10
15
20
25
30
35
40
45
Reach (ft)
depth assumed downstream. Supercritical flow upstream.


Elev (ft)
Line 24 - DMH1-DMH2
DMH-1
DMH-2
Line 25
Line 23
67.447Lf - 12" @ 7.41%
131.00
126.00
121.00
116.00
111.00
106.00
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

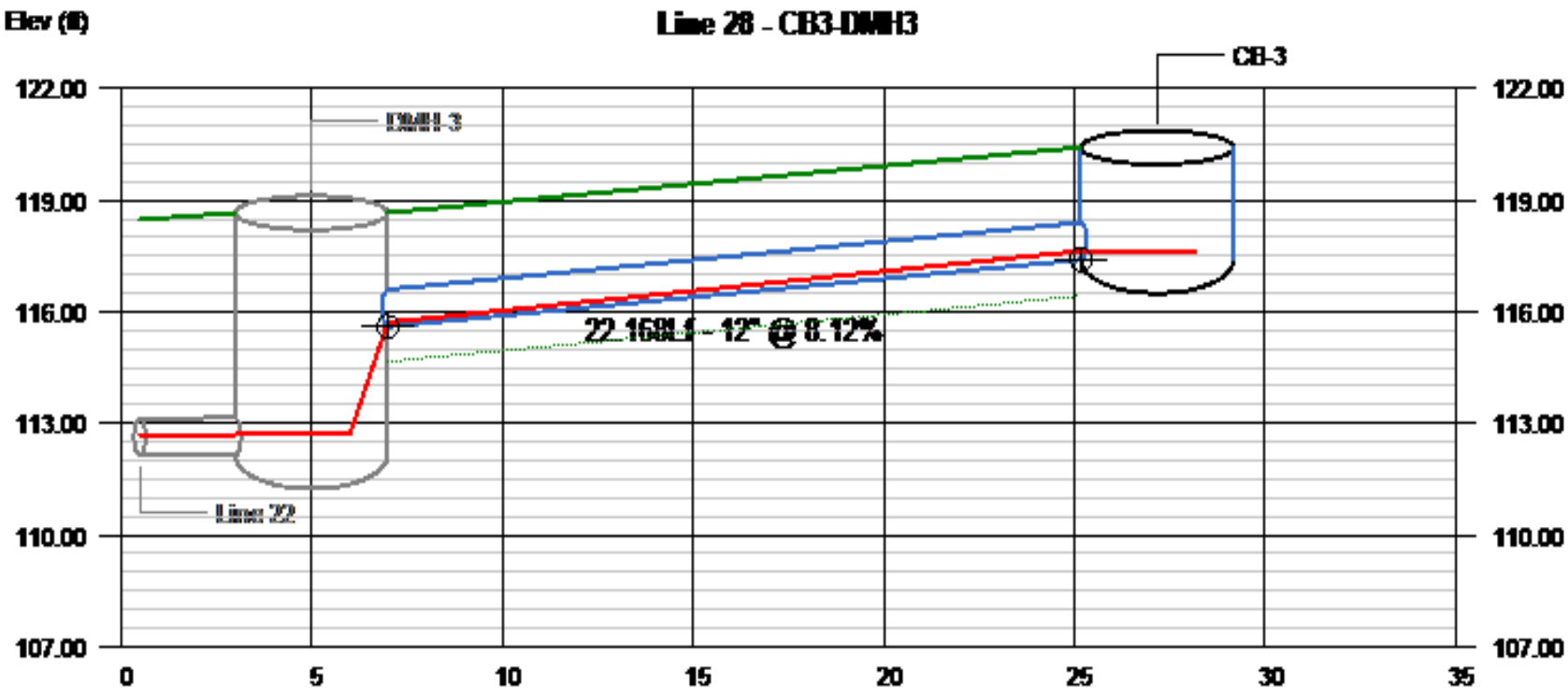


depth assumed downstream. Supercritical flow upstream.

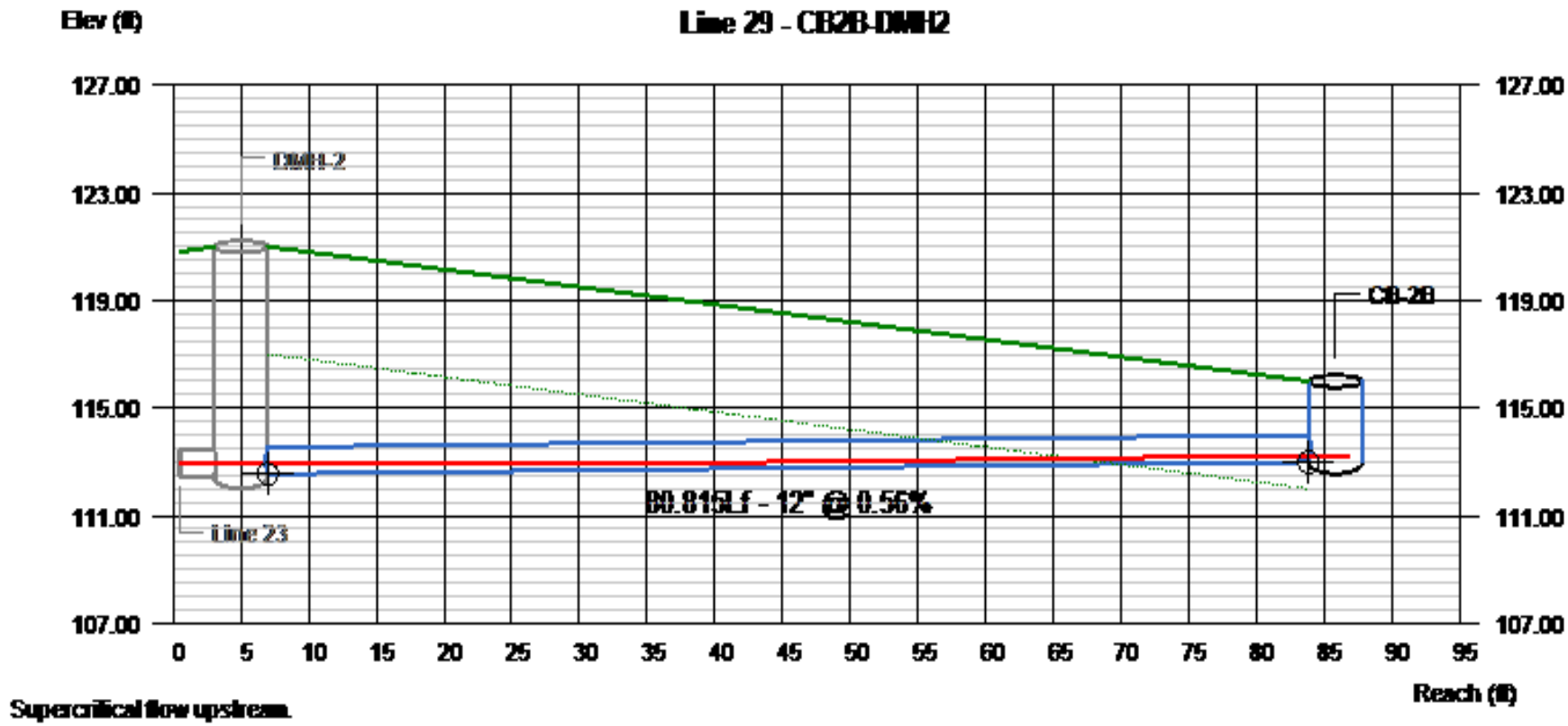

Elev (ft)
Line 26 - CB1B-DMH1
138.00
134.00
130.00
126.00
122.00
118.00
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Reach (ft)
CB-1B
DMH-1
Line 24
76.694LF - 12" @ 7.30%
depth assumed downstream. Supercritical flow upstream.

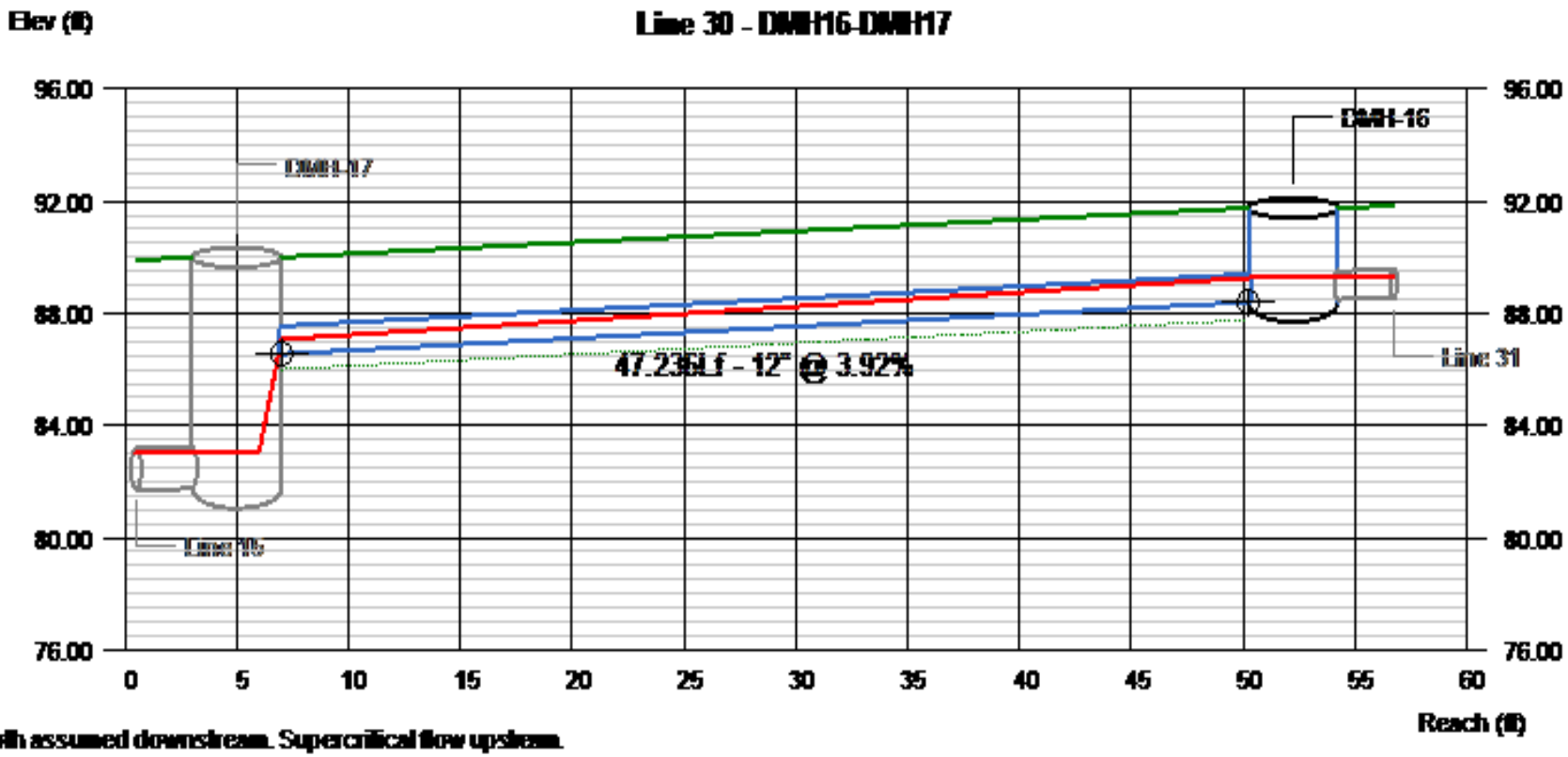


depth assumed downstream. Supercritical flow upstream.

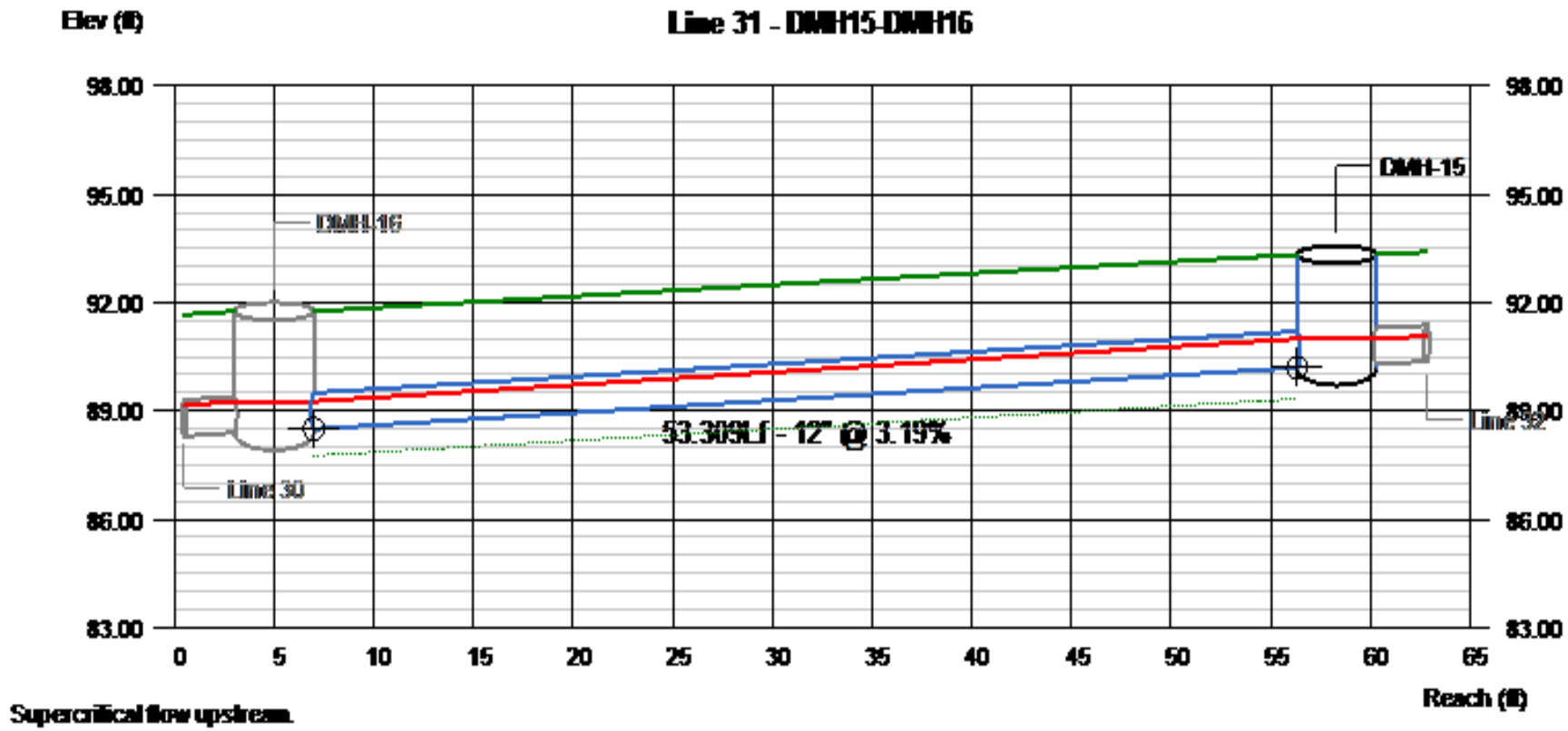


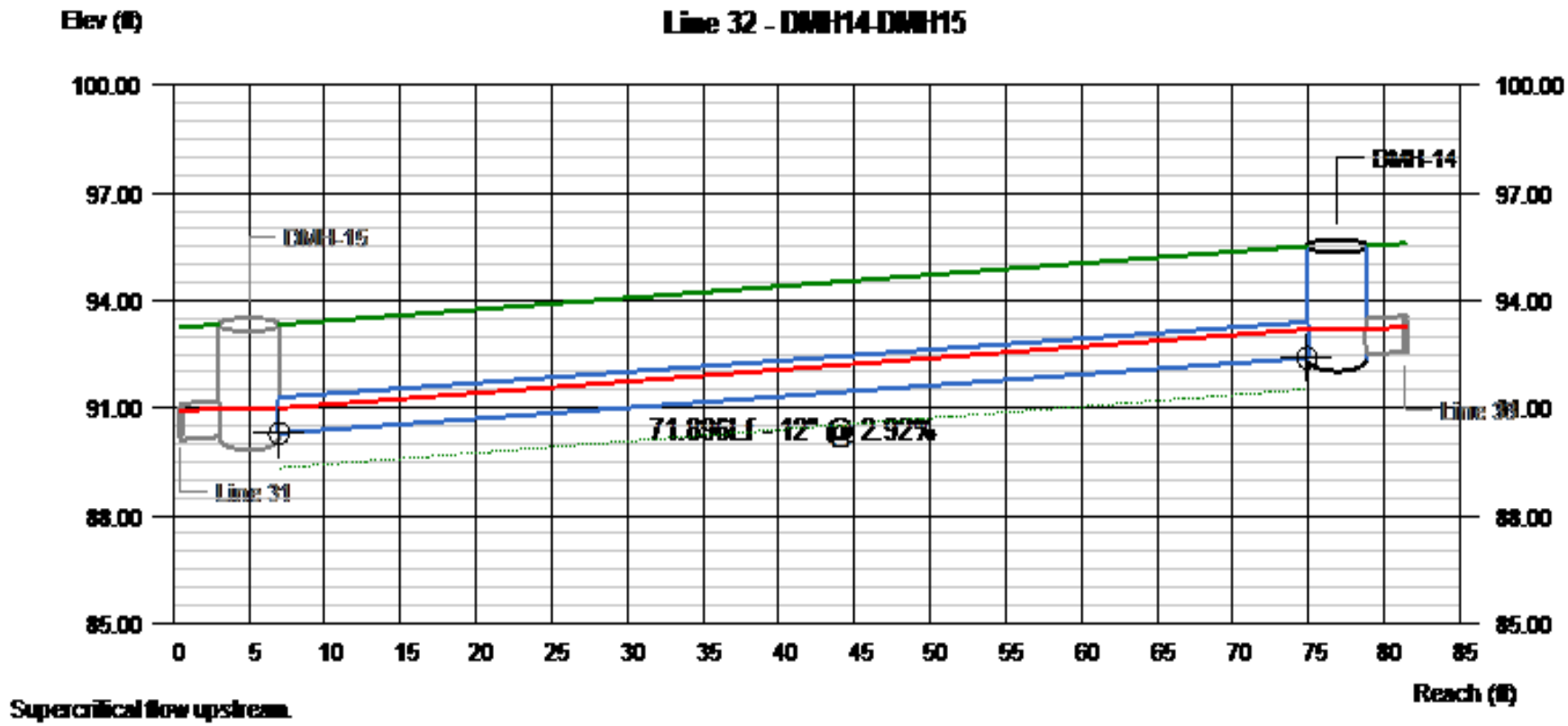
depth assumed downstream. Supercritical flow upstream.

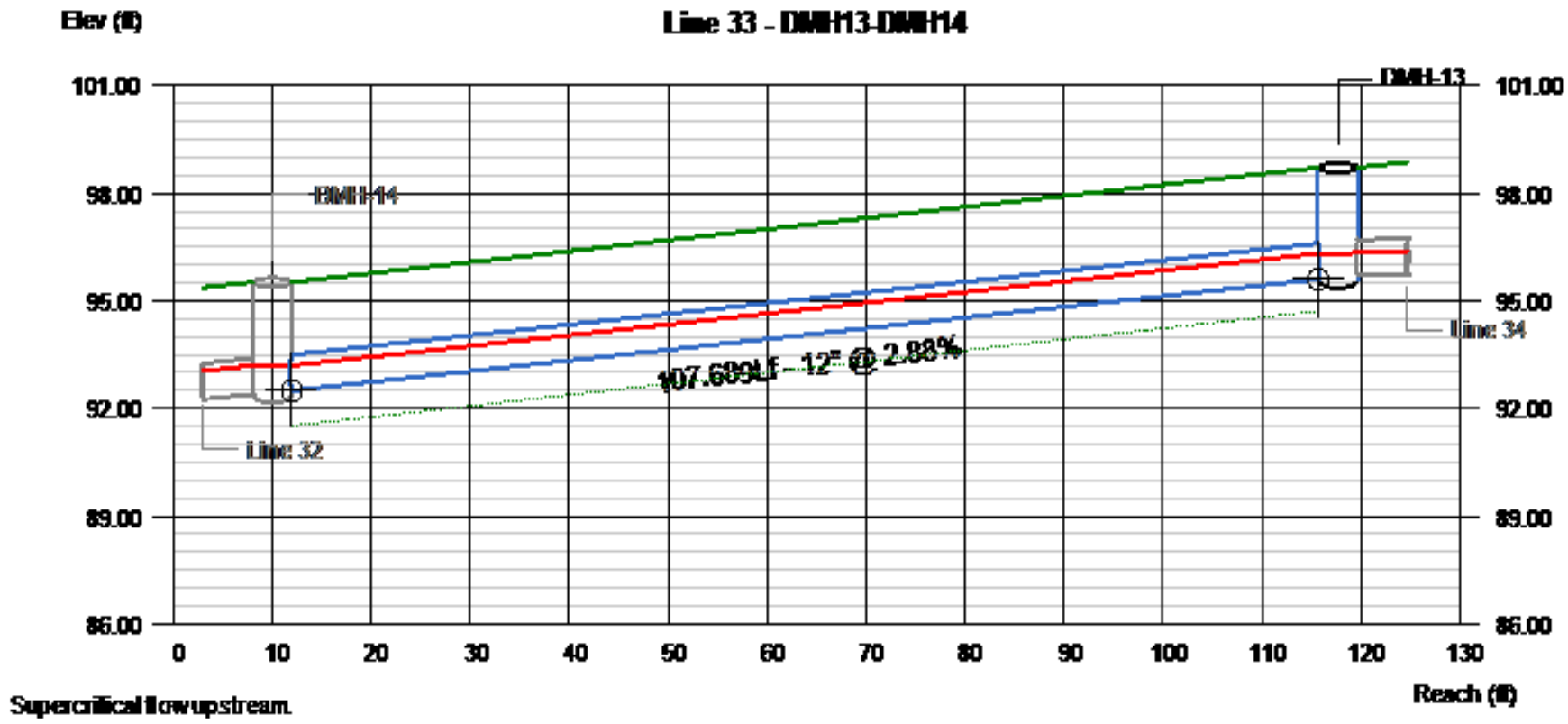

Elev (ft)
Line 29 - CB2B-DMH2
127.00
123.00
119.00
115.00
111.00
107.00
DMH-2
CB-2B
Line 23
80.81 LF - 12" @ 0.56%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Reach (ft)
Supercritical flow upstream.

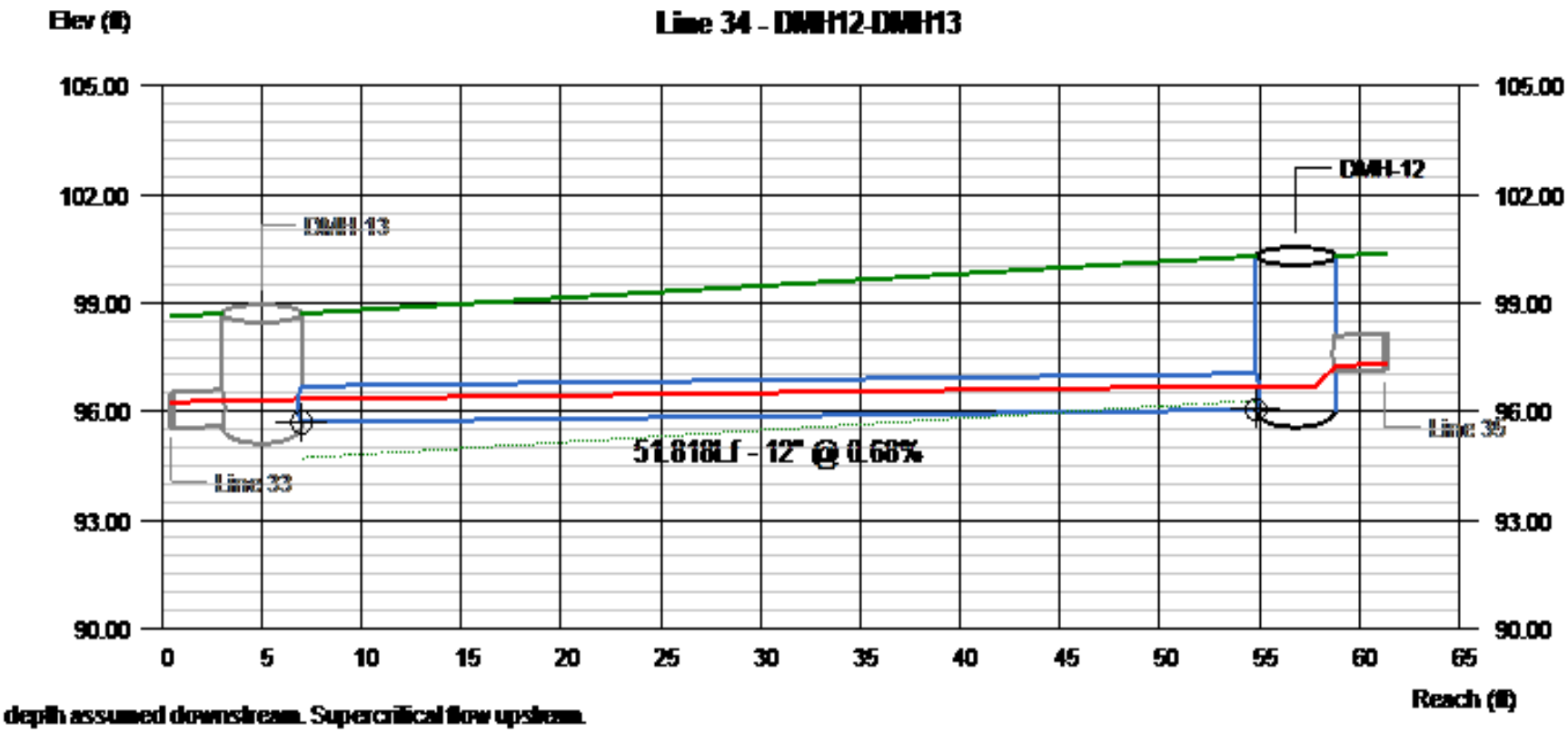


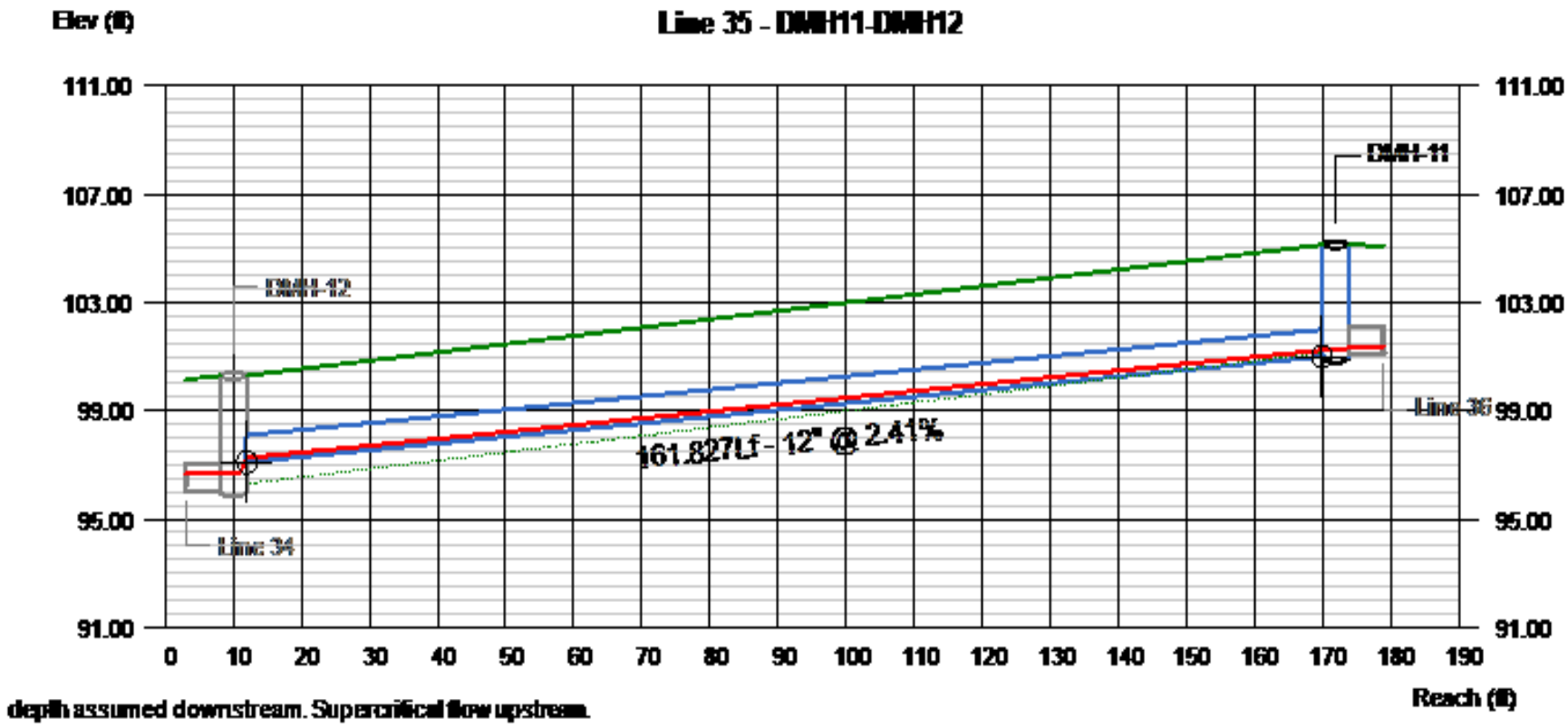
depth assumed downstream. Supercritical flow upstream.

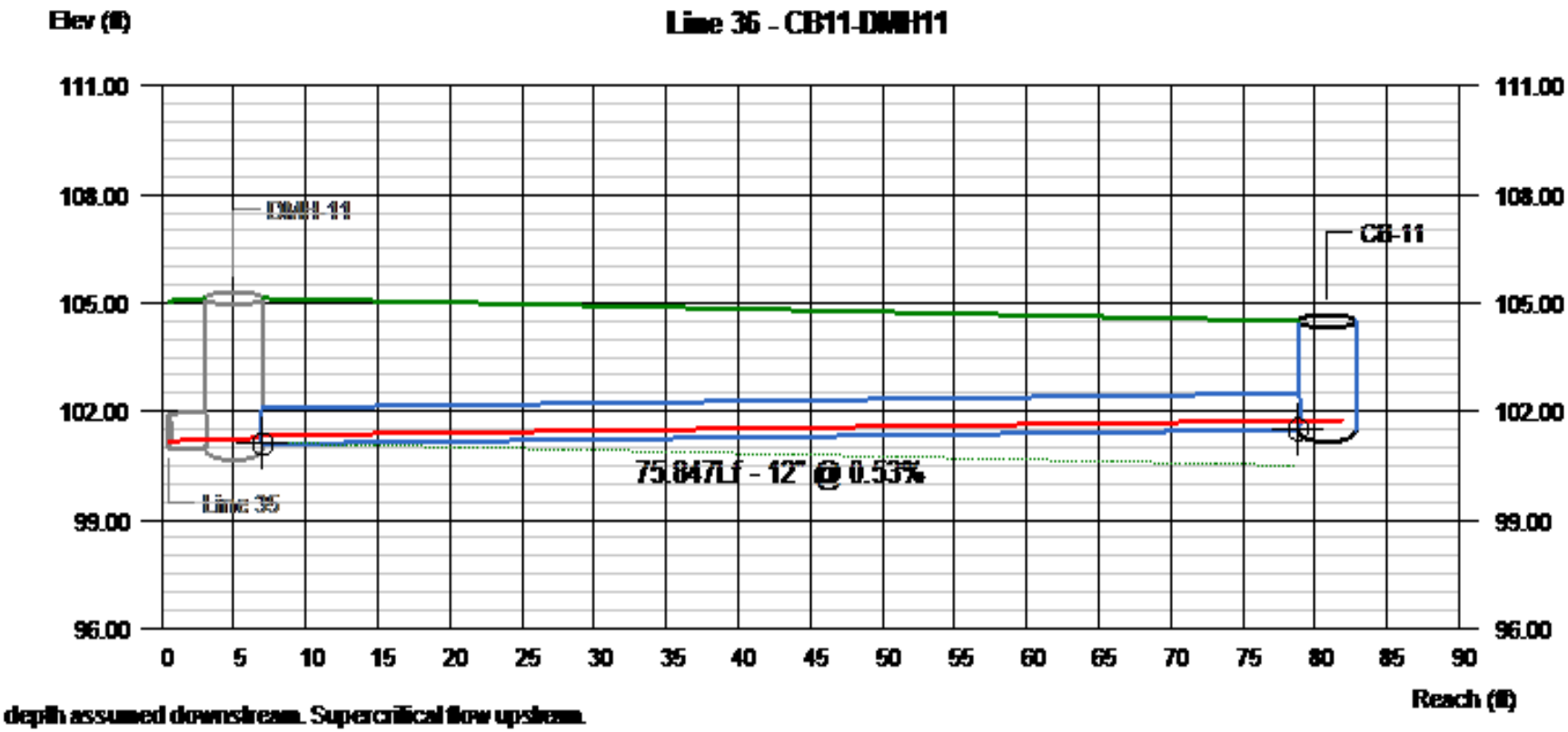

Elev (ft)
Line 31 - DMH15-DMH16
98.00
95.00
92.00
89.00
86.00
83.00
DMH-15
DMH-16
Line 30
Line 32
53.30ft - 12" @ 3.19%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Reach (ft)
Supercritical flow upstream.

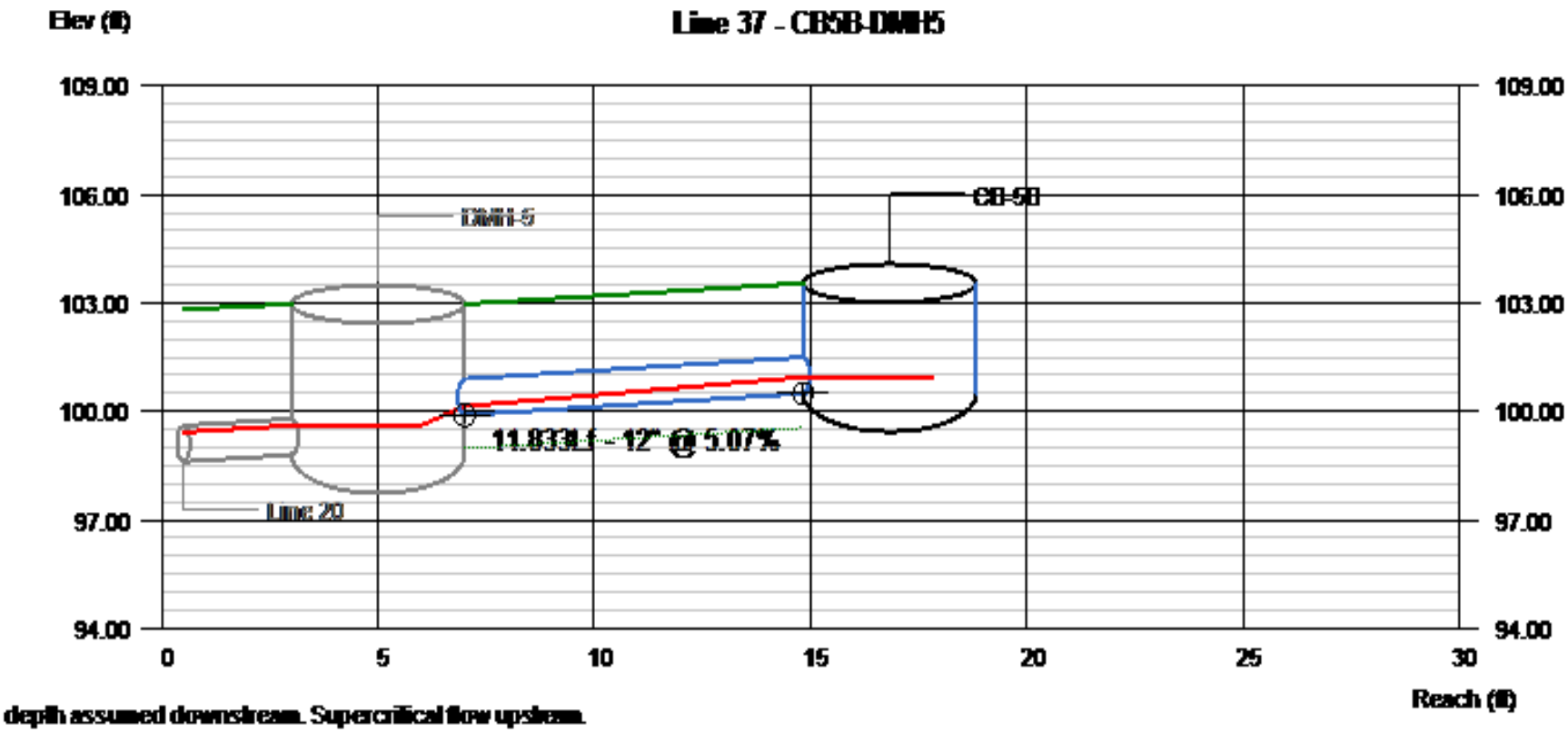

Elev (ft)
Line 32 - DMH14-DMH15
100.00
97.00
94.00
91.00
88.00
85.00
DMH-14
DMH-15
Line: 31
Line: 31
71.69LF - 12" @ 2.92%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Reach (ft)
Supercritical flow upstream.

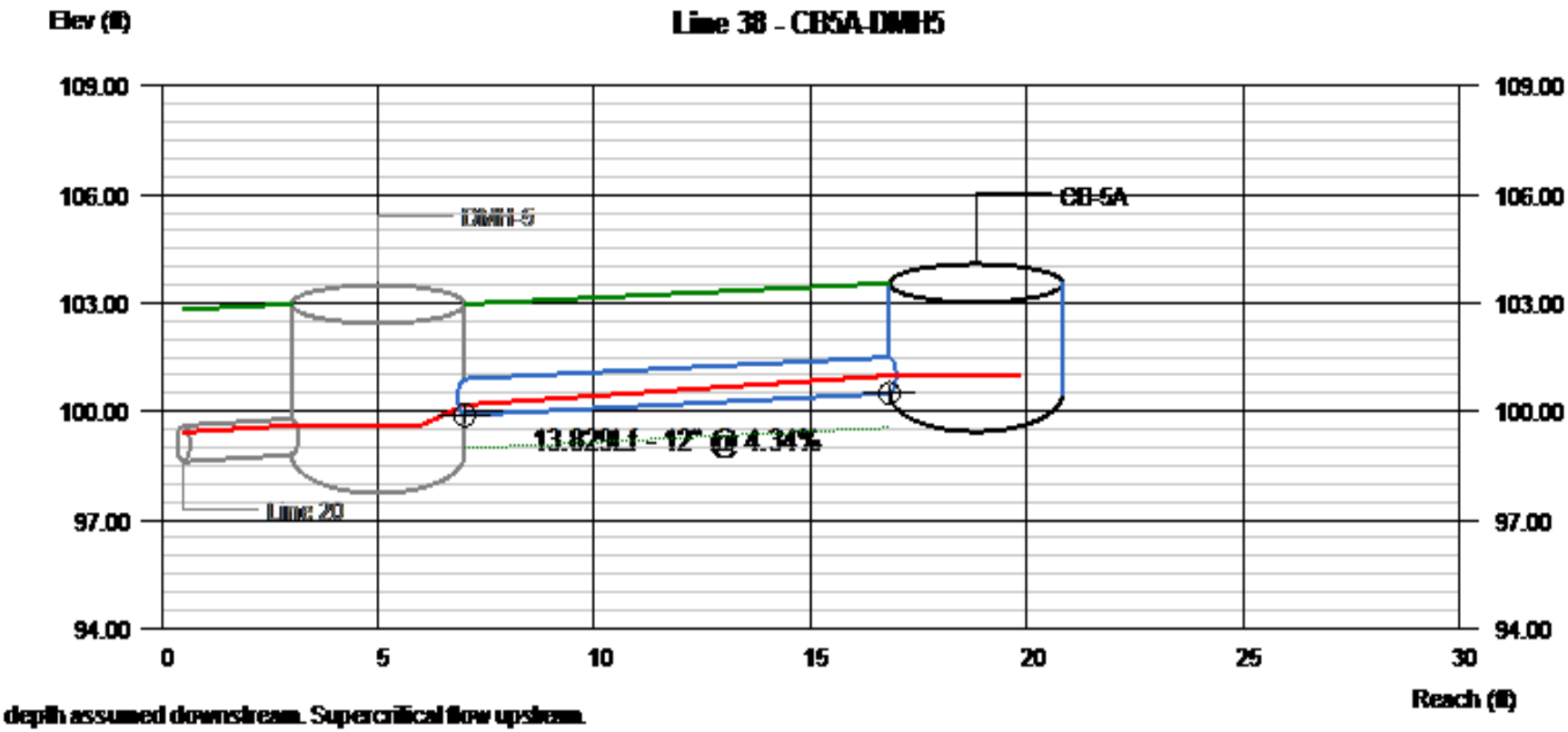

Elev (ft)
Line 33 - DMH13-DMH14
101.00
98.00
95.00
92.00
89.00
86.00
DMH-13
DMH-14
Line: 34
Line: 32
107.689 LF - 12" @ 2.88%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Reach (ft)
Supercritical flow upstream.

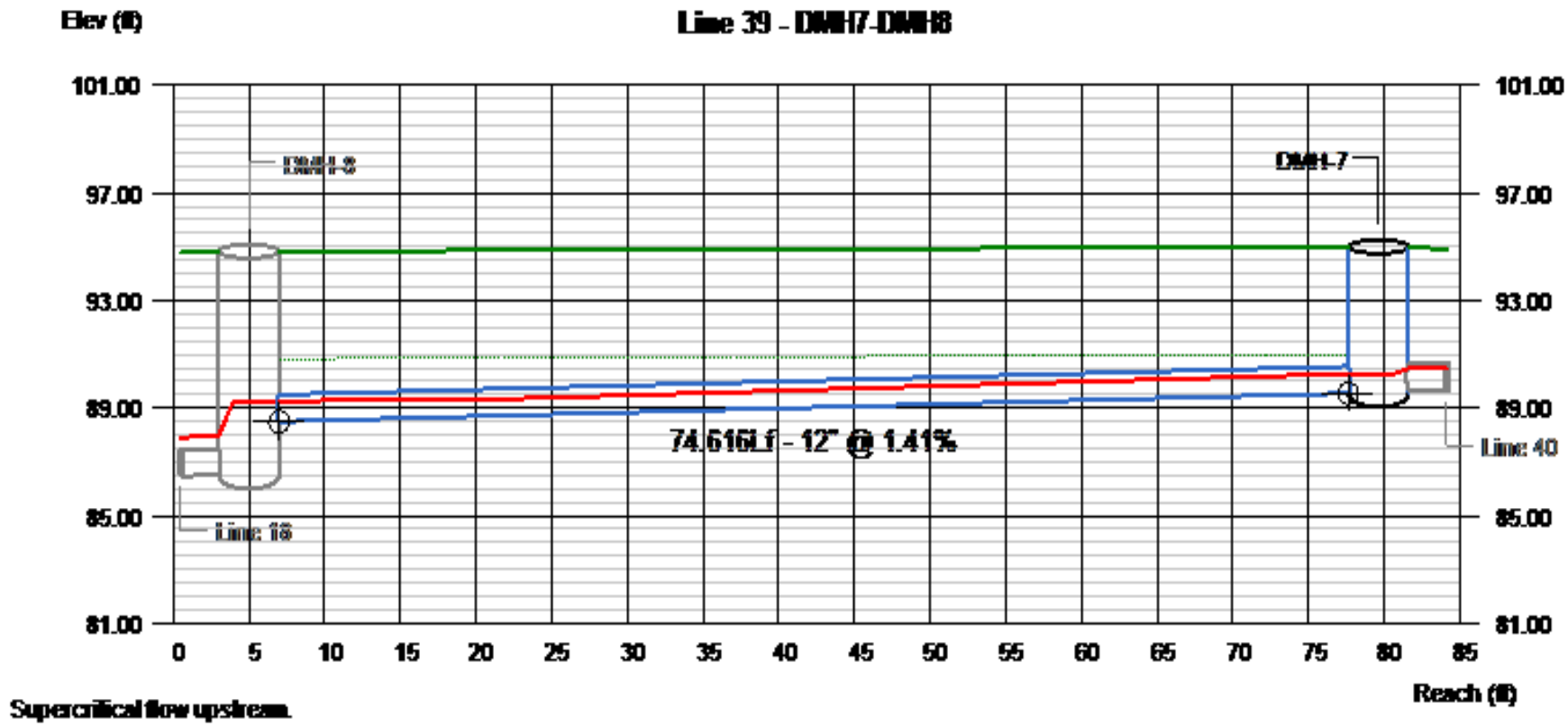

Elev (ft)
Line 34 - DMH12-DMH13
105.00
102.00
99.00
96.00
93.00
90.00
DMH-12
DMH-13
Line 33
Line 35
51.818LF - 12" @ 0.68%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

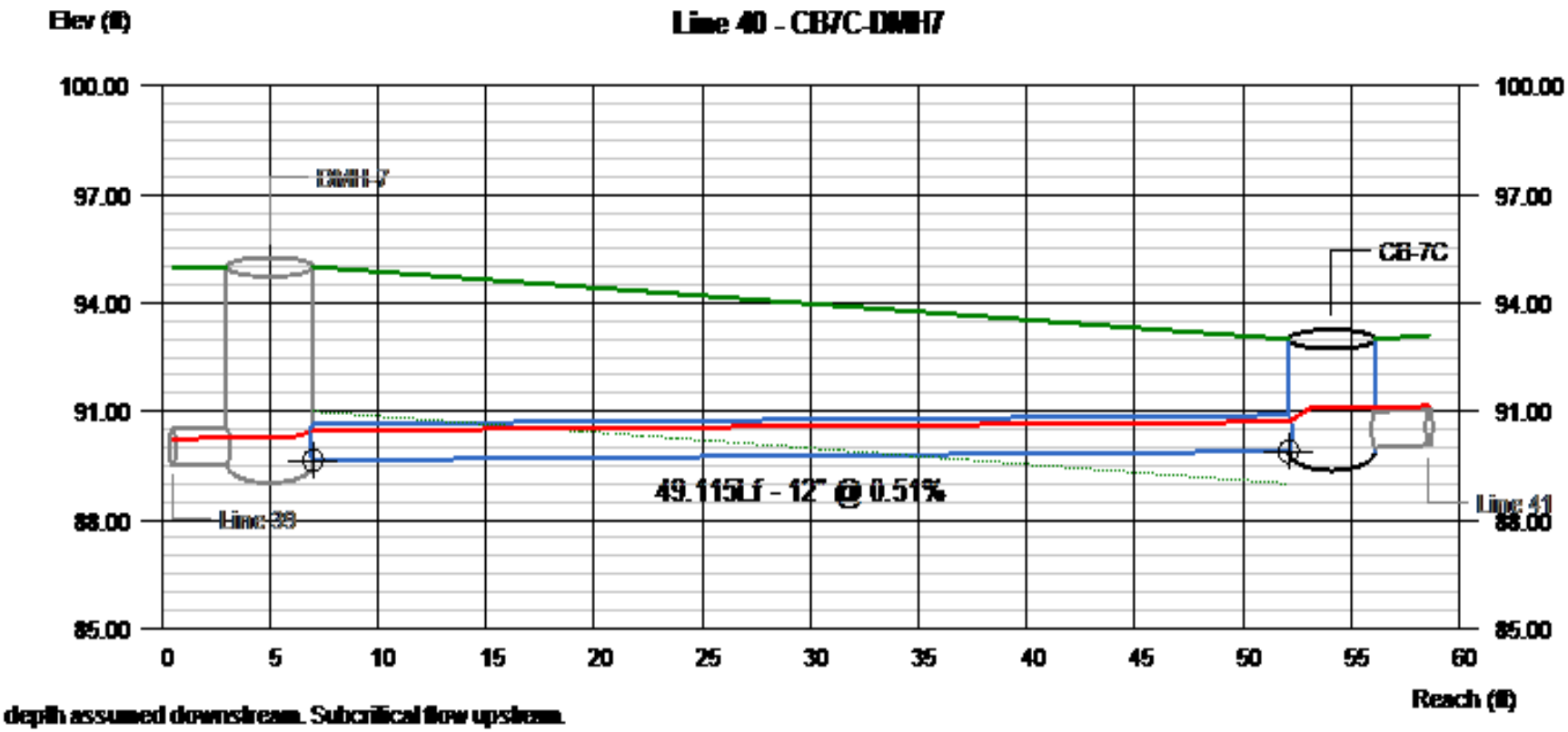

Elev (ft)
Line 35 - DMH11-DMH12
111.00
107.00
103.00
99.00
95.00
91.00
DMH-11
DMH-12
Line 35
Line 34
161.827Lf - 12" @ 2.41%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

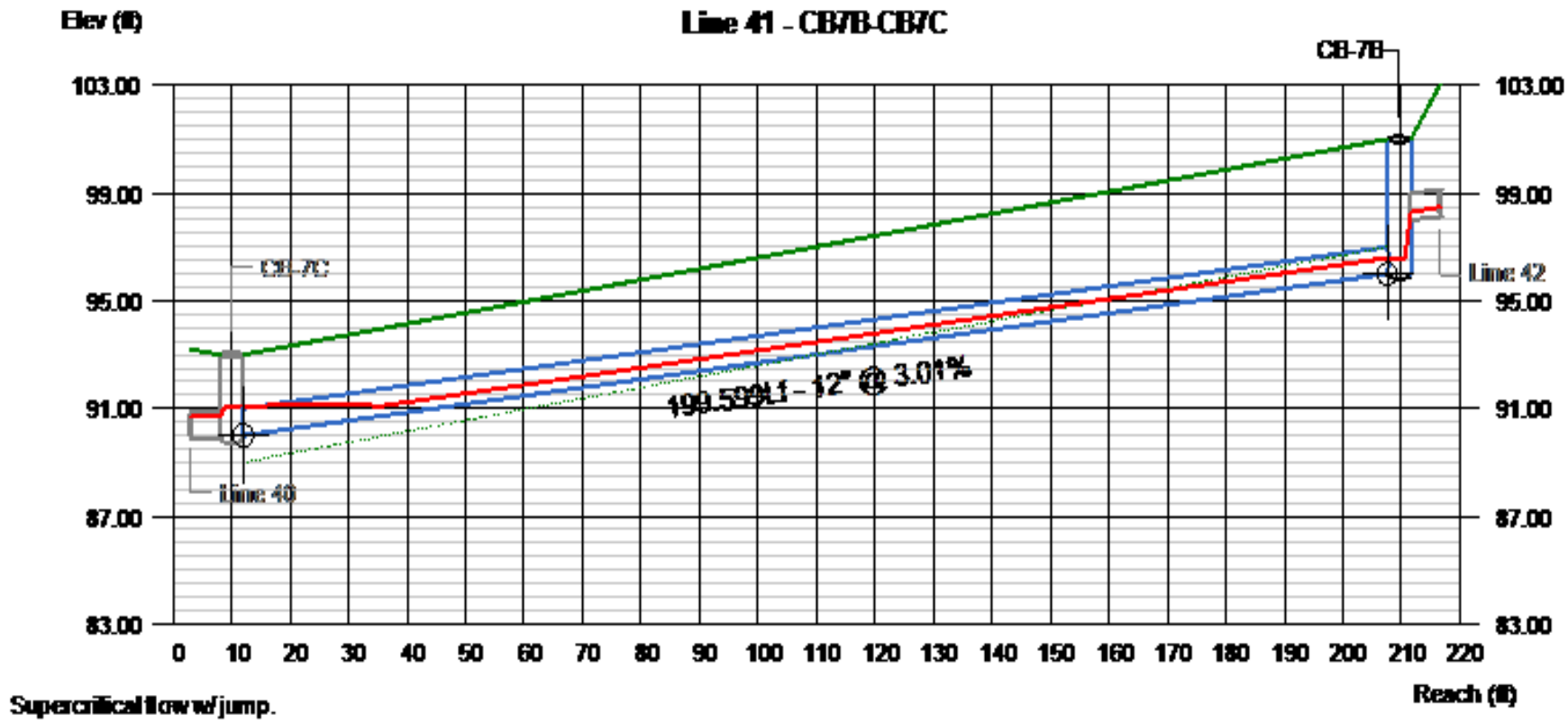

Elev (ft)
Line 36 - CB11-DMH11
111.00
108.00
105.00
102.00
99.00
96.00
DMH-11
CB-11
Line 35
75.847LF - 12" @ 0.53%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

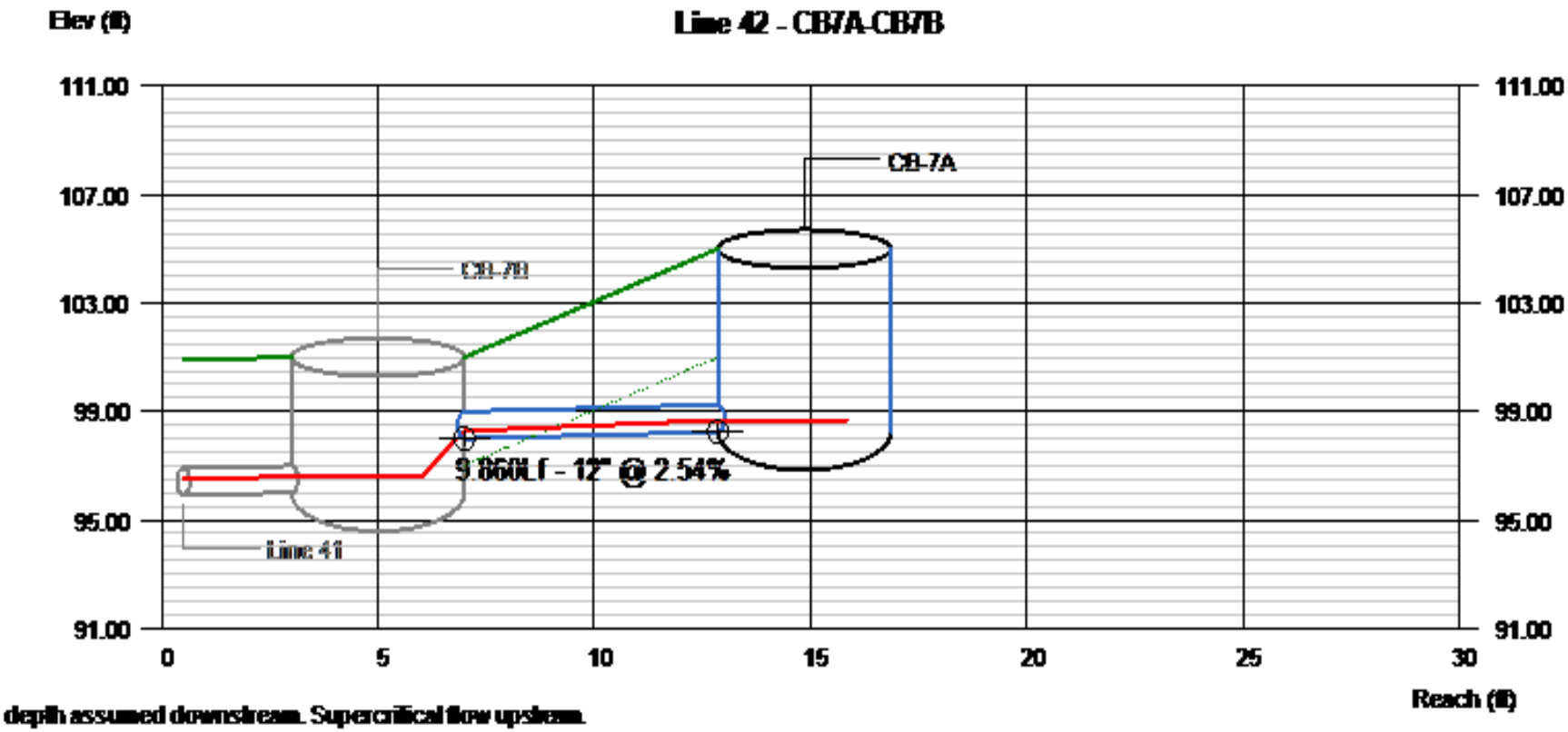

Elev (ft)
Line 37 - CB5B-DMH5
109.00
106.00
103.00
100.00
97.00
94.00
DMH-5
CB-5B
11.833 ft - 12" @ 5.07%
Line 20
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

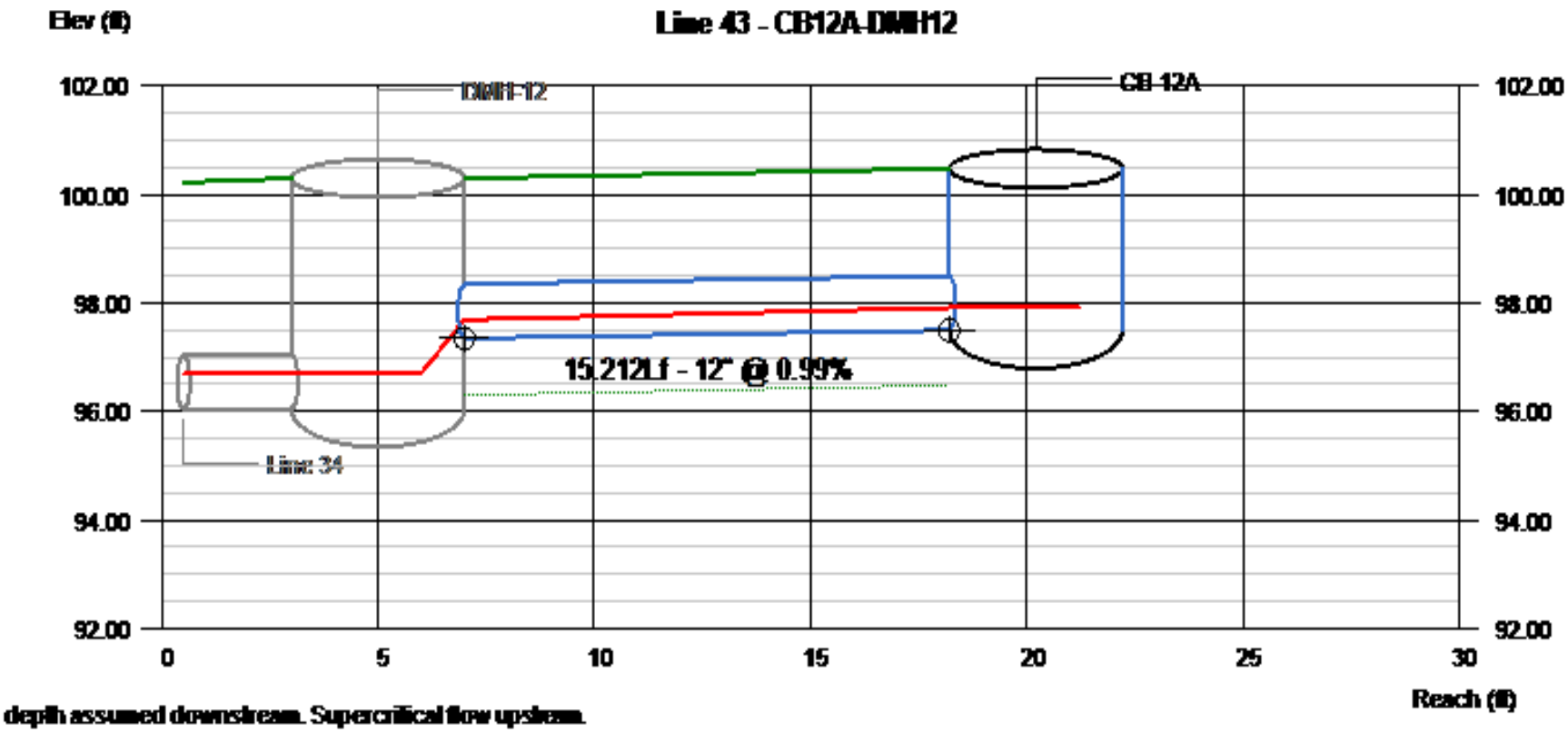

Elev (ft)
Line 38 - CB5A-DMH5
109.00
106.00
103.00
100.00
97.00
94.00
DMH-5
CB-5A
13.829 ft - 12" @ 4.34%
Line 20
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

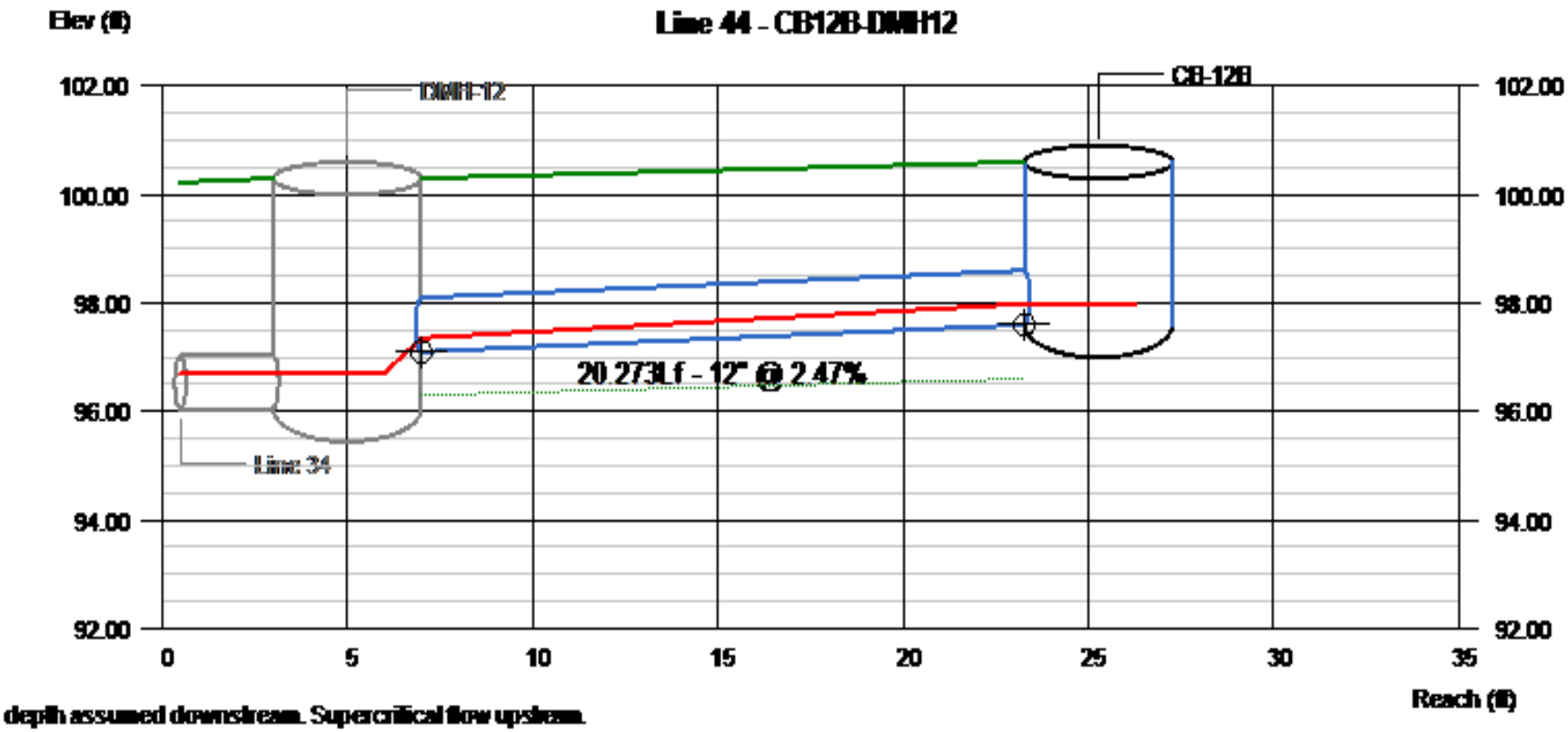

Elev (ft)
Line 39 - DMH7-DMH8
101.00
97.00
93.00
89.00
85.00
81.00
DMH-7
74.616Lf - 12" @ 1.41%
Line: 40
Line: 18
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Reach (ft)
Supercritical flow upstream.

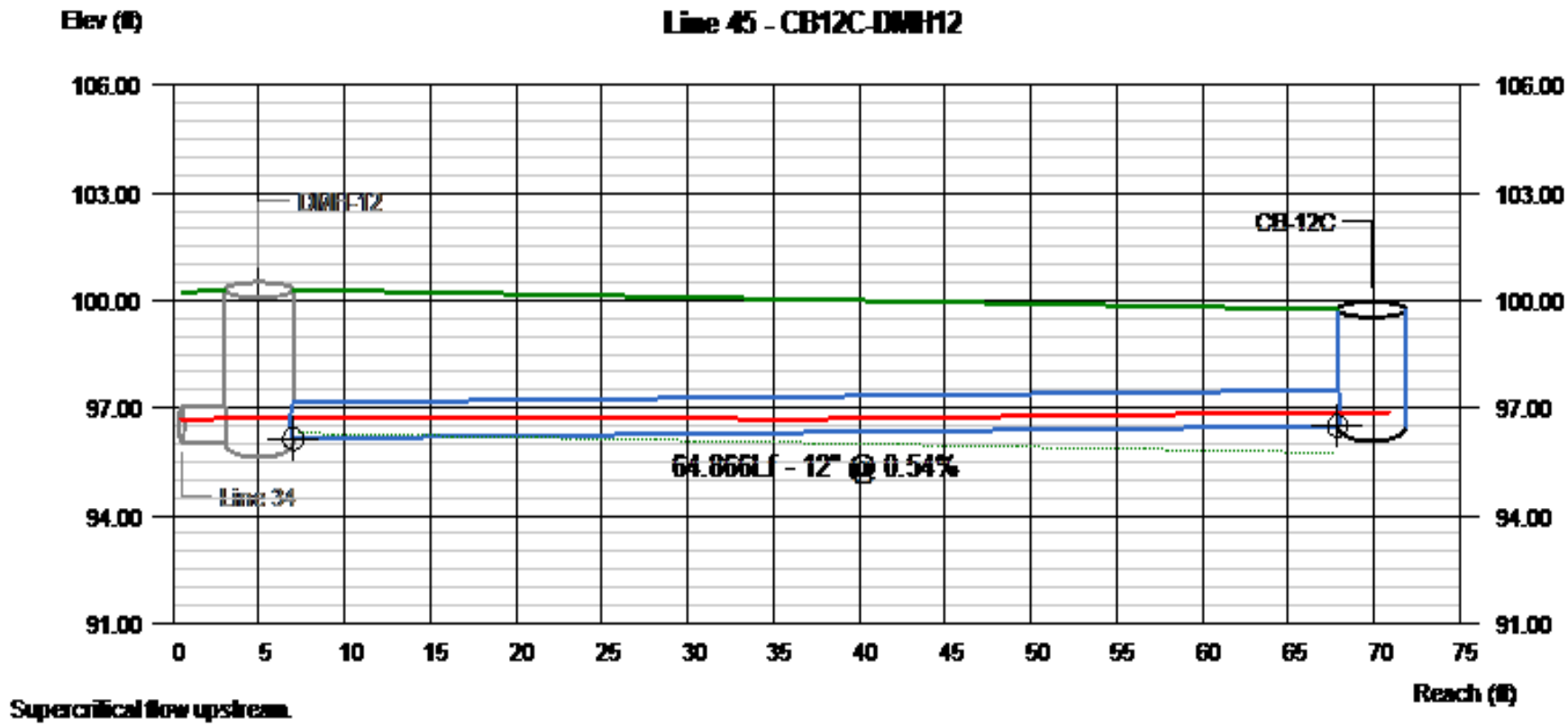

Elev (ft)
Line 40 - CB7C-DMH7
100.00
97.00
94.00
91.00
88.00
85.00
DMH-7
CB-7C
49.115Lf - 12" @ 0.51%
Line: 39
Line: 41
0
5
10
15
20
25
30
35
40
45
50
55
60
Reach (ft)
depth assumed downstream. Subcritical flow upstream.

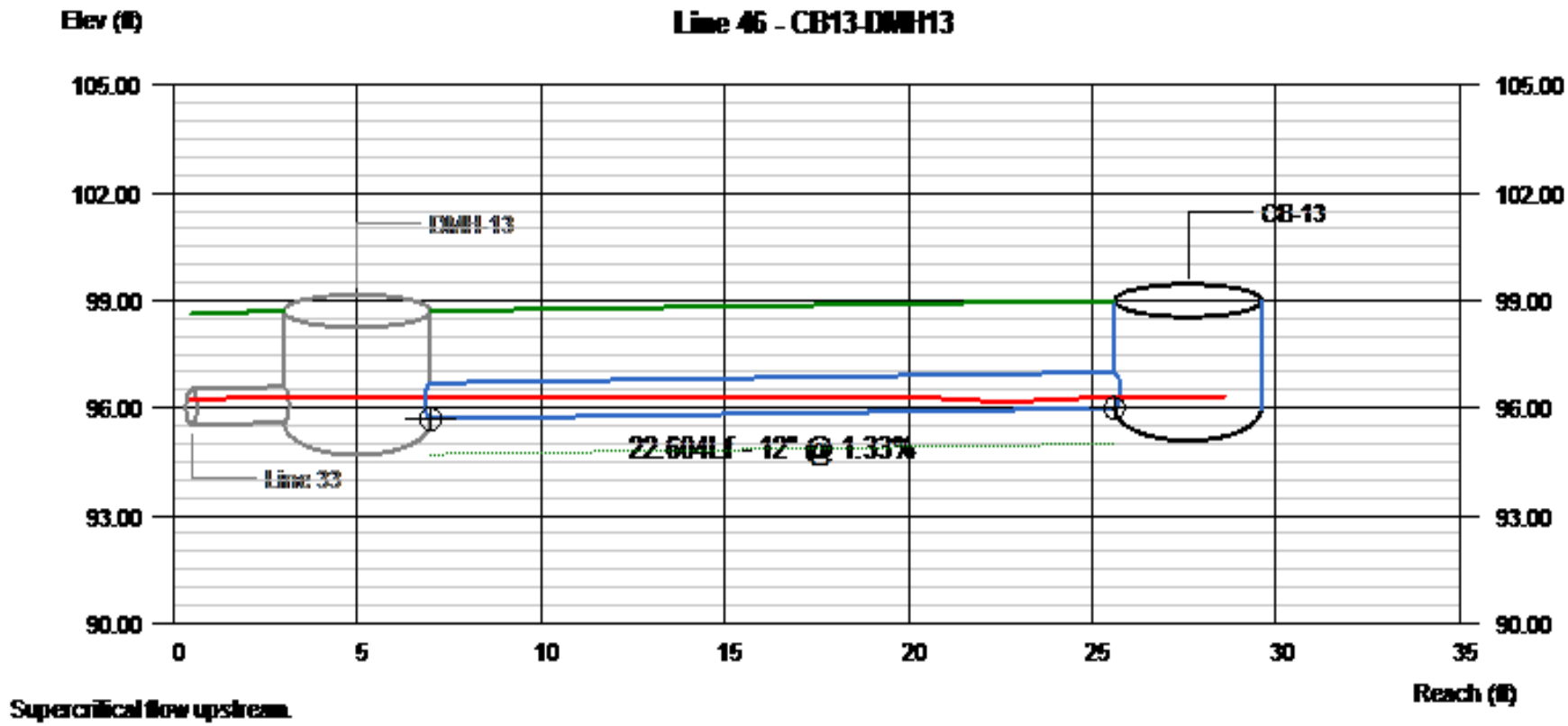

Elev (ft)
Line 41 - CB7B-CB7C
CB-7B
CB-7C
Line 42
Line 40
199.59ft - 12" @ 3.01%
103.00
99.00
95.00
91.00
87.00
83.00
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
Reach (ft)
Supercritical flow w/jump.

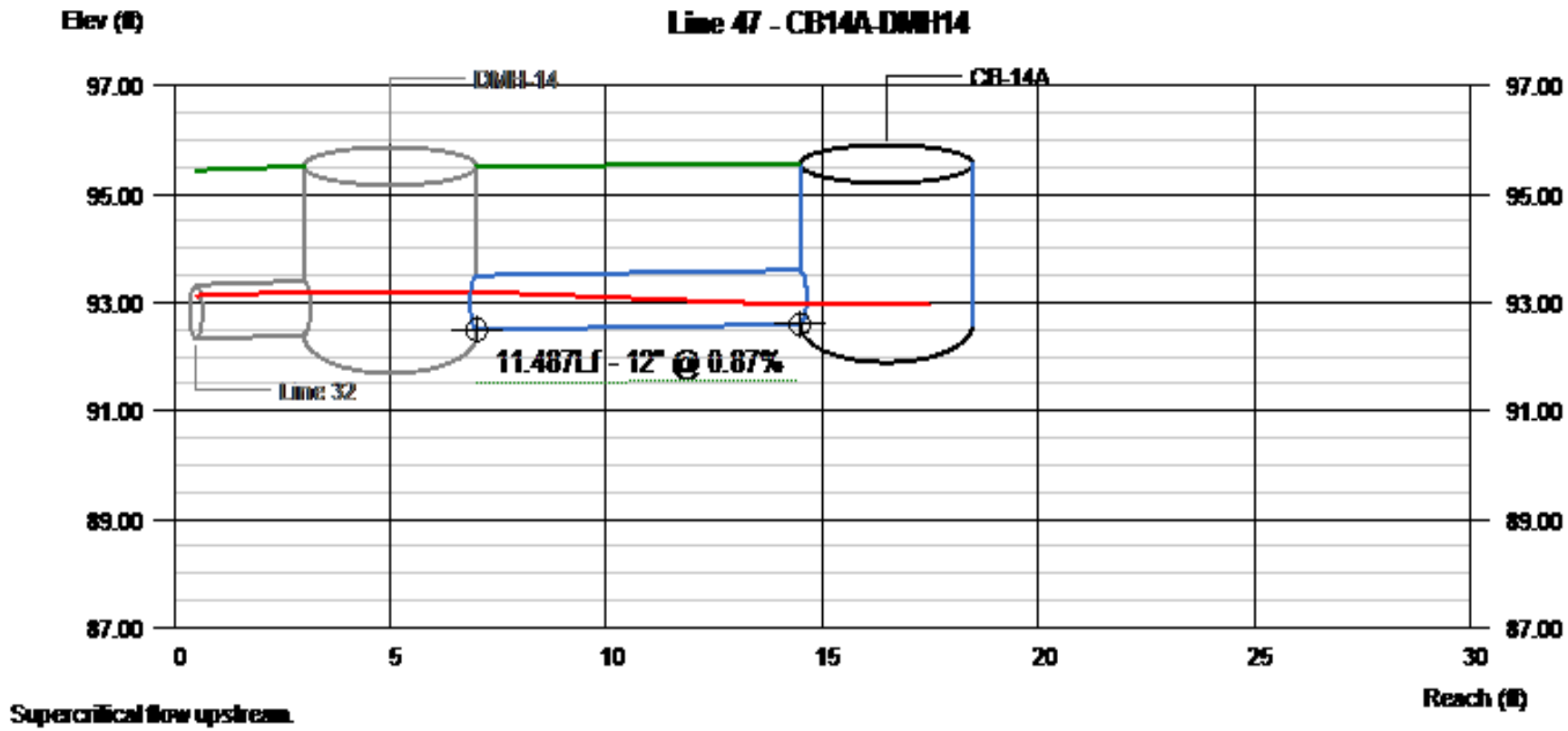

Elev (ft)
Line 42 - CB7A-CB7B
111.00
107.00
103.00
99.00
95.00
91.00
CB-7A
CB-7B
9.860LF - 12" @ 2.54%
Line 41
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

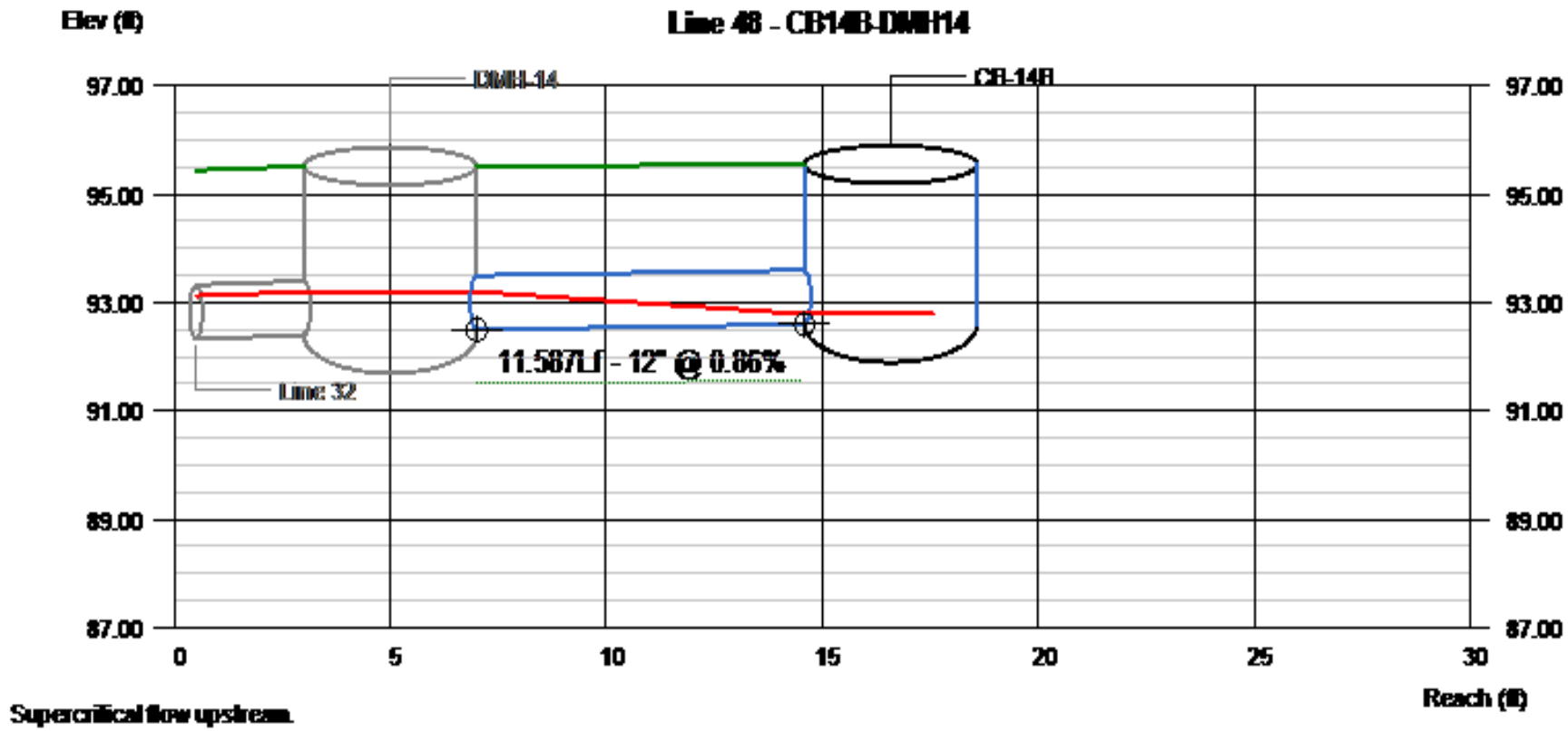

Elev (ft)
Line 43 - CB12A-DMH12
DMH-12
CB-12A
102.00
100.00
98.00
96.00
94.00
92.00
15.212Lf - 12" @ 0.99%
Line: 34
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

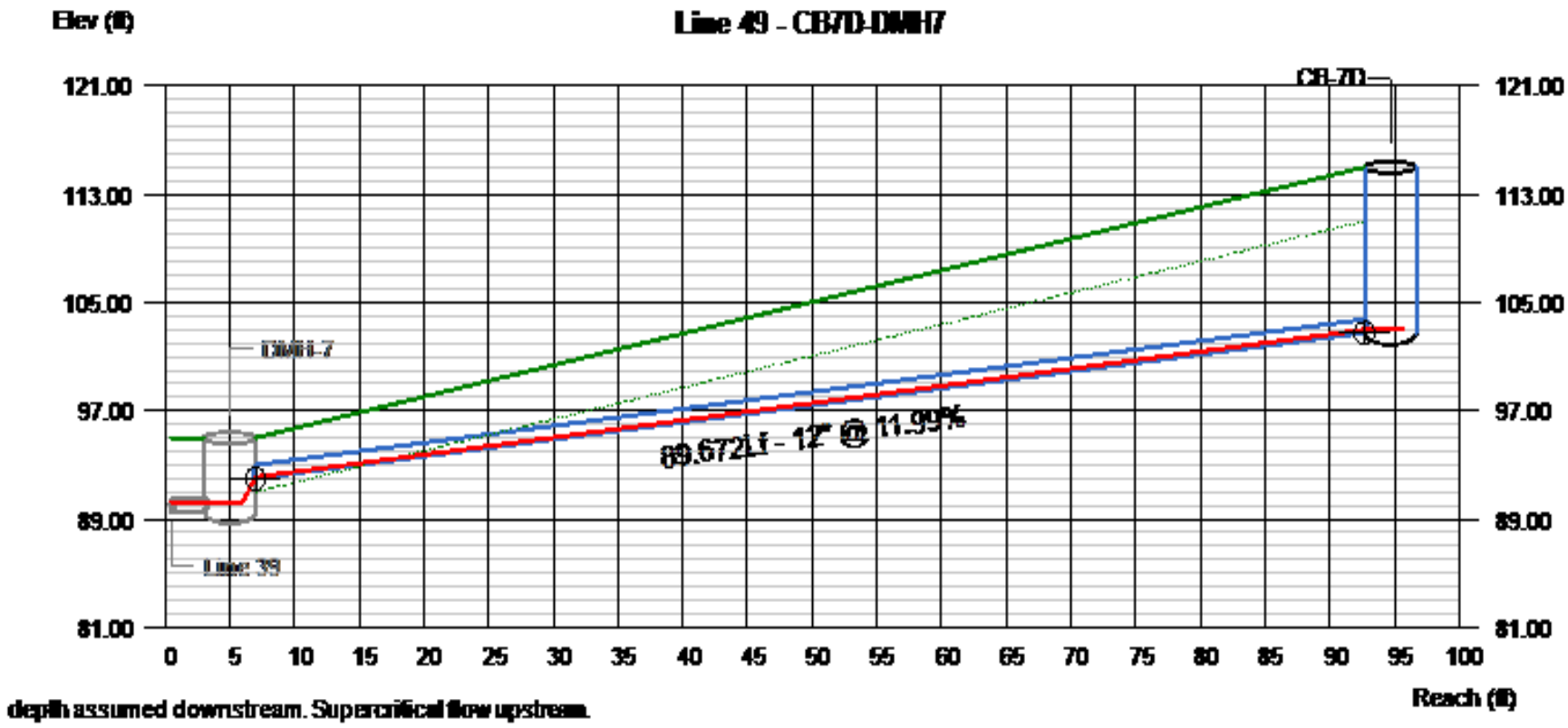

Elev (ft)
Line 44 - CB12B-DMH12
DMH-12
CB-12B
102.00
100.00
98.00
96.00
94.00
92.00
20.273 Lf - 12" @ 2.47%
Line: 34
0
5
10
15
20
25
30
35
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

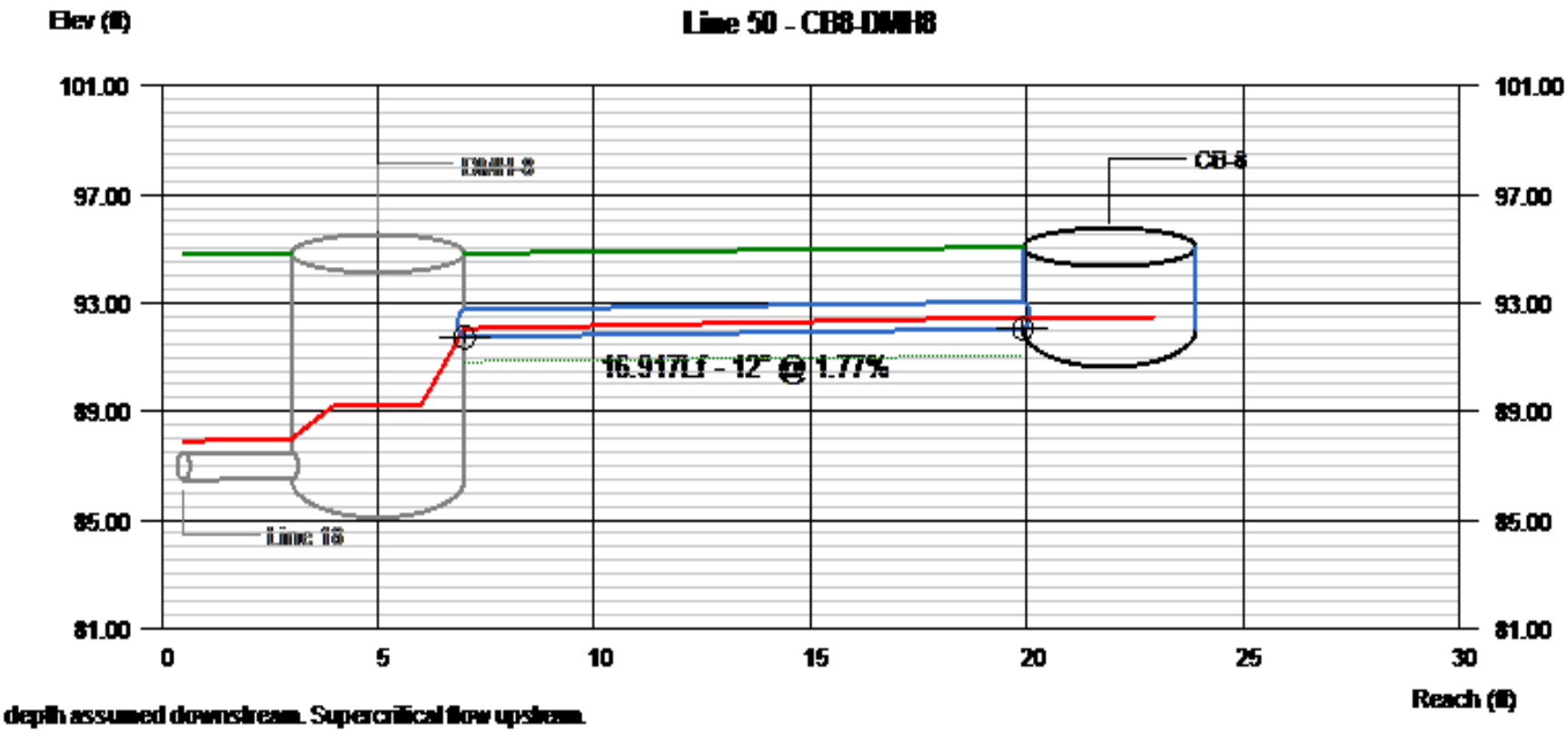

Elev (ft)
Line 45 - CB12C-DMH12
106.00
103.00
100.00
97.00
94.00
91.00
DMH-12
CB-12C
Line: 34
64.066Lf - 12" @ 0.54%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Reach (ft)
Supercritical flow upstream.

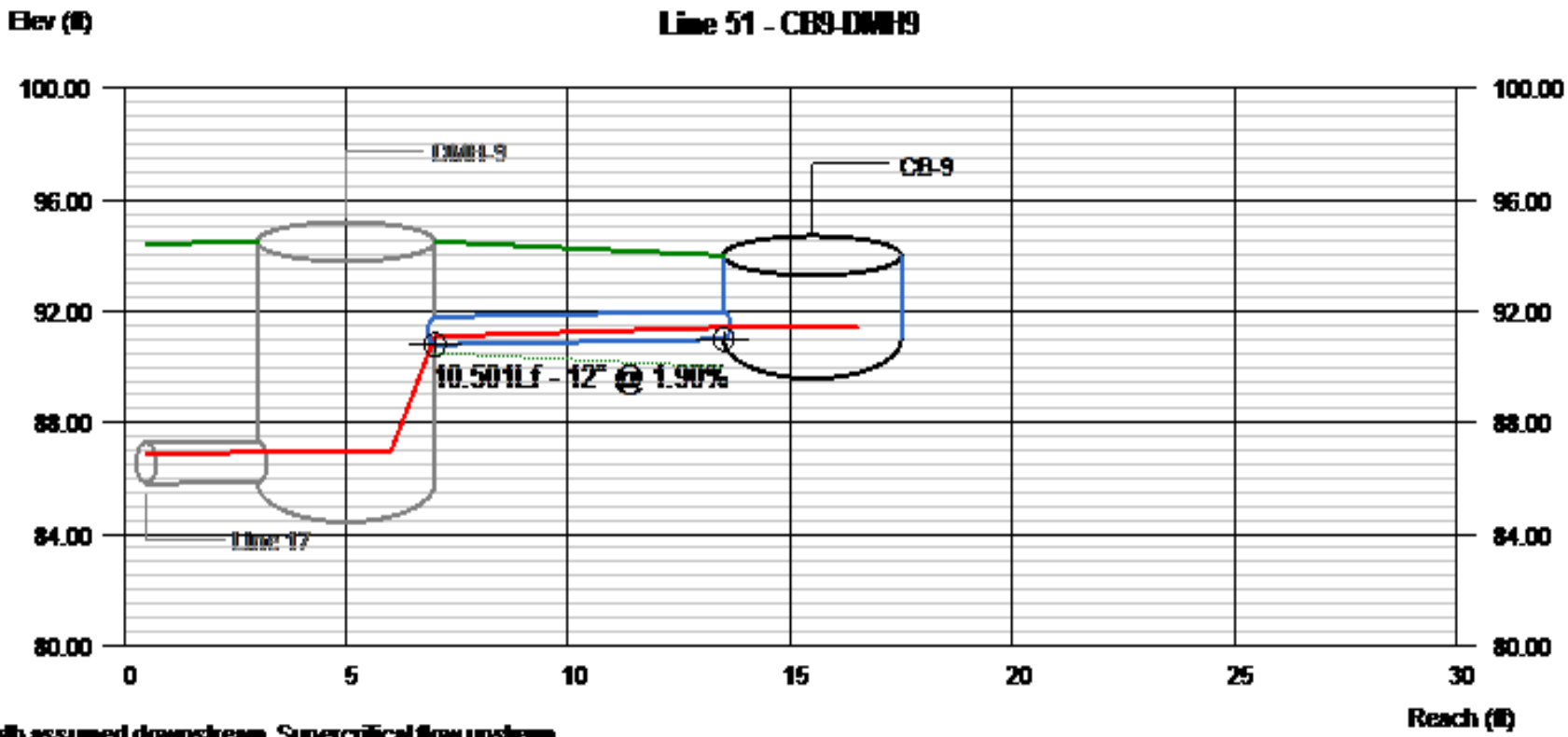

Elev (ft)
Line 46 - CB13-DMH13
105.00
102.00
99.00
96.00
93.00
90.00
DMH-13
CB-13
22.604LF - 12" @ 1.33%
Line: 33
0
5
10
15
20
25
30
35
Reach (ft)
Supercritical flow upstream.


Elev (ft)
Line 47 - CB14A-DMH14
DMH-14
CB-14A
97.00
95.00
93.00
91.00
89.00
87.00
11.467LF - 12" @ 0.87%
Line: 32
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

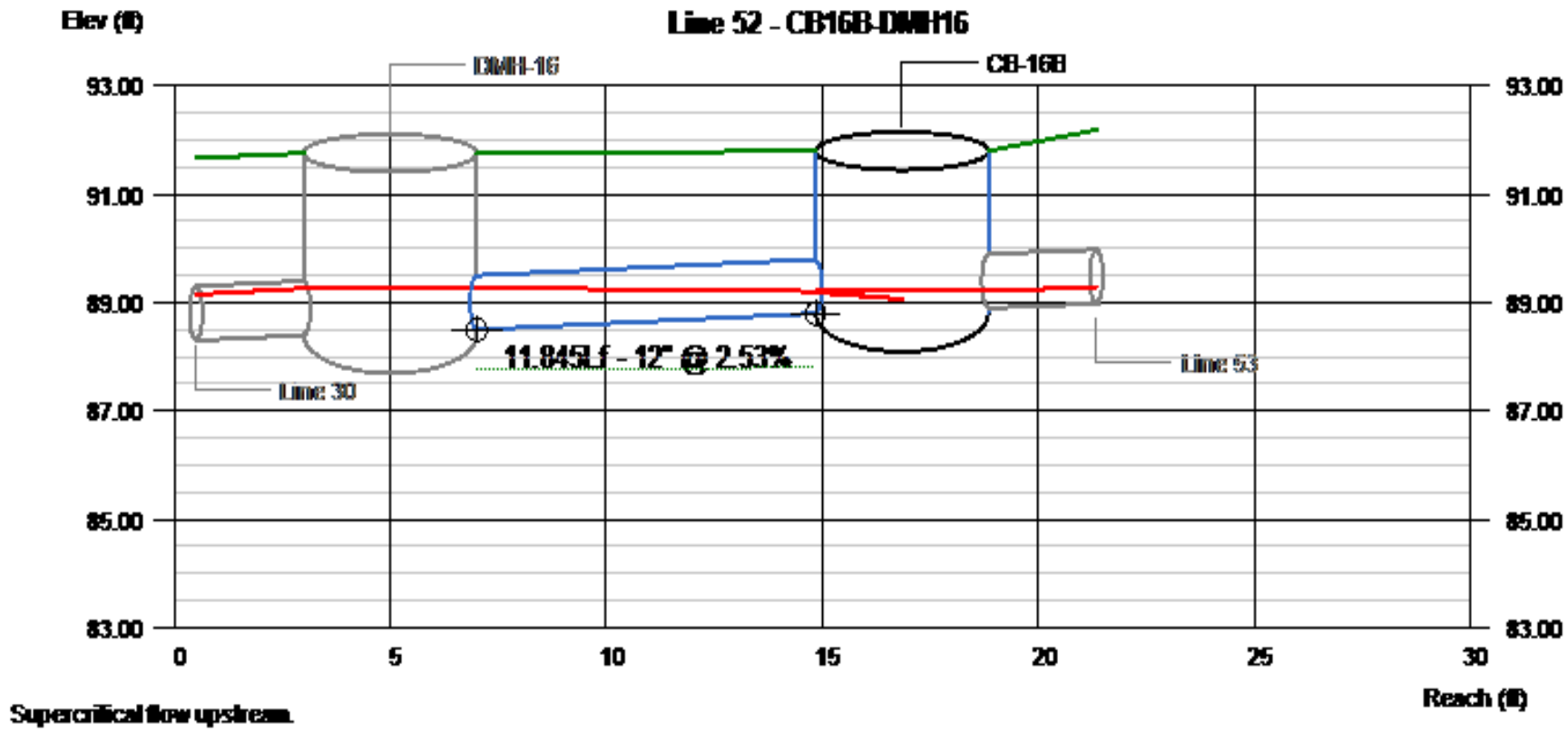

Elev (ft)
Line 48 - CB14B-DMH14
DMH-14
CB-14B
97.00
95.00
93.00
91.00
89.00
87.00
11.587LF - 12" @ 0.86%
Line: 32
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

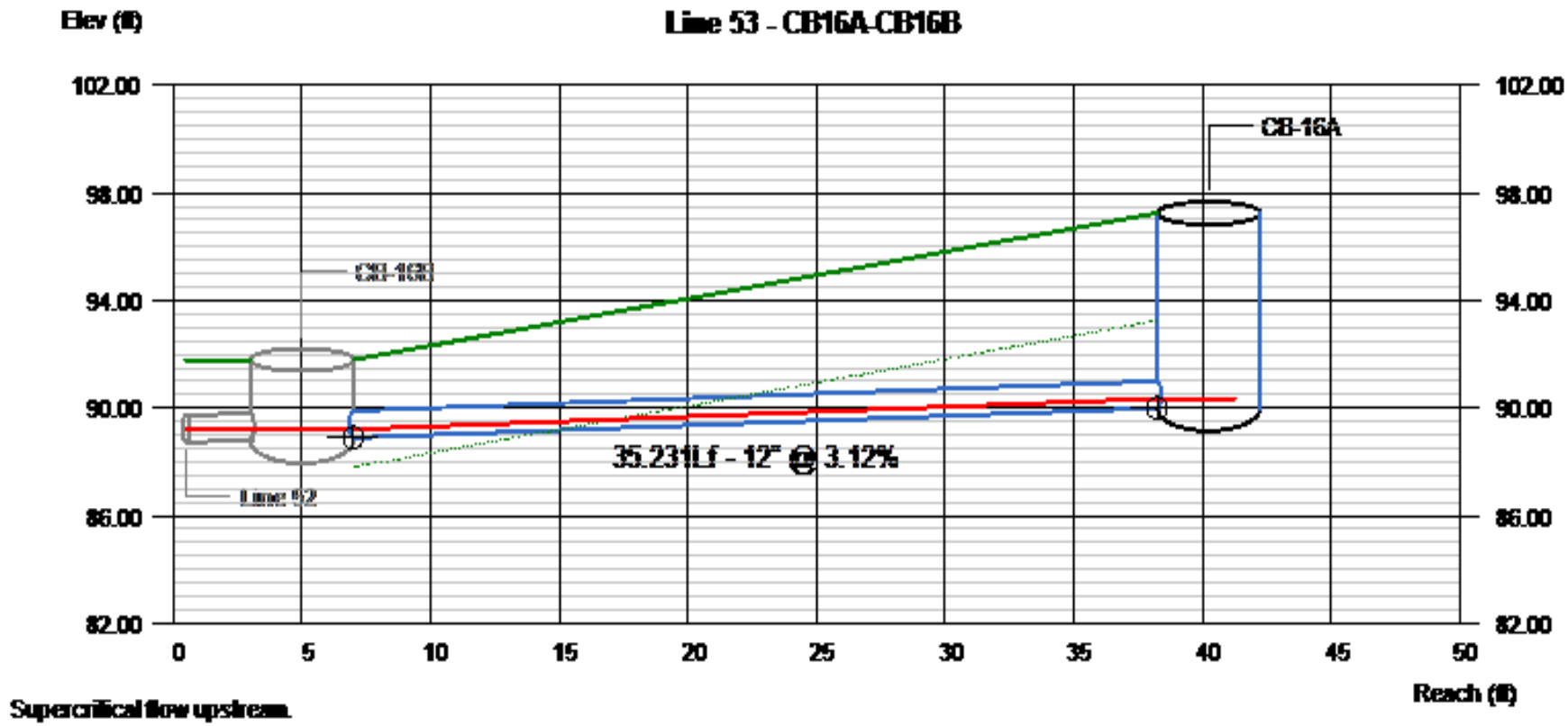

Elev (ft)
Line 49 - CB7D-DMH7
121.00
113.00
105.00
97.00
89.00
81.00
CB-7D
DMH-7
Line: 39
89.672Li - 12" @ 11.99%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

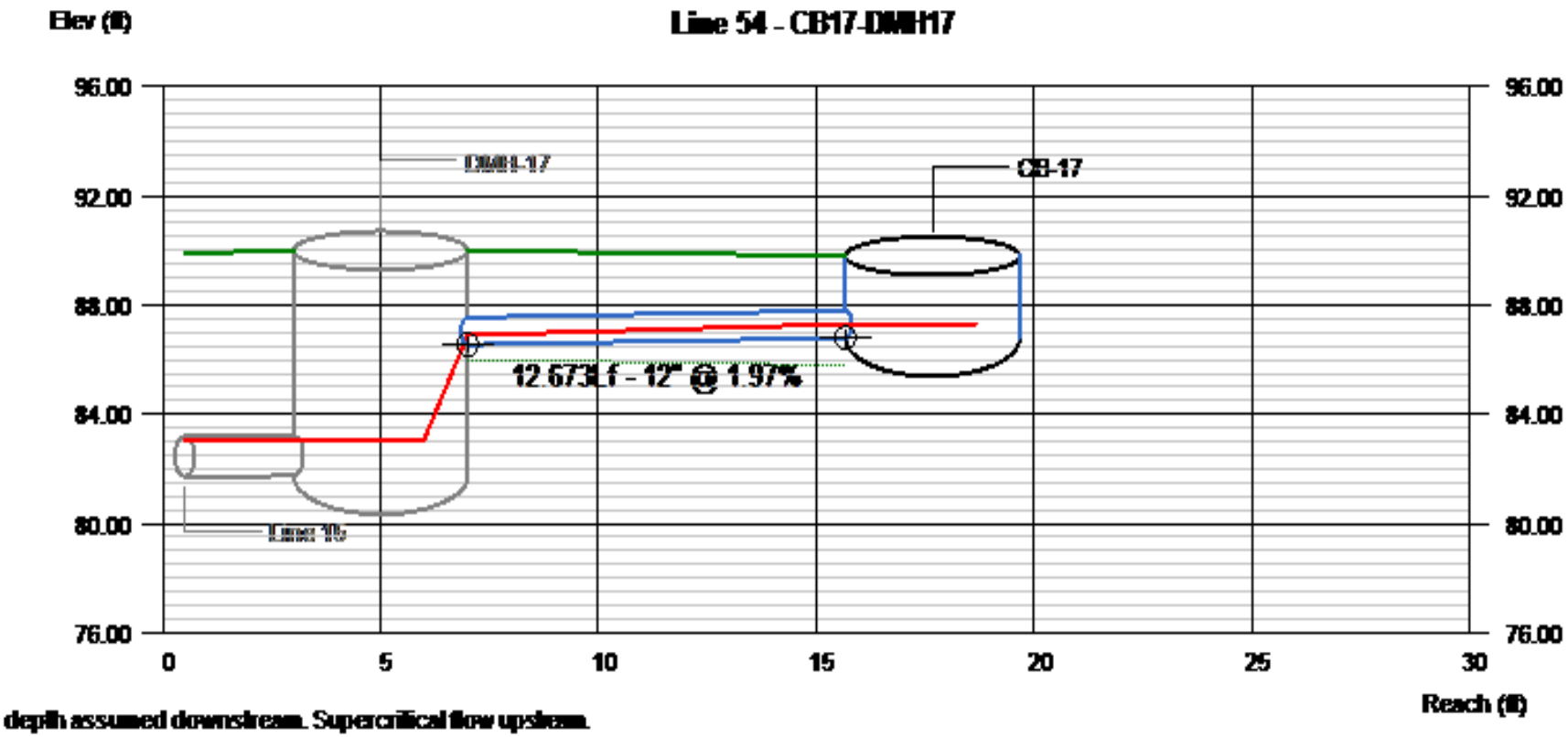

Elev (ft)
Line 50 - CB8-DMH8
101.00
97.00
93.00
89.00
85.00
81.00
CB-8
16.917LF - 12" @ 1.77%
Line: 18
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

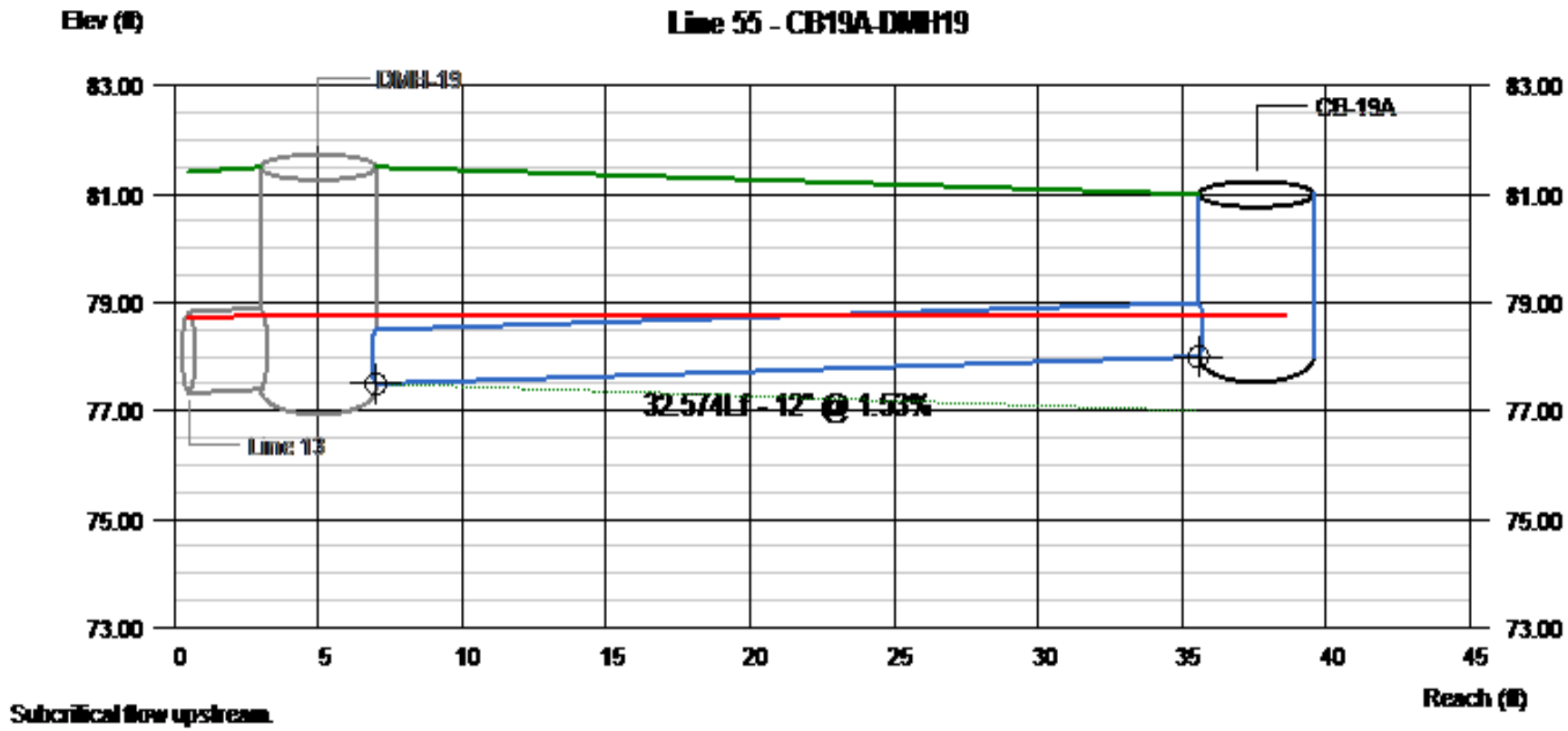


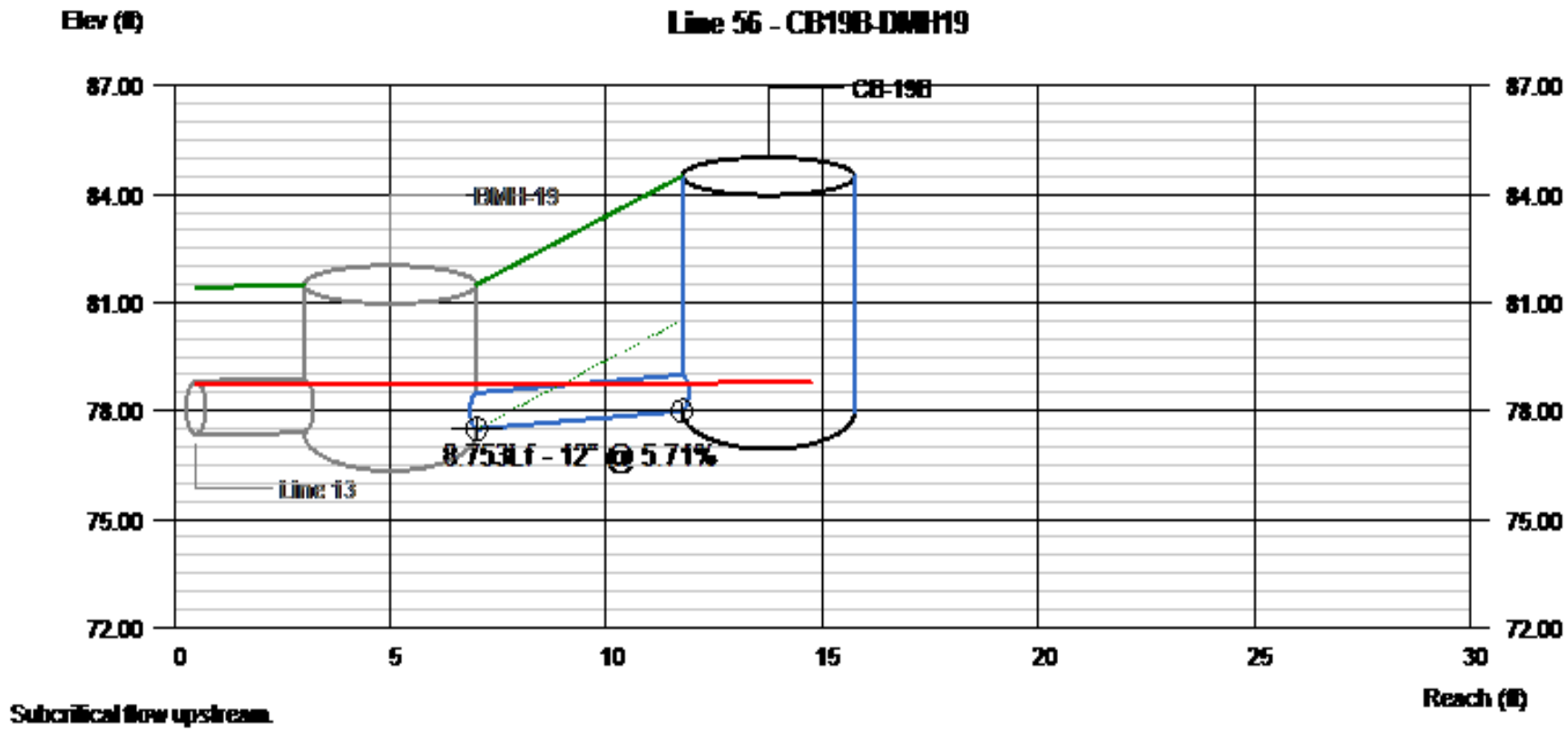
depth assumed downstream. Supercritical flow upstream.

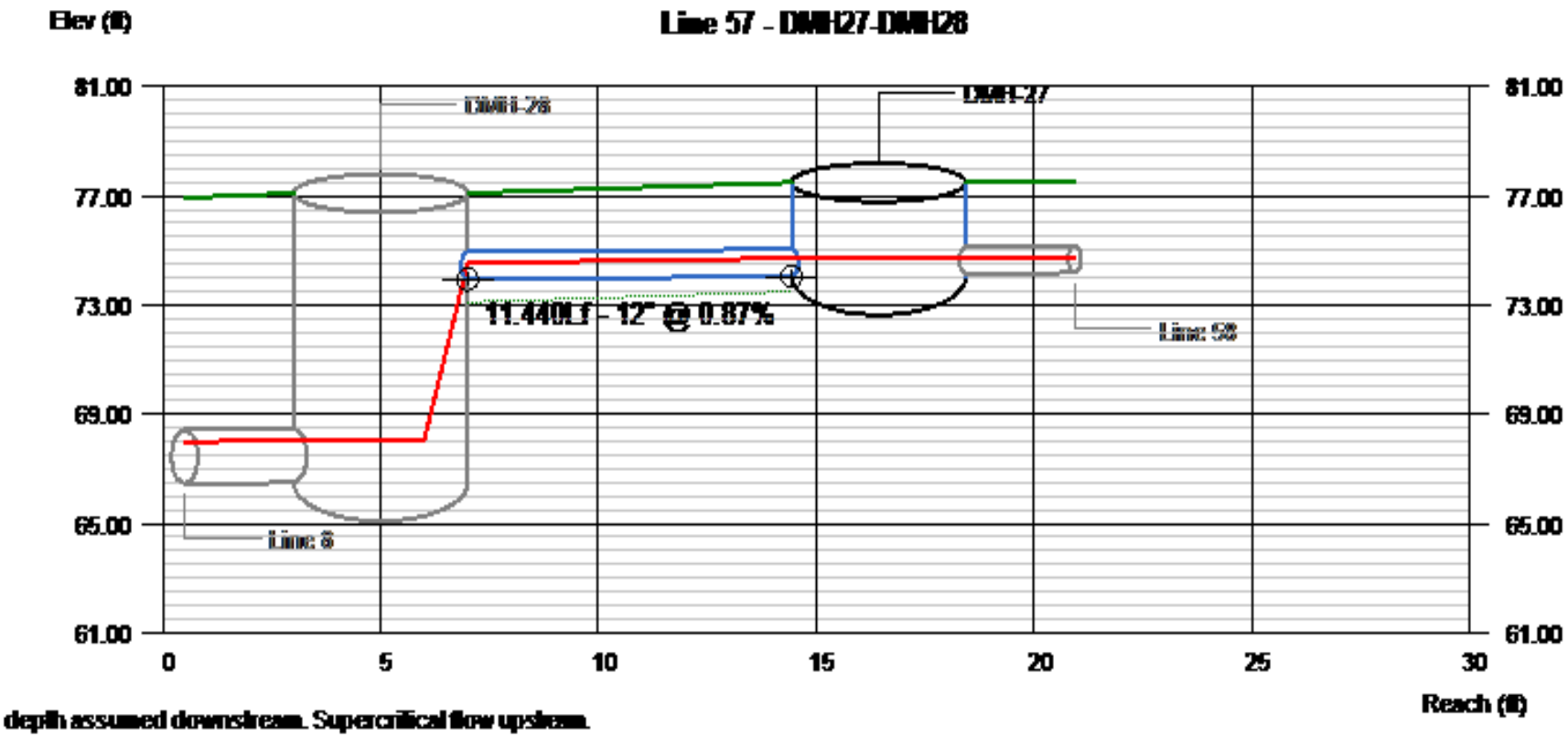

Elev (ft)
Line 52 - CB16B-DMH16
DMH-16
CB-16B
93.00
91.00
89.00
87.00
85.00
83.00
11.84 cfs - 12" @ 2.53%
Line: 30
Line: 53
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

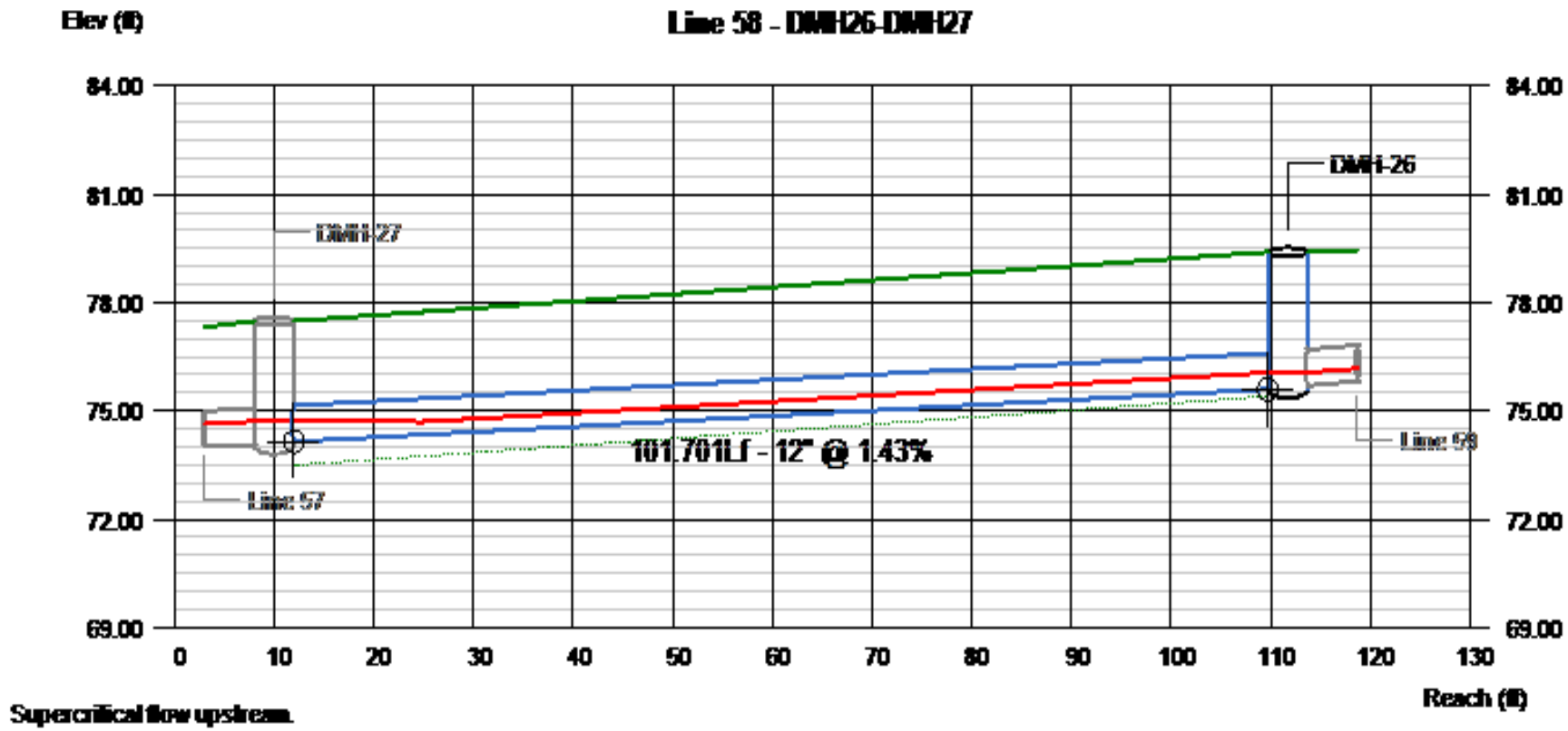

Elev (ft)
Line 53 - CB16A-CB16B
102.00
98.00
94.00
90.00
86.00
82.00
CB-16A
35.231Lf - 12" @ 3.12%
Line 52
0
5
10
15
20
25
30
35
40
45
50
Reach (ft)
Supercritical flow upstream.

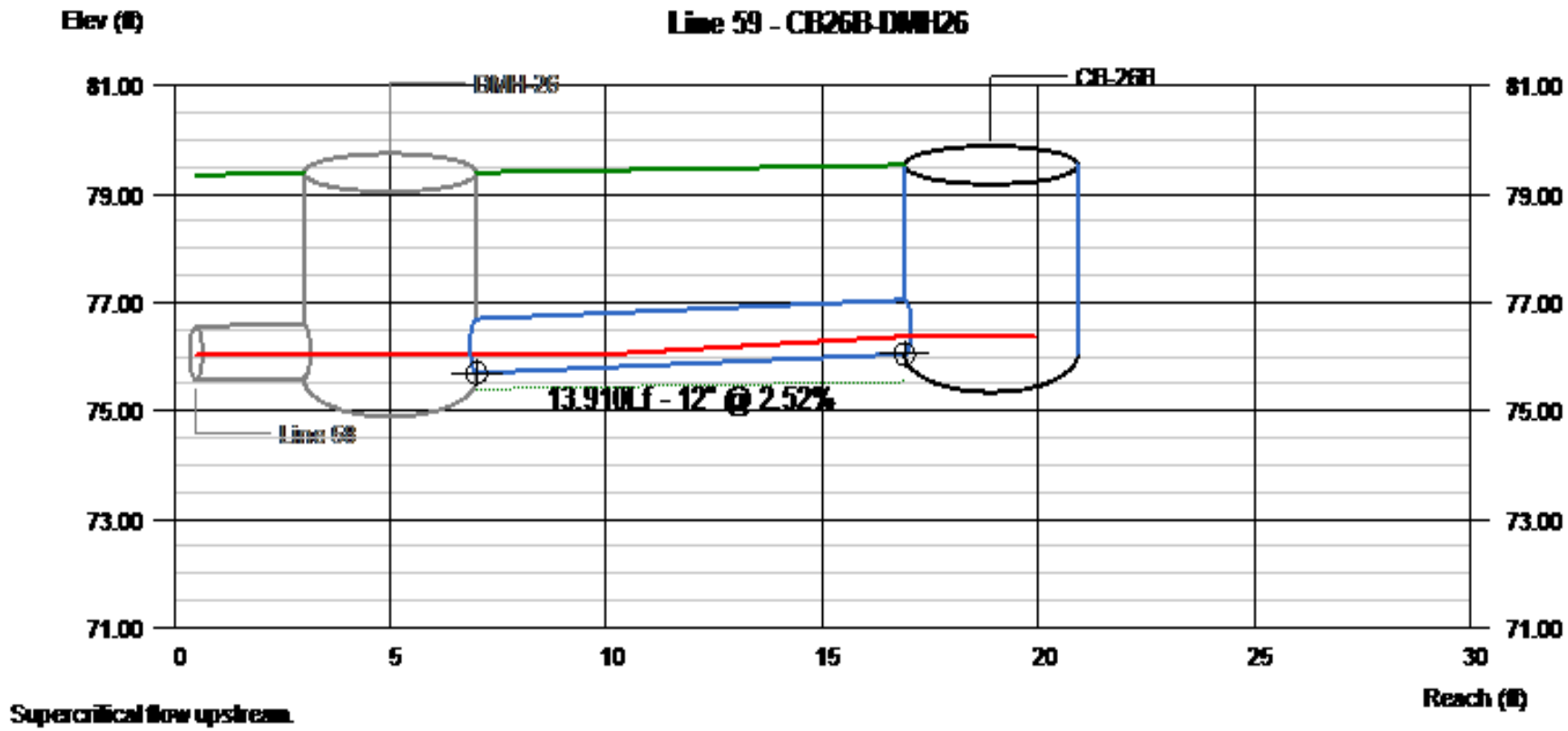

Elev (ft)
Line 54 - CB17-DMH17
96.00
92.00
88.00
84.00
80.00
76.00
DMH-17
CB-17
12.673 f - 12" @ 1.97%
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

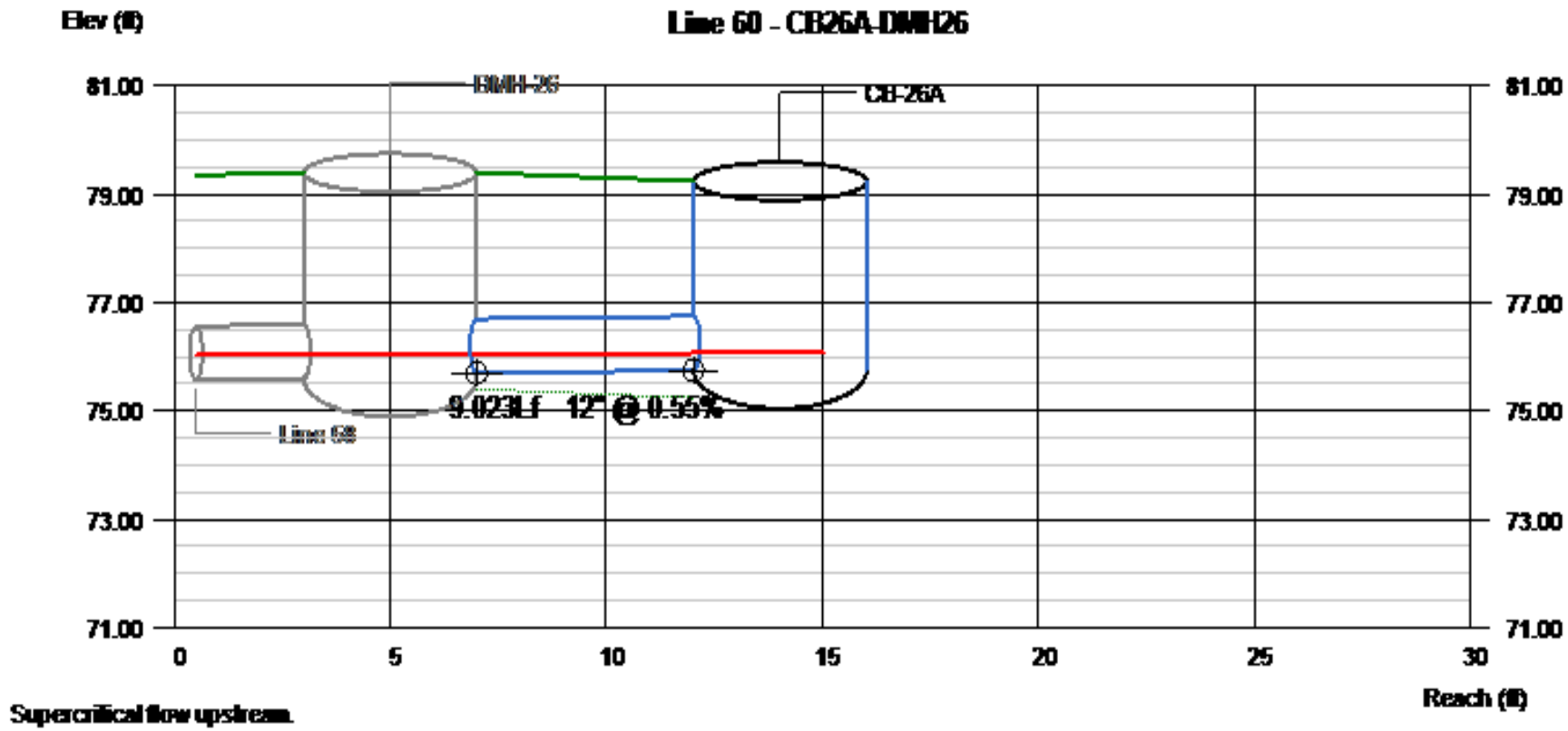

Elev (ft)
Line 55 - CB19A-DMH19
DMH-19
CB-19A
Line: 13
32.574LF - 12" @ 1.53%
83.00
81.00
79.00
77.00
75.00
73.00
0
5
10
15
20
25
30
35
40
45
Reach (ft)
Subcritical flow upstream.

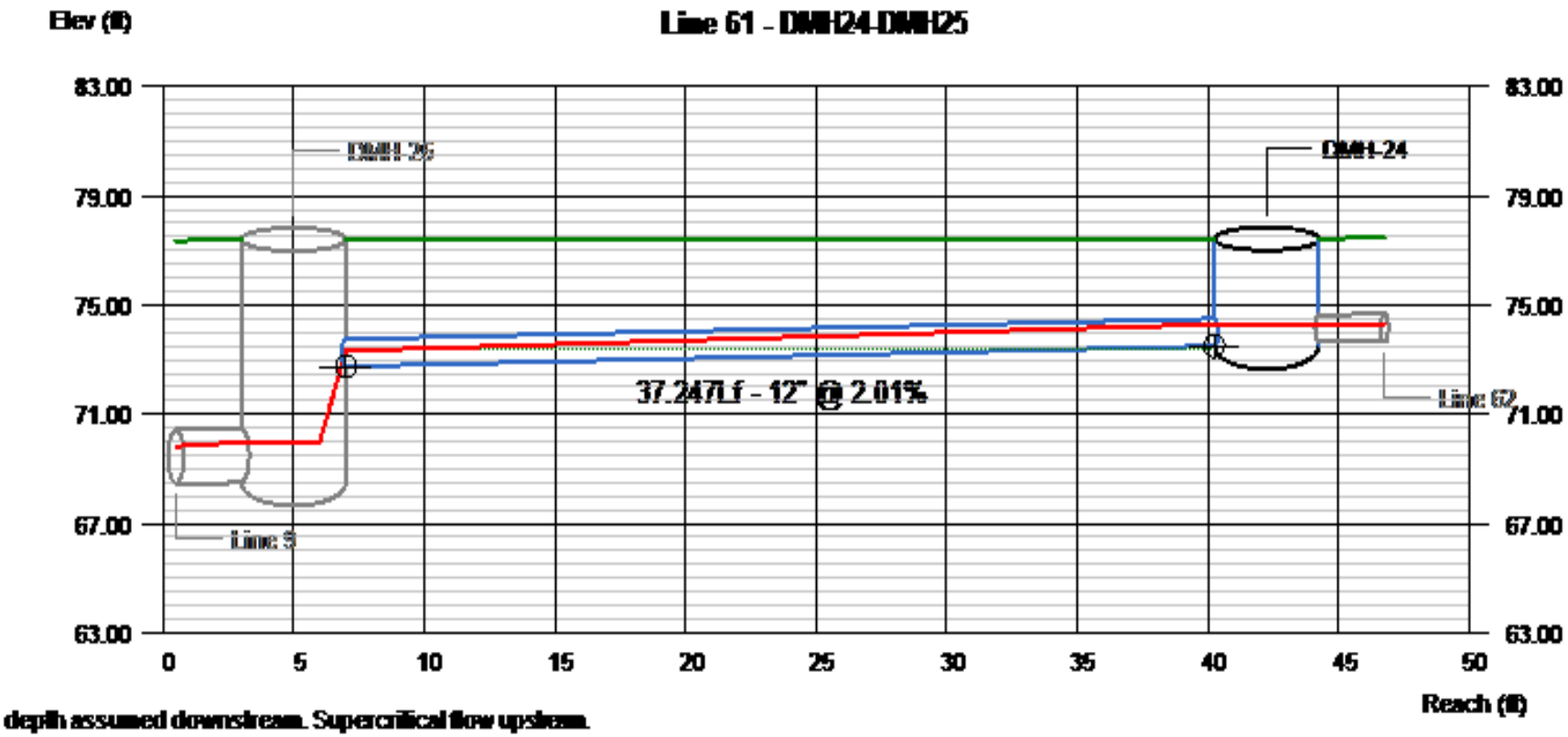

Elev (ft)
Line 56 - CB19B-DMH19
87.00
84.00
81.00
78.00
75.00
72.00
CB-19B
DMH-19
8.753Lf - 12" @ 5.71%
Line 13
0
5
10
15
20
25
30
Reach (ft)
Subcritical flow upstream.

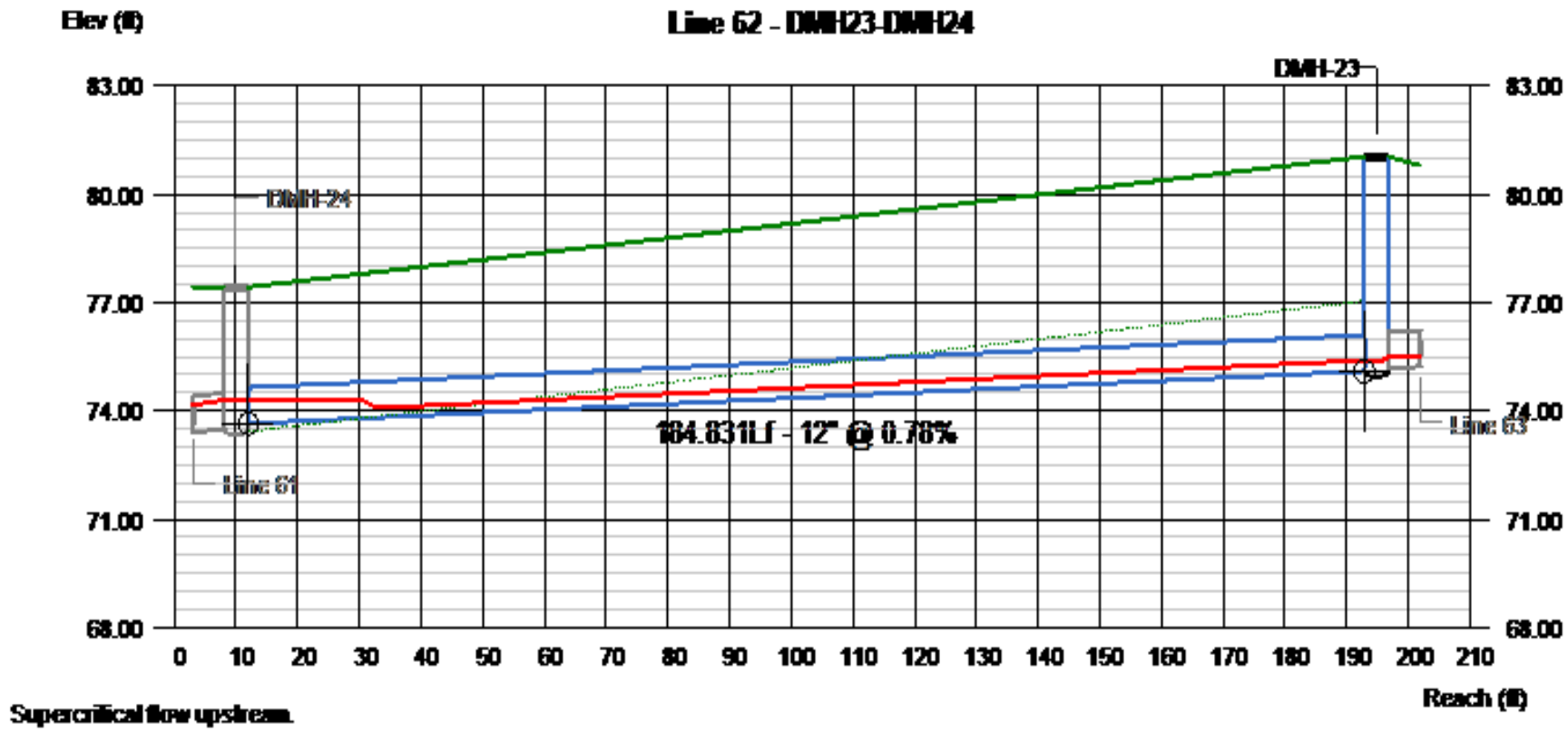

Elev (ft)
Line 57 - DMH27-DMH28
81.00
77.00
73.00
69.00
65.00
61.00
DMH-26
DMH-27
11.44ft - 12" @ 0.87%
Line: 58
Line: 6
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

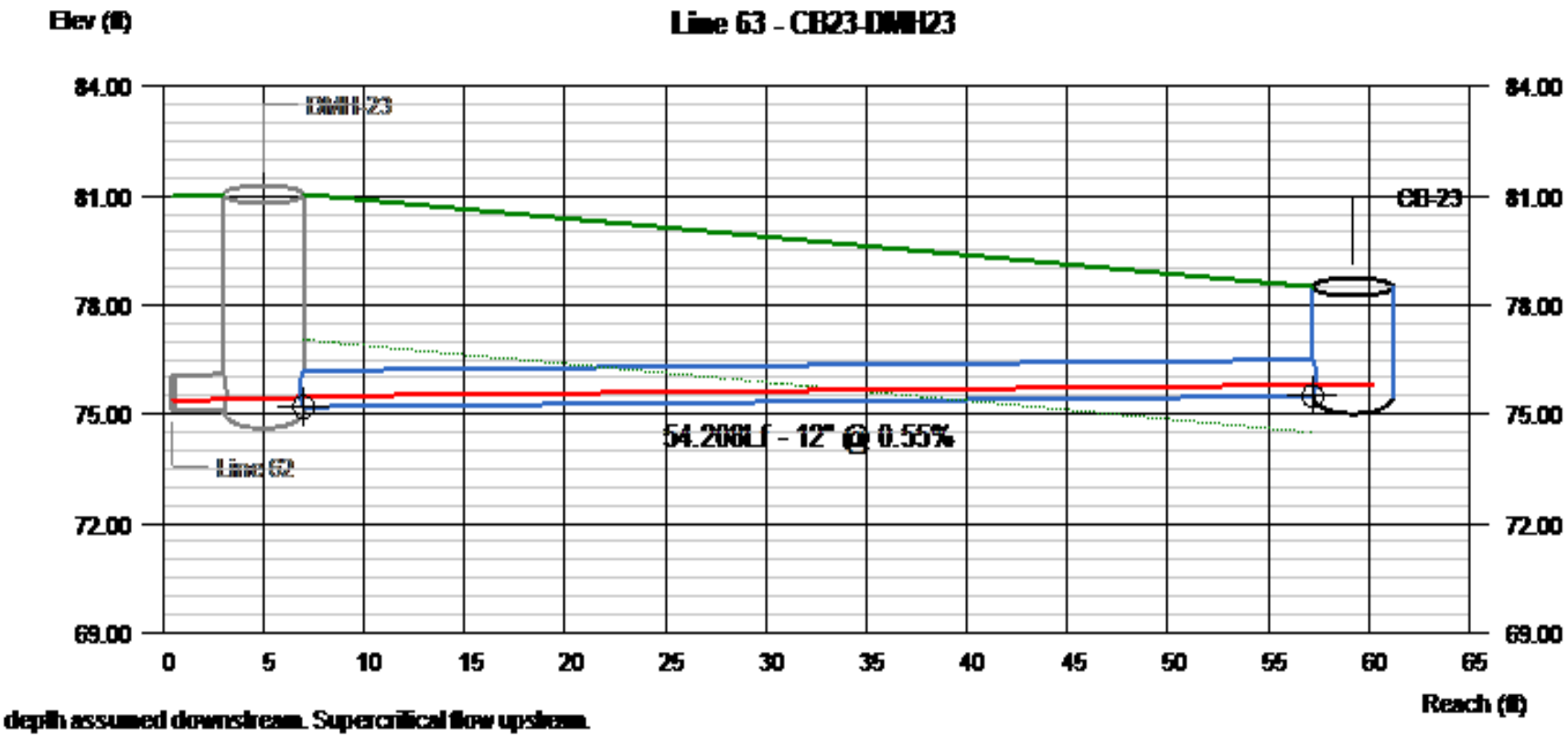

Elev (ft)
Line 58 - DMH26-DMH27
84.00
81.00
78.00
75.00
72.00
69.00
DMH-27
DMH-26
Line 57
Line 59
101.701LF - 12" @ 1.43%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Reach (ft)
Supercritical flow upstream.

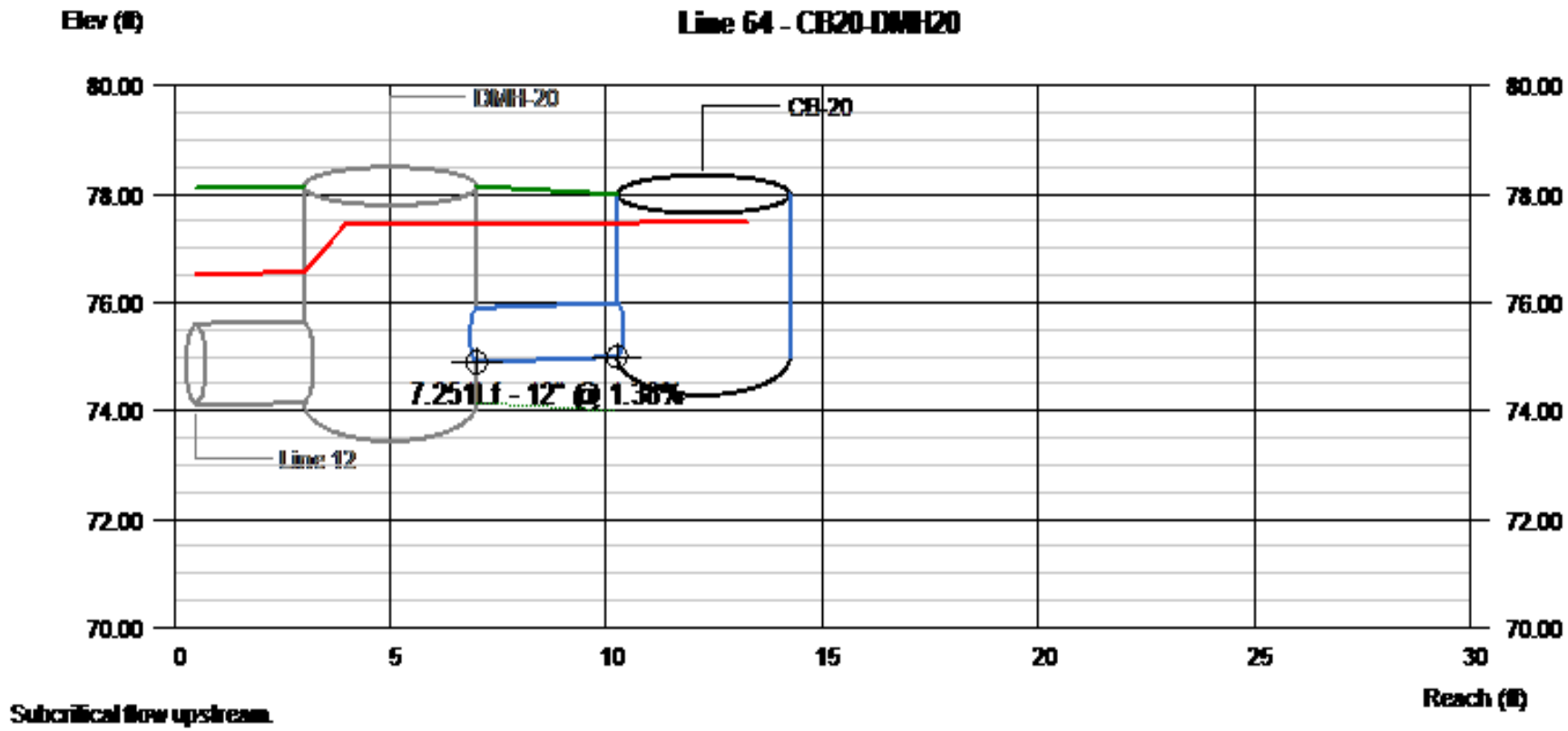

Elev (ft)
Line 59 - CB26B-DMH26
DMH-26
CB-26B
Line 58
13.910Lf - 12" @ 2.52%
81.00
79.00
77.00
75.00
73.00
71.00
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

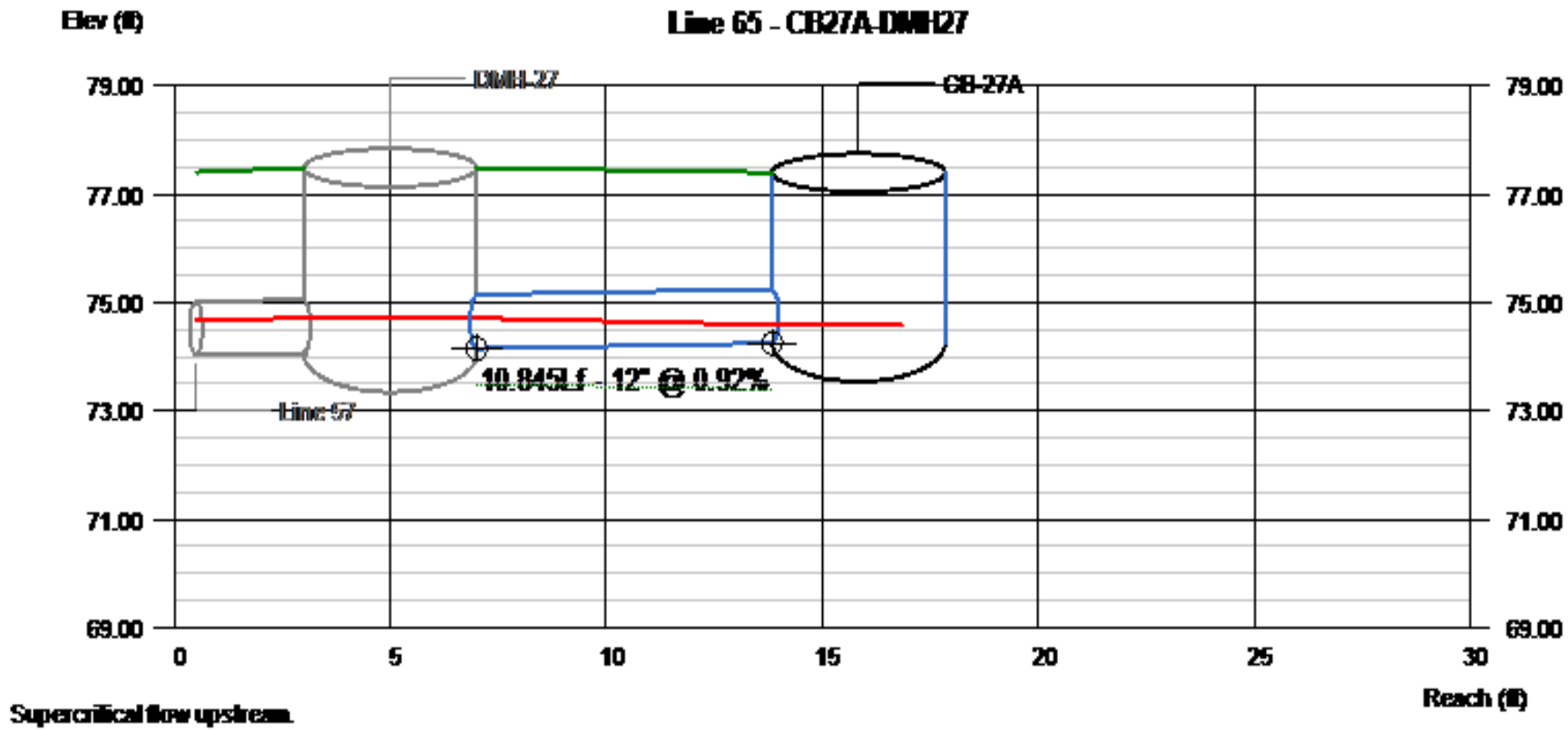

Elev (ft)
Line 60 - CB26A-DMH26
DMH-26
CB-26A
Line 68
9.023 LF 12" @ 0.55%
81.00
79.00
77.00
75.00
73.00
71.00
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

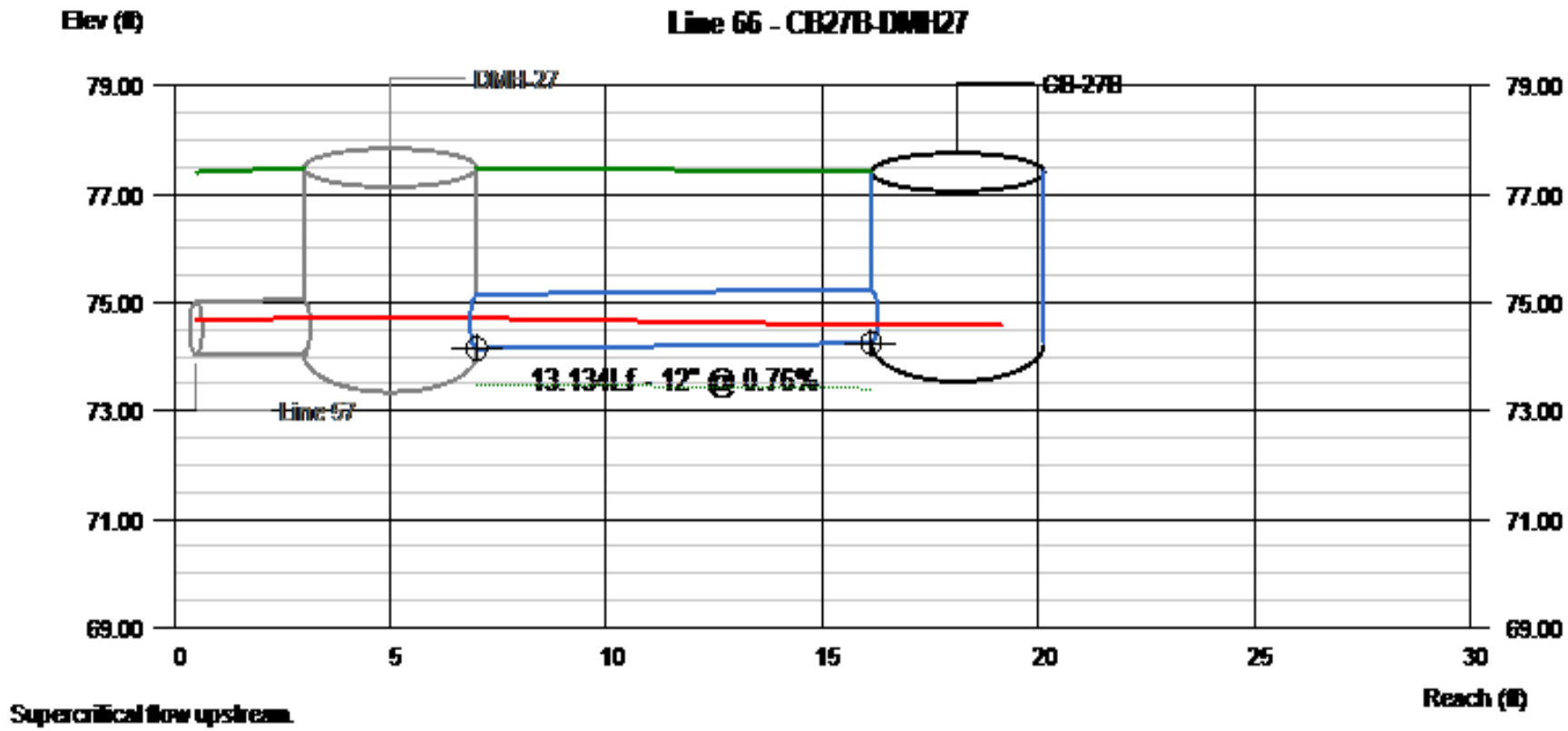

Elev (ft)
Line 61 - DMH24-DMH25
83.00
79.00
75.00
71.00
67.00
63.00
DMH-25
DMH-24
37.24ft/Lf - 12" @ 2.01%
Line: 62
Line: 5
0
5
10
15
20
25
30
35
40
45
50
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

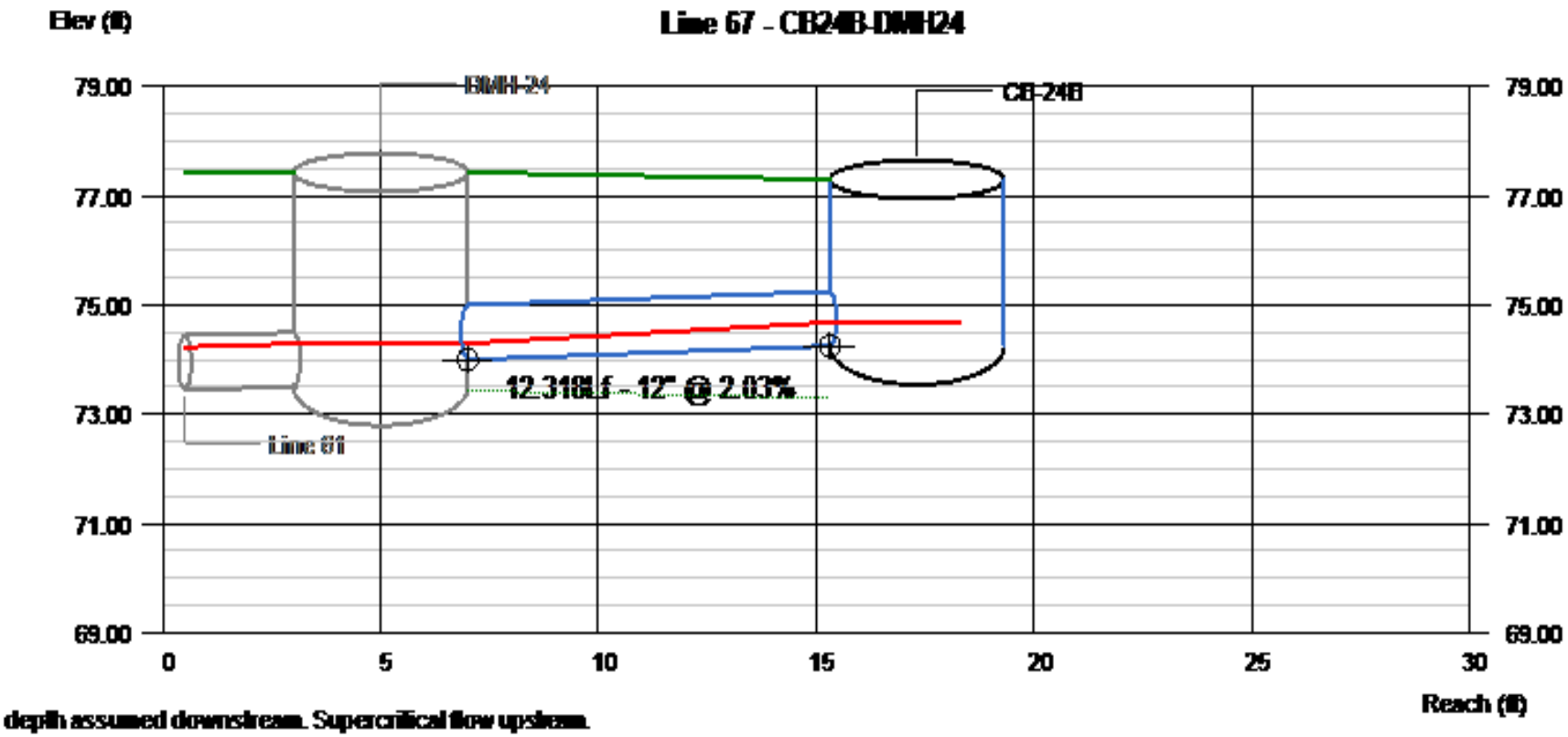

Elev (ft)
Line 62 - DMH23-DMH24
DMH-23
DMH-24
83.00
80.00
77.00
74.00
71.00
68.00
164.631LF - 12" @ 0.78%
Line 61
Line 63
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210
Reach (ft)
Supercritical flow upstream.

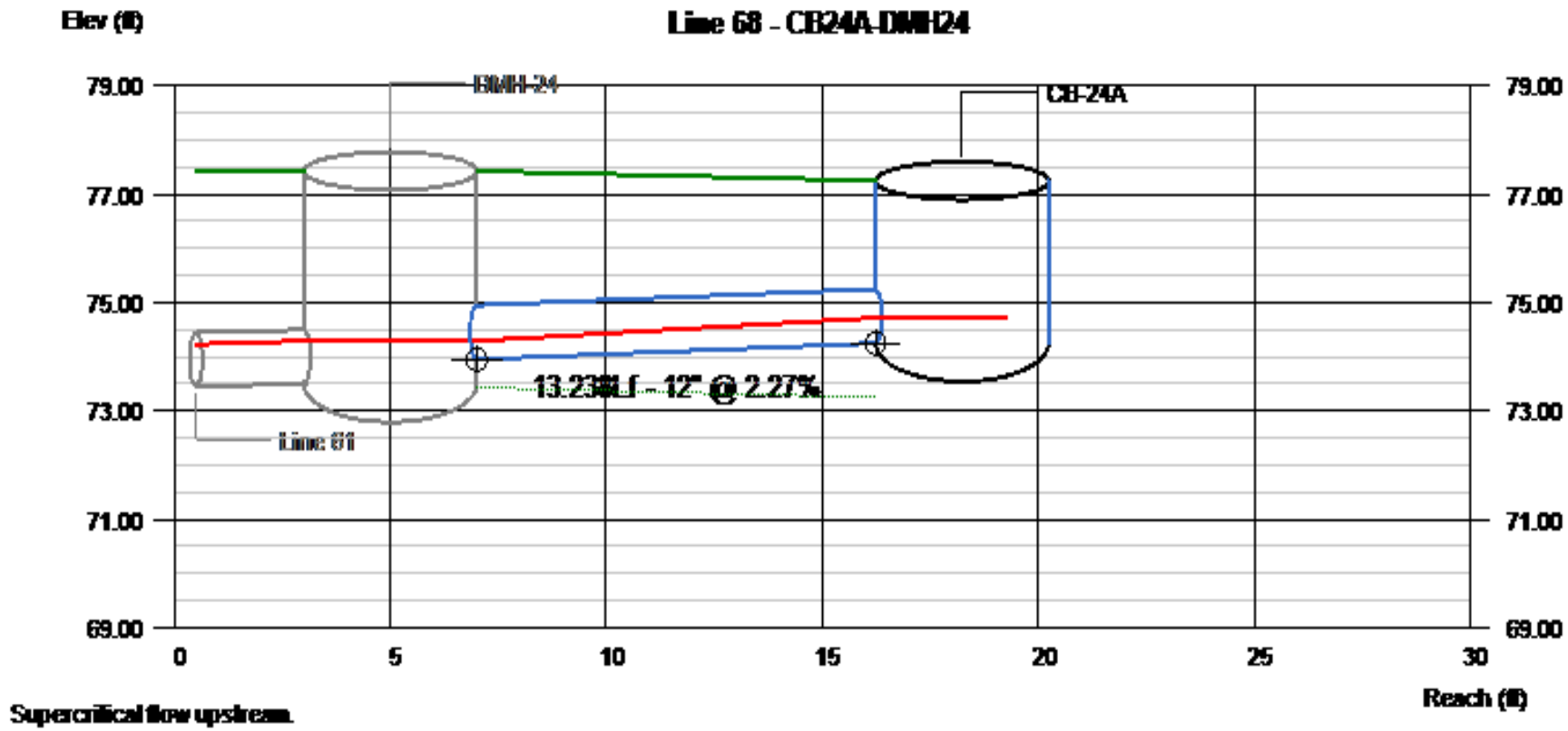

Elev (ft)
Line 63 - CB23-DMH23
84.00
81.00
78.00
75.00
72.00
69.00
DMH-23
CB-23
Line 62
54.208LF - 12" @ 0.55%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

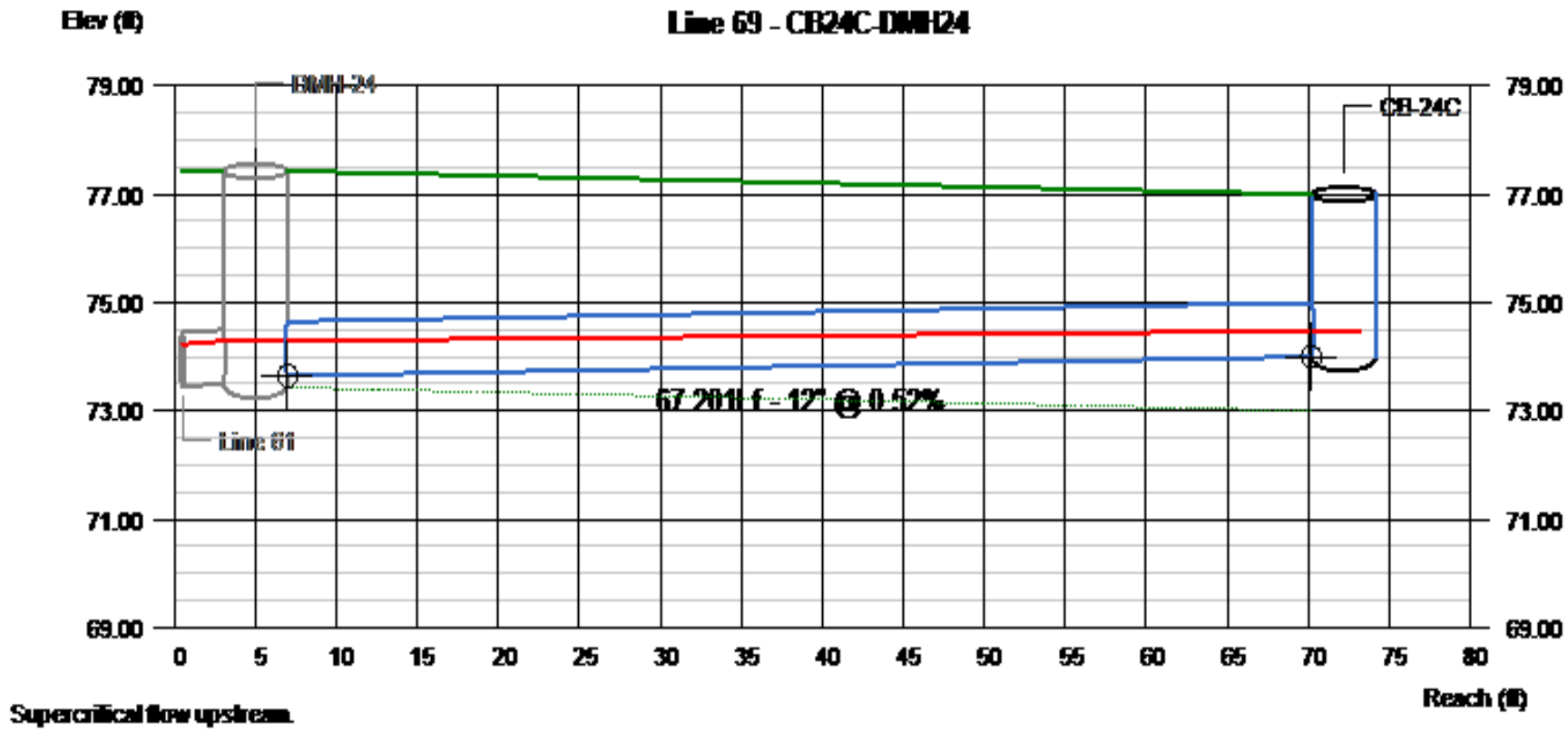

Elev (ft)
Line 64 - CB20-DMH20
80.00
78.00
76.00
74.00
72.00
70.00
DMH-20
CB-20
7.25 LF - 12" @ 1.38%
Line 12
0
5
10
15
20
25
30
Reach (ft)
Subcritical flow upstream.

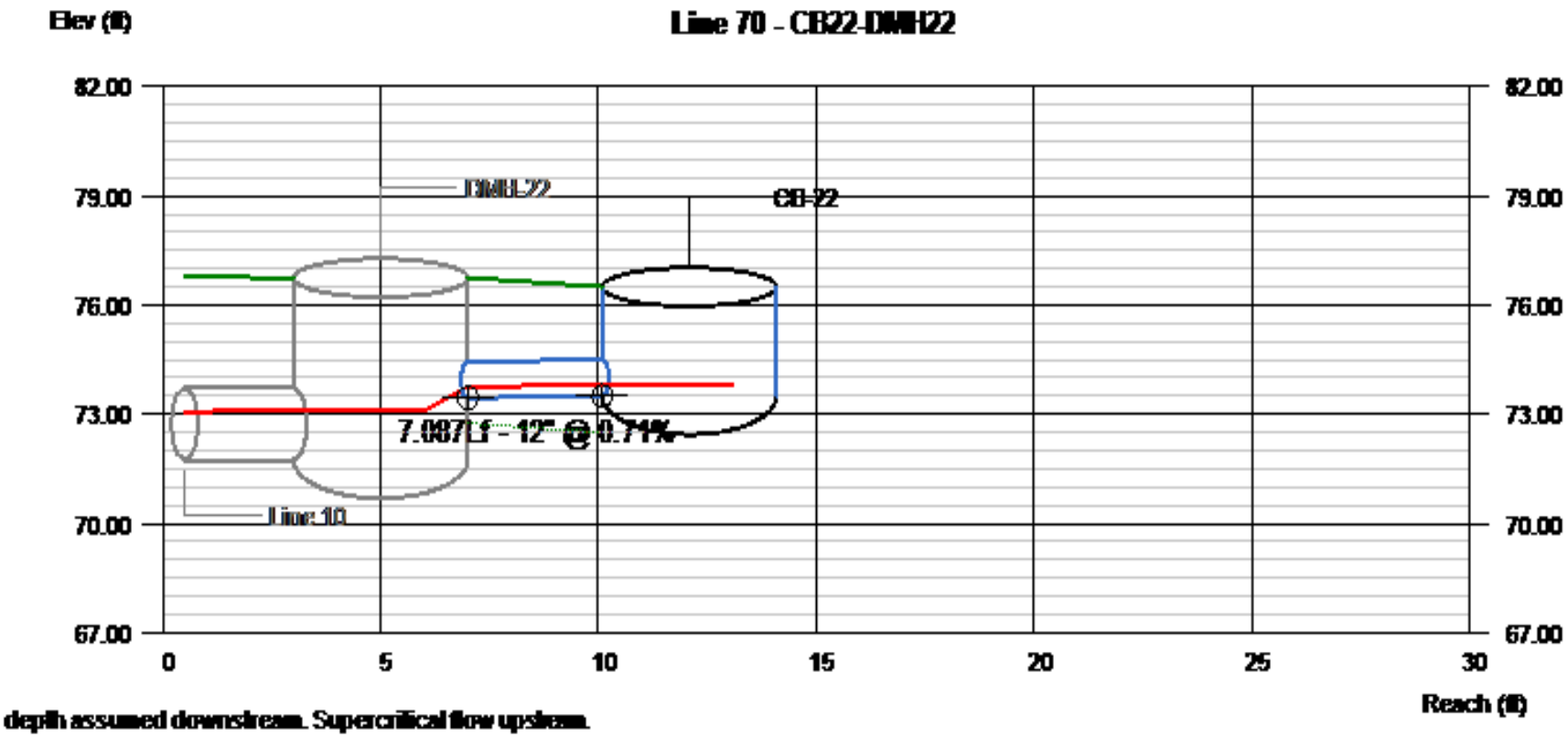

Elev (ft)
Line 65 - CB27A-DMH27
DMH-27
CB-27A
79.00
77.00
75.00
73.00
71.00
69.00
10.845 ft - 12" @ 0.92%
Line 57
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

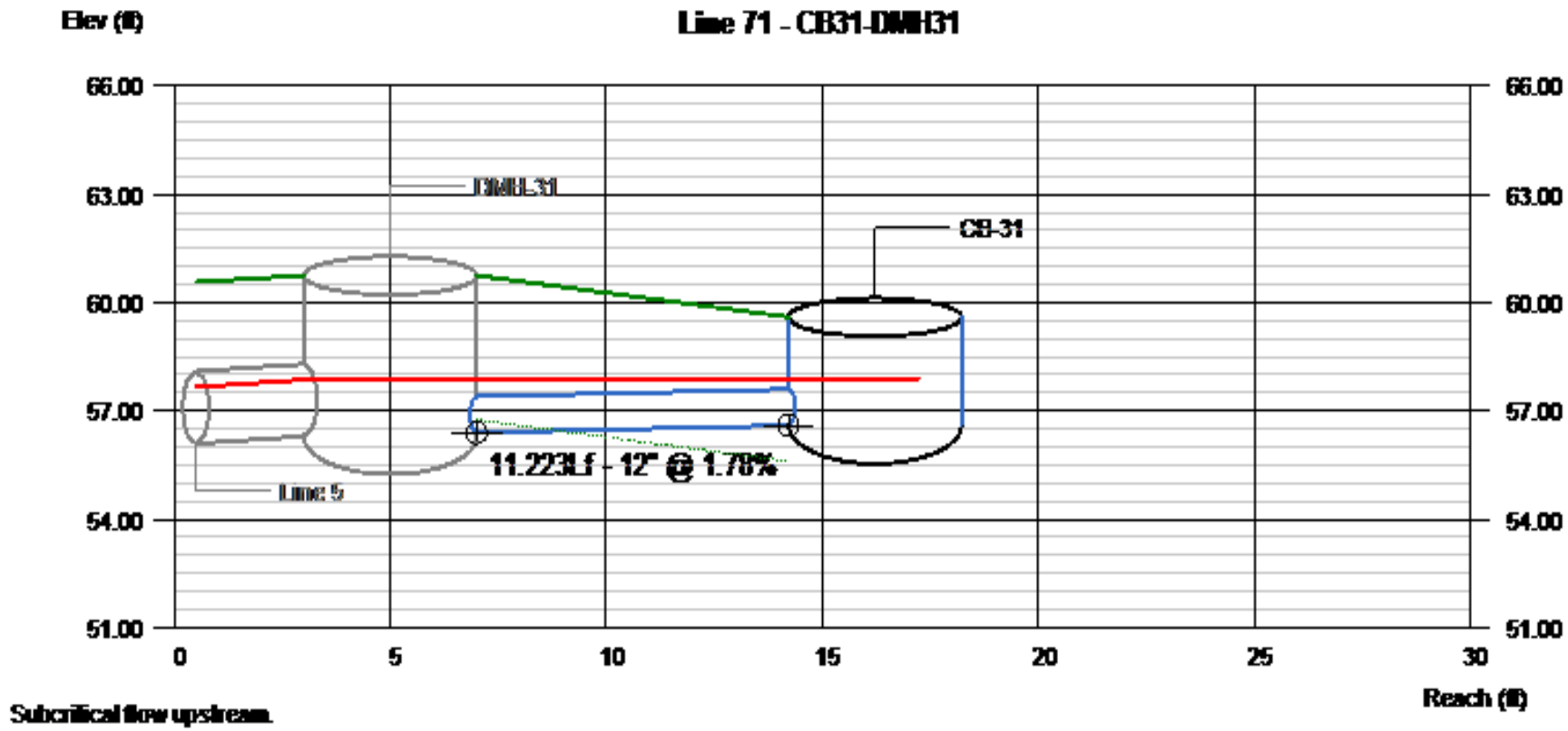

Elev (ft)
Line 66 - CB27B-DMH27
DMH-27
CB-27B
79.00
77.00
75.00
73.00
71.00
69.00
13.134Lf - 12" @ 0.76%
Line 57
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

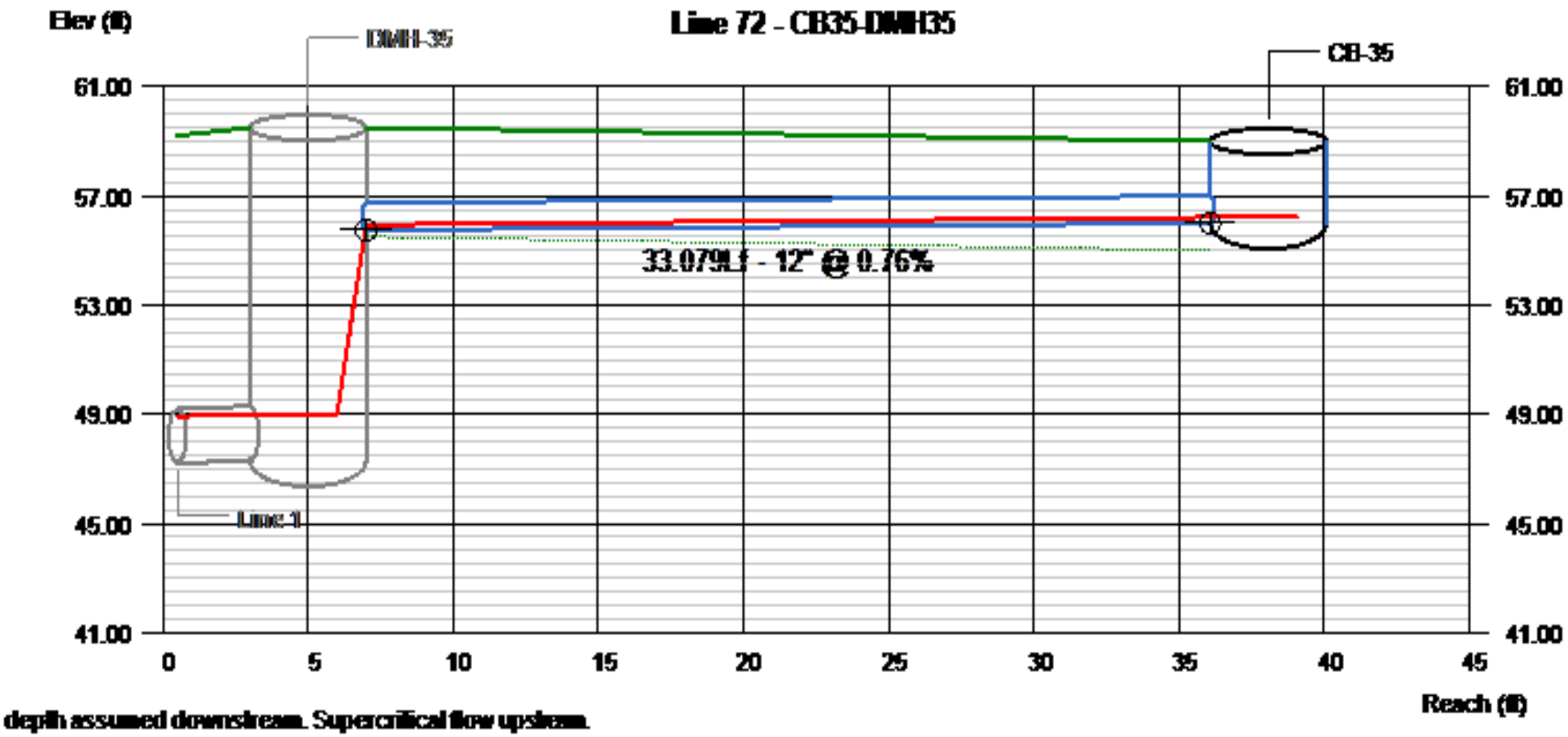

Elev (ft)
Line 67 - CB24B-DMH24
DMH-24
CB-24B
12.318 ft - 12" @ 2.03%
Line 61
79.00
77.00
75.00
73.00
71.00
69.00
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

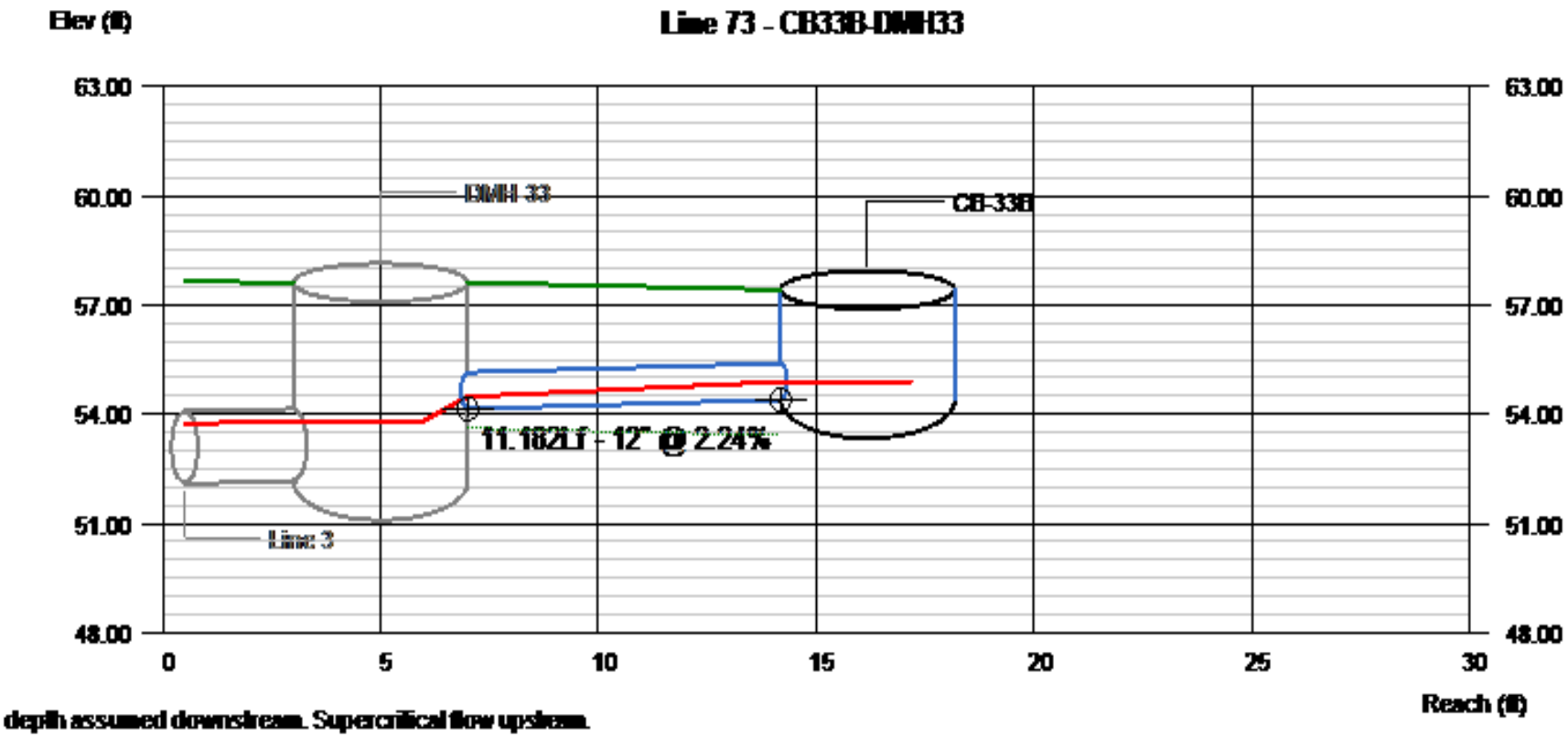

Elev (ft)
Line 68 - CB24A-DMH24
DMH-24
CB-24A
13.23ft - 12" @ 2.27%
Line 61
79.00
77.00
75.00
73.00
71.00
69.00
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

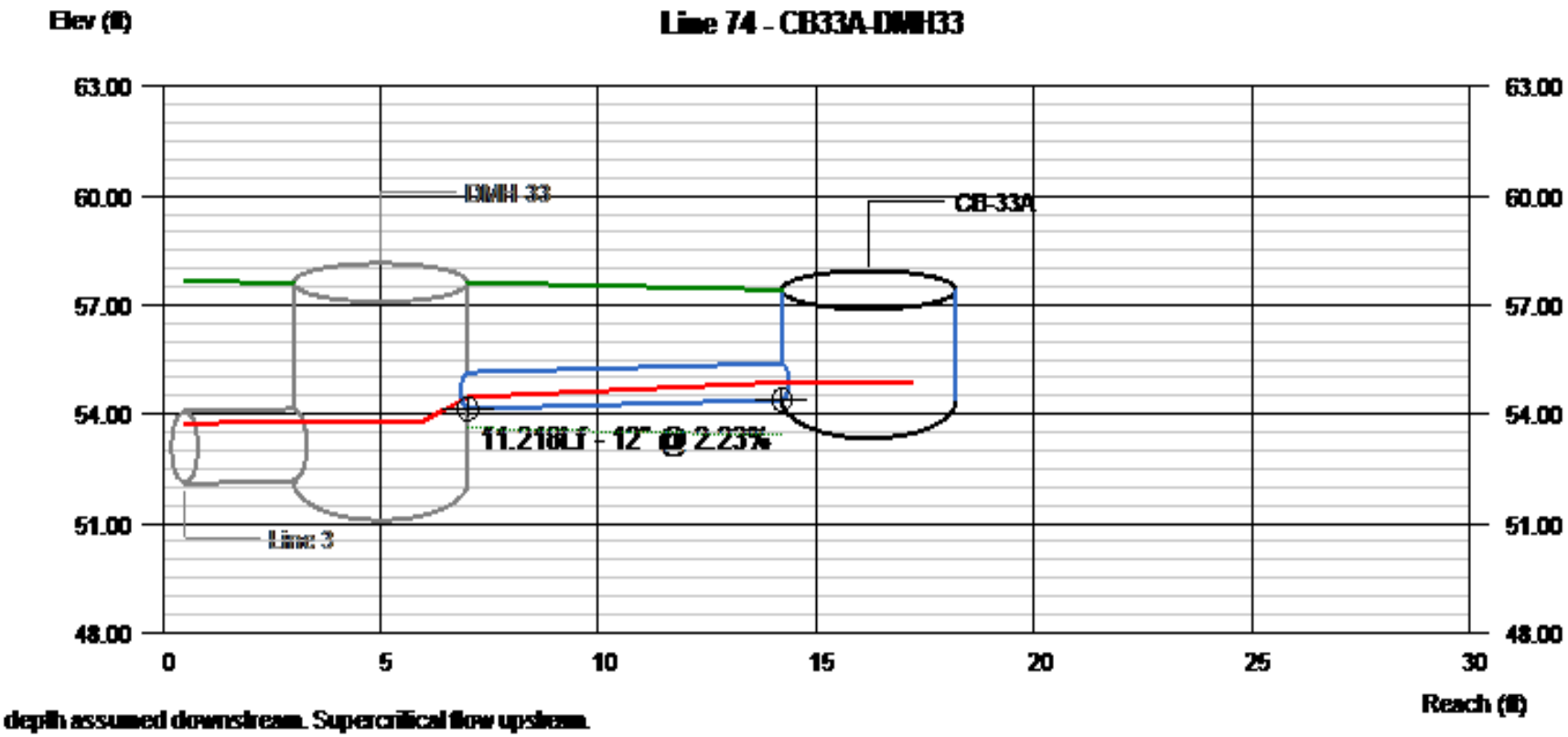

Elev (ft)
Line 69 - CB24C-DMH24
DMH-24
CB-24C
Line 61
67.201 ft - 12" @ 0.52%
79.00
77.00
75.00
73.00
71.00
69.00
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Reach (ft)
Supercritical flow upstream.

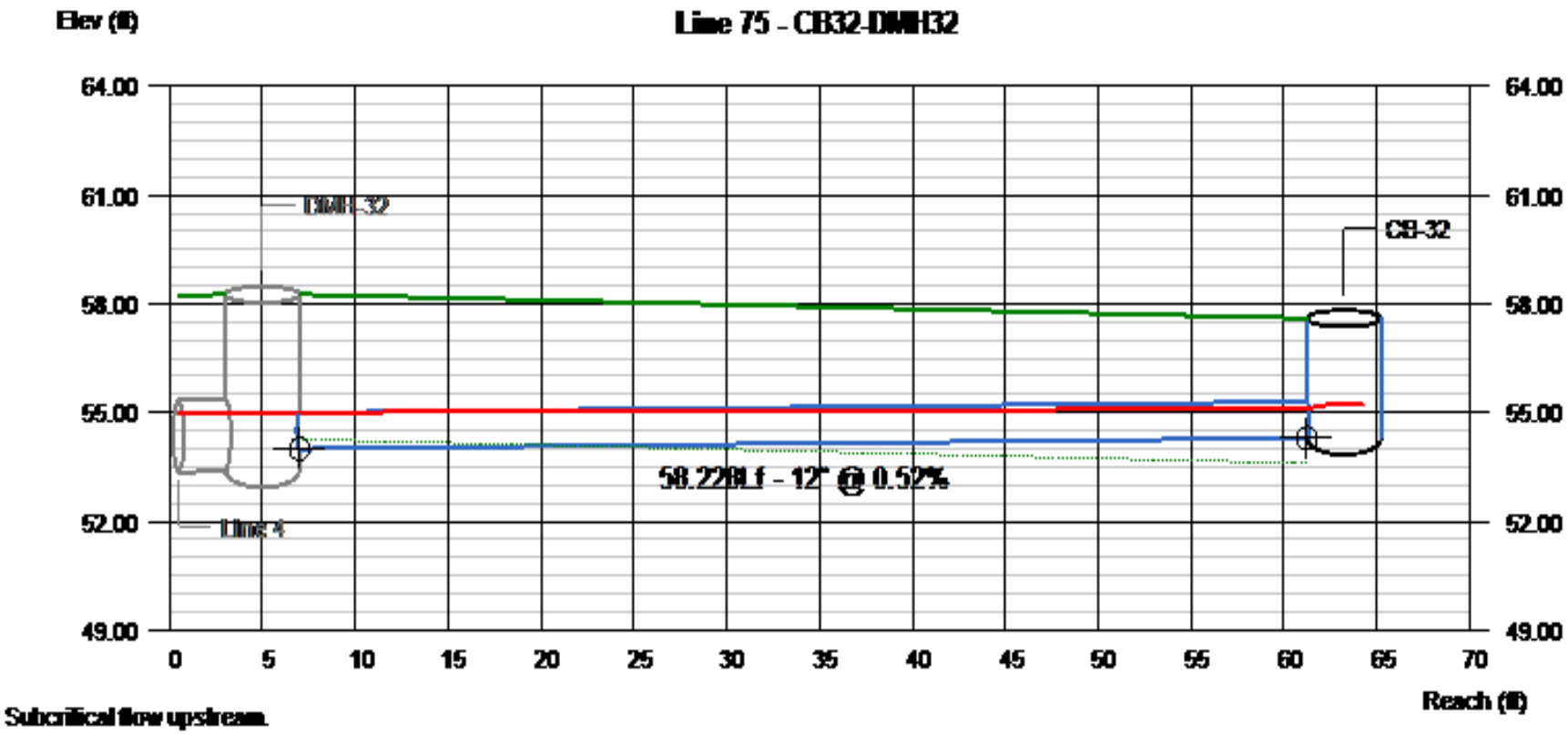

Elev (ft)
Line 70 - CB22-DMH22
82.00
79.00
76.00
73.00
70.00
67.00
DMH22
CB22
7.087 LF - 12" @ 0.71%
Line 10
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

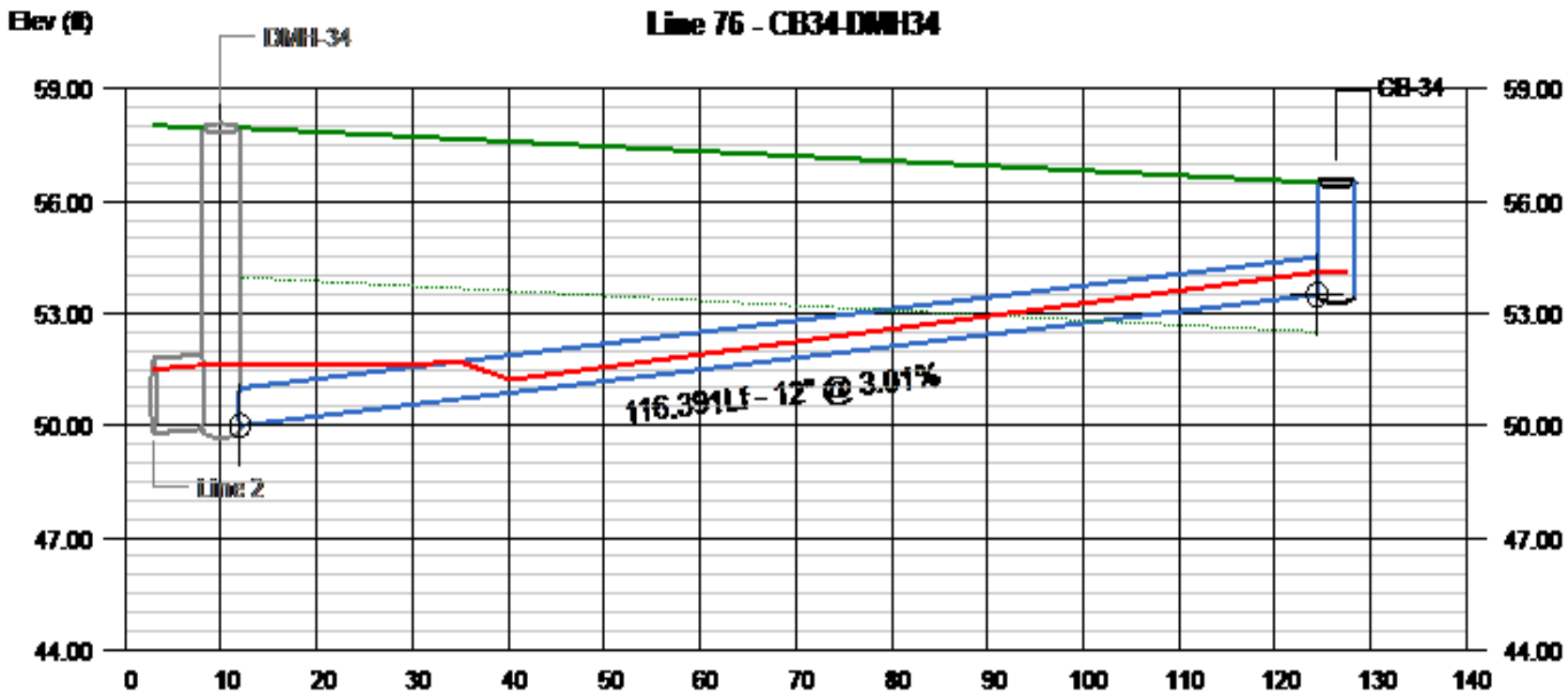

Elev (ft)
Line 71 - CB31-DMH31
66.00
63.00
60.00
57.00
54.00
51.00
DMH-31
CB-31
11.223 lf - 12" @ 1.78%
Line: 5
0
5
10
15
20
25
30
Reach (ft)
Subcritical flow upstream.


Elev (ft)
Line 72 - CB35-DMH35
DMH-35
CB-35
61.00
57.00
53.00
49.00
45.00
41.00
33.079LF - 12" @ 0.76%
Line 1
0
5
10
15
20
25
30
35
40
45
Reach (ft)
depth assumed downstream. Supercritical flow upstream.


Elev (ft)
Line 73 - CB33B-DMH33
63.00
60.00
57.00
54.00
51.00
48.00
DMH 33
CB-33B
11.1821 - 12" @ 2.24%
Line 3
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

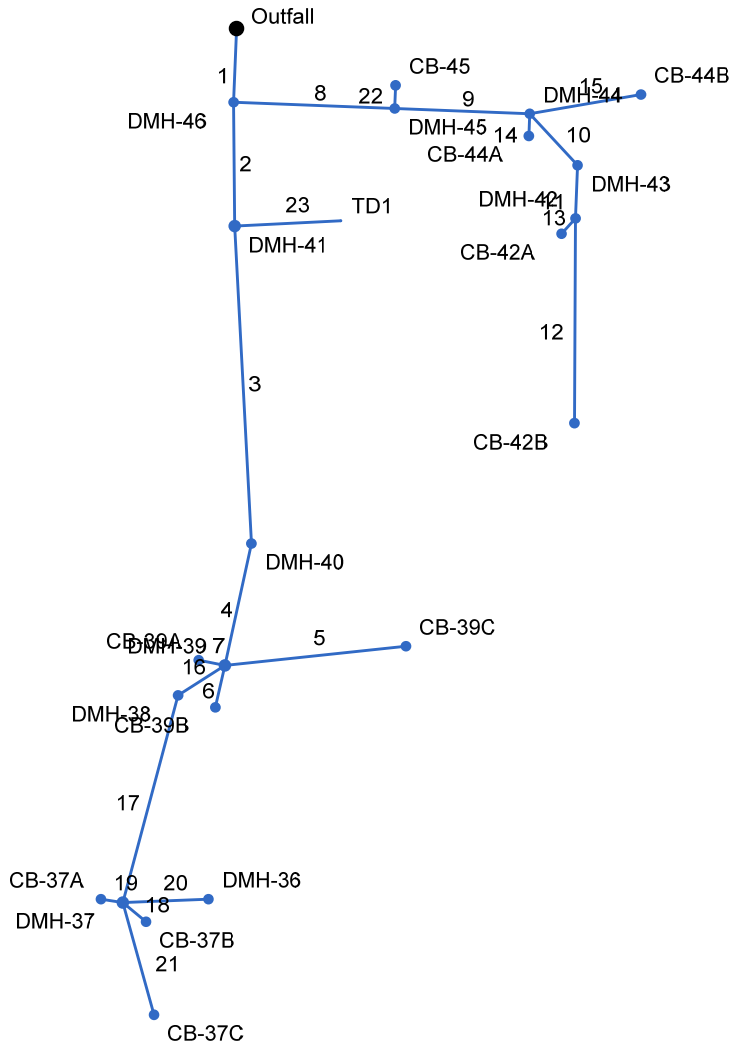

Elev (ft)
Line 74 - CB33A-DMH33
63.00
60.00
57.00
54.00
51.00
48.00
DMH 33
CB-33A
11.21ft - 12" @ 2.23%
Line: 3
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.


Elev (ft)
Line 75 - CB32-DMH32
64.00
61.00
58.00
55.00
52.00
49.00
DMH-32
CB-32
Line 4
58.22ft - 12" @ 0.52%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Reach (ft)
Subcritical flow upstream.



Supercritical flow w/jump.

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



Project File: Woburn_System-2.stm	Number of lines: 23	Date: 4/26/2020

Storm Sewers v11.00

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	38.349	92.238	MH	0.00	0.00	0.00	6.0	118.00	8.61	121.30	12	Cir	0.012	1.00	132.05	DMH46-OUTFALL
2	1	64.255	-2.714	MH	0.00	0.45	0.90	6.0	121.55	2.02	122.85	12	Cir	0.012	1.00	131.50	DMH41-DMH46
3	2	164.829	-2.527	MH	0.00	0.00	0.00	6.0	122.95	2.00	126.25	12	Cir	0.012	0.31	133.50	DMH40-DMH41
4	3	64.930	15.160	MH	0.00	0.00	0.00	6.0	126.35	2.08	127.70	12	Cir	0.012	1.00	140.39	DMH39-DMH40
5	4	94.122	-108.306	DrGrt	0.00	0.23	0.75	6.0	137.25	2.02	139.15	12	Cir	0.012	1.00	142.15	CB39C-DMH39
6	4	22.185	0.798	Grate	0.00	0.07	0.66	6.0	136.65	2.03	137.10	12	Cir	0.012	1.00	140.10	CB39B-DMH39
7	4	13.875	90.000	Grate	0.00	0.20	0.75	6.0	136.65	3.24	137.10	12	Cir	0.012	1.00	140.10	CB39A-DMH39
8	1	83.280	-90.000	MH	0.00	0.00	0.00	6.0	125.00	3.96	128.30	12	Cir	0.012	1.00	134.92	DMH45-DMH46
9	8	69.853	0.000	MH	0.00	0.00	0.00	6.0	128.40	2.00	129.80	12	Cir	0.012	1.00	137.26	DMH44-DMH45
10	9	36.413	45.000	MH	0.00	0.00	0.00	6.0	133.50	4.53	135.15	12	Cir	0.012	0.75	138.29	DMH43-DMH44
11	10	27.519	45.000	MH	0.00	0.00	0.00	6.0	135.25	1.09	135.55	12	Cir	0.012	0.68	138.84	DMH42-DMH43
12	11	106.315	-1.953	DrGrt	0.00	0.19	0.78	6.0	135.65	2.87	138.70	12	Cir	0.012	1.00	141.72	CB42B-DMH42
13	11	10.852	39.428	Grate	0.00	0.23	0.81	6.0	135.65	2.30	135.90	12	Cir	0.012	1.00	138.89	CB42A-DMH42
14	9	11.536	90.000	Grate	0.00	0.10	0.66	6.0	133.50	3.90	133.95	12	Cir	0.012	1.00	137.49	CB44A-DMH44
15	9	58.305	-12.074	Grate	0.00	0.02	0.87	6.0	129.90	1.03	130.50	12	Cir	0.012	1.00	138.43	CB44B-DMH44
16	4	28.721	45.303	MH	0.00	0.00	0.00	6.0	127.80	0.52	127.95	12	Cir	0.012	0.72	139.89	DMH38-DMH39
17	16	111.252	-42.588	MH	0.00	0.00	0.00	6.0	128.05	0.49	128.60	12	Cir	0.012	1.00	132.59	DMH37-DMH38
18	17	15.617	-65.138	Grate	0.00	0.28	0.54	6.0	129.15	0.96	129.30	12	Cir	0.012	1.00	132.30	CB37B-DMH37
19	17	11.447	84.750	Grate	0.00	0.28	0.90	6.0	129.15	1.31	129.30	12	Cir	0.012	1.00	132.30	CB37A-DMH37
20	17	44.300	-107.114	MH	0.00	0.45	0.90	6.0	129.15	3.05	130.50	12	Cir	0.012	1.00	133.50	DMH36-DMH37
21	17	60.370	-30.364	DrGrt	0.00	0.04	0.30	6.0	128.70	0.50	129.00	12	Cir	0.012	1.00	131.50	CB37C-DMH37
22	8	12.000	-90.000	DrGrt	0.00	0.20	0.78	6.0	128.40	10.00	129.60	12	Cir	0.012	1.00	134.68	CB45-DMH45
23	2	54.833	-92.528	None	0.00	0.11	0.48	6.0	128.00	3.37	129.85	8	Cir	0.012	1.00	0.00	TD1-DMH41

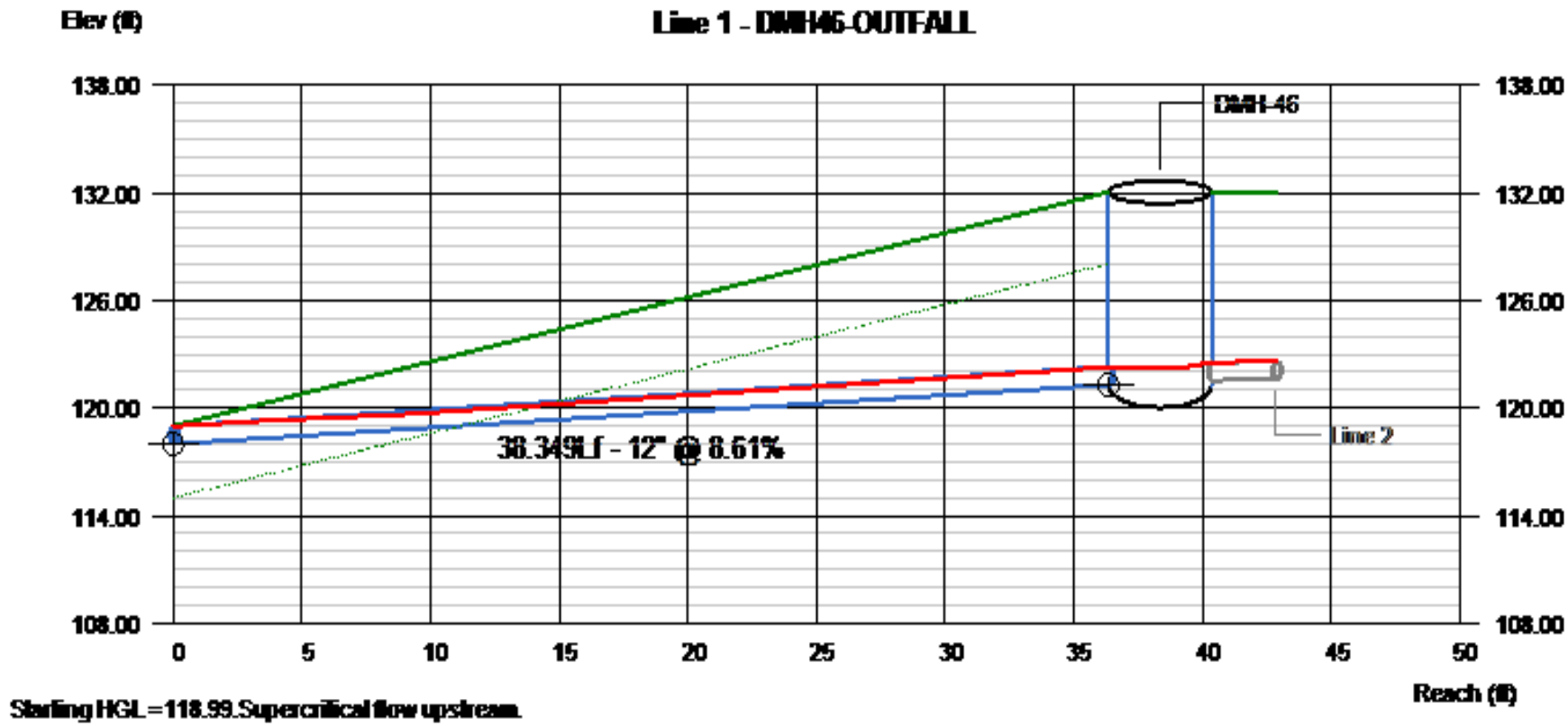
Project File: Woburn_System-2.stm | Number of lines: 23 | Date: 4/26/2020

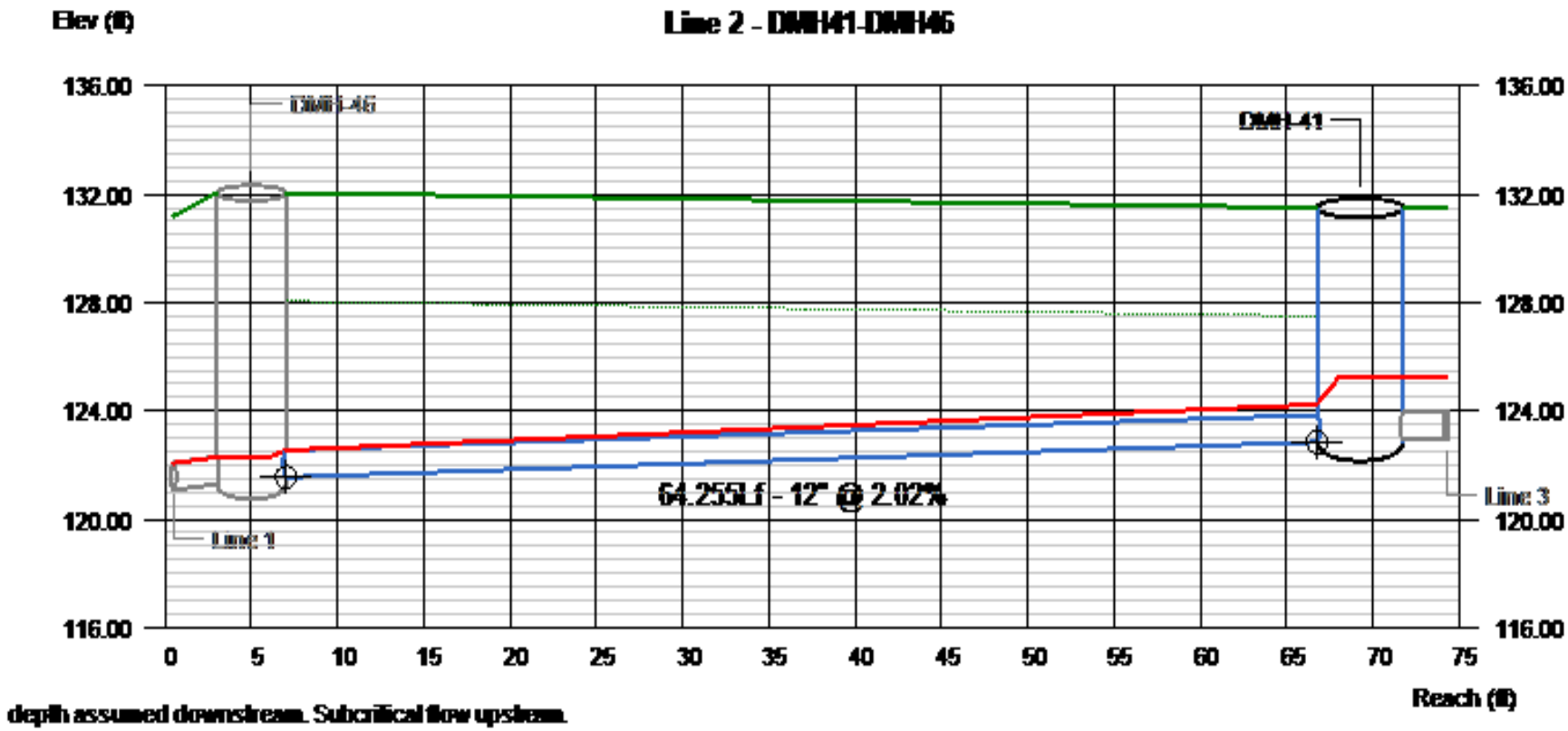
My Report

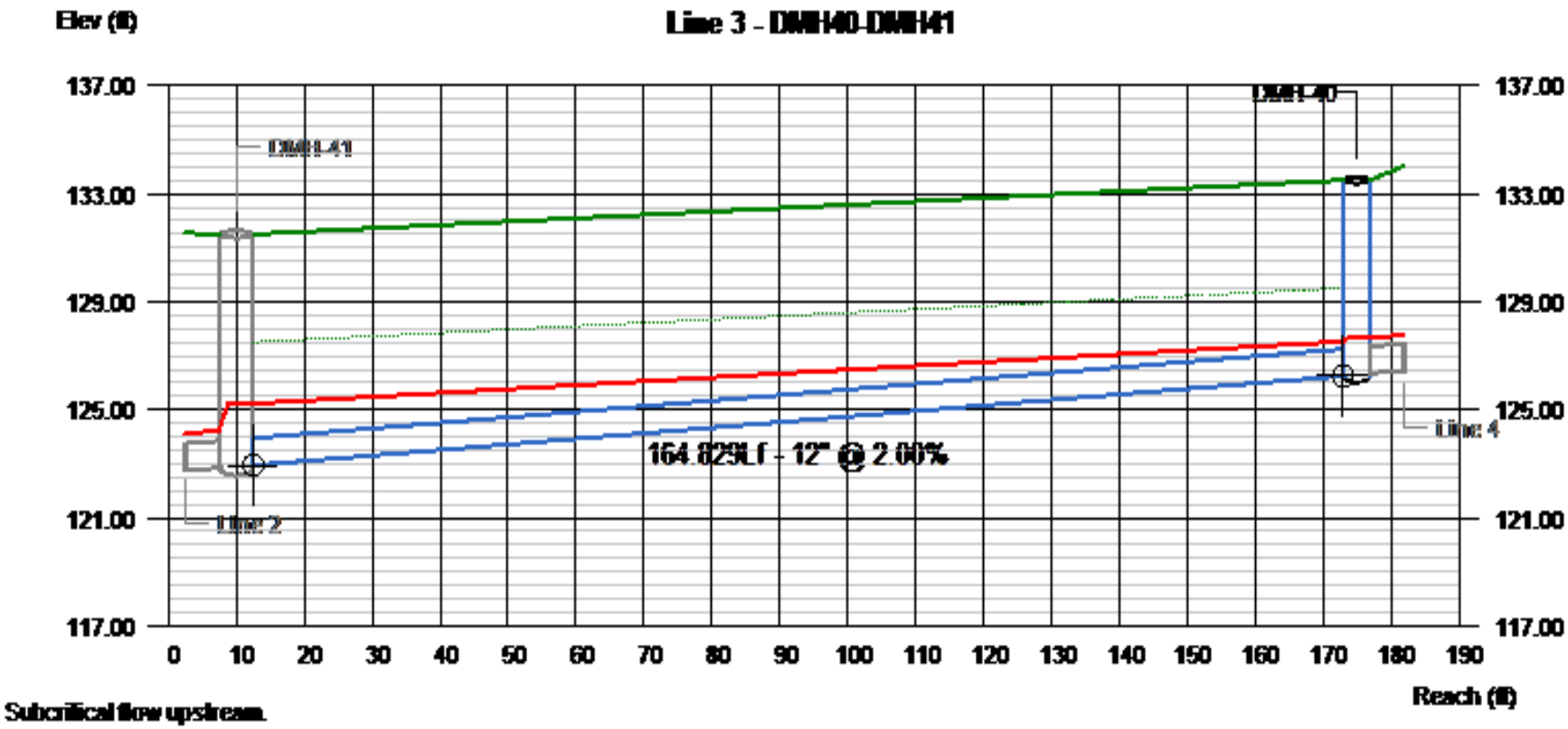
Line No.	Line ID	Flow Rate (cfs)	Line Length (ft)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Q Byp (cfs)	Byp Ln No	Minor Loss (ft)	HGL Jnct (ft)	DnStm Ln No	Junct Type
1	DMH46-OUTFALL	8.42	38.349	118.00	121.30	8.61	118.99	122.29 j	....	n/a	n/a	122.29	Outfall	MH
2	DMH41-DMH46	6.26	64.255	121.55	122.85	2.02	122.55	124.24	....	n/a	0.99	125.23	1	MH
3	DMH40-DMH41	4.55	164.829	122.95	126.25	2.00	125.23	127.53	....	n/a	0.16	127.69	2	MH
4	DMH39-DMH40	4.57	64.930	126.35	127.70	2.08	127.69	128.59 j	....	n/a	n/a	128.59	3	MH
5	CB39C-DMH39	0.94	94.122	137.25	139.15	2.02	137.53	139.56	0.52	7	n/a	139.56	4	Dp-Grate
6	CB39B-DMH39	0.25	22.185	136.65	137.10	2.03	136.80	137.31	0.00	18	n/a	137.31	4	Grate
7	CB39A-DMH39	0.82	13.875	136.65	137.10	3.24	136.88	137.48	0.28	19	0.14	137.48	4	Grate
8	DMH45-DMH46	2.43	83.280	125.00	128.30	3.96	125.39	128.97	....	n/a	0.30	128.97	1	MH
9	DMH44-DMH45	1.79	69.853	128.40	129.80	2.00	128.97	130.37	....	n/a	0.23	130.37	8	MH
10	DMH43-DMH44	1.71	36.413	133.50	135.15	4.53	133.81	135.71	....	n/a	0.17	135.71	9	MH
11	DMH42-DMH43	1.72	27.519	135.25	135.55	1.09	135.71	136.11	....	n/a	0.15	136.11	10	MH
12	CB42B-DMH42	0.81	106.315	135.65	138.70	2.87	136.11	139.08 j	0.43	13	n/a	139.08	11	Dp-Grate
13	CB42A-DMH42	1.02	10.852	135.65	135.90	2.30	136.11	136.32 j	0.32	14	n/a	136.32	11	Grate
14	CB44A-DMH44	0.36	11.536	133.50	133.95	3.90	133.65	134.20	0.00	Offsite	0.09	134.20	9	Grate
15	CB44B-DMH44	0.09	58.305	129.90	130.50	1.03	130.37	130.63 j	0.00	22	n/a	130.63	9	Grate
16	DMH38-DMH39	3.16	28.721	127.80	127.95	0.52	128.80	128.95	....	n/a	0.18	129.13	4	MH
17	DMH37-DMH38	3.18	111.252	128.05	128.60	0.49	129.13	129.89	....	n/a	0.26	130.14	16	MH
18	CB37B-DMH37	0.82	15.617	129.15	129.30	0.96	130.14	129.68	0.00	Offsite	n/a	129.68	17	Grate
19	CB37A-DMH37	1.37	11.447	129.15	129.30	1.31	130.14	129.80	0.00	Offsite	0.19	129.80	17	Grate
20	DMH36-DMH37	2.21	44.300	129.15	130.50	3.05	130.14	131.13 j	....	n/a	n/a	131.13	17	MH
21	CB37C-DMH37	0.07	60.370	128.70	129.00	0.50	130.14	130.14	0.00	Sag	0.00	130.14	17	Dp-Grate
22	CB45-DMH45	0.85	12.000	128.40	129.60	10.00	128.97	129.99 j	0.26	Offsite	n/a	129.99	8	Dp-Grate
23	TD1-DMH41	0.29	54.833	128.00	129.85	3.37	128.16	130.10	....	n/a	n/a	130.10	2	None

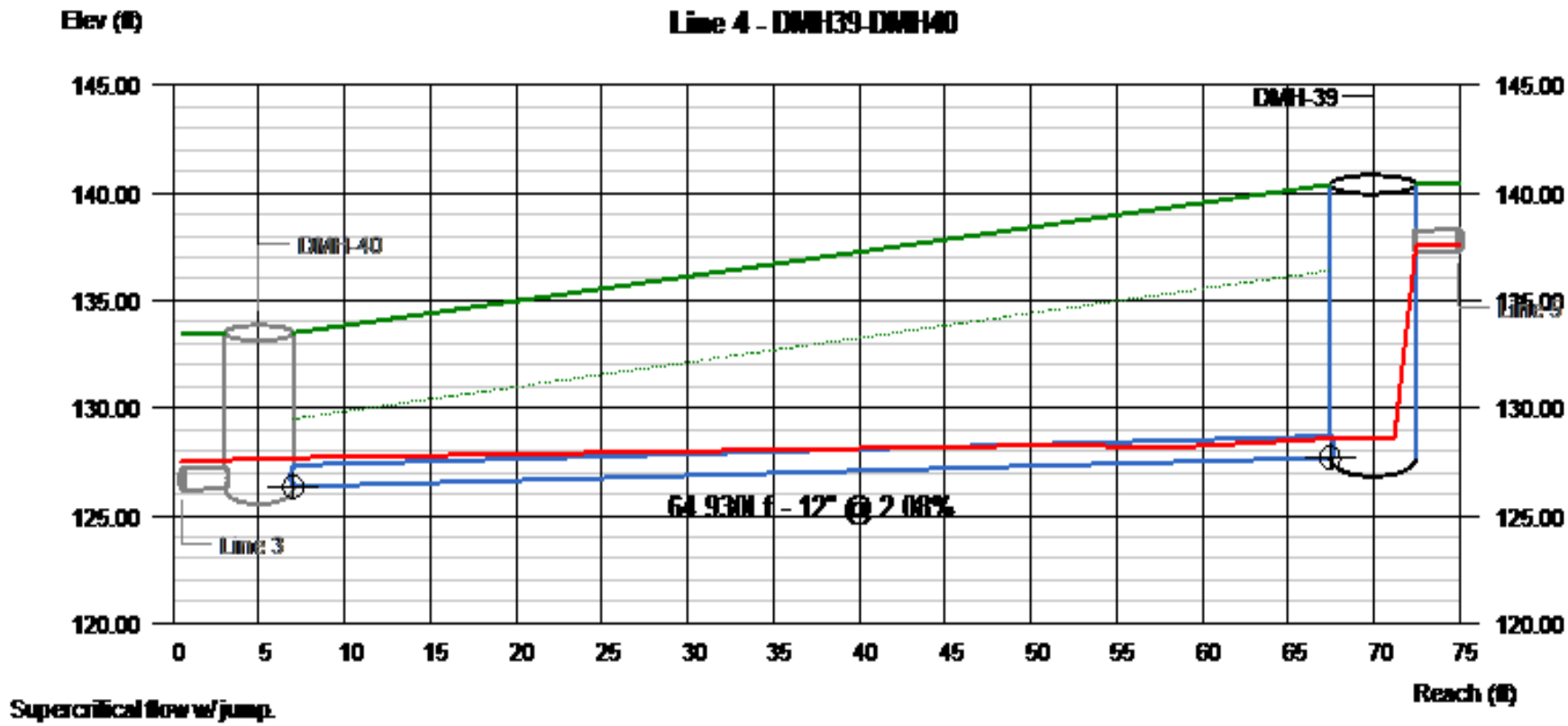
Project File: Woburn_System-2.stm | Number of lines: 23 | Date: 4/26/2020

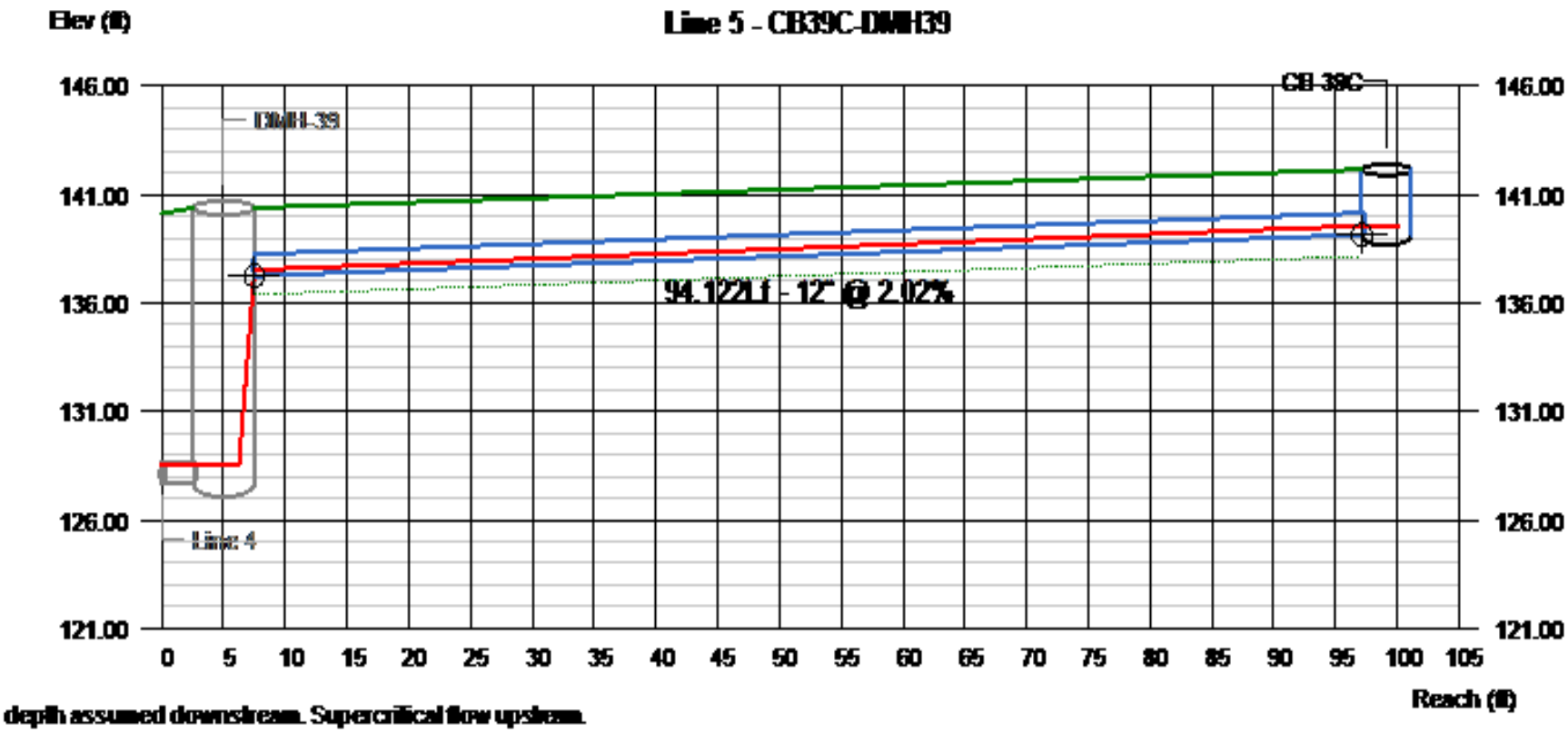
NOTES: ** Critical depth

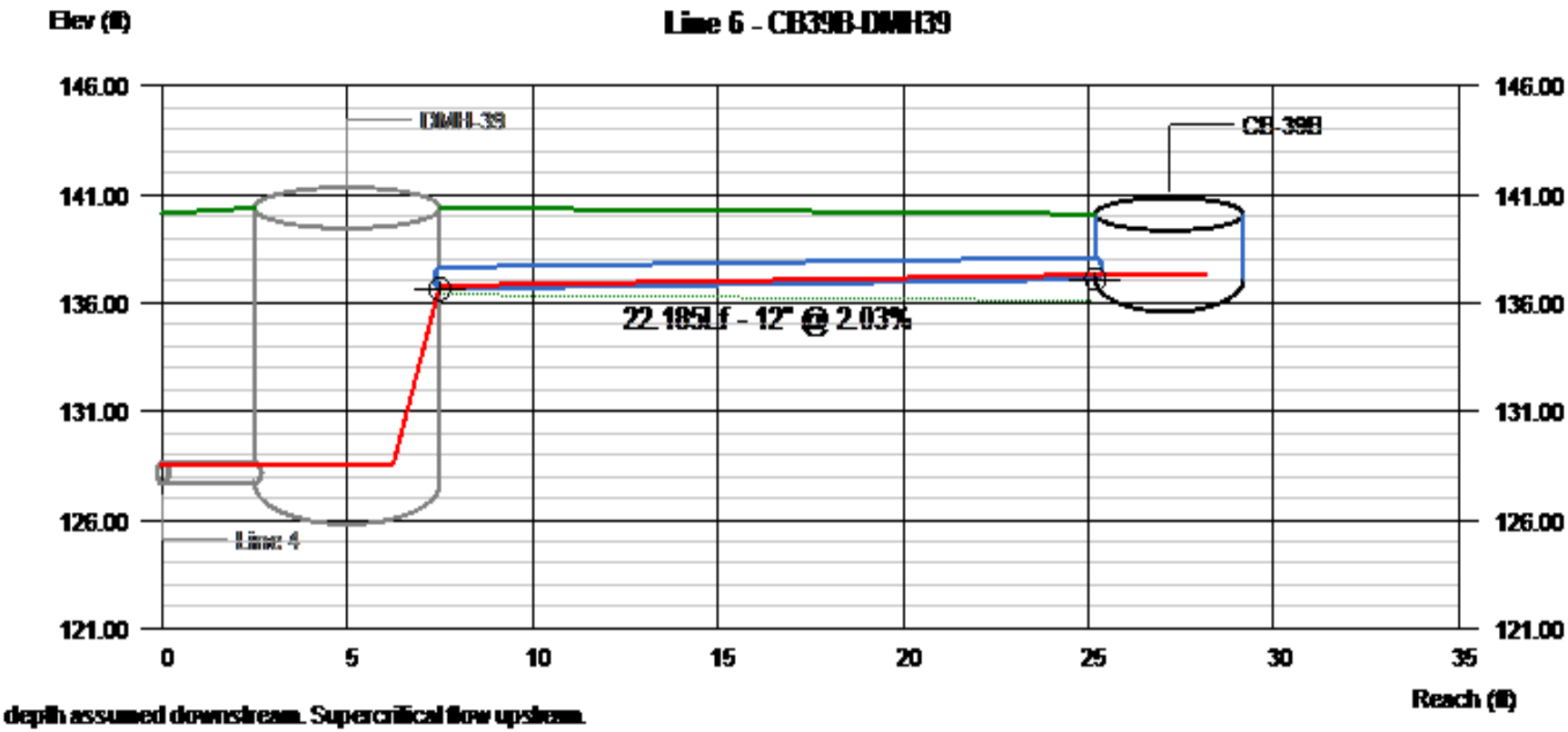

Elev (ft)
Line 1 - DMH46-OUTFALL
138.00
132.00
126.00
120.00
114.00
108.00
DMH-46
Line 2
38.34 LF - 12" @ 8.61%
0
5
10
15
20
25
30
35
40
45
50
Reach (ft)
Starting HGL = 118.99. Supercritical flow upstream.

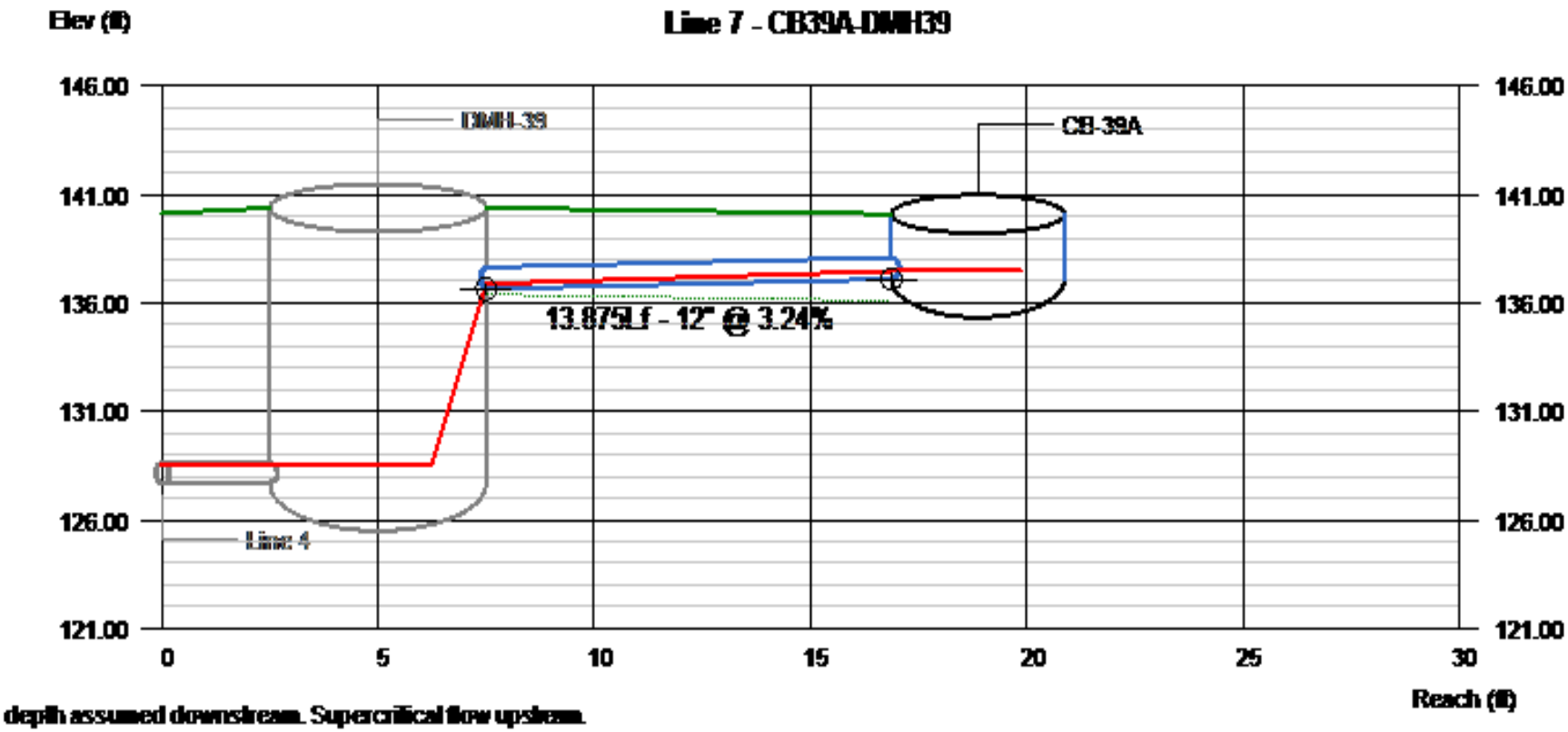

Elev (ft)
Line 2 - DMH41-DMH46
136.00
132.00
128.00
124.00
120.00
116.00
DMH-46
DMH-41
Line 1
Line 3
64.25 LF - 12" @ 2.02%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Reach (ft)
depth assumed downstream. Subcritical flow upstream.

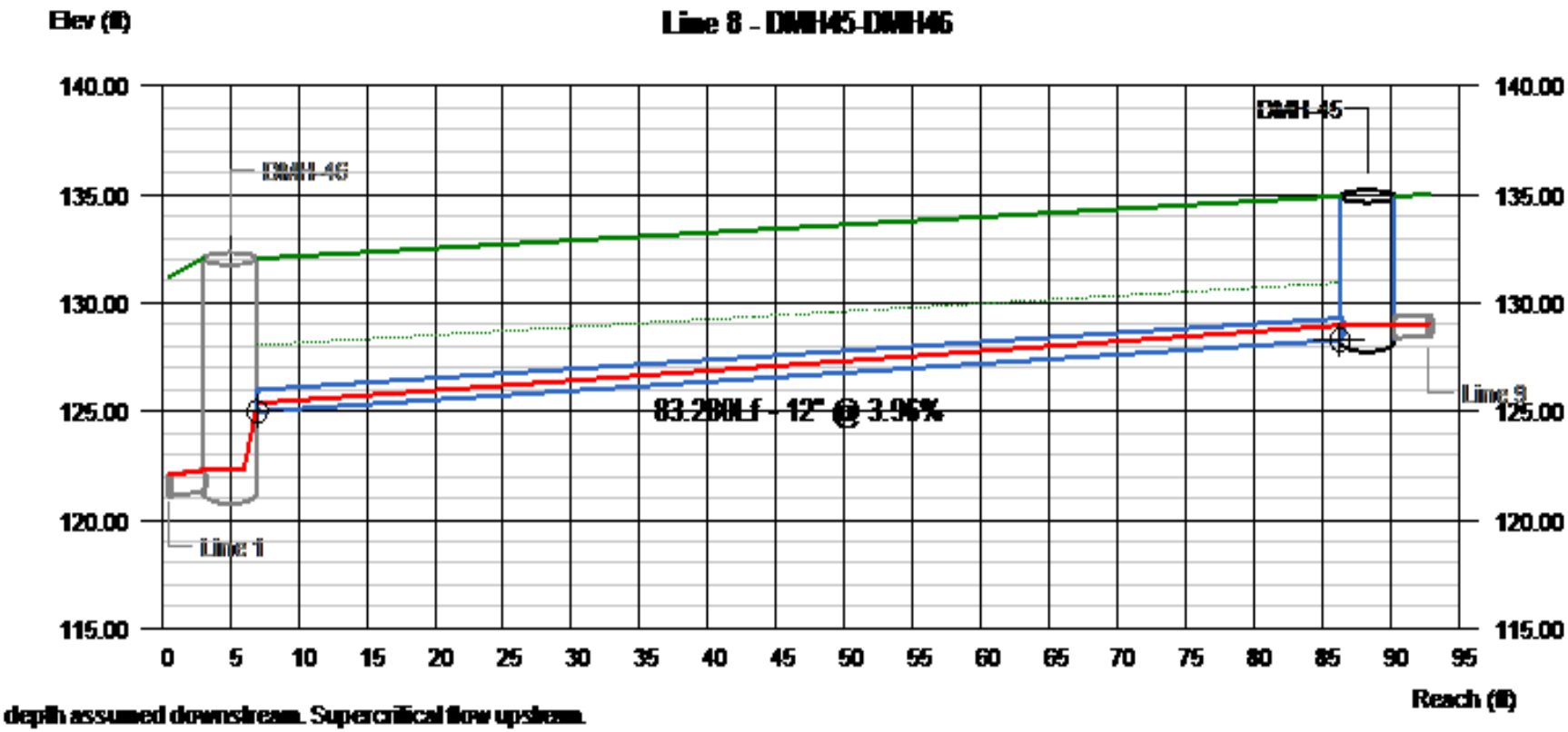

Elev (ft)
Line 3 - DMH40-DMH41
137.00
133.00
129.00
125.00
121.00
117.00
DMH41
DMH40
Line 2
Line 4
164.829LF - 12" @ 2.00%
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
Reach (ft)
Subcritical flow upstream.

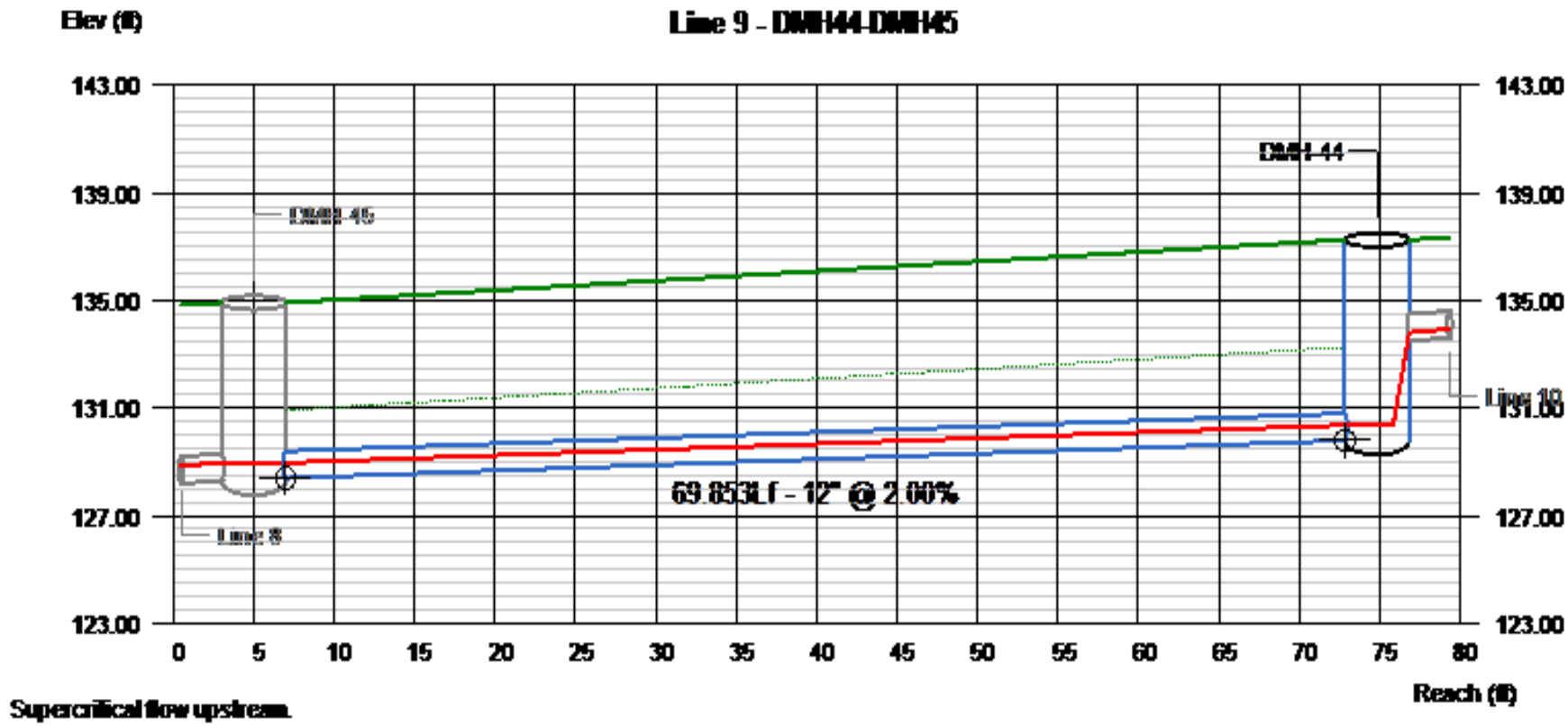

Elev (ft)
Line 4 - DMH39-DMH40
145.00
140.00
135.00
130.00
125.00
120.00
DMH-39
DMH-40
Line 3
64.9301 ft - 12" @ 2.08%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Reach (ft)
Supercritical flow w/jump.

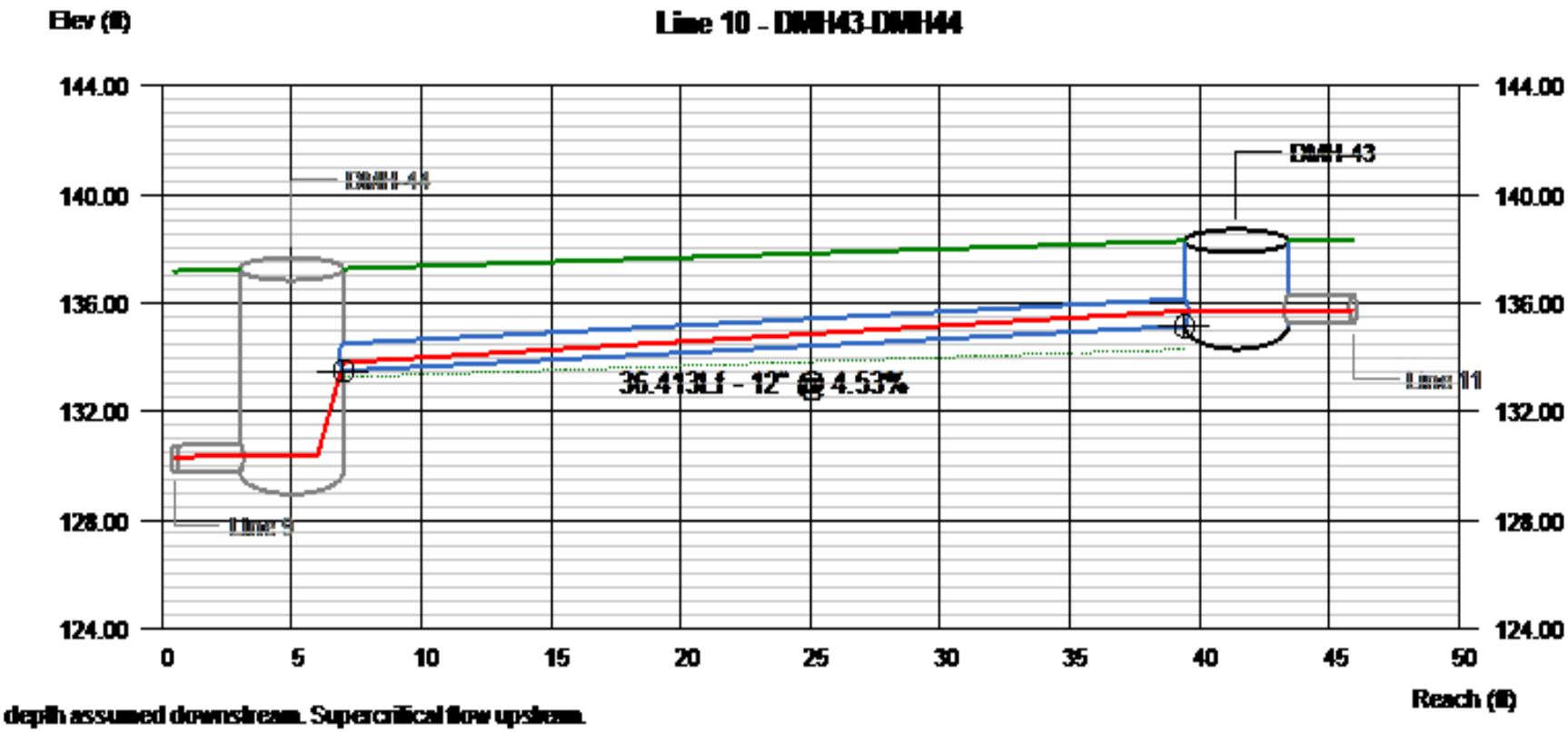

Elev (ft)
Line 5 - CB39C-DMH39
146.00
141.00
136.00
131.00
126.00
121.00
DMH-39
CB-39C
Line 4
94.122 lf - 12" @ 2.02%
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

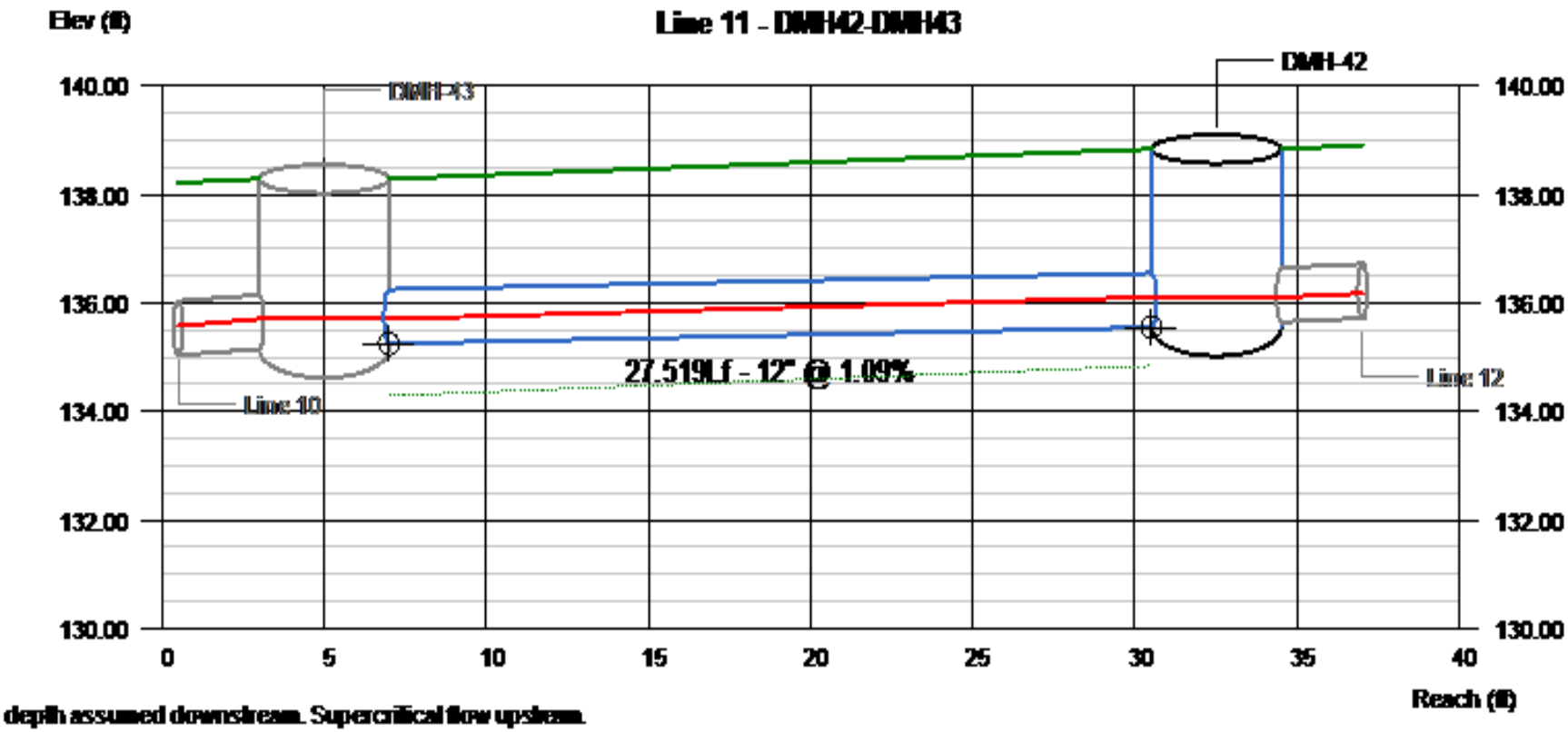

Elev (ft)
Line 6 - CB39B-DMH39
146.00
141.00
136.00
131.00
126.00
121.00
DMH-39
CB-39B
22.185Lf - 12" @ 2.03%
Line: 4
0
5
10
15
20
25
30
35
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

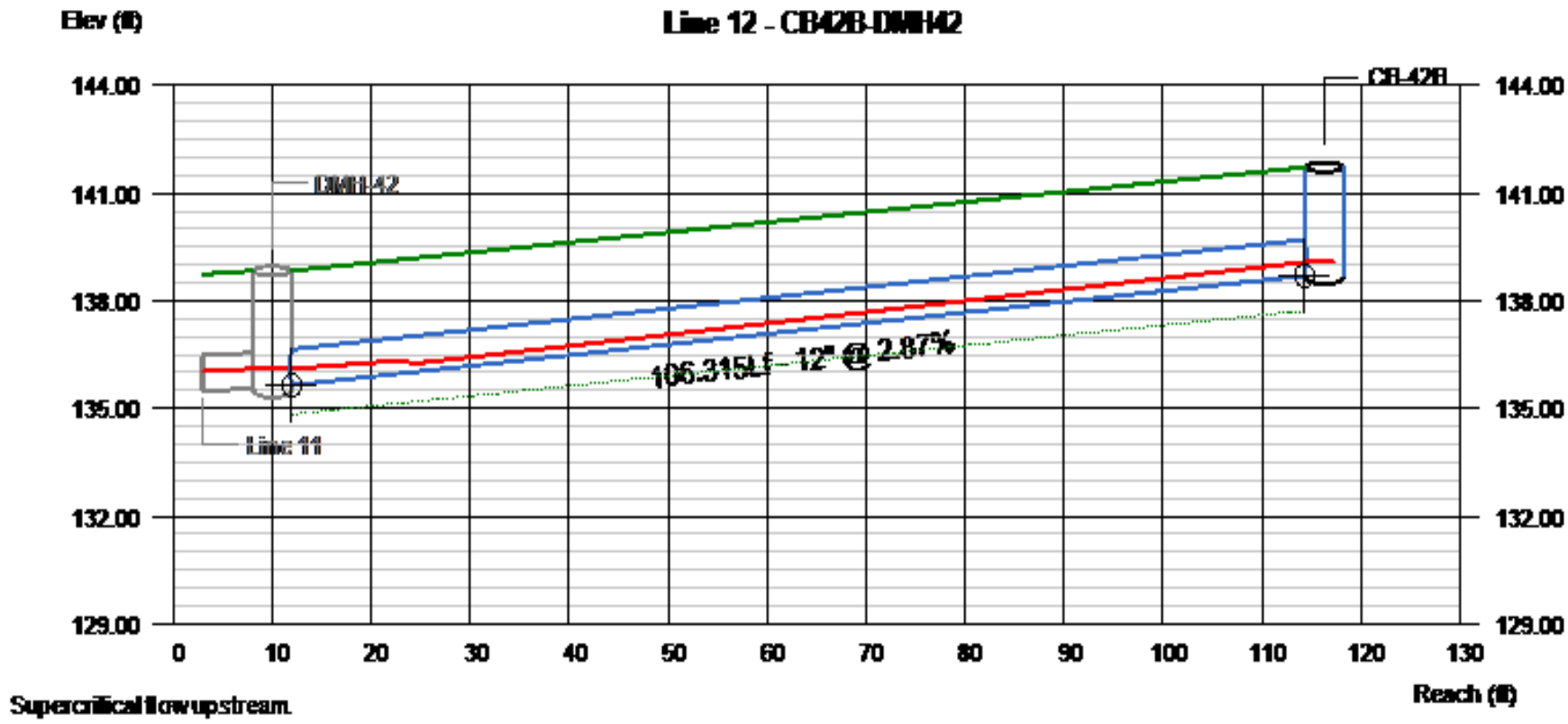

Elev (ft)
Line 7 - CB39A-DMH39
146.00
141.00
136.00
131.00
126.00
121.00
DMH-39
CB-39A
13.875Lf - 12" @ 3.24%
Line 4
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

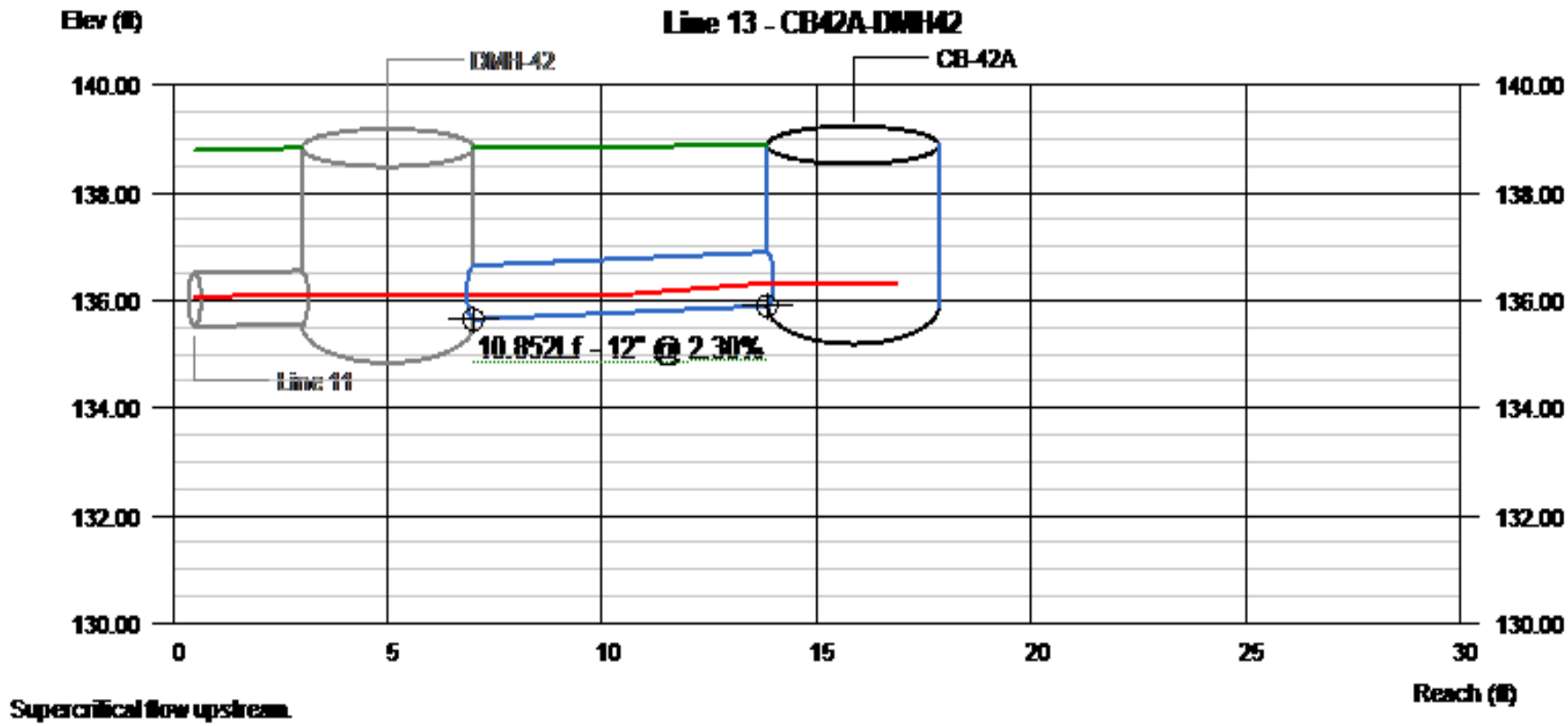

Elev (ft)
Line 8 - DMH45-DMH46
140.00
135.00
130.00
125.00
120.00
115.00
DMH-45
DMH-46
Line 9
Line 1
83.28lf - 12" @ 3.96%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

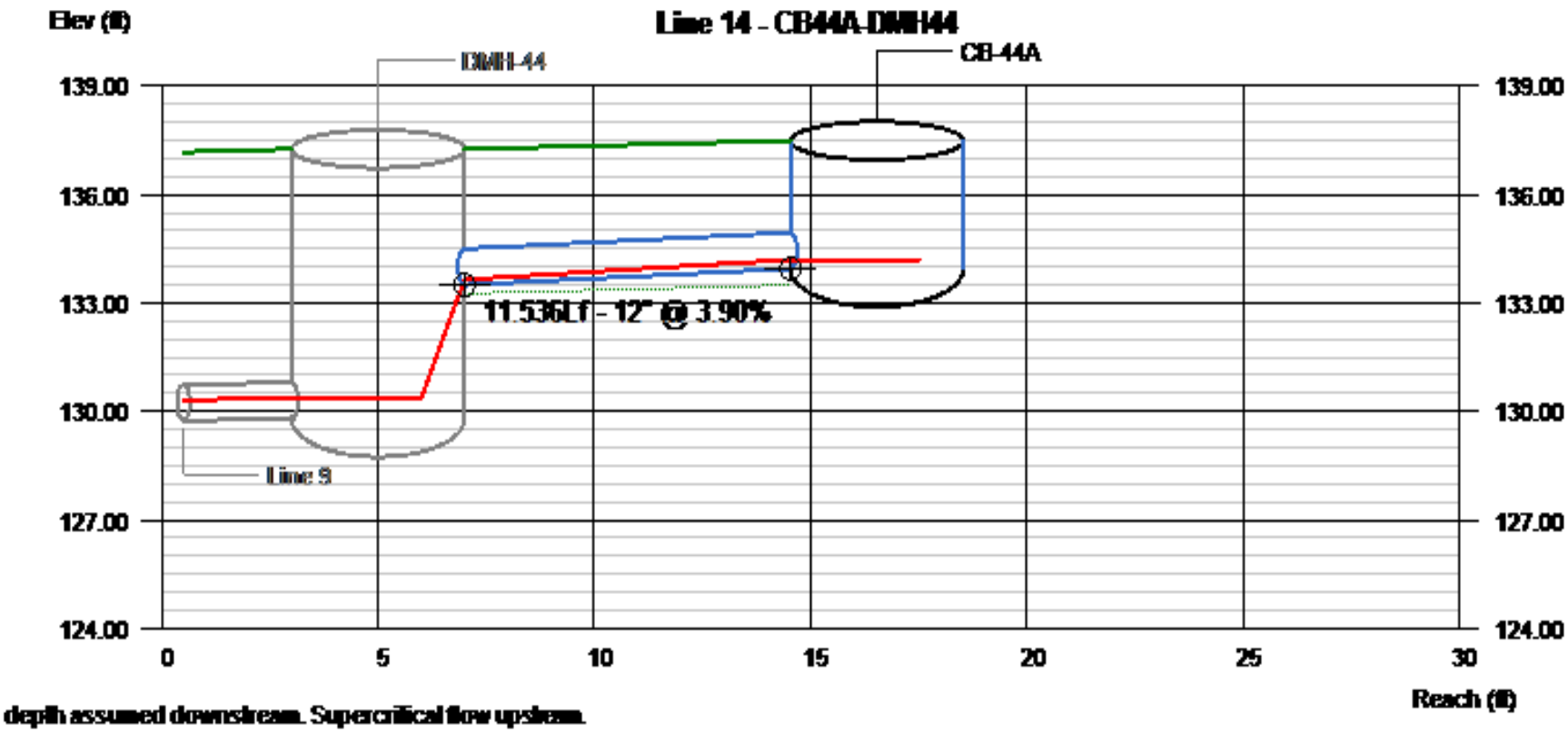

Elev (ft)
Line 9 - DMH44-DMH45
143.00
139.00
135.00
131.00
127.00
123.00
DMH-44
Line 10
69.853LF - 12" @ 2.00%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Reach (ft)
Supercritical flow upstream.

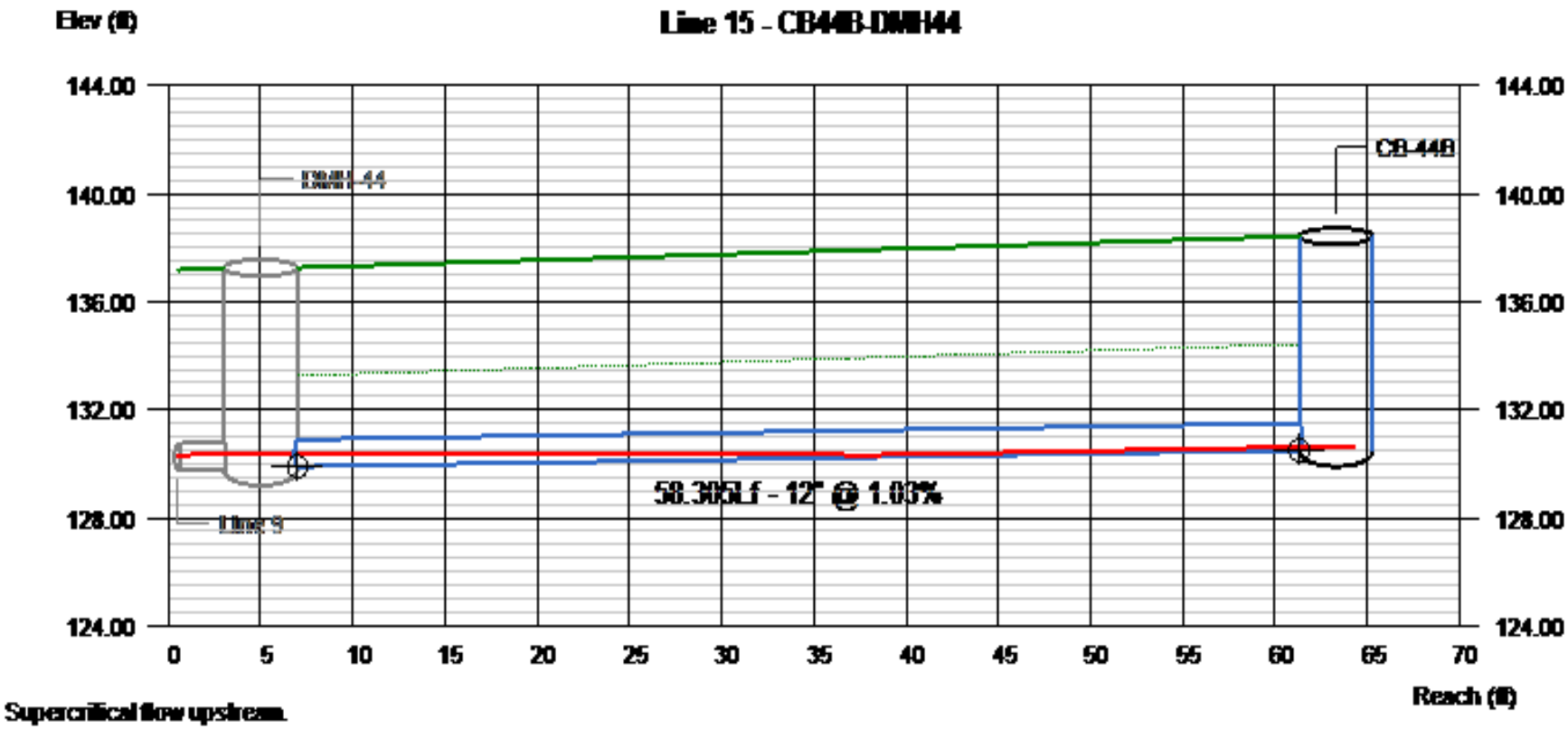

Elev (ft)
Line 10 - DMH43-DMH44
144.00
140.00
136.00
132.00
128.00
124.00
DMH-43
36.413Lf - 12" @ 4.53%
Line 11
0
5
10
15
20
25
30
35
40
45
50
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

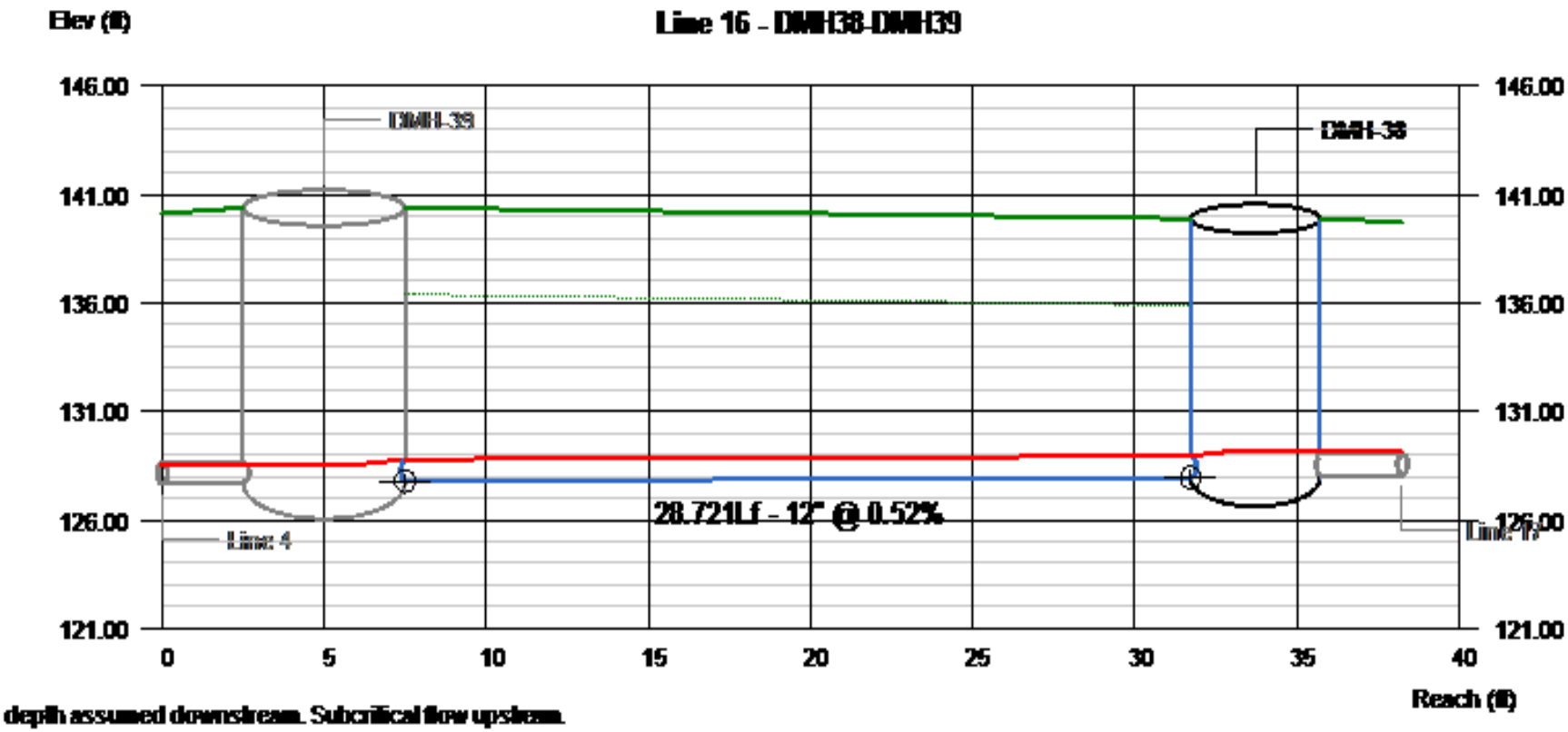

Elev (ft)
Line 11 - DMH42-DMH43
DMH-42
DMH-43
140.00
138.00
136.00
134.00
132.00
130.00
27.519Lf - 12" @ 1.09%
Line 10
Line 12
0
5
10
15
20
25
30
35
40
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

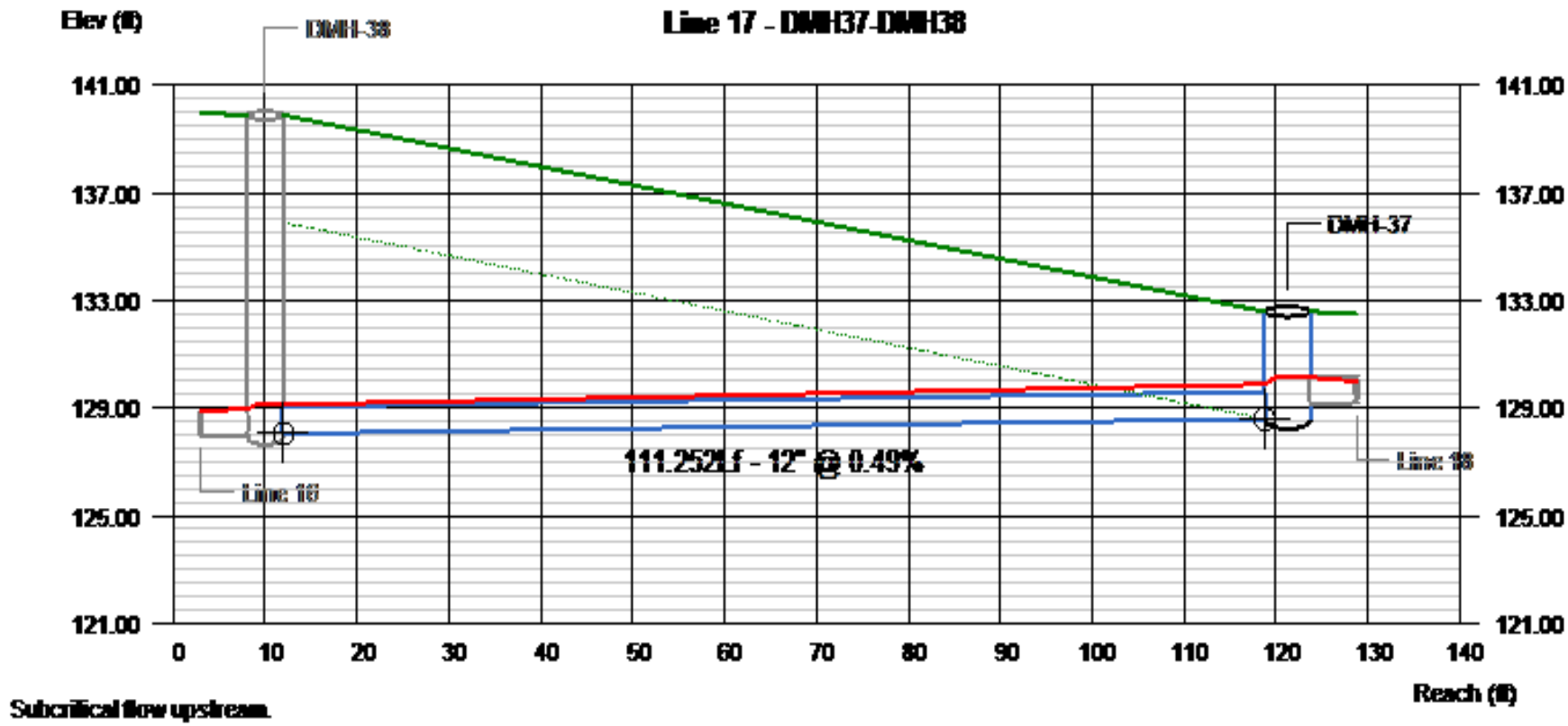

Elev (ft)
Line 12 - CB42B-DMH42
CB-42B
DMH42
Line 11
106.315LF - 12" @ 2.87%
144.00
141.00
138.00
135.00
132.00
129.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Reach (ft)
Supercritical flow upstream.

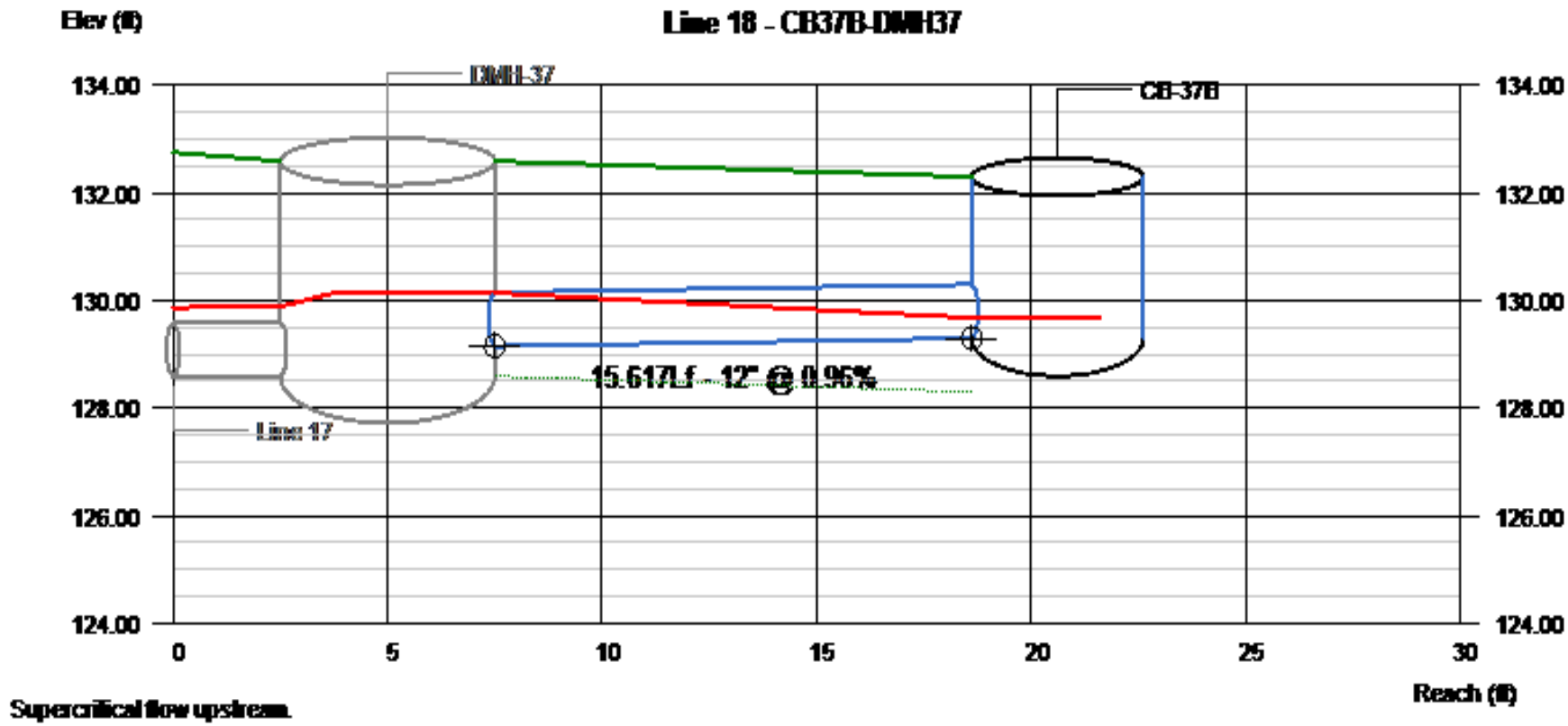

Elev (ft)
Line 13 - CB42A-DMH42
DMH-42
CB-42A
140.00
138.00
136.00
134.00
132.00
130.00
10.852ft - 12" @ 2.30%
Line 11
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

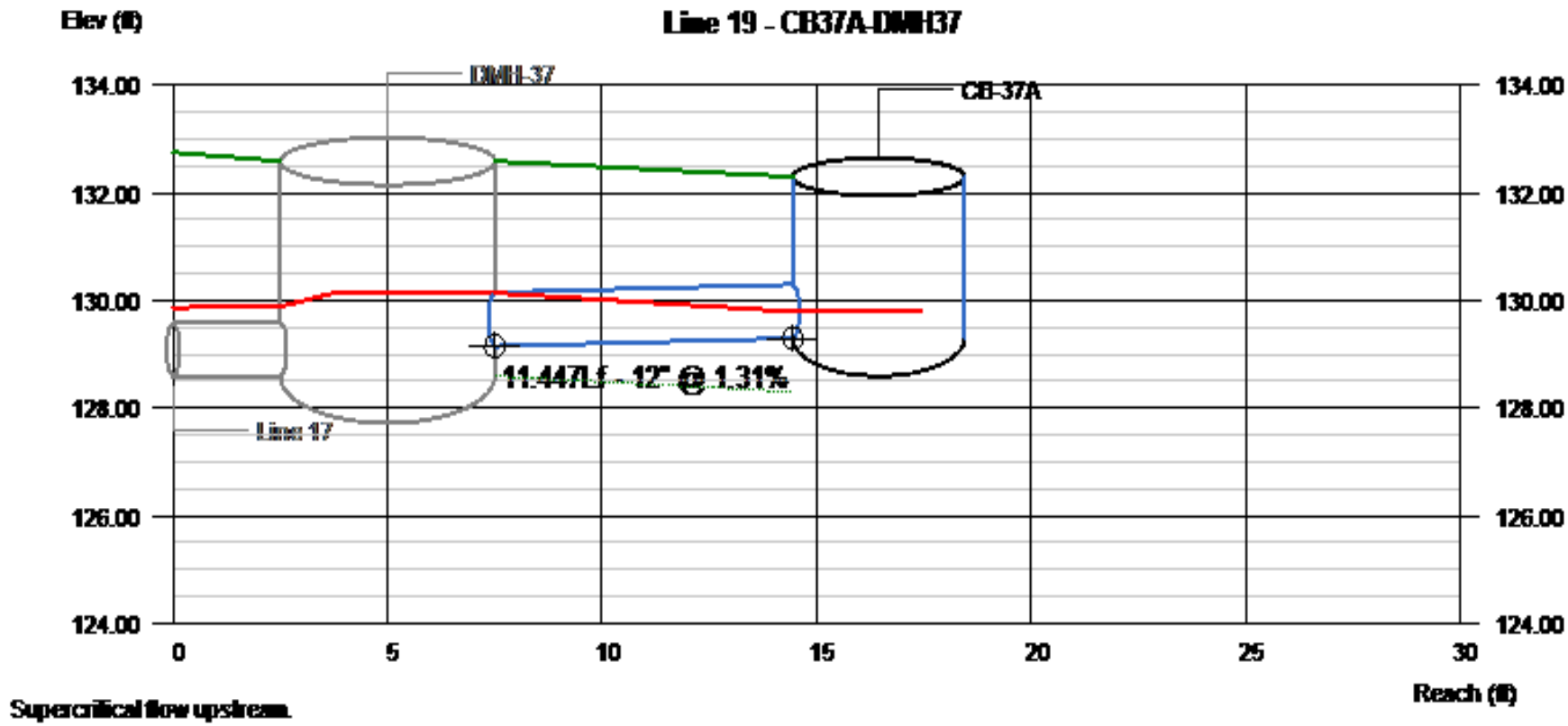

Elev (ft)
Line 14 - CB44A-DMH44
DMH-44
CB-44A
139.00
136.00
133.00
130.00
127.00
124.00
11.536Lf - 12" @ 3.90%
Line 9
0
5
10
15
20
25
30
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

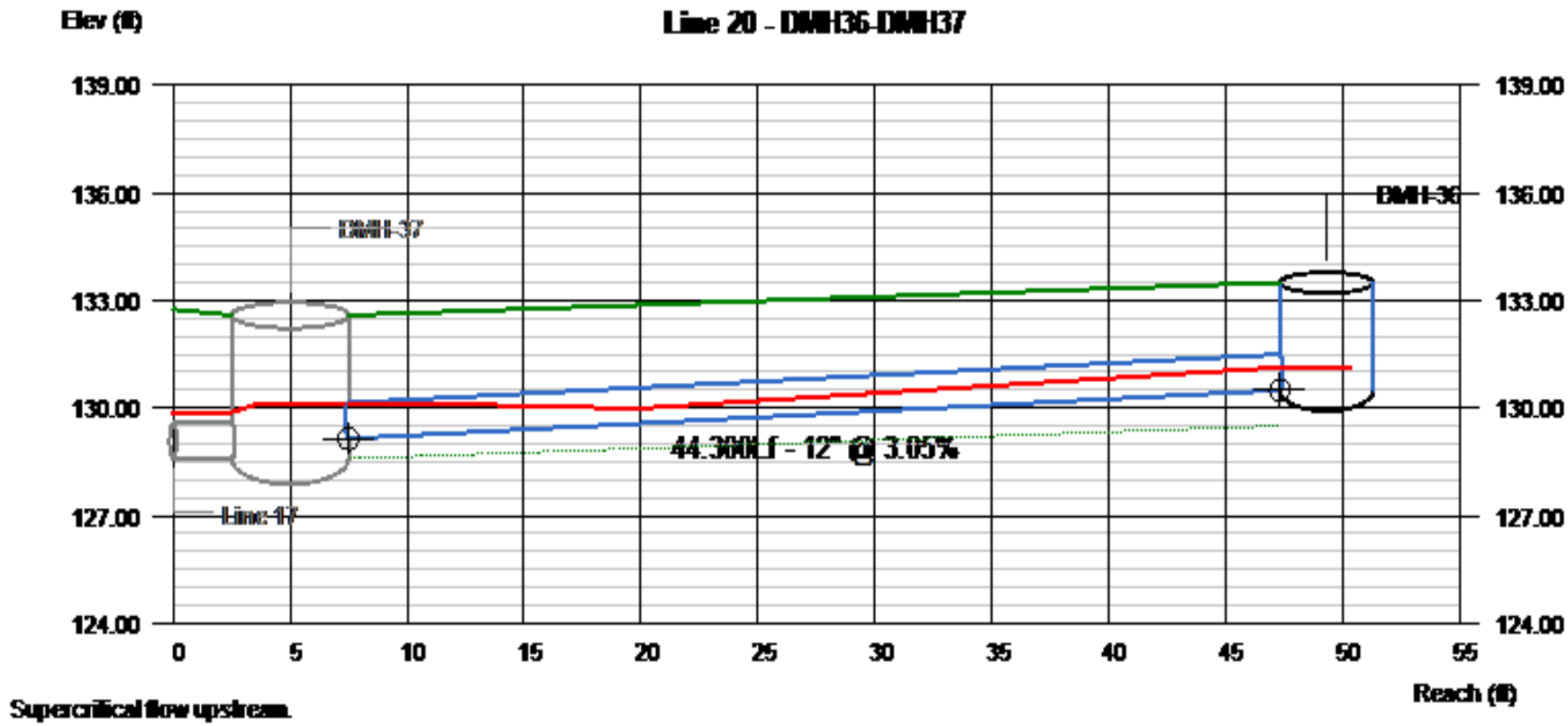

Elev (ft)
Line 15 - CB44B-DMH44
144.00
140.00
136.00
132.00
128.00
124.00
CB-44B
Line 9
58.305Lf - 12" @ 1.03%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Reach (ft)
Supercritical flow upstream.

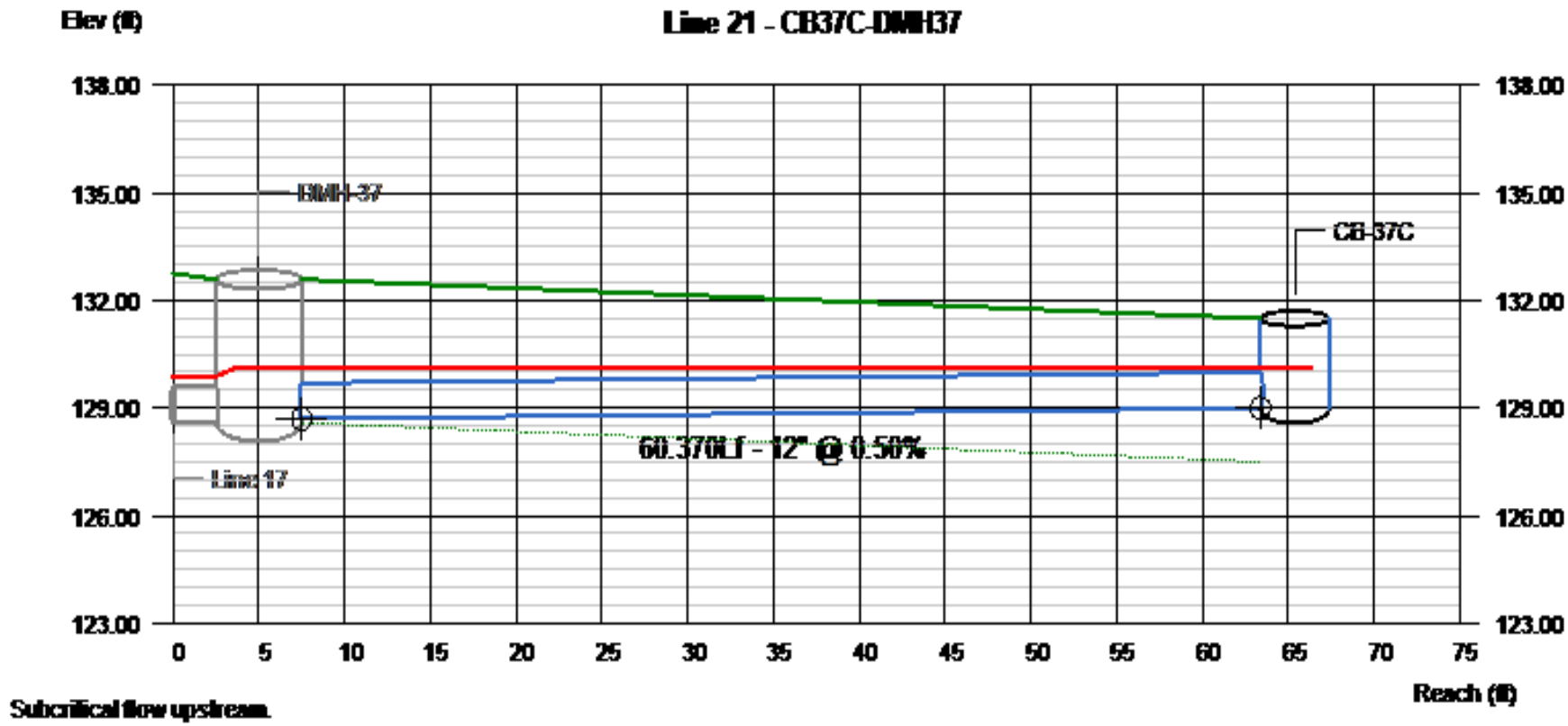

Elev (ft)
Line 16 - DMH38-DMH39
146.00
141.00
136.00
131.00
126.00
121.00
DMH-39
DMH-38
Line: 4
28.721Lf - 12" @ 0.52%
0
5
10
15
20
25
30
35
40
Reach (ft)
depth assumed downstream. Subcritical flow upstream.

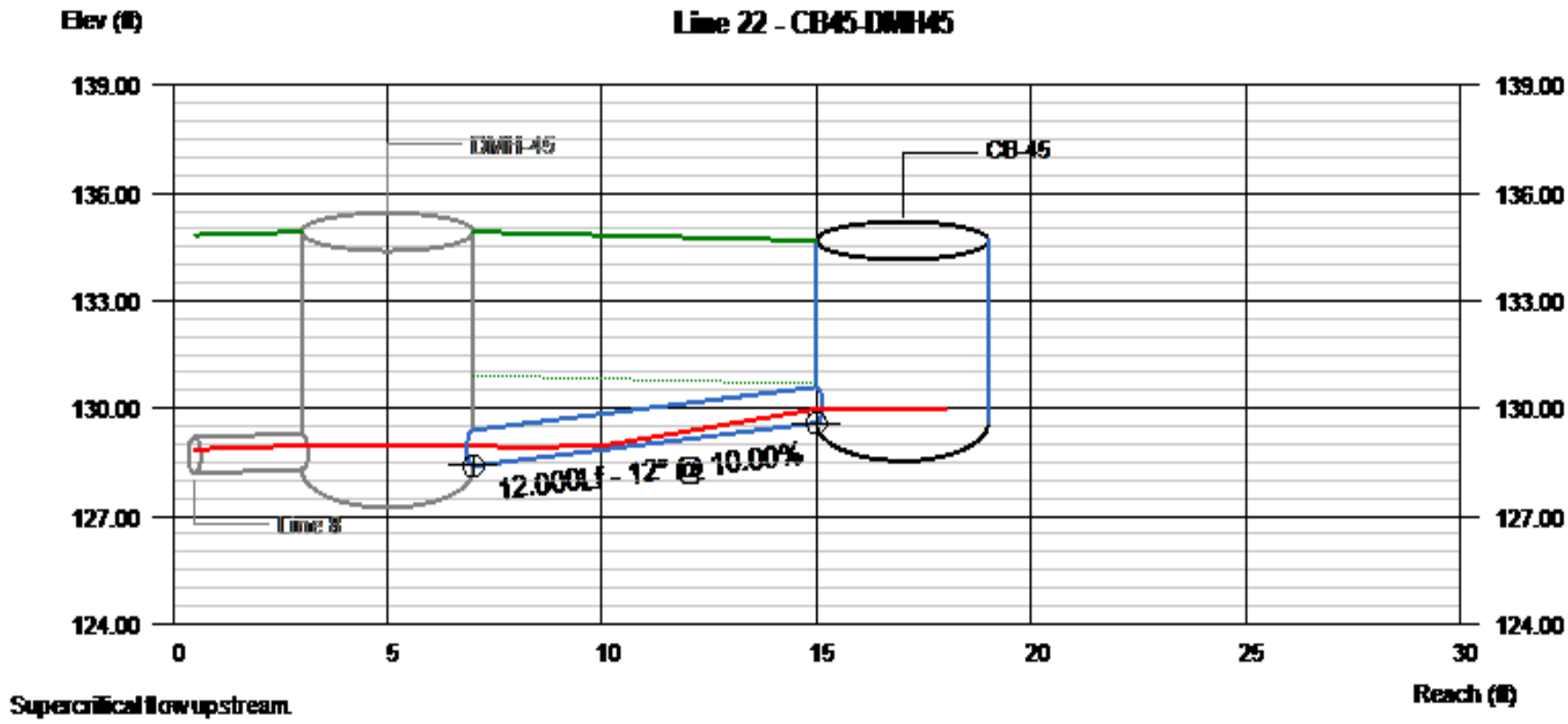

Elev (ft)
Line 17 - DMH37-DMH38
DMH-38
DMH-37
Line: 16
Line: 18
111.252ft - 12" @ 0.49%
141.00
137.00
133.00
129.00
125.00
121.00
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
Reach (ft)
Subcritical flow upstream.

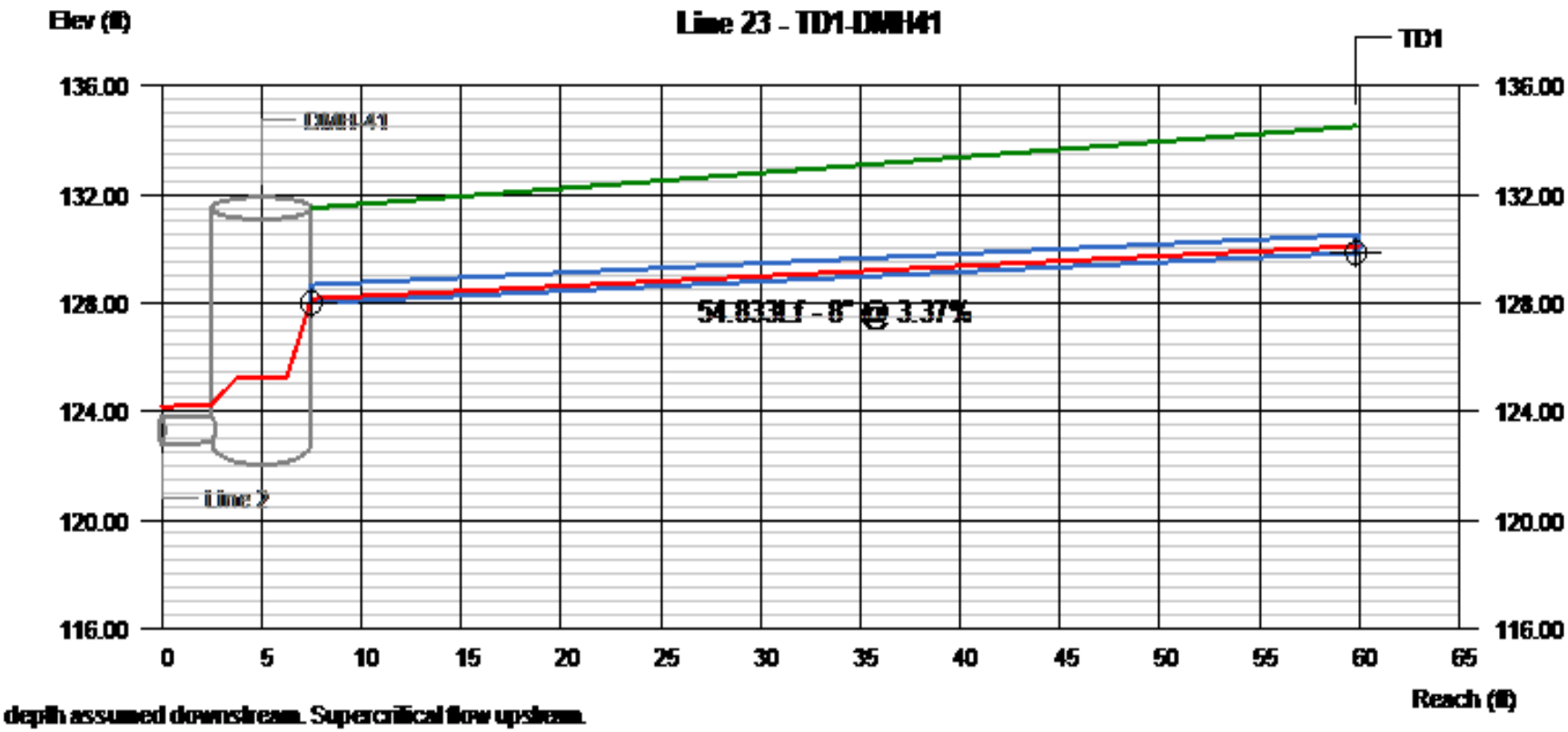

Elev (ft)
Line 18 - CB37B-DMH37
DMH-37
CB-37B
134.00
132.00
130.00
128.00
126.00
124.00
15.617Lf - 12" @ 0.96%
Line 17
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.


Elev (ft)
Line 19 - CB37A-DMH37
DMH-37
CB-37A
134.00
132.00
130.00
128.00
126.00
124.00
11.447LF - 12" @ 1.31%
Line 17
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.

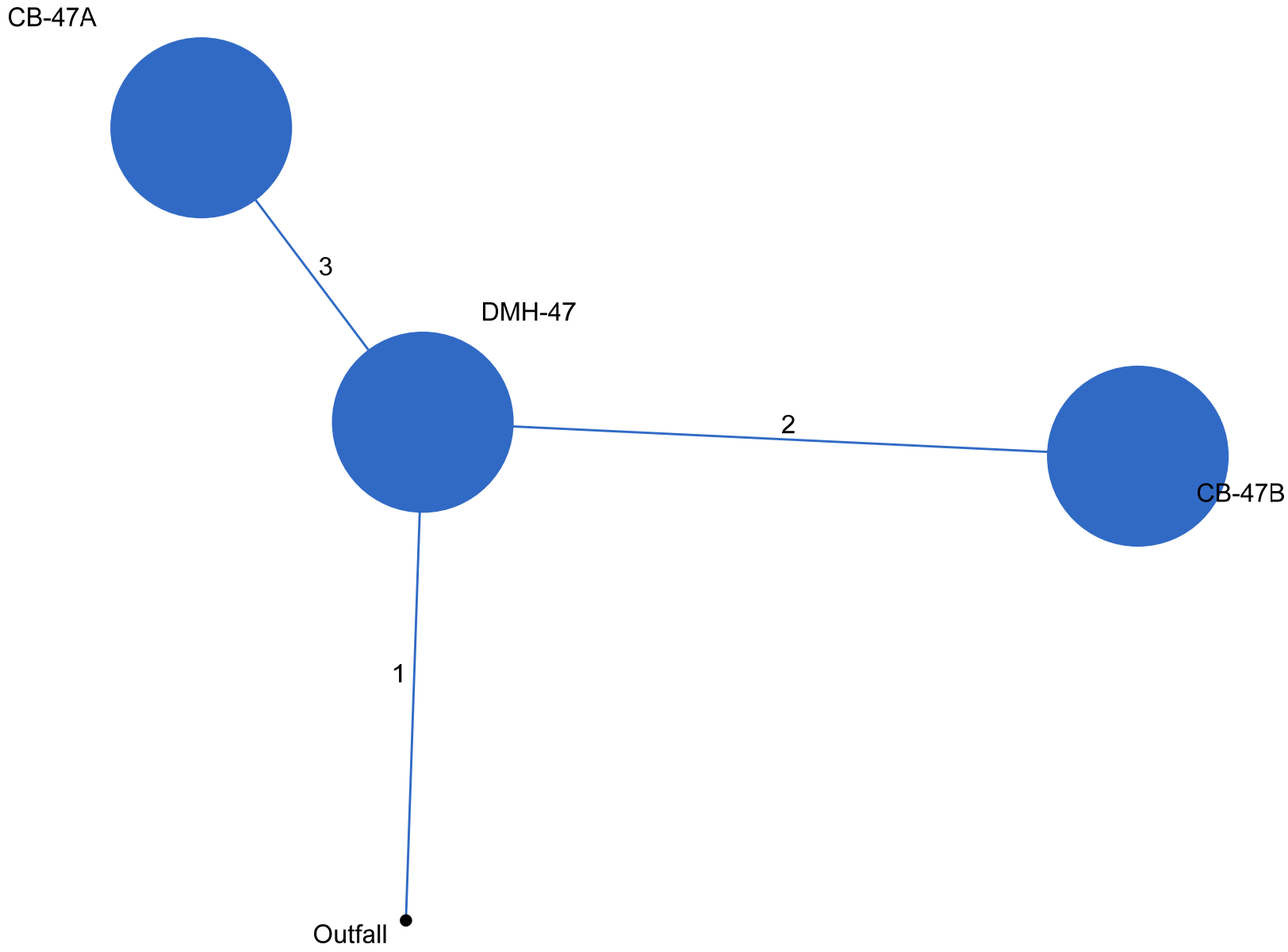

Elev (ft)
Line 20 - DMH36-DMH37
139.00
136.00
133.00
130.00
127.00
124.00
DMH-37
DMH-36
Line 17
44.30ft.f - 12" @ 3.05%
0
5
10
15
20
25
30
35
40
45
50
55
Reach (ft)
Supercritical flow upstream.


Elev (ft)
Line 21 - CB37C-DMH37
138.00
135.00
132.00
129.00
126.00
123.00
DMH-37
CB-37C
60.37(ft) - 12" @ 0.50%
Line 17
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Reach (ft)
Subcritical flow upstream.


Elev (ft)
Line 22 - CB45-DMH45
139.00
136.00
133.00
130.00
127.00
124.00
DMH-45
CB-45
Line 8
12.000LF - 12" @ 10.00%
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.


Elev (ft)
Line 23 - TD1-DMH41
TD1
DMH41
Line 2
54.833 lf - 8" @ 3.37%
136.00
132.00
128.00
124.00
120.00
116.00
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Reach (ft)
depth assumed downstream. Supercritical flow upstream.

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



Project File: Woburn_System-3.stm	Number of lines: 3	Date: 4/26/2020

Storm Sewers v11.00

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	10.905	-87.762	MH	0.00	0.00	0.00	6.0	119.00	2.29	119.25	12	Cir	0.012	1.00	125.26	DMH47-OUTFALL
2	1	15.902	90.000	Grate	0.31	0.32	0.69	6.0	119.50	3.77	120.10	12	Cir	0.012	1.00	125.10	CB47B-DMH47
3	1	8.113	-39.853	Grate	0.00	0.11	0.84	6.0	119.50	7.40	120.10	12	Cir	0.012	1.00	125.10	CB47A-DMH47

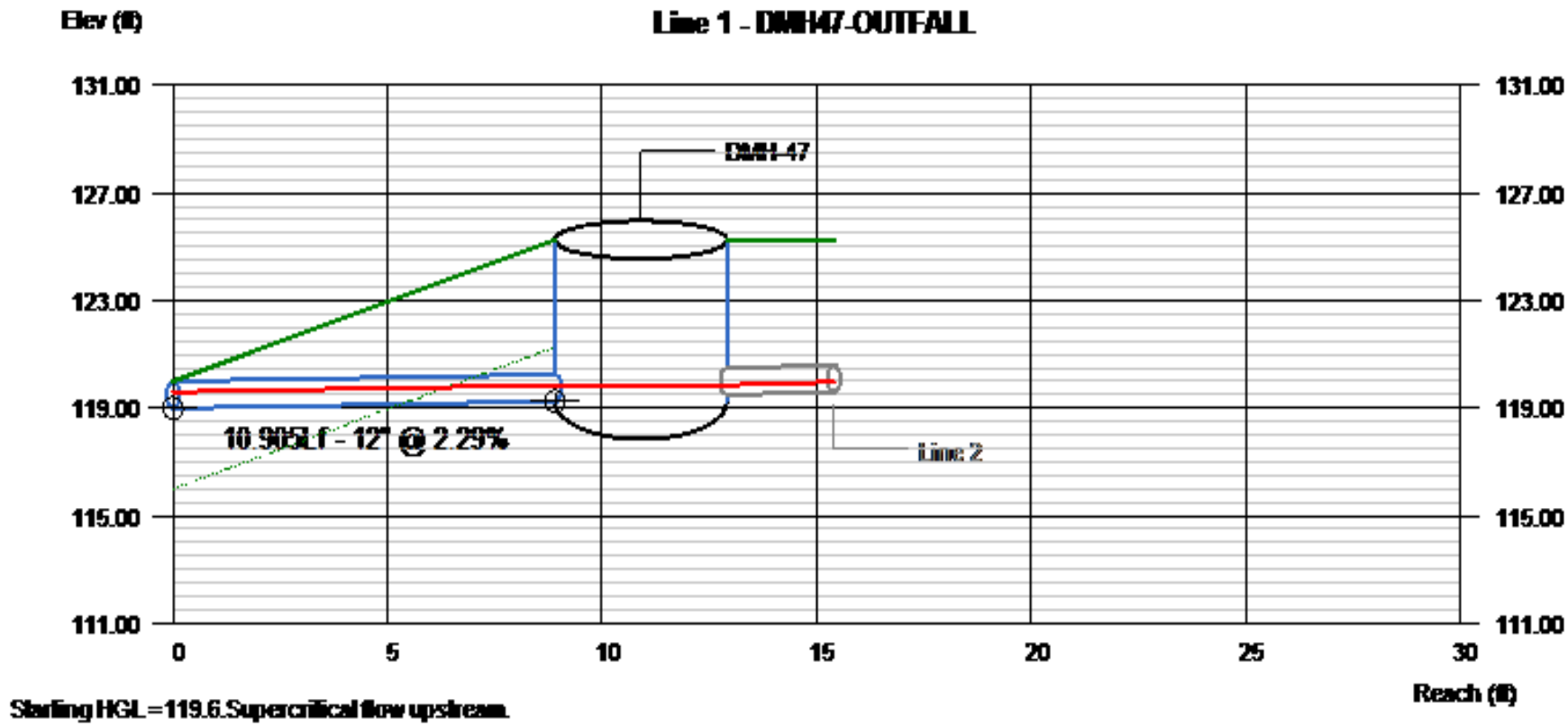
Project File: Woburn_System-3.stm | Number of lines: 3 | Date: 4/26/2020

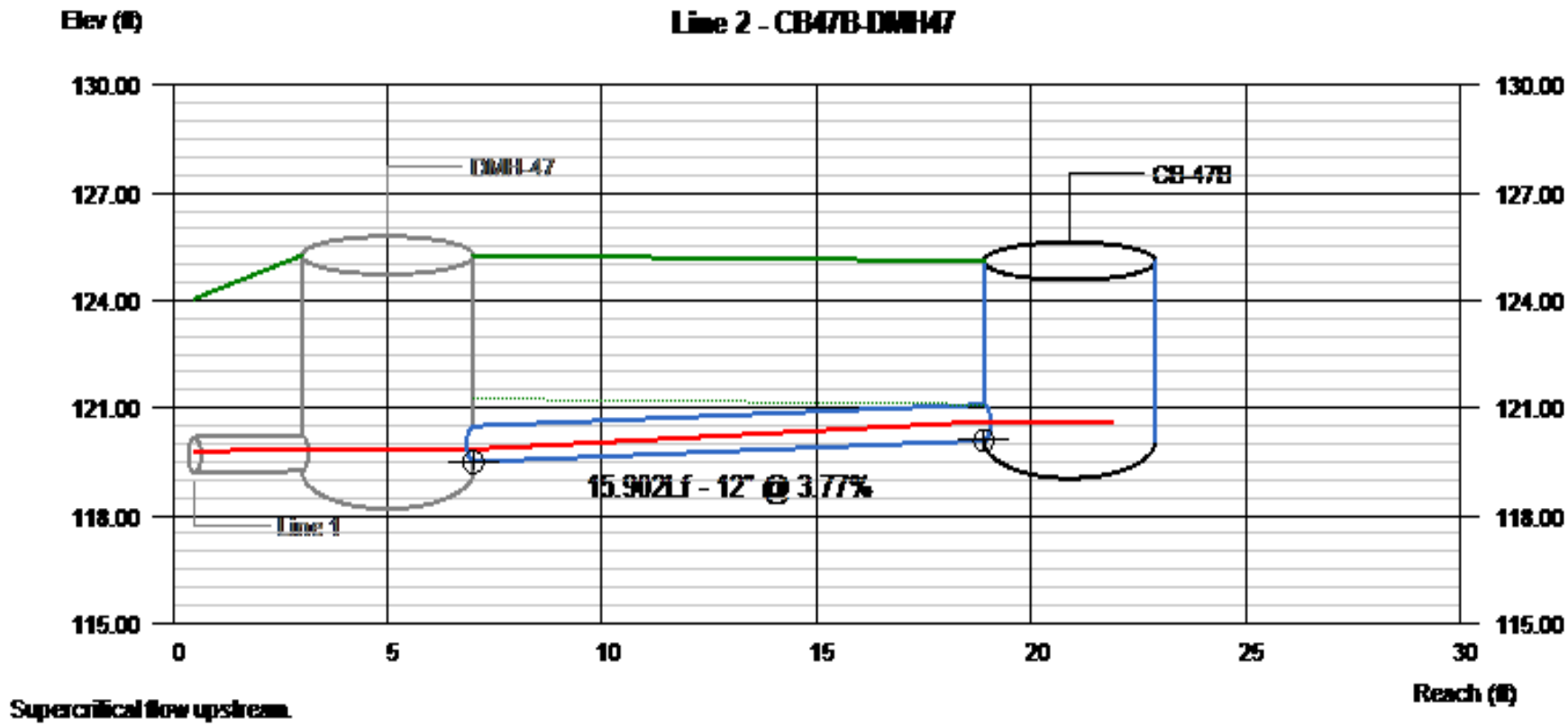
My Report

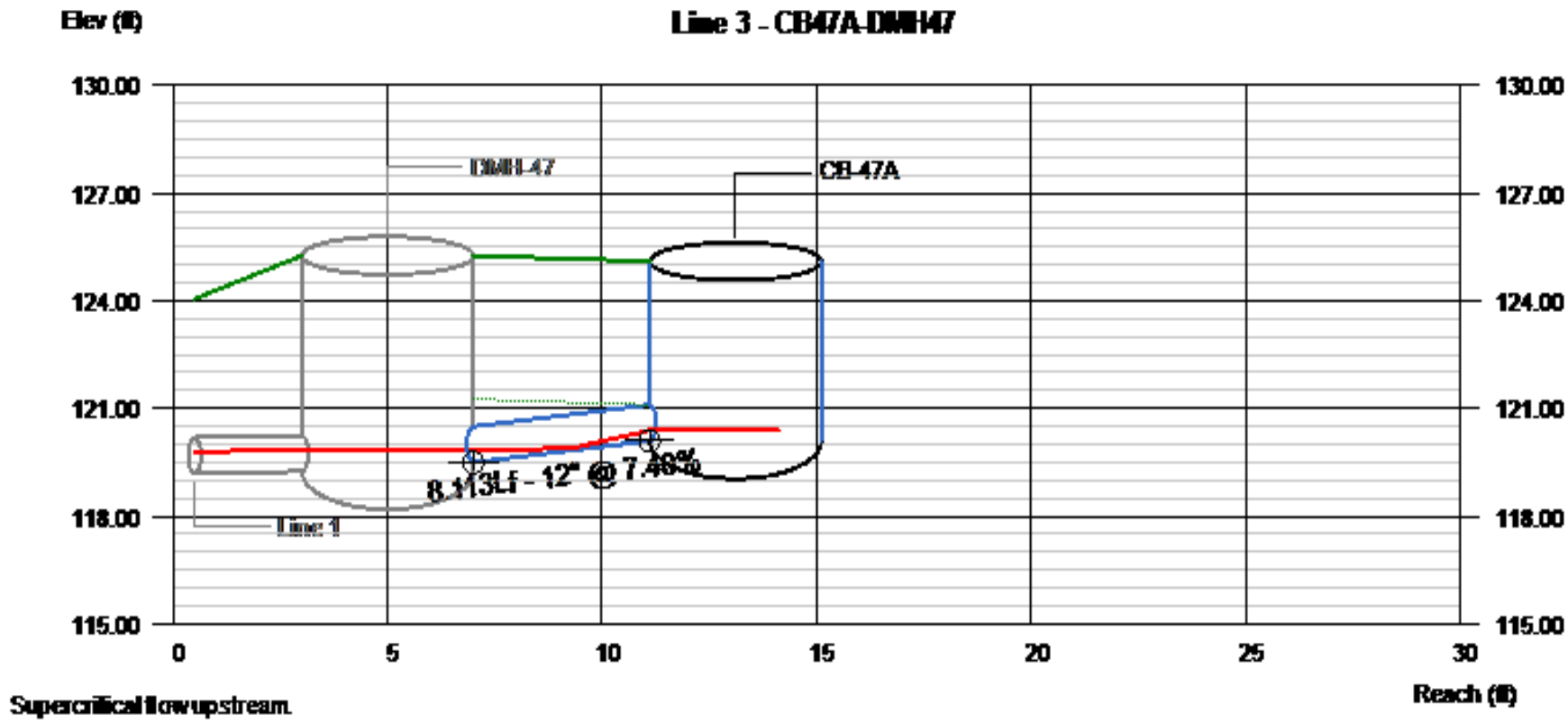
Line No.	Line ID	Flow Rate (cfs)	Line Length (ft)	Invert Dn (ft)	Invert Up (ft)	Line Slope (%)	HGL Dn (ft)	HGL Up (ft)	Q Byp (cfs)	Byp Ln No	Minor Loss (ft)	HGL Jnct (ft)	DnStm Ln No	Junct Type
1	DMH47-OUTFALL	2.00	10.905	119.00	119.25	2.29	119.60	119.85	....	n/a	n/a	119.85	Outfall	MH
2	CB47B-DMH47	1.51	15.902	119.50	120.10	3.77	119.85	120.62	0.00	Sag	n/a	120.62	1	Grate
3	CB47A-DMH47	0.50	8.113	119.50	120.10	7.40	119.85	120.39 j	0.00	Sag	n/a	120.39	1	Grate

Project File: Woburn_System-3.stm | Number of lines: 3 | Date: 4/26/2020

NOTES: ** Critical depth


Elev (ft)
Line 1 - DMH47-OUTFALL
131.00
127.00
123.00
119.00
115.00
111.00
DMH-47
10.90SLf - 12" @ 2.29%
Line 2
0
5
10
15
20
25
30
Reach (ft)
Starting HGL = 119.6.Supercritical flow upstream.


Elev (ft)
Line 2 - CB47B-DMH47
130.00
127.00
124.00
121.00
118.00
115.00
DMH-47
CB-47B
15.902Lf - 12" @ 3.77%
Line 1
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.


Elev (ft)
Line 3 - CB47A-DMH47
130.00
127.00
124.00
121.00
118.00
115.00
DMH-47
CB-47A
Line 1
8.113Lf - 12" @ 7.46%
0
5
10
15
20
25
30
Reach (ft)
Supercritical flow upstream.