

Industrial Park Design

Narrative and Details

T&L COMMERCIAL DEVELOPMENT

DEQ DESIGN & ASSOCIATES

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1 Project Description

T & L Commercial Development is proposing to develop a 6.7 acre vacant lot. The lot is located in Small County at 1111 Landry Lane. The project includes the construction of one 20,000 SF office building. Two travel lanes connect two separate parking lots, one on either side of the office building to Landry Lane. An employee picnic area is located at the rear of the office building and connected to the western parking lot. The McCutcheon Pedestrian plaza and outdoor walkways connect various entrances to the building and parking lots. The parking lots provide a total of 70 parking spaces. The total traffic average daily trips to the site is estimated to be 100.

The office park is intended to meet the needs of a functioning business while also offering places for employees to enjoy the outdoors. Providing the patio area adjacent to an open turf area and meadow allow for a more aesthetically open and natural place for employees to escape the office if only for a few minutes. The site is zoned B-2 and the development is a by-right development with no special provisions or waivers. The adjacent properties to the east, north, and west are all vacant and forested.

2 Existing Site Conditions

The vast majority of the existing site is a grassed, open field, with a small portion along the northern edge of the property that is forested. There is approximately 5.8 acres of fair conditioned open space and 0.9 acres of forest. The site is on moderate slopes, with an average slope of 7% sloping mostly down to Landry Lane, with the eastern and western edges draining to either side. The soils are predominantly Hydrologic Soil Group (HSG) C soils, as indicated by the NRCS Websoil Survey, which indicates moderately well drained soils. Specifically they are classified as Codorus silt loam (43%) and Delanco loam (57%).

There are no known wetlands or streams on-site, however the southern edge of the property along Landry Lane drains through an existing 18" RCP pipe under the road to an existing stream, called Harper Creek. Harper Creek is an intermittent stream and is in poor condition, with a down cutting

channel. No erosion around the culvert was evident during a field visit by DEQ Design & Associates, but channel erosion and downcutting was taking place immediately downstream.

The site is in the Chesapeake Bay watershed and Harper Creek drains to DD stream, which is impaired for bacteria. A TMDL has not been developed for the impaired waterway.

3 Proposed Site Conditions

The proposed site conditions include 1.95 acres of impervious cover, including two parking areas, the travel lanes, building rooftop, pedestrian pathways, and an employee patio. Approximately 3.50 acres of forest and rehabilitated open space are proposed with another 1.25 acres of managed turf. The total site area is 6.7 acres.

The managed turf areas were minimized to 1.25 acres in order to reduce the amount of future maintenance and mowing and to preserve the existing land cover at the proposed site. Offsite runoff up slope of the proposed site will be treated and consist of undisturbed open space as well.

4 Site Drainage and Hydrology

4.1 Existing Site Hydrology and Drainage

Currently there is one primary drainage area of approximately 5.8 acres draining the site. It begins just north of the northern edge of the property and flows overland to the existing culvert along the southern edge of the property that drains under Landry Lane, which serves as the outlet from the site. The culvert then outfalls to Harper Creek on the other side of the road. The existing culvert is an 18" concrete pipe that is undersized for the site currently. Large storms every few years flood the road. Flows also exit the pipe at high velocities and have caused severe erosion downstream. The time of concentration (T_c) was estimated as 22 minutes and the curve number (CN) equal to 79 based on fair existing site conditions.

The 24 hour precipitation amounts for select storm events are shown in the table below. The region is located in Smalltown, VA, which is in a Type II storm type region.

Table 4-1: Precipitation, 24 hour storm events for select storm events

	1-year	2-year	10-year	100-year
24-hour total	2.6 in	3.6 in	5.6 in	9.3 in

The existing peak flows from the site were modeled in HEC-HMS using the TR-55 method and are summarized in Table 4-2 below. Refer to the Existing Conditions sheet for land use breakouts, curve number, time of concentration, and the drainage area delineation.

Table 4-2: Existing Peak Flows from Site

Event	1 Year	2 Year	10 Year
Flow (cfs)	3.6	7.8	17.5

4.2 SWM Requirements for Proposed Site

The water quality and water quantity requirements for the site are discussed in this section. The site is subject to regulations effective from July 1, 2024.

4.2.1 Hydrology

The post-development drainage area for the property is 5.3 acres, which is slightly smaller than the pre-development drainage area. The composite CN is 79, with an assumed Tc of 5 minutes for all DAs. To the east and west edges of the site portions of runoff totaling less than 0.3 acres have been pushed to other drainage areas through the proposed grading of the site.

4.2.2 Water Quality Requirements

The Virginia Runoff Reduction Method Spreadsheet, version 4.1, was used to estimate total phosphorus (TP) loads from the proposed site. The loads are primarily from the impervious surfaces and managed turf areas. The TP load from the site for the proposed land use is 2.97 lb/yr with a required reduction of 1.23 lb/yr. The proposed nitrogen loading is 39 lb/yr. See Appendix A for detailed calculations.

4.2.3 Water Quantity Requirements

- A. Channel Protection Requirement - The site drains concentrated stormwater flow into a natural stormwater conveyance system. Therefore, the energy balance equation must be satisfied for the 1-year storm. The energy balance equation is:

$$Q_{1,post} \times V_{post} \leq Q_{1,pre} \times V_{pre}$$

Where **Qpre = 3.6 cfs** and **Vpre = 0.43 Acre-ft**. The Vpost and Qpost shall be less than the product of Qpre and Vpre. Qallowable is 4.1 cfs. See Appendix B for detailed calculations.

- B. Flood Protection – The existing outfall is currently experiencing localized flooding, as the culvert is undersized. Therefore, the SWM Plan was designed such that the 10 year, 24 hour post-development peak discharge will be less than the pre-development 10-year, 24 hour storm event.

$$Q_{10,post} \leq Q_{10,pre}$$

The flood protection criteria are satisfied as:

the pre-development **Q_{10,post} of 15.9 cfs**, is less than the post-development **Q_{10,post} of 17.5 cfs**.

5 Proposed Stormwater Management Plan

5.1 Methodology

Due to the site's location upstream of an existing stream channel and the future road easement on the property special consideration was taken to design the layout of the proposed development. In order to minimize the need for water quality and quantity control on site, and in order to minimize post-construction landscape maintenance, Environmental Site Design was implemented. This also allowed for an increased area of rehabilitated open space and forest cover on the site. The project site currently receives runoff from upland offsite areas as well. These offsite areas will not be disturbed and will maintain their current land use and land cover type.

As mentioned, the proposed site land use was chosen in order to minimize the necessary water quantity and quality control devices on the project site, however, the proposed impervious and managed turf cover changes the runoff conditions of the site and will require necessary management. Offsite drainage will also be treated along with the project drainage. The drainage area remains mostly the same, but will be slightly modified due to the grading of the site, with a reduction of 0.4 acres.

A variety of BMPs are also utilized in order to reduce total phosphorous loading and peak flows from the site. These include permeable pavement, a cistern, extended detention, and a dry swale. A stormwater network under the west parking lot will capture offsite, roof, BMP, and parking drainage that will outfall to a BMP at the southern end of the site. At the eastern side of the project and swale adjacent to the proposed parking lot will flow into a different stormwater network that will also outfall to the BMP at the south end of the project. The BMP will then flow to the culvert under Landry Lane to Harper Creek.

Upstream of the project offsite drainage flow onto the project site and is captured by a drop inlet to the north of the project and a dry swale to the east of the project. The variety of stormwater BMPs on the project reduce runoff and nutrients leaving the site. A Bentley Pondpack model was set up to simulate routing and to assess compliance with the water quantity requirements. Adjusted curve numbers were used to account for the proposed runoff reduction methods and a pond was simulated to account for the proposed Extended Detention storage. Appendix C shows the Pondpack Model graphic and Appendix D includes the results of the Pondpack routing results.

The post drainage and routing model showed the post development discharge show a decreased 10 year discharge of **$Q_{10, \text{post}}$ of 15.9 cfs**. A separate analysis was conducted using this reduced peak flow; this analysis showed that this reduction was sufficient to reduce flooding of the site, so that the road is not overtopped. The headwater elevation at the culvert for the 10 year storm went from 517.6 ft to 516.7 ft.

6 Best Management Practice Designs and Treatment

Four different practices were chosen to treat the runoff from the site. All practices were designed in accordance with the VA DEQ P-BMP Design Specifications (VSMHB and VRRM 4.1), and each design is described in detail below.

6.1 Cistern

The most upstream practice at the site is a cistern located at the north end of the project that will collect 0.2 acres of roof runoff and store the runoff for later use for managing and maintaining the developed site. The cistern was designed using the provided DEQ Cistern Design Spreadsheet.

Assumptions used in determining the cistern size were:

- All managed turf areas (54,450 s.f.) will be irrigated using the water captured by the cistern
- 70 people will be working in the building

In order for the cistern to be 90% efficient a 7,000 gallon tank was chosen. If the cistern overflows it will enter the stormwater system and be treated downstream by other proposed BMPs. The cistern will provide a 0.4 lb/yr phosphorous removal through volume reduction and 621 c.f. of runoff reduction.

6.2 Permeable Pavement

Permeable pavement was selected for two locations, one in the eastern parking lot on the south end, and the other located at the most western portion of the project located in the loading dock impervious area. Traffic in the parking lots is expected to be minimal, so permeable pavement is a viable option. Each location follows the VA DEQ design guidance for level one permeable pavement installations. The total phosphorous reduction attributed to the two locations of permeable pavement is 0.25 lb/yr and 776 c.f. of runoff reduction. See the detail design sheets for further details. The table below separates the runoff reduction and phosphorous reduction at each proposed permeable pavement location.

Table 6-1: Permeable Pavement individual Phosphorous Removal and Runoff Reduction

Location	Drainage Area	Phosphorous	Runoff Reduction
West	0.3	0.15	466
South East	0.2	0.10	310
Total	0.5	0.25	776

6.3 Dry Swale

A dry swale will be located to the eastern portion of the project and will capture offsite, parking lot, and roof drainage. The dry swale drains to the stormwater system and then outfalls to the extended detention basin at the southern end of the parking lot. The dry swale provides 0.71 lb/yr of runoff reduction and 1,584 c.f. of runoff reduction. The dry swale will be a level 2 design and is designed in accordance with the VA DEQ design specifications. For the final design for the dry swale can be found in the detailed design sheets.

6.4 Extended Detention

At the terminus of the stormwater system an extended detention pond will collect most of the drainage from the site. The extended detention is a level 1 and is the final treatment runoff flows out of the site. The basin detains runoff to lower peak flows leaving the site through an orifice, riser structure

and a spillway that is activated by the 10 year storm. The extended detention basin does not provide any runoff reduction, but does provide 0.20 lb/yr of phosphorous removal. The extended detention was designed according to the extended detention level 1 guidance in the VA DEQ design specifications. Detailed design information can be found on the design sheet.

7 Compliance Summary

Several measures were taken to reduce the impact of the proposed development on the downstream areas. A summary is provided below.

Table 7-1: Water Quality Compliance Summary

Post-development Load (lbs/yr)	Required Load Reduction (lbs/yr)	Provided Load Reduction (lbs/yr)	Post-development Adjusted Load (lbs/yr)
2.97	1.23	1.31	1.66

The BMPs collectively reduce TP by **1.31 lb/yr** which exceeds the reduction requirement of **1.23 lb/yr**. The Water quantity compliance is assessed at the single outlet point from the site, the existing culvert that is located along Landry Lane. The channel protection summary is provided in the table below:

Table 7-2: Water Quantity, Channel Protection Compliance Summary

Q_{Pre}, 1 year (cfs)	V_{Pre}, 1 year (Ac-ft)	Q_{Allowable}, 1 year (cfs)	Q_{Post}, 1 year (cfs)	V_{Post}, 1 year (Ac-ft)
3.62	0.43	4.1	3.56	0.33

The channel protection criteria are met as 3.56 cfs is less than the allowable 1-year peak discharge of 4.1 cfs. The flood protection criteria is summarized below:

Table 7-3: Water Quantity, Flood Protection Compliance Summary

Pre-development Q, 10 year (cfs)	Post-development, Q, 10 (cfs)
17.5	15.9

The flood protection criteria is met as the post-development 10 year peak flow rate is less than the pre-development peak flow rate. In addition, the flow has been reduced such that the road is not overtopped during a 10 year storm under post-development conditions.

Appendices

Appendix A: Water Quality Calculations

DEQ Virginia Runoff Reduction Method New Development Compliance Spreadsheet - Version 4.1

BMP Design Specifications List: 2024 Sids & Specs

Site Summary

Project Title: NA

Date: NA

Site Land Cover Summary					
	A soils	B Soils	C Soils	D Soils	Totals
Forest (acres)	0.00	0.00	3.25	0.00	3.25
Mixed Open (acres)	0.00	0.00	0.25	0.00	0.25
Managed Turf (acres)	0.00	0.00	1.25	0.00	1.25
Impervious Cover (acres)	0.00	0.00	1.95	0.00	1.95
					6.70
					100

Site TV and Land Cover Nutrient Loads	
Site Rv	0.34
Treatment Volume (ft ³)	0
TP Load (lb/yr)	2.97
TN Load (lb/yr)	38.97
Total TP Load Reduction Required (lb/yr)	0.00

Site Compliance Summary	
Total Runoff Volume Reduction (ft ³)	2,981
Total TP Load Reduction Achieved (lb/yr)	1.31
Total TN Load Reduction Achieved (lb/yr)	16.45
Remaining Post Development TP Load (lb/yr)	1.66
Remaining TP Load Reduction (lb/yr) Required	0.00

** TARGET TP REDUCTION EXCEEDED BY 0.09 LB/YEAR **

Drainage Area Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
Forest (acres)	3.25	0.00	0.00	0.00	0.00	3.25
Mixed Open (acres)	0.25	0.00	0.00	0.00	0.00	0.25
Managed Turf (acres)	1.25	0.00	0.00	0.00	0.00	1.25
Impervious Cover (acres)	1.95	0.00	0.00	0.00	0.00	1.95
Total Area (acres)	6.70	0.00	0.00	0.00	0.00	6.70

Drainage Area Compliance Summary

	D.A. A	D.A. B	D.A. C	D.A. D	D.A. E	Total
TP Load Reduced (lb/yr)	1.31	0.00	0.00	0.00	0.00	1.31
TN Load Reduced (lb/yr)	16.45	0.00	0.00	0.00	0.00	16.45

Drainage Area A Summary

Land Cover Summary

	A Soils	B Soils	C Soils	D Soils	Total	% of Total
Forest (acres)	0.00	0.00	3.25	0.00	3.25	49
Mixed Open (acres)	0.00	0.00	0.25	0.00	0.25	4
Managed Turf (acres)	0.00	0.00	1.25	0.00	1.25	19
Impervious Cover (acres)	0.00	0.00	1.95	0.00	1.95	29
					6.70	

BMP Selections

Practice	Mixed Open Credit Area (acres)	Managed Turf Credit Area (acres)	Impervious Cover Credit Area (acres)	BMP Treatment Volume (ft ³)	TP Load from Upstream Practices (lbs)	Untreated TP Load to Practice (lbs)	TP Removed (lb/yr)	TP Remaining (lb/yr)	Downstream Treatment to be Employed
2. h. To Rainwater Harvesting (P-BAS-04)			0.2	689.70	0.00	0.17	0.15	0.02	8.a. ED #1
3.a. Permeable Pavement #1 (P-FL-03)			0.5	1,724.25	0.00	0.43	0.25	0.18	8.a. ED #1
5.b. Dry Swale #2 (P-CNV-02)		0.5	0.65	2,640.83	0.00	0.93	0.71	0.22	8.a. ED #1
8.a. ED #1 (P-BAS-03)		0.6	0.55	4,449.47	0.42	0.92	0.20	1.14	
Total Impervious Cover Treated (acres)		1.90							
Total Mixed Open Treated (acres)		0.00							
Total Turf Area Treated (acres)		1.10							
Total TP Load Reduction Achieved in D.A. (lb/yr)		1.31							
Total TN Load Reduction Achieved in D.A. (lb/yr)		16.45							

Runoff Volume and CN Calculations

	1-year storm	2-year storm	10-year storm
Target Rainfall Event (in)	2.60	0.00	0.00

Drainage Areas	RV & CN	Drainage Area A	Drainage Area B	Drainage Area C	Drainage Area D	Drainage Area E
CN		79	0	0	0	0
RR (ft ³)		2,981	0	0	0	0
1-year return period	RV w/o RR (ws-in)	0.91	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	0.78	0.00	0.00	0.00	0.00
	CN adjusted	76	0	0	0	0
2-year return period	RV w/o RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	CN adjusted	100	0	0	0	0
10-year return period	RV w/o RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	RV w RR (ws-in)	0.00	0.00	0.00	0.00	0.00
	CN adjusted	100	0	0	0	0

Appendix B: Water Quantity Calculations

Existing Conditions:

$$\text{Pre: } S = \frac{1000}{CN} - 10 = \frac{1000}{79} - 10 = 2.7 \text{ in}$$

$$q_{pre} = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{(2.6 - (0.2 \times 2.7))^2}{2.6 + (0.8 \times 2.7)} = 0.90 \text{ in}$$

$$V_{pre} = q \times A \times \frac{1}{12} = 0.90 \text{ in} \times 5.7 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = \mathbf{0.43 \text{ Acre} - \text{ft}}$$

Proposed Conditions:

$$\text{Post: } S = \frac{1000}{CN} - 10 = \frac{1000}{76} - 10 = 3.16 \text{ in}$$

$$q_{post} = \frac{(P - 0.2S)^2}{P + 0.8S} = \frac{(2.6 - (0.2 \times 3.16))^2}{2.6 + (0.8 \times 3.16)} = 0.76 \text{ in}$$

$$V_{post} = q \times A \times \frac{1}{12} = 0.76 \text{ in} \times 5.3 \text{ Ac} \times \frac{1 \text{ ft}}{12 \text{ in}} = \mathbf{0.33 \text{ Acre} - \text{ft}}$$

Energy Balance:

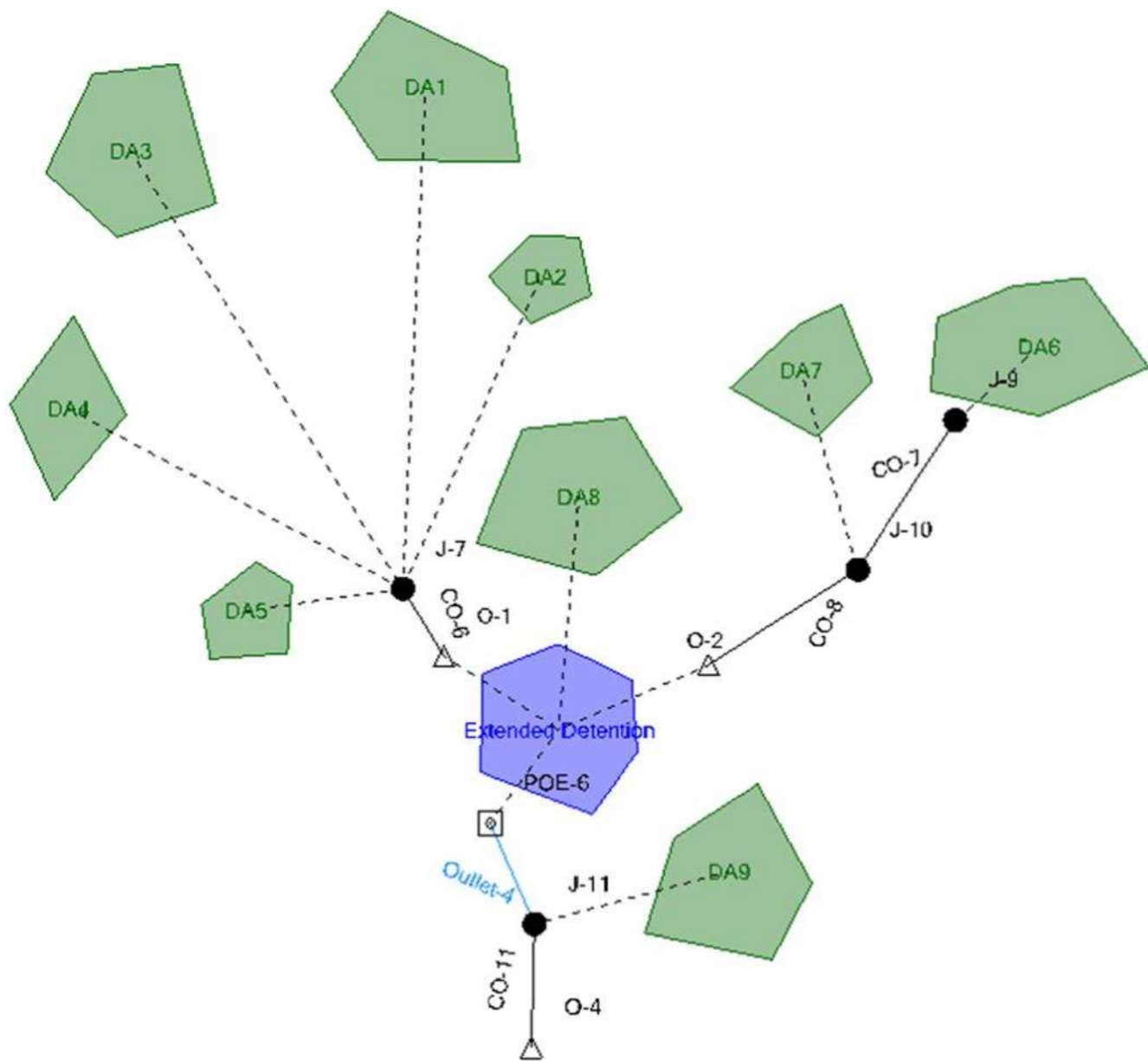
$$Q_{post} \leq Q_{pre} \left(\frac{V_{pre}}{V_{post}} \right)$$

$$= 3.6 \left(\frac{0.43}{0.33} \right)$$

$$= 4.7 \text{ cfs}$$

Allowable $Q_1 > \text{Proposed } Q_1$

Appendix C: Pondpack Model Schematic



Appendix D: Pondpack Routing Results

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)
DA3	1-Year	1	0.025	11.930	0.47
DA3	2-Year	2	0.045	11.920	0.84
DA3	10-Year	10	0.088	11.920	1.65
DA6	1-Year	1	0.128	11.930	2.33
DA6	2-Year	2	0.236	11.930	4.43
DA6	10-Year	10	0.484	11.920	9.13
DA1	1-Year	1	0.060	11.930	1.09
DA1	2-Year	2	0.113	11.930	2.11
DA1	10-Year	10	0.235	11.920	4.43
DA4	1-Year	1	0.023	11.930	0.42
DA4	2-Year	2	0.041	11.930	0.77
DA4	10-Year	10	0.083	11.920	1.57
DA8	1-Year	1	0.059	11.930	1.10
DA8	2-Year	2	0.104	11.920	1.97
DA8	10-Year	10	0.205	11.920	3.85
DA9	1-Year	1	0.032	12.010	0.52
DA9	2-Year	2	0.066	11.930	1.19
DA9	10-Year	10	0.150	11.930	2.83
DA7	1-Year	1	0.033	11.920	0.60
DA7	2-Year	2	0.049	11.920	0.87
DA7	10-Year	10	0.082	11.920	1.41
DA2	1-Year	1	0.027	11.920	0.51
DA2	2-Year	2	0.042	11.920	0.78
DA2	10-Year	10	0.074	11.920	1.33
DA5	1-Year	1	0.049	11.920	0.89
DA5	2-Year	2	0.073	11.920	1.31
DA5	10-Year	10	0.122	11.920	2.12

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)
J-7	1-Year	1	0.184	11.930	3.36
J-7	2-Year	2	0.314	11.920	5.81
J-7	10-Year	10	0.602	11.920	11.10
J-9	1-Year	1	0.128	11.930	2.33
J-9	2-Year	2	0.236	11.930	4.43
J-9	10-Year	10	0.484	11.920	9.13
J-10	1-Year	1	0.161	11.920	1.54
J-10	2-Year	2	0.285	11.920	1.82
J-10	10-Year	10	0.566	11.920	2.36
O-4	1-Year	1	0.472	12.030	3.56
O-4	2-Year	2	0.803	12.040	8.01
O-4	10-Year	10	1.565	11.880	11.30

Subsection: Master Network Summary

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)
J-11	1-Year	1	0.472	12.030	3.56
J-11	2-Year	2	0.804	12.030	8.03
J-11	10-Year	10	1.555	12.010	15.90

Pond Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ac-ft)	Time to Peak (hours)	Peak Flow (ft ³ /s)	Maximum Water Surface Elevation (ft)	Maximum Pond Storage (ac-ft)
Extended Detention (IN)	1-Year	1	0.404	11.930	5.99	(N/A)	(N/A)
Extended Detention (OUT)	1-Year	1	0.441	12.080	3.17	518.70	0.080
Extended Detention (IN)	2-Year	2	0.703	11.930	9.57	(N/A)	(N/A)
Extended Detention (OUT)	2-Year	2	0.738	12.040	7.08	519.22	0.121
Extended Detention (IN)	10-Year	10	1.375	11.930	17.23	(N/A)	(N/A)
Extended Detention (OUT)	10-Year	10	1.405	12.020	13.54	519.77	0.173