

# Technical Memorandum #16



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Subject: Detention volume comparison between forested and pasture existing conditions using Continuous Flow Modeling with and without LID.  
Project 14505  
No.:

## Introduction

This study's purpose is to compare pond sizes resulting from a forested existing condition to a pasture existing condition using Ecology's Flow Duration Standards with the WWHM3 modeling software. Pond sizes designed in accordance with Clark County's Current Code (CCC) are also included for comparison. Note that the current Clark County Code requires detention pond sizing to evaluate existing conditions as the least developed condition in the 30 years prior to new development.

Three developments were evaluated for this study. Two of the developments have been constructed in Clark County, and the third is a hypothetical development. The constructed developments include *Bridge Creek Village* (dense single family residential) and *99<sup>th</sup> Street Development* (commercial). The hypothetical development was modeled to represent a less dense residential development. The hypothetical development was modeled with the same soil types and existing conditions as Bridge Creek Village.

## Summary of Results

Modeling results for the three developments show that assuming a forested existing condition results in larger detention pond sizes than assuming a pasture existing condition. Pond sizes resulting from a forested existing condition were 1.3 to 1.5 times larger than assuming a pasture existing condition.

Table 1 lists the pond sizes calculated for the three developments based on Clark County's current code and Ecology's flow duration standards, with and without LID for forested and pasture existing conditions.

Table 1 Pond Size Comparison (area of top of pond in acres)					
Development	Current CCC Existing Condition Varies*	Ecology Flow Duration Standards – w/out LID		Ecology Flow Duration Standards – With LID	
		Existing Forested	Existing Pasture	Existing Forested	Existing Pasture
Bridge Creek (as constructed)	0.50	1.00	0.66	0.80	0.56
Hypothetical Development	0.24	1.04	0.72	0.55	0.41
99 <sup>th</sup> Street	600 LF 72” Pipe	2,244 LF 72” Pipe	1,508 LF 72” Pipe	802 LF 72” Pipe	585 LF 72” Pipe

\*Bridge Creek Village CCC modeling – Existing conditions modeled as forested (wooded w/ underbrush)  
 99<sup>th</sup> Street CCC modeling – Existing Conditions modeled as pasture.

Please see the attached technical report for a detailed description of the models evaluated for this study.

## Attachment - Technical Report

### Pond Sizing with WWHM3

The WWHM3 Autopond and Autovault features were used to size some of the detention ponds in this study. The ponds designed with these feature resulted in outflow duration curves that matched the existing condition duration curves closely and did not require fine tuning.

### Bridge Creek Village

Bridge Creek Village is a 58 lot, single family residential development constructed on 6.3 acres of flat land (0-5% slope) with Hydrologic Soil Group (HSG) B soils. The water table was evaluated at the project site and is recorded in a geotechnical report to be approximately 4 feet below grade. The high water table could act to limit site infiltration rates and the storage available to maintain higher infiltration rates for the entire duration of a storm. For this reason Bridge Creek Village was modeled with HSG C.

### Current CCC Pond Sizing (from project Stormwater Report)

Prior to the site being developed the land cover consisted of a wooded area with underbrush. These conditions were modeled for the entire site using a single event, unit hydrograph method (SCS method) for pre-developed conditions.

Post developed conditions resulted in approximately 53% of the site becoming impervious. The site was constructed with a wetpond to provide both detention and water quality treatment volumes. The areas as modeled using the single event method for post developed conditions follow:

- Roofs: 1.45 acres
- Pavement: 1.74 acres
- Pond: 0.30 acres
- Lawn: 2.81 acres

A wetpond was constructed on site with a live storage volume of about 2 acre-feet (approximately 0.5 acres, 4-ft deep). This does not include the treatment storage provided in the bottom of the wetpond.

### Ecology's Flow Duration Pond Sizing without LID

Due to high groundwater resulting in unfavorable conditions for infiltration, the entire site was modeled as *C, Forest, Flat* and *C, Pasture, Flat* for existing conditions.

For modeling post-development conditions in WWHM3 without LID, site areas were modeled as follows:

- C, Lawn, Flat: 2.96 acres
- Parking Lot, Flat: 3.34 acres

**Ecology’s Flow Duration Pond Sizing with LID**

Due to high groundwater resulting in unfavorable conditions for infiltration, the entire site was modeled as C, Forest, Flat and C, Pasture, Flat for existing conditions. For post-development conditions the LID facility modeled included pervious pavement for driveways and sidewalks.

To model the post-development site in WWHM3 using LID facilities, site areas were modeled as follows:

- C, Lawn, Flat: 2.96 acres
- C Lawn, Flat (to model pervious pavement for driveways and sidewalks): 1.0-acre
- Roof tops, Flat: 1.34 acres
- Roads, Flat: 1.0-acre

**Flow Duration Pond Sizing**

The Autopond feature in WWHM3 was used to design detention ponds meeting Ecology’s flow duration standards assuming both forested and pasture for existing conditions. Detention ponds were designed with a depth of 4 feet, a 3-foot riser height, a length to width ratio of 1, and 3:1 (H:V) side slopes. With these settings the Autopond feature only adjusted the flow control configuration and the bottom length and width of the pond. The bottom length and width were used with the side slopes and 4-foot total depth to calculate the top area of the pond. Table A1 compares the results of the Bridge Creek Village, detention pond top areas.

Table A1 Bridge Creek Village Detention Pond Size Comparison			
Design Method	Top Area (acres)		Depth (ft)
	Existing Forested	Existing Pasture	
Current CCC	0.50*	N/A	4.0
Ecology’s Flow Duration w/out LID	1.00	0.66	4.0
Ecology’s Flow Duration w/ LID	0.80	0.56	4.0

\* Current CCC requires pre-developed conditions to be modeled as the least developed condition in the previous 30 years, for Bridge Creek Village this was a forested condition (for CCC modeling, existing conditions were defined as *wooded with underbrush*).

## Hypothetical Development

The hypothetical development was modeled with a total area of 11.39 acres and consisted of 58, 7,500 sq-ft lots. This development was modeled with the same soil types and existing conditions as the Bridge Creek Village Development.

## Current CCC Pond Sizing

The Santa Barbara Urban Hydrograph (SBUH) method was used to model the Hypothetical Development with the *Hydraflow Hydrograph* software. Prior to the site being developed the land cover consisted of a wooded area with underbrush. These conditions were modeled using the SBUH method for the entire site under pre-development conditions.

The areas as modeled using the SBUH method for post-development conditions follow:

- Impervious: 6.0 acres
- Lawn: 5.39 acres

A detention pond was then sized in accordance with the current CCC. The optimum pond size was calculated to be 0.24 acres, with a 5-ft depth (including freeboard).

## Ecology's Flow Duration Pond Sizing without LID

The entire site was modeled as *C, Forest, Flat* and *C, Pasture, Flat* for existing conditions.

For post-development conditions without the use of LID, the site areas were modeled as follows:

- Roofs: 4.0 acres
- Streets: 1.0-acre
- Driveways and sidewalks: 1.0-acre
- C, Lawn, Flat: 5.39 acres

## Ecology's Flow Duration Pond Sizing with LID

The entire site was modeled as *C, Forest, Flat* and *C, Pasture, Flat* for existing conditions.

For post-development conditions, pervious pavement was modeled for sidewalks and driveways, and the runoff from 1.25 acres of impervious roof area was directed to and completely infiltrated by rain gardens with 10ft x 10ft bottom areas on each lot. These rain gardens were modeled as an equivalent composite rain garden measuring 76 ft x 76 ft. The rain garden was modeled as a trapezoidal pond with 1.8-feet of effective depth, an infiltration rate of 0.5 inches/hour, and a riser weir overflow. The amount of roof area routed to the modeled rain garden was limited to the amount the rain garden could completely infiltrate resulting in no overflow. This area was calculated to be 1.25 acres by WWHM3. This area was not included in the basin used to size the detention pond.

For post-development conditions with the use of LID, the site was modeled as follows:

- C, Lawn, Flat: 5.39 acres
- C, Lawn, Flat: 1.0-acre (to model pervious pavement for driveways and sidewalks)
- Routed to rain garden and not used in detention pond sizing: 1.25-acres (from roofs)
- Roofs, Flat: 2.75 acres (remaining roof area)
- Roads, Flat: 1.0-acre

### Flow Duration Pond Sizing

The Autopond feature in WWHM3 was used to design detention ponds meeting Ecology’s flow duration standards assuming both forested and pasture for existing conditions. Detention ponds were designed with a depth of 4 feet, a 3-foot riser height, a length to width ratio of 1, and 3:1 (H:V) side slopes. With these settings the Autopond feature only adjusted the flow control configuration and the bottom length and width of the pond. The bottom length and width were used with the side slopes and 4-foot total depth to calculate the top area of the pond. Table A1 compares the results of the Bridge Creek Village, detention pond top areas. Table A2 compares the results of the hypothetical development detention pond sizes.

Table A2 Hypothetical Development Detention Pond Size Comparison			
Design Method	Top Area (acres)		Depth (ft)
	Existing Forested	Existing Pasture	
Current CCC	0.24*	N/A	5.0
Ecology’s Flow Duration w/out LID	1.04	0.72	7.0
Ecology’s Flow Duration w/ LID	0.55	0.41	7.0

\* Current CCC requires pre-developed conditions to be modeled as the least developed condition in the previous 30 years, for Bridge Creek Village this was a forested condition (for CCC modeling, existing conditions were defined as *wooded with underbrush*).

### 99<sup>th</sup> Street Development

The 99<sup>th</sup> Street Development consists of two commercial buildings and a parking lot constructed on 2.63 acres of flat land (0-5% slope) with Hillsboro Series soils. Hillsboro Series soils are listed as HSG B, however experience with these soils in this area show that they are poorly drained. For this reason they were modeled as HSG C soils in WWHM3 for this study.

### Current CCC Pond Sizing

Prior to development site cover consisted of grass with a few trees and one residence with a gravel road. The stormwater management plan for this project modeled these conditions to determine the peak pre-development flow using a unit hydrograph method. An underground storage tank consisting of 600 feet of 72-inch diameter pipe was constructed as the detention facility for this development. A water quality manhole with filters was installed downstream of the tank to provide treatment.

**Ecology’s Flow Duration Pond Sizing without LID**

The entire site was modeled as *C, Forest, Flat* and *C, Pasture, Flat* for existing conditions. Post-development conditions resulted in approximately 89% of the site becoming impervious. The post-development site areas were modeled as follows:

- Roof Area, Flat: 0.51 acres
- Parking Lot, Flat: 1.37 acres
- Sidewalk, Flat: .18 acres
- C, Lawn, Flat: 0.57 acres

**Ecology’s Flow Duration Pond Sizing with LID**

The entire site was modeled as *C, Forest, Flat* and *C, Pasture, Flat* for existing conditions. The WWHM3 model with LID was programmed with the parking lot and sidewalks constructed with permeable pavement over the existing underlying soil. The overflow from the pervious pavement was accounted for in the sizing of the detention pond by the model. Pervious pavement was modeled as *C, Lawn, Flat*.

**Flow Duration Pond Sizing**

The Autovault feature in WWHM3 was used to determine the detention volumes required to meet Ecology’s flow duration standards assuming both forested and pasture for existing conditions. These volumes were used to calculate the lengths of 72-inch diameter pipe required for underground storage. Table A3 compares the results of the 99<sup>th</sup> Street Development’s lengths of underground 72-inch diameter detention pipe.

Table A3 99 <sup>th</sup> Street Development Detention Pond Size Comparison				
Design Method	Volume (ft <sup>3</sup> )		Feet of 72-inch Pipe	
	Existing Forested	Existing Pasture	Existing Forested	Existing Pasture
Current CCC	N/A	16,964*	N/A	600*
Ecology’s Flow Duration w/out LID	63,469	42,645	2,244	1,508
Ecology’s Flow Duration w/ LID	22,693	16,553	802	585

\* Current CCC requires pre-developed conditions to be modeled as the least developed condition in the previous 30 years, for the 99<sup>th</sup> Street development this was a pasture with a few trees and a single family residence with a gravel drive. (for CCC modeling, existing conditions were defined as *pasture*).