Wilmington Area Planning Council

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RESOLUTION

BY THE WILMINGTON AREA PLANNING COUNCIL (WILMAPCO) TO ENDORSE THE ROCKY RUN UNDERPASS FEASIBILITY STUDY

WHEREAS, the Wilmington Area Planning Council (WILMAPCO) has been designated the Metropolitan Planning Organization (MPO) for Cecil County, Maryland and New Castle County, Delaware by the Governors of Maryland and Delaware, respectively; and

WHEREAS, the WILMAPCO Council recognizes that comprehensive planning for future land use, transportation, sustainable economic development, environmental protection and enhancement, and community health and livability are necessary actions to implement the goals and objectives in the 2050 Regional Transportation Plan (RTP); and

WHEREAS, the DelDOT requested that WILMAPCO coordinate with them to develop a feasibility study to utilize the existing Rocky Run culvert to create a grade-separated bicycle and pedestrian crossing of Concord Pike/US 202; and

WHEREAS, the Rocky Run Underpass Feasibility Study assessed existing hydrology, safety, and environmental conditions; and

WHEREAS, the Rocky Run Underpass Feasibility Study utilized the Concord Pike Monitoring Community, and technical committee and thorough public engagement throughout the planning process; and

WHEREAS, the Rocky Run Underpass Feasibility Study puts forth recommendations which will mitigate community safety concerns, improve the multimodal transportation network, and maintain necessary hydrologic flow through the culvert to mitigate flooding concerns;

NOW, THEREFORE, BE IT RESOLVED that the Wilmington Area Planning Council does hereby endorse the final report and recommendations of the Rocky Run Underpass Feasibility Study.

Date: ____________________

John Sisson, Chairperson
Wilmington Area Planning Council

ROCKY RUN UNDERPASS FEASIBILITY STUDY

DRAFT

AUGUST 2025

WILMAPCO

DelDOT

WILMAPCO RESOLUTION

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1 INTRODUCTION

The Wilmington Area Planning Council (WILMAPCO), in partnership with the Delaware Department of Transportation (DelDOT), initiated the feasibility study of a pedestrian/bicycle underpass at the Rocky Run Culvert on US 202/Concord Pike. The feasibility study was funded in WILMAPCO's Fiscal Year 2025 Unified Planning Work Program. The purpose of this study was to determine the feasibility of creating a crossing under Concord Pike/US 202 in the location of the existing Rocky Run culvert. The consultant team of RK&K led the development of the feasibility study, with Kramer and Associates providing facilitation services at two public workshops.

This segment of Concord Pike is characterized by large, retail and institutional frontage with expansive surface parking lots on both sides (**Figure 1**). This results in a limited number of side streets and curb cuts. The spacing between these access points is typically between 500 to 1,000 feet. Extensive open space and park land exists beyond the frontage along the west side of Concord Pike. There are sidewalks along Concord Pike in most sections, with a notable exception near Concord Mall, just to the north of this culvert location. The sidewalks that do exist along Concord Pike are generally narrow, located immediately adjacent to the roadway, and frequently interrupted by driveway curb cuts. These driveways create potential conflict zones between pedestrians and drivers.

Apart from a shared-use path on the Wilmington University campus in the northeast portion of the study area, the Concord Pike corridor generally does not have dedicated bicycle facilities. In some locations, people on bikes who do ride along Concord Pike must do so either on the roadway sharing a vehicle lane or on the sidewalk. The same characteristics make Concord Pike a challenging and uncomfortable place to walk—narrow sidewalks, high traffic volumes and speeds, and numerous driveways—also make it a difficult place to bike. Streets on either side of Concord Pike have lower traffic volumes and speeds, but these roadways can be disconnected and difficult to navigate. There are shared-use pathways that accommodate both pedestrians and bicyclists within the open space network along the western side and southern end of the study area. The trails in Brandywine Creek State Park, First State National Historical Park, and Alapocas Run State Park provide recreational opportunities but are not easy to access by foot or bike for many residents of the study area.

Figure 1. Study Area Map

1.1 CONCORD PIKE MASTER PLAN

The Rocky Run Pedestrian/Bicycle Underpass was originally identified as a part of the *US 202/Concord Pike Master Plan*, endorsed by WILMAPCO Council in September 2020. The Concord Pike Monitoring Committee (CPMC) has rated this project as an Initial Priority as part of their Project Prioritization Exercise in 2023.

This location had been selected as the focus area for this study due to the existing stream culvert and the site topography. The culvert is located in a natural depression which could allow for sufficient clearance under the roadway for a bike/pedestrian underpass. There had also been speculation by the CPMC that one of the three culvert cells could be closed off to the stream and utilized as a pedestrian underpass.

1.2 FEASIBILITY STUDY SCOPE

The study considered use of one (or more) of the three cells of the existing culvert structure for Rocky Run and also examined other potential crossings of US 202/Concord Pike, including a new tunnel, pedestrian/bicycle overpass, and improved at-grade crossings at existing traffic signals. The study included topographic information and hydrological analysis to determine if an underpass is feasible at this location and intended to provide a concept that can move forward as a fundable project.

The study also examined the existing and planned trail network in this area to determine the most feasible and useful connections that will be needed to create safe and accessible connections between existing neighborhoods and amenities on either side of the corridor.

This feasibility study includes a Planning and Environmental Linkages (PEL) Study. PEL Studies are a collaborative and integrated approach to transportation decision-making that considers environmental, community, and economic issues early in the planning process. This information and analysis can then be utilized to inform the National Environmental Policy Act (NEPA) review process. PEL Studies are a Federal Highway Administration (FHWA) initiative used to help make better-informed project-level decisions and to shorten project delivery time, following provisions set forth in 23 United States Code 168(b)(1)(A) and associated regulations under 23 Code of Federal Regulations 450.212(d) and 450.313(e). The PEL document is focused mainly on analysis related to the feasibility study but could provide the pre-NEPA documentation for future initiatives related to the recommendations.

1.3 COMMITTEES AND PUBLIC INVOLVEMENT

A Technical Advisory Committee (TAC) collaborated with the project team on the feasibility study and was used to ensure all analysis and assumptions were based upon best practices, standards, and available information. The TAC also reviewed information that was being developed ahead of public outreach, including Advisory Committees, Public Workshops, and property owner meetings. The TAC included:

- **DelDOT:** Bryce Baker, Cooper Bowers, Paul Moser, Scott Walls
- **DNREC:** Brendan Diener, Nathan Attard
- **New Castle County:** Matt Rogers
- **WILMAPCO:** Dan Blevins, Dave Gula
- **Woodlawn Trustees:** Rich Przywara

- **Brandywine Conservancy:** Elena Hadley
- **University of Delaware Water Resources Center:** Jerry Kauffman

The TAC met with the project team four times over the course of the feasibly study: October 22, 2024, January 7, 2025, March 11, 2025, and May 6, 2025.

The CPMC was used as the study's Public Advisory Committee to provide input and feedback ahead of public workshops. The CPMC was an important stakeholder group for this study and consensus building and stakeholder support for the plan was a key element in this process. This was accomplished through a facilitated stakeholder outreach process that included meetings and interactive workshops. Updates were presented to the CPMC at both its November 18, 2024, and April 16, 2025, meetings. Along with the Project Partners and State/County Elected Officials, the CPMC members included:

- Bike Delaware (DE): James Wilson
- Brandywine Conservancy: Elena Hadley
- Civic League for NCC: Bill Dunn
- Council of Civic Organizations of Brandywine Hundred: R.J. Miles
- Committee of 100: Doug Eitelman
- DE Greenways: Terri Jones
- DE Office of State Planning Coordination: Samantha Bulkilvish
- DE State Police: Lt. Michael Butkus
- New Castle County Chamber of Commerce: Emma Odren
- Woodlawn Trustees: Richard Przywara

The project team organized and held two public workshops at important milestones to obtain public comments:

- February 10, 2025: Presented an overview of the feasibility study, goals, and objectives, and provided preliminary technical analysis
- June 2, 2025 (as part of CPMC Annual Workshop): Presented recommendations

This feasibility study provides an overview of the hydrological analysis performed to assess different culvert reconfigurations; evaluate alternatives for trail crossings of Concord Pike, including a new tunnel, pedestrian/bicycle bridge over Concord Pike, and at-grade crossings; assess connections to provide connectivity to adjacent land uses; and recommends next steps for a potential phased implementation approach to the crossing and trail connections on both the west and east sides of Concord Pike.

2 HYDROLOGICAL ANALYSIS

2.1 HYDROLOGY

Peak discharges for Rocky Run at the US 202/Concord Pike crossing were calculated using Fixed Regional Regression Equations for the *Piedmont Region from Peak-Flow and Low-Flow Magnitude Estimates at Defined Frequencies and Durations for Nontidal Streams in Delaware* (Unites States Geological Survey [USGS] SIR 2022-5005) (Hammond, 2022). A drainage basin was delineated with a single point of interest at the upstream end of the US 202 culvert. Where practical, this hydrologic analysis for Rocky Run was coordinated with and adjusted to be consistent with other studies performed within the watershed including the Plan for Rocky Run Environmental Protection Report (Cruz-Ortiz, 2015) from University of Delaware Water Resources Agency and the Brandywine Flood Study (Brandywine Conservancy, 2025). The variables used for hydrology calculations and the sources from which they were derived can be found in **Table 1** and **Figure 2** below.

Table 1: Input Variables for Delaware Fixed Regional Regression Equations

Variable	Value	Source
Drainage Area	0.85 sq miles	USGS StreamStats (3m DEM)
Mean Basin Slope	3.77%	USGS StreamStats (3m DEM)
Percent Impervious	41.04%	Plan for Rocky Run Environmental Protection Report
Percent Storage	1.02%	USGS National Hydrology Dataset
Percent Hydrologic Soil Type ‘D’	40.76%	USDA NRCS Web Soil Survey

While the Fixed Regional Regression Equations were derived using empirical data from stream gages across the region, there are some variables within the Rocky Run watershed that are not accounted for in the equations. To account for errors in the regression equations, Section 104.2.6 of the DelDOT *Bridge Design Manual* recommends applying confidence intervals to the calculated discharges as a conservative measure to provide greater assurance that the design flows accurately represent the site conditions. Due to Concord Pike being classified as a principal arterial roadway, Table 104-1 in the *Bridge Design Manual* dictates that the upper 67% confidence interval should be used as the design flow for the analysis. **Table 2**, below, documents the results of the hydrologic analysis.

Table 2: Peak Discharges for Rocky Run at US 202

Description	Discharge (cfs)				
	2-Yr	5-Yr	10-Yr	50-Yr	100-Yr
Lower 67% Confidence Interval	215.5	355.3	459.2	736.7	860.6
Calculated Discharge	303.2	469.9	594.1	968.0	1,165.2
*Upper 67% Confidence Interval	426.5	621.4	768.7	1,271.9	1,577.7

* Design flows used for Hydraulic Analysis; Yr = year

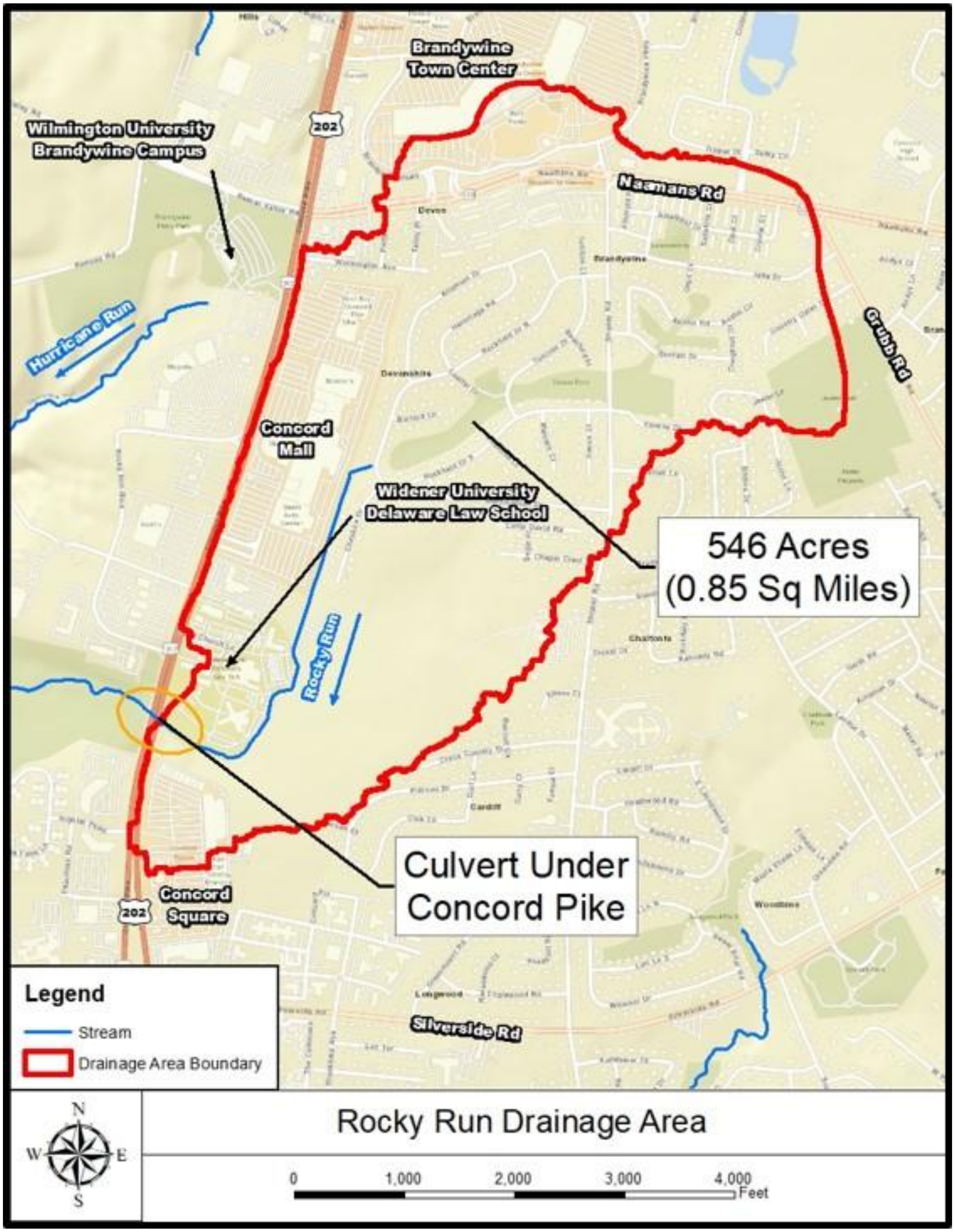


Figure 2: Rocky Run Drainage Area Map

2.2 HYDRAULIC MODELING

In order to analyze the potential hydraulic/flooding impact of the culvert retrofit, RK&K developed a steady state, one-dimensional hydraulic model using version 6.2 of the Hydrologic Engineering Center's River Analysis System (HEC-RAS) software.

2.2.1 Cross Section Geometry

One-dimensional hydraulic models use cross sections to define the terrain on a given project reach. Unlike two-dimensional models, where flow is modeled across a mesh surface, the cross sections in a one-dimensional model define the geometry at a single location and any change in terrain is interpolated between two defined cross sections. Therefore, cross sections need to be placed logically throughout the model to most accurately define the geometry of the site and capture any major hydraulic changes. For this model of Rocky Run, 18 cross sections were drawn to define the stream corridor.

2.2.1.1 Topography

The Rocky Run HEC-RAS model used two primary sources to define the topography. The first was a site-specific topographic survey, which was performed by RK&K surveyors in September 2024. The survey totaled 185 shots and was comprised of six cross sections (three upstream and three downstream) that were approximately 150 feet wide and spaced 200 feet apart, as well as other miscellaneous points around the culverts which would help define their geometry.

To supplement any gaps in the topographic survey and expand the model area, flown Light Detection and Ranging (LiDAR) was obtained for the area from publicly available sources. Three LiDAR datasets were downloaded and compared to the known elevations from the topographic survey. This led to a 2014 dataset from the National Oceanic and Atmospheric Association being chosen as the most appropriate dataset for this analysis. **Figure 3**, below, shows how the LiDAR and topographic survey were merged to create a cross section within the model.

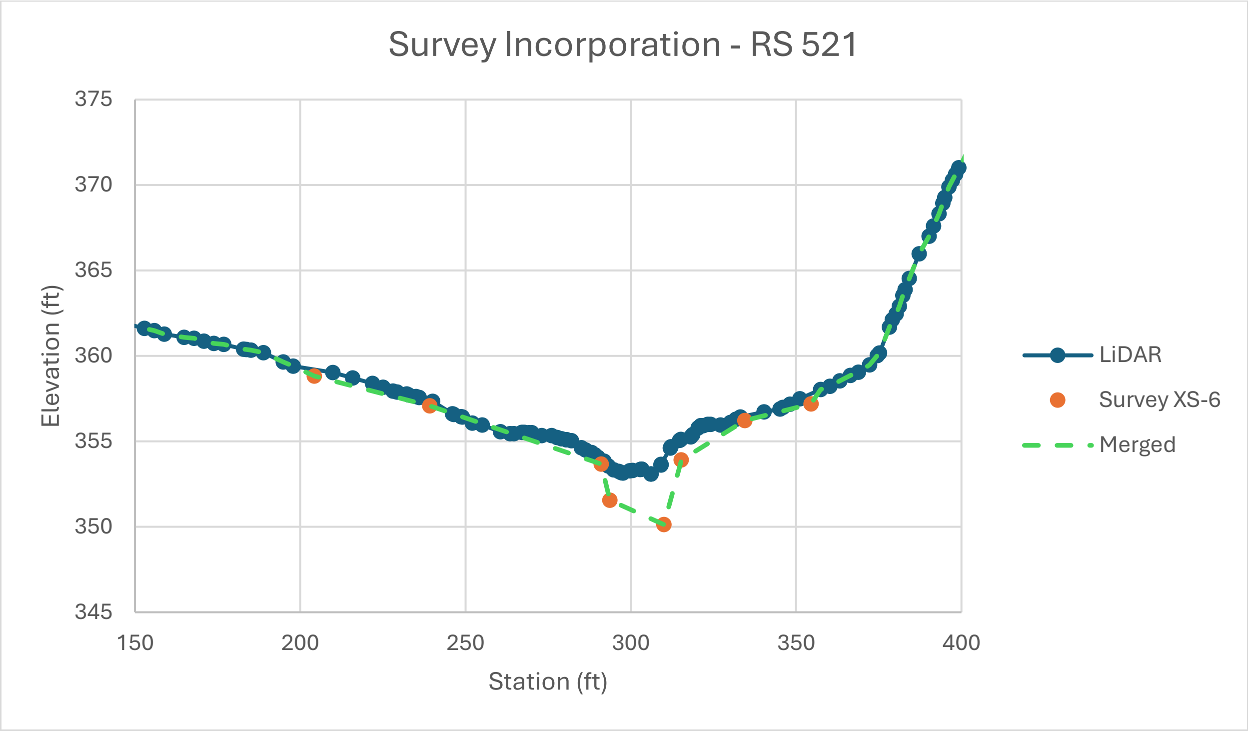


Figure 3: Incorporation of Survey Cross Sections

2.2.1.2 Roughness Values

In the natural world, different types of land cover resist channel and floodplain flows differently (e.g., flow velocities in a parking lot as opposed to a field of tall grass). In HEC-RAS, to account for the impact of the different land uses in a stream corridor, a Manning's roughness coefficient (n-value) is assigned to each type of land cover present and a weighted average of the roughness coefficients across a cross section are used in the hydraulic calculations. On the Rocky Run site, aerial photography and site reconnaissance were used to spatially delineate each specific land cover and a Manning's n value was assigned to each (see **Table 3**). A map of the delineated land cover shapes is provided in Appendix A.

Table 3: Land Cover Roughness Values

Land Cover	Manning's N-Value
Building	N/A*
Concrete Channel	0.015
Densely Wooded	0.100
Impervious	0.015
Lightly Wooded	0.080
Open Space	0.030
Natural Channel	0.035
Open Water	0.010

* Buildings were not assigned a roughness value but were modeled as vertical obstructions which flow had to go around

2.2.1.3 Culvert Definition

The existing triple box culvert beneath Concord Pike was modeled using data from the topographic survey and measurements taken in the field. All three culvert cells have a span of eight feet and a height of seven feet; however, each has its own upstream and downstream invert elevation and barrel slope. In order to most accurately portray the hydraulic efficiency of the culvert, the headwall was modeled as having 45-degree flared wing walls with a beveled inlet top edge as shown in **Figure 4**.

Typically, when modeling a culvert, the elevation profile used to define the roadway above the culvert is taken along the crown (typically the centerline) of the road to evaluate potential overtopping. In this case however, as discussed further in the Model Iterations (Section 2.3 below), both of the DelDOT hydraulic standards being used to evaluate this project involve elevations along the edge of pavement so a profile along the edge of pavement was pulled from the LiDAR dataset and set as the roadway for this model.

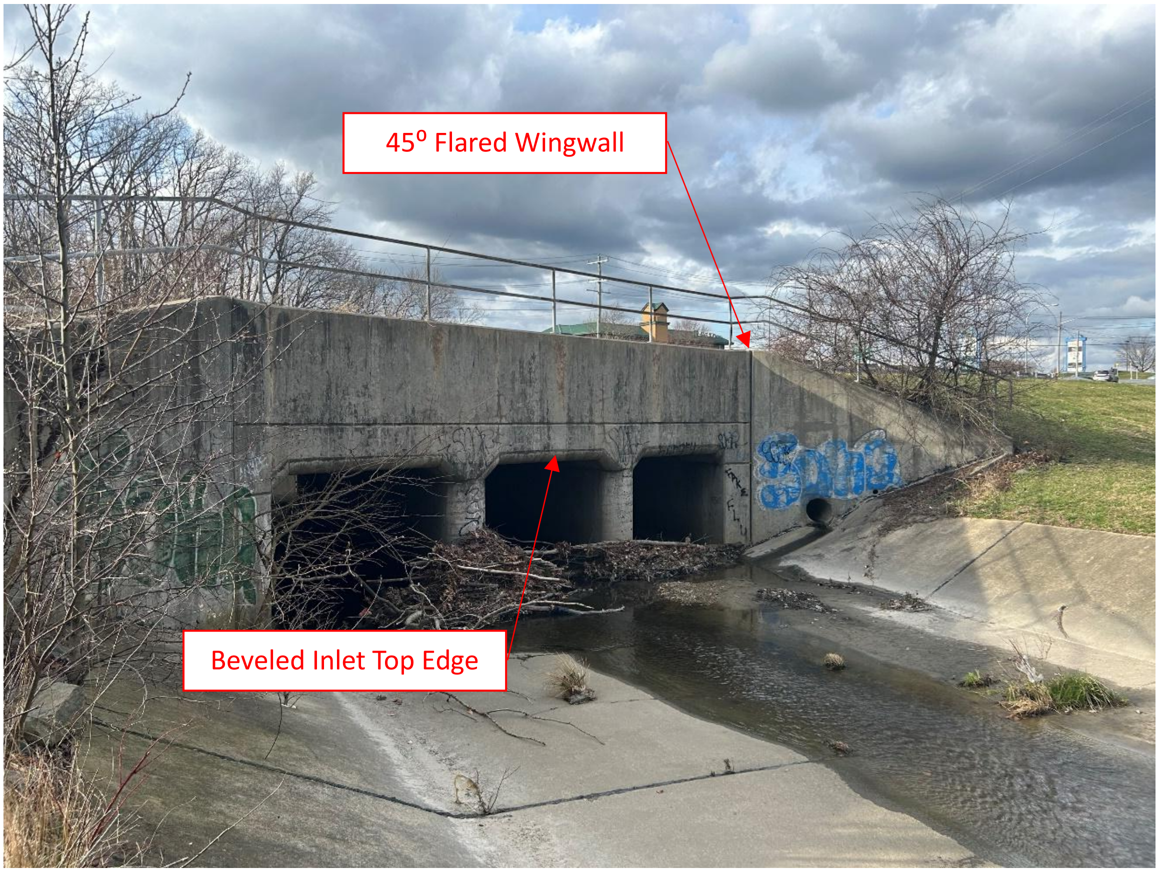


Figure 4: Upstream Side of Triple Box Culvert Under Concord Pike

2.2.2 Boundary Conditions

Boundary conditions within a HEC-RAS model are used to define points in the model where flow either enters or leaves the model reach. The model developed for this analysis has a single inflow and single outflow point. The upstream boundary condition was defined at the most upstream cross section (RS 2509) and consists of the peak discharges calculated during the hydrologic analysis, above. The downstream boundary condition was defined at the most downstream cross section (RS 198) and, since there is not a known rating curve (stage vs. discharge) at this location, it was determined that setting the boundary condition to be normal depth of flow was appropriate. Based on several iterations of the hydraulic model, a water surface slope of 0.85 percent was used for the energy calculations.

2.3 MODEL ITERATIONS/OUTPUTS

Once the Existing Conditions simulation was completed and any model instabilities were addressed, the results established a baseline for comparison against different Proposed Condition iterations. In addition to comparing the proposed results against the existing conditions, there were two hydraulic requirements that any proposed changes to the culvert needed to meet. According to the *DelDOT Bridge Design Manual*, as a principal arterial roadway and hurricane evacuation route, any designed culvert or bridge along US 202 must:

1) Maintain a minimum one-foot freeboard difference between the 50-Year (Yr) headwater elevation and the edge of pavement (Section 104.3.1.1) and.
2) Not cause the 100-Yr headwater to overtop the roadway or encroach on the travel lanes (Section 104.2.5).

Using the LiDAR dataset discussed previously, the low point along the edge of pavement profile in the vicinity of the culvert was determined to be 370.76’. This elevation was used across all of the model iterations to ensure compliance with both DelDOT hydraulic requirements.

For clarity, the result tables displayed throughout the body of this report will focus on supporting the discussion and may not include all cross sections or storm events included in the model. Full model results can be found in Appendix A.

2.3.1 Existing Conditions

The Existing Conditions model simulation was run to establish baseline results against which the proposed design iterations would be evaluated. The existing conditions water surface profile shows Rocky Run breaching its banks and accessing the floodplain somewhere between the 10-yr and 50-yr design storm discharges. During the 100-yr design storm, water surface elevations exceed the top of the culvert, creating a backwater effect and impacting a number of buildings on the Widener Law School campus (see **Figure 5**). The existing conditions water surface elevations for each modeled design storm are summarized in **Table 4**, below, and maps of the various inundation boundaries can be found in Appendix A.

Table 4: Existing Conditions Water Surface Elevation Summary Table

River Station	2-Yr	5-Yr	10-Yr	50-Yr	100-Yr
2509	368.21	368.95	369.40	369.80	370.06
2404	367.21	367.90	368.30	369.69	370.13
2303	367.02	367.59	367.92	368.91	369.48
2194	366.77	367.35	367.69	368.32	368.81
2085	366.68	367.32	367.71	368.52	368.88
1924	366.39	366.99	367.36	368.24	368.71
1746	365.50	366.13	366.50	367.31	367.75
1632	364.59	365.46	365.98	366.57	367.02
1527	363.61	364.20	364.60	365.41	366.23

River Station	2-Yr	5-Yr	10-Yr	50-Yr	100-Yr
1320	361.77	362.44	363.01	364.85	366.14
1129	361.51	362.49	363.16	365.19	366.41
1095	361.69	362.61	363.25	365.19	366.25
1023	**Concord Pike – US 202**				
935	361.10	361.72	362.12	363.14	363.60
842	360.22	360.69	361.01	361.97	362.45
714	357.36	358.07	358.59	359.90	360.50
521	354.50	354.96	355.23	355.99	356.50
364	353.26	353.71	353.99	354.77	355.15
198	351.04	351.54	351.85	352.70	353.13
DelDOT Hydraulic Criteria A			**370.76’ – 365.19’ = 5.57’ > 1.0’**		
DelDOT Hydraulic Criteria B			**366.25’ < 370.76’**		

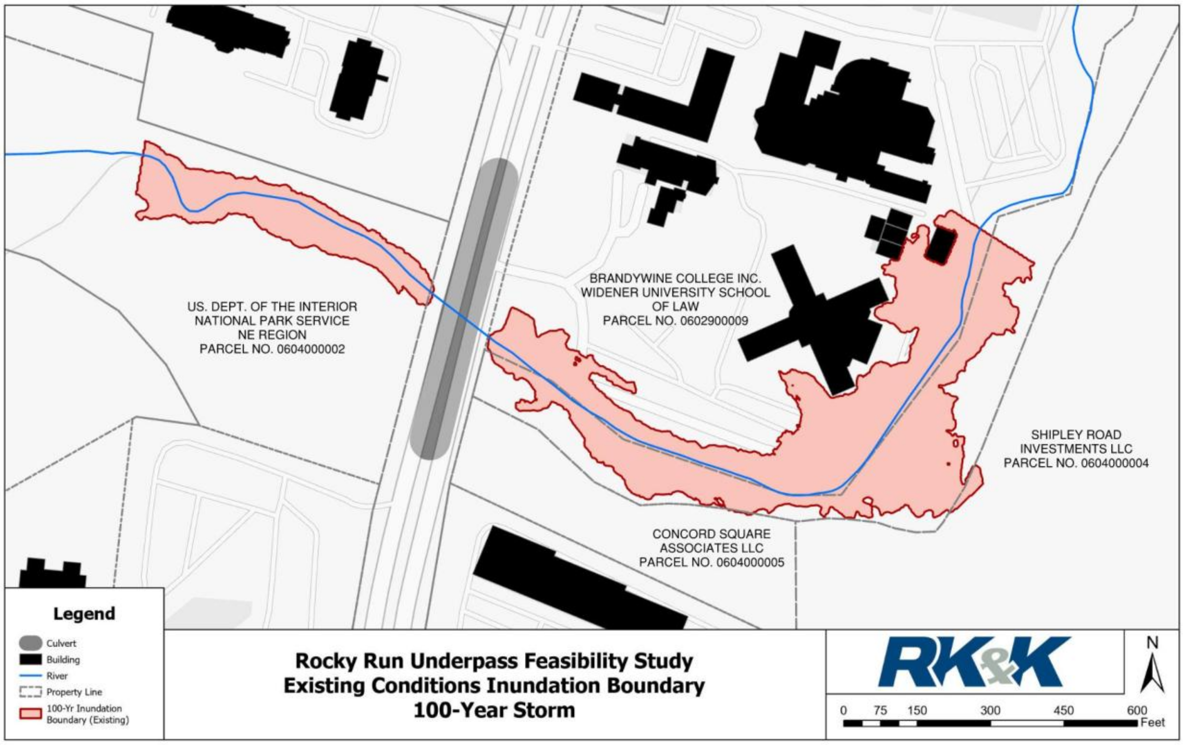


Figure 5: Existing Conditions 100-Yr Inundation Boundary Map

The existing 50-Yr and 100-Yr water surface elevations just above the culvert are 365.19’ and 366.25’, respectively. These values satisfy the two DelDOT hydraulic criteria required by the *Bridge Design Manual*.

2.3.2 Complete Closure

The first proposed conditions model iteration that was explored was a complete closure of the southernmost culvert cell to storm flows. This iteration was intended to model the most conservative possible scenario where the structure would act as a dual cell box culvert and the repurposed pedestrian/bicycle cell would not provide any conveyance. While there were several benefits to this configuration, primarily from a public safety/risk management perspective during high magnitude storm events, the water surface comparison results in **Table 5** show that a complete closure of one of the cells would cause significant increases to upstream flooding (see **Figure 6**).

Despite water surface elevation increasing more than four feet higher than the existing condition during some of the larger storm events, a complete closure of the southern culvert cell would still satisfy both of the DelDOT hydraulic criteria being used for this analysis. It should be noted, however, that DelDOT would not be amenable to this scenario. The third cell provides valuable additional conveyance that reduces flood risk during larger or non-design storm events. Preserving that capacity aligns with DelDOT's broader commitment to public safety and resilience, particularly given the urbanized upstream area and proximity to impacted structures like the Widener campus.

Table 5: Complete Closure Water Surface Comparison Table

River Sta	2-Yr			50-Yr			100-Yr		
	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)
2509	368.21	368.21	0	369.80	369.80	0	370.06	370.28	0.22
2404	367.21	367.21	0	369.69	369.69	0	370.13	370.38	0.25
2303	367.02	367.02	0	368.91	368.91	0	369.48	370.25	0.77
2194	366.77	366.77	0	368.32	368.34	0.02	368.81	370.18	1.37
2085	366.68	366.68	0	368.52	368.73	0.21	368.88	370.26	1.38
1924	366.39	366.39	0	368.24	368.60	0.36	368.71	370.30	1.59
1746	365.50	365.50	0	367.31	368.17	0.86	367.75	370.26	2.51
1632	364.59	364.59	0	366.57	368.00	1.43	367.02	370.24	3.22
1527	363.61	363.61	0	365.41	367.93	2.52	366.23	370.16	3.93
1320	361.77	362.81	1.04	364.85	367.92	3.07	366.14	370.15	4.01
1129	361.51	362.84	1.33	365.19	367.93	2.74	366.41	370.14	3.73
1095	361.69	362.88	1.19	365.19	367.82	2.63	366.25	369.98	3.73
1023	**Concord Pike – US 202**								
935	361.10	361.10	0	363.14	363.14	0	363.60	363.60	0
842	360.22	360.22	0	361.97	361.97	0	362.45	362.45	0
714	357.36	357.36	0	359.90	359.90	0	360.50	360.50	0
DelDOT Hydraulic Criteria A					**370.76' – 367.82' = 2.94' > 1.0'**				
DelDOT Hydraulic Criteria B					**369.98' < 370.76'**				

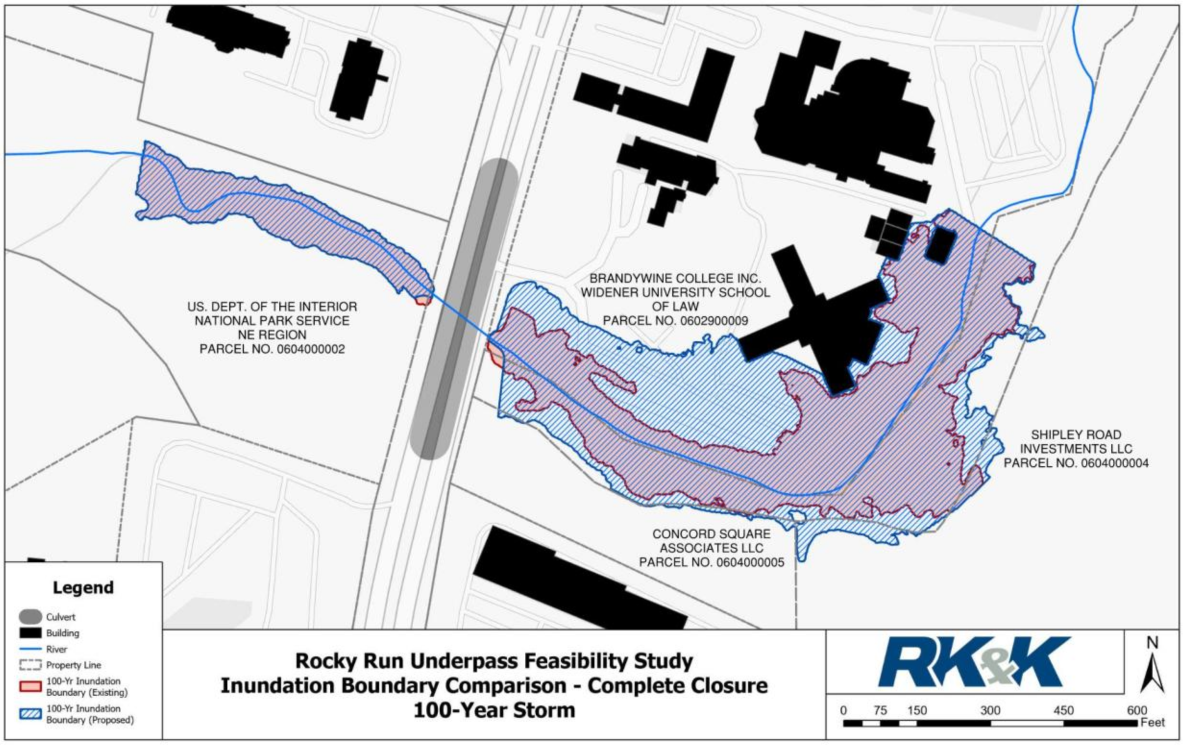


Figure 6: Complete Closure 100-Yr Inundation Boundary Map

2.3.3 Single Flood Wall

The second design iteration that was analyzed was the inclusion of a single flood wall. The flood wall would provide a barrier between the storm flows and the repurposed culvert cell for the smaller, more frequent, storm events. However, during larger storm events, water surface elevations would exceed the elevation of the top of the wall and the repurposed culvert cell could be used for conveyance. The height of the floodwall is anticipated to be between 4.5 feet and 5.5 feet. For this analysis, the top of the wall was set to a constant elevation of 364.00 feet (approximately 5.5 feet above the invert of the culvert).

Typically, in the HEC-RAS, a scenario like this could be modeled by making the flood wall perform hydraulically like a levee, but there is not a way to make the levee extend to the face of the culvert and stop flow from entering the “closed” cell. In order to model the intended design in HEC-RAS, two separate simulations were performed, one for smaller storms (2-yr, 5-yr, and 10-yr) and one for the larger storms (50-yr and 100-yr).

The large storm simulation defined levees in the two cross sections immediately upstream and downstream of Concord Pike. Since it was already known that the water surface elevations from these storms would far exceed the top of the proposed flood wall, the fact that the levees wouldn’t extend to the face of the culvert didn’t matter. The proposed condition water surface elevations would be almost identical to existing conditions exception for some minor energy losses associated with the levees (see **Figure 7**).

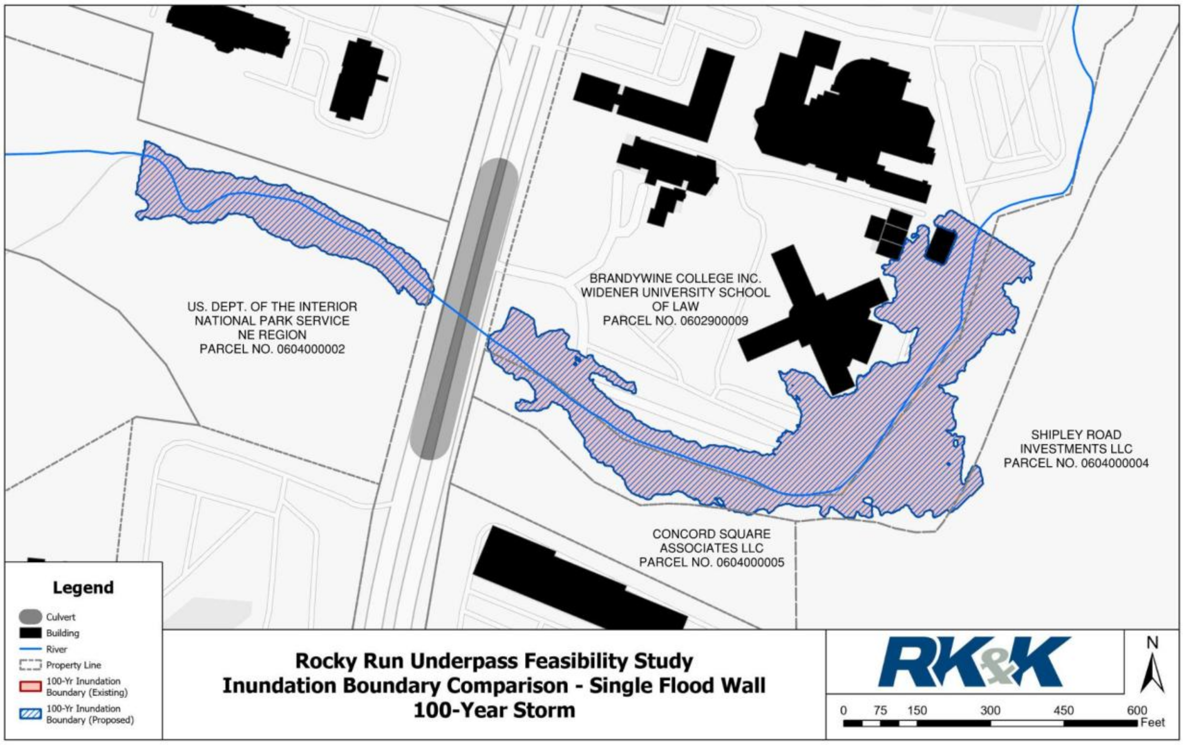


Figure 7: Single Flood Wall 100-Yr Inundation Boundary

The small storm simulation needed to incorporate a physical barrier to block flow entering the repurposed culvert cell. To achieve this, the geometry of the cross sections immediately upstream and downstream of Concord Pike were altered to block out the area that would be protected by the flood wall. When these scenarios were run, the 2-, 5-, and 10-yr storm events were forced into the two open culvert cells until the water surface elevations reached the top of the blockage. The proposed water surface elevations for the 2- and 5-yr storms remained below the top of the wall, but the 10-yr exceeded that elevation. This indicated that somewhere between the 5-yr and 10-yr discharges, the proposed flood wall would overtop, and the repurposed southern cell would begin conveying flood flows.

Due to the aforementioned limitations in the one-dimensional hydraulic modeling software, the water surface elevation of the 10-yr storm event was not able to be accurately computed in either of these model scenarios. The discharge for the 10-yr storm is large enough to overtop the proposed wall, but small enough that the water surface elevation within the southern culvert cell will not reach an equilibrium with the water surface elevation within the other two cells. **Table 6**, below, summarizes the water surface elevation comparison for the single flood wall design alternative.

Table 6: Single Flood Wall Water Surface Comparison Table

River Sta	2-Yr			5-Yr			100-Yr		
	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)
1527	363.61	363.61	0	364.20	364.20	0	366.23	366.23	0
1320	361.77	362.81	1.04	362.44	364.10	1.66	366.14	366.14	0
1129	361.51	362.84	1.33	362.49	364.18	1.69	366.41	366.42	0.01
1095	361.69	362.69	1.00	362.61	363.91	1.30	366.25	366.25	0
1023	**Concord Pike – US 202**								
935	361.10	360.87	-0.23	361.72	361.28	-0.44	363.60	363.63	0.03
842	360.22	360.22	0	360.69	360.69	0	362.45	362.45	0
714	357.36	357.36	0	358.07	358.07	0	360.50	360.50	0
DelDOT Hydraulic Criteria A					**370.76’ – 365.19’ = 5.57’ > 1.0’**				
DelDOT Hydraulic Criteria B					**366.25’ < 370.76’**				

2.3.4 Double Flood Wall

The idea for the third design iteration, a double flood wall, resulted from public comments from the Rocky Run Underpass Public Workshop held on February 10, 2025. Due to the constrained dimensions within the culvert cells, a few meeting attendees wondered if two floodwalls could be installed so that the northern and southern cells could each be used for one-way pedestrian/bike traffic. In this design configuration, lower flows would be restricted to just the middle culvert cell until water surface levels reached the top of wall elevation, then flow would spill over the walls at which point all three cells would convey flood flows beneath the roadway.

In order to model this design in the HEC-RAS, a similar approach was taken to the single wall option above. For the larger storms, two levees were added to cross sections RS 1095 and RS 935 to represent the two floodwalls. Since the 50-yr and 100-yr water surface elevations are significantly higher than the rest of the wall, those storms utilize all three culvert cells in an almost identical manner to the existing condition, save for some minor energy losses. In the smaller storm simulation, the geometry of RS 1095 and RS 935 were modified to show a physical blockage of the cross section where the two walls would force the flows into the middle culvert cell.

When both model simulations were run with the double wall configuration, all five of the modeled storm events overtopped the flood wall. Similar to the 10-yr storm event in the single wall iteration, the discharges for the 2-, 5-, and 10-yr storms were high enough to overtop the double flood walls but low enough that the water surface elevations do not reach an equilibrium across the three culvert cells, so water surface elevations could not be accurately computed using the one-dimensional modeling. **Table 7**, below, summarizes the water surface elevation comparison for the double flood wall design alternative.

Table 7: Double Flood Wall Water Surface Comparison Table

River Sta	50-Yr			100-Yr		
	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)	Existing W.S. Elev (ft)	Proposed W.S. Elev (ft)	Difference (ft)
1320	364.85	364.85	0	366.14	366.14	0
1129	365.19	365.19	0	366.41	366.42	0.01
1095	365.19	365.18	-0.01	366.25	366.25	0
1023	**Concord Pike – US 202**					
935	363.14	363.19	0.05	363.60	363.66	0.06
842	361.97	361.97	0	362.45	362.45	0
714	359.90	359.90	0	360.50	360.50	0
DelDOT Hydraulic Criteria A				**370.76’ – 365.18’ = 5.58’ > 1.0’**		
DelDOT Hydraulic Criteria B				**366.25’ < 370.76’**		

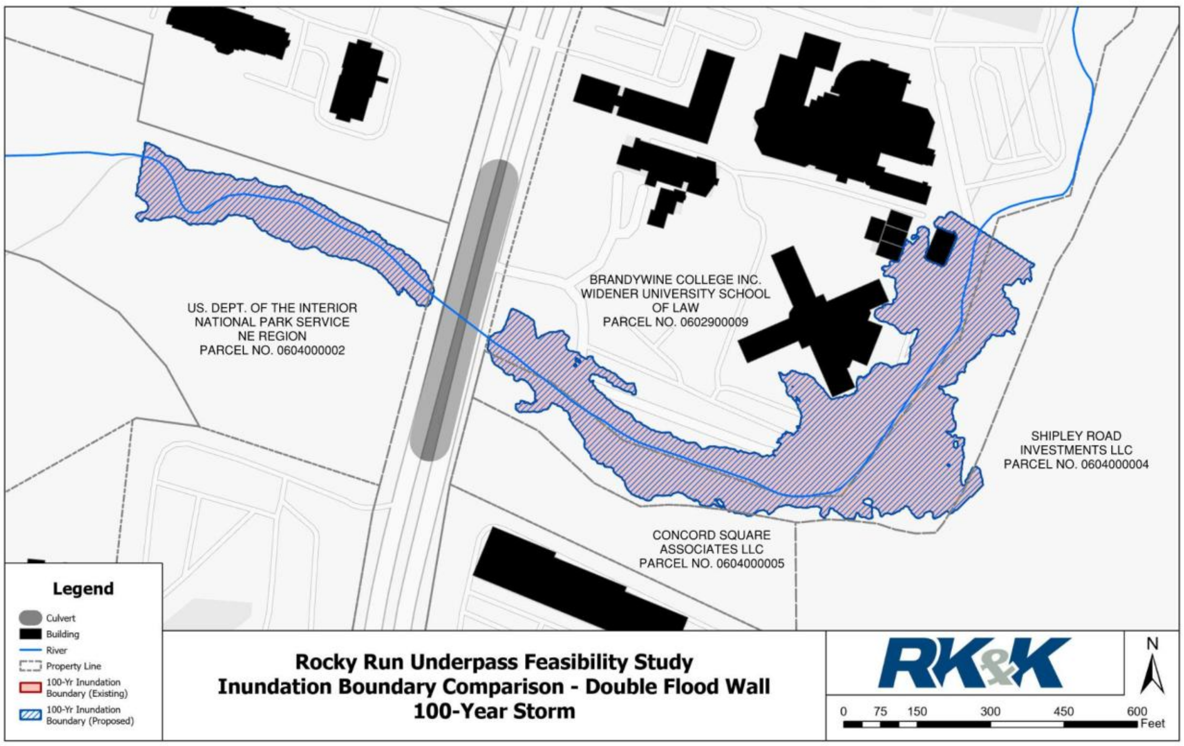


Figure 8: Double Flood Wall 100-Yr Inundation Map

2.4 HYDRAULIC ANALYSIS CONCLUSIONS AND RECOMMENDATIONS

The results of the hydraulic analysis of all three design configurations support the feasibility of repurposing a portion of the Rocky Run culvert under Concord Pike as a pedestrian/bike underpass. The resulting headwater elevations for all three of the alternatives satisfy the two primary hydraulic design requirements for the US 202 roadway classifications per the DelDOT *Bridge Design Manual*.

Despite being in compliance with the DelDOT design criteria, the complete closure of the culvert cell was determined to be the least desirable of the alternatives because of the increased flooding risk to upstream properties. Water surface elevations during the 100-yr storm simulation were as much as four feet higher than the existing condition when the capacity of the culvert was reduced to only two cells. The expanded inundation boundary (see Figure 6 and Appendix A) encroaches on several buildings on the Widener Delaware Law School property which are dry in the existing condition.

Both the single and double flood wall configurations eliminate the upstream flooding issue seen in the complete closure scenario (see Figure 7 and Figure 8). By allowing higher discharges to access the repurposed cells, the conveyance of the culvert will be practically identical to the existing condition for the larger storms. While there will be increased water surface elevations during the smaller storm events in both the single and double flood wall configurations, these increases are expected to be contained primarily within the existing channel banks and are expected to have negligible impacts to upstream properties.

Taking all of this into account, the project team's recommendation would be for design to move forward with the single flood wall alternative. While the internal dimensions of the culvert cells are smaller than would be preferred for a single two-way pedestrian tunnel, having two culvert cells open to flow would result in the single flood wall overtopping much less frequently than a double flood wall would. The results of a hydraulic analysis show that the single flood wall option would safely convey the 2- and 5-yr storms without overtopping while the double flood wall would not convey any of the modeled storms without overtopping. By proceeding with the single flood wall design, the underpass can find a balance between minimizing flood impacts to upstream properties while keeping the repurposed culvert cell as dry and safe as possible for the public.

Due to the aforementioned limitations with the 1D hydraulic modeling software, it is recommended that future design advancement includes the development of a 2D hydraulic model. A 2D model would increase understanding of what is happening hydraulically in between the 5- and 10-yr design storms when the single flood wall would overtop and the three culvert cells would all be conveying a different amount of flow. These model results would provide important supporting data for other components of the project like the structural design of the flood wall and potential storm drain network impacts.

It should be noted that, while there were representatives from DelDOT on the TAC for the project, no formal DelDOT review or support of this Hydrology and Hydraulics Analysis have been obtained. Since the culvert is owned by DelDOT and the majority of the proposed work would happen within the Concord Pike right-of-way, their involvement as the project progresses is critical.

3 TRAIL ALTERNATIVES ANLAYSIS

3.1 ALTERNATIVES DESCRIPTIONS

As stated in Section 1, the core purpose of this study is to find the best way to connect multimodal facilities across Concord Pike around the Rocky Run location, ideally between the existing sidewalk network and the Rocky Run Trail network in the First State National Historic Park. The *Concord Pike Master Plan* identified using the culvert as the primary option for crossing, but this study intended to explore all options to cross the roadway to recommend the most prudent investment.

Four trail alternatives for crossing Concord Pike were considered:

1. The culvert tunnel option deemed feasible from a hydrological standpoint in Chapter 2.
2. Enhanced at-grade crossing and surrounding sidewalks upgraded to wider shared-use paths to better accommodate both bicyclists and pedestrians.
3. A new tunnel under Concord Pike, likely just to the south of the culvert location.
4. A pedestrian bridge with Americans with Disabilities Act (ADA)-compliant ramp slopes to span Concord Pike, likely just to the south of the culvert location.

3.1.1 Culvert Tunnel Conversion (Underpass)

This option would follow the same assumptions that were applied to the hydraulic modeling – converting one of the three existing cells to a shared-use pathway that would allow pedestrians and people walking (not riding) their bicycles through the tunnel. This option would include upgrades such as warning signage and lighting, in addition to a single flood wall on the upstream side.

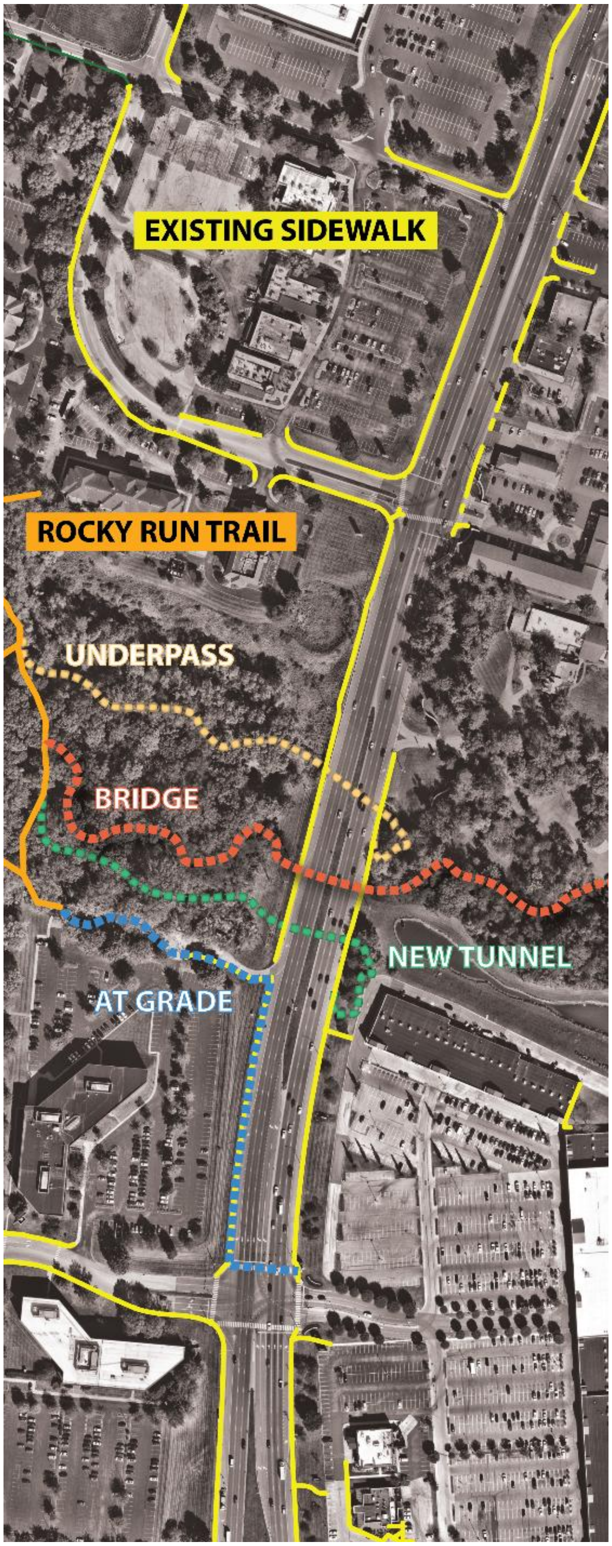
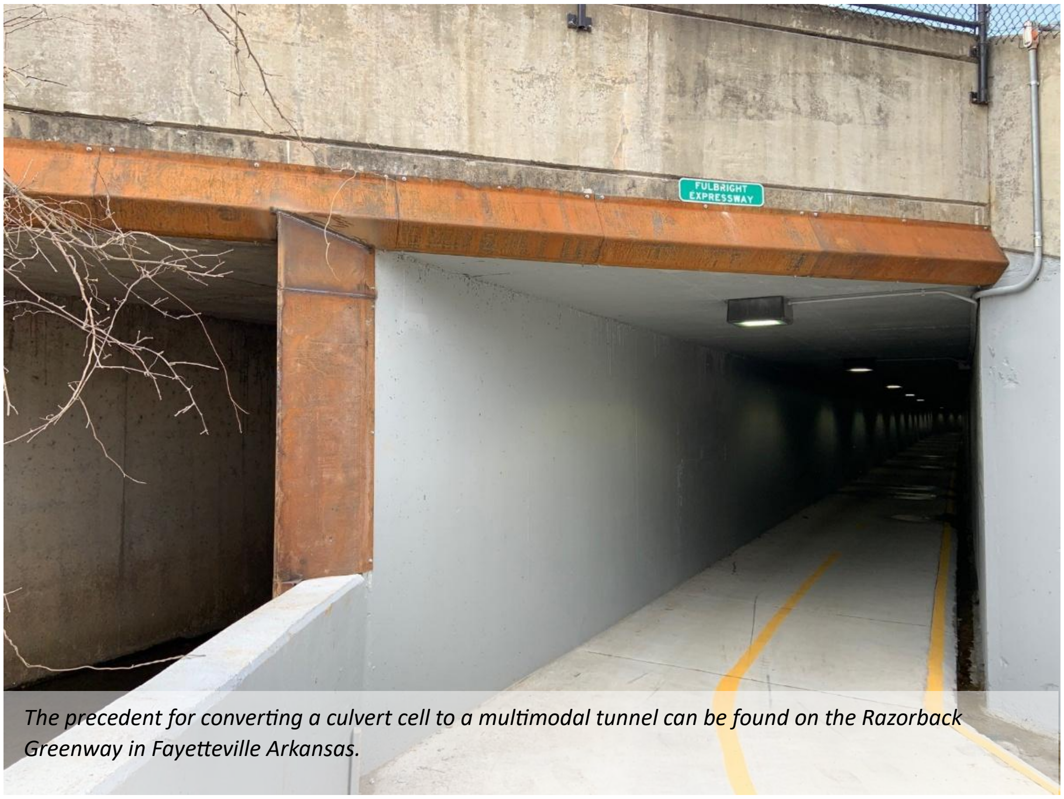


Figure 9: Graphic Display of the Four Crossing Alternatives

The culvert cell is eight feet wide and seven feet tall, short of the desired 10-foot by 10-foot dimensions for pedestrian/bicycle tunnels. There is a recent example of an underpass of Paper Mill Road north of Newark on DelDOT right-of-way that also has a tighter-than-desired space (although it met DelDOT Road Design Manual guidance when implemented), which could provide a case study and a precedent for implementation.

Figure 10: The Entrance to the Rocky Run Culvert Cell

The largest and most obvious advantage of the culvert tunnel conversion are inherent to the reason it was initially identified as the crossing conduit during the master planning process – it is already built and with pathway connections, it is a lower cost improvement that could be implemented in a shorter time frame as compared to a new tunnel or pedestrian bridge. One of the other main advantages is the culvert is completely separated from vehicular traffic, resulting in no conflict between pedestrians and vehicles. While the culvert appears to be relatively “plug-and-play”, one of the potential drawbacks could be user experience – the low head room, the tight pedestrian operating space, the significant length (120 feet), the noise from the arterial roadway overhead – all contribute to a less pedestrian comfort as compared to some of the other alternatives. This alternative has a planning level construction cost estimate of $700,000 in 2025 dollars.



The precedent for converting a culvert cell to a multimodal tunnel can be found on the Razorback Greenway in Fayetteville Arkansas.

Figure 11: Razorback Greenway

3.1.2 At-Grade Enhancements

Enhancing at-grade connectivity would involve three main elements:

1. Adding crossing treatments at the intersection of Righter Parkway and Concord Pike.
2. Upgrading the sidewalk on the west side of Concord Pike, between Righter Parkway and Rocky Run to a ten-foot wide shared-use path.
3. Building a new connection between the Rocky Run Trail network and the improved shared-use path.

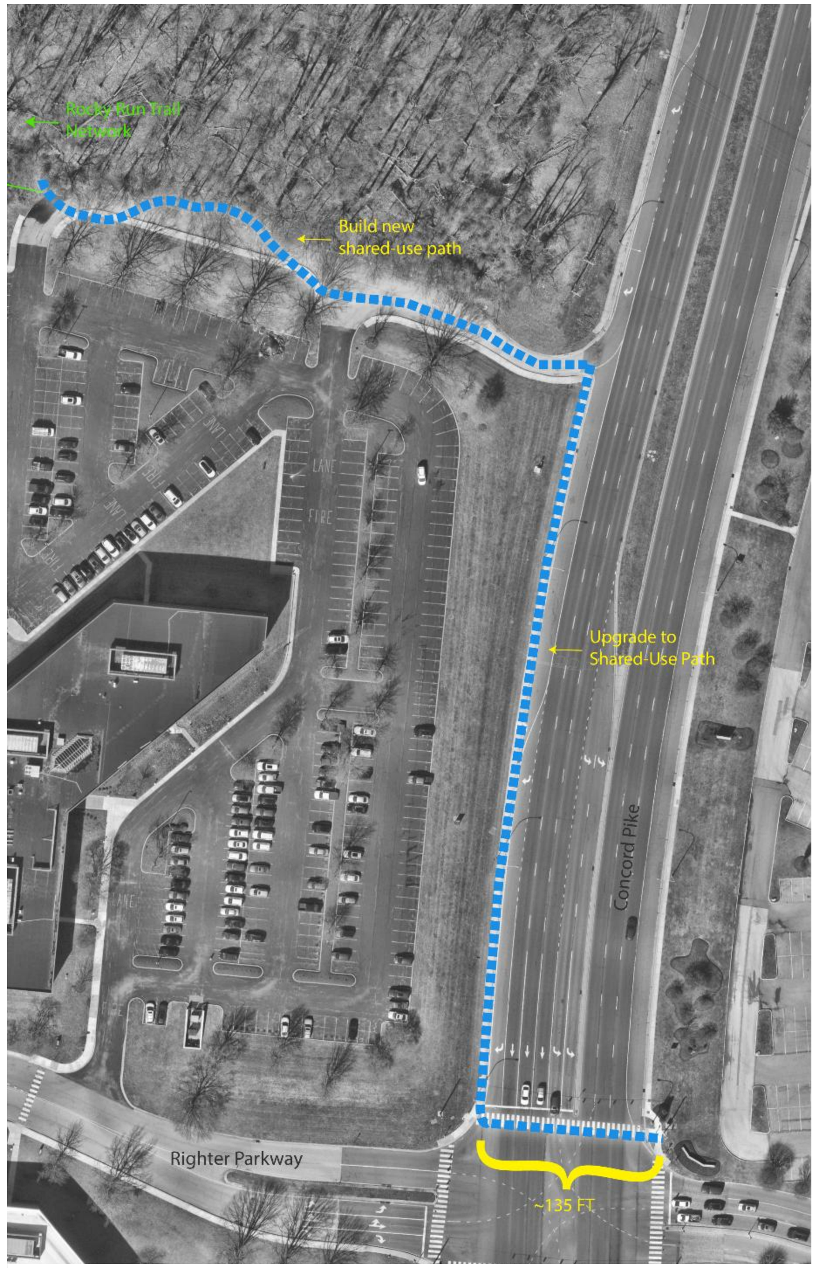


Figure 12: At-Grade Enhancements

Treatments at the crossing should include measures that make it easier and more inviting from a pedestrian experience. Currently, the crossing is quite long (~135 linear feet) and does not include a pedestrian refuge island in the middle of the nine vehicular lanes.

Of all the crossing options, the at-grade alternative is likely to be the least expensive and requires the least amount of permitting, although the proposed connection on the west side of Concord Pike is private right-of-way. Unlike the other options, this alternative does not completely separate pedestrians from vehicular traffic, and it is the least direct route from the east side of Concord Pike to the Rocky Run Trail Network in the National Park. This alternative has a planning level construction cost estimate of $400,000 in 2025 dollars.

3.1.3 New Tunnel

A new tunnel would be constructed near the existing culvert and have a similar trail connection on both sides of Concord Pike. Like the underpass option, the new tunnel would create total separation from vehicular traffic for trail users with the allowance for more comfort and operational space. Construction of the new tunnel would be significantly more expensive than the culvert conversion option. Design, permitting, construction, and right-of-way acquisition are also anticipated to cost much more with this alternative. This alternative has a planning level construction cost estimate of $5.7 million in 2025 dollars.

A new tunnel akin to this one in Frederick, MD would be more customizable than the culvert option but would likely require additional permitting and cost more.

Photo Credit: MG McLaren

Figure 13: New Bridge Under Roadway Example: Frederick, MD

3.1.4 Pedestrian Bridge

The final crossing alternative that was considered is a pedestrian bridge. The pedestrian bridge would be about 14 feet wide and would need to span Concord Pike at roughly 20 feet above the roadway surface. Since the trails sit between 20 and 40 vertical feet below the surface of the roadway, the bridge surface to the bottom of the ramp would need to be around 60 vertical feet. To satisfy accessibility guidelines and keep the ramp at a slope of no greater the five percent, significant switchbacks and added run would be required to both sides of the ramp.

This option would completely separate trail users from vehicular traffic, but the added length of the ramps would add distance, in addition to the inconvenience of having to go up and down to cross the road. Similar to the new tunnel option, it could be built to have sufficient operational space, but it would be much more expensive and entail greater regulatory complications than the culvert conversion and at-grade options. This alternative has a planning level construction cost estimate of $6.8 million in 2025 dollars.

Even when changing just a few feet in elevation, a significant amount of run is required on ramps to make them properly accessible

Photo Credit: Carolyn Ristau

Figure 14: Pedestrian/Bicycle Overpass Example: Buffalo, NY

3.2 PUBLIC AND STAKEHOLDER COORDINATION AND CONSIDERATIONS

3.2.1 February 10, 2025 Public Workshop Feedback Summary

On February 10, 2025, a public workshop was held to present project progress, share the results of the initial hydraulic analysis, and garner public feedback on the trail crossing options. The workshop took place at the Talleyville Fire Company at 3919 Concord Pike and featured a presentation as well as informational and interactive boards, along with the opportunity for attendees to submit comment cards.

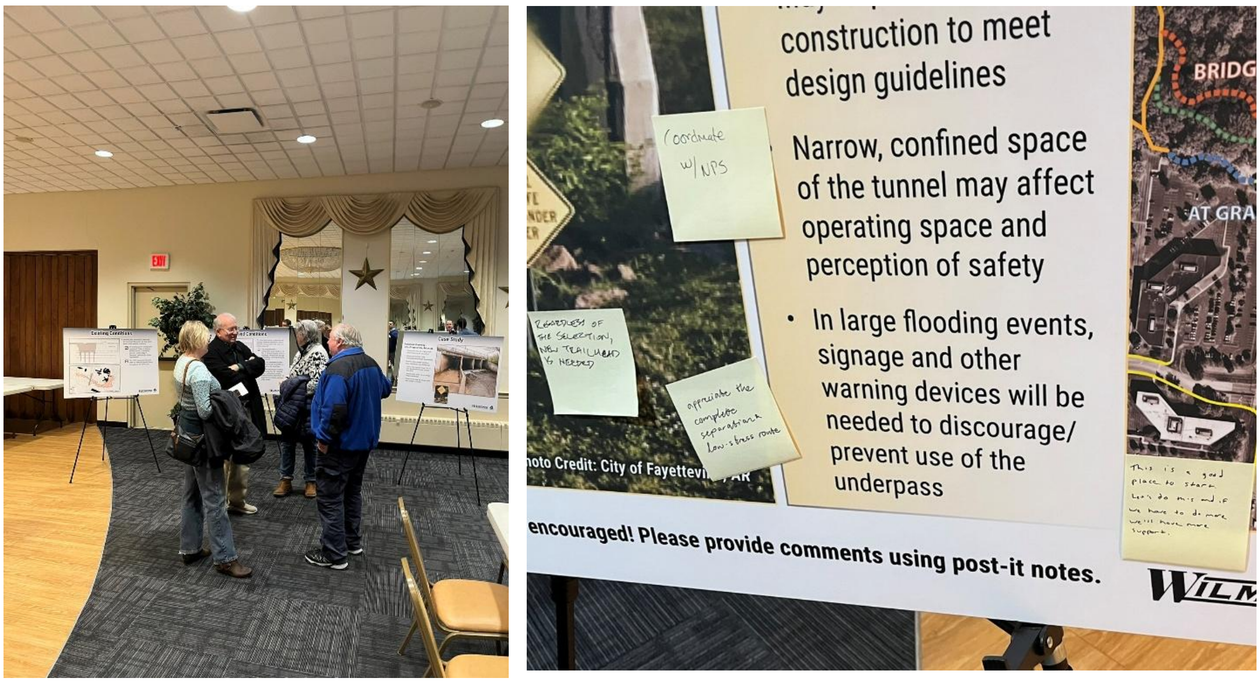


Figure 15: Images from the Public Workshop

The meeting was attended by 31 people, with varied feedback. There was no public consensus on a preferred alternative, but there was qualitative feedback for the project team to consider as the study progressed, such as:

- Further coordination with the National Park Service and the development process on the east side of Concord Pike.
- Consider DART riders on Concord Pike and make sure they have a clear opportunity for a safe crossing.
- Consider doing the lower-effort alternatives, such as the at-grade enhancements and culvert conversion, as immediate- and medium-term solutions and plan for a new tunnel as a long-term capital project.
- Look at trailhead options as part of the preferred alternative.
- Explore concept of utilizing two culvert cells for “one way” bike movements with flood walls

The public also had questions on whether a tunnel is in the best location and voiced public safety concerns about using the existing culvert. There also appeared to be minimal support for the pedestrian/bicycle bridge over Concord Pike.

Information from the Public Workshop is found in Appendix B. An overview from the second and final public workshop held on June 2, 2025 is found in Section 4.

3.2.2 First State National Historical Park Trail Master Plan

A meeting was held with Joshua Boles from the First State National Historical Park on March 31, 2025. Also in attendance were Rich Przywara (Woodlawn Trustees), Dave Gula (WILMAPCO), and Mark Tudor (RK&K). The discussion focused on the long-term plans anticipated for the National Park and how they could be coordinated with options being considered for the Rocky Run Culvert.

Joshua provided feedback on which approach could be the best option – an initial design for the Rocky Run Culvert Feasibility Study focused on connecting the use of the repurposed culvert to a shared-use path system along Concord Pike, which could then provide improved access to the existing trail heads. Any consideration of extending a trail parallel to Rocky Run into the National Park would have more substantial permitting and coordination requirements, which would complicate implementation and likely increase costs and mitigation requirements.

3.2.3 Widener University Delaware Law School

A meeting was held with Todd Clark from Widener University Delaware Law School on April 8, 2025. Consistent with the National Park Service meeting, also in attendance were Rich Przywara (Woodlawn Trustees), Dave Gula (WILMAPCO), and Mark Tudor (RK&K). The discussion focused on providing an update on the feasibility study and understanding how it may affect the Widener's property, both in their current use of their site and any future plans.

It was explained that a design approach of utilizing a flood wall with any repurposed one cell of the culvert would minimize the potential of flooding upstream on Widener property.

Todd also indicated that Widener is considering other locations to expand the law school. Any new use (or redevelopment) of their current property will consider how it could tie in and support the proposed trail network, including the potential repurposed south cell of the culvert.

3.3 PREFERRED ALTERNATIVE: THE CULVERT AND AT-GRADE IMPROVEMENTS

After weighing each factor and coordinating with project and area stakeholders, the preferred crossing solution is to move forward with the culvert conversion (underpass), as well as construct some at-grade improvements to the pedestrian network, in a phased approach.

	UNDERPASS ASSUMING CLOSE ONE CHAMBER WITH ADDITIONAL CONSTRUCTION TO MEET FHWA/AASHTO STANDARDS	**BRIDGE** ASSUMING LONG TRAIL WITH GRADUAL SLOPE CHANGE	**AT GRADE** ASSUMING NEW SHARED USE PATH IN PLACE OF EXISTING SIDEWALKS	**NEW TUNNEL** ASSUMING LOCATION NEAR EXISTING CULVERT SITE
ENVIRONMENTAL IMPACTS	● *CLOSE CHAMBER* *ADDITIONAL IMPERVIOUS* *REMOVE TREES*	● *STAY OUT OF CREEK* *TREE REMOVAL (LONG SPAN)* *CONSTRUCTION DISRUPTIVE*	●●● *MINIMAL TREE REMOVAL* *MINIMAL ADDITIONAL IMPERVIOUS* *NEW SHARED USE PATH*	●
UTILITY IMPACTS	●● *EXCAVATION MAY IMPACT*	● *IMPACTED OVERHEAD*	●●● *NONE TO MINIMAL*	●
STORMWATER CONVEYANCE	● *RE-ROUTE, RUN OFF FROM ROAD - IMPERVIOUS SURFACE*	●● *RUN OFF OF BRIDGE, INTO EX. SYSTEM*	●●● *NEGLIGIBLE*	●
PERCEPTION OF SECURITY	● *TIGHT, DARK, LONG*	●● *NOT VISIBLE*	●●● *MORE VISIBLE* *..... TO ESCAPE*	●
ROAD CROSSINGS	●●●	●●●	●	●●●
SEPARATION FROM TRAFFIC	●●●	●●	●	●●●
BIKE/PED OPERATING SPACE	●	●●	●●●	●●●
DIRECT ROUTE	●●●	●	●	●●●
CONSTRUCTIBILITY	●●	● *DISRUPTIVE TO TRAFFIC FLOW DURING CONSTRUCTION*	●●●	●
ADA ACCESSIBILITY	●●	●	●●●	●●

● = Poor
●● = Average
●●● = Excellent

Figure 16: Alternatives Comparison Matrix

Combining elements of the underpass and at grade alternatives provides the best attributes of both lower cost solutions, allows for multiple points of connection based on users' needs and preferences, and confirms the preferred option as developed in the 2021 *Concord Pike Master Plan*.

More details are found in Section 4: Feasibility Study Recommendations.

4 FEASIBLITY STUDY RECOMMENDATIONS

This feasibility study recognizes that improvements should be phased, based upon available resources and anticipated demand for the connected trail network. Land development activity also may dictate the phasing and timing of elements of the feasibility study recommendations.

4.1 PHASED APPROACH

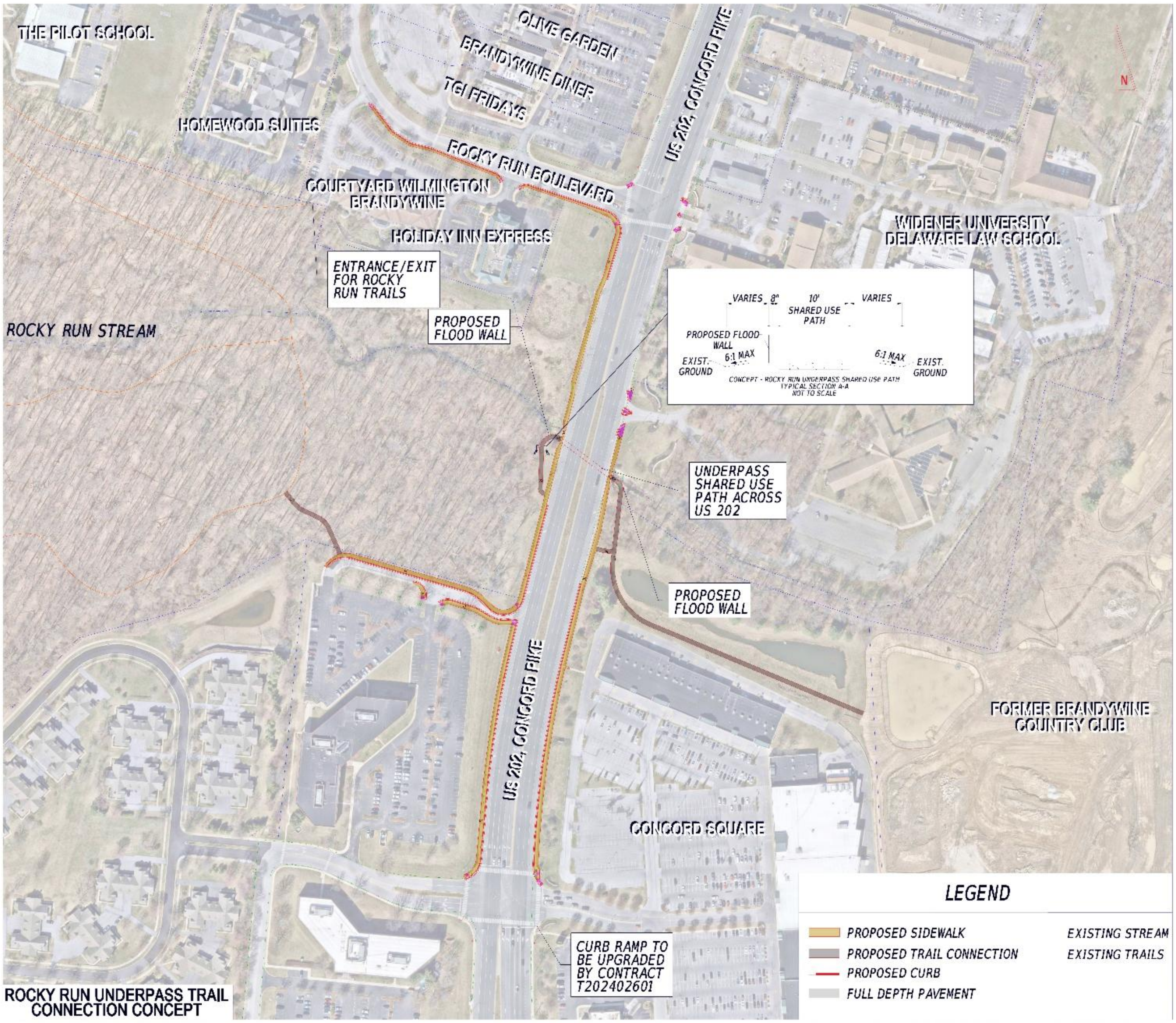
A phased approach has been developed that could be used for planning and programming considerations. The culvert cell is 8 feet wide and 7 feet high; therefore, while it does not meet all applicable design guidelines, a repurposed culvert cell can function as a pedestrian/bicycle connection with mitigation measures (warning signs, etc.). If demand increases, a future project for a new tunnel (separated from the current culvert) could be considered to provide a full 10 foot by 10-foot shared two-way pedestrian/bicycle facility.

The initial phase would include a repurpose south cell of the culvert for a pedestrian/bicycle underpass, with a single flood wall (4.5 feet to 5.5 feet max height). Lighting, resurfacing the existing culvert, signing and striping, and security elements would also be included. Drainage infrastructure from Concord Pike and the roadside, some which currently drain directly into the south culvert cell, would also need to be rerouted. Trail connections along Concord Pile connecting signalized intersections with existing National Park Trailheads and developments on the east side would also be included, along with any necessary upgrades to the existing at grade signalized crossing on Concord Pike at Widener University and Concord Plaza. **Figure 17** shows the recommended elements of the Initial Phase.

For potential future phases, additional elements could be constructed concurrently or separately based upon available funding and demand:

- New 10 foot by 10-foot tunnel.
- Widening/extension of existing Rocky Run Culvert to provide space for a 10-foot shared-use path on both sides of Concord Pike.
- Extension of trail west from culvert underpass parallel to Rocky Run to connect into existing National Park trail system.

Figure 17: Trail Network Recommendations



4.2 PLANNING LEVEL CONSTRUCTION COST ESTIMATES

Planning Level Construction Cost Estimates (in 2025 dollars) have been developed for the elements of each of the proposed phases. The shared-use paths and off-trail connection should be able, for the most part, to be utilized in any future phases. Note that these estimates do not include costs for design, right-of-way or environmental permitting.

- Initial Phase: $2,700,000
  - Repurposing Existing Culvert (including flood wall): $700,000
  - Shared-Use Paths: $1,800,000

  - Off Trail Connections: $200,000
- Future Phase(s): $6,385,000
  - New Tunnel: $5,700,000
  - Widening Existing Rocky Run Culvert: $500,000
  - Extension of Trail west of Concord Pike parallel to Rocky Run: $185,000

4.3 INITIAL PHASE DESIGN CONSIDERATIONS

The initial Phase Design should be developed to ensure a safe and accessible trail network for many years, as additional tail connections are made either in the National Park or by adjacent properties.

When the initial phase is implemented, and if use grows and the trail connections become more popular, the initial phase can be used to set the stage for future additional improvements.

Connections from the tunnel to the existing pathway network must be accessible and usable by people with disabilities and meet applicable ADA requirements. This includes the width of the constructed shared-use paths, grades, and materials. The shared-use path surface along Concord Pike, driveways, and adjacent to parking areas shall be concrete, and a minimum of 10 feet wide (except as noted at the Rocky Run culvert). Graded stone dust shall be used for connections into NPS areas as a transition to the natural material trail areas currently located through the park.

Stormwater shall be designed to address runoff from the shared-use path and trail network. It is anticipated that, given that the improvements consist of shared-use paths and trail connections, a standard plan will be utilized for stormwater review and approval. Stormwater designs should be focused on addressing water quality.

The flood wall shall be designed at a maximum height of 4.5 feet to 5.5 feet at its connection to the culvert, and the top of the flood wall shall stay at the same elevation as it ties into the slopes as the path connects to the shared-use paths along Concord Pike. Geotechnical investigations, analysis, and design will be needed to ensure the flood wall can withstand forces from larger storm events along Rocky Run.

Renderings have been developed (**Renderings 1 and 2**) to illustrate some of the details of the repurposing of the culvert, the flood wall, and the transition up the slope.

Rendering 1: Repurposed Culvert Looking from south side of Rocky Run, east of Concord Pike

Rendering 2: Repurposed South Cell of Culvert looking from East Side of Concord Pike

4.4 FUTURE PHASE DESIGN CONSIDERATIONS

As noted previously, if demand increases along the trail network and the repurposed south cell of the culvert, funding should be considered for a new tunnel that can provide a full 10 foot by 10-foot space for pedestrians and bicyclists. The tunnel will need to be separated from the existing Rocky Run culvert, so flood events do not impact the new tunnel. Geotechnical and subsurface utility investigations will be needed to fully understand the issues associated with the construction of the new tunnel, and considerations should be made for construction techniques that minimize closures to Concord Pike during construction.

Independent of the potential of a new tunnel, separate funding should also be pursued to lengthen the existing culvert to provide enough space for 10-foot-wide shared-use paths on both sides of Concord Pike. Currently, there is only enough space (6 to 7 feet) over the culvert, and additional demand may necessitate the need to address any “pinch” points.

Also, if demand increases and there becomes an increasing amount of use of the culvert by pedestrians and bicyclists, a more direct trail connection west from the culvert to the existing trail network in the National Park, along Rocky Run, could be implemented. The surface of this trail would be made of natural material to be consistent with other trails in the park and can be designed to meander to minimize impacts to existing trees and any wetlands.

4.5 JUNE 2, 2025 PUBLIC WORKSHOP FEEDBACK SUMMARY

A workshop was held on June 2, 2025 (as part of the annual workshop for the Concord Pike Monitoring Committee) to share the recommendations for a phased implementation plan. Workshop materials are found in Appendix B.

Eight boards detailed the feasibility process and phased recommendations, along with recommended next steps. A short presentation was also provided (repeated twice) during the two-hour workshop to provide an overview of the Rocky Run Feasibility Study and help orient workshop participants with the information and encourage them to fill out comment forms.

Eight workshop participants provided comments specific to the general question about the Rocky Run Pathway Feasibility Study. Most comments were related to issues that need to be considered and addressed as part of the design. The workshop comments are also found in Appendix B.

5 NEXT STEPS

Project implementation can take a variety of forms. This feasibility study recommends that WILMAPCO include the initial phase of the recommended improvements in the next update to the Regional Transportation Plan as required, so federally participating funding can be included in the Transportation Improvement Program and DelDOT's Capital Transportation Program.

5.1 POTENTIAL PERMITTING REQUIREMENTS AND PROCESSES

Permitting requirements will be based on whether federal funding will be included in funding the project, or whether it may be funded entirely by other sources, including state or private funding.

Regardless of funding sources, early coordination with the Park Service will be important. While potential impacts to Park Service property are anticipated to be minor with the anticipated initial phase, any impacts will likely dictate additional coordination requirements with other federal and state resource agencies.

Based upon the anticipated initial phase of improvements, the following permit coordination is anticipated:

- United States Army Corps of Engineers
- United States Fish and Wildlife Service
- United States NPS
- DNREC Subaqueous Land Permit
- DE State Historic Preservation Office Section 106
- New Castle County Flood Plain
- Erosion and Sediment Control Permit

If federal funds are utilized, 6(f) coordination may be required. If FHWA funds are part of the federal funds utilized, a Section 4(f) review will also be required.

5.2 AGENCY COORDINATION AND RELEVANT STAKEHOLDERS

Along with coordination with federal and state resource permitting agencies, this feasibility study also recognizes that continuing stakeholder involvement and input when the initial phase moves into advanced planning and/or design will be important. The CPMC should continue to be an advocate for funding the recommended improvement.

5.3 POTENTIAL FUNDING SOURCES

The Rocky Run Culvert under US 202 (BR 1-024) has been rated by DelDOT as currently in "Good" condition and therefore is not funded in any upcoming bridge maintenance or rehabilitation program. If funding for the repurposed culvert (along with shared-use path and trail connections) is desired in the foreseeable future, other funding sources will need to be explored.

With the focus on pedestrian/bicycle accessibility and safety, DelDOT's Active Transportation & Community Connections Program, which includes The Transportation Alternatives Program or projects funded by the Bicycle and Pedestrian Pool, could be a source of funding. This Program is funded by a combination of state funding (Transportation Trust Fund) and FHWA.

Federal (and to a limited degree state) grants could also be a source of funding. As properties develop and (re)develop along Concord Pike, there could be opportunities for private funding secured through New Castle County's Land Development Process.