Ivy Corridor Phase II Redesign
Final Design Report

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Capstone CE 4990
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Acknowledgements
We would like to thank Teresa Culver and Marshall Agee for their patience, expertise, and unwavering commitment to our learning and success.

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I. Problem Statement

Our task was to holistically design a vibrant and welcoming university hub at the Ivy Corridor Phase II site that will harmoniously flow with adjacent infrastructure, educate users on watershed issues, and meet the demands of our client and stakeholders.

II. Site Description

As shown in Figure 1, the Ivy Corridor Phase II project is a roughly 5-acre site located at the intersection of Ivy Road and Copeley Road and is adjacent to the under-construction Phase I site. It currently includes a 7-Eleven convenience store, University of Virginia (UVA) student housing, and other UVA-owned facilities. The site is bounded by Ivy Road to the south, Copeley Road to the west, a CSX rail line to the north, and Phase I to the east.

Figure 1. Ivy Corridor Phase II as outlined in orange.

III. Scope

Our design of the site involved a number of different work areas, as listed below, that cover the needs of the University based on sustainability, academic, hospitality, and transportation master planning.

- *Site Layout* – The Phase II design includes UVA buildings that replace and improve upon the existing conditions to produce a functional space with a distinct style. The goal is to include 300K gross square feet (GSF) of residential (student) space, 100K GSF of academic space, and 50K GSF of dining facilities. It also includes an outdoor classroom space and an interactive stormwater element. Site amenities are intended for university and community use.

- *Stormwater Management* – Another major component of the Ivy Corridor project is improvement of stormwater management. Site improvements change land cover and require new stormwater systems. In keeping with other recent University projects, the primary management system should be incorporated into the site rather than something that closes off a portion of the site.
- *Sustainability* – Any changes made to the site should support the University's sustainability goals. As part of this push, we examined the site using the Leadership in Energy and Environmental Design (LEED) scorecard. Climate change and infrastructure resilience were also considered in the stormwater management assessment.
- *Multimodal Transportation* – The corridor will connect Central Grounds to the Athletics Facilities and North Grounds. To support the movement of pedestrians, cyclists, transit and personal vehicles, our design gives special consideration to access, safety, and grading.
- *Construction Administration* – We were also responsible for construction administration documents that would be necessary to build the site. Cut-and-fill reports, cost estimates, erosion and sediment control, and construction schedules were prepared alongside the narrative report.
- *Utility Planning* – Our design for the site inevitably results in conflicts between utility and other infrastructure. We coordinated all new and existing utility lines to meet standards and to connect with existing infrastructure connecting to the site.

IV. Schedule

Please refer to Appendix A for our year-long schedule for this project. In the fall, we created a preliminary design for the site per our investigation of existing and adjacent site conditions. We also began examining stormwater design and drainage, grading, American with Disabilities Act (ADA) requirements, LEED certification, site access, and utilities. Necessary adjustments to the preliminary design were made in response to any design conflicts.

In the spring, we continued developing our stormwater best management practice (BMP) design, analyzed intersection sight distance, implemented ADA standards to our site grading, located fire hydrants and bike racks, reviewed erosion and sediment control, conducted climate resilience research, filled out the LEED scorecard for our final design, and estimated costs. Additionally, we created a plan set consisting of all relevant drawings for this project.

V. Summary of Existing Conditions

The existing Phase II site contains nine buildings, most of which were already owned by the University of Virginia prior to the beginning of work in the corridor. As of 2018, all parcels are owned and managed by either the University of Virginia Foundation or the Rectors and Visitors of the University of Virginia. Figure 2 indicates site usage as of Fall 2022. Southwest of the site, on the other side of the road, is the historic Lewis Mountain neighborhood, which is home to both permanent residents of the city and student renters. Farther up Ivy Road to the northwest is the Ivy Square shopping center.

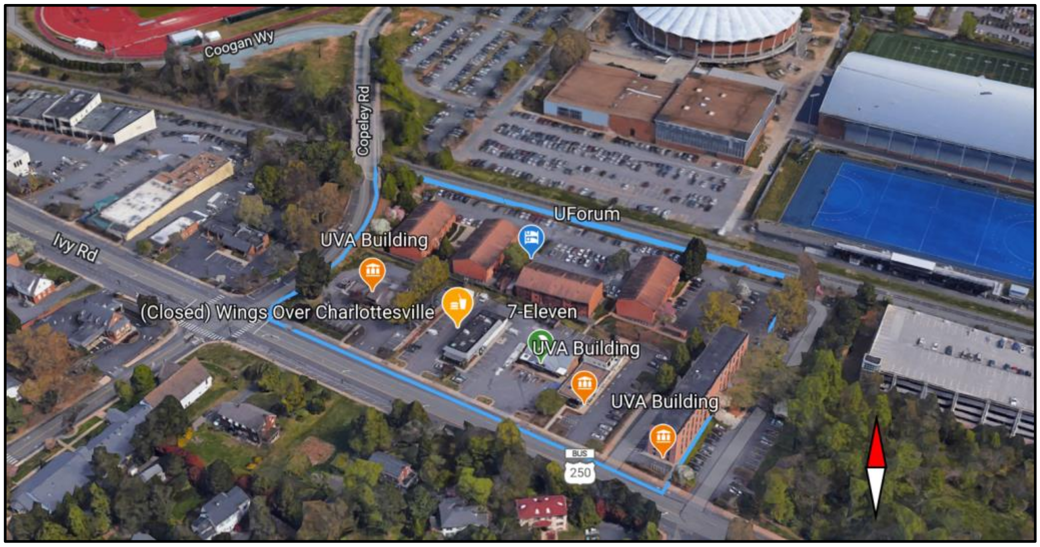


Figure 2. Google Earth imagery showing the Phase II building occupation. All four buildings in the rear of the site are part of the University Forum (UForum) apartment complex.

There is a significant (approx. 8 ft) elevation drop off between the Ivy Road-adjacent parcels and the UForum parcel that is supported by a cobblestone retaining wall. Topography concerns are covered more in depth in section D of the Final Design (p. 9). All land cover falls into the National Land Cover Dataset (NLCD) categories of medium or high intensity development, except for the vegetated cover supporting the slopes leading up to the Copeley Road bridge. Medium and high intensity development refers to sites that are majority impervious with high density housing and commercial units. Land use and land cover changes are discussed in section F of the Revised Design (p. 14). The site is accessed via six parking lot entrances along Ivy Road for commercial parcels and an access road off Ivy Road for the residential parcel. Concrete sidewalks run along both Copeley Road and Ivy Road as well as around site buildings.

For the purposes of this project, we redesigned the site with the assumption that all existing structures within the site boundary, such as buildings, roads, and sidewalks, will be demolished.

VI. Final Design

A. Design Narrative

Our proposed design (Figure 3) is centered around a central green space which contains the bioretention basin that serves as our primary stormwater management feature. There are elevated walkways crossing over the bioretention basin that allow site users to move through the basin. At the point where the walkways cross, there is a deck with benches for visitors to stop and sit within the green space. Informational signs, such as those found at the Dell Pond at UVA, are stationed near the basin to inform visitors about watershed issues and educate them on the function and significance of this site feature. Outside the bioretention basin but still within the central green is a small, 50-person amphitheater that faces toward the basin and can serve as outdoor learning space or as casual sitting space.

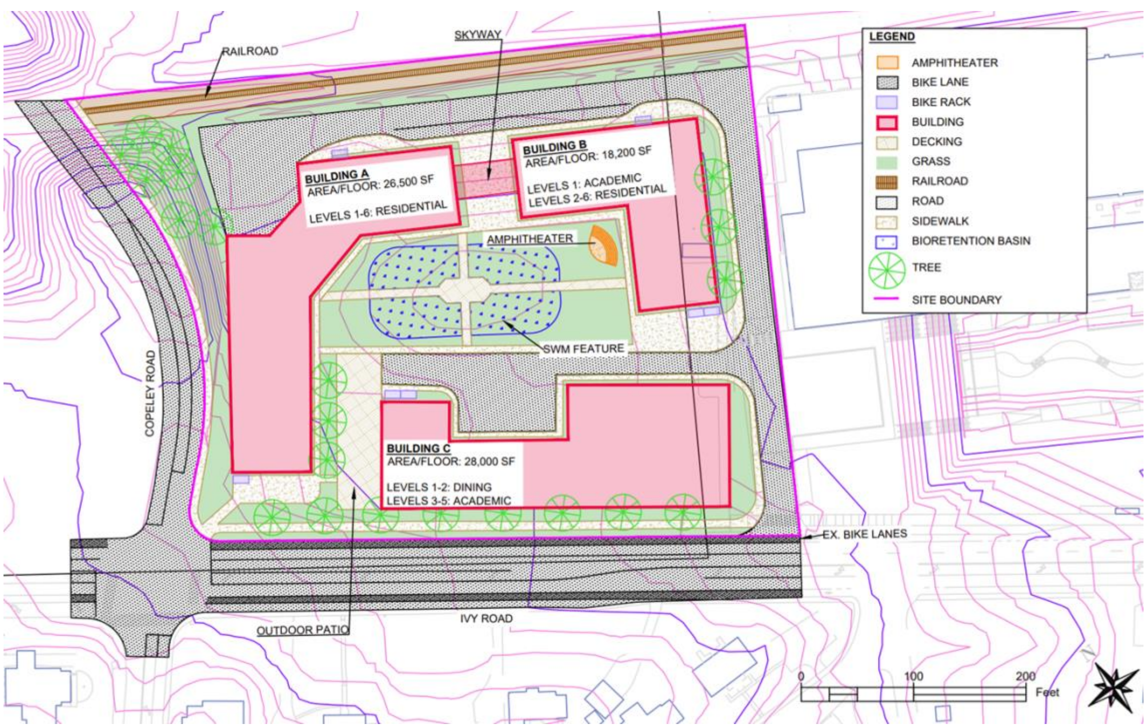


Figure 3. Final site layout for Ivy Corridor Phase II.

Bordering the central green are three buildings with various uses. Building A is a six-floor residential building with a below-grade parking garage for residents. Building B is a six-floor mixed-use building in which the first floor is academic space and the upper floors are residential. A sky walkway connects the upper floors of buildings A and B to unite what would otherwise be two distinct residential buildings. Building C along Ivy Road has two lower floors of dining space and three floors of academic space. The dining space in this building is open to community members and is intended to help ease the loss of the convenience store that must be demolished before construction begins. Many site elements, including the sky walkway, the mixed-use floors, and the central stormwater feature, are mirrored off similar features in the Brandon Avenue project elsewhere on Grounds.

Table 1 provides the GSF for the new site layout. The requirements for academic and dining were met, however, the area for residential is still short of approximately 50,000 GSF. While the guidelines were honored, we decided to prioritize green space over a larger building area. Regardless, the majority of the GSF expectations were met through this final design, and the site provides an enjoyable experience for a variety of different potential users.

Table 1. GSF Per Use

Building Type	Area (GSF)
Residential	250,000
Academic	102,200
Dining	56,000

Appendix C provides details on the preliminary site and why we made particular changes to the final design.

B. Zoning

According to the City of Charlottesville's Zoning District Map (Appendix D), the Ivy Corridor is zoned as a Mixed-use Urban Corridor and an Entrance Corridor overlay district. Mixed-use corridor districts are designed to foster mixed-use development, build attractive buildings near property lines and along streetscapes, minimize parking facilities, and develop multimodal transit. Ivy Road and Copeley Road are considered to be primary and linking streets respectively per Sec. 34-760A of the City's zoning code. It is important to note that while zoning regulations do exist, the Ivy Corridor is owned by UVA, who often abide by their own set of specifications, such as the UVA Facility Design Guidelines and Material Standards provided by the Office of the Architect. Thus, the following information will simply be used as a reference.

Per Sec. 34-757, building heights should not exceed 60', but they may be up to 80' through a special permit. Assuming that the standard floor height is 14', Buildings A and B, which are each 6 floors, exceed the 80' maximum height, meaning that a variance may need to be filed. Building C is 5 floors and may therefore be constructed using a special permit.

The City of Charlottesville also provides minimum required off-street parking ratios depending on the uses found in the site (Sec. 34-984.). However, the actual required parking count will be dependent on additional factors. First, UVA determines the amount of parking that will be made available for students. First years are not allowed to bring vehicles, and on-grounds upperclass housing residents may be placed in a lottery system to determine whether they can bring a vehicle, such as the procedure enacted at Bond House, due to limited available parking. Therefore, the required parking count for students may be less than the ratio detailed in the zoning ordinance. Secondly, the site is divided amongst residential, academic, and dining uses, which involves shared use. In cases similar to this, residential parking spaces are empty during the day and filled at night, while academic spaces are filled during the day and empty at night. Thus, parking may be shared between building uses to reduce redundancy in parking quantities. In terms of available parking, we are hoping to fulfill parking needs for the residential half of the site with the addition of a below-grade parking garage under Building A and temporary loading spaces for residents in Building B, whereas the academic half will use the existing Emmet-Ivy parking garage. Parking spaces will be the standard 9' x 18' with a 24'-wide drive aisle, and driveways will be at least 20' (Sec. 34-934.) for the new residential parking garage.

Lastly, building setbacks along Ivy Road should be between 5'-30' and setbacks along Copeley Road should be between 5'-20' (Sec. 34-758). Both requirements are satisfied through the final site layout.

C. Access & Transportation Considerations

Between Phases I and II lies an access road. The horizontal alignment and profile of this access road are shown in Figure 4. The profile was designed such that the road alignment matched our proposed grading for the site. The Institute of Transportation Engineers (ITE) recommends intersection angles of no less than 75°, with the ideal angle being 90°. The intersection angle between this access road and Ivy Road is 85°, which falls within the acceptable range. Additionally, the American Association of State Highway and Transportation Officials (AASHTO) provides equations to calculate intersection sight distances for safe turns onto main roads. The sight distances are depicted in Figure 5. We defined the intersection as stop-control and used the appropriate parameters to calculate the sight distance needed for left and right turns. The minimum full-access entrance spacing for undivided urban collector roads between 35 and 45 mph is 305' per the Virginia Department of Transportation (VDOT) Road Design Manual, and the current spacing exceeds this distance at 538’. Appendix E shows relevant calculations and tables containing design standards that we used for our design.

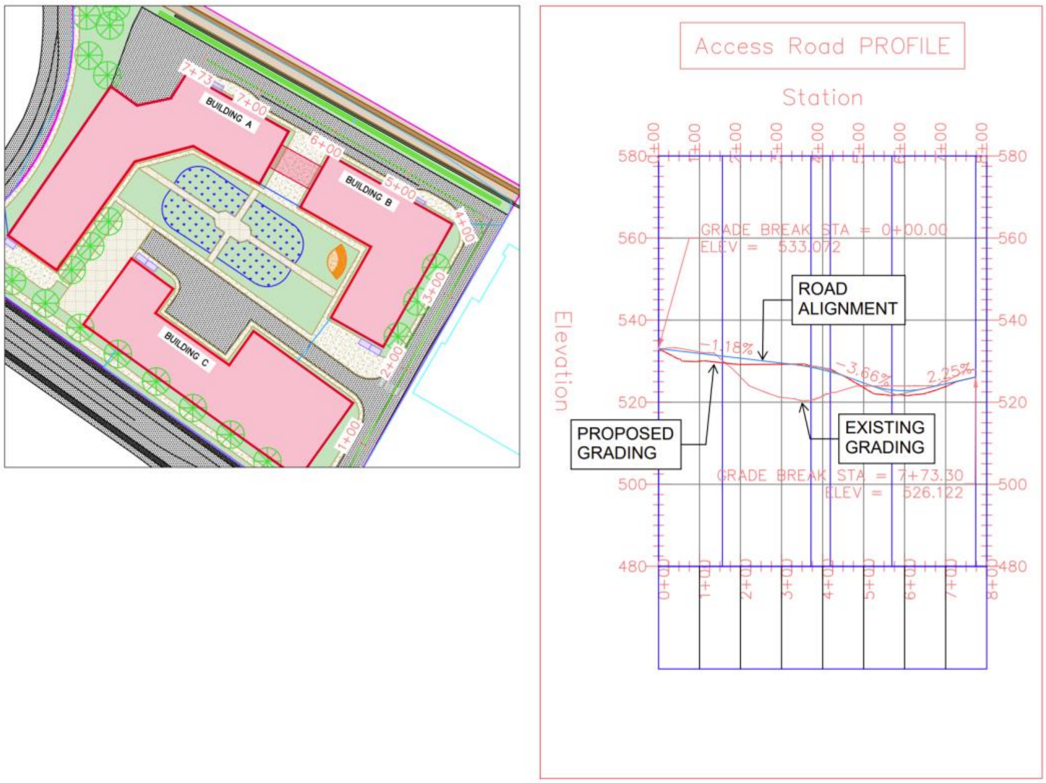


Figure 4. Road profile for the access road at Ivy Corridor Phase II. Shown to the left is the access road alignment with stations marked, and shown to the right is the profile.

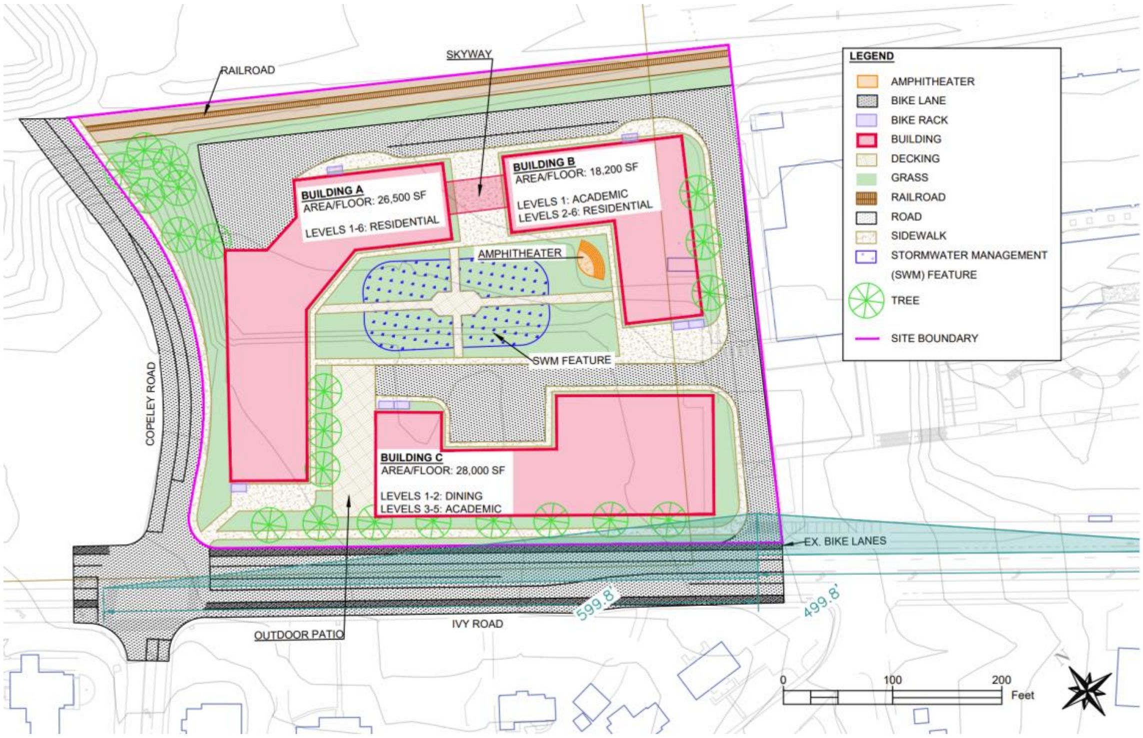


Figure 5. Sight distances for left and right turns at the access road intersection with Ivy Road.

With the exception of some proposed trees, the current site layout does not appear to have any issues with sight obstructions at this intersection, although the placement of other potential streetscape elements will need to be carefully examined. Table 2 lists possible obstructions.

Table 2. Potential Intersection Sight Obstructions

Signage	• UVA monument sign • Stop sign • Pedestrian crossing sign • Bike lane sign • No parking sign
Additional street furnishings	• Blue light emergency call box • Street lamps • Trees • Fire hydrants • Trash cans • benches

Curb radii will be dependent on the type of vehicles that will need to maneuver within the site. Table 3 details these vehicles using the Federal Highway Administration (FHWA) classification (Appendix F). Loading spaces for relevant vehicles require areas of at least 12 x 35' (Sec. 34-983.).

Table 3. Design Vehicles

Residential	Classes 1-3 (motorcycle, car, truck, van, facilities management), 5 (emergency vehicle, mail delivery truck), 15A (garbage truck)
Dining	Same as residential; 5/6/7 (supply truck)
Academic	Same as residential; 5/6 (supply truck)

Appendix G highlights hardscape details, such as pavement thicknesses and sidewalk sections, from the UVA Facility Design Guidelines that are applicable to the site. The minimum ADA dimensions required for the ramps and the maximum slope for the sidewalks in the area were also researched. The radius and inclination of the handrails that we will install on the site steps will comply with all of the ADA requirements. For micro-mobility (bikes, scooters, e-scooters, etc.), there is an existing bike path that runs along Ivy Road adjacent to the site. According to the city's code, at least one bicycle space should be built per 500 SF of bedroom area for dormitories and one bicycle space per 1,000 SF of public space (Sec. 34-881). However, we found these standards to yield an unreasonably high number of spaces and will instead determine quantities based on counts obtained from similar existing UVA buildings. Each space (which is expected to hold up to two bicycles) will be 1' wide x 2' deep in accordance with typical university spacings, and located 3' from a vertical surface. Assuming that each bike rack has six spaces, it is estimated that there be three to four bike racks spaced around the residential buildings and two around the dining and academic building, as depicted in Figure 3. With these bike racks, the site will be able to accommodate up to 72 bikes.

Finally, emergency access needs to be considered. Appendix H details acceptable fire truck turnarounds per the International Fire Code (IFC). Since our access to the buildings are dead ends that extend beyond 150’ from the road intersecting Phases I and II, compliant turnarounds must be ensured. The alternative 120-ft hammerhead was utilized and checked so that it was properly dimensioned, as shown in Figure 6. Furthermore, it was ensured that access existed 150’ from any point of these buildings so that a firetruck or emergency vehicle may drive close enough to the affected location.

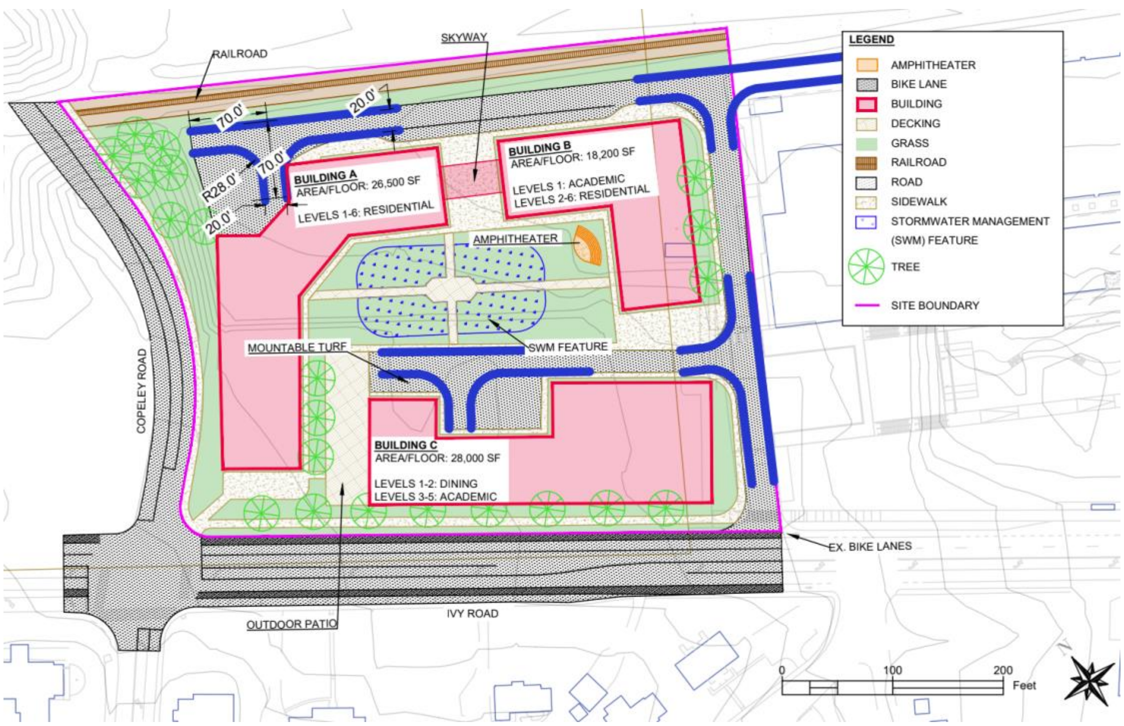


Figure 6. Verification of fire access turnarounds within the Phase II site.

D. Grading

One of the biggest challenges of designing the Phase II site was working around the elevation change across the site. From the corner of Ivy Road and Copeley Road to the northwest corner of the site near the future site of the University Hotel the elevation changes by about 27 feet. The elevation difference is more pronounced through the center of the site where an eight-foot drop separates the commercial parcels fronting the road from the university housing adjacent to the railroad. Our final design features a central space between the three buildings on site. In order to make the space flow as smoothly as possible between the different spaces, we raised the ground surface such that there is not more than four feet of elevation drop between finished floor elevations. This involves filling in much of the space behind the existing steep drop-off. From the central area, the site slopes down toward Ivy Road, the eastern access road, and the northern access road to tie into existing (or Phase I planned) elevations. Figures 7 and 8 show the existing and proposed site topography.

Figure 7. Topographic map of pre-redevelopment conditions at Ivy Corridor. The Phase II footprint is highlighted with a gray mask.

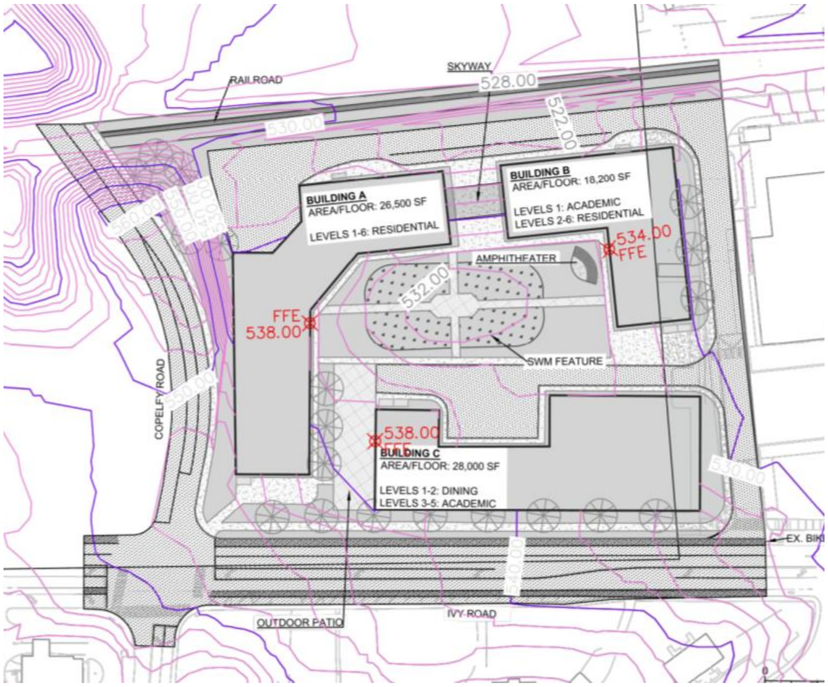


Figure 8. Proposed topographic map of Ivy Corridor Phase II with building finished floor elevations (FFE).

Our changes to the topography of the site also resulted in changes to the drainage patterns of runoff. Prior to redevelopment, the entire Phase II site was located within a single drainage area that empties into the stream located in Phase I (see Figure 9). The proposed site design splits the site into three distinct drainage areas that are each centered around a different practice. Water falling on the center of the site or any of the building roofs drains into the bioretention basin. Rain on the northern edge of the site flows to a vegetated ditch adjacent to the railroad. Water around the east access road drains to Phase I and the stormwater infrastructure contained therein (Figure 10).

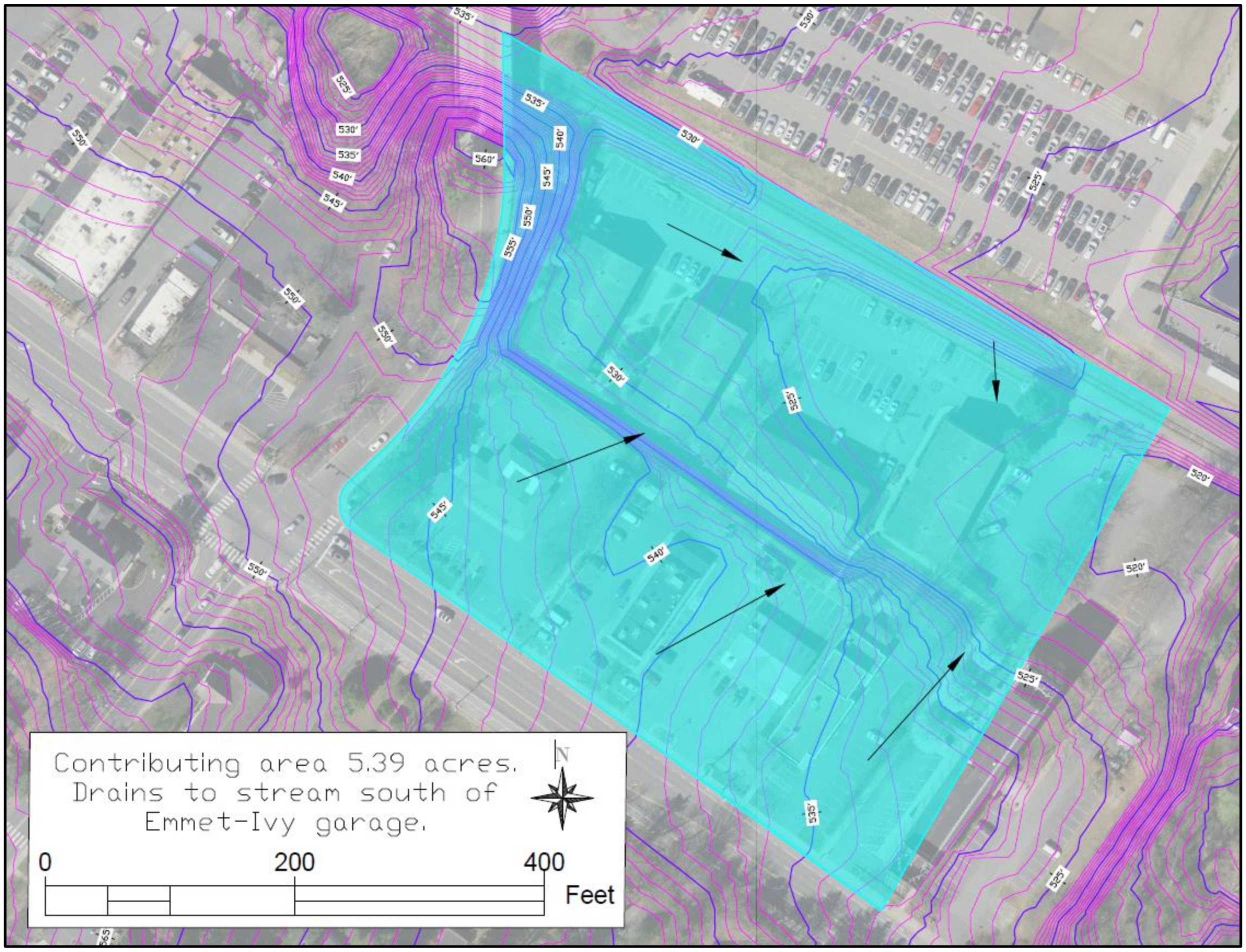


Figure 9. Phase II site drainage area prior to redevelopment, with arrows indicating approximate flow directions on different parts of the site.

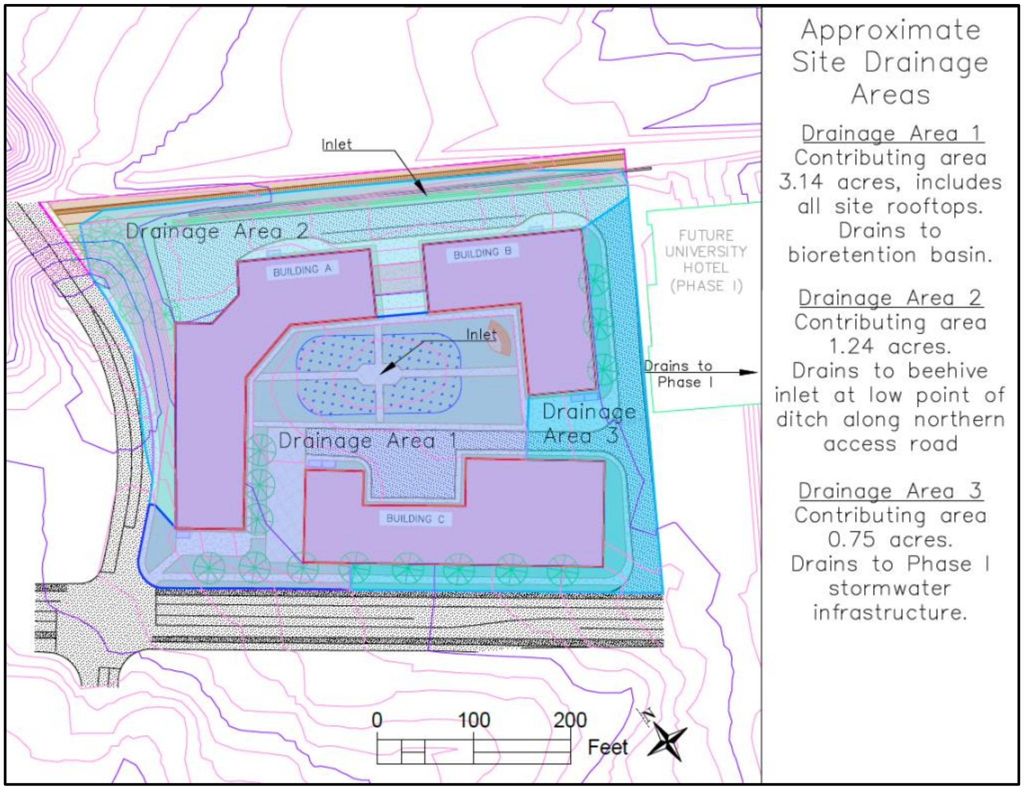


Figure 10. New drainage areas resulting from the topographic changes to the site.

E. Utilities

This site required the redesign of most of the utility lines in order to properly function, including water, sanitary sewer, natural gas, electric, telecommunications, and stormwater. The first four of these will need to be connected to buildings A, B, and C while stormwater will need to be connected to the stormwater management feature. Below is Figure 11 displaying the layout of the different utilities as well as connections to existing lines.

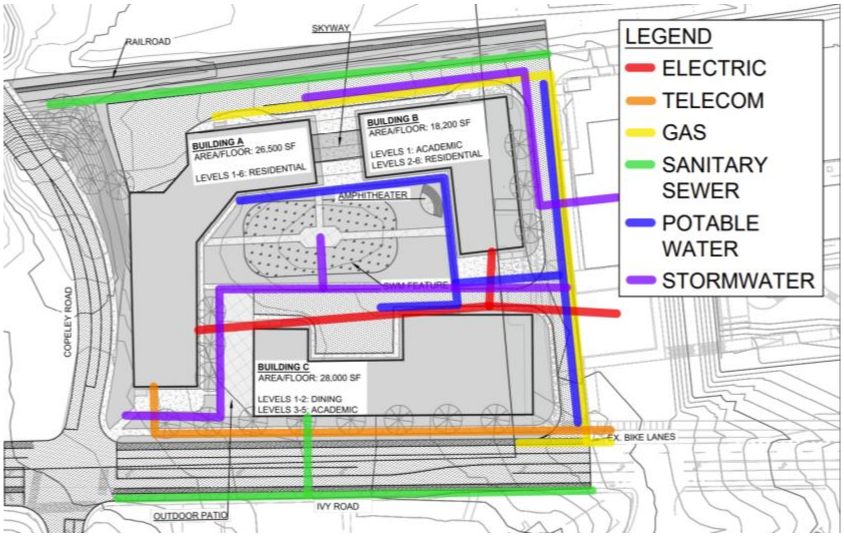


Figure 11. Utilities layout per the American Public Works Association uniform color code.

We designed the utility layout to match the existing layout of Phase 1. The electric line connects to the UVA power manhole P-4, the fiber optics connect to the UVA telecommunication handhole T-4 (Figure 12), and the stormwater line connects to the existing doghouse manhole (Figure 13) . The sanitary sewer will have the same location as the existing condition in Phase II for Buildings A and B. Building C will connect its sanitary sewer to the existing line in Ivy Road. The potable water line will connect to the Phase I pipes and provide for the three buildings. The gas line connects to the hotel in Phase I. The utility layout will be according to the standard specifications of the City of Charlottesville. Prior to installation, location of other utilities must be confirmed to adjust proper depth and clearance. Potable water line requires an edge to edge separation of 5 ft, for all the other utilities the required separation is 12 in. Potable water lines will also be linking to five fire hydrants above ground, two with classification of AA and three with classification of A. Based on the types of occupation, construction, and floor plan, the needed fire flow for each building was calculated and then used to determine the type and number of hydrants (Appendix I).

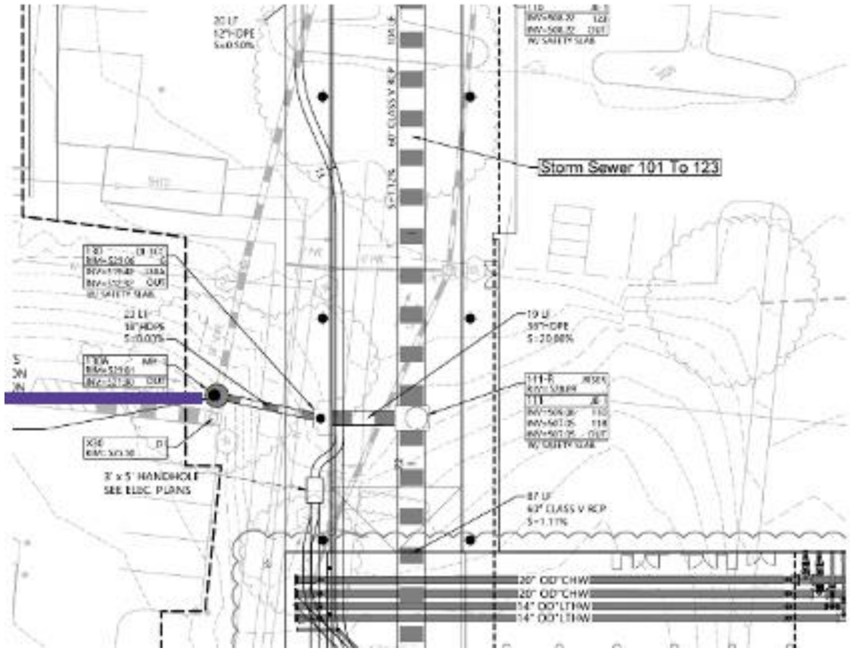


Figure 12. Storm line connection to existing doghouse manhole in phase I.

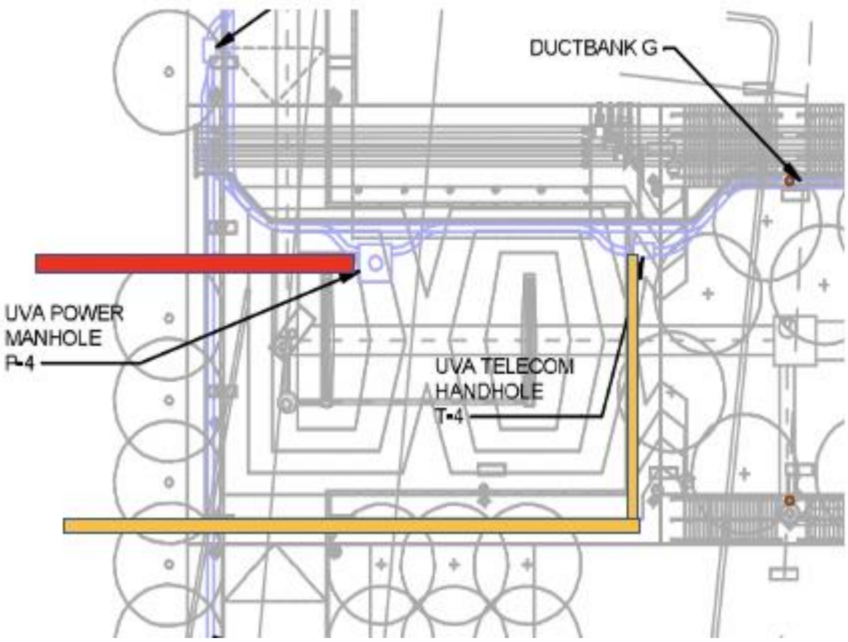


Figure 13. Electric line and telecommunication line connection to existing conditions in Phase I.

F. VRRM

Virginia stormwater regulations require that we use the Virginia Runoff Reduction Method (VRRM) or another similar method for determining the required level of water quality improvement. Because the Phase II site is an existing developed site, we used the ReDevelopment version of the VRRM spreadsheet to evaluate the preliminary design. Our proposed changes result in almost no change in total impervious area, but forest and open space area increases by 0.35 acres (200%). This conversion requires a total phosphorus (TP) reduction of 1.77 pounds/year. After further analysis of our site's post-development hydrology, the drainage areas were redrawn. A simple summary is available in Table 4 and a full summary report is included in Appendix J.

Table 4. Pre- and post-development water quality parameters from VRRM.

Land Cover Class Note 1	**Pre-ReDevelopment Area (Acres)**	**Post-Development Area (Acres)**
Forest/Open Space	0.12	0.37
Managed Turf	1.30	1.06
Impervious Cover	4.04	4.03
TP Load Reduction Required (lb/yr) = **1.77**		
Note 1. All site soils belong to hydrologic soil group (HSG) D.		

The VRRM spreadsheet allows for the application of stormwater best management practices (BMPs) within the site to meet the pollutant runoff reductions. A BMP comparison chart is shown in Appendix K. Performance credits for VRRM and physical specifications for construction are all contained in the Virginia DEQ 2013 DRAFT BMP Design Specifications. Our main BMP, the bioretention basin, treats 2.58 total acres of the site and removes 4.77 pounds of TP per year. Additionally, the 0.25 acre footprint of the basin counts as forest or open space in the land cover classification. The grass swale removes a further 0.28 lb/yr of TP. Overall, our design removes 5.05 lb/yr of total phosphorus, exceeding the requirement by 3.28 lb/yr.

G. SWMM

The Environmental Protection Agency's Storm Water Management Model (SWMM) is another tool for analyzing stormwater quantity and quality that also allows for more detailed incorporation of conduit systems. Our SWMM-based analysis focuses on the effects of site changes on channel and flood protection values. The model in Figure 15 represents the pre-redevelopment site (c. 2018) with a single outfall serving the entire site. The model in Figure 16 represents the post development site and proposed sewer piping. Upsystem subcatchments (S2 and S3 in fig. 14, S4 and S5 in fig. 15) are included to analyze the potential for flooding at the Phase II nodes and other nodes downstream. Only subcatchments comprising the Phase II site (S1 in fig.14; S1, S2, and S3 in fig. 15) are considered for channel protection calculations.

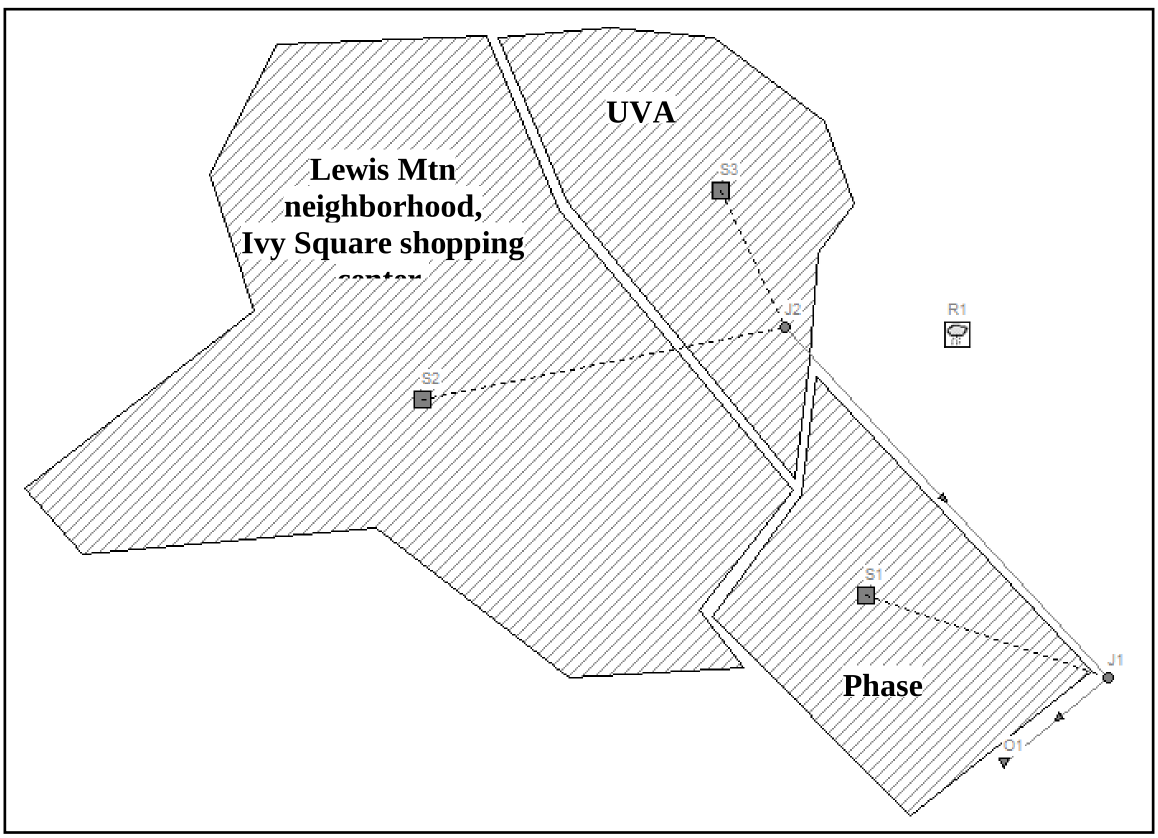


Figure 14. SWMM model for the Phase II parcel pre-redevelopment including upstream subcatchments (S2 and S3).

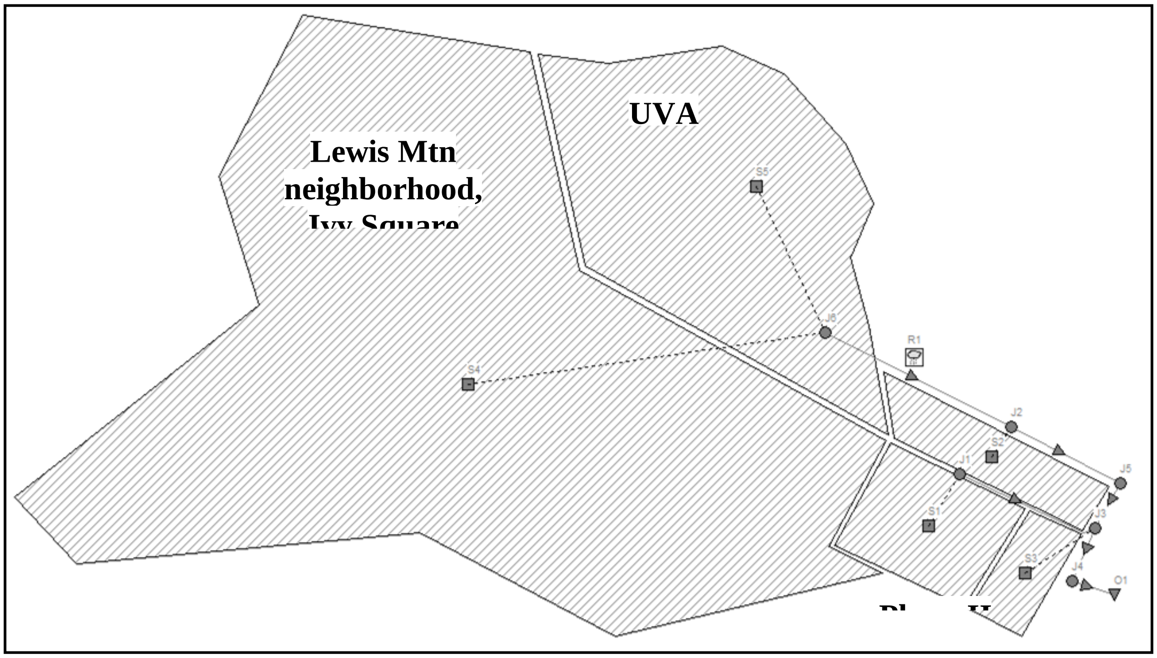


Figure 15. SWMM model for the Phase II parcel post-redevelopment including upstream subcatchments (S4 and S5).

The energy surrogate (or energy balance) is a value based on peak and volumetric runoff that is used to assess channel protection. For redevelopment projects involving man made conveyance systems, the Virginia Stormwater Management Program (VSMP) requires a 20% reduction in channelized flow as calculated by the formula:

$$q_{pDeveloped} \leq I.F.* (q_{pPre-Developed} * Q_{Pre-Developed})/Q_{Developed}$$

In which q_p is peak flow rate of runoff (cfs), Q is runoff depth (in), and I.F. is the improvement factor (0.8 for sites larger than 1 acre). As shown in Table 5 below, peak flows from both the 1-year, 24-hour and 2-year, 24-hour storms are below the allowable amount calculated based on the pre-redevelopment conditions.

Table 5. Channel protection values from SWMM for pre- and post-redevelopment scenarios. Requirements from the 2013 Draft Virginia DEQ Stormwater Management Handbook.

Flow Parameter from SWMM	**Storm Type**	
	1-year, 24-hour	2-year, 24-hour

Pre-Redevelopment	Surface Runoff Depth (in)	2.85	3.48
	Peak flow rate (cfs)	19.53	24.10
Allowable Post-development q_p		***32.32***	***37.24***
Post-Redevelopment	Surface Runoff Depth (in)	1.38	1.80
	Peak flow rate (cfs)	**7.55**	**9.39**

The SWMM model also allows for flood analysis based on the flow parameters from the 10-year, 24-hour design storm. Per the 2013 Draft VA DEQ Stormwater Management Handbook, a redevelopment project cannot induce or worsen flooding on-site or downstream. Additional models for the downstream nodes and conduits show flooding at a node near Carr's Hill Field (Figure 16), so standards require that peak outflow from Phase II decreases with redevelopment. Table 6 shows the peak outflow from the 10-year storm decreases by 12% so the flooding protection requirement is satisfied.

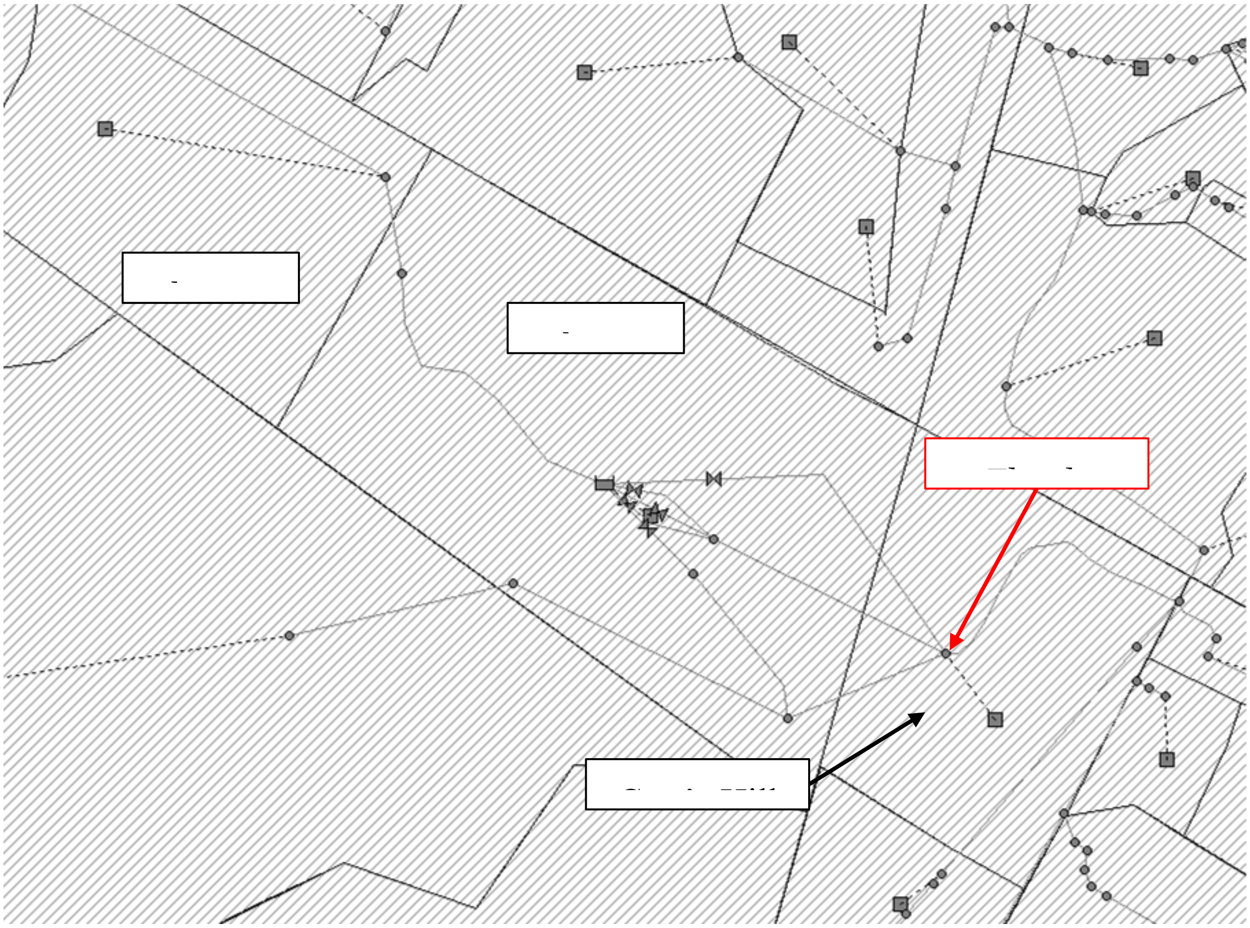


Figure 16. SWMM model produced by Biohabitats, Inc. showing downstream pipes, junctions, and other stormwater structures. The Phase I infrastructure is post-redevelopment and Phase II is pre-redevelopment. The flooding node is indicated by the red arrow.

Table 6. Peak outflow values for Phase II and contributing upstream subcatchments from the 10-year, 24-hour storm.

	Pre-Redevelopment	**Post-Redevelopment**
Peak Outflow (cfs)	388.57	340.12

H. BMP Design

The bioretention basin was designed in line with Specification 9: Bioretention from the Virginia Stormwater BMP Clearinghouse at Level 2. The higher design level provides enhanced nutrient removal and runoff reduction by including an additional gravel layer for filtration and storage. It takes up most of the green space in the center of the site but there are grass strips around all sides to pretreat stormwater and spread flow out evenly. Figure 17 shows a plan view of the bioretention basin with measurements and Figure 18 shows cross sections of the filter soil and gravel layers. The cross sections depict the elevated walkway, which was previously discussed in our design narrative as the interactive aspect of the stormwater feature.

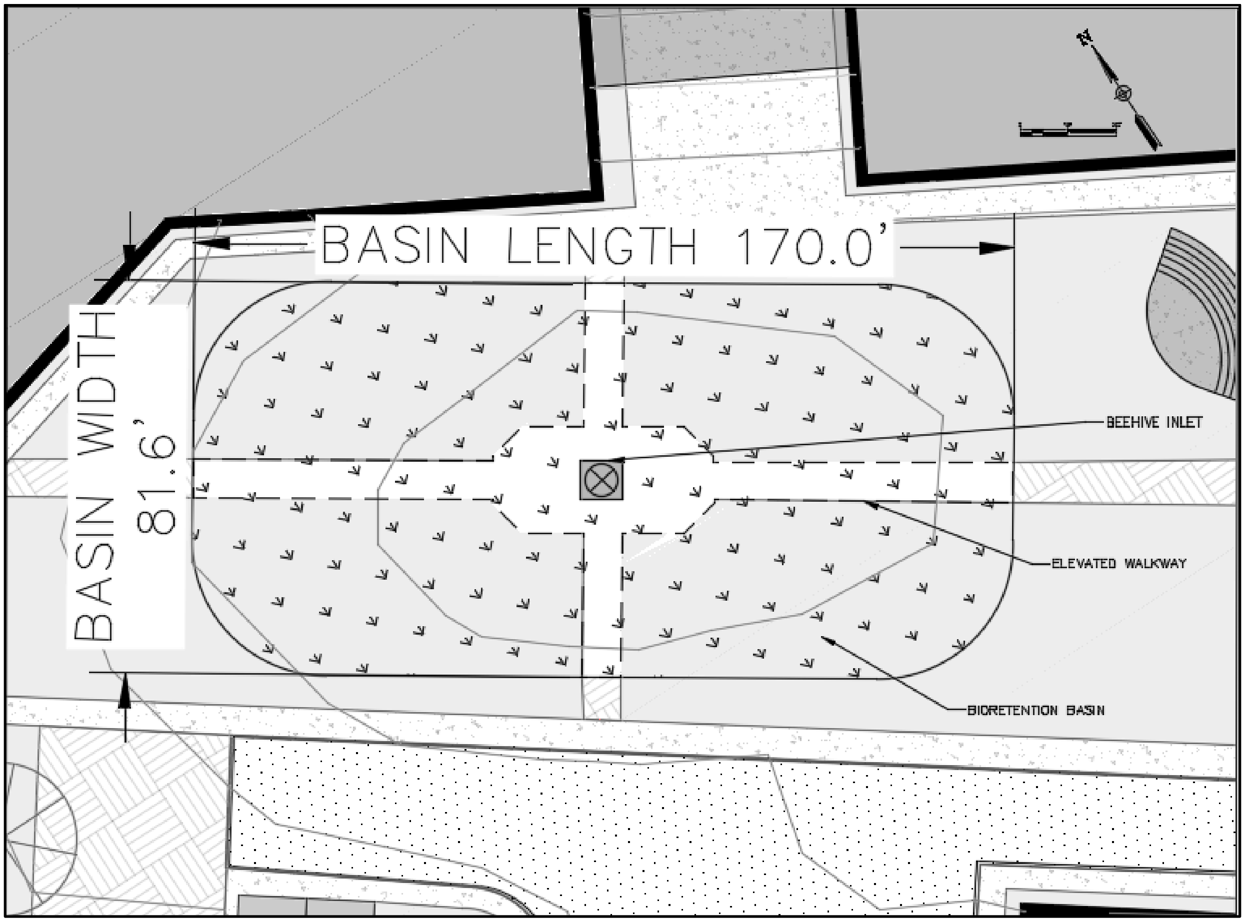


Figure 17. Plan view of the bioretention basin with length and width measurements. Dashed lines with white fill note the location of the elevated walkways above the basin.

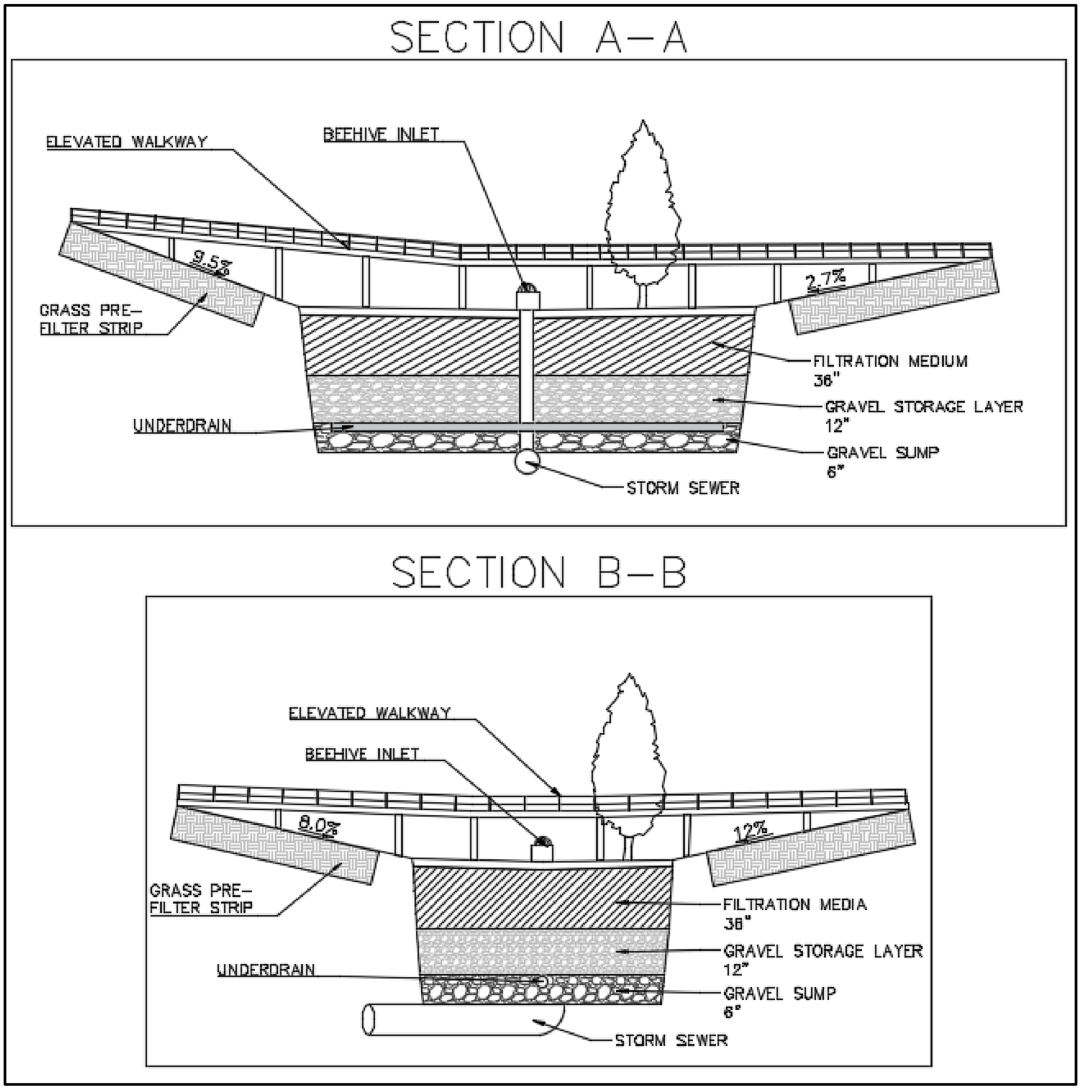


Figure 18. Cross sections of the bioretention basin. Section A-A shows a view cut along the basin length and section B-B shows a view cut along the basin width. Grass pre-filter slopes are typical for the lawn around the basin.

Plant recommendations for the main bioretention facility and the green spaces on site have been made based on plant recommendations in surrounding counties, maintenance, growth conditions (amount of sunlight and moisture preferred, tolerance to variable temperatures), whether the plant is native to Virginia, and aesthetics. Based on these categories, a hard fescue such as red fescue is an optimum choice for the grass cover on site. It has a green hue with a slight reddish tint and grows slowly, and therefore has low maintenance costs. It can grow in shade or full sun and can withstand temperature changes. For the bioretention BMP, several grasses and flowering plants have been selected. Virginia wild rye and riverbank wild rye are the tall grasses and swamp milkweed, butterflyweed, and blue mist flower are the perennials best suited for the bioretention facility. These plants were selected due to their ability to grow in shade or full sun and dry to saturated conditions. These plants also tolerate temperature fluctuations and are native to Virginia. They also only grow to about three feet in height, so they will not overtake the walkway over the bioretention garden.

I. Erosion and Sediment Control

Appendix L details the erosion and sediment control (ESC) construction narrative for the site. Figures 19 and 20 depict the phase I and II ESC plans, respectively. The construction entrance was placed uphill on pre-existing pavement and also along Ivy Road for easy access. The trailer was placed adjacent to this in a corner where there will not be any building construction. In phase I, the sediment basin/trap is at the lowest point of the site, whereas in phase II, the bioretention feature temporarily serves as a sediment basin. During phase II, permanent seeding will also be added to pervious areas on the site so that they are stabilized.

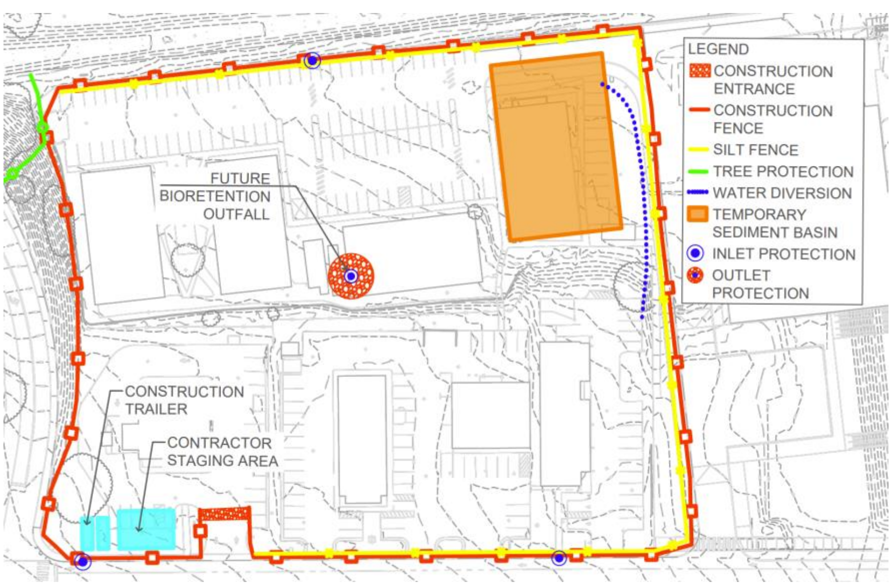


Figure 19. Phase I of the ESC plan. A silt fence wraps around the perimeter of the site except along Copeley Road. The construction entrance and trailer are placed uphill and the sediment basin is placed downhill.

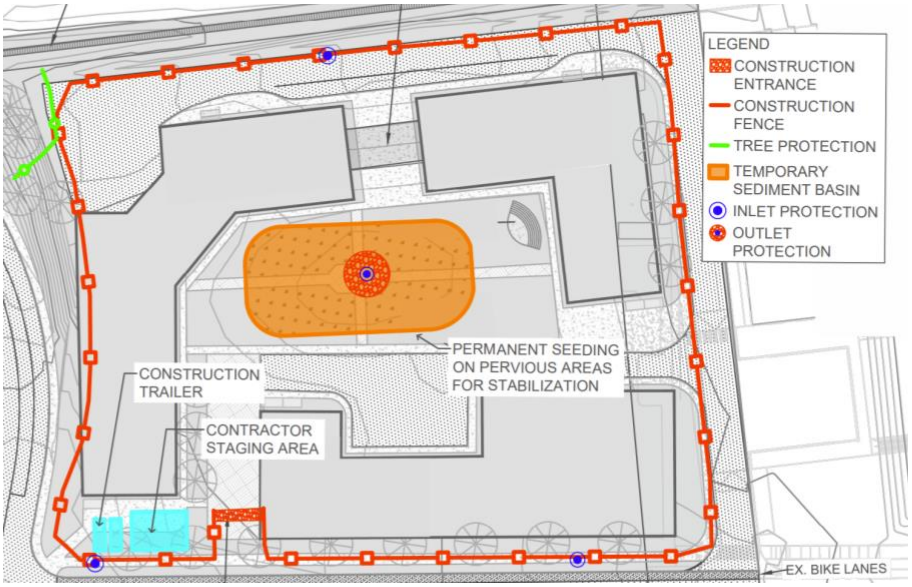


Figure 20. Phase II of the ESC plan. Bioretention serves as the sediment basin.

J. LEED

According to the United States Green Building Council (USGBC), the project best fits under the category of Neighborhood Land Development (ND) in the LEED Scorecard System. This scoring system is designed to evaluate redevelopment sites that incorporate a mix of residential and non-residential uses, and it takes into consideration all aspects of the site, not just buildings. As shown in Table 7 below, our site meets the minimum program requirements in order to be classified as ND.

Table 7. Minimum Program Requirements for ND LEED

	Program Requirement	Our Site
1	Permanent location on existing land	All structures will be permanently installed
2	Reasonable LEED boundaries	Site boundaries include all relevant hardscape, utilities, and SWM
3	At least two habitable buildings that do not exceed 1500 acres	Two residential buildings totaling 175,000 GSF (~4 acres)

Shown in Appendix M are the different categories in which points may be earned for an ND site. These categories include smart location and linkage, neighborhood pattern and design, green infrastructure and design, innovation and design process, and regional priority credits. Since some of the criteria do not directly fall under our scope, we will prioritize those that do. The credits applicable to our project are marked with a “Y” in the checklist in Appendix M. Such items include, but are not limited to, bicycle facilities, rainwater management, and reduced parking footprint. Details on how our project meets each applicable criterion can be found in Appendix M. Currently, our project is estimated to be awarded 41 LEED credits and meets all required LEED criteria that are applicable to our project. A significant portion of these points earned by our erosion and sediment control plan, innovative stormwater feature, and transportation design. Our project meets the 40 point minimum to have official LEED Certification. It is merely 9 points short of the minimum 50 points needed to be LEED Silver Certified. Our design does not encompass all of the design aspects of an in depth site plan, such as building-specific features like indoor water reduction and optimized building energy performance. If our design were to include these aspects, we predict our site design would easily earn LEED Silver accreditation.

K. Climate Resilience

The site has been designed to handle stormwater based on standards that incorporate design storms of historically reliable intensity. However, current climate modeling suggests that high-intensity storms will be more common in the future. Designing purely for current storm estimates may result in the system being overwhelmed later in its life so projected storms have also been assessed as a check for resilience. The NOAA Mid-Atlantic Regional Integrated Sciences and Assessment (MARISA) team developed an online tool that provides change factors for intensity-duration-frequency (IDF) curves across the Chesapeake Bay watershed and the state of Virginia. These change factors can be applied to current design storm depths from NOAA Atlas 14 to calculate anticipated depths of similar duration and frequency in 2070. Figure 21 compares current and projected storms in the city of Charlottesville.

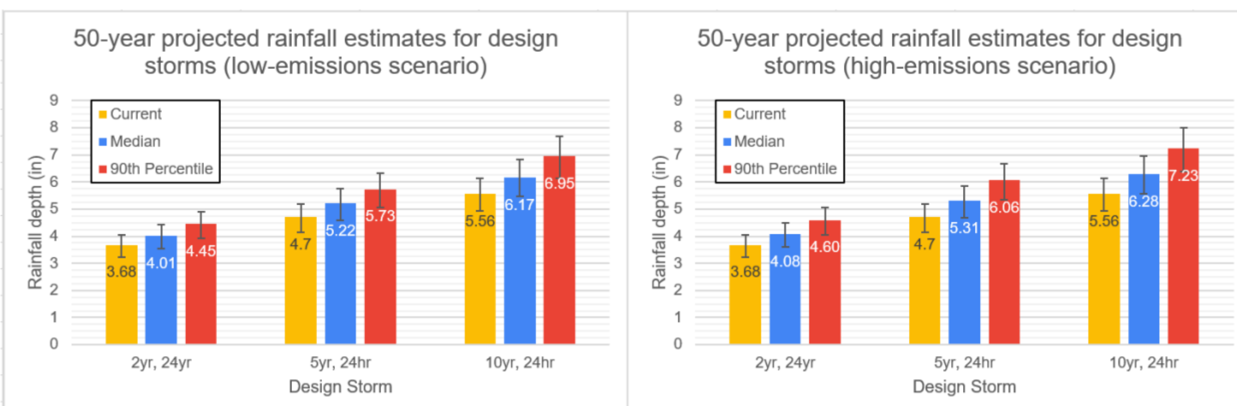


Figure 21. Storm depth projections for 2070 in the city of Charlottesville based on MARISA change factors. Change factors are available for both low- and high-CO2 emissions scenarios and at different model confidence values. Error bars reflect 90 percent confidence intervals from the NOAA Atlas 14 data.

The median adjusted storm depths were brought into SWMM to assess the ability of the site to manage future storm events. MARISA does not provide change factors for 1-year frequency storm events, so channel protection was evaluated with the 2-year storm only. Table 8 summarizes the results of climate resiliency SWMM modeling. Peak outflow from the 2-year events are lower than the design allowable value. Outflow from the 10-year storm events also fall below the required values, but the margins are smaller than for channel protection. Additional storage capacity would improve the site's ability to handle large events with greater confidence.

Table 8. SWMM parameters from climate resilience exploration.
The pre-redevelopment value for channel protection is the design allowable peak outflow calculated previously (see subsection G: SWMM above).

Channel Protection – 2yr, 24hr Peak Flow Rate (cfs)	
Pre-ReDevelopment	*32.32*
Low emissions projection	10.35
High emissions projection	10.55
Flood Protection – 10yr, 24hr Peak Flow Rate (cfs)	
Pre-ReDevelopment	*388.57*
Low emissions projection	344.61
High emissions projection	348.90

L. Cost Estimation

For the final portion of our project, we put together a cost estimate for all of the demolition and site work that would need to be completed. This estimate was based on data from the RS Means book on Site Work and Landscape Costs from 1998. An inflation factor of 1.83 was used to calculate modern-day costs. However, it is important to note that while generally, costs have inflated 1.83 times since 1998, the construction industry has had a larger inflation rate, and potential variation is captured in the design contingency. Also included in this estimate were cost percentages for mobilization (5%). Breakdowns by cost category can be seen in Table 9 with a full

2023 estimate of roughly $3.3 million; a projected breakdown of costs for 2023 and beyond is shown in Appendix N.

Table 9. Cost estimation broken down by category, USD (adjusted for inflation from 1998 values).

Cost Category	Adjusted 2023 Cost
Demolition	$611,620.74
Earthwork	$56,693.85
Utilities	$165,783.00
Hardscaping	$394,634.72
Landscaping	$1,125,046.80
Erosion & Sediment Control	$63,251.56
Mobilization	*5%*
Design Contingency	*25%*
2023 TOTAL	**$3,325,259.81**

VII. Discussion and Conclusion

Over the span of this 8-month long project, we faced multiple design challenges across and between different scope items; some were relatively straightforward, while others involved problem-solving sessions with the entire team. This ultimately led to solutions that made the site more functional, cohesive, and attractive. The following is a list of lessons that we learned throughout this process.

- Multiple iterations of the site layout are to be expected. The preliminary draft is rarely ever the final draft, so stagnancy and complacency should be avoided to prevent delaying the project schedule. The design process is all about trial and error in order to produce iterations that show growth and improvements from the last.
- Coordination between scope items is important. Although many scope item tasks were

assigned to individual team members, they should not be viewed as standalones, since they are all interdependent on one another. For instance, fire access and mobility rely heavily on the building site layout, as seen with the changes made between our preliminary and final site layout. Another example is grading and its effect on ADA building access, which was especially prevalent near the residential buildings due to the relatively steep slope beneath the sky walkway.

- Coordination could have also been improved by reordering the order in which scope items were addressed. Some items were completed too early and thus required multiple updates throughout the project's duration. We could have been efficient by holding off on these items until later in the project so that they only needed to be completed once.
- Another key factor to consider is connectivity with the surrounding perimeter of the project. Many features, such as pedestrian paths, utilities, and grading, are only realistically feasible if their transition is consistent with Phase I and other adjacent existing conditions. This realization underlined the importance of expanding our perspective so that we are not only looking at our site, but the greater community as a whole as well.
- Improvements should be made and edited as the project progresses to prevent work from piling up. Deliverables, such as the draft designs from spring semester, helped to alleviate this issue. On the other hand, we could have also started on items, such as the graphics in this report and the virtual plan sheet set, sooner so that less items needed refining near the end of the project.
- As engineers, it is easy to be caught up in the technical details of the project. However, it is just as important to consider the sociality of the site, especially when presenting the project to an audience of stakeholders. Elaborate on the "selling points" of the site and also

how users will be interacting with its features.

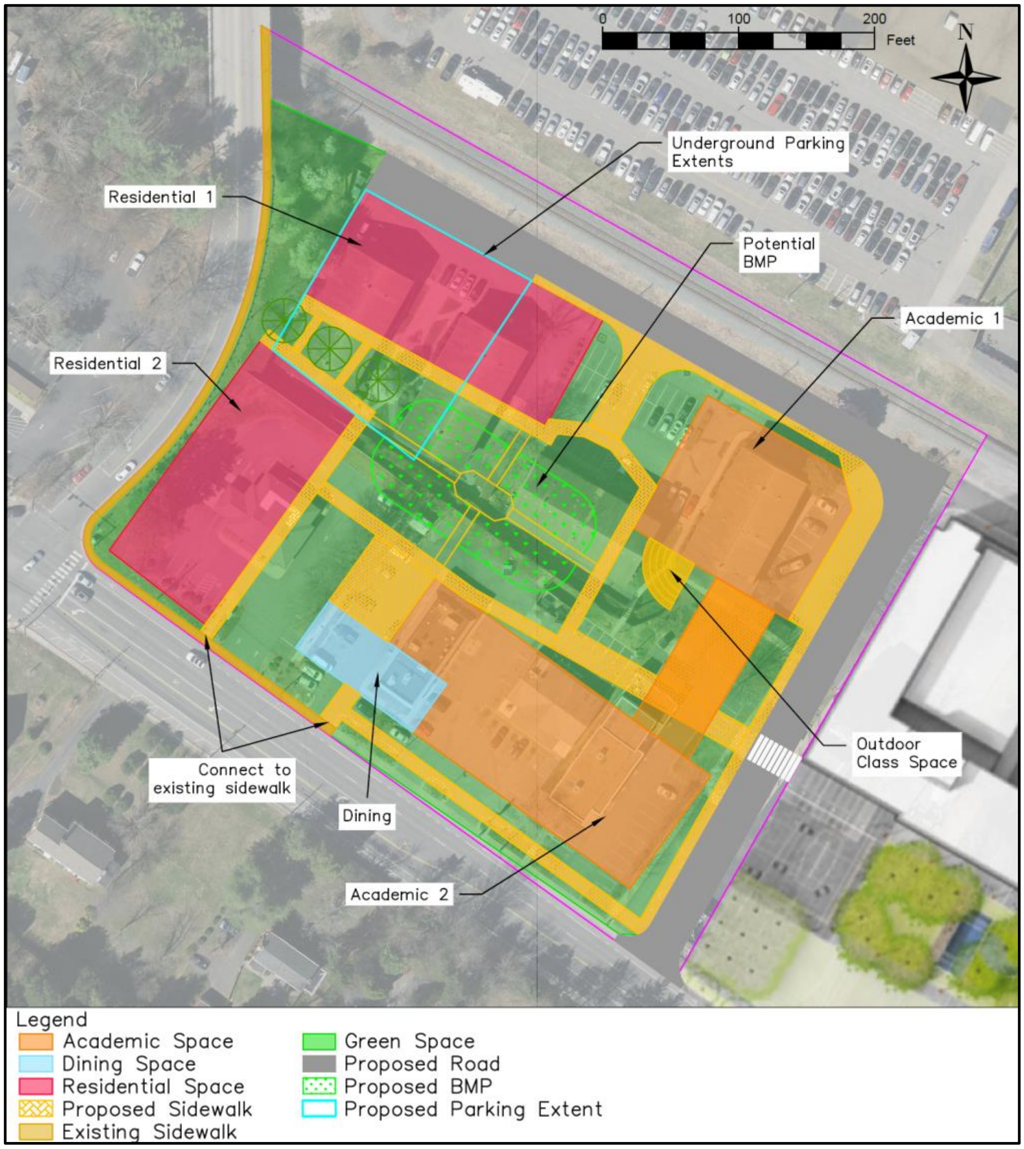
- Make sure that everyone in the team knows what to work on for increased productivity. We showed significant growth between our fall and spring semesters, and it was in large part due to our schedule. We crafted our spring schedule so that each team member had an individual task to complete every week, making our weekly meetings more effective because each member had updates to share. This also resulted in a greater output of work, allowing us to address everything discussed in the scope.
- Just try. Many of us began this project without having much knowledge about certain topics, and Civil 3D was also a huge learning process that took time. We learned that it is better to make attempts rather than to delay or not do tasks at all. In a similar vein, asking questions is critical throughout the design process; take advantage of weekly meetings to obtain resources or get clarification on task items.

Overall, we believe that the final design for the Ivy Corridor Phase II site adequately reflects the level of effort, detail, and thought that we gave to the project throughout the past several months. We successfully addressed everything outlined in our scope and presented these topics in a thorough and engaging way while also keeping social appeal and future implications in mind. Most importantly, our site suitably fulfills the mission underscored in our problem statement: to holistically design a vibrant and welcoming university hub at the Ivy Corridor Phase II site that harmoniously flows with adjacent infrastructure, educates users on watershed issues, and meets the demands of our client and stakeholders.

Appendix B – Team Contributions (as of 05/02/2023)

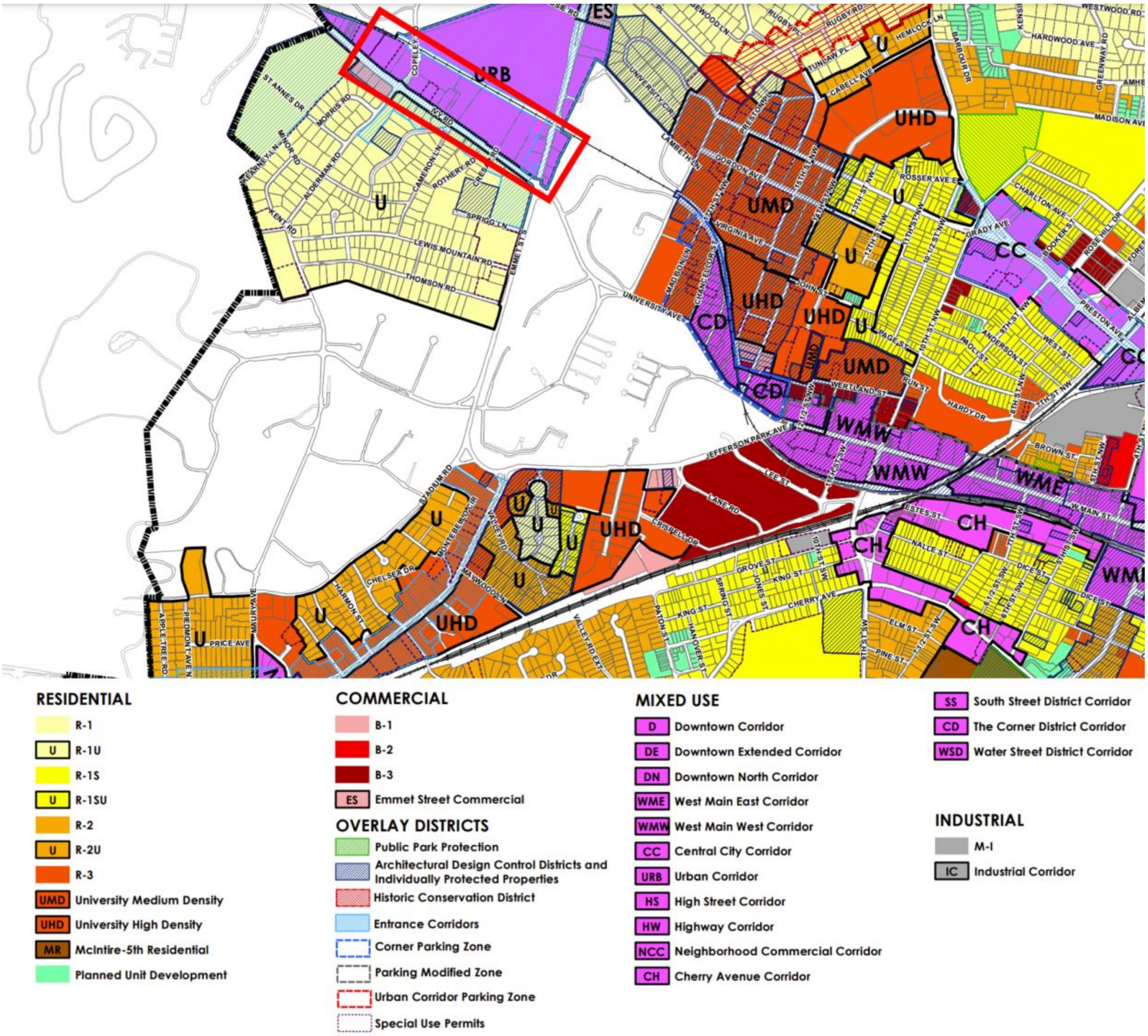
- Lex Clements:
  - Discussion of preliminary site layout
  - LEED Scorecard research
  - BMPs pros and cons; native plants research
  - Drainage/SWMM
  - Stormwater investigation (VRRM)
  - ESC phase I+II
  - Climate Resilience
- Eduardo Corro:
  - Discussion of preliminary site layout
  - ADA research
  - Utilities
  - Erosion and sediment control requirements/narrative
  - ESC phase I+II
- Soojin Jang:
  - Discussion of preliminary site layout
  - Zoning and access (fire access turnarounds)
  - Schedule organizer
  - AutoCAD revised site layout drawings
  - Intersection sight distance calculations and profile
  - ESC phase I+II
  - Final presentation slides/ poster graphics
- Noah McGhee:
  - Discussion of preliminary site layout
  - AutoCAD preliminary site layout drawings
  - Stormwater investigation (VRRM)
  - Elevation data preparation and exploration
  - Drainage/SWMM/BMP design
  - ADA around buildings
  - ESC phase I+II
  - Climate resilience
  - Cost estimation
- Cameron Murie:
  - Discussion of preliminary site layout
  - ADA research
  - Bike access research
  - Bike rack placement and dimensions
  - Fire hydrant calculations
  - ESC phase II
  - Cost estimation

Appendix C – Preliminary Site Layout



Our preliminary site design established a central green space around which the rest of the site was built. The two residential buildings are smaller than the final design and the skyway connects two academic buildings instead of uniting the residential space. This preliminary site layout posed two main issues that led to the need for a redesign. First, in an attempt to increase walkability and reduce pavement, there were not any off-street loading spaces for any of the buildings on our site. Second, the GSF of the building types did not meet the expectations outlined in our scope. The GSF for residential and dining were much lower than requested, whereas the GSF for academic exceeded expectations. As shown in our revised and final design, the basic structure of the preliminary site layout was maintained by keeping the central green space with the interactive stormwater management feature. The amphitheater was re-oriented so that those sitting on its steps would face towards this area.

Appendix D – Charlottesville Zoning District Map, Ivy Corridor outlined in red



Appendix E – Intersection Design Standards and Calculations

Sight Distance

- $d_{ISD} = 1.47 v_{major} t_g$ ← *account for additional lanes*
- Case B1: Left Turn
  - Passenger Car:
    d_{ISD} = (1.47)(40 mph)(7.5 sec + 0.5 sec) = 470.4 ft
  - Single-Unit Truck:
    d_{ISD} = (1.47)(40 mph)(9.5 sec + 0.7 sec) = 599.8 ft

- <u>Case B2: Right Turn</u>
  - Passenger Car:
    d_{ISD} = (1.47)(40 mph)(6.5 sec) = 382.2 ft

  - Single-Unit Truck:
    d_{ISD} = (1.47)(40 mph)(8.5 sec) = 499.8 ft

Table 7.8 Time Gap for Case B1—Left Turn from Stop

Design Vehicle	*Time Gap (t_g) (second) at Design Speed of Major Road*
Passenger Car	7.5
Single-unit Truck	9.5
Combination Truck	11.5

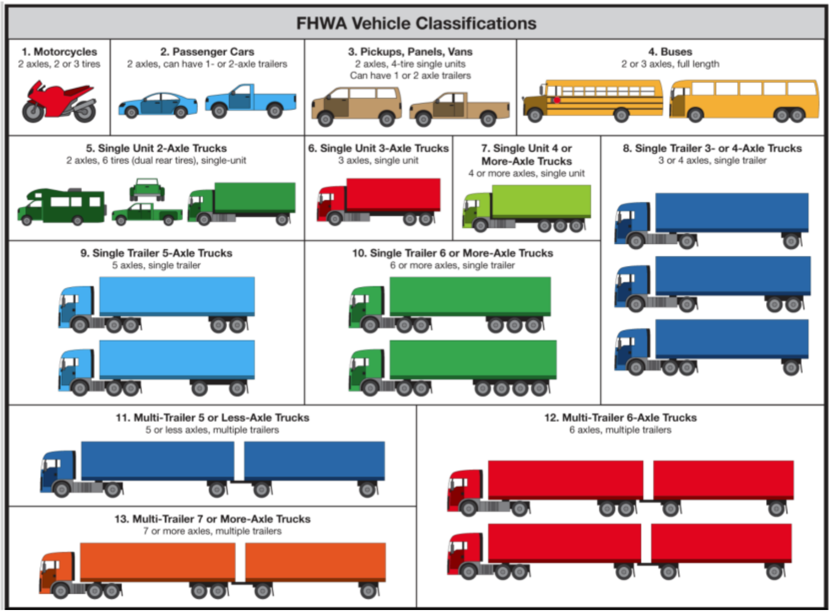
Note: Time gaps are for a stopped vehicle to turn left onto a two-lane highway with no median and grade 3 percent or less. The table values require adjustment as follows:
For multilane highways:
For left turns onto two-way highways with more than two lanes, add 0.5 seconds for passenger cars or 0.7 seconds for trucks for each additional lane, from the left, in excess of one, to be crossed by the turning vehicle.
For minor road approach grades:
If the approach grade is an upgrade that exceeds 3 percent, add 0.2 seconds for each percent grade for left turns
SOURCE: *A Policy on Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials, Washington, D.C., 2004, p. 660. Used with permission.

Intersection Spacing

Functional Classification	Design Speed (See Note 2)	Minimum Spacing (Distance) in Feet			
		Type 1 (Signalized)	Type 2 (Unsignalized/ Full Crossover)	Type 3 (Full Access /Directional Crossover)	Type 4 (Partial Access)
Principal Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	1,050 1,320 2,640	880 1,050 1,320	440 565 750	250 305 495
Minor Arterial	≤ 30 mph 35 to 45 mph ≥ 50 mph	880 1,050 1,320	660 660 1,050	355 470 555	200 250 425
Collector	≤ 30 mph 35 to 45 mph ≥ 50 mph	660 660 1,050	440 440 660	225 335 445	200 250 360
Local Street	See Note 1				

TABLE 2-2 MINIMUM SPACING STANDARDS FOR COMMERCIAL ACCESSES, INTERSECTIONS AND MEDIAN CROSSOVERS

Appendix F – Design Vehicles Chart



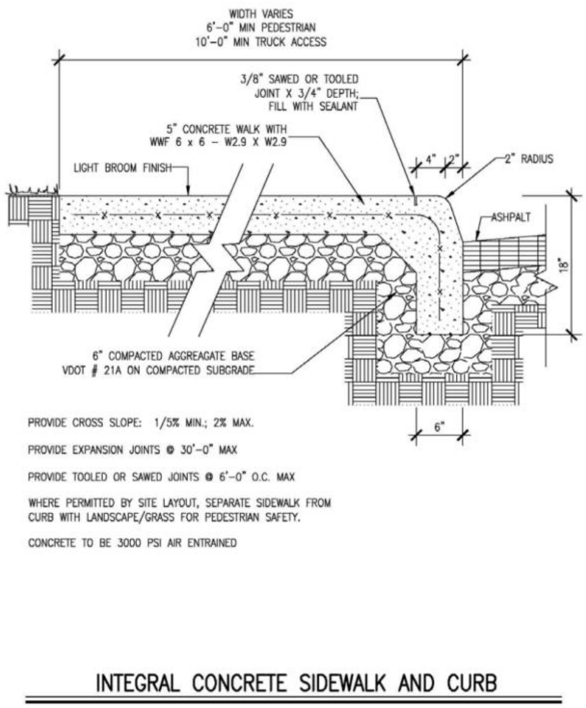
Appendix G – Hardscape Details

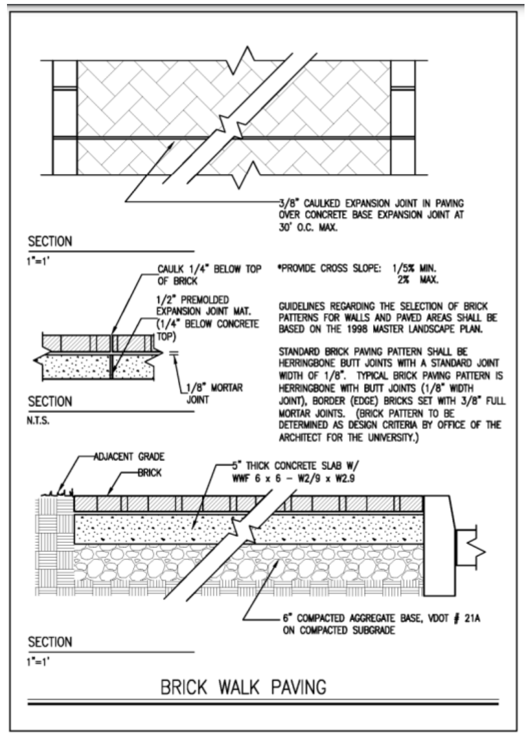
- Pavement

Course/VDOT Specification	Roads	Parking	Pedestrian walks
Surface/SM-9.5A	2”	1 ½ ”	2”
Binder/ BM-25.0A	3”	2”	Not applicable
Sub-base/21A	10”	6”	6”
Sub-grade compaction	*98%	95%	95%

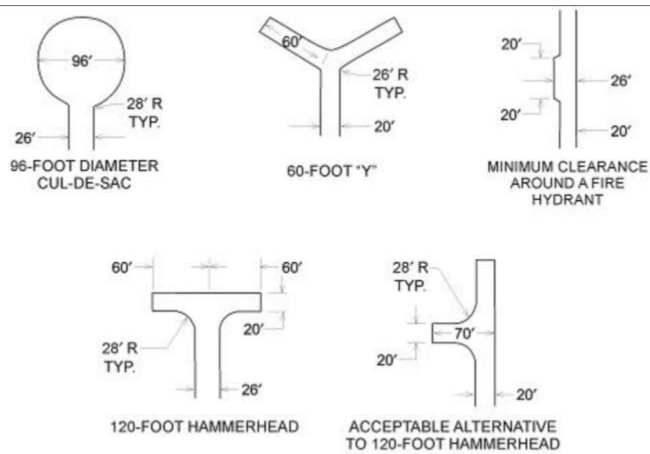
**Maximum dry density (ASTM D698, Method D)*

- Sidewalk





Appendix H – Fire Truck Turnaround



Appendix I - Needed Fire Flow Calculations

$$NFF = CO(1 + (X + P))$$

NFF = Needed Fire Flow (gpm)

C = construction factor → $18F\sqrt{A}$ with A as effective area (ft^2)

O = occupancy factor

X = exposure factor

P = communication factor

	A	**C**	**O**	**NFF**
Building 1*	92750	5482	.85	4715
Building 2*	63700	4543	.85	3860
Building 3	8400	5217	.85	4500

*****Although buildings 1 and 2 are connected via a skywalk, they will be treated as two separate buildings for the purposes of these calculations.

Appendix K – BMP Comparison Chart

	Bioretention	Dry Swale	Wet pond	Grass Channel
Green space	Yes	Yes	Yes	Yes
Serve Impervious and pervious surfaces	Yes	Yes	Yes	Yes
Filtration	Yes	Yes	Yes	Yes, Less
LEED credits	Yes	Yes	Yes	Yes, less
Annual Runoff Volume Reduction (Level 1/2)	40%/80%	40%/60%	0%/0%	20% (no CA)/10% (no CA) or 20% (with CA)
Total Phosphorus Mass Load Removal	55%/90%	52%/76%	50%/75%	20% (no CA)/24% (no CA) or 32% (with CA)
Total Nitrogen Mass Load Removal	64%/90%	55%/74%	30%/40%	36%/28% (no CA) or 36% (with CA)
Space	3-6% of contributing drainage area	3-5% of contributing drainage area	1-3% of contributing drainage area	Bigger than dry swale or bioretention
slope	1-5%	<4%	N/A	<4%
Contributing drainage Area	0.1-2.5 acres	<5 acres	10-25 acres	< 5 acres
Maintenance	High	Mid	Mid	Low

Appendix M – LEED Potential Credit Checklist

LEED v4 for Neighborhood Development Plan Project Checklist					
Applicability		**Type**	**Credit Title**	**Qualifications Met by Project**	**Number of Credits Earned**
Yes	**No**	**Smart Location & Linkage**			**28 possible**
Y		Prereq	Smart Location	Project is located on an infill site.	Required - Met
	N	Prereq	Imperiled Species and Ecological Communities		Required
Y		Prereq	Wetland and Water Body Conservation	Project is located on a site that includes no preproject wetlands, water bodies, land within 50 feet of wetlands, and land within 100 feet of water bodies.	Required - Met
	N	Prereq	Agricultural Land Conservation		Required
Y		Prereq	Floodplain Avoidance	Project is located on a site not part of a 100-year flood plain.	Required - Met
Y		Credit	Preferred Locations	Project is located on an infill site that is also a previously developed site. Project is located in an area that has existing connectivity (at least 4 intersections within ½ mile of the project boundary not constructed or funded by the developer within the past 10 years).	10

	N	Credit	Brownfield Remediation		0
Y		Credit	Access to Quality Transit	Project located on a site with existing transit service such that at least 50% of dwelling units and nonresidential use entrances (inclusive of existing buildings) are within a ¼-mile walking distance of bus, streetcar, or rideshare stops.	7
Y		Credit	Bicycle Facilities	The project boundary is within ¼ mile bicycling distance of an existing bicycle network extending at least three continuous miles and within this network connects to a school.	2
	N	Credit	Housing and Jobs Proximity		0
Y		Credit	Steep Slope Protection	Project does not meet requirements (over 40% of land with slope between 15-25% will be developed	0
	N	Credit	Site Design for Habitat or Wetland and Water Body Conservation		0
	N	Credit	Restoration of Habitat or Wetlands and Water Bodies		0
	N	Credit	Long-Term Conservation Management of Habitat or Wetlands and Water Bodies		0
Yes	**No**	**Neighborhood Pattern & Design**			**41 possible**

Y		Prereq	Walkable Streets	Project has 90% of new buildings have a functional entry onto the circulation network.	Required - Met
Y		Prereq	Compact Development	Project has access to quality transit and residential components having a density greater than 12 units per acre.	Required - Met
Y		Prereq	Connected and Open Community	Project has connectivity within ¼ mile of the project boundary that is at least 90 intersections per square mile.	Required - Met
Y		Credit	Walkable Streets	Project includes 6 walkable street design features.	3
Y		Credit	Compact Development	Project's residential and nonresidential components are within range of required densities.	2
Y		Credit	Mixed-Use Neighborhoods	Project designed such that 50% of its dwelling units are within a 1/4-mile walking distance of 4 diverse uses.	1
	N	Credit	Housing Types and Affordability		0
Y		Credit	Reduced Parking Footprint	Project designed with less than 20% of site footprint used for off-street parking.	1
Y		Credit	Connected and Open Community	Project has connectivity within a ¼-mile distance of the project boundary greater than 400 intersections per square mile.	2
Y		Credit	Transit Facilities	Project contains transit facilities that will be funded by developer and space reserved for transit stops	1
Y		Credit	Transportation Demand Management	Project will have year round developer-sponsored transportation.	1

Y		Credit	Access to Civic & Public Space	Project has a civic or passive-use space, such as a square, park, or plaza, at least 1/6 acre in area lies within a ¼-mile (400-meter) walking distance of 90% of planned and existing dwelling units and nonresidential use entrances.	1
Y		Credit	Access to Recreation Facilities	Project is located near a publicly accessible outdoor recreation facility at least 1 acre in area, or a publicly accessible indoor recreational facility of at least 25,000 square feet, lies within a ½-mile walking distance of 90% of new and existing dwelling units and nonresidential use entrances.	1
	N	Credit	Visitability and Universal Design		0
	N	Credit	Community Outreach and Involvement		0
	N	Credit	Local Food Production		0
Y		Credit	Tree-Lined and Shaded Streetscapes	Project has trees at intervals of no more than 50 feet (exempting driveways) along at least 60% of the total existing and planned block length within the project.	1
	N	Credit	Neighborhood Schools		0

Yes	**No**	**Green Infrastructure & Buildings**			**31 possible**
	N	Prereq	Certified Green Building		Required
	N	Prereq	Minimum Building Energy Performance		Required

	N	Prereq	Indoor Water Use Reduction		Required
Y		Prereq	Construction Activity Pollution Prevention	Project includes a complete erosion and sediment control plan to reduce pollution offsite.	Required - Met
	N	Credit	Certified Green Buildings		0
	N	Credit	Optimize Building Energy Performance		0
	N	Credit	Indoor Water Use Reduction		0
Y		Credit	Outdoor Water Use Reduction	Project uses plant types that allow for the landscaping to require 30% less irrigation water than would be required with normal turf.	1
	N	Credit	Building Reuse		0
	N	Credit	Historic Resource Preservation and Adaptive Reuse		0
	N	Credit	Minimized Site Disturbance		0
Y		Credit	Rainwater Management	Project on previously developed site and manages runoff from the developed site for the 95th percentile using low-impact development (LID) and green infrastructure.	4
	N	Credit	Heat Island Reduction		0
	N	Credit	Solar Orientation		0

	N	Credit	Renewable Energy Production		0
	N	Credit	District Heating and Cooling		0
	N	Credit	Infrastructure Energy Efficiency		0
	N	Credit	Wastewater Management		0
	N	Credit	Recycled and Reused Infrastructure		0
	N	Credit	Solid Waste Management		0
	N	Credit	Light Pollution Reduction		0
		Innovation & Design Process			**6 possible**
Y		Credit	Innovation	Project exceeds requirements for the Rainwater Management credit and incorporates an innovation in stormwater management, the mixed use bioretention garden.	3
	N	Credit	LEED® Accredited Professional		0

		Regional Priority Credits			**4 possible**
	N	Credit	Regional Priority Credit: Region Defined		0
	N	Credit	Regional Priority Credit: Region Defined		0
	N	Credit	Regional Priority Credit: Region Defined		0
	N	Credit	Regional Priority Credit: Region Defined		0
		PROJECT TOTALS (Certification estimates)			41
Certified: 40-49 points, **Silver:** 50-59 points, **Gold:** 60-79 points, **Platinum:** 80+ points					

Appendix N - Cost Estimation Sheet

item	subcategory	quantity	units	unit price (1998)	total price (1998)	total price (2023)	total price (2024)	total price (2025)	total price (2026)	unit price (2027)
Building demolition	Site Demolition	1133230	CF	0.24	$271,975.20	$498,621.20	$511,086.73	$523,863.90	$536,960.50	$550,384.51
Fence demolition	Site Demolition	370	LF	1.56	$577.20	$1,058.20	$1,084.66	$1,111.77	$1,139.57	$1,168.05
Asphalt mill	Site Demolition	9317	SY	6.1	$56,836.41	$104,200.09	$106,805.09	$109,475.22	$112,212.10	$115,017.40
Fire hydrant removal	Site Demolition	1	Each	420	$420.00	$770.00	$789.25	$808.98	$829.21	$849.94
Clear and grub	Site Clearing	1.3	Acre	2,925	$3,802.50	$6,971.25	$7,145.53	$7,324.17	$7,507.27	$7,694.96
Excavation	Earthwork	6340	CY	2.31	$14,645.40	$26,849.90	$27,521.15	$28,209.18	$28,914.41	$29,637.27
Fill	Earthwork	7148	CY	1.39	$9,935.72	$18,215.49	$18,670.87	$19,137.65	$19,616.09	$20,106.49
Hauling	Earthwork	808	CY	7.85	$6,342.80	$11,628.47	$11,919.18	$12,217.16	$12,522.59	$12,835.65
Asphalt paving	Paving and Surfacing	42565	SF	1.76	$74,914.40	$137,343.07	$140,776.64	$144,296.06	$147,903.46	$151,601.05
Sidewalk	Paving and Surfacing	600	SF	3.4	$2,040.00	$3,740.00	$3,833.50	$3,929.34	$4,027.57	$4,128.26
Patio	Paving and Surfacing	5570	SF	4.91	$27,348.70	$50,139.28	$51,392.77	$52,677.58	$53,994.52	$55,344.39
Curb, straight	Paving and Surfacing	728	LF	5.8	$4,222.40	$7,741.07	$7,934.59	$8,132.96	$8,336.28	$8,544.69
Curb, curved	Paving and Surfacing	72	LF	11.65	$838.80	$1,537.80	$1,576.25	$1,615.65	$1,656.04	$1,697.44
Curb inlets	Paving and Surfacing	3	Each	197	$591.00	$1,083.50	$1,110.59	$1,138.35	$1,166.81	$1,195.98

Ped bridge	Paving and Surfacing	2600	SF	40.5	$105,300.00	$193,050.00	$197,876.25	$202,823.16	$207,893.74	$213,091.08
New fire hydrant	Utility	5	Each	1275	$6,375.00	$11,687.50	$11,979.69	$12,279.18	$12,586.16	$12,900.81
Concrete pipe	Utility	560	LF	222	$124,320.00	$227,920.00	$233,618.00	$239,458.45	$245,444.91	$251,581.03
Black steel pipe	Utility	650	LF	38.5	$25,025.00	$45,879.17	$47,026.15	$48,201.80	$49,406.84	$50,642.02
Underdrain	Utility	300	LF	7	$2,100.00	$3,850.00	$3,946.25	$4,044.91	$4,146.03	$4,249.68
Beehive drain (16' depth)	Utility	1	Each	4533	$4,533.00	$8,310.50	$8,518.26	$8,731.22	$8,949.50	$9,173.24
Storm manhole struc (10' depth)	Utility	1	Each	3430	$3,430.00	$6,288.33	$6,445.54	$6,606.68	$6,771.85	$6,941.14
Bioretention (Fairfax Co)	Landscaping	2312	CY	485	NA	$1,121,320.00	$1,149,353.00	$1,178,086.83	$1,207,539.00	$1,237,727.47
Silt fence	ESC	1180	LF	0.82	$967.60	$1,773.93	$1,818.28	$1,863.74	$1,910.33	$1,958.09
Seeding	Landscaping	46.2	MSF	44	$2,032.80	$3,726.80	$3,819.97	$3,915.47	$4,013.36	$4,113.69
Trailer office	Facilities	2	Each	6425	$12,850.00	$23,558.33	$24,147.29	$24,750.97	$25,369.75	$26,003.99
Fence, 6 ft chain link	ESC	1855	LF	11.15	$20,683.25	$37,919.29	$38,867.27	$39,838.96	$40,834.93	$41,855.80
Bike racks (Fairfax Co)	Facilities	7	Each	387	NA	$2,709.00	$2,776.73	$2,846.14	$2,917.30	$2,990.23
					Construction Items Subtotal	$2,557,892.17	$2,621,839.47	$2,687,385.46	$2,754,570.09	$2,823,434.34
					Mobilization (5%)	$127,894.61	$131,091.97	$134,369.27	$137,728.50	$141,171.72
					Design contingency (25%)	$639,473.04	$655,459.87	$671,846.36	$688,642.52	$705,858.59
					TOTAL	**$3,325,259.81**	**$3,408,391.31**	**$3,493,601.09**	**$3,580,941.12**	**$3,670,464.65**