

# **Site Redesign at Crozet Elementary**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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## **PROBLEM STATEMENT**

Crozet Elementary School in Albemarle County, Virginia, is expecting a sizable increase in the number of enrolled students due to redistricting between Crozet and Brownsville Elementary. This larger student population has prompted the need for the construction of an additional academic wing, as well as supporting site elements such as parking, access, and playground space. The goal of this capstone project is to work with professional engineers from Timmons Group, a land development firm, to develop and design site improvements at Crozet Elementary School. The site redesign will focus specifically on the school parking lot and traffic circulation, with the goals of increasing the number of both bus and car parking spaces available as well as separating bus circulation and car circulation on the site as much as possible. The total number of parking spaces is to include 136 car parking spaces and 12 bus parking spaces, incorporating five handicap accessible spaces as code requires. Additional considerations include attempting to incorporate a new stormwater management system into a play area for students, relocating any facilities that might be impacted by the redesign such as the outside basketball court, and maintaining the footprint of the existing soccer field.

## **STATEMENT OF SCOPE**

For this project, the goal will be to provide a set of construction documents ideally at a level of completion where a contractor could enact the proposed changes on the site. These construction sheets include an overall layout plan for our final design as well as a site grading and drainage plan, stormwater management plan, and an erosion and sediment control plan for phases 1 and 2 of construction. Pre-construction sheets will include a layout of existing conditions, and a demolition plan detailing items slated for removal on site. These plans will also come with site specific notes and details, as well as additional calculations done for stormwater

management and grading. All of the plans will abide by Albemarle County municipal code and design standards, VDOT regulations and design standards, ADA requirements, and other requirements as set forth by Crozet Elementary School. Relevant standards and details will be cited in the plans. Preliminary designs were made using the PDF editing program, Bluebeam Revu, to provide a general layout of the site and the direction the team intended to take. The final construction documents and site layouts will be completed and published in Civil 3D/AutoCAD, where more specifications of the final design will be addressed.

## **PROJECT SCHEDULE**

In the fall semester, the team stayed fairly on track with the original schedule, albeit making minor alterations to it along the way. These changes came mainly from delays in developing and choosing the initial concept design. The team finished this roughly two weeks after anticipated, primarily due to focusing on changes to the design in Bluebeam Revu which delayed transferring it into Civil 3D AutoCAD. At the end of the fall semester, Timmons Group shared a schedule for the spring they felt would be easier to keep based on the progress in the fall, and their knowledge of what was left to complete. This preliminary spring schedule can be seen in Appendix A.

The primary shift in the work schedule for the spring semester was in the format of the weekly meetings with Timmons Group. Initially in the fall, those meetings were mostly progress updates on what the capstone team had completed that week. In the spring, the Monday progress meeting became more of an informative workshop where the team would learn directly from Timmons about a specific subject, such as stormwater management or grading. The capstone team would then work on this topic throughout the week and reconvene at Timmon's local office where additional guidance and advice could be received from their professionals to revise what

had been accomplished since Monday. These in-office, informal meetings became more frequent throughout the spring semester as capstone members would drop by whenever they needed face-to-face help or a clarification on a difficult component, which helped prevent lack of expertise from causing delays.

There were a number of difficult circumstances affecting group members in their personal lives that did cause issues in keeping to the proposed spring schedule, but by and large team members would step up when others needed additional aid in finishing tasks by set deadlines. However, these situations did result in project deliverables only being fully completed at the beginning of May, and some of the more ambitious components being left out of the final project.

## **DESIGN**

The final deliverable for the capstone project is a complete sheet set of construction documents, with each sheet incorporating a different aspect of construction and design for the site. These individual sheets were also dependent on one another; updating one aspect of the site meant the rest needed to be altered as well. This iterative process meant the design was constantly evolving throughout the course of the project. The capstone team created a 30, 60, and 90% completion sheet set for review and constructive criticism from Timmons Group to help guide subsequent iterations. A brief summary of the main sheets and their completion process can be found below.

**Existing Layout:** This sheet was the easiest to create as the initial topographical survey and layout of the site was provided by Timmons Group from when they had worked on the project. The layout did need to be updated in terms of what data and layers were and were not visible in order to improve the legibility and presentation of the sheet for viewers.

**Demolition Plan:** The demolition plan is one of the first sheets in terms of the construction timeline but could only be started once the capstone team knew what the final design was going to look like, in order to know which portions of the existing layout would be kept or needed removal. Once a redesign layout was established, the demolition plan was updated to show where existing parking infrastructure would need to be removed. As the demolition plan was to be in black and white, the indicators for components being removed had to be visually distinct enough for viewers to differentiate between the various materials and components, without different colors but with the aid of a legend. As other sheets were updated, the demolition plan was also updated to accurately reflect the outer extents of removed material.

**Notes & Details:** The general notes and construction details for this sheet set were derived from existing regulations and standards from both the Virginia Department of Transportation as well as the Albemarle County Design Standards. The construction details became increasingly comprehensive as the capstone team gained a better understanding of what specific infrastructure was needed in the redesign, such as different curb types, traffic stops, and sidewalk requirements.

**Erosion & Sediment Control Phase 1:** The erosion and sediment control plan was devised into two phases to account for pre and post construction conditions. The first phase consisted of preconstruction conditions and would account for early stages of construction and the demolition phase. In this first phase, the emphasis was on formulating the limits of disturbance for the site and protecting the structures to be kept within our site. Since this sheet did not reference the other sheets created except the existing site layout, designing phase 1 was a relatively uniform process. Upon devising the limits of disturbance, a range of necessary measures were added to ensure that any structures, such as inlets or trees, near or within the vicinity of the limits of disturbances were protected.

**Erosion & Sediment Control Phase 2:** The second phase of the erosion and sediment control plan accounted for the latter construction conditions. As this sheet depended on the grading & drainage plan and final design layout, the second phase went through much more iterations than the first phase. Changes to these respective sheets would alter the number of inlet protections and the limits of disturbances, so efficient communication between team members was necessary to ensure that changes were uniform across the sheets. This sheet focused on communicating the necessary measures to be in place during the final part of the construction phase to ensure that sediment stays within the premise of our limits of disturbance. With guidance from Timmons Group, this sheet went through a number of revisions to ensure that professionalism and legibility was embedded in our design.

**E&S Notes & Details:** The erosion and sediment control notes and details were derived from existing regulations and standards set by the Virginia Department of Environmental Quality. Timmons Group advised the capstone team on which details to incorporate into the E&S Control plans, which included specific details for silt fences, inlet and outlet protection, tree protection, temporary seeding, and a construction entrance.

**Final Design Layout:** The redesigned layout for the school underwent the most changes during the course of this project. The capstone team developed a number of different potential layouts, previous iterations of proposed designs can be seen in Appendix B. These iterations included placing the separate bus lot in different locations, such as the northwest or southwest of the site, and the extra parking being added in large lots of twenty four spaces or more. However, these proposed designs were not chosen for further completion based on issues with feasibility of grading and spacing. The southwest slopes proved to be too steep for easy regrading which limited how much parking could be placed there. Ultimately the final design was arranged based

on smaller lot additions and using as much of the pre-existing parking as possible. This final design also separated bus and car traffic by placing the separate bus lot towards the rear of the site, in the northeast corner. This “final” design also underwent several iterations before it was considered complete, the main layout remaining generally the same but with changes such as the addition of an auxiliary lot in the north east to meet the 136 parking spaces requirements.

**Grading & Drainage Plan:** The development of the grading and drainage plan was an iterative process, much the same as the overall project. There was an immeasurable amount of trial and error involved in creating and editing the proposed surface within Civil 3D. Each adjustment of an elevation or slope often caused a chain reaction, which forced the team to have to use a lot of forethought prior to making changes. The final plan effectively directs surface runoff to the proper inlets and ensures that pedestrians are able to traverse the site safely.

**Stormwater Management Plan:** The stormwater management plan was based on data collected on both the existing conditions and post development plans. Every change to the land of development and grading caused alterations to the stormwater management plans. Data, including drainage areas, NOAA runoff, curve numbers, and TR-55 time of concentration were all used to create hydrographs. These provided the information needed for energy balance equations. From there, the orifices, weirs, culvers, and pipe dimensions of the underground retention and bioretention garden were adjusted to satisfy the energy balance equations.

## **DESIGN STANDARDS**

There were a number of design standards that were needed for the final design. This included transportation standards, grading standards, environmental standards and more. While Timmons Group did provide the capstone team with some general numbers and direction for design standards, the team had to research Virginia and Albemarle County standards and

regulations. State standards were typically adequate for the project, but the team did reference the Albemarle County Design Standards Manual to ensure the county did not have more stringent requirements that needed to be met. A federal standard incorporated into the project was that of the Americans with Disabilities Act, pertaining to parking. The team had to include a specific number of handicap accessible parking spaces and access aisles into the final design based on the increased size of the parking facilities. The maximum slope of the parking lot and sidewalks had to be 5% in order to be considered accessible.

Standards for stormwater management came from the Virginia Stormwater BMP Clearinghouse, which provides references for meeting Virginia Stormwater Management Program (VSMP) regulations. The VSMP requires the use of the Virginia Runoff Reduction Method (VRRM) to calculate total phosphorus available for removal and post development treatment volume to meet runoff quality and quantity standards. This site also provides a list of recognized Best Management Practices that could be incorporated into the redesign to meet pollutant removal standards. The listed requirements for each BMP, such as required size and runoff rates, helped shape decision making on which practices worked best within the confines of the site. Quantity standards were derived from area totals, hydrographs, runoff curve numbers, and time of concentration.

Erosion and sediment control standards came from the Virginia Department of Environmental Quality. Timmons Group directed the team on which practices they felt were relevant to this project and from there the team gathered relevant notes and details on E&S practices and how they should be arranged on site, which directed the creation of Phase 1 and 2 of the E&S control plan. The Virginia Department of Transportation has a comprehensive set of Road and Bridge Standards that the team used to find construction details for various pieces of



infrastructure around the site. These included curb types, drive aisle standards, and sidewalk and pavement details.

## **RESULTS**

The majority of the fall semester was focused on drafting potential site layouts and determining their effectiveness at meeting the project requirements as well as their feasibility of construction. The rest of the fall the team focused on converting conceptual work into a practical Civil 3D file where additional construction documents could be developed. The bulk of work within Civil 3D occurred in the spring semester, as well as most of the training/education on how to use CAD to complete the redesign to a professional standard. The fall was primarily conceptual while the spring was primarily practical, physically implementing the redesign into software and then into a finished product.

The capstone team was better able to delegate tasks to individual members this spring once the general layout had been mostly finalized. The lack of a central shared server for live updates between all group members did hinder the coordination between given tasks, for example between grading and stormwater, which necessitated a group member to serve as a point person to coordinate and assemble the final product. Many sheets were tightly coupled requiring multiple iterations as changes to one aspect of the design meant other aspects had to be updated to match. At three points during the semester, the team submitted to Timmons Group a sheet set at varying levels of completion: 30, 60, and 90%. The team then used the feedback and comments on those sheet sets to guide the next iteration of construction documents. Towards the end of the semester, this was primarily focused on the presentability and legibility of the content included on those sheets.

## **CONCLUSION**

The capstone team's final design successfully increased Crozet Elementary School's parking capacity up from 86 parking spaces to 136 spaces and 12 dedicated bus spaces, and helped separate car and bus traffic on site with the creation of a bus lot on the northeast area of the site. This design also met ADA standards for the number and location of handicap accessible spaces, and paths to the school. The team was also able to maintain the existing footprint of the soccer field and relocate the existing basketball court from its previous location where the additional academic wing was to be built. While the redesign did include new stormwater management systems, including the bioretention garden adjacent to the bus lot, the team was unable to specifically design the garden as an interactive area for kids as requested by Crozet Elementary staff. Overall, the team was successful in translating this site redesign into a complete sheet set of construction documents. This sheet set can be seen in Appendix C, and is the primary project deliverable.

Due to outside circumstances hindering progress, the team was unable to accomplish everything it set out to do at the start of the school year and had to prioritize certain design aspects. Initially, the team wanted to create a traffic routing simulation to confirm that the redesign traffic plan would improve circulation on site, but never had the time or ability to obtain the knowledge and software to do so. The team also wanted to potentially generate a cut and fill report based on the regrading needed for the new design but did not find time at the end of the semester to do so. Finally, the team considered generating a new utility layout for the redesign but considered that more in the realm of the architect or mechanical engineer and thus omitted it due to time constraints.

The team gained a great deal of knowledge in using Civil 3D from this project, as although there was some education on using Civil 3D in introductory civil classes, the level of

expertise needed to meet professional standards was well beyond that. Furthermore, while capstone members had gone through courses on the theory of many of the construction sheets, such as stormwater management or erosion and sediment control, no one had a lot of experience with putting theory into practice and developing a complete design. As such, the guidance and support from Timmons Group was invaluable in completing this project, and the capstone team would like to express their gratitude. The capstone experience was educational on both a technical and professional level for all team members.

## **APPENDICES**

### **Appendix A - Detailed Schedule**

- Spring Schedule developed by Timmons Group

### **Appendix B - Examples of Previous Designs**

- Previous Iterations and 30/60/90% Layout Sheets

### **Appendix C - Project Deliverables**

- Construction Document Sheet Set
- Additional Stormwater Calculations