Stormwater Management in Pine Ridge

The purpose of our project is to design a stormwater management system for a trailer court in South Dakota. The components of the system are concrete open channels, a sediment control structure, and detention basin. The software programs used to model the system are HEC-1 and Microsoft Excel. The two main variables the project focuses on are water flow and sediment movement. This report details the data needed to use the programs and the information we expect to gain.

The main function of HEC-1 is to determine the volume of runoff from a site. From this information, the water storage area can be found and the pond designed. HEC-1 divides the watershed into subbasins which have basically the same characteristics. This is the main assumption of the model. The watershed must have distinct sub-areas which can be distinguished and properties assigned. The sub-areas in our project are the trailer court lots or open spaces above each roadside channel. The components of HEC-1 are runoff, routing, reservoir, diversion, and pump. The components we will be using are runoff, routing, and reservoir. The runoff component consists of the precipitation and rainfall pattern. Runoff is computed by subtracting infiltration and detention. Routing is how the water flows through channels on the site. Runoff from each sub-area will flow into the channels and to the reservoir. The routing mechanisms in our design are concrete channels and the specific material will be designated by the roughness coefficient. The reservoir will be a detention pond. The purpose of the pond is to limit outflow to the nearby stream to pre-development flows. The pond will be designed to store excess runoff and to release it at a controlled rate. The principal spillway is an orifice which is sized to release water at pre-development rates. The emergency spillway is a weir which handles the 100-yr storm.

The first step is to run a simulation of the watershed before development. This will show us the pre-development runoff and give a baseline for what the post-development runoff must be reduced to. The inputs for this phase of the project are the rainfall pattern, rainfall data, curve number, drainage area, and time of concentration. All
of the parameters have already been determined. The rainfall pattern is Type II and the rainfall data has been obtained from TP 40. The Soil Conservation Service is the source for this data. The soil type and slope are known, allowing us to calculate the curve number. The time of concentration has also been calculated because the rainfall intensity has been interpolated from intensity charts. From this data, the pre-development runoff pattern can be determined in HEC-1 by subtracting the infiltration and detention from precipitation. The result will be an outflow-stage relationship.

The next step is to simulate the post-development watershed in HEC-1. The rainfall characteristics remain the same, but development will change the curve number and time of concentration. The watershed will also now be divided into subbasins. The areas of the subbasins have been determined by the urban design of the trailer court. The area upstream of the trailer court can also be simulated by delineating the watershed and determining how much area contributes to the watershed. The routing is concrete channels. The size of these channels has been determined by the peak flow rate entering each channel. The Rationale method was used to size the channels. However, HEC-1 simulation will determine if that sizing is sufficient to handle the flow. The channels converge into the detention pond. The detention pond must be sufficiently large to detain the storm until it can be released at the pre-development rate. The outflow is controlled first by the orifice. The orifice size is one variable which we can vary in our simulations. We will run multiple simulations using different orifice sizes until the pre-construction outflow-stage relationship is achieved.

The Excel spreadsheet will be used to size the sediment forebay. The sediment forebay will collect sediment before it enters the detention pond. The purpose of the sediment forebay is to improve water quality of discharged water. The size of the forebay depends on the volume of sediment leaving the trailer court. This has been determined using the Universal Soil Loss equation. The soil type, slope, rainfall, and landuse are all important factors. These parameters have been determined as well as particle size and settling velocity. The settling velocity determines the length required for sediment deposition. The sediment forebay will be located directly before the detention pond.
HEC-1 modeling of Stormwater management System in Pine Ridge

Determine runoff volume from site

Split up site into subbasins based on channel locations

Input: Drainage area of each basin, Rainfall pattern, Rainfall data, Soil type

Detention pond sized to prevent flooding from design storm and conveyance channels to carry flow to pond

Input: Channel length, Elevation and slope, Channel material

Excel Spreadsheet modeling of sediment forebay shape and size required

Input: Soil type, Slope length and angle, Drainage area, Landuse factor

Settling velocity and soil erosion calculated. Determines length for settling and volume of storage required