Chapter 5

Drainage

The three most important elements in good track are: #1 Drainage, #2 Drainage and #3 Drainage – Darrell Cantrell, Engineer Track (Retired) BNSF

Drainage is the subject of stormwater behavior as it relates to the properties of hydrology and hydraulics. This is a subject that is constantly being reviewed on a regular basis within the regulatory bodies of government and it is therefore always important to review local requirements to guide the engineer through the design process. Even though one method of analysis may be appropriate to use in an area one feels comfortable in, it may not be appropriate in another location. A good rule of thumb is to contact the local highway department as a starting point and continue your investigation to local authorities. The other primary source for the Engineer is the AREMA Manual for Railway Engineering, Chapter 1, Parts 3 & 4.

The engineer needs to be aware that one has to maintain existing drainage patterns and not increase headwaters upstream or downstream. Adjacent property owners, whether they are farmers or city dwellers, have certain rights and are protected under common law concerning storm water conveyance and elevation as it relates to property damage.

5.1 Hydrology

For the purposes of this Guide, Hydrology will be defined as the study of rainfall events (inches or inches per hour) and runoff (cubic feet per second) as related to the engineering design of conveyance features such as ditches and culverts. These conveyance features are typically designed to a particular storm event or storm frequency. In other words, a storm water conveyance feature is going to be associated with a certain amount of risk with respect to failure. For instance, a 100 year storm return period has a 1% probability of occurring in any given year, a 50 year storm has a 2% probability of occurring in any given year, and a 10 year storm has a 10% chance of occurring in any given year. So it is up to the designer to assign a certain amount of

5.3 Recommended Procedures

5.3.1 Existing Drainage Study

Before proceeding with the design of the project, it should be realized that it is always important to visit the actual project site and identify problems that may be encountered. Existing culverts always seem to be a problem and should be looked at carefully. Examples of potential problems include excessive ditch scouring and constant ponding of water along a ditch system. Railway ditches are typically very flat and do not drain well. However, the designer should always review the situation as if there is a solution. If it is economically feasible to remedy the situation, then the area should be regraded and repaired to what is recognized as common engineering practice.

Below is a recommended approach to an existing consistent drainage study:

- Utilize a USGS Quadrangle Map or a Hydrologic Atlas (HA) for the area.
- Plot existing and proposed railway right-of-way.
- Identify floodplain and floodway boundaries.
- Identify watershed areas based upon contour interpretation.
- Identify existing bridges, culverts and problem areas.
- Identify sheet and concentrated flow.
- Identify closed drainage systems.
- Select outlet points for each watershed area.
- Select the proper hydrology criteria (i.e. rainfall, frequency, formula, etc.).
- Calculate or run the model and assign flow rates to each of the watersheds.
- Add flow rates and hydrographs, as necessary, to determine proper flow through the watershed.
- Select the proper hydraulic method to determine storm water elevations.
- Conduct a plan-in-hand field review.

Remember the existing drainage study is the benchmark study on which all proposed drainage features are based.

5.3.2 Proposed Drainage System

The proposed drainage system typically addresses impacts to an existing man made or natural drainage system from a proposed improvement. This can take the form of new ditches and culverts or it can take the form of improving existing problem areas. Keep in mind that any improvement to an existing drainage system will more than likely affect surrounding drainage patterns and elevations on adjacent or downstream properties. For example, increasing the size of an existing cross culvert introduces more storm water flow rate to downstream property owners. The designer should determine whether this situation is going to present a problem.

Below is a recommended approach to the design of a proposed drainage system:

- Complete and review the existing drainage study.
- Superimpose the proposed improvements on a copy of the existing drainage study map.
- Locate new drainage features such as ditches, bridges and culverts.
- Are there floodplain and wetland impacts?
- Never relocate an existing outlet point unless it is absolutely necessary.
- Try to maintain existing watershed limits (sometimes these do change).
- Calculate the new hydrology for the watershed.
- Calculate the new hydraulics for the watershed.
- Compare the new data with the existing data at the same points.
- Initiate Permitting process.

For adjacent properties, it is ideal to obtain the same results between existing and proposed conditions and it may take a few iterations to obtain those results. Sometimes it is impossible for this to occur. By studying the upstream and downstream effects, the designer may be able to apply a certain amount of change that does not harm or cause damage to adjacent property owners. For example, a 0.1' or a 0.5' increase in headwater may be acceptable, or a 5% increase in flow velocity may be acceptable if the surrounding soil conditions are tolerable. There may be more

considerations to review. However, this is dependent upon the conditions and regulations unique to that project location.

5.3.3 Floodplain Encroachment Evaluation

The floodplain is identified by criteria established by the Federal Emergency Management Agency (FEMA) for the 100-year and 500-year storm events or known depression flood prone areas. Typically, the 100-year base flood elevation is the most commonly regulated stormwater elevation associated with rivers, streams and concentrated flow areas. FEMA, State Water Resource Departments, counties and local communities (that are part of the National Flood Insurance Program) closely monitor flood plain areas. Any change to the flood plain will generally result in extensive studies and computer modeling to be submitted for approval.

Below is a summary of possible floodplain permitting reviews.

FEMA:

- Physical Map Change (Extensive Floodplain Revisions)
- Letter of Map Revision (Typical Floodplain Revisions)
- Conditional Letter of Map Revision (Typical Floodplain Revisions done in the design phase)
- Elevation Criteria (Typically for building structures)

US Army Corps of Engineers:

- Excavation below normal water elevation

State Water Resource Department:

- Floodway (Area within a floodplain that demonstrates conveyance)

County (Some counties may not be involved in the review process):

- Floodplain
- Floodway
- Compensatory Storage (Excavation required to compensate for floodplain filling)
- Elevation Criteria (Typically for building structures)