DRAINAGE REVIEWS
HOW TO DO THEM AND WHAT TO LOOK FOR
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GOAL

Help agencies identify frequent drainage design mistakes in order to improve reviews and—in turn—help reduce loss of life and property.
GENERAL CONSIDERATIONS

TYPICAL SUBMITTAL REQUIREMENTS
- Narrative Report
- Tables
- Exhibits
- Hydrologic calculations
- Hydraulic calculations
- Engineering models
- No Adverse Impact Statement

- Setting up a drainage specific submittal checklist can ensure all information needed for the drainage review is provided.
- Ensure nothing is left out the report. Don’t assume you can open the model in the future.

DRAINAGE CRITERIA
- Design as well as study methodology and calculations must follow drainage criteria requirements.
- Avoid engineering for the designer.
- Ensure criteria is continually updated to reflect latest information, practices, and technology.

- Can your comments be backed up by the criteria?
- Is the criteria up-to-date and thorough enough to facilitate your review?

- Have entire engineering team READ the criteria and be familiar with it.
- Ask questions prior to submitting when different challenges arise.
- Provide documentation for variance requests.
GENERAL CONSIDERATIONS

ADVERSE IMPACTS
- Water Surface Elevation change < 0.00'
- Increase in flow rate leaving site
- Changes in flow patterns / velocities
- Changes in runoff volume?
- Use of runoff / floodplain storage
- Specifics vary by region / entity
- Master planning and phasing

- Clear documentation of impacts with drainage regulations
- Review models to check no adverse systemic and factors

Reviewers: Engineers:

GENERAL CONSIDERATIONS

MODELING VS DESIGN
- Drainage model should match what is shown in the preliminary or final design
- The modeling results should match the intent of the design
- Design is changed due to observed field conditions

- Clear documentation of model assumptions and simplifications within the drainage report
- Design is changed due to observed field conditions

Reviewers: Engineers:

DRAINAGE CONSIDERATIONS
DRAINAGE CONSIDERATIONS

HYDROLOGY
- Hydrologic methodology varies by watershed size and needs
  - Peak flow rates = used for conveyance system design
  - Hydrographs = used for routing or large basins
  - Sensitive to Infiltration and Time of Concentration changes
  - Pre-project to Post-project consistency is important
  - Check methodology used against criteria
  - Ensure hydrograph method is being used if complicated routing or wet weather conditions exist
  - Ensure consistency pre to post

ONSITE CONVEYANCE SYSTEMS
- Storm sewer, inlet, roadside ditches, etc.
- Design storm is typically contained within drainage easements, roadway, or within underground systems
- Extreme event (100-yr event) should be kept within public ROW and drainage easements
- Excessive ponding should be avoided (need to ensure emergency vehicles always have access)
  - Has inlet capacity been calculated?
  - How is the extreme event being handled properly?
  - Is the starting WSEL correct?
  - Adequate maintenance access?

DETENTION
- Impervious vs. Floodplain Mitigation = Keep Separate!
- Impervious Detention Rates = 0.45 – 0.75 ac-ft
  - Simple Approach vs Routing
  - Beat the Peak
  - Public Perception
  - Does the detention rate make sense?
  - Who is going to maintain?
  - Is the tailwater assumption correct?
  - Consider public perception

Floodplain mitigation and detention mitigation cannot overlap!
DRAINAGE CONSIDERATIONS

OUTFALLS
- Outfalls of prospective detention and drainage facilities impacting property if not designed properly
- Point discharge vs. sheet flow
- Private vs. Public Property
- Public Perception
- Erosive velocities into the downstream channels
- Sizing typically dependent on pre-project flow rates (important!)  

- Consider all aspects of impacts: velocities, erosion, discharges, flow patterns
- Is the tailwater assumption correct? (critical)
- Attempt to drain to public right of way
- Is it back how you fixed it?

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DRAINAGE CONSIDERATIONS

MAJOR CHANNELS
- Trapezoidal geometry is standard
- Concrete vs. Grass
- Low-flow pilot channel
- Can result in loss of floodplain storage
- Can result in increased flow rates downstream
- Potential environmental impacts
- Benching becoming more common: preserve impacts to floodplain storage and environment

- Is floodplain storage being removed?
- What are downstream impacts?
- What are environmental impacts?
- Can natural conditions be preserved? (park, trails, etc.)
- Was benching considered?

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DRAINAGE CONSIDERATIONS

CULVERTS
- Boxes or pipes
- Concrete vs. Plastic
- Design storm (or 100-year)?
- High headlosses
- Change in velocity cause erosion and sedimentation

- Do high head losses cause impacts to neighboring properties?
- How high will the road carry?
- Is erosion being taken care of?
- Are design assumptions correct?
- What's going on downstream (TW)?
- Concrete pipes are not the most the most flash proof than plastic

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DRAINAGE CONSIDERATIONS

TAILWATER
- During the end of the modeling should account for tailwater impacts of receiving channels
- Tailwater can affect the size of channel/detention/ulvert
- Size of receiving system should be considered. Joint probability for large drainage area differences
- Static or variable (modeled)?

Annotations:
- Criteria should include guidance on anticipated downstream conditions
- Top of Pipe, static WSEL, or variable WSEL?
- Is your pond filling up too soon by TW?

DRAINAGE CONSIDERATIONS

MAINTENANCE
- Regulations based on width and slope are often driven by the ability of the maintenance crews to access the sites
- Widths are required to get equipment on the site
- Variances are often wanted to maximize space within the property

Annotations:
- Coordinate with maintenance groups to understand complications of the variances
- Have maintenance crews review criteria and recommend changes
- Coordinate with maintenance groups to understand complications.
- Follow maintenance driven criteria and avoid "shortcuts"

DRAINAGE CONSIDERATIONS

OFFSITE FLOWS
- Property adjacent to the proposed development may drain through the development
- Offsite flow should be accounted for with the design of local roads
- Homebuilders typically do not consider offsite drainage when bringing in fill for houses

Annotations:
- Verify offsite flow patterns with topographic maps
- Existing drainage along not exactly match the proposed parcel area (generally inaccurate)
- Summarize the offsite flows to ensure no impacts or from the development
- Discuss how the drainage infrastructure incorporates offsite flow within the report

Reviewers:
Engineers:
DRAINAGE CONSIDERATIONS

FLOODPLAIN
- Floodplain Regulations
- Conveyance (Upstream Impacts) ~ 0 rise
- Storage (Downstream Impacts) ~ 1:1 mitigation
- Steady (conveyance) vs Unsteady (conveyance and storage) Modeling
- Drainage Impact Analysis ~ H&H Modeling
- GSLIM vs LOMR
- FEMA

Questions:
- Is a floodplain permit required?
- Will a CLOMR or LOMR be required?
- Is the modeling appropriate?
- Is fill being mitigated?
- Can natural conditions be preserved? ~ Park, trails, etc.
- Consider both upstream and downstream impacts.
- FEMA and FPA regulations?

CONCLUSION

KEY TAKEAWAYS
- Start with big picture questions and move into the details.
- Before getting into the model review, does the overall approach make sense?
- Do the assumptions make sense?
- Are there "red flags" or "oddities"?
- Do the results fit within typical ranges (e.g., detention rate greater than 0.45 ac-ft/ac)?
- Focus on the critical pieces of the design.
- Don't forget to consider the entire project life (construction and maintenance as well as phasing).
- Be familiar with the latest modeling software ~ technology is rapidly changing!
- Regulatory criteria is your primary support ~ it's important to keep it up-to-date!

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