PDN Stage 2HY2 – Hydraulics QC Checklist

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| **SPOT ID/Project TIP #:** | Click or tap to edit. |
| **County:** | Click or tap to edit. |

2HY2: Drainage Design for Field Inspection

Deliverables: Drainage Plans for Merger CP4B Meeting and Minutes

Drainage Plans for Field Inspection

Railroad Drainage Submittals

| **Item #** | **Review Item** | **Yes** | **No** | **N/A** |
| --- | --- | --- | --- | --- |
|  | **Guidelines** |  |  |  |
|  | Current version of [Guidelines for Drainage Studies and Hydraulic Design](https://connect.ncdot.gov/resources/hydro/Pages/DrainageStudiesGuidelines.aspx) (Guidelines) used to complete redline drainage design |  |  |  |
|  | All pipes on project designed in accordance with the [NCDOT Pipe Material Selection Guide](https://connect.ncdot.gov/resources/hydro/Pages/DrainageStudiesGuidelines.aspx) |  |  |  |
|  | Redline drainage design completed to meet the guidance set forth in [Post-Construction Stormwater Program Manual](https://connect.ncdot.gov/resources/hydro/Pages/Highway-Stormwater-Program.aspx) |  |  |  |
|  | Stormwater control measures are designed to the standards and specifications described in the [BMP Toolbox Manual](https://connect.ncdot.gov/resources/hydro/Pages/Highway-Stormwater-Program.aspx) |  |  |  |
|  | Hydraulics Unit resource page referenced for new bulletins and other guidance |  |  |  |
|  | **Field Visit and Hydraulic Surveys** |  |  |  |
|  | Field visit completed in accordance with Chapter 5 of the Guidelines for Drainage Studies and Hydraulic Design |  |  |  |
|  | Drainage Design Field Investigation Checklist from Chapter 5 of the Guidelines is completed. |  |  |  |
|  | Photos taken with locations and direction identified. |  |  |  |
|  | Field interviews conducted for flood history, existing drainage patterns, etc. |  |  |  |
|  | Existing drainage problems have been adequately documented (notes and photos) |  |  |  |
|  | Apparent discrepancies in jurisdictional features between those as noted in the NRTR and as observed in the field have been coordinated with the Project Manager and Environmental lead. |  |  |  |
|  | **Wetland and Jurisdictional Features** |  |  |  |
|  | Correct location and surveys line style shown for JS linework and not the NEU line style. |  |  |  |
|  | Top of Banks shown for channels at all major drainage structures, and all jurisdictional streams where riparian buffer rules apply. |  |  |  |
|  | All rip rap has been drawn to scale in wetlands and jurisdictional streams. |  |  |  |
|  | Pipes are not buried in wetlands |  |  |  |
|  | Equalizer pipes have been used where needed. |  |  |  |
|  | All ditches discharging directly into or near wetlands have a V10 equal to or less than 2 fps. |  |  |  |
|  | Adequate ditch length (100’ per acre) is provided to provide swale treatment for ditches prior to entering riparian buffers. |  |  |  |
|  | Pipe depths in jurisdictional features are in conformance with Chapter 9 of the Guidelines. |  |  |  |
|  | Buffer zones are drawn correctly. Buffer zones drawn using TB or High Water Line (HWL) or Normal Water Line (NWL) in CAMA counties with 30’ offset for BZ1 and 20’ offset for BZ2 from BZ1. Correct offsets maintained through bends and acute angles. |  |  |  |
|  | **Drainage Plans for Merger CP4B Meeting and Minutes** |  |  |  |
|  | Concurrence Point 4B Meeting is complete; Draft and Final Meeting Minutes have been prepared and distributed |  |  |  |
|  | **Redline Drainage Designs for Field Inspection** |  |  |  |
|  | **General** |  |  |  |
|  | Drainage design conforms to agreed design assumptions and direction from Hydraulics Pre-Design Meeting, and the pSMP, with any deviations documented |  |  |  |
|  | Drainage design meets or exceeds existing performance/level of service |  |  |  |
|  | Design appears to meet all anticipated environmental permitting requirements, PCSP requirements, and implements avoidance and minimization measures to the maximum extent practical. |  |  |  |
|  | Location of pipe end treatments and rip rap in roadside ditches are appropriate for the clear recovery zone of the roadway classification |  |  |  |
|  | For any required HEC-RAS modeling, the HEC-RAS checklist for the Hydraulic Survey Reports was followed and completed. |  |  |  |
|  | **Existing Drainage Patterns** |  |  |  |
| 1. .6 | Existing drainage patterns are complete and sufficiently marked in accordance with Items to Include on Redline Drainage Plans in Chapter 5 of the Guidelines |  |  |  |
| 5.7 | All existing drainage items identified in Items to Include on Redline Drainage Plans are included. |  |  |  |
| 5.8 | LiDAR used to supplement project survey generated contours as needed to close out drainage areas. |  |  |  |
| 5.9 | Photos taken as needed to document pre-project conditions, particularly where existing drainage problems exist, and areas with high risk of drainage complaints (ex. drainage outlets, etc.). |  |  |  |
| 5.10 | Existing drainage problems have been evaluated, and proposed drainage design attempts to remedy those that may be considered the responsibility of NCDOT, in consultation with Division/Project Manager/Hydraulics Unit. |  |  |  |
| 5.11 | Proposed drainage design maintains existing drainage patterns. No diversions present in design. |  |  |  |
|  | **Inlet and Spread Computations** |  |  |  |
| 5.12 | SBG called for where warranted and in consultation with Division due to guardrail placement, steep slopes, close proximity to high value resources, etc. At a minimum, locations with 2 or more lanes draining to a shoulder point with guardrail need SBG. |  |  |  |
|  | Spread designed to meet criteria listed in Chapter 10 of the Guidelines |  |  |  |
|  | Absolute intensity of 4 in/hr used to calculate spread for pavement inlets along roadway alignment. Yard, ditch, and pipe inlets have been computed using true intensity based on appropriate time of concentration for anticipated future land use for the 10 YR storm. |  |  |  |
|  | Bypass has been checked at intersections, ends of medians, and raised islands, shoulder berm gutter, and rollovers. Max bypass is 0.1 cfs from a 4 in/hr storm throughout the design. Protection added where appropriate for bypass at end of curb runs. |  |  |  |
|  | Correct bypass assignments used. |  |  |  |
|  | Appropriate Tc values used for inlet computations |  |  |  |
|  | Depth of flow for structures in ditch lines and DIs used as yard inlets reported in remarks columns of the inlet comp sheet. |  |  |  |
|  | Appropriate future development used to determine C values. |  |  |  |
|  | Confirm greatest spread (left/right or sag) reported at sag locations (checked at min .003 ft/ft grade) |  |  |  |
|  | Super rollover locations have been checked for spread, hydroplaning potential, and bypass issues. |  |  |  |
|  | Correct structure type (both box and frame & grate) used (Type 2GI-A used for greater than 24” pipe in narrow side of structure). Traffic bearing structures used for any box within 4’ of the travel lane. |  |  |  |
|  | **Bridge Spread for Grade Separations** |  |  |  |
| 5.22 | Bridge spread checked. If deck drains required, correct spacing has been used based on structure type |  |  |  |
|  | Spread calculations and any deck drain requirements are shown on the redline drainage plans for bridges that do not require a hydraulic structure report. |  |  |  |
|  | Correct type and size of deck drain used (rectangular slots for cored slab/box beam and circular openings for girder) |  |  |  |
|  | Deck drains avoided over railroad ROW, sidewalks, and travel lanes for grade separated crossings |  |  |  |
|  | If bridge contains a crest, spread has been checked in at least 10 ft increments up to 50 ft from either side of crest. |  |  |  |
|  | No drainage structures are in the approach slab. |  |  |  |
|  | Structures lead has been informed of deck drain requirements for bridges |  |  |  |
|  | **Storm and Pipe Computations** |  |  |  |
| 5.29 | Time of concentration values are reasonable. Shorter systems should not exceed 10 min Tc values. |  |  |  |
|  | At least 0.5’ of freeboard is obtained throughout system. If 0.5’ of freeboard not practical, provide justification if the top elevation of the structure used for freeboard in remarks column. |  |  |  |
|  | For sags without relief the appropriate 25 YR or 50 YR storm has been analyzed. |  |  |  |
|  | Standard depth boxes used to maximum extent practical |  |  |  |
|  | Systems have been reviewed to remove extra-deep structures where practical. MHs used where boxes deeper than 12’ are required. |  |  |  |
|  | Pipe crowns matched for system calcs. |  |  |  |
|  | Correct pipe material used per the [NCDOT Pipe Material Selection Guide](https://connect.ncdot.gov/resources/hydro/Pages/Guidelines-Drainage-Studies.aspx). Concrete pipes not used for slopes greater than 10% unless pipe is anchored by drainage box on downstream end. Appropriate metal pipe (CSP or CAAP) used for slopes greater than 10%. |  |  |  |
|  | System pipes crossing alignments at heavy skews have been avoided to the maximum extent practicable |  |  |  |
|  | Pipes acting as trunk lines or under C&G have been kept out of the travel lane. CBs or other structures have been added as needed to avoid pipe deflection. |  |  |  |
|  | User supplied discharges avoided. Base area linked to node as required for upstream, offsite system flow. |  |  |  |
|  | Sealed systems called for in all areas with contaminated soils. |  |  |  |
|  | Drop boxes or other measures implemented to reduce excessive outlet velocities as practicable. |  |  |  |
|  | Pipes to be retained have been video-inspected where appropriate. |  |  |  |
|  | **Channel and Ditch Designs** |  |  |  |
| 5.42 | Proposed ditches have equal or greater capacity then existing ditches |  |  |  |
|  | Adequate depth provided in ditch design to drain subgrade in cuts and/or provide adequate freeboard in fills. |  |  |  |
|  | Calculations provided for all ditching |  |  |  |
|  | Ditches evaluated for shear stress with appropriate liner shown based on current guidance |  |  |  |
|  | Ditch detail provided for all ditches and channel relocations. Stationing provided in detail matches plan view, XSC, and profile |  |  |  |
|  | The minimum depth provided on details meets the requirements determined by the ditch computations |  |  |  |
|  | Ditches in plan view drafted correctly based on [Roadway Ditch Drafting Guidelines](https://connect.ncdot.gov/projects/Roadway/Training/Forms/AllItems.aspx#InplviewHash3e046438-e7e9-4e31-ae46-4b74fe70b60b=) and labeled appropriately with quantities. |  |  |  |
|  | All ditches begin/end stations tie to existing or proposed ground elevations. |  |  |  |
|  | All ditches plotted in profiles with beginning and ending stations and correct slope |  |  |  |

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|  | All ditches plotted in XSC with correct front slopes, backs slopes, and inverts shown. XSCs match ditch detail for station range. |  |  |  |

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|  | **Pipe Data Sheets** |  |  |  |
| 5.52 | Information shown on PDS matches information shown on redline plans and the Hydraulic Computation Blocks on the profiles. |  |  |  |
|  | PDS inlet and outlet control information reflective of methodology used (HDS-5, HY-8, etc.) |  |  |  |
|  | Drainage area delineations have been checked |  |  |  |
|  | Appropriate design storm used. Correct HW elevation and HW control feature (1.5 below shoulder point, controlling site feature, etc.) used. |  |  |  |
|  | The greater of calculated TW or (dc+d)/2 has been used for outlet control calculations |  |  |  |
|  | PDS contains TW computations. |  |  |  |
|  | Elevations shown on the PDS are clearly reflected in the plans. |  |  |  |
|  | Buried depth and buried elevation noted along with clear distinction that PDS based on effective hydraulic opening |  |  |  |
|  | Minimum cross pipe size used is 18” |  |  |  |
|  | Appropriate hydraulic method used (Rational, USGS regression equations, etc.) with future land use considered. Stream Stats verified by other method. Calculated Qs used on PDS. |  |  |  |
|  | Tc calculations provided for non-standard Tc values (typically larger than 10 min.) |  |  |  |
|  | Appropriate pipe material and Manning’s n value used. |  |  |  |
|  | PDS completed for all cross pipes crossing an alignment (including those part of a system) with the appropriate design frequency used and pipes are not excessively oversized. |  |  |  |
|  | Correct overtopping location and elevation used. Correct overtopping feature noted on PDS. |  |  |  |
|  | If cross pipe in basin or ditch with another cross pipe, HWs have been balanced between cross pipes. |  |  |  |
|  | Appropriate class of pipe and outlet protection identified under Recommended Structure. |  |  |  |
|  | **Outlet Analysis** |  |  |  |
| 5.68 | Outlet analyses (pre/post) performed for all drainage outlets. Measures/corrective actions taken to minimize impacts to adjacent property where appropriate. |  |  |  |
|  | Required easement for future maintenance of measures/corrective actions is shown. |  |  |  |
|  | **Stormwater BMPs** |  |  |  |
| 5.70 | Acceptable design criteria met using the current version of the [NCDOT Stormwater BMP Toolbox](https://connect.ncdot.gov/resources/hydro/Pages/Highway-Stormwater-Program.aspx) |  |  |  |
|  | For each BMP on project, Hydraulic lead has completed appropriate checklist from Appendix A of the BMP Toolbox |  |  |  |
|  | All BMPs requiring grading work have a grading plan provided in submittal with slope stakes and proposed contours. All basins also have a North and South & East and West cross section of the basin in addition to grading plan |  |  |  |
|  | A minimum 10’ ROW or PDE is provided around all BMPs. |  |  |  |
|  | BMPs are constructed in cut to the maximum extent practicable. If not in cut, berms and embankments are in accordance to Section 2.3 of BMP Toolbox. |  |  |  |
|  | Access way in the post construction phase is provided to BMPs for maintenance equipment. |  |  |  |
|  | Grassed Swale designated BMPs are within regular mowing limits for maintenance operations |  |  |  |
|  | All pre and post values are reasonable for routing calculations |  |  |  |
|  | Outlet control structure elevations are appropriate, and BMP will function as designed. This includes orifices and underdrains, the top of structure serving as the secondary orifice, and the emergency spillway. |  |  |  |
|  | Anti-seep measures are provided for outlet pipes protruding through fill sections |  |  |  |
|  | For infiltration basins, correct soil conductivity is used based on provided geotechnical borings |  |  |  |
|  | Seasonal High Water Table noted on plans. If SHWT will cause detention basins to be inundated with groundwater, calculation takes starting water surface elevation into account when determining capacity. |  |  |  |
|  | Seasonal High Water Table has been compared to elevation of underdrain outlet for all media filters (bio-retention, filtration, or swales). Design will not drain groundwater or create “boulevard” ditching |  |  |  |
|  | Stormwater wetlands will maintain minimum water levels through interception of water table or constant source of water to survive drought conditions. |  |  |  |
|  | If any temporary erosion control basins were converted to permanent post-construction stormwater BMPs, the design complies with NCDOT’s guidance for Co-Located Erosion Control & Post-Construction Stormwater Control Facilities |  |  |  |
|  | **Field Inspection Plan Set Production** |  |  |  |
| 5.85 | Redline drainage plans produced in conformance with [NCDOT’s Compliance Documentation Workflow for Rule 15A NCAC 04B .0109](https://connect.ncdot.gov/resources/hydro/Pages/Guidelines-Drainage-Studies.aspx) |  |  |  |
|  | All drainage items have been incorporated into the roadway plan set, drafted correctly, and are clearly visible. |  |  |  |
|  | Ditch elevations and pipe outlet elevations are in agreement |  |  |  |
|  | 36” and larger pipes have headwall perpendicular to pipe |  |  |  |
|  | Outlet protection on pipes 36” and larger is at least Class I Rip Rap |  |  |  |
|  | Adequate ROW, TDE, and PDE shown. |  |  |  |
|  | Max slopes shown on cross sections agree with Geotechnical recommendations. |  |  |  |
|  | Existing ponds wholly or partially within proposed R/W are indicated on plans to be either drained or filled in (to the R/W line at a minimum) such that no ponds remain within NCDOT proposed R/W. |  |  |  |
|  | Items that appear on multiple sheets or at sheet cut lines are labeled on each sheet |  |  |  |
|  | Redline Drainage Plans posted to SharePoint with notification given to Project Manager |  |  |  |
| **6** | **Field Inspection Meeting** |  |  |  |
| 6.1 | Field inspection plan set reviewed by Hydraulics engineer to determine any potential conflicts with other Alignment Defined (Stage 2) tasks |  |  |  |
| 6.2 | Information required to complete environmental permit drawings has been obtained, such as amount and type of clearing required and construction methods and impacts required for construction of major drainage structures (e.g., temporary work bridges, causeways, and work pads). |  |  |  |
| **7** | **Railroad Coordination** |  |  |  |
| 7.1 | Field inspection comments incorporated into drainage plans |  |  |  |
| 7.2 | Proposed drainage inside of railroad right of way meets the railroad company’s applicable drainage design standards. |  |  |  |
| 7.3 | An outlet analysis has been completed where warranted using the railroad’s design storm event (e.g. 100 yr.) and NCDOT design events (2 yr., 5 yr., 10 yr.) |  |  |  |
| 7.4 | Redline drainage plans, calculations, and any other pertinent drainage information submitted to the project manager. |  |  |  |

*For items marked* ***No*** *that require further explanation, provide comments or action items in the table below.*

| **Item #** | **Comments and Action Items** |
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| Click to edit. | Click to edit. |

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| **This checklist may not be comprehensive to every project. All items may not be applicable for smaller projects. It is the responsibility of the reviewer to ensure that all necessary information has been provided and an adequate review performed.** | | | |
| **QC Reviewer Name:** | | Click to edit. | **Date:** | Click to edit. | |
| **QC Reviewer (Signature):** | |  |  |  | |