

DRAFT ENGINEERING REPORT

Recurrent Flooding Issues

FOR

**THE TOWN OF CARRBORO
PUBLIC WORKS DEPARTMENT**



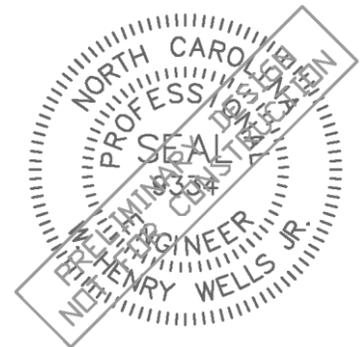
Rainbow Drive on June 30, 2013

PREPARED BY:

SUNGATE DESIGN GROUP, P.A.



915 JONES FRANKLIN ROAD
RALEIGH, NORTH CAROLINA 27606
TEL (919) 859-2243 FAX (919) 859-6258
ENG FIRM LICENSE NO. C-890



Recurrent Flooding Problems in Carrboro

On June 30, 2013 heavy rainfall caused significant flooding in many areas of Carrboro. In response to the flooding, six areas were identified that were subject to recurrent flooding complaints and therefore warranted further study to identify potential causes of the flooding and available mitigation measures. The areas identified were Tom's Creek, Old Pittsboro Road, Morningside Drive, Broad Street, 1020 West Main Street and streambank erosion on Morgan Creek and an unnamed Tributary to Morgan Creek at the Public Works facility. The Public Works Department commissioned Sungate Design Group to initiate Preliminary Studies in 2014 which included Hydrologic/Hydraulic analyses, interviews with affective property owners, possible mitigation efforts and associated costs. The studies were completed in August, 2014, and the results were presented to the Board of Aldermen on May 19, 2015. On December 23 and December 30, 2015 Carrboro again experienced heavy rainfall which produced flooding in the aforementioned six areas previously studied and also in other areas of Town including Robert Hunt Drive (which is downstream of Morningside Drive), Rocky Brook Mobile Home Park, 207 Oleander Drive, Piedmont Health Center, 111 B Pine Street and Morgan Creek Streambank failure near 404 Manor Ridge Drive. An update on the most recent flooding on Tom's Creek was presented to the BOA on January 12, 2016 and discussion ensued regarding Tom's Creek and the other flooded areas. The BOA expressed concern that mitigating flooding problems at one specific location in the stream could cause flooding problems elsewhere downstream since the storage created by the flooding problem would be effectively removed. They recommended that Hydrologic analyses be undertaken so that the Town could review and address potential downstream flooding issues prior to authorizing design of flood mitigation projects

The purpose of this report is to evaluate the severity of the flooding problems; propose methods for prioritizing the projects and then recommending associated mitigation issues. First preliminary analyses, including Hydrologic and Hydraulic studies need to be completed on flooding problem areas where necessary. This will enable an evaluation of both up and downstream effects of the all mitigation alternatives. After the studies have been completed, project priority then needs to be established based on damage assessment, number of properties affected, estimated cost of proposed mitigation measures and frequency of flooding. Finally, methods for project financing need to be evaluated including creation of a Stormwater Utility, increased tax rate, available state and federal grants, property assessments, issuance of bonds or other available funding.

Flooding Projects Identified After June 30, 2013 Storms

Tom's Creek

Since 1982, flooding along Tom's Creek during Hurricanes, Tropical Storms and heavy localized storms which caused damage to existing structures have been reported. The latest flooding events were a localized rainfall event in June of 2013 and two other events in December of 2015. Over the years, numerous studies have been conducted by Carrboro staff, the US Army Corps of Engineers and others in an effort to abate the flooding problem. To date, none of the potential solutions have been implemented due to either environmental concerns or funding issues. Tom's

Creek has recently been included as a FEMA designated stream with a Base Flood Elevation (100-year) established. The FEMA study was used in the preliminary analysis prepared by Sungate which was limited to the area between West Main Street and Rainbow Drive. The FEMA study is also limited to effects of the 100-year storm and does not address other frequency storms or downstream affects caused by upsizing a culvert. The program does not account for passive or designed impoundments within the watershed. There are four road crossings on Tom's Creek which create backwater and therefore, have exacerbated flooding to various degrees due in part to culverts which are now undersized based on current standards. Below are several alternatives that were investigated as part of the preliminary CIP study dated 8/7/14:

1. West Main Street – West Main Street is an NCDOT road. Increasing the culvert size would not mitigate flooding problems. Even removing the culvert and the existing road fill in its entirety would not remove flooded structures from the floodplain.
2. Lorraine Street - There is currently a 66" pipe under Lorraine Street on Tom's Creek. The pipe is in poor condition with a corroded invert and sectional deformity likely caused by structural overload. The culvert currently causes backwater in the 100-year storm event which causes Lorraine Street to overtop. If the pipe size were to be increased to a 96" RCP, the 100-year water surface elevation would be lowered so that 400 Lorraine, 204 James, 206 James and 208 James would be removed from the 100-year flood plain.
3. Carol Street - There are 2 @ 36" pipes currently under Carol Street on Tom's Creek. The culverts currently cause backwater in the 100-year storm event which causes Carol Street to overtop. If the pipe were to be upsized to a 72" RCP, the 100-year water surface elevation would be lowered so that 116 Carol, 118 Carol and 300 James would be removed from the 100-year flood plain.
4. Rainbow Drive – There are 2@ 30" pipes currently under Rainbow Drive on Tom's Creek. The culverts currently cause backwater in the 100-year storm event which causes Rainbow Drive to overtop. If the pipe were to be upsized to a 72" RCP, the 100-year water surface elevation would be slightly lowered; however no dwellings would be removed from the 100-year flood plain. This is due to the fact that the existing elevation of Rainbow Drive at the culvert is considerably lower than either Carol or Lorainne; and therefore, overtopping of the road occurs earlier in the storm event. Once the road is overtopped the elevation of the flood increases much slower since the conveyance over the road is much greater than through the culverts.

There were no field surveys undertaken during the Preliminary Study so no verification of the information in the FEMA model was performed.

It is recommended that a full Hydrologic/Hydraulic analysis in the watershed be undertaken. The HEC RAS model is already available from FEMA and can be used for the revisions necessary to evaluate up and downstream effects caused by single or multiple revisions to the size of the culverts and/or grade changes at the road locations. The Hydrologic analysis will be completed using HEC HMS modeling program which was also created by the US Army Corp of Engineer. This model allows input for existing land use and impervious area or proposed zoning.

Estimate for Hydrologic/Hydraulic analysis including surveys will be \$31,500.00. This does not include final plan preparation, environmental permitting, final surveys or CLOMR and LOMR preparation.

Old Pittsboro Road

In August, 2000, It was reported by a property owner on Old Pittsboro Road that stormwater from recent rainfalls had overtopped the ditch at her drive pipe and washed through her yard causing erosion on her property. There was no flood damage to the dwelling or any utilities or ancillary structures located on the property. On July 30, 2013 we received photos showing flooding on property, 100 Carr Street, at the intersection of East Carr Street and South Greensboro Street. The reported flooding was likely caused, in part, by the inadequate size of the storm drain outlet system under South Greensboro Street. It was also reported that stormwater flow from the Old Pittsboro Road ditch overtopped the ditch and flooded the road. Flooding in Old Pittsboro Road had been reported on several other occasions between 2000 and 2013. Below are several alternatives that were investigated as part of the preliminary CIP study dated 8/7/14:

Alternative #1 would be to construct an adequately sized drainage system within the existing ditch in Old Pittsboro Road from the existing system in South Greensboro Street past 108 Old Pittsboro Road. The proposed system would consist of 60" and 66" pipes along with grated inlets at the drive locations installed in the ditch. Installation of an adequately sized system would eliminate flooding problems on 100 Carr Street and along Old Pittsboro Road.

Alternative #2 would be to construct an adequately sized drainage system (as in Alternative #1 from the existing drainage system in South Greensboro Street under Old Pittsboro Road tying into the exiting ditch beyond 108 Old Pittsboro Road.

Alternative #3 would be to reshape and lower the ditch along Old Pittsboro Road to add more conveyance to the ditch and to facilitate installation of the 60" pipe at the existing junction box in South Greensboro Street as in Alternatives #1 and #2. The ditch would need to be approximately 6 feet deep. This would make the top of the ditch approximately 36 feet wide at the top which would require significantly more Right-of-Way; would require removal of most of the mature vegetation on the north side of the road; would require purchase and removal of an ancillary structure and would closely encroach on two dwellings.

Alternative #4 would be to install a detention facility in the watershed. The site considered for location of the detention facility is the Town owned property at the north corner of South Greensboro Street and Carr Street. An underground stormwater BMP could be installed beneath the proposed building for the site. This could provide significant stormwater storage and possibly cut the peak discharge to levels that the existing ditch and pipe system along Old Pittsboro Road could handle.

It is recommended that no further hydrologic/hydraulic investigation be undertaken at this time. A cursory hydrologic investigation was undertaken at the time of Sungate's Preliminary Study in order to provide a rough cost estimate for the alternatives listed. A detailed Hydrologic Study is not warranted in the matter since the stream discharges into a larger stream just downstream of the project area. Once a decision is made regarding the above alternatives, project surveying, final design and Construction Plans can be completed.

Morningside Drive

The property owners at Lots 103, 105, and 107 Morningside Drive experience periodic nuisance flooding of the land adjacent to Morningside Drive. None of the structures located on the lots have experienced flood damage above the finished floor elevation. However, the flooding does impact the accessibility to the structures located on Lots 103 and 105 when the associated driveways are inundated. There is an existing single 24" RCP under Morningside Drive and according to current Town Standards, it is undersized for the contributing watershed. Based on the calculated peak flow rates, Morningside Drive overtops in less than the 1-year storm event.

According to the Carrboro LUO, this crossing should be sized to handle the 25-year storm event. In order to convey the 25-year storm event without overtopping the roadway, three 30-inch RCP open-end pipes would be required. Multiple pipes would be needed due to limited elevation difference between the channel bed and roadway surface. Storm events greater than the 25-year event, would continue to overtop the existing road. While increasing the number and size of the cross-pipes will reduce the frequency of flooding on the Lots, the low areas on the Lots will still be inundated periodically unless the driveway and parking areas are raised above the elevation of the roadway sag. The pipe under the driveway to Lot 105 will also need to be replaced by the property owners with a larger appropriately sized pipe.

It is recommended that a full Hydrologic/Hydraulic analysis in the watershed be undertaken. Other flooding complaints have been received from property owners downstream of the crossing. The HEC RAS (Hydraulic model) would be created to evaluate up and downstream effects caused by to the size of the culvert and/or grade changes at the road location. The Hydrologic analysis will be done using the HEC HMS model which was also created by the US Army Corp of Engineer. This model allows input for existing land use and impervious area or proposed zoning and takes existing detention into account.

Estimate for Hydrologic/Hydraulic analysis including surveys will be \$24,800.00. This does not include final plan preparation, environmental permitting or final surveys.

Broad Street

During a June 30, 2013 storm, Broad Street was overtopped by flooding and a portion of the downstream embankment was washed away. There is a 24" pipe under Broad Street at this

location. The subject culvert crossing is located near 408 Broad Street. The pipe crossing is located on Tanyard Branch which is a tributary to Bolin Creek. There is no flooding on adjacent properties up or downstream of the 24" pipe which cause damage to any existing structures. Below are several alternatives that were investigated as part of the preliminary CIP study dated 8/7/14:

Alternative #1

The 24" pipe will not pass the 2-year storm based on the proposed zoning conditions in the contributing watershed without overtopping the road. This does not meet the current Town of Carrboro standard for cross pipes. In order to meet current Town of Carrboro standards, which require passage of the 25-year storm, the pipe will have to be upsized to a 54" RCP with a headwall on the inlet end. In addition, the 54" pipe provides enough conveyance so that the road will not be overtopped in the 100-year storm event; thereby, eliminating the slope stability problem.

Alternative #2

Since the road has been rarely overtopped historically and is a dead end road with only five platted properties between the culvert and the end of the road, alternative #2 would be to pave the portion of the road where overtopping occurs and to armor the downstream fill slope with rip rap to prevent erosion of the road structure. Although this would not bring the crossing up to current Carrboro Standards, it would provide for safe ingress and egress after road overtopping has ceased. The maximum overtopping depth in the 100-year storm event would be approximately 1.3 feet. This alternative would require paving approximately 50 feet of the road surface and placing rip rap on approximately 50 linear feet of the downstream fill slope.

It is recommended that no further hydrologic/hydraulic investigation be undertaken at this time. A thorough hydrologic investigation was undertaken at the time of Sungate's Preliminary Study. In addition, the drive culverts and drives downstream of the Broad Street crossing were designed without taking detention provided by the undersized pipe into consideration and therefore should not be affected by enlarging the culvert or stabilizing the existing road fill. Once a decision is made regarding the above alternatives, project surveying and final Construction Plans can be completed.

1020 West Main Street

In April, 2010 the property owner at 1020 West Mail Street reported that his crawl space and his adjacent neighbor's property were being flooded due to back up of stormwater from downstream property, Calvary Baptist Church. Drainage from the 1020 West Main property is conveyed across the Church property in an existing 24" storm system. In December, 2013, the property owner again registered a complaint about his crawl space and shed being flooded by recent rains. He stated that in his opinion, upstream development and associated impervious surface were

causing increased runoff and exacerbating his flooding problems. Below are several alternatives that were investigated as part of the preliminary CIP study dated 8/7/14:

Alternative #1 would be to construct a 3 foot base overflow ditch from the properties to the existing drainage system in West Main Street. The ditch would parallel the access drive to West Main Street and would tie into the existing 42" drainage system in West Main Street. The ditch would be constructed exclusively on the Calvary Baptist Church property. There have been no discussions with the church as to the availability of the property for drainage ditch construction. This alternative and all others will reduce flooding in all storms up to the 100-year below the elevation of the crawl space, HVAC units and the shed. It is not anticipated that there will be downstream impacts since these alternatives tie directly into the existing drainage system in West Main Street.

Alternative #2 consists of replacing a portion of the existing 24" pipe system on the church property with a 3 @ 36" pipe from the properties to the existing storm drop inlet on the church property and then extending the system to the existing driveway and then continuing under the existing access drive to the drainage system in West Main Street. In order for the pipe system to work, the invert at the inlet of the system will have to be lowered by approximately 1.5 feet.

Alternative #3 would combine alternatives #1 and #2 and consists of construction of a 3 foot base ditch from the properties to the outlet of the existing 24" system on the church property and then constructing a new system 2 @ 42" system in the existing shared driveway to tie into the existing system in West Main Street.

Alternative #4 would be to install one or more detention facilities in the watershed. Due to the density of development and the lack of open space, this alternative was not considered to be feasible.

It is recommended that no further hydrologic/hydraulic investigation be undertaken at this time. A thorough hydrologic investigation was undertaken at the time of Sungate's Preliminary Study. Once a decision is made regarding the above alternatives, project surveying and final Construction Plans can be completed.

Town of Carrboro Public Works Facility

During the storm of June, 2013, a large scour hole was created at the outlet of the 8' X 8' Reinforced Box Culvert under NC 54 Bypass on an unnamed tributary to Morgan Creek. The resulting scour hole caused the stream to shift to the west and severely eroded the stream bank along the TOC Public Works Facility. The property line of the Public Works Facility runs down the middle of the stream. The erosive velocities left the banks of the Public Works side of the stream on an extremely steep slope and in an unstable condition. Further erosion could cause damage to a shed and other structures on the Public Works property.

In order to stabilize the eroded bank, the stream will first need to be restored to a more stable geometric pattern followed by installation of non-erosive bank stabilization (Class II rip rap). At

the same time, a suitable energy dissipater will also need to be installed at the outlet of the existing culvert to prevent further stream bank erosion. NCDOT has been contacted, and they agree that simply attempting to stabilize the bank on the Public Works property without installing the dissipater may not prevent further erosion to the stream bank and may also cause erosion of the stream bank on the eastern side of the stream. NCDOT met with the Town to observe the damage and to discuss NCDOT's responsibility for remediation of the problem. Their position was that they would participate in the financing of the streambank stabilization but would need to have temporary and permanent construction easements in place prior to committing funds. Public Works is currently working on the necessary easements.

During the same storm, the stream banks of Morgan Creek suffered significant erosion along the Public Works Property. There is an OWASA sewer line which parallels the bank of the stream and is in close proximity to the stream bank. Continued erosion could compromise the sewer line and increase the sediment load carried by Morgan Creek. Preliminary analysis, design estimates and construction estimates have been submitted to Public Works.

It is recommended that no further hydrologic/hydraulic investigation be undertaken at this time. A thorough investigation was undertaken at the time of Sungate's Study. Once a decision is made regarding the feasibility of both projects, project surveying and final Construction Plans can be completed. It should be noted that lumping both projects together under one construction contract may be cost effective.

Additional Flooding Projects Identified after December Flooding

Robert Hunt Drive

During the December 23, 2015 storm, the property owner at 205 Robert Hunt Drive reported that his property and his adjoining neighbor's property were inundated by flood waters approximately 25 feet wide. These properties are located at the upstream face of the culvert under Robert Hunt Drive. The existing culvert is 3 @ 30" RCP pipe. In addition, the property owner stated that he incurred approximately \$20,000.00 in flood damages due to the June 30, 2013 storm. No previous analysis has been done on this property; however, several observations of the stream up and downstream of the crossing were made by Sungate with the Public Works Department in late 1990 and early 2000. This property is 280 feet downstream of Morningside Drive.

It is recommended that a full Hydrologic/Hydraulic analysis in the watershed be undertaken. Other flooding complaints have been received from property owners downstream of the crossing. The HEC RAS Hydraulic model would be created to evaluate up and downstream effects caused by to the size of the culvert and/or grade changes at the road location. The Hydrologic analysis will be completed using the HEC HMS hydrologic model which was also created by the US Army Corp of Engineer. This model allows input for existing land use and impervious area or proposed zoning and takes existing detention into account. This analysis could be completed in conjunction with the Morningside study.

Estimate for Hydrologic/Hydraulic analysis including surveys is included in the price for Morningside Drive above. This does not include final plan preparation, environmental permitting or final surveys.

Rocky Brook Mobile Home Park

During flooding on June 30, 2013, Rocky Brook Mobile Home Park located on South Greensboro Street experienced severe flooding. The flooding was caused in part by backwater from the existing 8' X 8' Box Culvert under NC 54 Bypass. Based on analysis done by the NCDOT Hydraulics Unit, the backwater from the culvert exacerbates flooding on three of the mobile homes. Based on the new flood mapping for Carrboro the three mobile homes in the backwater of the road crossing are shown to be in the FEMA floodplain along with the remainder of the structures.

South Green is a newly planned development in the watershed directly upstream of Rocky Brook is currently under construction. The development will add more impervious area, but has been designed to match or decrease the peak flow from the site. The designer for the project has submitted information to the Town verifying this condition.

It is recommended that no further hydrologic/hydraulic investigation be undertaken at this time. A thorough hydrologic investigation was provided by FEMA and the developer for South Green.

207 Oleander Road

During the December 30, 2015 storm, the property owner reported flooding in the rear and side yard of his property. Based on an inspection of the property on 2/5/16, there is a ditch located on the southwestern side of the property near or on the property line. The ditch is defined but is shallow and discharges directly into the roadway over the valley curb. There are no drainage structures on Oleander Road in the curb near the property. It appears that the elevation of the ditch is at or slightly higher than the elevation of the fenced rear yard of the property. In addition it appears that there is a slight knoll in the side yard between the rear yard and the ditch which obstructs the flow of water toward the ditch. The drainage area to the rear of the property is approximately 1.2 acres and consists of one dwelling and the remainder grass and trees. It does not appear that any Town owned Right-of-Way drains to the property.

It is recommended that no further Hydrologic/Hydraulic analysis in the watershed be undertaken at this point. The property owner should be contacted with a recommendation to regrade the side yard to effectively drain the rear yard toward the existing ditch. An alternative would be to cut a new ditch from the rear yard and tie it into the existing ditch. If the existing ditch along the property lines needs to be lowered to accept the drainage from the rear yard, then it should also be included in the regrading plan. The outlet elevation of the ditch at the valley curb should not be changed.

Piedmont Health Center

During the December 30, 2015 storm, the railroad ditch directly behind the Piedmont Health Center overflowed into the parking lot. The volume and rate of the discharge from the ditch overwhelmed the two drop inlets and the piping system located in the parking lot and threatened to flood the finished floor of the building. Sand bags were placed around the door and flooding was prevented. In 2004, the building was expanded to the south and a storm drainage system was added in the new parking lot. The existing storm drainage system was not analyzed or enlarged or revised at the time of the expansion; however, flooding of the two drop inlets in the existing parking lot had occurred during storms prior to 2004.

It is recommended that a full Hydrologic/Hydraulic analysis in the watershed be undertaken to determine the extent that the overflow from the railroad ditch plays in the flooding problem. If the discharge from the rail ditch contributes significantly to the flooding problem, then the railroad should be contacted and requested to correct the drainage problem in their ditch.

Estimate for Hydrologic/Hydraulic analysis including surveys will be \$12,800.00. This does not include final plan preparation, environmental permitting or final surveys.

111-B Pine Street

During the December 30, 2015 storm, the property owner at 111B Pine Street observed that the outlet ditch from an 18" cross pipe on Pine Street overflowed its banks on his property. The water came close to the foundation of the house but did not cause any structural damage. Inspection of the property on 2/5/16 showed that the ditch is located approximately 10 feet away from the house and runs in a southeasterly direction parallel to the house. Approximately 95 feet from the street at the rear of the dwelling, a welded wire fence has been constructed across the stream and debris has accumulated on the fence to the level of natural ground outside the stream. The debris has caused blockage of the flow and could be a major cause of the reported flooding. The drainage area to the pipe is approximately 5.5 acres and is completely built out. Based on current Town standards, the pipe is not adequately sized for the anticipated discharge from the watershed. While this is not a desirable situation, it actually benefits the downstream property since it provides some stormwater storage and thereby may actually reduce the discharge downstream of the pipe while not causing reported flooding on upstream properties. The ditch does not appear to be within in a public easement.

It is recommended that no further Hydrologic/Hydraulic analysis in the watershed be undertaken at this point. The property owner should be contacted with a recommendation to remove the fence in the drainage way to see if it reduces the flooding on his property. In order to meet current Town standards the pipe would need to be increased to a 30". Increasing the size of the pipe could actually exacerbate the flooding problem. If the discharge from the rail ditch contributes significantly to the flooding problem, then the railroad should be contacted and requested to correct the drainage problem in their ditch.

Morgan Creek Stream Bank Failure - 404 Manor Ridge Drive

The Property owner of 404 Manor Ridge Drive reported that the stream banks of Morgan Creek at the rear of his property had begun to severely erode after recent rainfall events during December and January. His concern related to the impacts that the bank failure might have to a Duke Energy service road which is used to access the electrical transmission towers within the Duke easement which parallels the creek. An inspection of the stream and easement was conducted on 2/10/16. Both stream banks of Morgan Creek are extremely steep with sparse vegetative cover in the area of his property. The banks on the opposite side of the creek have eroded to the extent that a large tree has been undermined and has fallen into the creek. The banks on the 404 property are also showing signs of recent erosion. The erosion has exposed bedrock and boulders but the bank in its present state is less steep and appears more stable than the opposite bank. Further erosion should be halted due to the rock exposed on the channel bank.

It is recommended that no further Hydrologic/Hydraulic analysis on this project be undertaken at this point. The banks in this area are similar to the banks in other areas of Morgan Creek and other urban piedmont stream. It is recommended that Duke Energy be contacted and apprised of the situation so that they can assess the impacts to their access road and possible impacts to the towers.

