SOLTESZ LLC

Preliminary
Prince George's Plaza Transit District Overlay Zone
Wells Run Floodplain Investigation
Existing Conditions

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I hereby Certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland, License No. _____, Expiration date: _____

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1. INTRODUCTION

1.1. Purpose of Study

M-NCPPC is preparing the Prince George's Plaza Transit District Development Plan (TDDP) and it is advantageous to determine current and future stream flow conditions in the Wells Run watershed and suggested improvements to benefit the future redevelopment of the Prince George's Plaza area. The study will include all of PG Plaza TDDP drainage areas that drains to Wells Run. This existing condition report establishes the predeveloped condition, existing condition, and ultimate condition runoff for six points in the upper reaches of the Wells Run watershed to the location of another tributary from the northeast. The drainage area in the existing condition study totals 0.47 square miles, see Table 1. A comparison of peak discharge values for this drainage area is provided in Table 7.

The second phase of the study (Phase 2) will extend the hydrology analysis downstream to the mouth at the Northeast Branch of the Anacostia River by including the information from the 2015 Soltesz report on Wells Run. A number of alternative flow reduction options including but not limited to, onsite underground storage for 10 and 100-year control for each parcel, evaluation of impact by providing SWM facility at Nine Ponds site, combination of the two, etc., will be evaluated in the Phase 2 study.

This study (Phase 1 and 2) will not include any water surface elevation determination within the watershed or water quality determination. It is anticipated that redevelopment water quality measures necessary to meet Prince George's County Code subtitle 32 within the Prince George's Plaza TDDP will be provided by each property owner at the time of redevelopment and will not be addressed by this study.

1.2. Background

The Wells Run watershed has been subject to extensive flooding studies in the last several years. In addition to the MNCPPC work proposed as part of the TDOZ, there are three (3) other ongoing studies, plus the County's regulatory 100-year floodplain delineation, that will support this effort. They include:

- Wells Run Investigation (Prepared by Soltesz - March 2015)
- Riverdale Park Channel Rehabilitation Project (DPW&T CIP Project No. 664285 for Wells Run Channel Rehabilitation - Ongoing)
- Nine Ponds Site - Conceptual Stormwater Computations (Prepared by Soltesz - July 2011)

Of the three (3) projects, only the Nine Ponds Stormwater study evaluated improvements to reduce peak discharges that would affect the floodplain delineation. The remaining efforts were aimed at establishing flooding limits in Wells Run. Prince George's County DPW&T has field surveyed the concrete channel as part of their channel rehabilitation project from the mouth of Wells Run at the Northeast Branch of the Anacostia River to US Route 1. Because this project is over 3,000 feet downstream from the Prince George's Plaza TDDP, it will not have any impact on this evaluation.

2. WATERSHED DESCRIPTION

2.1. Location and Size

The Prince George Plaza TDDP is located approximately one mile north of the District of Columbia. It is approximately 363 acres in size and lies mostly within Hyattsville Maryland. The transit district is anchored by the Prince George Plaza Metro Station, the Mall at Prince Georges, and the University Town Center mixed-use development. The Wells Run watershed is primarily located in the northern and eastern portions of the TDDP. Approximately 146.4 acres of the TDDP is within the Wells Run watershed.

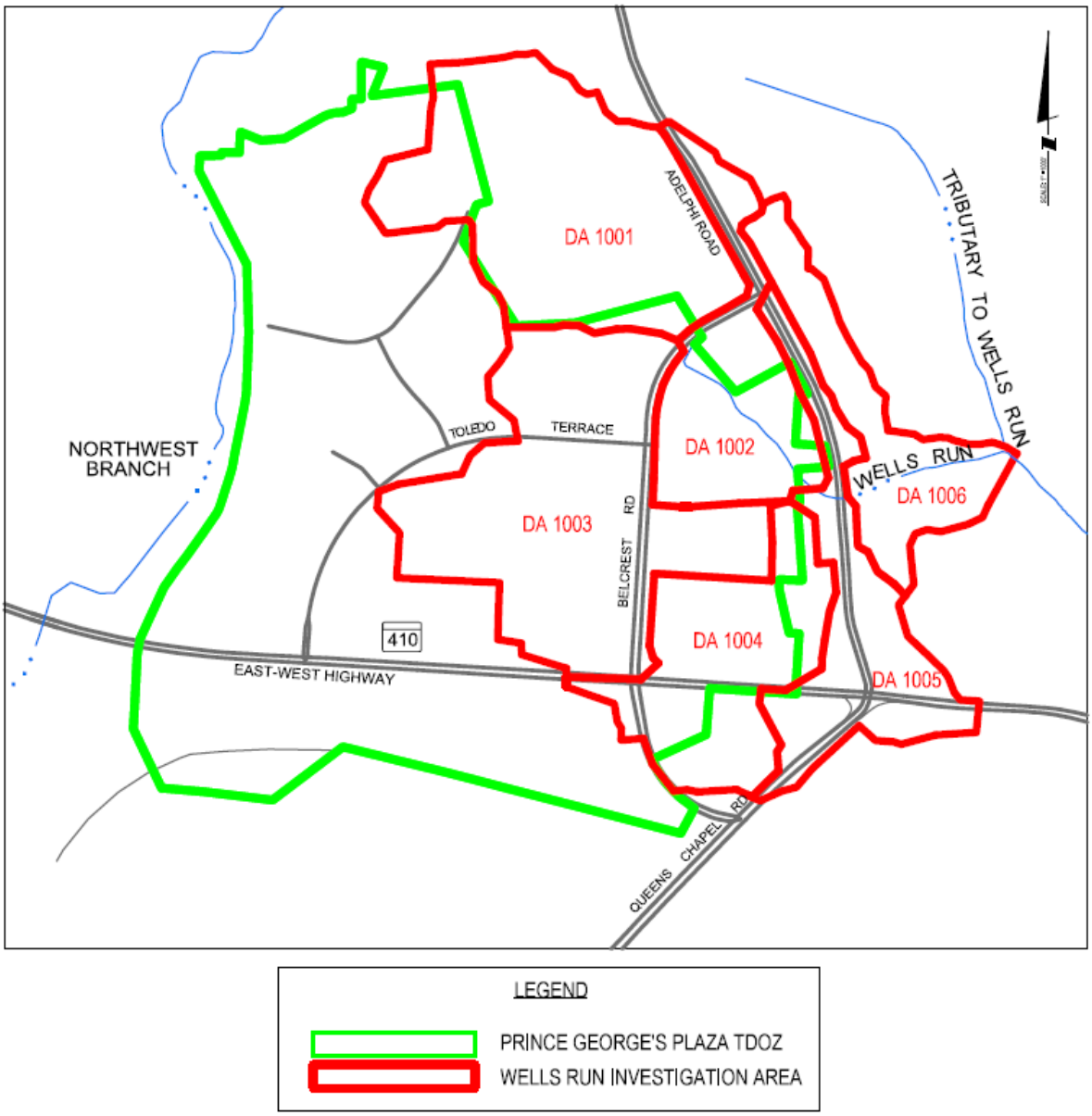

Figure 1: Prince George's Plaza Transit District Development Plan

2.2. Existing Land Use

The area of Wells Run watershed within the Prince Georges Plaza TDDP is substantially developed to a highly impervious state. The TDDP is primarily zoned commercial for approximately 42%, along with high density residential of 27%, and moderate density residential of 33%. The commercial segment has a minimal amount of green area. In addition the Prince Georges Plaza Metro station is also located within the watershed. The area north of the TDDP is composed of primarily single-family homes and Northwestern High School. This area drains to the east side of the TDDP.

2.3. Soil Types

The United States Department of Agriculture Natural Resources Conservation Service (NRCS) also formerly known as the Soil Conservation Service, prepared a soils survey for Prince Georges County and it was published in 2011. Most of the original soils have been modified by the development practices within the watershed. This includes the original farming operation that existed in the TDDP as well as the development process started in the mid-1950s. The 1967 soil survey used with the predeveloped condition analysis identifies about 48% in the Hydrologic Soils Group (HSG) “B” and 52% in HSG “C”. The soils include Beltsville Bibb, Chillum, Christiana, Fallsington, Mattapex, and Sunnyside.

The 2011 soils survey used for the existing condition and ultimate conditions analysis indicate that HSG “C” consists of 10% of the watershed and HSG “D” has the remaining 90%. The 90% includes at least 12% of paved area that has the same RCN regardless of soil group. The predominant soil complexes from the 2011 survey include the following Beltsville, Christina-Downer, Russett-Christiana, Fallsington, Issue-Urban, Zekiah-Issue, and Urban. Urban is a soil type that has been combined with multiple soils and is mostly paved. Soil complexes that include Christiana, Beltsville, and Urban (Mixed Soils with impervious cover) are prevalent for 90% of the watershed.

3. HYDROLOGIC ANALYSIS METHODOLOGY

3.1. NRCS TR-20 Method

The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) TR-20 Method is a synthetic hydrograph method based on a dimensionless unit hydrograph and synthetic or natural rainstorms used to determine peak runoff for a specified storm event. To determine the peak runoff using TR-20, the drainage area, rainfall data, runoff curve number, and time of concentration must be determined. In this analysis, the predeveloped, existing condition, and the ultimate zoning land use condition were modeled. All of the data generated were input into the program Win TR-20 Computer Program for Project Formulation Hydrology, Version 3.10.

3.2. Drainage Area

The Wells Run watershed for the main stem west of the confluence (0.47 square miles) with another stream stem (0.28 square miles) that drains the area from the

northeast was divided into six subareas in order to better model the TDDP and other contributing areas. Subarea 1000 from the 2015 study prepared by Soltesz includes the same boundary. The subareas that include substantial portions of the TDDP are 61%, 100%, 1004. Additionally part of subareas 1001 and a very small part of subarea 1005 contain some portion of the TDDP. The subarea drainage area versus TDDP area are in table 1. The limit of the study for the TDDP is located approximately 1,150 feet east of Adelphi Road or *1,400* feet east of the north-south TDDP project limits where it crosses Toledo Terrace.

Subarea	TDDP (acres)	Total Area (acres)	% of Total Area
1001	14.69	73.40	20.0
1002	22.09	36.28	61
1003	82.62	82.62	100
1004	26.92	42.13	64.4
1005	0.13	36.33	0.3
1006	0	86	0.0
Total	**146.5**	**300.6 or 0.47 mi^2**	

Table 1: TDDP Area versus Watershed Area

3.3. Rainfall Data

NRCS has developed synthetic 24-hour rainfall distributions based on NOAA data dated 2004, based on rainfall data through 2000. Prince George's County has adopted these rainfall values. Table 2 provides a comparison to the rainfall values from the values in current use as compared to values used in earlier studies.

	1-Year	2-Year	10-Year	100-Year
TP-40	2.7"	3.3"	5.3"	7.4"
NOAA 14	2.63"	3.19"	4.93"	8.49"

Table 2: TP-40 versus NOAA 14 Rainfall Values

3.4 Runoff Curve Number

Runoff curve numbers (CNs) are found in standard tables from TR-55 and are based on the hydrologic soil group (HSG), ground cover type and treatment, and hydrologic condition. Use of the standard tables assumes an average antecedent runoff condition (ARC). For areas of varied soil types, ground covers, and hydrologic conditions, the area can be divided into regions and a composite CN determined by weighting each region CN within the area.

The region areas and land use information were input into the USDA NRCS program Win TR-55 Small Watershed Hydrology, Version 1.00.10 to determine composite CN values for each sub-area.

For pre-developed conditions, the land-use was assumed to be either meadow or woods using the land cover on the 1938 aerial photograph. This follows the guidance from MDE in their *2000 Maryland Stormwater Design Manual, Volumes I and II (MDE 2000 and 2009).*

The existing condition run off current number is based on the land use and the latest whole survey from or for Prince Georges County. There are some areas, approximately 50 acres that although zoned commercial, is shown as completely impervious as a review of the aerial photography indicates there are no to minimal green islands or other pervious areas that could help reduce the runoff curve number. The impervious area for Northwestern High School was measured and a runoff curve number was developed for the area owned by the school board. The same analysis was prepared for the garden style apartments located in sub areas 1003. An impervious area percentage of approximately 40% was used.

For ultimate conditions i.e. the conditions that would be used for a floodplain study, both the State and the County require the use of Master Plan zoning. The existing condition land use was use to establish land use and the current report also follows this requirement except in some areas where the current land use is more impervious than the underlying zone. In those cases, the underlying intensity was used.

For the approximately four parcels that were not developed in subareas 1001, 1002, 1003 and 1004, the open space area was assumed to be developed to Master Plan zoning.

Subarea	Drainage Area (Acres)	Predeveloped	Existing	Ultimate
1001	73.40	65	84	87
1002	35.94	66	90	91
1003	82.83	62	91	92
1004	41.78	70	94	95
1005	37.02	58	93	93
1006	29.78	69	86	86

Table 3: Comparative Runoff Curve Numbers (CN)

3.5. Time of Concentration

Time of concentration (Tc) is the time it takes water to travel from the hydraulically most distant point in the watershed to a point of interest within the watershed. TR-55 methodology computes Tc by summing all the travel times (Tt) for consecutive components of the drainage conveyance system where the water moves as sheet flow, shallow concentrated flow, open channel flow, or a combination of these.

Sheet flow, sometimes called overland flow, occurs at the upper reaches of the watershed. Sheet flow has shallow depths is relatively uniform over the surface.

Sheet flow typically does not extend beyond flow lengths of 100 feet. Sheet flow transitions into shallow concentrated flow where depths increase and the flow paths become more defined. Shallow concentrated flow transitions into open channel flow within a defined channel.

For this study, the parameters for each flow component were input into the USDA NRCS program Win TR-55 Small Watershed Hydrology, Version 1.00.10 to determine Tt values. The Tc values were determined for each sub-area and added together to compute the Tc value at the key study locations. See Exhibit 1 for predeveloped and Exhibit 2 for existing and ultimate condition T_C flow paths. A summary of the time of concentration for each subarea and for each land use condition is summarized in Table 3.

The slope was assumed to be the same as in the existing conditions travel path. Secondly, the shallow concentrated flow was assumed to be pervious for the same length as on the existing conditions. Lastly, the channel flow use the same cross-section from sub area 1002 and it was adjusted based on the slope of the ground over the existing storm drain system. This is not a perfect solution to developing the predevelopment time of concentration, however we believe it is a reasonable attempt to replicate the conditions at the time of 1938.

3.5.1. Sheet Flow

The parameters used to calculate sheet flow Tt are flow length (L), manning's roughness coefficient (n) from Table 3-1 from TR-55, rainfall duration (P2), and land slope (S), using the formula:

$$Tt = (0.007)\ (nL)\ 0.8\ /\ (P20.5S\ 0.4)$$

Sheet flow for this analysis was computed using the 100 foot maximum flow length; Manning's n values selected as representative along the flow path; and the land slope calculated from aerial topographic maps and field data.

The recommendation of the NRCS is to use the 2-year precipitation event in a TR-55 analysis, which for Prince George's County is 3.19 inches. However, for the preparation of a floodplain study, the County requires the use of the 100-year precipitation event, or 8.49 inches. Therefore in this study for the 100-year storm event all Tc values use 8.49 inches and the Tc values for the Wells Run sub-areas prepared have been modified to reflect this requirement.

Since predeveloped conditions cannot be easily replicated because of development in the watershed, the sheet flow path is the same for all three conditions. The predeveloped flow path will use the same slope as existing conditions, with a maximum length of 100 feet and use either grass (n=0.24) if the reach was non-wooded in 1938 or woods (n=0.40) if no development existed. The year 1938 is selected because an aerial photograph is available from the Prince George's County GIS and therefore the land use prior to substantial intense development in the watershed may be used to establish a predeveloped flow condition.

3.5.2. Shallow Concentrated Flow

Shallow concentrated flow for this analysis was computed using a flow length determined from aerial topographic maps and field data. Watercourse slope was also determined from aerial topographic maps. The parameters used to calculate shallow concentrated flow Tt are flow length (L), watercourse slope (s) and flow type usually paved or unpaved. For predeveloped conditions, a value for short grass pasture was used. The equations for all 3 covers were obtained from *NRCS National Engineering Handbook Part 630 Chapter 15,* Figure 15-4.The slope and flow type are used to determine average velocity (V). Tt is then calculated using the formula:

$$Tt = L/3600V$$

The average velocity was determined using Figure 15-4 from the NEH 630 manual.

3.5.3. Channel Flow

The parameters used to calculate channel flow Tt include flow length (L), watercourse slope (S), roughness (n), and channel cross-sectional area (A) and wetted perimeter (Wp). Average velocity (V) and Tt are calculated using the formulas:

$$V = (1.49)\ (A/Wp)^{2/3}(S^{1/2})/n$$
$$Tt = L/3600V$$

Channel flow for this analysis was computed using flow lengths, slopes, and channel cross-sections determined from aerial topographic maps and field data. Since the watershed is primarily developed, the data from the HEC-2 cross sections will be used. When a storm drain pipe was part of the flow path, the average velocity was assumed to be 6 feet per second. The T_C is summarized in Table 4 for storms less than the 100-year and for the 100-year storm for predeveloped and existing/ultimate conditions.

Subarea	Time of Concentration (Hours)		Time of Concentration (Hours) for 100-Year	
	Predeveloped	Existing/Ultimate	Predeveloped	Existing/Ultimate
1001	0.49	0.41	0.40	0.31
1002	0.55	0.37	0.46	0.31
1003	0.39	0.15	0.31	0.14
1004	0.55	0.17	0.43	0.16
1005	0.33	0.18	0.28	0.15
1006	0.50	0.37	0.39	0.29

Table 4: Comparative Time of Concentration (T_C)

4. HYROLOGIC ANALYSIS SUMMARY

4.1. Comparative Runoff Curve Numbers

This section discusses the changes in the runoff current numbers among three studies. First, the 1993 study which was used to develop the County floodplain limits, has a runoff curve number of 85 for the six (6) sub areas in the study plus the area to the east (subarea 2000) with a total drainage area of 0.72 square miles. This study also used the 1967 soils survey.

The 2015 study, prepared by Soltesz determined for ultimate land use condition there was a runoff curve number of 90 for subarea 1000 that encompasses the six subareas of this study. In conjunction with the RCN of 83 from the residential area to the east, this would yield a runoff curve number composite of 88 as compared to 85 from the original county study.

For existing conditions, a composite curve number of 90 has been determined for the six subareas. With the development of the remaining parcels, the RCN would be increased to 91, which is consistent with the results from the Soltesz 2015 study. The difference will primarily be the result of refined computation for a portion of the site which is totally impervious. The normal assumption for a commercial area is 85% impervious.

4.2. Stream Reach Cross Sections

The NRCS-TR-20 uses a Muskingum-Cunge (M-C) approach. The M-C method is a spin-off of the Muskingum method that has been used for many years in river forecast operations by the National Weather Service, U.S. Army Corps of Engineers and similar organizations. Both the M-C and Muskingum methods use a series of routing coefficients that are defined by the routing period, dt, a travel time constant for the routing reach, K, and a weighting factor, “x”. In the traditional river forecast environment, there are usually recorded inflow and outflow hydrographs that can be used to define K and x and earlier experiences on the river can evolve the optimal value of “dt”.

Without historic records of inflow and outflow hydrographs, K is estimated by the length of the routing reach and the celerity of a small gravity wave moving through the reach. The length of the routing reach is a decision made by the user. The celerity of the small gravity wave requires an estimate of the average velocity, width and depth of flow through the routing reach. The value of x is defined from the routing reach length, average width, average slope, celerity of a gravity wave, and the peak discharge entering the reach.

This study uses the same cross section location and data as the County 1993 NRCS TR-20 analysis or the U.S. Army Corps of Engineers HEC-2. Whenever possible in this model, the cross sections were used from the HEC-2 and only used the TR-20 data when additional information was required.

4.3. Stormwater Management Facilities

4.3.1. Existing Stormwater Management Facilities

There are no SWM facilities that provide quantity control within the watershed. Several properties have provided some water quality improvements in particular at Northwestern High School which is north of the TDDP.

4.4 TR-20 Model Comparison

A comparison of the reached flow between the Wells Run Investigation (Prepared by Soltesz - March 2015) (2015 study) and this study indicate flows is provided. The only purpose for the 2015 study at this time is to document the peak flow from subarea 1000. The predeveloped flows are substantially lower than the existing or ultimate conditions\ ranging from 17 % to about 50%. Until they are integrated into the TR-20 model for the entire watershed no conclusions can be made. It should be recognized that one of the purposes of the predeveloped flow determination was to provide a goal for SWM release rates of SWM is required for individual properties.

Subarea	Predeveloped Conditions	Existing Conditions	Ultimate Conditions
1001	25 cfs	97 cfs	111 cfs
1002	13 cfs	64 cfs	66 cfs
1003	22 cfs	217 cfs	224 cfs
1004	21 cfs	114 cfs	117 cfs
1005	6 cfs	97 cfs	97 cfs
1006	15 cfs	47 cfs	47 cfs
Confluence	98 cfs	563 cfs	584 cfs
2015 Study**	N/A	N/A	580* cfs

***Used 100yr Tc Computation**

Table 5: 2-Year Storm Comparison

Subarea	Predeveloped Conditions	Existing Conditions	Ultimate Conditions
1001	80 cfs	185 cfs	200 cfs
1002	39 cfs	109 cfs	111 cfs
1003	85 cfs	365 cfs	371 cfs
1004	55 cfs	18 5cfs	185 cfs
1005	32 cfs	160 cfs	160 cfs
1006	40 cfs	86 cfs	86 cfs
Confluence	318 cfs	960 cfs	978 cfs
2015 Study**	N/A	N/A	1,056* cfs

***Used 100yr Tc Computation**

Table 6: 10-Year Storm Comparison

Subarea	Predeveloped Conditions	Existing Conditions	Ultimate Conditions
1001	252 cfs	419 cfs	435 cfs
1002	118 cfs	21 9cfs	221 cfs
1003	291 cfs	679 cfs	684 cfs
1004	157 cfs	335 cfs	337 cfs
1005	119 cfs	303 cfs	303 cfs
1006	116 cfs	183 cfs	183 cfs
Confluence	982 cfs	1,842 cfs	1,864 cfs
2015 Study **	N/A	N/A	1,709 cfs

Table 7: 100-Year Storm Comparison

** “Wells Run Investigation”, Prepared by Soltesz, March 2015

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