Appendix J

Whipple Creek Watershed-Scale Stormwater Plan Report

Whipple Creek Watershed Existing and Future Land Cover Data

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Introduction

Clark County is conducting a watershed level study of Whipple Creek watershed as mandated under NPDES permit requirements. The project includes development of HSPF model to represent the hydrologic and stream flow conditions of the watershed under both existing and future land use conditions. An existing HSPF model developed by Otak (2006) was used as a starting point and was updated to represent the current and future land cover conditions. The entire watershed is divided into 27 sub-basins based on the topography and or hydrologic control points. The sub-basin boundaries are shown in Figure 1. The existing land cover is based on the current development conditions throughout the watershed while the future land covers are based on the future buildout conditions as defined in the County's comprehensive growth management plan. The general procedures used to calculate the land cover types under both conditions are presented in the subsequent paragraphs.

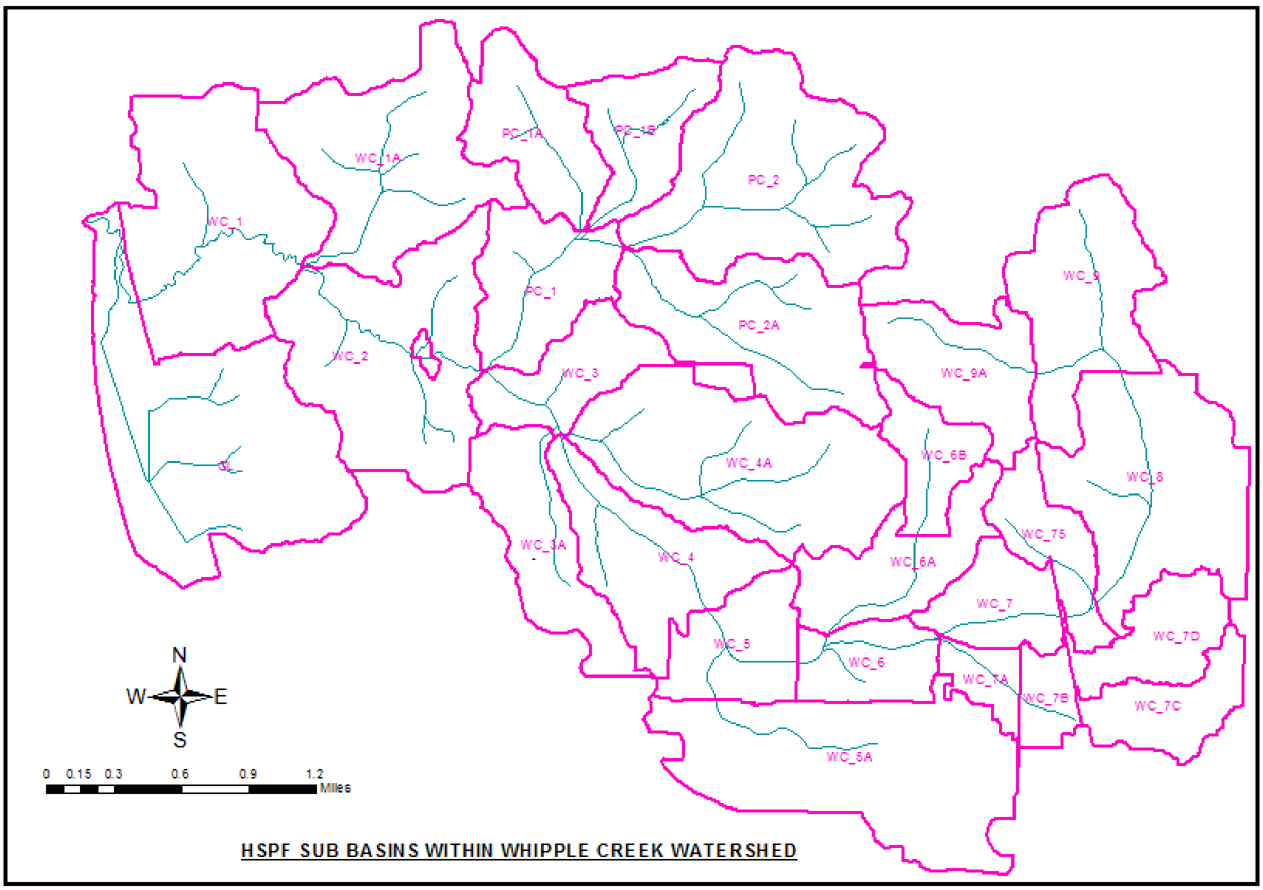

Figure-1. Whipple Creek Watershed HSPF Sub-basins.

Existing Land Cover

The original HSPF model developed in 2006 had used land covers as reflected in the County's aerial imagery 2002. While some areas have seen significant development since 2002, the land use conditions from that year provided a good "base" condition from which future development impacts were measured. The most recent available aerial imagery (2014) in County's GIS section was used to update land cover for the calibrated existing condition. ArcGIS tool was used to measure and update the land cover types within the identified areas of change.

The entire impervious area within each sub-basin was further broken down into four different categories as listed below.

- Residential Roof
- Residential Pavement
- Non-Residential Roof
- Non-Residential Pavement

The main objective of this break down is to effectively estimate the impact of certain BMPs such as street sweeping and downspout disconnection that only apply to certain types of impervious surface.

A 'roof to pavement' ratio was established for various land use types and was applied throughout the watershed in order to break down the total impervious area into roof and pavement. Three representative areas were used to represent one each of high density residential, low density residential, and non-residential land use types. The land cover type GIS layer created by Clark County in 2002 using LiDAR, Orthophoto, and Infra-Red data differentiated roofs and pavement for the calculation. Table 1 below shows the ratios calculated for representative areas.

Table 1: Roof/Pavement Ratio for Various Land Use Types

Land Use Type	Impervious Area Type		Roof to Pavement Ratio
	Roof (acres)	Pavement (acres)	
High density residential (Figure-2)	60.40	462.84	0.13
Low density residential (Figure-3)	15.23	32.99	0.46
Non-residential (Figure-4)	17.90	314.45	0.06

A fully developed residential area located to the east of interstate I-5 was picked to represent a high density residential site. An area located along NW 149th corridor on the west side and just outside of urban growth boundary was chosen to represent a low density residential site. An area along NE 139th street on the west side of interstate I-5 was selected to represent a non-residential site. The representative areas for each land use type are shown in Figures 2 through 4.

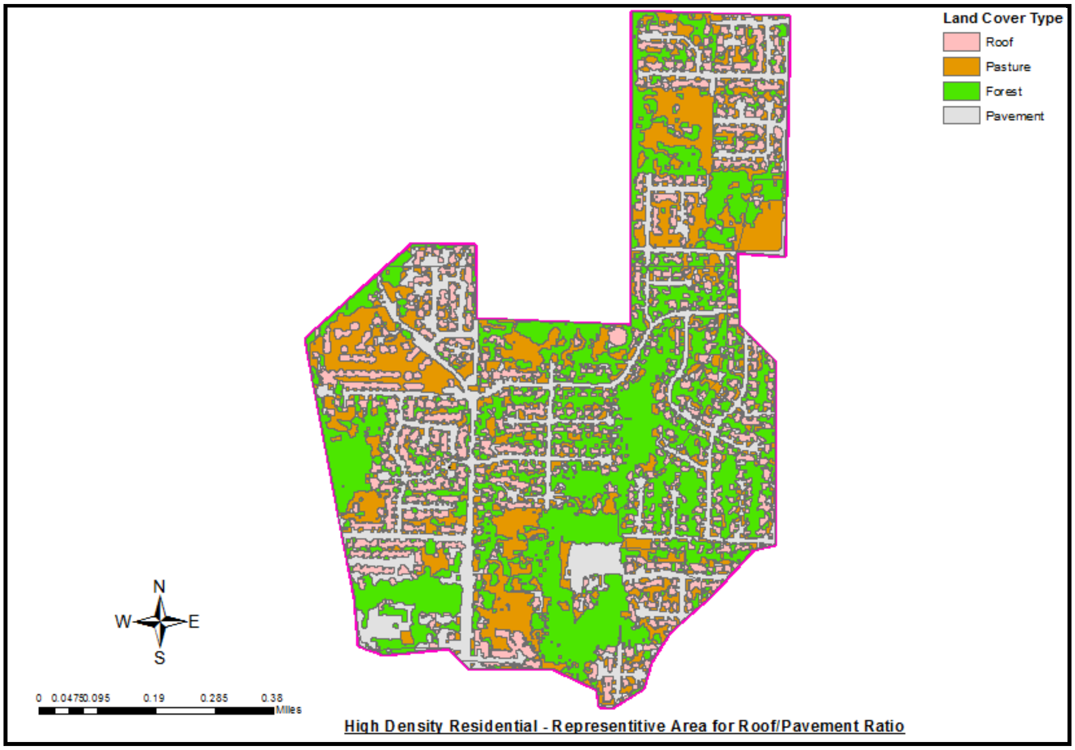

Figure-2. High Density Residential Land Use- Representative Area

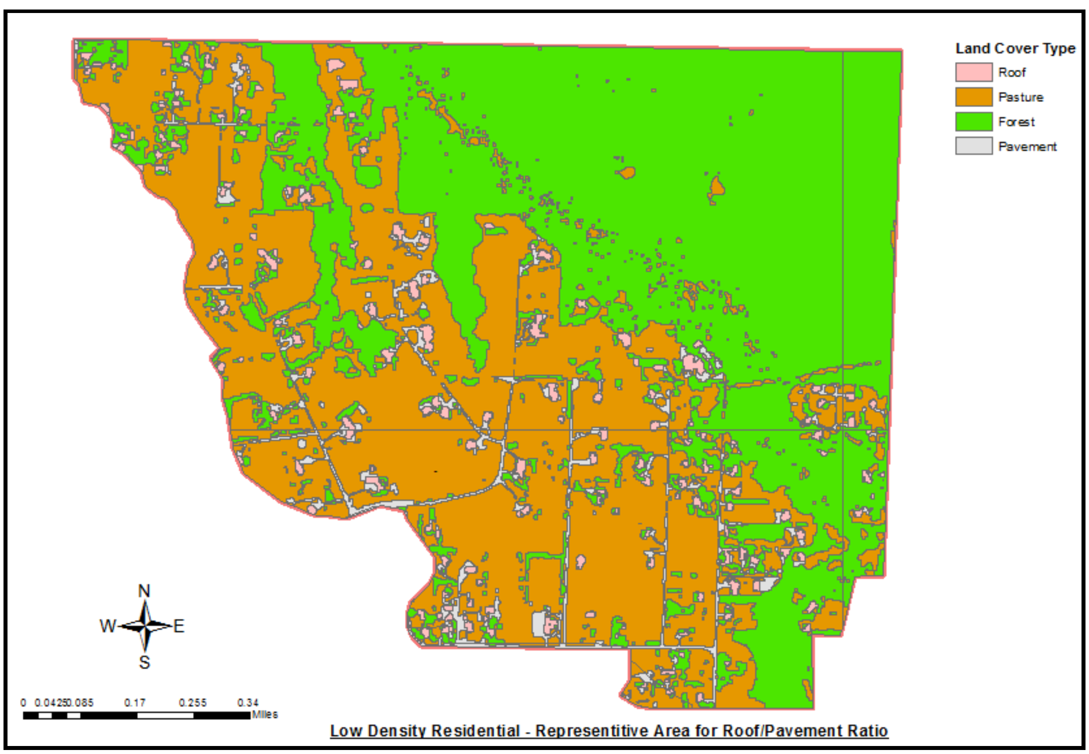

Figure-3. Low Density Residential Land Use- Representative Area

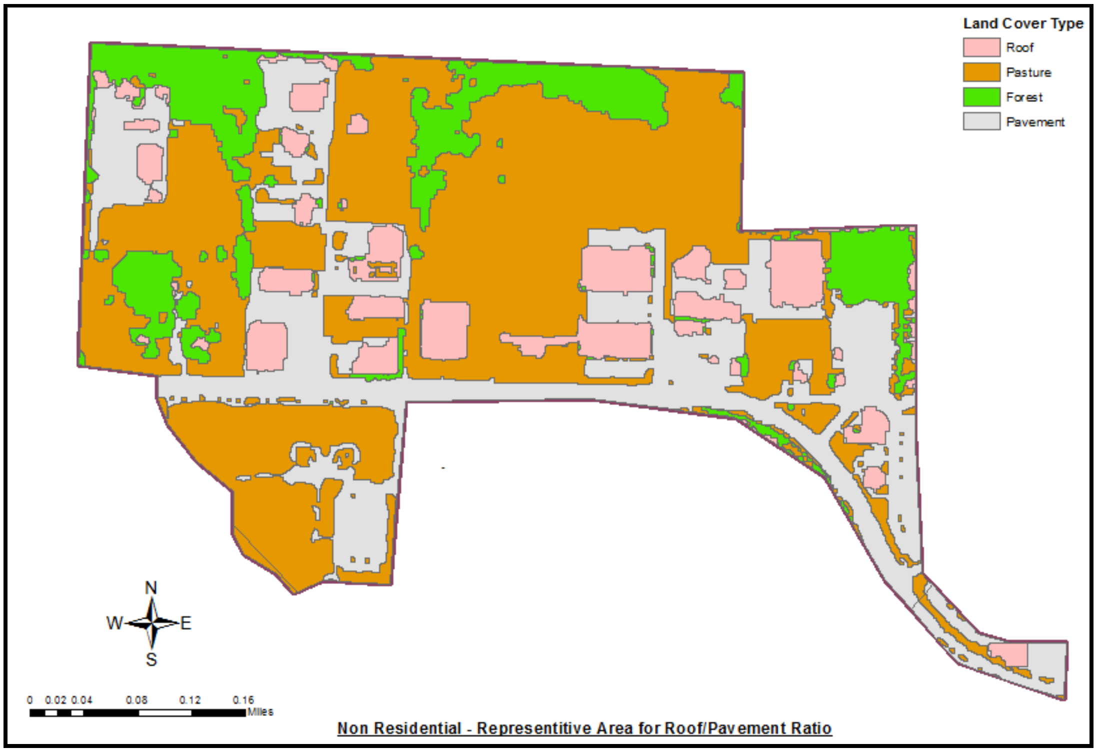

Figure-4. Non Residential Land Use- Representative Area

Future Land Cover

The future conditions land use assumptions were based on the County's comprehensive growth management plan for the area outside of urban growth boundary. The future land use assumptions were based on Predictive Land Use Model for Sewers (PLUMS) developed by Clark Regional Wastewater District (CRWWD) for the area inside the urban growth boundary. A list of HSPF sub-basins with a breakdown based on their location inside or outside of UGA boundaries is presented in Table 2.

Table 2: HSPF Sub-basins

Within UGA Boundary	Outside of UGA Boundary
WC_9	GL
WC_9A	WC_1
WC_8	WC_1A
WC_75	WC_2
WC_7D	WC_3
WC_7C	WC_3A
WC_7B	WC_4
WC_7A	PC_1
WC_7	PC_1A
WC_6B	PC_1B
WC_6A	PC_2
WC_6	PC_2A
WC_5A	
WC_5	
WC_4A	

GIS information for zoning from Clark County's comprehensive plan (2016) was applied for the sub-basins located outside of UGA, intending to represent full buildout of the basins. In general, it is assumed that the parcels will be developed to the maximum extent allowed by the proposed zoning. Exception was the 100-foot priority habitat buffer located on both sides of Whipple Creek, Packard Creek, and major tributaries. These areas will be modeled as forest, consistent with the County's Critical Areas Ordinance. All the areas encompassed between the buffers on either side of the stream will be modeled as forest. As the future land cover calculation was solely based on the book values from the comprehensive plan, the resulting impervious areas for some of the sub-basins were less than in the existing condition. In such instances, the impervious area from the existing condition was matched for the future condition. That means it was assumed that the already developed area will continue to hold in the future condition.

For the sub-basins located inside the UGA, PLUMS model was used to identify the future land use types. PLUMS model was created by CRWWD as a planning tool to represent how areas inside the urban growth boundary are expected to develop and it more accurately represents the lot by lot potential to develop in the area. Roof to Pavement ratio from Table 1 above was used to break down the total impervious areas within each sub-basin into roofs and pavements. Break down of land cover types for various land use/zoning categories for future conditions are shown in Table 3.

Table 3: Future Land Use and HSPF Land Cover Percentages					
Description	EIA %	Forest %	Pasture %	Lawn %	Wetlands
Urban Low Density Res	23			77	
Urban Medium Density Res	23			77	
Community Commercial	85			15	
General Commercial	85			15	
Light Industrial	85			15	
Mixed Use	48			52	
Public Facility	23			77	
Parks/Open Space	0	25	25	50	
Urban Reserve	23			77	
Rural 5	6		75	19	
Agriculture			100		
Agri-Wildlife		50	50		
Water					100
Employment Center	85			15	
Rural 10	4		77	19	
Rural 20	4		77	19	
Forest		100			

The resulting land cover types within each sub-basin for both existing and future land use conditions are shown in Appendix A. Sub-basins located within the Urban Growth Boundary generally show an increase in impervious area along with a decrease in forested or pasture areas. In more rural areas, the existing land use is largely unchanged in the future land use scenario. Table 4 shows the change in impervious area for several key sub-basins.

Table 4: Land Use Change in Key Sub-basins					
Sub-basin	Location	Total Sub-basin Area (acres)	Exiting Impervious Percentage	Future Impervious Percentage	Change
WC_8	Major sub-basin east of I-5	459.83	15%	26%	11%
WC_5A	Southern sub-basin south of 149th	561.43	27%	28%	1%
WC_4A	Central Sub-basin near Whipple Creek Park	522.31	3%	9%	6%
PC_2	Northern sub-basin of Packard Creek	518.05	4%	5%	1%
WC_2	Main stem sub-basin downstream of 41st	496.78	5%	5%	0%

Appendix A

(Table Summary of Existing and Future Land Cover Data)

Whipple Creek Watershed Existing Land Cover in acres

Sub-basins	Impervious Land (IMPLND 100)				Pervious Land (PERLND)									Water (500)
	Residential		Non-residential		SG3			SG4			SG5			
	Roof	Pavement	Roof	Pavement	Forest (200)	Pasture (210)	Lawn (220)	Forest (260)	Pasture (270)	Lawn (280)	Forest (300)	Pasture (310)	Lawn (320)	
GL	6.78	14.73	-	-	140.74	271.28	32.27	-	-	-	-	-	-	184.85
WC_1	9.02	19.60	-	-	146.62	234.87	95.33	-	-	-	-	-	-	1.78
WC_1A	6.84	14.87	-	-	-	-	-	145.38	190.22	82.40	-	-	-	-
WC_2	7.40	16.10	-	-	127.58	253.21	92.49	-	-	-	-	-	-	-
WC_3	1.61	3.50	-	-	63.38	82.42	17.81	-	-	-	-	-	-	0.44
WC_3A	3.45	7.51	-	-	43.70	140.85	35.14	-	-	-	-	-	-	-
WC_4	2.79	6.05	-	-	167.20	77.35	29.33	-	-	-	-	-	-	-
WC_4A	1.85	14.19	-	-	221.70	-	-	37.19	168.15	79.22	-	-	-	-
WC_5	6.23	13.54	-	-	77.47	35.97	44.48	-	-	-	-	-	-	-
WC_5A	8.30	63.90	2.37	41.70	83.06	60.81	293.01	-	-	-	-	-	5.76	2.53
WC_6	4.27	32.81	-	-	49.31	6.91	42.24	-	-	-	-	-	-	-
WC_6A	1.51	11.58	1.56	18.10	35.80	80.82	52.69	-	-	-	-	-	-	0.50
WC_6B	0.13	1.02	2.02	35.35	-	-	-	19.15	21.28	40.51	-	-	-	-
WC_7	0.35	2.69	1.38	5.71	52.61	50.90	25.97	-	-	-	-	-	-	0.22
WC_7A	0.90	6.94	-	-	24.42	14.93	16.91	-	-	-	-	-	-	-
WC_7B	0.20	1.52	0.84	14.67	12.17	18.93	18.53	-	-	-	-	-	-	-
WC_7C	3.44	26.49	-	-	-	-	-	28.13	9.19	74.21	-	-	-	-
WC_7D	4.13	31.73	-	-	-	-	-	23.44	3.09	90.50	-	-	-	1.30
WC_75	2.97	22.87	0.35	6.07	-	-	-	14.31	35.22	57.27	-	-	-	-
WC_8	7.74	59.56	-	-	-	-	-	179.85	68.29	144.39	-	-	-	-
WC_9	2.27	17.43	0.84	14.66	-	-	-	99.05	107.10	77.69	-	-	-	-
WC_9A	1.27	9.90	2.4	42.30	-	-	-	44.34	47.41	76.89	-	-	-	-
PC_1	2.81	6.12	-	-	-	-	-	109.20	84.36	17.27	-	-	-	-
PC_1A	2.16	4.71	-	-	-	-	-	74.26	92.84	35.88	-	-	-	-
PC_1B	2.20	4.78	-	-	-	-	-	63.73	79.12	27.53	-	-	-	-
PC_2	6.70	14.58	-	-	-	-	-	196.59	212.73	87.46	-	-	-	-
PC_2A	4.72	10.26	-	-	-	-	-	116.76	191.94	68.60	-	-	-	-

Whipple Creek Watershed Future (Build-out) Land Cover in acres

Sub-basins	Impervious Land (IMPLND 100)				Pervious Land (PERLND)									Water (500)
	Residential		Non-residential		SG3			SG4			SG5			
	Roof	Pavement	Roof	Pavement	Forest (200)	Pasture (210)	Lawn (220)	Forest (260)	Pasture (270)	Lawn (280)	Forest (300)	Pasture (310)	Lawn (320)	
GL	6.78	14.73	-	-	35.60	359.11	49.58	-	-	-	-	-	-	184.85
WC_1	9.02	19.60	-	-	135.20	248.07	95.33	-	-	-	-	-	-	-
WC_1A	6.84	14.87	-	-	-	-	-	137.30	198.30	82.40	-	-	-	-
WC_2	7.40	16.10	-	-	109.10	271.69	92.49	-	-	-	-	-	-	-
WC_3	1.61	3.50	-	-	63.38	82.86	17.81	-	-	-	-	-	-	-
WC_3A	3.45	7.51	-	-	41.40	143.15	35.14	-	-	-	-	-	-	-
WC_4	2.86	6.23	-	-	167.20	77.10	29.33	-	-	-	-	-	-	-
WC_4A	3.39	23.01	1.07	18.80	221.70	-	-	10.28	87.47	156.58	-	-	-	-
WC_5	6.23	13.54	-	-	60.90	32.09	64.93	-	-	-	-	-	-	-
WC_5A	12.46	95.84	2.68	47.05	66.20	8.06	323.39	-	-	-	-	-	5.76	-
WC_6	4.27	32.81	-	-	36.00	6.73	55.73	-	-	-	-	-	-	-
WC_6A	2.55	19.60	3.46	60.66	31.86	1.77	82.66	-	-	-	-	-	-	-
WC_6B	0.13	1.02	2.02	35.35	-	-	-	19.15	1.59	60.20	-	-	-	-
WC_7	0.55	4.26	3.52	62.32	41.20	-	27.98	-	-	-	-	-	-	-
WC_7A	1.45	11.13	0.43	7.58	14.83	-	28.68	-	-	-	-	-	-	-
WC_7B	0.48	3.66	1.93	34.09	6.50	-	20.20	-	-	-	-	-	-	-
WC_7C	3.82	29.36	-	-	-	-	-	8.07	1.67	98.54	-	-	-	-
WC_7D	4.13	31.73	-	-	-	-	-	15.13	3.30	99.90	-	-	-	-
WC_75	2.97	22.87	1.06	37.74	-	-	-	14.31	1.70	58.41	-	-	-	-
WC_8	13.22	101.68	0.19	3.37	-	-	-	138.85	15.17	187.35	-	-	-	-
WC_9	3.22	24.73	25.18	142.72	-	-	-	28.63	-	94.56	-	-	-	-
WC_9A	2.20	16.93	5.82	102.14	-	-	-	15.32	-	82.10	-	-	-	-
PC_1	2.81	6.12	-	-	-	-	-	109.20	84.33	17.30	-	-	-	-
PC_1A	2.92	6.34	-	-	-	-	-	55.50	109.21	35.88	-	-	-	-
PC_1B	2.79	6.08	-	-	-	-	-	29.50	110.90	28.09	-	-	-	-
PC_2	7.63	16.58	-	-	-	-	-	114.50	291.89	87.46	-	-	-	-
PC_2A	5.26	25.14	0.19	3.36	-	-	-	96.70	147.64	113.99	-	-	-	-