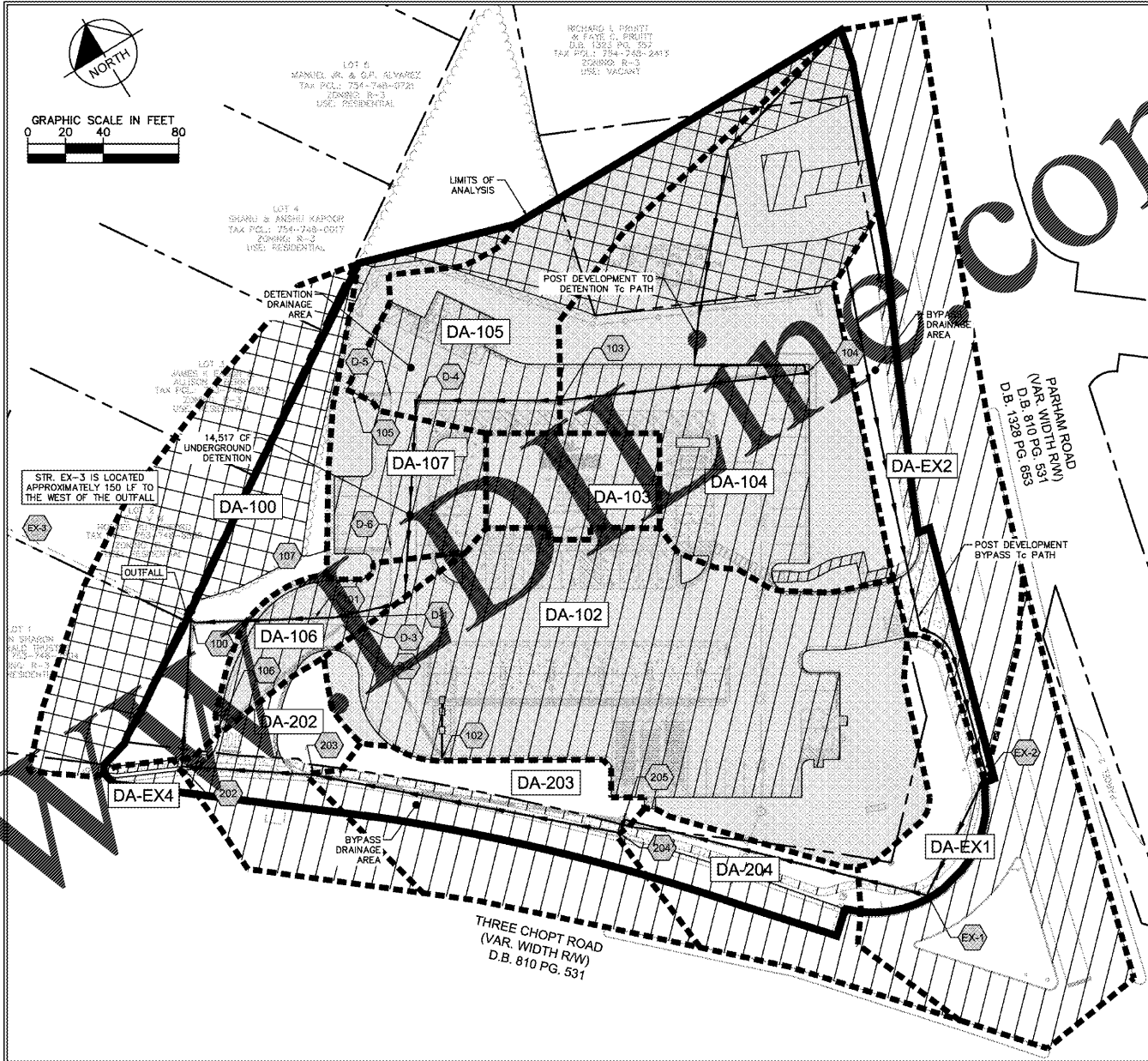
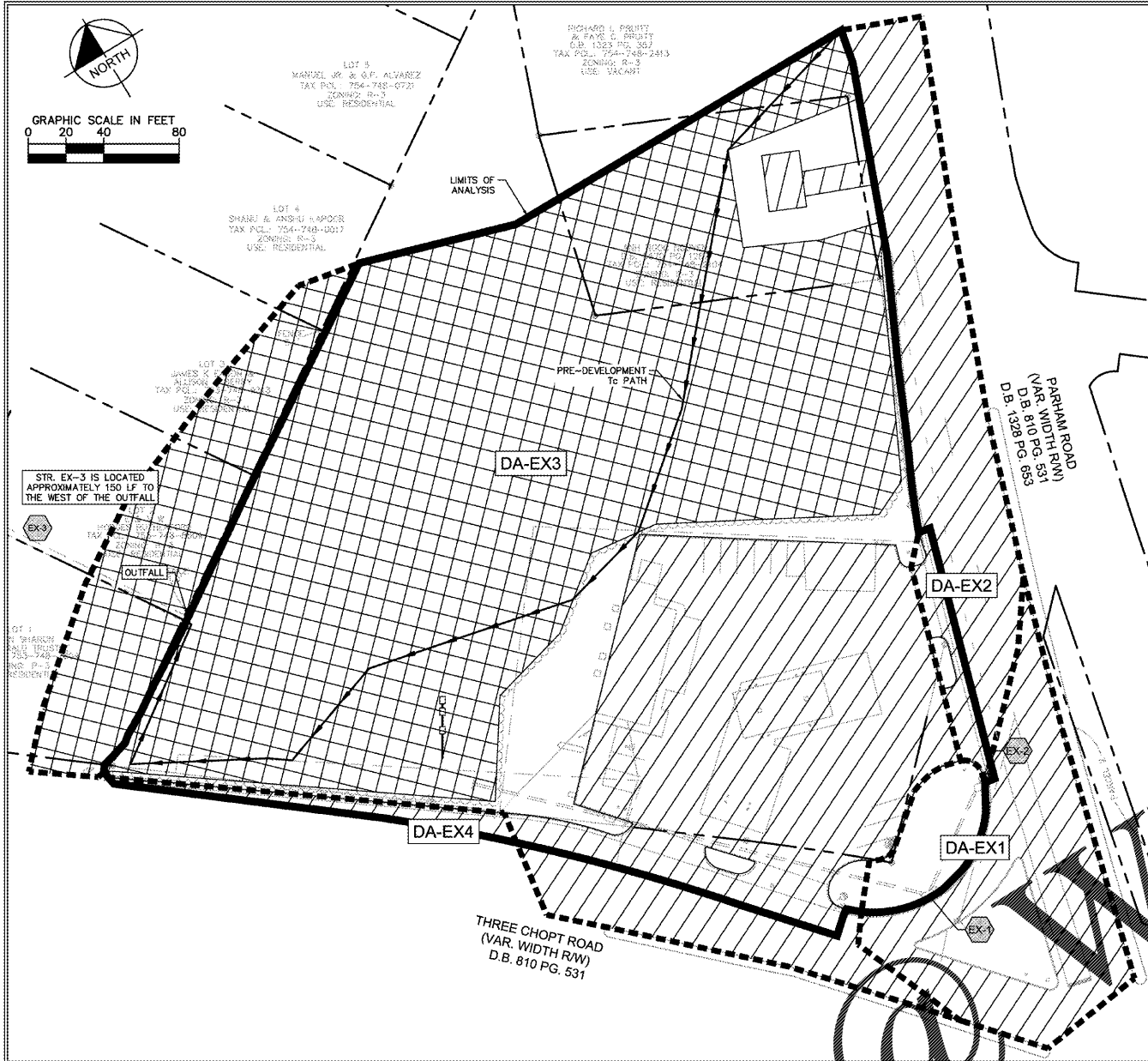


PRE-DEVELOPMENT

POST-DEVELOPMENT



**LEGEND**

- IMPERVIOUS COVER
- MANAGED TURF
- FOREST / OPEN SPACE
- DETENTION DRAINAGE AREA (2.28 ACRES)
- DRAINAGE STRUCTURE CALLOUT
- DRAINAGE AREA LABEL (DA-101)
- DRAINAGE BOUNDARY
- LIMITS OF ANALYSIS (3.08 AC)

**STORMWATER QUANTITY NARRATIVE**

TO ADDRESS STORMWATER QUANTITY REQUIREMENTS FOR PROPOSED SITE, THE ENERGY BALANCE METHOD CHOSE THE LIMITS OF ANALYSIS USED FOR THE ENERGY BALANCE CALCULATIONS (3.08 ACRES) INCLUDE THE LIMITS OF DISTURBANCE (2.65 ACRES) WITH THE EXCEPTION OF THE NORTHERN PARHAM TURN LANE DIVISION OF THE NATIONAL AREA DRAINING TO A PROPOSED DETENTION SYSTEM. TO ADDRESS STORMWATER QUANTITY FOR THE NORTHERN PARHAM TURN LANE DIVISION, SEE SHEET CG-100 FOR DETAILS.

THERE IS ONE POINT OF OUTFALL ON THE SITE.

- DRAINAGE FROM THE SITE FLOWS INTO AN EXISTING 27" X 40" ELLIPTICAL PIPE WHICH DRAINS TO THE NORTHWEST.

IN ORDER TO MEET THE ENERGY BALANCE REQUIREMENTS FOR THE 1-YEAR STORM, UNDERGROUND DETENTION IS PROPOSED ON THE WEST SIDE OF THE WAWA BUILDING. A STORMTANK SYSTEM WITH A CONTROL STRUCTURE IS PROPOSED TO REDUCE THE FLOW TO THE REQUIRED 1-YEAR FLOW RATE. SIMILARLY, DETENTION OF THE 10-YEAR AND 50-YEAR STORM IS ALSO REQUIRED, SO THE CONTROL STRUCTURE WILL LOWER THE POST-DEVELOPMENT 10-YEAR AND 50-YEAR FLOW RATES BELOW THE 10-YEAR PRE-DEVELOPMENT RATE.

A HYDRAFLOW MODEL WAS USED TO DESIGN THE DETENTION SYSTEM. THE MODEL INCLUDES 2 DRAINAGE AREAS TO MEET THE REQUIREMENTS OF THE ENERGY BALANCE: THE AREA ON-SITE WHICH DRAINS TO THE DETENTION SYSTEM (POST TO DETENTION) AND THE AREA THAT CANNOT BE CONVEYED TO THE UNDERGROUND SYSTEM (BYPASS). THESE AREAS WERE COMBINED INTO ONE HYDROGRAPH (COMBINE) TO SHOW THAT THE 1-YEAR, 10-YEAR, AND 50-YEAR POST DEVELOPMENT FLOW REQUIREMENTS ARE MET AT THE POINT OF OUTFALL.

**CHANNEL PROTECTION:** THE ENERGY BALANCE HAS BEEN USED AT THE OUTFALL TO MANAGE RUNOFF.

**FLOOD PROTECTION:** POST-DEVELOPMENT 10-YEAR FLOWS HAVE BEEN KEPT BELOW THE PRE-DEVELOPMENT 10-YEAR FLOW RATE.

**50 / 10 DETENTION:** POST DEVELOPMENT 50-YEAR FLOWS HAVE BEEN KEPT BELOW THE PRE-DEVELOPMENT 10-YEAR FLOW RATE.

**ENERGY BALANCE CALCULATIONS**

Pre-Development			
Runoff Curve Number (CN)	83	Storm Event	Runoff Volume V
Drainage Area	3.08 acres	1-year	13,605
Impervious Area	0.82 acres	10-year	12.47
Managed Turf	0.39 acres	50-year	20.09
Forest/Open Space	1.87 acres		
Time of Concentration (Tc)	14.0 min		

Post-Development (Prior to Routing)			
Runoff Curve Number (CN)	89	Storm Event	Runoff Volume V
Runoff Curve Number (CN)	89	1-year	18,264
Drainage Area	3.08 acres	10-year	14.41
Impervious Area	1.62 acres	50-year	21.97
Managed Turf	1.03 acres		
Forest/Open Space	0.44 acres		
Time of Concentration (Tc)	14.0 min		

**Channel Protection Compliance**

Energy Balance Equation, 1-year Storm:

$$Q_{post} < 1.1 \times Q_{pre} \times RV_{pre}/RV_{post}$$

Improvement Factor: 0.8

$$6.49 < 2.87$$

DETENTION REQUIRED

**Flood Protection Compliance**

10-year storm:

$$Q_{post} < Q_{pre}$$

14.41 < 12.47

DETENTION REQUIRED

**Post-Development Summary (Routed Flows)**

Storm Event	Peak Flow q (cfs)
1-year	2.31 (< Required 2.87 cfs)
10-year	8.53 (< Required 12.47 cfs)
50-year	12.37 (< Required 12.47 cfs)

**1-YEAR STORM ROUTING SUMMARY**

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time Interval (min)	Time to Peak (min)	Hyd. Volume (cuft)	Inflow (hyds)	Maximum elevation (ft)	Total edge used (cuft)	Hydrograph Description
1	SCS Runoff	4.824	2	722	13,305	---	---	---	PRE-DEVELOPMENT
2	SCS Runoff	6.494	2	722	18,264	---	---	---	POST DEVELOPMENT
3	SCS Runoff	6.021	2	722	14,170	---	---	---	POST TO DETENTION
4	SCS Runoff	1.890	2	720	4,362	---	---	---	BYPASS
5	Reservoir	1.498	2	736	12,586	3	252.49	5,478	DETENTION
6	Combine	2.893	2	722	17,988	4.5	---	---	COMBINE

**50-YEAR STORM ROUTING SUMMARY**

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time Interval (min)	Time to Peak (min)	Hyd. Volume (cuft)	Inflow (hyds)	Maximum elevation (ft)	Total edge used (cuft)	Hydrograph Description
1	SCS Runoff	20.09	2	722	57,883	---	---	---	PRE-DEVELOPMENT
2	SCS Runoff	21.97	2	722	65,205	---	---	---	POST DEVELOPMENT
3	SCS Runoff	18.46	2	722	49,208	---	---	---	POST TO DETENTION
4	SCS Runoff	6.281	2	720	18,974	---	---	---	BYPASS
5	Reservoir	8.569	2	730	48,757	3	257.75	14,208	DETENTION
6	Combine	12.37	2	730	85,731	4.5	---	---	COMBINE

**10-YEAR STORM ROUTING SUMMARY**

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time Interval (min)	Time to Peak (min)	Hyd. Volume (cuft)	Inflow (hyds)	Maximum elevation (ft)	Total edge used (cuft)	Hydrograph Description
1	SCS Runoff	12.47	2	722	35,193	---	---	---	PRE-DEVELOPMENT
2	SCS Runoff	14.41	2	722	41,744	---	---	---	POST DEVELOPMENT
3	SCS Runoff	10.88	2	722	31,747	---	---	---	POST TO DETENTION
4	SCS Runoff	4.620	2	720	10,820	---	---	---	BYPASS
5	Reservoir	5.504	2	732	31,396	3	265.52	9,814	DETENTION
6	Combine	8.831	2	724	41,916	4.5	---	---	COMBINE

**DRAINAGE AREA SUMMARY**

DRAINAGE AREA LABEL	INLET	TOTAL AREA (AC)	IMPERVIOUS AREA (AC)	MANAGED TURF AREA (AC)	FOREST/ OPEN SPACE AREA (AC)	C	CN	CA	TIME OF CONC. Tc (min)
EX-1	EX-1	0.40	0.28	0.12	0.00	0.72	90.8	0.288	5.0
EX-2	EX-2	0.47	0.38	0.09	0.00	0.89	97.7	0.344	5.0
EX-3	EX-3	5.33	0.82	0.33	2.18	0.45	77.3	1.480	14.0
EX-4	EX-4	0.05	0.05	0.00	0.00	0.90	98.0	0.045	5.0
Pre Total		4.36	1.53	0.46	2.18	0.52	80.7	1.413	
EX-1	EX-1	0.44	0.30	0.14	0.00	0.71	90.4	0.312	5.0
EX-2	EX-2	0.47	0.39	0.08	0.00	0.80	93.9	0.375	11.0
EX-4	EX-4	0.02	0.02	0.00	0.00	0.90	89.0	0.018	5.0
100	100	0.51	0.00	0.09	0.42	0.30	70.7	0.153	5.0
102	102	0.86	0.66	0.20	0.00	0.76	92.4	0.655	5.0
103	103	0.11	0.11	0.00	0.00	0.90	98.0	0.098	5.0
104	104	0.73	0.27	0.27	0.19	0.52	81.9	0.380	11.0
105	105	0.30	0.13	0.05	0.12	0.55	82.3	0.166	5.0
106	106	0.09	0.09	0.00	0.00	0.89	97.7	0.081	5.0
107	107	0.19	0.12	0.06	0.02	0.67	88.3	0.128	5.0
202	202	0.21	0.17	0.04	0.00	0.78	91.2	0.166	5.0
203	203	0.27	0.20	0.07	0.00	0.74	91.6	0.202	5.0
204	204	0.17	0.13	0.04	0.00	0.75	92.0	0.130	5.0
Post Total		4.38	2.58	1.05	0.75	0.65	87.5	1.410	

NOTE: THE CA VALUES FOR DRAINAGE AREAS EX-1 AND EX-2 INCREASED IN THE POST-DEVELOPMENT CONDITION AND WERE ANALYZED FOR ADEQUACY AS PART OF THE STORM DRAINAGE CALCULATIONS ON SHEET CG-302. WITHIN THE LIMITS OF ANALYSIS, THE CA VALUE FOR EX-4 DECREASED IN THE POST-DEVELOPMENT CONDITION; THEREFORE, NO FURTHER ANALYSIS FOR DRAINAGE AREA EX-4 IS NECESSARY.

**Kimley»Horn**

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**WAWA AT PARHAM AND THREE CHOPT AND WATER AND WASTE QUANTITY PLAN**

PREPARED FOR: **REBEC CO.**  
HENRICO COUNTY, VIRGINIA

REVISIONS:

No.	DATE	BY
1	11/07/18	RRP
2	07/02/19	RRP
3	01/03/19	RRP
4	01/14/19	RRP
5	01/17/19	RRP

POD# 2018-00101 & 00196

SHEET NUMBER: **CG-201**