

HYDROLOGY STUDY REPORT

PROJECT SITE:

**V.I. DEPARTMENT OF PUBLIC WORKS (DPW)
6A SUSANNABERG
CRUZ BAY, ST. JOHN, USVI 00830**



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INTRODUCTION

This site was previously developed and has a considerable amount of development that currently exist. The proposed improvements primarily encompass the replacement of the existing storm damaged maintenance building with a new state-of-the-art single story maintenance facility measuring approximately 4,370 gross square footage. The new facility will essentially fall within the same general footprint as the existing approximately combined 4,810 square feet structures.

This hydrology study will focus on a pre-development vs. a post-development analysis to ensure that the proposed improvements do not adversely impact stormwater quality and quantity beyond the pre-existing condition. Any additional impacts will be quantified and properly mitigated in accordance with the Department of Planning and Natural Resources (DPNR) requirements.

SOILS CLASSIFICATION

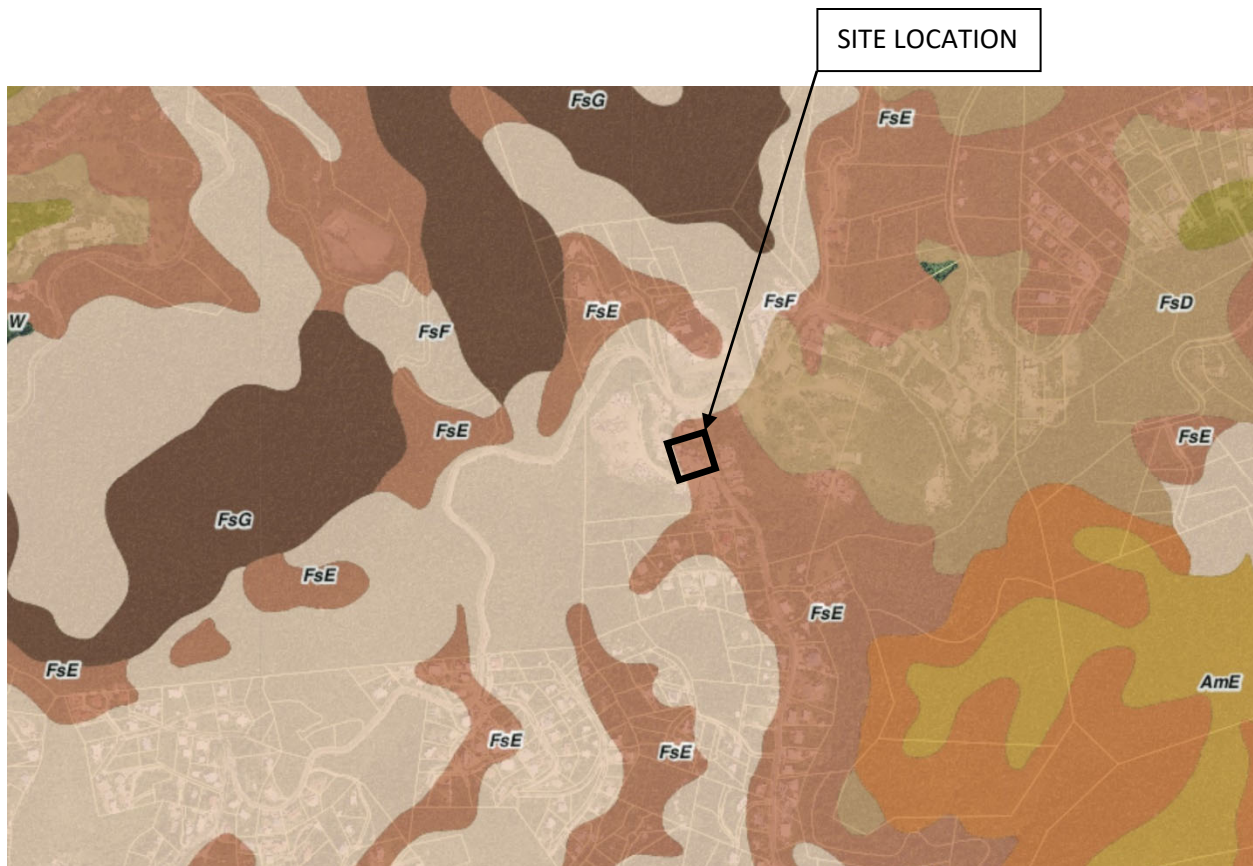
For Curve Number (CN) determination, there are four (4) main types of Hydrologic Soils Classification which are as follows:

Group A – Soils that have low runoff potential when thoroughly wet. These soils typically have less than 10% clays and more than 90% sand or gravel.

Group B – Soils that have moderately low runoff potential when thoroughly wet. These soils typically have between 10% - 20% clays and 50% - 90% sand.

Group C – Soils that have moderately high runoff potential when thoroughly wet. These soils typically have between 20% - 40% clays and less than 50% sand.

Group D – Soils that have high runoff potential when thoroughly wet. These soils typically have greater than 40% clays and less than 50% sand.



St. Croix Hydrologic Soils Classification (Source: <https://usvi.mapgeo.io>)

Based on the above, the Hydrologic Soils Classification for the Site is **Group E**. This soil classification type is synonymous with Group D in Table 3.6 below.

CURVE NUMBER (CN) CLASSIFICATION

The curve number classification is determined based on land use type and hydrologic soil type. The table below indicates CN values for various land uses and hydrologic soil types.

Table 3-6. Typical Curve Number Values for Urban Areas (SCS 1986)

Cover description Cover type and hydrologic condition	Average percent impervious area ¹	Curve numbers for hydrologic soil group			
		A	B	C	D
<i>Fully developed urban areas (vegetation established)</i>					
<i>Open space (lawns, parks, golf courses, cemeteries, etc.) ²:</i>					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
<i>Impervious areas:</i>					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
<i>Streets and roads:</i>					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
<i>Western desert urban areas:</i>					
Natural desert landscaping (pervious areas only) ⁴		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
<i>Urban districts:</i>					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
<i>Residential districts by average lot size:</i>					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
<i>Developing urban areas</i>					
<i>Newly graded areas</i>					
(pervious areas only, no vegetation) ⁵		77	86	91	94
<i>Idle lands (CN's are determined using cover types similar to those in table 2.2c).</i>					

¹ Average runoff condition, and $I_a = 0.2S$.

² The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

³ CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

⁴ Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 96) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

⁵ Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Based on the above, the site falls into four (4) distinct classifications listed as follows:

Poor Condition (grass cover < 50%) – this accounts for the grass cover within the property.

Gravel (including right-of-way) – this accounts for the gravel ground cover within the property.

Paved; open ditches (including right-of-way) – this accounts for the paved surfaces within the property.

Commercial and business – this accounts for the buildings within the property.

BASIN CHARACTERISTICS

The disturbed area of the site is approximately 0.74 acres broken down into four (4) major ground cover types. The table below shows the breakdown along with a Weighted Curve Number for each category and ultimately for the entire site.

➤ PRE-DEVELOPMENT

TABLE 1 - PRE-DEVELOPMENT BASIN CHARACTERISTICS			
DESCRIPTION	AREA	UNITS	WEIGHTED CURVE NUMBER (CN)
BUILDINGS	0.16	AC	95
PAVEMENT & SIDEWALK	0.08	AC	98
GRASS COVER	0.34	AC	89
ASPHALT PAVEMENT	0.16	AC	98

TOTAL AREA	0.74	AC
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WEIGHTED CN VALUE	93
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➤ POST-DEVELOPMENT

TABLE 2 - POST-DEVELOPMENT BASIN CHARACTERISTICS			
DESCRIPTION	AREA	UNITS	WEIGHTED CURVE NUMBER (CN)
BUILDINGS	0.09	AC	95
CONCRETE PAVEMENT & SIDEWALK	0.23	AC	98
PERVIOUS PAVEMENT (GRAVEL)	0.02	AC	91
GRASS COVER	0.40	AC	89

TOTAL AREA	0.74	AC
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WEIGHTED CN VALUE	93
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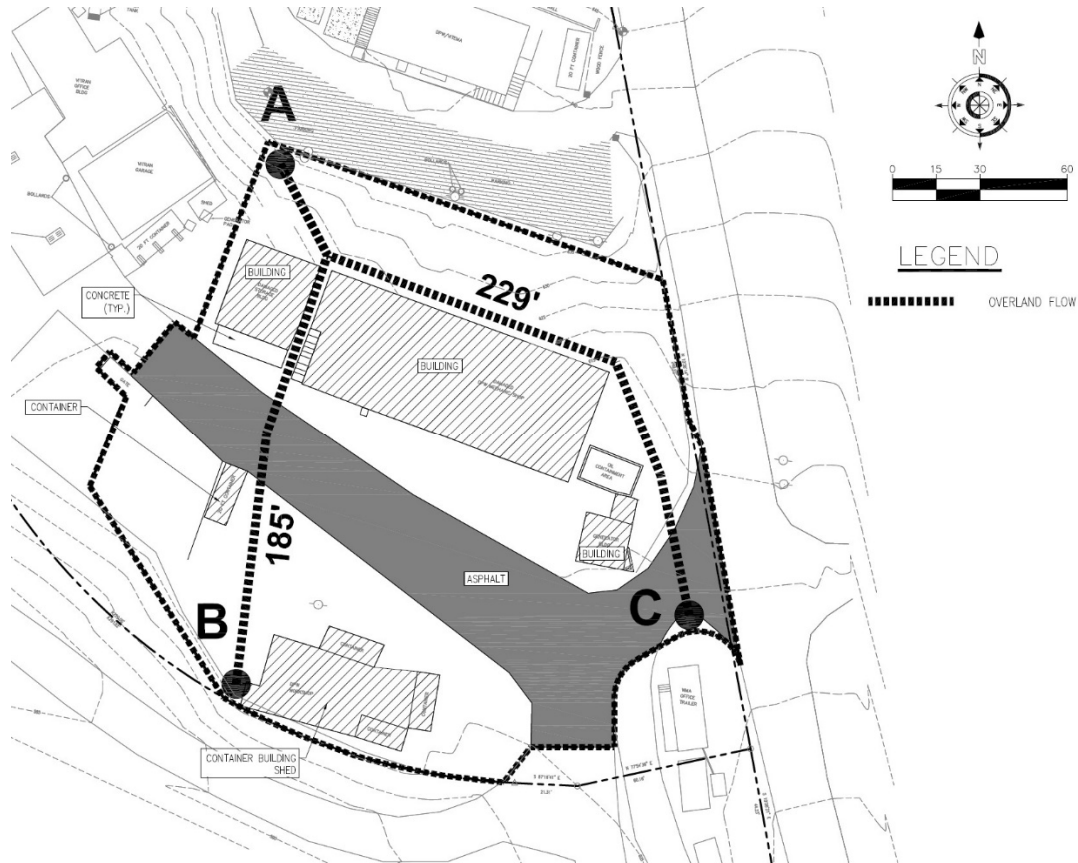
TIME OF CONCENTRATION (T_c)

The time of concentration is necessary to estimate peak discharge and is dependent upon the watershed characteristics. To accurately determine T_c, the hydraulics of each part of the flow path must be considered separately.

➤ **PRE-DEVELOPMENT**

In the pre-development, the site has two distinct flow paths, both of which are **overland** flow as follows:

- A-B (Overland Flow) – 185 ft. travel distance @ average slope of 16.2%
- A-C (Overland Flow) – 229 ft. travel distance @ average slope of 15.3%



The flow pattern will be evaluated to determine the Time of Concentration (T_c) which will be used to determine the stormwater water runoff volume.

$P_{24} =$ 4 IN (2yr_24 HOUR CUMMULATIVE RAINFALL AMOUNT)

$$T_t = \frac{(.007) (nL)^{.8}}{(P)^{.5} (S)^{.4}}$$

(OVERLAND FLOW)

TABLE 3 - PRE-DEVELOPMENT TIME OF CONCENTRATION Tc (2yr - 24 HOUR STORM)				
SEGMENT DESCRIPTION	SLOPE (S)	LENGTH (L)	MANNING'S COEF. (n)	Tt (hrs)
A-B (OVERLAND FLOW)	0.162	185	0.03	0.029
A-C (OVERLAND FLOW)	0.153	229	0.03	0.035

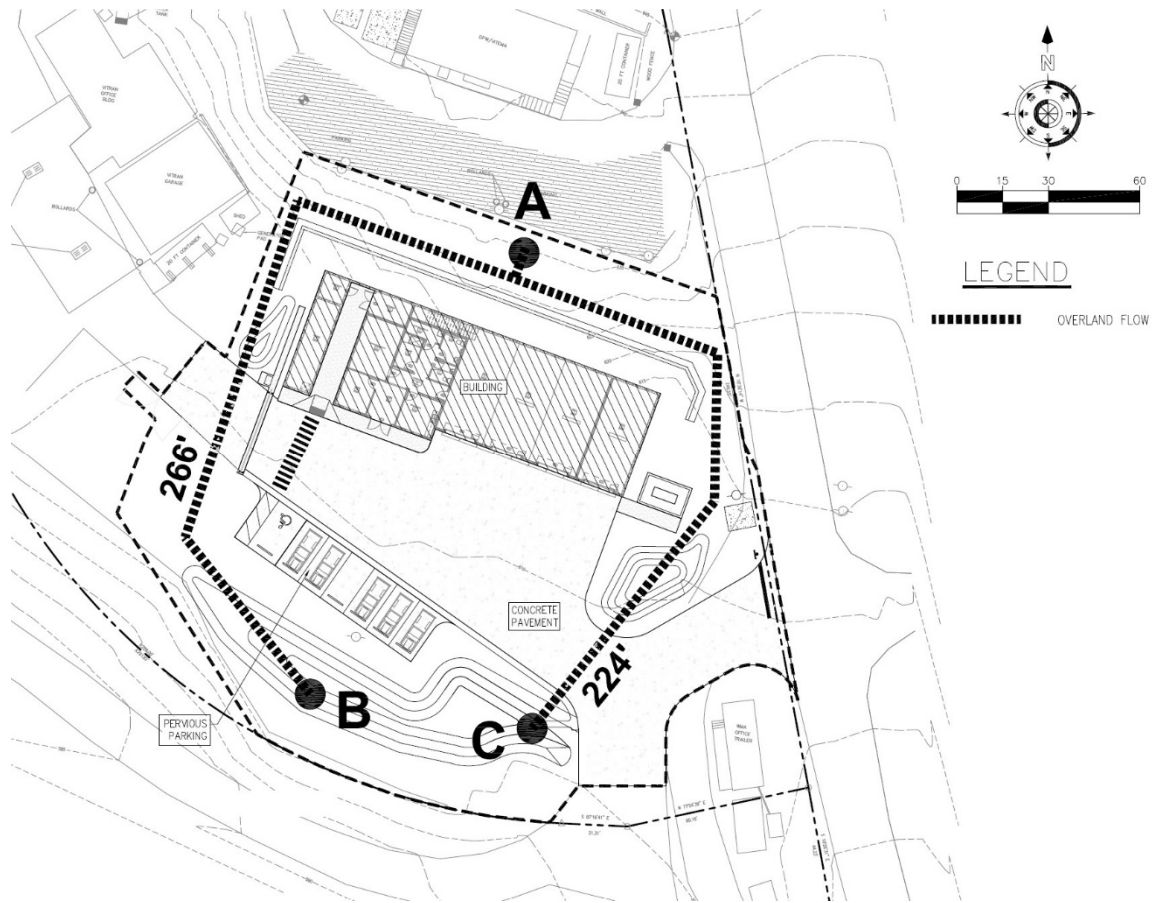
CONTROLS!!

$T_c = \sum T_t =$ 0.035 hrs (2YR - 24HR STORM)

➤ POST-DEVELOPMENT

In the post-development, the site has two distinct flow paths, both of which are overland flow as follows:

- A-B (Overland Flow) – 266 ft. travel distance @ average slope of 3%
- A-C (Overland Flow) – 224 ft. travel distance @ average slope of 5%



The flow pattern will be evaluated to determine the Time of Concentration (Tc) which will be used to determine the stormwater water runoff volume.

$P_{24} = 4 \text{ IN}$ (2yr₂₄ HOUR CUMMULATIVE RAINFALL AMOUNT)

$$T_t = \frac{(.007) (nL)^{.8}}{(P)^{.5} (S)^{.4}}$$

(OVERLAND FLOW)

TABLE 4 - POST-DEVELOPMENT TIME OF CONCENTRATION Tc (2yr - 24 HOUR STORM)				
SEGMENT DESCRIPTION	SLOPE (S)	LENGTH (L)	MANNING'S COEF. (n)	Tt (hrs)
A-B (OVERLAND FLOW)	0.03	266	0.03	0.075
A-C (OVERLAND FLOW)	0.05	224	0.03	0.053

CONTROLS!!

$T_c = \sum T_t = 0.075 \text{ hrs}$ (2YR - 24HR STORM)

RUNOFF (Q) AND STORAGE VOLUME (V)

DPNR Runoff Onsite Storage Requirements as per the *Territorial Pollutant Discharge Elimination System - General Permit Number VIGSA0000* is as follows:

- 1) 3600 cubic feet per acre (1" over 1 acre) or,
- 2) 2yr – 24 hours storm; which is greater

➤ PRE-DEVELOPMENT

PRE-DEVELOPMENT - RUNOFF (Q) AND TOTAL VOLUME (V)

Runoff equation

$$Q = \frac{\left[P - 0.2 \left(\frac{1000}{CN} - 10 \right) \right]^2}{P + 0.5 \left(\frac{1000}{CN} - 10 \right)}$$

where:

Q = runoff (in)
 P = rainfall (in)
 CN = runoff curve number

Volume Equation

$$V = QA$$

where:

Q = runoff (ft)
 A = Area (ac)

DPNR Runoff Onsite Storage Requirements
 (Territorial Pollutant Discharge Elimination System - General Permit Number VIGSA0000)

- 1) 3600 cubic feet per acre (1" over 1 acre), or
- 2) 2 yr - 24 hour storm; whichever is greater

1) 3600 CUBIC FEET PER ACRE

Disturbed Site Acreage = 0.74 ac

V = 0.06 ac-ft

2) 2 YR - 24 HOUR STORM

STORM EVENT	P (in)	CN	Q (in)	Area (ac)	V (ac-ft)
2 - YEAR	4	93	3.22	0.74	0.20

CONTROLS!

As can be noted from the above calculations, the 2yr – 24 hr. storm event generates the most runoff in the pre-development/ current site condition.

➤ **POST-DEVELOPMENT**

POST-DEVELOPMENT - RUNOFF (Q) AND TOTAL VOLUME (V)

Runoff equation

$$Q = \frac{\left[P - 0.2 \left(\frac{1000}{CN} - 10 \right) \right]^2}{P + 0.8 \left(\frac{1000}{CN} - 10 \right)}$$

where:
 Q = runoff (in)
 P = rainfall (in)
 CN = runoff curve number

Volume Equation

$$V = QA$$

where:
 Q = runoff (ft)
 A = Area (ac)

DPNR Runoff Onsite Storage Requirements
 (Territorial Pollutant Discharge Elimination System - General Permit Number VIGSA0000)

- 1) 3600 cubic feet per acre (1" over 1 acre), or
- 2) 2 yr - 24 hour storm; whichever is greater

1) 3600 CUBIC FEET PER ACRE

Disturbed Site Acreage = 0.74 ac

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2) 2 YR - 24 HOUR STORM

STORM EVENT	P (in)	CN	Q (in)	Area (ac)	V (ac-ft)
2 - YEAR	4	93	3.22	0.74	0.20

CONTROLS!

As can be noted from the above calculations, the 2yr – 24 hr. storm event generates the most runoff in the post-development.

CONCLUSION

The proposed improvements do not result in any net increase in building and impervious areas over the existing condition which is evident in the pre vs. post runoff coefficient remaining exactly the same at 93. As such, technically no additional storage would be required as the post development does not create any adverse impacts when compared to the pre-development. However, rather than provide nothing, a decision was taken to further improve the existing condition by providing enough storage to cover at least 1-inch of runoff over the entire disturbed site which equates to **0.06 ac-ft**. Site layout allowed for a slightly larger storage volume resulting in three (3) retention ponds totally **0.085 ac-ft**.

Stormwater Retention Pond Calculations

POND No. 1

Stage	Area	Area	Average Area	Incremental Volume	Cumulative Pond Volume
(ft)	(Sq. Ft)	(Acres)	(Acres)	(Ac-ft)	(Ac-ft)
605.0	447	0.010			
606.0	1,134	0.026	0.02	0.02	0.02
607.0	2,056	0.047	0.04	0.04	0.05

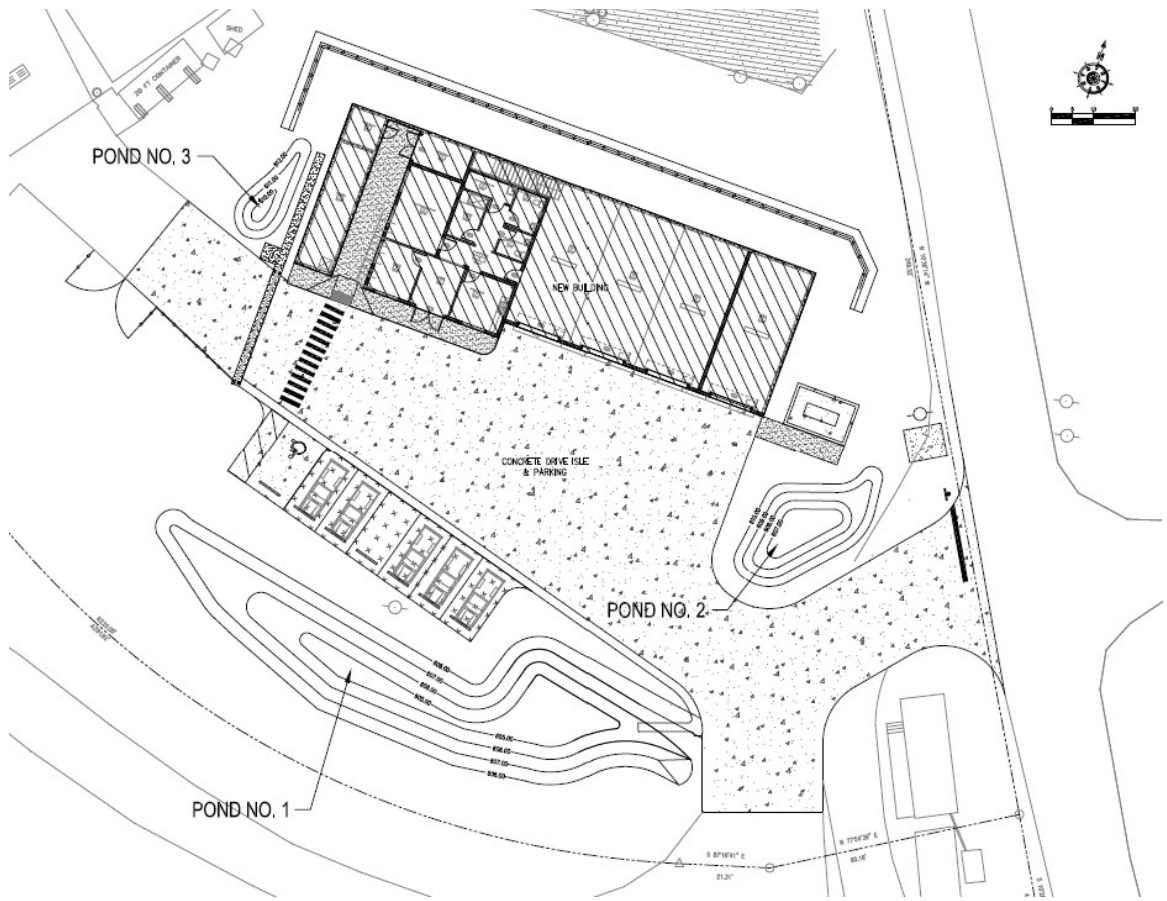
POND No. 2

Stage	Area	Area	Average Area	Incremental Volume	Cumulative Pond Volume
(ft)	(Sq. Ft)	(Acres)	(Acres)	(Ac-ft)	(Ac-ft)
607.0	119	0.003			
608.0	235	0.005	0.00	0.00	0.00
609.0	403	0.009	0.01	0.01	0.01
610.0	594	0.014	0.01	0.02	0.03

POND No. 3

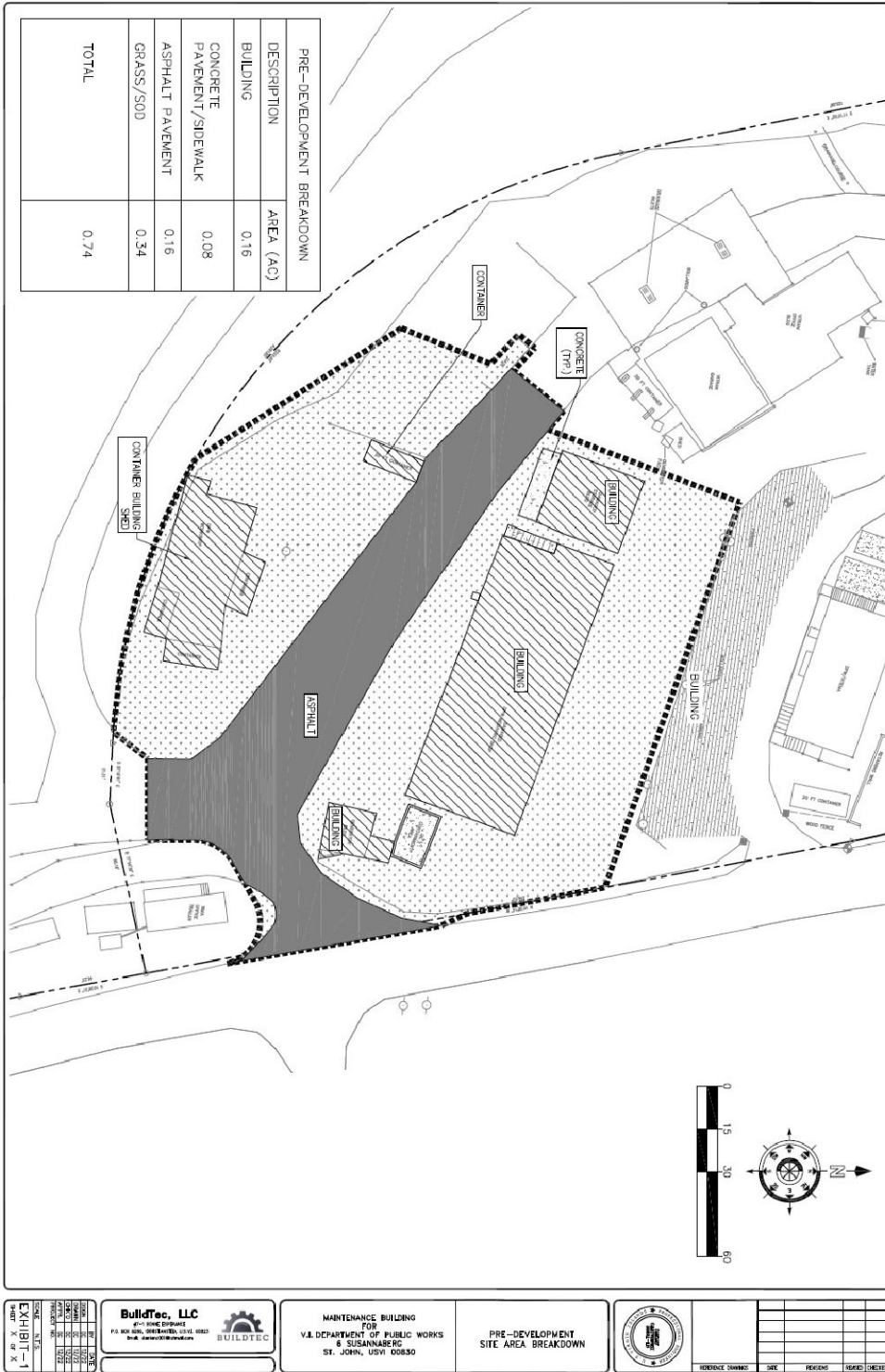
Stage	Area	Area	Average Area	Incremental Volume	Cumulative Pond Volume
(ft)	(Sq. Ft)	(Acres)	(Acres)	(Ac-ft)	(Ac-ft)
610.0	19	0.000			
611.0	91	0.002	0.00	0.00	0.00
612.0	206	0.005	0.00	0.00	0.005

Proposed Cumulative Pond Storage of 0.085 Ac-ft >> Required Storage of 0.000 Ac-ft



STORAGE POND LAYOUT FOR A TOTAL VOLUME OF 0.085 AC-FT

APPENDICES



PRE-DEVELOPMENT SITE AREA BREAKDOWN

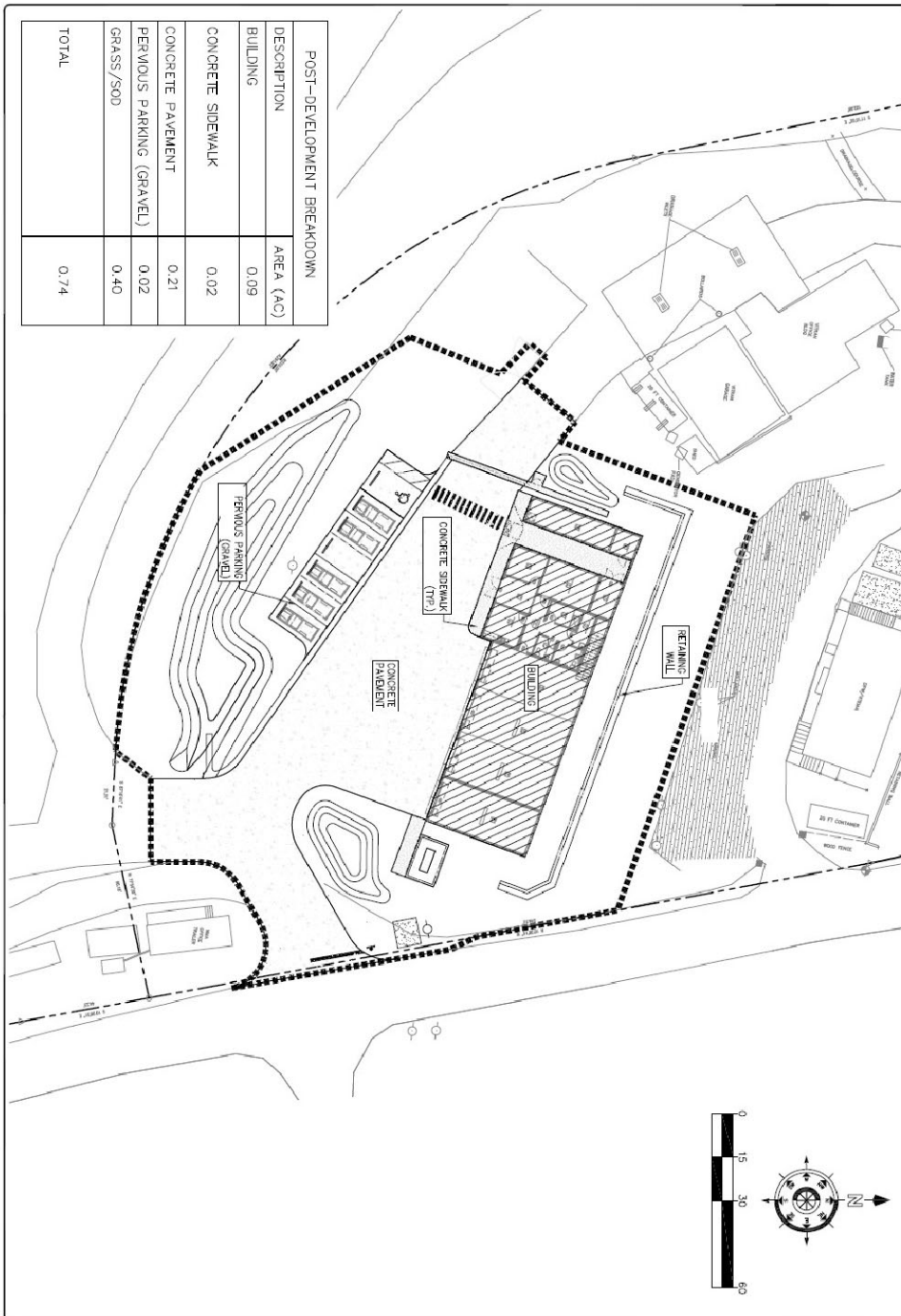


EXHIBIT - 2 SHEET 1 OF 1	 BuildTec, LLC 4700 S. STATE ST. SUITE 100 ST. JOHNS, VI 99203 TEL: 339-533-7777 WWW.BUILDTEC.COM	MAINTENANCE BUILDING FOR VI DEPARTMENT OF PUBLIC WORKS & SUGARBURG ST. JOHN, USVI 00830	POST-DEVELOPMENT SITE AREA BREAKDOWN		PREPARED BY:	DATE:	REVISION:	CHECKED:
					DRAWN BY:	DATE:	REVISION:	CHECKED:

POST-DEVELOPMENT SITE AREA BREAKDOWN