January 2015

MS4 Infeasibility & Outfall Level Exclusion Report

Project Number:
STP00-0186-01(025)

P.I. Number:
621720

Widening and Reconstruction of SR 92 from South of Nebo Road to North of SR 120

Paulding County

FOR

GEORGIA DEPARTMENT OF TRANSPORTATION

Prepared by:
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INDEX

1. MS4 Infeasibility & Outfall Level Exclusion Report

2. Feasibility Summary Matrix of Post-Construction BMP

3. Infeasibility Letter

4. Study Area Location Map

5. detailed basin study summaries for drainage areas A-0 through G-4

Georgia Department of Transportation

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Widening and Reconstruction of SR 92 from South of Nebo Road to North of SR 120

PI No. 621720

Paulding County

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Executive Summary

In all, 49 drainage basins were studied along the SR 92 widening corridor as well as at the SR 120, SR 120 Conn., SR 360, and US 278/SR 6 intersections for MS4 applicability. After studying the drainage basins, 43 drainage basins were considered infeasible due to cost and 4 basins were not required for MS4 due to either project or outfall level exclusions. The remaining 2 drainage basins that were found feasible to provide Post Construction BMPs are required to be added into the design of the project per the MS4 permit. BMPs for basin B-2 and basin E-3 are considered feasible for implementation into the project design.

A detailed Feasibility Summary Matrix for post-construction BMPs and detailed basin study summaries are also provided including area maps/plans, calculations, and graphs within the appendix.

Infeasibility Summary Table

Drainage Area ID	Infeasible BMP	Applicable Standard Design Criteria	Applicable Infeasibility Criteria or Policy
A-0	Bioretention Area / Dry Detention Pond	WQ_v, Cp_v, Q_{p25},Q_f	Cost
A-1A	Bioretention Area	WQ_v, Cp_v	Cost
A-1B	Bioretention Area	WQ_v, Cp_v	Cost
A-2	Bioretention Area	WQ_v, Cp_v	Cost
A-3A	N/A	N/A	Level Exclusion 1
A-3B	Bioretention Area	WQ_v, Cp_v	Cost
A-4	N/A	N/A	Level Exclusion 6
A-5	Bioretention Area	WQ_v	Cost
A-6A	Bioretention Area	WQ_v, Cp_v	Cost
A-6B	Bioretention Area	WQ_v, Cp_v	Cost
B-1	Bioretention Area	WQ_v, Cp_v	Cost
B-3A	Bioretention Area	WQ_v, Cp_v	Cost
B-3B	Bioretention Area	WQ_v, Cp_v	Cost
B-4A	Bioretention Area / Dry Detention Pond	WQ_v, Cp_v, Q_{p25},Q_f	Cost
B-4B	Bioretention Area	WQ_v, Cp_v	Cost
B-5	Bioretention Area	WQ_v, Cp_v, Q_{p25},Q_f	Cost
C-1	Bioretention Area	WQ_v, Cp_v	Cost
C-2	Bioretention Area	WQ_v, Cp_v	Cost
C-3	Bioretention Area	WQ_v, Cp_v	Cost
C-4	Bioretention Area	WQ_v, Cp_v, Q_{p25},Q_f	Cost
C-5	Bioretention Area	WQ_v, Cp_v	Cost
C-6	Bioretention Area	WQ_v, Cp_v	Cost
D-1	Bioretention Area	WQ_v, Cp_v	Cost
D2-1	Bioretention Area	WQ_v, Cp_v	Displacement
D2-5	Bioretention Area	WQ_v, Cp_v	Cost
D-3	Bioretention Area	WQ_v, Cp_v, Q_{p25},Q_f	Cost
D-4	Bioretention Area	WQ_v, Cp_v	Cost
D5-1	Bioretention Area	WQ_v, Cp_v	Cost
D5-2	Bioretention Area	WQ_v, Cp_v	Displacement
E1-1A	Bioretention Area	WQ_v, Cp_v	Cost
E1-1B	Bioretention Area	WQ_v, Cp_v	Cost
E2-1	Bioretention Area	WQ_v, Cp_v	Cost
E2-2	Bioretention Area	WQ_v, Cp_v	Cost
E-4	Bioretention Area	WQ_v, Cp_v	Cost
E5-1	Bioretention Area	WQ_v, Cp_v	Cost
E5-2	N/A	N/A	Level Exclusion 6
E6-1	Bioretention Area	WQ_v, Cp_v	Cost
E6-2	Bioretention Area	WQ_v, Cp_v	Cost- Displacement
E6-3	Bioretention Area	WQ_v, Cp_v	Cost
E6-4	N/A	N/A	Level Exclusion 6

Drainage Area ID	Infeasible BMP	Applicable Standard Design Criteria	Applicable Infeasibility Criteria or Policy
F-1	Bioretention Area	WQ_v, Cp_v	Cost
F-2	Sand Filter	WQ_v, Cp_v	Cost
F-3	Bioretention Area	WQ_v, Cp_v, Q_{p25},Q_f	Cost
G-1	Sand Filter	WQ_v, Cp_v	Cost
G-2	Sand Filter	WQ_v, Cp_v	Displacement
G-3	Bioretention Area	1, 2	Cost
G-4	N/A	N/A	Level Exclusion 6

Design Methodology

Design Methodology:

1. Locate the Ultimate Outfall of the drainage basin and delineate the existing and proposed drainage areas. The Ultimate Outfall is located where the water following a drainage way leaves the Right of Way. Sheet flow is not considered to be an outfall with respect to MS4 design.
2. Study the drainage basin for the most feasible location to place a post construction BMP.
3. For each proposed drainage basin, the drainage design was altered so that the offsite water can bypass the project and the water required to be treated and stored for detention can be isolated and directed to a proposed BMP location.
4. Obtain the following:
    a. The total area draining to the proposed BMP
    b. The impervious area draining to the BMP
    c. The existing pavement area within the total area
5. Use the areas obtained and pre and post basin data to compute the four post-construction stormwater management requirements. See calculation methodology clarification for additional information.
    - Stormwater Runoff Quality Reduction Volume, WQ_v [1]
    - Stream Channel / Aquatic Resource Protection Volume, CP_v [2]
    - Overbank Flood Protection Volume, Q_{p25} [2]
    - Extreme Flood Protection Volume, Q_{f100} [2]
6. Stack[3] the 3 quantity volumes (CP_v, Q_{p25}, Q_{f100}) on top of the WQ_v to determine if a downstream analysis is required.
7. If the CP_v is the highest stacked volume, skip to step 8. This requirement can typically be handled by the use of Quality Type BMP, generally an enhanced dry swale or a bioretention basin. A downstream study is not required when the CP_v is the highest

[1] GDOT "Method 3" was used to calculate the WQ_v. See Page 5 for an explanation of "Method 3."
[2] Area within the Right of way has been used to calculate Q_d.
[3] See page 3 for stacking method.

volume, it is understood that the Q_{p25} and Q_{f100} are included within the CP_v. Meaning that significant detention, or the use of a Quantity Type BMP, is not required.

8. If either the Q_{p25} or the Q_{f100} is the highest stacked volume, a downstream analysis needs to be completed to determine if the flow from the proposed design has increased the flow from the existing condition and if detention may be required. A point 10 times downstream of the project drainage area is selected. After analysis, if the increase in flow at the 10 times point is greater than 5% of the existing flow, a detention pond will be required to release stormwater at the same rate as the existing condition.
9. The BMP menu is used, and depending on the requirement that controls, a BMP is selected. Many factors are considered when selecting between different BMPs to use, such as, Cost, Maintenance, Safety, and Site Constraints. If a Quantity Type BMP is selected, typically a dry detention pond, a BMP to handle the Quality will also be required to treat 80% of the total suspended solids. An enhanced swale, sand filter, and a bioretention basin were studied for water quality applications.
10. After selection, the BMP is then considered feasible or infeasible by reviewing the following criteria. If any of the following criteria are triggered the BMP is considered infeasible:
    1) The construction cost of the BMP is greater than 10% of the construction cost of the drainage basin.
    2) Project delays of 90 days or greater.
    3) Loss of habitat for endangered or threatened species.
    4) Significant damage to a cultural or community resource.
    5) Displacement of a residence or business.
    6) Violation of a Federal or State law or regulation.
    7) Site has shallow bedrock, contaminated soil, high groundwater, utilities, or underground facilities.
    8) Soil infiltration capacity is limited, where the soil hydraulic conductivity is less than 10^{-4} cm/second.
    9) Site is too small to infiltrate a significant volume.
    10) Site does not allow for gravity flow to the appropriate BMP.
11. If the BMP is considered feasible, the proposed BMP will be implemented into the overall project design.
12. If the BMP is deemed infeasible, a letter to the Chief Engineer stating the reasons for infeasibility will be drafted for his/her approval and signature.

<u>Project Assumptions and Understanding:</u>

- The Ultimate Outfall is located where the water following a drainage way leaves the Right of Way.
- Sheet flow is not considered with respect to MS4 design.
- If a parcel with an existing driveway does not have a proposed driveway shown in the provided current design files, the parcel is considered a displacement and the remaining area within that parcel can be used to provide an MS4 BMP.

- Site area in the downstream analysis computation refers to the area from right of way to right of way along the basin drainage area. This differs from the drainage areas used to compute the BMP volumes.
- Getting 10 times downstream when performing a downstream study is not always applicable (i.e. the confluence of a stream). The study is performed at the most logical location downstream, which might include a confluence point, making the study area much larger than 10 times the site area.
- When determining the results from the downstream analysis, a 5% increase threshold from the pre-condition to the post-condition was used when determining if detention was required along with sound engineering judgment that the increased flows would not cause adverse impacts downstream of the project.
- Enhanced Dry Swales, Surface Sand Filters, and Bioretention Basins were studied for the Quality Type BMPs.
- Grass channels were not considered due to soils infiltration rates less than 10^{-4} cm/sec.
- A Dry Detention Pond was used as a Quantity Type BMP where necessary.
- When both Quality and Quantity Type BMPs are needed in tandem within the same basin, an all or nothing approach will be utilized. This means that both BMPs have to be considered feasible or the entire basin becomes infeasible.
- Maintenance cost is not included in the cost analysis for each studied BMP. However, maintenance is taken into consideration when selecting the appropriate BMP for each basin. For example, if a Surface Sand Filter is the lowest cost option and a Bioretention Basin is the next highest cost, a Bioretention Basin is ultimately chosen because of a lower maintenance burden to the department.
- The total cost of Construction and Utilities for each basin is determined as a ratio of the total project length versus the basin length (See Figure 1). The Project Construction Cost was adjusted to remove 'big ticket items' such as the Wall Cost and the Fuel Price Adjustment Cost. Bridge costs were not included in provided cost estimates.
- Since the project passes through both rural and highly developed commercial areas, the total Right of Way Cost for each basin was calculated per acre based on land use.
- See Figure 1 for a breakdown of the cost calculations on a per linear foot basis. These are used in Feasibility Criteria '1', cost of BMP, calculations.
- Enhanced Swale lengths were calculated to not allow for volume storage with in the filter media. This follows the "Blue Book" method and not the method described in the GDOT Drainage Manual.
- GDOT "Method 3" describes the approach to calculating the Water Quality Volume. Within the drainage area to the BMP, subtract the existing impervious area from the proposed impervious area. That difference is then divided by the drainage area to the BMP and multiplied by 100. This is the Percent Impervious Area used to calculate R_v, which in turn is used to calculate the Water Quality Volume.

<u>Calculation Methodology clarification:</u>

Based on the meeting held on 1-13-2015 these items have been agreed:

- Generally the Georgia Stormwater Management Manual (GSMM) and GDOT Drainage Manual were followed.
- It was agreed that the stacking method use is as follow: The CPv is stored on top of the water quality volume, the Qp25 is stored on top of the water quality volume, and the Qf100 is stored on top of the water quality volume.
- It was agreed that the used calculation method known as "Method 3" for the Water Quality Calculation is acceptable and no change is required. "Method 3" calculates WQv using I = (Impervious area post /total post area) x 100 - (Impervious area pre /total pre area) x 100

  Then, Rv= (0.05+0.009) x I
- Area within the Right of Way has been used to calculate Accumulated Direct Runoff (Qd).This is based on Blue Book examples that calculate runoff increases not only by the impervious pavement areas but also from side slope areas that are not flowing into the urban drainage systems.
- Based on the stacking method, downstream analysis is only needed for the basins that Q_{p25} or Q_{f100} controls. Downstream analysis has been provided but in all cases renders BMP infeasible due to cost. Storm water detention design will need to be studied for each outfall as it relates to stormwater drainage design even if it has been deemed infeasible for implementation per MS4 requirements.
- Grading plans, outlet structure information and details for feasible BMPs will be included in the future overall project design.

Downstream Analysis

25-year Storm Event Peak Flow Rate at Downstream Analysis Point

Study Area	Pre-Development Flow (cfs)	Post-Development Flow without BMPs (cfs)	Post-Development Flow with BMPs (cfs)
A-0	13.77	15.64	Same as Existing flow
B-4A	59.32	63.96	Same as Existing flow
B-5	257.52	257.52	Same as Existing flow
C-4	823.13	823.13	Same as Existing flow
D-3	1282.44	1282.44	Same as Existing flow
E-3	113.66	121.69	Same as Existing flow
F-3	91.51	93.15	Same as Existing flow

Results/Conclusions

A detailed Feasibility Summary Matrix for post-construction BMPs and detailed basin study summaries for drainage areas A-0 through G-4 are provided within the appendix.

Infeasibility Results Table

Drainage Area ID	Drainage Area (ac)	Infeasible BMP	Contributing Stormwater Outlets/Drainage System ID	Standard Design Criteria Deemed Infeasible	Applicable Infeasibility Criteria or Policy
A-0	0.45	Bioretention Area / Pond	Added Drainage System	WQ_v, Cp_v, Q_{p25},Q_f	Cost
A-1A	1.33	Bioretention Area	Drainage System A & B	WQ_v, Cp_v	Cost
A-1B	1.2	Bioretention Area	Drainage System A & B	WQ_v, Cp_v	Cost
A-2	2	Bioretention Area	Drainage System C	WQ_v, Cp_v	Cost
A-3A	n/a	N/A	Cross Pipe 13	N/A	Level Exclusion 1
A-3B	7.26	Bioretention Area	Drainage System D (D-32A)	WQ_v, Cp_v	Cost
A-4	n/a	N/A	Drainage System D (D-31A)	N/A	Level Exclusion 6
A-5	3.01	Bioretention Area	Drainage System D (D-30A)	WQ_v	Cost
A-6A	0.26	Bioretention Area	Added Drainage System	WQ_v, Cp_v	Cost
A-6B	1.76	Bioretention Area	Drainage System D (D-19)	WQ_v, Cp_v	Cost
B-1	0.85	Bioretention Area	Drainage System F (F-22A)	WQ_v, Cp_v	Cost
B-3A	4.5	Bioretention Area	Drainage System G (G-8A)	WQ_v, Cp_v	Cost
B-3B	4.5	Bioretention Area	Drainage System G (G-8A)	WQ_v, Cp_v	Cost
B-4A	1.28	Bioretention Area / Pond	Drainage System H (H-2)	WQ_v, Cp_v, Q_{p25},Q_f	Cost
B-4B	1.4	Bioretention Area	Drainage System H (H-10)	WQ_v, Cp_v	Cost
B-5	3.68	Bioretention Area	Drainage System H (H-15)	WQ_v, Cp_v, Q_{p25},Q_f	Cost
C-1	7.81	Bioretention Area	Drainage System I	WQ_v, Cp_v	Cost
C-2	2.06	Bioretention Area	Drainage System I (I-23A)	WQ_v, Cp_v	Cost
C-3	0.77	Bioretention Area	Drainage System I (I-24)	WQ_v, Cp_v	Cost
C-4	1.53	Bioretention Area	Drainage System J (J-11A)	WQ_v, Cp_v, Q_{p25},Q_f	Cost
C-5	6.06	Bioretention Area	Drainage System J (J-19)	WQ_v, Cp_v	Cost
C-6	7.38	Bioretention Area	Drainage System K (K-18A)	WQ_v, Cp_v	Cost
D-1	2.63	Bioretention Area	Drainage System V (V-7A)	WQ_v, Cp_v	Cost
D2-1	2.65	Bioretention Area	Drainage System V (V-46)	WQ_v, Cp_v	Displacement
D2-5	2.09	Bioretention Area	Drainage System V (V-26B)	WQ_v, Cp_v	Cost
D-3	3.7	Bioretention Area	Drainage System V (V-23A)	WQ_v, Cp_v, Q_{p25},Q_f	Cost
D-4	2.16	Bioretention Area	Drainage System V (V-18)	WQ_v, Cp_v	Cost
D5-1	2	Bioretention Area	Drainage System V (V-30)	WQ_v, Cp_v	Cost
D5-2	1.1	Bioretention Area	Drainage System V (V-30)	WQ_v, Cp_v	Displacement

Drainage Area ID	Drainage Area (ac)	Infeasible BMP	Contributing Stormwater Outlets/Drainage System ID	Standard Design Criteria Deemed Infeasible	Applicable Infeasibility Criteria or Policy
E1-1A	1.36	Bioretention Area	Cross Pipe 30	WQ_v, Cp_v	Cost
E1-1B	2.13	Bioretention Area	Drainage System W (W-9B) - Ditch	WQ_v, Cp_v	Cost
E2-1	0.86	Bioretention Area	Ditch	WQ_v, Cp_v	Cost
E2-2	2.01	Bioretention Area	Ditch	WQ_v, Cp_v	Cost
E-4	2.46	Bioretention Area	Drainage System X (X-18A)	WQ_v, Cp_v	Cost
E5-1	2.78	Bioretention Area	Drainage System S (S-5A) - Ditch	WQ_v, Cp_v	Cost
E5-2	n/a	N/A	Sheet Flow	N/A	Level Exclusion 6
E6-1	5.24	Bioretention Area	Exist. Culvert - Ditch	WQ_v, Cp_v	Cost
E6-2	4.54	Bioretention Area	Exist. Culvert - Ditch	WQ_v, Cp_v	Cost-Displacement
E6-3	1.53	Bioretention Area	Exist. Culvert - Ditch	WQ_v, Cp_v	Cost
E6-4	n/a	N/A	Exist. Culvert - Ditch	N/A	Level Exclusion 6
F-1	3.54	Bioretention Area	Drainage System Z (Z-5B)	WQ_v, Cp_v	Cost
F-2	1.87	Sand Filter	Drainage System Z (Z-11A)	WQ_v, Cp_v	Cost
F-3	2.03	Bioretention Area	Drainage System U (U-1B)	WQ_v, Cp_v, Q_{p25},Q_f	Cost
G-1	3.44	Sand Filter	Drainage System Q (Q-9A)	WQ_v, Cp_v	Cost
G-2	6.36	Sand Filter	Drainage System Q (Q-21)	WQ_v, Cp_v	Displacement
G-3	0.54	Bioretention Area	Drainage System Q (Q-13)	1, 2	Cost
G-4	n/a	N/A	Drainage System Q (Q-12)	N/A	Level Exclusion 6

See attachment for detailed Feasibility Summary Matrix for post-construction BMPs.

Drainage Area and Footprint Figures for Infeasible BMPs

See attachment for detailed basin study summaries for drainage areas A-0 through G-4.

Water Quality Calculations

See attachment for detailed basin study summaries for drainage areas A-0 through G-4.

Channel Protection Calculations

See attachment for detailed basin study summaries for drainage areas A-0 through G-4.

Hydrologic Model Output

See attachment for detailed basin study summaries for drainage areas A-0 through G-4.

Downstream Analysis Output

See attachment for detailed basin study summaries for drainage areas A-0 through G-4.

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Feasibility Summary Matrix of Post-Construction BMP

Prepared By: Heath & Lineback Engineers INCORPORATED

Study Area	Alignment	Outfall Descr.	Outfall Station	Side	Stacked Quality / Quantity				10X Downstream study?	Fails Infeasibility Criteria Study (see description below)										Feasible? (Yes/No)	BMP Selection													Notes
					WQ_v	CP_v	Q_{p25}	Q_{p100}		1	2	3	4	5	6	7	8	9	10		Filter Strips	Grassed Channels	Enhanced Dry Swales	Enhanced Wet Swales	Infiltration Trenches	Bioslopes	Sand Filters	Bioretention Basin	Dry Detention Basins	Wet Detention Basins	Stormwater Wetlands	OGFC	Level Spreader	
A-0	SR 92	Begin Project Tie-in	11+00	RT	✓	✓	✓	✓	Yes	Yes	No	No	No	No	No	No	No	No	No	No	✗[9]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✓[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
A-1A	SR 92	X-Pipe 1 / Stream 1	17+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
A-1B	SR 92	X-Pipe 1 / Stream 1	17+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
A-2	SR 92	X-Pipe 2 / Stream 2	24+50	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
A-3A	Nebo Rd	X-Pipe 13	18+00	LT	✗	✗	✗	✗	No	-	-	-	-	-	-	-	-	-	-	Not Reqd	-	-	-	-	-	-	-	-	-	-	-	-	-	**Project Level Exclusion** - Sideroad not owned by GDOT. Coordinate with local GVMT.
A-3B	SR 92	54" Pipe	52+75	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	ESA restricts BMP location.
A-4	SR 92	Bridge / Stream 10	56+00	RT	✗	✗	✗	✗	No	-	-	-	-	-	-	-	-	-	-	Not Reqd	-	-	-	-	-	-	-	-	-	-	-	-	-	**Outfall Level Exclusion** - Impervious area has been reduced within the drainage basin.
A-5	SR 92	System	57+00	RT	✓	✗*	✗*	✗*	No*	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	* N/A - Outfall drains directly into Mill Creek which has a drainage area = 13 SM; Quantity requirements have been waved.
A-6A	SR 92	System	69+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
A-6B	SR 92	X-Pipe 32 / System	68+50	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✓[9]	
B-1	SR 92	Pipe / System	76+75	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
B-2	SR 92	X-Pipe 3 / Stream 11	79+50	LT	✓	✓	✗	✗	No	No	No	No	No	No	No	No	No	No	No	Yes	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	Assumes the property required for BMP is fully acquired per road widening.
B-3A	SR 92	X-Pipe 4 / Stream 14	93+50	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
B-3B	SR 92	X-Pipe 4 / Stream 14	93+50	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
B-4A	SR 92	System	107+30	LT	✓	✓	✓	✓	Yes	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✓[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
B-4B	SR 92	System	107+30	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
B-5	SR 92	X-Pipe 5 / System	113+75	LT	✓	✓	✓*	✓*	Yes	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	* After 10X analysis, detention is not required.
C-1	SR 92	X-Pipe 25 / X-Pipe 6	148+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
C-2	SR 92	X-Pipe 7 / System	149+65	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
C-3	SR 92	X-Pipe 8 / Stream 25	153+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
C-4	SR 92	System (J-11A)	162+50	RT	✓	✓	✓*	✓*	Yes	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	* After 10X analysis, detention is not required.
C-5	SR 92	Culvert 11/Stream 28	168+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
C-6	SR 92	X-Pipe 10	193+50	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
D-1	SR 92	X-Pipe 33 / Stream 41	209+50	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
D2-1	SR 92	System	219+50	RT	✓	✓	✗	✗	No	No	No	No	No	Yes	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
D2-5	SR 92	System	220+50	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
D-3	SR 92	X-Pipe 12	230+10	LT	✓	✓	✓*	✓*	Yes	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	* After 10X analysis, detention is not required.
D-4	SR 92	System (V-18)	241+00	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
D5-1	SR 92	X-Pipe 16	249+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
D5-2	SR 92	Proposed Drive Pipe	249+00	RT	✓	✓	✗	✗	No	-	No	No	No	Yes	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	Cost analysis was not done because the BMP would displace a business.
E1-1A	SR 120	Upstream of X-Pipe 30	23+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E1-1B	SR 120	Downstream of X-Pipe 30	23+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E2-1	SR 120	Concrete Flume	15+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E2-2	SR 120	Existing System	14+50	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E-3	SR 92	X-Pipe 17	285+00	RT	✓	✓	✓	✓	Yes	No	No	No	No	No	No	No	No	No	No	Yes	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✓[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	Bioretention Basin and Dry Detention Pond installed in tandem. Assumes the property required for BMP is fully acquired per road widening.
E-4	SR 92	X-Pipe 18	289+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E5-1	SR 92	System (S-5A)	307+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E5-2	SR 92	Existing Ditch	309+00	LT	✗	✗	✗	✗	No	-	-	-	-	-	-	-	-	-	-	Not Reqd	-	-	-	-	-	-	-	-	-	-	-	-	-	**Outfall Level Exclusion** - Impervious area has been reduced within the drainage basin.
E6-1	SR 120	Concrete Flume	42+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E6-2	SR 120	Stream 48A	42+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	Yes	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E6-3	SR 120	Ditch/Stream 48	42+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
E6-4	SR 120	Ditch/Stream 48	43+25	RT	✗	✗	✗	✗	No	-	-	-	-	-	-	-	-	-	-	Not Reqd	-	-	-	-	-	-	-	-	-	-	-	-	-	**Outfall Level Exclusion** - Impervious area has been reduced within the drainage basin.
F-1	SR 360	X-Pipe 28/ Stream 37	50+50	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
F-2	SR 360	System/Stream 40	60+00	RT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✓[3]	✗[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
F-3	SR 360	System (U-1B)	29+50	LT	✓	✓	✓*	✓*	Yes	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	* After 10X analysis, detention is not required.
G-1	US 278/SR 6	Concrete Flume	75+00	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✓[3]	✗[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	Results in significant impacts to commercial property.
G-2	US 278/SR 6	State Water 19	74+90	RT	✓	✓	✗	✗	No	-	No	No	No	Yes	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✓[3]	✗[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	Cost analysis was not done because the BMP would displace a business.
G-3	US 278/SR 6	Existing Pipe	78+00	LT	✓	✓	✗	✗	No	Yes	No	No	No	No	No	No	No	No	No	No	✗[1]	✗[2]	✗[3]	✗[3]	✗[3,4]	✗[1]	✗[3]	✓[3]	✗[5]	✗[6]	✗[6,7]	✗[1,8]	✗[9]	
G-4	US 278/SR 6	Existing Pipe	77+00	RT	✗	✗	✗	✗	No	-	-	-	-	-	-	-	-	-	-	Not Reqd	-	-	-	-	-	-	-	-	-	-	-	-	-	**Outfall Level Exclusion** - Impervious area has not changed within the drainage basin.

Infeasibility Criteria

1. Additional cost of 10% or greater per each outfall drainage area
2. Project delays of 90 days or greater
3. Loss of habitat for endangered or threatened species
4. Significant damage to cultural or community resource
5. Result in the displacement of a residence or business
6. Result in the violation of a federal or state law or regulation
7. Site has shallow bedrock, contaminated soil, high groundwater, utilities, or underground facilities.
8. Soil infiltration capacity is limited (However, engineered media could be brought in for an additional cost.)
9. Site is too small to infiltrate a significant volume
10. Site does not allow for gravity flow to the appropriate BMP

BMP Selection

1. Used in conjunction with rural roadway sections.
2. Existing site soil has a minimum infiltration rate of 0.27 in/hr.
3. Designed primarily for stormwater quaility with limited ability for channel protection.
4. Should not be constructed by Fill Sections due to the possibility of creating an unstable subgrade.
5. Controls for stormwater quantity - not intended to provide water quality treatment, provides 65% TSS.
6. Minimum drainage area is required to maintain the permanent pool and/or a continuous base flow.
7. Large land area requirement.
8. No stormwater quantity control.
9. Downgradient of the existing terrain to steep.

January 22, 2015

Glen Behrend,P.E., Program Manager
Georgia Environmental Protection Division
Watershed Protection Branch
Nonpoint Source Program, Stormwater Unit
4220 International Parkway, Suite 101
Atlanta, Georgia 30354

RE: MS4 permit, Post Construction Infeasibility for GDOT Project PI #621720, Paulding County

Dear Mr. Behrend:
A thorough investigation by qualified engineers designing post construction BMPs in compliance with GDOT's GAR041000 was completed on the above referenced project. Each of the following design criteria was examined:

1. Stormwater Runoff Quality/Reduction
2. Stream Channel Aquatic Resource Protection
3. Overbank Protection
4. Extreme Flood Protection

It was determined that the placement of BMPs to address one or more of the above criteria at the following outfalls is infeasible or not required per outfall level exclusions at 47 out of 49 study locations. A summary of these outfalls is listed below:

Alignment	Outfall Station	Side	Reason for Infeasibility	Criteria found infeasible	Study Area /Reference Section
SR 92	11+00	RT	Cost	1, 2, 3, 4	A-0
SR 92	17+00	RT	Cost	1, 2	A-1A
SR 92	17+00	RT	Cost	1, 2	A-1B
SR 92	24+50	RT	Cost	1, 2	A-2
Nebo Rd	18+00	LT	Level Exclusion 1	N/A	A-3A
SR 92	52+75	RT	Cost	1, 2	A-3B
SR 92	56+00	RT	Level Exclusion 6	N/A	A-4
SR 92	57+00	RT	Cost	1**	A-5
SR 92	69+00	RT	Cost	1, 2	A-6A
SR 92	68+50	LT	Cost	1, 2	A-6B
SR 92	76+75	LT	Cost	1, 2	B-1
SR 92	93+50	LT	Cost	1, 2	B-3A
SR 92	93+50	LT	Cost	1, 2	B-3B
SR 92	107+30	LT	Cost	1, 2, 3, 4	B-4A
SR 92	107+30	RT	Cost	1, 2	B-4B
SR 92	113+75	LT	Cost	1, 2, 3, 4*	B-5
SR 92	148+00	RT	Cost	1, 2	C-1
SR 92	149+65	RT	Cost	1, 2	C-2

Glen Behrend,P.E., Program Manager
PI# 621720
January 22, 2015

Alignment	Outfall Station	Side	Reason for Infeasibility	Criteria found infeasible	Study Area /Reference Section
SR 92	153+00	RT	Cost	1, 2	C-3
SR 92	162+50	RT	Cost	1, 2, 3, 4*	C-4
SR 92	168+00	RT	Cost	1, 2	C-5
SR 92	193+50	RT	Cost	1, 2	C-6
SR 92	209+50	RT	Cost	1, 2	D-1
SR 92	219+50	RT	Displacement	1, 2	D2-1
SR 92	220+50	RT	Cost	1, 2	D2-5
SR 92	230+10	LT	Cost	1, 2, 3, 4*	D-3
SR 92	241+00	LT	Cost	1, 2	D-4
SR 92	249+00	RT	Cost	1, 2	D5-1
SR 92	249+00	RT	Displacement	1, 2	D5-2
SR 120	23+00	RT	Cost	1, 2	E1-1A
SR 120	23+00	RT	Cost	1, 2	E1-1B
SR 120	15+00	RT	Cost	1, 2	E2-1
SR 120	14+50	LT	Cost	1, 2	E2-2
SR 92	289+00	RT	Cost	1, 2	E-4
SR 92	307+00	RT	Cost	1, 2	E5-1
SR 92	309+00	LT	Level Exclusion 6	N/A	E5-2
SR 120	42+00	RT	Cost	1, 2	E6-1
SR 120	42+00	RT	Cost- Displacement	1, 2	E6-2
SR 120	42+00	RT	Cost	1, 2	E6-3
SR 120	43+25	RT	Level Exclusion 6	N/A	E6-4
SR 360	50+50	RT	Cost	1, 2	F-1
SR 360	60+00	RT	Cost	1, 2	F-2
SR 360	29+50	LT	Cost	1, 2, 3, 4*	F-3
US 278/SR 6	75+00	LT	Cost	1, 2	G-1
US 278/SR 6	74+90	RT	Displacement	1, 2	G-2
US 278/SR 6	78+00	LT	Cost	1, 2	G-3
US 278/SR 6	77+00	RT	Level Exclusion 6	N/A	G-4

Level Exclusion 1: Roadway is not owned or operated by the Department.
Level Exclusion 6: Net impervious surface area within the outfall drainage area is reduced or remains the same as pre-developed condition.
* After 10X analysis, detention is not required.
** Outfall drains directly into Mill Creek which has a drainage area = 13 ^{SM}; Quantity requirements have been waved.

Glen Behrend,P.E., Program Manager
PI# 621720
January 22, 2015

Please see the referenced sections listed for supporting documentation, specific information, and further explanation of why post construction BMP's were determined infeasible.

Sincerely,
Georgia Department of Transportation

Margaret Pirkle, P.E.
Chief Engineer

Enclosure(s)

1/22/2015 3:45:56 PM	PRF	J:\2011006\2011006021\621720\H&L FILES\621720\621720MS4_01.dgn	STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
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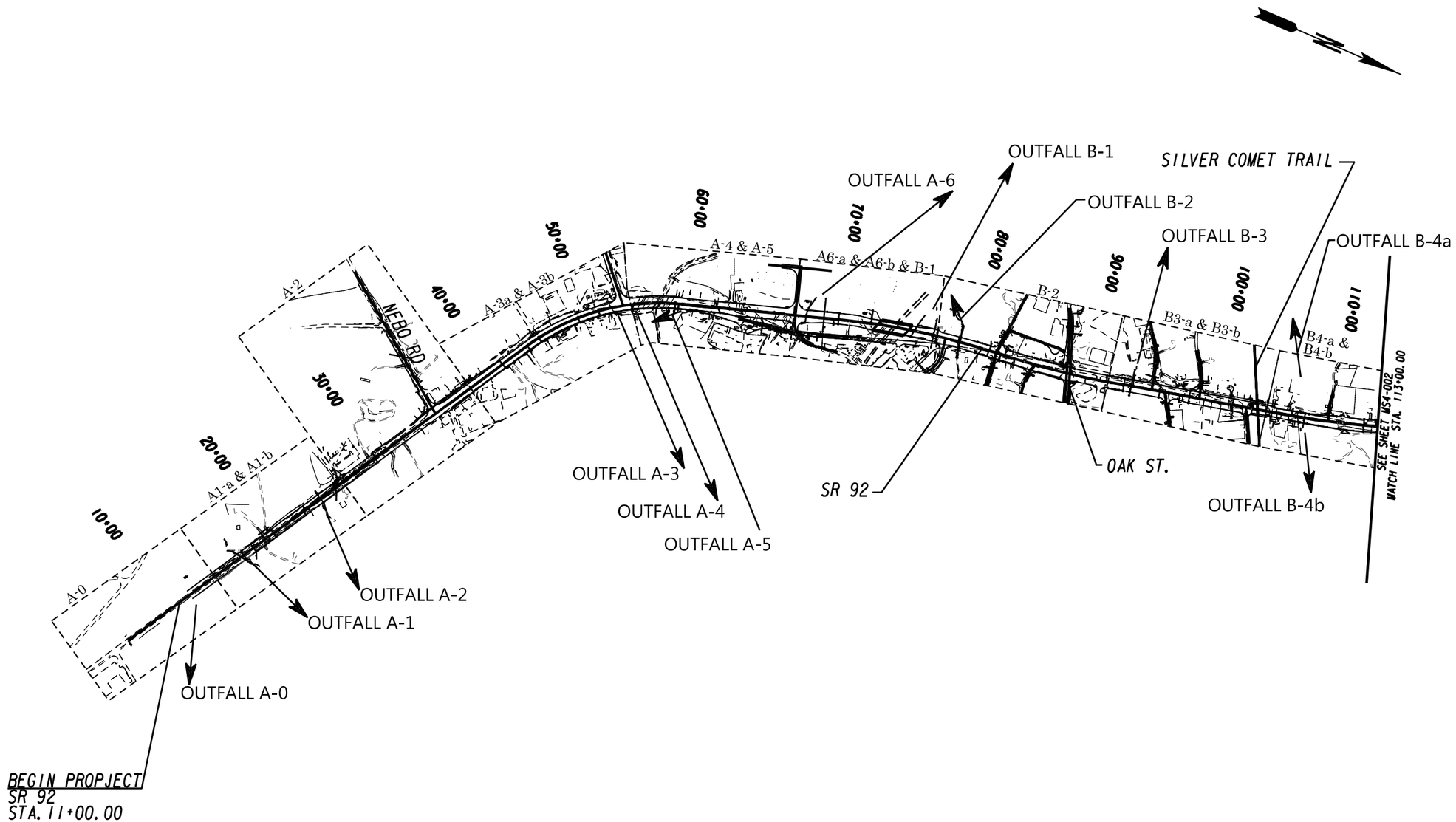


Heath & Lineback Engineers
INCORPORATED
2390 CANTON ROAD, BUILDING 200
MARIETTA, GEORGIA 30066-5393
(770)424-1668

GEORGIA
DEPARTMENT OF TRANSPORTATION

SCALE IN FEET
0 400 800 1600

REVISION DATES

STATE OF GEORGIA
DEPARTMENT OF TRANSPORTATION
OFFICE: ROADWAY DESIGN

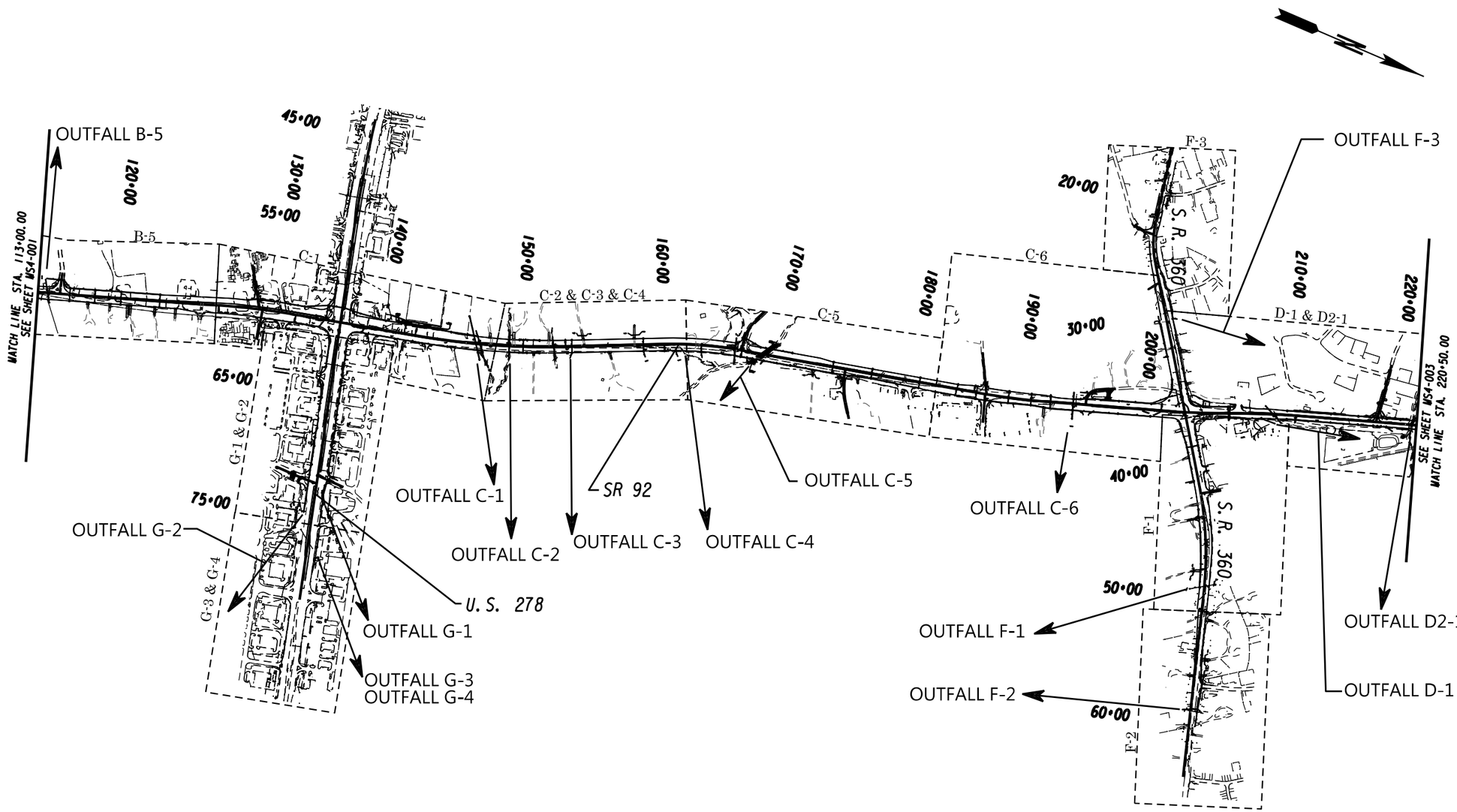
MS4 STUDY AREA LOCATION

STP00-0186-01(025)
PAULDING COUNTY

DRAWING No.
MS4-001

3/1/2007 GPUN

STATE	PROJECT NUMBER	SHEET NO.	TOTAL SHEETS
GA	STP00-0186-01(025)		



Heath & Lineback Engineers
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GEORGIA
DEPARTMENT OF TRANSPORTATION

SCALE IN FEET
0 400 800 1600

REVISION DATES		

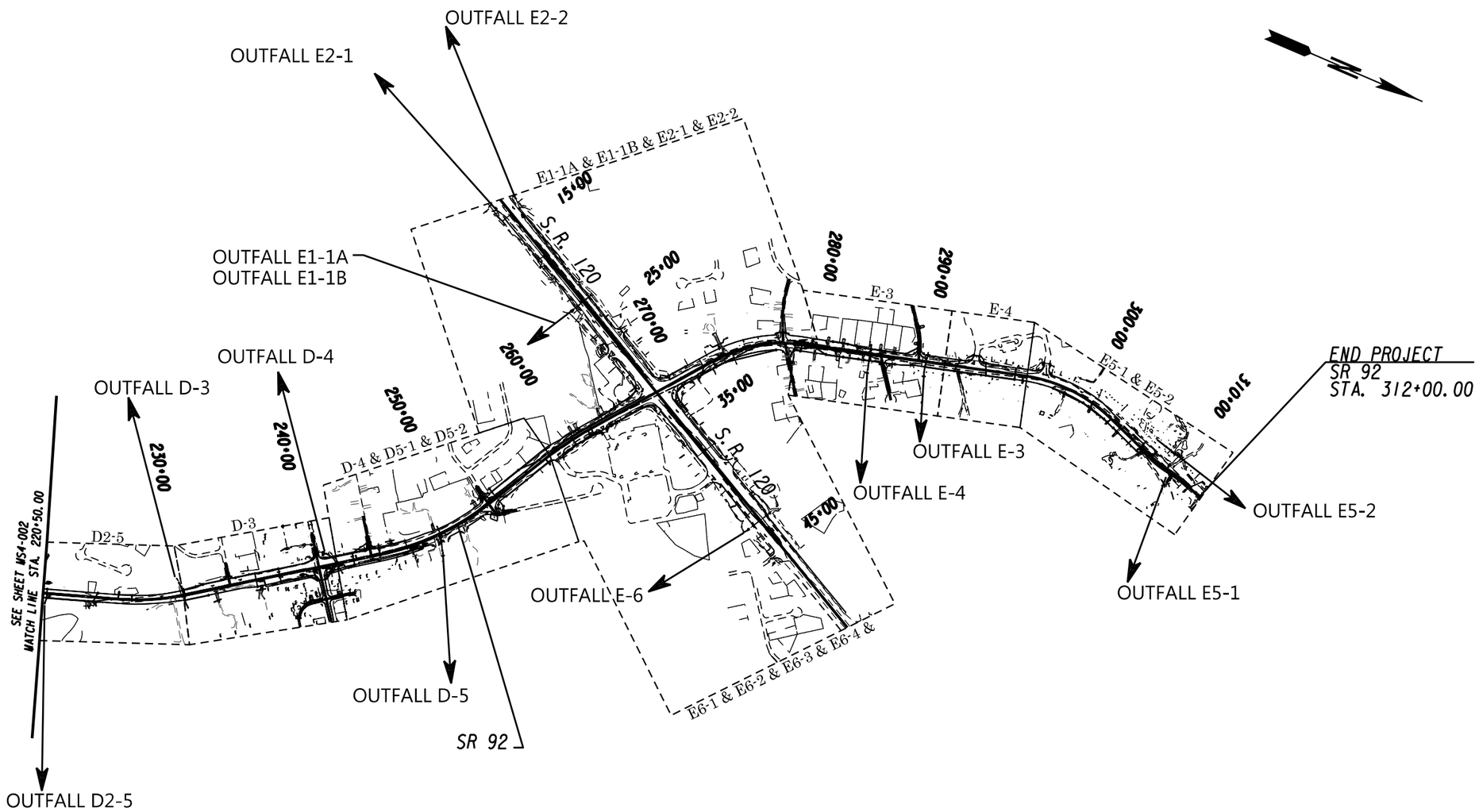
STATE OF GEORGIA
DEPARTMENT OF TRANSPORTATION
OFFICE: ROADWAY DESIGN

MS4 STUDY AREA LOCATION

STP00-0186-01(025)
PAULDING COUNTY

DRAWING No.
MS4-002

3/1/2007 GPUN



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MARIETTA, GEORGIA 30066-5393
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GEORGIA
DEPARTMENT OF TRANSPORTATION

SCALE IN FEET
0 400 800 1600

REVISION DATES

STATE OF GEORGIA
DEPARTMENT OF TRANSPORTATION
OFFICE: ROADWAY DESIGN

MS4 STUDY AREA LOCATION

STP00-0186-01(025)
PAULDING COUNTY

DRAWING No.
MS4-003

3/1/2007 GPVA

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 19, 2014
Designed By: DTS
Checked By: SCF - 11-19-14

Basin A0 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The outfall of Drainage Basin A0 was located and the existing and proposed basin drainage areas were delineated (See Figures A0.1 and A0.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	1,000	1,000
Quantity	Channel Protection, CP_v	1,180	2,180
	Overbank Flood Protection, Q_{p25}	1,028	2,028
	Extreme Flood Protection, Q_{f100}	1,263	2,263

- The total area draining to the MS4 BMP is 0.45 Ac. The total impervious area is 0.34 Ac. The existing pavement area for the site is 0.11 Ac. The area required for storage and quantity management is 0.34 Ac (See Figure A0.3).
- See General Summary sheet for additional information and overall calculation process.
- The Extreme Flood Protection volume triggers a 10 times downstream analysis.
- It was determined from that downstream analysis that the flows would cause a downstream increase of more than 5%, and that detention would be necessary (See Figure A0.4).
- A detention pond will be provided for the quantity volume (See Figure A0.6).
- 3 BMPs were studied to handle the quality volume; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 10 feet wide by 43 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs (See Figure A0.5).
- The design will require a flow splitter (See Figure A0.7).
- The flow produced by the existing paved area of 0.11 Ac will not be detained. It will be directed into the Dry Detention Basin through the flow splitter and will pass over the emergency spillway.
- A small amount of flow on the west side of SR 92 is being redirected to the east side to be treated by the proposed BMP.
- Modifications to the drainage design by the addition of pipes and catch basins are required to catch water from the end of the curb and gutter (See Figure A0.7).
- The BMP construction cost is 48.0% of the roadway construction cost within this basin making this basin infeasible (See Figure A0.8).
- None of the other infeasibility criteria apply to this basin.
- Stormwater detention for this basin should be addressed in the stormwater drainage design for the project.

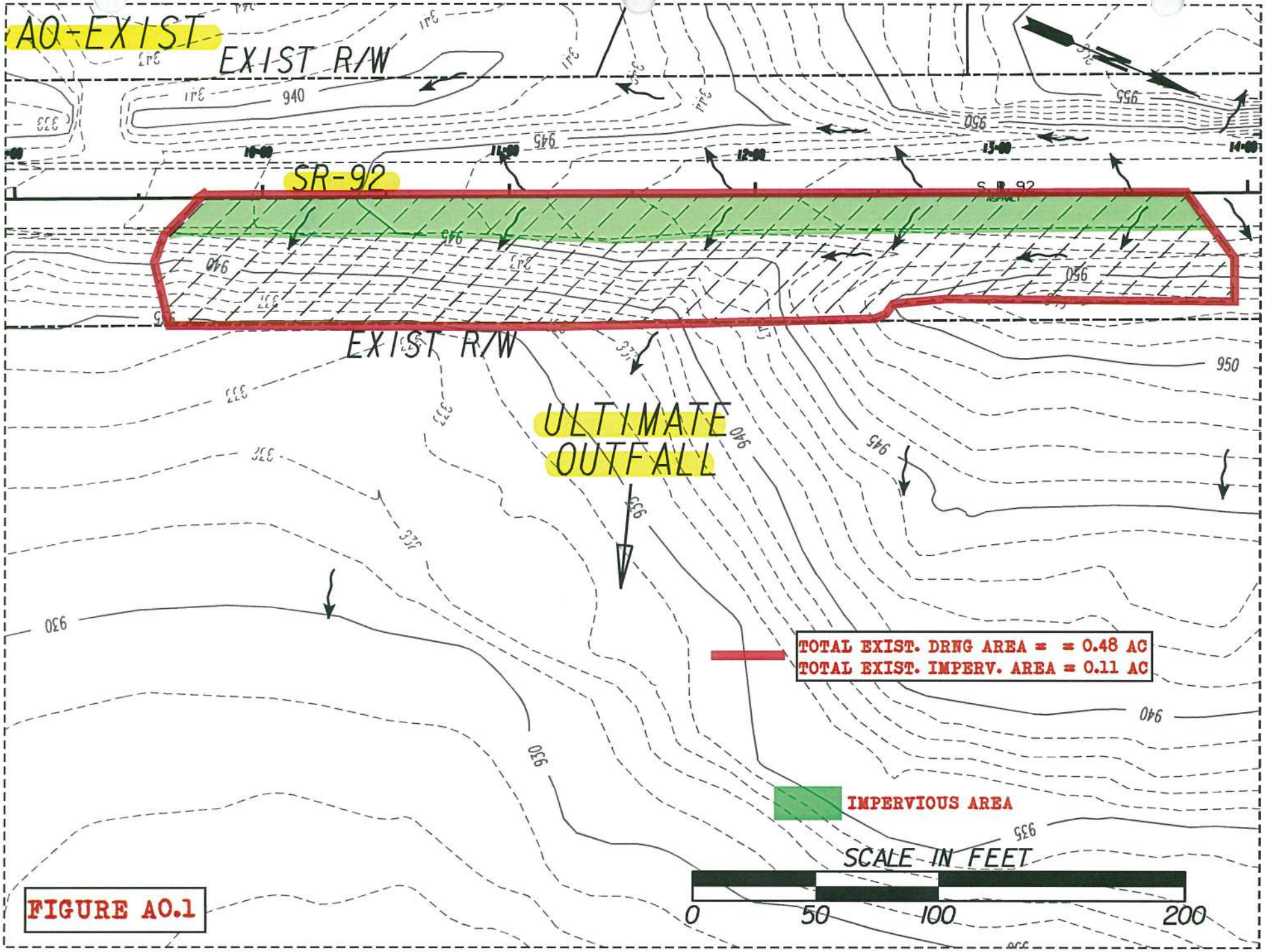

AO-EXIST
EXIST R/W
940
945
950
955
SR-92
EXIST R/W
ULTIMATE
OUTFALL
930
935
TOTAL EXIST. DRNG AREA = = 0.48 AC
TOTAL EXIST. IMPERV. AREA = 0.11 AC
IMPERVIOUS AREA
SCALE IN FEET
0
50
100
200

FIGURE AO.1

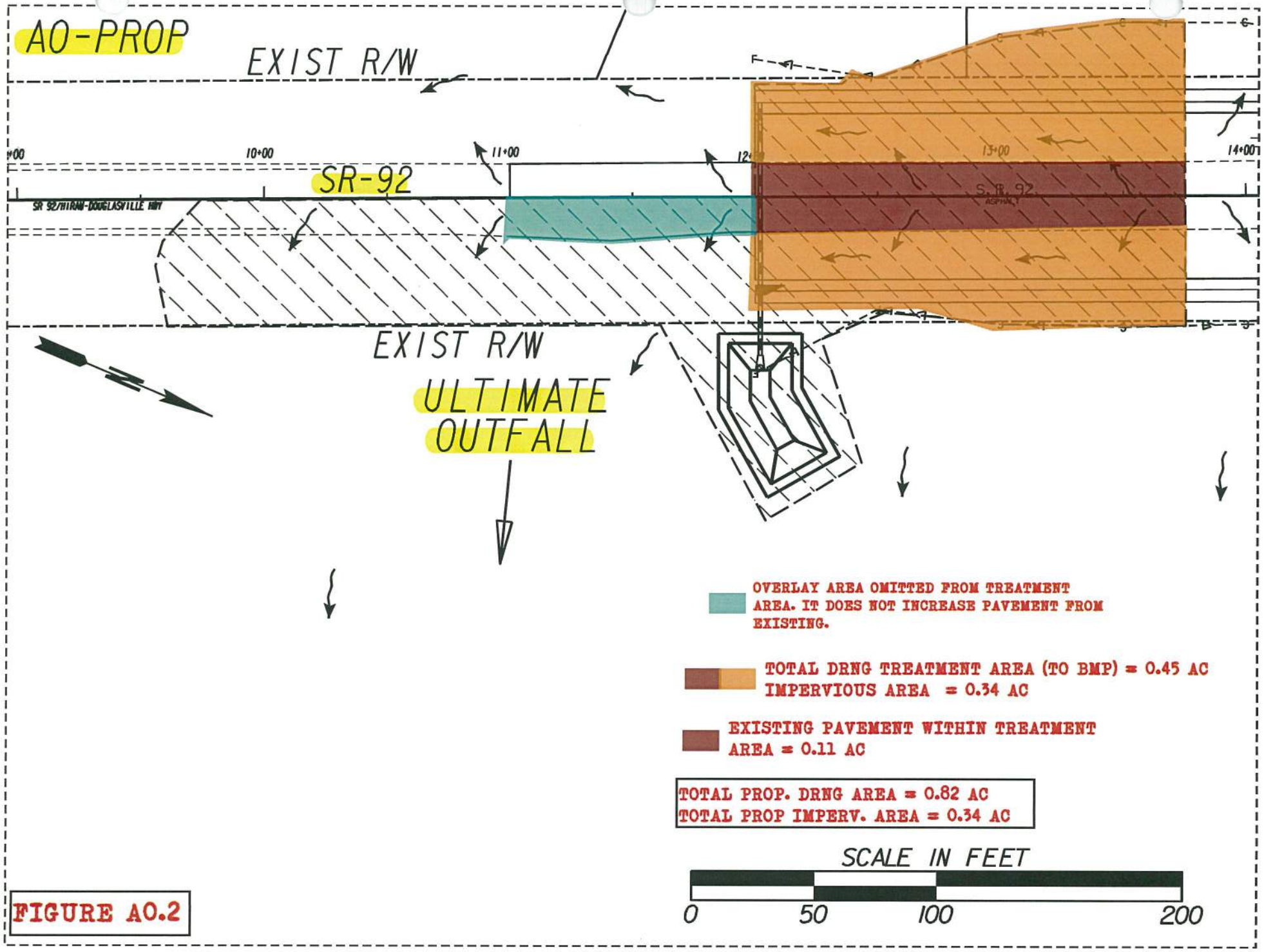

AO-PROP
EXIST R/W
10+00
11+00
13+00
14+00
SR-92
SR 92/MIRAM-DOUGLASVILLE HWY
S.R. 92
ASPHALT
EXIST R/W
ULTIMATE
OUTFALL
OVERLAY AREA OMITTED FROM TREATMENT AREA. IT DOES NOT INCREASE PAVEMENT FROM EXISTING.
TOTAL DRNG TREATMENT AREA (TO BMP) = 0.45 AC
IMPERVIOUS AREA = 0.34 AC
EXISTING PAVEMENT WITHIN TREATMENT AREA = 0.11 AC
TOTAL PROP. DRNG AREA = 0.82 AC
TOTAL PROP IMPERV. AREA = 0.34 AC
SCALE IN FEET
0
50
100
200

FIGURE AO.2

Project: 2 Widening & Reconstruction | **Unified St water Sizing Criteria** | 621720

H&L Des. | Jan-15

Outfall: *A-0* | Calcs.: DS

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	0.48
Impervious Area =	0.11
Pervious Area=	0.37

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.10 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.591

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.176	0.180
$I_a/P_{10\text{-}yr}$=	0.107	0.110
$I_a/P_{25\text{-}yr}$=	0.091	0.100
$I_a/P_{100\text{-}yr}$=	0.075	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.96

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.34
$Q_{d\ 10\text{-}yr}$=	3.08
$Q_{d\ 25\text{-}yr}$=	3.92
$Q_{d\ 100\text{-}yr}$ =	5.22

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (qu) - cfs/mi2/in

$q_{u1\text{-}yr}$=	950
$q_{u10\text{-}yr}$=	995
$q_{u25\text{-}yr}$=	1000
$q_{u100\text{-}yr}$=	1000

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	0.95
$Q_{p10\text{-}yr}$=	2.30
$Q_{p25\text{-}yr}$=	2.94
$Q_{p100\text{-}yr}$=	3.92

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi^2

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	0.82
Impervious Area =	0.34
Pervious Area =	0.48
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	82

Time of Concentration (See Table A) = 0.10 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.433

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.129	0.130
$I_a/P_{10\text{-}yr}$=	0.078	0.100
$I_a/P_{25\text{-}yr}$=	0.067	0.100
$I_a/P_{100\text{-}yr}$=	0.055	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.17

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.68
$Q_{d\ 10\text{-}yr}$=	3.57
$Q_{d\ 25\text{-}yr}$=	4.45
$Q_{d\ 100\text{-}yr}$ =	5.81

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (qu) - cfs/mi2/in

$q_{u1\text{-}yr}$=	990
$q_{u10\text{-}yr}$=	1000
$q_{u25\text{-}yr}$=	1000
$q_{u100\text{-}yr}$=	1000

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	2.13
$Q_{p10\text{-}yr}$=	4.57
$Q_{p25\text{-}yr}$=	5.70
$Q_{p100\text{-}yr}$=	7.44

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi^2

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	0.45	Acre
Total Impervious Area - A_{POST}	0.34	Acre
Existing Pavement Area - A_{PRE} (5)	0.11	Acre
Area Required for Quantity - A_{QUAN} (4)	0.34	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft^3)
0.45	0.23	51.11	0.00	0.510	0.023	1,000

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft^3)
0.02	0.65	0.031	1,358

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,562

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)^2 -0.804(qo/qi)^3 *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft^3)
0.516	0.27	0.034	1,486

$$V_s = Qp25 = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,710

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)^2 -0.804(qo/qi)^3 *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft^3)
0.527	0.27	0.044	1,909

$$V_s = Qf = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 2,196

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)^2 -0.804(qo/qi)^3 *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure AØ-4

January 2015

Outfall A0
Downstream Analysis Conclusions

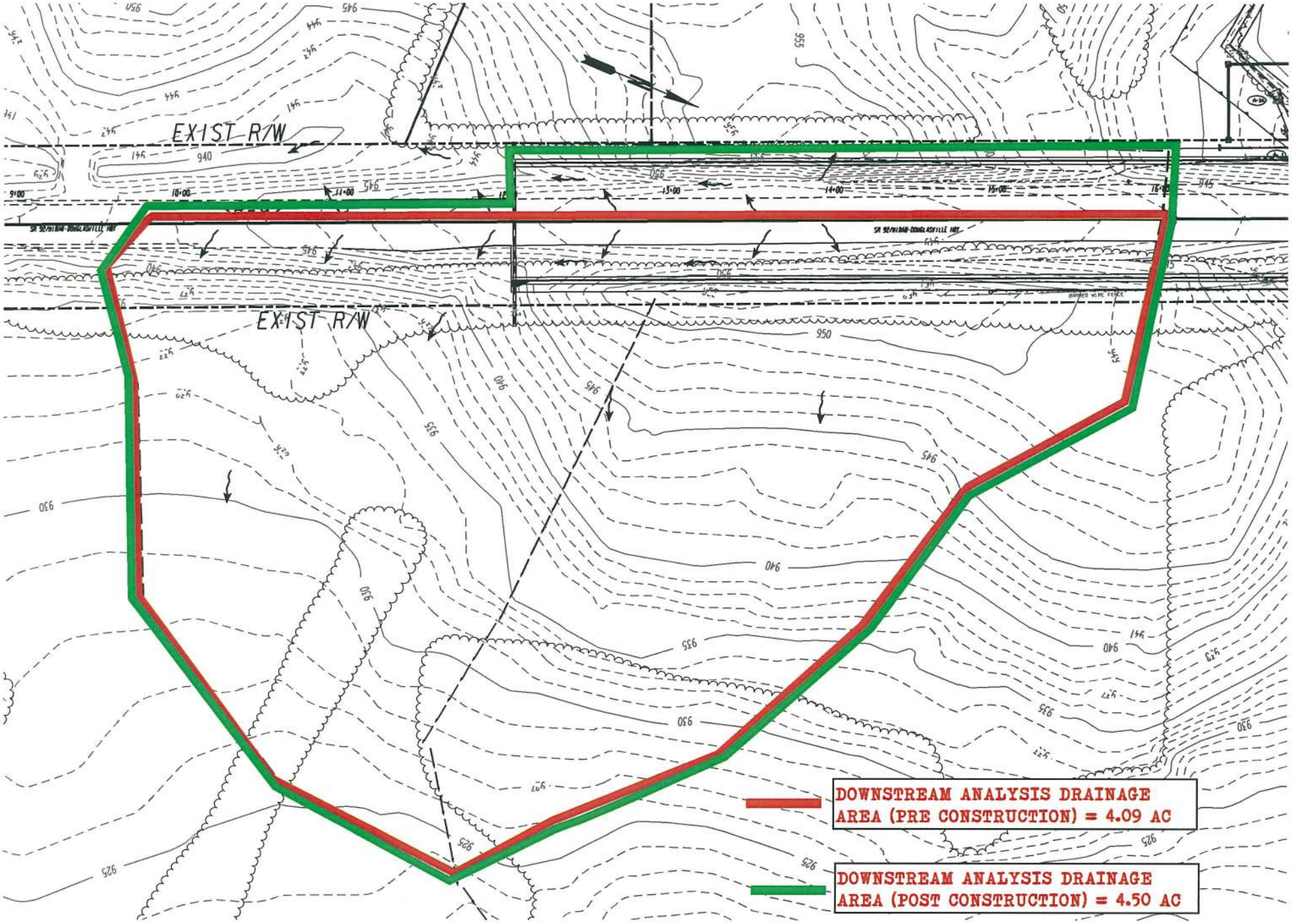
The drainage areas were delineated using a combination of the USGS quadrangle maps and the existing contours. The site area of the drainage outfall is 0.45 Ac. The 10 times watershed basin analysis area is 4.5 Ac.

The study location is approximately 450 feet downstream of the drainage outfall. The time of concentration calculations and the curve number calculations for the downstream analysis have been included along with the hydrographs depicting the pre and post conditions of the 25 and 100 year storms.

Per GDOT requirements, Storm Detention is required when adverse impacts are caused by the post-development flow and where downstream structures are subject to increased depth of flooding. The following table summarizes the results of the downstream analysis.

Outfall A0	Storm Return Frequency	Pre-Developed Peak Discharge (cfs)	Post-Developed Peak Discharge (cfs)	Discharge Increase (cfs)	% Increase
Downstream Analysis	25	13.77	15.64	1.87	13.58
	100	18.97	21.41	2.44	12.86

The analysis of the downstream conditions reflects an increase of more than 5% for both the 25 and the 100 year return periods, which represent the Overbank Flood Protection and the Extreme Flood Protection, respectively. The discharge increase for both storm frequencies falls above the GDOT maximum, so therefore according to the GDOT Policy guidelines, the detention requirement shall be required at this location.


EXIST R/W
EXIST R/W
DOWNSTREAM ANALYSIS DRAINAGE AREA (PRE CONSTRUCTION) = 4.09 AC
DOWNSTREAM ANALYSIS DRAINAGE AREA (POST CONSTRUCTION) = 4.50 AC

Curve Number Calculation
10X Downstream Assessment for Outfall A0

PRE-CONDITION type "C" soil group	TOTAL AREA 4.09 Ac	
	IMPERVIOUS AREA 0.11 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 0.00 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 3.98	71
	COMPOSITE PRE CN	71

POST-CONDITION type "C" soil group	TOTAL AREA 4.5 Ac	
	IMPERVIOUS AREA 0.3 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 0 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 4.2	71
	COMPOSITE PRE CN	72

COMP: DS

CHK :

10X Downstream Assessment for Outfall A0

TIME OF CONCENTRATION CALCULATION

Aug-14

PI No.: 621720

Drainage Area No.	Segment 1- Sheet Flow [1,2]					Segment 2- Shallow Channel [3]				Segment 3 - Open Channel [4]								TIME OF CONCENTRATION (Tc) MINUTE	Computed Intensity			
	Manning Roughness(n)	Flow Length (L) - ft	Land Slope (S) - ft/ft	i(Just for Sheet Flow)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Slope (s) - ft/ft	Velocity (ft/s)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Estimated Q	Manning Roughness Coeeficient (n)	Qn	Slope (S) - ft/ft	Vn	Velocity (ft/s)	Time of Travel (Tt)- Minute		I_{10}	I_{25}	I_{50}	I_{100}
10X A0 Pre	Computed Elsewhere				16.000	Computed Elsewhere			2.50	Assumed Values							1.00	**19.50**	4.96	5.71	6.28	6.87
10X AO Post	Computed Elsewhere				16.000	Computed Elsewhere			2.50	Assumed Values							1.00	**19.50**	4.96	5.71	6.28	6.87

Notes:

1. Kinematic Wave Equation has been used for Segment-1 time of travel (*GDOT Drainage Design manual* Page 4.9).
2. For Segment-1, "I" Values have been compared with Table A-3 "*Georgia Stormwater Management Manual* " (Page A-3)- Per *GDOT Drainage Design Manual* (page 4.13).
3. For Segment 2 Formula see *"GDOT Drainage Design manual "* Page 4.12 .
4. For Segment 3 :
   - 4.1. Find concentrated Flow length (ft)
   - 4.2. find Estimated Q value (use i from Segment 1)
   - 4.3. Qn= $Q_{estimated}$ x Manning
   - 4.4. find Vn from Table 5-19 (see *"GDOT Drainage Design manual* " Page 5.56)
   - 4.5. Velocity = Vn / Manning
5. see *"GDOT Drainage Design manual "* Page 5-25 & 5-26

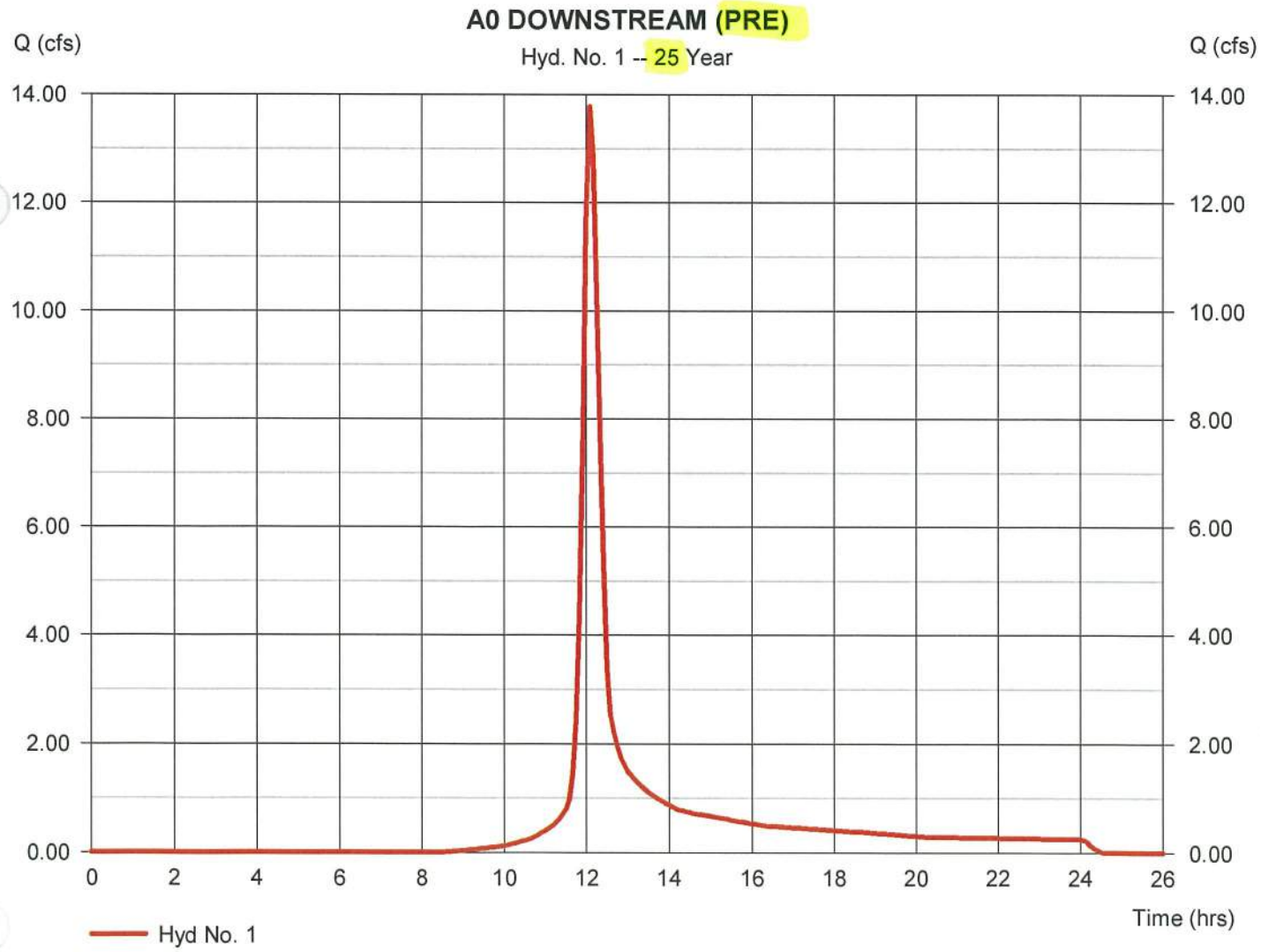
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Thursday, 01 / 15 / 2015

Hyd. No. 1

A0 DOWNSTREAM (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 13.77 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.08 hrs
Time interval	= 5 min	Hyd. volume	= 48,847 cuft
Drainage area	= 4.090 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.50 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



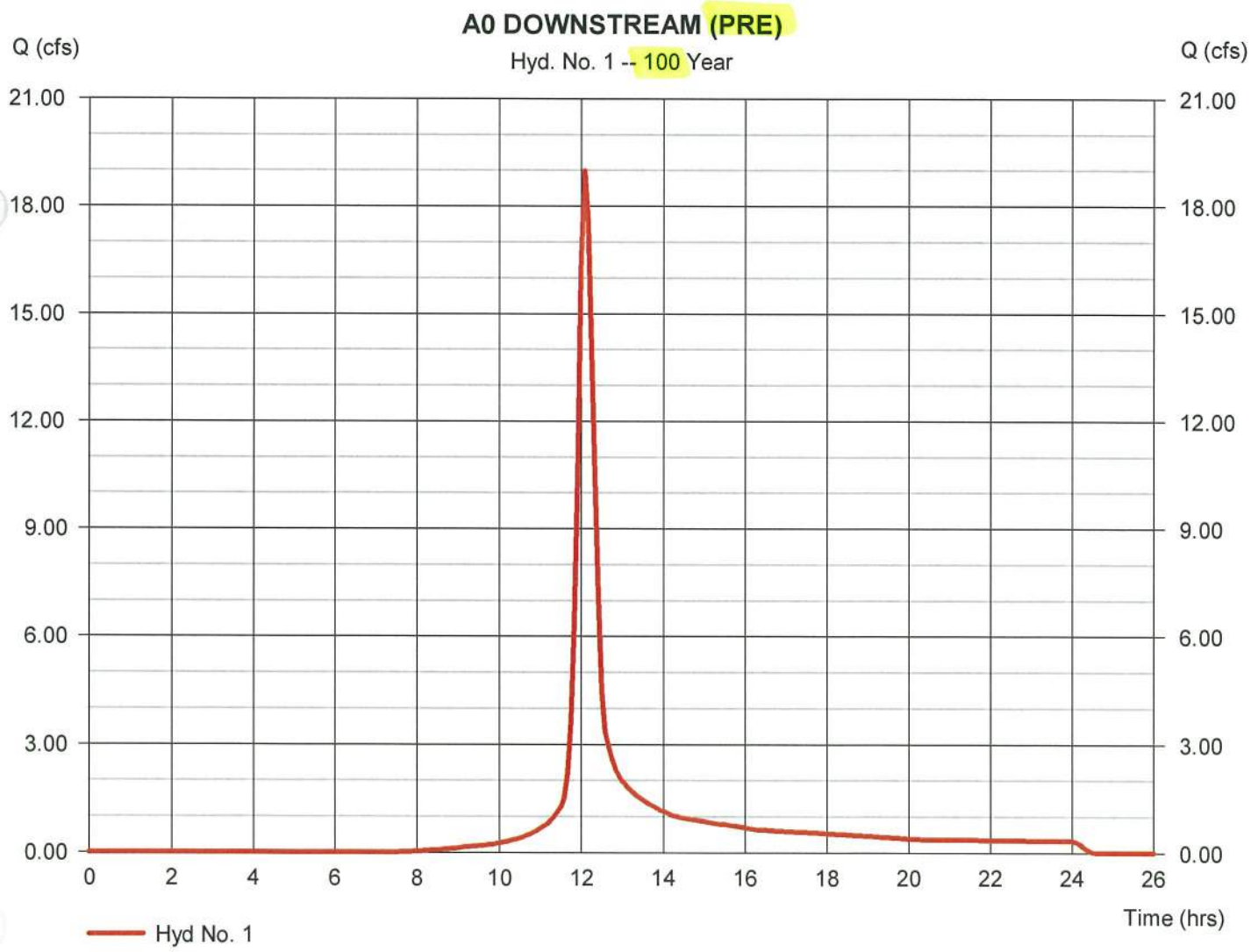
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Thursday, 01 / 15 / 2015

Hyd. No. 1

A0 DOWNSTREAM (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 18.97 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.08 hrs
Time interval	= 5 min	Hyd. volume	= 66,956 cuft
Drainage area	= 4.090 ac	Curve number	= 71
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.50 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



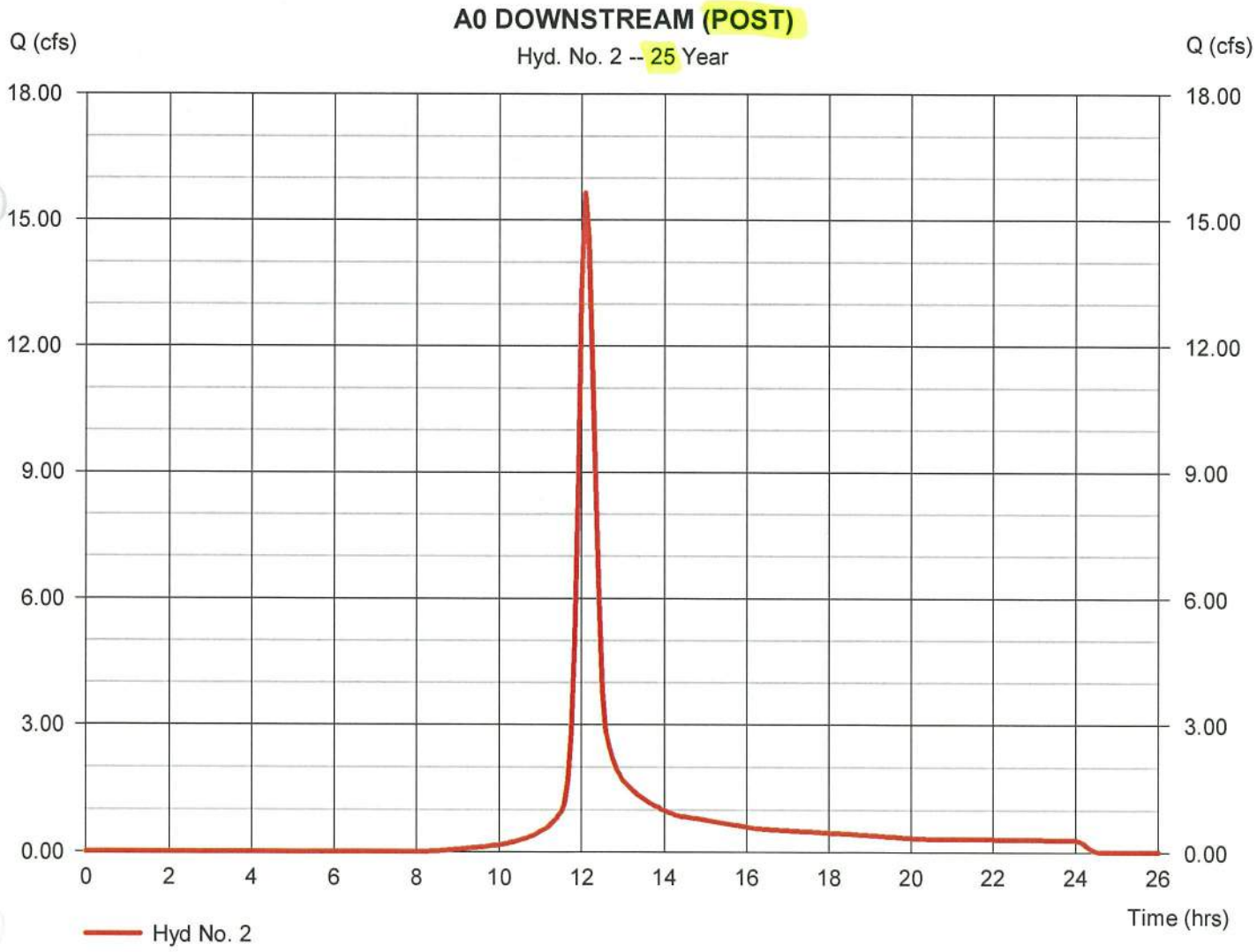
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Thursday, 01 / 15 / 2015

Hyd. No. 2

A0 DOWNSTREAM (POST)

Hydrograph type	= SCS Runoff	Peak discharge	= 15.64 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.08 hrs
Time interval	= 5 min	Hyd. volume	= 55,378 cuft
Drainage area	= 4.500 ac	Curve number	= 72
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.50 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Thursday, 01 / 15 / 2015

Hyd. No. 2

A0 DOWNSTREAM (POST)

Hydrograph type	= SCS Runoff	Peak discharge	= 21.41 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.08 hrs
Time interval	= 5 min	Hyd. volume	= 75,538 cuft
Drainage area	= 4.500 ac	Curve number	= 72
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 19.50 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

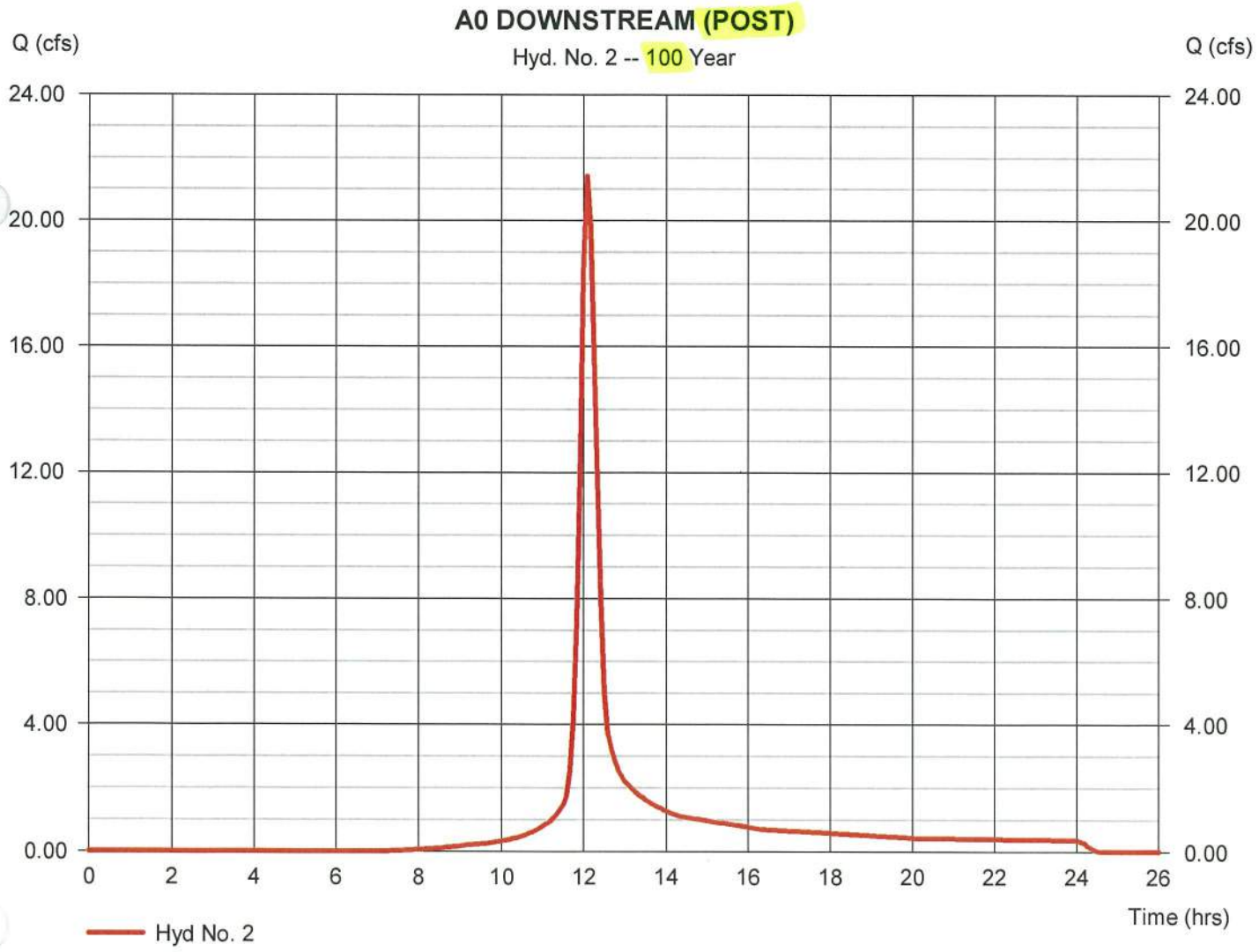


FIGURE A0.5

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-0*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: DS

	Computed Volumes	Stacked Volumes
WQ_v	1,000	1,000
CP_v	1,180	2,180
Q_{p25}	1,028	2,028
Q_{f100}	1,263	2,263

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**131**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	1007	ft^3	>	1000	ft^3

Swale Dimensions:

A swale that is **131** ft long and that is **8** ft wide.

Pond Dimensions:

Pond sized to detain 1,263 ft^3 plus 1 ft of freeboard
See AutoCAD Pond Report for exact pond size

Surface Sand Filter

WQ_v	=	1,000	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **57** ft^2

Actual Filter Bed Dimensions: Width **6** ft; Length **12** ft; 72 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*WQv**

A_S = **66** ft^2

Actual Sediment Chamber Dimensions: Width **6** ft; Length **12** ft; 72 ft^2

Bioretention Area

WQ_v	=	1,000	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **421** ft^2

Actual Filter Bed Dimensions: Width **10** ft; Length **43** ft; 430 ft^2

FIGURE A0.6

Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2015 by Autodesk, Inc. v10.4 Friday, 10 / 24 / 201

Pond No. 1 - A-0

Pond Data

Trapezoid -Bottom L x W = 20.0 x 10.0 ft , Side slope = 3.00:1 , Bottom elev. = 940.00 ft , Depth = 5.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	940.00	200	0	0
0.50	940.50	299	124	124
1.00	941.00	416	178	302
1.50	941.50	551	241	543
2.00	942.00	704	313	856
2.50	942.50	875	394	1,250
3.00	943.00	1,064	484	1,734
3.50	943.50	1,271	583	2,317
4.00	944.00	1,496	691	3,008
4.50	944.50	1,739	808	3,816
5.00	945.00	2,000	934	4,750

2.1' AT DESIGN VOLUME
+1' FREEBOARD
3.1' DEEP

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Tot cf
0.00	0	940.00	---	---	---	---	---	---	---	---	---	---	0.0
0.50	124	940.50	---	---	---	---	---	---	---	---	---	---	0.0
1.00	302	941.00	---	---	---	---	---	---	---	---	---	---	0.0
1.50	543	941.50	---	---	---	---	---	---	---	---	---	---	0.0
2.00	856	942.00	---	---	---	---	---	---	---	---	---	---	0.0
2.50	1,250	942.50	---	---	---	---	---	---	---	---	---	---	0.0
3.00	1,734	943.00	---	---	---	---	---	---	---	---	---	---	0.0
3.50	2,317	943.50	---	---	---	---	---	---	---	---	---	---	0.0
4.00	3,008	944.00	---	---	---	---	---	---	---	---	---	---	0.0
4.50	3,816	944.50	---	---	---	---	---	---	---	---	---	---	0.0
5.00	4,750	945.00	---	---	---	---	---	---	---	---	---	---	0.0

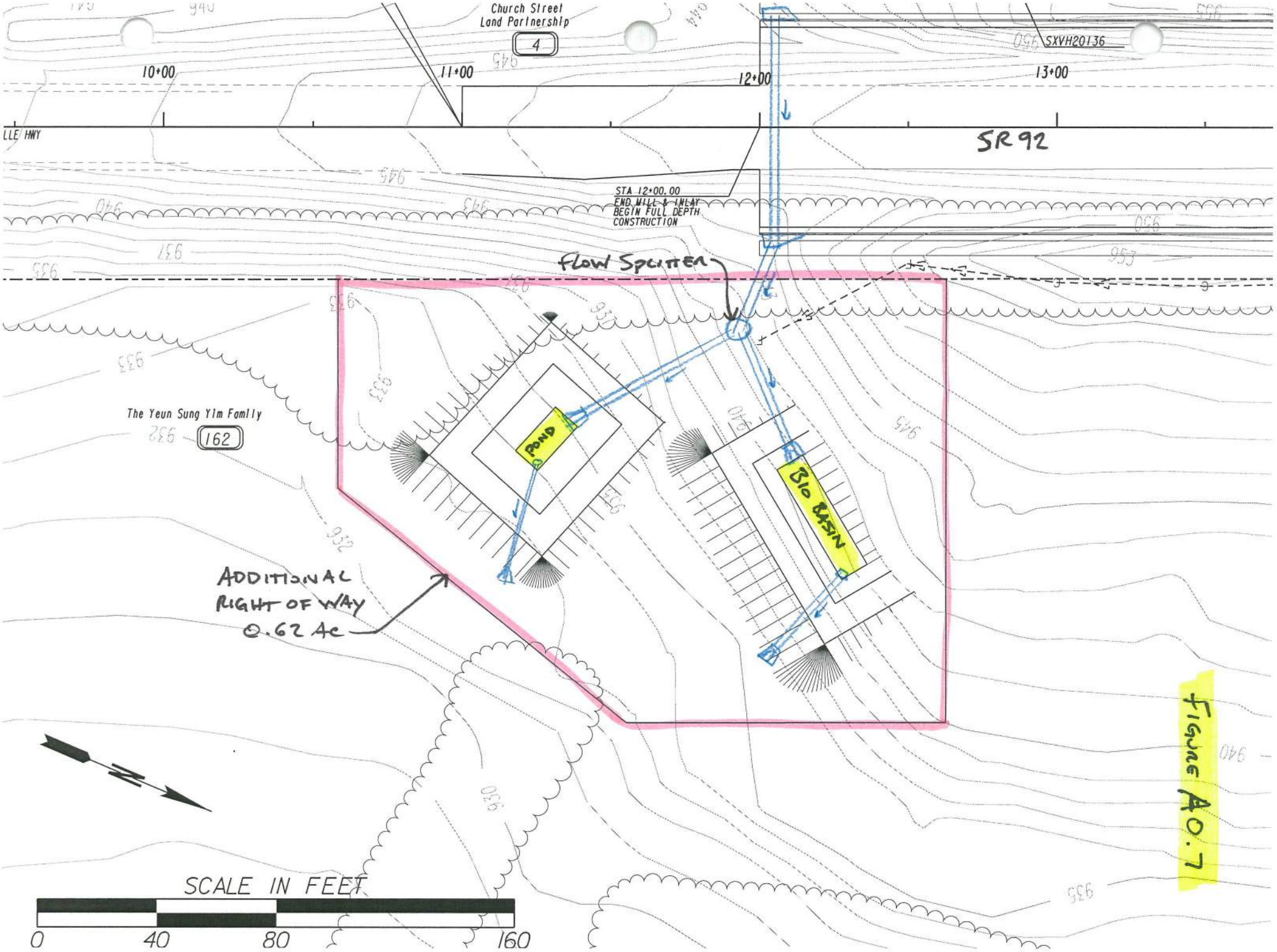

Church Street
Land Partnership
4
SXVH20136
10+00
11+00
12+00
13+00
LLE HWY
SR 92
STA 12+00.00
END MILL & INLAY
BEGIN FULL DEPTH
CONSTRUCTION
Flow Splitter
The Yeun Sung Yim Family
162
POND
BIO BASIN
ADDITIONAL
RIGHT OF WAY
0.62 Ac
SCALE IN FEET
0
40
80
160

Figure A0.7

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin A0

Basin A0 200 LF of Roadway construction cost within basin

Item	Basin A0 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 13,742.50	$ 35,640.00	$ 37,620.00	$ 30,935.00
Utilities ✪	$ 15,331.92	$ -	$ -	$ -
Construction ✪	$ 130,664.83	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 3,500.00	$ 3,750.00	$ 3,100.00
Grading	$ -	$ 10,950.00	$ 3,600.00	$ 4,080.00
Drainage	$ -	$ 35,404.38	$ 42,991.00	$ 38,618.00
Total	$ 159,739.25	$ 85,494.38	$ 87,961.00	$ 76,733.00
	Percent of BMP Cost to Total	**53.5%**	**55.1%**	**48.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0
Sub Total:	$	-
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.5497
Sub Total:	$	13,742.50
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	13,742.50

✪ See General Summary Explaination for Cost Method

Figure A0.8

BMP Construction Cost Worksheet Basin A0

Dry Enhanced Swale with Detention Basin

Length:	131	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.7128	Ac	
Total:	$ 35,640.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 35,640.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.7	Disturbed Ac	
$ 3,500.00		

Grading

Cut	Fill	
75.000	1750.000	
$ 6.00	per CY	
Total: $ 10,950.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	3	EA		3	EA
	$ 15,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	97	CY	$ 30.00	$ 2,156.38
Uddrn Sys w/ Gravel	-	161	LF	$ 20.00	$ 3,220.00
Additional Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	60	LF	$ 43.00	$ 2,580.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	8	SY	Fabric	8	SY
	$ 460.00			$ 38.00	

Sub Total: $ 35,404.38

Surface Sand Filter with Detention Basin

	Filter Bed	Sediment Chamber	
Length:	12	12	ft
Width:	6	6	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.7524	Ac	
Total:	$ 37,620.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 37,620.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.75	Disturbed Ac	
$ 3,750.00		

Grading

Cut	Fill	
50.000	550.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		4	EA
	$ 20,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	4	CY	$ 45.00	$ 180.00
Uddrn Sys w/ Gravel	-	75	LF	$ 20.00	$ 1,500.00
Top Soil		1	CY	$ 20.00	$ 20.00
Addl Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	72	SF	$ 5.00	$ 360.00
Dist Wall Conc/Steel	-	2	CY	$ 1,020.00	$ 2,040.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	36	SY	Filter Fabric	36	SY
	$ 2,070.00			$ 171.00	

Sub Total: $ 42,991.00

Bioretention Area with Detention Basin

Length:	43	ft
Width:	10	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.6187	Ac	
Total:	$ 30,935.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 30,935.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.62	Disturbed Ac	
$ 3,100.00		

Grading

Cut	Fill	
50.000	630.000	
$ 6.00	per CY	
Total: $ 4,080.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		3	EA
	$ 20,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	32	CY	$ 30.00	$ 960.00
Uddrn Sys w/ Gravel	-	45	LF	$ 20.00	$ 900.00
Mulch	-	48	SY	$ 15.00	$ 720.00
Additional Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	2	EA	$ 30.00	$ 60.00
Ground Cover	-	6	EA	$ 15.00	$ 90.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	8	SY	Fabric	8	SY
	$ 460.00			$ 38.00	

Sub Total: $ 38,618.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 11, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin A-1A Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin A-1 was located and the existing and proposed basin drainage areas were delineated (See Figures A-1A.1 and A-1A.2). The design of the proposed roadway and the site limitation requires the roadway drainage to be treated by two BMPs, A-1A and A-1B, to reduce the size of the proposed BMPs. From the delineated drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,858	3,858
Quantity	Channel Protection, CP_v	2,936	6,794
	Overbank Flood Protection, Q_{p25}	1,881	5,739
	Extreme Flood Protection, Q_{f100}	2,490	6,348

- The total area draining to the MS4 structure is 1.33 Ac. The total impervious area is 1.21 Ac. The existing pavement area for the site is 0.30 Ac. The area required for storage and quantity management is 1.03 Ac (See Figure A-1A.3). The flow produced by the existing paved area of 0.30 Ac will pass through the proposed BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 18 feet wide by 160 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure A-1A.4).
- A bypass ditch is required to direct offsite stormwater around the proposed BMP on the west side of SR 92 (See Figure A-1A.5)
- Some modifications to the proposed drainage design can be made such as a few catch basins can be adjusted to minimum depth and system A can combine with system B. This allows stream 1 to be bypassed from the untreated roadway drainage with a separate drainage culvert (See Figure A-1A.5).
- Rock has been located on the west side of SR 92 Sta 21+50 to Sta 23+00. However, it is not within the limits of the proposed BMP (See Figure A-1A.2).
- The BMP construction cost is 13.5% of the roadway construction cost in this basin making this basin infeasible (See Figure A-1A.6).
- None of the other infeasibility criteria apply to this basin.

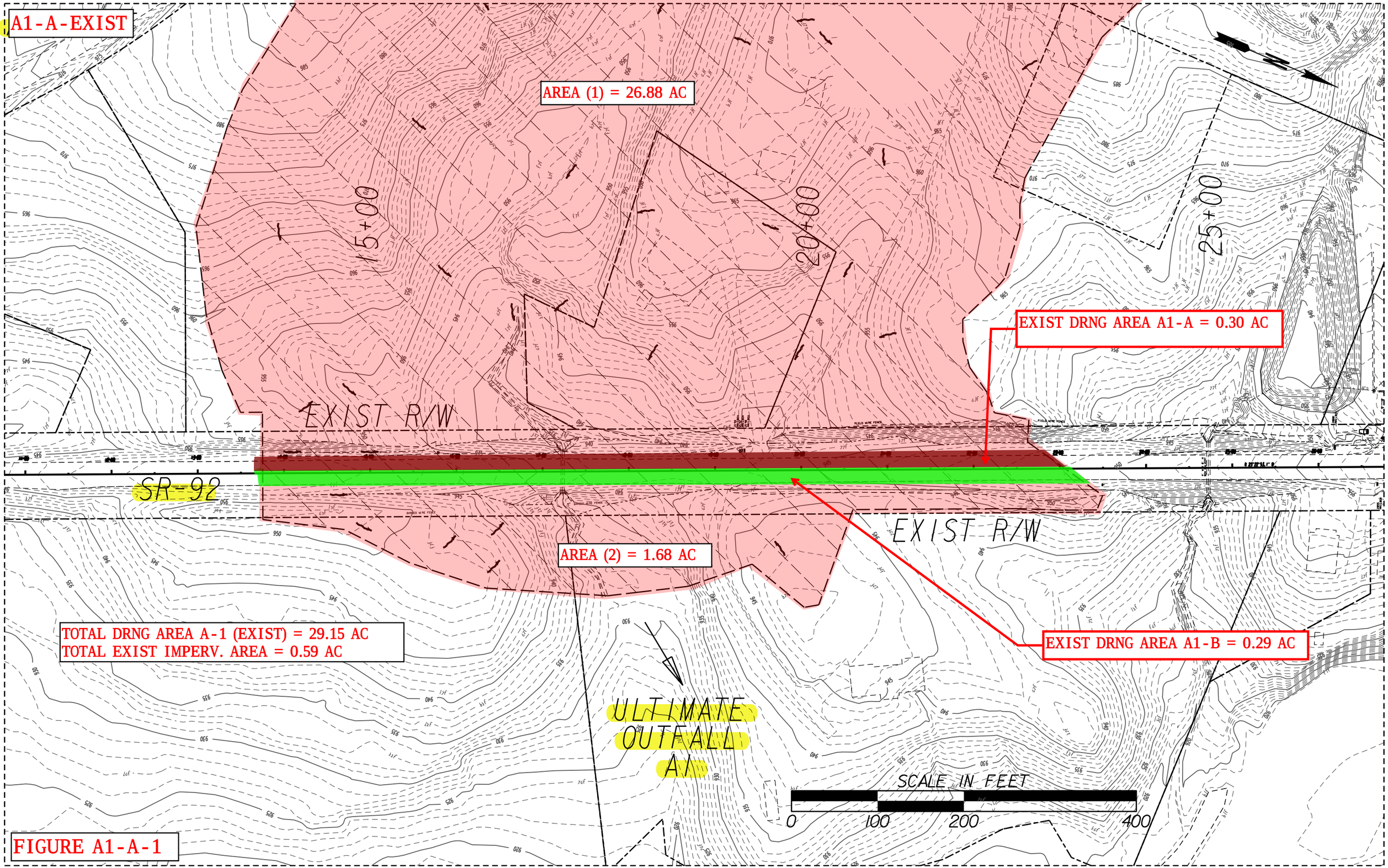

A1-A-EXIST
AREA (1) = 26.88 AC
15+00
20+00
25+00
EXIST DRNG AREA A1-A = 0.30 AC
EXIST R/W
SR-92
EXIST R/W
AREA (2) = 1.68 AC
TOTAL DRNG AREA A-1 (EXIST) = 29.15 AC
TOTAL EXIST IMPERV. AREA = 0.59 AC
EXIST DRNG AREA A1-B = 0.29 AC
ULTIMATE
OUTFALL
A1
SCALE IN FEET
0
100
200
400

FIGURE A1-A-1

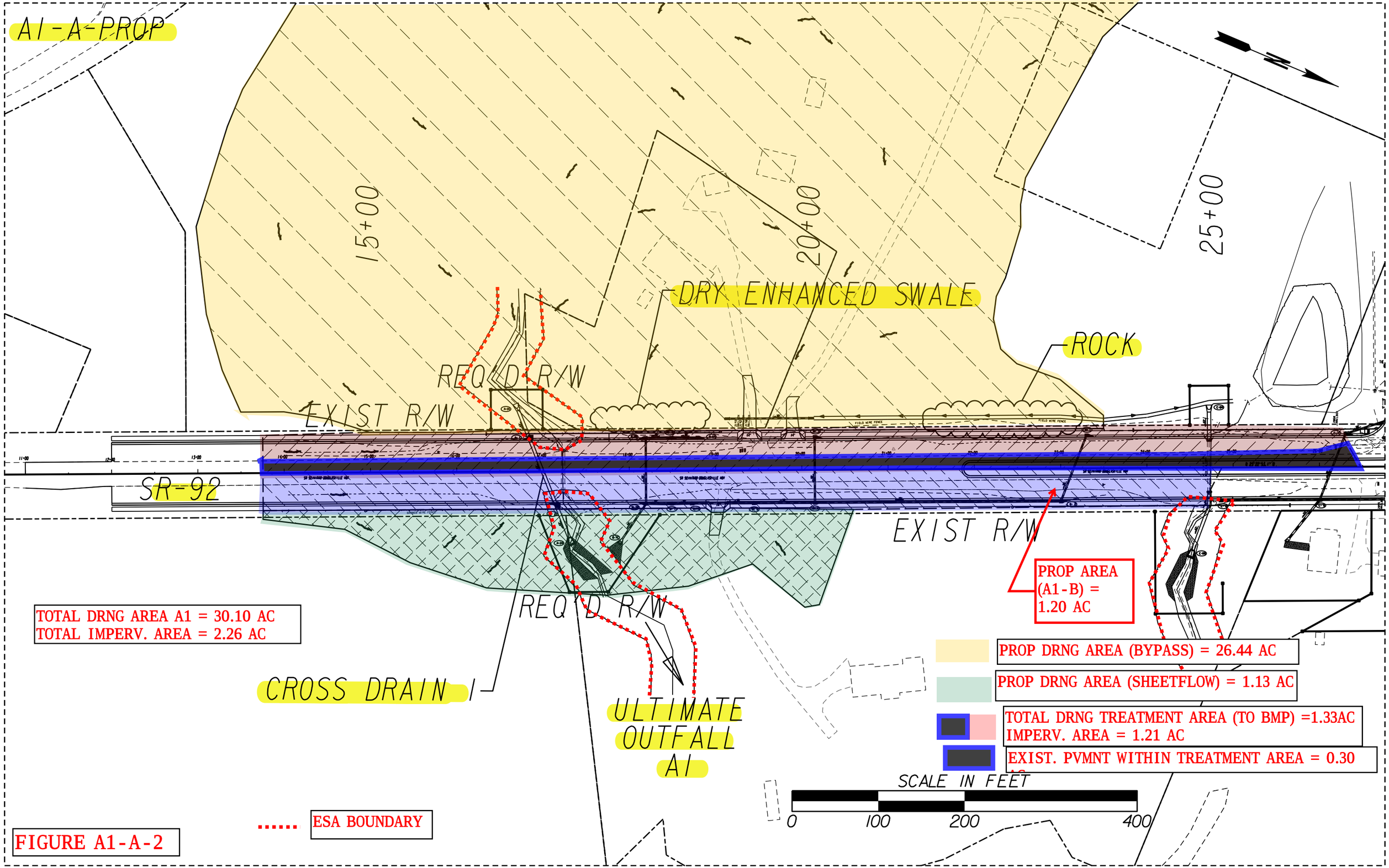

A1-A-PROP
15+00
20+00
25+00
DRY ENHANCED SWALE
ROCK
REQ'D R/W
EXIST R/W
SR-92
EXIST R/W
REQ'D R/W
PROP AREA (A1-B) = 1.20 AC
TOTAL DRNG AREA A1 = 30.10 AC
TOTAL IMPERV. AREA = 2.26 AC
CROSS DRAIN 1
ULTIMATE OUTFALL A1
PROP DRNG AREA (BYPASS) = 26.44 AC
PROP DRNG AREA (SHEETFLOW) = 1.13 AC
TOTAL DRNG TREATMENT AREA (TO BMP) =1.33AC
IMPERV. AREA = 1.21 AC
EXIST. PVMNT WITHIN TREATMENT AREA = 0.30
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE A1-A-2

Project: SR 92 Widening & Reconstruction
H&L Design
Outfall: A-1a

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: DS

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	29.15
Impervious Area =	0.59
Pervious Area=	28.56

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	72

Time of Concentration (See Table A) = 0.24 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.795

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.237	0.237
$I_a/P_{10\text{-}yr}$=	0.144	0.144
$I_a/P_{25\text{-}yr}$=	0.123	0.123
$I_a/P_{100\text{-}yr}$=	0.100	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.98

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.01
$Q_{d\ 10\text{-}yr}$=	2.57
$Q_{d\ 25\text{-}yr}$=	3.34
$Q_{d\ 100\text{-}yr}$ =	4.57

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	700
$q_{u10\text{-}yr}$=	710
$q_{u25\text{-}yr}$=	730
$q_{u100\text{-}yr}$=	750

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	32.06
$Q_{p10\text{-}yr}$=	82.96
$Q_{p25\text{-}yr}$=	111.21
$Q_{p100\text{-}yr}$=	156.19

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	30.10
Impervious Area =	2.26
Pervious Area =	27.84
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 0.24 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.739

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.220	0.220
$I_a/P_{10\text{-}yr}$=	0.134	0.134
$I_a/P_{25\text{-}yr}$=	0.114	0.114
$I_a/P_{100\text{-}yr}$=	0.093	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.69

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.09
$Q_{d\ 10\text{-}yr}$=	2.70
$Q_{d\ 25\text{-}yr}$=	3.49
$Q_{d\ 100\text{-}yr}$ =	4.74

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	700
$q_{u10\text{-}yr}$=	710
$q_{u25\text{-}yr}$=	730
$q_{u100\text{-}yr}$=	750

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	35.82
$Q_{p10\text{-}yr}$=	90.08
$Q_{p25\text{-}yr}$=	119.95
$Q_{p100\text{-}yr}$=	167.28

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.33	Acre
Total Impervious Area - A_{POST}	1.21	Acre
Existing Pavement Area - A_{PRE} (5)	0.30	Acre
Area Required for Quantity - A_{QUAN} (4)	1.03	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.33	0.68	68.42	0.00	0.666	0.089	3,858

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.04	0.63	0.059	2,552

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 2,936

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.927	0.13	0.038	1,635

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,881

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.934	0.12	0.050	2,165

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 2,490

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE A-1A.3

FIGURE A-1A.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-1a*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: DS

	Computed Volumes	Stacked Volumes
WQ_v	3,858	3,858
CP_v	2,936	6,794
Q_{p25}	1,881	5,739
Q_{f100}	2,490	6,348

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**884**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	6796	ft^3	>	6794	ft^3

Swale Dimensions:

A swale that is **884** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	6,794	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **387** ft^2

Actual Filter Bed Dimensions:	Width	**14**	ft
	Length	**28**	ft
		392	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **448** ft^2

Actual Sediment Chamber Dimensions:	Width	**14**	ft
	Length	**32**	ft
		448	ft^2

Bioretention Area

CP_v	=	6,794	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **2,861** ft^2

Actual Filter Bed Dimensions:	Width	**18**	ft
	Length	**160**	ft
		2880	ft^2

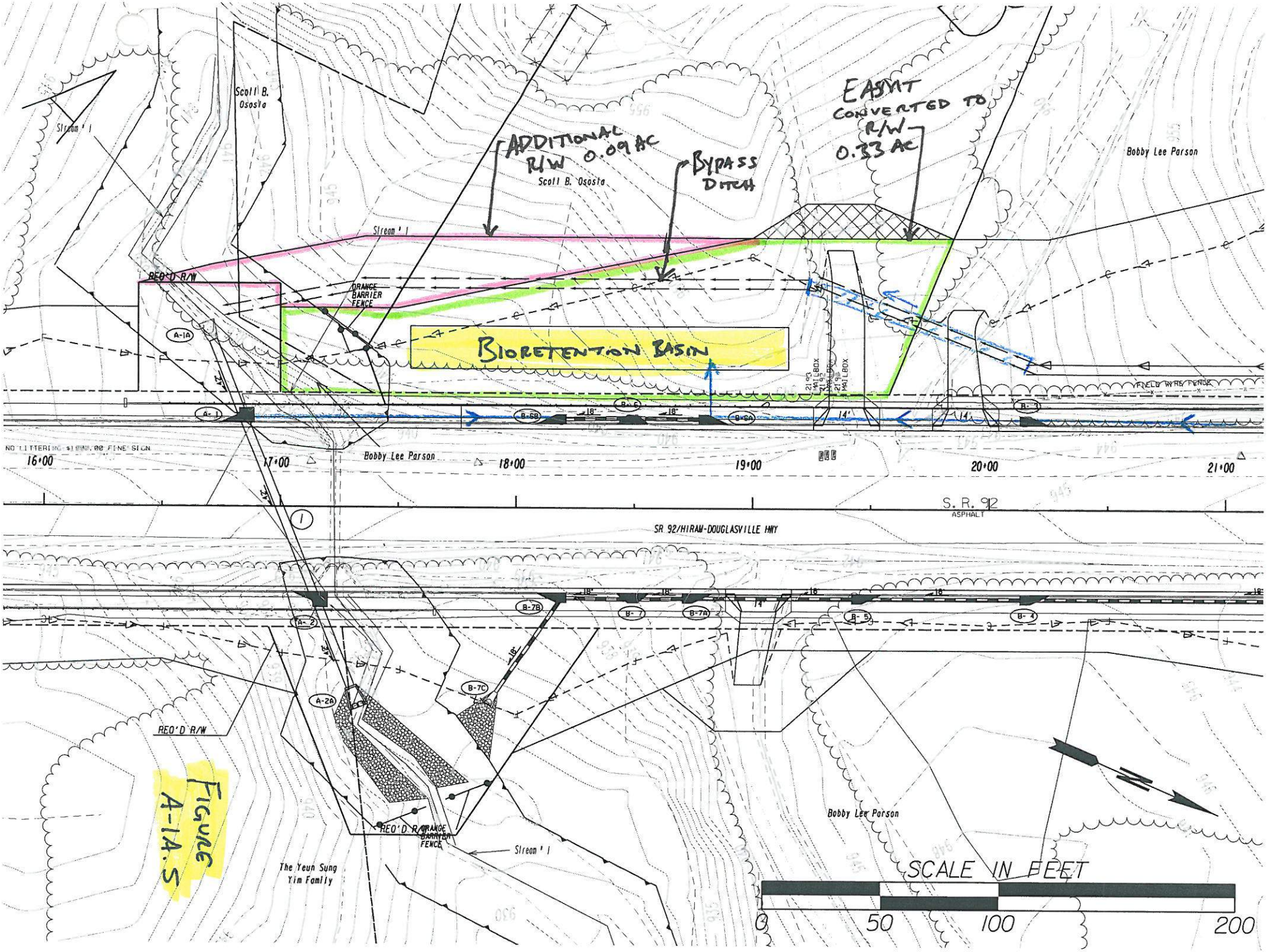

Scott B. Ososta
Stream #1
ADDITIONAL R/W 0.09 AC
Scott B. Ososta
BYPASS DITCH
EASMT CONVERTED TO R/W 0.33 AC
Bobby Lee Parson
REQ'D R/W
ORANGE BARRIER FENCE
BIORETENTION BASIN
A-1A
A-1
B-6B
B-6
B-6A
B-3
21.93 MAILBOX
21.93 MAILBOX
21.93 MAILBOX
WIRE FENCE
NO LITTERING $1000.00 FINE SIGN
16+00
17+00
18+00
19+00
20+00
21+00
S. R. 92
ASPHALT
SR 92/HIRAM-DOUGLASVILLE HWY
B-7B
B-7
B-7A
B-5
B-4
A-2
A-2A
B-7C
REQ'D R/W
REQ'D R/W
ORANGE BARRIER FENCE
Stream #1
The Yeun Sung Yim Family
Bobby Lee Parson
SCALE IN FEET
0
50
100
200

FIGURE A-1A.5

Infeasibility Criteria #1: Cost of Construction

11/6/2014

Basin A-1A

Basin A-1A 650 LF of Roadway construction cost within basin

Item	Basin A-1A Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 32,630.00	$ 54,090.00	$ 20,045.00	$ 12,750.00
Utilities ✪	$ 49,828.76	$ -	$ -	$ -
Construction ✪	$ 424,660.69	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 8,050.00	$ 2,818.00	$ 2,265.00
Grading	$ -	$ 48,000.00	$ 24,000.00	$ 18,000.00
Drainage	$ -	$ 47,761.69	$ 58,984.00	$ 35,268.00
Total	$ 507,119.45	$ 157,901.69	$ 105,847.00	$ 68,283.00
	Percent of BMP Cost to Total	**31.1%**	**20.9%**	**13.5%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.0636
Sub Total:	$	3,180.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		1.178
Sub Total:	$	29,450.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	32,630.00

✪ See General Summary Explaination for Cost Method

FIGURE A-1A.6

BMP Construction Cost Worksheet Basin A-1A

Dry Enhanced Swale

Length:	884	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.557	Ac	
Total:	$ 27,850.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	1.0496	Ac	
Total:	$ 26,240.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 54,090.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.61	Disturbed Ac	
$ 8,050.00		

Grading

Cut	Fill	
8000.000	0.000	
$ 6.00	per CY	
Total: $ 48,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		0	EA
	$ 5,000.00			$ -	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	655	CY	$ 30.00	$ 14,551.44
Uddrn Sys w/ Gravel	-	914	LF	$ 20.00	$ 18,280.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	60	LF	$ 43.00	$ 2,580.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	49	SY		49	SY
	$ 2,817.50			$ 232.75	

Sub Total: $ 47,761.69

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	28	32	ft
Width:	14	14	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.2382	Ac	
Total:	$ 11,910.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.3254	Ac	
Total:	$ 8,135.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 20,045.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.5636	Disturbed Ac	
$ 2,818.00		

Grading

Cut	Fill	
4000.000	0.000	
$ 6.00	per CY	
Total: $ 24,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		4	EA
	$ 20,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	22	CY	$ 45.00	$ 990.00
Uddrn Sys w/ Gravel	-	115	LF	$ 20.00	$ 2,300.00
Top Soil		4	CY	$ 20.00	$ 80.00
Addl Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	392	SF	$ 5.00	$ 1,960.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	224	SY	Filter Fabric	224	SY
	$ 12,880.00			$ 1,064.00	

Sub Total: $ 58,984.00

Bioretention Area

Length:	160	ft
Width:	18	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.09	Ac	
Total:	$ 4,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.33	Ac	
Total:	$ 8,250.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 12,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.453	Disturbed Ac	
$ 2,265.00		

Grading

Cut	Fill	
3000.000	0.000	
$ 6.00	per CY	
Total: $ 18,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	214	CY	$ 30.00	$ 6,420.00
Uddrn Sys w/ Gravel	-	81	LF	$ 20.00	$ 1,620.00
Mulch	-	320	SY	$ 15.00	$ 4,800.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	13	EA	$ 30.00	$ 390.00
Ground Cover	-	34	EA	$ 15.00	$ 510.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	48	SY		48	SY
	$ 2,760.00			$ 228.00	

Sub Total: $ 35,268.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 11, 2014
Designed By: DTS
Checked By: *SCF 11-19-14*

Basin A-1B Summary
BMP Recommendation – Infeasible
Fails Feasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin A-1 was located and the existing and proposed basin drainage areas were delineated (See Figures A-1B.1 and A-1B.2). The design of the proposed roadway and the site limitation requires the roadway drainage to be treated by two BMPs, A-1A and A-1B, to reduce the size of the proposed BMPs. From the delineated drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,241	3,421
Quantity	Channel Protection, CP_v	2,594	5,835
	Overbank Flood Protection, Q_{p25}	1,662	4,903
	Extreme Flood Protection, Q_{f100}	2,200	5,441

- The total area draining to the MS4 structure is 1.20 Ac. The total impervious area is 1.05 Ac. The existing pavement area for the site is 0.29 Ac. The area required for storage and quantity management is 0.91 Ac (See Figure A-1B.3). The flow produced by the existing paved area of 0.29 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 36 feet wide by 70 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure A-1B.4).
- Some modifications to the proposed drainage design can be made such as a few catch basins can be adjusted to minimum depth and system A can combine with system B. This allows stream 1 to be bypassed from the untreated roadway drainage with a separate drainage culvert (See Figure A-1B.5).
- The BMP construction cost is 11.4% of the roadway construction cost in this basin making this basin infeasible (See Figure A-1B.6).
- None of the other infeasibility criteria apply to this basin.

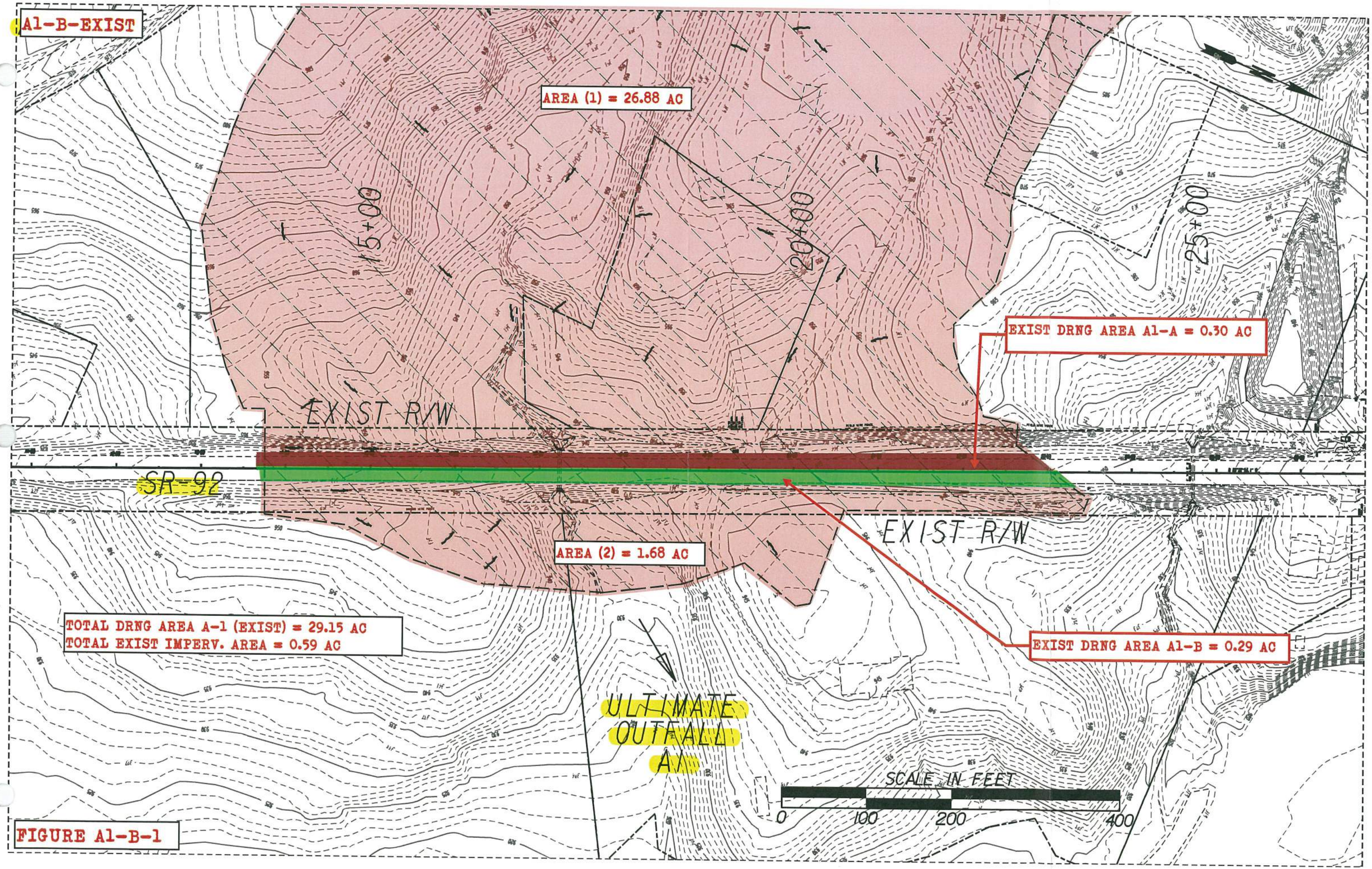

A1-B-EXIST
AREA (1) = 26.88 AC
15+00
20+00
25+00
EXIST DRNG AREA A1-A = 0.30 AC
EXIST R/W
SR-92
EXIST R/W
AREA (2) = 1.68 AC
TOTAL DRNG AREA A-1 (EXIST) = 29.15 AC
TOTAL EXIST IMPERV. AREA = 0.59 AC
EXIST DRNG AREA A1-B = 0.29 AC
ULTIMATE OUTFALL A1
SCALE IN FEET
0
100
200
400

FIGURE A1-B-1

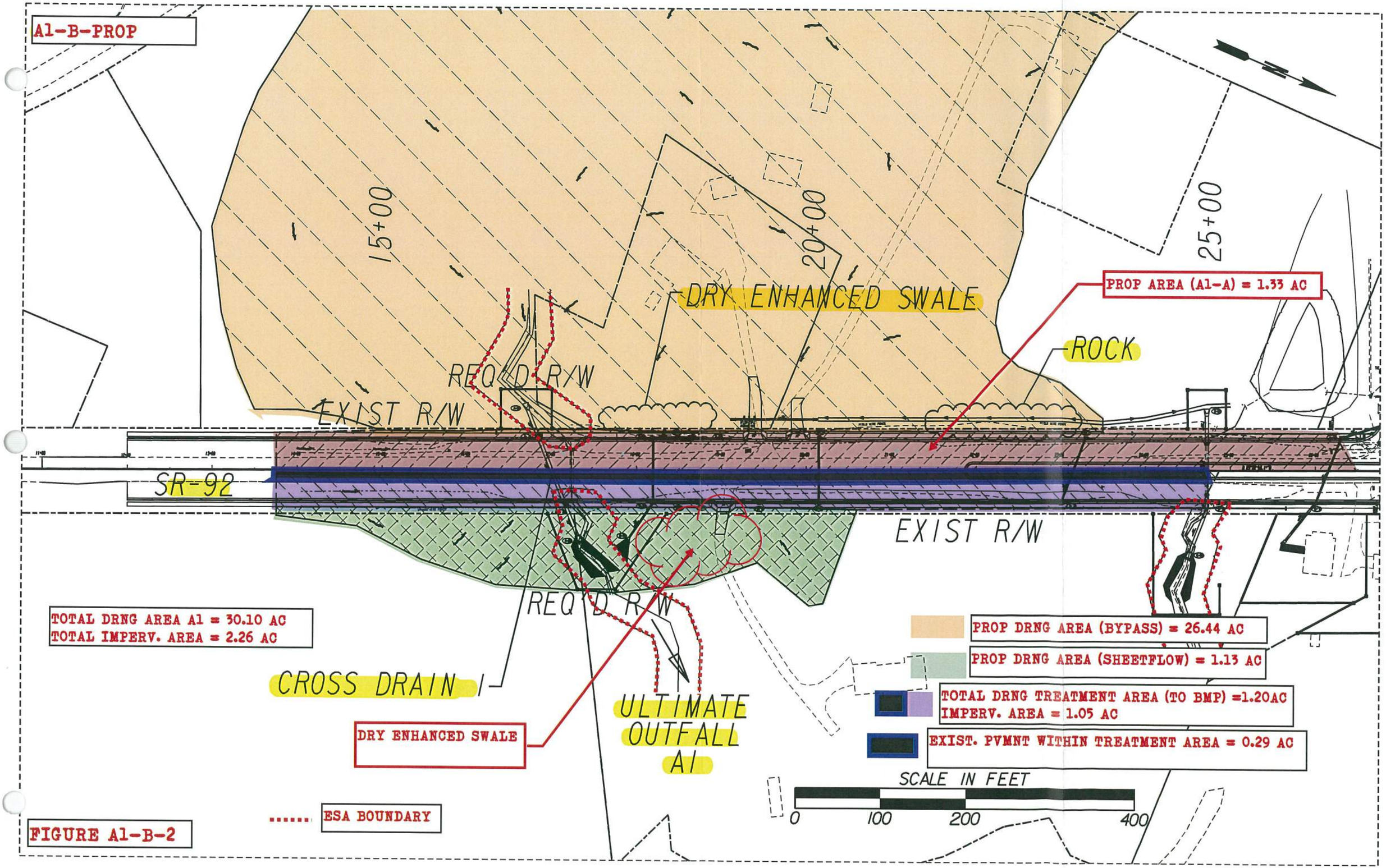

A1-B-PROP
15+00
20+00
25+00
DRY ENHANCED SWALE
PROP AREA (A1-A) = 1.33 AC
ROCK
REQ'D R/W
EXIST R/W
SR-92
EXIST R/W
REQ'D R/W
TOTAL DRNG AREA A1 = 30.10 AC
TOTAL IMPERV. AREA = 2.26 AC
CROSS DRAIN
DRY ENHANCED SWALE
ULTIMATE OUTFALL A1
PROP DRNG AREA (BYPASS) = 26.44 AC
PROP DRNG AREA (SHEETFLOW) = 1.13 AC
TOTAL DRNG TREATMENT AREA (TO BMP) =1.20AC
IMPERV. AREA = 1.05 AC
EXIST. PVMNT WITHIN TREATMENT AREA = 0.29 AC
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE A1-B-2

Project: SR 92 Widening & Reconstruction

H&L Design

Outfall: *A-1b*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: DS

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	29.15
Impervious Area =	0.59
Pervious Area=	28.56

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	72

Time of Concentration (See Table A) = 0.24 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.795

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.237	0.237
$I_a/P_{10\text{-}yr}$=	0.144	0.144
$I_a/P_{25\text{-}yr}$=	0.123	0.123
$I_a/P_{100\text{-}yr}$=	0.100	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.98

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.01
$Q_{d\ 10\text{-}yr}$=	2.57
$Q_{d\ 25\text{-}yr}$=	3.34
$Q_{d\ 100\text{-}yr}$ =	4.57

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	700
$q_{u10\text{-}yr}$=	710
$q_{u25\text{-}yr}$=	730
$q_{u100\text{-}yr}$=	750

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	32.06
$Q_{p10\text{-}yr}$=	82.96
$Q_{p25\text{-}yr}$=	111.21
$Q_{p100\text{-}yr}$=	156.19

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	30.10
Impervious Area =	2.26
Pervious Area =	27.84
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 0.24 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.739

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.220	0.220
$I_a/P_{10\text{-}yr}$=	0.134	0.134
$I_a/P_{25\text{-}yr}$=	0.114	0.114
$I_a/P_{100\text{-}yr}$=	0.093	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.69

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.09
$Q_{d\ 10\text{-}yr}$=	2.70
$Q_{d\ 25\text{-}yr}$=	3.49
$Q_{d\ 100\text{-}yr}$ =	4.74

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	700
$q_{u10\text{-}yr}$=	710
$q_{u25\text{-}yr}$=	730
$q_{u100\text{-}yr}$=	750

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	35.82
$Q_{p10\text{-}yr}$=	90.08
$Q_{p25\text{-}yr}$=	119.95
$Q_{p100\text{-}yr}$=	167.28

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.20	Acre
Total Impervious Area - A_{POST}	1.05	Acre
Existing Pavement Area - A_{PRE} (5)	0.29	Acre
Area Required for Quantity - A_{QUAN} (4)	0.91	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.20	0.63	63.33	0.00	0.620	0.074	3,241

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.04	0.63	0.052	2,255

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 2,594

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.927	0.13	0.033	1,444

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,662

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.934	0.12	0.044	1,912

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 2,200

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure A-18.3

FIGURE A-1B.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-1b*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: DS

	Computed Volumes	Stacked Volumes
WQ_v	3,241	3,241
CP_v	2,594	5,835
Q_{p25}	1,662	4,903
Q_{f100}	2,200	5,441

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**760**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	5843	ft^3	>	5835	ft^3

Swale Dimensions:

A swale that is **760** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	5,835	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **333** ft^2

Actual Filter Bed Dimensions:	Width	**13**	ft
	Length	**26**	ft
		338	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_S = **385** ft^2

Actual Sediment Chamber Dimensions:	Width	**13**	ft
	Length	**30**	ft
		390	ft^2

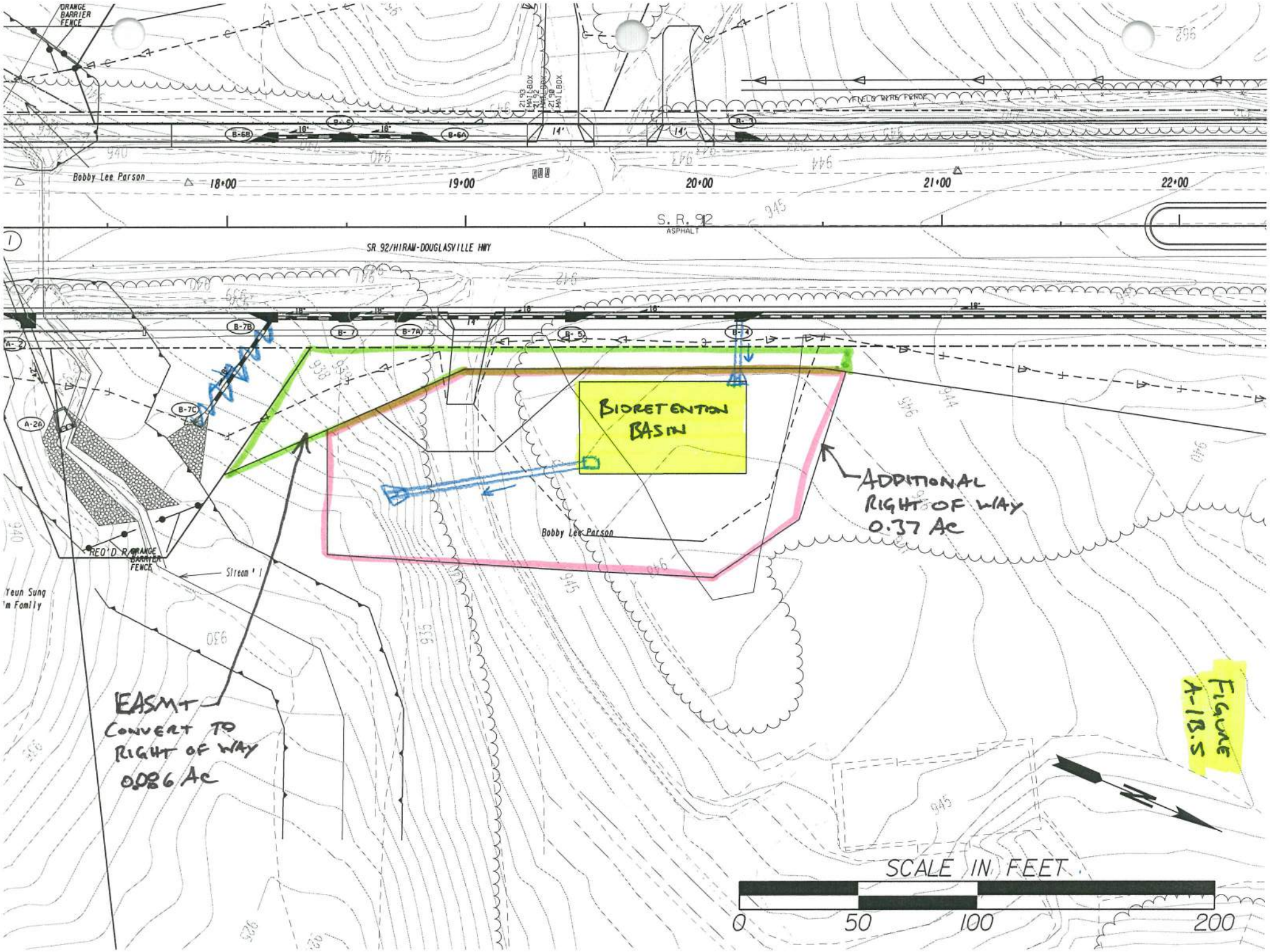
Bioretention Area

CP_v	=	5,835	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **2,457** ft^2

Actual Filter Bed Dimensions:	Width	**36**	ft
	Length	**70**	ft
		2520	ft^2


ORANGE BARRIER FENCE
FIELD WIRE FENCE
Bobby Lee Parson
18+00
19+00
20+00
21+00
22+00
S. R. 92
ASPHALT
SR 92/HIRAM-DOUGLASVILLE HWY
BIORETENTION BASIN
ADDITIONAL RIGHT OF WAY 0.37 AC
Bobby Lee Parson
REO'D RE ORANGE BARRIER FENCE
Stream 1
Teun Sung
'm Family
EASMT CONVERT TO RIGHT OF WAY 0.086 AC
FIGURE A-18.5
SCALE IN FEET
0
50
100
200

Infeasibility Criteria #1: Cost of Construction
Basin A-1B

11/6/2014

Basin A-1B 650 LF of Roadway construction cost within basin

Item	Basin A-1B Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 15,325.00	$ 43,500.00	$ 31,055.00	$ 20,650.00
Utilities ✪	$ 49,828.76	$ -	$ -	$ -
Construction ✪	$ 424,660.69	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,500.00	$ 3,350.00	$ 2,300.00
Grading	$ -	$ 12,600.00	$ 6,000.00	$ 5,790.00
Drainage	$ -	$ 41,669.79	$ 35,768.75	$ 27,189.50
Total	$ 489,814.45	$ 102,269.79	$ 76,173.75	$ 55,929.50
	Percent of BMP Cost to Total	**20.9%**	**15.6%**	**11.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.1888
Sub Total:	$	9,440.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.2354
Sub Total:	$	5,885.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	15,325.00

✪ See General Summary Explaination for Cost Method

FIGURE A-1B.6

BMP Construction Cost Worksheet Basin A-1B

Dry Enhanced Swale

Length:	760	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.82	Ac	
Total:	$ 41,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.1	Ac	
Total:	$ 2,500.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 43,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.9	Disturbed Ac	
$ 4,500.00		

Grading

Cut	Fill	
2000.000	100.000	
$ 6.00	per CY	
Total: $ 12,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		2	EA	
	$ 5,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	563	CY	$ 30.00	$ 12,510.29
Uddrn Sys w/ Gravel	-	790	LF	$ 20.00	$ 15,800.00
Additional Pipe	18"	25	LF	$ 43.00	$ 1,075.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	42	SY		42	SY	
	$ 2,415.00			$ 199.50		

Sub Total: $ 41,669.79

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	26	30	ft
Width:	13	13	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.5734	Ac	
Total:	$ 28,670.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.0954	Ac	
Total:	$ 2,385.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 31,055.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.67	Disturbed Ac	
$ 3,350.00		

Grading

Cut	Fill	
1000.000	0.000	
$ 6.00	per CY	
Total: $ 6,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	19	CY	$ 45.00	$ 855.00
Uddrn Sys w/ Gravel	-	110	LF	$ 20.00	$ 2,200.00
Top Soil		4	CY	$ 20.00	$ 80.00
Addl Pipe	18"	25	LF	$ 43.00	$ 1,075.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	338	SF	$ 5.00	$ 1,690.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY	
	195	SY	Filter Fabric	195	SY	
	$ 11,212.50			$ 926.25		

Sub Total: $ 35,768.75

Bioretention Area

Length:	70	ft
Width:	36	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.37	Ac	
Total:	$ 18,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.086	Ac	
Total:	$ 2,150.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 20,650.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.46	Disturbed Ac	
$ 2,300.00		

Grading

Cut	Fill	
965.000	0.000	
$ 6.00	per CY	
Total: $ 5,790.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		2	EA	
	$ 5,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	187	CY	$ 30.00	$ 5,610.00
Uddrn Sys w/ Gravel	-	162	LF	$ 20.00	$ 3,240.00
Mulch	-	280	SY	$ 15.00	$ 4,200.00
Additional Pipe	18"	25	LF	$ 43.00	$ 1,075.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	11	EA	$ 30.00	$ 330.00
Ground Cover	-	30	EA	$ 15.00	$ 450.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	42	SY		42	SY	
	$ 2,415.00			$ 199.50		

Sub Total: $ 27,189.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: DTS
Checked By: 11-19-14

Basin A-2 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin A-2 was located and the existing and proposed basin drainage areas were delineated (See Figures A-2.1 and A-2.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	5,376	5,376
Quantity	Channel Protection, CP_v	4,520	9,896
	Overbank Flood Protection, Q_{p25}	2,627	8,003
	Extreme Flood Protection, Q_{f100}	3,358	8,734

- The total area draining to the MS4 pond is 2.00 Ac. The total impervious area is 1.78 Ac. The existing pavement area for the site is 0.52 Ac. The area required for storage and quantity management is 1.48 Ac (See Figure A-2.3). The flow produced by the existing paved area of 0.52 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin that is 40 feet wide by 105 feet long. The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure A-2.4).
- Stream 2 is bypassed from the untreated roadway drainage with a separate drainage culvert.
- The east side of SR 92 is more suitable than the west side due to a detention pond, businesses and a church parking lot on the west side.
- See Figure A-2.5 for a layout of the proposed bioretention basin.
- The proposed bioretention basin would require the displacement of a residence (See Figure A-2.5)
- The BMP cost is 16.0% of the roadway cost in this basin making this basin infeasible (See Figure A-2.6).
- None of the other infeasibility criteria apply to this basin.

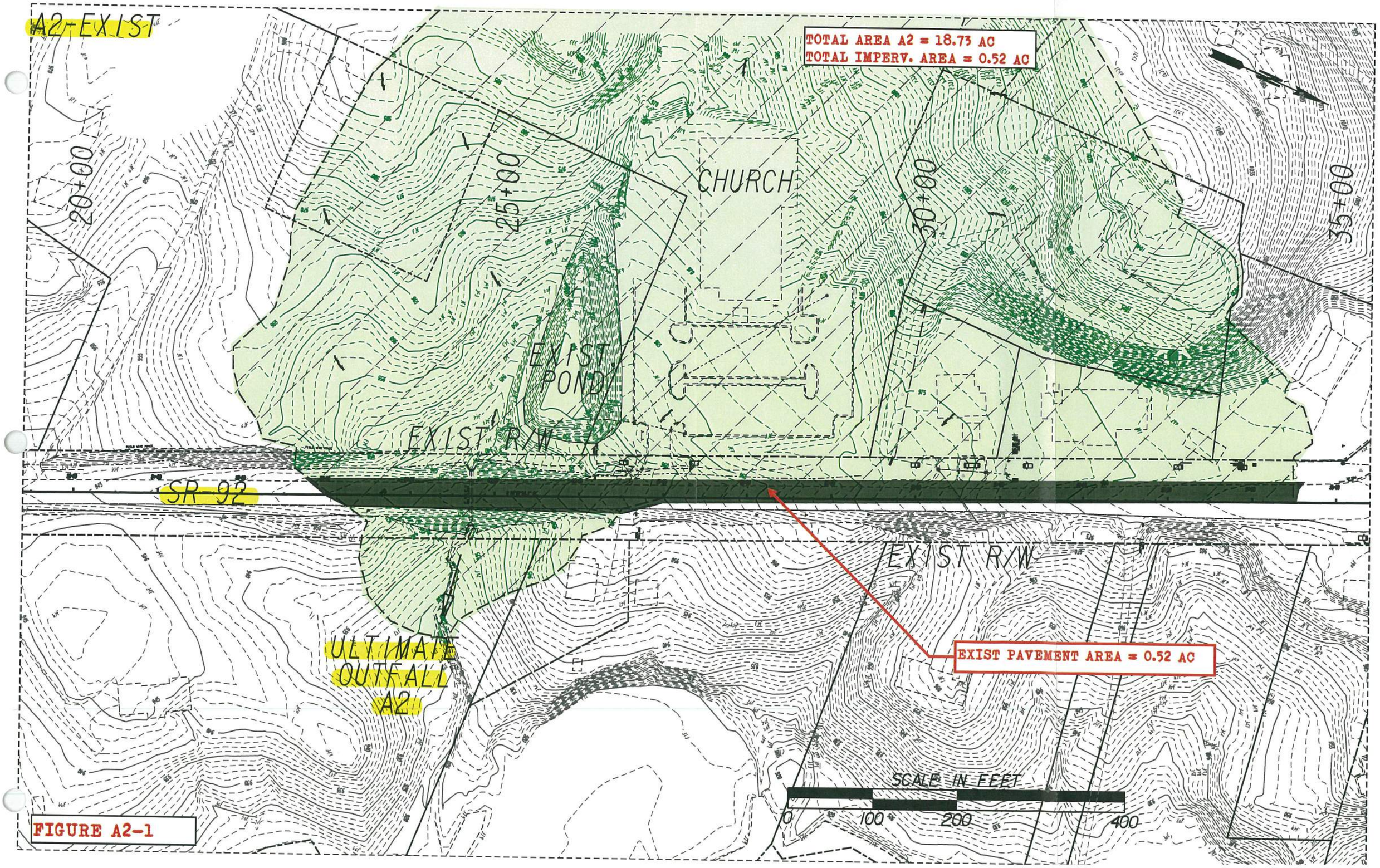

A2-EXIST
TOTAL AREA A2 = 18.73 AC
TOTAL IMPERV. AREA = 0.52 AC
20+00
25+00
30+00
35+00
CHURCH
EXIST POND
EXIST R/W
SR-92
EXIST R/W
ULTIMATE OUTFALL A2
EXIST PAVEMENT AREA = 0.52 AC
SCALE IN FEET
0
100
200
400

FIGURE A2-1

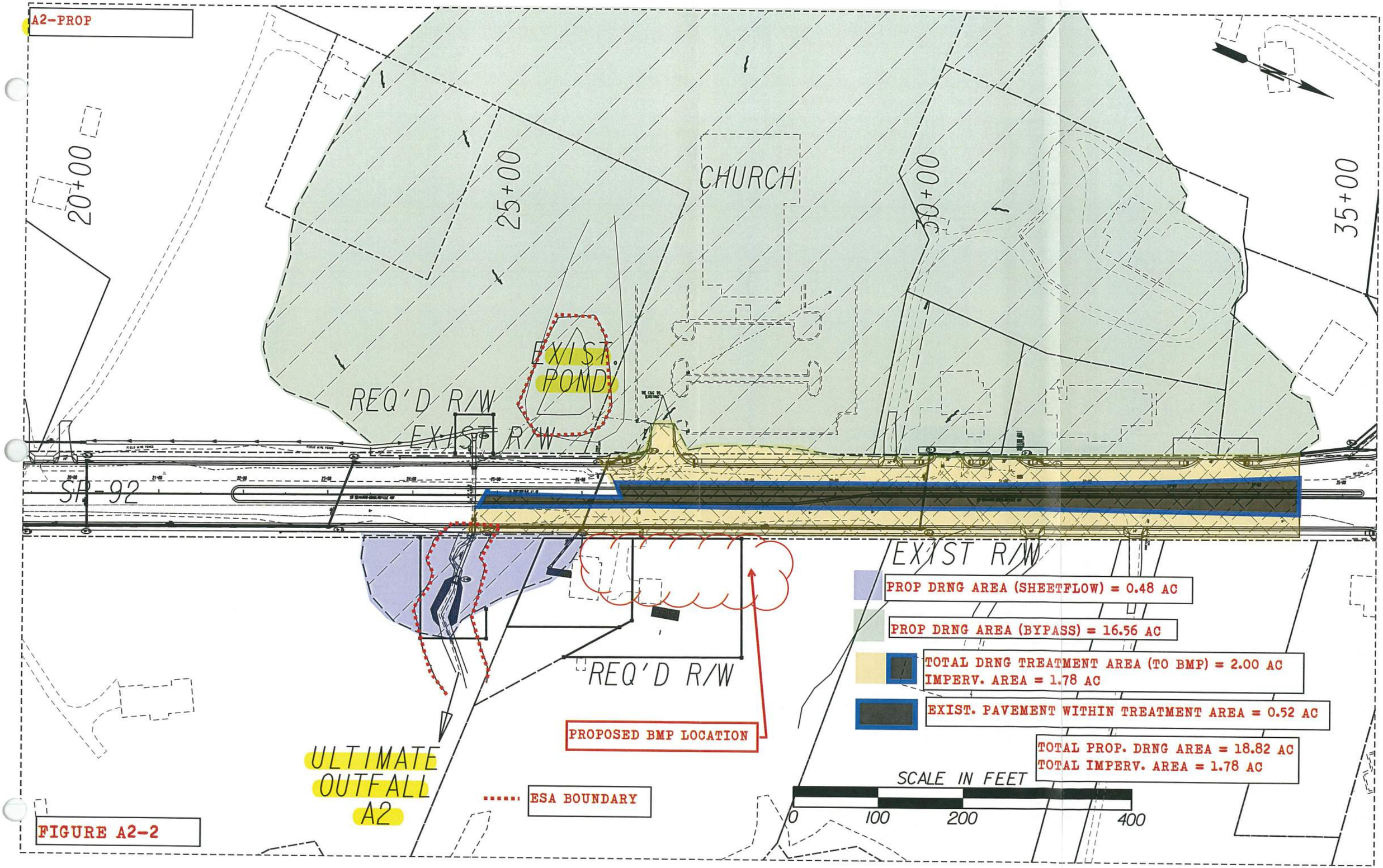

A2-PROP
20+00
25+00
30+00
35+00
CHURCH
EXIST. POND
REQ'D R/W
EXIST R/W
SR-92
REQ'D R/W
EXIST R/W
PROP DRNG AREA (SHEETFLOW) = 0.48 AC
PROP DRNG AREA (BYPASS) = 16.56 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.00 AC
IMPERV. AREA = 1.78 AC
EXIST. PAVEMENT WITHIN TREATMENT AREA = 0.52 AC
TOTAL PROP. DRNG AREA = 18.82 AC
TOTAL IMPERV. AREA = 1.78 AC
PROPOSED BMP LOCATION
ULTIMATE OUTFALL A2
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE A2-2

Project: SR 92 Widening & Reconstruction

H&L Design

Outfall: *A-2*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: DS

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)

Total Area (ac) =	18.73
Impervious Area =	0.52
Pervious Area=	18.21

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	72

Time of Concentration (See Table A) = 0.17 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.787

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.234	0.234
$I_a/P_{10\text{-}yr}$=	0.143	0.143
$I_a/P_{25\text{-}yr}$=	0.122	0.122
$I_a/P_{100\text{-}yr}$=	0.099	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.94

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.02
$Q_{d\ 10\text{-}yr}$=	2.58
$Q_{d\ 25\text{-}yr}$=	3.37
$Q_{d\ 100\text{-}yr}$ =	4.60

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (qu) - cfs/mi2/in

$q_{u1\text{-}yr}$=	790
$q_{u10\text{-}yr}$=	820
$q_{u25\text{-}yr}$=	825
$q_{u100\text{-}yr}$=	850

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	20.45
$Q_{p10\text{-}yr}$=	53.93
$Q_{p25\text{-}yr}$=	70.68
$Q_{p100\text{-}yr}$=	99.46

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi^2

F_p= 0.87

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)

Total Area =	18.82
Impervious Area =	1.78
Pervious Area =	17.04
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.17 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.719

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.214	0.214
$I_a/P_{10\text{-}yr}$=	0.130	0.130
$I_a/P_{25\text{-}yr}$=	0.111	0.111
$I_a/P_{100\text{-}yr}$=	0.091	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.60

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.12
$Q_{d\ 10\text{-}yr}$=	2.75
$Q_{d\ 25\text{-}yr}$=	3.55
$Q_{d\ 100\text{-}yr}$ =	4.80

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (qu) - cfs/mi2/in

$q_{u1\text{-}yr}$=	800
$q_{u10\text{-}yr}$=	825
$q_{u25\text{-}yr}$=	830
$q_{u100\text{-}yr}$=	850

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	22.89
$Q_{p10\text{-}yr}$=	57.94
$Q_{p25\text{-}yr}$=	75.32
$Q_{p100\text{-}yr}$=	104.44

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi^2

F_p= 0.87

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.00	Acre
Total Impervious Area - A_{POST}	1.78	Acre
Existing Pavement Area - A_{PRE} (5)	0.52	Acre
Area Required for Quantity - A_{QUAN} (4)	1.48	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft^3)
2.00	0.63	63.00	0.00	0.617	0.123	***5,376***

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft^3)
0.02	0.65	0.090	***3,930***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= ***4,520***

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)^2 -0.804(qo/qi)^3

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft^3)
0.938	0.12	0.052	***2,284***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= ***2,627***

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)^2 -0.804(qo/qi)^3

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft^3)
0.952	0.11	0.067	***2,919***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= ***3,358***

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)^2 -0.804(qo/qi)^3

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure A-2.3

FIGURE A-2.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-2*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: DS

	Computed Volumes	Stacked Volumes
WQ_v	5,376	5,376
CP_v	4,520	9,896
Q_{p25}	2,627	8,003
Q_{f100}	3,358	8,734

Dry Enhanced Swale

Average Depth	=	0.75	ft
Length	=	**1288**	ft
Width	=	8	ft
Left Side Slope	=	3	:1
Right Side Slope	=	3	:1
Area	=	7.6875	ft^2
Slope	=	0.01	ft/ft
Storage Volume	=	9902	ft^3 > 9896 ft^3

Swale Dimensions:

A swale that is **1288** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	9,896	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **564** ft^2

Actual Filter Bed Dimensions:	Width	**17**	ft
	Length	**34**	ft
		578	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_S = **653** ft^2

Actual Sediment Chamber Dimensions:	Width	**17**	ft
	Length	**39**	ft
		663	ft^2

Bioretention Area

CP_v	=	9,896	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,167** ft^2

Actual Filter Bed Dimensions:	Width	**40**	ft
	Length	**105**	ft
		4200	ft^2

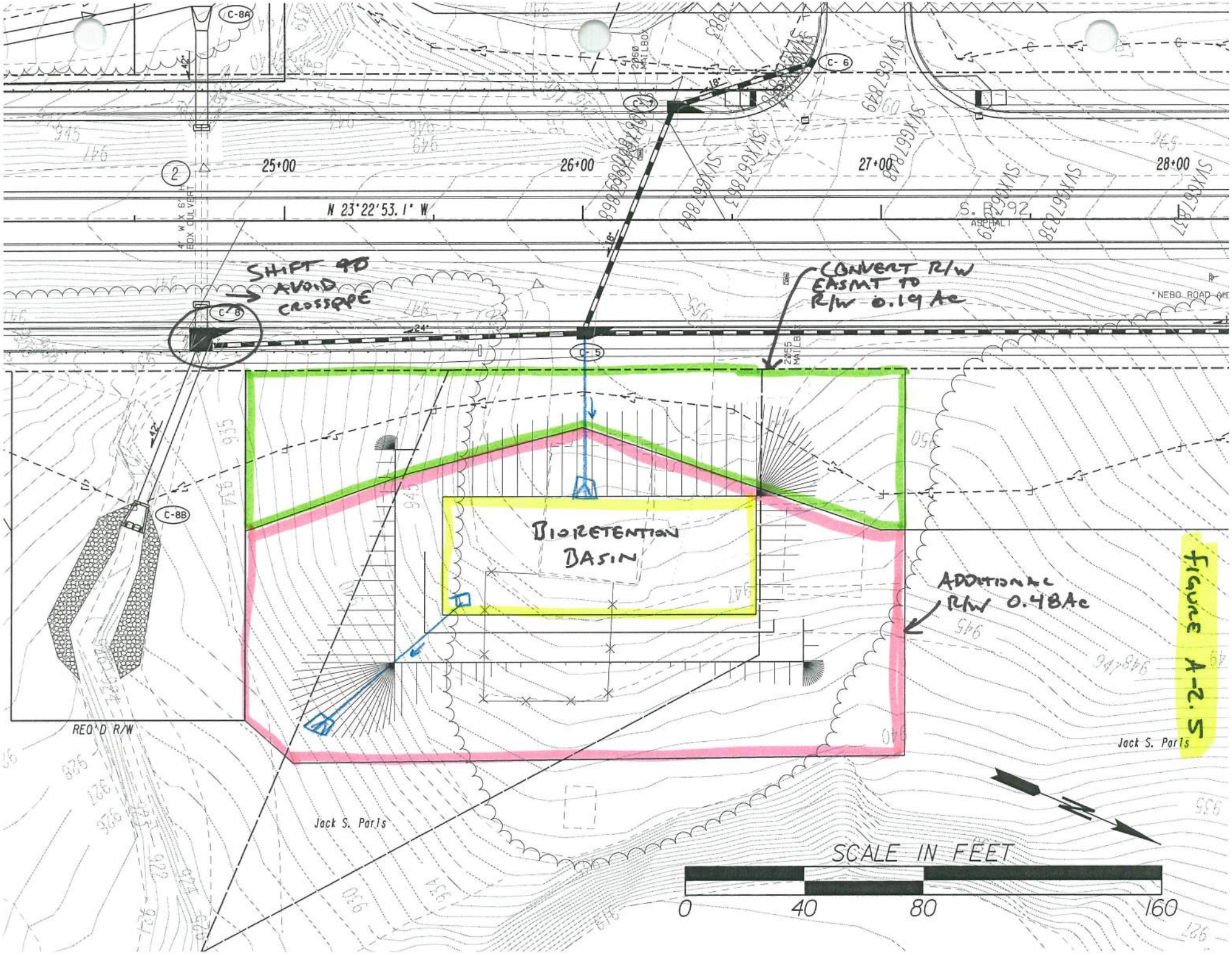

C-8A
C-6
C-7
C-5
C-8
C-8B
25+00
26+00
27+00
28+00
N 23°22'53.1" W
S. 92
ASPHALT
NEBO ROAD
4' W X 6' H BOX CULVERT
2060 MAILBOX
2055 MAILBOX
SHIFT 90 AVOID CROSSPIPE
CONVERT R/W EASMT TO R/W 0.19 Ac
BIORETENTION BASIN
ADDITIONAL R/W 0.48Ac
REQ'D R/W
Jack S. Paris
Jack S. Paris
SCALE IN FEET
0
40
80
160

Figure A-2.5

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin A-2

Basin A-2 860 LF of Roadway construction cost within basin

Item	Basin A-2 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 115,108.75	$ 114,385.00	$ 70,802.50	$ 68,697.50
Utilities ✪	$ 65,927.28	$ -	$ -	$ -
Construction ✪	$ 561,858.76	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,900.00	$ 3,050.00	$ 2,850.00
Grading	$ -	$ 12,000.00	$ 6,600.00	$ 10,200.00
Drainage	$ -	$ 60,443.65	$ 49,080.88	$ 37,432.50
Total	$ 742,894.79	$ 191,728.65	$ 129,533.38	$ 119,180.00
Percent of BMP Cost to Total		**25.8%**	**17.4%**	**16.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.9104
Sub Total:	$	45,520.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0.3573
Sub Total:	$	8,932.50
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0.3305
Sub Total:	$	20,656.25
Right of Way Cost Total:	$	115,108.75

✪ See General Summary Explaination for Cost Method

FIGURE A-2.6

BMP Construction Cost Worksheet Basin A-2

Dry Enhanced Swale

Length:	1288	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	1.3439	Ac	
Total:	$ 67,195.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2876	Ac	
Total:	$ 7,190.00		
Residential Relocation	$ 40,000.00	EA	
	1		
Total:	$ 40,000.00		
Sub Total:	$ 114,385.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.98	Disturbed Ac	
$ 4,900.00		

Grading

Cut	Fill	
1000.000	1000.000	
$ 6.00		per CY
Total: $ 12,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	954	CY	$ 30.00	$ 21,201.65
Uddrn Sys w/ Gravel	-	1318	LF	$ 20.00	$ 26,360.00
Additional Pipe	24"	50	LF	$ 52.00	$ 2,600.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	72	SY		72	SY
	$ 4,140.00			$ 342.00	

Sub Total: $ 60,443.65

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	34	39	ft
Width:	17	17	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.5148	Ac	
Total:	$ 25,740.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2025	Ac	
Total:	$ 5,062.50		
Residential Relocation	$ 40,000.00	EA	
	1		
Total:	$ 40,000.00		
Sub Total:	$ 70,802.50		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.61	Disturbed Ac	
$ 3,050.00		

Grading

Cut	Fill	
790.000	310.000	
$ 6.00		per CY
Total: $ 6,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	33	CY	$ 45.00	$ 1,485.00
Uddrn Sys w/ Gravel	-	130	LF	$ 20.00	$ 2,600.00
Top Soil		6	CY	$ 20.00	$ 120.00
Addl Pipe	24"	50	LF	$ 52.00	$ 2,600.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	578	SF	$ 5.00	$ 2,890.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	331.5	SY	Filter Fabric	331.5	SY
	$ 19,061.25			$ 1,574.63	

Sub Total: $ 49,080.88

Bioretention Area

Length:	105	ft
Width:	40	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.48	Ac	
Total:	$ 24,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.1879	Ac	
Total:	$ 4,697.50		
Residential Relocation	$ 40,000.00	EA	
	1		
Total:	$ 40,000.00		
Sub Total:	$ 68,697.50		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.57	Disturbed Ac	
$ 2,850.00		

Grading

Cut	Fill	
1510.000	190.000	
$ 6.00		per CY
Total: $ 10,200.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	312	CY	$ 30.00	$ 9,360.00
Uddrn Sys w/ Gravel	-	180	LF	$ 20.00	$ 3,600.00
Mulch	-	467	SY	$ 15.00	$ 7,005.00
Additional Pipe	24"	50	LF	$ 43.00	$ 2,150.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	18	EA	$ 30.00	$ 540.00
Ground Cover	-	50	EA	$ 15.00	$ 750.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	70	SY		70	SY
	$ 4,025.00			$ 332.50	

Sub Total: $ 37,432.50

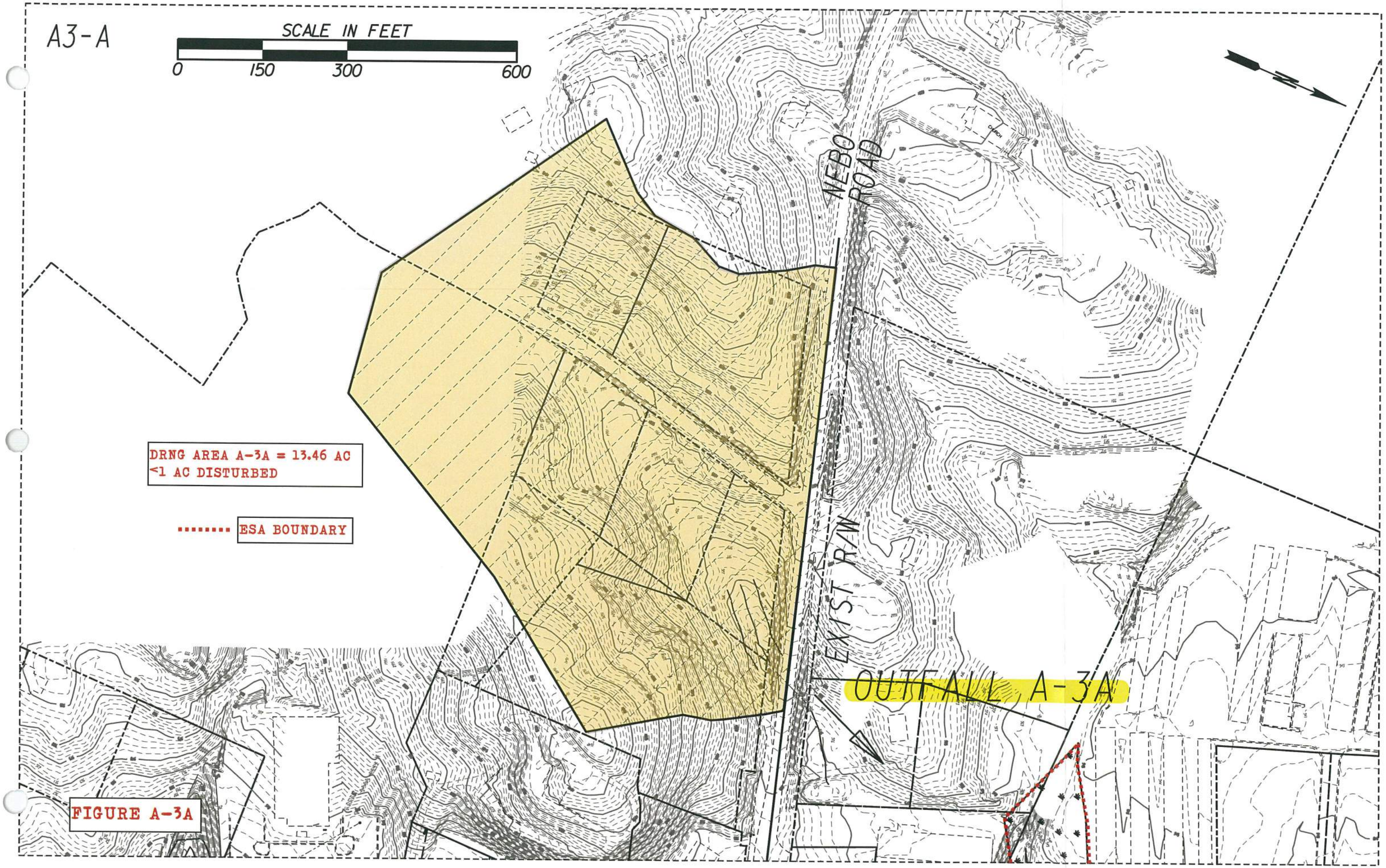
Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 12, 2014
Designed By: DTS
Checked By: SCF 11-13-14

Basin A-3A Summary
BMP Recommendation – Not Required

The ultimate outfall of Drainage Basin A-3A was located and the existing and proposed drainage basin areas were delineated (See Figure A-3A). The drainage basin flows into a cross pipe that flows under Nebo Road. Nebo Road is a sideroad that is currently not owned by GDOT.

According to the GDOT Policy on Post-Construction BMPs (section 1.2 Post-Construction BMP Exclusions), under the Project Level Exclusions, number 1 states that 'roadways that are not owned or operated by the Department may not require post-construction BMPs. Coordination with the local government is necessary for determination.'


A3-A
SCALE IN FEET
0
150
300
600
NEBO ROAD
DRNG AREA A-3A = 13.46 AC
<1 AC DISTURBED
ESA BOUNDARY
EXIST R/W
OUTFALL A-3A
FIGURE A-3A

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 12, 2014
Designed By: DTS
Checked By: SCF 11-19-14

Basin A-3B Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin A-3B was located and the existing and proposed basin drainage areas were delineated (See Figures A-3B.1 and A-3B.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	5,816	5,816
Quantity	Channel Protection, CP_v	10,108	15,924
	Overbank Flood Protection, Q_{p25}	5,051	10,867
	Extreme Flood Protection, Q_{f100}	6,754	12,570

- The total area draining to the MS4 structure is 7.26 Ac. The total impervious area is 4.77 Ac. The existing pavement area for the site is 3.69 Ac. The area required for storage and quantity management is 3.57 Ac (See Figure A-3B.3). The flow produced by the existing paved area of 3.69 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- Rock has been located on the east and west side of SR 92 Sta 37+00 to Sta 42+00 and would not be in the way of a BMP (See Figure A-3B.2).
- An underground storage tank was located at Sta 40+00 RT and would not be in the way of a BMP (See Figure A-3B.2).
- 3 BMPs were sized; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin that is 35 feet wide by 194 feet long. This option was selected to minimize right of way costs and impacts to the business. The bioretention basin will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure A-3B.4).
- See figure A-3B.5 for a layout of the bioretention basin.
- The BMP cost is 14.5% of the roadway cost in this basin making this basin infeasible (See Figure A-3B.6).
- None of the other infeasibility criteria apply to this basin.

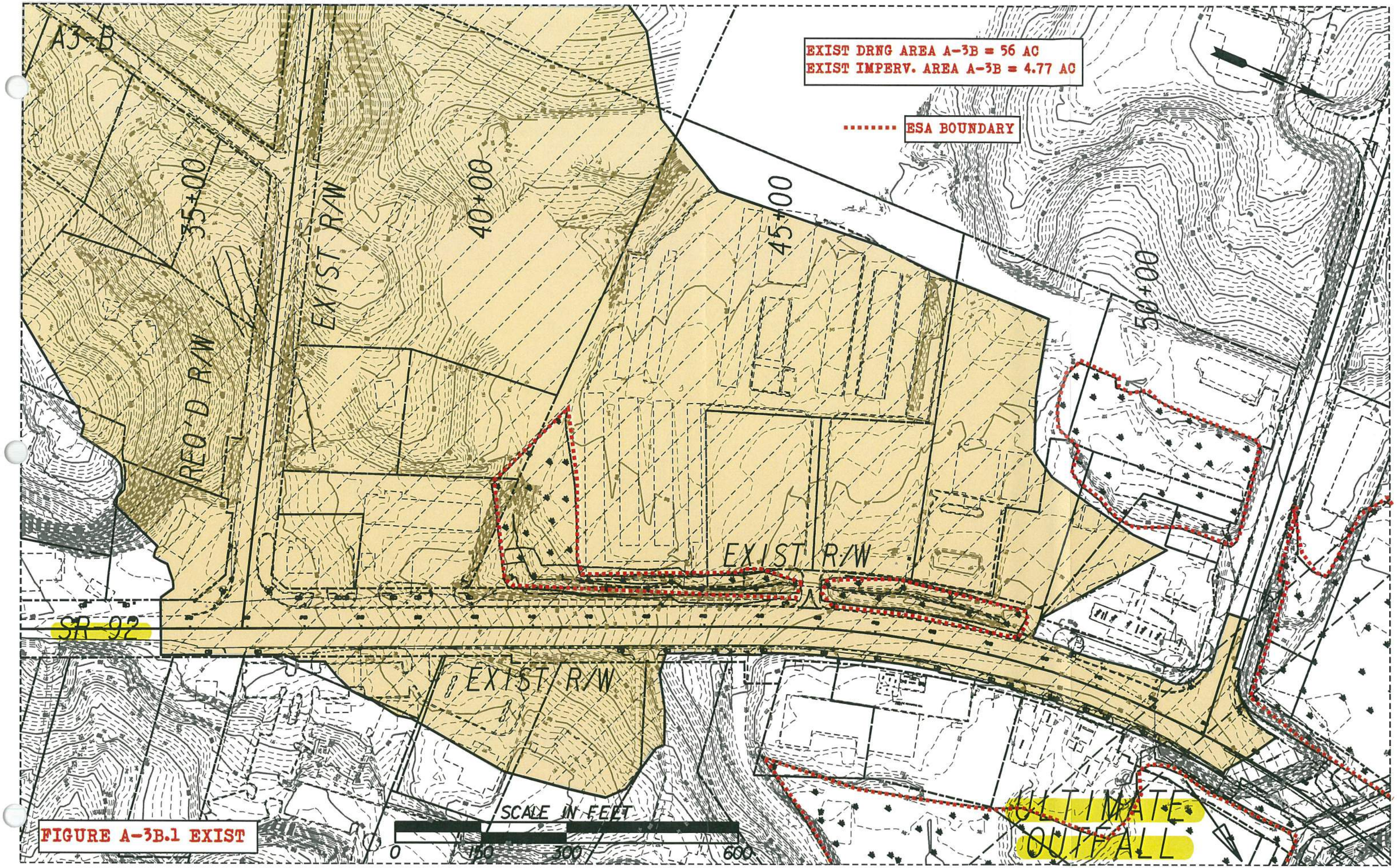


FIGURE A-3B.1 EXIST

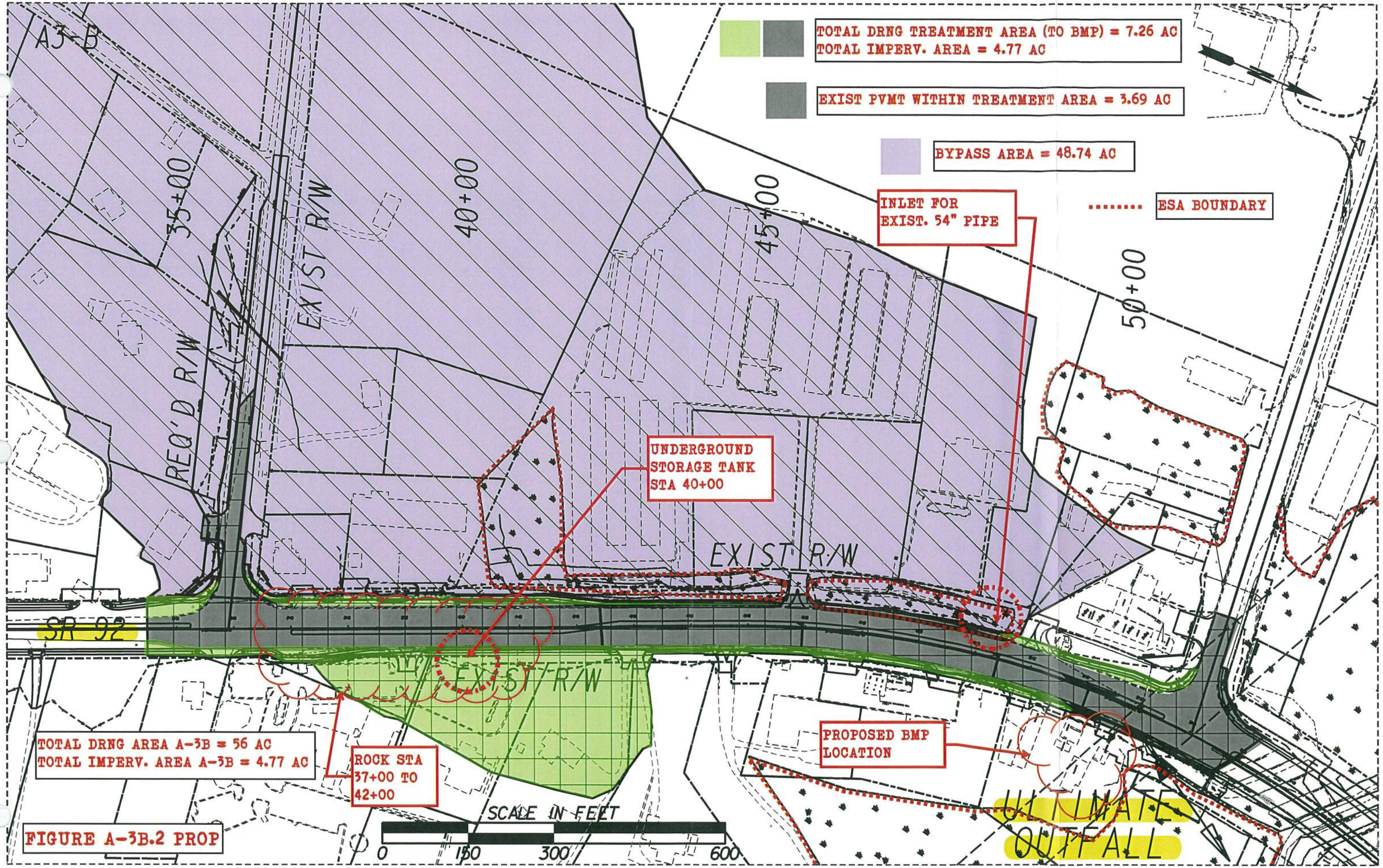


FIGURE A-3B.2 PROP

Project: 92 Widening & Reconstruction
H&L De
Outfall: *A-3b*

Unified Stormwater Sizing Criteria

I: 621720
Nov-14
Calcs.: DS

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)

Total Area (ac) =	56
Impervious Area =	3.69
Pervious Area=	52.31

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 1.00 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.748

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.223	0.223
$I_a/P_{10\text{-}yr}$=	0.136	0.136
$I_a/P_{25\text{-}yr}$=	0.115	0.115
$I_a/P_{100\text{-}yr}$=	0.094	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.74

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.07
$Q_{d\ 10\text{-}yr}$=	2.68
$Q_{d\ 25\text{-}yr}$=	3.47
$Q_{d\ 100\text{-}yr}$ =	4.71

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Pick Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	350
$q_{u10\text{-}yr}$=	360
$q_{u25\text{-}yr}$=	360
$q_{u100\text{-}yr}$=	360

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	24.67
$Q_{p10\text{-}yr}$=	63.20
$Q_{p25\text{-}yr}$=	81.95
$Q_{p100\text{-}yr}$=	111.36

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 0.75

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)

Total Area =	56
Impervious Area =	4.77
Pervious Area =	51.23
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 1.00 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.729

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.217	0.217
$I_a/P_{10\text{-}yr}$=	0.132	0.132
$I_a/P_{25\text{-}yr}$=	0.112	0.112
$I_a/P_{100\text{-}yr}$=	0.092	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.64

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.10
$Q_{d\ 10\text{-}yr}$=	2.72
$Q_{d\ 25\text{-}yr}$=	3.52
$Q_{d\ 100\text{-}yr}$ =	4.77

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Pick Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	350
$q_{u10\text{-}yr}$=	360
$q_{u25\text{-}yr}$=	360
$q_{u100\text{-}yr}$=	360

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	25.35
$Q_{p10\text{-}yr}$=	64.31
$Q_{p25\text{-}yr}$=	83.19
$Q_{p100\text{-}yr}$=	112.78

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 0.75

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	7.26	Acre
Total Impervious Area - A_{POST}	4.77	Acre
Existing Pavement Area - A_{PRE} (5)	3.69	Acre
Area Required for Quantity - A_{QUAN} (4)	3.57	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
7.26	0.15	14.88	0.00	0.184	0.134	5,816

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.985	0.10	0.101	4,392

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 5,051

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.05	0.61	0.202	8,789

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 10,108

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.987	0.09	0.135	5,872

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 6,754

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE A-3B.3

FIGURE A-3B.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-3b*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: DS

	Computed Volumes	Stacked Volumes
WQ_v	5,816	5,816
CP_v	10,108	15,924
Q_{p25}	5,051	10,867
Q_{f100}	6,754	12,570

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**2072**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	15929	ft^3	>	15924	ft^3

Swale Dimensions:

A swale that is **2072** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	15,924	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **908** ft^2

Actual Filter Bed Dimensions:	Width	**22**	ft
	Length	**44**	ft
		968	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **1051** ft^2

Actual Sediment Chamber Dimensions:	Width	**22**	ft
	Length	**48**	ft
		1056	ft^2

Bioretention Area

CP_v	=	15,924	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **6,705** ft^2

Actual Filter Bed Dimensions:	Width	**35**	ft
	Length	**194**	ft
		6790	ft^2

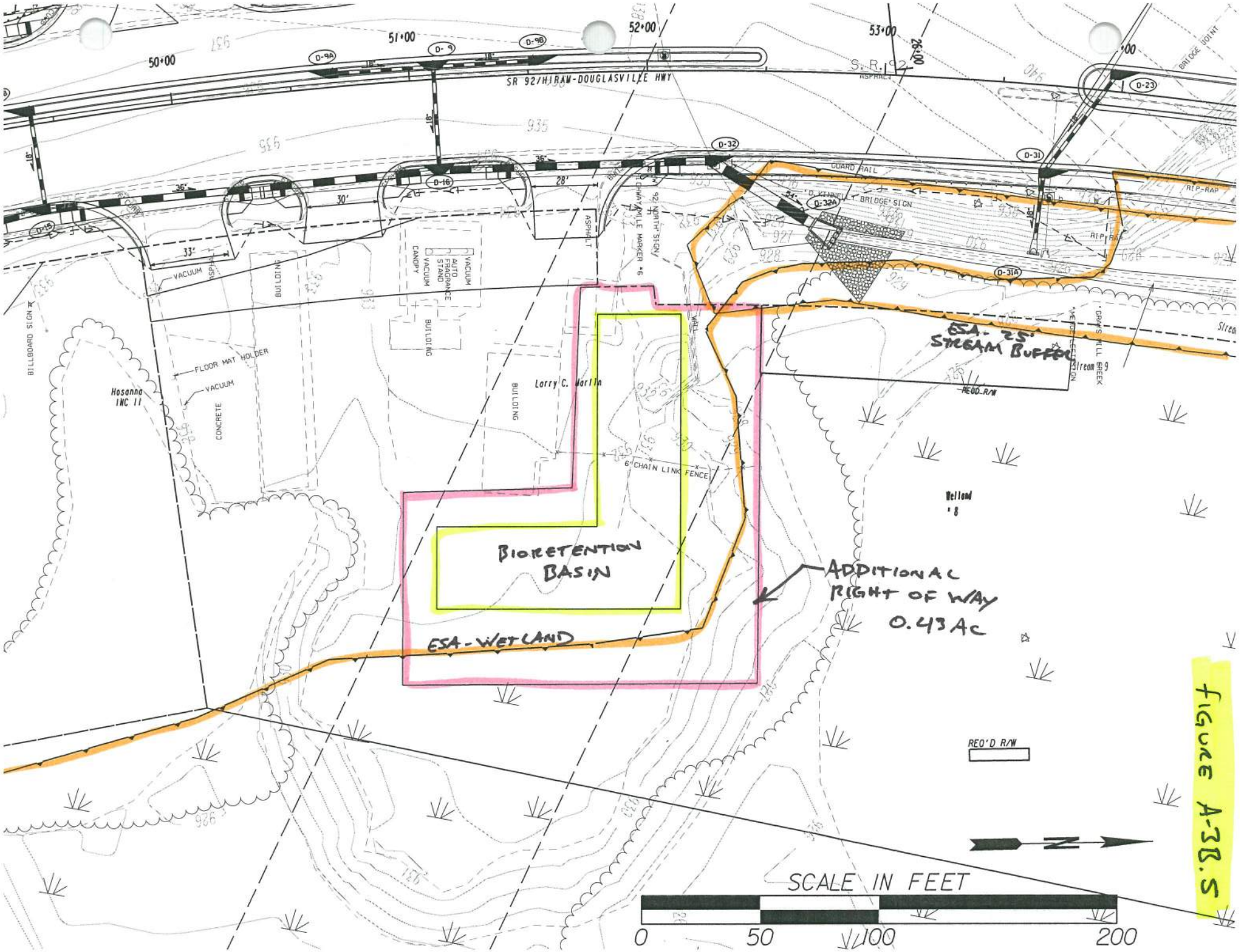

SR 92/HIRAM-DOUGLASVILLE HWY
50+00
51+00
52+00
53+00
S.R. 92
ASPHALT
BRIDGE JOINT
GUARD RAIL
RIP-RAP
'D. KENNELLY BRIDGE' SIGN
BILLBOARD SIGN
VACUUM
BUILDING
AUTO FRAGRANCE STAND
CANOPY
FLOOR MAT HOLDER
Hosanna INC II
CONCRETE
Larry C. Martin
6' CHAIN LINK FENCE
WALL
ESA - 25' STREAM BUFFER
REQ'D R/W
Stream 9
BIORETENTION BASIN
ADDITIONAL RIGHT OF WAY 0.43 Ac
ESA - WETLAND
REQ'D R/W
N
SCALE IN FEET
0
50
100
200

FIGURE A-3B.5

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin A-3B

Basin A-3B 1950 LF of Roadway construction cost within basin

Item	Basin A-3B Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 75,826.25	$ 327,100.00	$ 327,100.00	$ 153,750.00
Utilities ✪	$ 149,486.27	$ -	$ -	$ -
Construction ✪	$ 1,273,982.07	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 12,100.00	$ 12,100.00	$ 2,150.00
Grading	$ -	$ 36,000.00	$ 7,200.00	$ 3,600.00
Drainage	$ -	$ 99,305.75	$ 68,388.00	$ 58,601.50
Total	$ 1,499,294.59	$ 474,505.75	$ 414,788.00	$ 218,101.50
	Percent of BMP Cost to Total	**31.6%**	**27.7%**	**14.5%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0
Sub Total:	$	-
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.1143
Sub Total:	$	2,857.50
Commercial Right of Way @	$	125,000.00
		0.2605
Sub Total:	$	32,562.50
Commercial Perm Easmt @	$	62,500.00
		0.6465
Sub Total:	$	40,406.25
Right of Way Cost Total:	$	75,826.25

✪ See General Summary Explaination for Cost Method

FIGURE A-3B.6

BMP Construction Cost Worksheet Basin A-3B

Dry Enhanced Swale

Length:	2072	ft
Width:	8	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	2.4168	Ac	
Total:	$ 302,100.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00		
	1		
Total:	$ 25,000.00		
Sub Total:	$ 327,100.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
2.42	Disturbed Ac	
$ 12,100.00		

Grading

Cut	Fill	
3000.000	3000.000	
$ 6.00	per CY	
Total: $ 36,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1535	CY	$ 30.00	$ 34,107.00
Uddrn Sys w/ Gravel	-	2102	LF	$ 20.00	$ 42,040.00
Additional Pipe	24"	100	LF	$ 52.00	$ 5,200.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	115	SY		115	SY
	$ 6,612.50			$ 546.25	

Sub Total: $ 99,305.75

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	44	48	ft
Width:	22	22	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	2.4168	Ac	
Total:	$ 302,100.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00		
	1		
Total:	$ 25,000.00		
Sub Total:	$ 327,100.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
2.42	Disturbed Ac	
$ 12,100.00		

Grading

Cut	Fill	
800.000	400.000	
$ 6.00	per CY	
Total: $ 7,200.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	54	CY	$ 45.00	$ 2,430.00
Uddrn Sys w/ Gravel	-	155	LF	$ 20.00	$ 3,100.00
Top Soil		9	CY	$ 20.00	$ 180.00
Addl Pipe	24"	100	LF	$ 52.00	$ 5,200.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	968	SF	$ 5.00	$ 4,840.00
Dist Wall Conc/Steel	-	5	CY	$ 1,020.00	$ 5,100.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	528	SY	Filter Fabric	528	SY
	$ 30,360.00			$ 2,508.00	

Sub Total: $ 68,388.00

Bioretention Area

Length:	194	ft
Width:	35	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.43	Ac	
Total:	$ 53,750.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Cost to Cure	$ 100,000.00	LS	
(Impacts tp parking, prop access)	1		
Total:	$ 100,000.00		
Sub Total:	$ 153,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.43	Disturbed Ac	
$ 2,150.00		

Grading

Cut	Fill	
600.000	0.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	503	CY	$ 30.00	$ 15,090.00
Uddrn Sys w/ Gravel	-	157.5	LF	$ 20.00	$ 3,150.00
Mulch	-	755	SY	$ 15.00	$ 11,325.00
Additional Pipe	24"	100	LF	$ 52.00	$ 5,200.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	29	EA	$ 30.00	$ 870.00
Ground Cover	-	80	EA	$ 15.00	$ 1,200.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	114	SY		114	SY
	$ 6,555.00			$ 541.50	

Sub Total: $ 58,601.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 12, 2014
Designed By: DTS
Checked By: SCF 11-13-14

Basin A-4 Summary
BMP Recommendation – Not required per outfall level exclusion

The ultimate outfall of Drainage Basin A-4 was located and the existing and proposed basin drainage areas were delineated (See Figure A-4.1). The existing and proposed drainage areas were the same, as were the impervious areas with the exception of approximately 1000 square feet that is being redirected to drainage structure D-32.

According to the GDOT Policy on Post-Construction BMPs (section 1.2 Post-Construction BMP Exclusions), under the Outfall Level Exclusions, number 6 states that "whereby the net impervious surface area within that outfall's drainage area has been reduced or remains the same as pre-developed conditions, post-construction stormwater requirements will not apply."

A4

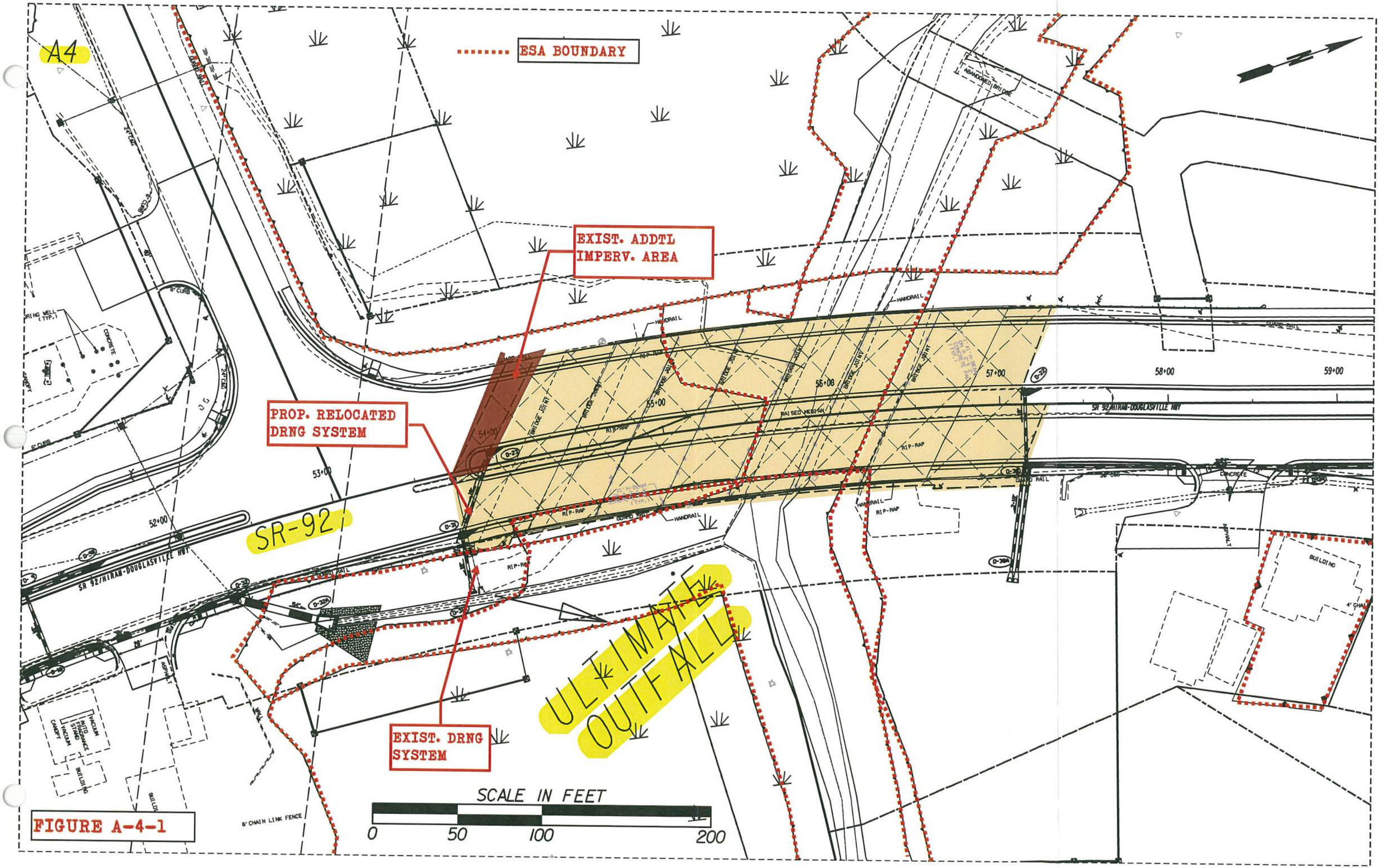


FIGURE A-4-1

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 17, 2014
Designed By: DTS
Checked By: SCF 11-19-14

Basin A-S Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin A-5 was located and the existing and proposed basin drainage areas were delineated (See Figures A-5.1 and A-5.2). From those drainage areas the MS4 requirements, Water quality volume was calculated and stacked. The following chart shows the computed volume.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	8,124	8,124
Quantity	Channel Protection, CP_v	N/A	N/A
	Overbank Flood Protection, Q_{p25}	N/A	N/A
	Extreme Flood Protection, Q_{f100}	N/A	N/A

The basin outfall drains directly into Mill Creek which has an upland drainage area equal to 13 square miles. The Quantity volumes can be waived when draining into surface waters with a drainage area greater than 5 square miles.

- The total area draining to the MS4 pond is 3.01 Ac. The total impervious area is 2.85 Ac. The existing pavement area for the site is 0.95 Ac. The area required for storage and quantity management is 2.07 Ac (See Figure A-5.3). The flow produced by the existing paved area of 0.95 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- Since Quantity requirements have been waived, the BMPs will be designed to handle the Water Quality Volume.
- A Downstream hydraulic analysis is not necessary since flood protection is not required.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 40 feet by 86 feet. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume (See Figure A-5.4).
- A pipe to direct the pavement water to the bioretention basin will need to be installed under the bypass ditch (See Figure A-5.5).
- Modifications to the proposed drainage design will be required to separate the clean bypass water from mixing with the polluted pavement water.
- The BMP cost is 12.0% of the roadway cost in this basin making this basin infeasible (See Figure A-5.6).
- None of the other infeasibility criteria apply to this basin.

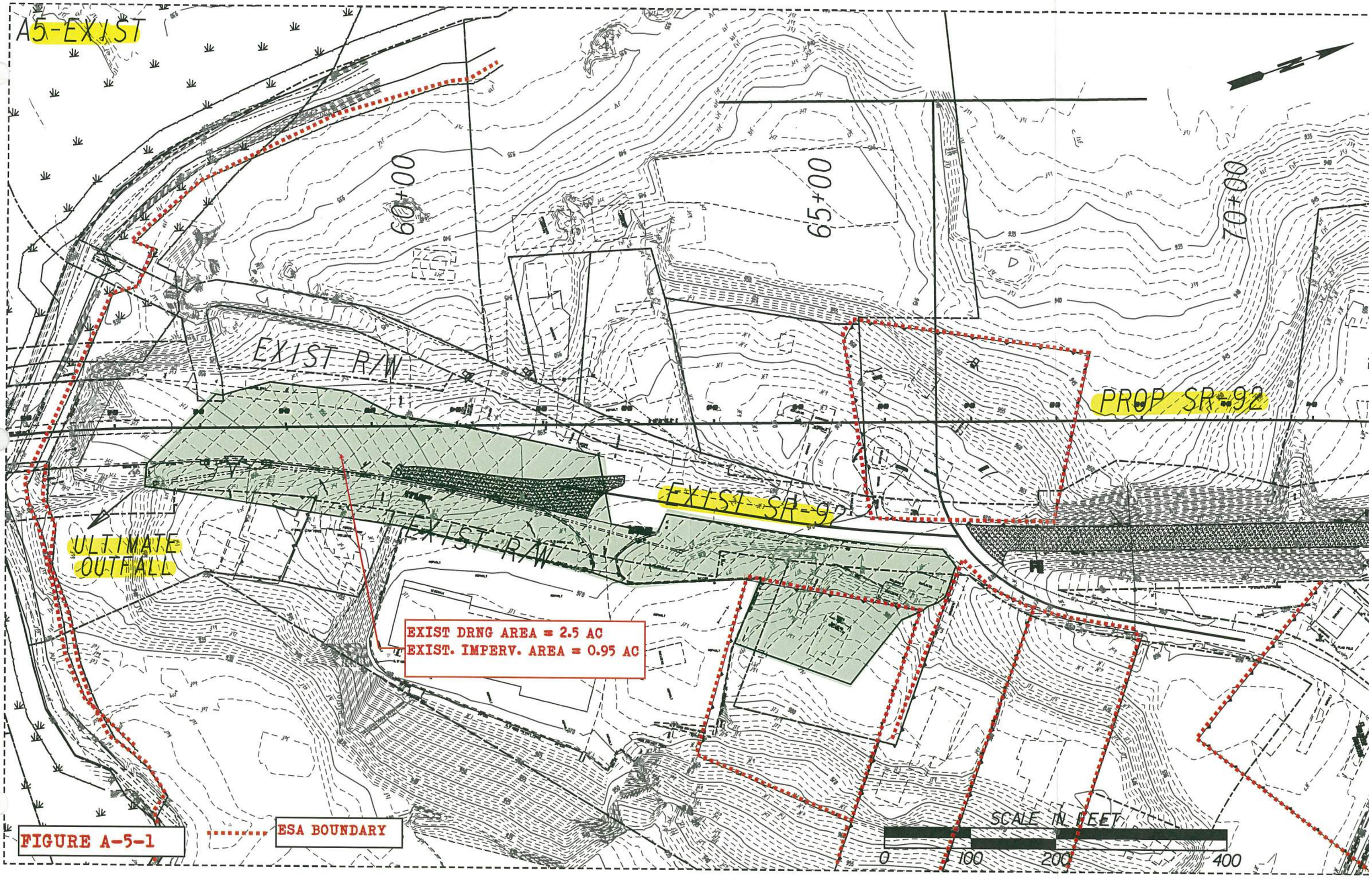

A5-EXIST
60+00
65+00
70+00
EXIST R/W
PROP SR-92
EXIST SR-92
EXIST R/W
ULTIMATE OUTFALL
EXIST DRNG AREA = 2.5 AC
EXIST. IMPERV. AREA = 0.95 AC
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE A-5-1

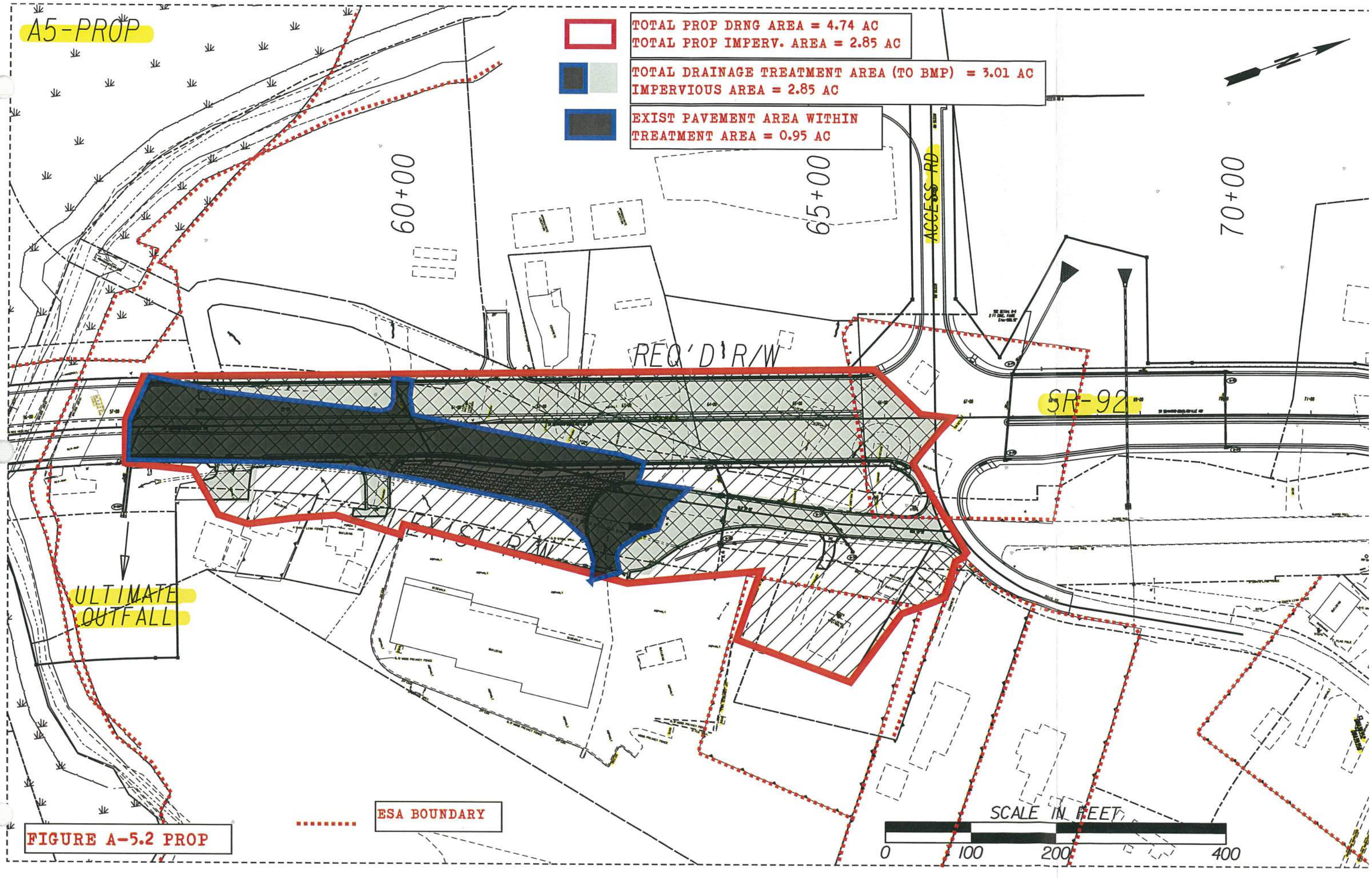


FIGURE A-5.2 PROP

Proj[illegible]R 92 Widening & Reconstruction
H&L [illegible]ign
Outfall: A-5

Unified S[illegible]mwater Sizing Criteria

[illegible]21720
Nov-14
Calcs.: DS

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	2.50
Impervious Area =	0.95
Pervious Area=	1.55

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	81

Time of Concentration (See Table A) = 0.08 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.461

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.137	0.137
$I_a/P_{10\text{-}yr}$=	0.084	0.100
$I_a/P_{25\text{-}yr}$=	0.071	0.100
$I_a/P_{100\text{-}yr}$=	0.058	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.31

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.61
$Q_{d\ 10\text{-}yr}$=	3.47
$Q_{d\ 25\text{-}yr}$=	4.35
$Q_{d\ 100\text{-}yr}$ =	5.70

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	1000
$q_{u10\text{-}yr}$=	1000
$q_{u25\text{-}yr}$=	1000
$q_{u100\text{-}yr}$=	1000

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	6.31
$Q_{p10\text{-}yr}$=	13.57
$Q_{p25\text{-}yr}$=	17.00
$Q_{p100\text{-}yr}$=	22.25

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	4.74
Impervious Area =	2.85
Pervious Area =	1.89
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	87

Time of Concentration (See Table A) = 0.08 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.293

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.087	0.100
$I_a/P_{10\text{-}yr}$=	0.053	0.100
$I_a/P_{25\text{-}yr}$=	0.045	0.100
$I_a/P_{100\text{-}yr}$=	0.037	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.46

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.08
$Q_{d\ 10\text{-}yr}$=	4.08
$Q_{d\ 25\text{-}yr}$=	5.00
$Q_{d\ 100\text{-}yr}$ =	6.40

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	1000
$q_{u10\text{-}yr}$=	1000
$q_{u25\text{-}yr}$=	1000
$q_{u100\text{-}yr}$=	1000

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	15.38
$Q_{p10\text{-}yr}$=	30.25
$Q_{p25\text{-}yr}$=	37.06
$Q_{p100\text{-}yr}$=	47.40

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	3.01	Acre
Total Impervious Area - A_{POST}	2.85	Acre
Existing Pavement Area - A_{PRE} (5)	0.95	Acre
Area Required for Quantity - A_{QUAN} (4)	2.07	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
3.01	0.63	63.29	0.00	0.620	0.187	**8,124**

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.234	**10,181**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **11,709**

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.459	0.29	0.253	**11,010**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **12,662**

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.470	0.29	0.318	**13,858**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **15,938**

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure A-5.3

FIGURE A-5.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-5*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: DS

	Computed Volumes	Stacked Volumes	
WQ_v	8,124	8,124	
CP_v	11,709	19,833	○
Q_{p25}	12,662	20,786	○
Q_{f100}	15,938	24,062	○

○ Not required to store these volumes because the outfall drains directly into Mill Creek which has an upland drainage area of 13 square miles.

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**1057**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	8126	ft^3	>	8124	ft^3

Swale Dimensions:

A swale that is **1057** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

WQv	=	8,124	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **463** ft^2

Actual Filter Bed Dimensions:	Width	**16**	ft
	Length	**32**	ft
		512	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*WQv**

A_S = **536** ft^2

Actual Sediment Chamber Dimensions:	Width	**16**	ft
	Length	**34**	ft
		544	ft^2

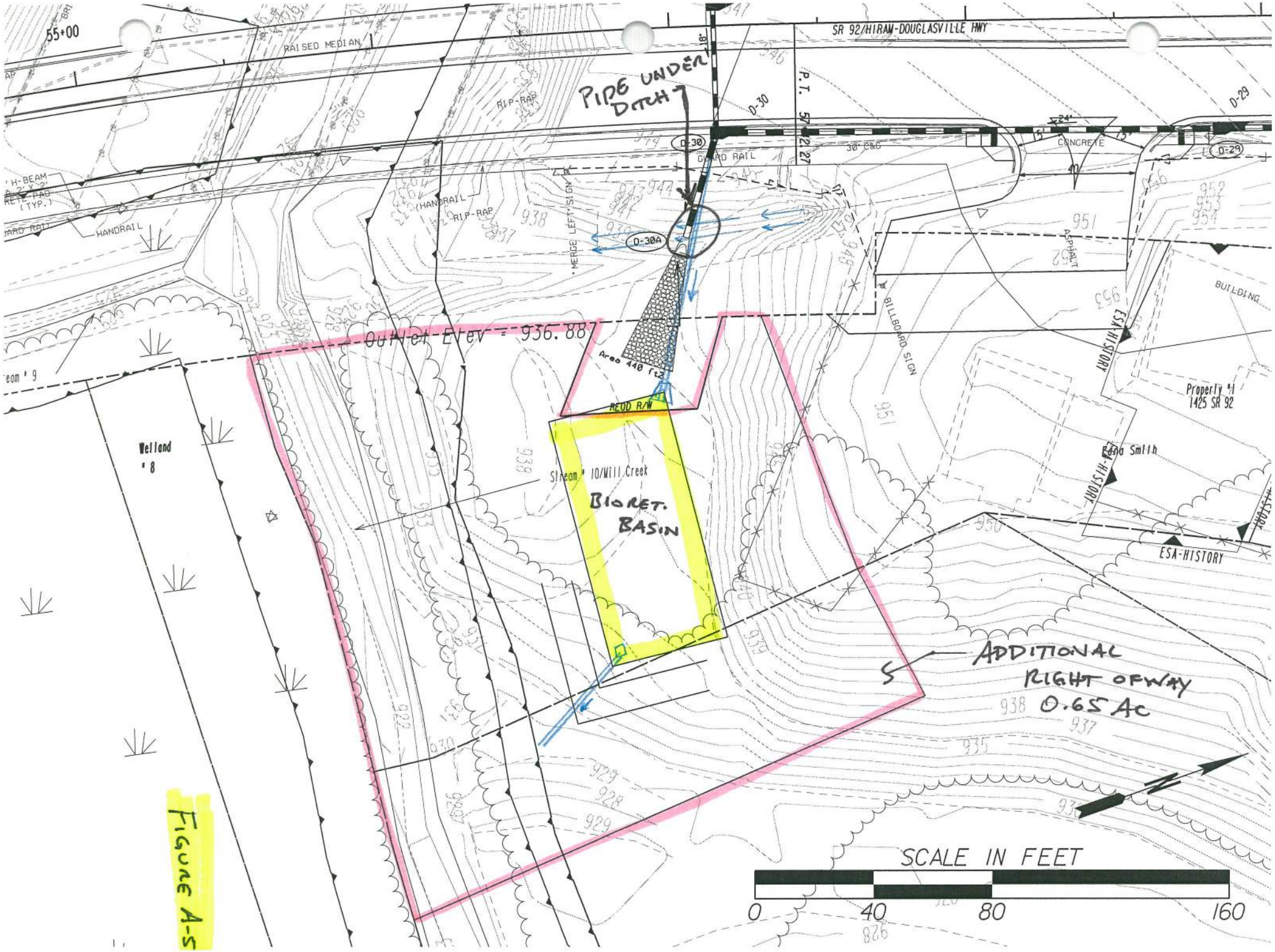
Bioretention Area

WQv	=	8,124	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **3,421** ft^2

Actual Filter Bed Dimensions:	Width	**40**	ft
	Length	**86**	ft
		3440	ft^2


55+00
SR 92/HIRAM-DOUGLASVILLE HWY
RAISED MEDIAN
PIPE UNDER DITCH
RIP-RAP
D-30
D-29
P.T. 57+27
30' C&G
CONCRETE
GUARD RAIL
HANDRAIL
H-BEAM
MERGE LEFT SIGN
D-30A
ASPHALT
BILLBOARD SIGN
BUILDING
Outlet Elev = 936.88
Area 440 ft2
REQD R/W
Property #1
1425 SR 92
Fano Smith
ESA-HISTORY
Wetland #8
Stream #10/Mill Creek
BIORET. BASIN
ADDITIONAL RIGHT OF WAY 0.65 Ac
SCALE IN FEET
0
40
80
160
FIGURE A-5

Infeasibility Criteria #1: Cost of Construction

11/12/2014

Basin A-5

Basin A-5 975 LF of Roadway construction cost within basin

Item	Basin A-5 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 321,345.00	$ 340,325.00	$ 94,337.50	$ 81,600.00
Utilities ✪	$ 74,743.13	$ -	$ -	$ -
Construction ✪	$ 636,991.03	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 13,600.00	$ 3,750.00	$ 3,250.00
Grading	$ -	$ 24,000.00	$ 7,920.00	$ 3,900.00
Drainage	$ -	$ 52,911.93	$ 46,447.00	$ 35,640.50
Total	$ 1,033,079.17	$ 430,836.93	$ 152,454.50	$ 124,390.50
	Percent of BMP Cost to Total	**41.7%**	**14.8%**	**12.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.8934
Sub Total:	$	44,670.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		1.3384
Sub Total:	$	167,300.00
Commercial Perm Easmt @	$	62,500.00
		0.31
Sub Total:	$	19,375.00
Commercial Relocation Cost	$	25,000.00
		2
Sub Total:	$	50,000.00
Right of Way Cost Total:	$	321,345.00

✪ See General Summary Explaination for Cost Method

figure A-5.6

BMP Construction Cost Worksheet Basin A-5

Dry Enhanced Swale

Length:	1057	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	2.7226	Ac	
Total:	$ 340,325.00		
Sub Total:	$ 340,325.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
2.72	Disturbed Ac	
$ 13,600.00		

Grading

Cut	Fill	
2000.000	2000.000	
$ 6.00	per CY	
Total: $ 24,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		2	EA	
	$ 5,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	783	CY	$ 30.00	$ 17,399.18
Uddrn Sys w/ Gravel	-	1087	LF	$ 20.00	$ 21,740.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY	
	59	SY	Fabric	59	SY	
	$ 3,392.50			$ 280.25		

Sub Total: $ 52,911.93

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	32	34	ft
Width:	16	16	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.7547	Ac	
Total:	$ 94,337.50		
Sub Total:	$ 94,337.50		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.75	Disturbed Ac	
$ 3,750.00		

Grading

Cut	Fill	
470.000	850.000	
$ 6.00	per CY	
Total: $ 7,920.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	29	CY	$ 45.00	$ 1,305.00
Uddrn Sys w/ Gravel	-	125	LF	$ 20.00	$ 2,500.00
Top Soil		5	CY	$ 20.00	$ 100.00
Addl Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	512	SF	$ 5.00	$ 2,560.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY	
	272	SY	Filter Fabric	272	SY	
	$ 15,640.00			$ 1,292.00		

Sub Total: $ 46,447.00

Bioretention Area

Length:	86	ft
Width:	40	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.6528	Ac	
Total:	$ 81,600.00		
Sub Total:	$ 81,600.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.65	Disturbed Ac	
$ 3,250.00		

Grading

Cut	Fill	
475.000	175.000	
$ 6.00	per CY	
Total: $ 3,900.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		2	EA	
	$ 5,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	255	CY	$ 30.00	$ 7,650.00
Uddrn Sys w/ Gravel	-	180	LF	$ 20.00	$ 3,600.00
Mulch	-	383	SY	$ 15.00	$ 5,745.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	15	EA	$ 30.00	$ 450.00
Ground Cover	-	41	EA	$ 15.00	$ 615.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY	
	58	SY	Fabric	58	SY	
	$ 3,335.00			$ 275.50		

Sub Total: $ 35,640.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 12, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin A-6A Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin A-6A was located and the existing and proposed basin drainage areas were delineated (See Figures A-6A.1 and A-6A.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	167	167
Quantity	Channel Protection, CP_v	790	957
	Overbank Flood Protection, Q_{p25}	599	766
	Extreme Flood Protection, Q_{f100}	762	929

- The total area draining to the MS4 pond is 0.26 Ac. The total impervious area is 0.14 Ac. The existing pavement area for the site is 0.11 Ac. The area required for storage and quantity management is 0.15 Ac (See Figure A-6A.3). The flow produced by the existing paved area of 0.11 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 12 feet wide by 34 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure A-6A.4).
- A BMP is required since the basin is still within the existing right of way of SR 92, even though located along a side road (See Figure A-6A.5).
- Modifications to the design by adding curb and gutter will be required along Main Street to separate the bypass flow from the treatment flow and to direct the treatment flow into the BMP (See Figure A-6A.5).
- An additional catch basin and additional pipes will be required (See Figure A-6A.5).
- The treated water after leaving the swale will flow into an existing drop inlet and be considered bypass flow to area A-6B, though ultimately flowing to outfall A-6. See Basin A-6B report for additional information.
- The BMP construction cost is 27.4% of the roadway construction cost within this basin making this basin infeasible (See Figure A-6A.6).
- None of the other infeasibility criteria apply to this basin.

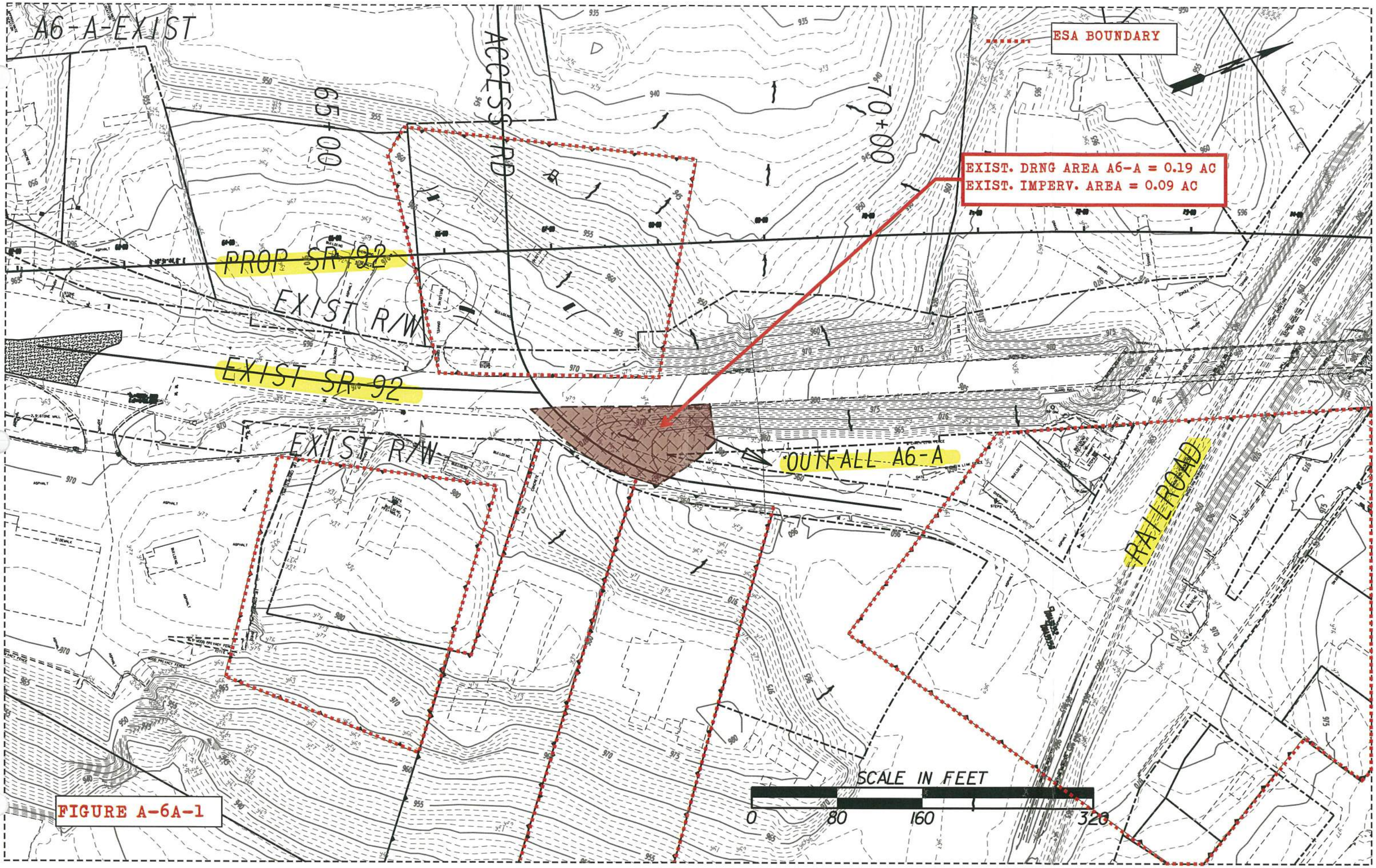

A6-A-EXIST
ESA BOUNDARY
EXIST. DRNG AREA A6-A = 0.19 AC
EXIST. IMPERV. AREA = 0.09 AC
ACCESS RD
65+00
70+00
PROP SR 92
EXIST R/W
EXIST SR 92
EXIST R/W
OUTFALL A6-A
RAILROAD
SCALE IN FEET
0
80
160
320

FIGURE A-6A-1

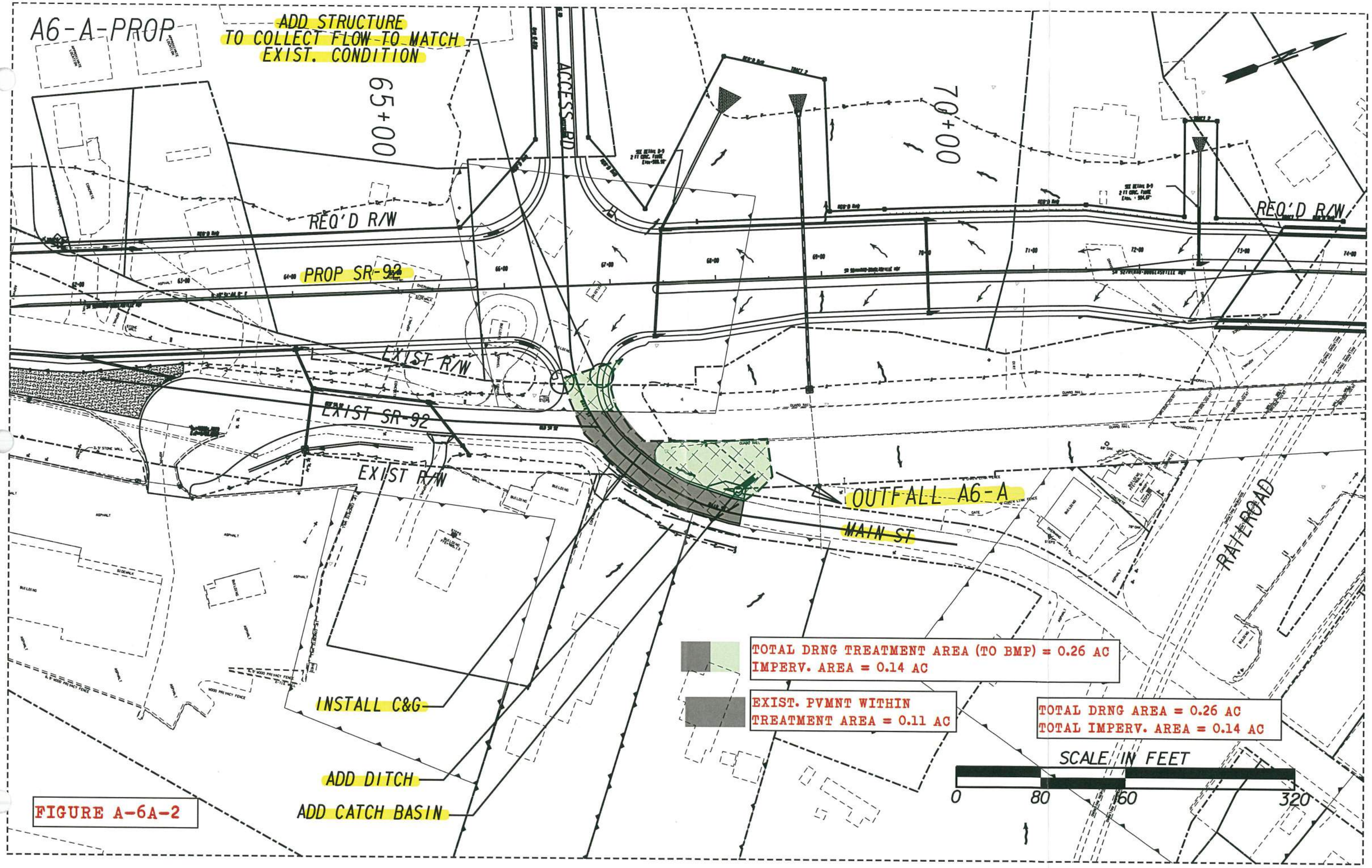

A6-A-PROP
ADD STRUCTURE TO COLLECT FLOW TO MATCH EXIST. CONDITION
65+00
70+00
ACCESS RD
REQ'D R/W
PROP SR-92
EXIST R/W
EXIST SR-92
EXIST R/W
OUTFALL A6-A
MAIN ST
RAILROAD
INSTALL C&G
ADD DITCH
ADD CATCH BASIN
TOTAL DRNG TREATMENT AREA (TO BMP) = 0.26 AC
IMPERV. AREA = 0.14 AC
EXIST. PVMNT WITHIN TREATMENT AREA = 0.11 AC
TOTAL DRNG AREA = 0.26 AC
TOTAL IMPERV. AREA = 0.14 AC
SCALE IN FEET
0
80
160
320

FIGURE A-6A-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: A-6A

Unified Stormwater Sizing Criteria
Table B

Pr. 621720
Nov-14
Calcs.: MAC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	0.19
Impervious Area =	0.09
Pervious Area=	0.11

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	83

Time of Concentration (See Table A) = 0.21 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.413

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.123	0.120
$I_a/P_{10\text{-}yr}$=	0.075	0.100
$I_a/P_{25\text{-}yr}$=	0.064	0.100
$I_a/P_{100\text{-}yr}$=	0.052	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.06

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.73
$Q_{d\ 10\text{-}yr}$=	3.64
$Q_{d\ 25\text{-}yr}$=	4.53
$Q_{d\ 100\text{-}yr}$ =	5.89

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	775
$q_{u10\text{-}yr}$=	790
$q_{u25\text{-}yr}$=	790
$q_{u100\text{-}yr}$=	790

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	0.41
$Q_{p10\text{-}yr}$=	0.87
$Q_{p25\text{-}yr}$=	1.08
$Q_{p100\text{-}yr}$=	1.40

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	0.26
Impervious Area =	0.14
Pervious Area =	0.12
Credit Area =	0.00

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	85

Time of Concentration (See Table A) = 0.24 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.341

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.102	0.100
$I_a/P_{10\text{-}yr}$=	0.062	0.100
$I_a/P_{25\text{-}yr}$=	0.053	0.100
$I_a/P_{100\text{-}yr}$=	0.043	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.71

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.93
$Q_{d\ 10\text{-}yr}$=	3.90
$Q_{d\ 25\text{-}yr}$=	4.80
$Q_{d\ 100\text{-}yr}$ =	6.19

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	750
$q_{u10\text{-}yr}$=	750
$q_{u25\text{-}yr}$=	750
$q_{u100\text{-}yr}$=	750

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	0.59
$Q_{p10\text{-}yr}$=	1.20
$Q_{p25\text{-}yr}$=	1.47
$Q_{p100\text{-}yr}$=	1.90

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	0.26	Acre
Total Impervious Area - A_{POST}	0.14	Acre
Existing Pavement Area - A_{PRE} (5)	0.11	Acre
Area Required for Quantity - A_{QUAN} (4)	0.15	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
0.26	0.11	10.69	0.00	0.146	0.004	167

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) R_v = 0.05 + 0.009 (I)
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.016	687

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 790

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.731	0.20	0.012	520

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 599

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.739	0.20	0.015	662

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 762

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

figure A-6A.3

FIGURE A-6A.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-6A*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: MAC

	Computed Volumes	Stacked Volumes
WQ_v	167	167
CP_v	790	957
Q_{p25}	599	766
Q_{f100}	762	929

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**125**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	961	ft^3	>	957	ft^3

Swale Dimensions:

A swale that is **125** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	957	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **55** ft^2

Actual Filter Bed Dimensions:	Width	**6**	ft
	Length	**12**	ft
		72	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_S = **63** ft^2

Actual Sediment Chamber Dimensions:	Width	**6**	ft
	Length	**12**	ft
		72	ft^2

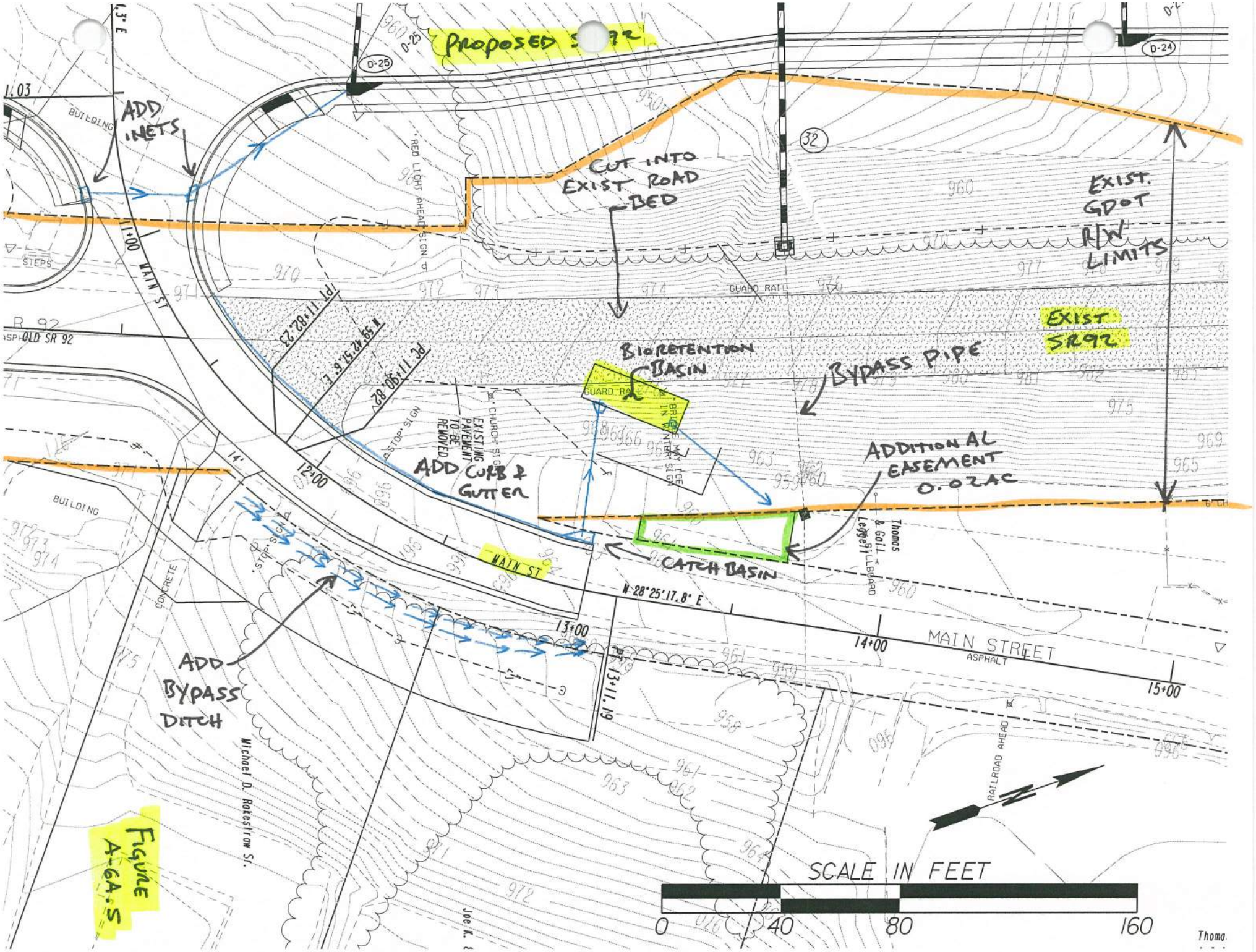
Bioretention Area

CP_v	=	957	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **403** ft^2

Actual Filter Bed Dimensions:	Width	**12**	ft
	Length	**34**	ft
		408	ft^2


PROPOSED SR92
ADD INETS
CUT INTO EXIST ROAD BED
EXIST. GDOT R/W LIMITS
EXIST SR92
BIORETENTION BASIN
BYPASS PIPE
ADDITIONAL EASEMENT 0.02AC
ADD CURB & GUTTER
CATCH BASIN
ADD BYPASS DITCH
FIGURE A-6A.5
MAIN STREET
ASPHALT
MAIN ST
OLD SR 92
BUILDING
STEPS
CONCRETE
GUARD RAIL
RED LIGHT AHEAD SIGN
STOP SIGN
CHURCH ST
EXISTING PAVEMENT TO BE REMOVED
BRIDGE MAY BE ICE IN WINTER SIGN
RAILROAD AHEAD
Thomas & Gail Leggett
Michael D. Ratestrow Sr.
Joe K.
PC 11+90.87
PT 11+82.23
N 59°42'52.6" E
N 28°25'17.8" E
PC 13+11.19
11+00
12+00
13+00
14+00
15+00
SCALE IN FEET
0
40
80
160

Infeasibility Criteria #1: Cost of Construction
Basin A-6A

11/17/2014

Basin A-6A 216 LF of Roadway construction cost within basin

Item	Basin A-6A Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 3,103.75	$ 956.25	$ -	$ 956.25
Utilities ✪	$ 16,558.48	$ -	$ -	$ -
Construction ✪	$ 141,118.01	$ 4,550.00	$ 4,550.00	$ 4,550.00
Clearing and Grubbing	$ -	$ 100.00	$ -	$ 3,250.00
Grading	$ -	$ 6,300.00	$ 3,600.00	$ 3,600.00
Drainage	$ -	$ 34,593.36	$ 50,011.00	$ 31,705.75
Total	$ 160,780.24	$ 46,499.61	$ 58,161.00	$ 44,062.00
	Percent of BMP Cost to Total	**28.9%**	**36.2%**	**27.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0
Sub Total:	$	-
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.1159
Sub Total:	$	2,897.50
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0.0033
Sub Total:	$	206.25
Commercial Relocation Cost	$	25,000.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	3,103.75

✪ See General Summary Explaination for Cost Method

figure A-6A.6

BMP Construction Cost Worksheet — Basin A-6A

Dry Enhanced Swale

Length:	125	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.0153	Ac	
Total:	$ 956.25		
Sub Total:	$ 956.25		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.02	Disturbed Ac	
$ 100.00		

Grading

Cut	Fill	
1000.000	50.000	
$ 6.00	per CY	
Total: $ 6,300.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		1	EA
	$ 20,000.00			$ 400.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	93	CY	$ 30.00	$ 2,057.61
Uddrn Sys w/ Gravel	-	155	LF	$ 20.00	$ 3,100.00
Additional Pipe	18"	200	LF	$ 43.00	$ 8,600.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	7	SY		7	SY
	$ 402.50			$ 33.25	

Sub Total: $ 34,593.36

Construction

	Quantity	Unit	Cost	Total
TP 2 Curb and Gutter	160	LF	$ 20.00	$ 3,200.00
Sidewalk	90	SY	$ 15.00	$ 1,350.00
			Sub Total:	$ 4,550.00

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	12	12	ft
Width:	6	6	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ -		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0	Disturbed Ac	
$ -		

Grading

Cut	Fill	
400.000	200.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	6	EA		3	EA
	$ 30,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	4	CY	$ 45.00	$ 180.00
Uddrn Sys w/ Gravel	-	75	LF	$ 20.00	$ 1,500.00
Top Soil		1	CY	$ 20.00	$ 20.00
Addl Pipe	18"	200	LF	$ 43.00	$ 8,600.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	72	SF	$ 5.00	$ 360.00
Dist Wall Conc/Steel	-	2	CY	$ 1,020.00	$ 2,040.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	36	SY	Filter Fabric	36	SY
	$ 2,070.00			$ 171.00	

Sub Total: $ 50,011.00

Construction

	Quantity	Unit	Cost	Total
TP 2 Curb and Gutter	160	LF	$ 20.00	$ 3,200.00
Sidewalk	90	SY	$ 15.00	$ 1,350.00
			Sub Total:	$ 4,550.00

Bioretention Area

Length:	34	ft
Width:	12	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.0153	Ac	
Total:	$ 956.25		
Sub Total:	$ 956.25		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.65	Disturbed Ac	
$ 3,250.00		

Grading

Cut	Fill	
400.000	200.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	3	EA		2	EA
	$ 15,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	31	CY	$ 30.00	$ 930.00
Uddrn Sys w/ Gravel	-	54	LF	$ 20.00	$ 1,080.00
Mulch	-	46	SY	$ 15.00	$ 690.00
Additional Pipe	18"	200	LF	$ 43.00	$ 8,600.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	5	EA	$ 30.00	$ 150.00
Ground Cover	-	10	EA	$ 15.00	$ 150.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	7	SY		7	SY
	$ 402.50			$ 33.25	

Sub Total: $ 31,705.75

Construction

	Quantity	Unit	Cost	Total
TP 2 Curb and Gutter	160	LF	$ 20.00	$ 3,200.00
Sidewalk	90	SY	$ 15.00	$ 1,350.00
			Sub Total:	$ 4,550.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
5TP00-0186-01(025)

November 17, 2014
Designed By: MAC
Checked By: SCF 11-17-14

Basin A-6B Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin A-6B was located and the existing and proposed basin drainage areas were delineated (See Figures A-6B.1 and A-6B.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	4,038	4,038
Quantity	Channel Protection, CP_v	3,834	7,872
	Overbank Flood Protection, Q_{p25}	2,996	7,034
	Extreme Flood Protection, Q_{f100}	3,625	7,663

- The total area draining to the MS4 pond is 1.76 Ac. The total impervious area is 1.61 Ac. The existing pavement area for the site is 0.68 Ac. The area required for storage and quality treatment is 1.08 Ac (See Figure A-6B.3). The flow produced by the existing paved area of 0.68 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 50 feet wide by 67 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure A-6B.4).
- Modifications to the drainage design will be required including adding additional pipes and structures. They will be required to separate the bypass flow from the treatment flow and to direct the treatment flow into the BMP. Some pipes will be removed from the existing design (See Figure A-6B.2).
- See Figure A-6B.5 for the layout of the bioretention area.
- The BMP construction cost is 12.0% of the roadway construction cost within this basin making this basin infeasible (See Figure A-6B.6).
- None of the other infeasibility criteria apply to this basin.

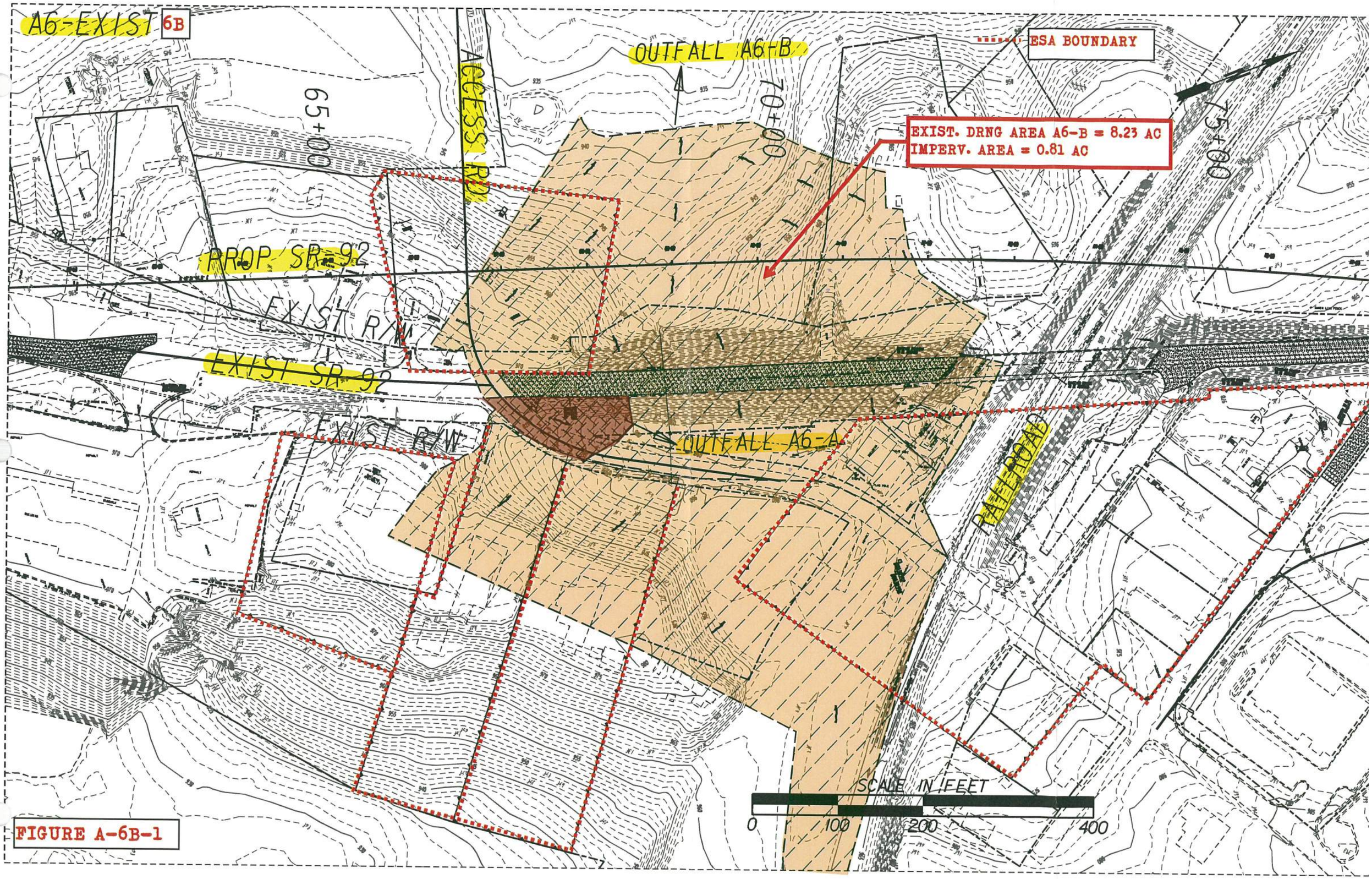

A6-EXIST
6B
OUTFALL A6-B
ESA BOUNDARY
EXIST. DRNG AREA A6-B = 8.23 AC
IMPERV. AREA = 0.81 AC
ACCESS RD
65+00
70+00
75+00
PROP SR-92
EXIST R/W
EXIST SR-92
EXIST R/W
OUTFALL A6-A
SCALE IN FEET
0
100
200
400

FIGURE A-6B-1

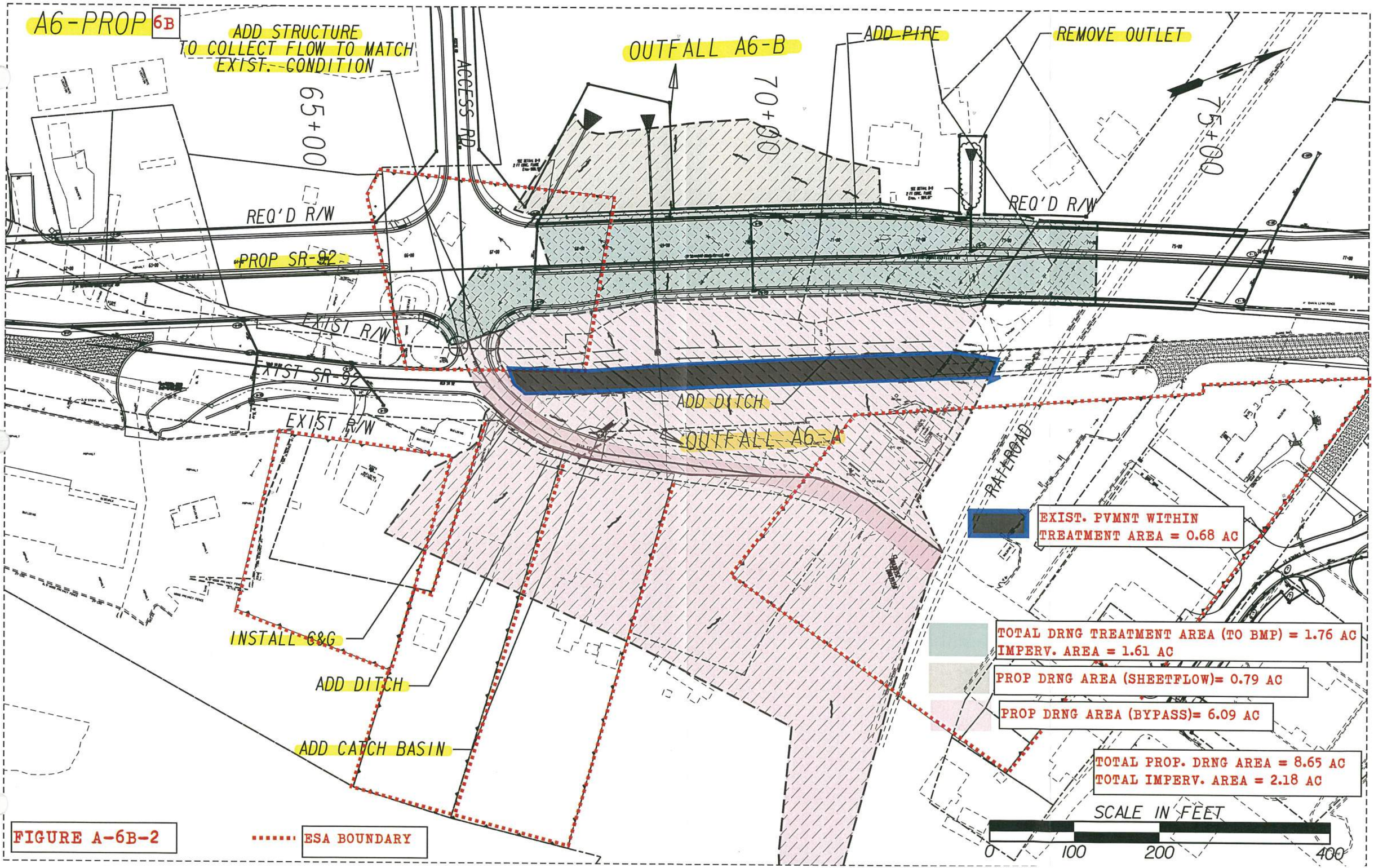

A6-PROP 6B
ADD STRUCTURE TO COLLECT FLOW TO MATCH EXIST. CONDITION
OUTFALL A6-B
ADD PIPE
REMOVE OUTLET
ACCESS RD.
65+00
70+00
75+00
REQ'D R/W
PROP SR-92
EXIST R/W
EXIST SR-92
ADD DITCH
OUTFALL A6-A
RAILROAD
INSTALL C&G
ADD DITCH
ADD CATCH BASIN
EXIST. PVMNT WITHIN TREATMENT AREA = 0.68 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.76 AC
IMPERV. AREA = 1.61 AC
PROP DRNG AREA (SHEETFLOW)= 0.79 AC
PROP DRNG AREA (BYPASS)= 6.09 AC
TOTAL PROP. DRNG AREA = 8.65 AC
TOTAL IMPERV. AREA = 2.18 AC
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE A-6B-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: A-6B

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	8.23
Impervious Area =	0.81
Pervious Area=	7.42

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.93 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.715

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.213	0.21
$I_a/P_{10\text{-}yr}$=	0.130	0.13
$I_a/P_{25\text{-}yr}$=	0.110	0.11
$I_a/P_{100\text{-}yr}$=	0.090	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.58

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.12
$Q_{d\ 10\text{-}yr}$=	2.75
$Q_{d\ 25\text{-}yr}$=	3.56
$Q_{d\ 100\text{-}yr}$ =	4.81

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	340
$q_{u10\text{-}yr}$=	350
$q_{u25\text{-}yr}$=	365
$q_{u100\text{-}yr}$=	375

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	4.92
$Q_{p10\text{-}yr}$=	12.40
$Q_{p25\text{-}yr}$=	16.71
$Q_{p100\text{-}yr}$=	23.23

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	8.65
Impervious Area =	2.18
Pervious Area =	6.46
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	78

Time of Concentration (See Table A) = 0.93 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.570

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.170	0.17
$I_a/P_{10\text{-}yr}$=	0.103	0.1
$I_a/P_{25\text{-}yr}$=	0.088	0.1
$I_a/P_{100\text{-}yr}$=	0.072	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.85

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.38
$Q_{d\ 10\text{-}yr}$=	3.14
$Q_{d\ 25\text{-}yr}$=	3.99
$Q_{d\ 100\text{-}yr}$ =	5.30

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	345
$q_{u10\text{-}yr}$=	375
$q_{u25\text{-}yr}$=	375
$q_{u100\text{-}yr}$=	375

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	6.43	0.764847
$Q_{p10\text{-}yr}$=	15.91	
$Q_{p25\text{-}yr}$=	20.19	
$Q_{p100\text{-}yr}$=	26.83	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.76	Acre
Total Impervious Area - A_{POST}	1.61	Acre
Existing Pavement Area - A_{PRE} (5)	0.68	Acre
Area Required for Quantity - A_{QUAN} (4)	1.08	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.76	0.53	52.86	0.00	0.526	0.093	4,038

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)	
0.05	0.61	0.077	3,333	(+15% ED)= 3,834

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)	
0.827	0.17	0.060	2,604	(+15% ED)= 2,996

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)	
0.866	0.15	0.072	3,152	(+15% ED)= 3,625

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

figure A-6B.3

FIGURE A-6B.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *A-6B*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	4,038	4,038
CP_v	3,834	7,872
Q_{p25}	2,996	7,034
Q_{f100}	3,625	7,663

Dry Enhanced Swale

Average Depth	=	0.75	ft
Length	=	**1025**	ft
Width	=	8	ft
Left Side Slope	=	3	:1
Right Side Slope	=	3	:1
Area	=	7.6875	ft^2
Slope	=	0.01	ft/ft
Storage Volume	=	7880	ft^3 > 7872 ft^3

Swale Dimensions:

A swale that is **1025** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	7,872	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **449** ft^2

Actual Filter Bed Dimensions:	Width	**15**	ft
	Length	**30**	ft
		450	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **520** ft^2

Actual Sediment Chamber Dimensions:	Width	**15**	ft
	Length	**35**	ft
		525	ft^2

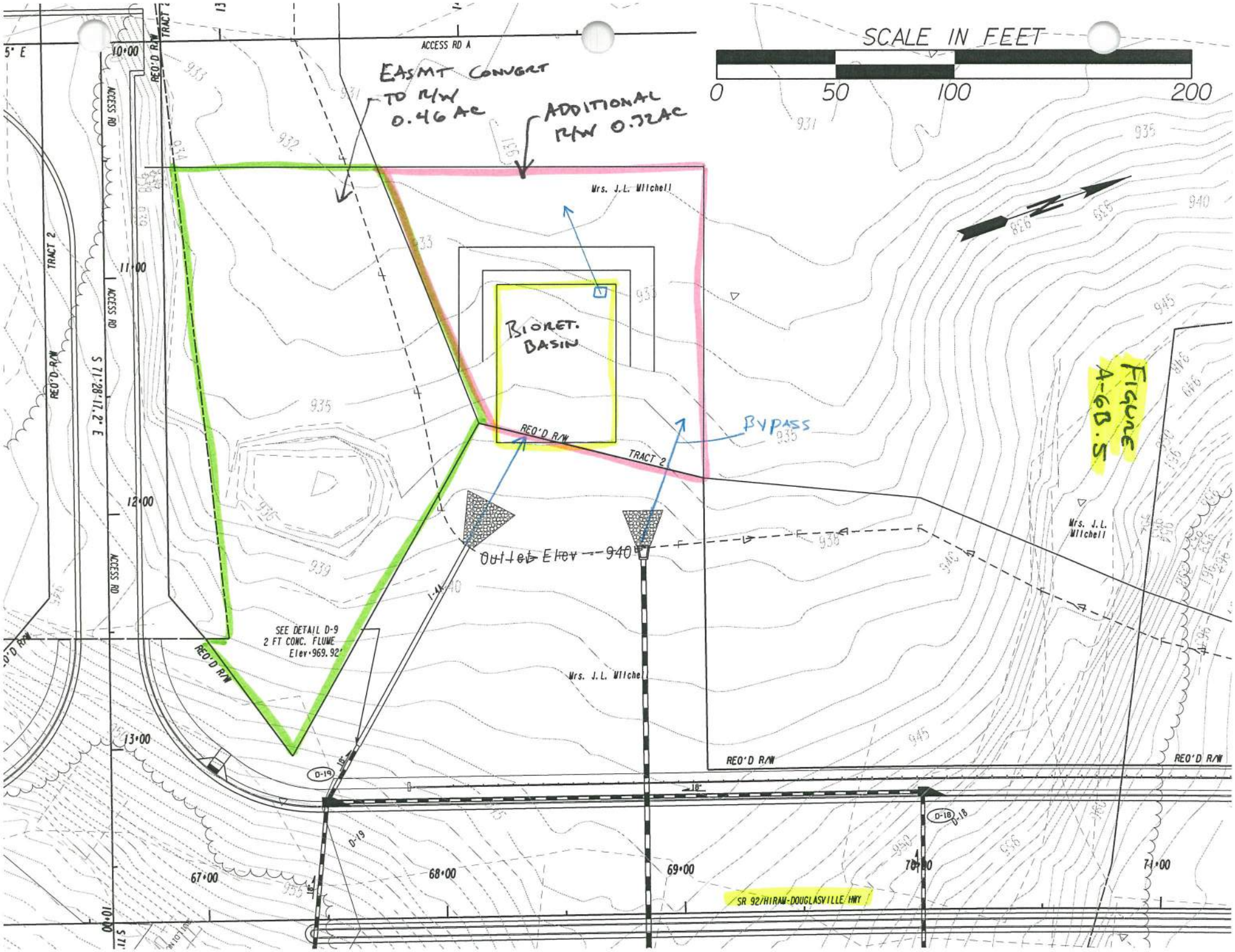
Bioretention Area

CP_v	=	7,872	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **3,315** ft^2

Actual Filter Bed Dimensions:	Width	**50**	ft
	Length	**67**	ft
		3350	ft^2


SCALE IN FEET
0
50
100
200
EASMT CONVERT TO R/W 0.46 AC
ADDITIONAL R/W 0.72AC
BIORET. BASIN
BYPASS
Outlet Elev 940
FIGURE 4-6B.5
ACCESS RD A
ACCESS RD
TRACT 2
REQ'D R/W
Mrs. J.L. Mitchell
SEE DETAIL D-9
2 FT CONC. FLUME
Elev 969.92'
S 71°28'17.2" E
SR 92/HIRAM-DOUGLASVILLE HWY
D-19
D-18
67+00
68+00
69+00
70+00
71+00
10+00
11+00
12+00
13+00

Infeasibility Criteria #1: Cost of Construction
Basin A-6B

11/13/2014

Basin A-6B 700 LF of Roadway construction cost within basin

Item	Basin A-6B Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 269,647.50	$ 77,262.50	$ 37,970.00	$ 27,357.50
Utilities ✪	$ 53,661.74	$ -	$ -	$ -
Construction ✪	$ 457,326.90	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 5,680.00	$ 2,411.00	$ 1,580.50
Grading	$ -	$ 8,400.00	$ 5,340.00	$ 3,960.00
Drainage	$ -	$ 76,970.68	$ 71,415.63	$ 61,071.00
Total	$ 780,636.13	$ 168,313.18	$ 117,136.63	$ 93,969.00
	Percent of BMP Cost to Total	**21.6%**	**15.0%**	**12.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		3.5718
Sub Total:	$	178,590.00
Residential Relocation Cost	$	40,000.00
		2
Sub Total:	$	80,000.00
Residential Perm Easmt @	$	25,000.00
		0.4423
Sub Total:	$	11,057.50
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Commercial Relocation Cost	$	25,000.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	269,647.50

✪ See General Summary Explaination for Cost Method

FIGURE A-6B.6

BMP Construction Cost Worksheet Basin A-6B

Dry Enhanced Swale

Length:	1025	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	1.136	Ac	
Total:	$ 56,800.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.8185	Ac	
Total:	$ 20,462.50		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 77,262.50		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.136	Disturbed Ac	
$ 5,680.00		

Grading

Cut	Fill	
800.000	600.000	
	$ 6.00	per CY
Total:	$ 8,400.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	4	EA		1	EA	
	$ 20,000.00			$ 400.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	759	CY	$ 30.00	$ 16,872.43
Uddrn Sys w/ Gravel	-	1055	LF	$ 20.00	$ 21,100.00
Additional Pipe	18"	350	LF	$ 43.00	$ 15,050.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	57	SY		57	SY	
	$ 3,277.50			$ 270.75		

Sub Total: $ 76,970.68

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	30	35	ft
Width:	15	15	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.4822	Ac	
Total:	$ 24,110.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.5544	Ac	
Total:	$ 13,860.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 37,970.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.4822	Disturbed Ac	
$ 2,411.00		

Grading

Cut	Fill	
560.000	330.000	
	$ 6.00	per CY
Total:	$ 5,340.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	5	EA		3	EA	
	$ 25,000.00			$ 1,200.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	25	CY	$ 45.00	$ 1,125.00
Uddrn Sys w/ Gravel	-	120	LF	$ 20.00	$ 2,400.00
Top Soil		5	CY	$ 20.00	$ 100.00
Addl Pipe	18"	350	LF	$ 43.00	$ 15,050.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	450	SF	$ 5.00	$ 2,250.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY	
	262.5	SY	Filter Fabric	262.5	SY	
	$ 15,093.75			$ 1,246.88		

Sub Total: $ 71,415.63

Bioretention Area

Length:	67	ft
Width:	50	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.3161	Ac	
Total:	$ 15,805.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.4621	Ac	
Total:	$ 11,552.50		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 27,357.50		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.3161	Disturbed Ac	
$ 1,580.50		

Grading

Cut	Fill	
610.000	50.000	
	$ 6.00	per CY
Total:	$ 3,960.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	4	EA		2	EA	
	$ 20,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	249	CY	$ 30.00	$ 7,470.00
Uddrn Sys w/ Gravel	-	225	LF	$ 20.00	$ 4,500.00
Mulch	-	373	SY	$ 15.00	$ 5,595.00
Additional Pipe	18"	350	LF	$ 43.00	$ 15,050.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	5	EA	$ 30.00	$ 150.00
Ground Cover	-	10	EA	$ 15.00	$ 150.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	56	SY		56	SY	
	$ 3,220.00			$ 266.00		

Sub Total: $ 61,071.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin B-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin B-1 was located and the existing and proposed basin drainage areas were delineated (See Figures B-1.1 and B-1.2). From those drainage areas the MS4 requirements, Water Quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	2,063	2,063
Quantity	Channel Protection, CP_v	2,362	4,425
	Overbank Flood Protection, Q_{p25}	1,537	3,600
	Extreme Flood Protection, Q_{f100}	1,979	4,042

- The total area draining to the MS4 pond is 0.85 Ac. The total impervious area is 0.83 Ac. The existing pavement area for the site is 0.35 Ac. The area required for storage and quantity management is 0.50 Ac (See Figure B-1.3). The flow produced by the existing paved area of 0.35 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 22 feet wide by 85 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure B-1.4).
- Additional pipes and structures will be necessary to divide the offsite water and the treatment water. The offsite water will bypass the BMP. However, some pipes will be eliminated from the existing design (See Figure B-1.5).
- The BMP construction cost is 10.8% of the roadway construction cost within this basin making this basin infeasible (See Figure B-1.6).
- None of the other infeasibility criteria apply to this basin.

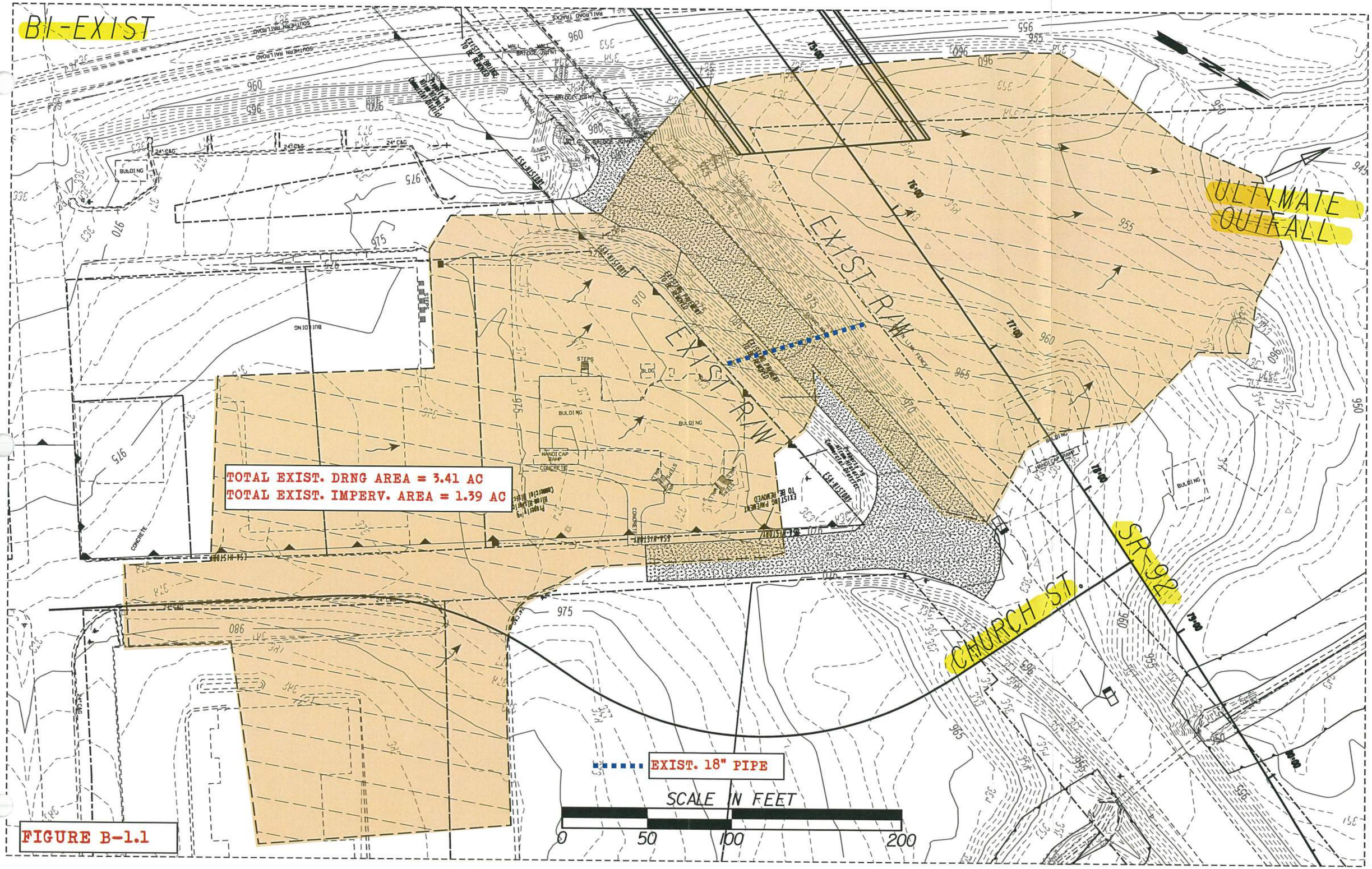

B1-EXIST
ULTIMATE OUTFALL
EXIST R/W
SR 92
CHURCH ST.
TOTAL EXIST. DRNG AREA = 3.41 AC
TOTAL EXIST. IMPERV. AREA = 1.39 AC
EXIST. 18" PIPE
SCALE IN FEET
0
50
100
200

FIGURE B-1.1

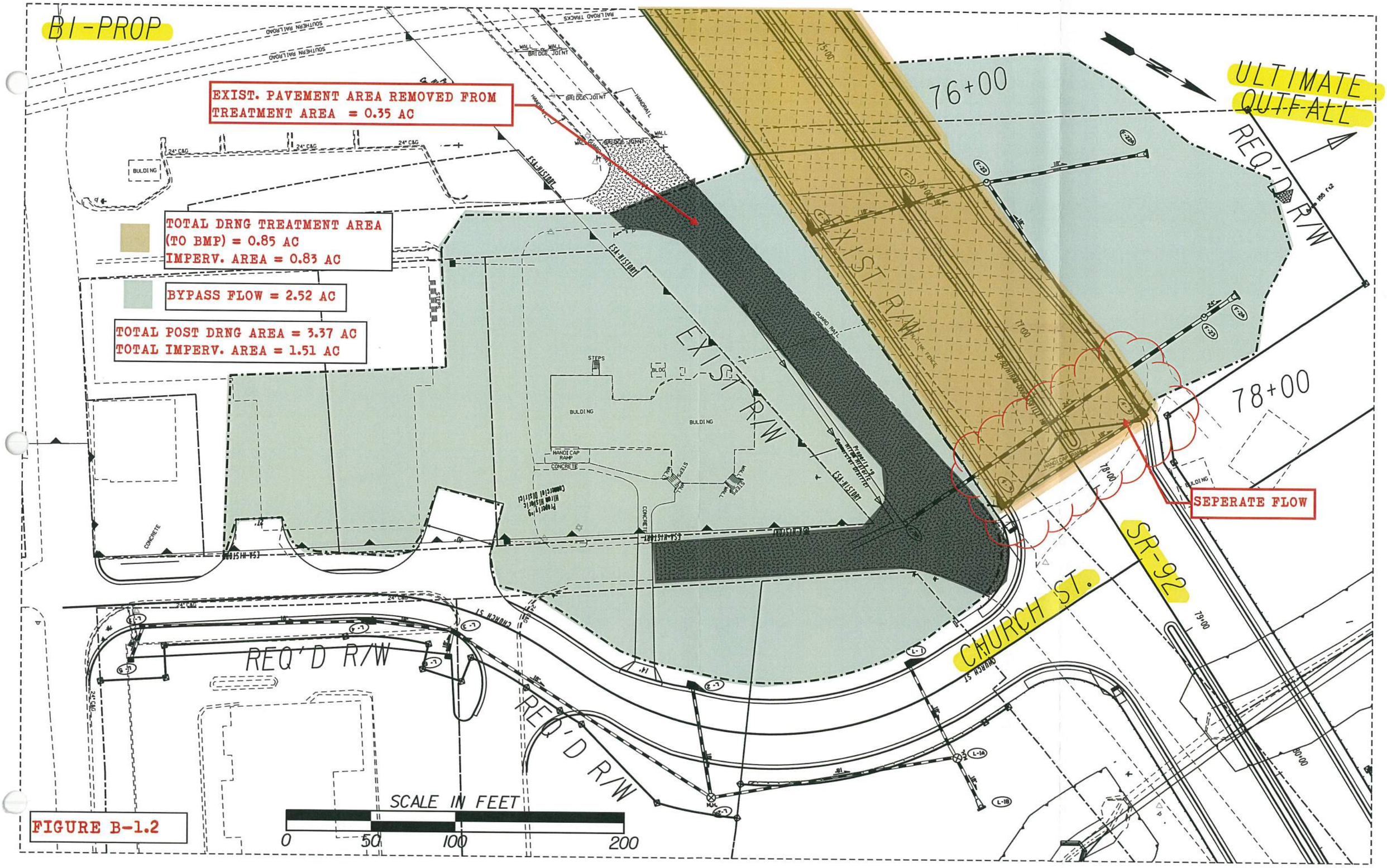

BI-PROP
EXIST. PAVEMENT AREA REMOVED FROM TREATMENT AREA = 0.35 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 0.85 AC
IMPERV. AREA = 0.83 AC
BYPASS FLOW = 2.52 AC
TOTAL POST DRNG AREA = 3.37 AC
TOTAL IMPERV. AREA = 1.51 AC
ULTIMATE OUTFALL
REQ'D R/W
EXIST R/W
76+00
78+00
SEPERATE FLOW
SR-92
CHURCH ST.
SCALE IN FEET
0
50
100
200

FIGURE B-1.2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: B-1

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	3.41
Impervious Area =	1.39
Pervious Area=	2.02

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	82

Time of Concentration (See Table A) = 0.32 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.438

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.130	0.13
$I_a/P_{10\text{-}yr}$=	0.079	0.1
$I_a/P_{25\text{-}yr}$=	0.068	0.1
$I_a/P_{100\text{-}yr}$=	0.055	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.19

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.67
$Q_{d\ 10\text{-}yr}$=	3.55
$Q_{d\ 25\text{-}yr}$=	4.43
$Q_{d\ 100\text{-}yr}$ =	5.79

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	645
$q_{u10\text{-}yr}$=	660
$q_{u25\text{-}yr}$=	660
$q_{u100\text{-}yr}$=	660

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	5.74
$Q_{p10\text{-}yr}$=	12.48
$Q_{p25\text{-}yr}$=	15.59
$Q_{p100\text{-}yr}$=	20.34

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	3.37
Impervious Area =	1.51
Pervious Area =	1.86
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	83

Time of Concentration (See Table A) = 0.22 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.406

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.121	0.12
$I_a/P_{10\text{-}yr}$=	0.074	0.1
$I_a/P_{25\text{-}yr}$=	0.063	0.1
$I_a/P_{100\text{-}yr}$=	0.051	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.03

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.75
$Q_{d\ 10\text{-}yr}$=	3.66
$Q_{d\ 25\text{-}yr}$=	4.55
$Q_{d\ 100\text{-}yr}$ =	5.92

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	750
$q_{u10\text{-}yr}$=	775
$q_{u25\text{-}yr}$=	775
$q_{u100\text{-}yr}$=	775

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	6.92	0.829109
$Q_{p10\text{-}yr}$=	14.95	
$Q_{p25\text{-}yr}$=	18.59	
$Q_{p100\text{-}yr}$=	24.15	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	0.85	Acre
Total Impervious Area - A_{POST}	0.83	Acre
Existing Pavement Area - A_{PRE} (5)	0.35	Acre
Area Required for Quantity - A_{QUAN} (4)	0.50	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
0.85	0.57	56.55	0.00	0.559	0.047	2,063

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) $R_v = 0.05 + 0.009\ (I)$
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.839	0.16	0.031	1,336

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 1,537

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area
(See GSMM Page 2.2-9)

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.047	2,053

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 2,362

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area
(See GSMM Page 2.2-9)

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.842	0.16	0.040	1,721

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 1,979

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area
(See GSMM Page 2.2-9)

FIGURE B-1.3

FIGURE B-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-1*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	2,063	2,063
CP_v	2,362	4,425
Q_{p25}	1,537	3,600
Q_{f100}	1,979	4,042

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**576**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	4428	ft^3	>	4425	ft^3

Swale Dimensions:

A swale that is **576** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	4,425	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **252** ft^2

Actual Filter Bed Dimensions:	Width	**12**	ft
	Length	**24**	ft
		288	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **292** ft^2

Actual Sediment Chamber Dimensions:	Width	**12**	ft
	Length	**25**	ft
		300	ft^2

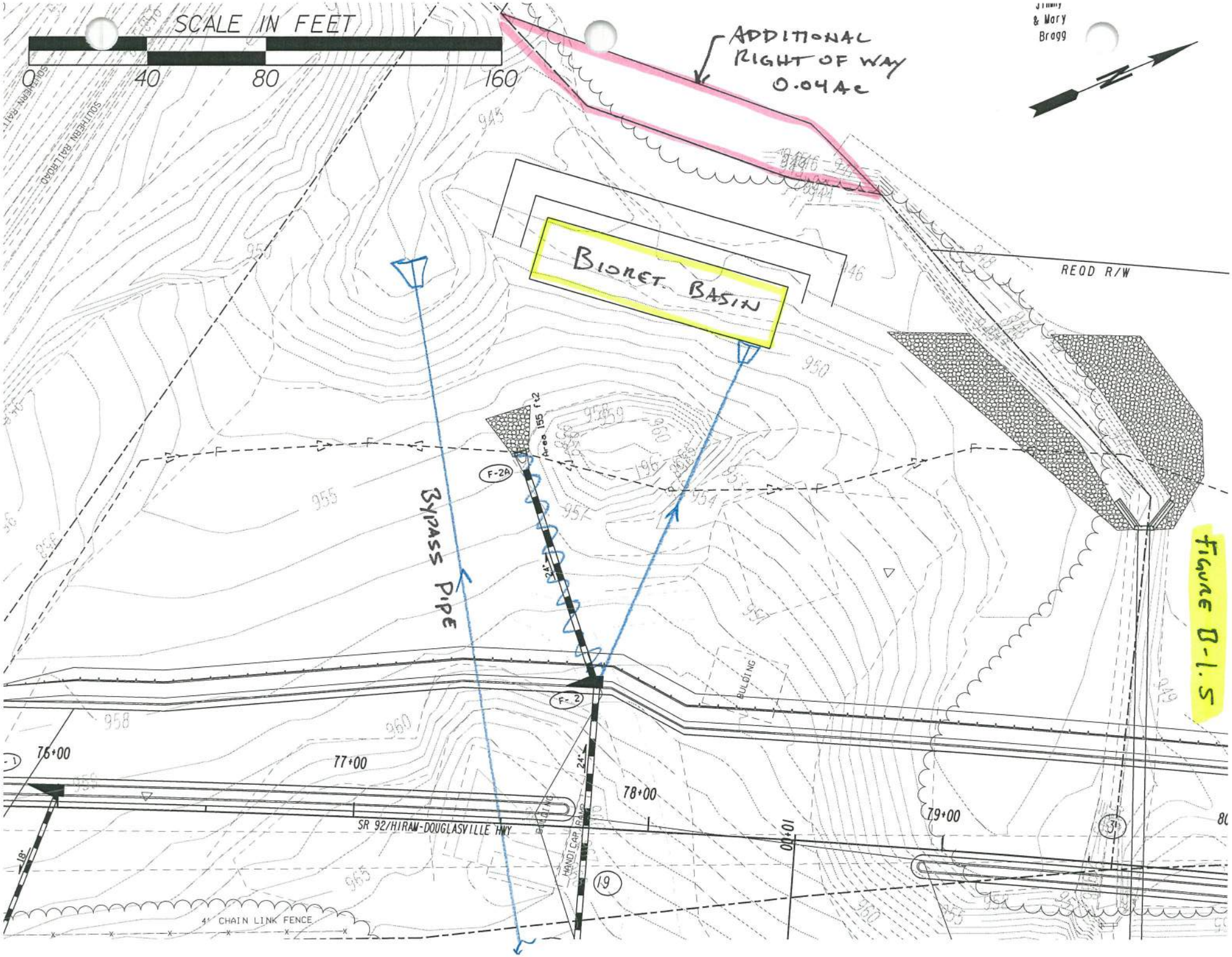
Bioretention Area

CP_v	=	4,425	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **1,863** ft^2

Actual Filter Bed Dimensions:	Width	**22**	ft
	Length	**85**	ft
		1870	ft^2


SCALE IN FEET
0
40
80
160
ADDITIONAL RIGHT OF WAY 0.04Ac
Jimmy & Mary Bragg
BIORET BASIN
REQD R/W
BYPASS PIPE
F-2A
F-2
Area 155 ft2
24"
18"
BUILDING
HANDICAP RAMP
76+00
77+00
78+00
79+00
10+00
SR 92/HIRAW-DOUGLASVILLE HWY
SOUTHERN RAILROAD
4' CHAIN LINK FENCE
19
Figure B-1.5

Infeasibility Criteria #1: Cost of Construction
Basin B-1

11/14/2014

Basin B-1 340 LF of Roadway construction cost within basin

Item	Basin B-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 146,320.00	$ 49,790.00	$ 2,060.00	$ 2,060.00
Utilities ✪	$ 26,064.27	$ -	$ -	$ -
Construction ✪	$ 222,130.21	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,979.00	$ 3,146.00	$ 3,009.50
Grading	$ -	$ 24,000.00	$ 5,700.00	$ 3,600.00
Drainage	$ -	$ 40,833.48	$ 42,982.50	$ 34,002.00
Total	$ 394,514.48	$ 119,602.48	$ 53,888.50	$ 42,671.50
	Percent of BMP Cost to Total	**30.3%**	**13.7%**	**10.8%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		2.1264
Sub Total:	$	106,320.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Commercial Relocation Cost	$	25,000.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	146,320.00

✪ See General Summary Explaination for Cost Method

Figure B-1.6

BMP Construction Cost Worksheet Basin B-1

Dry Enhanced Swale

Length:	576	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$	50,000.00	per Ac
		0.9958	Ac
Total:	$	49,790.00	
Residential Perm Easmt @	$	25,000.00	per Ac
		0	Ac
Total:	$	-	
Residential Relocation @	$	40,000.00	
		0	
Total:	$	-	
Sub Total:	$	49,790.00	

Utilities

Gas Main	$	22.00	per LF
		0	LF
	$	-	
16" Water Main	$	75.00	per LF
		0	LF
	$	-	
Overhead Power	$	25,000.00	per pole
		0	poles
	$	-	
Sub Total:	$	-	

Clearing and Grubbing

$	5,000.00	per Ac Disturbed
	0.9958	Disturbed Ac
$	4,979.00	

Grading

Cut	Fill	
2000.000	2000.000	
$	6.00	per CY
Total: $	24,000.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$	5,000.00	per EA	FES	$	400.00	per EA
		1	EA			2	EA
	$	5,000.00			$	800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	427	CY	$ 30.00	$ 9,481.48
Uddrn Sys w/ Gravel	-	606	LF	$ 20.00	$ 12,120.00
Bypass Pipe	24"	220	LF	$ 52.00	$ 11,440.00

Rip Rap TP3,18"	$	57.50	per SY	Filter Fabric	$	4.75	per SY
		32	SY			32	SY
	$	1,840.00			$	152.00	

Sub Total: $ 40,833.48

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	24	25	ft
Width:	12	12	ft

Right of Way

Residential Right of Way @	$	50,000.00	per Ac
		0.0412	Ac
Total:	$	2,060.00	
Residential Perm Easmt @	$	25,000.00	per Ac
		0	Ac
Total:	$	-	
Residential Relocation @	$	40,000.00	
		0	
Total:	$	-	
Sub Total:	$	2,060.00	

Utilities

Gas Main	$	22.00	per LF
		0	LF
	$	-	
16" Water Main	$	75.00	per LF
		0	LF
	$	-	
Overhead Power	$	25,000.00	per pole
		0	poles
	$	-	
Sub Total:	$	-	

Clearing and Grubbing

$	5,000.00	per Ac Disturbed
	0.6292	Disturbed Ac
$	3,146.00	

Grading

Cut	Fill	
850.000	100.000	
$	6.00	per CY
Total: $	5,700.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$	5,000.00	per EA	FES	$	400.00	per EA
		2	EA			4	EA
	$	10,000.00			$	1,600.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	16	CY	$ 45.00	$ 720.00
Uddrn Sys w/ Gravel	-	105	LF	$ 20.00	$ 2,100.00
Top Soil		3	CY	$ 20.00	$ 60.00
Outlet Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Bypass Pipe	24"	220	LF	$ 52.00	$ 11,440.00
Imperm Geotextile	-	288	SF	$ 5.00	$ 1,440.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$	57.50	per SY	Filter Fabric	$	4.75	per SY
		150	SY			150	SY
	$	8,625.00			$	712.50	

Sub Total: $ 42,982.50

Bioretention Area

Length:	85	ft
Width:	22	ft

Right of Way

Residential Right of Way @	$	50,000.00	per Ac
		0.0412	Ac
Total:	$	2,060.00	
Residential Perm Easmt @	$	25,000.00	per Ac
		0	Ac
Total:	$	-	
Commercial Perm Easmt @	$	62,500.00	per Ac
		0	Ac
Total:	$	-	
Sub Total:	$	2,060.00	

Utilities

Gas Main	$	22.00	per LF
		0	LF
	$	-	
16" Water Main	$	75.00	per LF
		0	LF
	$	-	
Overhead Power	$	25,000.00	per pole
		0	poles
	$	-	
Sub Total:	$	-	

Clearing and Grubbing

$	5,000.00	per Ac Disturbed
	0.6019	Disturbed Ac
$	3,009.50	

Grading

Cut	Fill	
400.000	200.000	
$	6.00	per CY
Total: $	3,600.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$	5,000.00	per EA	FES	$	400.00	per EA
		1	EA			3	EA
	$	5,000.00			$	1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	139	CY	$ 30.00	$ 4,170.00
Uddrn Sys w/ Gravel	-	99	LF	$ 20.00	$ 1,980.00
Mulch	-	208	SY	$ 15.00	$ 3,120.00
Outlet Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Bypass Pipe	24"	220	LF	$ 52.00	$ 11,440.00
Shrubs	-	25	EA	$ 30.00	$ 750.00
Ground Cover	-	75	EA	$ 15.00	$ 1,125.00

Rip Rap TP3,18"	$	57.50	per SY	Filter Fabric	$	4.75	per SY
		32	SY			32	SY
	$	1,840.00			$	152.00	

Sub Total: $ 34,002.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 18, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin B-2 Summary
BMP Recommendation – Feasible

The ultimate outfall of Drainage Basin B-2 was located and the existing and proposed basin drainage areas were delineated (See Figures B-2.1 and B-2.2). From those drainage areas the MS4 requirements, Water Quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	8,337	8,337
Quantity	Channel Protection, CP_v	7,144	15,481
	Overbank Flood Protection, Q_{p25}	3,928	12,265
	Extreme Flood Protection, Q_{f100}	4,859	13,196

- The Green and Purple areas (See Figure B-2.2) were initially considered for MS4 but were ultimately ruled out because they are basins located on side roads not owned by the department. These areas were included in the bypass area for outfall B-2.
- The total area draining to the MS4 pond is 3.30 Ac. The total impervious area is 2.87 Ac. The existing pavement area for the site is 0.93 Ac. The area required for storage and quantity management is 2.37 Ac (See Figure B-2.3). The flow produced by the existing paved area of 0.93 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 65 feet wide by 101 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure B-2.4).
- Based on the proposed road design, we are assuming the property at STA 81+50 RT will be acquired. This leaves ample space for a bioretention area, as no additional right of way or easement is required (See Figure B-2.5).
- Additional pipes are required to separate the bypass flow from the treatment flow and to direct the treatment flow into the BMP. Some pipes will be removed from the existing design (See Figure B-2.5).
- The BMP construction cost is 7.0% of the roadway construction cost within this basin (See Figure B-2.6).
- None of the other infeasibility criteria apply to this basin making this basin feasible.

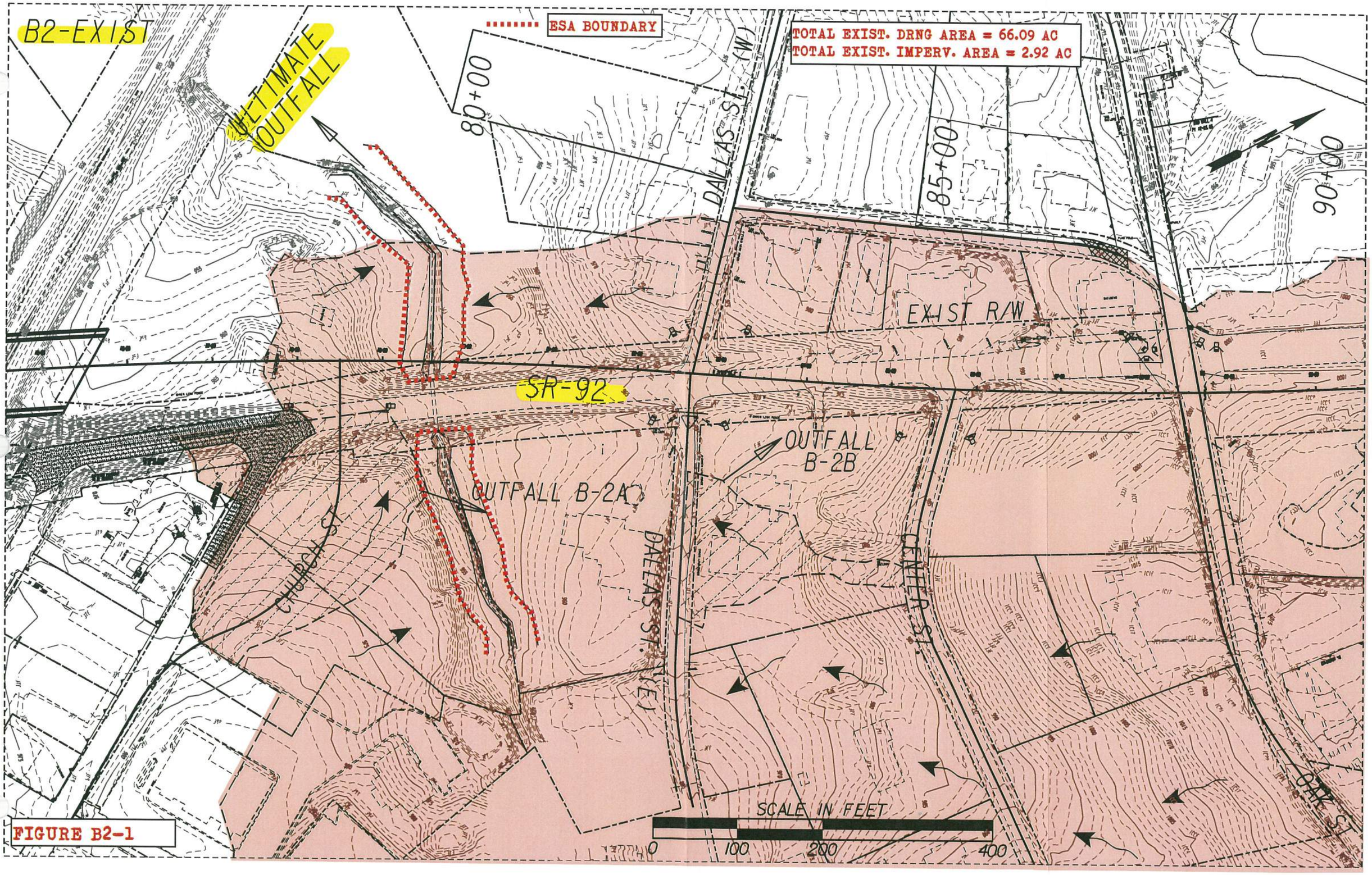

B2-EXIST
ULTIMATE OUTFALL
ESA BOUNDARY
TOTAL EXIST. DRNG AREA = 66.09 AC
TOTAL EXIST. IMPERV. AREA = 2.92 AC
80+00
85+00
90+00
DALLAS ST. (W)
EXIST R/W
SR-92
OUTFALL B-2B
OUTFALL B-2A
CHURCH ST.
DALLAS ST. (E)
CENTER ST.
LAKE ST.
SCALE IN FEET
0
100
200
400

FIGURE B2-1

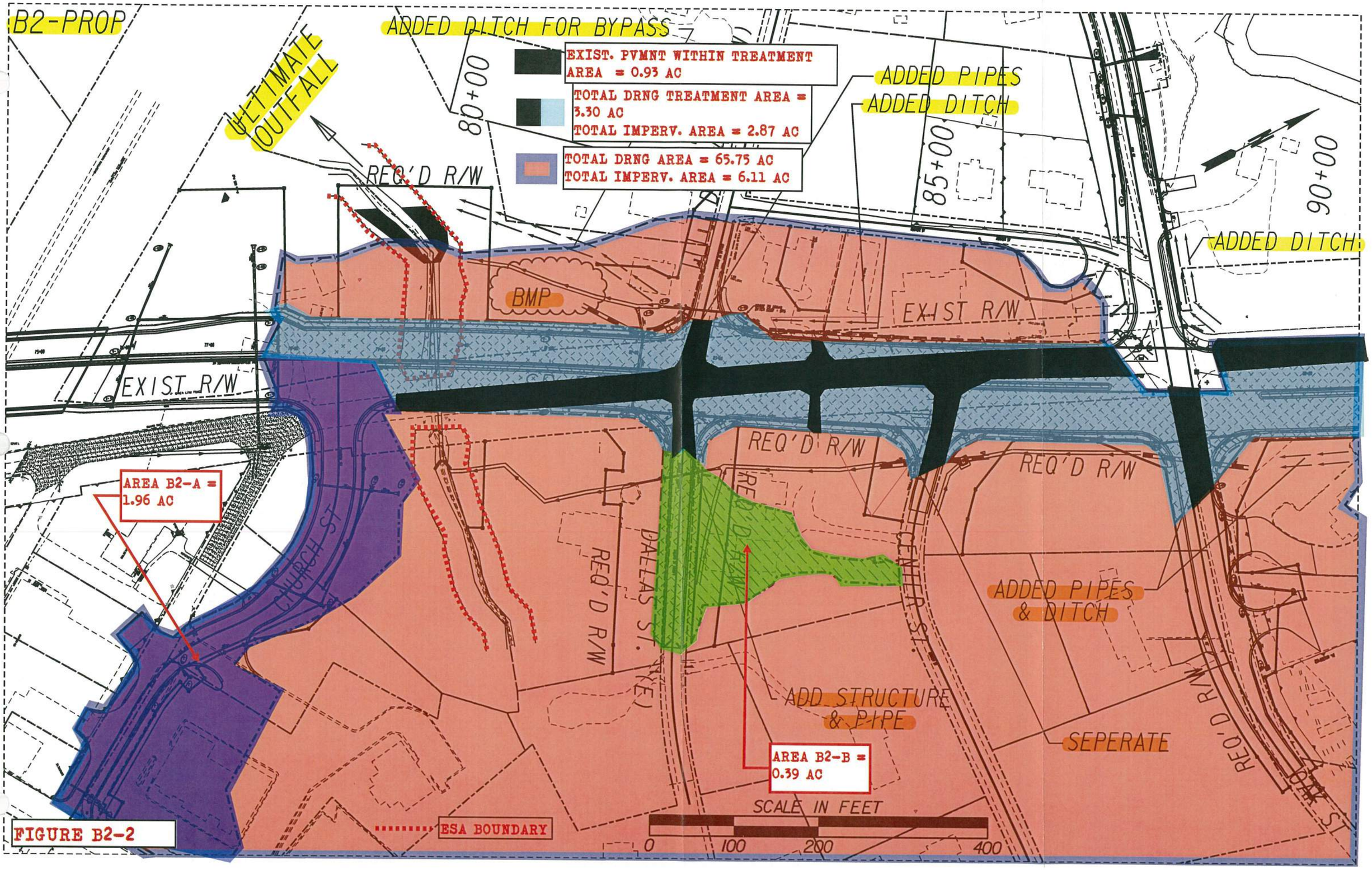

B2-PROP
ADDED DITCH FOR BYPASS
ULTIMATE OUTFALL
EXIST. PVMNT WITHIN TREATMENT AREA = 0.93 AC
TOTAL DRNG TREATMENT AREA = 3.30 AC
TOTAL IMPERV. AREA = 2.87 AC
TOTAL DRNG AREA = 65.75 AC
TOTAL IMPERV. AREA = 6.11 AC
ADDED PIPES
ADDED DITCH
80+00
85+00
90+00
REQ'D R/W
ADDED DITCH
BMP
EXIST R/W
EXIST R/W
REQ'D R/W
REQ'D R/W
REQ'D R/W
AREA B2-A = 1.96 AC
CHURCH ST
DALLAS ST. (E)
REQ'D R/W
CENTER ST.
ADDED PIPES & DITCH
ADD STRUCTURE & PIPE
SEPERATE
AREA B2-B = 0.39 AC
REQ'D R/W
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE B2-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: B-2

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	66.09
Impervious Area =	2.92
Pervious Area=	63.16

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	72

Time of Concentration (See Table A) = 0.25 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.770

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.229	0.23
$I_a/P_{10\text{-}yr}$=	0.140	0.14
$I_a/P_{25\text{-}yr}$=	0.119	0.12
$I_a/P_{100\text{-}yr}$=	0.097	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.85

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.04
$Q_{d\ 10\text{-}yr}$=	2.62
$Q_{d\ 25\text{-}yr}$=	3.41
$Q_{d\ 100\text{-}yr}$ =	4.65

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	675
$q_{u10\text{-}yr}$=	710
$q_{u25\text{-}yr}$=	735
$q_{u100\text{-}yr}$=	750

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	72.57
$Q_{p10\text{-}yr}$=	192.29
$Q_{p25\text{-}yr}$=	258.78
$Q_{p100\text{-}yr}$=	359.85

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	65.75
Impervious Area =	6.11
Pervious Area =	59.64
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.25 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.721

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.215	0.22
$I_a/P_{10\text{-}yr}$=	0.131	0.13
$I_a/P_{25\text{-}yr}$=	0.111	0.11
$I_a/P_{100\text{-}yr}$=	0.091	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.60

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.12
$Q_{d\ 10\text{-}yr}$=	2.74
$Q_{d\ 25\text{-}yr}$=	3.54
$Q_{d\ 100\text{-}yr}$ =	4.80

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	685
$q_{u10\text{-}yr}$=	720
$q_{u25\text{-}yr}$=	745
$q_{u100\text{-}yr}$=	750

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	78.52	0.924
$Q_{p10\text{-}yr}$=	202.75	
$Q_{p25\text{-}yr}$=	271.13	
$Q_{p100\text{-}yr}$=	369.66	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	3.30	Acre
Total Impervious Area - A_{POST}	2.87	Acre
Existing Pavement Area - A_{PRE} (5)	0.93	Acre
Area Required for Quantity - A_{QUAN} (4)	2.37	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
3.30	0.59	58.96	0.00	0.581	0.191	8,337

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) $R_v = 0.05 + 0.009\ (I)$
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.954	0.11	0.078	3,415

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 3,928

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.143	6,211

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 7,144

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.973	0.10	0.097	4,224

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 4,859

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

figure B-2.3

FIGURE B-2.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-2*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	8,337	8,337
CP_v	7,144	15,481
Q_{p25}	3,928	12,265
Q_{f100}	4,859	13,196

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**2014**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	15483	ft^3	>	15481	ft^3

Swale Dimensions:

A swale that is **2014** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	15,481	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **883** ft^2

Actual Filter Bed Dimensions:	Width	**21**	ft
	Length	**42**	ft
		882	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_S = **1022** ft^2

Actual Sediment Chamber Dimensions:	Width	**21**	ft
	Length	**49**	ft
		1029	ft^2

Bioretention Area

CP_v	=	15,481	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **6,518** ft^2

Actual Filter Bed Dimensions:	Width	**65**	ft
	Length	**101**	ft
		6565	ft^2

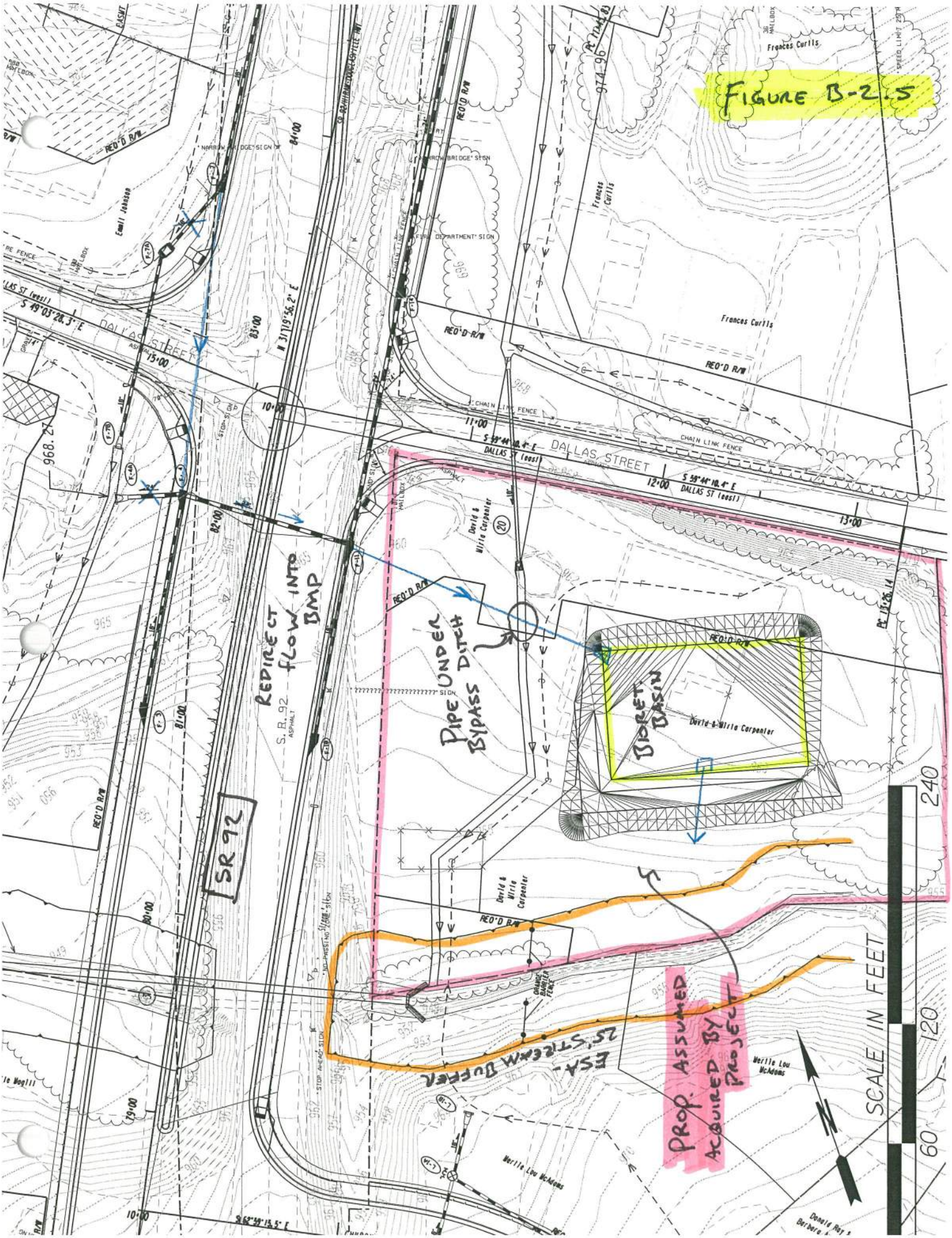


FIGURE B-2.5
REDIRECT FLOW INTO BMP
PIPE UNDER DITCH BYPASS
BIORET BASIN
SR 92
S.R. 92
DALLAS STREET
ESA - 25' STREAM BUFFER
PROP. ASSUMED ACQUIRED BY PROJECT
SCALE IN FEET
240
120
60
Frances Curtis
David & Wirla Carpenter
Merlie Lou McAdams
Donald Ray Barber
REQ'D R/W
CHAIN LINK FENCE
S 59°44'10.4" E
DALLAS ST (east)
S 49°03'28.3" E
N 31°19'56.2" E
S 62°59'15.5" E
968.27
974.96
PC 15.26
NARROW BRIDGE SIGN
FIRE DEPARTMENT SIGN
STOP AHEAD SIGN
NO PASSING ZONE SIGN
SPEED LIMIT 25 MPH
MAILBOX
ASPHALT
CHANGE BARBED FENCE

Infeasibility Criteria #1: Cost of Construction
Basin B-2

11/13/2014

Basin B-2 1270 LF of Roadway construction cost within basin

Item	Basin B-2 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 346,987.50	$ 29,770.00	$ -	$ -
Utilities ✪	$ 97,357.72	$ -	$ -	$ -
Construction ✪	$ 829,721.66	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 7,540.00	$ 4,563.50	$ 4,563.50
Grading	$ -	$ 18,000.00	$ 7,710.00	$ 6,390.00
Drainage	$ -	$ 114,704.26	$ 89,892.63	$ 77,837.50
Total	$ 1,274,066.88	$ 170,014.26	$ 102,166.13	$ 88,791.00
	Percent of BMP Cost to Total	**13.3%**	**8.0%**	**7.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		2.0802
Sub Total:	$	104,010.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0.9528
Sub Total:	$	23,820.00
Commercial Right of Way @	$	125,000.00
		0.43366
Sub Total:	$	54,207.50
Commercial Perm Easmt @	$	62,500.00
		1.1992
Sub Total:	$	74,950.00
Commercial Relocation Cost	$	25,000.00
		2
Sub Total:	$	50,000.00
Right of Way Cost Total:	$	346,987.50

✪ See General Summary Explaination for Cost Method

FIGURE B-2.6

BMP Construction Cost Worksheet Basin B-2

Dry Enhanced Swale

Length:	2014	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.5954	Ac	
Total:	$ 29,770.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 29,770.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.508	Disturbed Ac	
$ 7,540.00		

Grading

Cut	Fill	
2000.000	1000.000	
$ 6.00	per CY	
Total: $ 18,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		2	EA
	$ 20,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1492	CY	$ 30.00	$ 33,152.26
Uddrn Sys w/ Gravel	-	2044	LF	$ 20.00	$ 40,880.00
Additional Pipe	18"	300	LF	$ 43.00	$ 12,900.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	112	SY		112	SY
	$ 6,440.00			$ 532.00	

Sub Total: $ 114,704.26

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	42	49	ft
Width:	21	21	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ -		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.9127	Disturbed Ac	
$ 4,563.50		

Grading

Cut	Fill	
1060.000	225.000	
$ 6.00	per CY	
Total: $ 7,710.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	5	EA		3	EA
	$ 25,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	49	CY	$ 45.00	$ 2,205.00
Uddrn Sys w/ Gravel	-	150	LF	$ 20.00	$ 3,000.00
Top Soil		9	CY	$ 20.00	$ 180.00
Addl Pipe	18"	300	LF	$ 43.00	$ 12,900.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	882	SF	$ 5.00	$ 4,410.00
Dist Wall Conc/Steel	-	5	CY	$ 1,020.00	$ 5,100.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	514.5	SY	Filter Fabric	514.5	SY
	$ 29,583.75			$ 2,443.88	

Sub Total: $ 89,892.63

Bioretention Area

Length:	101	ft
Width:	65	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ -		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.9127	Disturbed Ac	
$ 4,563.50		

Grading

Cut	Fill	
815.000	250.000	
$ 6.00	per CY	
Total: $ 6,390.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		2	EA
	$ 20,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	487	CY	$ 30.00	$ 14,610.00
Uddrn Sys w/ Gravel	-	292.5	LF	$ 20.00	$ 5,850.00
Mulch	-	730	SY	$ 15.00	$ 10,950.00
Additional Pipe	18"	300	LF	$ 43.00	$ 12,900.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	28	EA	$ 30.00	$ 840.00
Ground Cover	-	78	EA	$ 15.00	$ 1,170.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	110	SY		110	SY
	$ 6,325.00			$ 522.50	

Sub Total: $ 77,837.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: MAC
Checked By: SCF 11-18-14

Basin B-3A Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin B-3 was located and the existing and proposed basin drainage areas were delineated (See Figures B-3A.1 and B-3A.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	8,567	8,567
Quantity	Channel Protection, CP_v	11,699	20,266
	Overbank Flood Protection, Q_{p25}	6,666	15,233
	Extreme Flood Protection, Q_{f100}	7,689	16,256

- The total area draining to the MS4 pond is 4.50 Ac. The total impervious area is 3.07 Ac. The existing pavement area for the site is 1.14 Ac. The area required for storage and quantity management is 3.37 Ac (See Figure B-3A.3). The flow produced by the existing paved area of 1.14 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were sized; an enhanced swale, a surface sand filter, and a bioretention area (See Figure B-3A.4).
- Due to the required size of an MS4 BMP needed to handle the volume calculated, it was determined that in order to install anything and stay out of the 25' ESA Stream Buffer on the left side of the road, it would be necessary to displace some tennis courts (a community resource) (See Figure B-3A.2).
- An alternate was then studied that would modify the drainage design to outfall and treat the water on the right side of the road, then release the water through the cross pipe under SR 92.

The ultimate outfall remained the same as B-3, however the treatment areas where divided into B-3A and B-3B. From those new drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes, were recalculated and again stacked. The following chart shows the computed volumes for Basin B-3A.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,426	3,426
Quantity	Channel Protection, CP_v	3,442	6,868
	Overbank Flood Protection, Q_{p25}	1,962	5,388
	Extreme Flood Protection, Q_{f100}	2,263	5,689

- The total area draining to the MS4 pond is 1.33 Ac. The total impervious area is 1.14 Ac. The existing pavement area for the site is 0.34 Ac. The area required for storage and quantity management is 0.99 Ac (See Figure B-3A.5). The flow produced by the existing paved area of 0.34 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 27 feet wide by 110 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure B-3A.6).
- Offsite water will be directed around the BMP by the use of a bypass ditch (See Figure B-3A.7).
- Modifications to the drainage design will be necessary to direct the treatment flow into the BMP and to separate the bypass flow (See Figure B-3A.7).
- The BMP construction cost is 16.7% of the roadway construction cost within this basin making this basin infeasible (See Figure B-3A.8).
- None of the other infeasibility criteria apply to this basin.

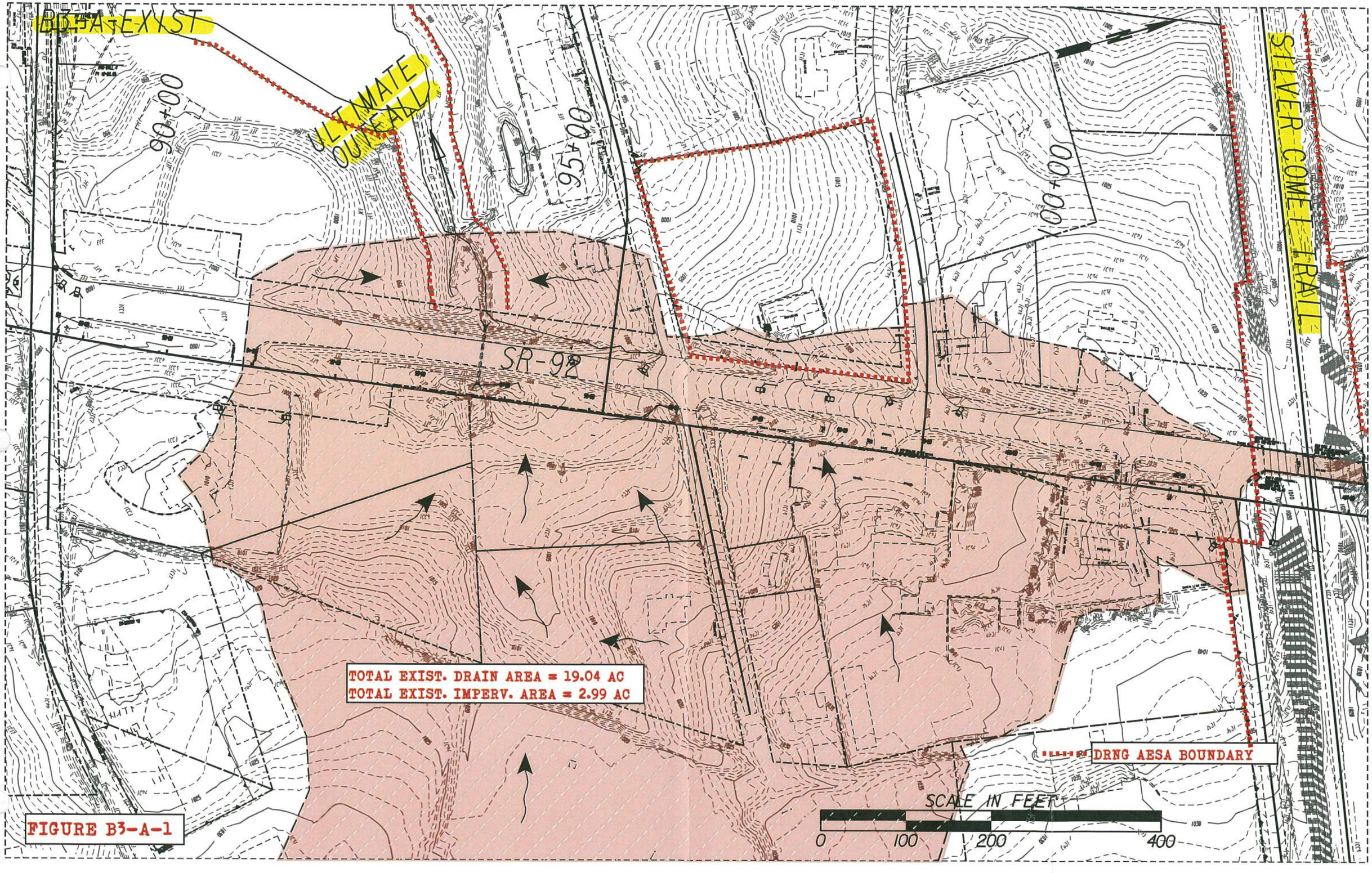

B3-A-EXIST
ULTIMATE OUTFALL
90+00
95+00
100+00
SR-92
SILVER COMET TRAIL
TOTAL EXIST. DRAIN AREA = 19.04 AC
TOTAL EXIST. IMPERV. AREA = 2.99 AC
DRNG AESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE B3-A-1

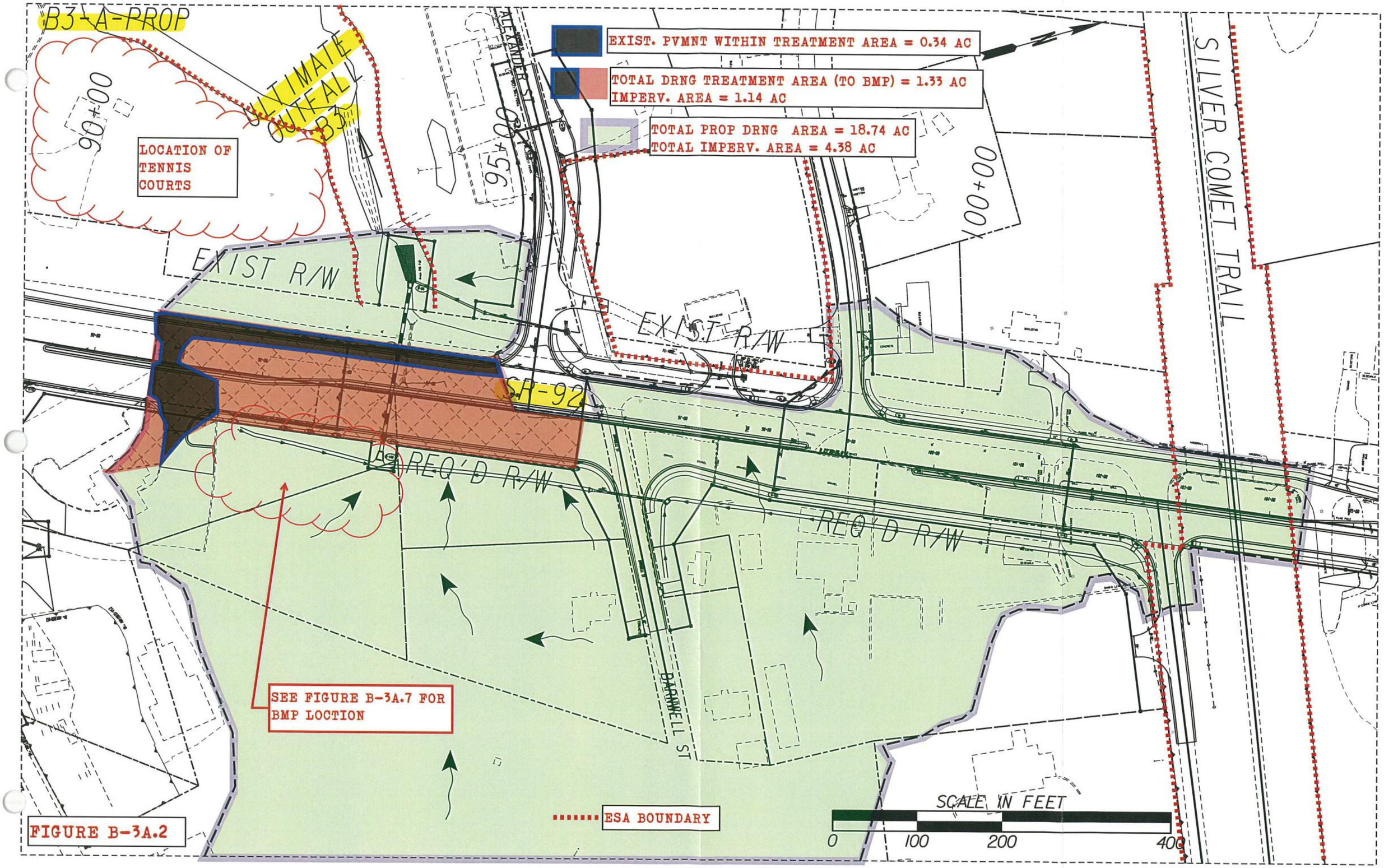

B3-A-PROP
ULTIMATE OUTFALL B3
90+00
LOCATION OF TENNIS COURTS
EXIST. PVMNT WITHIN TREATMENT AREA = 0.34 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.33 AC
IMPERV. AREA = 1.14 AC
TOTAL PROP DRNG AREA = 18.74 AC
TOTAL IMPERV. AREA = 4.38 AC
ALEXANDER ST
95+00
00+00
SILVER COMET TRAIL
EXIST R/W
EXIST R/W
SR-92
REQ'D R/W
REQ'D R/W
BARNWELL ST
SEE FIGURE B-3A.7 FOR BMP LOCTION
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE B-3A.2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: B-3 ULT. OUTFALL

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	19.035
Impervious Area =	2.990
Pervious Area=	16.045

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.83 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.658

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.196	0.20
$I_a/P_{10\text{-}yr}$=	0.119	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.11
$I_a/P_{100\text{-}yr}$=	0.083	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.29

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.22
$Q_{d\ 10\text{-}yr}$=	2.90
$Q_{d\ 25\text{-}yr}$=	3.72
$Q_{d\ 100\text{-}yr}$ =	5.00

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	370
$q_{u10\text{-}yr}$=	390
$q_{u25\text{-}yr}$=	395
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	13.41
$Q_{p10\text{-}yr}$=	33.63
$Q_{p25\text{-}yr}$=	43.70
$Q_{p100\text{-}yr}$=	60.20

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	18.741
Impervious Area =	4.377
Pervious Area =	14.364
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.82 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.587

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.175	0.18
$I_a/P_{10\text{-}yr}$=	0.106	0.11
$I_a/P_{25\text{-}yr}$=	0.091	0.10
$I_a/P_{100\text{-}yr}$=	0.074	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.94

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.35
$Q_{d\ 10\text{-}yr}$=	3.09
$Q_{d\ 25\text{-}yr}$=	3.93
$Q_{d\ 100\text{-}yr}$ =	5.24

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	375
$q_{u10\text{-}yr}$=	395
$q_{u25\text{-}yr}$=	405
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	14.79	0.906
$Q_{p10\text{-}yr}$=	35.77	
$Q_{p25\text{-}yr}$=	46.65	
$Q_{p100\text{-}yr}$=	62.10	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	4.503	Acre
Total Impervious Area - A_{POST}	3.073	Acre
Existing Pavement Area - A_{PRE} (5)	1.138	Acre
Area Required for Quantity - A_{QUAN} (4)	3.37	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
4.50	0.43	42.97	0.00	0.437	0.197	8,567

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.937	0.12	0.133	5,796

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,666

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

q_o/q_i: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

V_s/V_r= 0.682-1.43(q_o/q_i)+1.64(q_o/q_i)² -0.804(q_o/q_i)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.047	0.62	0.234	10,173

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 11,699

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

q_o/q_i: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

V_s/V_r= 0.682-1.43(q_o/q_i)+1.64(q_o/q_i)² -0.804(q_o/q_i)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.969	0.10	0.153	6,686

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 7,689

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

q_o/q_i: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

V_s/V_r= 0.682-1.43(q_o/q_i)+1.64(q_o/q_i)² -0.804(q_o/q_i)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE B-3A.3

FIGURE B-3A.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: B-3 ULT. OUTFALL

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	8,567	8,567
CP_v	11,699	20,266
Q_{p25}	6,666	15,233
Q_{f100}	7,689	16,256

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**2637**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	20272	ft^3	>	20266	ft^3

Swale Dimensions:

A swale that is **2637** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	20,266	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,156** ft^2

Actual Filter Bed Dimensions:	Width	**25**	ft
	Length	**50**	ft
		1250	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **1338** ft^2

Actual Sediment Chamber Dimensions:	Width	**25**	ft
	Length	**54**	ft
		1350	ft^2

Bioretention Area

CP_v	=	20,266	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **8,533** ft^2

Actual Filter Bed Dimensions:	Width	**80**	ft
	Length	**107**	ft
		8560	ft^2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *B-3A*

Unified Stormwater Sizing Criteria

Pr. 021720

Nov-14

Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	19.04
Impervious Area =	2.99
Pervious Area=	16.05

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.83 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.658

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.196	0.20
$I_a/P_{10\text{-}yr}$=	0.119	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.11
$I_a/P_{100\text{-}yr}$=	0.083	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.29

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.22
$Q_{d\ 10\text{-}yr}$=	2.90
$Q_{d\ 25\text{-}yr}$=	3.72
$Q_{d\ 100\text{-}yr}$ =	5.00

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	370
$q_{u10\text{-}yr}$=	390
$q_{u25\text{-}yr}$=	395
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	13.41
$Q_{p10\text{-}yr}$=	33.63
$Q_{p25\text{-}yr}$=	43.70
$Q_{p100\text{-}yr}$=	60.20

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	18.74
Impervious Area =	4.38
Pervious Area =	14.36
Credit Area =	0.00

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.82 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.587

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.175	0.18
$I_a/P_{10\text{-}yr}$=	0.106	0.11
$I_a/P_{25\text{-}yr}$=	0.091	0.10
$I_a/P_{100\text{-}yr}$=	0.074	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.94

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.35
$Q_{d\ 10\text{-}yr}$=	3.09
$Q_{d\ 25\text{-}yr}$=	3.93
$Q_{d\ 100\text{-}yr}$ =	5.24

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	375
$q_{u10\text{-}yr}$=	395
$q_{u25\text{-}yr}$=	405
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	14.79	0.906
$Q_{p10\text{-}yr}$=	35.77	
$Q_{p25\text{-}yr}$=	46.65	
$Q_{p100\text{-}yr}$=	62.10	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.33	Acre
Total Impervious Area - A_{POST}	1.14	Acre
Existing Pavement Area - A_{PRE} (5)	0.34	Acre
Area Required for Quantity - A_{QUAN} (4)	0.99	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.33	0.60	60.15	0.00	0.591	0.079	**3,426**

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) $R_v = 0.05 + 0.009\ (I)$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.047	0.62	0.069	**2,993**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **3,442**

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.937	0.12	0.039	**1,705**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **1,962**

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.969	0.10	0.045	**1,967**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **2,263**

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure B-3A.5

FIGURE B-3A.6

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-3A*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	3,426	3,426
CP_v	3,442	6,868
Q_{p25}	1,962	5,388
Q_{f100}	2,263	5,689

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**894**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	6873	ft^3	>	6868	ft^3

Swale Dimensions:

A swale that is **894** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	6,868	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **392** ft^2

Actual Filter Bed Dimensions:	Width	**14**	ft
	Length	**28**	ft
		392	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **453** ft^2

Actual Sediment Chamber Dimensions:	Width	**14**	ft
	Length	**33**	ft
		462	ft^2

Bioretention Area

CP_v	=	6,868	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **2,892** ft^2

Actual Filter Bed Dimensions:	Width	**27**	ft
	Length	**110**	ft
		2970	ft^2

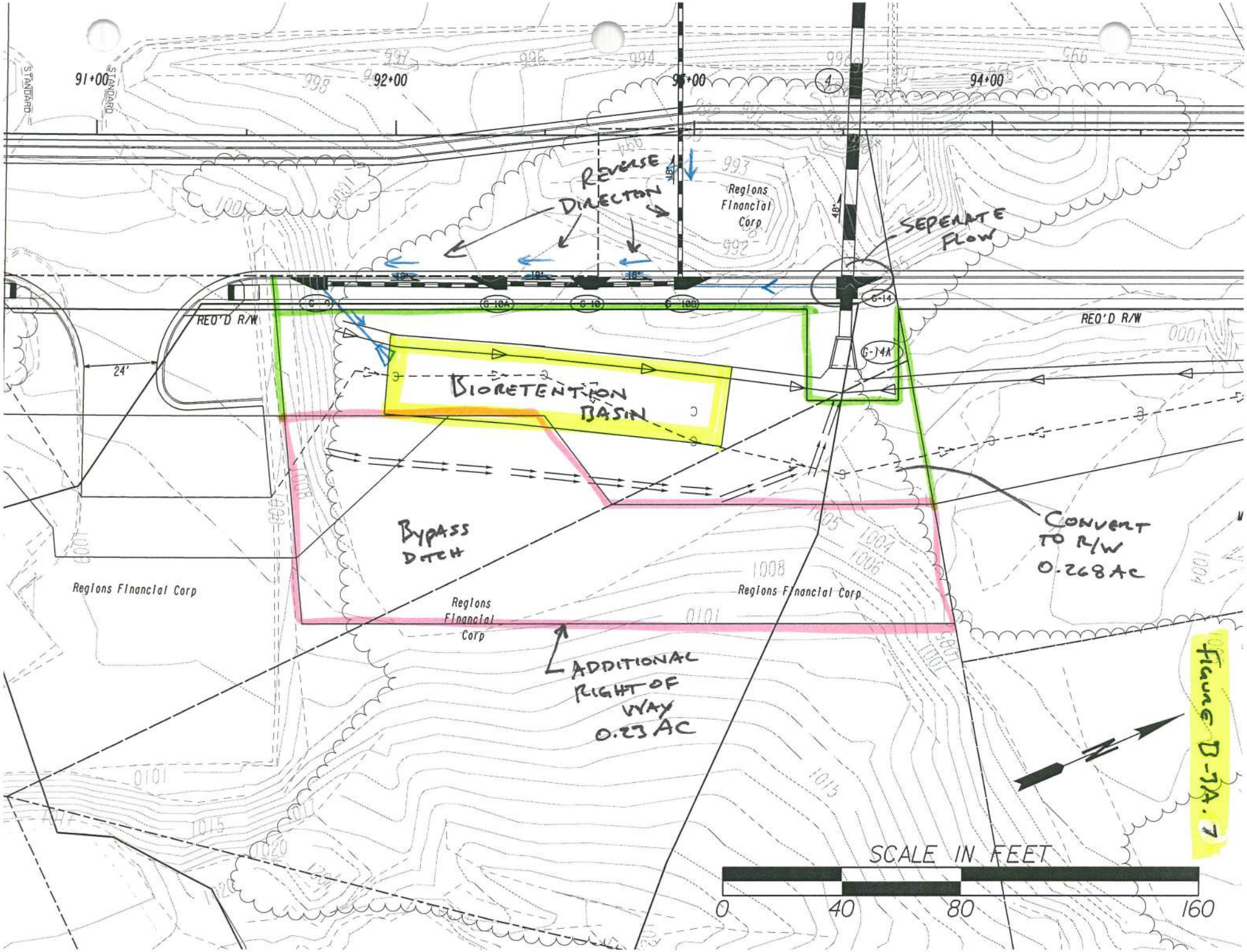

91+00
92+00
93+00
94+00
STANDARD
REVERSE DIRECTION
Regions Financial Corp
SEPERATE FLOW
REQ'D R/W
REQ'D R/W
24'
BIORETENTION BASIN
BYPASS DITCH
CONVERT TO R/W 0.268 AC
Regions Financial Corp
Regions Financial Corp
Regions Financial Corp
ADDITIONAL RIGHT OF WAY 0.23 AC
SCALE IN FEET
0
40
80
160

Figure B-7A.7

Infeasibility Criteria #1: Cost of Construction
Basin B-3A

11/13/2014

Basin B-3A 550 LF of Roadway construction cost within basin

Item	Basin B-3A Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 91,698.75	$ 132,675.00	$ 81,725.00	$ 45,875.00
Utilities ✪	$ 42,162.79	$ -	$ -	$ -
Construction ✪	$ 359,328.28	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 5,120.00	$ 2,936.50	$ 1,714.50
Grading	$ -	$ 18,000.00	$ 6,900.00	$ 3,900.00
Drainage	$ -	$ 45,333.55	$ 40,664.75	$ 30,902.50
Total	$ 493,189.82	$ 201,128.55	$ 132,226.25	$ 82,392.00
	Percent of BMP Cost to Total	**40.8%**	**26.8%**	**16.7%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.9296
Sub Total:	$	46,480.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0.2076
Sub Total:	$	25,950.00
Commercial Perm Easmt @	$	62,500.00
		0.3083
Sub Total:	$	19,268.75
Commercial Relocation Cost	$	25,000.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	91,698.75

✪ See General Summary Explaination for Cost Method

figure B-3A.8

BMP Construction Cost Worksheet Basin B-3A

Dry Enhanced Swale

Length:	894	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.9272	Ac	
Total:	$ 115,900.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.2684	Ac	
Total:	$ 16,775.00		
Sub Total:	$ 132,675.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.024	Disturbed Ac	
$ 5,120.00		

Grading

Cut	Fill	
2000.000	1000.000	
	$ 6.00	per CY
Total:	$ 18,000.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	662	CY	$ 30.00	$ 14,716.05
Uddrn Sys w/ Gravel	-	924	LF	$ 20.00	$ 18,480.00
Additional Pipe	18"	75	LF	$ 43.00	$ 3,225.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	50	SY		50	SY
	$ 2,875.00			$ 237.50	

Sub Total: $ 45,333.55

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	28	33	ft
Width:	14	14	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.3854	Ac	
Total:	$ 48,175.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.2684	Ac	
Total:	$ 33,550.00		
Sub Total:	$ 81,725.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.5873	Disturbed Ac	
$ 2,936.50		

Grading

Cut	Fill	
1000.000	150.000	
	$ 6.00	per CY
Total:	$ 6,900.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	22	CY	$ 45.00	$ 990.00
Uddrn Sys w/ Gravel	-	115	LF	$ 20.00	$ 2,300.00
Top Soil		4	CY	$ 20.00	$ 80.00
Addl Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	392	SF	$ 5.00	$ 1,960.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	231	SY		231	SY
	$ 13,282.50			$ 1,097.25	

Sub Total: $ 40,664.75

Bioretention Area

Length:	110	ft
Width:	27	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.2328	Ac	
Total:	$ 29,100.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.2684	Ac	
Total:	$ 16,775.00		
Sub Total:	$ 45,875.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.3429	Disturbed Ac	
$ 1,714.50		

Grading

Cut	Fill	
650.000	0.000	
	$ 6.00	per CY
Total:	$ 3,900.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	220	CY	$ 30.00	$ 6,600.00
Uddrn Sys w/ Gravel	-	121.5	LF	$ 20.00	$ 2,430.00
Mulch	-	330	SY	$ 15.00	$ 4,950.00
Additional Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	13	EA	$ 30.00	$ 390.00
Ground Cover	-	35	EA	$ 15.00	$ 525.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	50	SY		50	SY
	$ 2,875.00			$ 237.50	

Sub Total: $ 30,902.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: MAC
Checked By: SCF 11-18-14

Basin B-3B Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin B-3 was located and the existing and proposed basin drainage areas were delineated (See Figures B-3B.1 and B-3B.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	8,567	8,567
Quantity	Channel Protection, CP_v	11,699	20,266
	Overbank Flood Protection, Q_{p25}	6,666	15,233
	Extreme Flood Protection, Q_{f100}	7,689	16,256

- The total area draining to the MS4 pond is 4.50 Ac. The total impervious area is 3.07 Ac. The existing pavement area for the site is 1.14 Ac. The area required for storage and quantity management is 3.37 Ac (See Figure B-3B.3). The flow produced by the existing paved area of 1.14 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were sized; an enhanced swale, a surface sand filter, and a bioretention area (See Figure B-3B.4).
- Due to the required size of an MS4 BMP needed to handle the volume calculated, it was determined that in order to install anything and stay out of the 25' ESA Stream Buffer on the left side of the road, it would be necessary to displace some tennis courts (a community resource) (See Figure B-3B.2).
- An alternate was then studied that would modify the drainage design to outfall and treat the water on the right side of the road, then release the water through the cross pipe under SR 92.

The ultimate outfall remained the same as B-3, however the treatment areas where divided into B-3A and B-3B. From those new drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes, were recalculated and again stacked. The following chart shows the computed volumes for Basin B-3B.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	6,138	6,138
Quantity	Channel Protection, CP_v	8,205	14,343
	Overbank Flood Protection, Q_{p25}	4,676	10,814
	Extreme Flood Protection, Q_{f100}	5,393	11,531

- The total area draining to the MS4 pond is 3.16 Ac. The total impervious area is 2.19 Ac. The existing pavement area for the site is 0.80 Ac. The area required for storage and quantity management is 2.36 Ac (See Figure B-3B.5). The flow produced by the existing paved area of 0.80 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 29 feet wide by 210 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure B-3B.6).
- Offsite water will be directed around the BMP by the use of a bypass ditch (See Figure B-3B.7).
- Modifications to the drainage design will be necessary to direct the treatment flow into the BMP and to separate the bypass flow (See Figure B-3B.7).
- The BMP construction cost is 11.0% of the roadway construction cost within this basin making this basin infeasible (See Figure B-3B.8).
- None of the other infeasibility criteria apply to this basin.

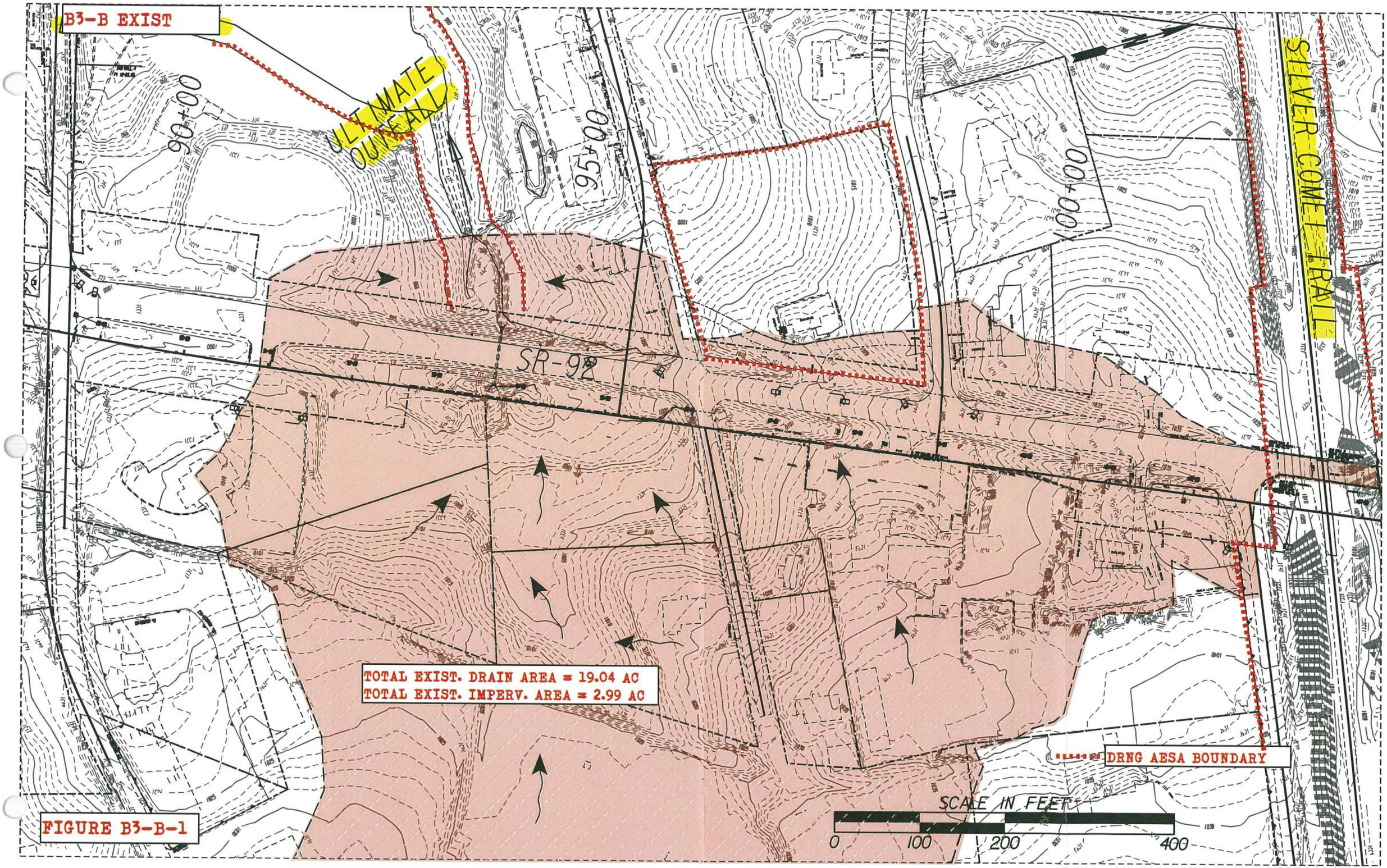

B3-B EXIST
ULTIMATE OUTFALL
90+00
95+00
100+00
SILVER COMET TRAIL
SR-92
TOTAL EXIST. DRAIN AREA = 19.04 AC
TOTAL EXIST. IMPERV. AREA = 2.99 AC
DRNG AESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE B3-B-1

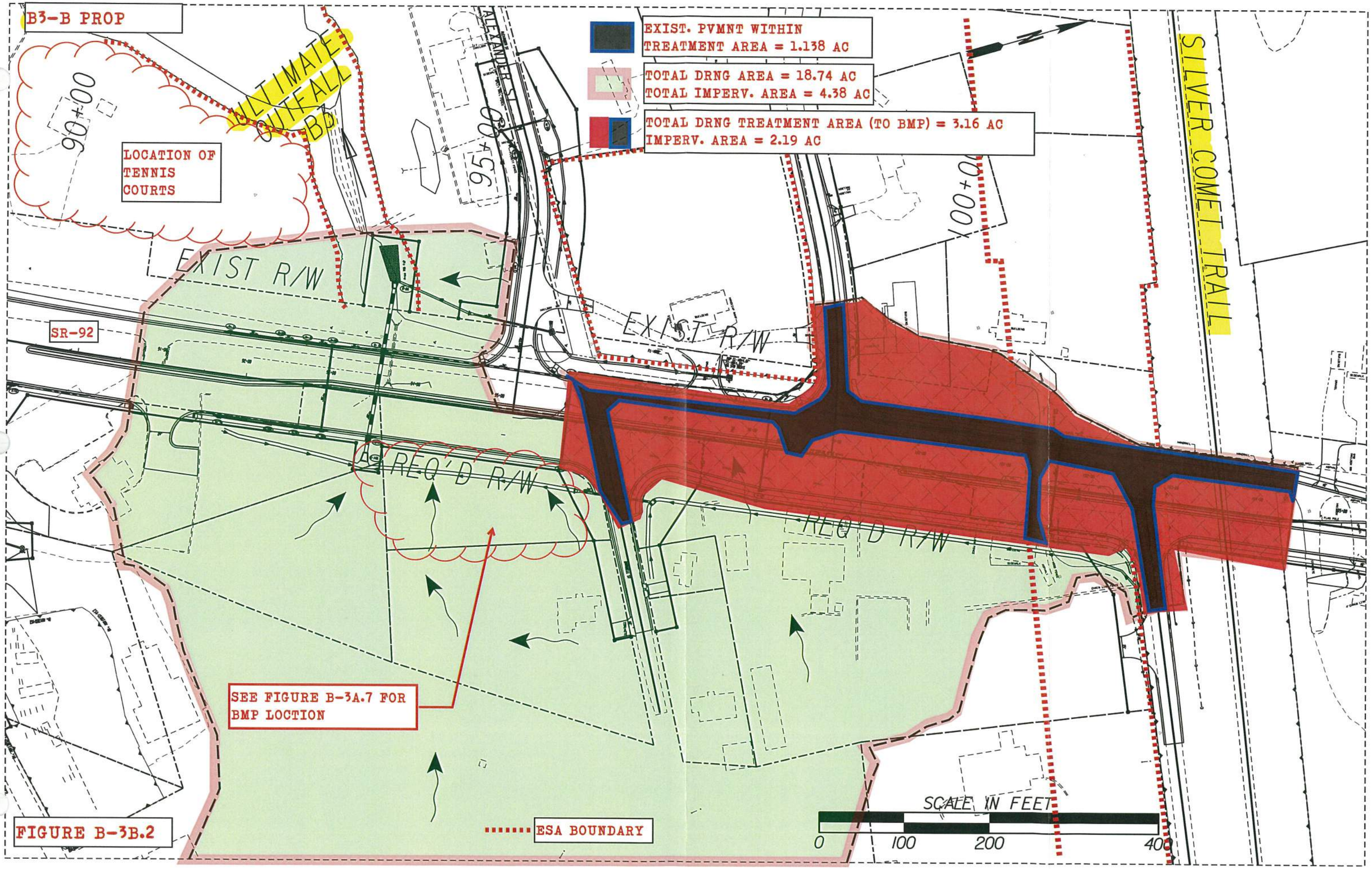

B3-B PROP
ULTIMATE OUTFALL B3
LOCATION OF TENNIS COURTS
90+00
95+00
100+00
ALEXANDER ST
EXIST. PVMNT WITHIN TREATMENT AREA = 1.138 AC
TOTAL DRNG AREA = 18.74 AC
TOTAL IMPERV. AREA = 4.38 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 3.16 AC
IMPERV. AREA = 2.19 AC
EXIST R/W
EXIST R/W
SR-92
REQ'D R/W
REQ'D R/W
SILVER COMET TRAIL
SEE FIGURE B-3A.7 FOR BMP LOCTION
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE B-3B.2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: B-3

Unified Stormwater Sizing Criteria
Table B

Pr. 621720
Nov-14
Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	19.035
Impervious Area =	2.990
Pervious Area=	16.045

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.83 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.658

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.196	0.20
$I_a/P_{10\text{-}yr}$=	0.119	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.11
$I_a/P_{100\text{-}yr}$=	0.083	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.29

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.22
$Q_{d\ 10\text{-}yr}$=	2.90
$Q_{d\ 25\text{-}yr}$=	3.72
$Q_{d\ 100\text{-}yr}$ =	5.00

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	370
$q_{u10\text{-}yr}$=	390
$q_{u25\text{-}yr}$=	395
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	13.41
$Q_{p10\text{-}yr}$=	33.63
$Q_{p25\text{-}yr}$=	43.70
$Q_{p100\text{-}yr}$=	60.20

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	18.741
Impervious Area =	4.377
Pervious Area =	14.364
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.82 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.587

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.175	0.18
$I_a/P_{10\text{-}yr}$=	0.106	0.11
$I_a/P_{25\text{-}yr}$=	0.091	0.10
$I_a/P_{100\text{-}yr}$=	0.074	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.94

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.35
$Q_{d\ 10\text{-}yr}$=	3.09
$Q_{d\ 25\text{-}yr}$=	3.93
$Q_{d\ 100\text{-}yr}$ =	5.24

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	375
$q_{u10\text{-}yr}$=	395
$q_{u25\text{-}yr}$=	405
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	14.79	0.906
$Q_{p10\text{-}yr}$=	35.77	
$Q_{p25\text{-}yr}$=	46.65	
$Q_{p100\text{-}yr}$=	62.10	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	4.503	Acre
Total Impervious Area - A_{POST}	3.073	Acre
Existing Pavement Area - A_{PRE} (5)	1.138	Acre
Area Required for Quantity - A_{QUAN} (4)	3.37	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
4.50	0.43	42.97	0.00	0.437	0.197	8,567

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) R_v = 0.05 + 0.009 (I)
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.047	0.62	0.234	10,173

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 11,699

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.937	0.12	0.133	5,796

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,666

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection Discussion
qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.969	0.10	0.153	6,686

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 7,689

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure B-3B.3

FIGURE B-3B.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-3*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	8,567	8,567
CP_v	11,699	20,266
Q_{p25}	6,666	15,233
Q_{f100}	7,689	16,256

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**2637**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	20272	ft^3	>	20266	ft^3

Swale Dimensions:

A swale that is **2637** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	20,266	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,156** ft^2

Actual Filter Bed Dimensions:	Width	**25**	ft
	Length	**50**	ft
		1250	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_S = **1338** ft^2

Actual Sediment Chamber Dimensions:	Width	**25**	ft
	Length	**54**	ft
		1350	ft^2

Bioretention Area

CP_v	=	20,266	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **8,533** ft^2

Actual Filter Bed Dimensions:	Width	**80**	ft
	Length	**107**	ft
		8560	ft^2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: B-3B

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	19.04
Impervious Area =	2.99
Pervious Area=	16.05

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.83 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.658

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.196	0.20
$I_a/P_{10\text{-}yr}$=	0.119	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.11
$I_a/P_{100\text{-}yr}$=	0.083	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.29

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.22
$Q_{d\ 10\text{-}yr}$=	2.90
$Q_{d\ 25\text{-}yr}$=	3.72
$Q_{d\ 100\text{-}yr}$ =	5.00

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	370
$q_{u10\text{-}yr}$=	390
$q_{u25\text{-}yr}$=	395
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	13.41
$Q_{p10\text{-}yr}$=	33.63
$Q_{p25\text{-}yr}$=	43.70
$Q_{p100\text{-}yr}$=	60.20

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	18.74
Impervious Area =	4.38
Pervious Area =	14.36
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.82 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.587

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.175	0.18
$I_a/P_{10\text{-}yr}$=	0.106	0.11
$I_a/P_{25\text{-}yr}$=	0.091	0.10
$I_a/P_{100\text{-}yr}$=	0.074	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.94

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.35
$Q_{d\ 10\text{-}yr}$=	3.09
$Q_{d\ 25\text{-}yr}$=	3.93
$Q_{d\ 100\text{-}yr}$ =	5.24

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	375
$q_{u10\text{-}yr}$=	395
$q_{u25\text{-}yr}$=	405
$q_{u100\text{-}yr}$=	405

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	14.79	0.906
$Q_{p10\text{-}yr}$=	35.77	
$Q_{p25\text{-}yr}$=	46.65	
$Q_{p100\text{-}yr}$=	62.10	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	3.16	Acre
Total Impervious Area - A_{POST}	2.19	Acre
Existing Pavement Area - A_{PRE} (5)	0.80	Acre
Area Required for Quantity - A_{QUAN} (4)	2.36	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
3.16	0.44	43.99	0.00	0.446	0.141	6,138

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) R_v = 0.05 + 0.009 (I)
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.937	0.12	0.093	4,065

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,676

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.047	0.62	0.164	7,135

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 8,205

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.969	0.10	0.108	4,689

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 5,393

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure B-3B.5

FIGURE B-3B.6

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-3B*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	6,138	6,138
CP_v	8,205	14,343
Q_{p25}	4,676	10,814
Q_{f100}	5,393	11,531

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**1866**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	14345	ft^3	>	14343	ft^3

Swale Dimensions:

A swale that is **1866** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	14,343	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **818** ft^2

Actual Filter Bed Dimensions:	Width	**21**	ft
	Length	**42**	ft
		882	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_S = **947** ft^2

Actual Sediment Chamber Dimensions:	Width	**21**	ft
	Length	**46**	ft
		966	ft^2

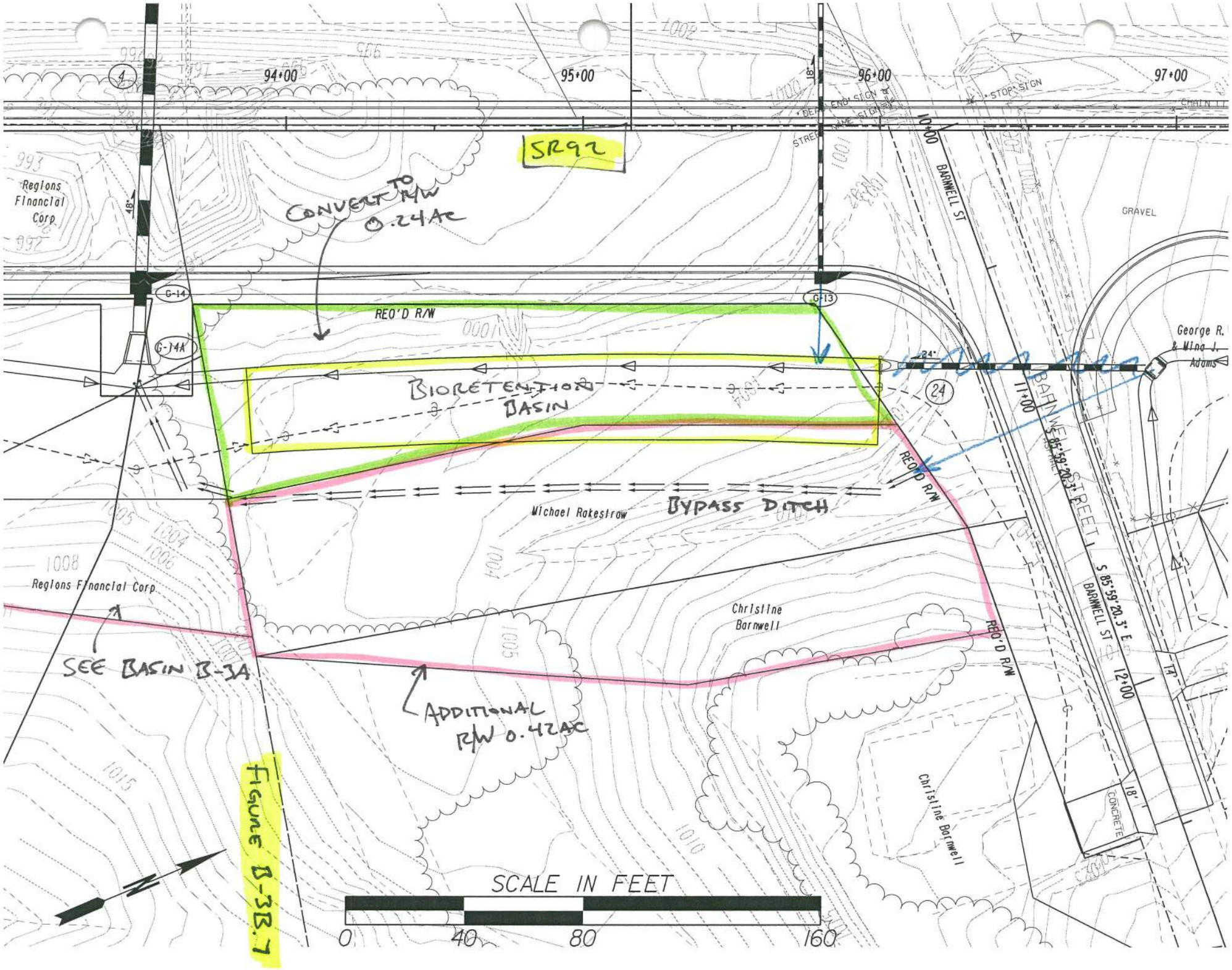
Bioretention Area

CP_v	=	14,343	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **6,039** ft^2

Actual Filter Bed Dimensions:	Width	**29**	ft
	Length	**210**	ft
		6090	ft^2


SR92
CONVERT TO R/W 0.24AC
REQ'D R/W
BIORETENTION BASIN
BYPASS DITCH
Michael Rakestraw
Christine Barnwell
Regions Financial Corp
SEE BASIN B-3A
ADDITIONAL R/W 0.42AC
FIGURE B-3B.7
BARNWELL ST
BARNWELL STREET
S 85°59'20.3" E
George R. & Nina J. Adams
GRAVEL
CONCRETE
STOP SIGN
SCALE IN FEET
0
40
80
160

Infeasibility Criteria #1: Cost of Construction
Basin B-3B

11/13/2014

Basin B-3B 860 LF of Roadway construction cost within basin

Item	Basin B-3B Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 159,153.75	$ 116,970.00	$ 63,815.00	$ 27,300.00
Utilities ✪	$ 65,927.28	$ -	$ -	$ -
Construction ✪	$ 561,858.76	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 7,500.00	$ 2,936.50	$ 2,636.00
Grading	$ -	$ 27,000.00	$ 3,600.00	$ 2,400.00
Drainage	$ -	$ 90,547.80	$ 74,331.75	$ 53,904.50
Total	$ 786,939.79	$ 242,017.80	$ 144,683.25	$ 86,240.50
	Percent of BMP Cost to Total	**30.8%**	**18.4%**	**11.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.2142
Sub Total:	$	10,710.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0.8899
Sub Total:	$	111,237.50
Commercial Perm Easmt @	$	62,500.00
		0.5953
Sub Total:	$	37,206.25
Commercial Relocation Cost	$	25,000.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	159,153.75

✪ See General Summary Explaination for Cost Method

FIGURE B-3B.

BMP Construction Cost Worksheet Basin B-3B

Dry Enhanced Swale

Length:	1866	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	1.4182	Ac	
Total:	$ 70,910.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2424	Ac	
Total:	$ 6,060.00		
Residential Relocation @	$ 40,000.00		
	1		
Total:	$ 40,000.00		
Sub Total:	$ 116,970.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.5	Disturbed Ac	
$ 7,500.00		

Grading

Cut	Fill	
3000.000	1500.000	
$ 6.00	per CY	
Total: $ 27,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		3	EA	
	$ 10,000.00			$ 1,200.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1382	CY	$ 30.00	$ 30,716.05
Uddrn Sys w/ Gravel	-	1896	LF	$ 20.00	$ 37,920.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	103	SY		103	SY	
	$ 5,922.50			$ 489.25		

Sub Total: $ 90,547.80

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	42	46	ft
Width:	21	21	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.4841	Ac	
Total:	$ 24,205.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2424	Ac	
Total:	$ 6,060.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.2684	Ac	
Total:	$ 33,550.00		
Sub Total:	$ 63,815.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.5873	Disturbed Ac	
$ 2,936.50		

Grading

Cut	Fill	
450.000	150.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	4	EA		3	EA	
	$ 20,000.00			$ 1,200.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	49	CY	$ 45.00	$ 2,205.00
Uddrn Sys w/ Gravel	-	150	LF	$ 20.00	$ 3,000.00
Top Soil		9	CY	$ 20.00	$ 180.00
Addl Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	882	SF	$ 5.00	$ 4,410.00
Dist Wall Conc/Steel	-	5	CY	$ 1,020.00	$ 5,100.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY	
	483	SY	Filter Fabric	483	SY	
	$ 27,772.50			$ 2,294.25		

Sub Total: $ 74,331.75

Bioretention Area

Length:	210	ft
Width:	29	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.4248	Ac	
Total:	$ 21,240.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2424	Ac	
Total:	$ 6,060.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 27,300.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.5272	Disturbed Ac	
$ 2,636.00		

Grading

Cut	Fill	
300.000	100.000	
$ 6.00	per CY	
Total: $ 2,400.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		3	EA	
	$ 10,000.00			$ 1,200.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	452	CY	$ 30.00	$ 13,560.00
Uddrn Sys w/ Gravel	-	130.5	LF	$ 20.00	$ 2,610.00
Mulch	-	677	SY	$ 15.00	$ 10,155.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Shrubs	-	26	EA	$ 30.00	$ 780.00
Ground Cover	-	72	EA	$ 15.00	$ 1,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	102	SY		102	SY	
	$ 5,865.00			$ 484.50		

Sub Total: $ 53,904.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: MAC
Checked By: SCF 11-18-14

Basin B-4A Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

Initially, the drainage area of outfall B-4 was delineated and it was determined that the proposed drainage design altered the existing condition by too much. The proposed design had all the flow draining to the right side of SR 92. It would better match the existing condition if the left side flow drained left and the right side drained to the right, as the existing condition does. This would also result in smaller MS4 post-construction ponds because the pre and post condition peak flows would be closer so the ponds would be required to retain less volume.

The ultimate outfall of Drainage Basin B-4A was located and the existing and proposed basin drainage areas were delineated (See Figures B-4A.1 and B-4A.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	1,048	1,048
Quantity	Channel Protection, CP_v	3,322	4,370
	Overbank Flood Protection, Q_{p25}	3,218	4,266
	Extreme Flood Protection, Q_{f100}	3,868	4,916

- The total area draining to the MS4 pond is 1.28 Ac. The total impervious area is 0.92 Ac. The existing pavement area for the site is 0.72 Ac. The area required for storage and quantity management is 0.56 Ac (See Figure B-4A.3). The flow produced by the existing paved area of 0.72 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- Because the Extreme Flood Protection volume is the largest volume, it triggers a 10 times downstream analysis to determine if an increase in flow would cause an adverse effect to homes downstream of the project.
- It was determined from that analysis that the flows would cause a downstream increase of more than 5%, and that detention will be necessary (See Figure B-4A.4).
- A detention pond will be provided for the quantity volume (See Figures B-4A.6 and B-4A.7).
- 3 BMPs were studied to handle the quality volume; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 23 feet wide by 20 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs (See Figure B-4A.5).
- Installing the sand surface filter or the enhanced swale would require displacing the residence at STA 106+50 LT (See Figure B-4A.7).
- The design will require a flow splitter (See Figure B-4A.7). The water initially will flow unimpeded through a flow splitter and into the bioretention area. When a certain volume is

reached, the water will flow over a weir within the flow splitter and flow into the Dry Detention Basin.

- The BMP construction cost is 10.6% of the roadway construction cost within this basin making this basin infeasible (See Figure B-4A.8).
- None of the other infeasibility criteria apply to this basin.
- Stormwater detention for this basin should be addressed in the stormwater drainage design for the project.

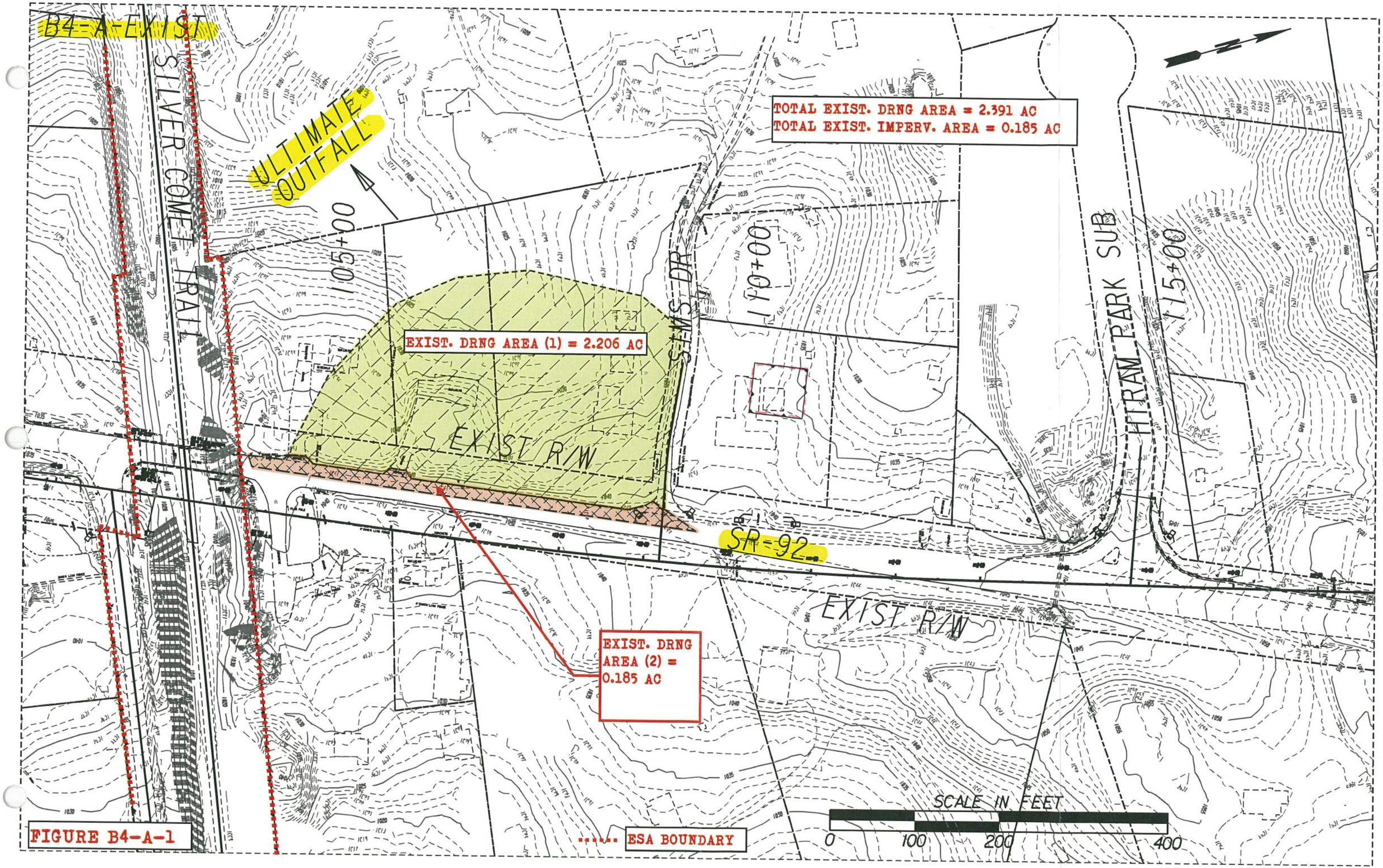

B4-A-EX ST
ULTIMATE OUTFALL
SILVER COMET TRAIL
105+00
110+00
115+00
SEMS DR
HIRAM PARK SUB
TOTAL EXIST. DRNG AREA = 2.391 AC
TOTAL EXIST. IMPERV. AREA = 0.185 AC
EXIST. DRNG AREA (1) = 2.206 AC
EXIST R/W
SR-92
EXIST R/W
EXIST. DRNG AREA (2) = 0.185 AC
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE B4-A-1

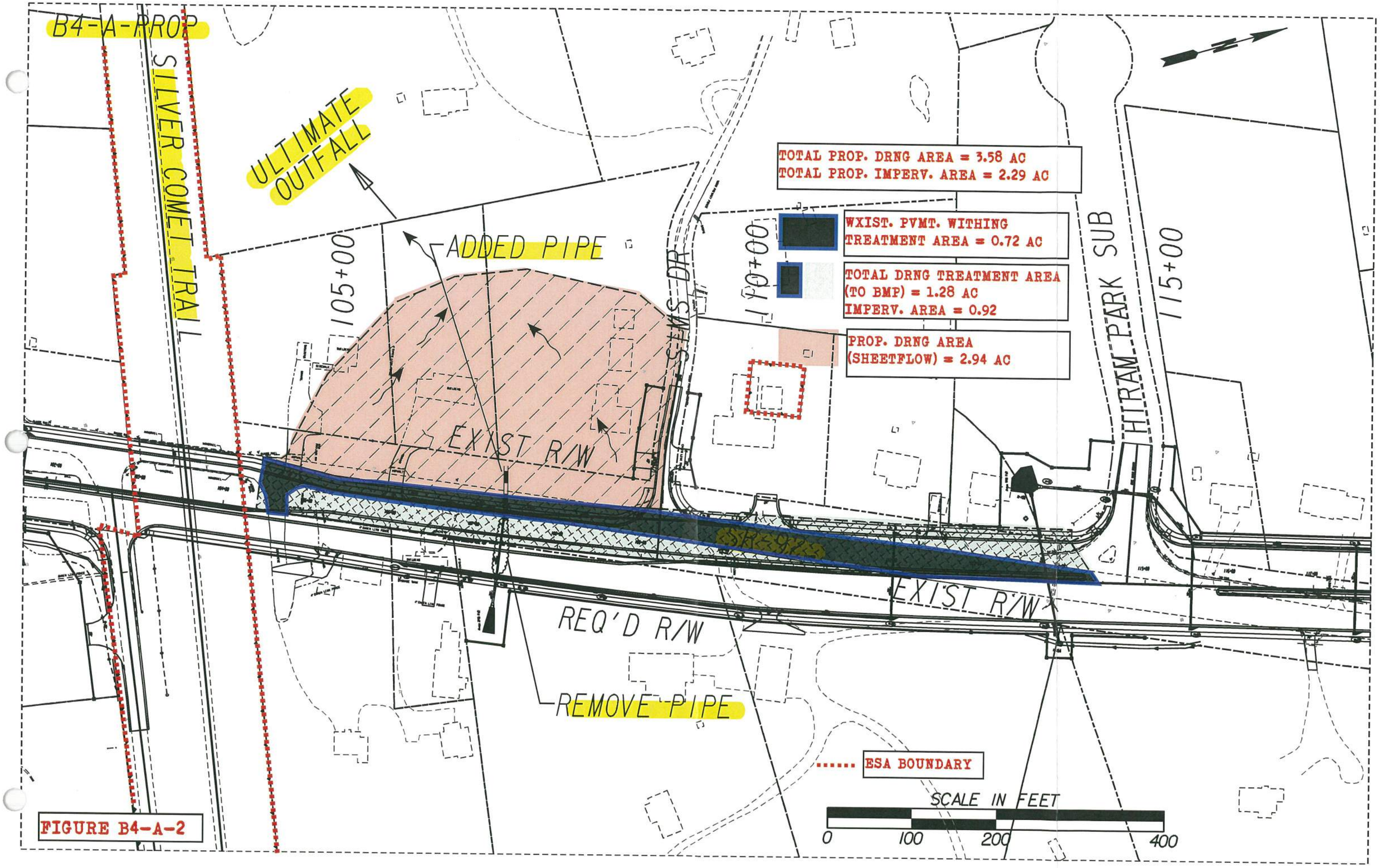

B4-A-PROP
SILVER COMET TRAIL
ULTIMATE OUTFALL
ADDED PIPE
105+00
110+00
115+00
SIMS DR
HIRAM PARK SUB
TOTAL PROP. DRNG AREA = 3.58 AC
TOTAL PROP. IMPERV. AREA = 2.29 AC
WXIST. PVMT. WITHING TREATMENT AREA = 0.72 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.28 AC
IMPERV. AREA = 0.92
PROP. DRNG AREA (SHEETFLOW) = 2.94 AC
EXIST R/W
EXIST R/W
REQ'D R/W
REMOVE PIPE
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE B4-A-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *B-4A*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	2.39
Impervious Area =	0.19
Pervious Area=	2.21

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 0.25 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.736

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.219	0.22
$I_a/P_{10\text{-}yr}$=	0.133	0.13
$I_a/P_{25\text{-}yr}$=	0.114	0.11
$I_a/P_{100\text{-}yr}$=	0.093	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.68

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.09
$Q_{d\ 10\text{-}yr}$=	2.70
$Q_{d\ 25\text{-}yr}$=	3.50
$Q_{d\ 100\text{-}yr}$ =	4.75

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	690
$q_{u10\text{-}yr}$=	710
$q_{u25\text{-}yr}$=	720
$q_{u100\text{-}yr}$=	730

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	2.81
$Q_{p10\text{-}yr}$=	7.17
$Q_{p25\text{-}yr}$=	9.41
$Q_{p100\text{-}yr}$=	12.95

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	3.58
Impervious Area =	2.29
Pervious Area =	1.28
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	88

Time of Concentration (See Table A) = 0.35 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.265

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.079	0.10
$I_a/P_{10\text{-}yr}$=	0.048	0.10
$I_a/P_{25\text{-}yr}$=	0.041	0.10
$I_a/P_{100\text{-}yr}$=	0.033	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.32

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.17
$Q_{d\ 10\text{-}yr}$=	4.20
$Q_{d\ 25\text{-}yr}$=	5.12
$Q_{d\ 100\text{-}yr}$ =	6.53

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	630
$q_{u10\text{-}yr}$=	630
$q_{u25\text{-}yr}$=	630
$q_{u100\text{-}yr}$=	630

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	7.63	0.369
$Q_{p10\text{-}yr}$=	14.78	
$Q_{p25\text{-}yr}$=	18.03	
$Q_{p100\text{-}yr}$=	22.97	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.28	Acre
Total Impervious Area - A_{POST}	0.92	Acre
Existing Pavement Area - A_{PRE} (5)	0.72	Acre
Area Required for Quantity - A_{QUAN} (4)	0.56	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.28	0.15	15.30	0.00	0.188	0.024	**1,048**

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) $R_v = 0.05 + 0.009\ (I)$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.066	**2,889**

(+15% ED)= **3,322**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.522	0.27	0.064	**2,797**

(+15% ED)= **3,218**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.564	0.25	0.077	**3,363**

(+15% ED)= **3,868**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

figure B-4A.3

FIGURE B-4A.4

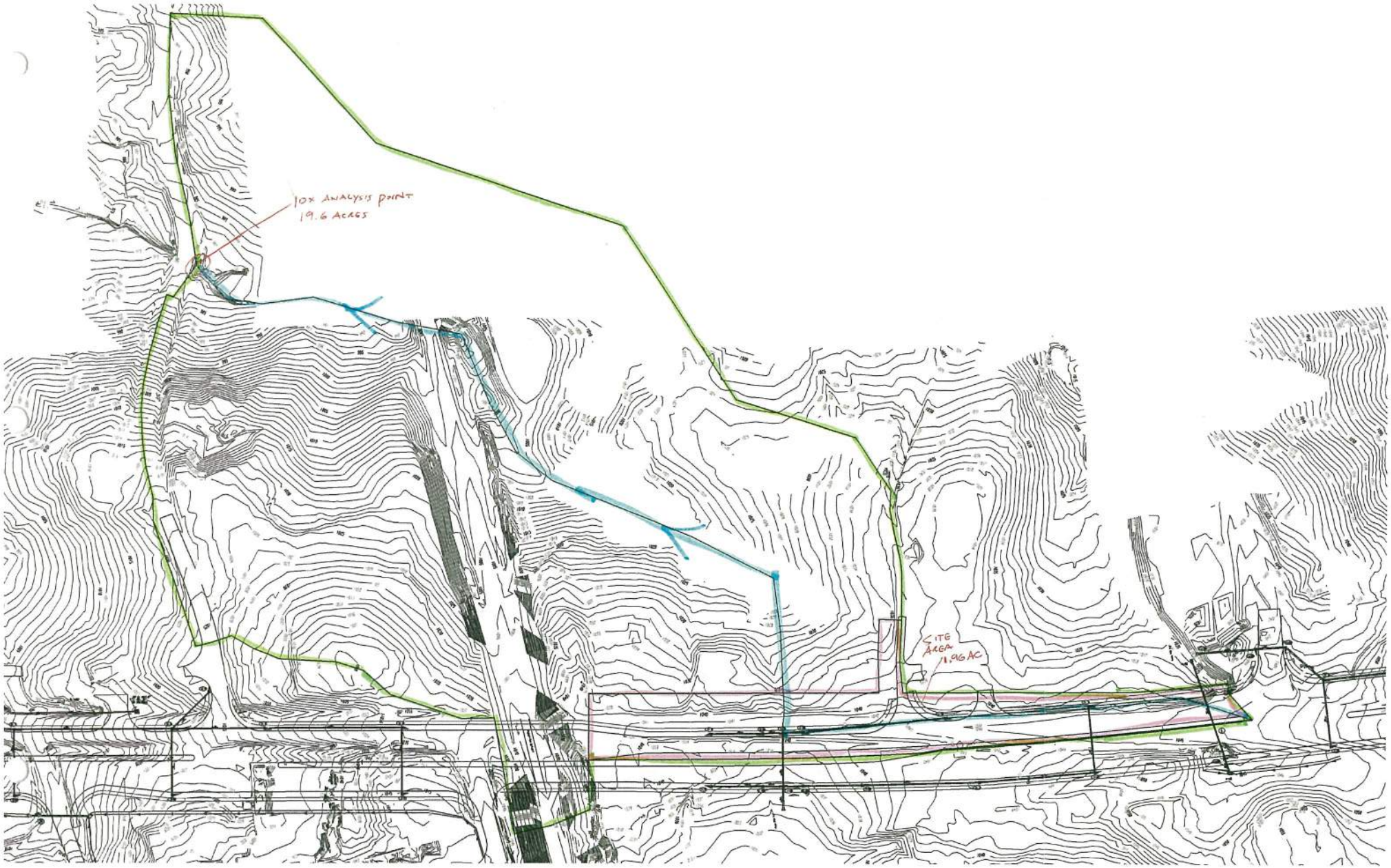
Outfall B-4A
10X Downstream Analysis Conclusions

The drainage areas were delineated using a combination of the USGS quadrangle maps and the existing contours. The site area of the drainage outfall is 1.96 Ac. The 10 times watershed basin analysis area is 19.60 Ac, which is approximately 1250 feet downstream of the drainage outfall. The immediate downstream crossing is an existing 24" pipe under Fitzgerald Street. The time of concentration calculations and the curve number calculations for the downstream analysis have been included along with the hydrographs depicting the pre and post conditions of the 25 and 100 year storms.

Per GDOT requirements, Storm Detention is required when adverse impacts are caused by the post-development flow and where downstream structures are subject to increased depth of flooding. The following table summarizes the results of the 10X downstream analysis.

Outfall B-4A	Storm Return Frequency	Pre-Developed Peak Discharge (cfs)	Post-Developed Peak Discharge (cfs)	Discharge Increase (cfs)	% Increase
10% Downstream Analysis	25	59.32	63.96	4.64	7.3
	100	79.89	85.64	5.75	6.7

The analysis of the 10X downstream conditions reflects an increase of over 5% for both the 25 and the 100 year return periods, which represent the Overbank Flood Protection and the Extreme Flood Protection, respectively. The discharge increase for both storm frequency's is above the GDOT maximum and could adversely affect the downstream watershed so therefore detention shall be provided at this location.


10x ANALYSIS POINT
19.6 ACRES
SITE
AREA
1.96 AC

Curve Number Calculation
10X Downstream Assessment for Outfall B4-a

Nov-14

PRE-CONDITION type "C" soil group	TOTAL AREA 18.7 Ac	
	IMPERVIOUS AREA 0.9 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 4.63 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 13.17	71
	COMPOSITE PRE CN	75

POST-CONDITION type "C" soil group	TOTAL AREA 19.6 Ac	
	IMPERVIOUS AREA 1.59 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 4.76 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 13.25	71
	COMPOSITE PRE CN	76

COMP: MC

CHK :

10X Downstream Assessment for Outfall B-4A

TIME OF CONCENTRATION CALCULATION

Nov-14

PI No.: xxxxxx

Drainage Area No.	Segment 1- Sheet Flow [1,2]					Segment 2- Shallow Channel [3]				Segment 3 - Open Channel [4]								TIME OF CONCENTRATION (Tc) MINUTE	Computed Intensity			
	Manning Roughness(n)	Flow Length (L) - ft	Land Slope (S) - ft/ft	i(Just for Sheet Flow)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Slope (s) - ft/ft	Velocity (ft/s)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Estimated Q	Manning Roughness Coeeficient (n) [5]	Qn	Slope (S) - ft/ft	Vn	Velocity (ft/s)	Time of Travel (Tt)- Minute		I_{10}	I_{25}	I_{50}	I_{100}
10X B-4A Pre	0.410	340	0.05	4.89	23.50	365	0.058	3.88	1.57	695	9.41	0.035	0.33	0.024	0.1	2.86	4.05	**29.12**	4.09	4.75	5.24	5.75
10X B-4A Post	0.410	250	0.03	5.07	22.45	1065	0.05	3.61	4.92	695	18.03	0.035	0.63	0.024	0.13	3.71	3.12	**30.49**	4.00	4.64	5.12	5.63

Notes:

1. Kinematic Wave Equation has been used for Segment-1 time of travel (*GDOT Drainage Design manual* Page 4.9).
2. For Segment-1, "I" Values have been compared with Table A-3 "*Georgia Stormwater Management Manual* " (Page A-3)- Per *GDOT Drainage Design Manual* (page 4.13).
3. For Segment 2 Formula see *"GDOT Drainage Design manual "* Page 4.12 .
4. For Segment 3 :
   - 4.1. Find concentrated Flow length (ft)
   - 4.2. find Estimated Q value (use i from Segment 1)
   - 4.3. Qn= $Q_{estimated}$ x Manning
   - 4.4. find Vn from Table 5-19 (see "*GDOT Drainage Design manual* " Page 5.56)
   - 4.5. Velocity = Vn / Manning
5. see *"GDOT Drainage Design manual "* Page 5-25 & 5-26

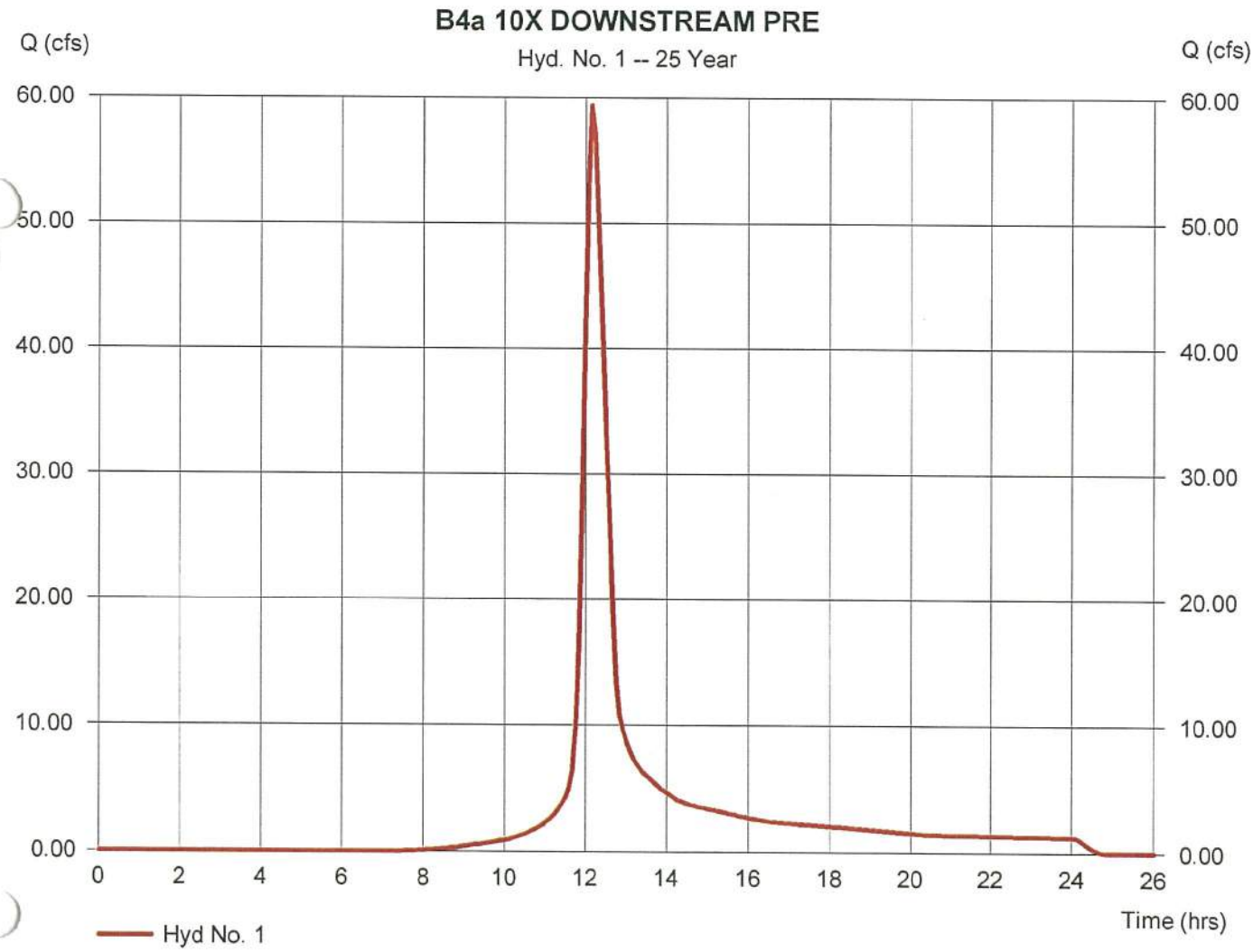
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 07 / 15 / 2014

Hyd. No. 1

B4a 10X DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 59.32 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 258,642 cuft
Drainage area	= 18.700 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 29.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



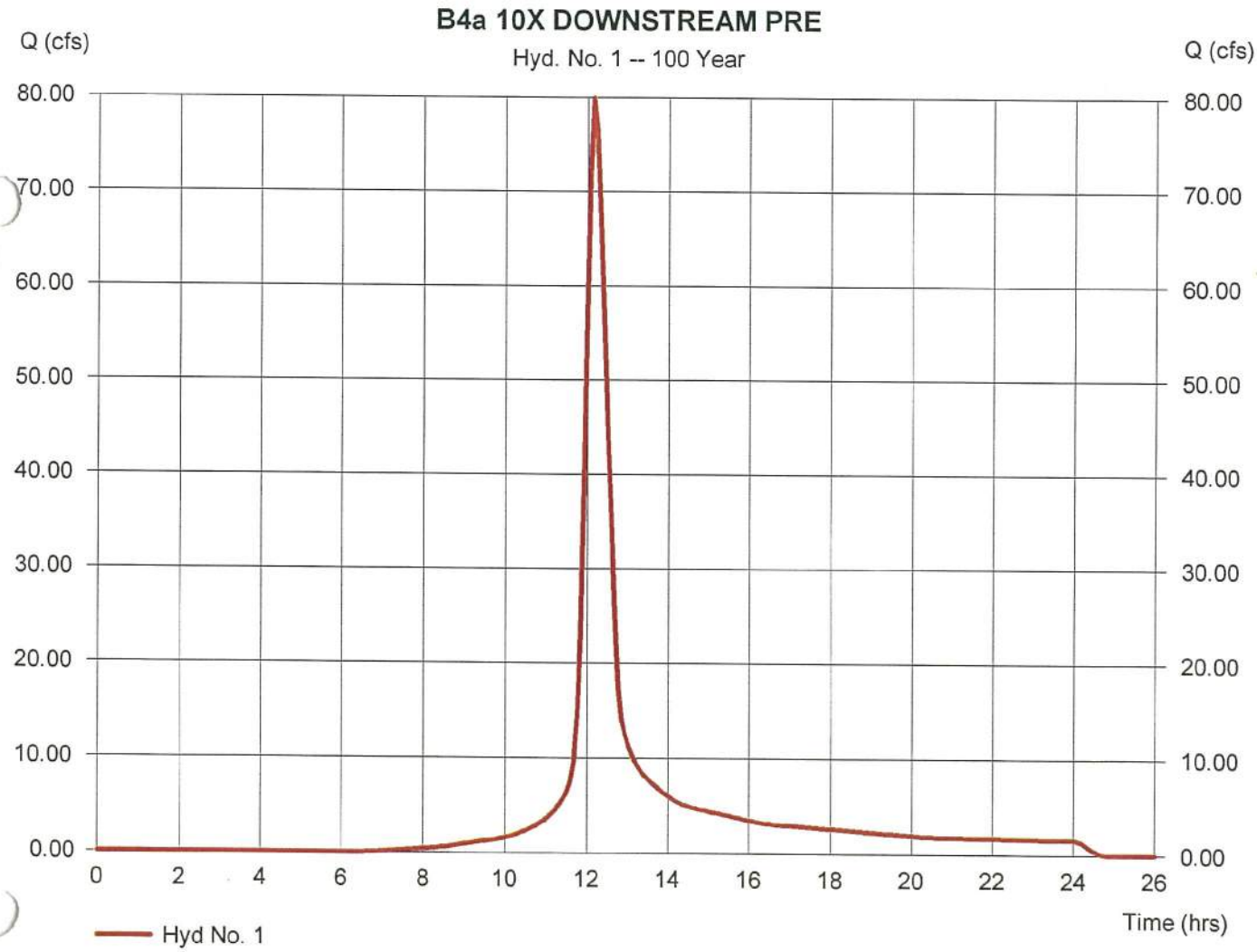
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 07 / 15 / 2014

Hyd. No. 1

B4a 10X DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 79.89 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 347,879 cuft
Drainage area	= 18.700 ac	Curve number	= 75
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 29.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



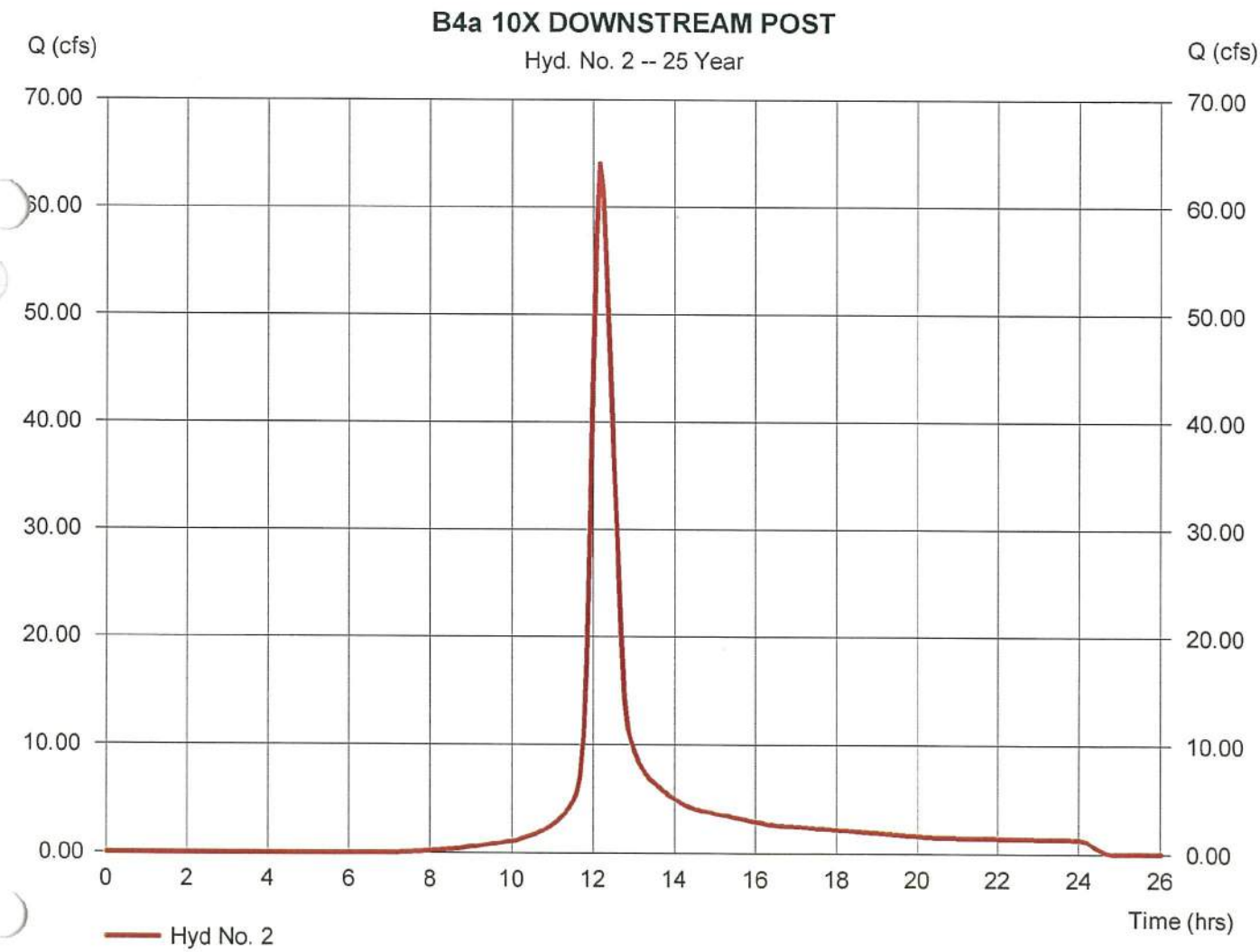
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 07 / 15 / 2014

Hyd. No. 2

B4a 10X DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 63.96 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 278,649 cuft
Drainage area	= 19.600 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 30.50 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 07 / 15 / 2014

Hyd. No. 2

B4a 10X DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 85.64 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 373,104 cuft
Drainage area	= 19.600 ac	Curve number	= 76
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 30.50 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

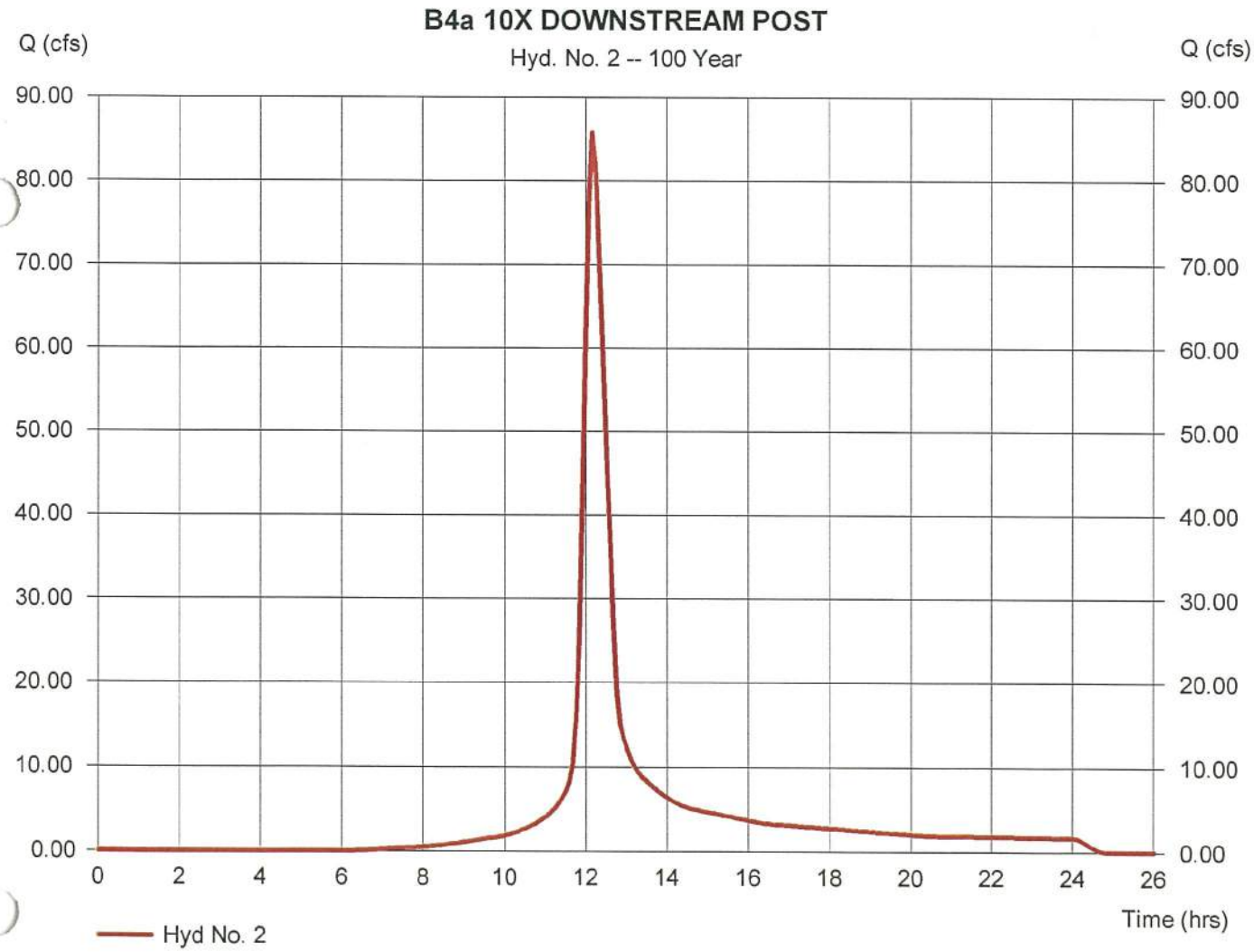


FIGURE B-4A.5

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-4A*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	1,048	1,048
CP_v	3,322	4,370
Q_{p25}	3,218	4,266
Q_{f100}	3,868	4,916

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**137**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	1053	ft^3	>	1048	ft^3

Swale Dimensions:

A swale that is **137** ft long and that is **8** ft wide.

Pond Dimensions:

Pond sized to detain 3,868 ft^3 plus 1 ft of freeboard
See AutoCAD Pond Report for exact pond size

Surface Sand Filter

WQ_v	=	1,048	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **60** ft^2

Actual Filter Bed Dimensions:	Width	**6**	ft
	Length	**12**	ft
		72	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **69** ft^2

Actual Sediment Chamber Dimensions:	Width	**6**	ft
	Length	**12**	ft
		72	ft^2

Bioretention Area

WQ_v	=	1,048	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **441** ft^2

Actual Filter Bed Dimensions:	Width	**23**	ft
	Length	**20**	ft
		460	ft^2

Pond Report

FIGURE B-4A.6

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Thursday, 11 / 13 / 2014

Pond No. 1 - <New Pond>

Pond Data

Trapezoid -Bottom L x W = 50.0 x 25.0 ft, Side slope = 3.00:1, Bottom elev. = 1035.00 ft, Depth = 4.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	1035.00	1,250	0	0
0.40	1035.40	1,436	537	537
0.80	1035.80	1,633	613	1,150
1.20	1036.20	1,842	695	1,845
1.60	1036.60	2,062	780	2,625
2.00	1037.00	2,294	871	3,496 ← 2.1' DESIGN VOLUME
2.40	1037.40	2,537	966	4,462 + 1.0' FREEBOARD
2.80	1037.80	2,792	1,066	5,527
3.20	1038.20	3,059	1,170	6,697 ← 3.1'
3.60	1038.60	3,337	1,279	7,976
4.00	1039.00	3,626	1,392	9,368

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

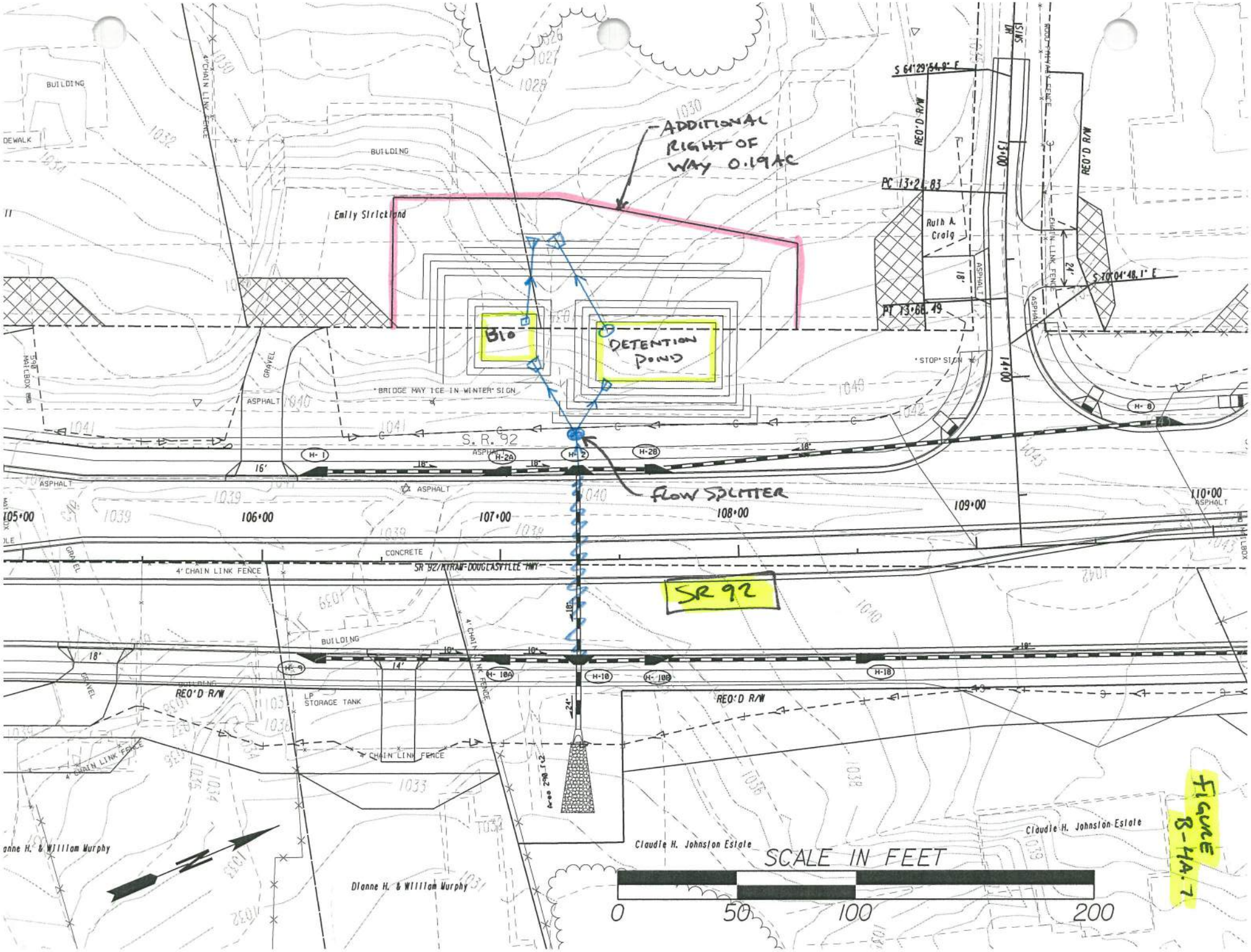
Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	1035.00	---	---	---	---	---	---	---	---	---	---	0.000
0.40	537	1035.40	---	---	---	---	---	---	---	---	---	---	0.000
0.80	1,150	1035.80	---	---	---	---	---	---	---	---	---	---	0.000
1.20	1,845	1036.20	---	---	---	---	---	---	---	---	---	---	0.000
1.60	2,625	1036.60	---	---	---	---	---	---	---	---	---	---	0.000
2.00	3,496	1037.00	---	---	---	---	---	---	---	---	---	---	0.000
2.40	4,462	1037.40	---	---	---	---	---	---	---	---	---	---	0.000
2.80	5,527	1037.80	---	---	---	---	---	---	---	---	---	---	0.000
3.20	6,697	1038.20	---	---	---	---	---	---	---	---	---	---	0.000
3.60	7,976	1038.60	---	---	---	---	---	---	---	---	---	---	0.000
4.00	9,368	1039.00	---	---	---	---	---	---	---	---	---	---	0.000


ADDITIONAL RIGHT OF WAY 0.19AC
BIO
DETENTION POND
FLOW SPLITTER
SR 92
Emily Strickland
Ruth A. Craig
Claudie H. Johnston Estate
Dianne H. & William Murphy
S. R. 92
SR 92/KTRAN-DOUGLASVILLE HWY
REQ'D R/W
BUILDING
LP STORAGE TANK
4' CHAIN LINK FENCE
CONCRETE
ASPHALT
GRAVEL
"BRIDGE MAY ICE IN WINTER" SIGN
"STOP" SIGN
PC 13+24.83
PT 13+68.49
S 64°29'54.9" E
S 70°04'48.1" E
105+00
106+00
107+00
108+00
109+00
110+00
SCALE IN FEET
0
50
100
200
FIGURE B-HA.7

Infeasibility Criteria #1: Cost of Construction
Basin B-4A

11/13/2014

Basin B-4A 500 LF of Roadway construction cost within basin

Item	Basin B-4A Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 61,930.00	$ 85,190.00	$ 85,190.00	$ 9,685.00
Utilities ✪	$ 38,329.81	$ -	$ -	$ -
Construction ✪	$ 326,662.07	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,500.00	$ 4,500.00	$ 968.50
Grading	$ -	$ 27,000.00	$ 4,500.00	$ 3,600.00
Drainage	$ -	$ 26,593.14	$ 42,431.00	$ 30,968.00
Total	$ 426,921.88	$ 143,283.14	$ 136,621.00	$ 45,221.50
	Percent of BMP Cost to Total	**33.6%**	**32.0%**	**10.6%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.2689
Sub Total:	$	13,445.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0.0854
Sub Total:	$	2,135.00
Commercial Right of Way @	$	125,000.00
		0.0414
Sub Total:	$	5,175.00
Commercial Perm Easmt @	$	62,500.00
		0.0188
Sub Total:	$	1,175.00
Commercial Relocation Cost	$	25,000.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	61,930.00

✪ See General Summary Explaination for Cost Method

figure B-4A.8

BMP Construction Cost Worksheet — Basin B-4A

Dry Enhanced Swale with Detention Basin

Length:	137	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.9038	Ac	
Total:	$ 45,190.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Relocation @	$ 40,000.00		
	1		
Total:	$ 40,000.00		
Sub Total:	$ 85,190.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.9	Disturbed Ac	
$ 4,500.00		

Grading

Cut	Fill	
3000.000	1500.000	
$ 6.00	per CY	
Total: $ 27,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	3	EA		3	EA
	$ 15,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	101	CY	$ 30.00	$ 2,255.14
Uddrn Sys w/ Gravel	-	167	LF	$ 20.00	$ 3,340.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	8	SY		8	SY
	$ 460.00			$ 38.00	

Sub Total: $ 26,593.14

Surface Sand Filter with Detention Basin

	Filter Bed	Sediment Chamber	
Length:	12	12	ft
Width:	6	6	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.9038	Ac	
Total:	$ 45,190.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Relocation @	$ 40,000.00		
	1		
Total:	$ 40,000.00		
Sub Total:	$ 85,190.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.9	Disturbed Ac	
$ 4,500.00		

Grading

Cut	Fill	
450.000	300.000	
$ 6.00	per CY	
Total: $ 4,500.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	5	EA		3	EA
	$ 25,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	4	CY	$ 45.00	$ 180.00
Uddrn Sys w/ Gravel	-	75	LF	$ 20.00	$ 1,500.00
Top Soil		1	CY	$ 20.00	$ 20.00
Addl Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Outlet Pipe	18"	150	LF	$ 43.00	$ 6,450.00
Imperm Geotextile	-	72	SF	$ 5.00	$ 360.00
Dist Wall Conc/Steel	-	2	CY	$ 1,020.00	$ 2,040.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	36	SY	Filter Fabric	36	SY
	$ 2,070.00			$ 171.00	

Sub Total: $ 42,431.00

Bioretention Area with Detention Basin

Length:	23	ft
Width:	20	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.1937	Ac	
Total:	$ 9,685.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 9,685.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.1937	Disturbed Ac	
$ 968.50		

Grading

Cut	Fill	
300.000	300.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	3	EA		3	EA
	$ 15,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	35	CY	$ 30.00	$ 1,050.00
Uddrn Sys w/ Gravel	-	90	LF	$ 20.00	$ 1,800.00
Mulch	-	52	SY	$ 15.00	$ 780.00
Additional Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Outlet Pipe	18"	150	LF	$ 43.00	$ 6,450.00
Shrubs	-	10	EA	$ 30.00	$ 300.00
Ground Cover	-	30	EA	$ 15.00	$ 450.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	8	SY		8	SY
	$ 460.00			$ 38.00	

Sub Total: $ 30,968.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: MAC
Checked By: SCF 11-18-14

Basin B-4B Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

Initially, the drainage area of outfall B-4 was delineated and it was determined that the proposed drainage design altered the existing condition by too much. The proposed design had all the flow draining to the right side of SR 92. It would better match the existing condition if the left side flow drained left and the right side drained to the right, as the existing condition does. This would also result in smaller MS4 post-construction ponds because the pre and post condition peak flows would be closer so the ponds would be required to retain less volume.

The ultimate outfall of Drainage Basin B-4B was located and the existing and proposed basin drainage areas were delineated (See Figures B-4B.1 and B-4B.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,740	3,740
Quantity	Channel Protection, CP_v	7,091	10,831
	Overbank Flood Protection, Q_{p25}	5,412	9,152
	Extreme Flood Protection, Q_{f100}	6,433	10,173

- The total area draining to the MS4 BMP is 1.40 Ac. The total impervious area is 0.96 Ac. The existing pavement area for the site is 0.08 Ac. The area required for storage and quantity management is 1.32 Ac (See Figure B-4B.3). The flow produced by the existing paved area of 0.08 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 30 feet wide by 152 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure B-4B.4).
- Modifications to the drainage design will be necessary in this basin (See Figure B-4B.5).
- See figure B-4b.5 for a layout of the bioretention area.
- The BMP construction cost is 18.3% of the roadway construction cost within this basin making this basin infeasible (See Figure B-4B.6).
- None of the other infeasibility criteria apply to this basin.

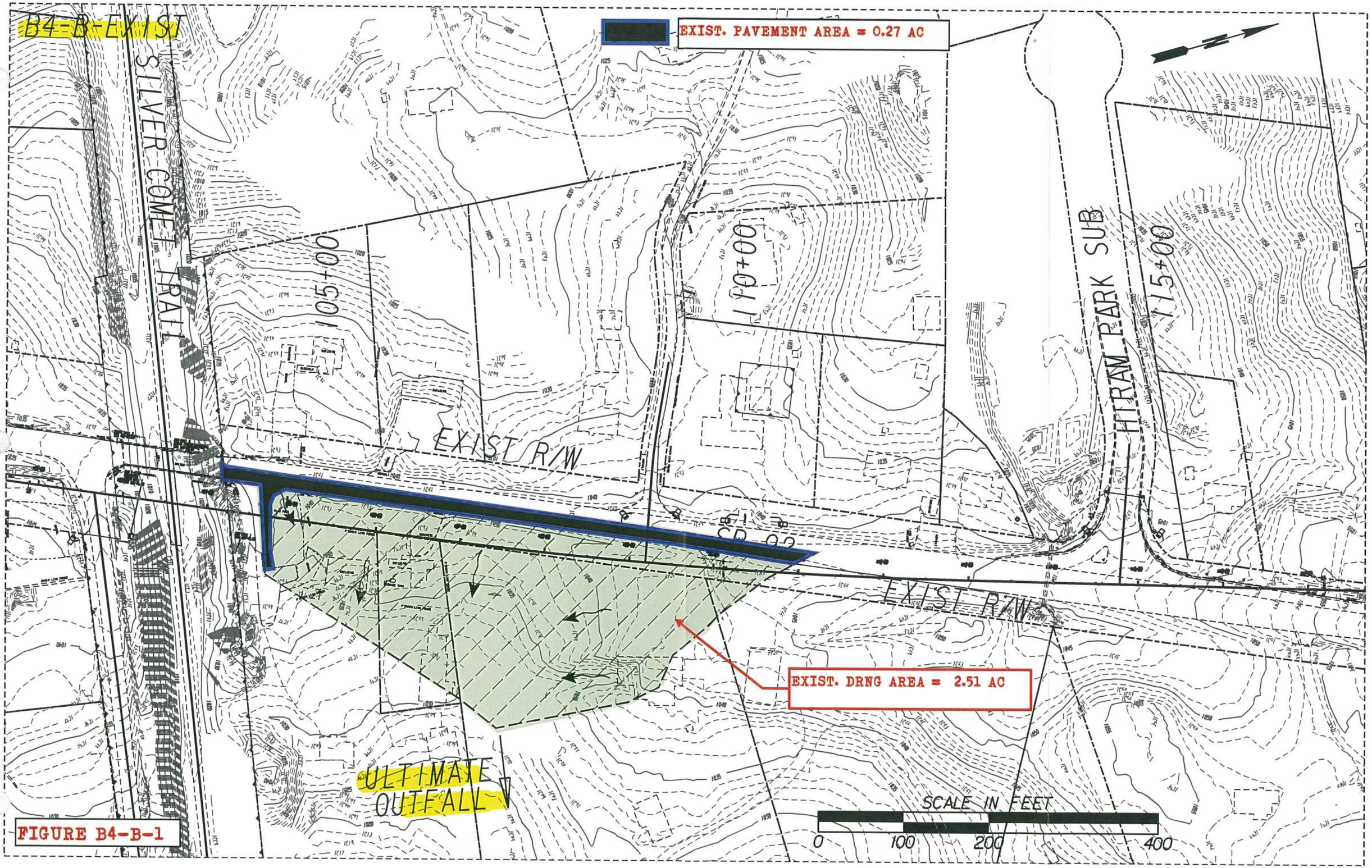

B4-B-EXIST
EXIST. PAVEMENT AREA = 0.27 AC
SILVER COME TRAIL
105+00
110+00
115+00
HIRAM PARK SUB
EXIST R/W
EXIST R/W
EXIST. DRNG AREA = 2.51 AC
ULTIMATE OUTFALL
SCALE IN FEET
0
100
200
400

FIGURE B4-B-1

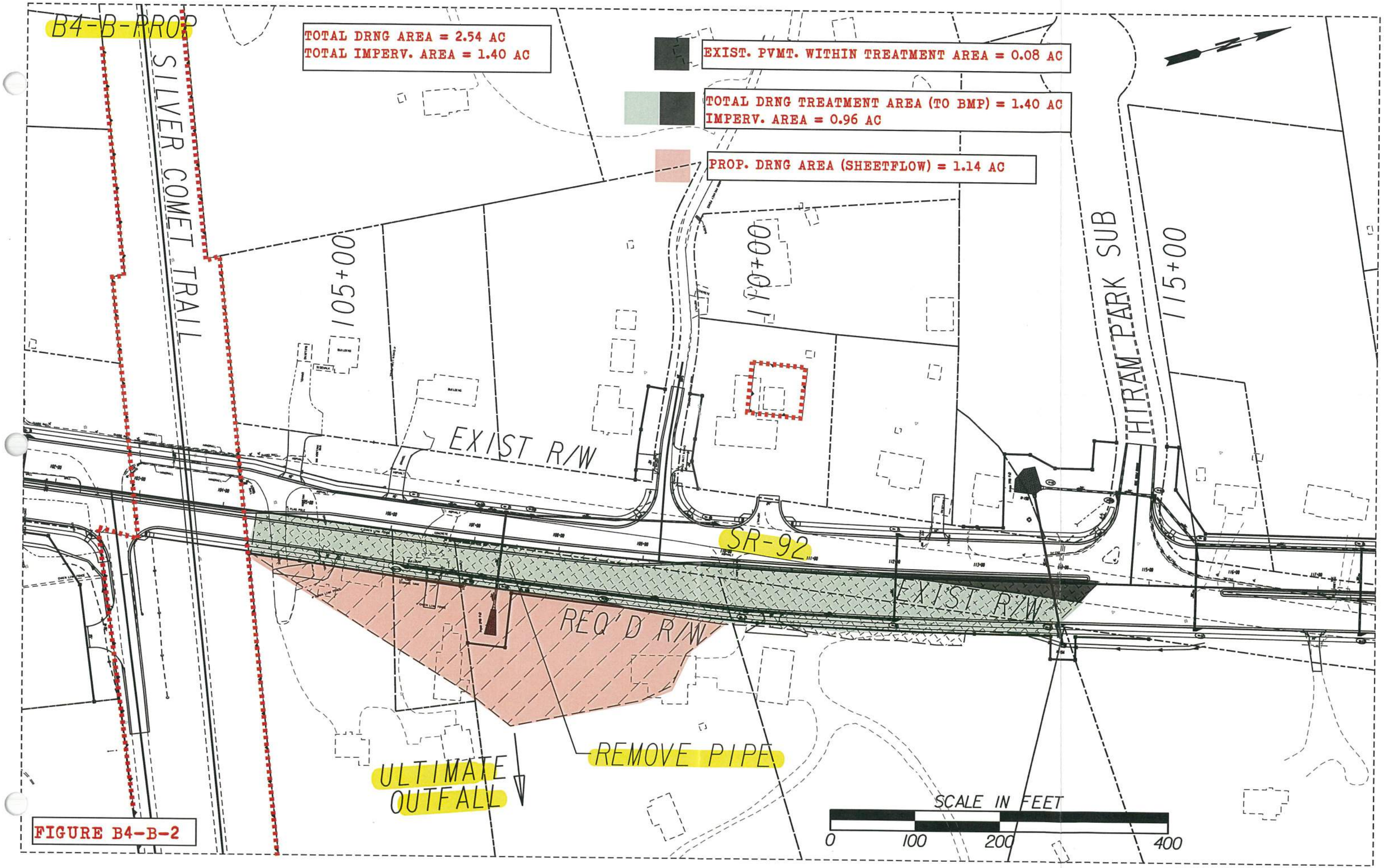

B4-B-PROP
TOTAL DRNG AREA = 2.54 AC
TOTAL IMPERV. AREA = 1.40 AC
EXIST. PVMT. WITHIN TREATMENT AREA = 0.08 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.40 AC
IMPERV. AREA = 0.96 AC
PROP. DRNG AREA (SHEETFLOW) = 1.14 AC
SILVER COMET TRAIL
105+00
110+00
115+00
HTRAM PARK SUB
EXIST R/W
SR-92
REQ'D R/W
EXIST R/W
REMOVE PIPE
ULTIMATE OUTFALL
SCALE IN FEET
0
100
200
400

FIGURE B4-B-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: B-4B

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	2.51
Impervious Area =	0.27
Pervious Area=	2.23

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.20 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.705

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.210	0.21
$I_a/P_{10\text{-}yr}$=	0.128	0.13
$I_a/P_{25\text{-}yr}$=	0.109	0.11
$I_a/P_{100\text{-}yr}$=	0.089	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.52

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.14
$Q_{d\ 10\text{-}yr}$=	2.78
$Q_{d\ 25\text{-}yr}$=	3.59
$Q_{d\ 100\text{-}yr}$ =	4.85

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	750
$q_{u10\text{-}yr}$=	780
$q_{u25\text{-}yr}$=	790
$q_{u100\text{-}yr}$=	800

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	3.35
$Q_{p10\text{-}yr}$=	8.49
$Q_{p25\text{-}yr}$=	11.10
$Q_{p100\text{-}yr}$=	15.19

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	2.54
Impervious Area =	1.40
Pervious Area =	1.14
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	86

Time of Concentration (See Table A) = 0.20 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.328

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.098	0.10
$I_a/P_{10\text{-}yr}$=	0.059	0.10
$I_a/P_{25\text{-}yr}$=	0.051	0.10
$I_a/P_{100\text{-}yr}$=	0.041	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.64

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.97
$Q_{d\ 10\text{-}yr}$=	3.95
$Q_{d\ 25\text{-}yr}$=	4.86
$Q_{d\ 100\text{-}yr}$ =	6.24

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	800
$q_{u10\text{-}yr}$=	800
$q_{u25\text{-}yr}$=	800
$q_{u100\text{-}yr}$=	800

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	6.24	0.537
$Q_{p10\text{-}yr}$=	12.51	
$Q_{p25\text{-}yr}$=	15.40	
$Q_{p100\text{-}yr}$=	19.79	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.40	Acre
Total Impervious Area - A_{POST}	0.96	Acre
Existing Pavement Area - A_{PRE} (5)	0.08	Acre
Area Required for Quantity - A_{QUAN} (4)	1.32	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.40	0.63	62.57	0.00	0.613	0.086	3,740

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) $R_v = 0.05 + 0.009\ (I)$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.721	0.20	0.108	4,705

(+15% ED)= 5,412

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.142	6,165

(+15% ED)= 7,091

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.768	0.19	0.128	5,594

(+15% ED)= 6,433

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

figure B-4B.3

FIGURE B-4B.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-4B*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	3,740	3,740
CP_v	7,091	10,831
Q_{p25}	5,412	9,152
Q_{f100}	6,433	10,173

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**1409**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	10832	ft^3	>	10831	ft^3

Swale Dimensions:

A swale that is **1409** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	10,831	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **618** ft^2

Actual Filter Bed Dimensions:	Width	**18**	ft
	Length	**36**	ft
		648	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_S = **715** ft^2

Actual Sediment Chamber Dimensions:	Width	**18**	ft
	Length	**40**	ft
		720	ft^2

Bioretention Area

CP_v	=	10,831	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,560** ft^2

Actual Filter Bed Dimensions:	Width	**30**	ft
	Length	**152**	ft
		4560	ft^2

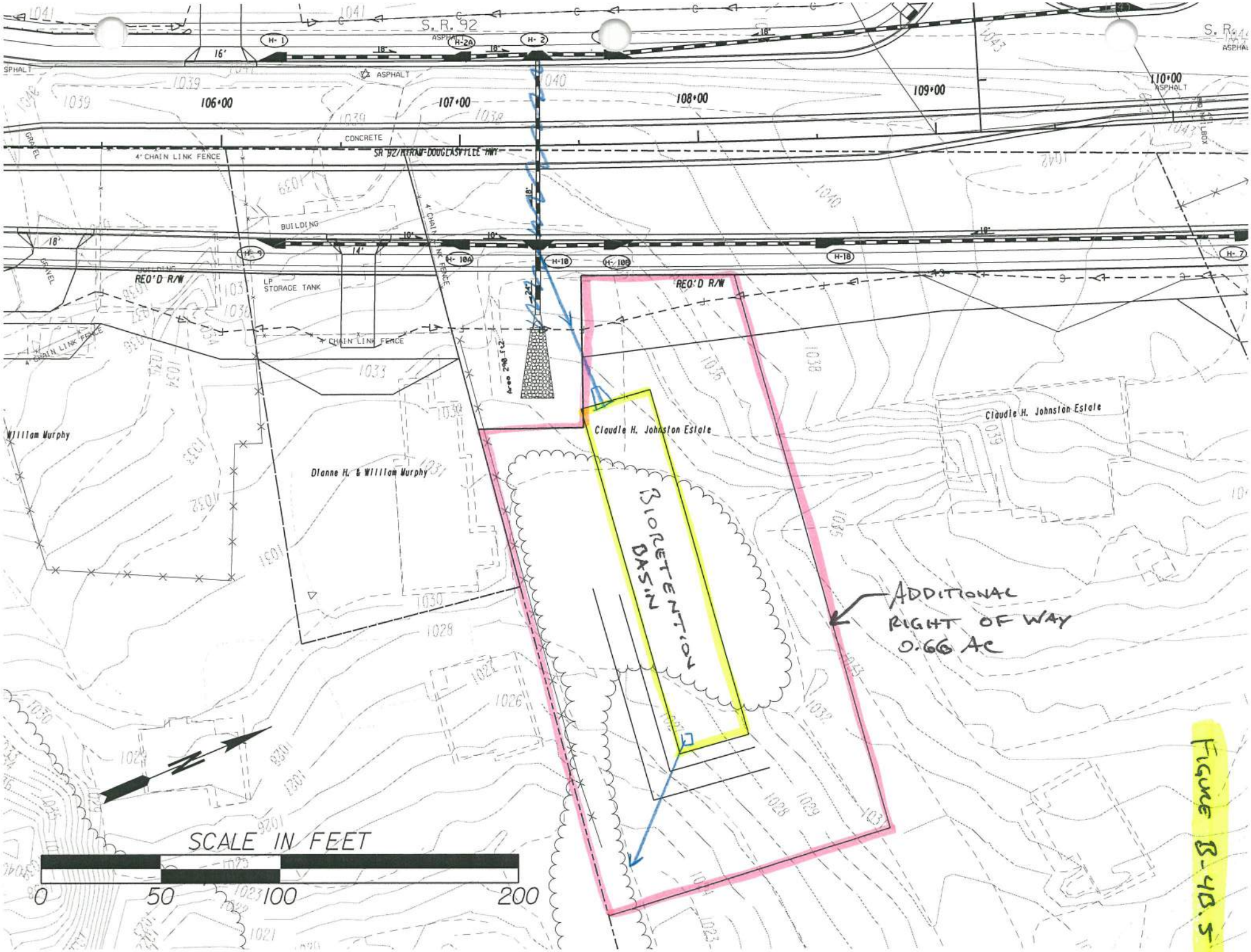

S.R. 92
ASPHALT
106+00
107+00
108+00
109+00
110+00
CONCRETE
4' CHAIN LINK FENCE
SR 92/RTRAW-DOUGLASVILLE HWY
BUILDING
REQ'D R/W
LP STORAGE TANK
CHAIN LINK FENCE
William Murphy
Dianne H. & William Murphy
Claudie H. Johnston Estate
BIORETENTION BASIN
ADDITIONAL RIGHT OF WAY 0.66 AC
SCALE IN FEET
0
50
100
200

Figure B-40.5

Infeasibility Criteria #1: Cost of Construction

11/14/2014

Basin B-4B

Basin B-4B 500 LF of Roadway construction cost within basin

Item	Basin B-4B Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 65,405.00	$ 118,760.00	$ 37,315.00	$ 32,885.00
Utilities ✪	$ 38,329.81	$ -	$ -	$ -
Construction ✪	$ 326,662.07	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 11,900.00	$ 3,750.00	$ 3,300.00
Grading	$ -	$ 27,000.00	$ 8,820.00	$ 6,840.00
Drainage	$ -	$ 61,828.92	$ 49,270.00	$ 35,626.00
Total	$ 430,396.88	$ 219,488.92	$ 99,155.00	$ 78,651.00
	Percent of BMP Cost to Total	**51.0%**	**23.0%**	**18.3%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		1.0617
Sub Total:	$	53,085.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.4928
Sub Total:	$	12,320.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Commercial Relocation Cost	$	25,000.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	65,405.00

✪ See General Summary Explaination for Cost Method

figure B-4B.6

BMP Construction Cost Worksheet Basin B-4B

Dry Enhanced Swale

Length:	1409	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	2.3752	Ac	
Total:	$ 118,760.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Relocation @	$ 40,000.00		
	0		
Total:	$ -		
Sub Total:	$ 118,760.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
2.38	Disturbed Ac	
$ 11,900.00		

Grading

Cut	Fill	
3000.000	1500.000	
$ 6.00	per CY	
Total: $ 27,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		0	EA	
	$ 5,000.00			$ -		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1044	CY	$ 30.00	$ 23,193.42
Uddrn Sys w/ Gravel	-	1439	LF	$ 20.00	$ 28,780.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	78	SY		78	SY
	$ 4,485.00			$ 370.50	

Sub Total: $ 61,828.92

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	36	40	ft
Width:	18	18	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.7463	Ac	
Total:	$ 37,315.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Relocation @	$ 40,000.00		
	0		
Total:	$ -		
Sub Total:	$ 37,315.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.75	Disturbed Ac	
$ 3,750.00		

Grading

Cut	Fill	
1360.000	110.000	
$ 6.00	per CY	
Total: $ 8,820.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	36	CY	$ 45.00	$ 1,620.00
Uddrn Sys w/ Gravel	-	135	LF	$ 20.00	$ 2,700.00
Top Soil		6	CY	$ 20.00	$ 120.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	648	SF	$ 5.00	$ 3,240.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	360	SY		360	SY
	$ 20,700.00			$ 1,710.00	

Sub Total: $ 49,270.00

Bioretention Area

Length:	152	ft
Width:	30	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.6577	Ac	
Total:	$ 32,885.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 32,885.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.66	Disturbed Ac	
$ 3,300.00		

Grading

Cut	Fill	
960.000	180.000	
$ 6.00	per CY	
Total: $ 6,840.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		1	EA	
	$ 5,000.00			$ 400.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	338	CY	$ 30.00	$ 10,140.00
Uddrn Sys w/ Gravel	-	135	LF	$ 20.00	$ 2,700.00
Mulch	-	507	SY	$ 15.00	$ 7,605.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Shrubs	-	10	EA	$ 30.00	$ 300.00
Ground Cover	-	30	EA	$ 15.00	$ 450.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	76	SY		76	SY
	$ 4,370.00			$ 361.00	

Sub Total: $ 35,626.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: MAC
Checked By: SLF 11-19-14

Basin B-S Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin B-5 was located and the existing and proposed basin drainage areas were delineated (See Figures B-5.1 and B-5.2). From those drainage areas the MS4 requirements, Water Quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	7,388	7,388
Quantity	Channel Protection, CP_v	12,686	20,074
	Overbank Flood Protection, Q_{p25}	12,233	19,621
	Extreme Flood Protection, Q_{f100}	15,365	22,753

- The total area draining to the MS4 pond is 3.68 Ac. The total impervious area is 3.13 Ac. The existing pavement area for the site is 1.45 Ac. The area required for storage and quantity management is 2.23 Ac (See Figure B-5.3). The flow produced by the existing paved area of 1.45 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- Because the Extreme Flood Protection volume is the largest volume, it triggers a 10 times downstream analysis to determine if an increase in flow would cause an adverse effect to homes downstream of the project. To do the downstream analysis normally a point that is 10 times the site area is located and studied for increased flows. However in this case a stream was reached that has a large upland drainage area. It was decided to do the downstream analysis at the confluence point with the stream and to include the upland area.
- The analysis showed that the flows would not cause a downstream increase of more than 5%, and that detention would not be necessary (See Figure B-5.4).
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin that is 50 feet wide by 170 feet long. The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure B-5.5).
- The proposed project requires a property acquisition. However, additional right of way is required from a property that looks to be prepped to construct 4 to 5 single family homes as part of Hiram Park Subdivision. For this reason the commercial value of property was used. (See Figure B-5.6).
- See figure B-5.6 for a layout of the proposed bioretention area.
- The BMP construction cost is 14.7% of the roadway construction cost within this basin making this basin infeasible (See Figure B-5.7).
- None of the other infeasibility criteria apply to this basin.

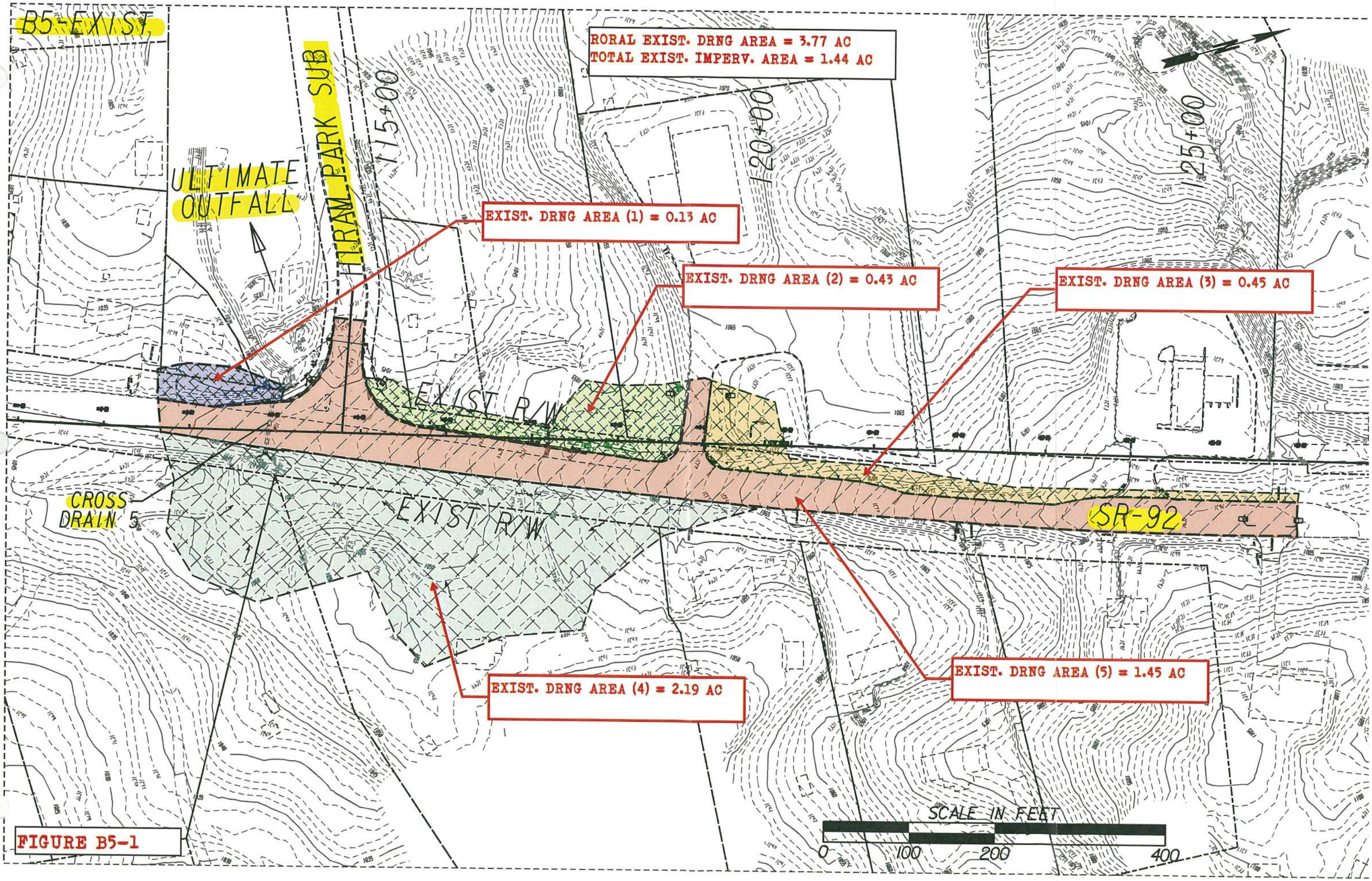

B5-EXIST
ULTIMATE OUTFALL
HIRAM PARK SUB
115+00
120+00
125+00
RORAL EXIST. DRNG AREA = 3.77 AC
TOTAL EXIST. IMPERV. AREA = 1.44 AC
EXIST. DRNG AREA (1) = 0.13 AC
EXIST. DRNG AREA (2) = 0.43 AC
EXIST. DRNG AREA (3) = 0.45 AC
EXIST R/W
EXIST R/W
CROSS DRAIN 5
SR-92
EXIST. DRNG AREA (4) = 2.19 AC
EXIST. DRNG AREA (5) = 1.45 AC
SCALE IN FEET
0
100
200
400

FIGURE B5-1

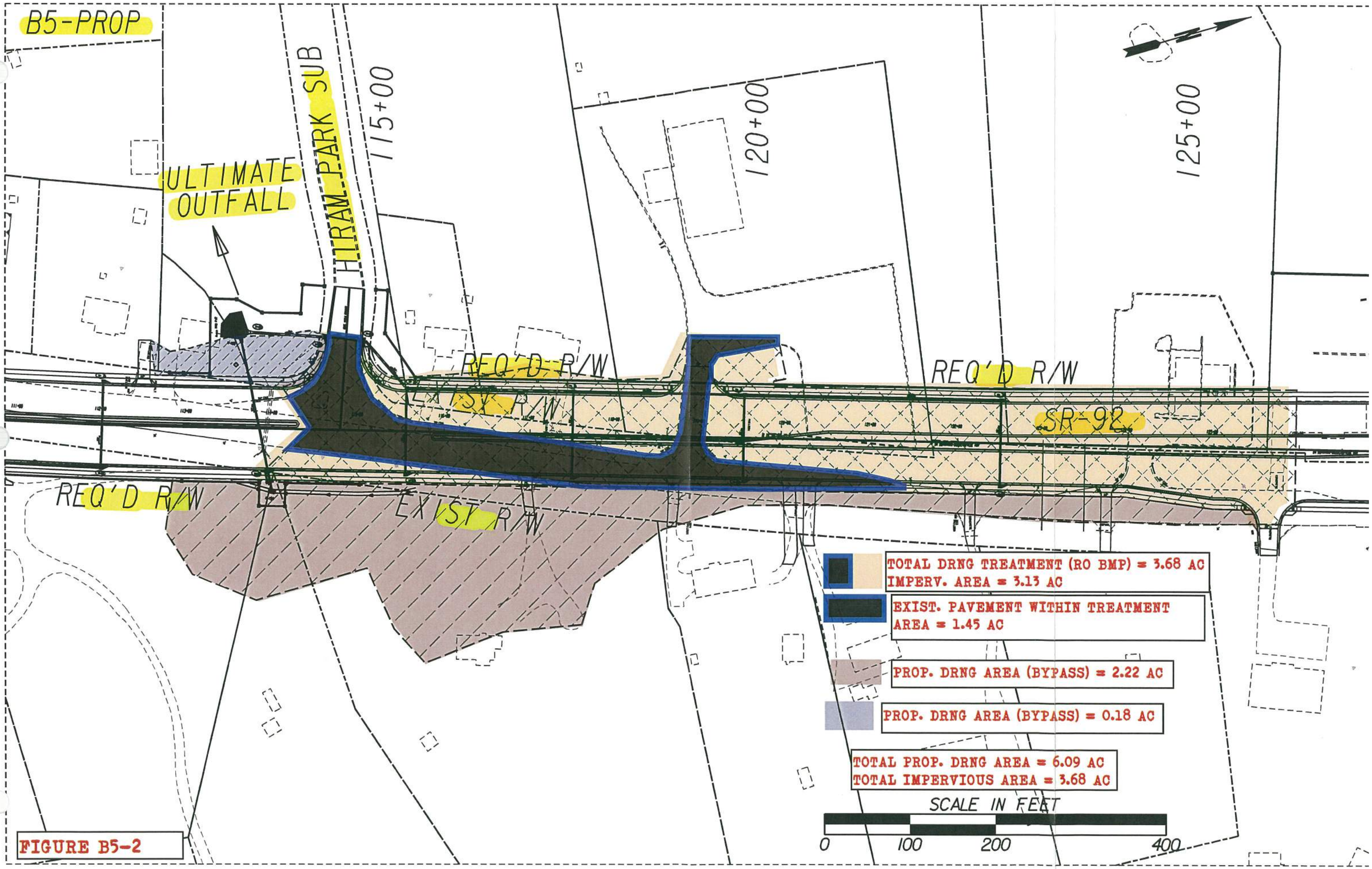

B5-PROP
ULTIMATE OUTFALL
HIRAM PARK SUB
115+00
120+00
125+00
REQ'D R/W
EXIST R/W
REQ'D R/W
SR-92
REQ'D R/W
EXIST R/W
TOTAL DRNG TREATMENT (RO BMP) = 3.68 AC
IMPERV. AREA = 3.13 AC
EXIST. PAVEMENT WITHIN TREATMENT AREA = 1.45 AC
PROP. DRNG AREA (BYPASS) = 2.22 AC
PROP. DRNG AREA (BYPASS) = 0.18 AC
TOTAL PROP. DRNG AREA = 6.09 AC
TOTAL IMPERVIOUS AREA = 3.68 AC
SCALE IN FEET
0
100
200
400

FIGURE B5-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *B-5*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: mac

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	3.77
Impervious Area =	1.44
Pervious Area=	2.33

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	81

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.460

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.137	0.137
$I_a/P_{10\text{-}yr}$=	0.083	0.100
$I_a/P_{25\text{-}yr}$=	0.071	0.100
$I_a/P_{100\text{-}yr}$=	0.058	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.30

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.62
$Q_{d\ 10\text{-}yr}$=	3.48
$Q_{d\ 25\text{-}yr}$=	4.36
$Q_{d\ 100\text{-}yr}$ =	5.70

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	890
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	8.48
$Q_{p10\text{-}yr}$=	18.45
$Q_{p25\text{-}yr}$=	23.10
$Q_{p100\text{-}yr}$=	30.24

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	6.09
Impervious Area =	3.68
Pervious Area =	2.41
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	87

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.291

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.086	0.100
$I_a/P_{10\text{-}yr}$=	0.053	0.100
$I_a/P_{25\text{-}yr}$=	0.045	0.100
$I_a/P_{100\text{-}yr}$=	0.037	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.45

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.08
$Q_{d\ 10\text{-}yr}$=	4.09
$Q_{d\ 25\text{-}yr}$=	5.01
$Q_{d\ 100\text{-}yr}$ =	6.41

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	900
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	17.84	0.475474
$Q_{p10\text{-}yr}$=	35.05	
$Q_{p25\text{-}yr}$=	42.93	
$Q_{p100\text{-}yr}$=	54.89	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	3.68	Acre
Total Impervious Area - A_{POST}	3.13	Acre
Existing Pavement Area - A_{PRE} (5)	1.45	Acre
Area Required for Quantity - A_{QUAN} (4)	2.23	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
3.68	0.46	45.65	0.00	0.461	0.170	***7,388***

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.538	0.26	0.244	***10,637***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **12,233**

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.253	***11,030***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **12,686**

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.551	0.26	0.307	***13,360***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **15,365**

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE B-5.3

November 2014

FIGURE B-5.4

Outfall B-5
10X Downstream Analysis Conclusions

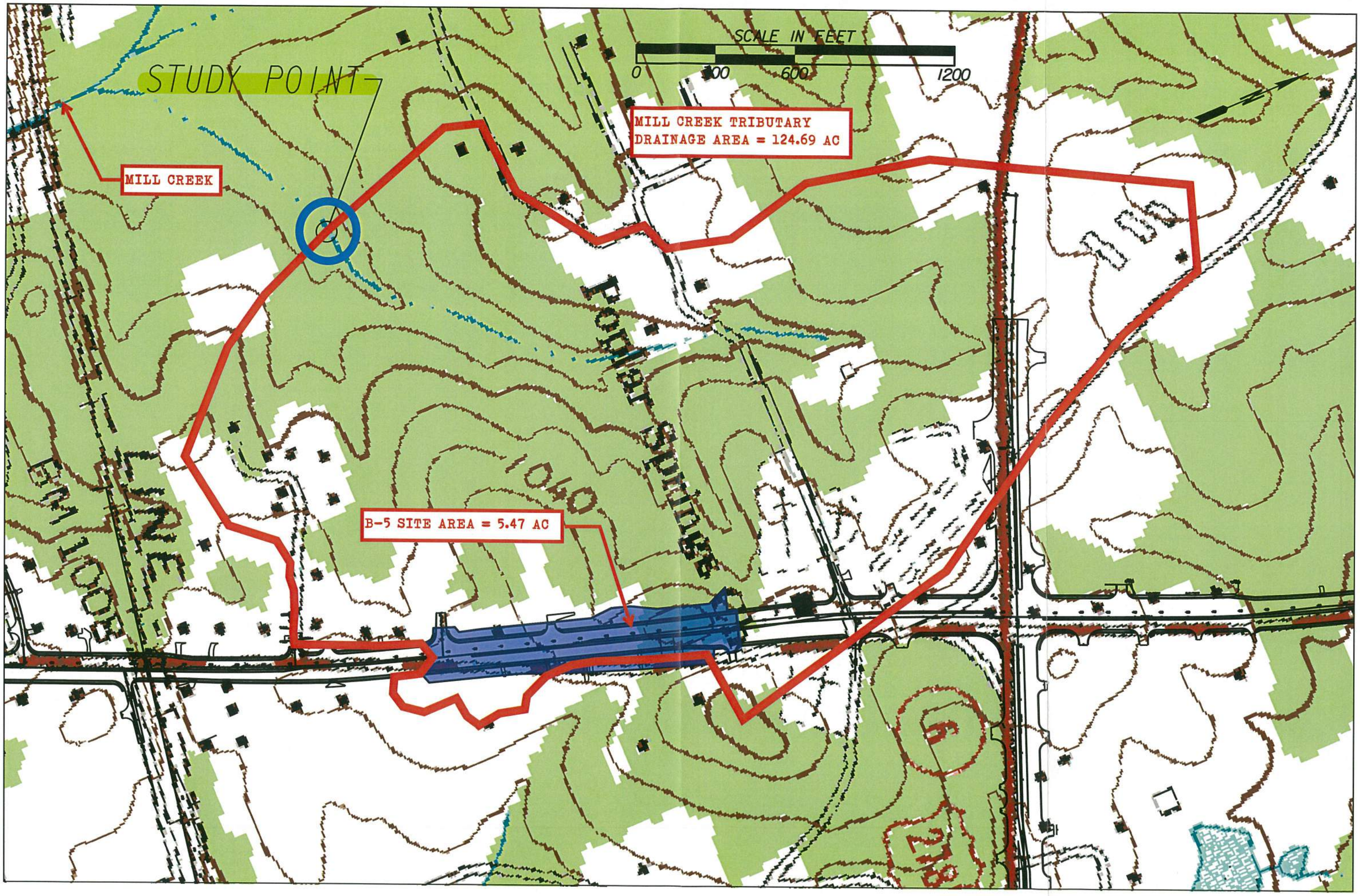
The drainage areas were delineated using a combination of the USGS quadrangle maps and the existing contours. The site area of the drainage outfall is 5.47 Ac. The 10 times watershed basin analysis area is 54.70 Ac, however a tributary branch to Mill Creek is reached before the 10 times basin area can be reached. The drainage area for the tributary branch is 124.69 Ac.

Curve number calculations for the downstream analysis have been included along with the hydrographs depicting the pre and post conditions of the 25 and 100 year storms.

Per GDOT requirements, Storm Detention is required when adverse impacts are caused by the post-development flow and where downstream structures are subject to increased depth of flooding. The following table summarizes the results of the 10X downstream analysis.

Outfall B-5	Storm Return Frequency	Pre-Developed Peak Discharge (cfs)	Post-Developed Peak Discharge (cfs)	Discharge Increase (cfs)	% Increase
10% Downstream Analysis	25	257.52	257.52	0.00	0.0
	100	332.96	332.96	0.00	0.0

The analysis of the 10X downstream conditions reflects a 0.0% increase for both the 25 and the 100 year return periods, which represent the Overbank Flood Protection and the Extreme Flood Protection, respectively. The discharge increase for both storm frequency's is below the GDOT maximum and will not adversely affect the downstream watershed so therefore detention will not be provided at this location.


SCALE IN FEET
0
300
600
1200
STUDY POINT
MILL CREEK
MILL CREEK TRIBUTARY
DRAINAGE AREA = 124.69 AC
B-5 SITE AREA = 5.47 AC
ROBERT SUTTLE
1040
EM 1008
278

Curve Number Calculation
10X Downstream Assessment for Outfall B5

Nov-14

PRE-CONDITION type "C" soil group	TOTAL AREA 124.7 Ac	
	IMPERVIOUS AREA 46.455 Ac	98
	RESIDENTIAL AREA 24.24 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 54.005	71
	COMPOSITE PRE CN	83

POST-CONDITION type "C" soil group	TOTAL AREA 124.7 Ac	
	IMPERVIOUS AREA 47.855 Ac	98
	RESIDENTIAL AREA 23.65 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 53.185	71
	COMPOSITE PRE CN	83

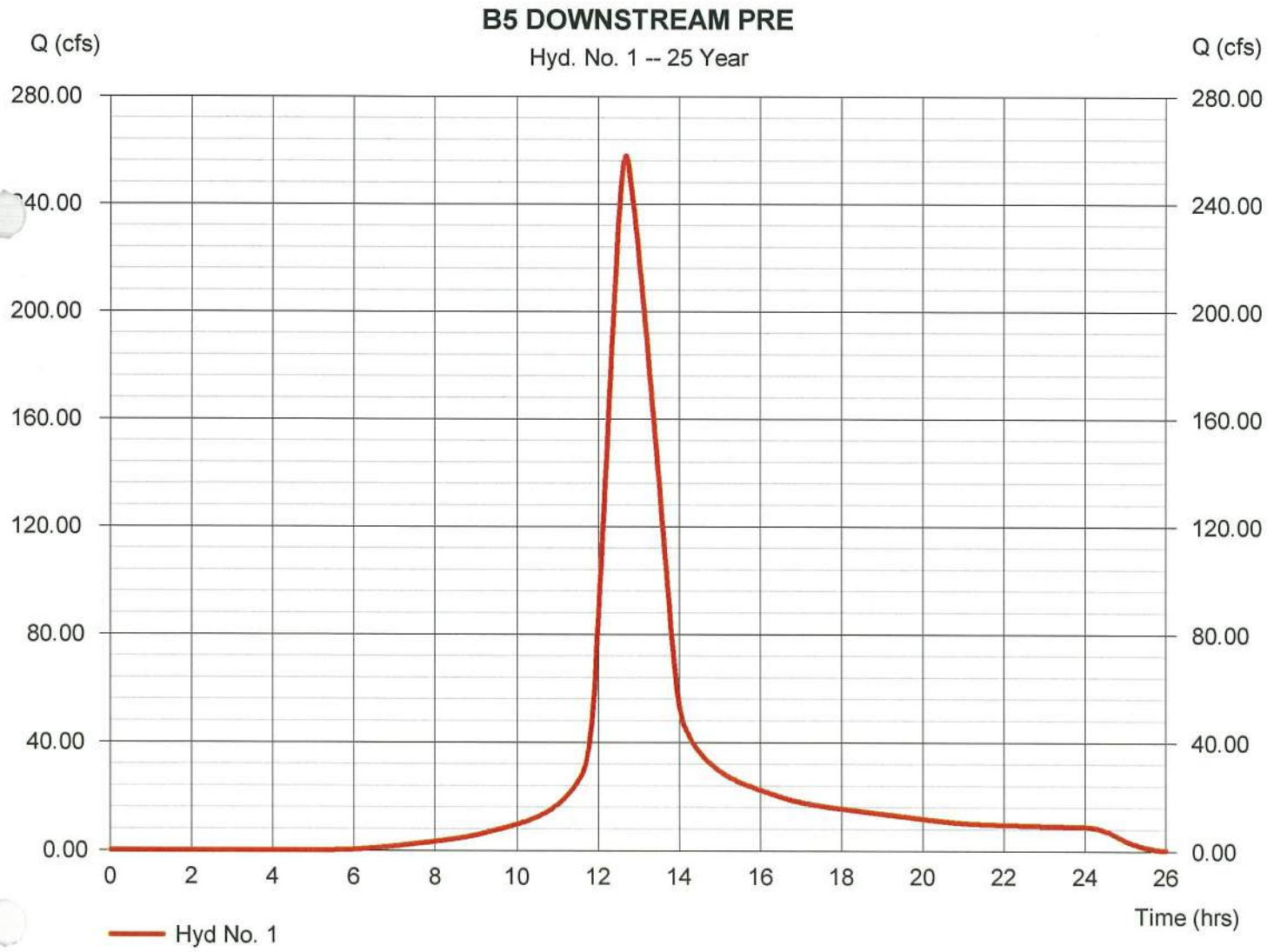
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 14 / 2014

Hyd. No. 1

B5 DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 257.52 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.70 hrs
Time interval	= 2 min	Hyd. volume	= 2,054,581 cuft
Drainage area	= 124.700 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 80.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



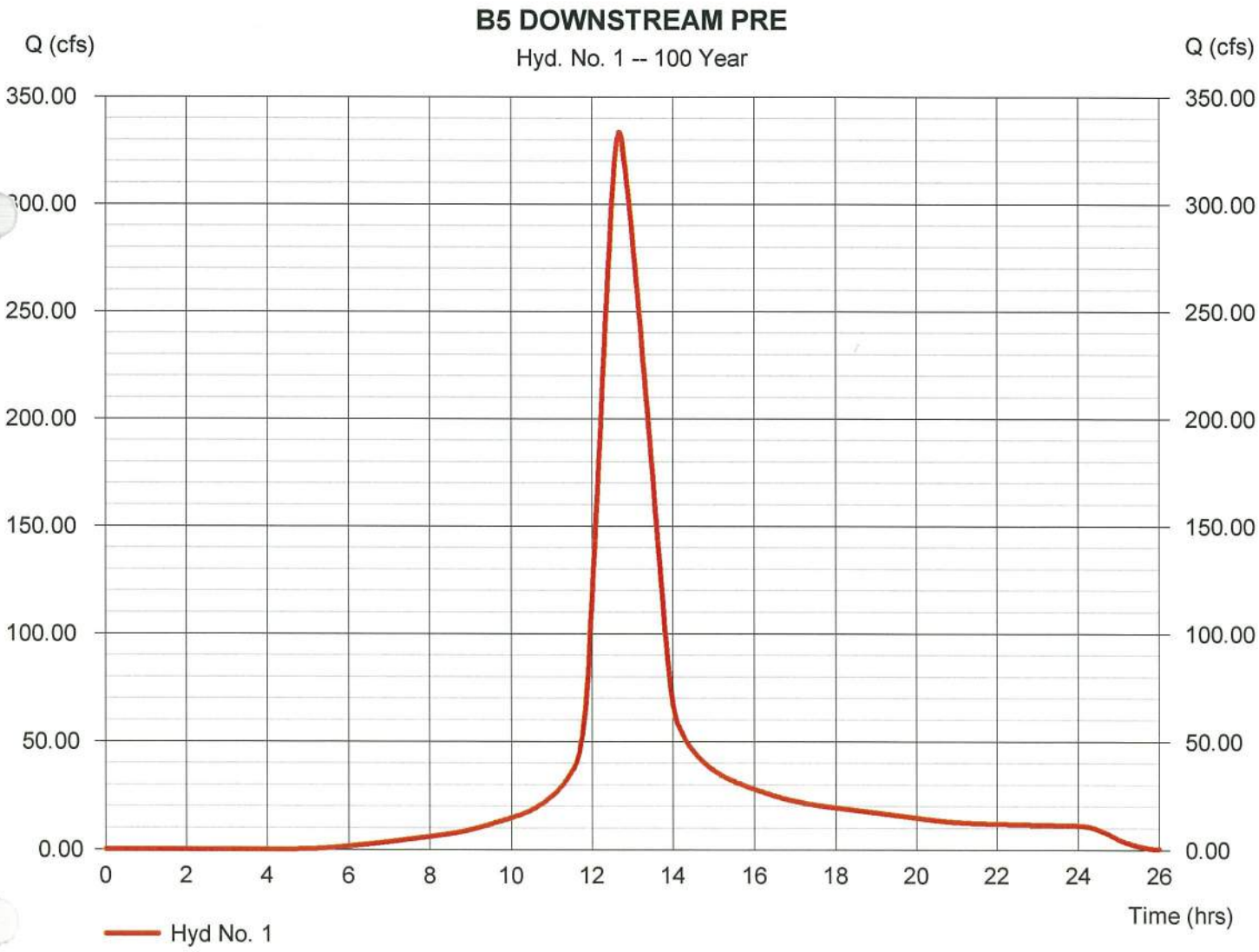
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 14 / 2014

Hyd. No. 1

B5 DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 332.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.67 hrs
Time interval	= 2 min	Hyd. volume	= 2,671,174 cuft
Drainage area	= 124.700 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 80.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



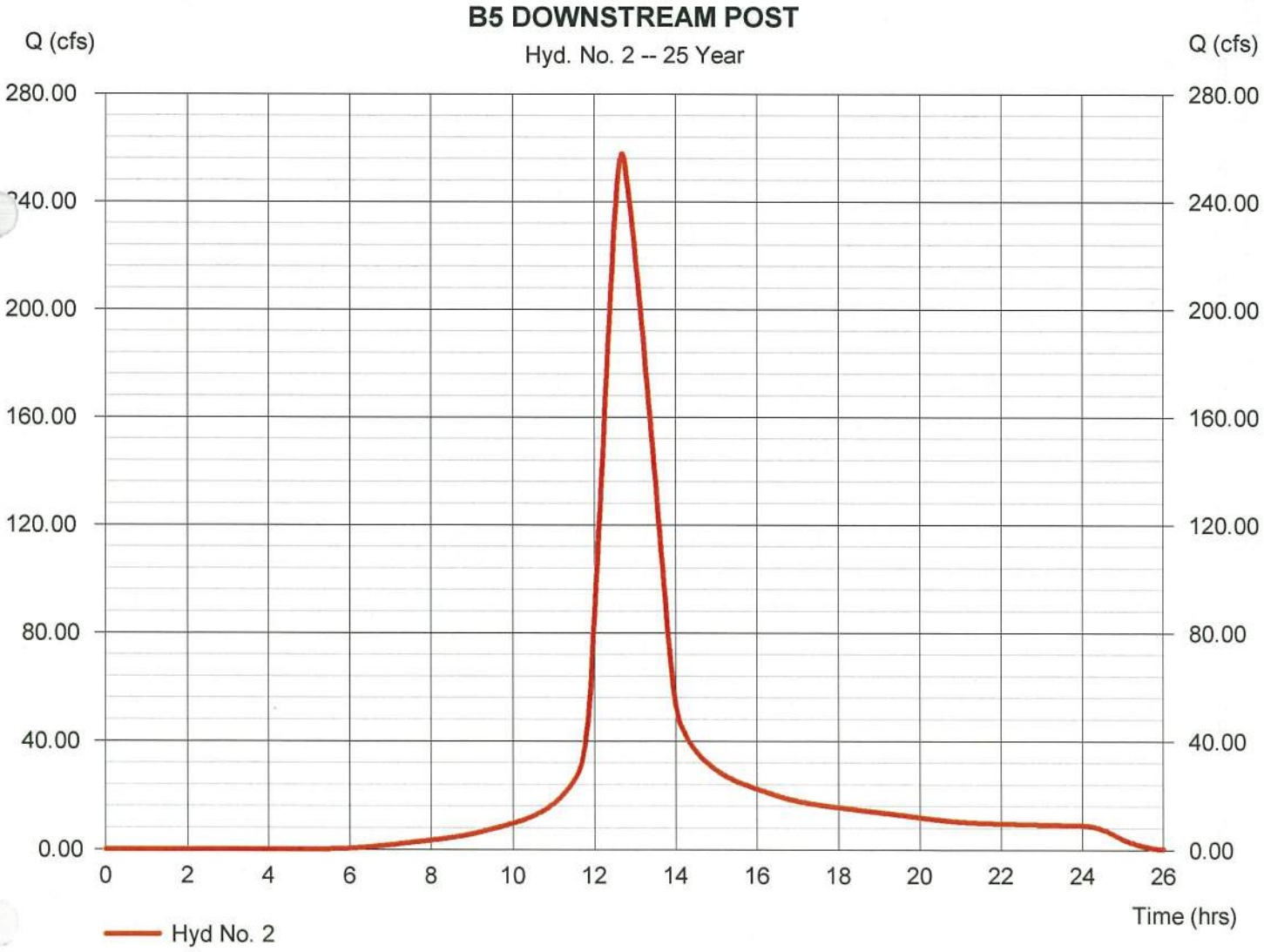
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 14 / 2014

Hyd. No. 2

B5 DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 257.52 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.70 hrs
Time interval	= 2 min	Hyd. volume	= 2,054,581 cuft
Drainage area	= 124.700 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 80.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 14 / 2014

Hyd. No. 2

B5 DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 332.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.67 hrs
Time interval	= 2 min	Hyd. volume	= 2,671,174 cuft
Drainage area	= 124.700 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 80.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

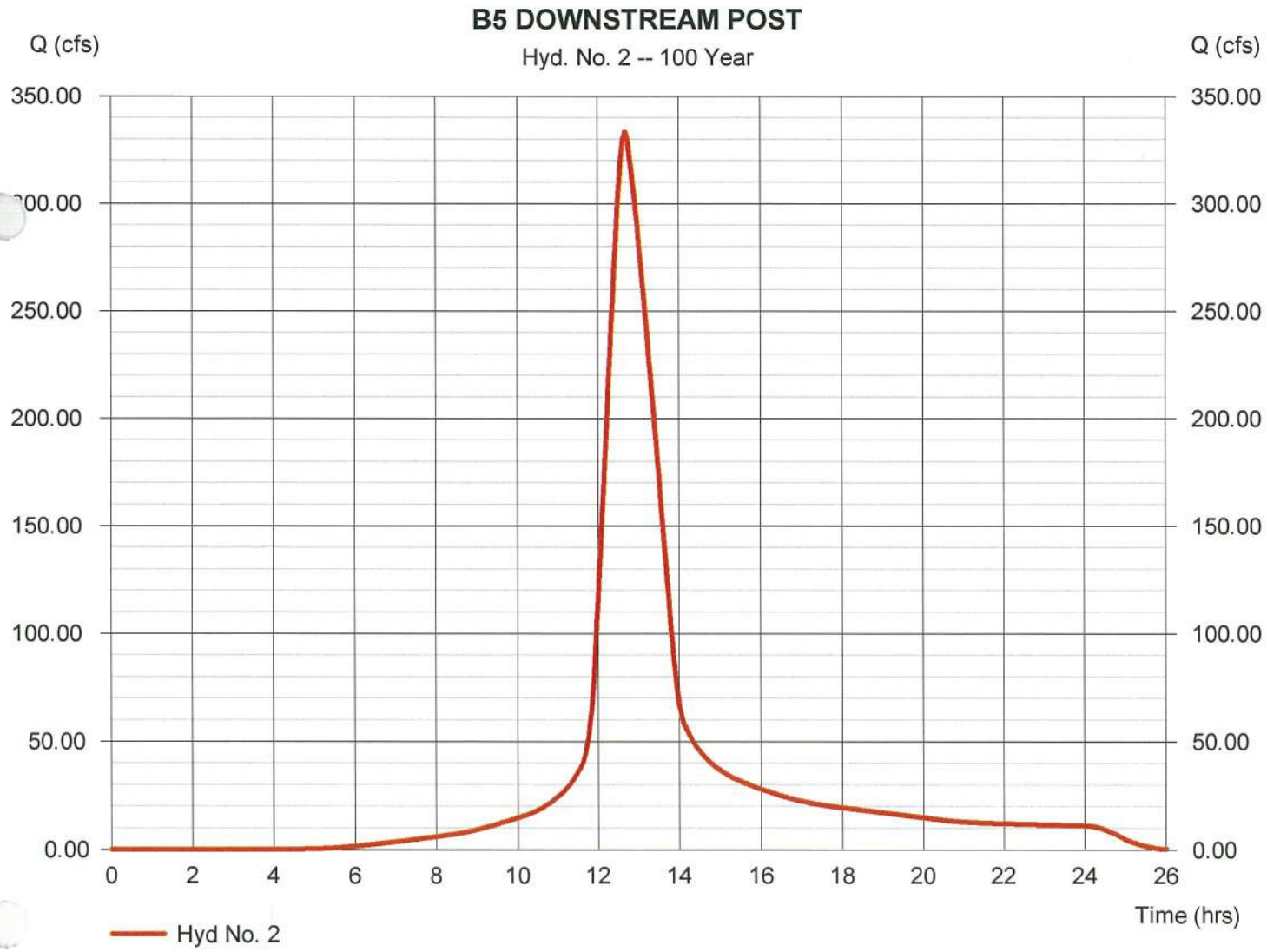


FIGURE B-5.5

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *B-5*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: mac

	Computed Volumes	Stacked Volumes
WQ_v	7,388	7,388
CP_v	12,686	20,074
Q_{p25}	12,233	19,621
Q_{f100}	15,365	22,753

Dry Enhanced Swale

Average Depth	=	0.75	ft		
Length	=	**2612**	ft		
Width	=	8	ft		
Left Side Slope	=	3	:1		
Right Side Slope	=	3	:1		
Area	=	7.6875	ft^2		
Slope	=	0.01	ft/ft		
Storage Volume	=	20080	ft^3	>	20074 ft^3

Swale Dimensions:

A swale that is **2612** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	20,074	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,145** ft^2

Actual Filter Bed Dimensions: Width **24** ft; Length **48** ft; 1152 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CPv**

A_s = **1325** ft^2

Actual Sediment Chamber Dimensions: Width **24** ft; Length **56** ft; 1344 ft^2

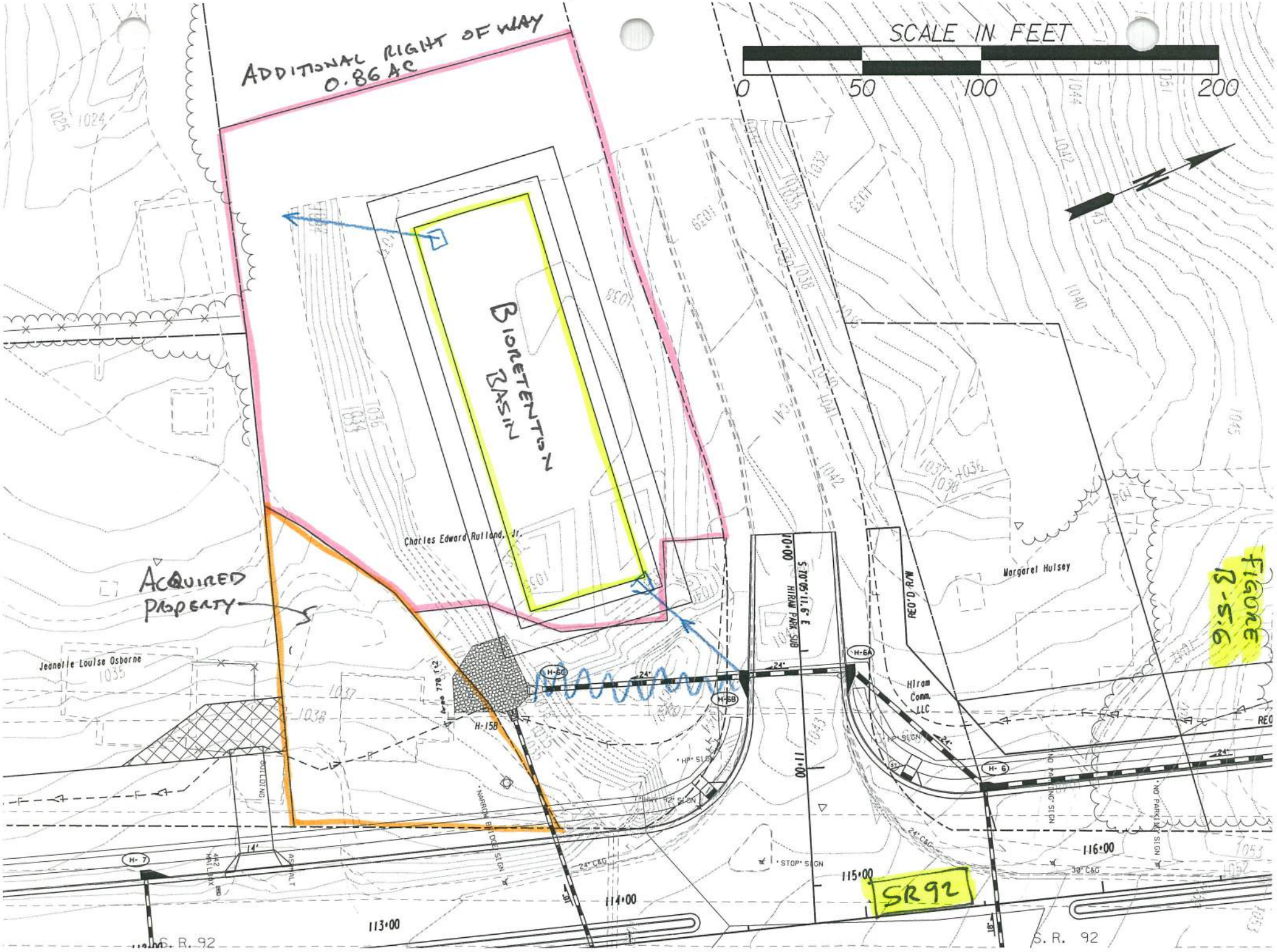
Bioretention Area

CP_v	=	20,074	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **8,452** ft^2

Actual Filter Bed Dimensions: Width **50** ft; Length **170** ft; 8500 ft^2


ADDITIONAL RIGHT OF WAY
0.86 AC
SCALE IN FEET
0
50
100
200
BIORETENTION BASIN
Charles Edward Rutland, Jr.
ACQUIRED PROPERTY
Jeanette Louise Osborne
Margaret Hulsey
Hiram Comm. LLC
REQ'D R/W
HIRAM PARK SUB
S 10°09'11.9" E
100.00
110.00
115.00
116.00
114.00
113.00
24" C&G
30" C&G
STOP SIGN
NARROW BRIDGE SIGN
NO PARKING SIGN
H-6
H-6A
H-6B
H-7
H-15B
S.R. 92
SR92
FIGURE B-5.6

Infeasibility Criteria #1: Cost of Construction

11/18/2014

Basin B-5

Basin B-5 1200 LF of Roadway construction cost within basin

Item	Basin B-5 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 304,656.25	$ 351,712.50	$ 99,037.50	$ 108,075.00
Utilities ✪	$ 91,991.55	$ -	$ -	$ -
Construction ✪	$ 783,988.97	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 14,068.50	$ 3,950.00	$ 4,323.00
Grading	$ -	$ 60,000.00	$ 5,760.00	$ 4,380.00
Drainage	$ -	$ 109,862.13	$ 72,042.00	$ 56,514.50
Total	$ 1,180,636.76	$ 535,643.13	$ 180,789.50	$ 173,292.50
	Percent of BMP Cost to Total	**45.4%**	**15.3%**	**14.7%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.788
Sub Total:	$	39,400.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0.2765
Sub Total:	$	6,912.50
Commercial Right of Way @	$	125,000.00
		1.2101
Sub Total:	$	151,262.50
Commercial Perm Easmt @	$	62,500.00
		0.6733
Sub Total:	$	42,081.25
Commercial Relocation Cost	$	25,000.00
		1
Sub Total:	$	25,000.00
Right of Way Cost Total:	$	304,656.25

✪ See General Summary Explaination for Cost Method

figure B-5.7

BMP Construction Cost Worksheet Basin B-5

Dry Enhanced Swale

Length:	2612	ft
Width:	8	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	2.8137	Ac	
Total:	$ 351,712.50		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00		
	0		
Total:	$ -		
Sub Total:	$ 351,712.50		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
2.8137	Disturbed Ac	
$ 14,068.50		

Grading

Cut	Fill	
5000.000	5000.000	
$ 6.00		per CY
Total: $ 60,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		0	EA	
	$ 5,000.00			$ -		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1935	CY	$ 30.00	$ 42,995.88
Uddrn Sys w/ Gravel	-	2642	LF	$ 20.00	$ 52,840.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	145	SY		145	SY	
	$ 8,337.50			$ 688.75		

Sub Total: $ 109,862.13

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	48	56	ft
Width:	24	24	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.7923	Ac	
Total:	$ 99,037.50		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00		
	0		
Total:	$ -		
Sub Total:	$ 99,037.50		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.79	Disturbed Ac	
$ 3,950.00		

Grading

Cut	Fill	
660.000	300.000	
$ 6.00		per CY
Total: $ 5,760.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	64	CY	$ 45.00	$ 2,880.00
Uddrn Sys w/ Gravel	-	165	LF	$ 20.00	$ 3,300.00
Top Soil		11	CY	$ 20.00	$ 220.00
Outlet Pipe	18"	50	LF	$ 43.00	$ 2,150.00
Imperm Geotextile	-	1152	SF	$ 5.00	$ 5,760.00
Dist Wall Conc/Steel	-	5	CY	$ 1,020.00	$ 5,100.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	672	SY		672	SY	
	$ 38,640.00			$ 3,192.00		

Sub Total: $ 72,042.00

Bioretention Area

Length:	170	ft
Width:	50	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.8646	Ac	
Total:	$ 108,075.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00		
	0		
Total:	$ -		
Sub Total:	$ 108,075.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.8646	Disturbed Ac	
$ 4,323.00		

Grading

Cut	Fill	
300.000	430.000	
$ 6.00		per CY
Total: $ 4,380.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	1	EA		1	EA	
	$ 5,000.00			$ 400.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	630	CY	$ 30.00	$ 18,900.00
Uddrn Sys w/ Gravel	-	225	LF	$ 20.00	$ 4,500.00
Mulch	-	945	SY	$ 15.00	$ 14,175.00
Outlet Pipe	18"	50	LF	$ 43.00	$ 2,150.00
Shrubs	-	34	EA	$ 30.00	$ 1,020.00
Ground Cover	-	102	EA	$ 15.00	$ 1,530.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	142	SY		142	SY	
	$ 8,165.00			$ 674.50		

Sub Total: $ 56,514.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: 11-19-14 SCJ

Basin C-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin C-1 was located and the existing and proposed basin drainage areas were delineated (See Figure C-1.1 and Figure C-1.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	16,795	16,795
Quantity	Channel Protection, CP_v	14,241	31,036
	Overbank Flood Protection, Q_{p25}	10,662	27,457
	Extreme Flood Protection, Q_{f100}	13,094	29,889

- The total area draining to the MS4 BMP is 7.81 Ac. The total impervious area is 7.61 Ac. The existing pavement area for the site is 3.76 Ac. The area required for storage and quantity management is 4.05 Ac (See Figure C-1.3). The flow produced by the existing paved area of 3.76 Ac will not be detained and will pass through the overflow structure.
- The flow produced by the existing paved area of 3.76 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 65' and minimum length of 202' (See Figure C-1.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume (See Figure C-1.4).
- See figure C-1.5 for a layout of the bioretention basin.
- The BMP construction cost is 12.7% of the roadway construction cost within this basin making this basin infeasible (See Figure C-1.6).
- None of the other infeasibility criteria apply to this basin making this basin feasible.

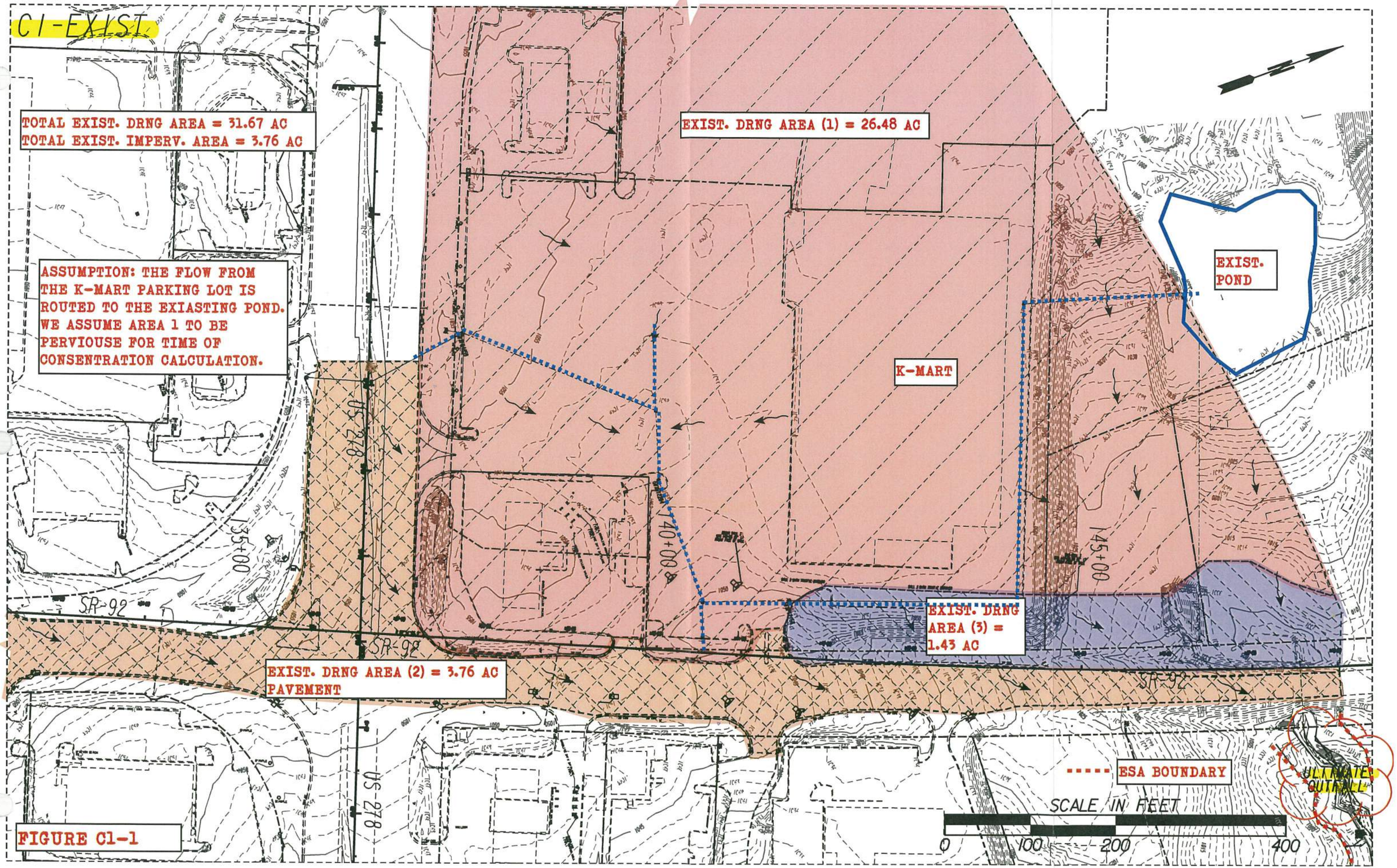

C1-EXIST.
TOTAL EXIST. DRNG AREA = 31.67 AC
TOTAL EXIST. IMPERV. AREA = 3.76 AC
ASSUMPTION: THE FLOW FROM THE K-MART PARKING LOT IS ROUTED TO THE EXIASTING POND. WE ASSUME AREA 1 TO BE PERVIOUSE FOR TIME OF CONSENTRATION CALCULATION.
EXIST. DRNG AREA (1) = 26.48 AC
EXIST. POND
K-MART
US 278
135+00
140+00
145+00
SR-92
EXIST. DRNG AREA (3) = 1.43 AC
EXIST. DRNG AREA (2) = 3.76 AC PAVEMENT
ESA BOUNDARY
ULTIMATE OUTFALL
SCALE IN FEET
0
100
200
400

FIGURE C1-1

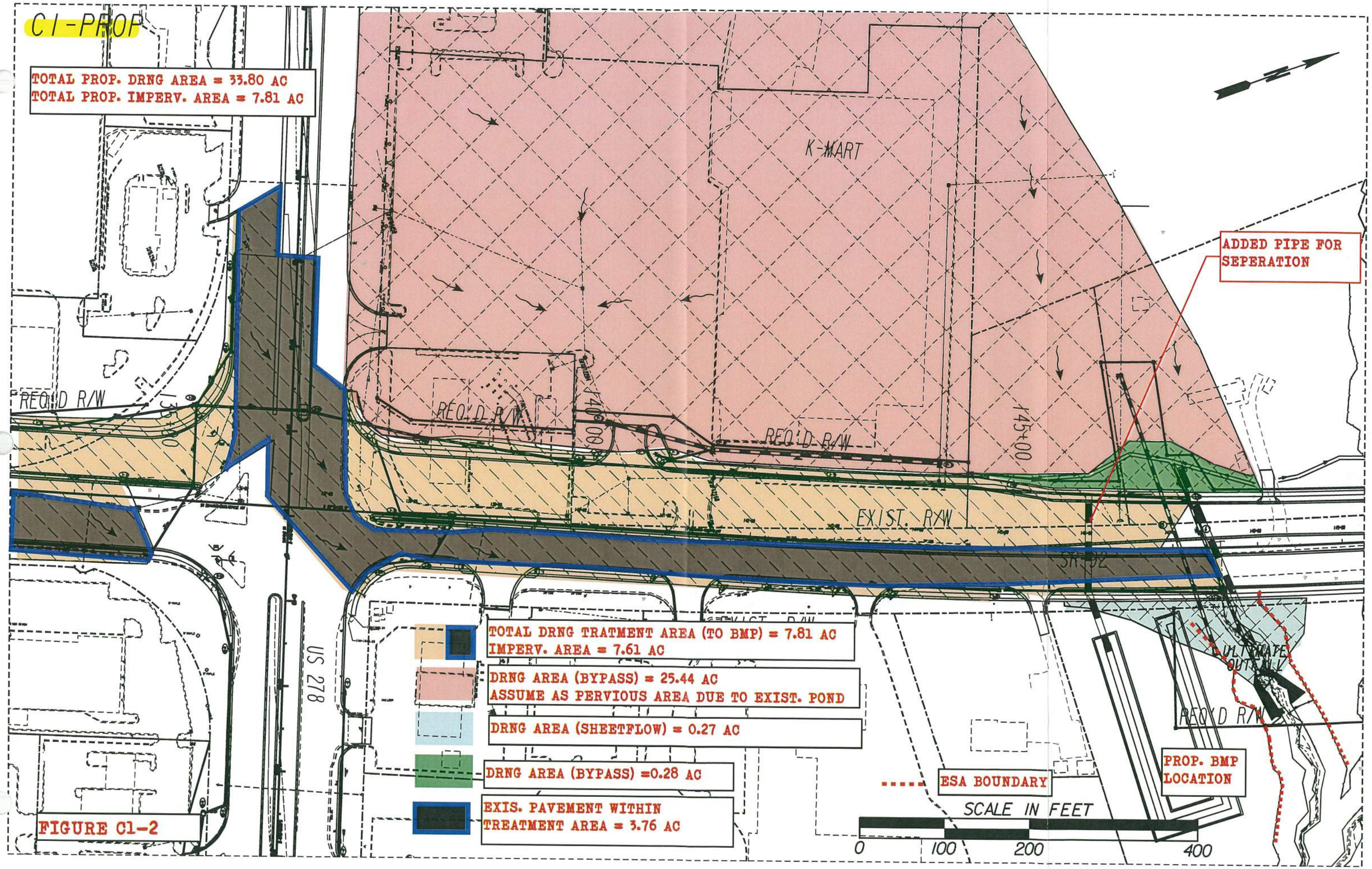

C1-PROP
TOTAL PROP. DRNG AREA = 33.80 AC
TOTAL PROP. IMPERV. AREA = 7.81 AC
K-MART
ADDED PIPE FOR SEPERATION
REQ'D R/W
REQ'D R/W
REQ'D R/W
140+00
145+00
EXIST. R/W
SR 92
US 278
TOTAL DRNG TRATMENT AREA (TO BMP) = 7.81 AC
IMPERV. AREA = 7.61 AC
DRNG AREA (BYPASS) = 25.44 AC
ASSUME AS PERVIOUS AREA DUE TO EXIST. POND
DRNG AREA (SHEETFLOW) = 0.27 AC
DRNG AREA (BYPASS) =0.28 AC
EXIS. PAVEMENT WITHIN
TREATMENT AREA = 3.76 AC
ESA BOUNDARY
PROP. BMP LOCATION
ULTIMATE OUTFALL
REQ'D R/W
SCALE IN FEET
0
100
200
400

FIGURE C1-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: C1

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: FA

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	31.67
Impervious Area =	3.760
Pervious Area=	27.910

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.75 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.695

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.207	0.21
$I_a/P_{10\text{-}yr}$=	0.126	0.13
$I_a/P_{25\text{-}yr}$=	0.107	0.11
$I_a/P_{100\text{-}yr}$=	0.088	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.48

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.16
$Q_{d\ 10\text{-}yr}$=	2.80
$Q_{d\ 25\text{-}yr}$=	3.61
$Q_{d\ 100\text{-}yr}$ =	4.88

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	400
$q_{u10\text{-}yr}$=	420
$q_{u25\text{-}yr}$=	420
$q_{u100\text{-}yr}$=	430

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	22.89
$Q_{p10\text{-}yr}$=	58.28
$Q_{p25\text{-}yr}$=	75.10
$Q_{p100\text{-}yr}$=	103.79

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	33.80
Impervious Area =	7.810
Pervious Area =	25.990
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.75 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.589

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.175	0.18
$I_a/P_{10\text{-}yr}$=	0.107	0.11
$I_a/P_{25\text{-}yr}$=	0.091	0.10
$I_a/P_{100\text{-}yr}$=	0.074	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.95

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.34
$Q_{d\ 10\text{-}yr}$=	3.09
$Q_{d\ 25\text{-}yr}$=	3.93
$Q_{d\ 100\text{-}yr}$ =	5.23

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	410
$q_{u10\text{-}yr}$=	420
$q_{u25\text{-}yr}$=	430
$q_{u100\text{-}yr}$=	430

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	29.07	0.787
$Q_{p10\text{-}yr}$=	68.45	
$Q_{p25\text{-}yr}$=	89.17	
$Q_{p100\text{-}yr}$=	118.74	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	7.810	Acre
Total Impervious Area - A_{POST}	7.610	Acre
Existing Pavement Area - A_{PRE} (5)	3.760	Acre
Area Required for Quantity - A_{QUAN} (4)	4.050	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
7.81	0.49	49.30	0.00	0.494	0.386	16,795

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.04	0.63	0.284	12,383

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 14,241

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.842	0.16	0.213	9,270

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 10,662

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.874	0.15	0.261	11,386

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 13,094

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE C-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *C-1*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FA

	Computed Volumes	Stacked Volumes
WQ_v	16,795	16,795
CP_v	14,241	31,036
Q_{p25}	10,662	27,457
Q_{f100}	13,094	29,889

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**4040**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	31058	ft^3	>	31036	ft^3

Swale Dimensions:

A swale that is **4040** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	31,036	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,770** ft^2

Actual Filter Bed Dimensions:	Width	**30**	ft
	Length	**60**	ft
		1800	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **2048** ft^2

Actual Sediment Chamber Dimensions:	Width	**30**	ft
	Length	**70**	ft
		2100	ft^2

Bioretention Area

CP_v	=	31,036	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **13,068** ft^2

Actual Filter Bed Dimensions:	Width	**65**	ft
	Length	**202**	ft
		13130	ft^2

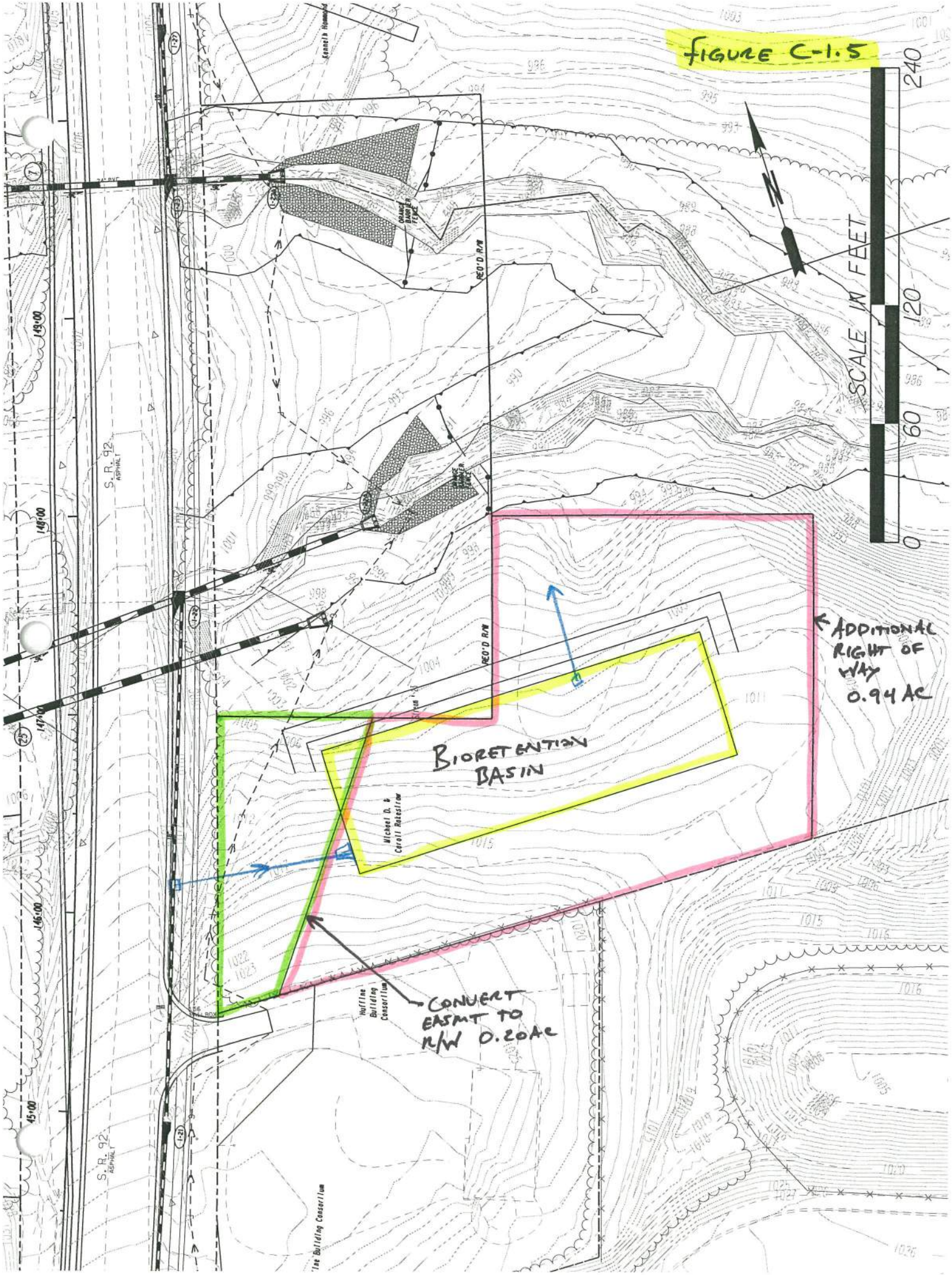


FIGURE C-1.5
SCALE IN FEET
0
60
120
240
N
S.R. 92
ASPHALT
REQ'D R/W
ORANGE BARRIER FENCE
Kenneth Hammond
Michael D. & Carol Rotestrow
Huffine Building Consortium
BIORETENTION BASIN
ADDITIONAL RIGHT OF WAY 0.94 AC
CONVERT EASMT TO R/W 0.20AC

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin C-1

Basin C-1 2100 LF of Roadway construction cost within basin

Item	Basin C-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 457,750.00	$ 406,250.00	$ 125,000.00	$ 130,000.00
Utilities ✪	$ 160,985.21	$ -	$ -	$ -
Construction ✪	$ 1,371,980.69	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 10,900.00	$ 5,500.00	$ 6,000.00
Grading	$ -	$ 34,020.00	$ 15,300.00	$ 25,920.00
Drainage	$ -	$ 169,683.81	$ 109,112.50	$ 91,382.75
Total	$ 1,990,715.90	$ 620,853.81	$ 254,912.50	$ 253,302.75
	Percent of BMP Cost to Total	**31.2%**	**12.8%**	**12.7%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		1.53
Sub Total:	$	76,500.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		3.05
Sub Total:	$	381,250.00
Comercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	457,750.00

✪ See General Summary Explaination for Cost Method

Figure C-1.6

BMP Construction Cost Worksheet Basin C-1

Dry Enhanced Swale

Length:	4040	ft
Width:	8	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
3.25 Ac
Total: $ 406,250.00

Commercial Perm Easmt @ $ 62,500.00 per Ac
0 Ac
Total: $ -
Sub Total: $ 406,250.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
2.18 Disturbed Ac
$ 10,900.00

Grading

Cut	Fill
3850.000	1820.000

$ 6.00 per CY
Total: $ 34,020.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 2,300.00 per EA
1 EA
$ 2,300.00

FES $ 400.00 per EA
1 EA
$ 400.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	2993	CY	$ 30.00	$ 66,502.06
Uddrn Sys w/ Gravel	-	4070	LF	$ 20.00	$ 81,400.00
Additional Pipe	24	100	LF	$ 52.00	$ 5,200.00

Rip Rap TP3,18" $ 57.50 per SY
223 SY
$ 12,822.50

Filter Fabric $ 4.75 per SY
223 SY
$ 1,059.25

Sub Total: $ 169,683.81

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	60	70	ft
Width:	30	30	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
0.85 Ac
Total: $ 106,250.00

Commercial Perm Easmt @ $ 62,500.00 per Ac
0.2 Ac
Total: $ 12,500.00
Sub Total: $ 118,750.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
1.1 Disturbed Ac
$ 5,500.00

Grading

Cut	Fill
1300.000	1250.000

$ 6.00 per CY
Total: $ 15,300.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
3 EA
$ 15,000.00

FES $ 400.00 per EA
EA
$ -

	Size	Quantity	Unit	Cost	Total
Sand	-	100	CY	$ 45.00	$ 4,500.00
Uddrn Sys w/ Gravel	-	195	LF	$ 20.00	$ 3,900.00
Top Soil		17	CY	$ 20.00	$ 340.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	1800	SF	$ 5.00	$ 9,000.00
Dist Wall Conc/Steel	-	7	CY	$ 1,020.00	$ 7,140.00

Rip Rap TP3,18" $ 57.50 per SY
1050 SY
$ 60,375.00

Filter Fabric $ 4.75 per SY
1050 SY
$ 4,987.50

Sub Total: $ 109,112.50

Bioretention Area

Length:	202	ft
Width:	65	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
0.94 Ac
Total: $ 117,500.00

Commercial Perm Easmt @ $ 62,500.00 per Ac
0.2 Ac
Total: $ 12,500.00
Sub Total: $ 130,000.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
1.2 Disturbed Ac
$ 6,000.00

Grading

Cut	Fill
3200.000	1120.000

$ 6.00 per CY
Total: $ 25,920.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
2 EA
$ 10,000.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	973	CY	$ 30.00	$ 29,190.00
Uddrn Sys w/ Gravel	-	292.5	LF	$ 20.00	$ 5,850.00
Mulch	-	1459	SY	$ 15.00	$ 21,885.00
Additional Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Outlet Pipe	18"	65	LF	$ 43.00	$ 2,795.00
Shrubs	-	56	EA	$ 30.00	$ 1,680.00
Ground Cover	-	155	EA	$ 15.00	$ 2,325.00

Rip Rap TP3,18" $ 57.50 per SY
219 SY
$ 12,592.50

Filter Fabric $ 4.75 per SY
219 SY
$ 1,040.25

Sub Total: $ 91,382.75

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: FA
Checked By: SLF 11-19-14

Basin C-2 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin C-2 was located and the existing and proposed basin drainage areas were delineated (See Figures C-2.1 and C-2.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	6,761	6,761
Quantity	Channel Protection, CP_v	4,586	11,347
	Overbank Flood Protection, Q_{p25}	2,752	9,513
	Extreme Flood Protection, Q_{f100}	3,681	10,442

- The total area draining to the MS4 BMP is 2.06 Ac. The total impervious area is 2.03 Ac. The existing pavement area for the site is 0.42 Ac. The area required for storage and quantity management is 1.64 Ac (See Figure C-2.3). The flow produced by the existing paved area of 0.42 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 60' and minimum length of 80'. The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure C-2.4).
- The two catch basins currently shown as tying to the proposed cross pipe around station 149+60 will need to be moved to the right a few feet to avoid off site flow from entering the proposed system.
-
- The BMP construction cost is 14.0% of the roadway construction cost within this basin making this basin infeasible (See Figure C-2.6).
- None of the other infeasibility criteria apply to this basin.

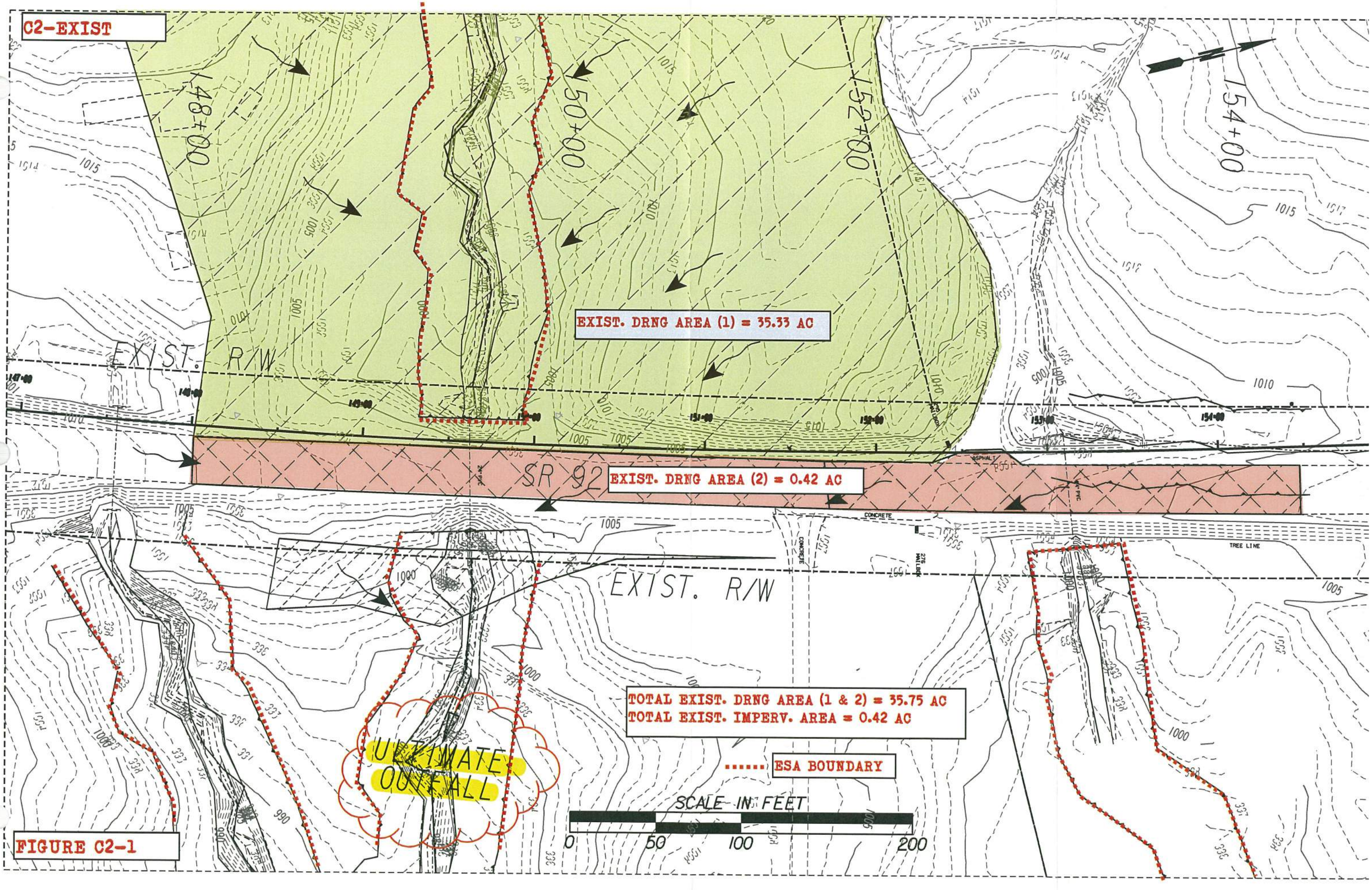

C2-EXIST
148+00
150+00
152+00
154+00
EXIST. DRNG AREA (1) = 35.33 AC
EXIST. R/W
SR 92
EXIST. DRNG AREA (2) = 0.42 AC
EXIST. R/W
TOTAL EXIST. DRNG AREA (1 & 2) = 35.75 AC
TOTAL EXIST. IMPERV. AREA = 0.42 AC
ESA BOUNDARY
ULTIMATE OUTFALL
SCALE IN FEET
0
50
100
200
TREE LINE
CONCRETE
ASPHALT

FIGURE C2-1

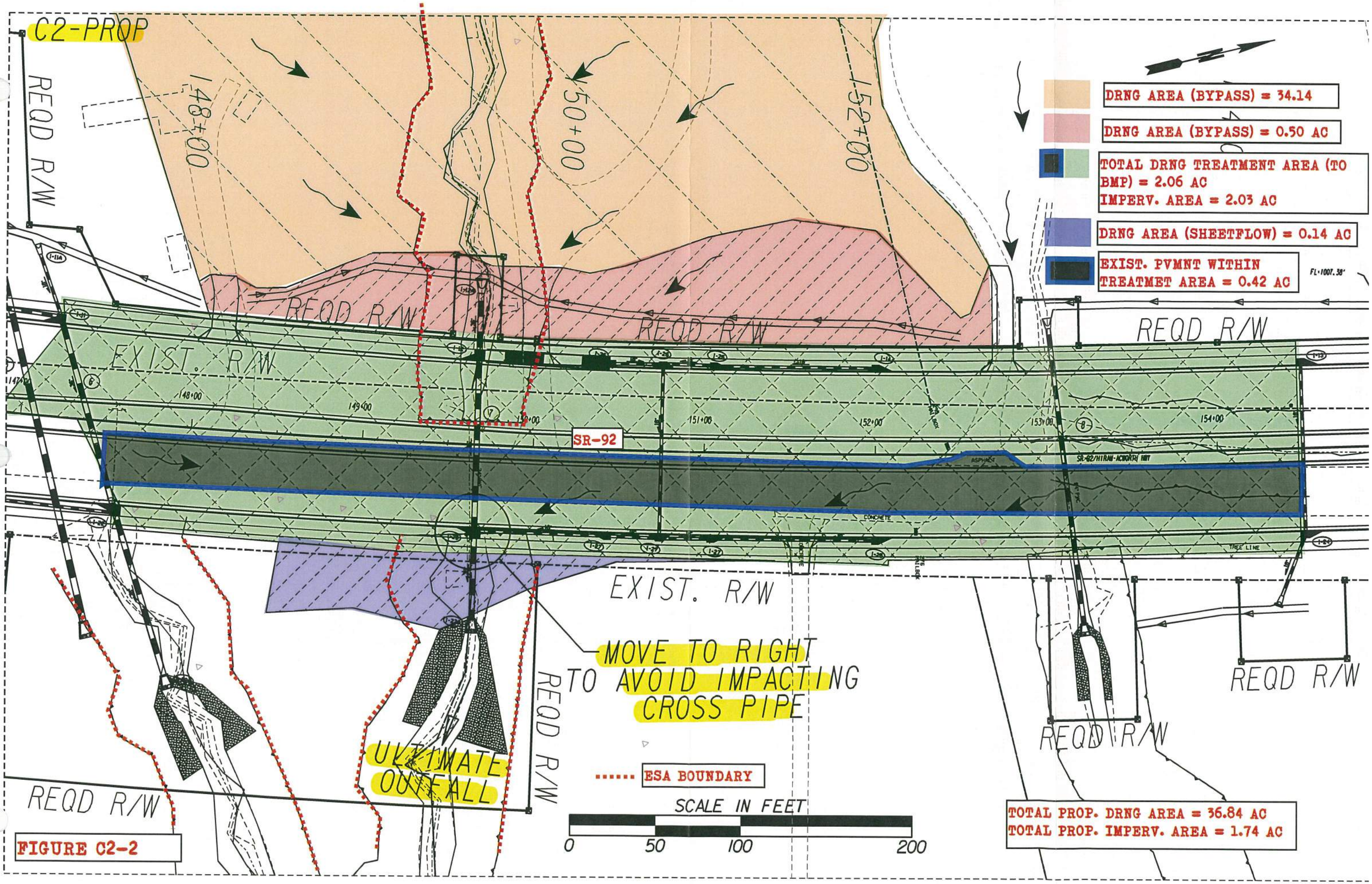

C2-PROP
REQD R/W
148+00
150+00
152+00
DRNG AREA (BYPASS) = 34.14
DRNG AREA (BYPASS) = 0.50 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.06 AC
IMPERV. AREA = 2.03 AC
DRNG AREA (SHEETFLOW) = 0.14 AC
EXIST. PVMNT WITHIN TREATMET AREA = 0.42 AC
FL=1007.38'
REQD R/W
REQD R/W
REQD R/W
EXIST. R/W
148+00
149+00
150+00
151+00
152+00
153+00
154+00
SR-92
EXIST. R/W
MOVE TO RIGHT TO AVOID IMPACTING CROSS PIPE
REQD R/W
REQD R/W
REQD R/W
REQD R/W
ULTIMATE OUTFALL
ESA BOUNDARY
SCALE IN FEET
0
50
100
200
TOTAL PROP. DRNG AREA = 36.84 AC
TOTAL PROP. IMPERV. AREA = 1.74 AC

FIGURE C2-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C2

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov. 2014
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	35.750
Impervious Area =	0.420
Pervious Area=	35.330

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	71

Time of Concentration (See Table A) = 0.25 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.804

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.239	0.24
$I_a/P_{10\text{-}yr}$=	0.146	0.15
$I_a/P_{25\text{-}yr}$=	0.124	0.12
$I_a/P_{100\text{-}yr}$=	0.102	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 4.02

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	0.99
$Q_{d\ 10\text{-}yr}$=	2.55
$Q_{d\ 25\text{-}yr}$=	3.32
$Q_{d\ 100\text{-}yr}$ =	4.55

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	850
$q_{u10\text{-}yr}$=	860
$q_{u25\text{-}yr}$=	880
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	47.15
$Q_{p10\text{-}yr}$=	122.26
$Q_{p25\text{-}yr}$=	163.29
$Q_{p100\text{-}yr}$=	228.55

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	36.840
Impervious Area =	1.740
Pervious Area =	35.100
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	72

Time of Concentration (See Table A) = 0.25 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.767

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.228	0.23
$I_a/P_{10\text{-}yr}$=	0.139	0.14
$I_a/P_{25\text{-}yr}$=	0.118	0.12
$I_a/P_{100\text{-}yr}$=	0.097	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.84

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.05
$Q_{d\ 10\text{-}yr}$=	2.63
$Q_{d\ 25\text{-}yr}$=	3.42
$Q_{d\ 100\text{-}yr}$ =	4.66

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	845
$q_{u10\text{-}yr}$=	855
$q_{u25\text{-}yr}$=	880
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	50.86	0.927
$Q_{p10\text{-}yr}$=	129.44	
$Q_{p25\text{-}yr}$=	173.13	
$Q_{p100\text{-}yr}$=	241.20	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.060	Acre
Total Impervious Area - A_{POST}	2.030	Acre
Existing Pavement Area - A_{PRE} (5)	0.420	Acre
Area Required for Quantity - A_{QUAN} (4)	1.640	Acre

(4) Only the new proposed areas should be considered with respect to water quality treatment and stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement is subtracted from the total drainage area and the total impervious area to compute the volumes needed for quality and quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.06	0.78	78.16	0.00	0.753	0.155	6,761

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.03	0.64	0.092	3,988

(+15% ED)= 4,586

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.943	0.12	0.055	2,393

(+15% ED)= 2,752

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.948	0.12	0.073	3,201

(+15% ED)= 3,681

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE C-2.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *C-2*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: FA

	Computed Volumes	Stacked Volumes
WQ_v	6,761	6,761
CP_v	4,586	11,347
Q_{p25}	2,752	9,513
Q_{f100}	3,681	10,442

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**1480**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	11378	ft^3	>	11347	ft^3

Swale Dimensions:

A swale that is **1480** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	11,347	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **647** ft^2

Actual Filter Bed Dimensions:	Width	**18**	ft
	Length	**36**	ft
		648	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **749** ft^2

Actual Sediment Chamber Dimensions:	Width	**18**	ft
	Length	**42**	ft
		756	ft^2

Bioretention Area

CP_v	=	11,347	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,778** ft^2

Actual Filter Bed Dimensions:	Width	**60**	ft
	Length	**80**	ft
		4800	ft^2

FIGURE C-2.5
CONVERT CSMT TO R/W 0.05 AC
ADDITIONAL R/W 0.41 AC
BIORET. BASIN
Kenneth Hammond.
Kenneth Hammond.
ORANGE BARRIER FENCE
ORANGE BARRIER FENCE
REQ'D R/W
SCALE IN FEET
0
50
100
200
CONCRETE
ASPHALT
MAILBOX
CITY LIMITS
SR 92/HIRAM-ACWORTH H
24" PVC
153+00
152+00
151+00
150+00
149+00

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin C-2

Basin C-2 700 LF of Roadway construction cost within basin

Item	Basin C-2 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 52,000.00	$ 101,000.00	$ 23,750.00	$ 21,750.00
Utilities ✪	$ 53,661.74	$ -	$ -	$ -
Construction ✪	$ 457,326.90	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 10,100.00	$ 1,900.00	$ 2,300.00
Grading	$ -	$ 21,000.00	$ 6,000.00	$ 7,800.00
Drainage	$ -	$ 64,846.64	$ 51,375.00	$ 46,890.00
Total	$ 562,988.63	$ 196,946.64	$ 83,025.00	$ 78,740.00
	Percent of BMP Cost to Total	**35.0%**	**14.7%**	**14.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		1.04
Sub Total:	$	52,000.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	52,000.00

✪ See General Summary Explaination for Cost Method

FIGURE C-2.6

BMP Construction Cost Worksheet Basin C-2

Dry Enhanced Swale

Length:	1480	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	2.02	Ac	
Total:	$ 101,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 101,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
2.02	Disturbed Ac	
$ 10,100.00		

Grading

Cut	Fill	
2250.000	1250.000	
	$ 6.00	per CY
Total:	$ 21,000.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1096	CY	$ 30.00	$ 24,362.14
Uddrn Sys w/ Gravel	-	1510	LF	$ 20.00	$ 30,200.00
Additional Pipe	18	40	LF	$ 52.00	$ 2,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	82	SY		82	SY
	$ 4,715.00			$ 389.50	

Sub Total: $ 64,846.64

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	36	40	ft
Width:	18	19	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac
	0.45	Ac
Total:	$ 22,500.00	
Residential Perm Easmt @	$ 25,000.00	per Ac
	0.05	Ac
Total:	$ 1,250.00	
Sub Total:	$ 23,750.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.38	Disturbed Ac	
$ 1,900.00		

Grading

Cut	Fill	
450.000	550.000	
	$ 6.00	per CY
Total:	$ 6,000.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	36	CY	$ 45.00	$ 1,620.00
Uddrn Sys w/ Gravel	-	135	LF	$ 20.00	$ 2,700.00
Top Soil		6	CY	$ 20.00	$ 120.00
Outlet Pipe	18"	120	LF	$ 43.00	$ 5,160.00
Imperm Geotextile	-	648	SF	$ 5.00	$ 3,240.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	380	SY	Filter Fabric	380	SY
	$ 21,850.00			$ 1,805.00	

Sub Total: $ 51,375.00

Bioretention Area

Length:	80	ft
Width:	60	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac
	0.41	Ac
Total:	$ 20,500.00	
Residential Perm Easmt @	$ 25,000.00	per Ac
	0.05	Ac
Total:	$ 1,250.00	
Sub Total:	$ 21,750.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.46	Disturbed Ac	
$ 2,300.00		

Grading

Cut	Fill	
1050.000	250.000	
	$ 6.00	per CY
Total:	$ 7,800.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	356	CY	$ 30.00	$ 10,680.00
Uddrn Sys w/ Gravel	-	270	LF	$ 20.00	$ 5,400.00
Mulch	-	534	SY	$ 15.00	$ 8,010.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	145	LF	$ 43.00	$ 6,235.00
Shrubs	-	21	EA	$ 30.00	$ 630.00
Ground Cover	-	57	EA	$ 15.00	$ 855.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	80	SY		80	SY
	$ 4,600.00			$ 380.00	

Sub Total: $ 46,890.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin C-3 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin C-3 was located and the existing and proposed basin drainage areas were delineated (See Figures C-3.1 and C-3.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	1,462	1,462
Quantity	Channel Protection, CP_v	1,376	2,838
	Overbank Flood Protection, Q_{p25}	N/A	1,462
	Extreme Flood Protection, Q_{f100}	N/A	1,462

Overbank Flood Protection and Extreme Flood Protection Volume calculations are not applicable due to a reduction of peak discharge flows. This is caused because of a reduction in overall basin area.

- The total area draining to the MS4 BMP is 0.77 Ac. The total impervious area is 0.68 Ac. The existing pavement area for the site is 0.35 Ac. The area required for storage and quantity management is 0.42 Ac (See Figure C-3.3). The flow produced by the existing paved area of 0.35 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 30' and minimum length of 40'. The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure C-3.4).
- See figure C-3.5 for a layout of the bioretention basin.
- The BMP construction cost is 11.0% of the roadway construction cost within this basin making this basin infeasible (See Figure C-3.6).
- None of the other infeasibility criteria apply to this basin.

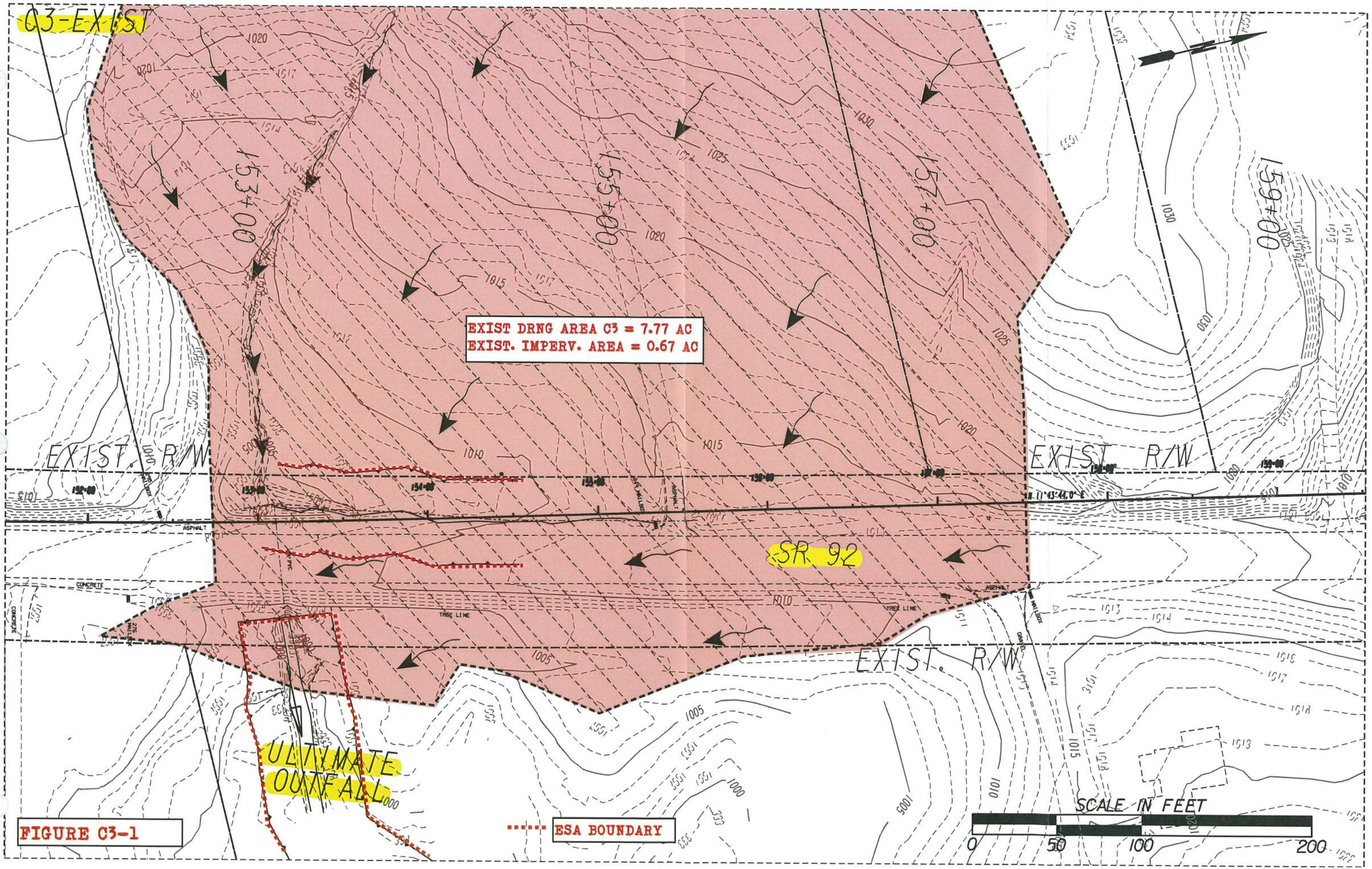

C3-EXIST
EXIST DRNG AREA C3 = 7.77 AC
EXIST. IMPERV. AREA = 0.67 AC
153+00
155+00
157+00
159+00
EXIST R/W
EXIST R/W
EXIST. R/W
SR 92
ULTYMATE OUTFALL
ESA BOUNDARY
SCALE IN FEET
0
50
100
200

FIGURE C3-1

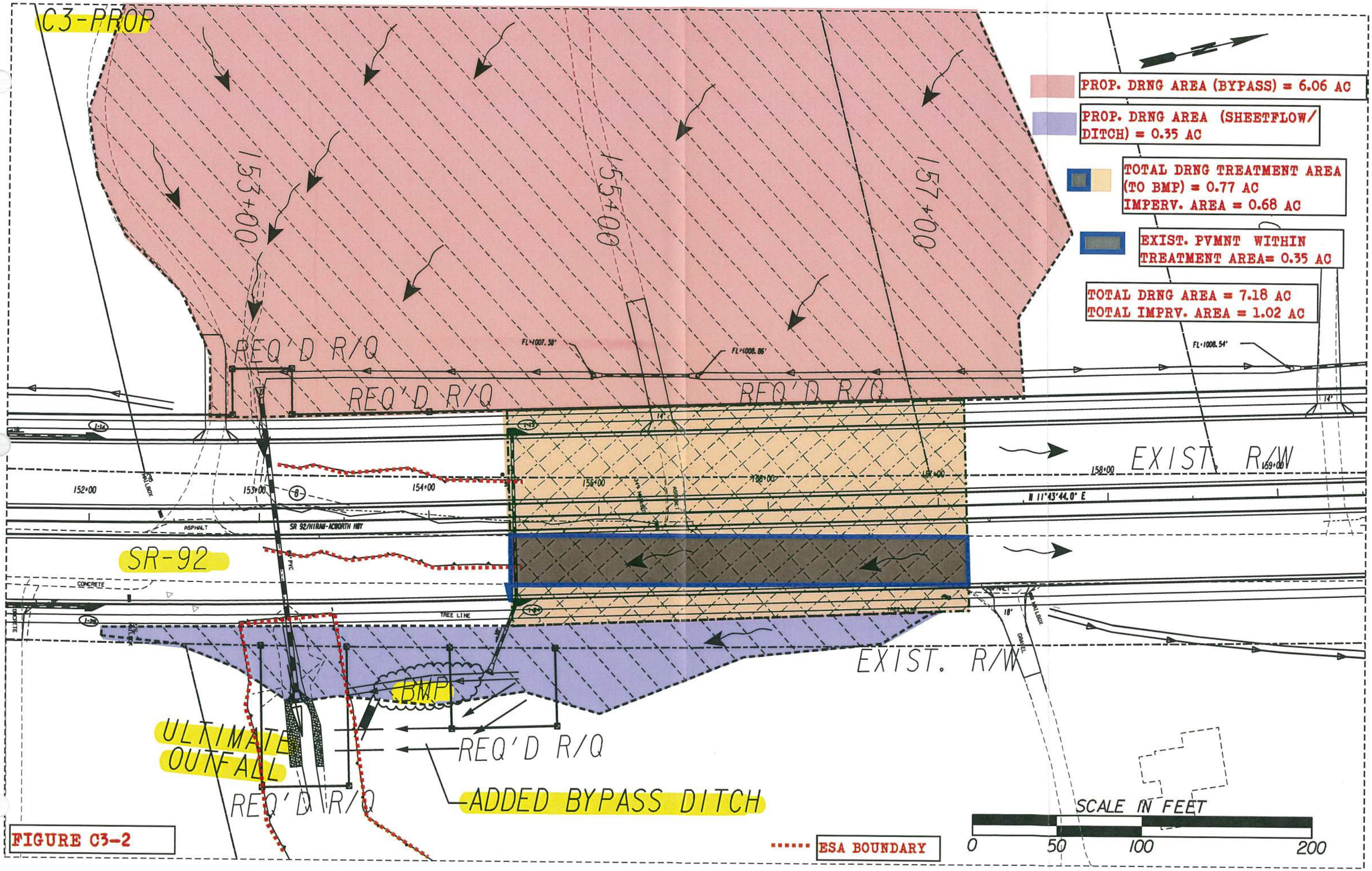

C3-PROP
PROP. DRNG AREA (BYPASS) = 6.06 AC
PROP. DRNG AREA (SHEETFLOW/ DITCH) = 0.35 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 0.77 AC
IMPERV. AREA = 0.68 AC
EXIST. PVMNT WITHIN TREATMENT AREA= 0.35 AC
TOTAL DRNG AREA = 7.18 AC
TOTAL IMPRV. AREA = 1.02 AC
153+00
155+00
157+00
REQ'D R/Q
REQ'D R/Q
REQ'D R/Q
FL=1007.58'
FL=1008.86'
FL=1008.54'
EXIST. R/W
152+00
153+00
154+00
155+00
156+00
157+00
158+00
159+00
N 11°43'44.0" E
SR 92/HIRAM-HOWORTH HWY
SR-92
ASPHALT
CONCRETE
TREE LINE
BMP
ULTIMATE OUTFALL
REQ'D R/Q
REQ'D R/Q
ADDED BYPASS DITCH
EXIST. R/W
SCALE IN FEET
0
50
100
200
ESA BOUNDARY

FIGURE C3-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C3

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	7.77
Impervious Area =	0.67
Pervious Area=	7.1

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 0.12 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i ** (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.727

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.217	0.22
$I_a/P_{10\text{-}yr}$=	0.132	0.13
$I_a/P_{25\text{-}yr}$=	0.112	0.11
$I_a/P_{100\text{-}yr}$=	0.092	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.64

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.11
$Q_{d\ 10\text{-}yr}$=	2.72
$Q_{d\ 25\text{-}yr}$=	3.52
$Q_{d\ 100\text{-}yr}$ =	4.78

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	925
$q_{u10\text{-}yr}$=	950
$q_{u25\text{-}yr}$=	955
$q_{u100\text{-}yr}$=	960

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	12.41
$Q_{p10\text{-}yr}$=	31.42
$Q_{p25\text{-}yr}$=	40.86
$Q_{p100\text{-}yr}$=	55.67

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	7.18
Impervious Area =	1.02
Pervious Area =	6.16
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.12 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i ** (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.673

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.200	0.2
$I_a/P_{10\text{-}yr}$=	0.122	0.12
$I_a/P_{25\text{-}yr}$=	0.104	0.1
$I_a/P_{100\text{-}yr}$=	0.085	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.36

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.19
$Q_{d\ 10\text{-}yr}$=	2.86
$Q_{d\ 25\text{-}yr}$=	3.68
$Q_{d\ 100\text{-}yr}$ =	4.95

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	930
$q_{u10\text{-}yr}$=	953
$q_{u25\text{-}yr}$=	960
$q_{u100\text{-}yr}$=	960

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	12.46
$Q_{p10\text{-}yr}$=	30.60
$Q_{p25\text{-}yr}$=	39.61
$Q_{p100\text{-}yr}$=	53.32

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	0.77	Acre
Total Impervious Area - A_{POST}	0.68	Acre
Existing Pavement Area - A_{PRE} (5)	0.35	Acre
Area Required for Quantity - A_{QUAN} (4)	0.42	Acre

(4) Only the new proposed areas should be considered with respect to water quality treatment and stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement is subtracted from the total drainage area and the total impervious area to compute the volumes needed for quality and quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
0.77	0.43	42.74	0.00	0.435	0.034	1,462

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.027	1,196

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,376

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
n/a	n/a	n/a	n/a

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= n/a

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
n/a	n/a	n/a	n/a

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= n/a

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE C-3.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C-3

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FA

	Computed Volumes	Stacked Volumes
WQ_v	1,462	1,462
CP_v	1,376	2,838
Q_{p25}	N/A	N/A
Q_{f100}	N/A	N/A

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**370**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	2844	ft^3	>	2838	ft^3

Swale Dimensions:

A swale that is **370** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	2,838	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **162** ft^2

Actual Filter Bed Dimensions:	Width	**9**	ft
	Length	**18**	ft
		162	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **187** ft^2

Actual Sediment Chamber Dimensions:	Width	**9**	ft
	Length	**21**	ft
		189	ft^2

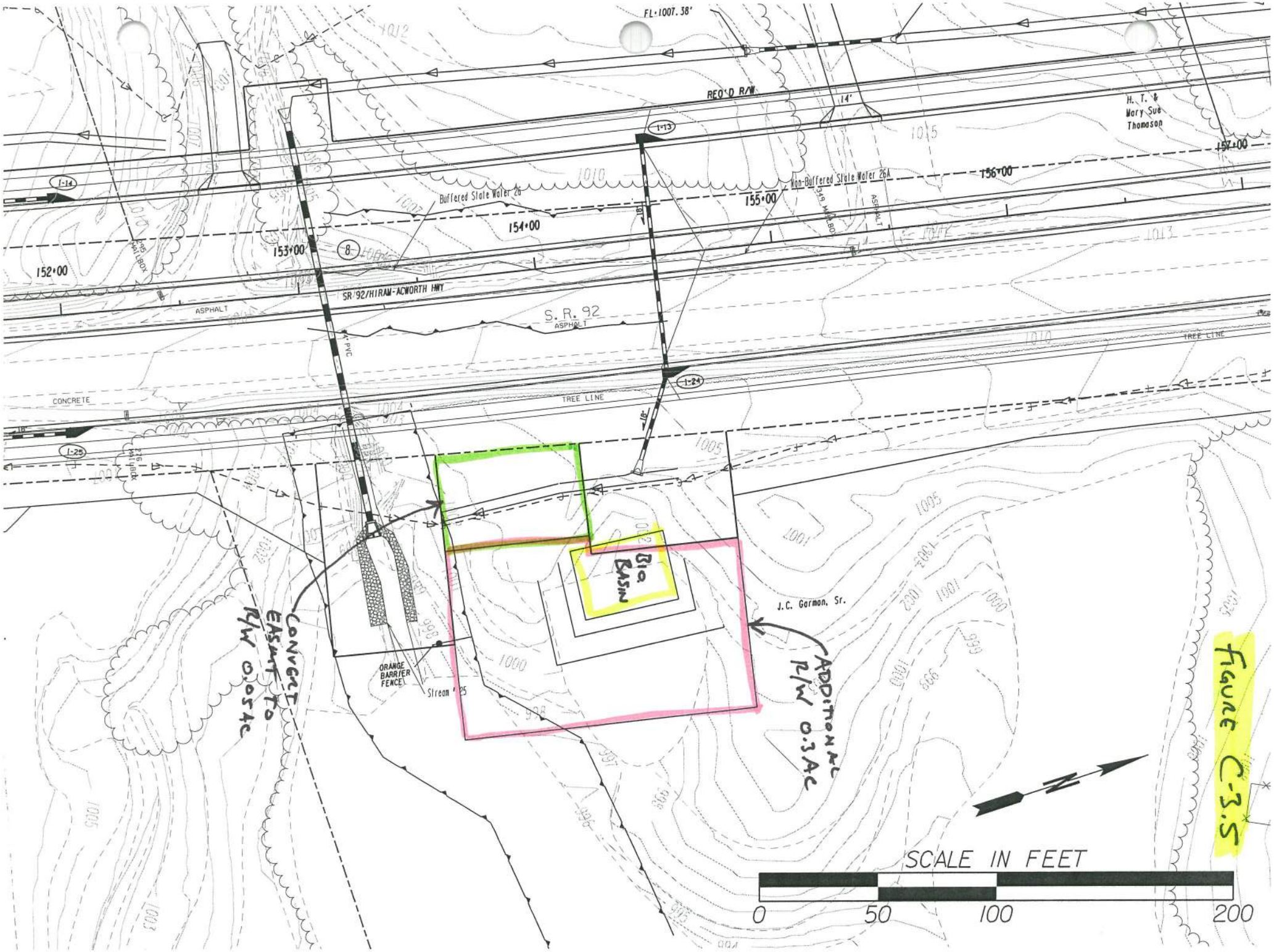
Bioretention Area

CP_v	=	2,838	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **1,195** ft^2

Actual Filter Bed Dimensions:	Width	**30**	ft
	Length	**40**	ft
		1200	ft^2


FL·1007.38'
REQ'D R/W
14'
H. T. & Mary Sue Thomason
1-13
1-14
1-24
1-25
Buffered State Water 26
Non-Buffered State Water 26A
152+00
153+00
154+00
155+00
156+00
157+00
SR 92/HIRAM-ACWORTH HWY
S. R. 92
ASPHALT
CONCRETE
TREE LINE
PVC
BIO BASIN
J.C. Gormon, Sr.
ORANGE BARRIER FENCE
Stream #25
CONVERT EASMT TO R/W 0.054AC
ADDITIONAL R/W 0.3AC
SCALE IN FEET
0
50
100
200
FIGURE C-3.5

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin C-3

Basin C-3 470 LF of Roadway construction cost within basin

Item	Basin C-3 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 32,000.00	$ 22,500.00	$ 11,250.00	$ 16,250.00
Utilities ✪	$ 36,030.02	$ -	$ -	$ -
Construction ✪	$ 307,062.34	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 2,250.00	$ 1,000.00	$ 1,500.00
Grading	$ -	$ 9,120.00	$ 3,600.00	$ 2,700.00
Drainage	$ -	$ 21,617.78	$ 28,442.63	$ 20,850.00
Total	$ 375,092.37	$ 55,487.78	$ 44,292.63	$ 41,300.00
Percent of BMP Cost to Total		**14.8%**	**11.8%**	**11.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.64
Sub Total:	$	32,000.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	32,000.00

✪ See General Summary Explaination for Cost Method

figure C-3.6

BMP Construction Cost Worksheet — Basin C-3

Dry Enhanced Swale

Length:	370	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.45	Ac	
Total:	$ 22,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 22,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.45	Disturbed Ac	
$ 2,250.00		

Grading

Cut	Fill	
920.000	600.000	
$ 6.00	per CY	
Total: $ 9,120.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	274	CY	$ 30.00	$ 6,090.53
Uddrn Sys w/ Gravel	-	400	LF	$ 20.00	$ 8,000.00
Additional Pipe	18	60	LF	$ 52.00	$ 3,120.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	21	SY	Fabric	21	SY
	$ 1,207.50			$ 99.75	

Sub Total: $ 21,617.78

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	18	21	ft
Width:	9	9	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.2	Ac	
Total:	$ 10,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.05	Ac	
Total:	$ 1,250.00		
Sub Total:	$ 11,250.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.2	Disturbed Ac	
$ 1,000.00		

Grading

Cut	Fill	
350.000	250.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	9	CY	$ 45.00	$ 405.00
Uddrn Sys w/ Gravel	-	90	LF	$ 20.00	$ 1,800.00
Top Soil		2	CY	$ 20.00	$ 40.00
Additional Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Imperm Geotextile	-	162	SF	$ 5.00	$ 810.00
Dist Wall Conc/Steel	-	2	CY	$ 1,020.00	$ 2,040.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	94.5	SY	Filter Fabric	94.5	SY
	$ 5,433.75			$ 448.88	

Sub Total: $ 28,442.63

Bioretention Area

Length:	40	ft
Width:	30	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.3	Ac	
Total:	$ 15,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.05	Ac	
Total:	$ 1,250.00		
Sub Total:	$ 16,250.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.3	Disturbed Ac	
$ 1,500.00		

Grading

Cut	Fill	
250.000	200.000	
$ 6.00	per CY	
Total: $ 2,700.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	89	CY	$ 30.00	$ 2,670.00
Uddrn Sys w/ Gravel	-	135	LF	$ 20.00	$ 2,700.00
Mulch	-	134	SY	$ 15.00	$ 2,010.00
Additional Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Outlet Pipe	18"	65	LF	$ 43.00	$ 2,795.00
Shrubs	-	6	EA	$ 30.00	$ 180.00
Ground Cover	-	15	EA	$ 15.00	$ 225.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	20	SY	Fabric	20	SY
	$ 1,150.00			$ 95.00	

Sub Total: $ 20,850.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 11, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin C4 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin C4 was located and the existing and proposed basin drainage areas were delineated (See Figures C-4.1 and C-4.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	2,980	2,980
Quantity	Channel Protection, CP_v	5,321	8,301
	Overbank Flood Protection, Q_{p25}	6,284	9,264
	Extreme Flood Protection, Q_{f100}	7,925	10,905

- The total area draining to the MS4 BMP is 1.53 Ac. The total impervious area is 1.02 Ac. The existing pavement area for the site is 0.35 Ac. The area required for storage and quantity management is 1.19 Ac (See Figure C-4.3).
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Extreme Flood Protection Volume. Therefore a downstream hydraulic analysis is necessary.
- It was determined from that downstream analysis that the flows would not cause a downstream increase and detention would not be necessary (See Figures C-4.4 and C-4.5).
- Overbank and Extreme Flood Volumes are not required since peak flows produced by this drainage basin do not increase peak flows to Rakestraw Creek by more than 5% (See Figure C-4.5).
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 50' and minimum length of 70' (See Figure C-4.6). The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure C-4.8). The flow produced by the existing paved area of 0.35 Ac will not be detained and will pass through the overflow structure.
- The BMP construction cost is 23.4% of the roadway construction cost within this basin making this basin infeasible (See Figure C-4.8).
- None of the other infeasibility criteria apply to this basin.

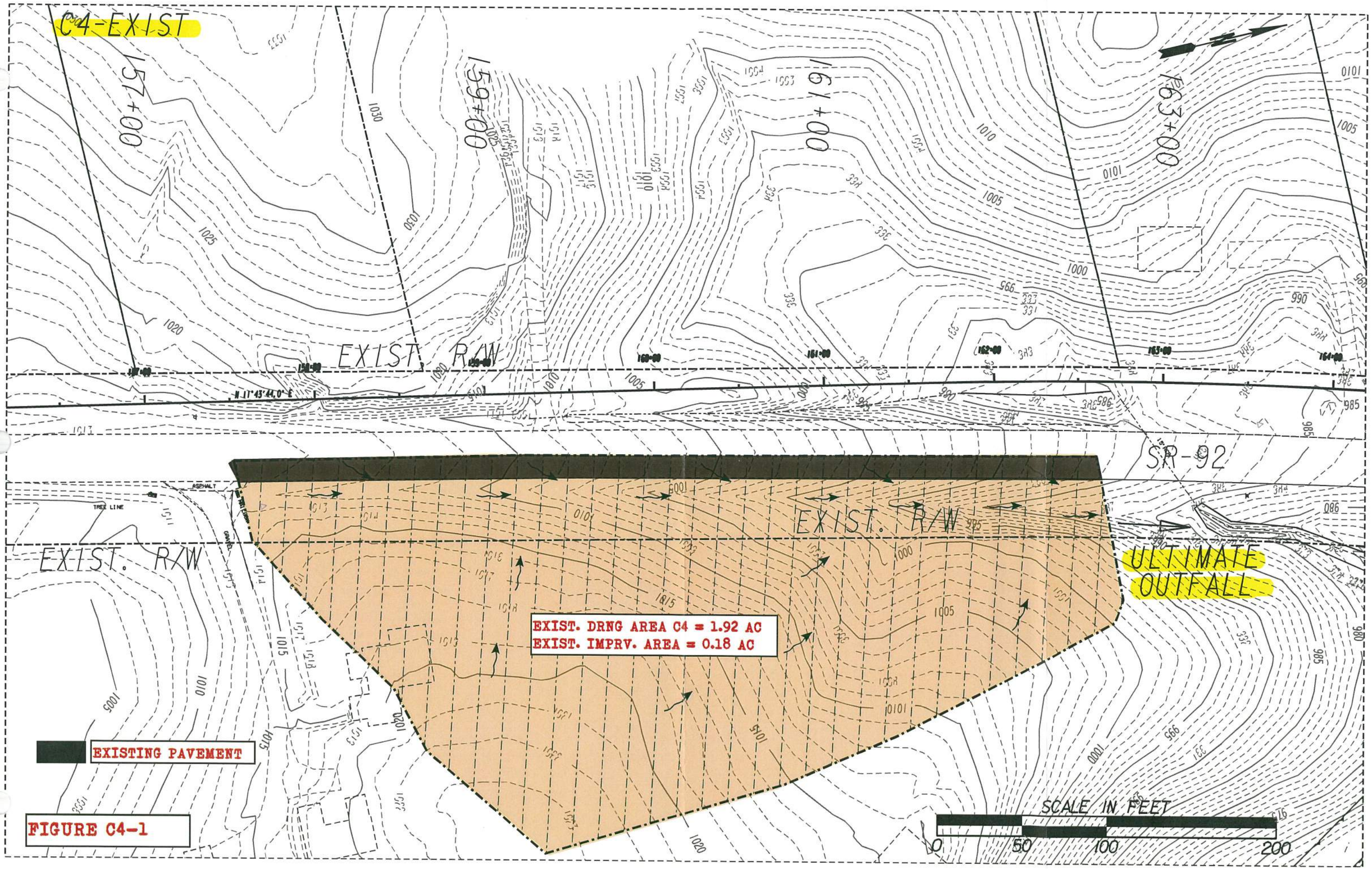

C4-EXIST
157+00
158+00
159+00
160+00
163+00
EXIST. R/W
SR-92
EXIST. R/W
EXIST. R/W
ULTIMATE OUTFALL
EXIST. DRNG AREA C4 = 1.92 AC
EXIST. IMPRV. AREA = 0.18 AC
EXISTING PAVEMENT
SCALE IN FEET
0
50
100
200

FIGURE C4-1

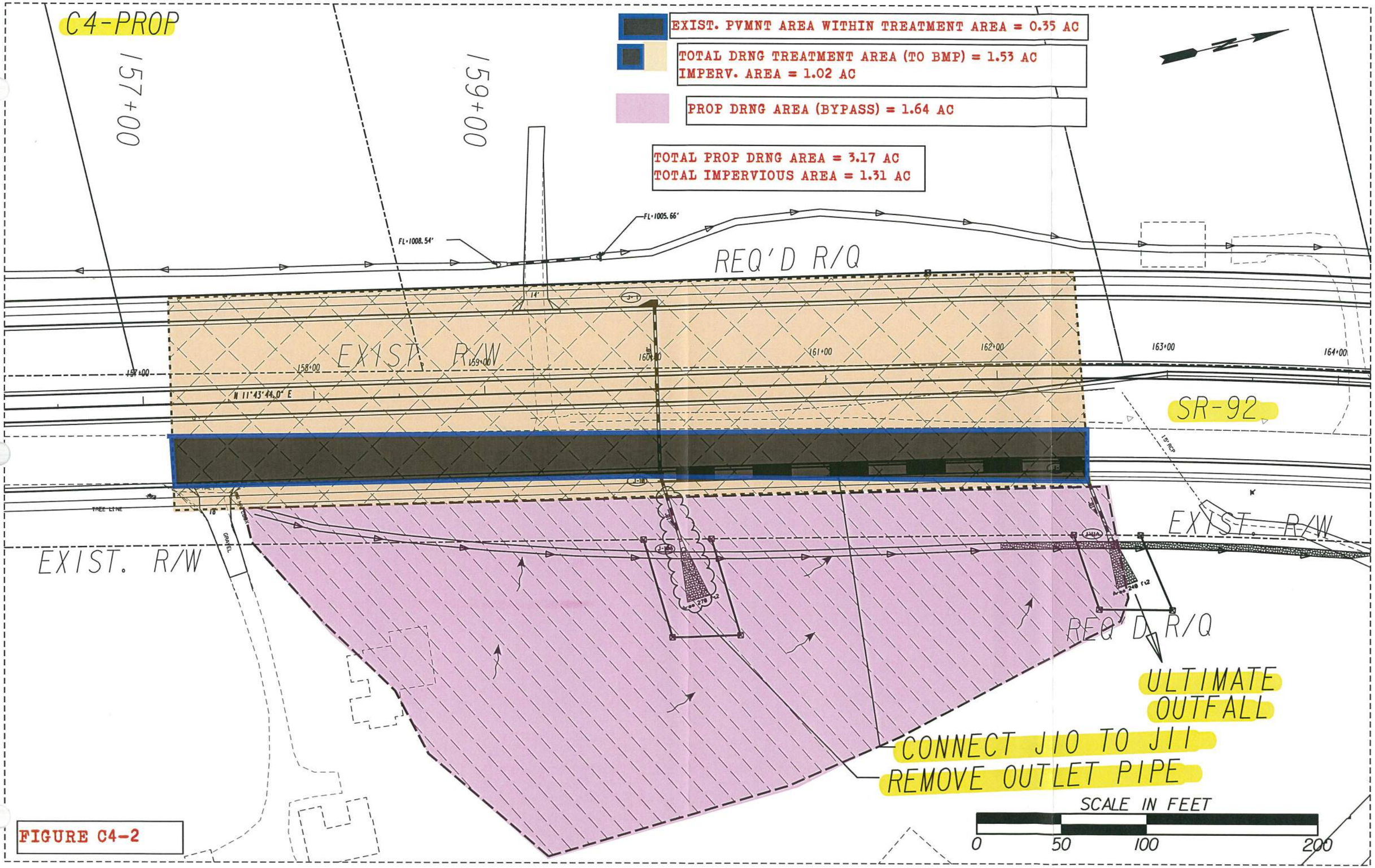

C4-PROP
157+00
159+00
EXIST. PVMNT AREA WITHIN TREATMENT AREA = 0.35 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.53 AC
IMPERV. AREA = 1.02 AC
PROP DRNG AREA (BYPASS) = 1.64 AC
TOTAL PROP DRNG AREA = 3.17 AC
TOTAL IMPERVIOUS AREA = 1.31 AC
FL=1008.54'
FL=1005.66'
REQ'D R/Q
EXIST. R/W
158+00
159+00
160+00
161+00
162+00
163+00
164+00
N 11°43'44.0" E
SR-92
15" RCP
TREE LINE
GRAVEL
EXIST. R/W
EXIST. R/W
REQ'D R/Q
ULTIMATE OUTFALL
CONNECT J10 TO J11
REMOVE OUTLET PIPE
SCALE IN FEET
0
50
100
200

FIGURE C4-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C4

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	1.92
Impervious Area =	0.18
Pervious Area=	1.74

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.720

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.214	0.214
$I_a/P_{10\text{-}yr}$=	0.130	0.130
$I_a/P_{25\text{-}yr}$=	0.111	0.111
$I_a/P_{100\text{-}yr}$=	0.091	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.60

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.12
$Q_{d\ 10\text{-}yr}$=	2.74
$Q_{d\ 25\text{-}yr}$=	3.54
$Q_{d\ 100\text{-}yr}$ =	4.80

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	840
$q_{u10\text{-}yr}$=	875
$q_{u25\text{-}yr}$=	890
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	2.81
$Q_{p10\text{-}yr}$=	7.20
$Q_{p25\text{-}yr}$=	9.46
$Q_{p100\text{-}yr}$=	12.96

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	3.17
Impervious Area =	1.31
Pervious Area =	1.86
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	82

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.434

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.129	0.129
$I_a/P_{10\text{-}yr}$=	0.079	0.100
$I_a/P_{25\text{-}yr}$=	0.067	0.100
$I_a/P_{100\text{-}yr}$=	0.055	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.17

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.68
$Q_{d\ 10\text{-}yr}$=	3.56
$Q_{d\ 25\text{-}yr}$=	4.45
$Q_{d\ 100\text{-}yr}$ =	5.80

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	875
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	7.28
$Q_{p10\text{-}yr}$=	15.89
$Q_{p25\text{-}yr}$=	19.83
$Q_{p100\text{-}yr}$=	25.87

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.53	Acre
Total Impervious Area - A_{POST}	1.02	Acre
Existing Pavement Area - A_{PRE} (5)	0.35	Acre
Area Required for Quantity - A_{QUAN} (4)	1.19	Acre

(4) Only the new proposed areas should be considered with respect to water quality treatment and stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement is subtracted from the total drainage area and the total impervious area to compute the volumes needed for quality and quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v(3)	WQ_v (ac-ft)	WQ_v (ft³)
1.53	0.44	44.12	0.00	0.447	0.068	2,980

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) $R_v = 0.05 + 0.009\ (I)$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.477	0.29	0.125	5,465

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,284

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.03	0.64	0.106	4,627

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 5,321

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.501	0.28	0.158	6,891

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 7,925

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Outfall C4
10X Downstream Analysis Conclusions

The drainage areas were delineated using a combination of the USGS quadrangle maps and the existing contours. The site area of the drainage outfall is 3.17 Ac. The 10 times watershed basin analysis area is 31.70 Ac, which cannot be reached before the drainage way confluences with a state water that has a large upland drainage area.

Curve number calculations for the downstream analysis have been included along with the hydrographs depicting the pre and post conditions of the 25 and 100 year storms.

Per GDOT requirements, Storm Detention is required when adverse impacts are caused by the post-development flow and where downstream structures are subject to increased depth of flooding. The following table summarizes the results of the downstream analysis.

Outfall C4	Storm Return Frequency	Pre-Developed Peak Discharge (cfs)	Post-Developed Peak Discharge (cfs)	Discharge Increase (cfs)	% Increase
Downstream Analysis	25	823.13	823.13	0	0
	100	1096.85	1096.85	0	0

The analysis of the 10X downstream conditions reflects an increase of 0% for both the 25 and the 100 year return periods, which represent the Overbank Flood Protection and the Extreme Flood Protection, respectively. The discharge increase for both storm frequency's is above the GDOT maximum and could adversely affect the downstream watershed so therefore detention shall be provided at this location.

Figure C-4.4

DOWN STREAM DRNG AREA = 1.61 SQ.MI

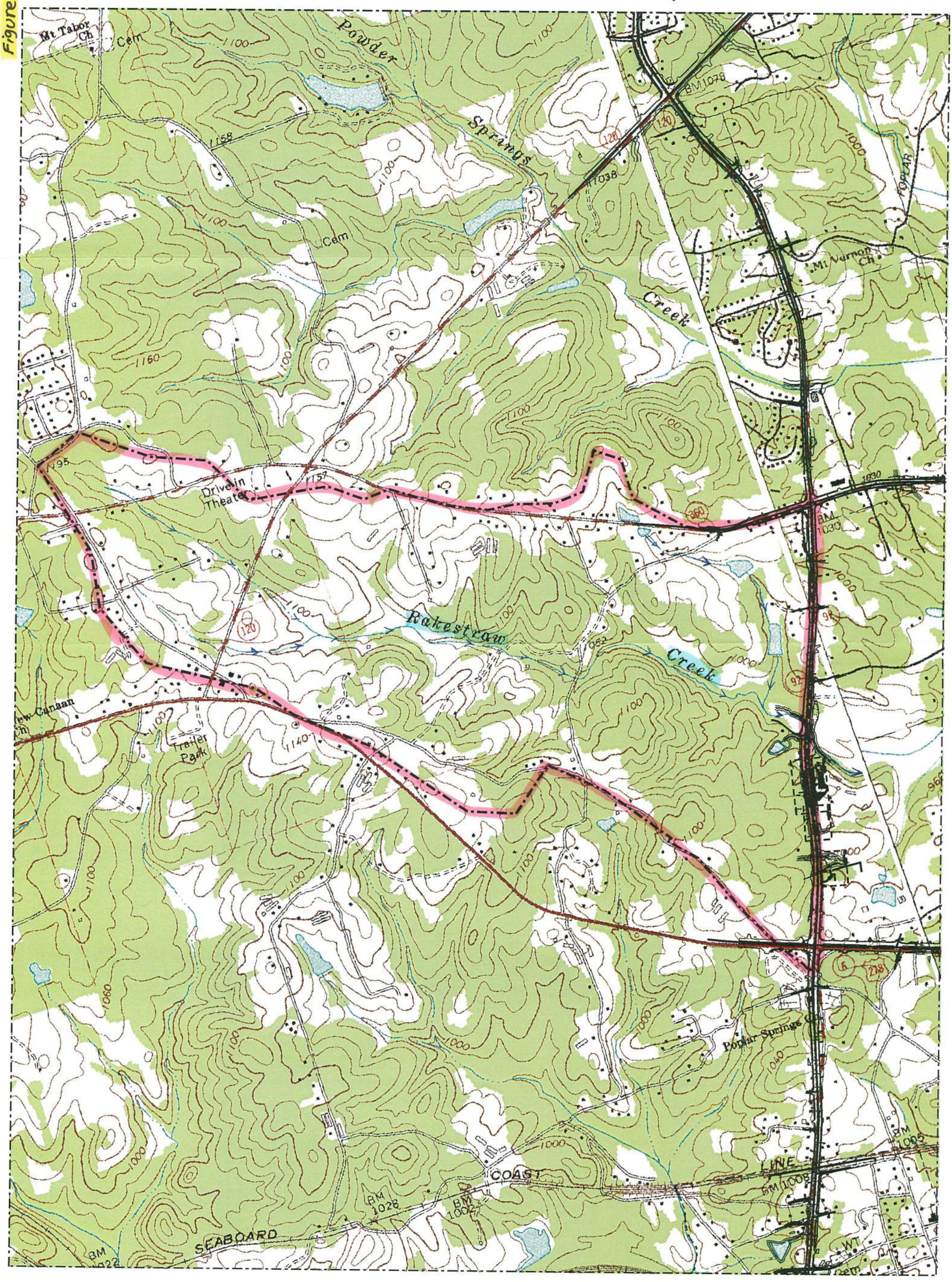


Figure C-4.5

Curve Number Calculation
10X Downstream Assessment for Outfall C4

Nov-14

PRE-CONDITION type "C" soil group	TOTAL AREA 1033.0 Ac	
	IMPERVIOUS AREA 220 Ac	98
	RESIDENTIAL AREA 144 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 669	71
	COMPOSITE PRE CN	78

POST-CONDITION type "C" soil group	TOTAL AREA 1033 Ac	
	IMPERVIOUS AREA 221.13 Ac	98
	RESIDENTIAL AREA 144 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 667.87	71
	COMPOSITE PRE CN	78

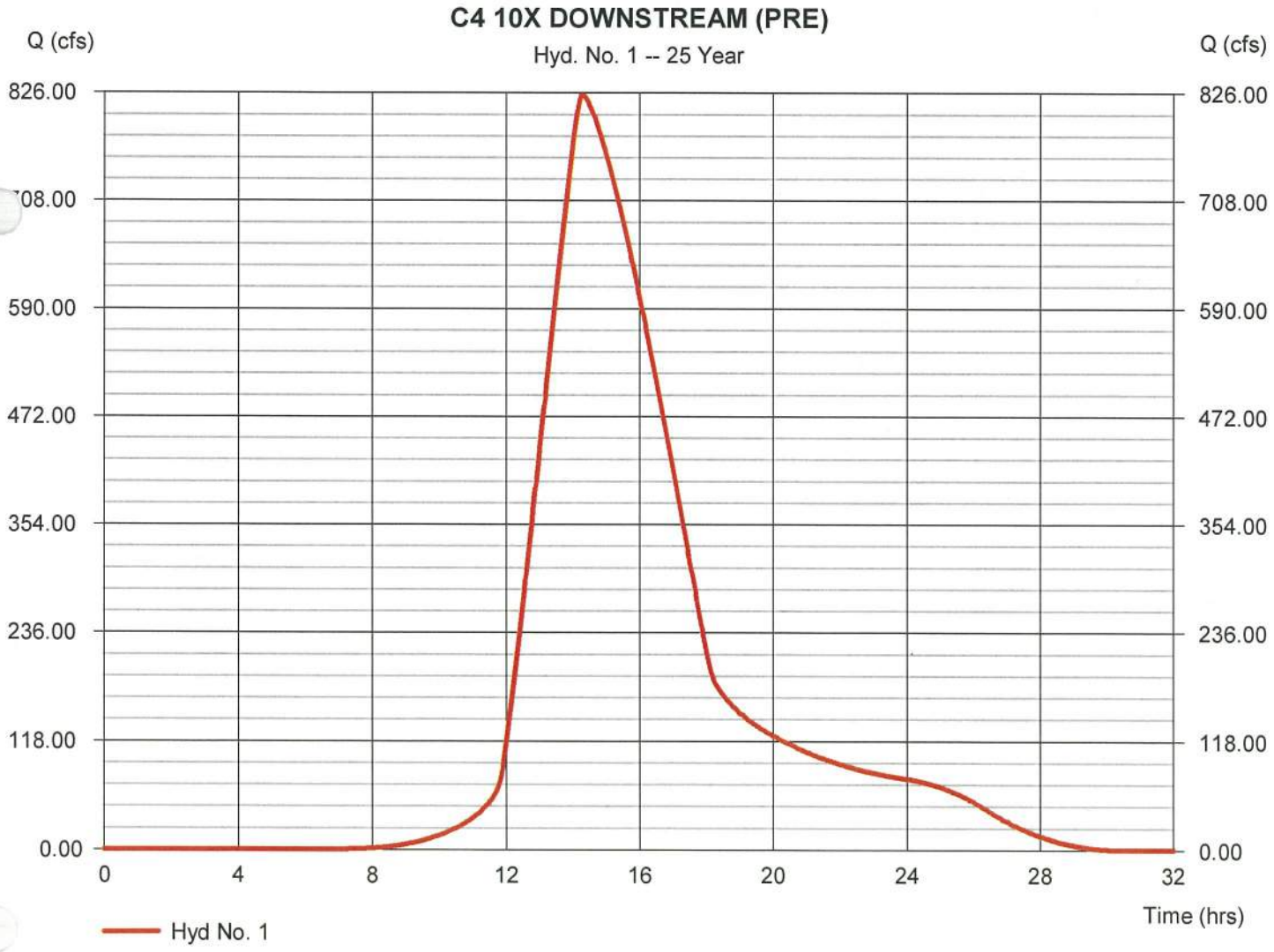
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 7 / 2014

Hyd. No. 1

C4 10X DOWNSTREAM (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 823.13 cfs
Storm frequency	= 25 yrs	Time to peak	= 14.30 hrs
Time interval	= 2 min	Hyd. volume	= 14,995,107 cuft
Drainage area	= 1033.000 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 240.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



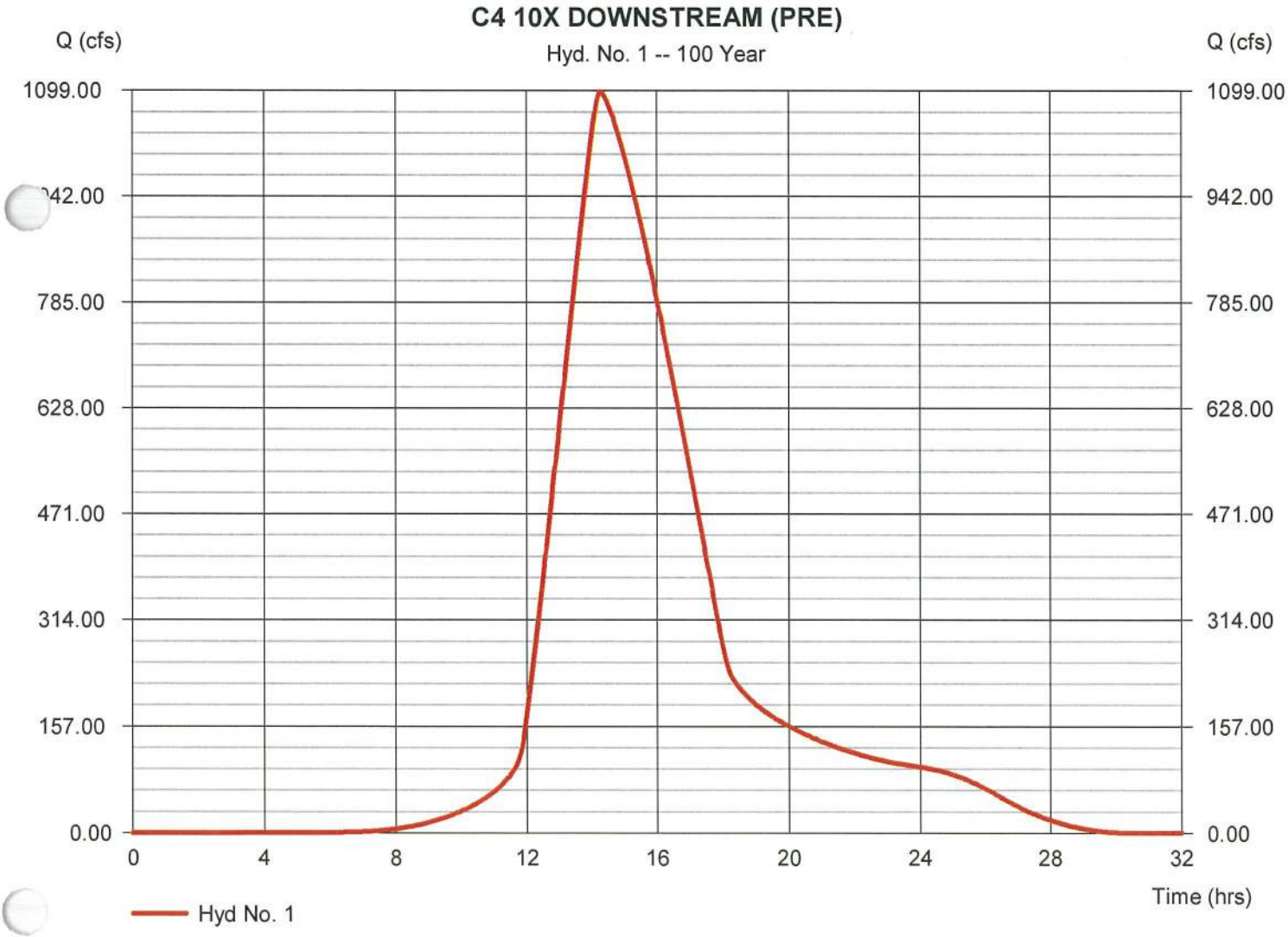
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 7 / 2014

Hyd. No. 1

C4 10X DOWNSTREAM (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 1096.85 cfs
Storm frequency	= 100 yrs	Time to peak	= 14.27 hrs
Time interval	= 2 min	Hyd. volume	= 19,902,976 cuft
Drainage area	= 1033.000 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 240.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



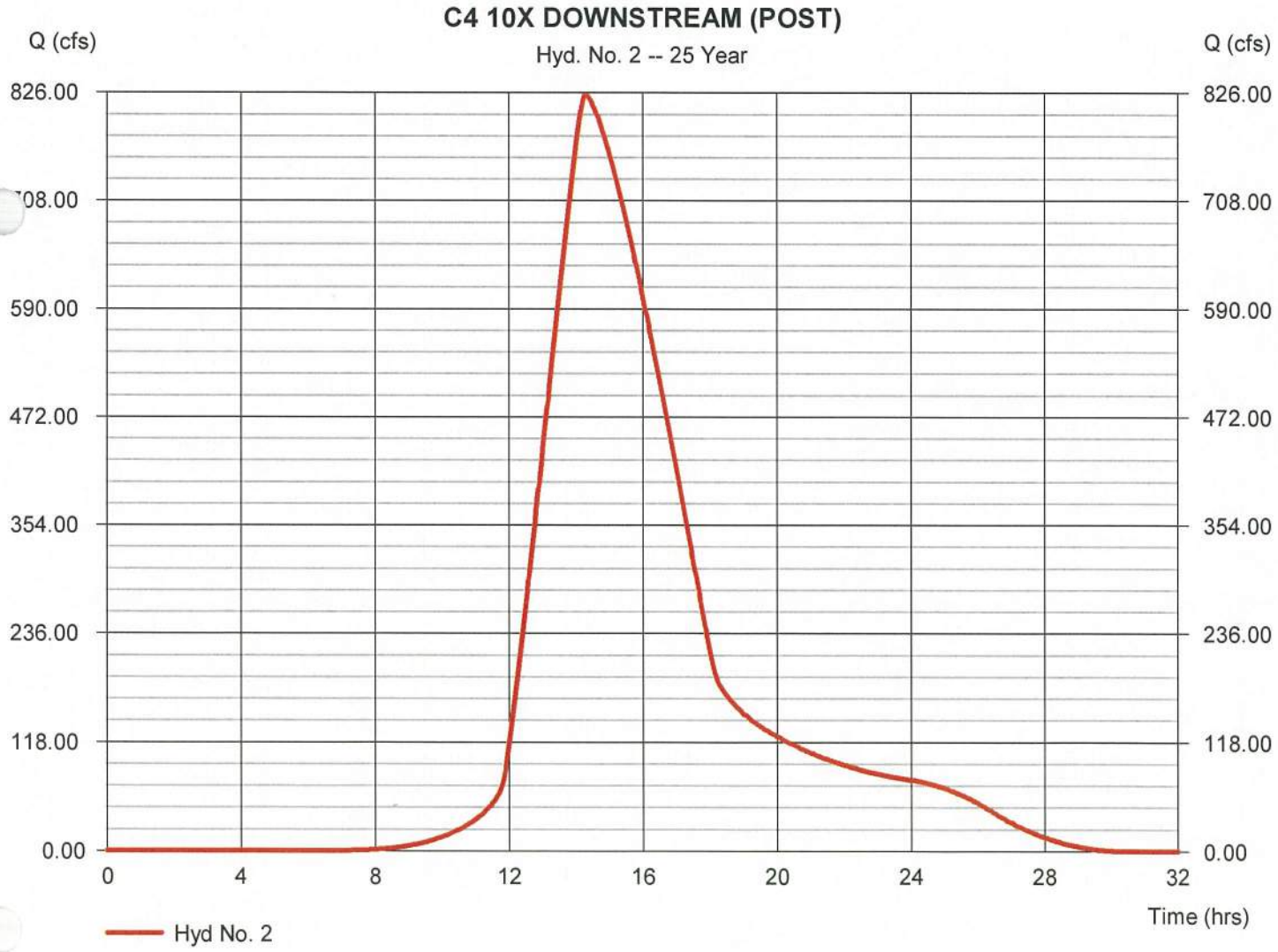
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 7 / 2014

Hyd. No. 2

C4 10X DOWNSTREAM (POST)

Hydrograph type	= SCS Runoff	Peak discharge	= 823.13 cfs
Storm frequency	= 25 yrs	Time to peak	= 14.30 hrs
Time interval	= 2 min	Hyd. volume	= 14,995,107 cuft
Drainage area	= 1033.000 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 240.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Friday, 11 / 7 / 2014

Hyd. No. 2

C4 10X DOWNSTREAM (POST)

Hydrograph type	= SCS Runoff	Peak discharge	= 1096.85 cfs
Storm frequency	= 100 yrs	Time to peak	= 14.27 hrs
Time interval	= 2 min	Hyd. volume	= 19,902,976 cuft
Drainage area	= 1033.000 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 240.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

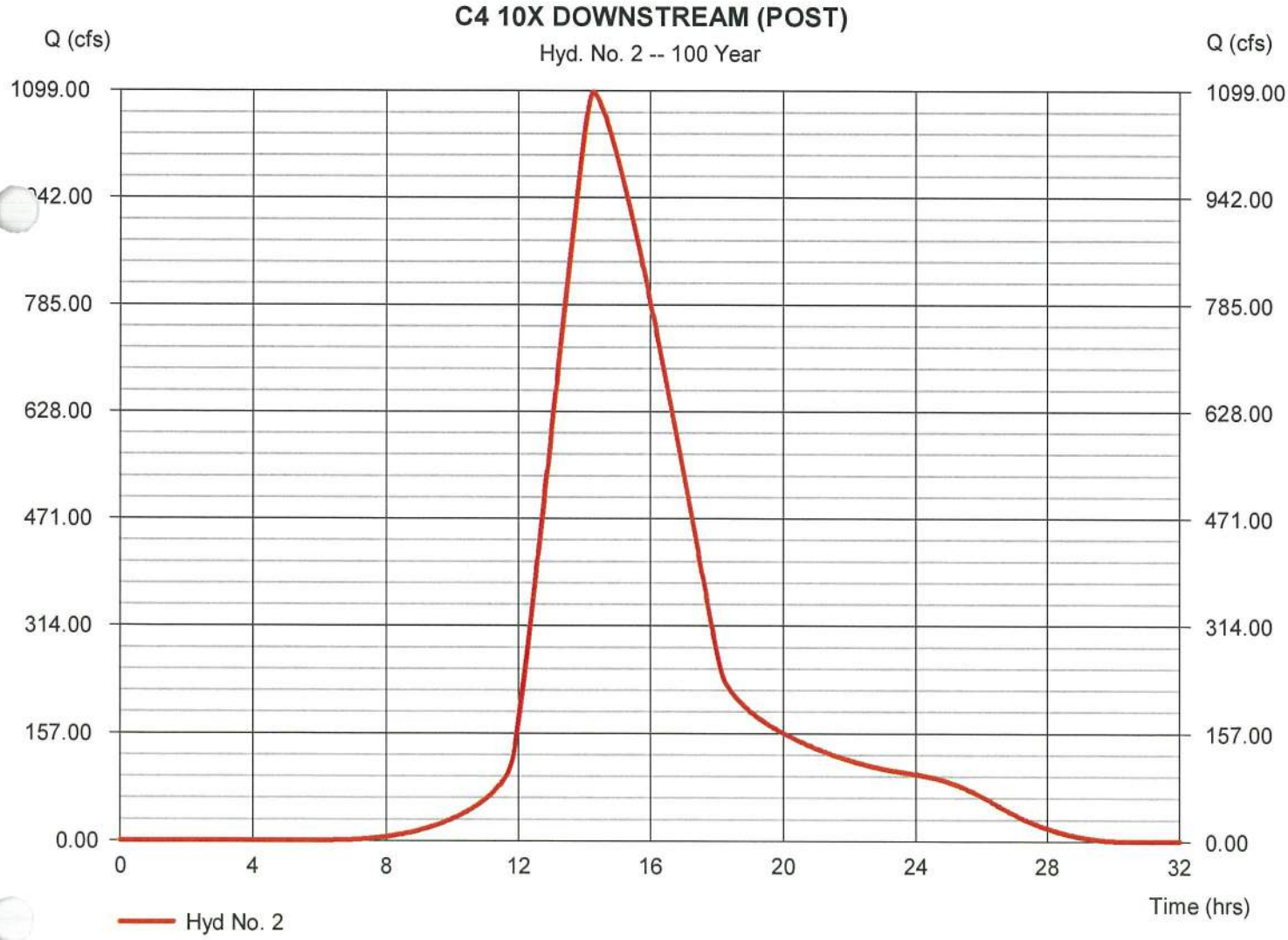


Figure C4_6

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *C4*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	2,980	2,980
CP_v	5,321	8,301
Q_{p25}	6,284	9,264
Q_{f100}	7,925	10,905

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	1080	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	8303	ft^3	>	8301	ft^3

Swale Dimensions:

A swale that is **1080** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	8,301	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **473** ft^2

Actual Filter Bed Dimensions:	Width	32	ft
	Length	15	ft
		480	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **548** ft^2

Actual Sediment Chamber Dimensions:	Width	34	ft
	Length	17	ft
		578	ft^2

Bioretention Area

CP_v	=	8,301	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **3,495** ft^2

Actual Filter Bed Dimensions:	Width	70	ft
	Length	50	ft
		3500	ft^2

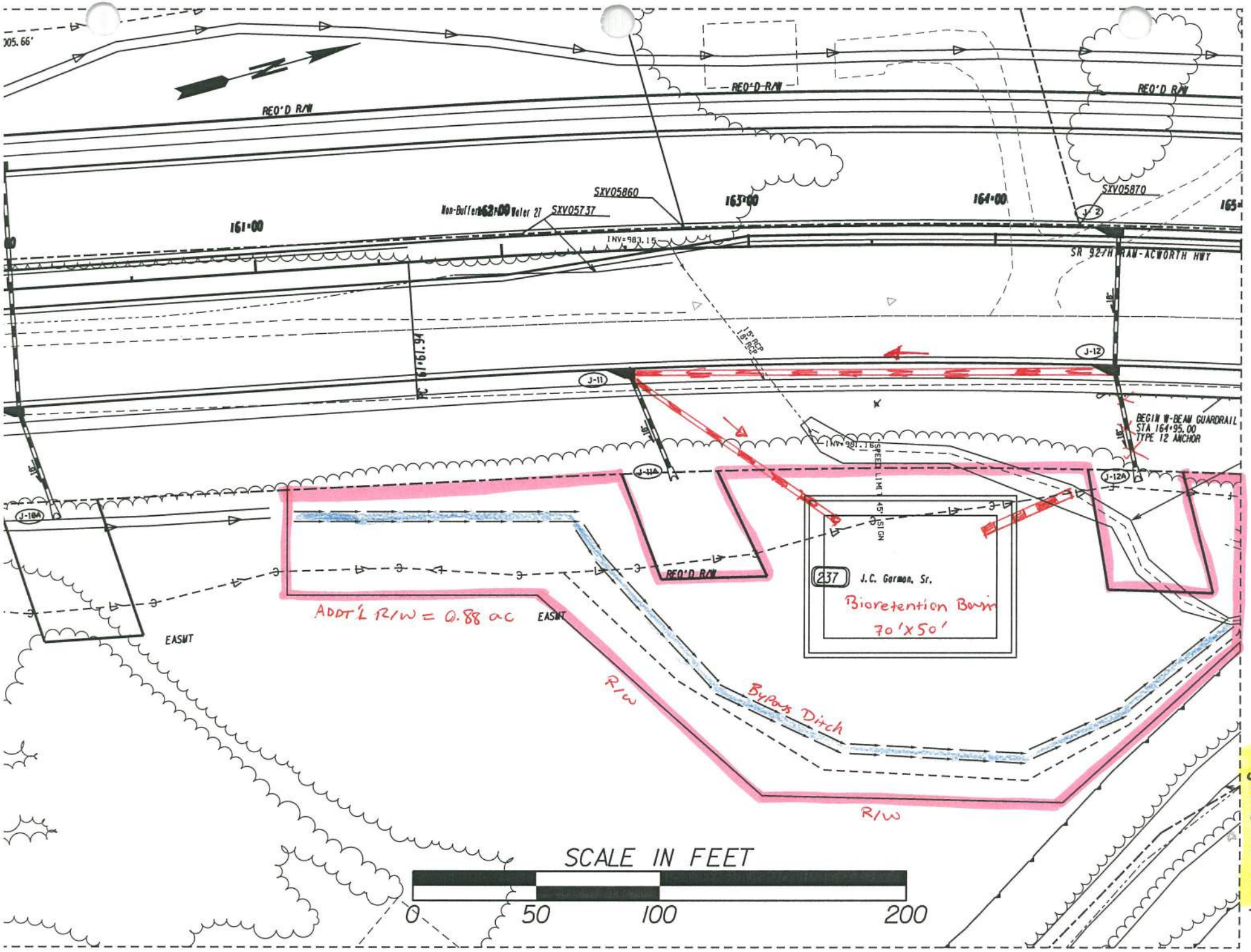

REQ'D R/W
REQ'D R/W
REQ'D R/W
REQ'D R/W
161+00
162+00
163+00
164+00
SXV05860
SXV05737
SXV05870
INV=983.15
SR 927H RAW-ACWORTH HWY
J-11
J-12
J-12A
J-10A
J-11A
BEGIN W-BEAM GUARDRAIL
STA 164+95.00
TYPE 12 ANCHOR
SPEED LIMIT 45 SIGN
237 J.C. Gorman, Sr.
Bioretention Basin
70'x50'
ADDT'L R/W = 0.88 ac
EASMT
EASMT
R/W
R/W
Bypass Ditch
SCALE IN FEET
0
50
100
200

Figure C-4-7

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin C-4

Basin C-4 550 LF of Roadway construction cost within basin

Item	Basin C-4 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 35,500.00	$ 47,000.00	$ 45,500.00	$ 44,000.00
Utilities ✪	$ 42,162.79	$ -	$ -	$ -
Construction ✪	$ 359,328.28	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,700.00	$ 4,550.00	$ 4,400.00
Grading	$ -	$ 18,600.00	$ 16,800.00	$ 12,600.00
Drainage	$ -	$ 57,992.78	$ 42,920.25	$ 41,157.75
Total	$ 436,991.07	$ 128,292.78	$ 109,770.25	$ 102,157.75
	Percent of BMP Cost to Total	**29.4%**	**25.1%**	**23.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.71
Sub Total:	$	35,500.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	35,500.00

✪ See General Summary Explaination for Cost Method

figure C-4.8

BMP Construction Cost Worksheet — Basin C-4

Dry Enhanced Swale

Length:	1080	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.94	Ac	
Total:	$ 47,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 47,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.94	Disturbed Ac	
$ 4,700.00		

Grading

Cut	Fill	
2100.000	1000.000	
	$ 6.00	per CY
Total:	$ 18,600.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	800	CY	$ 30.00	$ 17,777.78
Uddrn Sys w/ Gravel	-	1110	LF	$ 20.00	$ 22,200.00
Additional Pipe	18	215	LF	$ 52.00	$ 11,180.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	60	SY	Fabric	60	SY
	$ 3,450.00			$ 285.00	

Sub Total: $ 57,992.78

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	32	34	ft
Width:	15	17	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.91	Ac	
Total:	$ 45,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 45,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.91	Disturbed Ac	
$ 4,550.00		

Grading

Cut	Fill	
600.000	2200.000	
	$ 6.00	per CY
Total:	$ 16,800.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	26.66666667	CY	$ 45.00	$ 1,200.00
Uddrn Sys w/ Gravel	-	124	LF	$ 20.00	$ 2,480.00
Top Soil		5	CY	$ 20.00	$ 100.00
Outlet Pipe	18"	90	LF	$ 43.00	$ 3,870.00
Imperm Geotextile	-	480	SF	$ 5.00	$ 2,400.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	289	SY	Filter Fabric	289	SY
	$ 16,617.50			$ 1,372.75	

Sub Total: $ 42,920.25

Bioretention Area

Length:	70	ft
Width:	50	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.88	Ac	
Total:	$ 44,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 44,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.88	Disturbed Ac	
$ 4,400.00		

Grading

Cut	Fill	
300.000	1800.000	
	$ 6.00	per CY
Total:	$ 12,600.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	260	CY	$ 30.00	$ 7,800.00
Uddrn Sys w/ Gravel	-	225	LF	$ 20.00	$ 4,500.00
Mulch	-	389	SY	$ 15.00	$ 5,835.00
Additional Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	40	LF	$ 43.00	$ 1,720.00
Shrubs	-	15	EA	$ 30.00	$ 450.00
Ground Cover	-	42	EA	$ 15.00	$ 630.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	59	SY	Fabric	59	SY
	$ 3,392.50			$ 280.25	

Sub Total: $ 41,157.75

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin C-S Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin C-5 was located and the existing and proposed basin drainage areas were delineated (See Figure C-5.1 and Figure C-5.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	18,101	18,101
Quantity	Channel Protection, CP_v	15,632	33,733
	Overbank Flood Protection, Q_{p25}	6,632	24,733
	Extreme Flood Protection, Q_{f100}	8,905	27,006

- The total area draining to the MS4 BMP is 6.06 Ac. The total impervious area is 5.56 Ac. The existing pavement area for the site is 1.28 Ac. The area required for storage and quantity management is 4.78 Ac (See Figure C-5.3). The flow produced by the existing paved area of 1.28 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 80' and minimum length of 180'. The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure C-5.4).
- Modifications to the longitudinal systems are proposed to capture the entire roadway pavement and convey it to the BMP (See Figure C-5.5).
- The BMP construction cost is 10.5% of the roadway construction cost within this basin making this basin infeasible (See Figure C-5.6).
- None of the other infeasibility criteria apply to this basin.

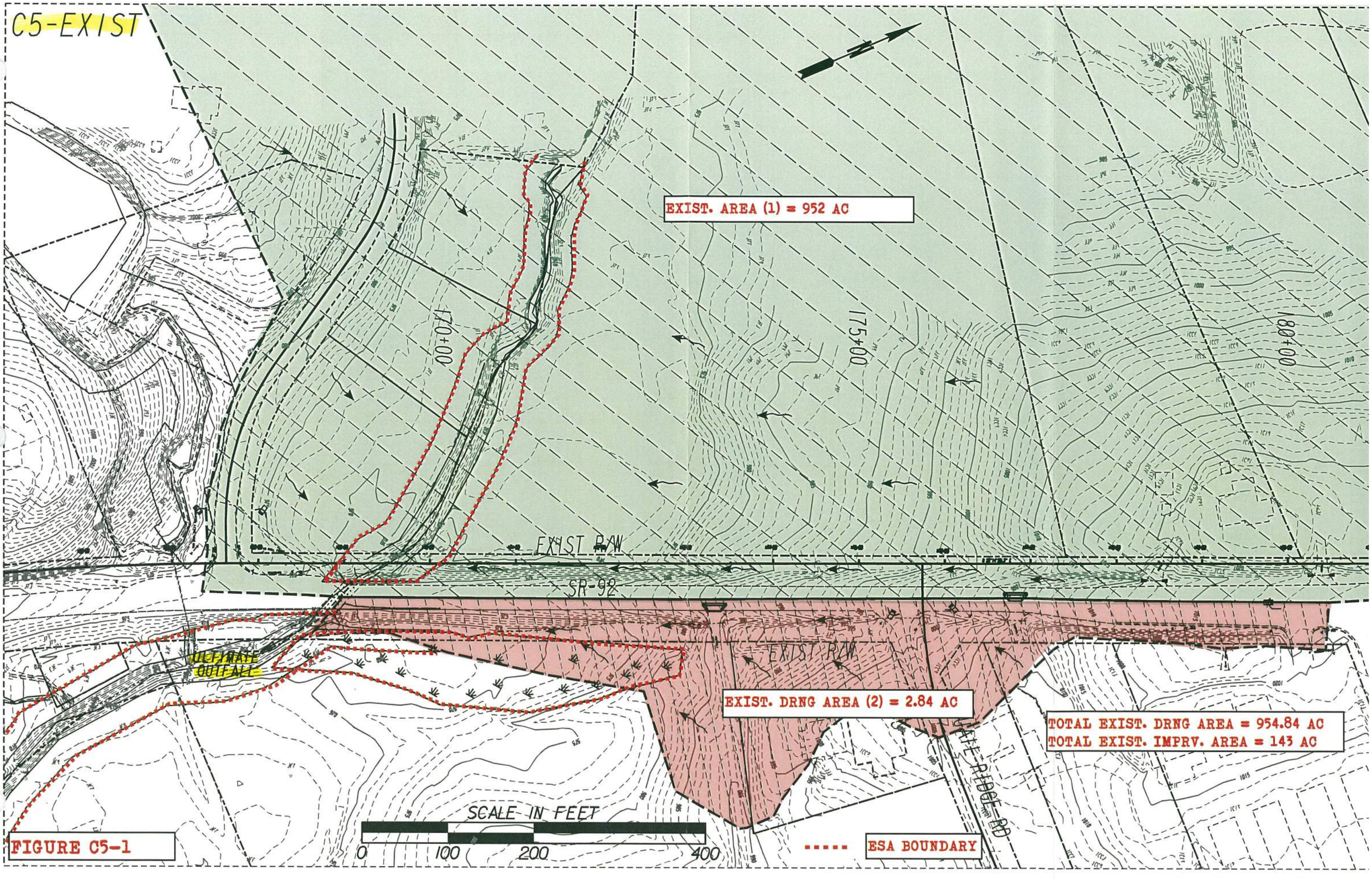

C5-EXIST
EXIST. AREA (1) = 952 AC
170+00
175+00
180+00
EXIST R/W
SR-92
EXIST R/W
ULTIMATE OUTFALL
EXIST. DRNG AREA (2) = 2.84 AC
TOTAL EXIST. DRNG AREA = 954.84 AC
TOTAL EXIST. IMPRV. AREA = 143 AC
SAFE RIDGE RD
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE C5-1

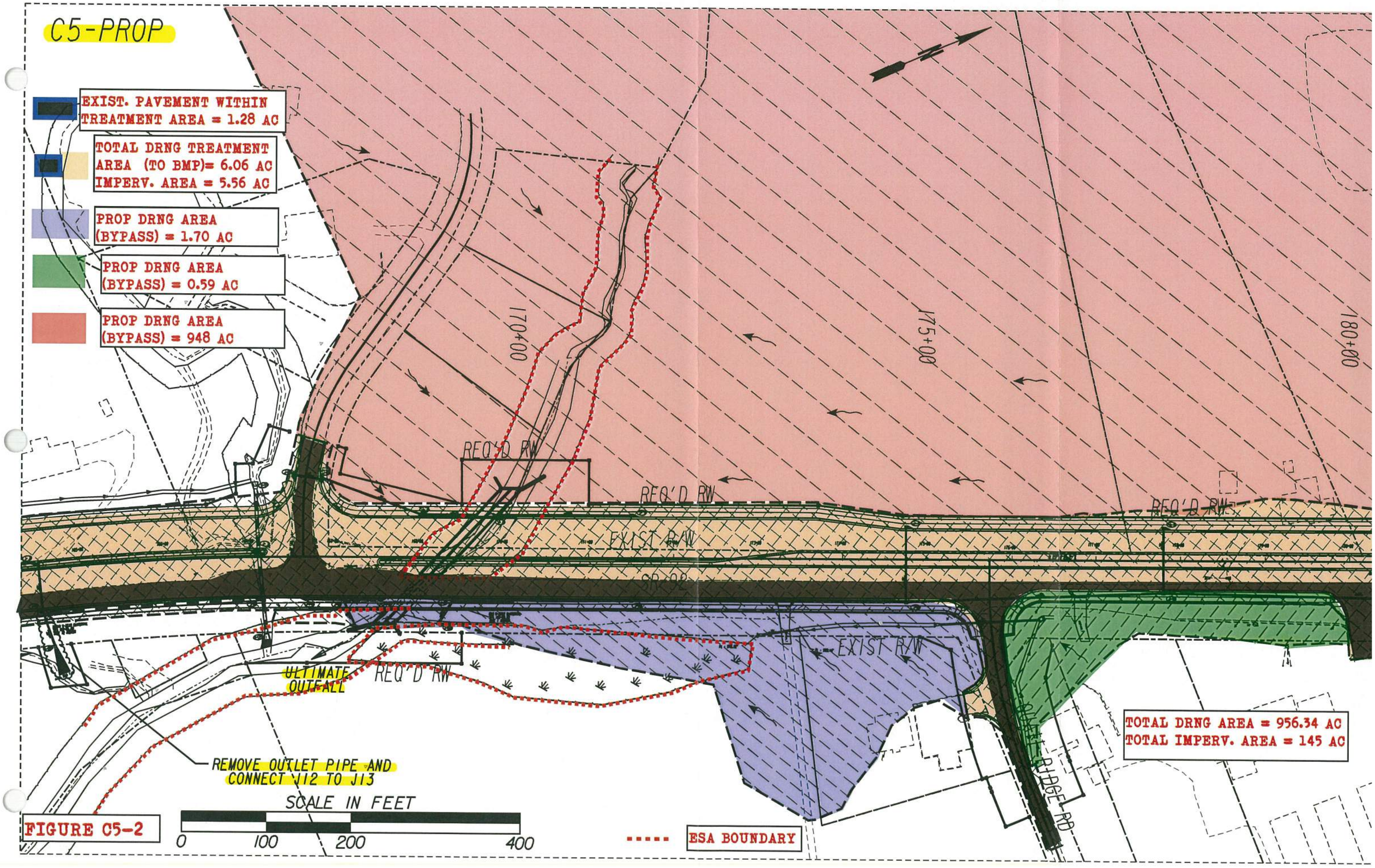

C5-PROP
EXIST. PAVEMENT WITHIN TREATMENT AREA = 1.28 AC
TOTAL DRNG TREATMENT AREA (TO BMP)= 6.06 AC
IMPERV. AREA = 5.56 AC
PROP DRNG AREA (BYPASS) = 1.70 AC
PROP DRNG AREA (BYPASS) = 0.59 AC
PROP DRNG AREA (BYPASS) = 948 AC
170+00
175+00
180+00
REQ'D RW
REQ'D RW
REQ'D RW
EXIST R/W
EXIST R/W
ULTIMATE OUTFALL
REQ'D RW
REMOVE OUTLET PIPE AND CONNECT J12 TO J13
TOTAL DRNG AREA = 956.34 AC
TOTAL IMPERV. AREA = 145 AC
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE C5-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C5

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Jun-14
Calcs.: FA

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	954.84
Impervious Area =	143
Pervious Area=	811.84

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 3.25 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.665

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.198	0.2
$I_a/P_{10\text{-}yr}$=	0.120	0.12
$I_a/P_{25\text{-}yr}$=	0.103	0.1
$I_a/P_{100\text{-}yr}$=	0.084	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.33

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.21
$Q_{d\ 10\text{-}yr}$=	2.88
$Q_{d\ 25\text{-}yr}$=	3.70
$Q_{d\ 100\text{-}yr}$ =	4.97

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	145
$q_{u10\text{-}yr}$=	150
$q_{u25\text{-}yr}$=	155
$q_{u100\text{-}yr}$=	155

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	260.96
$Q_{p10\text{-}yr}$=	644.79
$Q_{p25\text{-}yr}$=	855.45
$Q_{p100\text{-}yr}$=	1150.37

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	956.34
Impervious Area =	145
Pervious Area =	811.34
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 3.25 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.663

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.197	0.2
$I_a/P_{10\text{-}yr}$=	0.120	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.1
$I_a/P_{100\text{-}yr}$=	0.084	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.32

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.21
$Q_{d\ 10\text{-}yr}$=	2.89
$Q_{d\ 25\text{-}yr}$=	3.70
$Q_{d\ 100\text{-}yr}$ =	4.98

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	145
$q_{u10\text{-}yr}$=	150
$q_{u25\text{-}yr}$=	155
$q_{u100\text{-}yr}$=	155

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	262.02
$Q_{p10\text{-}yr}$=	646.84
$Q_{p25\text{-}yr}$=	857.99
$Q_{p100\text{-}yr}$=	1153.52

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	6.06	Acre
Total Impervious Area - A_{POST}	5.56	Acre
Existing Pavement Area - A_{PRE} (5)	1.28	Acre
Area Required for Quantity - A_{QUAN} (4)	4.78	Acre

(4) Only the new proposed areas should be considered with respect to water quality treatment and stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement is subtracted from the total drainage area and the total impervious area to compute the volumes needed for quality and quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
6.06	0.71	70.58	0.00	0.685	0.416	18,101

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.312	13,593

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 15,632

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.997	0.09	0.132	5,767

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,632

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.997	0.09	0.178	7,743

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 8,905

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure C-5.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C5

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	18,101	18,101
CP_v	15,632	33,733
Q_{p25}	6,632	24,733
Q_{f100}	8,905	27,006

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	4390	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	33748	ft^3	>	33733	ft^3

Swale Dimensions:

A swale that is **4390** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	33,733	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,924** ft^2

Actual Filter Bed Dimensions:	Width	62	ft
	Length	32	ft
		1984	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **2226** ft^2

Actual Sediment Chamber Dimensions:	Width	68	ft
	Length	34	ft
		2312	ft^2

Bioretention Area

CP_v	=	33,733	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **14,203** ft^2

Actual Filter Bed Dimensions:	Width	180	ft
	Length	80	ft
		14400	ft^2

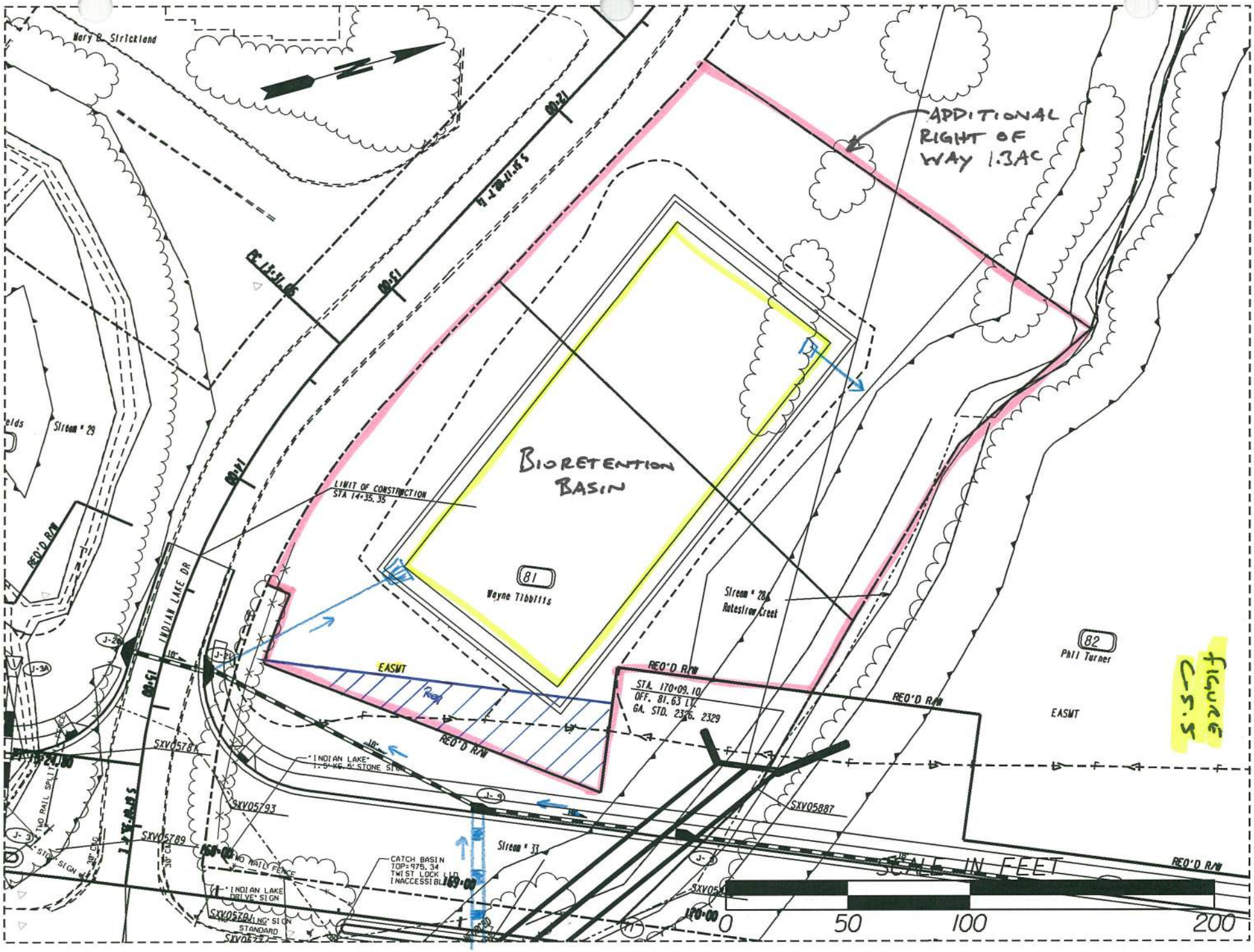

Mary B. Strickland
ADDITIONAL RIGHT OF WAY 1.3AC
BIORETENTION BASIN
LIMIT OF CONSTRUCTION STA 14+35.35
81
Wayne Tibbitts
Stream # 29
Stream # 28
Rutesiow Creek
82
Phil Turner
EASMT
REQ'D R/W
STA. 170+09.10
OFF. 81.63 LT
GA. STD. 2326, 2329
INDIAN LAKE DR
SXV05787
SXV05793
SXV05789
SXV05781
Stream # 33
CATCH BASIN
TOP=975.34
TWIST LOCK LID
INACCESSIBLE
"INDIAN LAKE" 1.5' KG 5' STONE SIGN
"INDIAN LAKE DRIVE" SIGN
NO RAIL FENCE
NO RAIL SPLIT FENCE
STOP SIGN
STANDARD
SCALE IN FEET
0
50
100
200

figure C5.5

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin C-5

Basin C-5 2030 LF of Roadway construction cost within basin

Item	Basin C-5 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 317,500.00	$ 192,500.00	$ 67,500.00	$ 67,500.00
Utilities ✪	$ 155,619.04	$ -	$ -	$ -
Construction ✪	$ 1,326,248.00	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 19,000.00	$ 4,900.00	$ 6,500.00
Grading	$ -	$ 28,500.00	$ 8,400.00	$ 13,380.00
Drainage	$ -	$ 197,194.12	$ 124,317.00	$ 100,830.00
Total	$ 1,799,367.04	$ 437,194.12	$ 205,117.00	$ 188,210.00
	Percent of BMP Cost to Total	**24.3%**	**11.4%**	**10.5%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		2.77
Sub Total:	$	138,500.00
Residential Relocation Cost	$	40,000.00
		2
Sub Total:	$	80,000.00
Residential Perm Easmt @	$	25,000.00
		2.61
Sub Total:	$	65,250.00
Commercial Right of Way @	$	125,000.00
		0.27
Sub Total:	$	33,750.00
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	317,500.00

✪ See General Summary Explaination for Cost Method

Figure C-5.6

BMP Construction Cost Worksheet Basin C-5

Dry Enhanced Swale

Length:	4390	ft
Width:	8	ft

Right of Way

Residential Right of Way @ $ 50,000.00 per Ac
3.8 Ac
Total: $ 190,000.00

Residential Perm Easmt @ $ 25,000.00 per Ac
0.1 Ac
Total: $ 2,500.00
Sub Total: $ 192,500.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
3.8 Disturbed Ac
$ 19,000.00

Grading

Cut	Fill
1550.000	3200.000

$ 6.00 per CY
Total: $ 28,500.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 2,300.00 per EA
1 EA
$ 2,300.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	3252	CY	$ 30.00	$ 72,263.37
Uddrn Sys w/ Gravel	-	4420	LF	$ 20.00	$ 88,400.00
Additional Pipe	18	352	LF	$ 52.00	$ 18,304.00

Rip Rap TP3,18" $ 57.50 per SY
243 SY
$ 13,972.50

Filter Fabric $ 4.75 per SY
243 SY
$ 1,154.25

Sub Total: $ 197,194.12

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	62	68	ft
Width:	32	34	ft

Right of Way

Residential Right of Way @ $ 50,000.00 per Ac
1.3 Ac
Total: $ 65,000.00

Residential Perm Easmt @ $ 25,000.00 per Ac
0.1 Ac
Total: $ 2,500.00
Sub Total: $ 67,500.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.98 Disturbed Ac
$ 4,900.00

Grading

Cut	Fill
650.000	750.000

$ 6.00 per CY
Total: $ 8,400.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
2 EA
$ 10,000.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Sand	-	110	CY	$ 45.00	$ 4,960.00
Uddrn Sys w/ Gravel	-	201	LF	$ 20.00	$ 4,020.00
Top Soil		19	CY	$ 20.00	$ 380.00
Outlet Pipe	18"	352	LF	$ 43.00	$ 15,136.00
Imperm Geotextile	-	1984	SF	$ 5.00	$ 9,920.00
Dist Wall Conc/Steel	-	7	CY	$ 1,020.00	$ 7,140.00

Rip Rap TP3,18" $ 57.50 per SY
1156 SY
$ 66,470.00

Filter Fabric $ 4.75 per SY
1156 SY
$ 5,491.00

Sub Total: $ 124,317.00

Bioretention Area

Length:	180	ft
Width:	80	ft

Right of Way

Residential Right of Way @ $ 50,000.00 per Ac
1.3 Ac
Total: $ 65,000.00

Residential Perm Easmt @ $ 25,000.00 per Ac
0.1 Ac
Total: $ 2,500.00
Sub Total: $ 67,500.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
1.3 Disturbed Ac
$ 6,500.00

Grading

Cut	Fill
300.000	1930.000

$ 6.00 per CY
Total: $ 13,380.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
1 EA
$ 5,000.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1067	CY	$ 30.00	$ 32,010.00
Uddrn Sys w/ Gravel	-	360	LF	$ 20.00	$ 7,200.00
Mulch	-	1600	SY	$ 15.00	$ 24,000.00
Additional Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	40	LF	$ 43.00	$ 1,720.00
Shrubs	-	62	EA	$ 30.00	$ 1,860.00
Ground Cover	-	170	EA	$ 15.00	$ 2,550.00

Rip Rap TP3,18" $ 57.50 per SY
240 SY
$ 13,800.00

Filter Fabric $ 4.75 per SY
240 SY
$ 1,140.00

Sub Total: $ 100,830.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin C-6 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin C6 was located and the existing and proposed basin drainage areas were delineated (See Figure C-6.1 and Figure C-6.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	15,761	15,761
Quantity	Channel Protection, CP_v	22,786	38,547
	Overbank Flood Protection, Q_{p25}	17,578	33,339
	Extreme Flood Protection, Q_{f100}	21,751	37,512

- The total area draining to the MS4 BMP is 7.38 Ac. The total impervious area is 5.56 Ac. The existing pavement area for the site is 1.95 Ac. The area required for storage and quantity management is 5.43 Ac (See Figure C-6.3). The flow produced by the existing paved area of 1.95 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 80' and minimum length of 205'. The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure C-6.4).
- Modifications to the longitudinal system on SR 360 are proposed to convey all the roadway flow into the proposed systems, and then routed to the swale for treatment (See Figure C-6.5)
- Commercial Right of Way was used because of the proposed commercial driveway shown in the construction plans and since the property at the intersection of SR 92 and SR 360 are commercial as well.
- The BMP construction cost is 16.4% of the roadway construction cost within this basin making this basin infeasible (See Figure C-6.6).
- With the residential value the BMP construction cost is 10.9% of the roadway construction within the basin.
- None of the other infeasibility criteria apply to this basin.

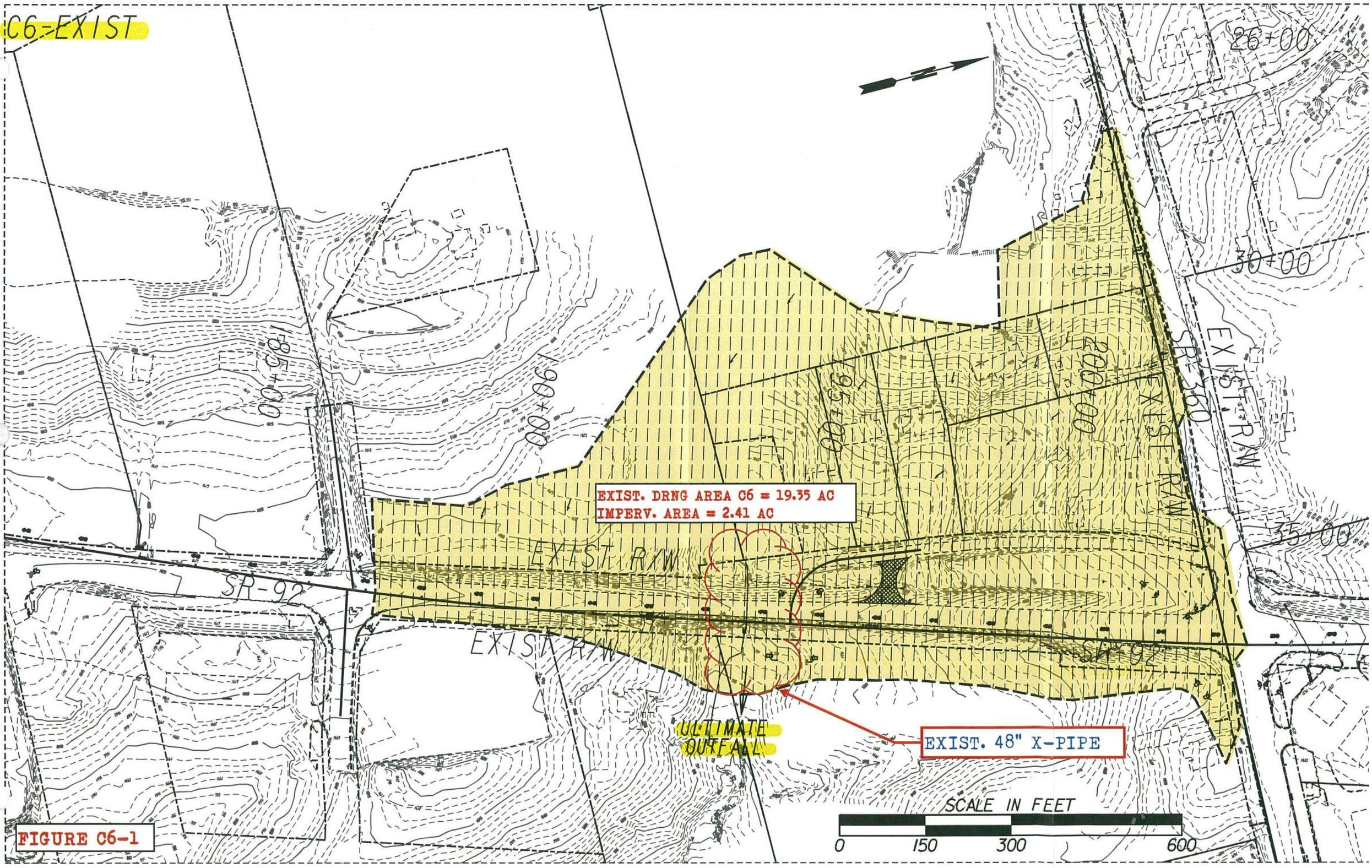

C6=EXIST
EXIST. DRNG AREA C6 = 19.35 AC
IMPERV. AREA = 2.41 AC
EXIST RW
SR-92
EXIST RW
SR-92
EXIST RW
SR-92
ULTIMATE OUTFALL
EXIST. 48" X-PIPE
SCALE IN FEET
0
150
300
600
85+00
90+00
95+00
20+00
25+00
26+00
30+00
35+00

FIGURE C6-1

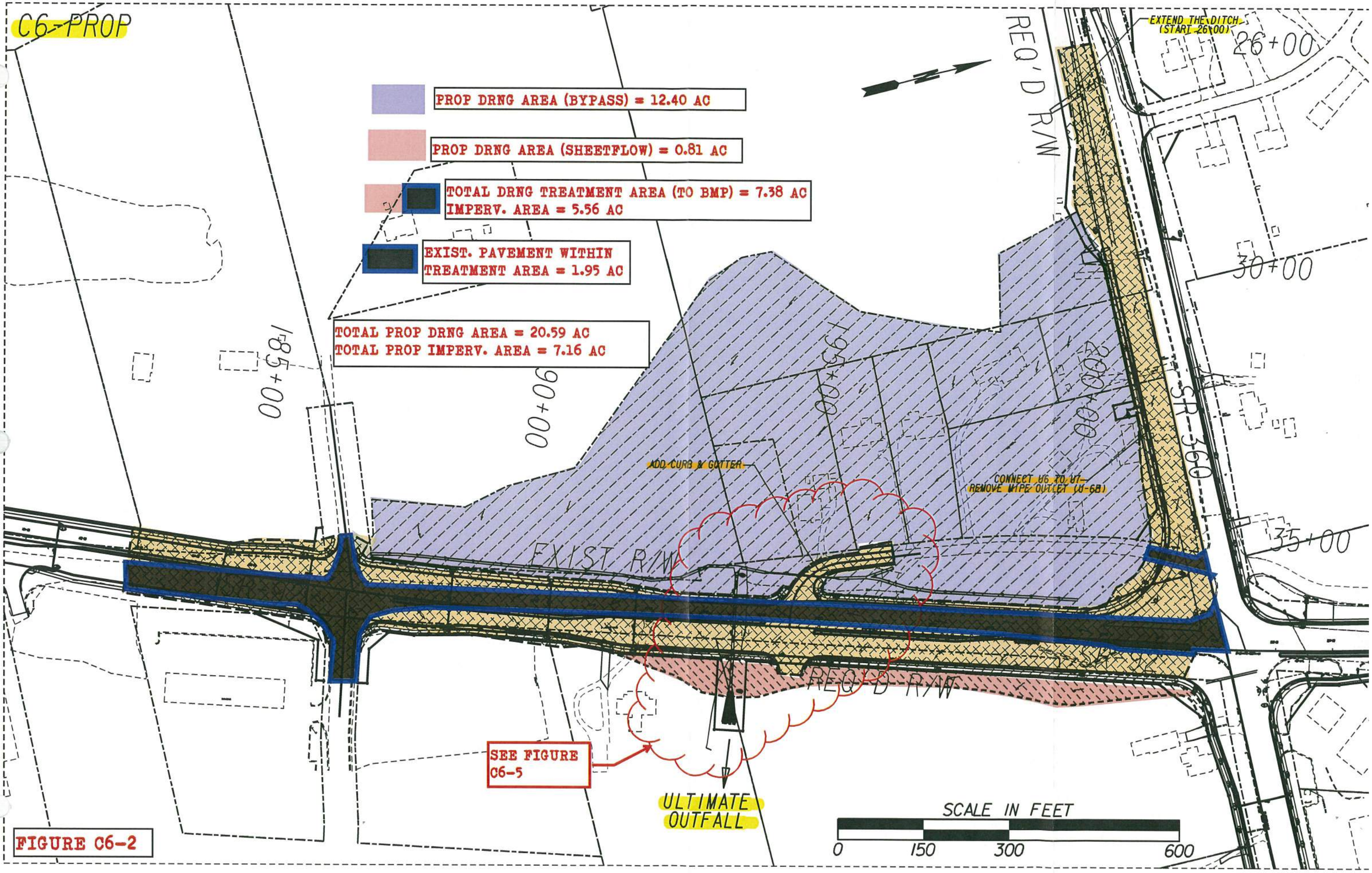

C6-PROP
PROP DRNG AREA (BYPASS) = 12.40 AC
PROP DRNG AREA (SHEETFLOW) = 0.81 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 7.38 AC
IMPERV. AREA = 5.56 AC
EXIST. PAVEMENT WITHIN
TREATMENT AREA = 1.95 AC
TOTAL PROP DRNG AREA = 20.59 AC
TOTAL PROP IMPERV. AREA = 7.16 AC
EXTEND THE DITCH
(STAR1 26+00)
REQ'D R/W
26+00
30+00
35+00
85+00
90+00
00+G6
00+G8
SR 360
ADD CURB & GUTTER
CONNECT U6 TO U7
REMOVE PIPE OUTLET (U-6B)
EXIST R/W
REQ'D R/W
SEE FIGURE
C6-5
ULTIMATE
OUTFALL
SCALE IN FEET
0
150
300
600

FIGURE C6-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C6

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov. 2014
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	19.35
Impervious Area =	2.41
Pervious Area=	16.94

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.18 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.690

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.205	0.21
$I_a/P_{10\text{-}yr}$=	0.125	0.13
$I_a/P_{25\text{-}yr}$=	0.106	0.11
$I_a/P_{100\text{-}yr}$=	0.087	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.45

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.17
$Q_{d\ 10\text{-}yr}$=	2.82
$Q_{d\ 25\text{-}yr}$=	3.63
$Q_{d\ 100\text{-}yr}$ =	4.90

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	790
$q_{u10\text{-}yr}$=	815
$q_{u25\text{-}yr}$=	830
$q_{u100\text{-}yr}$=	840

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	27.84
$Q_{p10\text{-}yr}$=	69.46
$Q_{p25\text{-}yr}$=	91.08
$Q_{p100\text{-}yr}$=	124.34

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	20.59
Impervious Area =	7.16
Pervious Area =	13.43
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	80

Time of Concentration (See Table A) = 0.17 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.488

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.145	0.15
$I_a/P_{10\text{-}yr}$=	0.088	0.1
$I_a/P_{25\text{-}yr}$=	0.075	0.1
$I_a/P_{100\text{-}yr}$=	0.062	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.44

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.55
$Q_{d\ 10\text{-}yr}$=	3.39
$Q_{d\ 25\text{-}yr}$=	4.26
$Q_{d\ 100\text{-}yr}$ =	5.60

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	825
$q_{u10\text{-}yr}$=	850
$q_{u25\text{-}yr}$=	850
$q_{u100\text{-}yr}$=	850

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	41.22
$Q_{p10\text{-}yr}$=	92.68
$Q_{p25\text{-}yr}$=	116.45
$Q_{p100\text{-}yr}$=	153.01

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	7.38	Acre
Total Impervious Area - A_{POST}	5.56	Acre
Existing Pavement Area - A_{PRE} (5)	1.95	Acre
Area Required for Quantity - A_{QUAN} (4)	5.43	Acre

(4) Only the new proposed areas should be considered with respect to water quality treatment and stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement is subtracted from the total drainage area and the total impervious area to compute the volumes needed for quality and quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
7.38	0.49	48.92	0.00	0.490	0.362	15,761

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.455	19,813

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 22,786

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.782	0.18	0.351	15,286

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 17,578

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.813	0.17	0.434	18,914

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 21,751

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

(See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure C-6.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: C6

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	15,761	15,761
CP_v	22,786	38,547
Q_{p25}	17,578	33,339
Q_{f100}	21,751	37,512

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	5020	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	38591	ft^3	>	38547	ft^3

Swale Dimensions:

A swale that is **5020** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	38,547	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **2,198** ft^2

Actual Filter Bed Dimensions: Width 35 ft; Length 64 ft; 2240 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **2544** ft^2

Actual Sediment Chamber Dimensions: Width 35 ft; Length 75 ft; 2625 ft^2

Bioretention Area

CP_v	=	38,547	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **16,230** ft^2

Actual Filter Bed Dimensions: Width 205 ft; Length 80 ft; 16400 ft^2

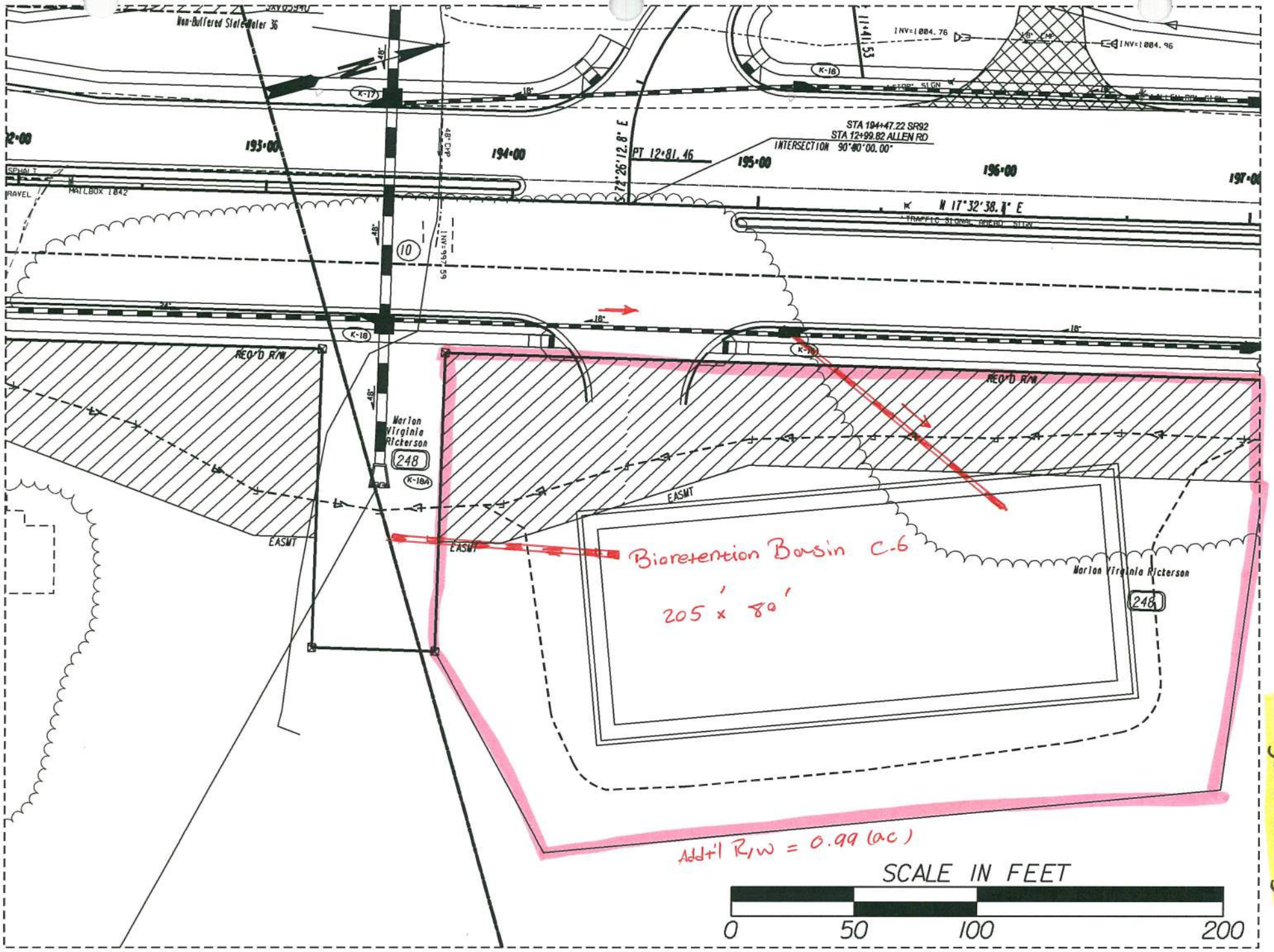

Non-Buffered Steel Guiler 36
K-17
K-18
K-18A
10
193+00
194+00
195+00
196+00
197+00
STA 194+47.22 SR92
STA 12+99.82 ALLEN RD
INTERSECTION 90°00'00.00"
PT 12+81.46
S 72°26'12.8" E
N 17°32'38.1" E
MAILBOX 1842
INV=1004.76
INV=1004.96
INV=997.59
REQ'D R/W
EASMT
Marion Virginia Rickerson
248
Bioretention Basin C-6
205' x 80'
Add'l R/W = 0.99 (ac)
SCALE IN FEET
0
50
100
200

Figure C6-5

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin C-6

Basin C-6 1900 LF of Roadway construction cost within basin

Item	Basin C-6 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 261,250.00	$ 552,500.00	$ 140,000.00	$ 151,250.00
Utilities ✪	$ 145,653.29	$ -	$ -	$ -
Construction ✪	$ 1,241,315.86	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 21,000.00	$ 4,900.00	$ 4,950.00
Grading	$ -	$ 29,400.00	$ 10,500.00	$ 6,720.00
Drainage	$ -	$ 214,376.99	$ 130,643.13	$ 107,446.50
Total	$ 1,648,219.15	$ 817,276.99	$ 286,043.13	$ 270,366.50
	Percent of BMP Cost to Total	**49.6%**	**17.4%**	**16.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		2.5
Sub Total:	$	125,000.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		1.2
Sub Total:	$	30,000.00
Commercial Right of Way @	$	125,000.00
		0.17
Sub Total:	$	21,250.00
Commercial Perm Easmt @	$	62,500.00
		1.36
Sub Total:	$	85,000.00
Right of Way Cost Total:	$	261,250.00

✪ See General Summary Explaination for Cost Method

Figure C-6.6

BMP Construction Cost Worksheet Basin C-6

Dry Enhanced Swale

Length:	5020	ft
Width:	8	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
4.2 Ac
Total: $ 525,000.00

Commercial Perm Easmt @ $ 62,500.00 per Ac
0.44 Ac
Total: $ 27,500.00
Sub Total: $ 552,500.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
4.2 Disturbed Ac
$ 21,000.00

Grading

Cut	Fill
1600.000	3300.000

$ 6.00 per CY
Total: $ 29,400.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 2,300.00 per EA
1 EA
$ 2,300.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	3719	CY	$ 30.00	$ 82,633.74
Uddrn Sys w/ Gravel	-	5050	LF	$ 20.00	$ 101,000.00
Additional Pipe	18	200	LF	$ 52.00	$ 10,400.00

Rip Rap TP3,18" $ 57.50 per SY
277 SY
$ 15,927.50

Filter Fabric $ 4.75 per SY
277 SY
$ 1,315.75

Sub Total: $ 214,376.99

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	64	75	ft
Width:	35	35	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
0.9 Ac
Total: $ 112,500.00

Commercial Perm Easmt @ $ 62,500.00 per Ac
0.44 Ac
Total: $ 27,500.00
Sub Total: $ 140,000.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.98 Disturbed Ac
$ 4,900.00

Grading

Cut	Fill
350.000	1400.000

$ 6.00 per CY
Total: $ 10,500.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
2 EA
$ 10,000.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Sand	-	124.44	CY	$ 45.00	$ 5,600.00
Uddrn Sys w/ Gravel	-	208	LF	$ 20.00	$ 4,160.00
Top Soil		21	CY	$ 20.00	$ 420.00
Outlet Pipe	18"	200	LF	$ 43.00	$ 8,600.00
Imperm Geotextile	-	2240	SF	$ 5.00	$ 11,200.00
Dist Wall Conc/Steel	-	8	CY	$ 1,020.00	$ 8,160.00

Rip Rap TP3,18" $ 57.50 per SY
1312.5 SY
$ 75,468.75

Filter Fabric $ 4.75 per SY
1312.5 SY
$ 6,234.38

Sub Total: $ 130,643.13

Bioretention Area

Length:	205	ft
Width:	80	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
0.99 Ac
Total: $ 123,750.00

Commercial Perm Easmt @ $ 62,500.00 per Ac
0.44 Ac
Total: $ 27,500.00
Sub Total: $ 151,250.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.99 Disturbed Ac
$ 4,950.00

Grading

Cut	Fill
300.000	820.000

$ 6.00 per CY
Total: $ 6,720.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
1 EA
$ 5,000.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1215	CY	$ 30.00	$ 36,450.00
Uddrn Sys w/ Gravel	-	360	LF	$ 20.00	$ 7,200.00
Mulch	-	1823	SY	$ 15.00	$ 27,345.00
Additional Pipe	18"	150	LF	$ 43.00	$ 6,450.00
Outlet Pipe	18"	50	LF	$ 43.00	$ 2,150.00
Shrubs	-	70	EA	$ 30.00	$ 2,100.00
Ground Cover	-	193	EA	$ 15.00	$ 2,895.00

Rip Rap TP3,18" $ 57.50 per SY
274 SY
$ 15,755.00

Filter Fabric $ 4.75 per SY
274 SY
$ 1,301.50

Sub Total: $ 107,446.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin D-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin D-1 was located and the existing and proposed basin drainage areas were delineated (See Figures D-1.1 and D-1.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,710	3,710
Quantity	Channel Protection, CP_v	5,353	9,063
	Overbank Flood Protection, Q_{p25}	1,560	5,270
	Extreme Flood Protection, Q_{f100}	2,041	5,751

- The total area draining to the MS4 BMP is 2.63 Ac. The total impervious area is 2.10 Ac. The existing pavement area for the site is 1.30 Ac. The area required for storage and quantity management is 1.33 Ac (See Figure D-1.3).
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area with a bottom width of 34' and minimum length of 113' (See Figure D-1.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure D-1.4). The flow produced by the existing paved area of 1.30 Ac will not be detained and will pass through the overflow structure.
- Commercial property value was used because it is owned by a development company and has two large commercial buildings on either side of the property.
- The BMP construction cost is 17.7% of the roadway construction cost within this basin making this basin infeasible (See Figure D-1.6).
- None of the other infeasibility criteria apply to this basin.

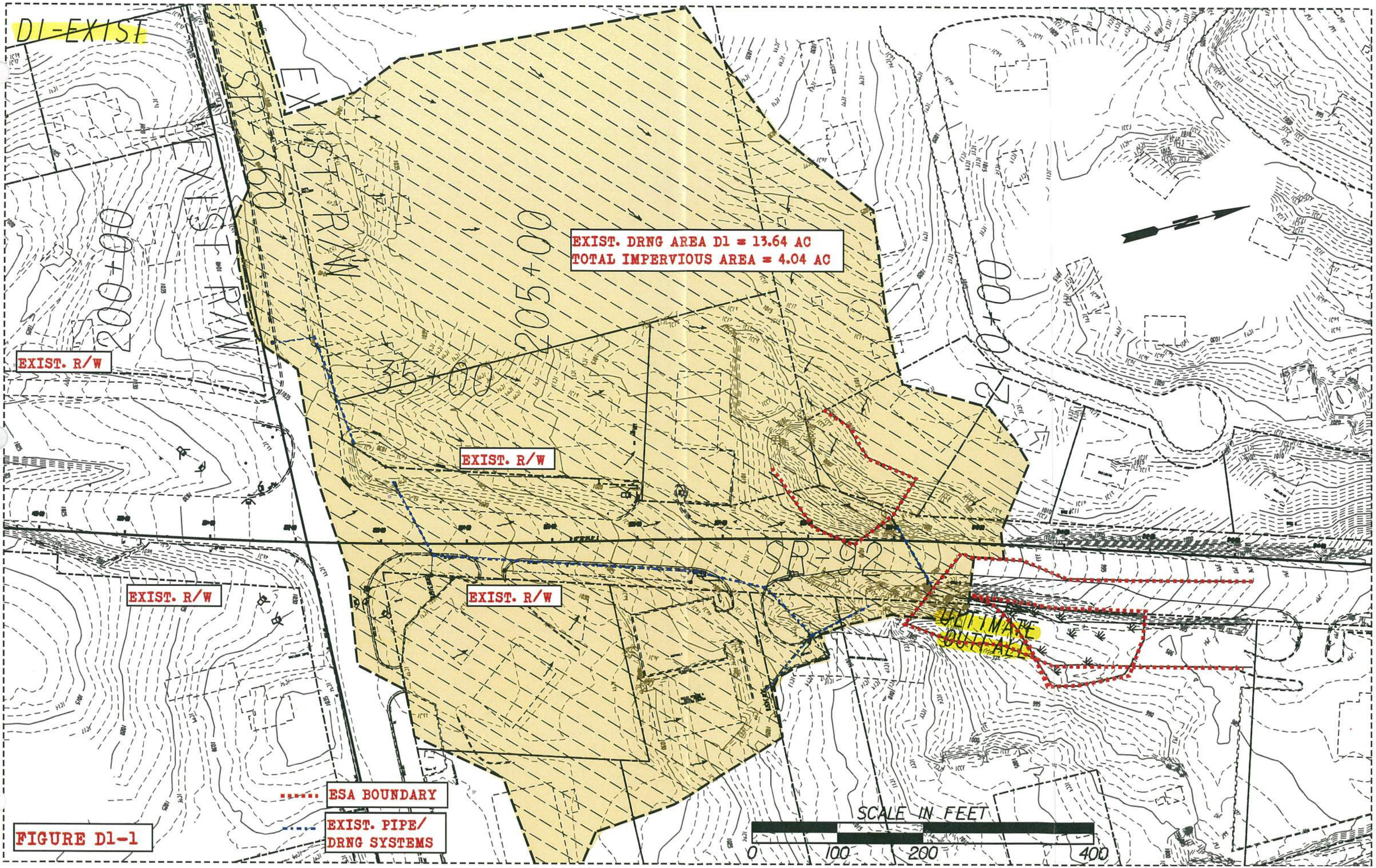

D1-EXIST
EXIST. DRNG AREA D1 = 13.64 AC
TOTAL IMPERVIOUS AREA = 4.04 AC
EXIST. R/W
EXIST. R/W
EXIST. R/W
EXIST. R/W
EXIST. R/W
SR-92
ULTIMATE OUTFALL
ESA BOUNDARY
EXIST. PIPE/ DRNG SYSTEMS
SCALE IN FEET
0
100
200
400

FIGURE D1-1

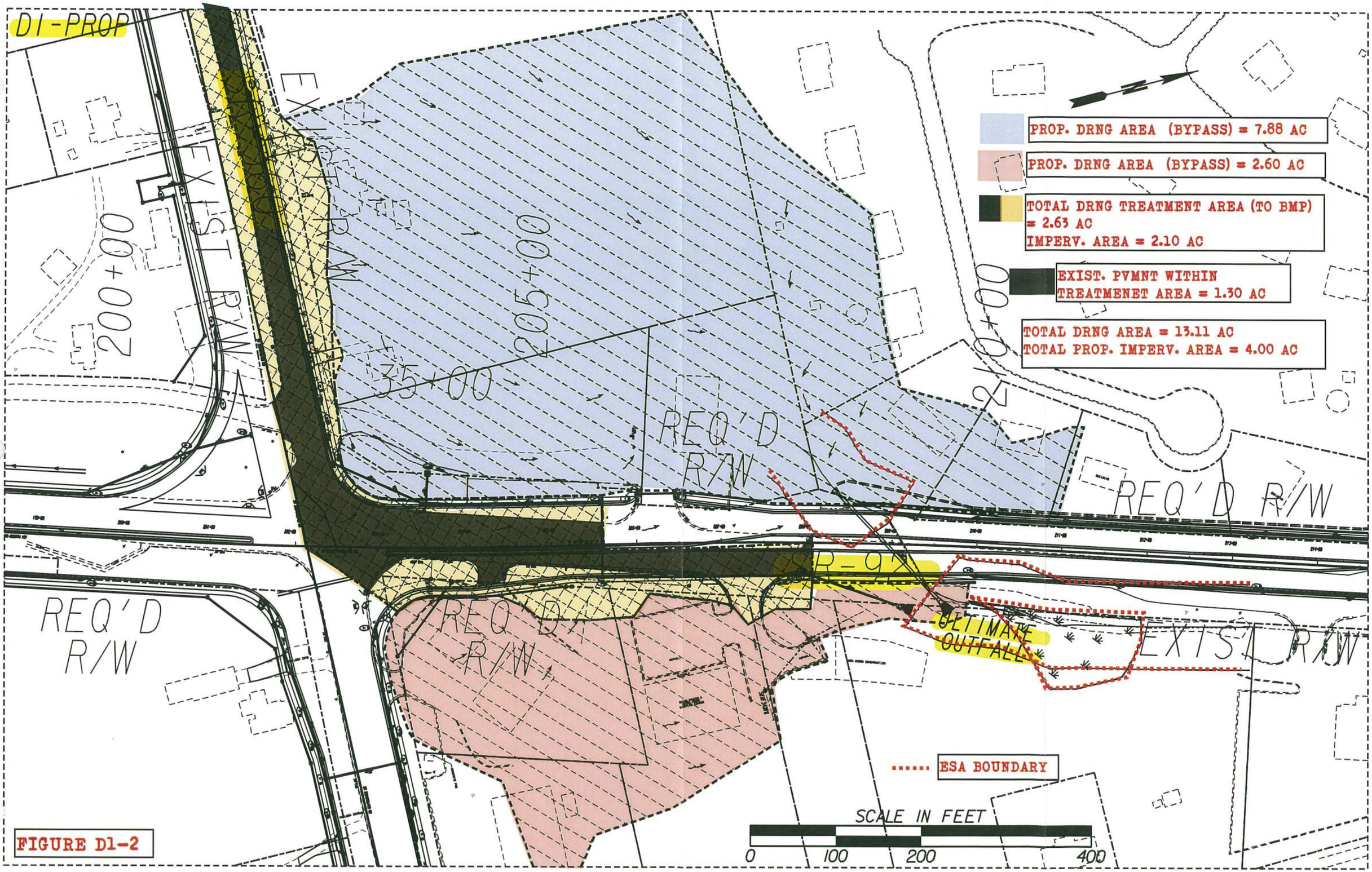

D1-PROP
PROP. DRNG AREA (BYPASS) = 7.88 AC
PROP. DRNG AREA (BYPASS) = 2.60 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.63 AC
IMPERV. AREA = 2.10 AC
EXIST. PVMNT WITHIN TREATMENET AREA = 1.30 AC
TOTAL DRNG AREA = 13.11 AC
TOTAL PROP. IMPERV. AREA = 4.00 AC
EXIST RW
200+00
205+00
210+00
35+00
REQ'D R/W
REQ'D R/W
REQ'D R/W
REQ'D R/W
R-9
ULTIMATE OUTFALL
EXIST R/W
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE D1-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: D1

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	13.64
Impervious Area =	4.04
Pervious Area=	9.6

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	79

Time of Concentration (See Table A) = 0.17 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.532

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.158	0.16
$I_a/P_{10\text{-}yr}$=	0.096	0.1
$I_a/P_{25\text{-}yr}$=	0.082	0.1
$I_a/P_{100\text{-}yr}$=	0.067	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.66

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.46
$Q_{d\ 10\text{-}yr}$=	3.25
$Q_{d\ 25\text{-}yr}$=	4.11
$Q_{d\ 100\text{-}yr}$ =	5.43

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	835
$q_{u10\text{-}yr}$=	850
$q_{u25\text{-}yr}$=	850
$q_{u100\text{-}yr}$=	850

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	25.94
$Q_{p10\text{-}yr}$=	58.95
$Q_{p25\text{-}yr}$=	74.47
$Q_{p100\text{-}yr}$=	98.42

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	13.11
Impervious Area =	4.00
Pervious Area =	9.11
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	79

Time of Concentration (See Table A) = 0.17 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.524

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.156	0.15
$I_a/P_{10\text{-}yr}$=	0.095	0.1
$I_a/P_{25\text{-}yr}$=	0.081	0.1
$I_a/P_{100\text{-}yr}$=	0.066	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.62

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.47
$Q_{d\ 10\text{-}yr}$=	3.28
$Q_{d\ 25\text{-}yr}$=	4.14
$Q_{d\ 100\text{-}yr}$ =	5.46

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	840
$q_{u10\text{-}yr}$=	850
$q_{u25\text{-}yr}$=	850
$q_{u100\text{-}yr}$=	850

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	25.36
$Q_{p10\text{-}yr}$=	57.06
$Q_{p25\text{-}yr}$=	72.02
$Q_{p100\text{-}yr}$=	95.09

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.63	Acre
Total Impervious Area - A_{POST}	2.10	Acre
Existing Pavement Area - A_{PRE} (5)	1.30	Acre
Area Required for Quantity - A_{QUAN} (4)	1.33	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.63	0.30	30.42	0.00	0.324	0.085	3,710

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.107	4,655

(+15% ED)= 5,353

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
1.034	0.07	0.031	1,357

(+15% ED)= 1,560

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
1.035	0.07	0.041	1,774

(+15% ED)= 2,041

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure D-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D1

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	3,710	3,710
CP_v	5,353	9,063
Q_{p25}	1,560	5,270
Q_{f100}	2,041	5,751

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	1180	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	9071	ft^3	>	9063	ft^3

Swale Dimensions:

A swale that is **1180** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	9,063	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **517** ft^2

Actual Filter Bed Dimensions:	Width	16	ft
	Length	33	ft
		528	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **598** ft^2

Actual Sediment Chamber Dimensions:	Width	16	ft
	Length	38	ft
		608	ft^2

Bioretention Area

CP_v	=	9,063	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **3,816** ft^2

Actual Filter Bed Dimensions:	Width	34	ft
	Length	113	ft
		3842	ft^2

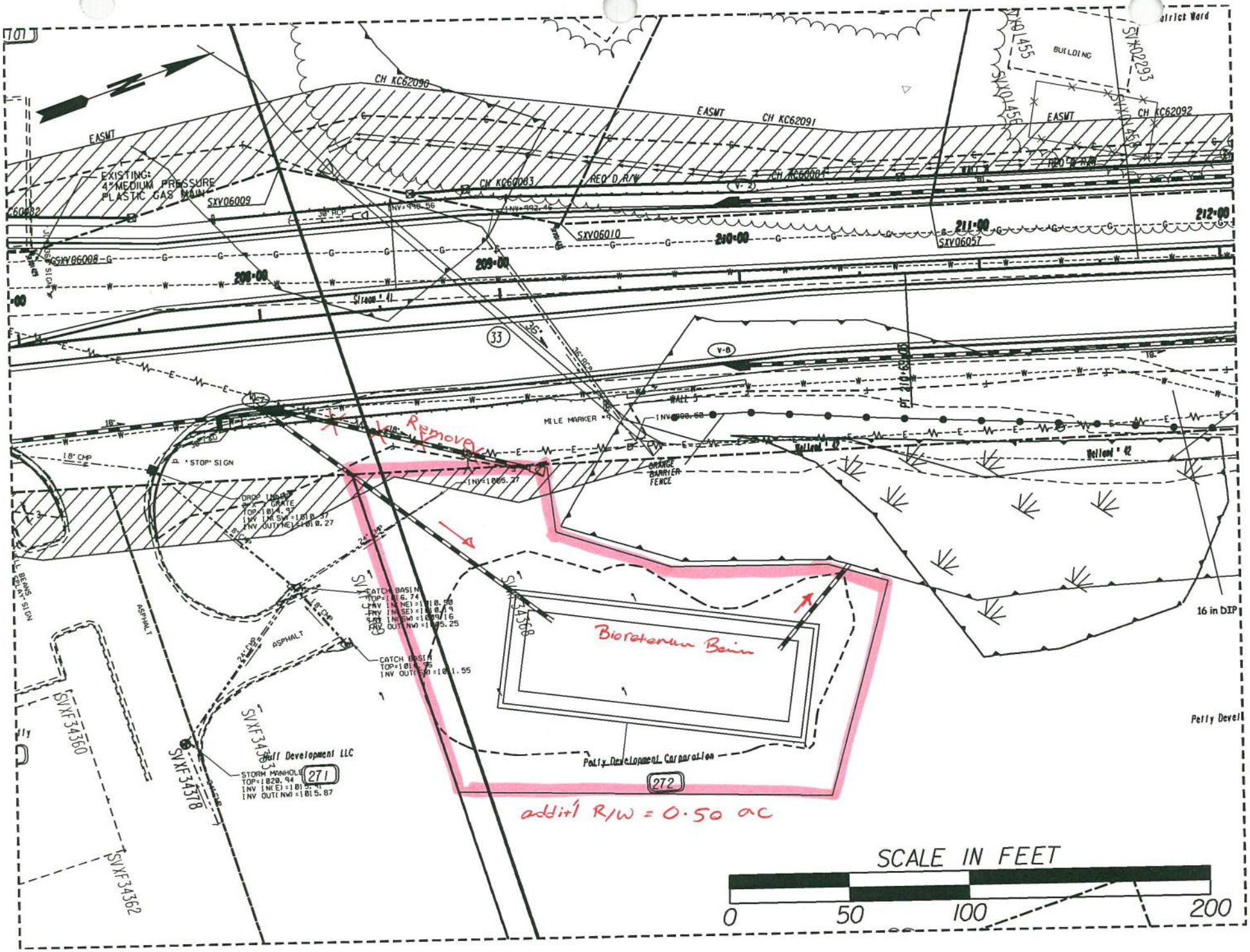

EASMT
CH KC62090
CH KC62091
CH KC62092
CH KC60083
CH KC60084
REQ'D R/W
EXISTING: 4" MEDIUM PRESSURE PLASTIC GAS MAIN
SXV06009
SXV06010
SXV06057
SXV06008
SXV01455
SXV02293
BUILDING
30" RCP
209+00
210+00
211+00
212+00
Stream #1
MILE MARKER #9
WALL 5
Wetland #2
ORANGE BARRIER FENCE
Remove
'STOP' SIGN
18" CMP
DROP INLET
CATCH BASIN
CATCH BASIN
STORM MANHOLE
ASPHALT
Biorotention Basin
Petty Development Corporation
Hoff Development LLC
16 in DIP
Petty Devel
SVXF34360
SVXF34361
SVXF34362
SVXF34363
SVXF34378
SVXF34368
271
272
additl R/W = 0.50 ac
SCALE IN FEET
0
50
100
200

Figure D-1.5

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin D1

Basin D1 800 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 49,500.00	$ 117,500.00	$ 66,250.00	$ 62,500.00
Utilities ✪	$ 61,327.70	$ -	$ -	$ -
Construction ✪	$ 522,659.31	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,700.00	$ 1,000.00	$ 2,500.00
Grading	$ -	$ 9,480.00	$ 12,120.00	$ 10,800.00
Drainage	$ -	$ 53,952.37	$ 47,542.00	$ 36,199.25
Total	$ 633,487.01	$ 185,632.37	$ 126,912.00	$ 111,999.25
	Percent of BMP Cost to Total	**29.3%**	**20.0%**	**17.7%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0
Sub Total:	$	-
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.38
Sub Total:	$	9,500.00
Commercial Right of Way @	$	125,000.00
		0.13
Sub Total:	$	16,250.00
Residential Perm Easmt @	$	62,500.00
		0.38
Sub Total:	$	23,750.00
Right of Way Cost Total:	$	49,500.00

✪ See General Summary Explaination for Cost Method

Figure D-1.6

BMP Construction Cost Worksheet Basin D1

Dry Enhanced Swale

Length:	1180	ft
Width:	8	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.94	Ac	
Total:	$ 117,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 117,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.94	Disturbed Ac	
$ 4,700.00		

Grading

Cut	Fill	
1220.000	360.000	
$ 6.00	per CY	
Total: $ 9,480.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	874	CY	$ 30.00	$ 19,423.87
Uddrn Sys w/ Gravel	-	1210	LF	$ 20.00	$ 24,200.00
Additional Pipe	18	60	LF	$ 52.00	$ 3,120.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	66	SY		66	SY
	$ 3,795.00			$ 313.50	

Sub Total: $ 53,952.37

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	33	38	ft
Width:	16	16	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.53	Ac	
Total:	$ 66,250.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 66,250.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.2	Disturbed Ac	
$ 1,000.00		

Grading

Cut	Fill	
1820.000	200.000	
$ 6.00	per CY	
Total: $ 12,120.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	29.33	CY	$ 45.00	$ 1,320.00
Uddrn Sys w/ Gravel	-	127	LF	$ 20.00	$ 2,540.00
Top Soil		5	CY	$ 20.00	$ 100.00
Outlet Pipe	18"	166	LF	$ 43.00	$ 7,138.00
Imperm Geotextile	-	528	SF	$ 5.00	$ 2,640.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	304	SY		304	SY
	$ 17,480.00			$ 1,444.00	

Sub Total: $ 47,542.00

Bioretention Area

Length:	113	ft
Width:	34	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.5	Ac	
Total:	$ 62,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 62,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.5	Disturbed Ac	
$ 2,500.00		

Grading

Cut	Fill	
1650.000	150.000	
$ 6.00	per CY	
Total: $ 10,800.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	285	CY	$ 30.00	$ 8,550.00
Uddrn Sys w/ Gravel	-	153	LF	$ 20.00	$ 3,060.00
Mulch	-	427	SY	$ 15.00	$ 6,405.00
Additional Pipe	18"	120	LF	$ 43.00	$ 5,160.00
Outlet Pipe	18"	46	LF	$ 43.00	$ 1,978.00
Shrubs	-	17	EA	$ 30.00	$ 510.00
Ground Cover	-	46	EA	$ 15.00	$ 690.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	65	SY		65	SY
	$ 3,737.50			$ 308.75	

Sub Total: $ 36,199.25

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin D2-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #S – The BMP would displace a residence if installed.

The ultimate outfall of Drainage Basin D-2-1 was located and the existing and proposed basin drainage areas were delineated (See Figures D-2-1.1 and D-2-1.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	5,086	5,086
Quantity	Channel Protection, CP_v	5,211	10,297
	Overbank Flood Protection, Q_{p25}	2,439	7,525
	Extreme Flood Protection, Q_{f100}	2,904	7,990

- The total area draining to the MS4 pond is 2.65 Ac. The total impervious area is 2.35 Ac. The existing pavement area for the site is 1.20 Ac. The area required for storage and quantity management is 1.45 Ac (See Figure D-2-1.3).
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 35' and minimum length of 125' (See Figure D-2-1.4). The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure D-2-1.4). The flow produced by the existing paved area of 1.20 Ac will not be detained and will pass through the overflow structure.
- The flow ultimately will flow into Powder Springs Creek on the upstream side of the bridge crossing instead of the downstream side.
- Additional pipes are required to separate the bypass flow from the treatment flow and to direct the treatment flow into the BMP. Some pipes will be removed from the existing design (See Figure D-2-1.5).
- Construction plans show a proposed retaining wall that reduces impacts to the property so the house can be saved.
- Displacement of a residence would be necessary for construction of the bioretention basin, making the basin infeasible (See Figure D2-1.5).
- None of the other infeasibility criteria apply to this basin.

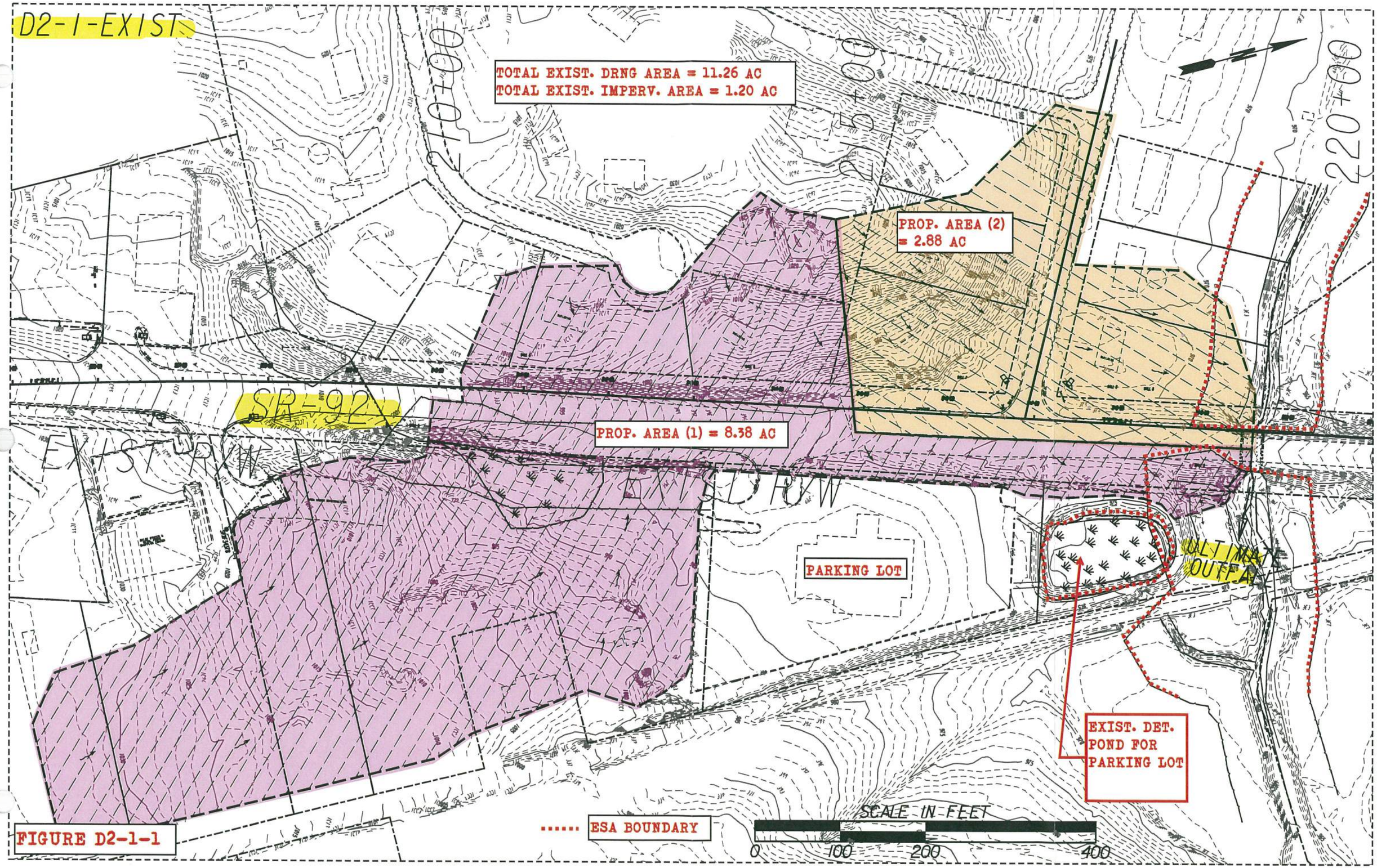

D2-1-EXIST
TOTAL EXIST. DRNG AREA = 11.26 AC
TOTAL EXIST. IMPERV. AREA = 1.20 AC
PROP. AREA (2) = 2.88 AC
SR-92
PROP. AREA (1) = 8.38 AC
EXIST. R/W
EXIST. R/W
PARKING LOT
ULTIMATE OUTFALL
EXIST. DET. POND FOR PARKING LOT
ESA BOUNDARY
SCALE IN FEET
0
100
200
400
220+00

FIGURE D2-1-1

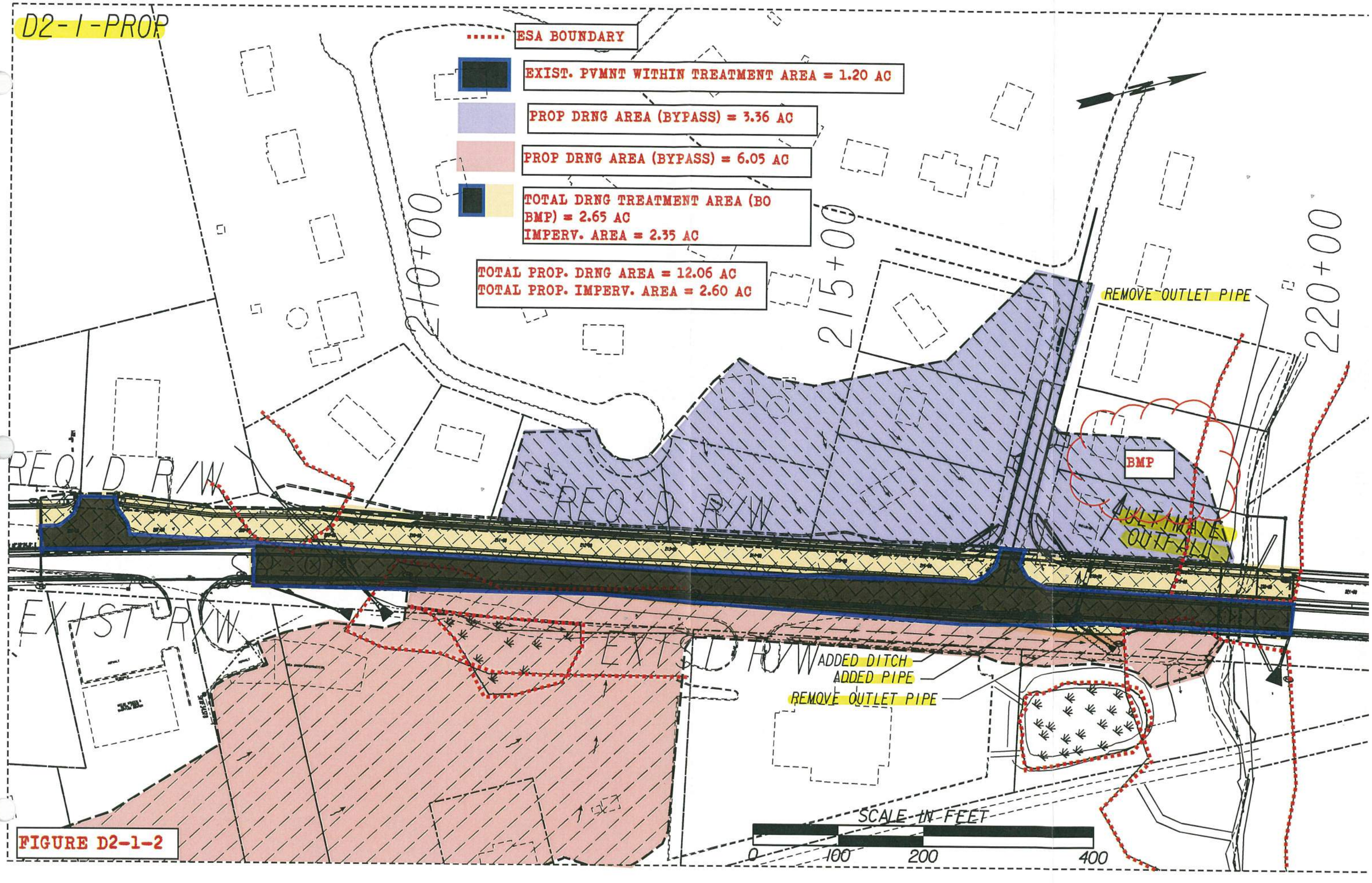

D2-1-PROP
ESA BOUNDARY
EXIST. PVMNT WITHIN TREATMENT AREA = 1.20 AC
PROP DRNG AREA (BYPASS) = 3.36 AC
PROP DRNG AREA (BYPASS) = 6.05 AC
TOTAL DRNG TREATMENT AREA (BO
BMP) = 2.65 AC
IMPERV. AREA = 2.35 AC
TOTAL PROP. DRNG AREA = 12.06 AC
TOTAL PROP. IMPERV. AREA = 2.60 AC
210+00
215+00
220+00
REMOVE OUTLET PIPE
BMP
ULTIMATE OUTFALL
REQ'D R/W
REQ'D R/W
EXIST R/W
EXIST R/W
ADDED DITCH
ADDED PIPE
REMOVE OUTLET PIPE
SCALE IN FEET
0
100
200
400

FIGURE D2-1-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D2-1

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	11.26
Impervious Area =	1.20
Pervious Area=	10.06

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.50 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.707

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.210	0.210
$I_a/P_{10\text{-}yr}$=	0.128	0.130
$I_a/P_{25\text{-}yr}$=	0.109	0.110
$I_a/P_{100\text{-}yr}$=	0.089	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.54

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.14
$Q_{d\ 10\text{-}yr}$=	2.77
$Q_{d\ 25\text{-}yr}$=	3.58
$Q_{d\ 100\text{-}yr}$ =	4.84

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	500
$q_{u10\text{-}yr}$=	520
$q_{u25\text{-}yr}$=	530
$q_{u100\text{-}yr}$=	540

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	10.00
$Q_{p10\text{-}yr}$=	25.38
$Q_{p25\text{-}yr}$=	33.38
$Q_{p100\text{-}yr}$=	45.98

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	12.06
Impervious Area =	2.60
Pervious Area =	9.46
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.60 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.603

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.180	0.180
$I_a/P_{10\text{-}yr}$=	0.109	0.110
$I_a/P_{25\text{-}yr}$=	0.093	0.100
$I_a/P_{100\text{-}yr}$=	0.076	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.02

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.32
$Q_{d\ 10\text{-}yr}$=	3.05
$Q_{d\ 25\text{-}yr}$=	3.88
$Q_{d\ 100\text{-}yr}$ =	5.18

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	450
$q_{u10\text{-}yr}$=	470
$q_{u25\text{-}yr}$=	470
$q_{u100\text{-}yr}$=	475

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	11.16	0.896
$Q_{p10\text{-}yr}$=	26.98	
$Q_{p25\text{-}yr}$=	34.39	
$Q_{p100\text{-}yr}$=	46.37	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.65	Acre
Total Impervious Area - A_{POST}	2.35	Acre
Existing Pavement Area - A_{PRE} (5)	1.20	Acre
Area Required for Quantity - A_{QUAN} (4)	1.45	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.65	0.43	43.40	0.00	0.441	0.117	5,086

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) $R_v = 0.05 + 0.009\ (I)$

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.971	0.10	0.049	2,122

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 2,439

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

q_o/q_i: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$

V_s/V_r= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.104	4,531

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 5,211

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

q_o/q_i: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

V_s/V_r= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.992	0.09	0.058	2,525

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} \cdot A_{QUAN}}{12}$$

(+15% ED)= 2,904

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

q_o/q_i: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$

V_s/V_r= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure D-2-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D2-1

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	5,086	5,086
CP_v	5,211	10,297
Q_{p25}	2,439	7,525
Q_{p100}	2,904	7,990

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	1340	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	10301	ft^3	>	10297	ft^3

Swale Dimensions:

A swale that is **1340** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	10,297	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **587** ft^2

Actual Filter Bed Dimensions:	Width	17	ft
	Length	35	ft
		595	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **680** ft^2

Actual Sediment Chamber Dimensions:	Width	17	ft
	Length	40	ft
		680	ft^2

Bioretention Area

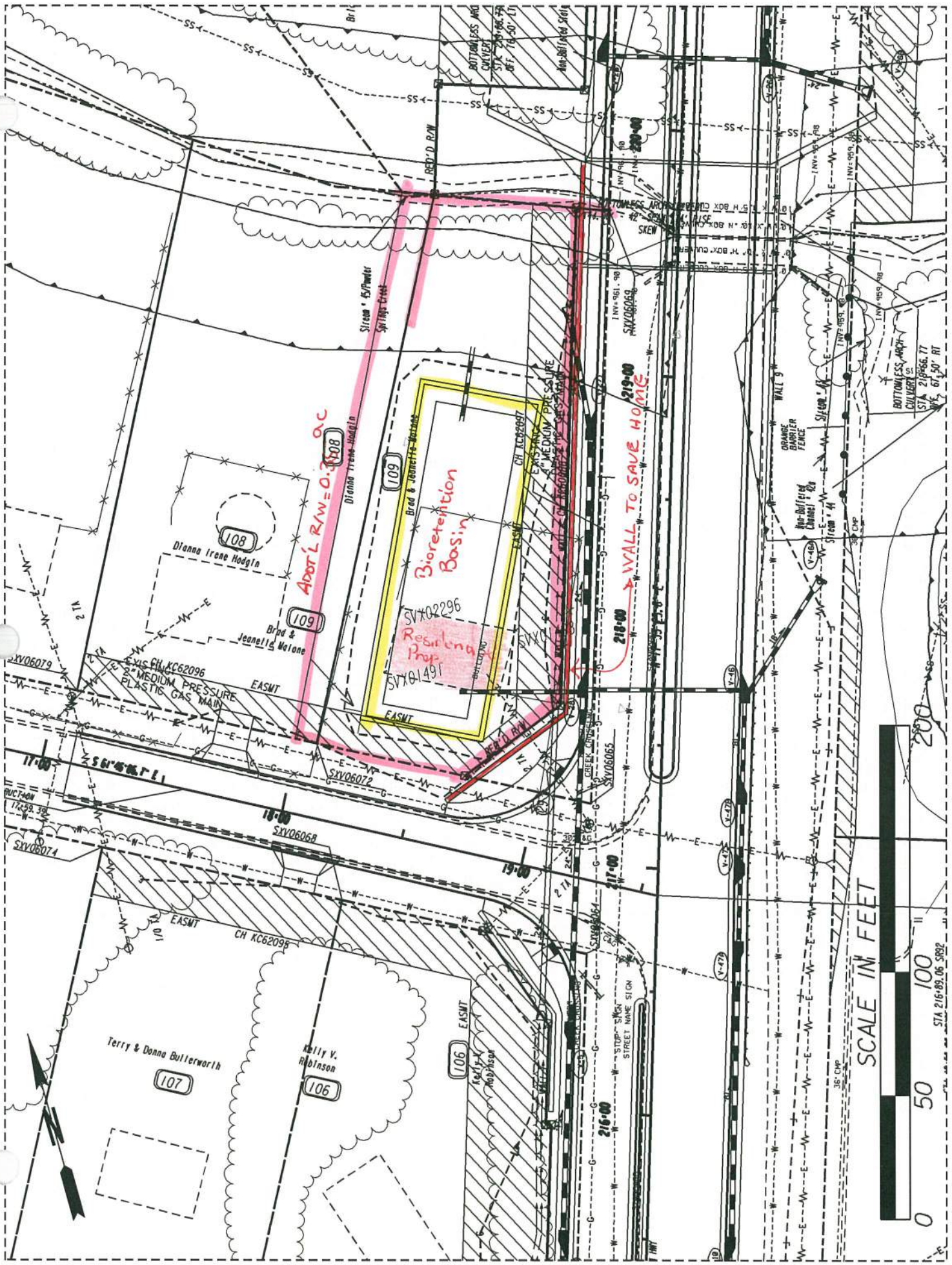
CP_v	=	10,297	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,336** ft^2

Actual Filter Bed Dimensions:	Width	35	ft
	Length	125	ft
		4375	ft^2

Figure D-2-1.S


ADD'L R/W=0.3 AC
WALL TO SAVE HOME
Bioretention Basin
SVX02296
Residential Prop.
SVX01491
Dianna Irene Hodgin
Brad & Jeanette Malone
Terry & Donna Butterworth
Kelly V. Robinson
108
109
107
106
EASWT
CH KC62096
EXIS CH KC62097
EXISTING 2" MEDIUM PRESSURE PLASTIC GAS MAIN
REQ'D R/W
SVX06079
SVX06072
SVX06068
SVX06071
SVX06065
SVX06064
SVX06069
Stream "15/Powder Springs Creek"
Stream "H"
Non-Buffered Channel "K"
BOTTOMLESS ARCH CULVERT
ORANGE BARRIER FENCE
WALL 9
STOP SIGN
STREET NAME SIGN
SCALE IN FEET
0
50
100
200
STA 216+89.06 SR92

Infeasibility Criteria #1: Cost of Construction
Basin D2-1

11/13/2014

Basin D2-1 1300 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 148,250.00	$ 145,000.00	$ 23,750.00	$ 21,250.00
Utilities ✪	$ 99,657.51	$ -	$ -	$ -
Construction ✪	$ 849,321.38	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 6,500.00	$ 2,000.00	$ 1,750.00
Grading	$ -	$ 9,060.00	$ 3,990.00	$ 3,600.00
Drainage	$ -	$ 61,324.11	$ 45,417.50	$ 34,049.25
Total	$ 1,097,228.89	$ 221,884.11	$ 75,157.50	$ 60,649.25
Percent of BMP Cost to Total		**20.2%**	**6.8%**	**5.5%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.4
Sub Total:	$	20,000.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0.83
Sub Total:	$	20,750.00
Commercial Right of Way @	$	125,000.00
		0.44
Sub Total:	$	55,000.00
Commercial Perm Easmt @	$	62,500.00
		0.2
Sub Total:	$	12,500.00
Right of Way Cost Total:	$	148,250.00

✪ See General Summary Explaination for Cost Method

Figure D-2-1

Figure D-2-1.7

BMP Construction Cost Worksheet Basin D2-1

Dry Enhanced Swale

Length:	1340	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	1.3	Ac	
Total:	$ 65,000.00		
Residential Relocation @	$ 40,000.00	each	
	2	EA	
Total:	$ 80,000.00		
Sub Total:	$ 145,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.3	Disturbed Ac	
$ 6,500.00		

Grading

Cut	Fill	
950.000	560.000	
$ 6.00	per CY	
Total: $ 9,060.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	993	CY	$ 30.00	$ 22,057.61
Uddrn Sys w/ Gravel	-	1370	LF	$ 20.00	$ 27,400.00
Additional Pipe	18	80	LF	$ 52.00	$ 4,160.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	74	SY		74	SY
	$ 4,255.00			$ 351.50	

Sub Total: $ 61,324.11

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	35	40	ft
Width:	17	17	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.4	Ac	
Total:	$ 20,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.15	Ac	
Total:	$ 3,750.00		
Sub Total:	$ 23,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.4	Disturbed Ac	
$ 2,000.00		

Grading

Cut	Fill	
220.000	445.000	
$ 6.00	per CY	
Total: $ 3,990.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	33.06	CY	$ 45.00	$ 1,487.50
Uddrn Sys w/ Gravel	-	132	LF	$ 20.00	$ 2,640.00
Top Soil		6	CY	$ 20.00	$ 120.00
Outlet Pipe	18"	50	LF	$ 43.00	$ 2,150.00
Imperm Geotextile	-	595	SF	$ 5.00	$ 2,975.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	340	SY		340	SY
	$ 19,550.00			$ 1,615.00	

Sub Total: $ 45,417.50

Bioretention Area

Length:	125	ft
Width:	35	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.35	Ac	
Total:	$ 17,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.15	Ac	
Total:	$ 3,750.00		
Sub Total:	$ 21,250.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.35	Disturbed Ac	
$ 1,750.00		

Grading

Cut	Fill	
200.000	400.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	325	CY	$ 30.00	$ 9,750.00
Uddrn Sys w/ Gravel	-	157.5	LF	$ 20.00	$ 3,150.00
Mulch	-	487	SY	$ 15.00	$ 7,305.00
Additional Pipe	18"	20	LF	$ 43.00	$ 860.00
Outlet Pipe	18"	30	LF	$ 43.00	$ 1,290.00
Shrubs	-	19	EA	$ 30.00	$ 570.00
Ground Cover	-	52	EA	$ 15.00	$ 780.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	73	SY		73	SY
	$ 4,197.50			$ 346.75	

Sub Total: $ 34,049.25

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin D2-S Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin D-2-5 was located and the existing and proposed basin drainage areas were delineated (See Figures D-2-5.1 and D-2-5.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,435	3,435
Quantity	Channel Protection, CP_v	6,482	9,917
	Overbank Flood Protection, Q_{p25}	4,991	8,426
	Extreme Flood Protection, Q_{f100}	6,154	9,589

- The total area draining to the MS4 BMP is 2.09 Ac. The total impervious area is 1.44 Ac. The existing pavement area for the site is 0.68 Ac. The area required for storage and quantity management is 1.41 Ac (See Figure D-2-5.3).
- The flow produced by the existing paved area of 0.68 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area with a bottom width of 35' and minimum length of 120' (See Figure D-2-5.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure D-2-5.4).
- Initially it was thought that the BMP would go on the right side, sandwiched in between the proposed project and Maxwell Rd. However after studying the area, it was concluded that in order to install a BMP here, Maxwell Rd will need to be realigned.
- A less costly option would be to put the swale on the left side of the road and modify the drainage design slightly (See Figure D-2-5.5).
- The BMP construction cost is 10.9% of the roadway construction cost within this basin making this basin infeasible (See Figure D-2-5.6).
- None of the other infeasibility criteria apply to this basin.

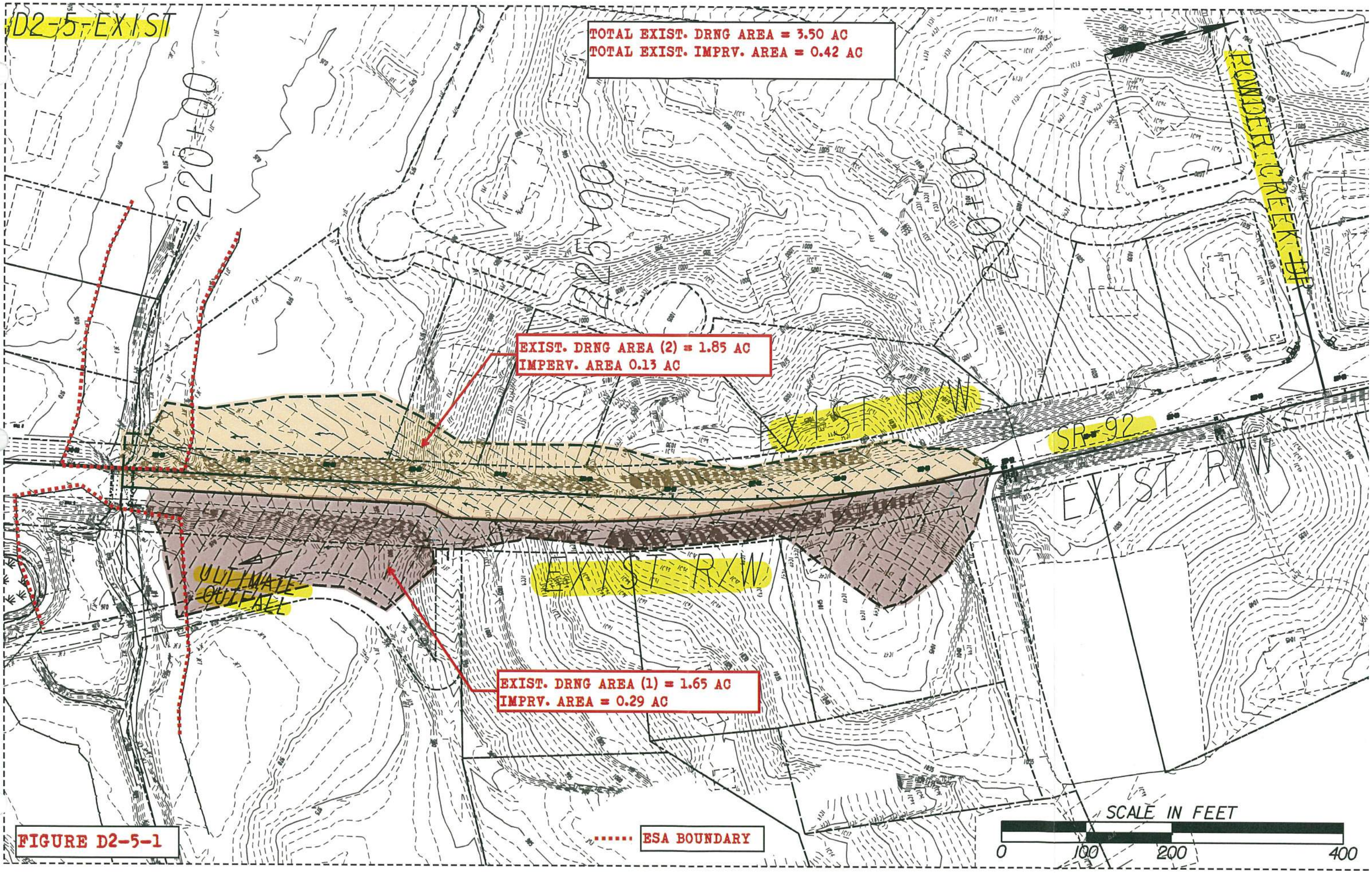

D2-5-EXIST
TOTAL EXIST. DRNG AREA = 3.50 AC
TOTAL EXIST. IMPRV. AREA = 0.42 AC
220+00
240+00
260+00
POWDER CREEK #4
EXIST. DRNG AREA (2) = 1.85 AC
IMPERV. AREA 0.13 AC
EXIST R/W
SR-92
EXIST R/W
EXIST R/W
ULTIMATE OUTFALL
EXIST. DRNG AREA (1) = 1.65 AC
IMPRV. AREA = 0.29 AC
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE D2-5-1

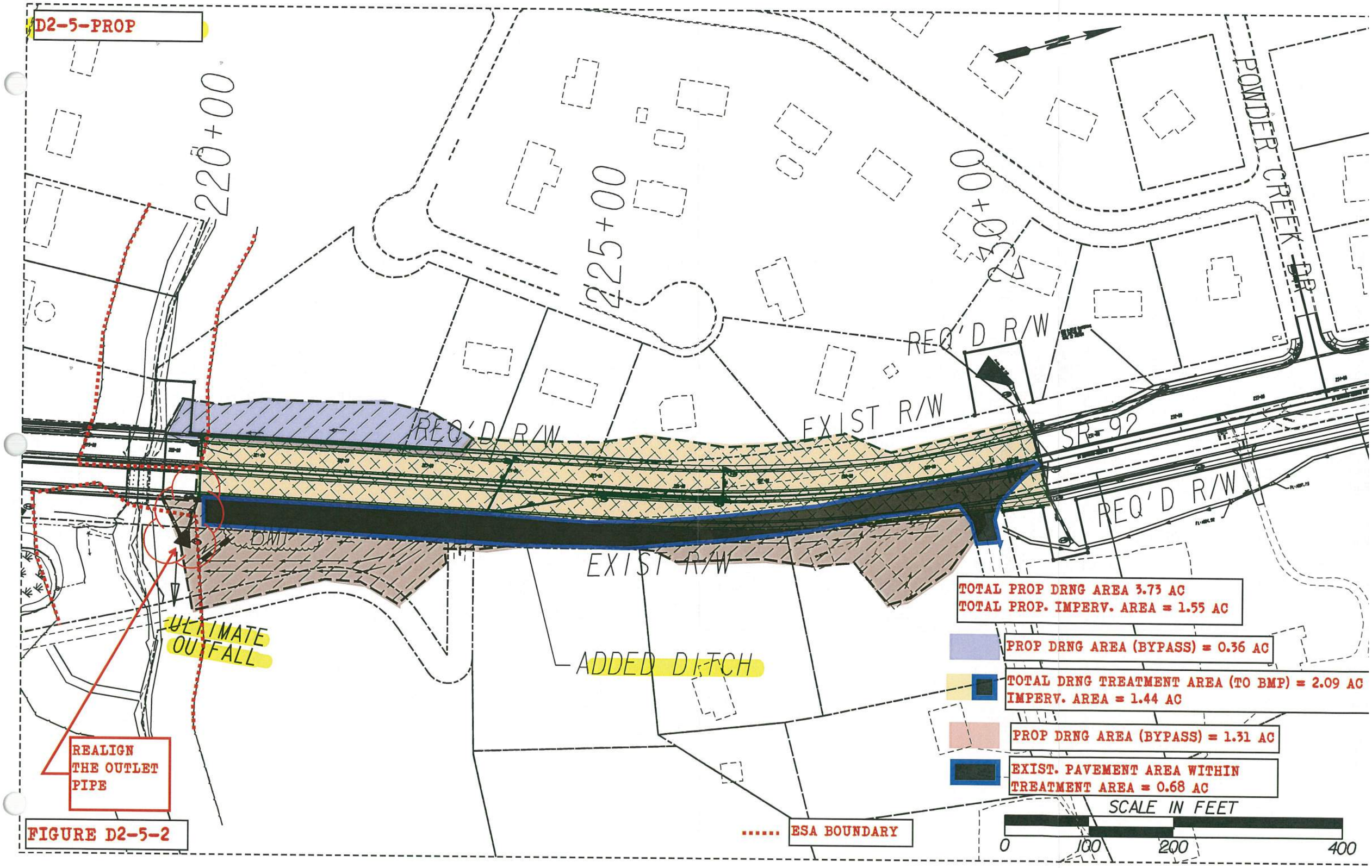

D2-5-PROP
220+00
225+00
230+00
POWDER CREEK DR
REQ'D R/W
EXIST R/W
SR 92
REQ'D R/W
REQ'D R/W
EXIST R/W
BMP
ULTIMATE OUTFALL
ADDED DITCH
REALIGN THE OUTLET PIPE
TOTAL PROP DRNG AREA 3.73 AC
TOTAL PROP. IMPERV. AREA = 1.55 AC
PROP DRNG AREA (BYPASS) = 0.36 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.09 AC
IMPERV. AREA = 1.44 AC
PROP DRNG AREA (BYPASS) = 1.31 AC
EXIST. PAVEMENT AREA WITHIN TREATMENT AREA = 0.68 AC
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE D2-5-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *D2-5*

Unified Stormwater Sizing Criteria

Table B

PI: 621720

Nov-14

Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	3.5
Impervious Area =	0.42
Pervious Area=	3.08

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.17 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.694

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.207	0.21
$I_a/P_{10\text{-}yr}$=	0.126	0.13
$I_a/P_{25\text{-}yr}$=	0.107	0.11
$I_a/P_{100\text{-}yr}$=	0.088	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.47

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.16
$Q_{d\ 10\text{-}yr}$=	2.81
$Q_{d\ 25\text{-}yr}$=	3.62
$Q_{d\ 100\text{-}yr}$ =	4.88

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	800
$q_{u10\text{-}yr}$=	840
$q_{u25\text{-}yr}$=	845
$q_{u100\text{-}yr}$=	850

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	5.07
$Q_{p10\text{-}yr}$=	12.90
$Q_{p25\text{-}yr}$=	16.71
$Q_{p100\text{-}yr}$=	22.69

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)		
Total Area =	3.73	12.05
Impervious Area =	1.55	
Pervious Area =	2.18	
Credit Area =	0.00	

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	82

Time of Concentration (See Table A) = 0.17 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.433

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.129	0.13
$I_a/P_{10\text{-}yr}$=	0.078	0.1
$I_a/P_{25\text{-}yr}$=	0.067	0.1
$I_a/P_{100\text{-}yr}$=	0.055	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.16

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.68
$Q_{d\ 10\text{-}yr}$=	3.57
$Q_{d\ 25\text{-}yr}$=	4.45
$Q_{d\ 100\text{-}yr}$ =	5.81

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	840
$q_{u10\text{-}yr}$=	850
$q_{u25\text{-}yr}$=	850
$q_{u100\text{-}yr}$=	850

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	8.24
$Q_{p10\text{-}yr}$=	17.69
$Q_{p25\text{-}yr}$=	22.07
$Q_{p100\text{-}yr}$=	28.78

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area (FOR D2-5)

Total Drainage Treatment Area - A_{TA}	2.09	Acre
Total Impervious Area - A_{POST}	1.44	Acre
Existing Pavement Area - A_{PRE} (5)	0.68	Acre
Area Required for Quantity - A_{QUAN} (4)	1.41	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.09	0.36	36.36	0.00	0.377	0.079	3,435

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.129	5,637

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,482

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.757	0.19	0.100	4,341

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,991

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.788	0.18	0.123	5,351

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,154

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure D-2-5.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D2-5

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	3,435	3,435
CP_v	6,482	9,917
Q_{p25}	4,991	8,426
Q_{f100}	6,154	9,589

Dry Enhanced Swale

Average Depth	=	0.75	ft
Length	=	1295	ft
Width	=	8	ft
Left Side Slope	=	3	:1
Right Side Slope	=	3	:1
Area	=	7.6875	ft^2
Slope	=	0.01	ft/ft
Storage Volume	=	9955	ft^3 > 9917 ft^3

Swale Dimensions:

A swale that is 1295 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	9,917	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **566** ft^2

Actual Filter Bed Dimensions:	Width	17	ft
	Length	34	ft
		578	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **655** ft^2

Actual Sediment Chamber Dimensions:	Width	17	ft
	Length	39	ft
		663	ft^2

Bioretention Area

CP_v	=	9,917	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,176** ft^2

Actual Filter Bed Dimensions:	Width	35	ft
	Length	120	ft
		4200	ft^2

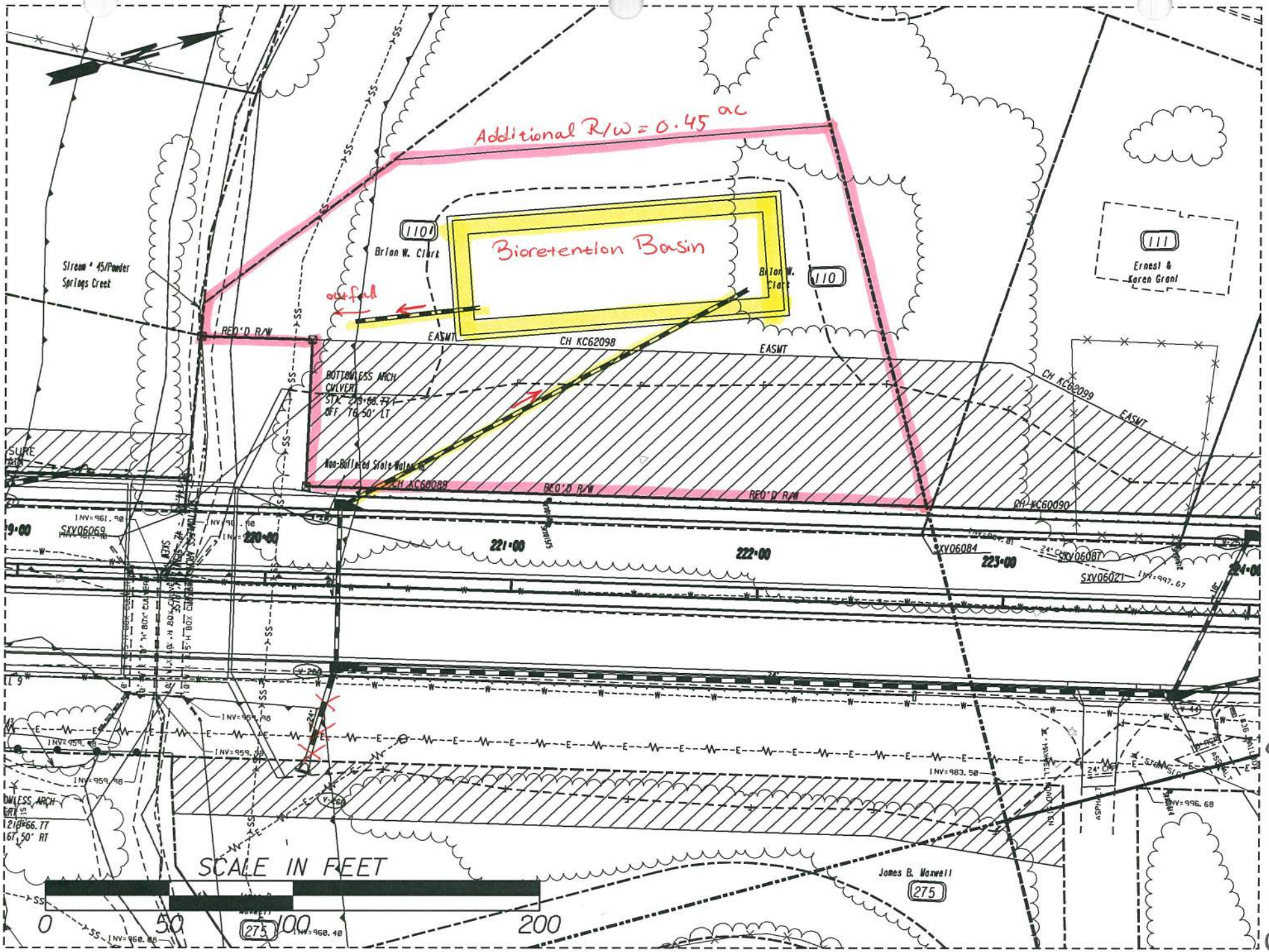

Additional R/W = 0.45 ac
Bioretention Basin
outfall
110A
Brian W. Clark
110
Brian W. Clark
111
Ernest & Karen Grant
Stream # 45/Powder Springs Creek
REQ'D R/W
EASMT
CH KC62098
EASMT
BOTTOMLESS ARCH CULVERT
Non-Balanced Stole Water
CH KC60088
REQ'D R/W
REQ'D R/W
CH KC62099
EASMT
CH KC60090
SXV06069
220+00
221+00
222+00
SXV06084
223+00
SXV06087
SXV06071
INV=997.67
INV=961.90
INV=983.50
INV=996.68
James B. Maxwell
275
SCALE IN FEET
0
50
100
200

Figure D-2.5.5

Infeasibility Criteria #1: Cost of Construction
Basin D2-5

11/13/2014

Basin D2-5 900 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 84,750.00	$ 36,500.00	$ 34,500.00	$ 32,500.00
Utilities ✪	$ 68,993.66	$ -	$ -	$ -
Construction ✪	$ 587,991.72	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 3,050.00	$ 2,450.00	$ 2,250.00
Grading	$ -	$ 9,600.00	$ 6,420.00	$ 6,270.00
Drainage	$ -	$ 61,638.87	$ 51,170.88	$ 39,562.50
Total	$ 741,735.39	$ 110,788.87	$ 94,540.88	$ 80,582.50
	Percent of BMP Cost to Total	**14.9%**	**12.7%**	**10.9%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.19
Sub Total:	$	9,500.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		1.41
Sub Total:	$	35,250.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	84,750.00

✪ See General Summary Explaination for Cost Method

Figure D-25

Figure D-2-5

BMP Construction Cost Worksheet Basin D2-5

Dry Enhanced Swale

Length:	1295	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.61	Ac	
Total:	$ 30,500.00		
Residential Perm Easemet @	$ 25,000.00	per Ac	
	0.24	Ac	
Total:	$ 6,000.00		
Sub Total:	$ 36,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.61	Disturbed Ac	
$ 3,050.00		

Grading

Cut	Fill	
350.000	1250.000	
$ 6.00	per CY	
Total: $ 9,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	959	CY	$ 30.00	$ 21,316.87
Uddrn Sys w/ Gravel	-	1325	LF	$ 20.00	$ 26,500.00
Additional Pipe	18	120	LF	$ 52.00	$ 6,240.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	72	SY		72	SY
	$ 4,140.00			$ 342.00	

Sub Total: $ 61,638.87

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	34	39	ft
Width:	17	17	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.49	Ac	
Total:	$ 24,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.4	Ac	
Total:	$ 10,000.00		
Sub Total:	$ 34,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.49	Disturbed Ac	
$ 2,450.00		

Grading

Cut	Fill	
440.000	630.000	
$ 6.00	per CY	
Total: $ 6,420.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	32.11	CY	$ 45.00	$ 1,445.00
Uddrn Sys w/ Gravel	-	130	LF	$ 20.00	$ 2,600.00
Top Soil		6	CY	$ 20.00	$ 120.00
Outlet Pipe	18"	200	LF	$ 43.00	$ 8,600.00
Imperm Geotextile	-	578	SF	$ 5.00	$ 2,890.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	331.5	SY		331.5	SY
	$ 19,061.25			$ 1,574.63	

Sub Total: $ 51,170.88

Bioretention Area

Length:	120	ft
Width:	35	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.45	Ac	
Total:	$ 22,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.4	Ac	
Total:	$ 10,000.00		
Sub Total:	$ 32,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.45	Disturbed Ac	
$ 2,250.00		

Grading

Cut	Fill	
425.000	620.000	
$ 6.00	per CY	
Total: $ 6,270.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	312	CY	$ 30.00	$ 9,360.00
Uddrn Sys w/ Gravel	-	157.5	LF	$ 20.00	$ 3,150.00
Mulch	-	467	SY	$ 15.00	$ 7,005.00
Additional Pipe	18"	150	LF	$ 43.00	$ 6,450.00
Outlet Pipe	18"	50	LF	$ 43.00	$ 2,150.00
Shrubs	-	18	EA	$ 30.00	$ 540.00
Ground Cover	-	50	EA	$ 15.00	$ 750.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	70	SY		70	SY
	$ 4,025.00			$ 332.50	

Sub Total: $ 39,562.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin D3 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin D3 was located and the existing and proposed basin drainage areas were delineated (See Figures D-3.1 and D-3.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	11,607	11,607
Quantity	Channel Protection, CP_v	13,133	24,740
	Overbank Flood Protection, Q_{p25}	12,146	23,753
	Extreme Flood Protection, Q_{f100}	15,261	26,868

- The total area draining to the MS4 BMP is 3.70 Ac. The total impervious area is 3.36 Ac. The existing pavement area for the site is 0.61 Ac. The area required for storage and quantity management is 3.10 Ac (See Figure D-3.3).
- The flow produced by the existing paved area of 0.61 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Extreme Flood Protection Volume. Because the Extreme Flood Protection volume is the largest volume, it triggers a 10 times downstream analysis to determine if an increase in flow would cause an adverse effect to homes and properties downstream of the project. To do the downstream analysis normally a point that is 10 times the site area is located and studied for increased flows. However in this case a stream was reached that has a large upland drainage area. It was decided to do the downstream analysis at the confluence point with the stream and to include the upland area.
- The analysis showed that the flows would not cause a downstream increase of more than 5%, and that detention would not be necessary (See Figure D-3.4).
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 60' and minimum length of 175' (See Figure D-3.7). The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure D-3.9).
- The BMP construction cost is 18.0% of the roadway construction cost within this basin making this basin infeasible (See Figure D-3.9).
- None of the other infeasibility criteria apply to this basin.

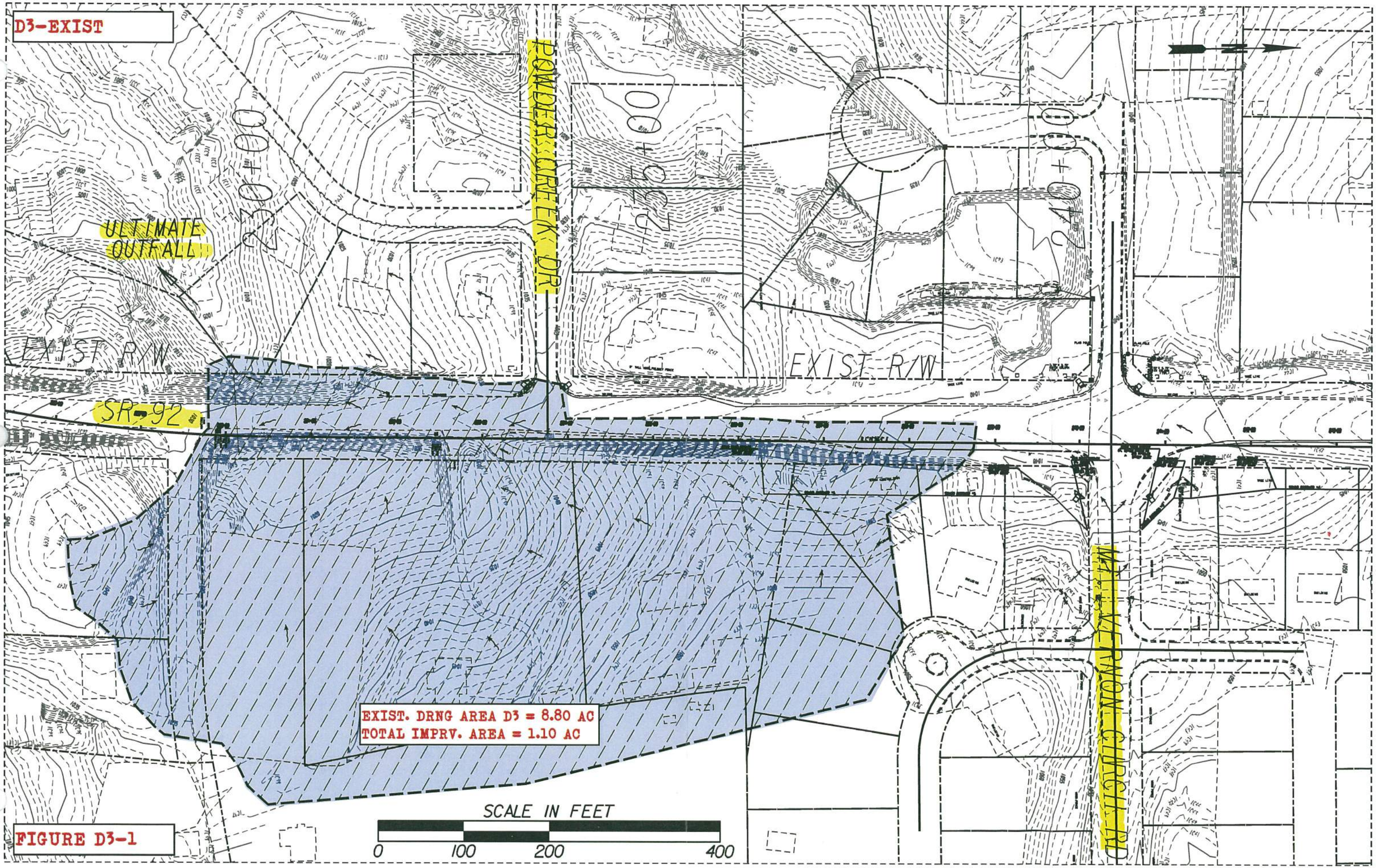

D3-EXIST
ULTIMATE OUTFALL
POWDER CREEK DR
EXIST R/W
EXIST R/W
SR-92
EXIST. DRNG AREA D3 = 8.80 AC
TOTAL IMPRV. AREA = 1.10 AC
SCALE IN FEET
0
100
200
400

FIGURE D3-1

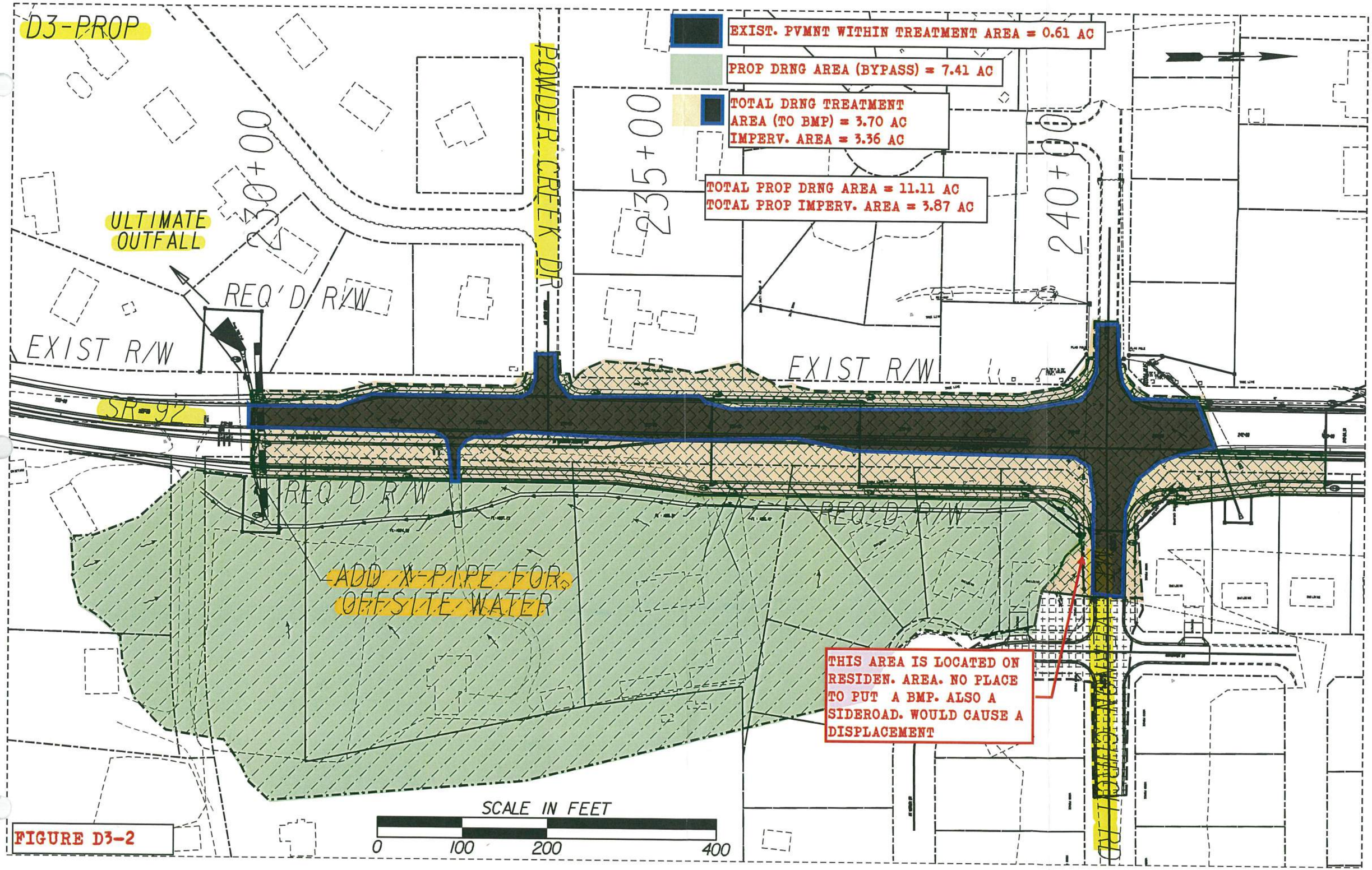

D3-PROP
EXIST. PVMNT WITHIN TREATMENT AREA = 0.61 AC
PROP DRNG AREA (BYPASS) = 7.41 AC
TOTAL DRNG TREATMENT
AREA (TO BMP) = 3.70 AC
IMPERV. AREA = 3.36 AC
TOTAL PROP DRNG AREA = 11.11 AC
TOTAL PROP IMPERV. AREA = 3.87 AC
POWDER CREEK DR
230+00
235+00
240+00
ULTIMATE
OUTFALL
REQ'D R/W
EXIST R/W
EXIST R/W
SR-92
REQ'D R/W
REQ'D R/W
ADD X-PIPE FOR
OFFSITE WATER
THIS AREA IS LOCATED ON
RESIDEN. AREA. NO PLACE
TO PUT A BMP. ALSO A
SIDEROAD. WOULD CAUSE A
DISPLACEMENT
SCALE IN FEET
0
100
200
400

FIGURE D3-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *D3*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: **FR**

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	8.8
Impervious Area =	1.1
Pervious Area=	7.7

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.20 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.689

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.205	0.21
$I_a/P_{10\text{-}yr}$=	0.125	0.13
$I_a/P_{25\text{-}yr}$=	0.106	0.11
$I_a/P_{100\text{-}yr}$=	0.087	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.45

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.17
$Q_{d\ 10\text{-}yr}$=	2.82
$Q_{d\ 25\text{-}yr}$=	3.63
$Q_{d\ 100\text{-}yr}$ =	4.90

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	750
$q_{u10\text{-}yr}$=	770
$q_{u25\text{-}yr}$=	785
$q_{u100\text{-}yr}$=	800

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	12.03
$Q_{p10\text{-}yr}$=	29.86
$Q_{p25\text{-}yr}$=	39.19
$Q_{p100\text{-}yr}$=	53.87

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	11.11
Impervious Area =	3.87
Pervious Area =	7.24
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	80

Time of Concentration (See Table A) = 0.20 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.487

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.145	0.15
$I_a/P_{10\text{-}yr}$=	0.088	0.1
$I_a/P_{25\text{-}yr}$=	0.075	0.1
$I_a/P_{100\text{-}yr}$=	0.062	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.44

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.55
$Q_{d\ 10\text{-}yr}$=	3.39
$Q_{d\ 25\text{-}yr}$=	4.26
$Q_{d\ 100\text{-}yr}$ =	5.60

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	760
$q_{u10\text{-}yr}$=	800
$q_{u25\text{-}yr}$=	800
$q_{u100\text{-}yr}$=	800

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	20.50
$Q_{p10\text{-}yr}$=	47.09
$Q_{p25\text{-}yr}$=	59.16
$Q_{p100\text{-}yr}$=	77.73

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	3.70	Acre
Total Impervious Area - A_{POST}	3.36	Acre
Existing Pavement Area - A_{PRE} (5)	0.61	Acre
Area Required for Quantity - A_{QUAN} (4)	3.10	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
3.70	0.74	74.46	0.00	0.720	0.266	**11,607**

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.262	**11,420**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **13,133**

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.662	0.22	0.242	**10,562**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **12,146**

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.693	0.21	0.305	**13,270**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **15,261**

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Outfall D-3
10X Downstream Analysis Conclusions

The drainage areas were delineated using a combination of the USGS quadrangle maps and the existing contours. The site area of the drainage outfall is 11.11 Ac. The 10 times watershed basin analysis area is 111.10 Ac, however Powder Springs Creek is reached before the 10 times basin area can be reached. The drainage area for Powder Springs Creek is 3.09 Sq. Miles.

Curve number calculations for the downstream analysis have been included along with the hydrographs depicting the pre and post conditions of the 25 and 100 year storms.

Per GDOT requirements, Storm Detention is required when adverse impacts are caused by the post-development flow and where downstream structures are subject to increased depth of flooding. The following table summarizes the results of the downstream analysis.

Outfall D-3	Storm Return Frequency	Pre-Developed Peak Discharge (cfs)	Post-Developed Peak Discharge (cfs)	Discharge Increase (cfs)	% Increase
Downstream Analysis	25	1282.44	1282.44	0	0
	100	1720.25	1720.25	0	0

The analysis of the 10X downstream conditions reflects an increase of 0% for both the 25 and the 100 year return periods, which represent the Overbank Flood Protection and the Extreme Flood Protection, respectively. The discharge increase for both storm frequency's is below the GDOT maximum and will not adversely affect the downstream watershed so therefore detention will not be provided at this location.

Figure D-3.5

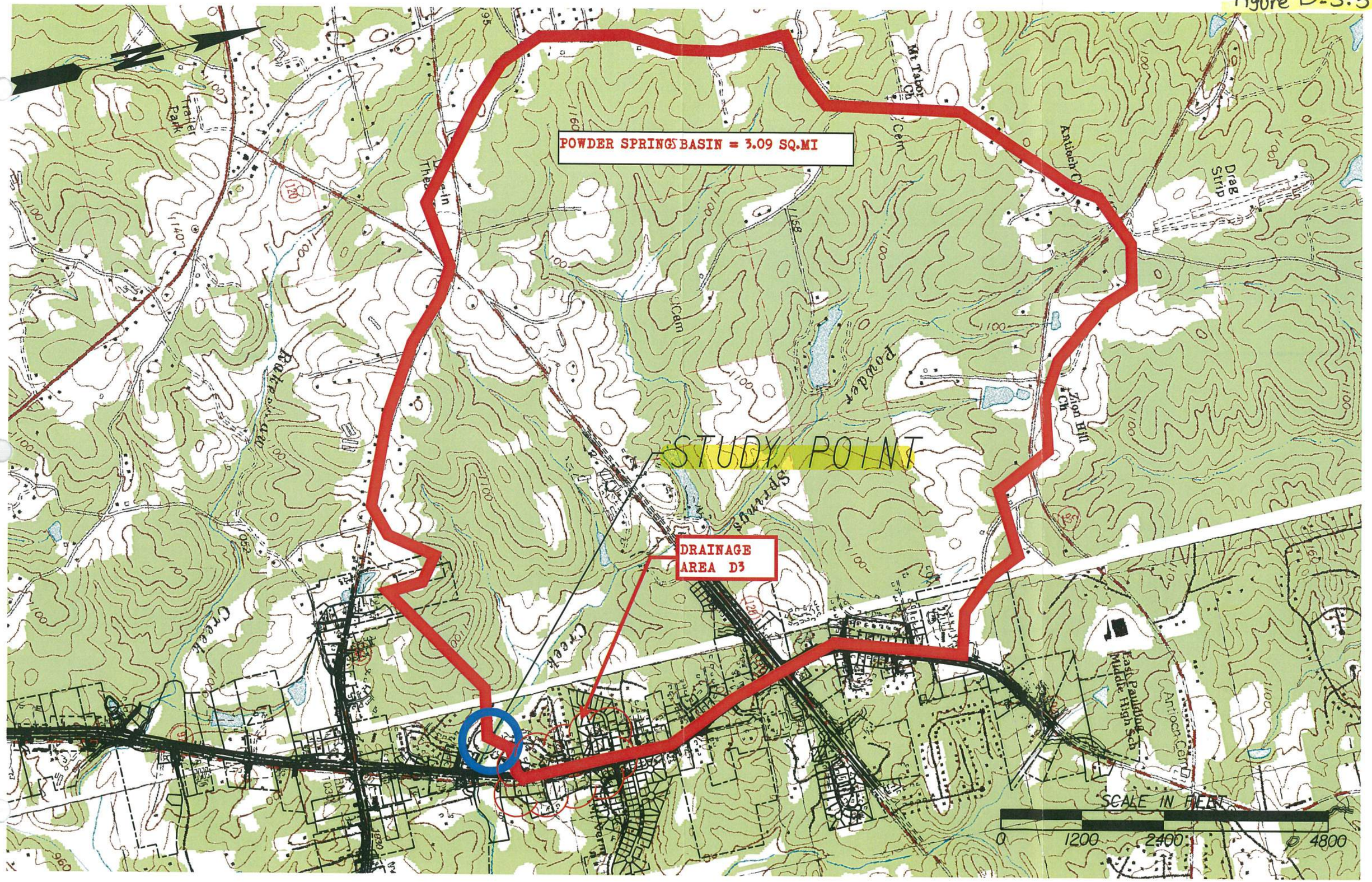

POWDER SPRINGS BASIN = 3.09 SQ.MI
STUDY POINT
DRAINAGE AREA D3
Trailer Park
Mt Tabor Ch
Cem
Antioch Ch
Drag Strip
Zion Hill Ch
Powder
Springs
Creek
Cem
East Paulding Middle High Sch
Antioch Cem
SCALE IN FEET
0
1200
2400
4800

Figure D-3.6

Curve Number Calculation
10X Downstream Assessment for Outfall D3

Nov-14

PRE-CONDITION type "C" soil group	TOTAL AREA 1980.0 Ac	
	IMPERVIOUS AREA 288.77 Ac	98
	RESIDENTIAL AREA 388 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 1303.23	71
	COMPOSITE PRE CN	77

POST-CONDITION type "C" soil group	TOTAL AREA 1980 Ac	
	IMPERVIOUS AREA 286 Ac	98
	RESIDENTIAL AREA 388 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 1306	71
	COMPOSITE PRE CN	77

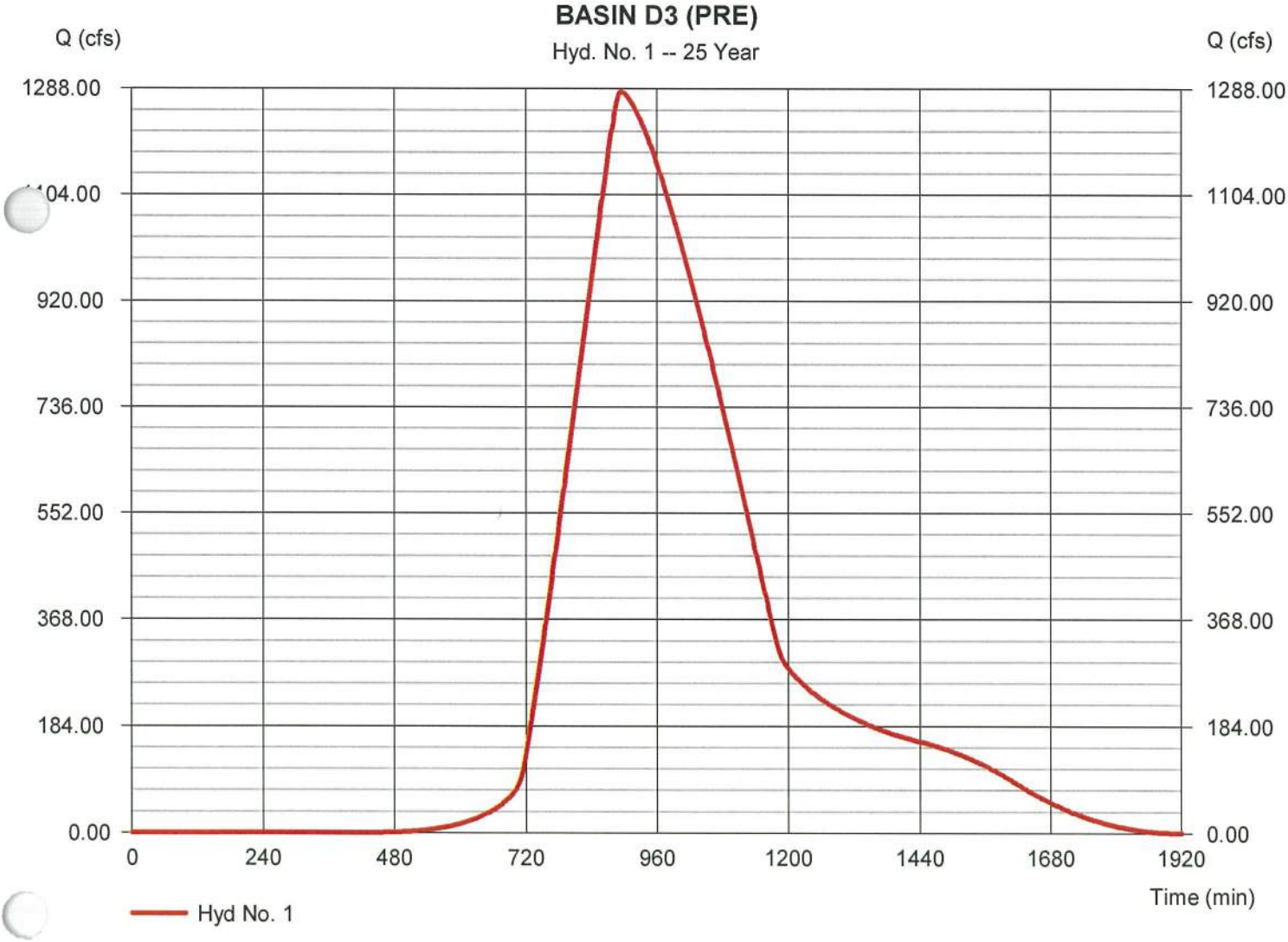
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 11 / 18 / 2014

Hyd. No. 1

BASIN D3 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 1282.44 cfs
Storm frequency	= 25 yrs	Time to peak	= 894 min
Time interval	= 2 min	Hyd. volume	= 28,002,352 cuft
Drainage area	= 1980.000 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 300.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



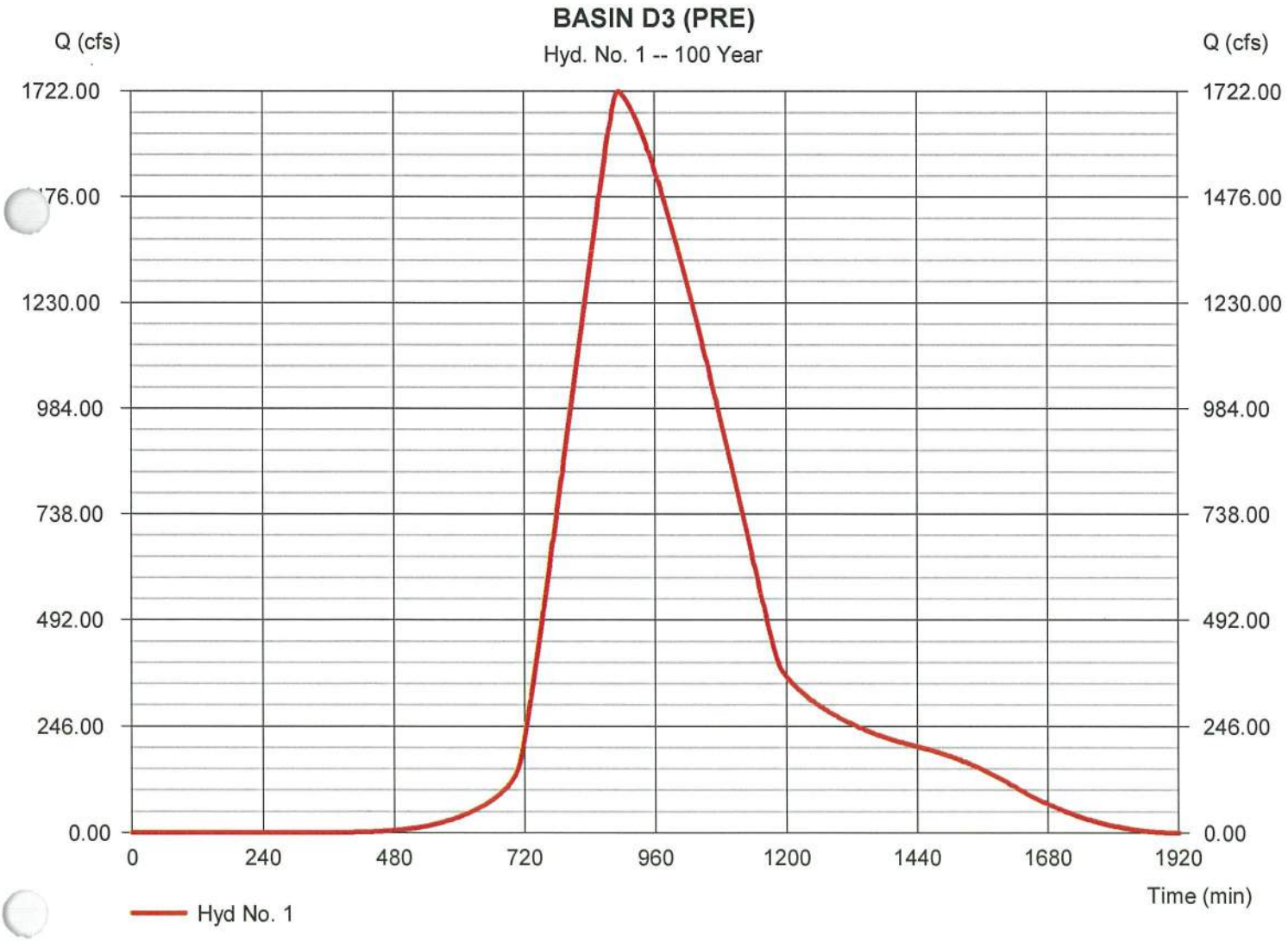
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 11 / 18 / 2014

Hyd. No. 1

BASIN D3 (PRE)

Hydrograph type	= SCS Runoff	Peak discharge	= 1720.25 cfs
Storm frequency	= 100 yrs	Time to peak	= 894 min
Time interval	= 2 min	Hyd. volume	= 37,329,216 cuft
Drainage area	= 1980.000 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 300.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



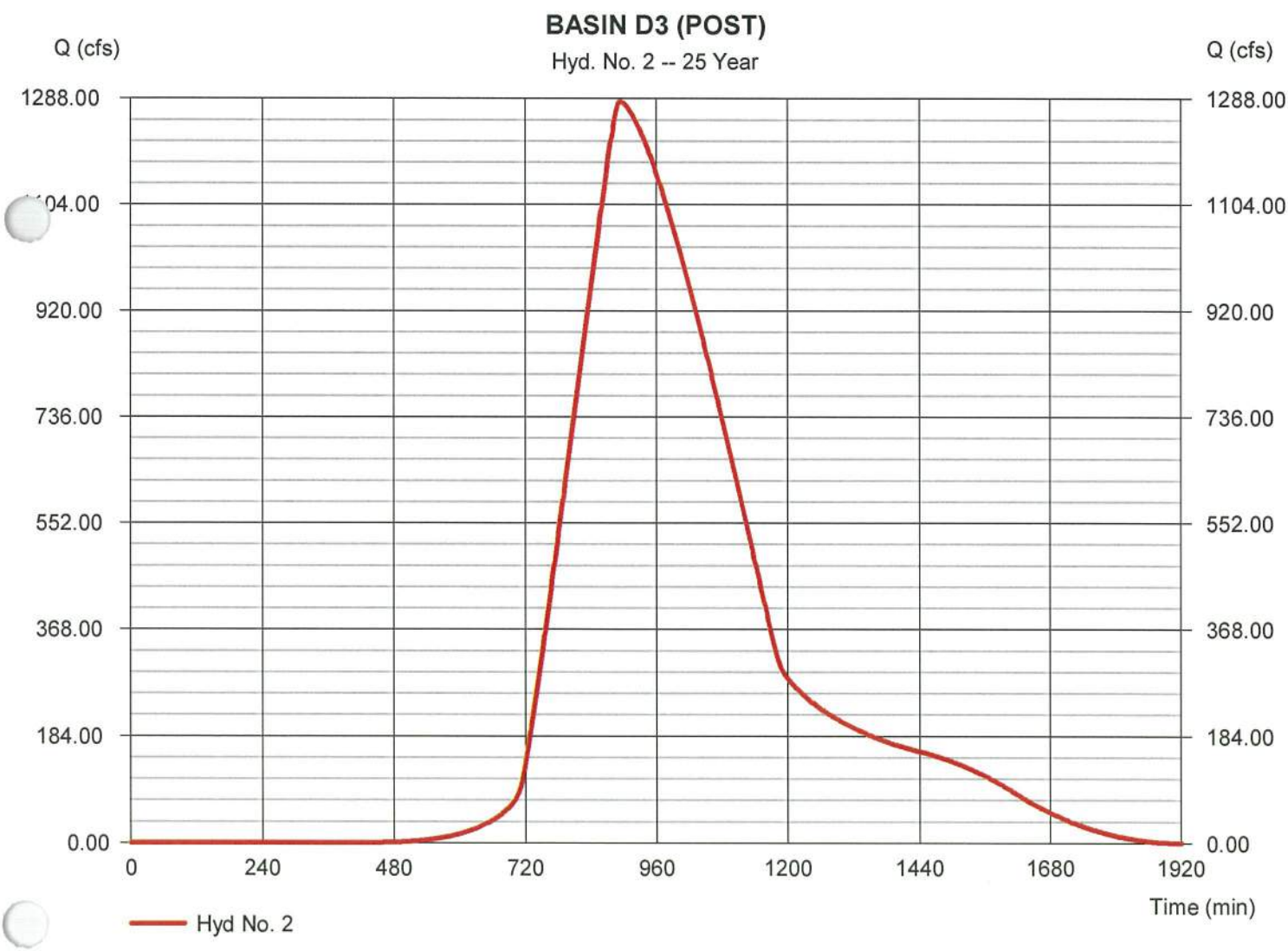
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 11 / 18 / 2014

Hyd. No. 2

BASIN D3 (POST)

Hydrograph type	= SCS Runoff	Peak discharge	= 1282.44 cfs
Storm frequency	= 25 yrs	Time to peak	= 894 min
Time interval	= 2 min	Hyd. volume	= 28,002,352 cuft
Drainage area	= 1980.000 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 300.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Tuesday, 11 / 18 / 2014

Hyd. No. 2

BASIN D3 (POST)

Hydrograph type	= SCS Runoff	Peak discharge	= 1720.25 cfs
Storm frequency	= 100 yrs	Time to peak	= 894 min
Time interval	= 2 min	Hyd. volume	= 37,329,216 cuft
Drainage area	= 1980.000 ac	Curve number	= 77
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 300.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

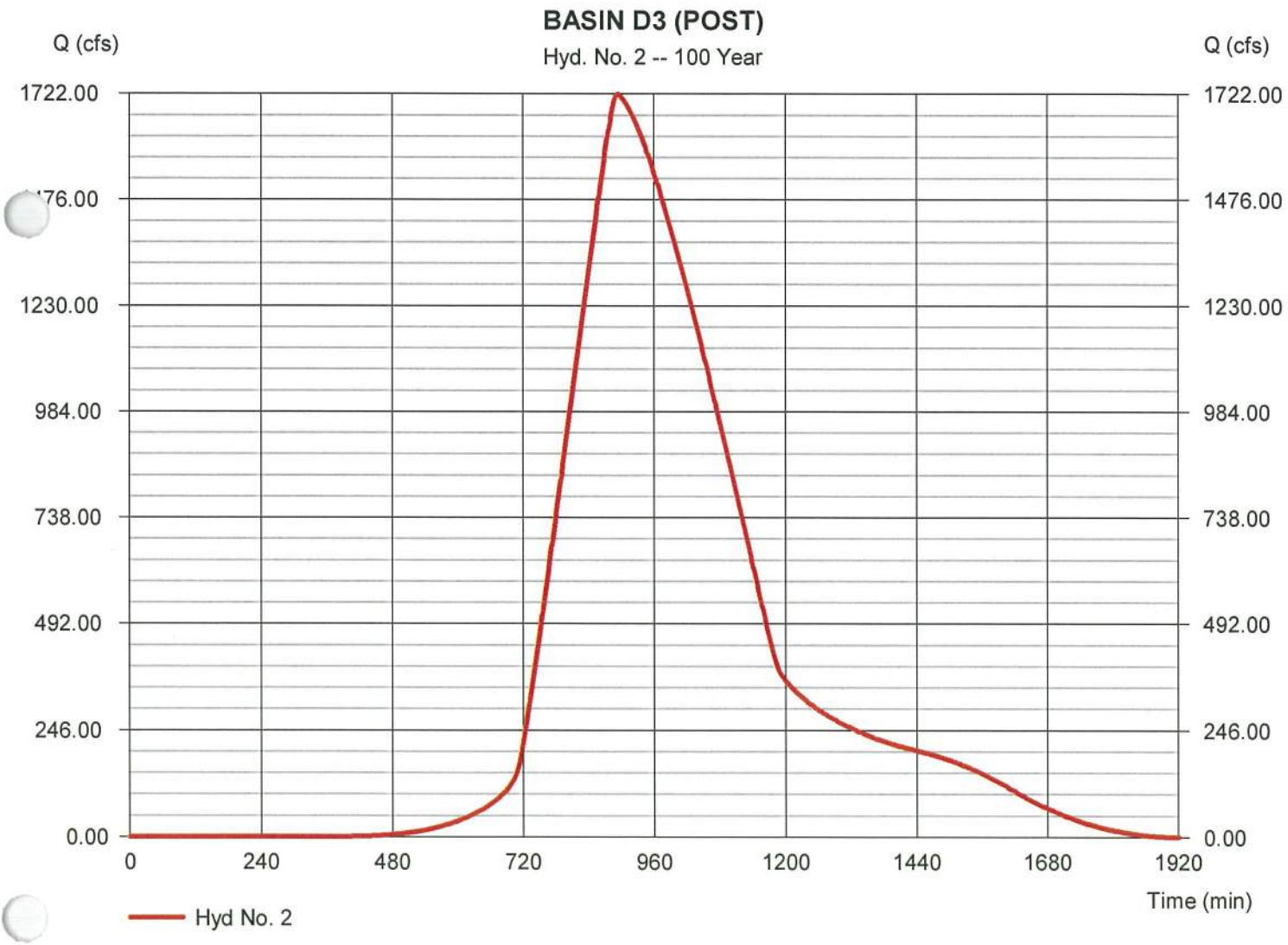


Figure D-3.7

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D3

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	11,607	11,607
CP_v	13,133	24,740
Q_{p25}	12,146	23,753
Q_{f100}	15,261	26,868

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	3220	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	24754	ft^3	>	24740	ft^3

Swale Dimensions:

A swale that is 3220 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	24,740	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,411** ft^2

Actual Filter Bed Dimensions: Width 27 ft; Length 53 ft; 1431 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **1633** ft^2

Actual Sediment Chamber Dimensions: Width 27 ft; Length 61 ft; 1647 ft^2

Bioretention Area

CP_v	=	24,740	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **10,417** ft^2

Actual Filter Bed Dimensions: Width 60 ft; Length 175 ft; 10500 ft^2

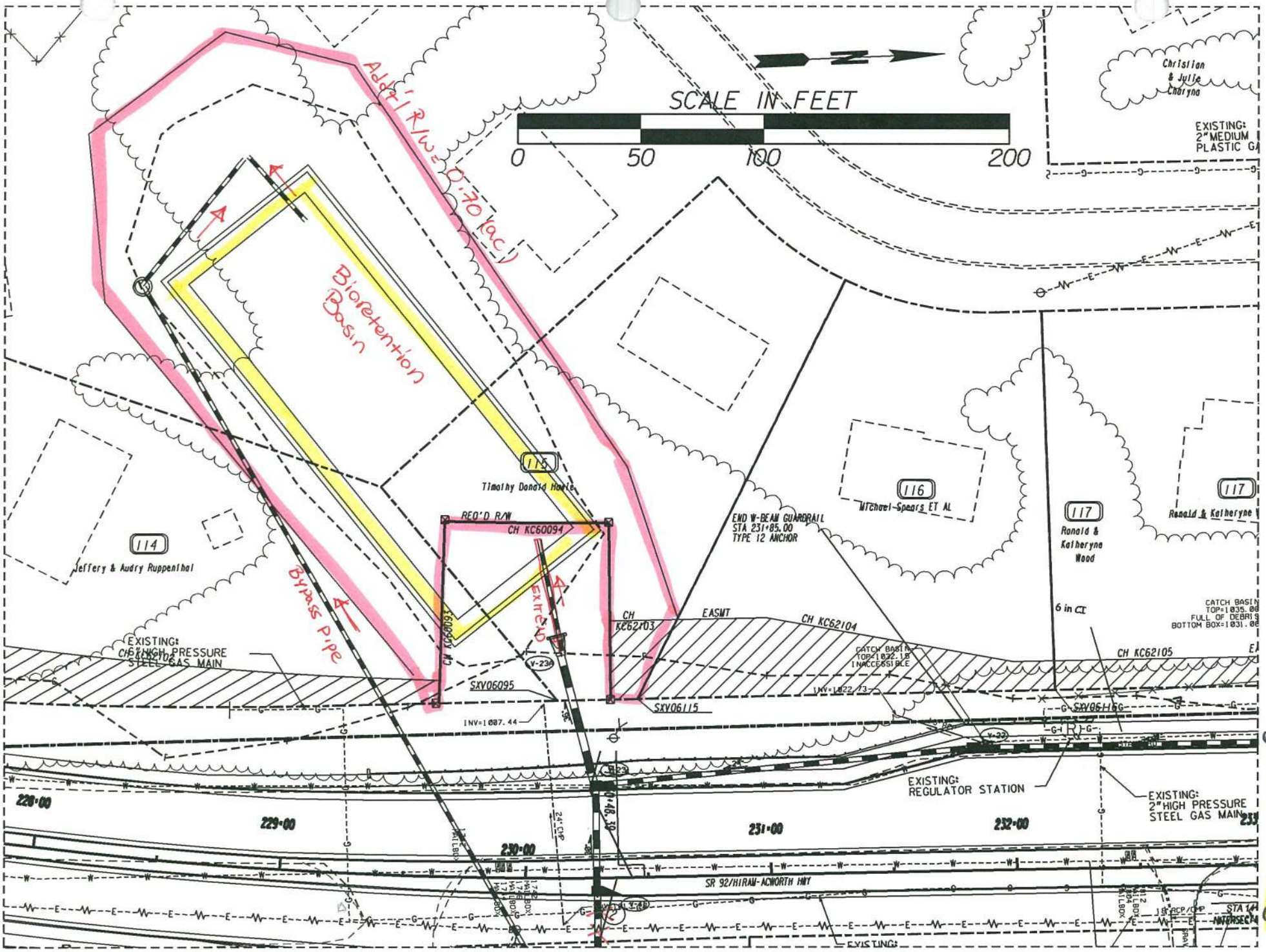

SCALE IN FEET
0
50
100
200
N
Add'l R/W=0.70 (ac)
Bioretention Basin
Bypass Pipe
Extend
Christian & Julie Charyna
EXISTING: 2" MEDIUM PLASTIC GA
115
Timothy Donald Hoyle
114
Jeffery & Audry Ruppenthal
116
Michael-Spears ET AL
117
Ronald & Katheryne Wood
117
Ronald & Katheryne
REQ'D R/W
CH KC60094
CH KC60093
CH KC62103
EASMT
CH KC62104
CH KC62105
END W-BEAM GUARDRAIL
STA 231+85.00
TYPE 12 ANCHOR
6 in CI
CATCH BASIN
TOP=1035.00
FULL OF DEBRIS
BOTTOM BOX=1031.00
EXISTING: 6" HIGH PRESSURE STEEL GAS MAIN
CH KC62102
V-23A
SXV06095
SXV06115
INV=1007.44
CATCH BASIN
TOP=1022.18
INACCESSIBLE
INV=1022.73
SXV06116
V-33
EXISTING: REGULATOR STATION
EXISTING: 2" HIGH PRESSURE STEEL GAS MAIN
228+00
229+00
230+00
231+00
232+00
233
24" CMP
SR 92/HIRAM-ACWORTH HWY
18" RCP/CMP
STA 14
INTERSECTION
EXISTING:

Figure D-3.8

Infeasibility Criteria #1: Cost of Construction

11/13/2014

Basin D3

Basin D3 1050 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 99,500.00	$ 102,500.00	$ 40,000.00	$ 35,000.00
Utilities ✪	$ 80,492.61	$ -	$ -	$ -
Construction ✪	$ 685,990.34	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 3,050.00	$ 4,000.00	$ 3,500.00
Grading	$ -	$ 16,200.00	$ 33,300.00	$ 27,900.00
Drainage	$ -	$ 145,184.62	$ 79,982.63	$ 89,153.75
Total	$ 865,982.95	$ 266,934.62	$ 157,282.63	$ 155,553.75
	Percent of BMP Cost to Total	**30.8%**	**18.2%**	**18.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.94
Sub Total:	$	47,000.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		2.1
Sub Total:	$	52,500.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	99,500.00

✪ See General Summary Explaination for Cost Method

Figure D-3.9

Figure D-3.10

BMP Construction Cost Worksheet — Basin D3

Dry Enhanced Swale

Length:	3220	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	1.8	Ac	
Total:	$ 90,000.00		
Residential Perm Easemet @	$ 25,000.00	per Ac	
	0.5	Ac	
Total:	$ 12,500.00		
Sub Total:	$ 102,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.61	Disturbed Ac	
$ 3,050.00		

Grading

Cut	Fill	
850.000	1850.000	
$ 6.00	per CY	
Total:	$ 16,200.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	2385	CY	$ 30.00	$ 53,004.12
Uddrn Sys w/ Gravel	-	3250	LF	$ 20.00	$ 65,000.00
Additional Pipe	18	250	LF	$ 52.00	$ 13,000.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	178	SY		178	SY
	$ 10,235.00			$ 845.50	

Sub Total: $ 145,184.62

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	53	61	ft
Width:	27	27	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.8	Ac	
Total:	$ 40,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 40,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.8	Disturbed Ac	
$ 4,000.00		

Grading

Cut	Fill	
350.000	5200.000	
$ 6.00	per CY	
Total:	$ 33,300.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	79.50	CY	$ 45.00	$ 3,577.50
Uddrn Sys w/ Gravel	-	178	LF	$ 20.00	$ 3,560.00
Top Soil		14	CY	$ 20.00	$ 280.00
Outlet Pipe	18"	600	LF	$ 43.00	$ 25,800.00
Imperm Geotextile	-	1431	SF	$ 5.00	$ 7,155.00
Dist Wall Conc/Steel	-	6	CY	$ 1,020.00	$ 6,120.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	823.5	SY		823.5	SY
	$ 47,351.25			$ 3,911.63	

Sub Total: $ 108,555.38

Bioretention Area

Length:	175	ft
Width:	60	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.7	Ac	
Total:	$ 35,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 35,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.7	Disturbed Ac	
$ 3,500.00		

Grading

Cut	Fill	
250.000	4400.000	
$ 6.00	per CY	
Total:	$ 27,900.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	778	CY	$ 30.00	$ 23,340.00
Uddrn Sys w/ Gravel	-	270	LF	$ 20.00	$ 5,400.00
Mulch	-	1167	SY	$ 15.00	$ 17,505.00
Additional Pipe	18"	500	LF	$ 43.00	$ 21,500.00
Outlet Pipe	18"	35	LF	$ 43.00	$ 1,505.00
Shrubs	-	45	EA	$ 30.00	$ 1,350.00
Ground Cover	-	124	EA	$ 15.00	$ 1,860.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	175	SY		175	SY
	$ 10,062.50			$ 831.25	

Sub Total: $ 89,153.75

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-18-14

Basin D-4 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin D-4 was located and the existing and proposed basin drainage areas were delineated (See Figures D-4.1 and D-4.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	5,781	5,781
Quantity	Channel Protection, CP_v	6,072	11,853
	Overbank Flood Protection, Q_{p25}	4,244	10,025
	Extreme Flood Protection, Q_{f100}	5,379	11,160

- The total area draining to the MS4 BMP is 2.16 Ac. The total impervious area is 2.09 Ac. The existing pavement area for the site is 0.74 Ac. The area required for storage and quantity management is 1.43 Ac (See Figure D-4.3). The flow produced by the existing paved area of 0.74 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area with a bottom width of 30' and minimum length of 167' (See Figure D-4.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure D-4.4).
- The bypass water and the outlet of the BMP would drain into an existing detention pond (See Figure D-4.5).
- With the addition of the BMP, the amount of flow getting to the existing detention pond, from the pre to the post conditions, remains the same. Therefore, the existing pond will remain untouched.
- Modifications to the proposed drainage design will be necessary to separate the bypass flow and to direct the treatment water into the BMP (See Figure D-4.5).
- The BMP construction cost is 13.4% of the roadway construction cost within this basin making this basin infeasible (See Figure D-4.6).
- None of the other infeasibility criteria apply to this basin.
- Stormwater detention will need to be addressed in the project drainage design due to the existing downstream detention pond.

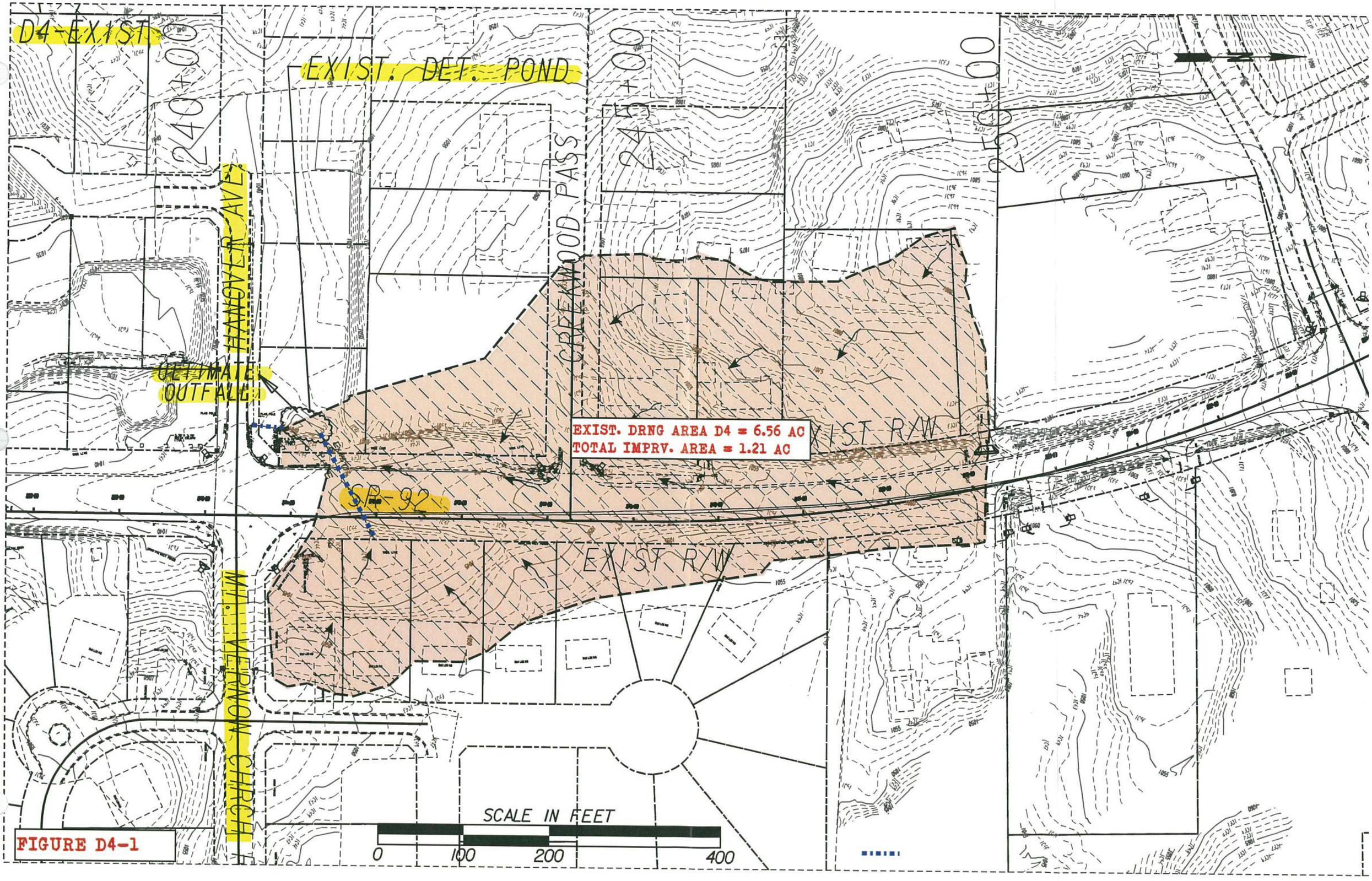

D4-EXIST
EXIST. DET. POND
240+00
245+00
250+00
HANOVER AVE.
CREEKWOOD PASS
ULTIMATE OUTFALL
EXIST. DRNG AREA D4 = 6.56 AC
TOTAL IMPRV. AREA = 1.21 AC
EXIST R/W
SP-92
EXIST R/W
MT. VERNON CHURCH
SCALE IN FEET
0
100
200
400

FIGURE D4-1

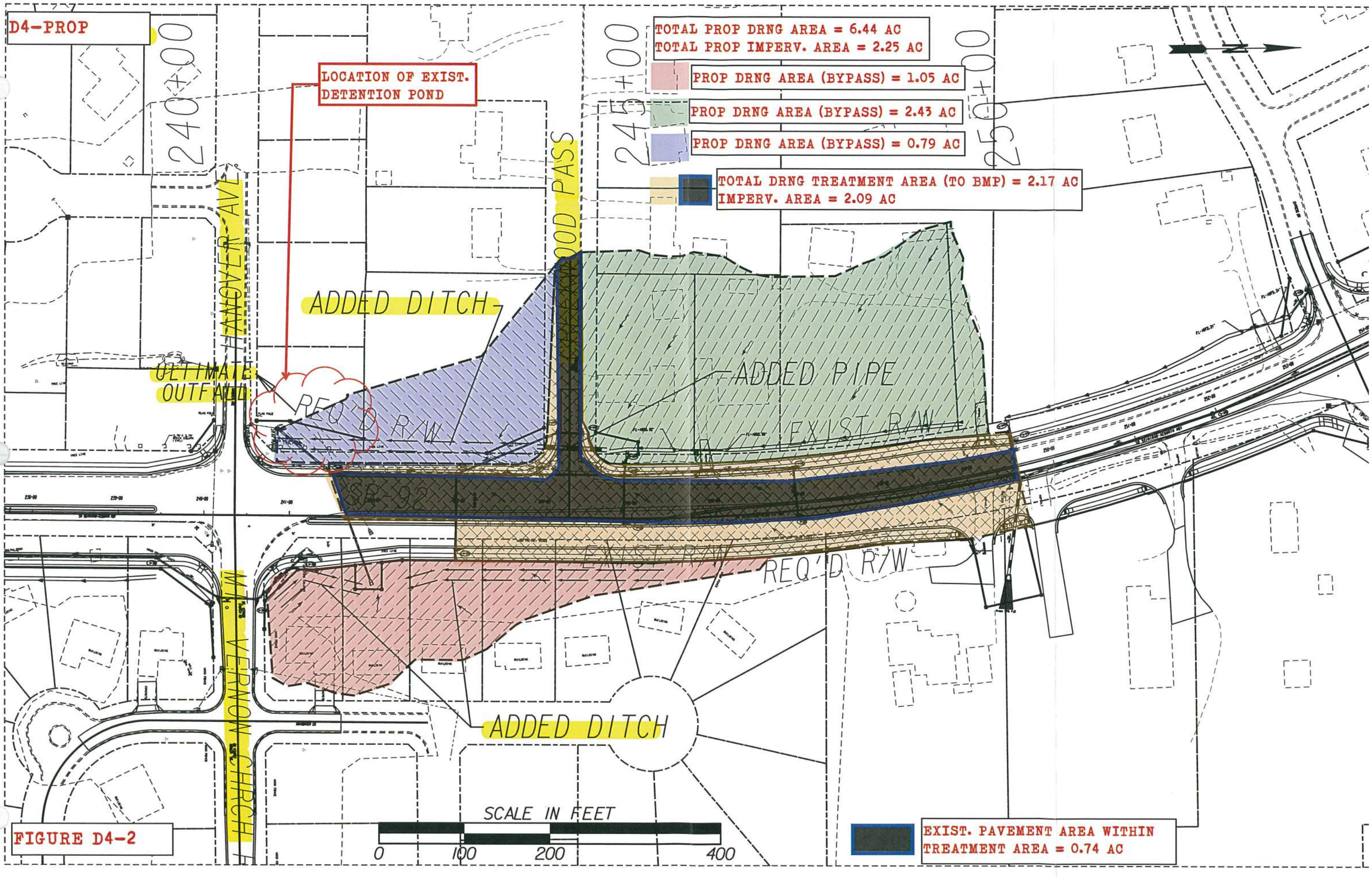

D4-PROP
TOTAL PROP DRNG AREA = 6.44 AC
TOTAL PROP IMPERV. AREA = 2.25 AC
PROP DRNG AREA (BYPASS) = 1.05 AC
PROP DRNG AREA (BYPASS) = 2.43 AC
PROP DRNG AREA (BYPASS) = 0.79 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.17 AC
IMPERV. AREA = 2.09 AC
LOCATION OF EXIST. DETENTION POND
240+00
245+00
250+00
ANOVER AVE
ADDED DITCH
ADDED PIPE
ULTIMATE OUTFALL
REQ'D R/W
EXIST R/W
SR-92
EXIST R/W
REQ'D R/W
VERNON CHRCH
ADDED DITCH
SCALE IN FEET
0
100
200
400
EXIST. PAVEMENT AREA WITHIN TREATMENT AREA = 0.74 AC

FIGURE D4-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D4

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	6.56
Impervious Area =	1.21
Pervious Area=	5.35

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	76

Time of Concentration (See Table A) = 0.12 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.632

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.188	0.19
$I_a/P_{10\text{-}yr}$=	0.115	0.12
$I_a/P_{25\text{-}yr}$=	0.098	0.1
$I_a/P_{100\text{-}yr}$=	0.080	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.16

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.26
$Q_{d\ 10\text{-}yr}$=	2.97
$Q_{d\ 25\text{-}yr}$=	3.80
$Q_{d\ 100\text{-}yr}$ =	5.08

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	880
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	910
$q_{u100\text{-}yr}$=	910

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	11.40
$Q_{p10\text{-}yr}$=	27.38
$Q_{p25\text{-}yr}$=	35.40
$Q_{p100\text{-}yr}$=	47.41

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	6.44
Impervious Area =	2.25
Pervious Area =	4.19
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	80

Time of Concentration (See Table A) = 0.10 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.487

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.145	0.15
$I_a/P_{10\text{-}yr}$=	0.088	0.1
$I_a/P_{25\text{-}yr}$=	0.075	0.1
$I_a/P_{100\text{-}yr}$=	0.061	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.43

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.56
$Q_{d\ 10\text{-}yr}$=	3.39
$Q_{d\ 25\text{-}yr}$=	4.26
$Q_{d\ 100\text{-}yr}$ =	5.60

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	975
$q_{u10\text{-}yr}$=	1000
$q_{u25\text{-}yr}$=	1000
$q_{u100\text{-}yr}$=	1000

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	15.27
$Q_{p10\text{-}yr}$=	34.15
$Q_{p25\text{-}yr}$=	42.90
$Q_{p100\text{-}yr}$=	56.36

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.16	Acre
Total Impervious Area - A_{POST}	2.09	Acre
Existing Pavement Area - A_{PRE} (5)	0.74	Acre
Area Required for Quantity - A_{QUAN} (4)	1.43	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.16	0.63	62.56	0.00	0.613	0.133	5,781

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.121	5,279

(+15% ED)= 6,072

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.825	0.17	0.085	3,691

(+15% ED)= 4,244

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.841	0.16	0.107	4,677

(+15% ED)= 5,379

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A = Total Treatment Area - Existing Pavement Area - Credit Area

Figure D-4-4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D4

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	5,781	5,781
CP_v	6,072	11,853
Q_{p25}	4,244	10,025
Q_{f100}	5,379	11,160

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	1545	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	11877	ft^3	>	11853	ft^3

Swale Dimensions:

A swale that is 1545 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	11,853	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **676** ft^2

Actual Filter Bed Dimensions: Width 19 ft; Length 36 ft; 684 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **782** ft^2

Actual Sediment Chamber Dimensions: Width 19 ft; Length 42 ft; 798 ft^2

Bioretention Area

CP_v	=	11,853	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,991** ft^2

Actual Filter Bed Dimensions: Width 30 ft; Length 167 ft; 5010 ft^2

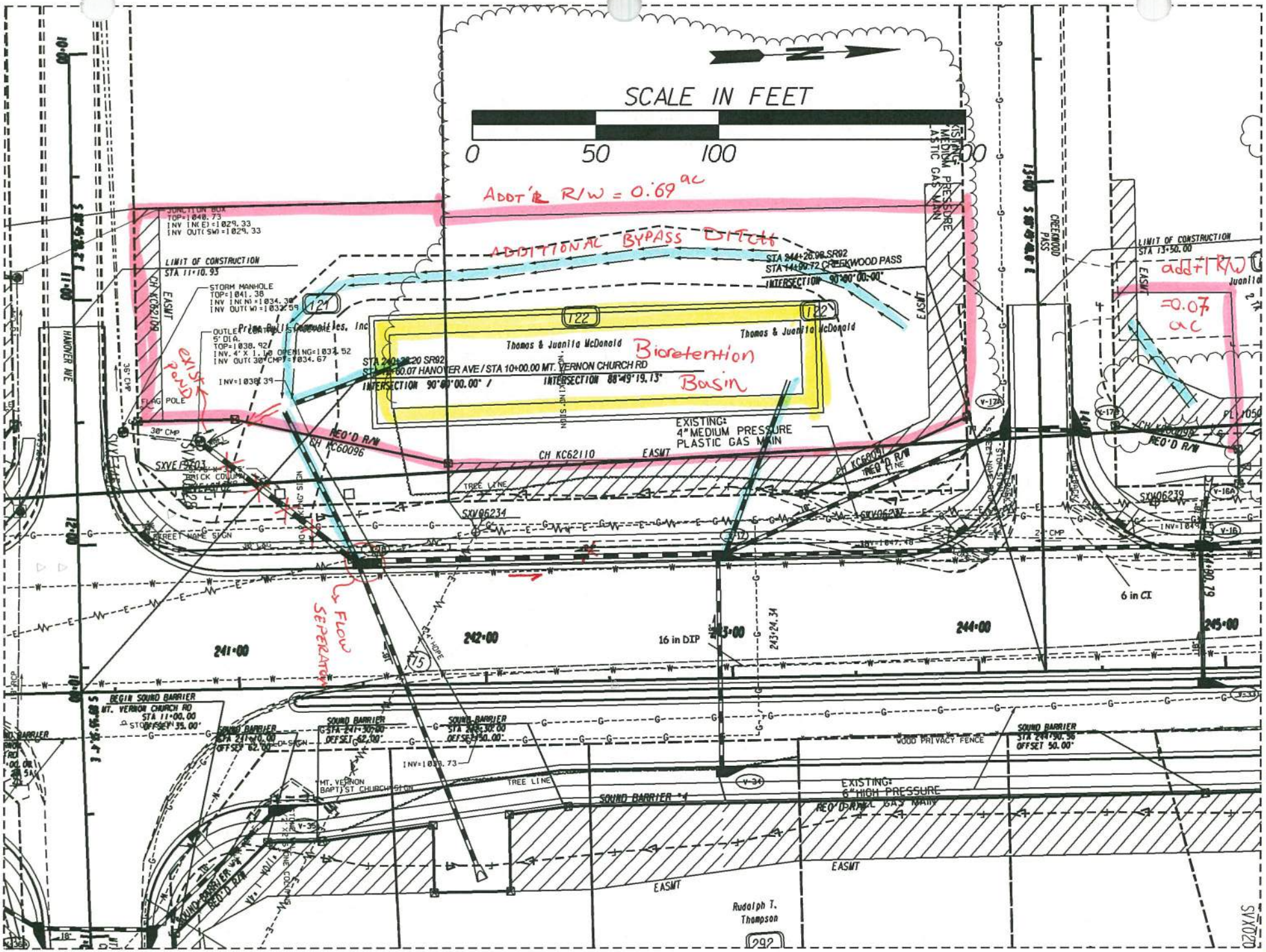

SCALE IN FEET
0
50
100
ADDT'L R/W = 0.69 ac
ADDITIONAL BYPASS DITCH
add'l R/W
=0.07 ac
Bioretention Basin
exist pond
FLOW SEPERATOR
Thomas & Juanita McDonald
Prime Bulk Commodities, Inc
EXISTING: 4" MEDIUM PRESSURE PLASTIC GAS MAIN
EXISTING: 6" HIGH PRESSURE STEEL GAS MAIN
LIMIT OF CONSTRUCTION
STA 11+10.93
STA 13+50.00
STORM MANHOLE
JUNCTION BOX
INTERSECTION 90°00'00.00"
INTERSECTION 88°49'19.13"
HANOVER AVE
CREEKWOOD PASS
MT. VERNON CHURCH RD
BEGIN SOUND BARRIER
SOUND BARRIER #1
WOOD PRIVACY FENCE
TREE LINE
EASMT
REQ'D R/W
CH KC62109
CH KC62110
CH KC60096
SXV06234
SXV06237
SXV06239
SXV0203
16 in DIP
6 in CI
241+00
242+00
243+00
244+00
245+00
Rudolph T. Thompson

Figure D-4.5

Infeasibility Criteria #1: Cost of Construction

11/13/2014

Basin D4

Basin D4 770 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 84,125.00	$ 45,500.00	$ 39,000.00	$ 38,000.00
Utilities ✪	$ 59,027.91	$ -	$ -	$ -
Construction ✪	$ 503,059.59	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,300.00	$ 3,900.00	$ 3,800.00
Grading	$ -	$ 10,020.00	$ 4,800.00	$ 4,560.00
Drainage	$ -	$ 73,185.60	$ 53,082.75	$ 40,164.00
Total	$ 646,212.50	$ 133,005.60	$ 100,782.75	$ 86,524.00
	Percent of BMP Cost to Total	**20.6%**	**15.6%**	**13.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.45
Sub Total:	$	22,500.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		1.19
Sub Total:	$	29,750.00
Commercial Right of Way @	$	125,000.00
		0.17
Sub Total:	$	21,250.00
Commercial Perm Easmt @	$	62,500.00
		0.17
Sub Total:	$	10,625.00
Right of Way Cost Total:	$	84,125.00

✪ See General Summary Explaination for Cost Method

Figure D-4.6

Figure D-4.

BMP Construction Cost Worksheet Basin D4

Dry Enhanced Swale

Length:	1545	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.86	Ac	
Total:	$ 43,000.00		
Residential Perm Easemet @	$ 25,000.00	per Ac	
	0.1	Ac	
Total:	$ 2,500.00		
Sub Total:	$ 45,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.86	Disturbed Ac	
$ 4,300.00		

Grading

Cut	Fill	
450.000	1220.000	
$ 6.00	per CY	
Total:	$ 10,020.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1144	CY	$ 30.00	$ 25,432.10
Uddrn Sys w/ Gravel	-	1575	LF	$ 20.00	$ 31,500.00
Additional Pipe	18	150	LF	$ 52.00	$ 7,800.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	86	SY		86	SY
	$ 4,945.00			$ 408.50	

Sub Total: $ 73,185.60

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	36	42	ft
Width:	19	19	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac
	0.78	Ac
Total:	$ 39,000.00	
Residential Perm Easmt @	$ 25,000.00	per Ac
	0	Ac
Total:	$ -	
Sub Total:	$ 39,000.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.78	Disturbed Ac	
$ 3,900.00		

Grading

Cut	Fill	
220.000	580.000	
$ 6.00	per CY	
Total:	$ 4,800.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	38.00	CY	$ 45.00	$ 1,710.00
Uddrn Sys w/ Gravel	-	136	LF	$ 20.00	$ 2,720.00
Top Soil		7	CY	$ 20.00	$ 140.00
Outlet Pipe	18"	125	LF	$ 43.00	$ 5,375.00
Imperm Geotextile	-	684	SF	$ 5.00	$ 3,420.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	399	SY		399	SY
	$ 22,942.50			$ 1,895.25	

Sub Total: $ 53,082.75

Bioretention Area

Length:	167	ft
Width:	30	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac
	0.76	Ac
Total:	$ 38,000.00	
Residential Perm Easmt @	$ 25,000.00	per Ac
	0	Ac
Total:	$ -	
Sub Total:	$ 38,000.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.76	Disturbed Ac	
$ 3,800.00		

Grading

Cut	Fill	
210.000	550.000	
$ 6.00	per CY	
Total:	$ 4,560.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	372	CY	$ 30.00	$ 11,160.00
Uddrn Sys w/ Gravel	-	135	LF	$ 20.00	$ 2,700.00
Mulch	-	557	SY	$ 15.00	$ 8,355.00
Additional Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Outlet Pipe	18"	50	LF	$ 43.00	$ 2,150.00
Shrubs	-	22	EA	$ 30.00	$ 660.00
Ground Cover	-	59	EA	$ 15.00	$ 885.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	84	SY		84	SY
	$ 4,830.00			$ 399.00	

Sub Total: $ 40,164.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin DS-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin D5-1 was located and the existing and proposed basin drainage areas were delineated (See Figures D5-1.1 and D5-1.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	4,513	4,513
Quantity	Channel Protection, CP_v	4,998	9,511
	Overbank Flood Protection, Q_{p25}	2,873	7,386
	Extreme Flood Protection, Q_{f100}	3,612	8,125

- The total area draining to the MS4 BMP is 2.00 Ac. The total impervious area is 1.80 Ac. The existing pavement area for the site is 0.76 Ac. The area required for storage and quantity management is 1.24 Ac (See Figure D5-1.3).
- The flow produced by the existing paved area of 0.76 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area with a bottom width of 25' and minimum length of 161' (See Figure D5-1.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure D5-1.4).
- Modifications to the proposed drainage design will be necessary to separate the bypass flow and to direct the treatment water into the BMP (See Figure D5-1.5).
- The BMP construction cost is 19.8% of the roadway construction cost within this basin making this basin infeasible (See Figure D5-1.6).
- None of the other infeasibility criteria apply to this basin.

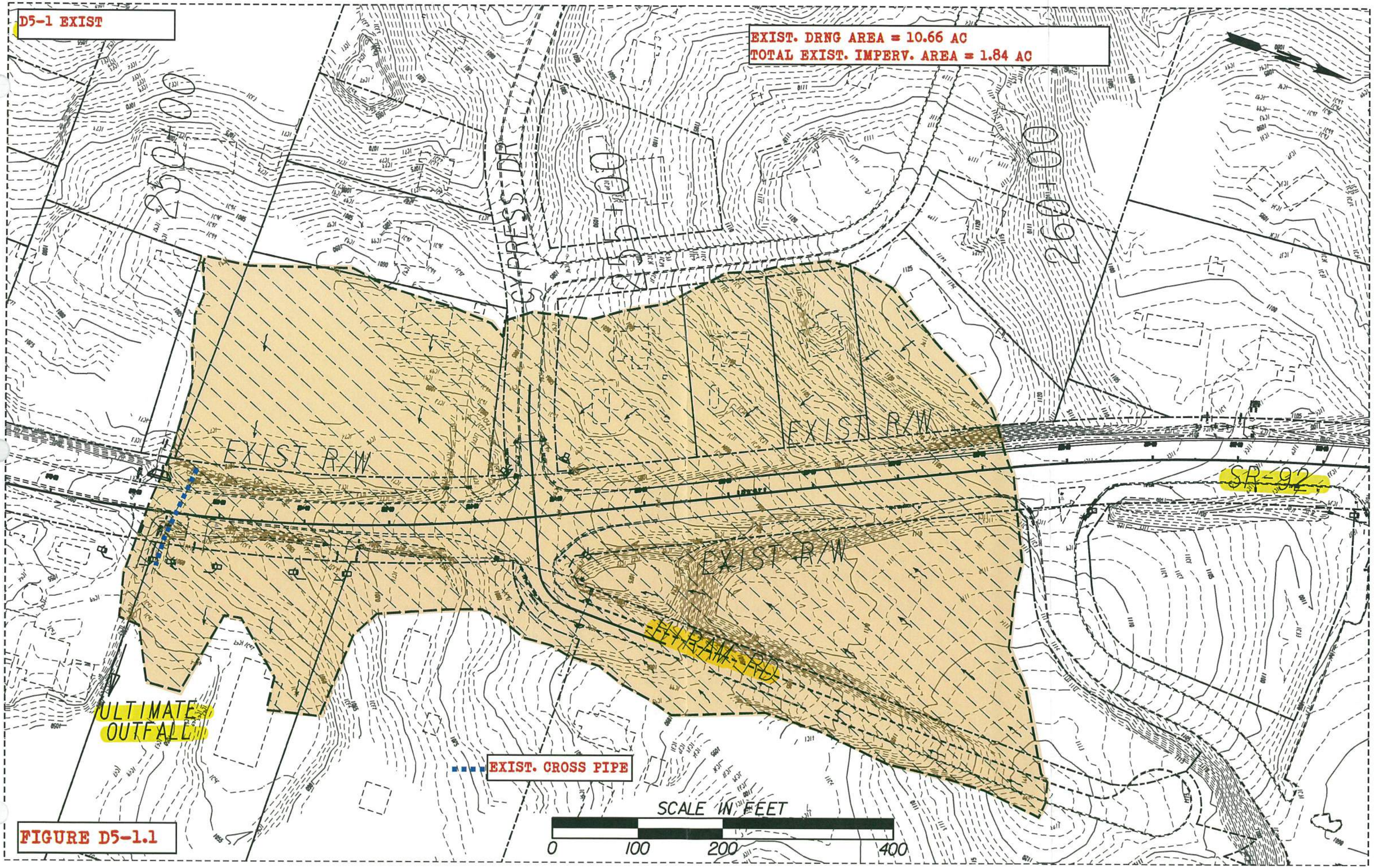

D5-1 EXIST
EXIST. DRNG AREA = 10.66 AC
TOTAL EXIST. IMPERV. AREA = 1.84 AC
CYPRESS DR
EXIST R/W
EXIST R/W
EXIST R/W
SR-92
ETIRAM RD
ULTIMATE OUTFALL
EXIST. CROSS PIPE
SCALE IN FEET
0
100
200
400

FIGURE D5-1.1

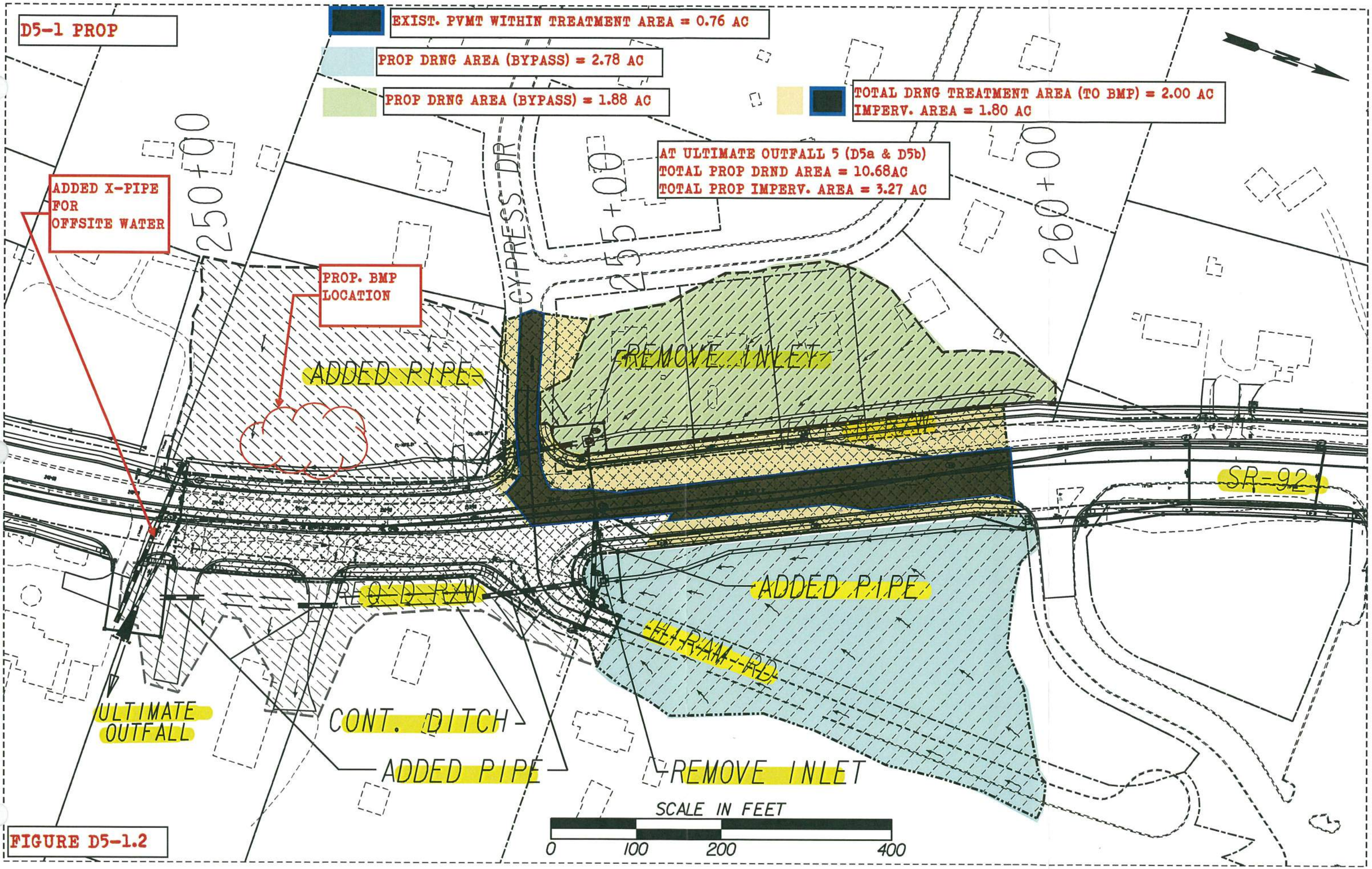

D5-1 PROP
EXIST. PVMT WITHIN TREATMENT AREA = 0.76 AC
PROP DRNG AREA (BYPASS) = 2.78 AC
PROP DRNG AREA (BYPASS) = 1.88 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.00 AC
IMPERV. AREA = 1.80 AC
AT ULTIMATE OUTFALL 5 (D5a & D5b)
TOTAL PROP DRND AREA = 10.68AC
TOTAL PROP IMPERV. AREA = 3.27 AC
ADDED X-PIPE
FOR
OFFSITE WATER
PROP. BMP
LOCATION
250+00
255+00
260+00
CYPRESS DR
ADDED PIPE
REMOVE INLET
REQ'D R/W
SR-92
ADDED PIPE
REQ'D R/W
ULTIMATE
OUTFALL
CONT. DITCH
ADDED PIPE
REMOVE INLET
SCALE IN FEET
0
100
200
400

FIGURE D5-1.2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *D5-1*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	10.66
Impervious Area =	1.84
Pervious Area=	8.82

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	76

Time of Concentration (See Table A) = 0.15 *hr*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.643

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.191	0.19
$I_a/P_{10\text{-}yr}$=	0.117	0.12
$I_a/P_{25\text{-}yr}$=	0.099	0.1
$I_a/P_{100\text{-}yr}$=	0.081	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.22

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.24
$Q_{d\ 10\text{-}yr}$=	2.94
$Q_{d\ 25\text{-}yr}$=	3.76
$Q_{d\ 100\text{-}yr}$ =	5.05

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	850
$q_{u10\text{-}yr}$=	890
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	17.61
$Q_{p10\text{-}yr}$=	43.56
$Q_{p25\text{-}yr}$=	56.41
$Q_{p100\text{-}yr}$=	75.64

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	10.68
Impervious Area =	3.27
Pervious Area =	7.41
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	79

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.523

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.156	0.16
$I_a/P_{10\text{-}yr}$=	0.095	0.1
$I_a/P_{25\text{-}yr}$=	0.081	0.1
$I_a/P_{100\text{-}yr}$=	0.066	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.62

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.48
$Q_{d\ 10\text{-}yr}$=	3.28
$Q_{d\ 25\text{-}yr}$=	4.14
$Q_{d\ 100\text{-}yr}$ =	5.46

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	860
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	21.18
$Q_{p10\text{-}yr}$=	49.26
$Q_{p25\text{-}yr}$=	62.17
$Q_{p100\text{-}yr}$=	82.07

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.00	Acre
Total Impervious Area - A_{POST}	1.80	Acre
Existing Pavement Area - A_{PRE} (5)	0.76	Acre
Area Required for Quantity - A_{QUAN} (4)	1.24	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v(3)	WQ_v (ac-ft)	WQ_v (ft³)
2.00	0.52	52.00	0.00	0.518	0.104	4,513

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.100	4,345

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,998

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.907	0.13	0.057	2,499

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 2,873

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.922	0.13	0.072	3,141

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 3,612

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure D5-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D5-1

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	4,513	4,513
CP_v	4,998	9,511
Q_{p25}	2,873	7,386
Q_{f100}	3,612	8,125

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	1240	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	9533	ft^3	>	9511	ft^3

Swale Dimensions:

A swale that is **1240** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	9,511	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **542** ft^2

Actual Filter Bed Dimensions:	Width	16	ft
	Length	34	ft
		544	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **628** ft^2

Actual Sediment Chamber Dimensions:	Width	17	ft
	Length	37	ft
		629	ft^2

Bioretention Area

CP_v	=	9,511	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,005** ft^2

Actual Filter Bed Dimensions:	Width	25	ft
	Length	161	ft
		4025	ft^2

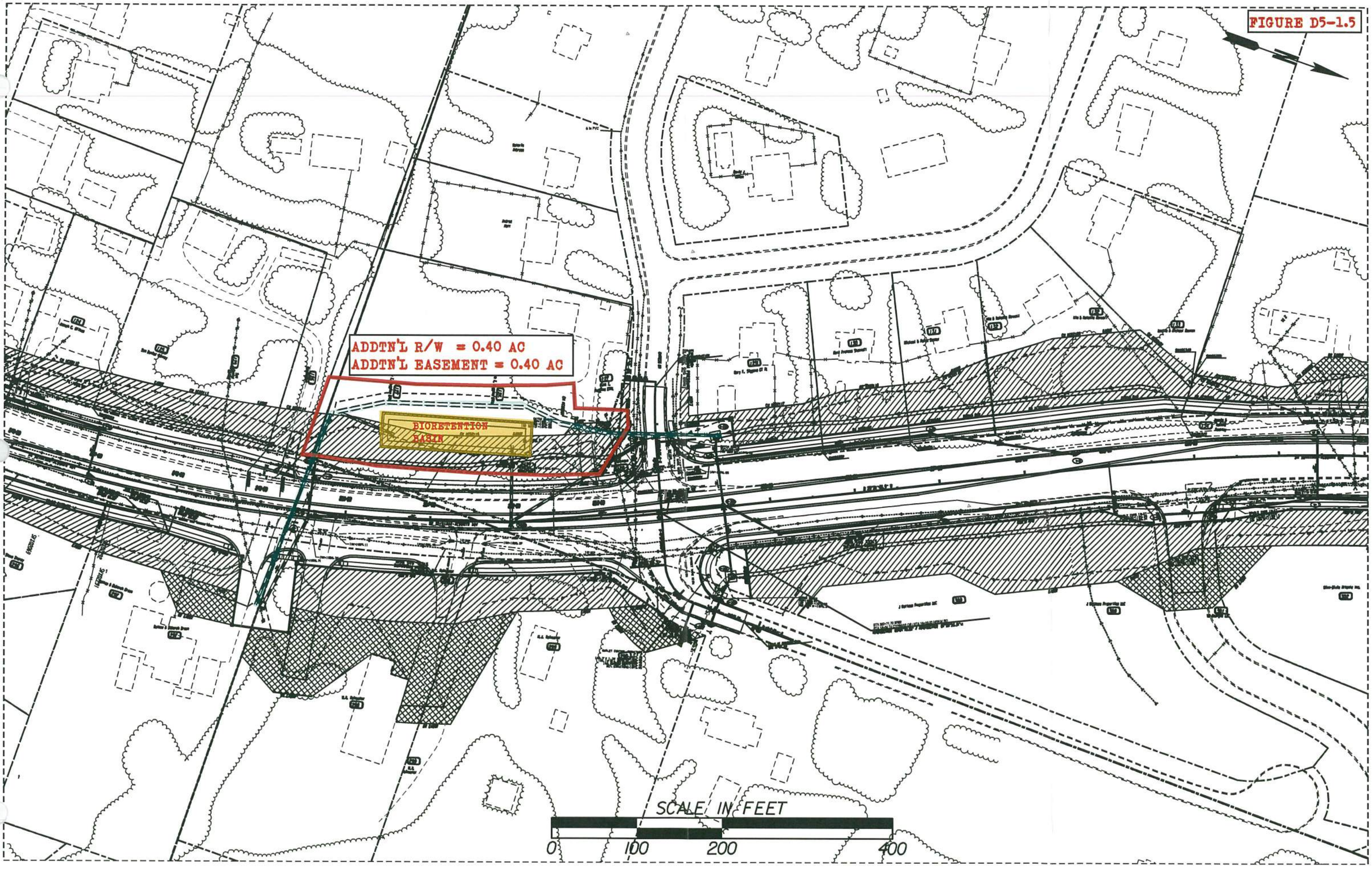


FIGURE D5-1.5
ADDTN'L R/W = 0.40 AC
ADDTN'L EASEMENT = 0.40 AC
BIORETENTION BASIN
SCALE IN FEET
0
100
200
400

Infeasibility Criteria #1: Cost of Construction
Basin D5-1

11/19/2014

Basin D5-1 600 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 56,500.00	$ 67,500.00	$ 21,000.00	$ 30,000.00
Utilities ✪	$ 45,995.77	$ -	$ -	$ -
Construction ✪	$ 391,994.48	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,750.00	$ 4,500.00	$ 2,000.00
Grading	$ -	$ 9,480.00	$ 6,720.00	$ 6,300.00
Drainage	$ -	$ 61,006.77	$ 71,607.63	$ 59,603.00
Total	$ 494,490.26	$ 142,736.77	$ 103,827.63	$ 97,903.00
	Percent of BMP Cost to Total	**28.9%**	**21.0%**	**19.8%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.42
Sub Total:	$	21,000.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		1.42
Sub Total:	$	35,500.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	56,500.00

✪ See General Summary Explaination for Cost Method

Figure D5-1.6

BMP Construction Cost Worksheet Basin D5-1

Dry Enhanced Swale

Length:	1240	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	1.2	Ac	
Total:	$ 60,000.00		
Residential Perm Easemet @	$ 25,000.00	per Ac	
	0.3	Ac	
Total:	$ 7,500.00		
Sub Total:	$ 67,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.95	Disturbed Ac	
$ 4,750.00		

Grading

Cut	Fill	
400.000	1180.000	
	$ 6.00	per CY
Total:	$ 9,480.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	919	CY	$ 30.00	$ 20,411.52
Uddrn Sys w/ Gravel	-	1270	LF	$ 20.00	$ 25,400.00
Additional Pipe	18	150	LF	$ 52.00	$ 7,800.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	69	SY		69	SY
	$ 3,967.50			$ 327.75	

Sub Total: $ 61,006.77

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	34	37	ft
Width:	16	17	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.42	Ac	
Total:	$ 21,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 21,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.9	Disturbed Ac	
$ 4,500.00		

Grading

Cut	Fill	
400.000	720.000	
	$ 6.00	per CY
Total:	$ 6,720.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	3	EA		2	EA
	$ 15,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	30.22	CY	$ 45.00	$ 1,360.00
Uddrn Sys w/ Gravel	-	129	LF	$ 20.00	$ 2,580.00
Top Soil		6	CY	$ 20.00	$ 120.00
Outlet Pipe	18"	590	LF	$ 43.00	$ 25,370.00
Imperm Geotextile	-	544	SF	$ 5.00	$ 2,720.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	314.5	SY		314.5	SY
	$ 18,083.75			$ 1,493.88	

Sub Total: $ 71,607.63

Bioretention Area

Length:	161	ft
Width:	25	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.4	Ac	
Total:	$ 20,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.4	Ac	
Total:	$ 10,000.00		
Sub Total:	$ 30,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.4	Disturbed Ac	
$ 2,000.00		

Grading

Cut	Fill	
300.000	750.000	
	$ 6.00	per CY
Total:	$ 6,300.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	299	CY	$ 30.00	$ 8,970.00
Uddrn Sys w/ Gravel	-	112.5	LF	$ 20.00	$ 2,250.00
Mulch	-	448	SY	$ 15.00	$ 6,720.00
Additional Pipe	18"	520	LF	$ 43.00	$ 22,360.00
Outlet Pipe	18"	70	LF	$ 43.00	$ 3,010.00
Shrubs	-	18	EA	$ 30.00	$ 540.00
Ground Cover	-	48	EA	$ 15.00	$ 720.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	68	SY		68	SY
	$ 3,910.00			$ 323.00	

Sub Total: $ 59,603.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin DS-2 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #S – The BMP would displace a business if installed

The ultimate outfall of Drainage Basin D5-2 was located and the existing and proposed basin drainage areas were delineated (See Figures D5-2.1 and D5-2.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	2,239	2,239
Quantity	Channel Protection, CP_v	2,862	5,101
	Overbank Flood Protection, Q_{p25}	1,645	3,884
	Extreme Flood Protection, Q_{f100}	2,068	4,307

- The total area draining to the MS4 structure is 1.10 Ac. The total impervious area is 0.90 Ac. The existing pavement area for the site is 0.39 Ac. The area required for storage and quality treatment is 0.71 Ac (See Figure D5-2.3). The flow produced by the existing paved area of 0.39 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were sized; an enhanced swale, a surface sand filter, and a bioretention area (See Figure D5-2.4). The smallest BMP is a bioretention area with a bottom width of 20' and minimum length of 160' (See Figure D5-2.4). In order to install the BMP within this basin, it will be necessary to displace at least one business (See Figure D5-2.5).
- Displacement of business would be necessary, making the basin infeasible (See Figure D5-2.5).
- A cost analysis was not done because the basin failed infeasibility criteria #5 first.

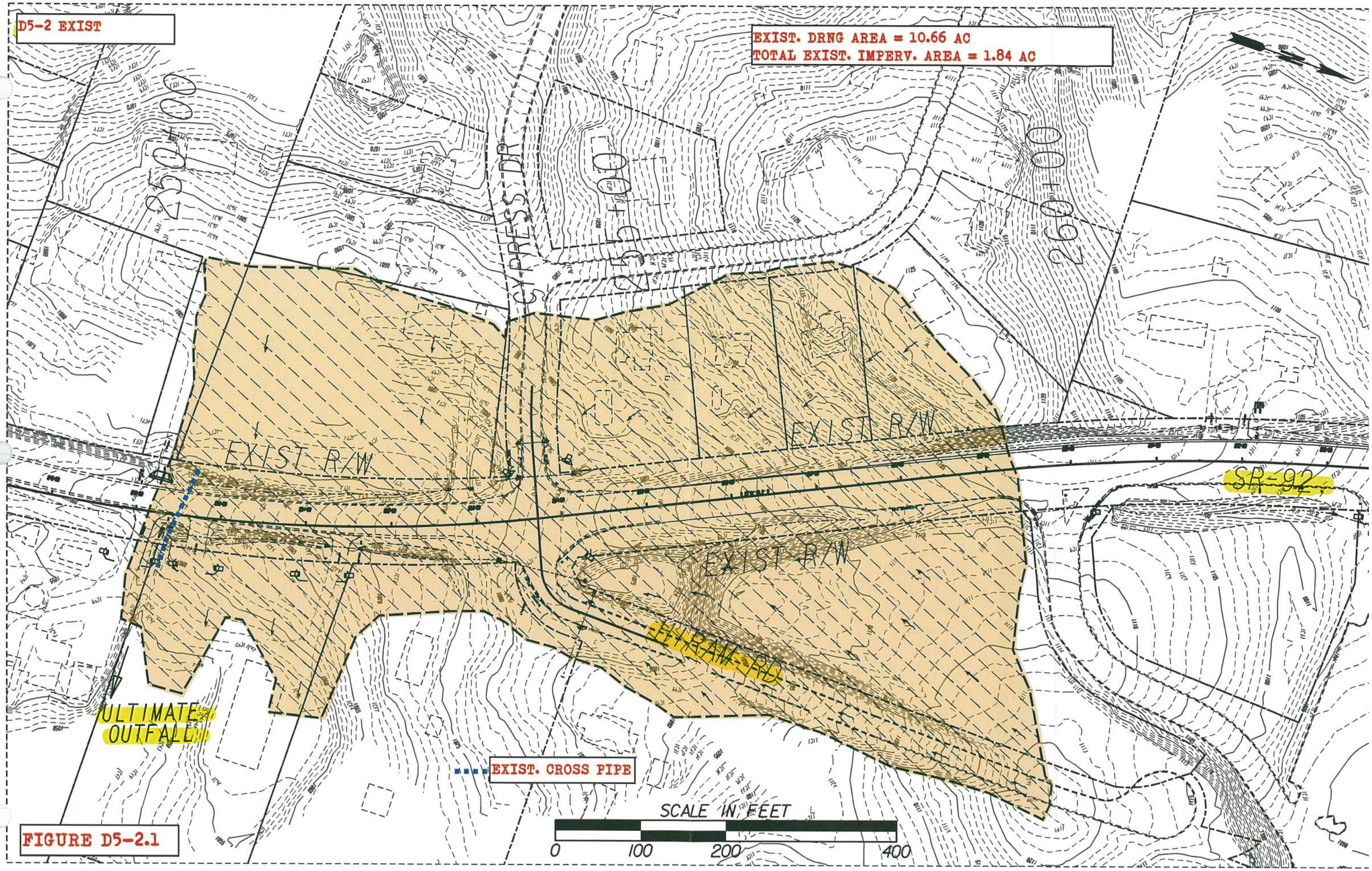

D5-2 EXIST
EXIST. DRNG AREA = 10.66 AC
TOTAL EXIST. IMPERV. AREA = 1.84 AC
CYPRESS DR
EXIST R/W
EXIST R/W
EXIST R/W
SR-92
ULTIMATE OUTFALL
EXIST. CROSS PIPE
SCALE IN FEET
0
100
200
400

FIGURE D5-2.1

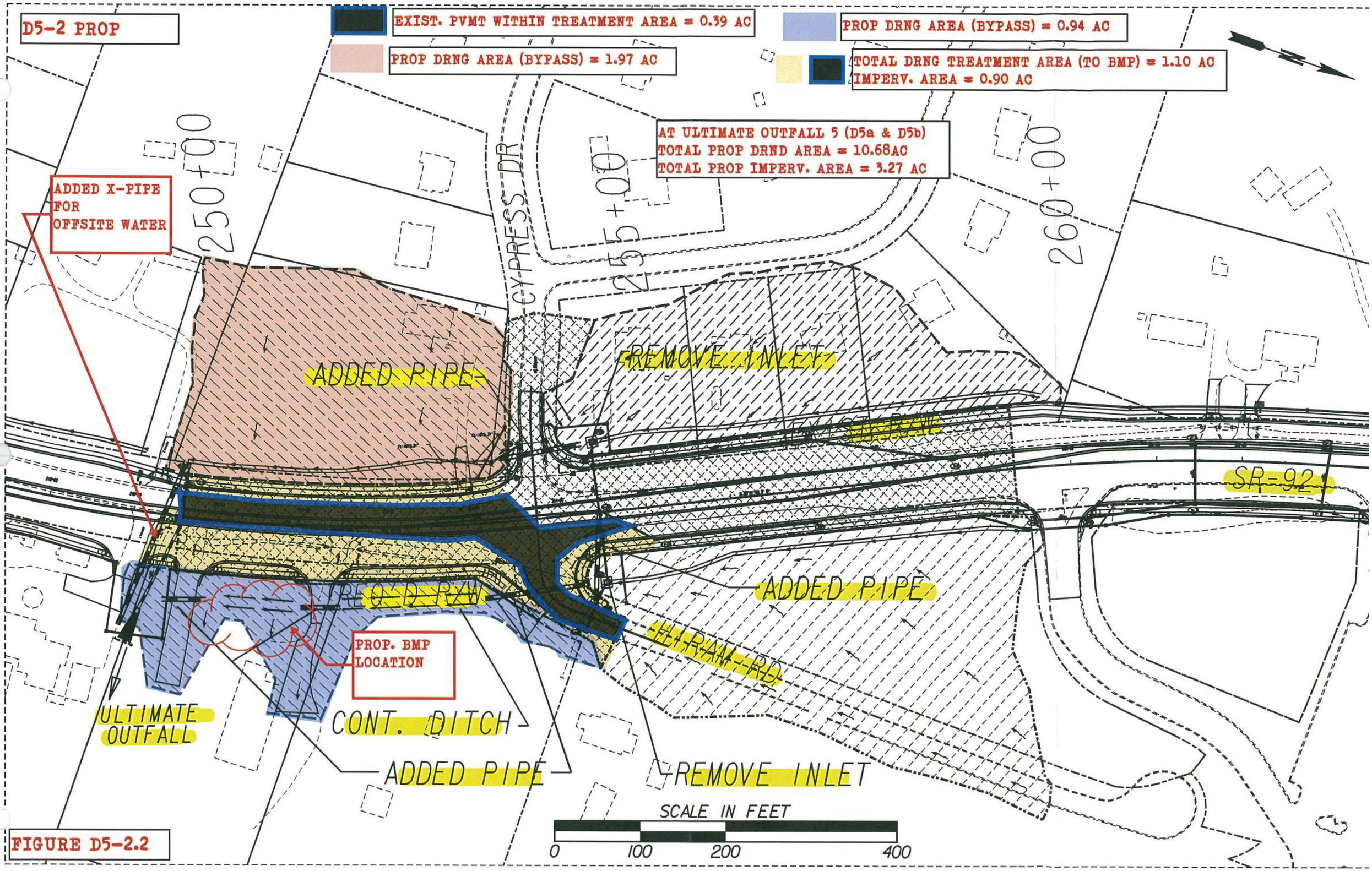

D5-2 PROP
EXIST. PVMT WITHIN TREATMENT AREA = 0.39 AC
PROP DRNG AREA (BYPASS) = 0.94 AC
PROP DRNG AREA (BYPASS) = 1.97 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.10 AC
IMPERV. AREA = 0.90 AC
AT ULTIMATE OUTFALL 5 (D5a & D5b)
TOTAL PROP DRND AREA = 10.68AC
TOTAL PROP IMPERV. AREA = 3.27 AC
ADDED X-PIPE
FOR
OFFSITE WATER
250+00
CY-PRESS DR
255+00
260+00
ADDED PIPE
REMOVE INLET
SR-92
REQ'D RZW
PROP. BMP
LOCATION
ADDED PIPE
HARAM RD
ULTIMATE
OUTFALL
CONT. DITCH
ADDED PIPE
REMOVE INLET
SCALE IN FEET
0
100
200
400

FIGURE D5-2.2

Project: SR 92 Widening & Reconstruction

Unified Stormwater Sizing Criteria

PI: 621720

H&L DESIGN

Nov-14

Pond #: *D5-2*

Calcs.: **FR**

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)

Total Area (ac) =	10.66
Impervious Area =	1.84
Pervious Area=	8.82

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	76

Time of Concentration (See Table A) = 0.15 *hr*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.643

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.191	0.19
$I_a/P_{10\text{-}yr}$=	0.117	0.12
$I_a/P_{25\text{-}yr}$=	0.099	0.1
$I_a/P_{100\text{-}yr}$=	0.081	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.22

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.24
$Q_{d\ 10\text{-}yr}$=	2.94
$Q_{d\ 25\text{-}yr}$=	3.76
$Q_{d\ 100\text{-}yr}$ =	5.05

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	850
$q_{u10\text{-}yr}$=	890
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	17.61
$Q_{p10\text{-}yr}$=	43.56
$Q_{p25\text{-}yr}$=	56.41
$Q_{p100\text{-}yr}$=	75.64

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)

Total Area =	10.68
Impervious Area =	3.27
Pervious Area =	7.41
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	79

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.523

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.156	0.16
$I_a/P_{10\text{-}yr}$=	0.095	0.1
$I_a/P_{25\text{-}yr}$=	0.081	0.1
$I_a/P_{100\text{-}yr}$=	0.066	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.62

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.48
$Q_{d\ 10\text{-}yr}$=	3.28
$Q_{d\ 25\text{-}yr}$=	4.14
$Q_{d\ 100\text{-}yr}$ =	5.46

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	860
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	21.18
$Q_{p10\text{-}yr}$=	49.26
$Q_{p25\text{-}yr}$=	62.17
$Q_{p100\text{-}yr}$=	82.07

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.10	Acre
Total Impervious Area - A_{POST}	0.90	Acre
Existing Pavement Area - A_{PRE} (5)	0.39	Acre
Area Required for Quantity - A_{QUAN} (4)	0.71	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.10	0.46	46.36	0.00	0.467	0.051	**2,239**

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.057	**2,488**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **2,862**

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.907	0.13	0.033	**1,431**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **1,645**

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.922	0.13	0.041	**1,798**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= **2,068**

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure D5-2.1

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: D5-2

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	2,239	2,239
CP_v	2,862	5,101
Q_{p25}	1,645	3,884
Q_{f100}	2,068	4,307

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	670	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	5151	ft^3	>	5101	ft^3

Swale Dimensions:

A swale that is **670** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	5,101	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **291** ft^2

Actual Filter Bed Dimensions:	Width	12	ft
	Length	25	ft
		300	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **337** ft^2

Actual Sediment Chamber Dimensions:	Width	13	ft
	Length	27	ft
		351	ft^2

Bioretention Area

CP_v	=	5,101	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **2,148** ft^2

Actual Filter Bed Dimensions:	Width	20	ft
	Length	108	ft
		2160	ft^2

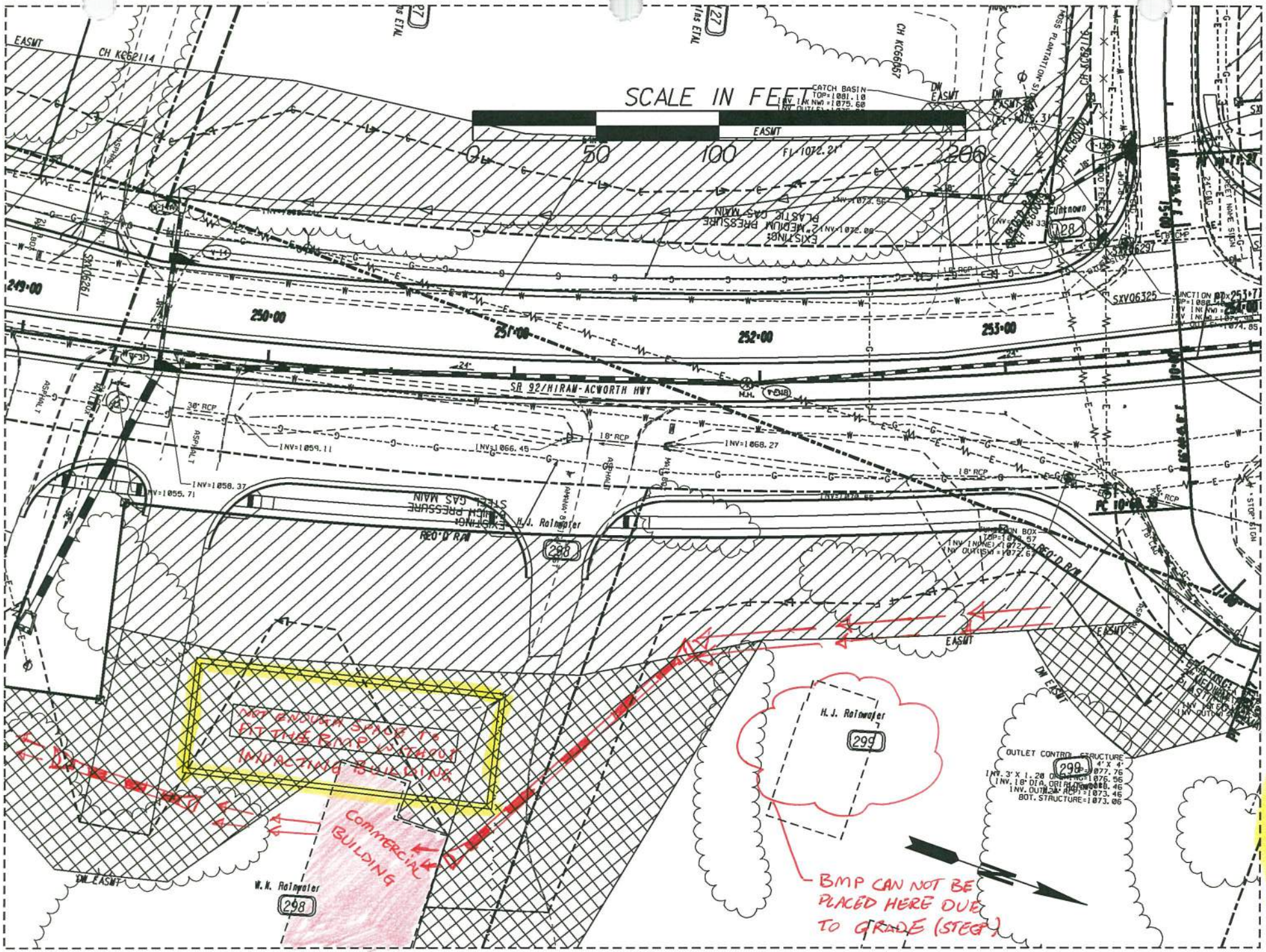

SCALE IN FEET
0
50
100
200
EASMT
CH KC62114
CH KC59957
CATCH BASIN
TOP=1081.10
INV. IN NW=1079.60
DW EASMT
EXISTING 2" MEDIUM PRESSURE PLASTIC GAS MAIN
INV=1072.56
INV=1072.00
Unknown
SXV06297
SXV06325
249+00
250+00
251+00
252+00
253+00
SR 92/HIRAM-ACWORTH HWY
30" RCP
18" RCP
INV=1059.11
INV=1066.45
INV=1068.27
INV=1058.37
INV=1055.71
EXISTING 6" HIGH PRESSURE STEEL GAS MAIN
H.J. Rainwater
REQ'D R/W
298
299
JUNCTION BOX
TOP=1076.57
INV. IN(NE)=1072.00
INV. OUT(SW)=1072.67
OUTLET CONTROL STRUCTURE
4' X 4'
INV. 3' X 1.20 ORIFICE=1077.76
INV. 18" DIA. ORIFICE=1076.56
INV. OUT(SW RCP)=1073.46
BOT. STRUCTURE=1073.06
NOT ENOUGH SPACE TO FIT THE BMP LOCATION WITHOUT IMPACTING BUILDING
COMMERCIAL BUILDING
W.N. Rainwater
BMP CAN NOT BE PLACED HERE DUE TO GRADE (STEEP)

Figure D5-2.5

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

January 17, 2015
Designed By: MAC
Checked By: Jan 17, 15 SCF

Basin E-1.1A Summary
BMP Recommendation - Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E1-1A was located and the existing and proposed basin drainage areas were delineated (See Figures E-1.1A.1 and E-1.1A.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	1,825	1,825
Quantity	Channel Protection, CP_v	1,558	3,383
	Overbank Flood Protection, Q_{p25}	586	2,411
	Extreme Flood Protection, Q_{f100}	760	2,585

- The total area draining to the MS4 BMP is 1.36 Ac. The total impervious area is 1.31 Ac. The existing pavement area for the site is 0.92 Ac. The area required for storage and quantity management is 0.44 Ac (See Figure E-1.1A.3).
- The flow produced by the existing paved area of 0.92 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 10 feet wide by 143 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E-1.1A.4).
- A bypass ditch along the left side of SR 120 will need to be installed to convey the offsite flow from entering the bioretention area (See Figure E-1.1A.5).
- Modifications to the design such as adding curb and gutter and installing drainage structures to SR 120 will need to be done to direct the polluted water to the bioretention area. The roadway flow from SR 92 will be connected to the proposed structures to be directed to the bioretention area. The roadway flow from SR 120 will drain off the rural shoulder and flow into the proposed swale (See Figure E-1.1A5).
- Approximately 500 LF of existing gas line along SR 120 will be impacted by the installation of the bioretention area.
- The BMP construction cost is 13.9% of the roadway construction cost within this basin making this basin infeasible (See Figure E-1.1A.6).
- None of the other infeasibility criteria apply to this basin.

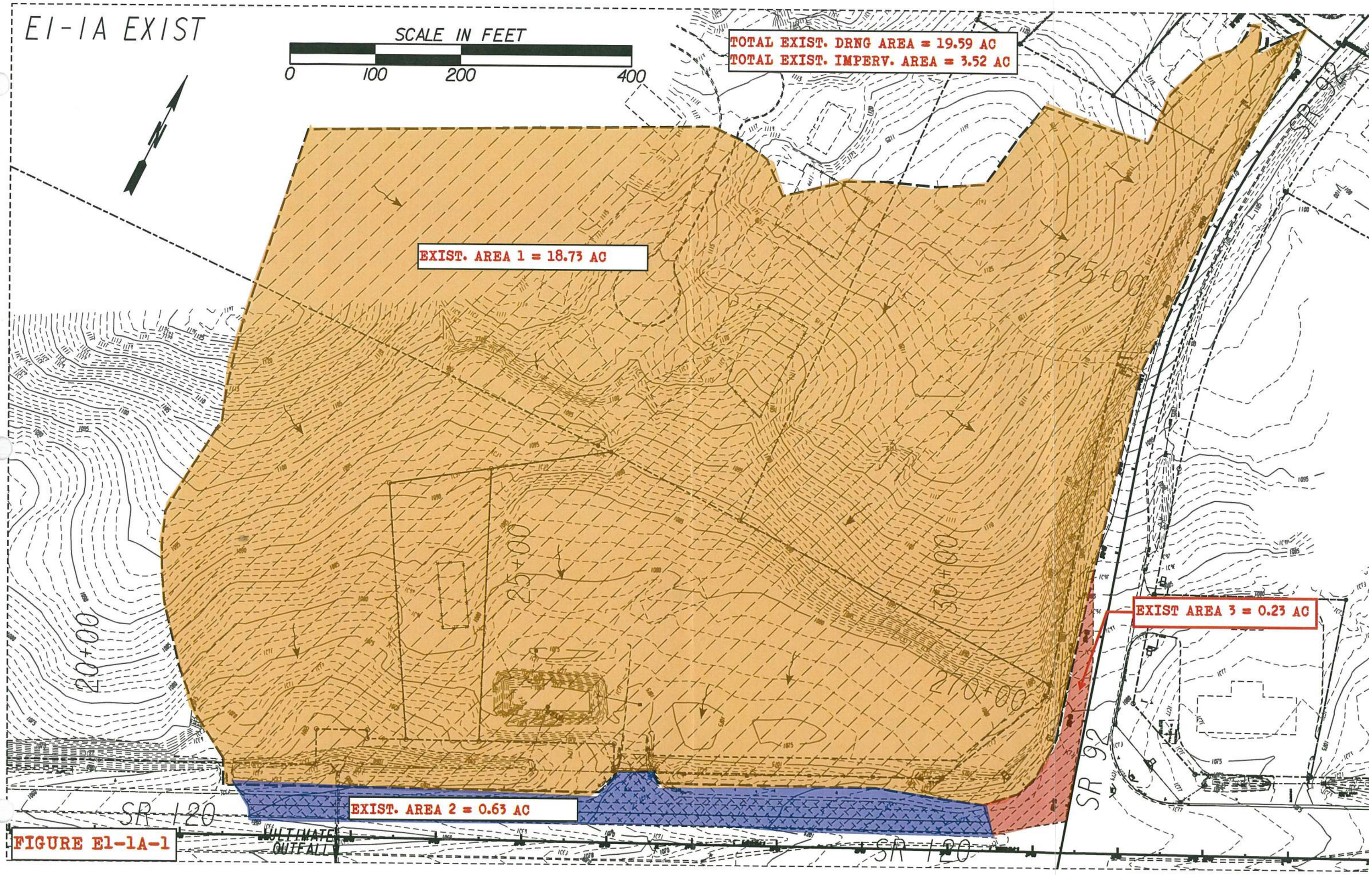


FIGURE E1-1A-1

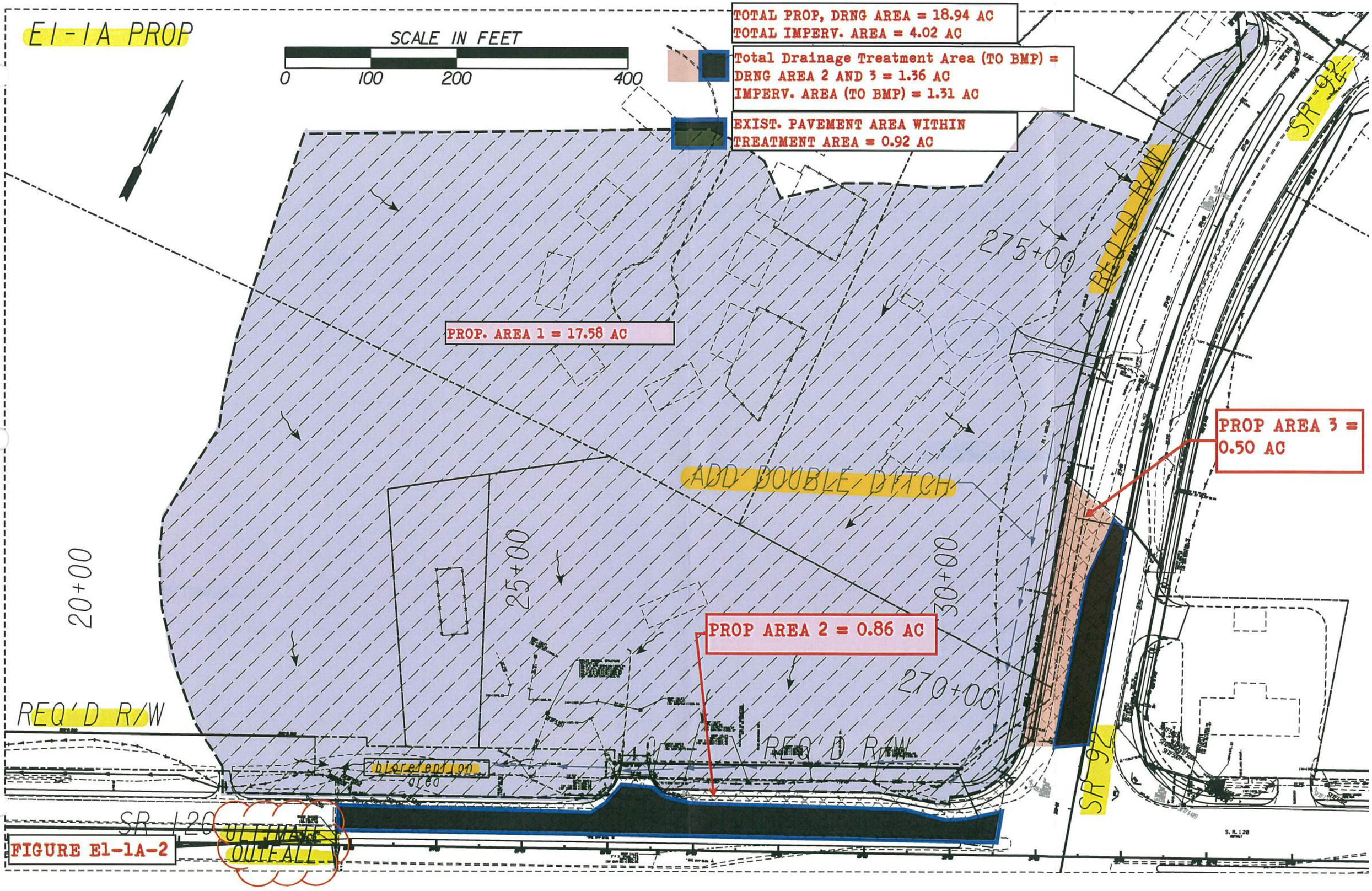


FIGURE E1-1A-2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *E1-1A (LEFT SR 120)*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: MC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	19.590
Impervious Area =	3.520
Pervious Area=	16.070

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	76

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.637

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.190	0.19
$I_a/P_{10\text{-}yr}$=	0.115	0.12
$I_a/P_{25\text{-}yr}$=	0.098	0.10
$I_a/P_{100\text{-}yr}$=	0.080	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.18

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.26
$Q_{d\ 10\text{-}yr}$=	2.96
$Q_{d\ 25\text{-}yr}$=	3.78
$Q_{d\ 100\text{-}yr}$ =	5.07

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	850
$q_{u10\text{-}yr}$=	880
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	32.67
$Q_{p10\text{-}yr}$=	79.63
$Q_{p25\text{-}yr}$=	104.20
$Q_{p100\text{-}yr}$=	139.61

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	18.940
Impervious Area =	4.020
Pervious Area =	14.920
Credit Area =	0.00

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.607

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.181	0.18
$I_a/P_{10\text{-}yr}$=	0.110	0.11
$I_a/P_{25\text{-}yr}$=	0.094	0.10
$I_a/P_{100\text{-}yr}$=	0.077	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.03

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.31
$Q_{d\ 10\text{-}yr}$=	3.04
$Q_{d\ 25\text{-}yr}$=	3.87
$Q_{d\ 100\text{-}yr}$ =	5.17

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	840
$q_{u10\text{-}yr}$=	870
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	32.57	1.003
$Q_{p10\text{-}yr}$=	78.23	
$Q_{p25\text{-}yr}$=	103.17	
$Q_{p100\text{-}yr}$=	137.69	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.36	Acre
Total Impervious Area - A_{POST}	1.31	Acre
Existing Pavement Area - A_{PRE} (5)	0.92	Acre
Area Required for Quantity - A_{QUAN} (4)	0.44	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.36	0.29	28.68	0.00	0.308	0.042	1,825

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

WQ_v =

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.031	1,355

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,558

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
1.010	0.08	0.012	509

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 586

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
1.014	0.08	0.015	661

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 760

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE E-1.14.3

FIGURE E-1.1A.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *E1-1A (LEFT SR 120)*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: MC

	Computed Volumes	Stacked Volumes
WQ_v	1,825	1,825
CP_v	1,558	3,383
Q_{p25}	586	2,411
Q_{f100}	760	2,585

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**441**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	3390	ft^3	>	3383	ft^3

Swale Dimensions:

A swale that is **441** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	3,383	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **193** ft^2

Actual Filter Bed Dimensions: Width **10** ft; Length **20** ft; 200 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **223** ft^2

Actual Sediment Chamber Dimensions: Width **10** ft; Length **23** ft; 230 ft^2

Bioretention Area

CP_v	=	3,383	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **1,424** ft^2

Actual Filter Bed Dimensions: Width **10** ft; Length **143** ft; 1430 ft^2

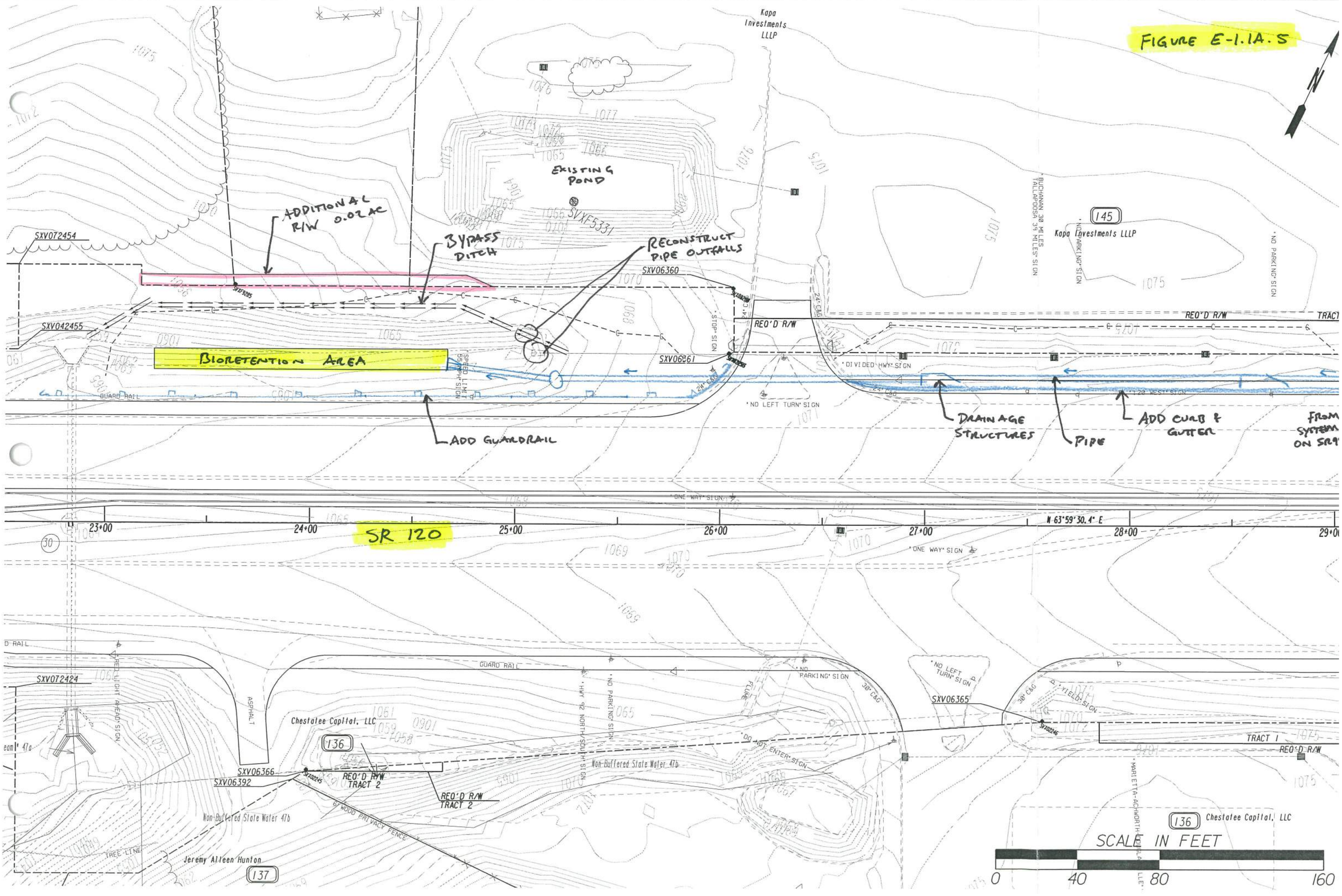


FIGURE E-1.1A.5
Kapa Investments LLLP
EXISTING POND
SVXF5331
ADDITIONAL R/W 0.02 AC
BYPASS DITCH
RECONSTRUCT PIPE OUTFALLS
SXV072454
SXV042455
SXV06360
SXV06361
BIORETENTION AREA
REQ'D R/W
TRACT
"STOP" SIGN
"SPEED LIMIT 55 MPH" SIGN
GUARD RAIL
"NO LEFT TURN" SIGN
"DIVIDED HWY" SIGN
"20 MPH" SIGN
"BUCHANAN 30 MILES TALLAPOOSA 39 MILES" SIGN
"NO PARKING" SIGN
145
Kapa Investments LLLP
DRAINAGE STRUCTURES
PIPE
ADD CURB & GUTTER
FROM SYSTEM ON SR9
ADD GUARDRAIL
"ONE WAY" SIGN
23+00
24+00
25+00
26+00
27+00
28+00
29+00
N 63°59'30.4" E
SR 120
30
SXV072424
ASPHALT
Chestatee Capital, LLC
136
SXV06366
SXV06392
REQ'D R/W TRACT 2
Non-Buffered State Water 47b
6' WOOD PRIVACY FENCE
TREE LINE
Jeremy Aileen Hunton
137
"HWY 9 NORTH/SOUTH" SIGN
"NO PARKING" SIGN
"DO NOT ENTER" SIGN
"NO LEFT TURN" SIGN
SXV06365
"YIELD" SIGN
TRACT 1
REQ'D R/W
"MARIETTA-ACHWORTH" SIGN
SCALE IN FEET
0
40
80
160

Infeasibility Criteria #1: Cost of Construction
Basin E1-1A

1/14/2015

Basin E1-1A 850 LF of Roadway construction cost within basin

Item	Basin E1-1A Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 145,640.00	$ 19,375.00	$ 9,977.50	$ 2,200.00
Utilities ✪	$ 65,160.68	$ 13,090.00	$ 36,000.00	$ 11,000.00
Construction ✪	$ 555,325.52	$ 16,750.00	$ 23,495.00	$ 23,495.00
Clearing and Grubbing	$ -	$ 150.00	$ 500.00	$ 100.00
Grading	$ -	$ 2,700.00	$ 6,300.00	$ 1,320.00
Drainage	$ -	$ 55,965.51	$ 78,898.75	$ 68,564.00
Total	$ 766,126.20	$ 108,030.51	$ 155,171.25	$ 106,679.00
	Percent of BMP Cost to Total	**14.1%**	**20.3%**	**13.9%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.9676
Sub Total:	$	48,380.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		1.1809
Sub Total:	$	29,522.50
Commercial Right of Way @	$	125,000.00
		0.1664
Sub Total:	$	20,800.00
Residential Perm Easmt @	$	62,500.00
		0.111
Sub Total:	$	6,937.50
Right of Way Cost Total:	$	145,640.00

✪ See General Summary Explaination for Cost Method

Figure E-1.1A.6

BMP Construction Cost Worksheet — Basin E1-1A

Dry Enhanced Swale

Length:	441	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.1	Ac	
Total:	$ 5,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.1	Ac	
Total:	$ 12,500.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.03	Ac	
Total:	$ 1,875.00		
Sub Total:	$ 19,375.00		

Utilities

Gas Main	$ 22.00	per LF	
	595	LF	
	$ 13,090.00		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ 13,090.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.03	Disturbed Ac	
$ 150.00		

Grading

Cut	Fill	
300.000	150.000	
	$ 6.00	per CY
Total:	$ 2,700.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		5	EA
	$ 5,000.00			$ 2,000.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	327	CY	$ 30.00	$ 7,259.26
Uddrn Sys w/ Gravel	-	471	LF	$ 20.00	$ 9,420.00
Additional Pipe	18	110	LF	$ 43.00	$ 4,730.00
Outlet Pipe	18	0	LF	$ 43.00	$ -
Bypass Flow Pipe	24	500	LF	$ 52.00	$ 26,000.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	25	SY		25	SY
	$ 1,437.50			$ 118.75	

Sub Total: $ 55,965.51

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	600	LF	$ 20.00	$ 12,000.00
Type 12 Anchorage	1	EA	$ 2,170.00	$ 2,170.00
Type 1 Anchorage	3	EA	$ 860.00	$ 2,580.00
			Sub Total:	$ 16,750.00

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	20	23	ft
Width:	10	10	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.0208	Ac	
Total:	$ 1,040.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.0715	Ac	
Total:	$ 8,937.50		
Sub Total:	$ 9,977.50		

Utilities

Gas Main	$ 22.00	per LF	
	500	LF	
	$ 11,000.00		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	1	poles	
	$ 25,000.00		
Sub Total:	$ 36,000.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.1	Disturbed Ac	
$ 500.00		

Grading

Cut	Fill	
1000.000	50.000	
	$ 6.00	per CY
Total:	$ 6,300.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	6	EA		2	EA
	$ 30,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	12	CY	$ 45.00	$ 540.00
Uddrn Sys w/ Gravel	-	95	LF	$ 20.00	$ 1,900.00
Top Soil		2	CY	$ 20.00	$ 40.00
Addl Pipe	18"	700	LF	$ 43.00	$ 30,100.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	200	SF	$ 5.00	$ 1,000.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	115	SY		115	SY
	$ 6,612.50			$ 546.25	

Sub Total: $ 78,898.75

Construction

	Quantity	Unit	Cost	Total
Tp2 Curb & Gutter	350	LF	$ 20.00	$ 7,000.00
Sidewalk	195	SY	$ 45.00	$ 8,775.00
W-Beam Guardrail	300	LF	$ 20.00	$ 6,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 23,495.00

Bioretention Area

Length:	143	ft
Width:	10	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.006	Ac	
Total:	$ 300.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.0152	Ac	
Total:	$ 1,900.00		
Sub Total:	$ 2,200.00		

Utilities

Gas Main	$ 22.00	per LF	
	500	LF	
	$ 11,000.00		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ 11,000.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.02	Disturbed Ac	
$ 100.00		

Grading

Cut	Fill	
150.000	70.000	
	$ 6.00	per CY
Total:	$ 1,320.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	5	EA		4	EA
	$ 25,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	106	CY	$ 30.00	$ 3,180.00
Uddrn Sys w/ Gravel	-	45	LF	$ 20.00	$ 900.00
Mulch	-	159	SY	$ 15.00	$ 2,385.00
Additional Pipe	18"	700	LF	$ 43.00	$ 30,100.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	7	EA	$ 30.00	$ 210.00
Ground Cover	-	17	EA	$ 15.00	$ 255.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	24	SY		24	SY
	$ 1,380.00			$ 114.00	

Sub Total: $ 68,564.00

Construction

	Quantity	Unit	Cost	Total
Tp2 Curb & Gutter	350	LF	$ 20.00	$ 7,000.00
Sidewalk	195	SY	$ 45.00	$ 8,775.00
W-Beam Guardrail	300	LF	$ 20.00	$ 6,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 23,495.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
5TP00-0186-01(025)

November 17, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin E1-1B Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E1-1B was located and the existing and proposed basin drainage areas were delineated (See Figures E-1.1B.1 and E-1.1B.2). From those drainage areas the MS4 requirements, the Water quality and Channel Protection volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,247	3,247
Quantity	Channel Protection, CP_v	3,014	6,261
	Overbank Flood Protection, Q_{p25}	N/A	3,247
	Extreme Flood Protection, Q_{f100}	N/A	3,247

Overbank Flood Protection and Extreme Flood Protection Volume calculations are not applicable due to a reduction of peak discharge flows. This is caused because of a reduction in overall basin area.

- The total area draining to the MS4 BMP is 2.13 Ac. The total impervious area is 2.06 Ac. The existing pavement area for the site is 1.35 Ac. The area required for storage and quantity management is 0.78 Ac (See Figure E-1.1B.3). The flow produced by the existing paved area of 1.35 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 20 feet wide by 132 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E-1.1B.4).
- A ditch to move the non-buffered state water around the BMP will be required and will direct the bypass flow from entering the BMP and mixing with the polluted water (See Figure E-1.1B.5).
- Guardrail will also need to be installed (See Figure E-1.1B.5).
- The BMP construction cost is 18.4% of the roadway construction cost within this basin making this basin infeasible (See Figure E-1.1B.6).
- None of the other infeasibility criteria apply to this basin.

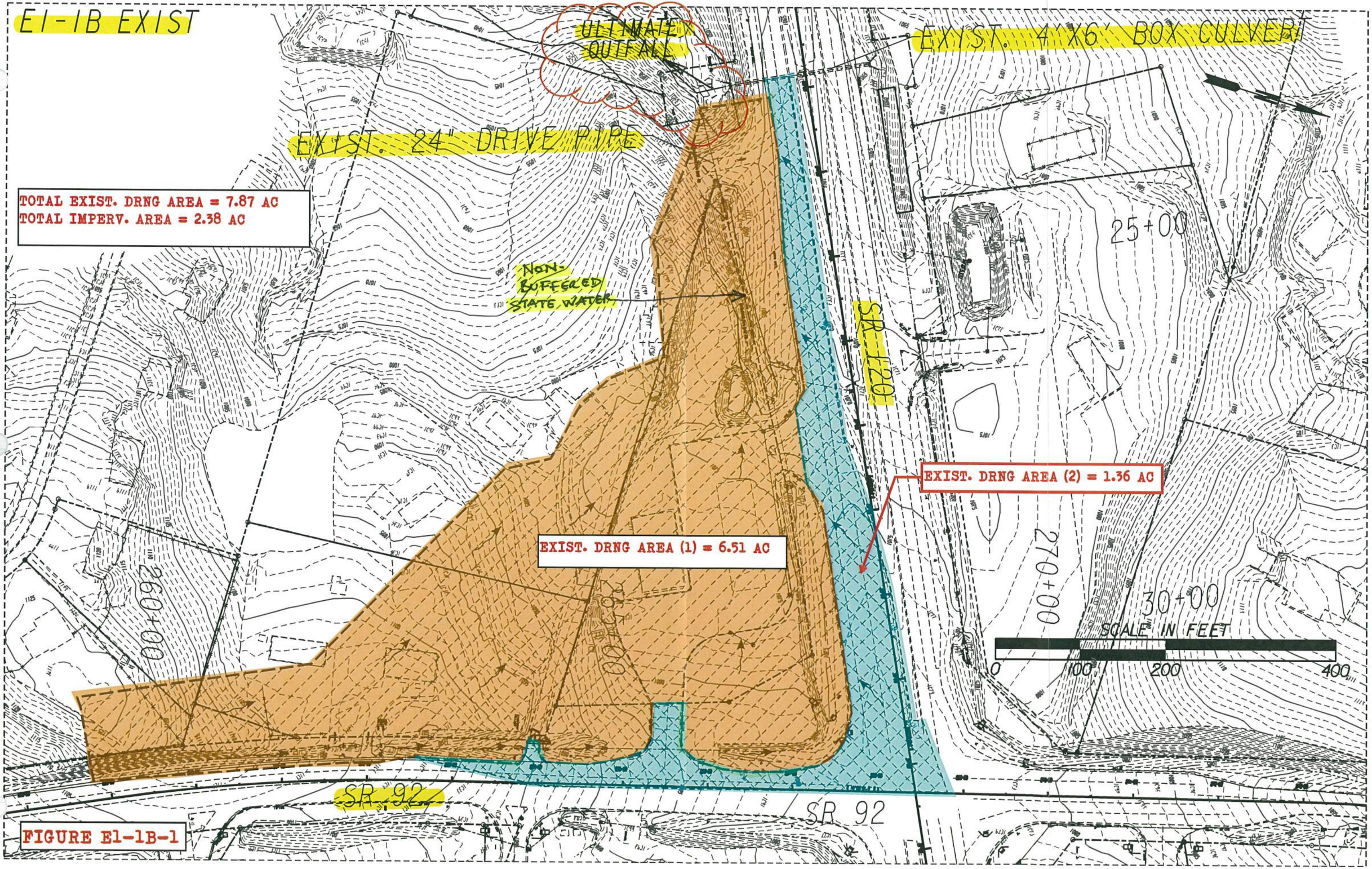


FIGURE E1-1B-1

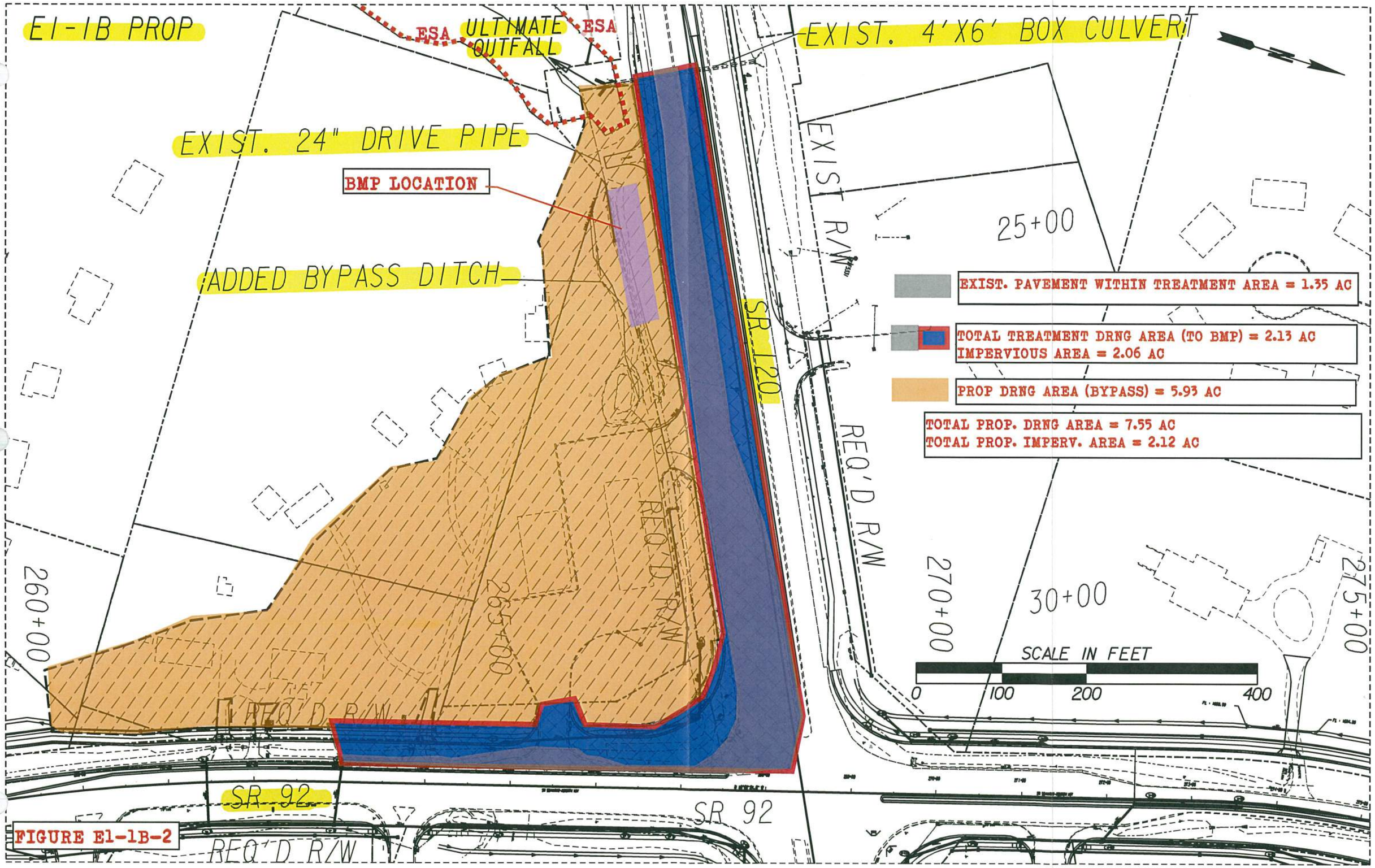


FIGURE E1-1B-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E1-1B (RIGHT SR 120)

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: MC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	7.870
Impervious Area =	2.380
Pervious Area=	5.490

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	79

Time of Concentration (See Table A) = 0.15 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.526

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.157	0.16
$I_a/P_{10\text{-}yr}$=	0.095	0.10
$I_a/P_{25\text{-}yr}$=	0.081	0.10
$I_a/P_{100\text{-}yr}$=	0.066	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.63

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.47
$Q_{d\ 10\text{-}yr}$=	3.27
$Q_{d\ 25\text{-}yr}$=	4.13
$Q_{d\ 100\text{-}yr}$ =	5.45

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	840
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	15.18
$Q_{p10\text{-}yr}$=	36.19
$Q_{p25\text{-}yr}$=	45.69
$Q_{p100\text{-}yr}$=	60.35

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	7.550
Impervious Area =	2.120
Pervious Area =	5.430
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	79

Time of Concentration (See Table A) = 0.15 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.545

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.162	0.16
$I_a/P_{10\text{-}yr}$=	0.099	0.10
$I_a/P_{25\text{-}yr}$=	0.084	0.10
$I_a/P_{100\text{-}yr}$=	0.069	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.73

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.43
$Q_{d\ 10\text{-}yr}$=	3.21
$Q_{d\ 25\text{-}yr}$=	4.07
$Q_{d\ 100\text{-}yr}$ =	5.38

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	845
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	14.26	1.065
$Q_{p10\text{-}yr}$=	34.12	
$Q_{p25\text{-}yr}$=	43.18	
$Q_{p100\text{-}yr}$=	57.17	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)
A: Total Area in mi²
F_p= 1
F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.13	Acre
Total Impervious Area - A_{POST}	2.06	Acre
Existing Pavement Area - A_{PRE} (5)	1.35	Acre
Area Required for Quantity - A_{QUAN} (4)	0.78	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.13	0.33	33.33	0.00	0.350	0.075	3,247

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) R_v = 0.05 + 0.009 (I)
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.060	2,621

(+15% ED)= 3,014

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
1.058	0.05	0.014	Peak Discharge Reduced

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
1.056	0.05	0.019	Peak Discharge Reduced

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qc/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

figure E-1.1B.3

FIGURE E-1.1B.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *E1-1B (RIGHT SR 120)*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: MC

	Computed Volumes	Stacked Volumes
WQ_v	3,247	3,247
CP_v	3,014	6,261
Q_{p25}	0	3,247
Q_{f100}	0	3,247

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**815**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	6265	ft^3	>	6261	ft^3

Swale Dimensions:

A swale that is **815** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	6,261	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **357** ft^2

Actual Filter Bed Dimensions:	Width	**14**	ft
	Length	**28**	ft
		392	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **413** ft^2

Actual Sediment Chamber Dimensions:	Width	**14**	ft
	Length	**30**	ft
		420	ft^2

Bioretention Area

CP_v	=	6,261	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **2,636** ft^2

Actual Filter Bed Dimensions:	Width	**20**	ft
	Length	**132**	ft
		2640	ft^2

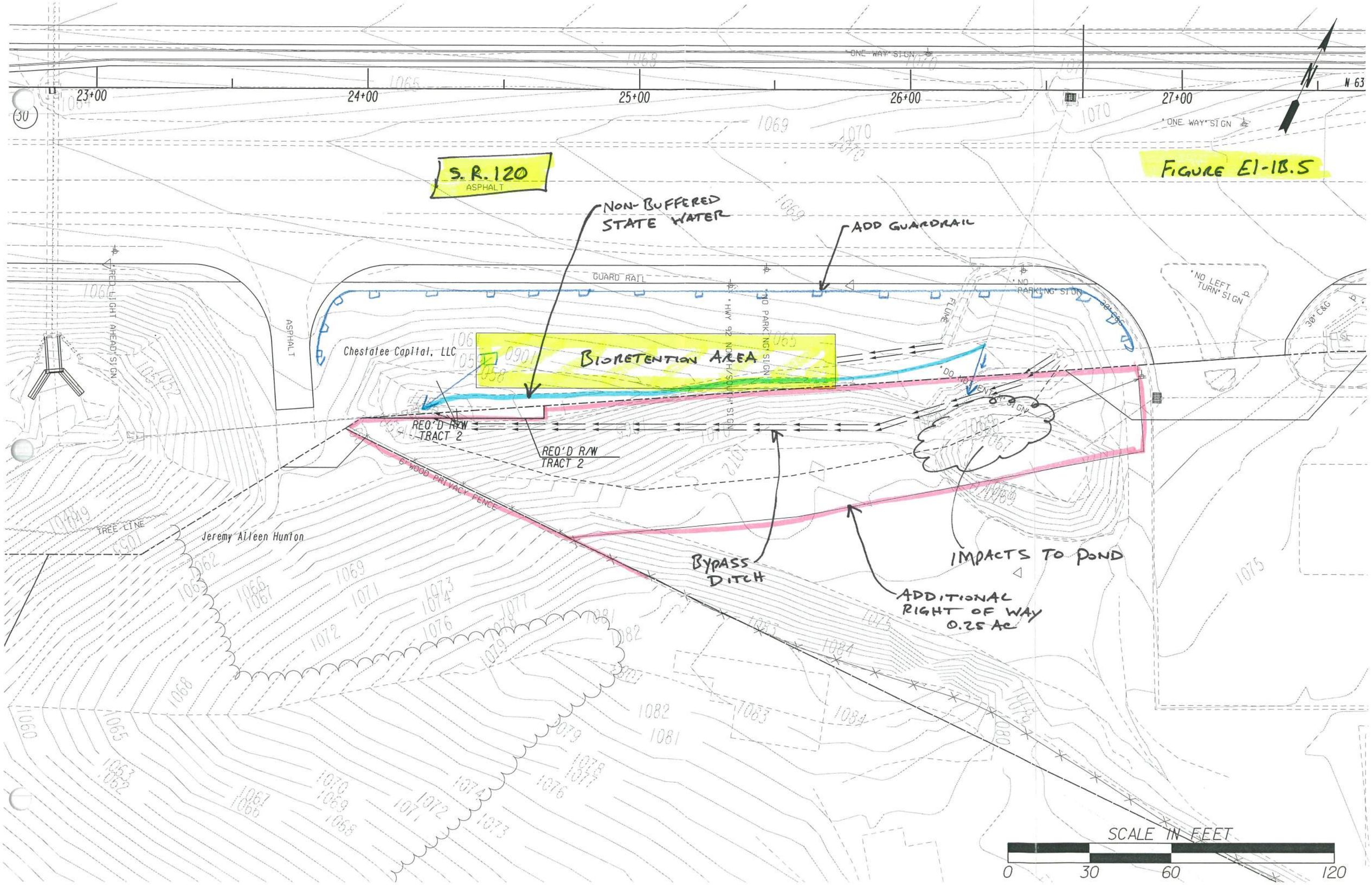


FIGURE E1-1B.5
S. R. 120
ASPHALT
NON-BUFFERED STATE WATER
ADD GUARDRAIL
BIORETENTION AREA
Chestatee Capital, LLC
Jeremy Aileen Hunton
REQ'D R/W TRACT 2
REQ'D R/W TRACT 2
BYPASS DITCH
IMPACTS TO POND
ADDITIONAL RIGHT OF WAY 0.25 AC
6' WOOD PRIVACY FENCE
TREE LINE
GUARD RAIL
ASPHALT
"RED LIGHT AHEAD" SIGN
"HWY 92 NORTH/SOUTH" SIGN
"NO PARKING" SIGN
"NO PARKING" SIGN
"DO NOT ENTER" SIGN
"NO LEFT TURN" SIGN
"ONE WAY" SIGN
"ONE WAY" SIGN
FLUME
30' C&G
23+00
24+00
25+00
26+00
27+00
N 63
SCALE IN FEET
0
30
60
120

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin E1-1B

Basin E1-1B 850 LF of Roadway construction cost within basin

Item	Basin E1-1B Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 24,157.50	$ 85,010.00	$ 83,750.00	$ 81,250.00
Utilities ✪	$ 65,160.68	$ -	$ -	$ -
Construction ✪	$ 555,325.52	$ 6,720.00	$ 6,720.00	$ 6,720.00
Clearing and Grubbing	$ -	$ 2,200.00	$ 1,350.00	$ 1,250.00
Grading	$ -	$ 10,350.00	$ 6,300.00	$ 3,600.00
Drainage	$ -	$ 44,046.89	$ 37,362.50	$ 25,709.00
Total	$ 644,643.70	$ 148,326.89	$ 135,482.50	$ 118,529.00
	Percent of BMP Cost to Total	**23.0%**	**21.0%**	**18.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.1786
Sub Total:	$	8,930.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.3091
Sub Total:	$	7,727.50
Commercial Right of Way @	$	125,000.00
		0.05
Sub Total:	$	6,250.00
Residential Perm Easmt @	$	62,500.00
		0.02
Sub Total:	$	1,250.00
Right of Way Cost Total:	$	24,157.50

✪ See General Summary Explaination for Cost Method

figure E1-1B.6

BMP Construction Cost Worksheet — Basin E1-1B

Dry Enhanced Swale

Length:	815	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.0237	Ac	
Total:	$ 1,185.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.2706	Ac	
Total:	$ 33,825.00		
Cost to Cure @	$ 50,000.00	LS	
(Damages to Detention Pond)	1		
Total:	$ 50,000.00		
Sub Total:	$ 85,010.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.44	Disturbed Ac	
$ 2,200.00		

Grading

Cut	Fill	
1150.000	575.000	
$ 6.00	per CY	
Total: $ 10,350.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		3	EA
	$ 5,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	604	CY	$ 30.00	$ 13,415.64
Uddrn Sys w/ Gravel	-	845	LF	$ 20.00	$ 16,900.00
Additional Pipe	18	110	LF	$ 43.00	$ 4,730.00
Outlet Pipe	18	0	LF	$ 43.00	$ -
Bypass Flow Pipe	18	0	LF	$ 43.00	$ -

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	45	SY	Fabric	45	SY
	$ 2,587.50			$ 213.75	

Sub Total: $ 44,046.89

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	250	LF	$ 20.00	$ 5,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 6,720.00

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	28	30	ft
Width:	14	14	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac
	0.27	Ac
Total:	$ 33,750.00	
Cost to Cure @	$ 50,000.00	LS
(Damages to Detention Pond)	1	
Total:	$ 50,000.00	
Sub Total:	$ 83,750.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.27	Disturbed Ac	
$ 1,350.00		

Grading

Cut	Fill	
1000.000	50.000	
$ 6.00	per CY	
Total: $ 6,300.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		4	EA
	$ 10,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	22	CY	$ 45.00	$ 990.00
Uddrn Sys w/ Gravel	-	115	LF	$ 20.00	$ 2,300.00
Top Soil		4	CY	$ 20.00	$ 80.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	392	SF	$ 5.00	$ 1,960.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	210	SY	Filter Fabric	210	SY
	$ 12,075.00			$ 997.50	

Sub Total: $ 37,362.50

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	250	LF	$ 20.00	$ 5,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 6,720.00

Bioretention Area

Length:	132	ft
Width:	20	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac
	0.25	Ac
Total:	$ 31,250.00	
Cost to Cure @	$ 50,000.00	LS
(Damages to Detention Pond)	1	
Total:	$ 50,000.00	
Sub Total:	$ 81,250.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.25	Disturbed Ac	
$ 1,250.00		

Grading

Cut	Fill	
500.000	100.000	
$ 6.00	per CY	
Total: $ 3,600.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		4	EA
	$ 5,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	196	CY	$ 30.00	$ 5,880.00
Uddrn Sys w/ Gravel	-	90	LF	$ 20.00	$ 1,800.00
Mulch	-	294	SY	$ 15.00	$ 4,410.00
Additional Pipe	18"	0	LF	$ 43.00	$ -
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	12	EA	$ 30.00	$ 360.00
Ground Cover	-	32	EA	$ 15.00	$ 480.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	44	SY	Fabric	44	SY
	$ 2,530.00			$ 209.00	

Sub Total: $ 25,709.00

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	250	LF	$ 20.00	$ 5,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 6,720.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November17, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin E2-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E2-1 was located and the existing and proposed basin drainage areas were delineated (See Figures E2-1.1 and E2-1.2). From those drainage areas the MS4 requirements, the Water Quality and Channel Protection volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	1,403	1,403
Quantity	Channel Protection, CP_v	1,021	2,424
	Overbank Flood Protection, Q_{p25}	N/A	1,403
	Extreme Flood Protection, Q_{f100}	N/A	1,403

The proposed total basin area and peak flows for the ultimate outfall decreased when compared to the existing area. Overbank Flood Protection and Extreme Flood Protection are not applicable because the peak discharge for the basin is decreased for the ultimate outfall. The process to compute those volumes compares the percent increase from the pre to the post, so it would result in a negative volume.

- The total area draining to the MS4 BMP is 0.86 Ac. The total impervious area is 0.86 Ac. The existing pavement area for the site is 0.55 Ac. The area required for storage and quantity management is 0.31 Ac (See Figure E2-1.3). The flow produced by the existing paved area of 0.55 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 8 feet wide by 130 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and the only one that returned a feasible result.
- The bioretention area will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E2-1.4).
- A bypass ditch and driveway pipes will be added to divert the offsite flow around the BMP (See Figure E2-1.5).
- Guardrail will also need to be installed (See Figure E2-1.5).
- The BMP construction cost is 11.4% of the roadway construction cost within this basin making this basin infeasible (See Figure E2-1.6).
- None of the other infeasibility criteria apply to this basin making this basin feasible.

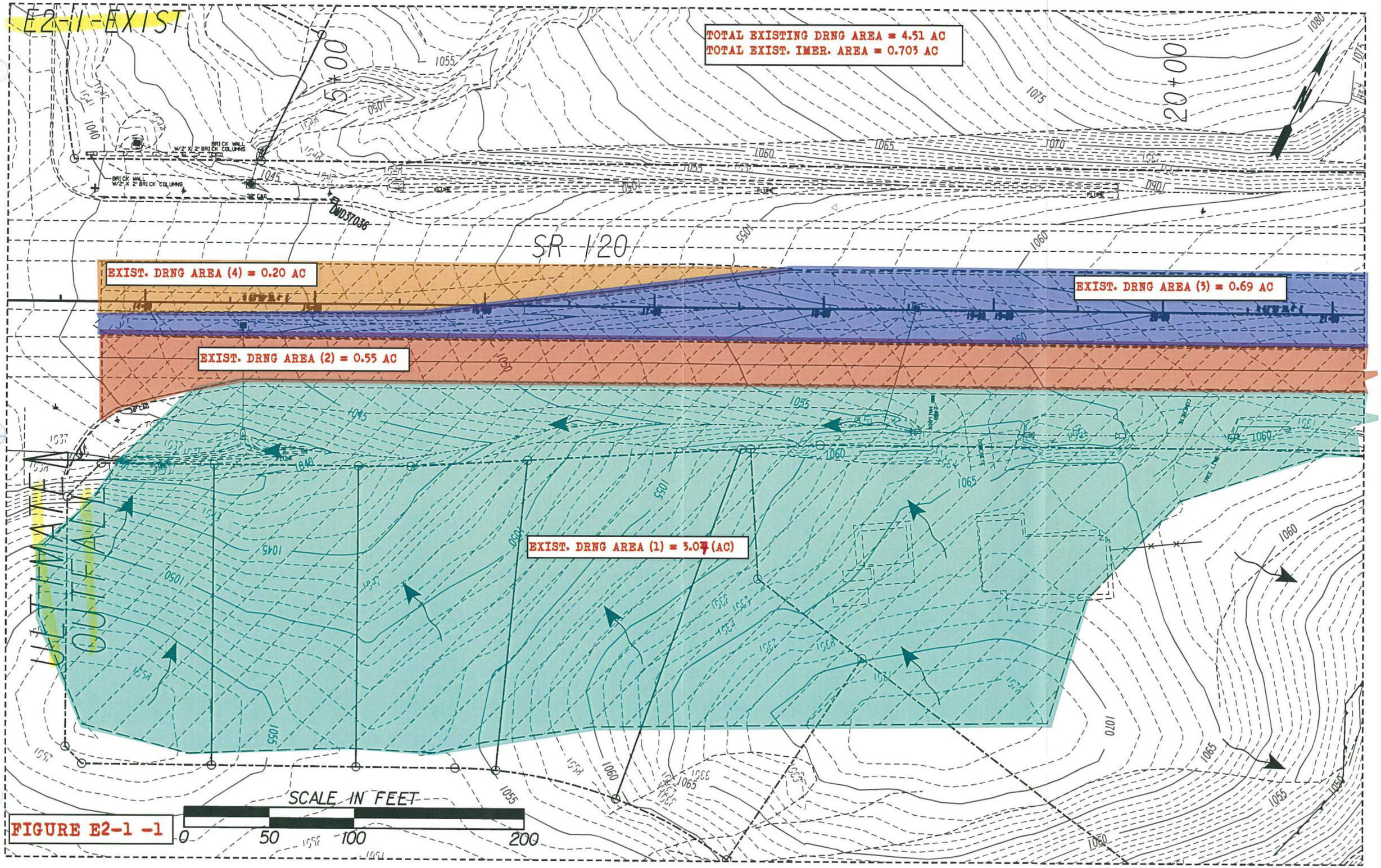

E2-1-EXIST
TOTAL EXISTING DRNG AREA = 4.51 AC
TOTAL EXIST. IMER. AREA = 0.703 AC
SR 120
EXIST. DRNG AREA (4) = 0.20 AC
EXIST. DRNG AREA (3) = 0.69 AC
EXIST. DRNG AREA (2) = 0.55 AC
EXIST. DRNG AREA (1) = 3.07 (AC)
SCALE IN FEET
0
50
100
200

FIGURE E2-1 -1

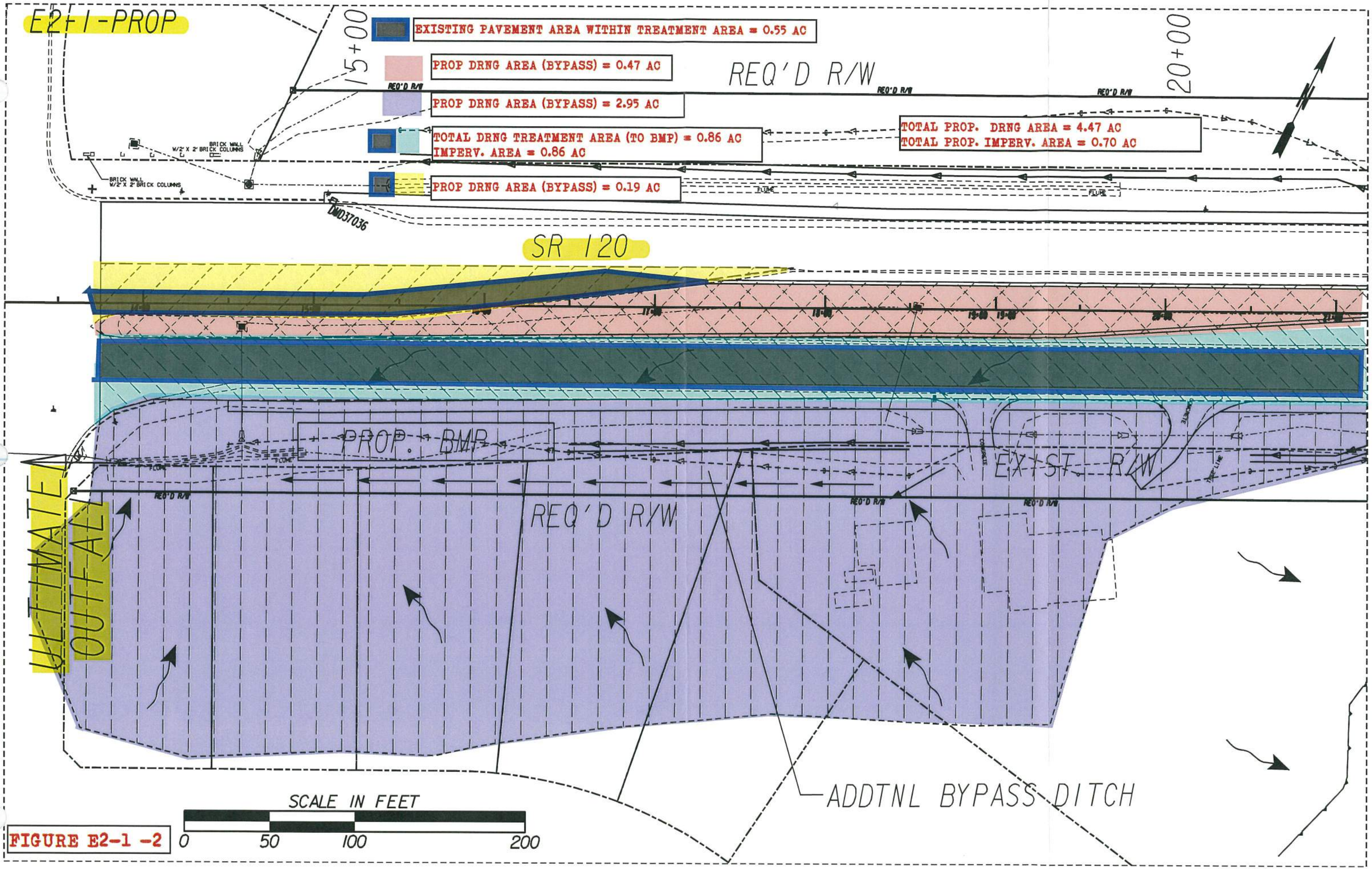

E2-1-PROP
15+00
20+00
EXISTING PAVEMENT AREA WITHIN TREATMENT AREA = 0.55 AC
PROP DRNG AREA (BYPASS) = 0.47 AC
PROP DRNG AREA (BYPASS) = 2.95 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 0.86 AC
IMPERV. AREA = 0.86 AC
PROP DRNG AREA (BYPASS) = 0.19 AC
TOTAL PROP. DRNG AREA = 4.47 AC
TOTAL PROP. IMPERV. AREA = 0.70 AC
REQ'D R/W
BRICK WALL
W/2' X 2' BRICK COLUMNS
DMD37036
SR 120
PROP. BMP
EXIST. R/W
REQ'D R/W
ULTIMATE OUTFALL
ADDTNL BYPASS DITCH
SCALE IN FEET
0
50
100
200

FIGURE E2-1 -2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *E2-1*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: MC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	4.510
Impervious Area =	0.703
Pervious Area=	3.807

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.15 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.659

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.196	0.20
$I_a/P_{10\text{-}yr}$=	0.119	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.10
$I_a/P_{100\text{-}yr}$=	0.083	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.30

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.22
$Q_{d\ 10\text{-}yr}$=	2.90
$Q_{d\ 25\text{-}yr}$=	3.72
$Q_{d\ 100\text{-}yr}$ =	4.99

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	850
$q_{u10\text{-}yr}$=	880
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	7.28
$Q_{p10\text{-}yr}$=	17.96
$Q_{p25\text{-}yr}$=	23.57
$Q_{p100\text{-}yr}$=	31.67

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	4.470
Impervious Area =	0.703
Pervious Area =	3.767
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.15 hr

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.658

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.196	0.20
$I_a/P_{10\text{-}yr}$=	0.119	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.10
$I_a/P_{100\text{-}yr}$=	0.083	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.29

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.22
$Q_{d\ 10\text{-}yr}$=	2.90
$Q_{d\ 25\text{-}yr}$=	3.72
$Q_{d\ 100\text{-}yr}$ =	5.00

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	850
$q_{u10\text{-}yr}$=	880
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	7.23	1.007
$Q_{p10\text{-}yr}$=	17.82	
$Q_{p25\text{-}yr}$=	23.38	
$Q_{p100\text{-}yr}$=	31.42	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	0.86	Acre
Total Impervious Area - A_{POST}	0.86	Acre
Existing Pavement Area - A_{PRE} (5)	0.55	Acre
Area Required for Quantity - A_{QUAN} (4)	0.31	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
0.86	0.36	36.05	0.00	0.374	0.032	***1,403***

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.020	***887***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= ***1,021***

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
1.008	0.08	0.008	***Peak Discharge Reduced***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
1.008	0.08	0.011	***Peak Discharge Reduced***

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

FIGURE E2-1.3

FIGURE E2-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *E2-1*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: MC

	Computed Volumes	Stacked Volumes
WQ_v	1,403	1,403
CP_v	1,021	2,424
Q_{p25}	0	1,403
Q_{f100}	0	1,403

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**316**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	2429	ft^3	>	2424	ft^3

Swale Dimensions:

A swale that is **316** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	2,424	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **138** ft^2

Actual Filter Bed Dimensions:	Width	**9**	ft
	Length	**18**	ft
		162	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **160** ft^2

Actual Sediment Chamber Dimensions:	Width	**9**	ft
	Length	**18**	ft
		162	ft^2

Bioretention Area

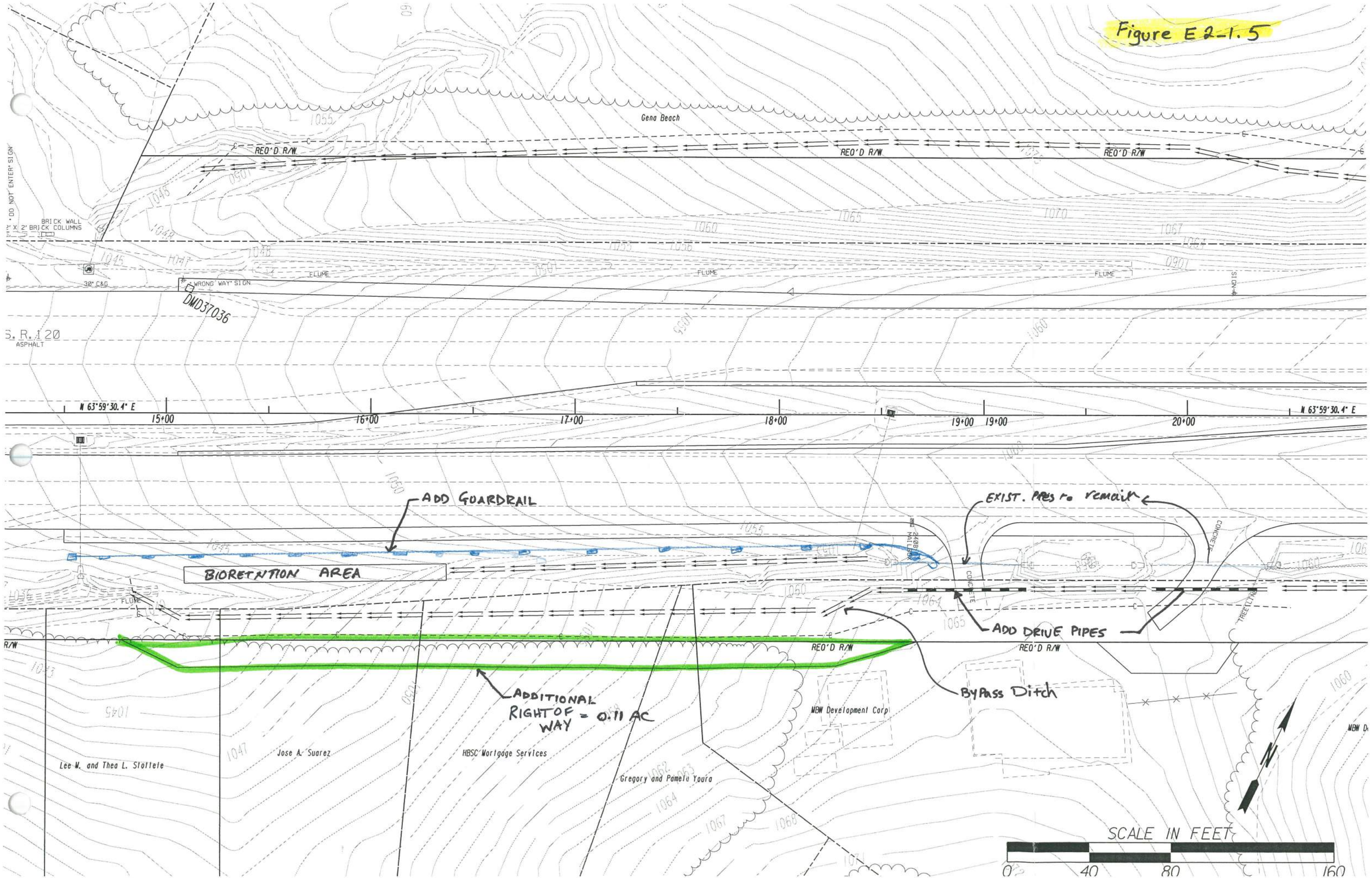
CP_v	=	2,424	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **1,021** ft^2

Actual Filter Bed Dimensions:	Width	**8**	ft
	Length	**128**	ft
		1024	ft^2

Figure E2-1.5


Gena Beach
REQ'D R/W
REQ'D R/W
REQ'D R/W
BRICK WALL
2' X 2' BRICK COLUMNS
30" C&G
"WRONG WAY" SIGN
DMD37036
FLUME
FLUME
FLUME
S.R. 120
ASPHALT
N 63°59'30.4" E
15+00
16+00
17+00
18+00
19+00
19+00
20+00
N 63°59'30.4" E
ADD GUARDRAIL
BIORETNTION AREA
EXIST. PIPES to remain
ADD DRIVE PIPES
ADDITIONAL RIGHT OF WAY = 0.11 AC
BYPASS Ditch
REQ'D R/W
REQ'D R/W
MBW Development Corp
Lee M. and Thea L. Stoltete
Jose A. Suarez
HBSC Mortgage Services
Gregory and Pamela Youra
SCALE IN FEET
0
40
80
160

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin E2-1

Basin E2-1 450 LF of Roadway construction cost within basin

Item	Basin E2-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 25,425.00	$ 1,720.00	$ 7,900.00	$ 5,500.00
Utilities ✪	$ 34,496.83	$ -	$ -	$ -
Construction ✪	$ 293,995.86	$ 11,530.00	$ 10,720.00	$ 10,720.00
Clearing and Grubbing	$ -	$ 350.00	$ 850.00	$ 350.00
Grading	$ -	$ 2,748.83	$ 3,900.00	$ 1,110.00
Drainage	$ -	$ 24,572.15	$ 26,037.25	$ 22,700.50
Total	$ 353,917.69	$ 40,920.97	$ 49,407.25	$ 40,380.50
	Percent of BMP Cost to Total	**11.6%**	**14.0%**	**11.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.5085
Sub Total:	$	25,425.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	25,425.00

✪ See General Summary Explaination for Cost Method

figure E2-1.6

BMP Construction Cost Worksheet — Basin E2-1

Dry Enhanced Swale

Length:	316	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.0688	Ac	
Total:	$ 1,720.00		
Sub Total:	$ 1,720.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.07	Disturbed Ac	
$ 350.00		

Grading

Cut	Fill	
200.000	258.138	
$ 6.00	per CY	
Total: $ 2,748.83		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		4	EA
	$ 5,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	234	CY	$ 30.00	$ 5,201.65
Uddrn Sys w/ Gravel	-	346	LF	$ 20.00	$ 6,920.00
Additional Pipe	18	110	LF	$ 43.00	$ 4,730.00
Outlet Pipe	18	0	LF	$ 43.00	$ -
Bypass Flow Pipe	18	0	LF	$ 43.00	$ -

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	18	SY	Fabric	18	SY
	$ 1,035.00			$ 85.50	

Sub Total: $ 24,572.15

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	425	LF	$ 20.00	$ 8,500.00
Type 12 Anchorage	1	EA	$ 2,170.00	$ 2,170.00
Type 1 Anchorage	1	EA	$ 860.00	$ 860.00
			Sub Total:	$ 11,530.00

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	18	18	ft
Width:	9	9	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.148	Ac	
Total:	$ 7,400.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.02	Ac	
Total:	$ 500.00		
Sub Total:	$ 7,900.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.17	Disturbed Ac	
$ 850.00		

Grading

Cut	Fill	
600.000	50.000	
$ 6.00	per CY	
Total: $ 3,900.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		4	EA
	$ 10,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	9	CY	$ 45.00	$ 405.00
Uddrn Sys w/ Gravel	-	90	LF	$ 20.00	$ 1,800.00
Top Soil		2	CY	$ 20.00	$ 40.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	162	SF	$ 5.00	$ 810.00
Dist Wall Conc/Steel	-	2	CY	$ 1,020.00	$ 2,040.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	81	SY	Fabric	81	SY
	$ 4,657.50			$ 384.75	

Sub Total: $ 26,037.25

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	450	LF	$ 20.00	$ 9,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 10,720.00

Bioretention Area

Length:	128	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.11	Ac	
Total:	$ 5,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 5,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.07	Disturbed Ac	
$ 350.00		

Grading

Cut	Fill	
180.000	5.000	
$ 6.00	per CY	
Total: $ 1,110.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		4	EA
	$ 5,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	76	CY	$ 30.00	$ 2,280.00
Uddrn Sys w/ Gravel	-	36	LF	$ 20.00	$ 720.00
Mulch	-	114	SY	$ 15.00	$ 1,710.00
Additional Pipe	18"	110	LF	$ 43.00	$ 4,730.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	28	EA	$ 30.00	$ 840.00
Ground Cover	-	84	EA	$ 15.00	$ 1,260.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	18	SY	Fabric	18	SY
	$ 1,035.00			$ 85.50	

Sub Total: $ 22,700.50

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	450	LF	$ 20.00	$ 9,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 10,720.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 17, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin E2-2 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E2-2 was located and the existing and proposed basin drainage areas were delineated (See Figures E2-2.1 and E2-2.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	1,340	1,340
Quantity	Channel Protection, CP_v	4,599	5,939
	Overbank Flood Protection, Q_{p25}	3,541	4,881
	Extreme Flood Protection, Q_{f100}	4,412	5,752

- The total area draining to the MS4 BMP is 2.01 Ac. The total impervious area is 0.89 Ac. The existing pavement area for the site is 0.66 Ac. The area required for storage and quantity management is 1.35 Ac (See Figure E2-2.3). The flow produced by the existing paved area of 0.66 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 15 feet wide by 170 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E-4.4).
- A bypass ditch along the left side of SR 92 will need to be installed to convey the offsite flow. Guardrail will also need to be installed (See Figure E2-2.5).
- The BMP construction cost is 26.9% of the roadway construction cost within this basin making this basin infeasible (See Figure E2-2.6).
- None of the other infeasibility criteria apply to this basin.

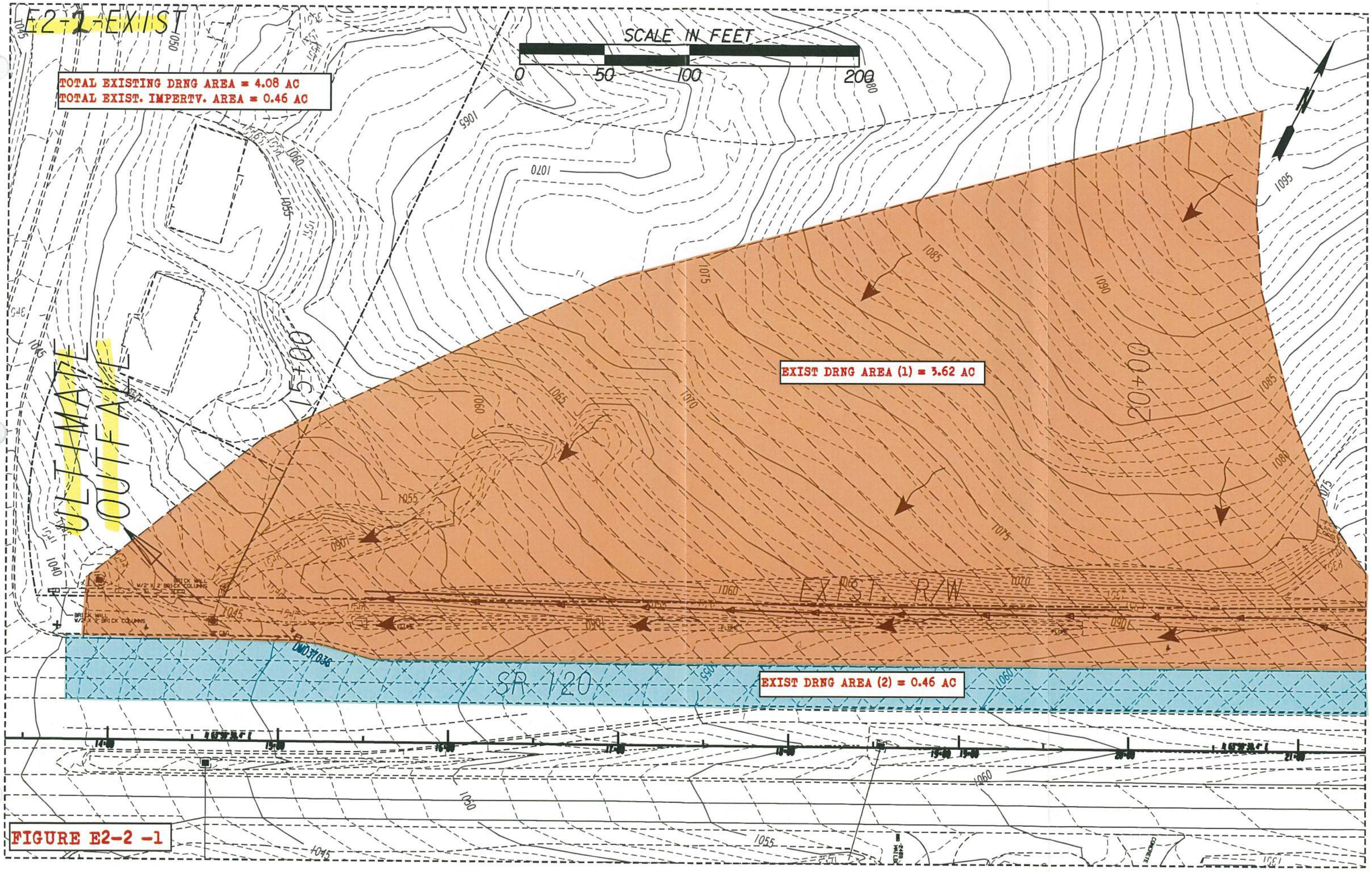

E2-2-EXIST
TOTAL EXISTING DRNG AREA = 4.08 AC
TOTAL EXIST. IMPERTV. AREA = 0.46 AC
SCALE IN FEET
0
50
100
200
N
EXIST DRNG AREA (1) = 3.62 AC
EXIST DRNG AREA (2) = 0.46 AC
ULTIMATE
OUTFALL
EXIST. R/W
SR 120
00+00
15+00
20+02
00+36
BRICK WALL
W/2' X 2' BRICK COLUMNS
CONCRETE
1040
1045
1050
1055
1060
1065
1070
1075
1080
1085
1090
1095

FIGURE E2-2 -1

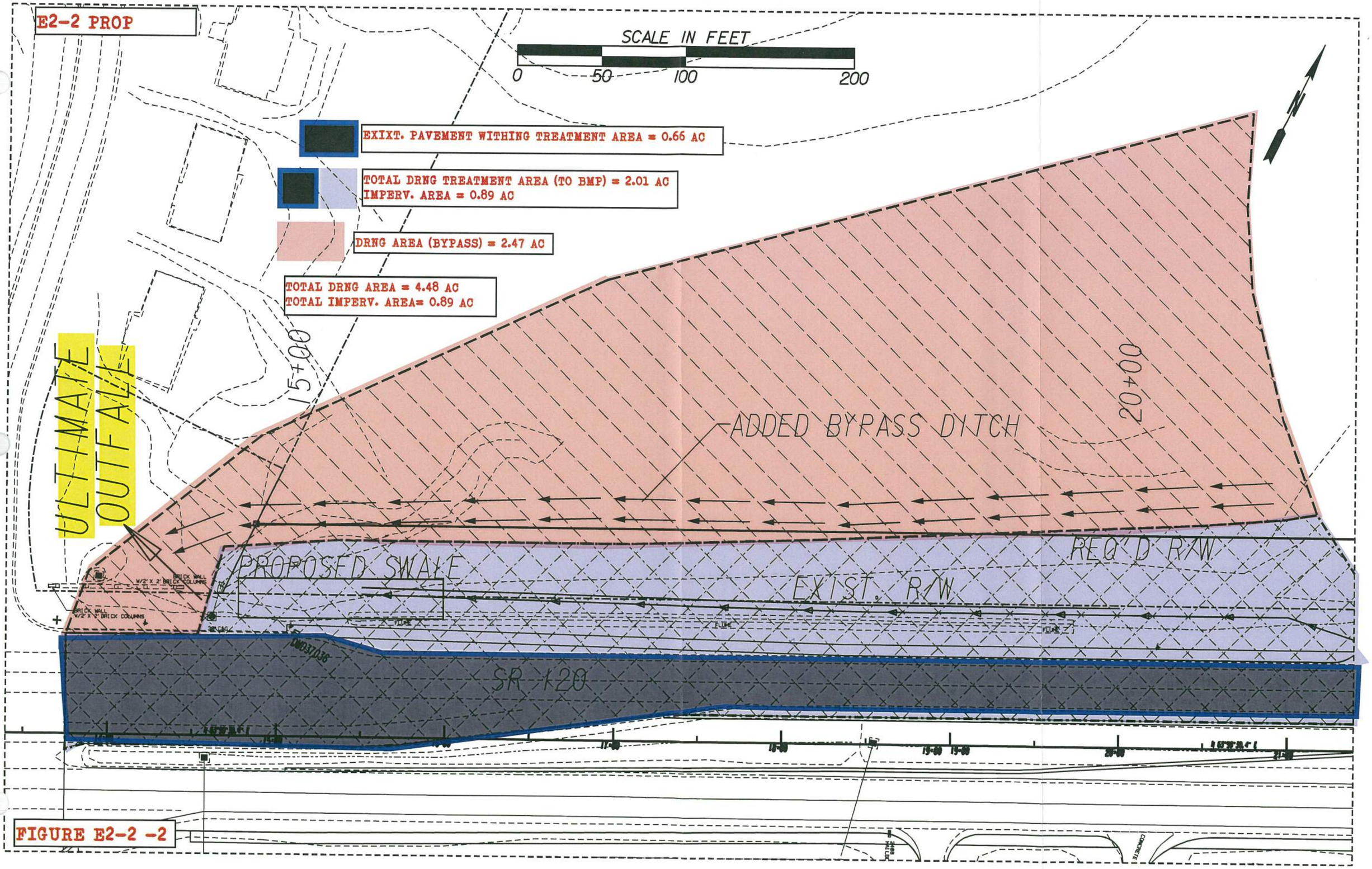

E2-2 PROP
SCALE IN FEET
0
50
100
200
EXIXT. PAVEMENT WITHING TREATMENT AREA = 0.66 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.01 AC
IMPERV. AREA = 0.89 AC
DRNG AREA (BYPASS) = 2.47 AC
TOTAL DRNG AREA = 4.48 AC
TOTAL IMPERV. AREA= 0.89 AC
ULTIMATE
OUTFALL
15+00
20+00
ADDED BYPASS DITCH
PROPOSED SWALE
EXIST. R/W
REQ'D R/W
SR 120
BRICK WALL
W/2' X 2' BRICK COLUMNS
FLUME
CONCRETE

FIGURE E2-2 -2

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: E2-2

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: MC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	4.077
Impervious Area =	0.462
Pervious Area=	3.615

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	74

Time of Concentration (See Table A) = 0.36 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.701

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.209	0.21
$I_a/P_{10\text{-}yr}$=	0.127	0.13
$I_a/P_{25\text{-}yr}$=	0.108	0.11
$I_a/P_{100\text{-}yr}$=	0.088	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.50

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.15
$Q_{d\ 10\text{-}yr}$=	2.79
$Q_{d\ 25\text{-}yr}$=	3.60
$Q_{d\ 100\text{-}yr}$ =	4.86

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	590
$q_{u10\text{-}yr}$=	620
$q_{u25\text{-}yr}$=	625
$q_{u100\text{-}yr}$=	640

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	4.31
$Q_{p10\text{-}yr}$=	11.02
$Q_{p25\text{-}yr}$=	14.33
$Q_{p100\text{-}yr}$=	19.82

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	4.480
Impervious Area =	0.890
Pervious Area =	3.590
Credit Area =	0.00

Curve Number *	
Type	CN
Impervious	98
Pervious	71
Composite CN=	76

Time of Concentration (See Table A) = 0.36 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.619

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.184	0.18
$I_a/P_{10\text{-}yr}$=	0.112	0.11
$I_a/P_{25\text{-}yr}$=	0.096	0.10
$I_a/P_{100\text{-}yr}$=	0.078	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.10

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.29
$Q_{d\ 10\text{-}yr}$=	3.00
$Q_{d\ 25\text{-}yr}$=	3.84
$Q_{d\ 100\text{-}yr}$ =	5.13

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	600
$q_{u10\text{-}yr}$=	625
$q_{u25\text{-}yr}$=	640
$q_{u100\text{-}yr}$=	640

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	5.41	0.798
$Q_{p10\text{-}yr}$=	13.14	
$Q_{p25\text{-}yr}$=	17.18	
$Q_{p100\text{-}yr}$=	22.97	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.01	Acre
Total Impervious Area - A_{POST}	0.89	Acre
Existing Pavement Area - A_{PRE} (5)	0.66	Acre
Area Required for Quantity - A_{QUAN} (4)	1.35	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.01	0.11	11.44	0.00	0.153	0.031	1,340

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.035	0.63	0.092	3,999

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,599

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.834	0.16	0.071	3,078

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 3,541

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.863	0.15	0.088	3,836

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,412

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure E2-2.3

FIGURE E2-2.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *E2-2*

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: MC

	Computed Volumes	Stacked Volumes
WQ_v	1,340	1,340
CP_v	4,599	5,939
Q_{p25}	3,541	4,881
Q_{f100}	4,412	5,752

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**773**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	5942	ft^3	>	5939	ft^3

Swale Dimensions:

A swale that is **773** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	5,939	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **339** ft^2

Actual Filter Bed Dimensions: Width **14** ft; Length **28** ft; 392 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **392** ft^2

Actual Sediment Chamber Dimensions: Width **14** ft; Length **28** ft; 392 ft^2

Bioretention Area

CP_v	=	5,939	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **2,501** ft^2

Actual Filter Bed Dimensions: Width **15** ft; Length **170** ft; 2550 ft^2

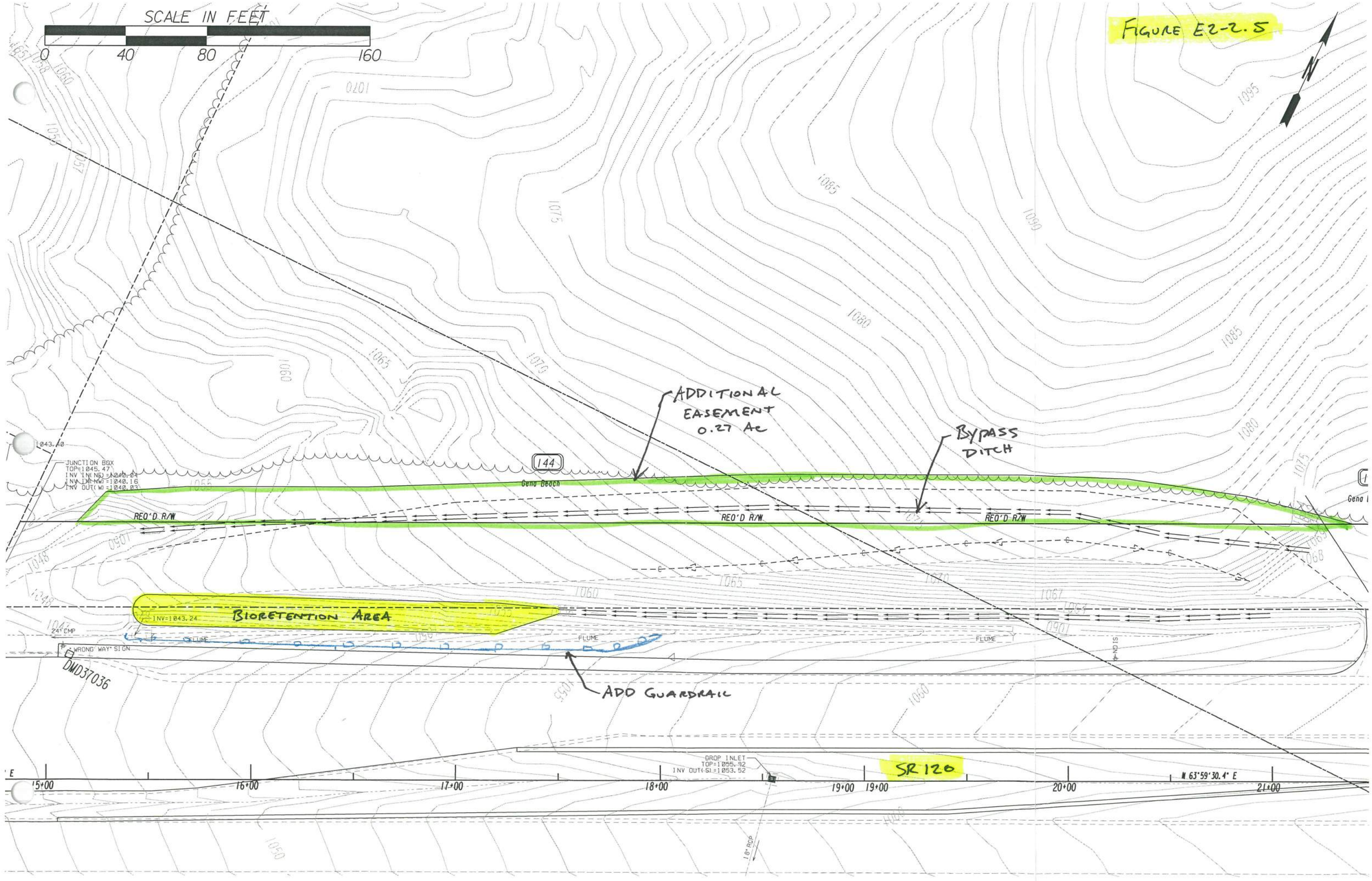


FIGURE E2-2.5
SCALE IN FEET
0
40
80
160
N
ADDITIONAL EASEMENT 0.27 Ac
BYPASS DITCH
144
Gena Beach
REQ'D R/W
REQ'D R/W
REQ'D R/W
BIORETENTION AREA
INV=1043.24
24" CMP
WRONG WAY SIGN
FLUME
FLUME
FLUME
DWD37036
ADD GUARDRAIL
JUNCTION BOX
TOP=1045.47
INV IN(NE)=1040.04
INV IN(NW)=1040.16
INV OUT(W)=1040.03
DROP INLET
TOP=1055.92
INV OUT(S)=1053.52
18" RCP
SR 120
15+00
16+00
17+00
18+00
19+00
19+00
20+00
21+00
N 63°59'30.4" E

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin E2-2

Basin E2-2 500 LF of Roadway construction cost within basin

Item	Basin E2-2 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 31,440.00	$ 6,750.00	$ 6,750.00	$ 6,750.00
Utilities ✪	$ 38,329.81	$ 59,900.00	$ 59,900.00	$ 59,900.00
Construction ✪	$ 326,662.07	$ 13,720.00	$ 8,030.00	$ 8,030.00
Clearing and Grubbing	$ -	$ 1,350.00	$ 1,350.00	$ 1,350.00
Grading	$ -	$ 3,384.00	$ 1,200.00	$ 1,260.00
Drainage	$ -	$ 36,461.03	$ 35,691.00	$ 29,369.01
Total	$ 396,431.88	$ 121,565.03	$ 112,921.00	$ 106,659.01
	Percent of BMP Cost to Total	**30.7%**	**28.5%**	**26.9%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.6288
Sub Total:	$	31,440.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	31,440.00

✪ See General Summary Explaination for Cost Methoc

E2-2.6

BMP Construction Cost Worksheet — Basin E2-2

Dry Enhanced Swale

Length:	773	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.27	Ac	
Total:	$ 6,750.00		
Sub Total:	$ 6,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	450	LF	
	$ 9,900.00		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	2	poles	
	$ 50,000.00		
Sub Total:	$ 59,900.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.27	Disturbed Ac	
$ 1,350.00		

Grading

Cut	Fill	
288.000	276.000	
	$ 6.00	per CY
Total:	$ 3,384.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		0	EA
	$ 5,000.00			$ -	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	573	CY	$ 30.00	$ 12,724.28
Uddrn Sys w/ Gravel	-	803	LF	$ 20.00	$ 16,060.00
Additional Pipe	18	0	LF	$ 43.00	$ -
Outlet Pipe	18	0	LF	$ 43.00	$ -
Bypass Flow Pipe	18	0	LF	$ 43.00	$ -

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	43	SY		43	SY
	$ 2,472.50			$ 204.25	

Sub Total: $ 36,461.03

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	600	LF	$ 20.00	$ 12,000.00
Type 12 Anchorage	0	EA	$ 2,170.00	$ -
Type 1 Anchorage	2	EA	$ 860.00	$ 1,720.00
			Sub Total:	$ 13,720.00

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	28	28	ft
Width:	14	14	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.27	Ac	
Total:	$ 6,750.00		
Sub Total:	$ 6,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	450	LF	
	$ 9,900.00		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	2	poles	
	$ 50,000.00		
Sub Total:	$ 59,900.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.27	Disturbed Ac	
$ 1,350.00		

Grading

Cut	Fill	
180.000	20.000	
	$ 6.00	per CY
Total:	$ 1,200.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	22	CY	$ 45.00	$ 990.00
Uddrn Sys w/ Gravel	-	115	LF	$ 20.00	$ 2,300.00
Top Soil		4	CY	$ 20.00	$ 80.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	392	SF	$ 5.00	$ 1,960.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	196	SY		196	SY
	$ 11,270.00			$ 931.00	

Sub Total: $ 35,691.00

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	250	LF	$ 20.00	$ 5,000.00
Type 12 Anchorage	1	EA	$ 2,170.00	$ 2,170.00
Type 1 Anchorage	1	EA	$ 860.00	$ 860.00
			Sub Total:	$ 8,030.00

Bioretention Area

Length:	170	ft
Width:	15	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.27	Ac	
Total:	$ 6,750.00		
Sub Total:	$ 6,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	450	LF	
	$ 9,900.00		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	2	poles	
	$ 50,000.00		
Sub Total:	$ 59,900.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.27	Disturbed Ac	
$ 1,350.00		

Grading

Cut	Fill	
200.000	10.000	
	$ 6.00	per CY
Total:	$ 1,260.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		3	EA
	$ 10,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	189	CY	$ 30.00	$ 5,670.00
Uddrn Sys w/ Gravel	-	67.5	LF	$ 20.00	$ 1,350.00
Mulch	-	284	SY	$ 15.00	$ 4,260.00
Additional Pipe	18"	0	LF	$ 43.00	$ -
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	11	EA	$ 30.00	$ 330.00
Ground Cover	-	30	EA	$ 15.00	$ 450.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.57	per SY
	43	SY		43	SY
	$ 2,472.50			$ 196.51	

Sub Total: $ 29,369.01

Construction

	Quantity	Unit	Cost	Total
W-Beam Guardrail	250	LF	$ 20.00	$ 5,000.00
Type 12 Anchorage	1	EA	$ 2,170.00	$ 2,170.00
Type 1 Anchorage	1	EA	$ 860.00	$ 860.00
			Sub Total:	$ 8,030.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November17, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin E-3 Summary
BMP Recommendation - Feasible

The ultimate outfall of Drainage Basin E-3 was located and the existing and proposed basin drainage areas were delineated (See Figures E-3.1 and E-3.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	4,486	4,486
Quantity	Channel Protection, CP_v	6,851	11,337
	Overbank Flood Protection, Q_{p25}	5,715	10,201
	Extreme Flood Protection, Q_{f100}	7,379	11,865

- The total area draining to the MS4 pond is 2.27 Ac. The total impervious area is 1.71 Ac. The existing pavement area for the site is 0.69 Ac. The area required for storage and quantity management is 1.58 Ac (See Figure E-3.3).
- See General Summary sheet for additional information and overall calculation process.
- The Extreme Flood Protection volume triggers a 10 times downstream analysis.
- It was determined from that downstream analysis that the flows would cause a downstream increase of more than 5%, and that detention would be necessary (See Figure E-3.4).
- A Dry Detention Pond will be provided for the quantity volume (See Figure E-3.6).
- 3 BMPs were studied to handle the quality volume; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 40 feet wide by 50 feet long. The bioretention area was deemed the lowest cost option between the 3 studied BMPs (See Figure E-3.5).
- The design will require a flow splitter (See Figure E-3.7).
- The flow produced by the existing paved area of 0.69 Ac will not be detained. It will be directed into the Dry Detention Pond through the flow splitter and will pass over the emergency spillway.
- There are three properties (from about STA 282+50 to STA 285+50 on the right side) that are being acquired as a result of the roadway construction. No additional right of way is expected due to the installation of the BMPs (See Figures E-3.2 and E-3.7).
- Modifications to the drainage design by the addition of ditches and pipes will be necessary to direct the treatment flow into the BMPs and to separate the bypass flow (See Figures E-3.2 and E-3.7).
- The BMP construction cost is 8.5% of the roadway construction cost within this basin (See Figure E-3.8).
- None of the other infeasibility criteria apply to this basin making this basin feasible.

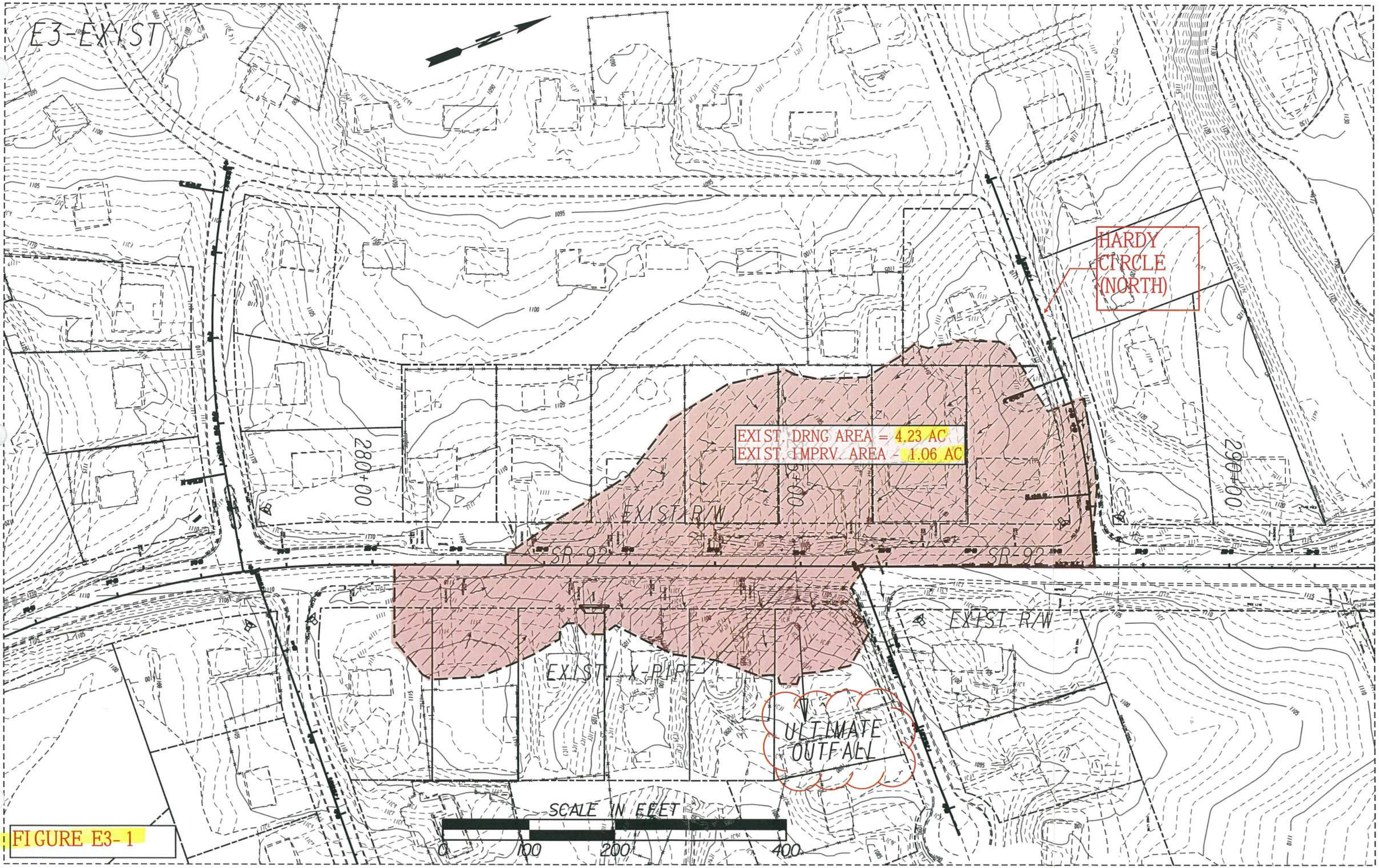

E3-EXIST
HARDY CIRCLE (NORTH)
EXIST. DRNG AREA = 4.23 AC
EXIST. IMPRV. AREA = 1.06 AC
280+00
EXIST R/W
SR 92
SR 92
EXIST R/W
EXIST X-PIPE
ULTIMATE OUTFALL
SCALE IN FEET
0
100
200
400

FIGURE E3-1

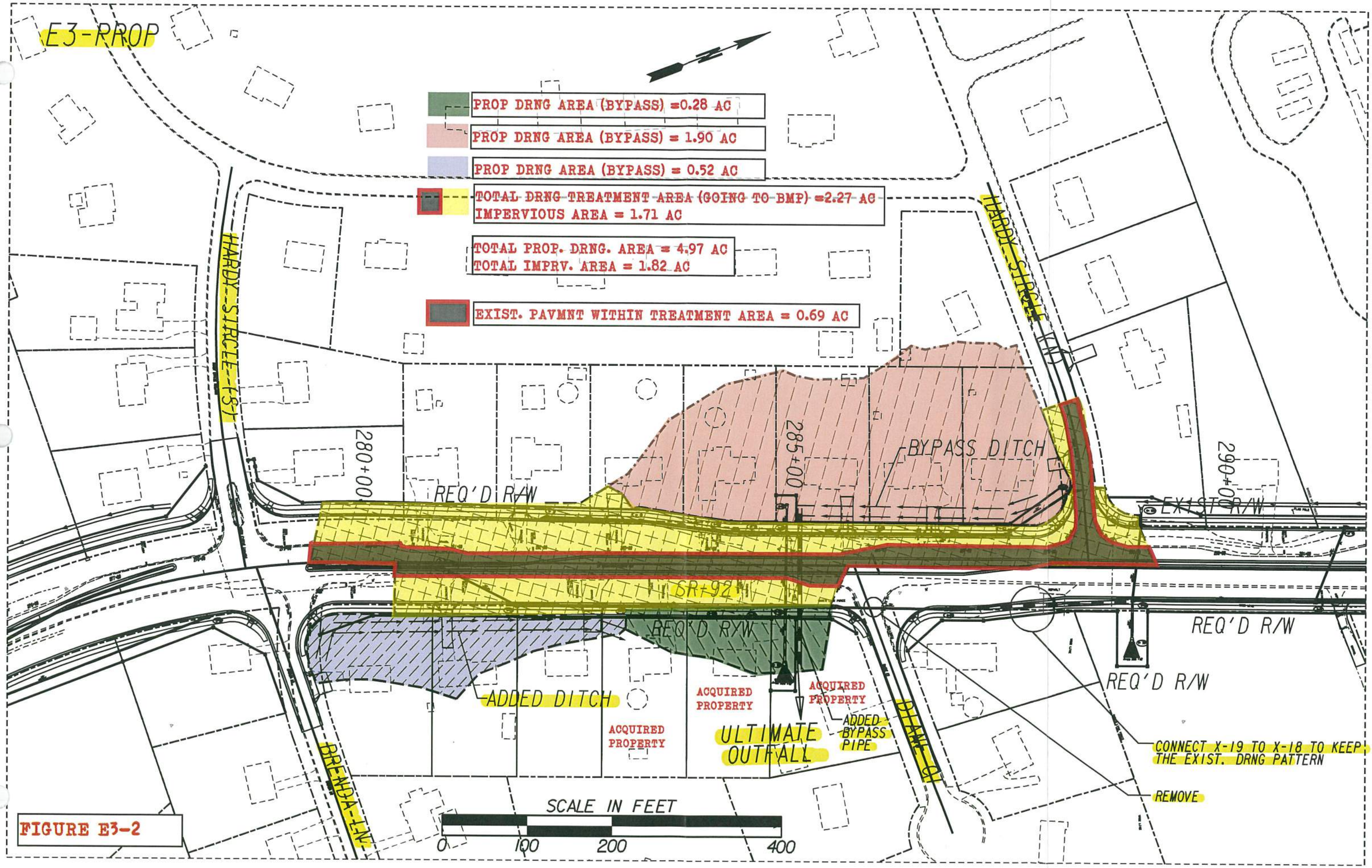

E3-PROP
PROP DRNG AREA (BYPASS) =0.28 AC
PROP DRNG AREA (BYPASS) = 1.90 AC
PROP DRNG AREA (BYPASS) = 0.52 AC
TOTAL DRNG TREATMENT AREA (GOING TO BMP) =2.27 AC
IMPERVIOUS AREA = 1.71 AC
TOTAL PROP. DRNG. AREA = 4.97 AC
TOTAL IMPRV. AREA = 1.82 AC
EXIST. PAVMNT WITHIN TREATMENT AREA = 0.69 AC
HARDY CIRCLE (S)
HARDY CIRCLE
280+00
285+00
290+00
BYPASS DITCH
REQ'D R/W
EXIST R/W
SR-92
REQ'D R/W
REQ'D R/W
REQ'D R/W
ADDED DITCH
ACQUIRED PROPERTY
ACQUIRED PROPERTY
ACQUIRED PROPERTY
ULTIMATE OUTFALL
ADDED BYPASS PIPE
BRENDA LN
CONNECT X-19 TO X-18 TO KEEP THE EXIST. DRNG PATTERN
REMOVE
SCALE IN FEET
0
100
200
400

FIGURE E3-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E3

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: MC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	4.23
Impervious Area =	1.06
Pervious Area=	3.17

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	78

Time of Concentration (See Table A) = 0.18 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.572

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.170	0.17
$I_a/P_{10\text{-}yr}$=	0.104	0.11
$I_a/P_{25\text{-}yr}$=	0.088	0.1
$I_a/P_{100\text{-}yr}$=	0.072	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.86

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.38
$Q_{d\ 10\text{-}yr}$=	3.14
$Q_{d\ 25\text{-}yr}$=	3.98
$Q_{d\ 100\text{-}yr}$ =	5.29

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	800
$q_{u10\text{-}yr}$=	825
$q_{u25\text{-}yr}$=	830
$q_{u100\text{-}yr}$=	830

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	7.28
$Q_{p10\text{-}yr}$=	17.10
$Q_{p25\text{-}yr}$=	21.84
$Q_{p100\text{-}yr}$=	29.02

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	4.97
Impervious Area =	1.82
Pervious Area =	3.15
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	81

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.473

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.141	0.14
$I_a/P_{10\text{-}yr}$=	0.086	0.1
$I_a/P_{25\text{-}yr}$=	0.073	0.1
$I_a/P_{100\text{-}yr}$=	0.060	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.36

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.59
$Q_{d\ 10\text{-}yr}$=	3.44
$Q_{d\ 25\text{-}yr}$=	4.31
$Q_{d\ 100\text{-}yr}$ =	5.65

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	875
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	10.79
$Q_{p10\text{-}yr}$=	24.03
$Q_{p25\text{-}yr}$=	30.13
$Q_{p100\text{-}yr}$=	39.51

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.27	Acre
Total Impervious Area - A_{POST}	1.71	Acre
Existing Pavement Area - A_{PRE} (5)	0.69	Acre
Area Required for Quantity - A_{QUAN} (4)	1.58	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.27	0.45	44.85	0.00	0.454	0.103	4,486

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

WQ_v =

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.137	5,957

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * AQU_{AN}}{12}$$

(+15% ED)= 6,851

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.725	0.20	0.114	4,969

$V_s = CP_v$ =

(+15% ED)= 5,715

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.734	0.20	0.147	6,416

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * AQU_{AN}}{12}$$

(+15% ED)= 7,379

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure E-2.3

FIGURE E-3.4

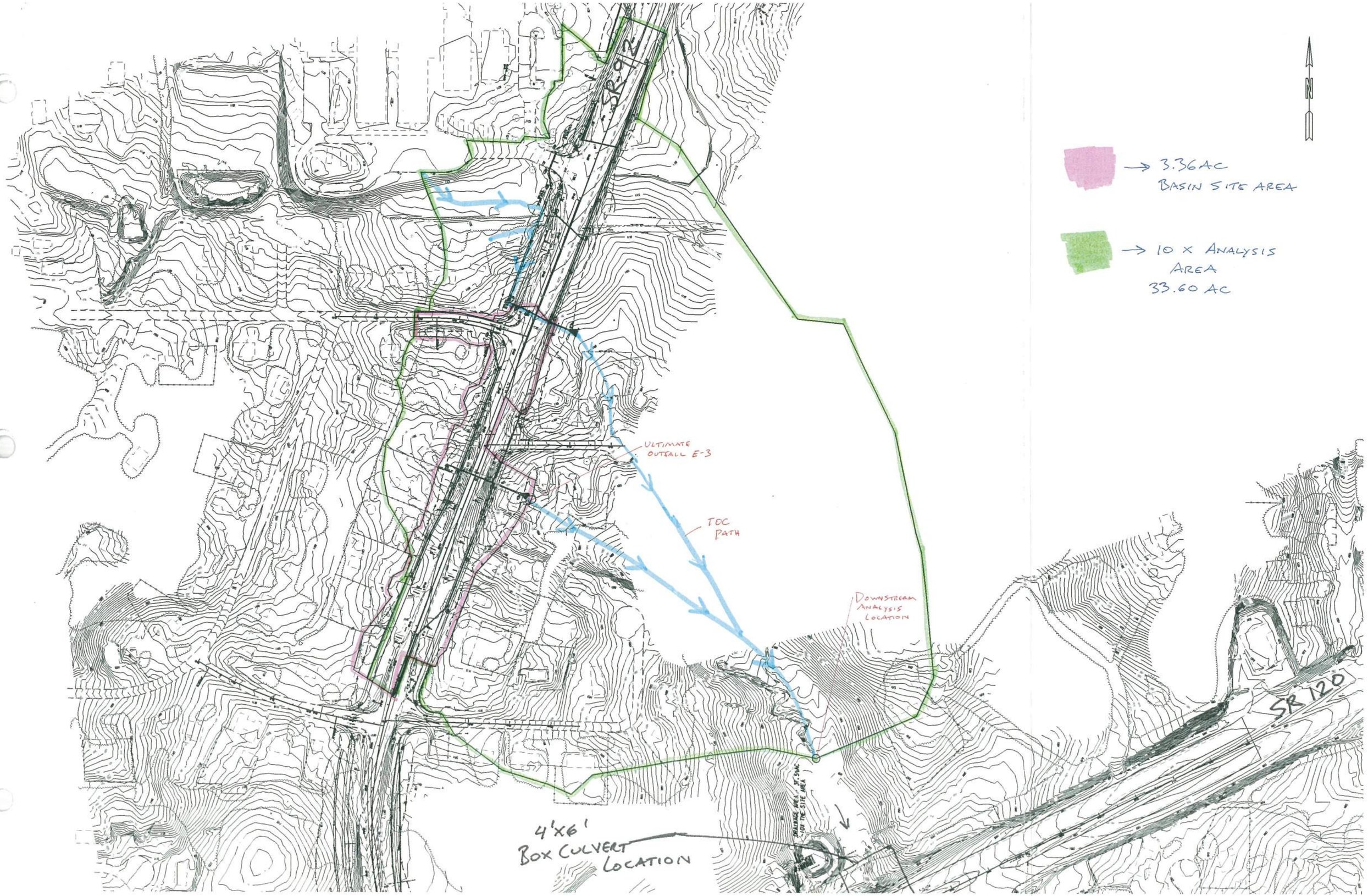
Outfall E3
10X Downstream Analysis Conclusions

The drainage areas were delineated using a combination of the USGS quadrangle maps and the existing contours. The site area of the drainage outfall is 3.36 Ac. The 10 times watershed basin analysis area is 33.60 Ac, which is approximately 1075 feet downstream of the drainage outfall. The immediate downstream crossing is an existing 4' wide by 6' tall box culvert under SR 120. The time of concentration calculations and the curve number calculations for the downstream analysis have been included along with the hydrographs depicting the pre and post conditions of the 25 and 100 year storms.

Per GDOT requirements, Storm Detention is required when adverse impacts are caused by the post-development flow and where downstream structures are subject to increased depth of flooding. The following table summarizes the results of the downstream analysis.

Outfall E3	Storm Return Frequency	Pre-Developed Peak Discharge (cfs)	Post-Developed Peak Discharge (cfs)	Discharge Increase (cfs)	% Increase
Downstream Analysis	25	113.66	121.69	8.03	7.1
	100	150.48	159.42	8.94	5.9

The analysis of the 10X downstream conditions reflects an increase of over 5% for both the 25 and the 100 year return periods, which represent the Overbank Flood Protection and the Extreme Flood Protection, respectively. The discharge increase for both storm frequency's is above the GDOT maximum and could adversely affect the downstream watershed so therefore detention shall be provided at this location.


N
→ 3.36 AC
BASIN SITE AREA
→ 10 x ANALYSIS
AREA
33.60 AC
SR 92
ULTIMATE
OUTFALL E-3
TOC
PATH
DOWNSTREAM
ANALYSIS
LOCATION
SR 120
4'x6'
BOX CULVERT
LOCATION

Curve Number Calculation
10X Downstream Assessment for Outfall E3

Jun-14

PRE-CONDITION type "C" soil group	TOTAL AREA 33.0 Ac	
	IMPERVIOUS AREA 2.41 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 15.81 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 14.78	71
	COMPOSITE PRE CN	78

POST-CONDITION type "C" soil group	TOTAL AREA 33.6 Ac	
	IMPERVIOUS AREA 4.63 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 15.03 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 13.94	71
	COMPOSITE PRE CN	80

COMP: MC

CHK :

10X Downstream Assessment for Outfall E3

TIME OF CONCENTRATION CALCULATION

Jun-14

PI No.: xxxxxx

Drainage Area No.	Segment 1- Sheet Flow [1,2]					Segment 2- Shallow Channel [3]				Segment 3 - Open Channel [4]								TIME OF CONCENTRATION (Tc) MINUTE	Computed Intensity			
	Manning Roughness(n)	Flow Length (L) - ft	Land Slope (S) - ft/ft	i(Just for Sheet Flow)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Slope (s) - ft/ft	Velocity (ft/s)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Estimated Q	Manning Roughness Coeeficient (n) [5]	Qn	Slope (S) - ft/ft	Vn	Velocity (ft/s)	Time of Travel (Tt)- Minute		I_{10}	I_{25}	I_{50}	I_{100}
10X E3 Pre	CALCULATED ELSEWHERE								26.00	1075	22.24	0.035	0.78	0.043	0.18	5.14	3.48	**29.48**	4.07	4.72	5.21	5.72
10X E3 Post	CALCULATED ELSEWHERE								26.00	1075	29.80	0.035	1.04	0.043	0.195	5.57	3.22	**29.22**	4.09	4.74	5.23	5.74

Notes:

1. Kinematic Wave Equation has been used for Segment-1 time of travel (*GDOT Drainage Design manual* Page 4.9).
2. For Segment-1, "I" Values have been compared with Table A-3 "*Georgia Stormwater Management Manual* " (Page A-3)- Per *GDOT Drainage Design Manual* (page 4.13).
3. For Segment 2 Formula see "*GDOT Drainage Design manual* " Page 4.12 .
4. For Segment 3 :
   - 4.1. Find concentrated Flow length (ft)
   - 4.2. find Estimated Q value (use i from Segment 1)
   - 4.3. Qn= $Q_{estimated}$ x Manning
   - 4.4. find Vn from Table 5-19 (see "*GDOT Drainage Design manual* " Page 5.56)
   - 4.5. Velocity = Vn / Manning
5. see "*GDOT Drainage Design manual* " Page 5-25 & 5-26

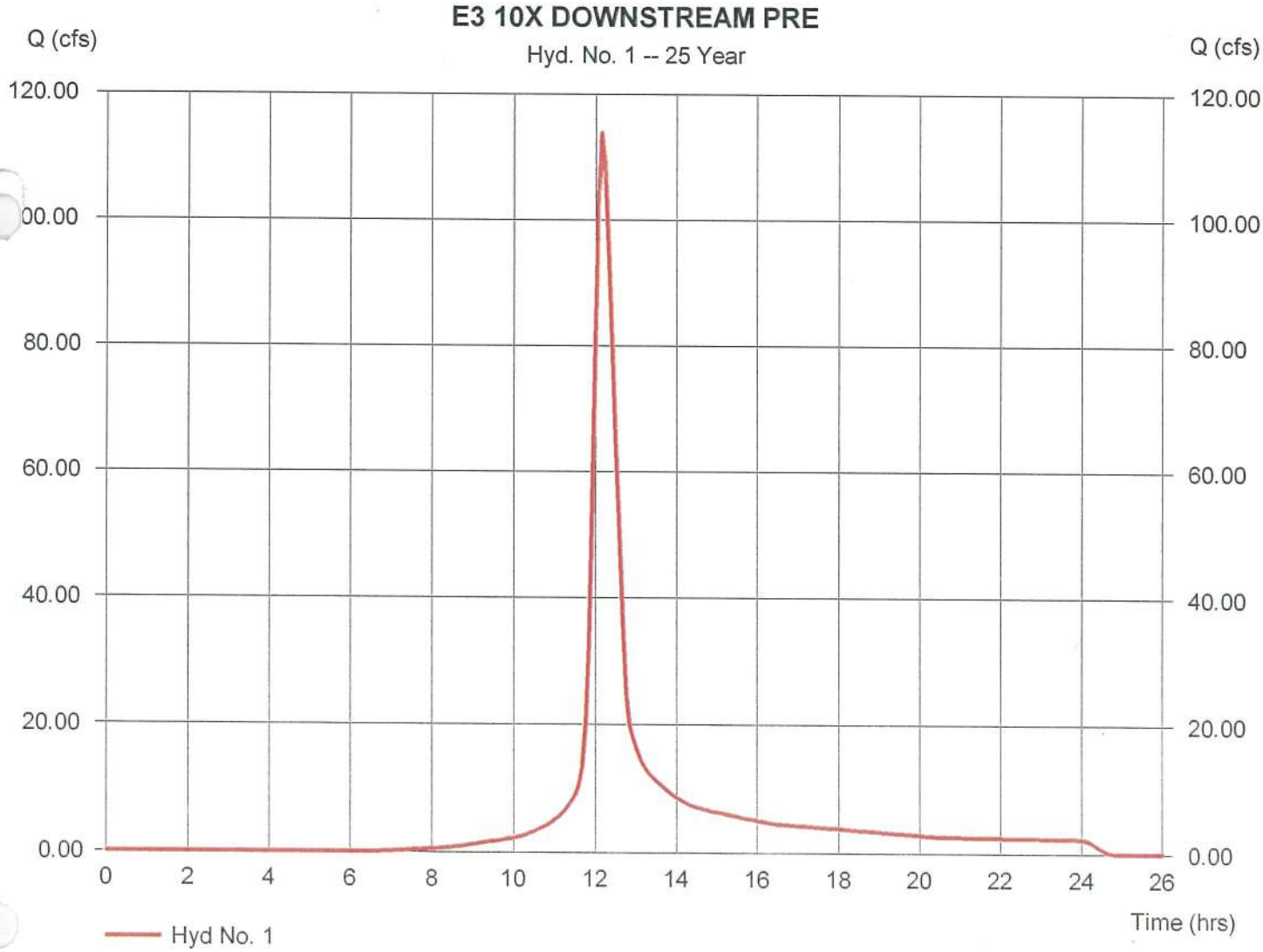
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Monday, 07 / 7 / 2014

Hyd. No. 1

E3 10X DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 113.66 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 494,871 cuft
Drainage area	= 33.000 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 29.50 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



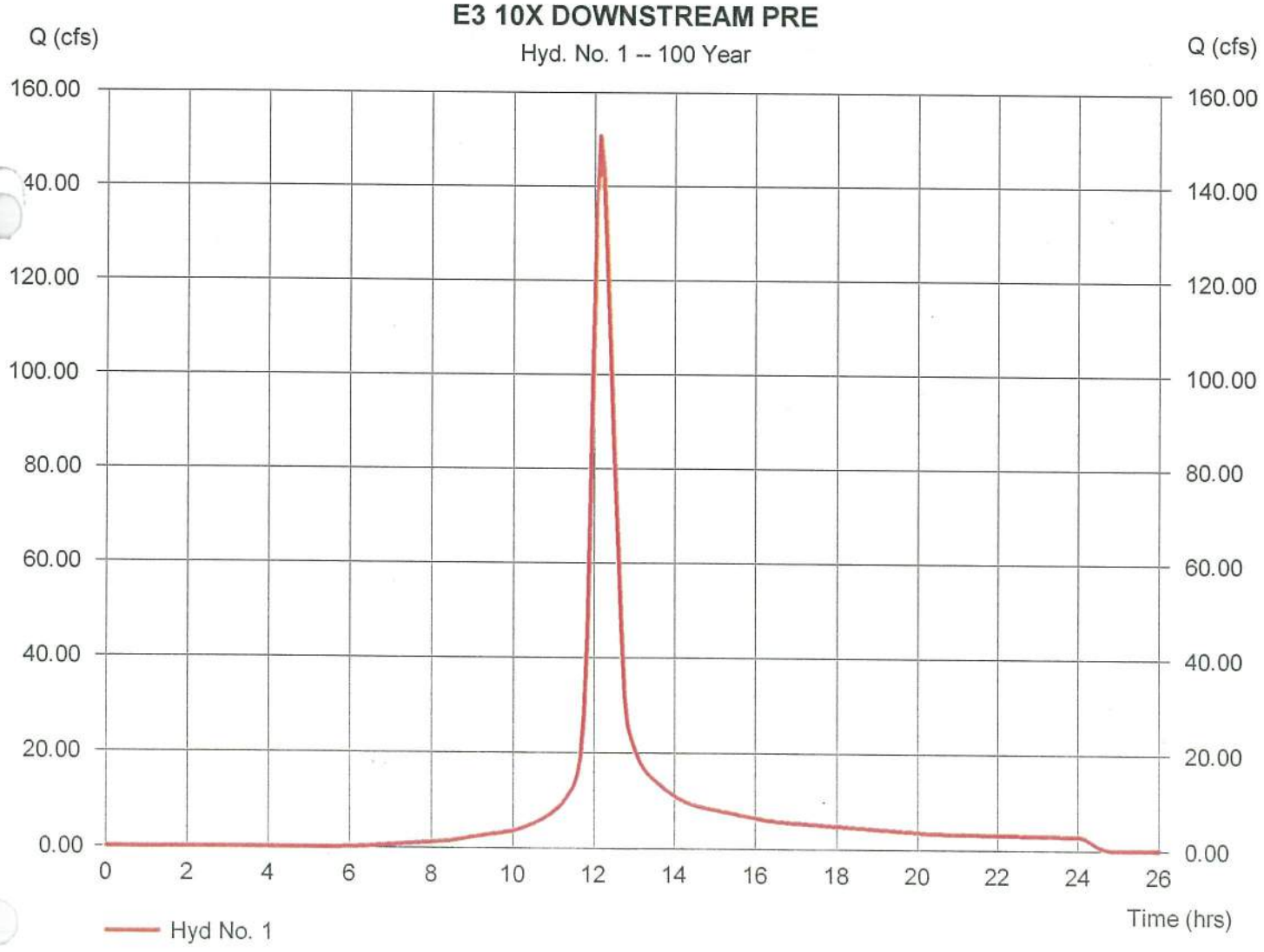
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Monday, 07 / 7 / 2014

Hyd. No. 1

E3 10X DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 150.48 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 656,843 cuft
Drainage area	= 33.000 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 29.50 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



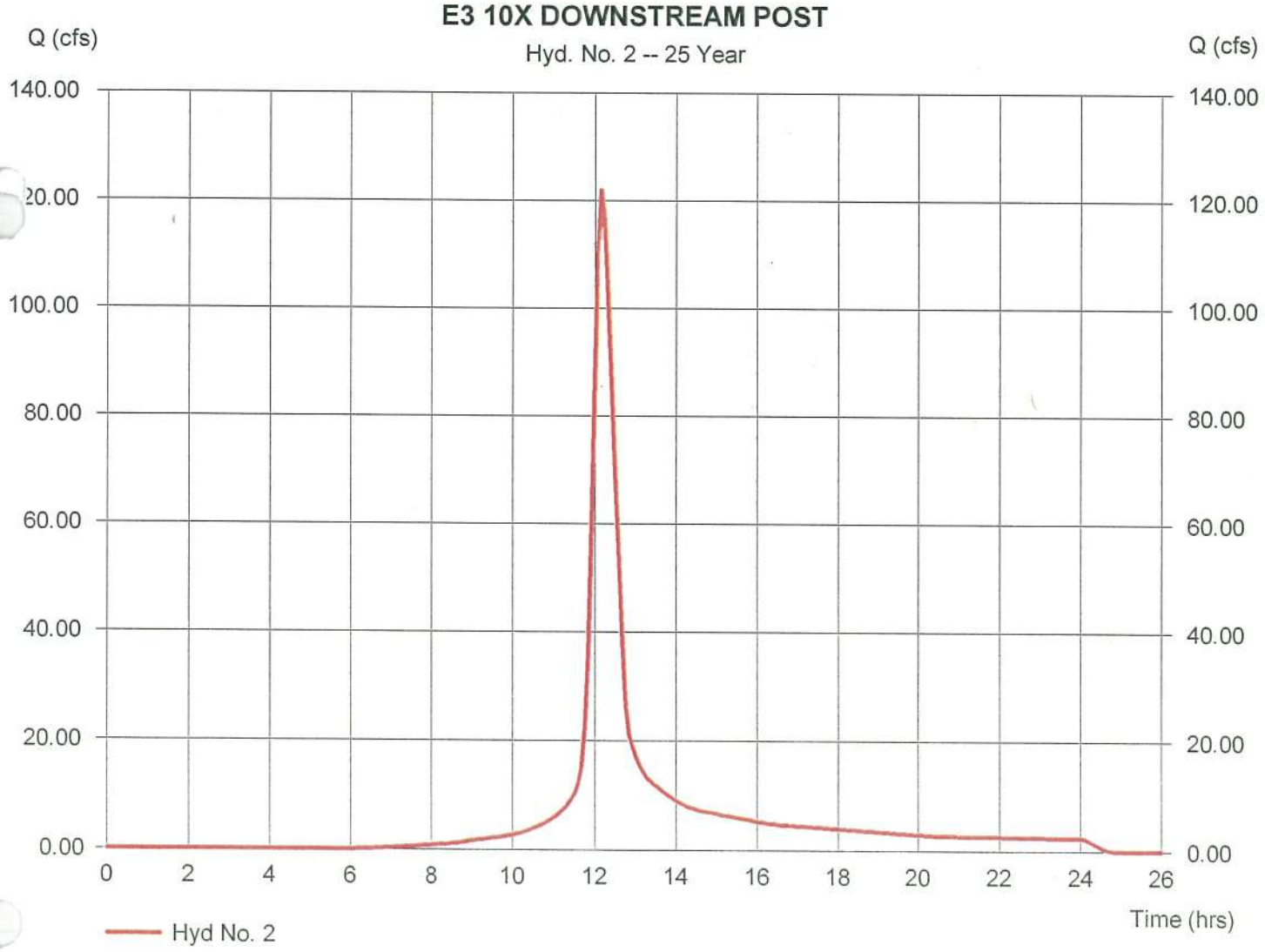
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Monday, 07 / 7 / 2014

Hyd. No. 2

E3 10X DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 121.69 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 530,416 cuft
Drainage area	= 33.600 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 29.25 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Monday, 07 / 7 / 2014

Hyd. No. 2

E3 10X DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 159.42 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.17 hrs
Time interval	= 5 min	Hyd. volume	= 698,082 cuft
Drainage area	= 33.600 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 29.25 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

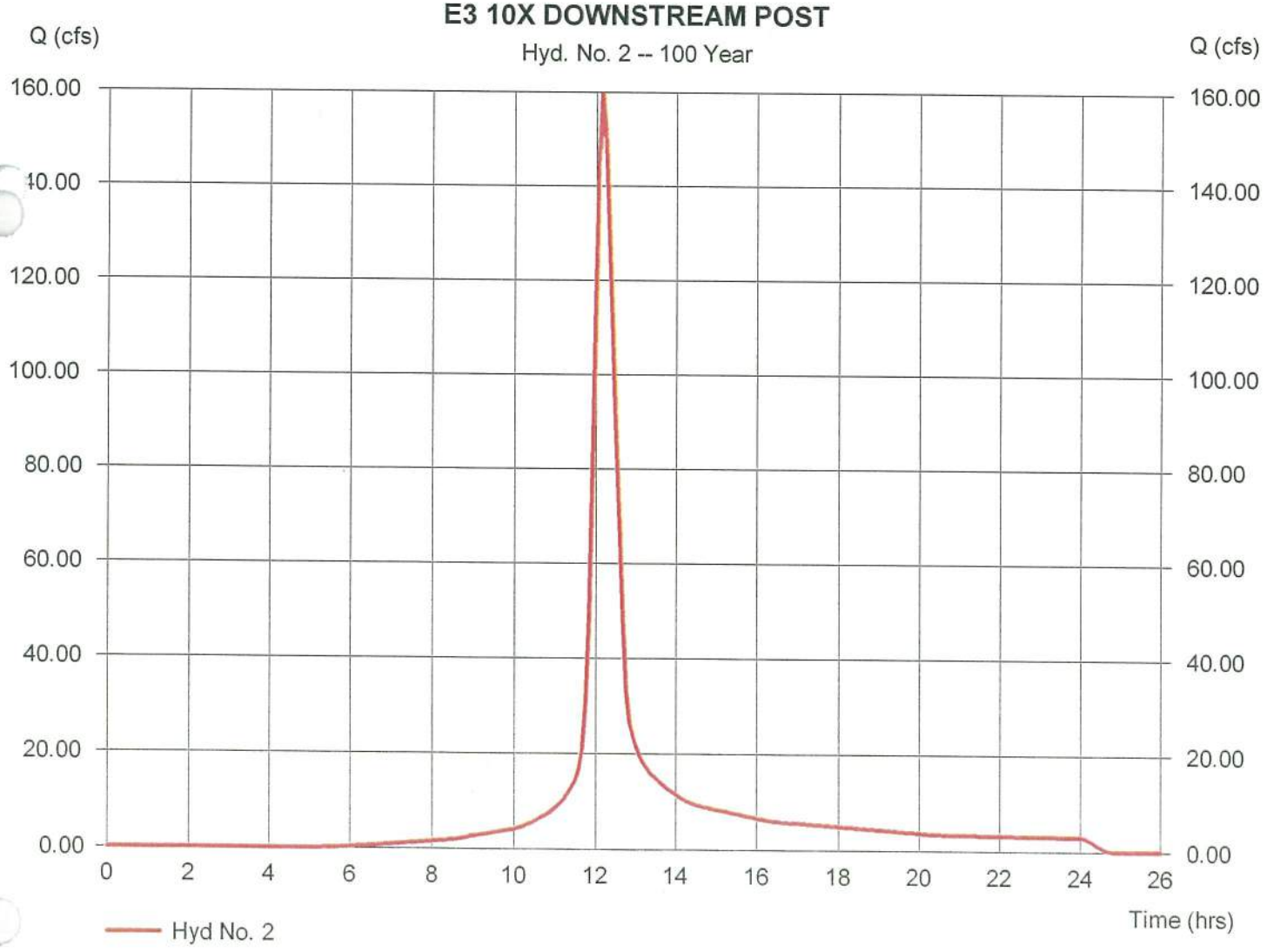


FIGURE E-3.5

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E3

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: MC

	Computed Volumes	Stacked Volumes
WQ_v	4,486	4,486
CP_v	6,851	11,337
Q_{p25}	5,715	10,201
Q_{f100}	7,379	11,865

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**584**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	4490	ft^3	>	4486	ft^3

Swale Dimensions:

A swale that is **584** ft long and that is **8** ft wide.

Pond Dimensions:

Pond sized to detain 7,379 ft^3 plus 1 ft of freeboard
See AutoCAD Pond Report for exact pond size

Surface Sand Filter

WQ_v	=	4,486	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **256** ft^2

Actual Filter Bed Dimensions: Width **12** ft; Length **24** ft; 288 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*WQv**

A_S = **296** ft^2

Actual Sediment Chamber Dimensions: Width **12** ft; Length **25** ft; 300 ft^2

Bioretention Area

WQ_v	=	4,486	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **1,889** ft^2

Actual Filter Bed Dimensions: Width **40** ft; Length **50** ft; 2000 ft^2

Pond Report

FIGURE E-3.6

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Tuesday, 10 / 21 / 2014

Pond No. 1 - E3

Pond Data

Trapezoid -Bottom L x W = 60.0 x 30.0 ft , Side slope = 3.00:1 , Bottom elev. = 1090.00 ft , Depth = 4.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)	
0.00	1090.00	1,800	0	0	
0.40	1090.40	2,022	764	764	
0.80	1090.80	2,255	855	1,619	
1.20	1091.20	2,500	951	2,570	
1.60	1091.60	2,756	1,051	3,620	
2.00	1092.00	3,024	1,156	4,776	
2.40	1092.40	3,303	1,265	6,041	
2.80	1092.80	3,594	1,379	7,420	← AT DESIGN VOLUME
3.20	1093.20	3,897	1,498	8,918	
3.60	1093.60	4,211	1,621	10,539	← PLUS 2' FREEBOARD
4.00	1094.00	4,536	1,749	12,288	

3.80' DEEP.

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)

TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	1090.00	---	---	---	---	---	---	---	---	---	---	0.000
0.40	764	1090.40	---	---	---	---	---	---	---	---	---	---	0.000
0.80	1,619	1090.80	---	---	---	---	---	---	---	---	---	---	0.000
1.20	2,570	1091.20	---	---	---	---	---	---	---	---	---	---	0.000
1.60	3,620	1091.60	---	---	---	---	---	---	---	---	---	---	0.000
2.00	4,776	1092.00	---	---	---	---	---	---	---	---	---	---	0.000
2.40	6,041	1092.40	---	---	---	---	---	---	---	---	---	---	0.000
2.80	7,420	1092.80	---	---	---	---	---	---	---	---	---	---	0.000
3.20	8,918	1093.20	---	---	---	---	---	---	---	---	---	---	0.000
3.60	10,539	1093.60	---	---	---	---	---	---	---	---	---	---	0.000
4.00	12,288	1094.00	---	---	---	---	---	---	---	---	---	---	0.000

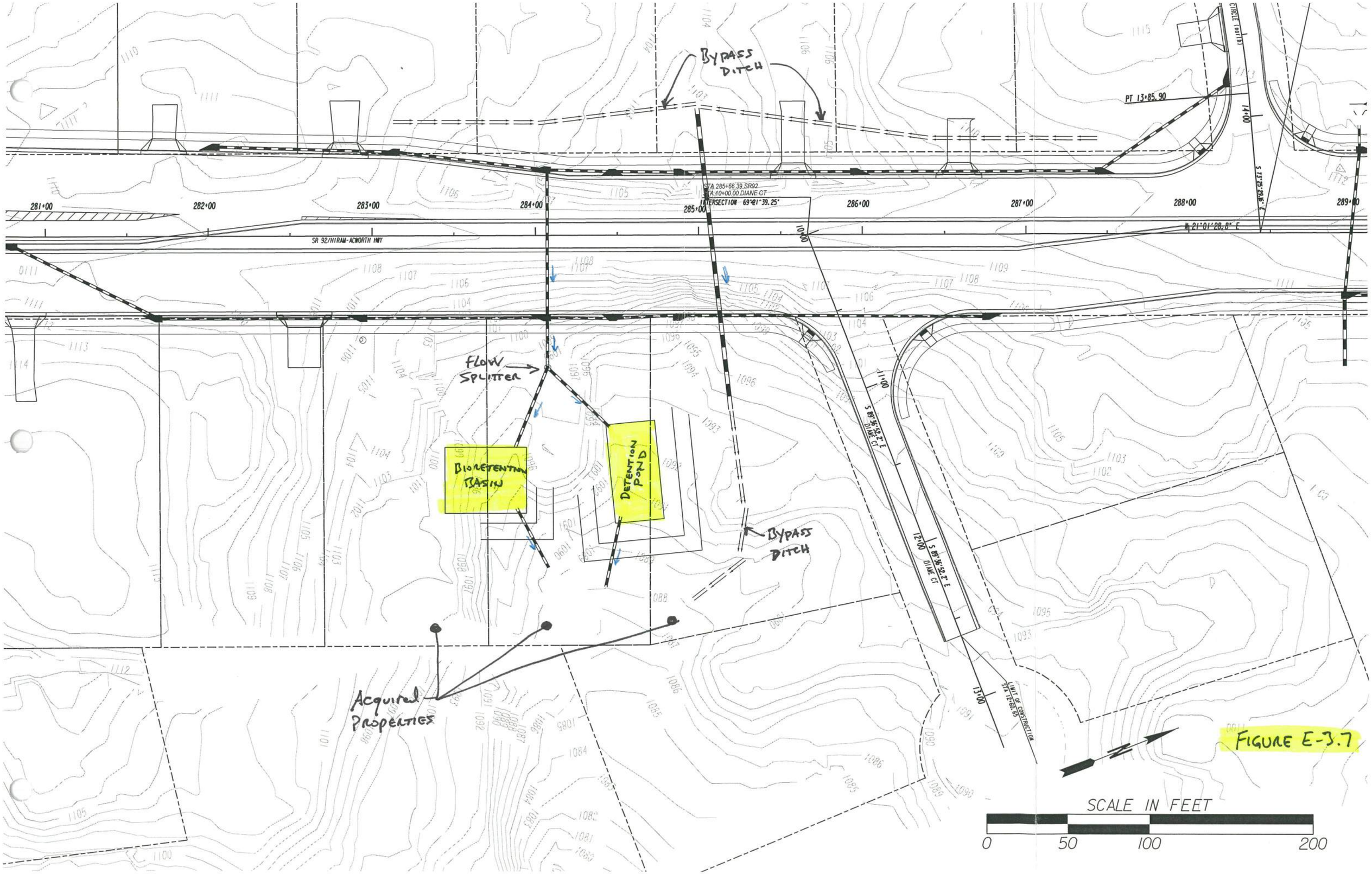

BYPASS DITCH
PT 13+85.90
CIRCLE (radius)
14+00
STA 285+66.39 SR92
STA 10+00.00 DIANE CT
INTERSECTION 69°21'39.25"
281+00
282+00
283+00
284+00
285+00
286+00
287+00
288+00
289+00
SR 92/HIRAM-ACWORTH HWY
N 21°01'28.8" E
10+00
11+00
12+00
13+00
S 89°38'32.2" E
DIANE CT
LIMIT OF CONSTRUCTION
STA 12+60.65
FLOW SPLITTER
BIORETENTION BASIN
DETENTION POND
BYPASS DITCH
Acquired PROPERTIES
SCALE IN FEET
0
50
100
200

FIGURE E-3.7

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin E3

Basin E3 850 LF of Roadway construction cost within basin

Item	Basin E3 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 223,500.00	$ 4,875.00	$ -	$ -
Utilities ✪	$ 65,160.68	$ -	$ -	$ -
Construction ✪	$ 555,325.52	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 5,500.00	$ 5,500.00	$ 5,500.00
Grading	$ -	$ 16,236.00	$ 8,970.00	$ 8,070.00
Drainage	$ -	$ 67,731.42	$ 66,821.50	$ 58,005.50
Total	$ 843,986.20	$ 94,342.42	$ 81,291.50	$ 71,575.50
Percent of BMP Cost to Total		**11.2%**	**9.6%**	**8.5%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		1.76
Sub Total:	$	88,000.00
Residential Relocation Cost	$	40,000.00
		3
Sub Total:	$	120,000.00
Residential Perm Easmt @	$	25,000.00
		0.62
Sub Total:	$	15,500.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	223,500.00

✪ See General Summary Explaination for Cost Method

Figure E-3.8

BMP Construction Cost Worksheet — Basin E3

Dry Enhanced Swale with Detention Basin

Length:	584	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.12	Ac	
Total:	$ 3,000.00		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.03	Ac	
Total:	$ 1,875.00		
Sub Total:	$ 4,875.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.1	Disturbed Ac	
$ 5,500.00		

Grading

Cut	Fill	
800.000	1906.000	
$ 6.00	per CY	
Total: $ 16,236.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	3	EA		5	EA
	$ 15,000.00			$ 2,000.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	433	CY	$ 30.00	$ 9,613.17
Uddrn Sys w/ Gravel	-	614	LF	$ 20.00	$ 12,280.00
Additional Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	60	LF	$ 43.00	$ 2,580.00
Bypass Flow Pipe	30"	217	LF	$ 62.00	$ 13,454.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	33	SY	Fabric	33	SY
	$ 1,897.50			$ 156.75	

Sub Total: $ 67,731.42

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	24	25	ft
Width:	12	12	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ -		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.1	Disturbed Ac	
$ 5,500.00		

Grading

Cut	Fill	
770.000	725.000	
$ 6.00	per CY	
Total: $ 8,970.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		4	EA
	$ 20,000.00			$ 1,600.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	16	CY	$ 45.00	$ 720.00
Uddrn Sys w/ Gravel	-	105	LF	$ 20.00	$ 2,100.00
Top Soil		3	CY	$ 20.00	$ 60.00
Addl Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Bypass Flow Pipe	30"	217	LF	$ 62.00	$ 13,454.00
Imperm Geotextile	-	288	SF	$ 5.00	$ 1,440.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	150	SY	Fabric	150	SY
	$ 8,625.00			$ 712.50	

Sub Total: $ 66,821.50

Bioretention Area

Length:	50	ft
Width:	40	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ -		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.1	Disturbed Ac	
$ 5,500.00		

Grading

Cut	Fill	
920.000	425.000	
$ 6.00	per CY	
Total: $ 8,070.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	3	EA		3	EA
	$ 15,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	149	CY	$ 30.00	$ 4,470.00
Uddrn Sys w/ Gravel	-	180	LF	$ 20.00	$ 3,600.00
Mulch	-	223	SY	$ 15.00	$ 3,345.00
Additional Pipe	18"	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Bypass Flow Pipe	30"	217	LF	$ 62.00	$ 13,454.00
Shrubs	-	9	EA	$ 30.00	$ 270.00
Ground Cover	-	24	EA	$ 15.00	$ 360.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	34	SY	Fabric	34	SY
	$ 1,955.00			$ 161.50	

Sub Total: $ 58,005.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: MAC
Checked By: SGF 11-19-14

Basin E-4 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E-4 was located and the existing and proposed basin drainage areas were delineated (See Figures E-4.1 and E-4.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,743	3,743
Quantity	Channel Protection, CP_v	6,175	9,918
	Overbank Flood Protection, Q_{p25}	3,655	7,398
	Extreme Flood Protection, Q_{f100}	4,538	8,281

- The total area draining to the MS4 BMP is 2.46 Ac. The total impervious area is 1.85 Ac. The existing pavement area for the site is 1.03 Ac. The area required for storage and quantity management is 1.43 Ac (See Figure E-4.3).
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 60 feet by 70 feet. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E-4.4). The flow produced by the existing paved area of 1.03 Ac will not be detained and will pass through the overflow structure.
- A bypass ditch is proposed along the left side of SR 92 and along Hardy Circle North to collect clean offsite water before mixing with the polluted roadway water. The bypassed water will be directed towards a proposed cross pipe that will run parallel to cross drain #18. By doing this the offsite flows will be kept separate from the required treated flows (See Figures E-4.2 and E-4.5).
- The BMP construction cost is 13.4% of the roadway construction cost within this basin making this basin infeasible (See Figure E-4.6).
- None of the other infeasibility criteria apply to this basin.

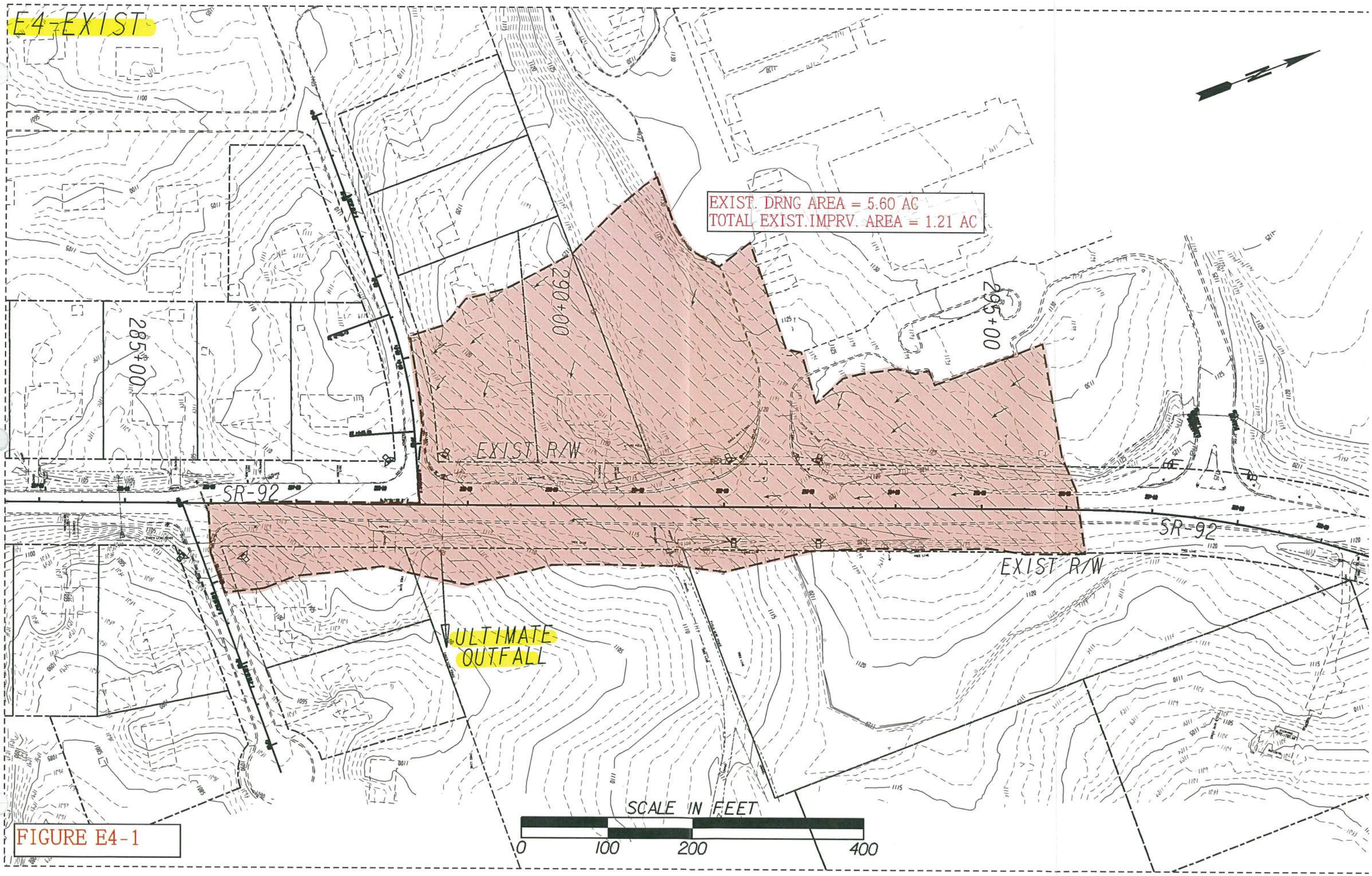

E4-EXIST
EXIST. DRNG AREA = 5.60 AC
TOTAL EXIST.IMPRV. AREA = 1.21 AC
285+00
290+00
295+00
EXIST R/W
SR-92
SR-92
EXIST R/W
ULTIMATE OUTFALL
SCALE IN FEET
0
100
200
400

FIGURE E4-1

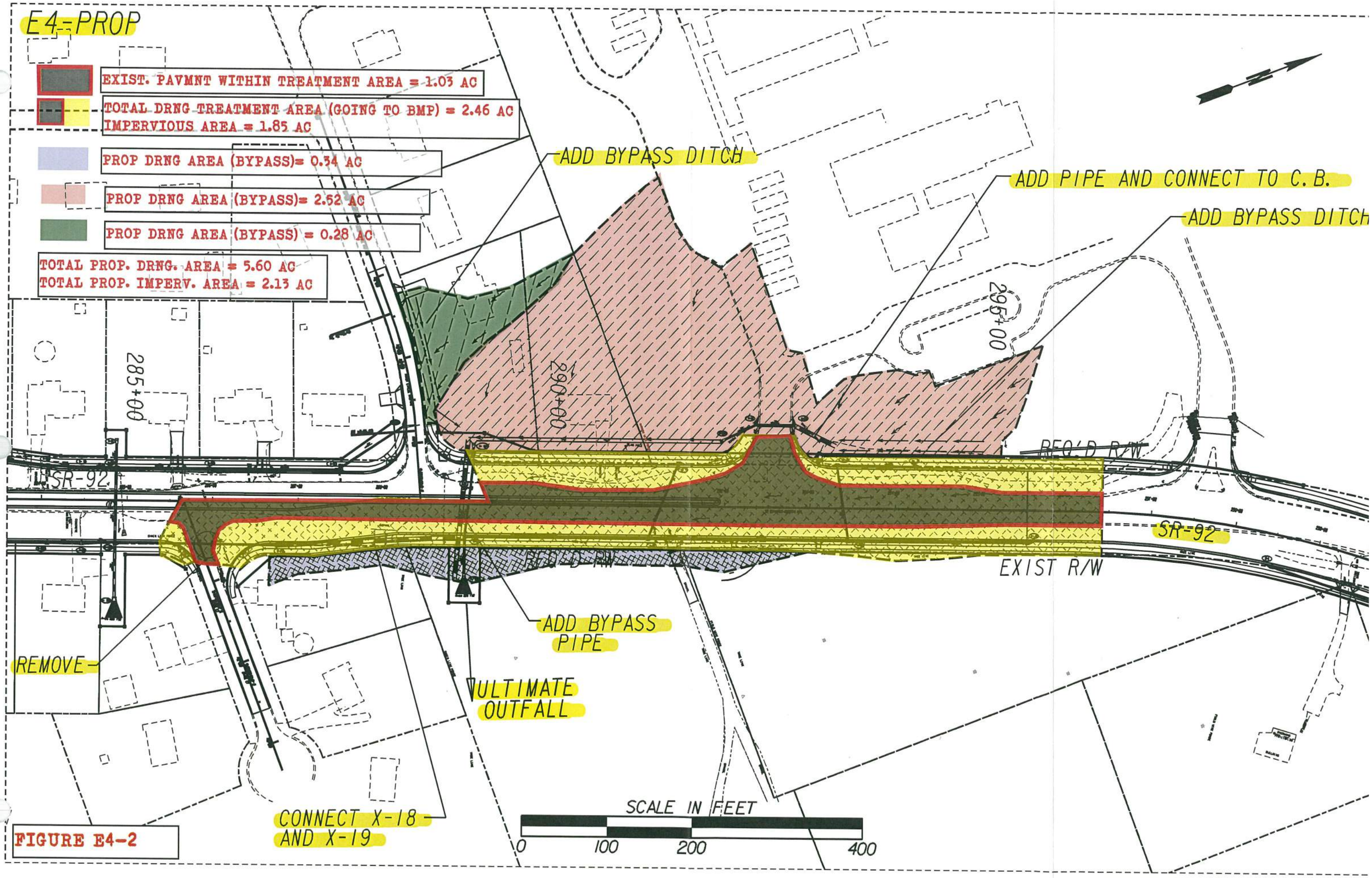

E4-PROP
EXIST. PAVMNT WITHIN TREATMENT AREA = 1.03 AC
TOTAL DRNG TREATMENT AREA (GOING TO BMP) = 2.46 AC
IMPERVIOUS AREA = 1.85 AC
PROP DRNG AREA (BYPASS)= 0.34 AC
PROP DRNG AREA (BYPASS)= 2.52 AC
PROP DRNG AREA (BYPASS) = 0.28 AC
TOTAL PROP. DRNG. AREA = 5.60 AC
TOTAL PROP. IMPERV. AREA = 2.13 AC
ADD BYPASS DITCH
ADD PIPE AND CONNECT TO C.B.
ADD BYPASS DITCH
285+00
290+00
295+00
SR-92
REQ'D R/W
EXIST R/W
ADD BYPASS PIPE
REMOVE
ULTIMATE OUTFALL
CONNECT X-18 AND X-19
SCALE IN FEET
0
100
200
400

FIGURE E4-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E4

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Jul-14
Calcs.: MC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	5.60
Impervious Area =	1.21
Pervious Area=	4.39

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.43 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.603

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.179	0.18
$I_a/P_{10\text{-}yr}$=	0.109	0.11
$I_a/P_{25\text{-}yr}$=	0.093	0.1
$I_a/P_{100\text{-}yr}$=	0.076	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.02

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.32
$Q_{d\ 10\text{-}yr}$=	3.05
$Q_{d\ 25\text{-}yr}$=	3.88
$Q_{d\ 100\text{-}yr}$ =	5.18

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	530
$q_{u10\text{-}yr}$=	560
$q_{u25\text{-}yr}$=	580
$q_{u100\text{-}yr}$=	580

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	6.11
$Q_{p10\text{-}yr}$=	14.93
$Q_{p25\text{-}yr}$=	19.71
$Q_{p100\text{-}yr}$=	26.30

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	5.60
Impervious Area =	2.13
Pervious Area =	3.48
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	81

Time of Concentration (See Table A) = 0.43 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.461

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.137	0.14
$I_a/P_{10\text{-}yr}$=	0.084	0.1
$I_a/P_{25\text{-}yr}$=	0.071	0.1
$I_a/P_{100\text{-}yr}$=	0.058	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.31

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.61
$Q_{d\ 10\text{-}yr}$=	3.47
$Q_{d\ 25\text{-}yr}$=	4.35
$Q_{d\ 100\text{-}yr}$ =	5.70

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	570
$q_{u10\text{-}yr}$=	580
$q_{u25\text{-}yr}$=	580
$q_{u100\text{-}yr}$=	580

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	8.05
$Q_{p10\text{-}yr}$=	17.64
$Q_{p25\text{-}yr}$=	22.10
$Q_{p100\text{-}yr}$=	28.93

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.46	Acre
Total Impervious Area - A_{POST}	1.85	Acre
Existing Pavement Area - A_{PRE} (5)	1.03	Acre
Area Required for Quantity - A_{QUAN} (4)	1.43	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.46	0.33	33.21	0.00	0.349	0.086	3,743

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.03	0.64	0.123	5,370

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * AQU_{AN}}{12}$$

(+15% ED)= 6,175

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.892	0.14	0.073	3,179

$V_s = CP_v =$

(+15% ED)= 3,655

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.909	0.13	0.091	3,946

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * AQU_{AN}}{12}$$

(+15% ED)= 4,538

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A QUAN = Total Treatment Area - Existing Pavement Area - Credit A

FIGURE E-4.3

Figure E-4.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E4

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: MC

	Computed Volumes	Stacked Volumes
WQ_v	3,743	3,743
CP_v	6,175	9,918
Q_{p25}	3,655	7,398
Q_{f100}	4,538	8,281

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	1295	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	9955	ft^3	>	9918	ft^3

Swale Dimensions:

A swale that is **1295** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	9,918	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **566** ft^2

Actual Filter Bed Dimensions:	Width	17	ft
	Length	34	ft
		578	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **655** ft^2

Actual Sediment Chamber Dimensions:	Width	17	ft
	Length	39	ft
		663	ft^2

Bioretention Area

CP_v	=	9,918	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,176** ft^2

Actual Filter Bed Dimensions:	Width	60	ft
	Length	70	ft
		4200	ft^2

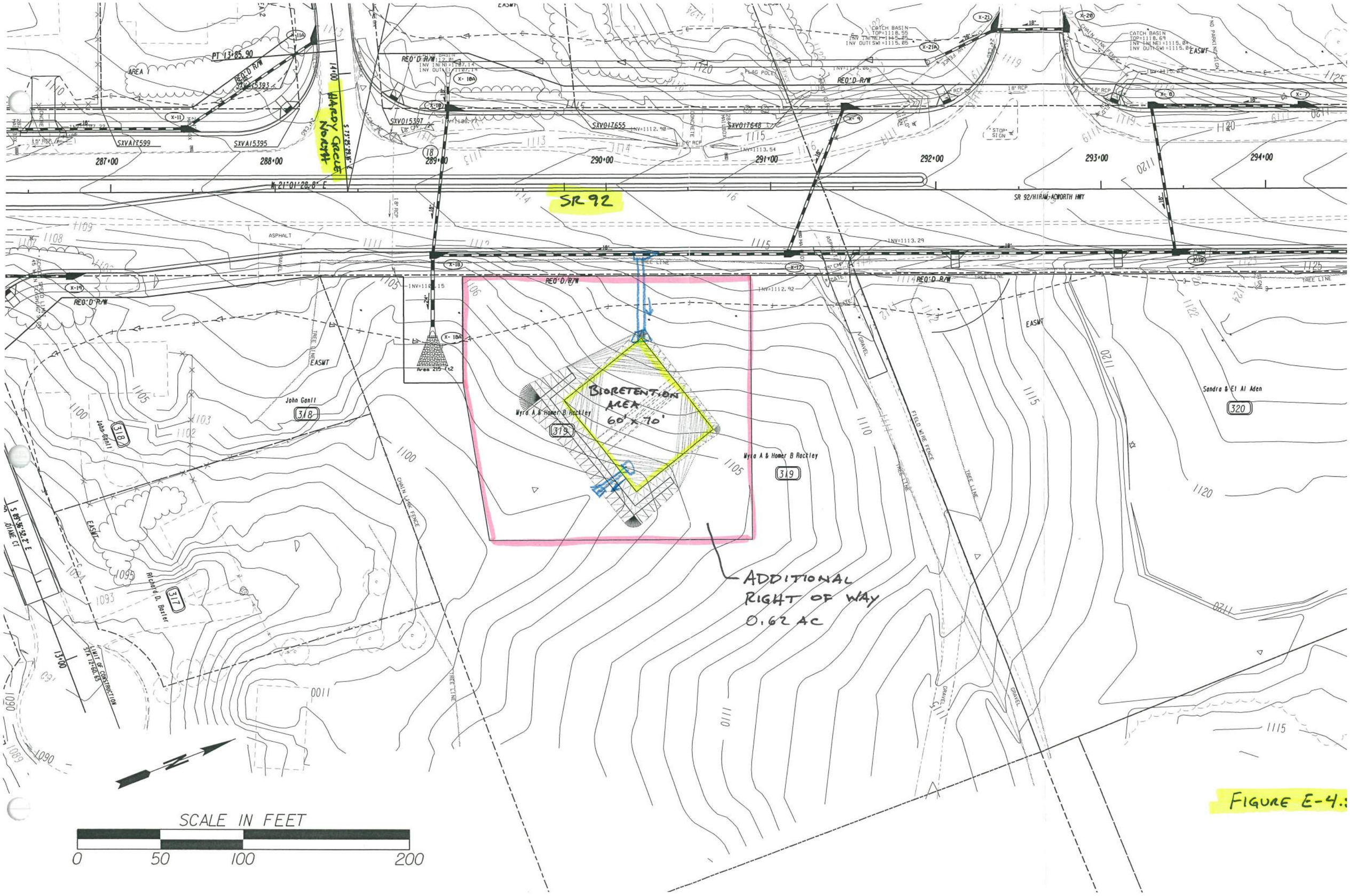

HARDY CREEK NORTH
SR 92
SR 92/HIRAM-ACWORTH HWY
BIORETENTION AREA 60' x 10'
ADDITIONAL RIGHT OF WAY 0.62 AC
REQ'D R/W
EASWT
Myra A & Homer B Rockley
John Ganll
Richard D. Barter
Sandra & El Al Aden
SCALE IN FEET
0
50
100
200

FIGURE E-4.

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin E4

Basin E4 750 LF of Roadway construction cost within basin

Item	Basin E4 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 70,610.00	$ 111,580.00	$ 43,320.00	$ 30,855.00
Utilities ✪	$ 57,494.72	$ -	$ -	$ -
Construction ✪	$ 489,993.10	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 11,158.00	$ 4,332.00	$ 3,085.50
Grading	$ -	$ 16,441.20	$ 3,030.00	$ 1,560.00
Drainage	$ -	$ 97,088.87	$ 46,910.88	$ 47,252.50
Total	$ 618,097.82	$ 236,268.07	$ 97,592.88	$ 82,753.00
	Percent of BMP Cost to Total	**38.2%**	**15.8%**	**13.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.5684
Sub Total:	$	28,420.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		1.6876
Sub Total:	$	42,190.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	70,610.00

✪ See General Summary Explaination for Cost Method

Figure E-4.6

BMP Construction Cost Worksheet — Basin E4

Dry Enhanced Swale

Length:	1295	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	2.2316	Ac	
Total:	$ 111,580.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 111,580.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
2.2316 Disturbed Ac
$ 11,158.00

Grading

Cut	Fill
1825.000	915.200

$ 6.00 per CY
Total: $ 16,441.20

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	4	EA		5	EA
	$ 20,000.00			$ 2,000.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	959	CY	$ 30.00	$ 21,316.87
Uddrn Sys w/ Gravel	-	1325	LF	$ 20.00	$ 26,500.00
Additional Pipe	18	250	LF	$ 43.00	$ 10,750.00
Outlet Pipe	18	60	LF	$ 43.00	$ 2,580.00
Bypass Flow Pipe	18	220	LF	$ 43.00	$ 9,460.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	72	SY		72	SY
	$ 4,140.00			$ 342.00	

Sub Total: $ 97,088.87

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	34	39	ft
Width:	17	17	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.8664	Ac	
Total:	$ 43,320.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 43,320.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.8664 Disturbed Ac
$ 4,332.00

Grading

Cut	Fill
470.000	35.000

$ 6.00 per CY
Total: $ 3,030.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	33	CY	$ 45.00	$ 1,485.00
Uddrn Sys w/ Gravel	-	130	LF	$ 20.00	$ 2,600.00
Top Soil		6	CY	$ 20.00	$ 120.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	578	SF	$ 5.00	$ 2,890.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	331.5	SY		331.5	SY
	$ 19,061.25			$ 1,574.63	

Sub Total: $ 46,910.88

Bioretention Area

Length:	60	ft
Width:	70	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.6171	Ac	
Total:	$ 30,855.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 30,855.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.6171 Disturbed Ac
$ 3,085.50

Grading

Cut	Fill
130.000	130.000

$ 6.00 per CY
Total: $ 1,560.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		3	EA
	$ 10,000.00			$ 1,200.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	312	CY	$ 30.00	$ 9,360.00
Uddrn Sys w/ Gravel	-	315	LF	$ 20.00	$ 6,300.00
Mulch	-	467	SY	$ 15.00	$ 7,005.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	18	EA	$ 30.00	$ 540.00
Ground Cover	-	50	EA	$ 15.00	$ 750.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	70	SY		70	SY
	$ 4,025.00			$ 332.50	

Sub Total: $ 47,252.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: MAC
Checked By: SCF 11-19-14

Basin ES-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E5-1 was located and the existing and proposed basin drainage areas were delineated (See Figure E5-1.1 and Figure E5-1.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	7,388	7,388
Quantity	Channel Protection, CP_v	6,673	14,061
	Overbank Flood Protection, Q_{p25}	3,006	10,394
	Extreme Flood Protection, Q_{f100}	4,006	11,394

- The total area draining to the MS4 BMP is 2.78 Ac. The total impervious area is 2.48 Ac. The existing pavement area for the site is 0.75 Ac. The area required for storage and quantity management is 2.03 Ac (See Figure E5-1.3).
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area that is 77 feet square. The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E5-1.4). The flow produced by the existing paved area of 0.75 Ac will not be detained and will pass through the overflow structure.
- The flow coming off SR 92 from the proposed system will be conveyed into the bioretention area through the proposed longitudinal system (See Figure E5-1.5).
- The BMP construction cost is 10.6% of the roadway construction cost within this basin making this basin infeasible (See Figure E5-1.6).
- None of the other infeasibility criteria apply to this basin.

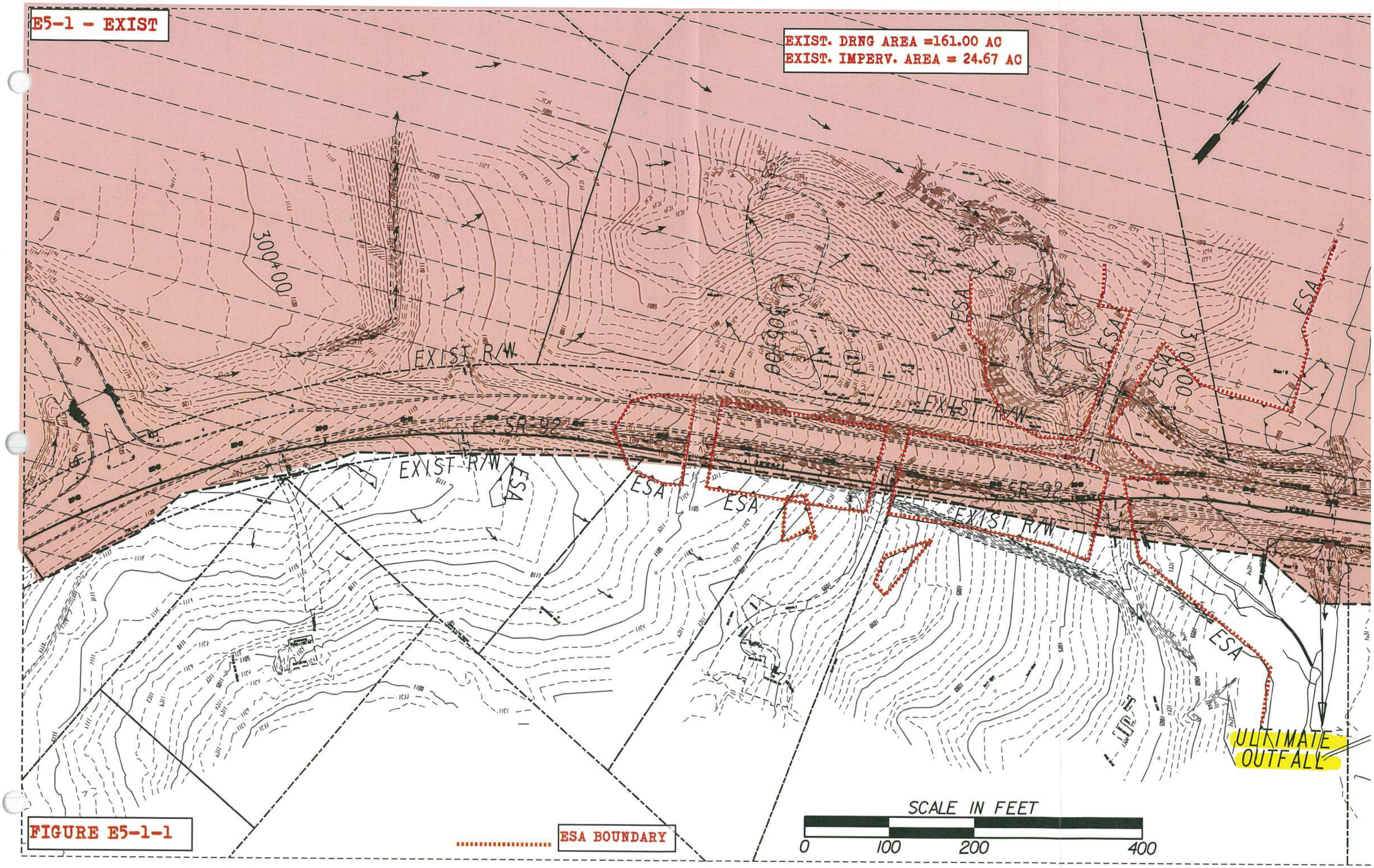

E5-1 - EXIST
EXIST. DRNG AREA =161.00 AC
EXIST. IMPERV. AREA = 24.67 AC
300+00
EXIST R/W
SR 92
EXIST R/W
ESA
ESA
ESA
ESA
ESA
ESA
ESA
ESA
ESA
ULTIMATE OUTFALL
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE E5-1-1

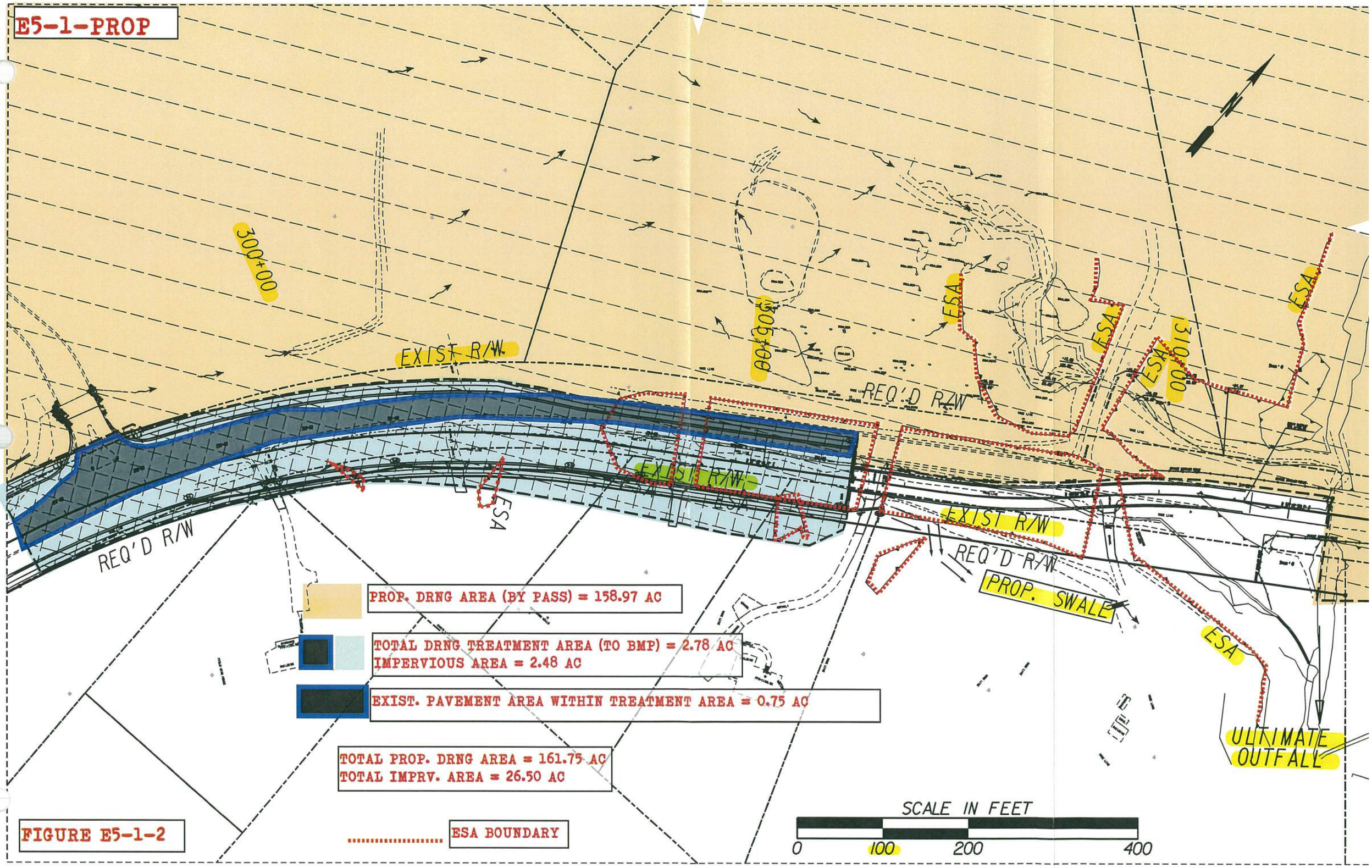

E5-1-PROP
300+00
EXIST R/W
REQ'D R/W
EXIST R/W
REQ'D R/W
ESA
ESA
ESA
ESA
ESA
ESA
EXIST R/W
REQ'D R/W
PROP. SWALE
ULTIMATE OUTFALL
PROP. DRNG AREA (BY PASS) = 158.97 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 2.78 AC
IMPERVIOUS AREA = 2.48 AC
EXIST. PAVEMENT AREA WITHIN TREATMENT AREA = 0.75 AC
TOTAL PROP. DRNG AREA = 161.75 AC
TOTAL IMPRV. AREA = 26.50 AC
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE E5-1-2

Project: SR 92 Widening & Reconstruction

GDOT DESIGN

Pond #: *E5-1*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: MC

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	161
Impervious Area =	24.67
Pervious Area=	136.33

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.85 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-3 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.662

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.197	0.2
$I_a/P_{10\text{-}yr}$=	0.120	0.12
$I_a/P_{25\text{-}yr}$=	0.102	0.1
$I_a/P_{100\text{-}yr}$=	0.084	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.31

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.21
$Q_{d\ 10\text{-}yr}$=	2.89
$Q_{d\ 25\text{-}yr}$=	3.71
$Q_{d\ 100\text{-}yr}$ =	4.99

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	360
$q_{u10\text{-}yr}$=	390
$q_{u25\text{-}yr}$=	395
$q_{u100\text{-}yr}$=	395

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	109.76
$Q_{p10\text{-}yr}$=	283.52
$Q_{p25\text{-}yr}$=	368.54
$Q_{p100\text{-}yr}$=	495.38

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	161.75
Impervious Area =	26.5
Pervious Area =	135.25
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 0.85 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-3 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.652

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.194	0.2
$I_a/P_{10\text{-}yr}$=	0.118	0.12
$I_a/P_{25\text{-}yr}$=	0.101	0.1
$I_a/P_{100\text{-}yr}$=	0.082	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.26

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.23
$Q_{d\ 10\text{-}yr}$=	2.92
$Q_{d\ 25\text{-}yr}$=	3.74
$Q_{d\ 100\text{-}yr}$ =	5.02

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	360
$q_{u10\text{-}yr}$=	390
$q_{u25\text{-}yr}$=	395
$q_{u100\text{-}yr}$=	395

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	111.85
$Q_{p10\text{-}yr}$=	287.45
$Q_{p25\text{-}yr}$=	373.20
$Q_{p100\text{-}yr}$=	500.99

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.78	Acre
Total Impervious Area - A_{POST}	2.48	Acre
Existing Pavement Area - A_{PRE} (5)	0.75	Acre
Area Required for Quantity - A_{QUAN} (4)	2.03	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.78	0.62	62.23	0.00	0.610	0.170	7,388

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.03	0.64	0.133	5,802

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,673

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

(See GSMM Page 2.2-9)

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.988	0.09	0.060	2,614

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 3,006

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

(See GSMM Page 2.2-9)

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.989	0.09	0.080	3,483

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,006

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

(See GSMM Page 2.2-9)

FIGURE E5-1.3

FIGURE E5-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: *E5-1*

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: MC

	Computed Volumes	Stacked Volumes
WQ_v	7,388	7,388
CP_v	6,673	14,061
Q_{p25}	3,006	10,394
Q_{f100}	4,006	11,394

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**1830**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	14068	ft^3	>	14061	ft^3

Swale Dimensions:

A swale that is **1830** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	14,061	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **802** ft^2

Actual Filter Bed Dimensions:	Width	**21**	ft
	Length	**42**	ft
		882	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **928** ft^2

Actual Sediment Chamber Dimensions:	Width	**21**	ft
	Length	**45**	ft
		945	ft^2

Bioretention Area

CP_v	=	14,061	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **5,920** ft^2

Actual Filter Bed Dimensions:	Width	**77**	ft
	Length	**77**	ft
		5929	ft^2

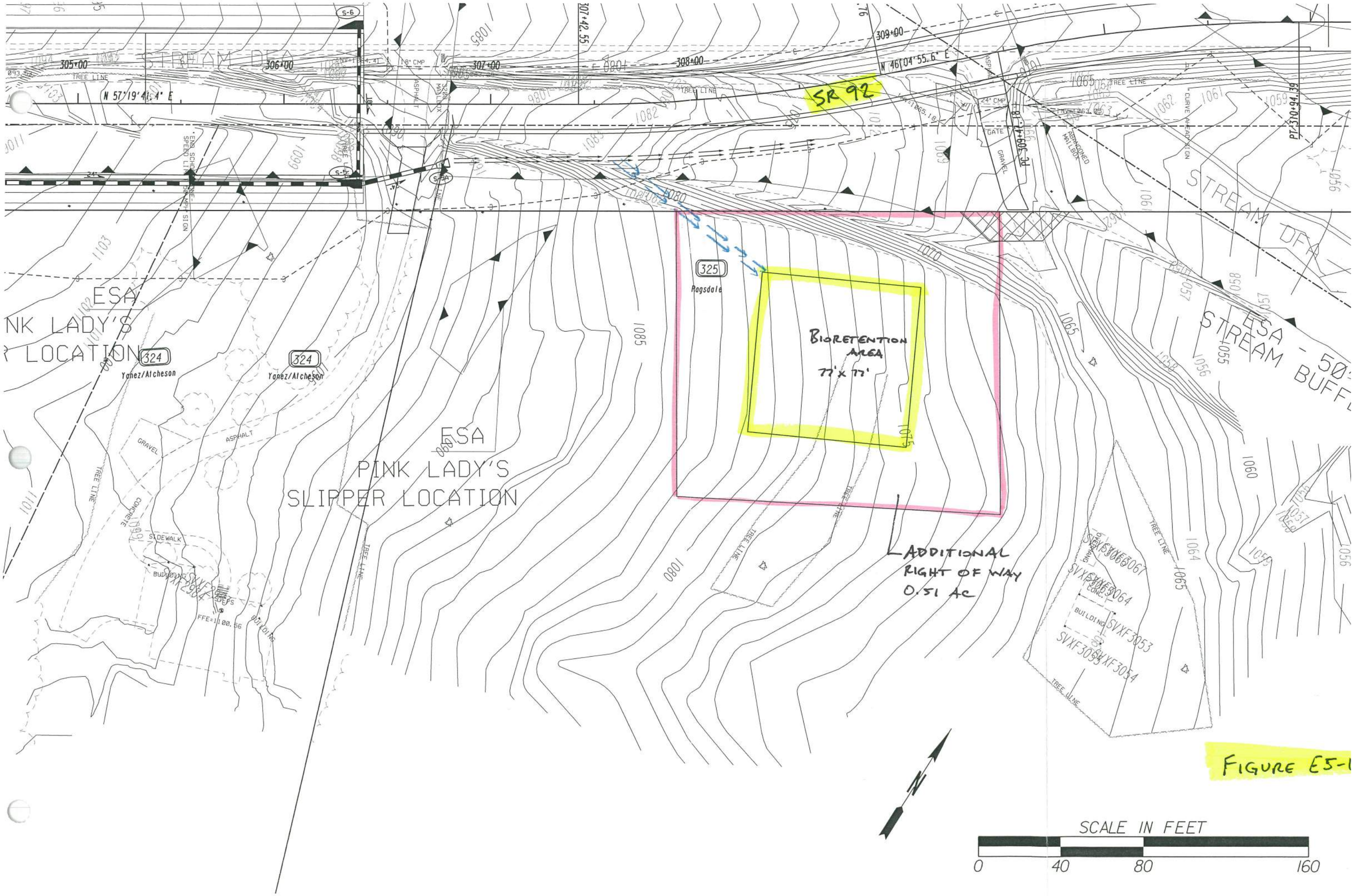

SR 92
N 57°19'41.4" E
N 46°04'55.6" E
305+00
306+00
307+00
308+00
309+00
307+42.55
PC 306+71.18
PT 310+94.39
STREAM DFA
ESA
PINK LADY'S
SLIPPER LOCATION
ESA
NK LADY'S
LOCATION
ESA - 50'
STREAM BUFFE
324
Yanez/Atcheson
325
Ragsdale
BIORETENTION
AREA
77' x 77'
ADDITIONAL
RIGHT OF WAY
0.51 AC
TREE LINE
GRAVEL
ASPHALT
CONCRETE
SIDEWALK
BUILDING
FFE=1100.56
SCALE IN FEET
0
40
80
160

FIGURE E5-1

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin E5-1

Basin E5-1 1000 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 93,562.50	$ 109,000.00	$ 43,500.00	$ 25,500.00
Utilities ✪	$ 76,659.62	$ -	$ -	$ -
Construction ✪	$ 653,324.14	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 10,900.00	$ 4,350.00	$ 2,550.00
Grading	$ -	$ 15,660.00	$ 12,096.00	$ 7,962.00
Drainage	$ -	$ 81,510.71	$ 59,408.13	$ 51,547.75
Total	$ 823,546.26	$ 217,070.71	$ 119,354.13	$ 87,559.75
	Percent of BMP Cost to Total	**26.4%**	**14.5%**	**10.6%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.602
Sub Total:	$	30,100.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.828
Sub Total:	$	20,700.00
Commercial Right of Way @	$	125,000.00
		0.04
Sub Total:	$	5,000.00
Residential Perm Easmt @	$	62,500.00
		0.6042
Sub Total:	$	37,762.50
Right of Way Cost Total:	$	93,562.50

✪ See General Summary Explaination for Cost Method

Figure E-5-1.6

BMP Construction Cost Worksheet Basin E5-1

Dry Enhanced Swale

Length:	1830	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	2.18	Ac	
Total:	$ 109,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 109,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
2.18	Disturbed Ac	
$ 10,900.00		

Grading

Cut	Fill	
2355.000	255.000	
$ 6.00	per CY	
Total: $ 15,660.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		1	EA
	$ 2,300.00			$ 400.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1356	CY	$ 30.00	$ 30,123.46
Uddrn Sys w/ Gravel	-	1860	LF	$ 20.00	$ 37,200.00
Additional Pipe	24	100	LF	$ 52.00	$ 5,200.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	101	SY	Fabric	101	SY
	$ 5,807.50			$ 479.75	

Sub Total: $ 81,510.71

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	42	45	ft
Width:	21	21	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.87	Ac	
Total:	$ 43,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 43,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.87	Disturbed Ac	
$ 4,350.00		

Grading

Cut	Fill	
348.000	1668.000	
$ 6.00	per CY	
Total: $ 12,096.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	49	CY	$ 45.00	$ 2,205.00
Uddrn Sys w/ Gravel	-	150	LF	$ 20.00	$ 3,000.00
Top Soil		9	CY	$ 20.00	$ 180.00
Outlet Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Imperm Geotextile	-	882	SF	$ 5.00	$ 4,410.00
Dist Wall Conc/Steel	-	5	CY	$ 1,020.00	$ 5,100.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	472.5	SY	Fabric	472.5	SY
	$ 27,168.75			$ 2,244.38	

Sub Total: $ 59,408.13

Bioretention Area

Length:	77	ft
Width:	77	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.51	Ac	
Total:	$ 25,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0	Ac	
Total:	$ -		
Sub Total:	$ 25,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.51	Disturbed Ac	
$ 2,550.00		

Grading

Cut	Fill	
1027.000	300.000	
$ 6.00	per CY	
Total: $ 7,962.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	440	CY	$ 30.00	$ 13,200.00
Uddrn Sys w/ Gravel	-	346.5	LF	$ 20.00	$ 6,930.00
Mulch	-	659	SY	$ 15.00	$ 9,885.00
Additional Pipe	18"	100	LF	$ 43.00	$ 4,300.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	26	EA	$ 30.00	$ 780.00
Ground Cover	-	70	EA	$ 15.00	$ 1,050.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	99	SY	Fabric	99	SY
	$ 5,692.50			$ 470.25	

Sub Total: $ 51,547.75

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 6, 2014
Designed By: MAC
Checked By: SF 11-10-14

Basin ES-2 Summary
BMP Recommendation - Not Required
Outfall Level Exclusion

- The ultimate outfall of Drainage Basin E5-2 was located and the existing and proposed basin drainage areas were delineated (See Figure E5-2.1). The difference between the existing and proposed drainage areas is negligible, as were the impervious areas. The MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes, could not be calculated.
- According to the GDOT Policy on Post-Construction BMPs (section 1.2 Post-Construction BMP Exclusions), under the Outfall Level Exclusions, number 6 states that whereby the net impervious surface area within that outfall's drainage area has been reduced or remains the same as pre-developed conditions, post-construction stormwater requirements will not apply.

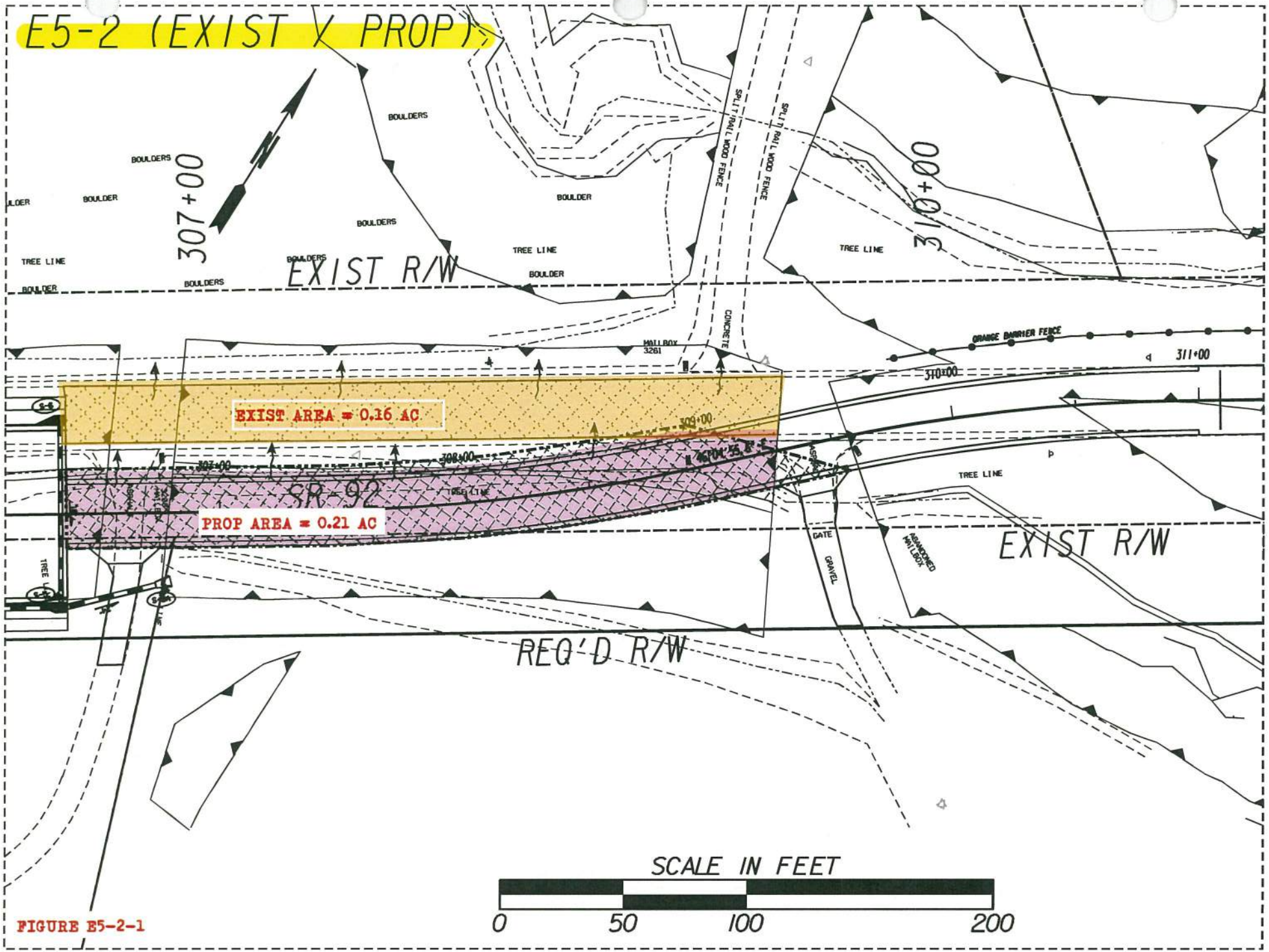

E5-2 (EXIST & PROP)
BOULDERS
BOULDER
TREE LINE
307+00
EXIST R/W
SPLIT RAIL WOOD FENCE
CONCRETE
MAILBOX 3261
310+00
ORANGE BARRIER FENCE
311+00
EXIST AREA = 0.16 AC
309+00
308+00
307+00
SR-92
PROP AREA = 0.21 AC
ASPHALT
GATE
GRAVEL
ABANDONED MAILBOX
REQ'D R/W
SCALE IN FEET
0
50
100
200

FIGURE E5-2-1

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin E6-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E6-1 was located and the existing and proposed basin drainage areas were delineated (See Figures E6-1.1 and E6-1.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	11,570	11,570
Quantity	Channel Protection, CP_v	8,558	20,128
	Overbank Flood Protection, Q_{p25}	5,078	16,648
	Extreme Flood Protection, Q_{f100}	6,251	17,821

- The total area draining to the MS4 BMP is 5.24 Ac. The total impervious area is 5.04 Ac. The existing pavement area for the site is 2.38 Ac. The area required for storage and quantity management is 2.86 Ac (See Figure E6-1.3). The flow produced by the existing paved area of 2.38 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area with a bottom width of 70' and minimum length of 122' (See Figure E6-1.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E6-1.4).
- Modifications to the proposed drainage design will be necessary to separate the bypass flow and to direct the treatment water into the BMP (See Figure E6-1.5).
- The BMP construction cost is 19.9% of the roadway construction cost within this basin making this basin infeasible (See Figure E6-1.6).
- None of the other infeasibility criteria apply to this basin.

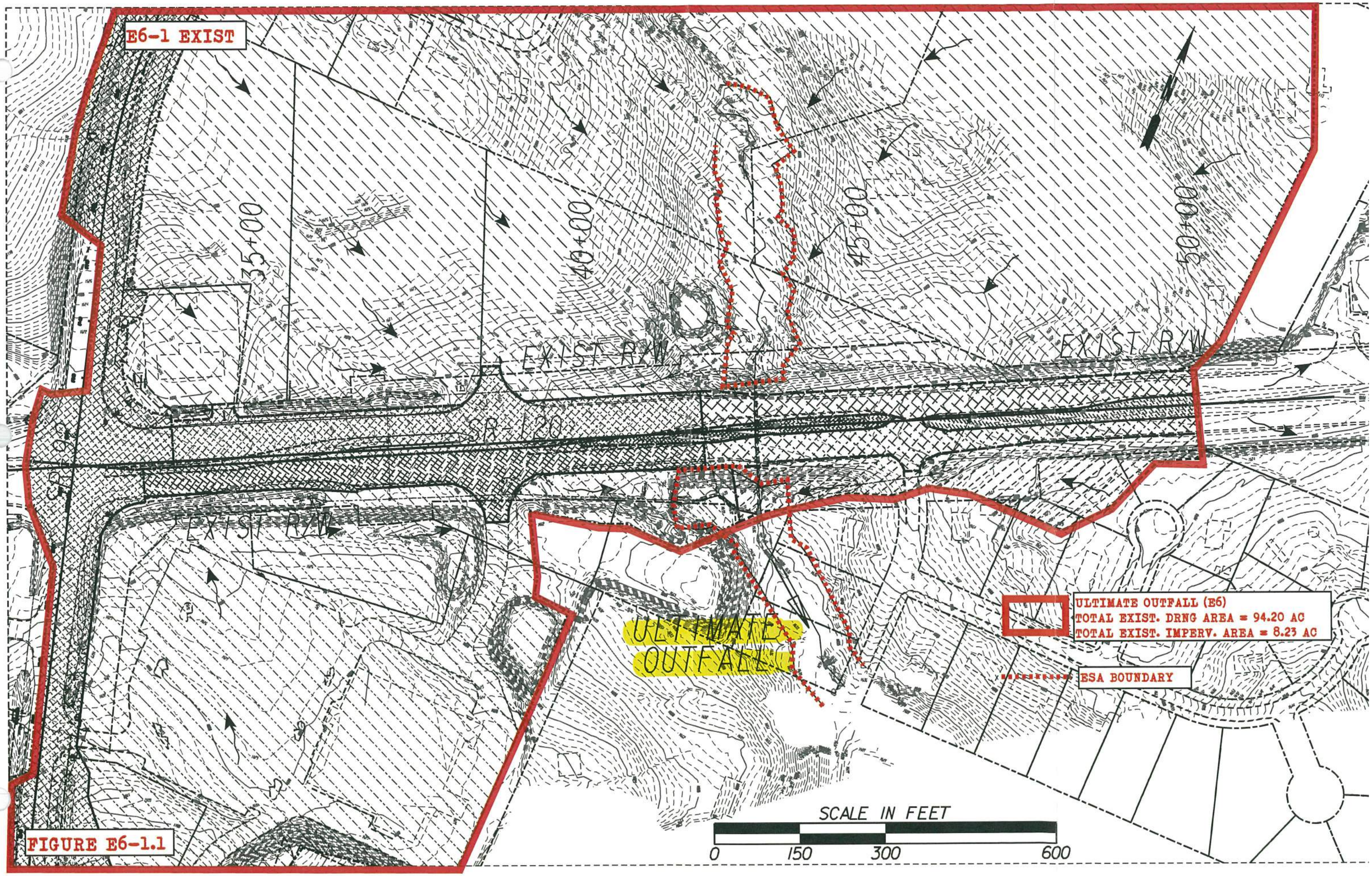

E6-1 EXIST
35+00
40+00
45+00
50+00
EXIST R/W
EXIST R/W
EXIST R/W
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL EXIST. DRNG AREA = 94.20 AC
TOTAL EXIST. IMPERV. AREA = 8.23 AC
ESA BOUNDARY
SCALE IN FEET
0
150
300
600

FIGURE E6-1.1

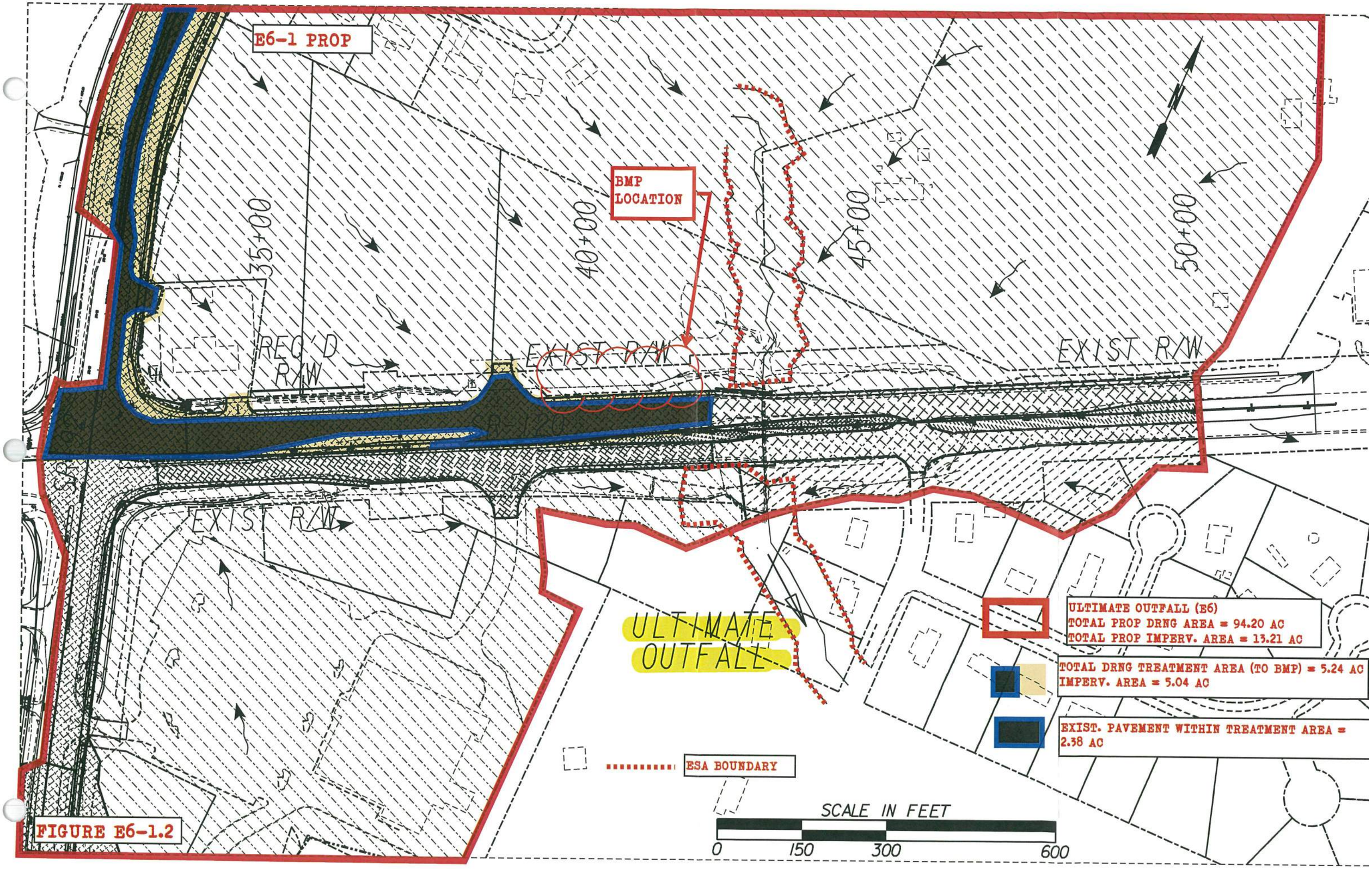

E6-1 PROP
BMP LOCATION
35+00
40+00
45+00
50+00
REQ'D R/W
EXIST R/W
EXIST R/W
EXIST R/W
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL PROP DRNG AREA = 94.20 AC
TOTAL PROP IMPERV. AREA = 13.21 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 5.24 AC
IMPERV. AREA = 5.04 AC
EXIST. PAVEMENT WITHIN TREATMENT AREA = 2.38 AC
ESA BOUNDARY
SCALE IN FEET
0
150
300
600

FIGURE E6-1.2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E6-1

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: FR

Area (acre)

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	94.2
Impervious Area =	8.23
Pervious Area=	85.97

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 1.00 *hr*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * *(in/hr)*	*time (hr)*	*P (inch)* **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.726

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.216	0.216
$I_a/P_{10\text{-}yr}$=	0.132	0.132
$I_a/P_{25\text{-}yr}$=	0.112	0.112
$I_a/P_{100\text{-}yr}$=	0.092	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.63

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.11
$Q_{d\ 10\text{-}yr}$=	2.73
$Q_{d\ 25\text{-}yr}$=	3.53
$Q_{d\ 100\text{-}yr}$ =	4.78

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	325
$q_{u10\text{-}yr}$=	345
$q_{u25\text{-}yr}$=	350
$q_{u100\text{-}yr}$=	355

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	52.96
$Q_{p10\text{-}yr}$=	138.50
$Q_{p25\text{-}yr}$=	181.71
$Q_{p100\text{-}yr}$=	249.78

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	94.2
Impervious Area =	13.21
Pervious Area =	80.99
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 1.00 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * *(in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.674

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.201	0.201
$I_a/P_{10\text{-}yr}$=	0.122	0.122
$I_a/P_{25\text{-}yr}$=	0.104	0.104
$I_a/P_{100\text{-}yr}$=	0.085	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.37

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.19
$Q_{d\ 10\text{-}yr}$=	2.86
$Q_{d\ 25\text{-}yr}$=	3.67
$Q_{d\ 100\text{-}yr}$ =	4.94

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	340
$q_{u10\text{-}yr}$=	345
$q_{u25\text{-}yr}$=	355
$q_{u100\text{-}yr}$=	355

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	59.59
$Q_{p10\text{-}yr}$=	145.11
$Q_{p25\text{-}yr}$=	191.91
$Q_{p100\text{-}yr}$=	258.38

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area E6-1

Total Drainage Treatment Area - A_{TA}	5.240	Acre
Total Impervious Area - A_{POST}	5.040	Acre
Existing Pavement Area - A_{PRE} (5)	2.380	Acre
Area Required for Quantity - A_{QUAN} (4)	2.860	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
5.24	0.51	50.76	0.00	0.507	0.266	11,570

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) R_v = 0.05 + 0.009 (I)
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.06	0.60	0.171	7,442

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 8,558

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.947	0.12	0.101	4,416

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 5,078

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.967	0.11	0.125	5,435

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,251

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure E-6-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E6-1

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	11,570	11,570
CP_v	8,558	20,128
Q_{p25}	5,078	16,648
Q_{f100}	6,251	17,821

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	2630	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	20218	ft^3	>	20128	ft^3

Swale Dimensions:

A swale that is **2630** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	20,128	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,148** ft^2

Actual Filter Bed Dimensions:	Width	**24**	ft
	Length	**48**	ft
		1152	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **1328** ft^2

Actual Sediment Chamber Dimensions:	Width	**26**	ft
	Length	**52**	ft
		1352	ft^2

Bioretention Area

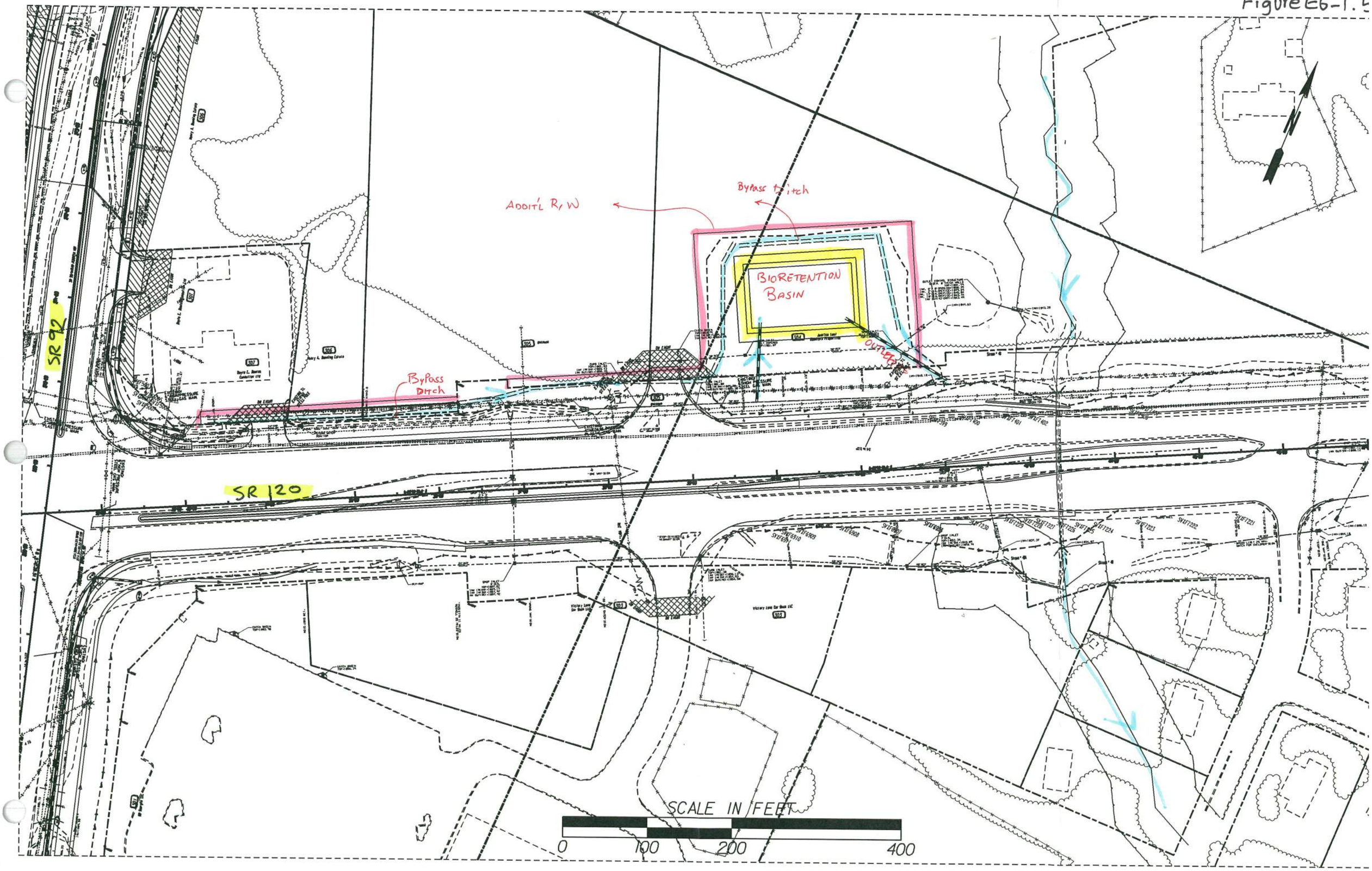
CP_v	=	20,128	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **8,475** ft^2

Actual Filter Bed Dimensions:	Width	**70**	ft
	Length	**122**	ft
		8540	ft^2

Figure E6-1.5


ADDIT'L R/W
Bypass Ditch
BIORETENTION BASIN
OUTFALL
BYPASS DITCH
SR 92
SR 120
SCALE IN FEET
0
100
200
400

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin E6-1

Basin E6-1 1100 LF of Roadway construction cost within basin

Item	Basin E6-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 245,125.00	$ 78,750.00	$ 131,250.00	$ 128,750.00
Utilities ✪	$ 84,325.59	$ 17,600.00	$ -	$ -
Construction ✪	$ 718,656.55	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 2,500.00	$ 5,900.00	$ 5,800.00
Grading	$ -	$ 9,600.00	$ 7,800.00	$ 8,820.00
Drainage	$ -	$ 113,880.68	$ 73,741.00	$ 65,451.75
Total	$ 1,048,107.14	$ 222,330.68	$ 218,691.00	$ 208,821.75
	Percent of BMP Cost to Total	**21.2%**	**20.9%**	**19.9%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.55
Sub Total:	$	27,500.00
Residential Relocation Cost	$	40,000.00
		1
Sub Total:	$	40,000.00
Residential Perm Easmt @	$	25,000.00
		0.38
Sub Total:	$	9,500.00
Commercial Right of Way @	$	125,000.00
		0.69
Sub Total:	$	86,250.00
Commercial Perm Easmt @	$	62,500.00
		1.31
Sub Total:	$	81,875.00
Right of Way Cost Total:	$	245,125.00

✪ See General Summary Explaination for Cost Method

FIGURE E6-1.6

BMP Construction Cost Worksheet Basin E6-1

Dry Enhanced Swale

Length:	2630	ft
Width:	8	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.5	Ac	
Total:	$ 62,500.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.26	Ac	
Total:	$ 16,250.00		
Sub Total:	$ 78,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	800	LF	
	$ 17,600.00		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ 17,600.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.5	Disturbed Ac	
$ 2,500.00		

Grading

Cut	Fill	
550.000	1050.000	
	$ 6.00	per CY
Total:	$ 9,600.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1948	CY	$ 30.00	$ 43,292.18
Uddrn Sys w/ Gravel	-	2660	LF	$ 20.00	$ 53,200.00
Additional Pipe	18	100	LF	$ 52.00	$ 5,200.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	146	SY	Fabric	146	SY
	$ 8,395.00			$ 693.50	

Sub Total: $ 113,880.68

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	48	52	ft
Width:	24	26	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.92	Ac	
Total:	$ 115,000.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.26	Ac	
Total:	$ 16,250.00		
Sub Total:	$ 131,250.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.18	Disturbed Ac	
$ 5,900.00		

Grading

Cut	Fill	
200.000	1100.000	
	$ 6.00	per CY
Total:	$ 7,800.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	64.00	CY	$ 45.00	$ 2,880.00
Uddrn Sys w/ Gravel	-	165	LF	$ 20.00	$ 3,300.00
Top Soil		11	CY	$ 20.00	$ 220.00
Outlet Pipe	18"	200	LF	$ 43.00	$ 8,600.00
Imperm Geotextile	-	1152	SF	$ 5.00	$ 5,760.00
Dist Wall Conc/Steel	-	5	CY	$ 1,020.00	$ 5,100.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	676	SY	Filter Fabric	676	SY
	$ 38,870.00			$ 3,211.00	

Sub Total: $ 73,741.00

Bioretention Area

Length:	122	ft
Width:	70	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	0.9	Ac	
Total:	$ 112,500.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0.26	Ac	
Total:	$ 16,250.00		
Sub Total:	$ 128,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.16	Disturbed Ac	
$ 5,800.00		

Grading

Cut	Fill	
420.000	1050.000	
	$ 6.00	per CY
Total:	$ 8,820.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	633	CY	$ 30.00	$ 18,990.00
Uddrn Sys w/ Gravel	-	315	LF	$ 20.00	$ 6,300.00
Mulch	-	949	SY	$ 15.00	$ 14,235.00
Additional Pipe	18"	120	LF	$ 43.00	$ 5,160.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	37	EA	$ 30.00	$ 1,110.00
Ground Cover	-	101	EA	$ 15.00	$ 1,515.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	143	SY	Fabric	143	SY
	$ 8,222.50			$ 679.25	

Sub Total: $ 65,451.75

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: 11-19-14

Basin E6-2 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 & #S – Cost of BMP & Displacements

The ultimate outfall of Drainage Basin E6-2 was located and the existing and proposed basin drainage areas were delineated (See Figures E6-2.1 and E6-2.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	6,792	6,792
Quantity	Channel Protection, CP_v	6,404	13,196
	Overbank Flood Protection, Q_{p25}	3,799	10,591
	Extreme Flood Protection, Q_{f100}	4,677	11,469

- The total area draining to the MS4 BMP is 4.54 Ac. The total impervious area is 3.88 Ac. The existing pavement area for the site is 2.40 Ac. The area required for storage and quantity management is 2.14 Ac (See Figure E6-2.3). The flow produced by the existing paved area of 2.40 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area with a bottom width of 56' and minimum length of 100' (See Figure E6-2.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E6-2.4).
- Modifications to the proposed drainage design will be necessary to separate the bypass flow and to direct the treatment water into the BMP (See Figure E6-2.5).
- The BMP construction cost is 45.1% of the roadway construction cost within this basin making this basin infeasible (See Figure E6-2.6).
- Google Earth shows that that there are newly constructed buildings and businesses operating on the site. The proposed BMP would displace these businesses making it infeasible.

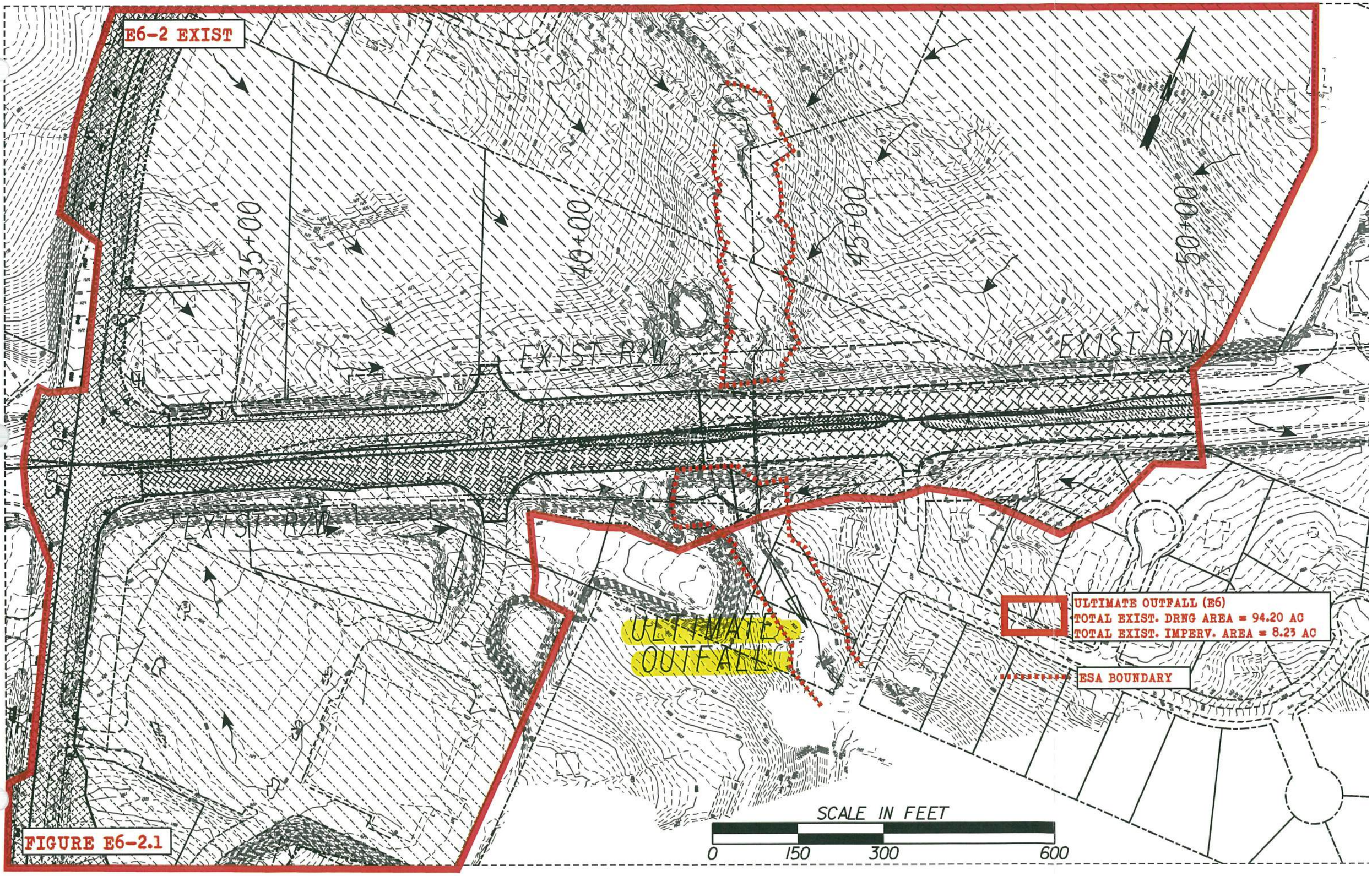

E6-2 EXIST
35+00
40+00
45+00
50+00
EXIST R/W
EXIST R/W
EXIST R/W
SR 120
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL EXIST. DRNG AREA = 94.20 AC
TOTAL EXIST. IMPERV. AREA = 8.23 AC
ESA BOUNDARY
SCALE IN FEET
0
150
300
600

FIGURE E6-2.1

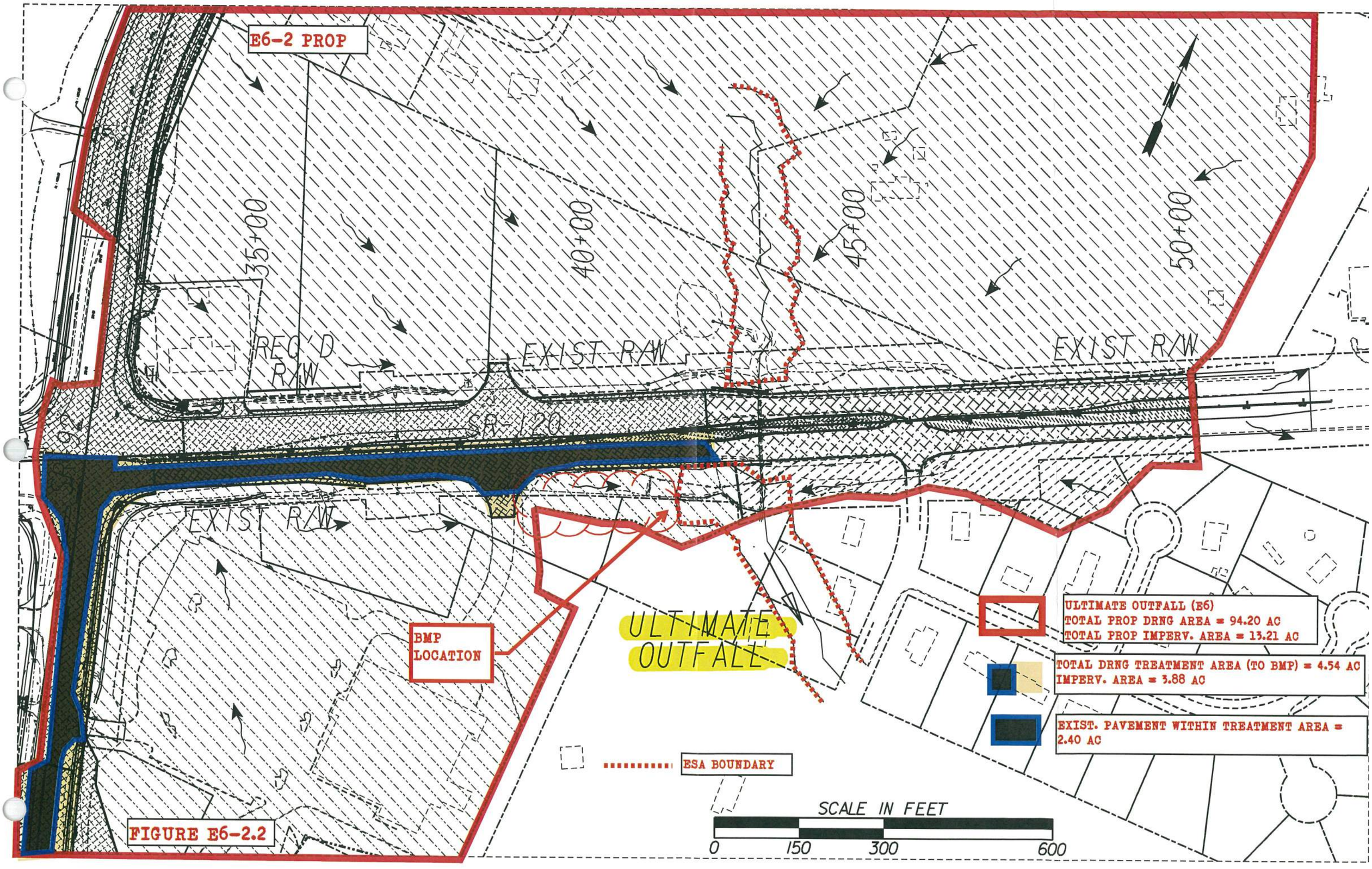

E6-2 PROP
35+00
40+00
45+00
50+00
REQ'D R/W
EXIST R/W
EXIST R/W
SR-120
EXIST R/W
BMP LOCATION
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL PROP DRNG AREA = 94.20 AC
TOTAL PROP IMPERV. AREA = 13.21 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 4.54 AC
IMPERV. AREA = 3.88 AC
EXIST. PAVEMENT WITHIN TREATMENT AREA = 2.40 AC
ESA BOUNDARY
SCALE IN FEET
0
150
300
600

FIGURE E6-2.2

H&L DESIGN

Pond #: E6-2

Unified Stormwater Sizing Criteria

Table B

PI: 621720

Nov-14

Calcs.: FR

Area (acre)

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	94.2
Impervious Area =	8.23
Pervious Area=	85.97

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 1.00 *hr*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.726

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.216	0.216
$I_a/P_{10\text{-}yr}$=	0.132	0.132
$I_a/P_{25\text{-}yr}$=	0.112	0.112
$I_a/P_{100\text{-}yr}$=	0.092	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.63

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.11
$Q_{d\ 10\text{-}yr}$=	2.73
$Q_{d\ 25\text{-}yr}$=	3.53
$Q_{d\ 100\text{-}yr}$ =	4.78

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	325
$q_{u10\text{-}yr}$=	345
$q_{u25\text{-}yr}$=	350
$q_{u100\text{-}yr}$=	355

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	52.96
$Q_{p10\text{-}yr}$=	138.50
$Q_{p25\text{-}yr}$=	181.71
$Q_{p100\text{-}yr}$=	249.78

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	94.2
Impervious Area =	13.21
Pervious Area =	80.99
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 1.00 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.674

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.201	0.201
$I_a/P_{10\text{-}yr}$=	0.122	0.122
$I_a/P_{25\text{-}yr}$=	0.104	0.104
$I_a/P_{100\text{-}yr}$=	0.085	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.37

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.19
$Q_{d\ 10\text{-}yr}$=	2.86
$Q_{d\ 25\text{-}yr}$=	3.67
$Q_{d\ 100\text{-}yr}$ =	4.94

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	340
$q_{u10\text{-}yr}$=	345
$q_{u25\text{-}yr}$=	355
$q_{u100\text{-}yr}$=	355

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	59.59
$Q_{p10\text{-}yr}$=	145.11
$Q_{p25\text{-}yr}$=	191.91
$Q_{p100\text{-}yr}$=	258.38

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area E6-2

Total Drainage Treatment Area - A_{TA}	4.540	Acre
Total Impervious Area - A_{POST}	3.880	Acre
Existing Pavement Area - A_{PRE} (5)	2.400	Acre
Area Required for Quantity - A_{QUAN} (4)	2.140	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
4.54	0.33	32.60	0.00	0.343	0.156	6,792

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.06	0.60	0.128	5,568

(+15% ED)= 6,404

$$V_s = CP_v = \frac{\left(\frac{V_s}{V_r}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.947	0.12	0.076	3,304

(+15% ED)= 3,799

$$V_s = CP_v = \frac{\left(\frac{V_s}{V_r}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.967	0.11	0.093	4,067

(+15% ED)= 4,677

$$V_s = CP_v = \frac{\left(\frac{V_s}{V_r}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure E6-2.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E6-2

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FA

	Computed Volumes	Stacked Volumes
WQ_v	6,792	6,792
CP_v	6,404	13,196
Q_{p25}	3,799	10,591
Q_{f100}	4,677	11,469

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	**1720**	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	13223	ft^3	>	13196	ft^3

Swale Dimensions:

A swale that is **1720** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	13,196	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **753** ft^2

Actual Filter Bed Dimensions:	Width	19	ft
	Length	40	ft
		760	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **871** ft^2

Actual Sediment Chamber Dimensions:	Width	19	ft
	Length	46	ft
		874	ft^2

Bioretention Area

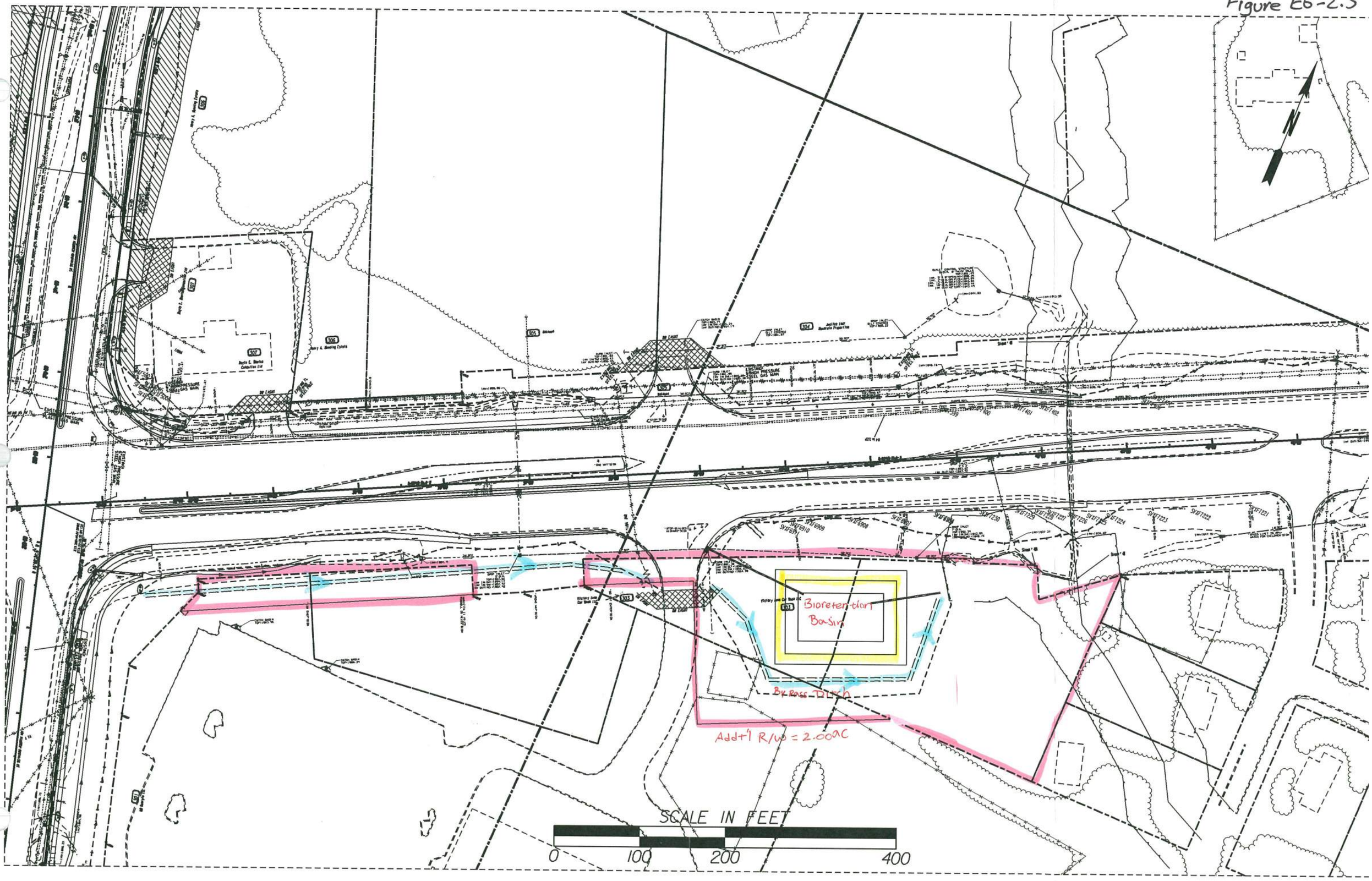
CP_v	=	13,196	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **5,556** ft^2

Actual Filter Bed Dimensions:	Width	56	ft
	Length	100	ft
		5600	ft^2

Figure E6-2.5


Bioretention Basin
Bypass Ditch
Add'l R/W = 2.00AC
SCALE IN FEET
0
100
200
400

Infeasibility Criteria #1: Cost of Construction

11/19/2014

Basin E6-2

Basin E6-2 1300 LF of Roadway construction cost within basin

Item	Basin E6-2 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 86,500.00	$ 400,000.00	$ 400,000.00	$ 400,000.00
Utilities ✪	$ 99,657.51	$ -	$ -	$ -
Construction ✪	$ 849,321.38	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 2,500.00	$ 9,000.00	$ 8,550.00
Grading	$ -	$ 9,240.00	$ 9,780.00	$ 9,900.00
Drainage	$ -	$ 76,226.51	$ 54,423.25	$ 48,796.50
Total	$ 1,035,478.89	$ 487,966.51	$ 473,203.25	$ 467,246.50
	Percent of BMP Cost to Total	**47.1%**	**45.7%**	**45.1%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.16
Sub Total:	$	8,000.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0.14
Sub Total:	$	3,500.00
Commercial Right of Way @	$	125,000.00
		0.4
Sub Total:	$	50,000.00
Commercial Perm Easmt @	$	62,500.00
		0.4
Sub Total:	$	25,000.00
Right of Way Cost Total:	$	86,500.00

✪ See General Summary Explaination for Cost Method

FIGURE E6-2.6

BMP Construction Cost Worksheet — Basin E6-2

Dry Enhanced Swale

Length:	1720	ft
Width:	8	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	2	Ac	
Total:	$ 250,000.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00	EA	
	2		
Total:	$ 50,000.00		
Cost to Cure @	$ 100,000.00		
(Damages to Power Sub-Station)	1	LS	
Total:	$ 100,000.00		
Sub Total:	$ 400,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.5	Disturbed Ac	
$ 2,500.00		

Grading

Cut	Fill	
440.000	1100.000	
$ 6.00	per CY	
Total: $ 9,240.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1274	CY	$ 30.00	$ 28,312.76
Uddrn Sys w/ Gravel	-	1750	LF	$ 20.00	$ 35,000.00
Additional Pipe	18	75	LF	$ 52.00	$ 3,900.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	95	SY	Fabric	95	SY
	$ 5,462.50			$ 451.25	

Sub Total: $ 76,226.51

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	40	46	ft
Width:	19	19	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	2	Ac	
Total:	$ 250,000.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00	EA	
	2		
Total:	$ 50,000.00		
Cost to Cure @	$ 100,000.00		
(Damages to Power Sub-Station)	1	LS	
Total:	$ 100,000.00		
Sub Total:	$ 400,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.8	Disturbed Ac	
$ 9,000.00		

Grading

Cut	Fill	
330.000	1300.000	
$ 6.00	per CY	
Total: $ 9,780.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	42.22	CY	$ 45.00	$ 1,900.00
Uddrn Sys w/ Gravel	-	144	LF	$ 20.00	$ 2,880.00
Top Soil		8	CY	$ 20.00	$ 160.00
Outlet Pipe	18"	200	LF	$ 43.00	$ 8,600.00
Imperm Geotextile	-	760	SF	$ 5.00	$ 3,800.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY		$ 4.75	per SY
	437	SY	Filter Fabric	437	SY
	$ 25,127.50			$ 2,075.75	

Sub Total: $ 54,423.25

Bioretention Area

Length:	100	ft
Width:	56	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	2	Ac	
Total:	$ 250,000.00		
Commercial Perm Easmt @	$ 62,500.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Relocation @	$ 25,000.00	EA	
	2		
Total:	$ 50,000.00		
Cost to Cure @	$ 100,000.00		
(Damages to Power Sub-Station)	1	LS	
Total:	$ 100,000.00		
Sub Total:	$ 400,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.71	Disturbed Ac	
$ 8,550.00		

Grading

Cut	Fill	
400.000	1250.000	
$ 6.00	per CY	
Total: $ 9,900.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	415	CY	$ 30.00	$ 12,450.00
Uddrn Sys w/ Gravel	-	252	LF	$ 20.00	$ 5,040.00
Mulch	-	623	SY	$ 15.00	$ 9,345.00
Additional Pipe	18"	120	LF	$ 43.00	$ 5,160.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	24	EA	$ 30.00	$ 720.00
Ground Cover	-	66	EA	$ 15.00	$ 990.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter	$ 4.75	per SY
	94	SY	Fabric	94	SY
	$ 5,405.00			$ 446.50	

Sub Total: $ 48,796.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 19, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin E6-3 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin E6-3 was located and the existing and proposed basin drainage areas were delineated (See Figures E6-3.1 and E6-3.2). From those drainage areas, the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows those volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	1,651	1,651
Quantity	Channel Protection, CP_v	2,559	4,210
	Overbank Flood Protection, Q_{p25}	1,518	3,169
	Extreme Flood Protection, Q_{f100}	1,869	3,520

- The total area draining to the MS4 BMP is 1.53 Ac. The total impervious area is 1.01 Ac. The existing pavement area for the site is 0.68 Ac. The area required for storage and quantity management is 0.86 Ac (See Figure E6-3.3).
- The flow produced by the existing paved area of 0.68 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a bioretention area with a bottom width of 23' and minimum length of 80' (See Figure E6-3.4). The bioretention area was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure E6-3.4).
- Modifications to the proposed drainage design will be necessary to separate the bypass flow and to direct the treatment water into the BMP (See Figure E6-3.5).
- In order to place the BMP utility relocations are required.
- The BMP construction cost is 71.4% of the roadway construction cost within this basin making this basin infeasible (See Figure E6-3.6).
- None of the other infeasibility criteria apply to this basin.

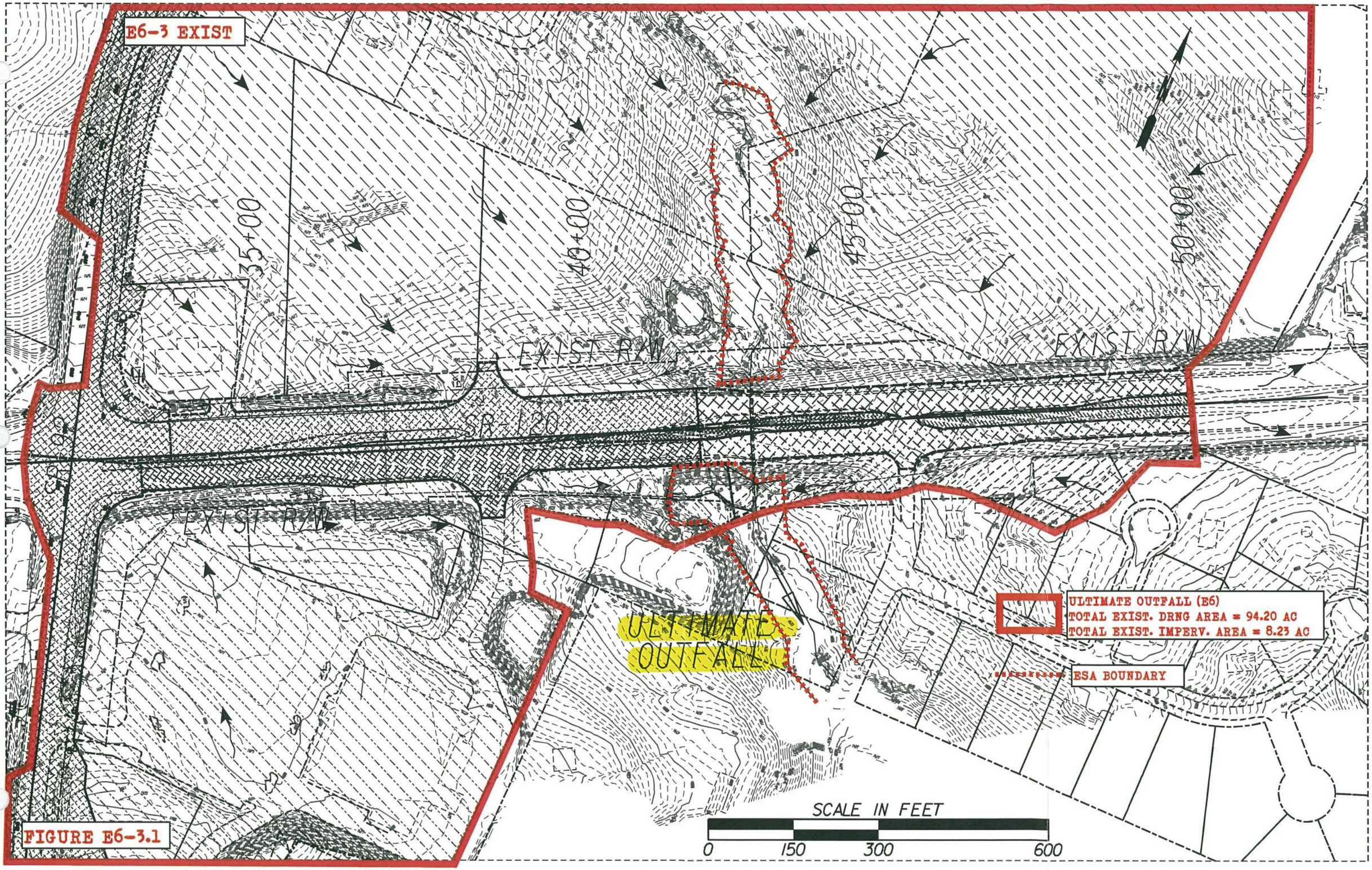

E6-3 EXIST
35+00
40+00
45+00
50+00
EXIST R/W
EXIST R/W
EXIST R/W
R-120
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL EXIST. DRNG AREA = 94.20 AC
TOTAL EXIST. IMPERV. AREA = 8.23 AC
ESA BOUNDARY
SCALE IN FEET
0
150
300
600

FIGURE E6-3.1

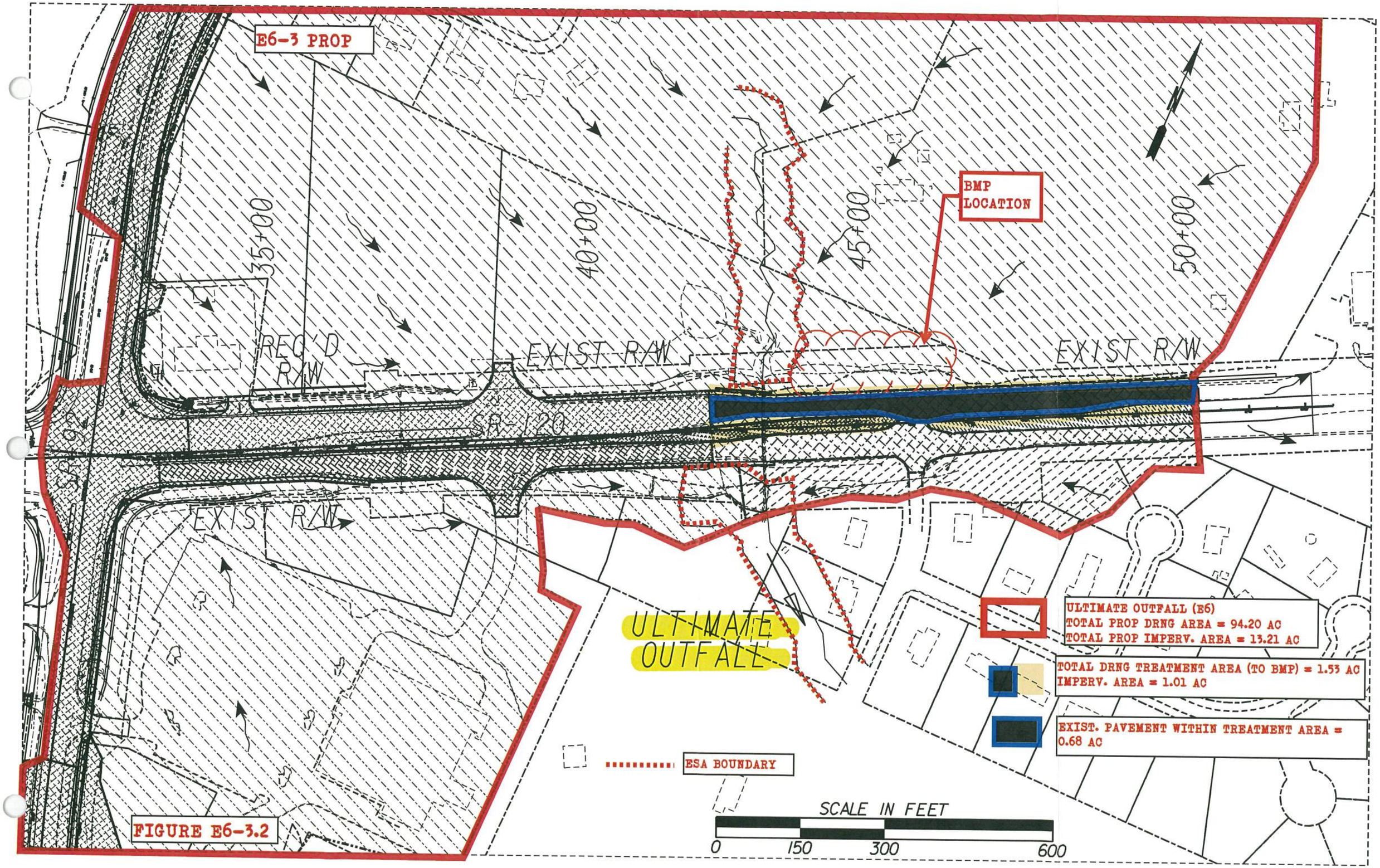

E6-3 PROP
BMP LOCATION
35+00
40+00
45+00
50+00
REQ'D R/W
EXIST R/W
EXIST R/W
SR-120
EXIST R/W
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL PROP DRNG AREA = 94.20 AC
TOTAL PROP IMPERV. AREA = 13.21 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.53 AC
IMPERV. AREA = 1.01 AC
EXIST. PAVEMENT WITHIN TREATMENT AREA = 0.68 AC
ESA BOUNDARY
SCALE IN FEET
0
150
300
600

FIGURE E6-3.2

H&L DESIGN
Pond #: E6-3

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: FR

Area (acre)

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	94.2
Impervious Area =	8.23
Pervious Area=	85.97

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 1.00 *hr*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.726

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.216	0.216
$I_a/P_{10\text{-}yr}$=	0.132	0.132
$I_a/P_{25\text{-}yr}$=	0.112	0.112
$I_a/P_{100\text{-}yr}$=	0.092	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.63

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.11
$Q_{d\ 10\text{-}yr}$=	2.73
$Q_{d\ 25\text{-}yr}$=	3.53
$Q_{d\ 100\text{-}yr}$ =	4.78

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	325
$q_{u10\text{-}yr}$=	345
$q_{u25\text{-}yr}$=	350
$q_{u100\text{-}yr}$=	355

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	52.96
$Q_{p10\text{-}yr}$=	138.50
$Q_{p25\text{-}yr}$=	181.71
$Q_{p100\text{-}yr}$=	249.78

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	94.2
Impervious Area =	13.21
Pervious Area =	80.99
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	75

Time of Concentration (See Table A) = 1.00 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.674

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.201	0.201
$I_a/P_{10\text{-}yr}$=	0.122	0.122
$I_a/P_{25\text{-}yr}$=	0.104	0.104
$I_a/P_{100\text{-}yr}$=	0.085	0.100

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.37

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.19
$Q_{d\ 10\text{-}yr}$=	2.86
$Q_{d\ 25\text{-}yr}$=	3.67
$Q_{d\ 100\text{-}yr}$ =	4.94

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	340
$q_{u10\text{-}yr}$=	345
$q_{u25\text{-}yr}$=	355
$q_{u100\text{-}yr}$=	355

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	59.59
$Q_{p10\text{-}yr}$=	145.11
$Q_{p25\text{-}yr}$=	191.91
$Q_{p100\text{-}yr}$=	258.38

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.53	Acre
Total Impervious Area - A_{POST}	1.01	Acre
Existing Pavement Area - A_{PRE} (5)	0.68	Acre
Area Required for Quantity - A_{QUAN} (4)	0.86	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
1.53	0.22	21.96	0.00	0.248	0.038	1,651

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) R_v = 0.05 + 0.009 (I)
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.947	0.12	0.030	1,320

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,518

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.06	0.60	0.051	2,225

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 2,559

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.967	0.11	0.037	1,625

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 1,869

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure E6-3.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: E6-3

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	1,651	1,651
CP_v	2,559	4,210
Q_{p25}	1,518	3,169
Q_{t100}	1,869	3,520

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	550	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	4228	ft^3	>	4210	ft^3

Swale Dimensions:

A swale that is **550** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	4,210	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **240** ft^2

Actual Filter Bed Dimensions:	Width	**11**	ft
	Length	**22**	ft
		242	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **278** ft^2

Actual Sediment Chamber Dimensions:	Width	**12**	ft
	Length	**25**	ft
		300	ft^2

Bioretention Area

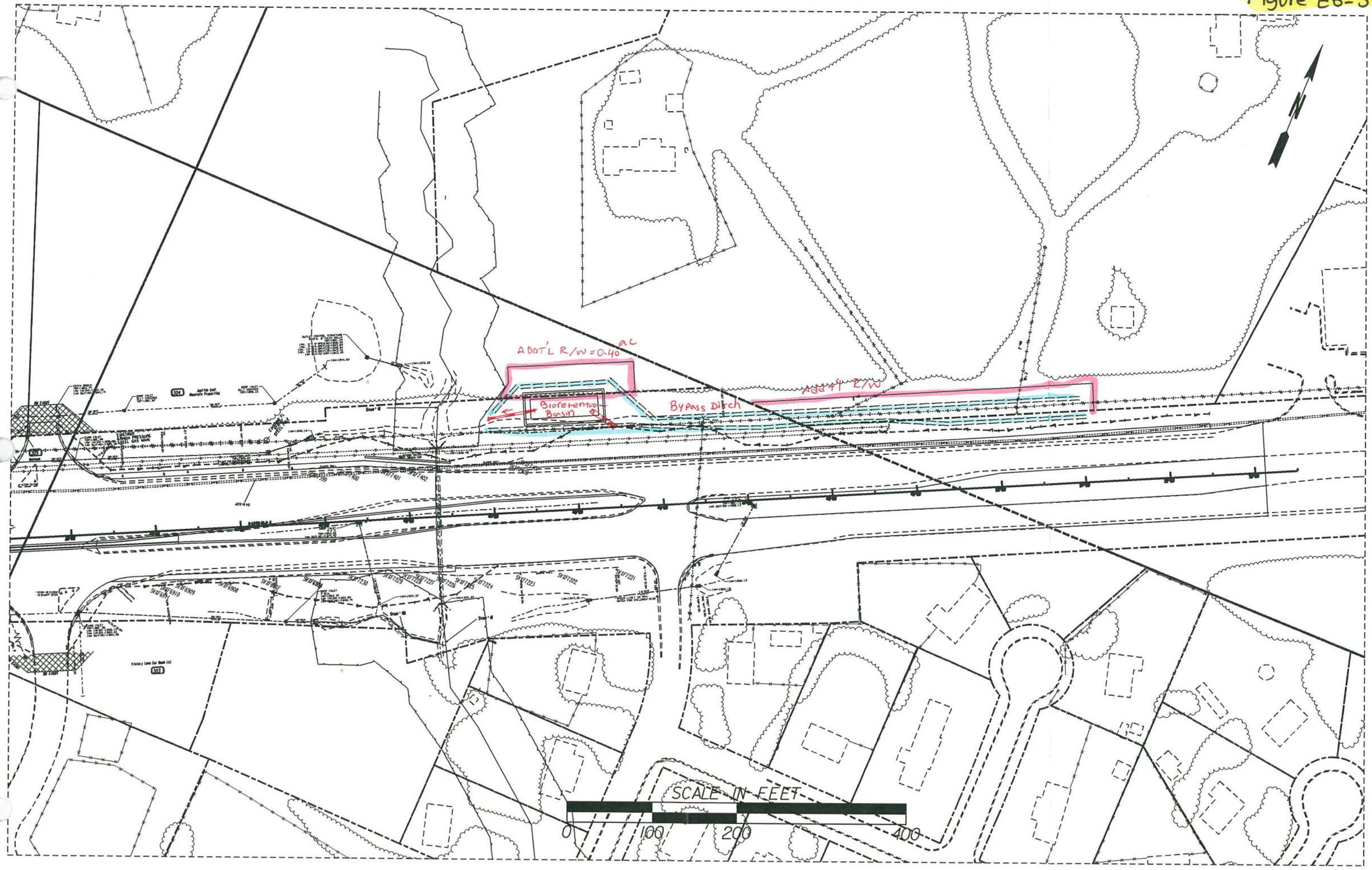
CP_v	=	4,210	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **1,773** ft^2

Actual Filter Bed Dimensions:	Width	**23**	ft
	Length	**80**	ft
		1840	ft^2

Figure E6-3.5


ADDT'L R/W = 0.40 ac
Bioretention Basin
Bypass Ditch
ADDT'L R/W
SCALE IN FEET
0
100
200
400

Infeasibility Criteria #1: Cost of Construction
Basin E6-3

11/19/2014

Basin E6-3 300 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ -	$ 113,750.00	$ 53,750.00	$ 50,000.00
Utilities ✪	$ 22,997.89	$ 75,000.00	$ 75,000.00	$ 75,000.00
Construction ✪	$ 195,997.24	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,550.00	$ 2,250.00	$ 2,000.00
Grading	$ -	$ 6,000.00	$ 3,300.00	$ 3,180.00
Drainage	$ -	$ 29,583.25	$ 30,672.50	$ 26,154.75
Total	$ 218,995.13	$ 228,883.25	$ 164,972.50	$ 156,334.75
	Percent of BMP Cost to Total	**104.5%**	**75.3%**	**71.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0
Sub Total:	$	-
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	-

✪ See General Summary Explaination for Cost Method

Figure E6-3.6

BMP Construction Cost Worksheet Basin E6-3

Dry Enhanced Swale

Length:	550	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.91	Ac	
Total:	$ 113,750.00		
Sub Total:	$ 113,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	3	poles	
	$ 75,000.00		
Sub Total:	$ 75,000.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.91	Disturbed Ac	
$ 4,550.00		

Grading

Cut	Fill	
300.000	700.000	
	$ 6.00	per CY
Total:	$ 6,000.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	407	CY	$ 30.00	$ 9,053.50
Uddrn Sys w/ Gravel	-	580	LF	$ 20.00	$ 11,600.00
Additional Pipe	18	75	LF	$ 52.00	$ 3,900.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	31	SY		31	SY
	$ 1,782.50			$ 147.25	

Sub Total: $ 29,583.25

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	22	25	ft
Width:	11	12	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.43	Ac	
Total:	$ 53,750.00		
Sub Total:	$ 53,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	3	poles	
	$ 75,000.00		
Sub Total:	$ 75,000.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.45	Disturbed Ac	
$ 2,250.00		

Grading

Cut	Fill	
200.000	350.000	
	$ 6.00	per CY
Total:	$ 3,300.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	13.44	CY	$ 45.00	$ 605.00
Uddrn Sys w/ Gravel	-	100	LF	$ 20.00	$ 2,000.00
Top Soil		3	CY	$ 20.00	$ 60.00
Outlet Pipe	18"	200	LF	$ 43.00	$ 8,600.00
Imperm Geotextile	-	242	SF	$ 5.00	$ 1,210.00
Dist Wall Conc/Steel	-	3	CY	$ 1,020.00	$ 3,060.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	150	SY		150	SY
	$ 8,625.00			$ 712.50	

Sub Total: $ 30,672.50

Bioretention Area

Length:	80	ft
Width:	23	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0	Ac	
Total:	$ -		
Commercial Right of Way @	$ 125,000.00	per Ac	
	0.4	Ac	
Total:	$ 50,000.00		
Sub Total:	$ 50,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	3	poles	
	$ 75,000.00		
Sub Total:	$ 75,000.00		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.4	Disturbed Ac	
$ 2,000.00		

Grading

Cut	Fill	
200.000	330.000	
	$ 6.00	per CY
Total:	$ 3,180.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 5,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	137	CY	$ 30.00	$ 4,110.00
Uddrn Sys w/ Gravel	-	103.5	LF	$ 20.00	$ 2,070.00
Mulch	-	205	SY	$ 15.00	$ 3,075.00
Additional Pipe	18"	120	LF	$ 43.00	$ 5,160.00
Outlet Pipe	18"	80	LF	$ 43.00	$ 3,440.00
Shrubs	-	8	EA	$ 30.00	$ 240.00
Ground Cover	-	22	EA	$ 15.00	$ 330.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	31	SY		31	SY
	$ 1,782.50			$147.25	

Sub Total: $ 26,154.75

Basin E6-4 Summary
BMP Recommendation- Not required per outfall level exclusion

- The ultimate outfall of Drainage Basin E6-4 was located and the existing and proposed basin drainage areas were delineated (See Figure E6-4.1 and Figure E6-4.2). The existing and proposed impervious areas were the same. The MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes, could not be calculated.
- According to the GDOT Policy on Post-Construction BMPs (section 1.2 Post-Construction BMP Exclusions), under the Outfall Level Exclusions, number 6 states that whereby the net impervious surface area within that outfall's drainage area has been reduced or remains the same as pre-developed conditions, post-construction stormwater requirements will not apply.

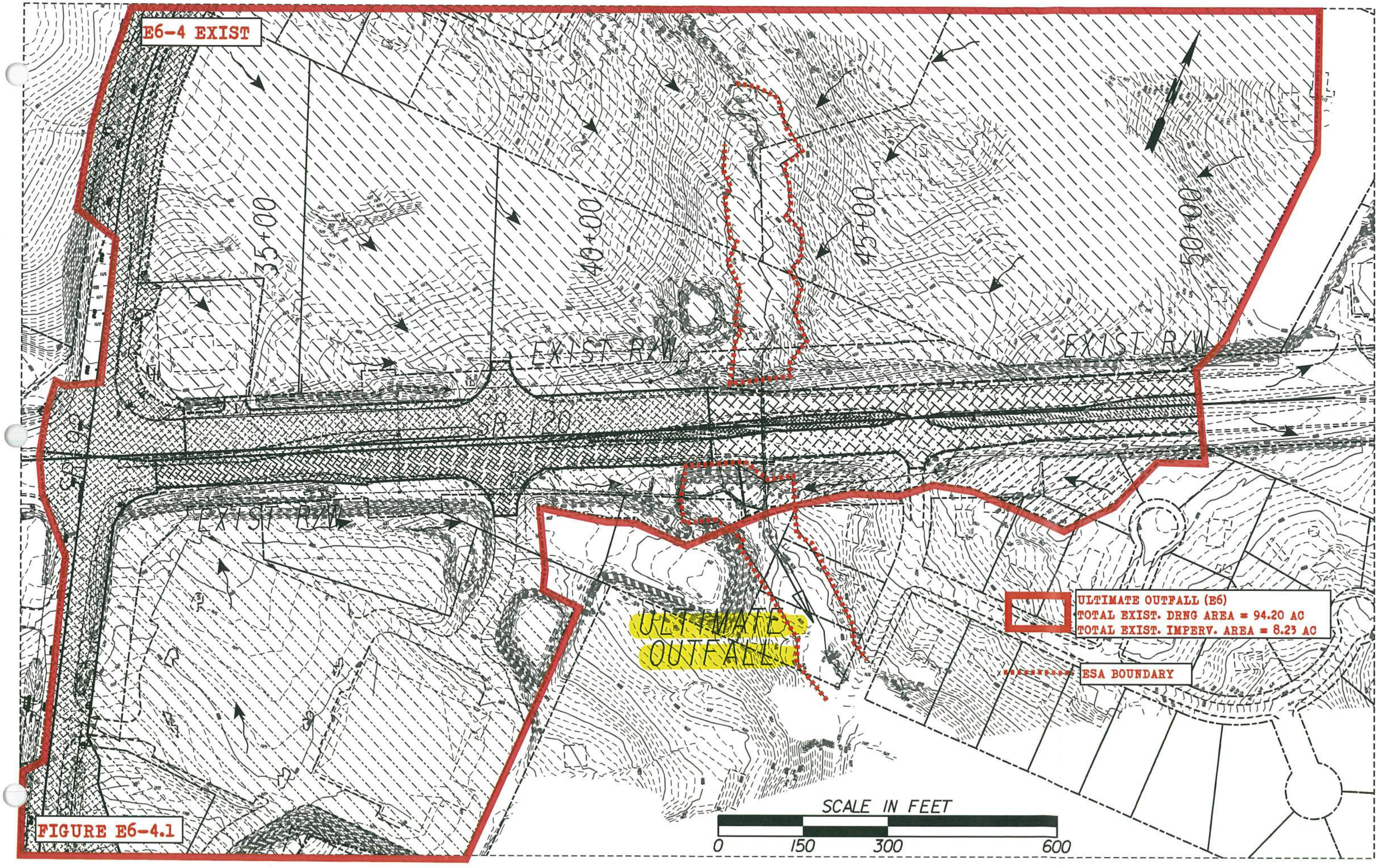

E6-4 EXIST
35+00
40+00
45+00
50+00
EXIST RXW
EXIST RXW
EXIST RXW
SR 120
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL EXIST. DRNG AREA = 94.20 AC
TOTAL EXIST. IMPERV. AREA = 8.23 AC
ESA BOUNDARY
SCALE IN FEET
0
150
300
600

FIGURE E6-4.1

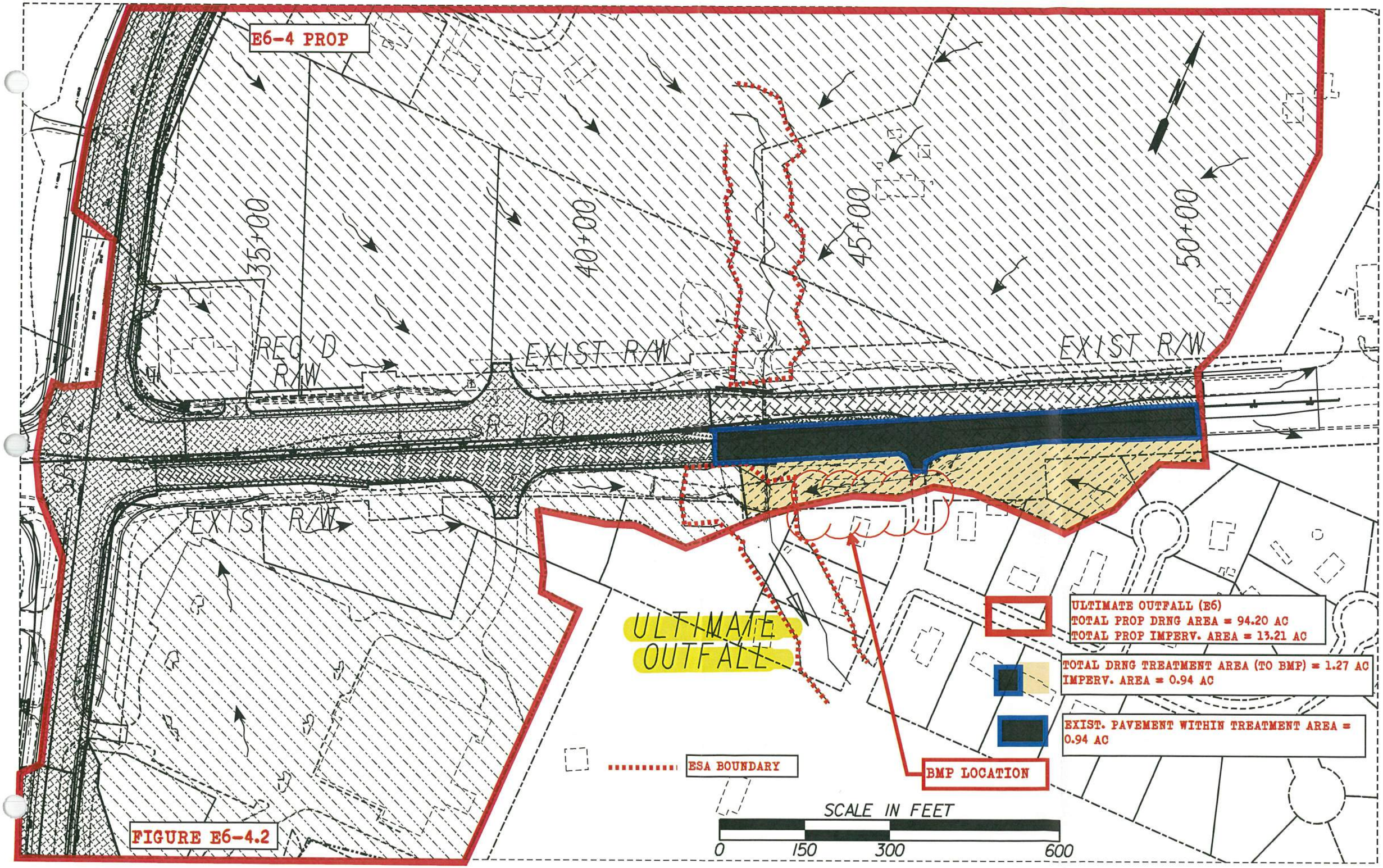

E6-4 PROP
35+00
40+00
45+00
50+00
REQ'D R/W
EXIST R/W
EXIST R/W
SR-120
EXIST R/W
ULTIMATE OUTFALL
ULTIMATE OUTFALL (E6)
TOTAL PROP DRNG AREA = 94.20 AC
TOTAL PROP IMPERV. AREA = 13.21 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 1.27 AC
IMPERV. AREA = 0.94 AC
EXIST. PAVEMENT WITHIN TREATMENT AREA = 0.94 AC
ESA BOUNDARY
BMP LOCATION
SCALE IN FEET
0
150
300
600

FIGURE E6-4.2

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin F-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin F1 was located and the existing and proposed basin drainage areas were delineated (See Figure F-1.1 and Figure F-1.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	8,083	8,083
Quantity	Channel Protection, CP_v	9,477	17,560
	Overbank Flood Protection, Q_{p25}	6,735	14,818
	Extreme Flood Protection, Q_{f100}	8,446	16,529

- The total area draining to the MS4 BMP is 3.54 Ac. The total impervious area is 2.72 Ac. The existing pavement area for the site is 0.86 Ac. The area required for storage and quantity management is 2.69 Ac (See Figure F-1.3).
- The flow produced by the existing paved area of 0.86 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 55' and minimum length of 135' (See Figure F-1.4). The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure F-1.4).
- Modifications to the drainage design by the addition of ditches and pipes will be necessary to direct the treatment flow into the BMP and to separate the bypass flow (See Figure F-1.5).
- The BMP construction cost is 15.4% of the roadway construction cost within this basin making this basin infeasible (See Figure F-1.6).
- None of the other infeasibility criteria apply to this basin.

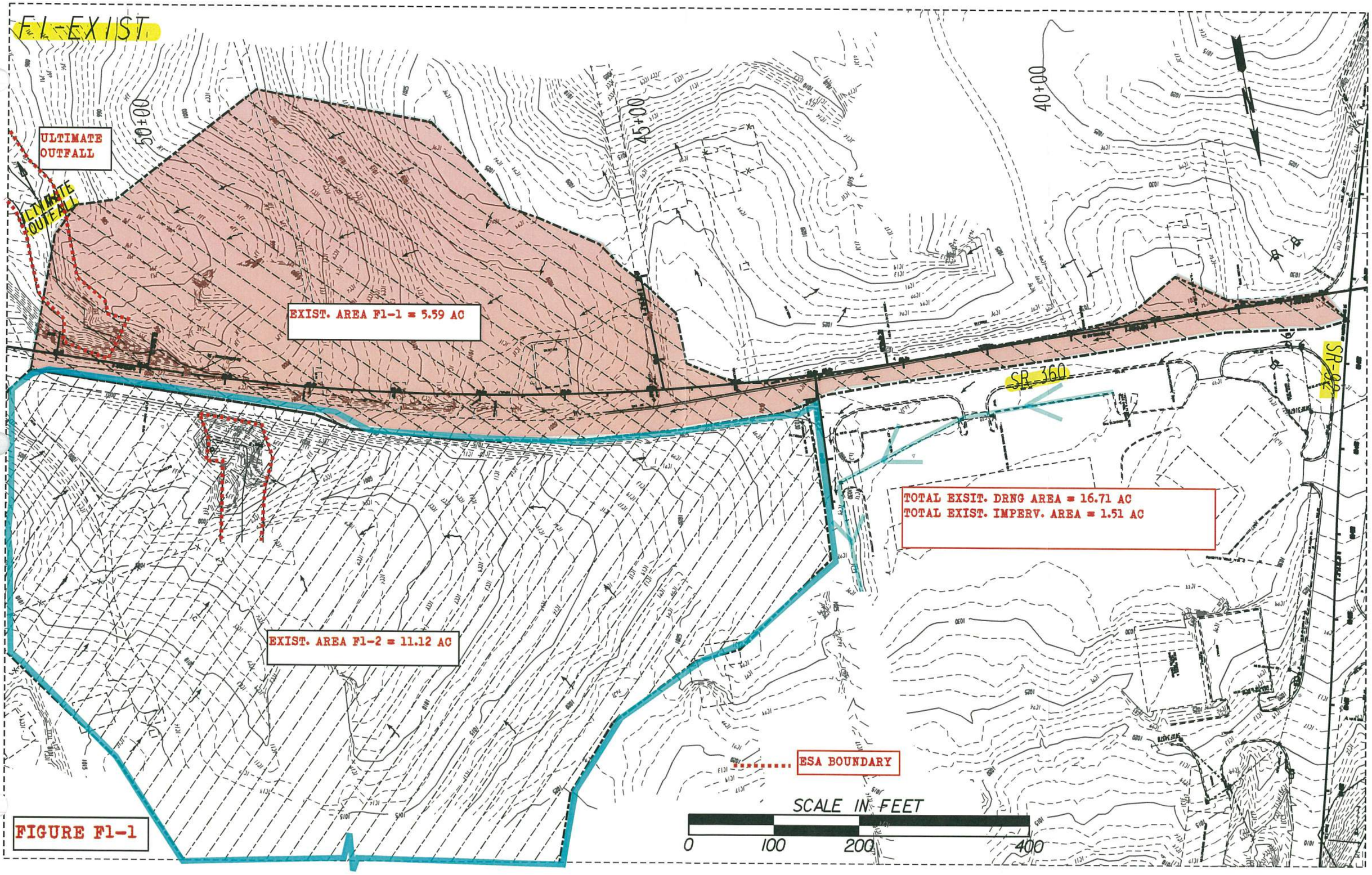

F1-EXIST
ULTIMATE OUTFALL
ULTIMATE OUTFALL
50+00
45+00
40+00
EXIST. AREA F1-1 = 5.59 AC
EXIST. AREA F1-2 = 11.12 AC
SR 360
SR-92
TOTAL EXSIT. DRNG AREA = 16.71 AC
TOTAL EXIST. IMPERV. AREA = 1.51 AC
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE F1-1

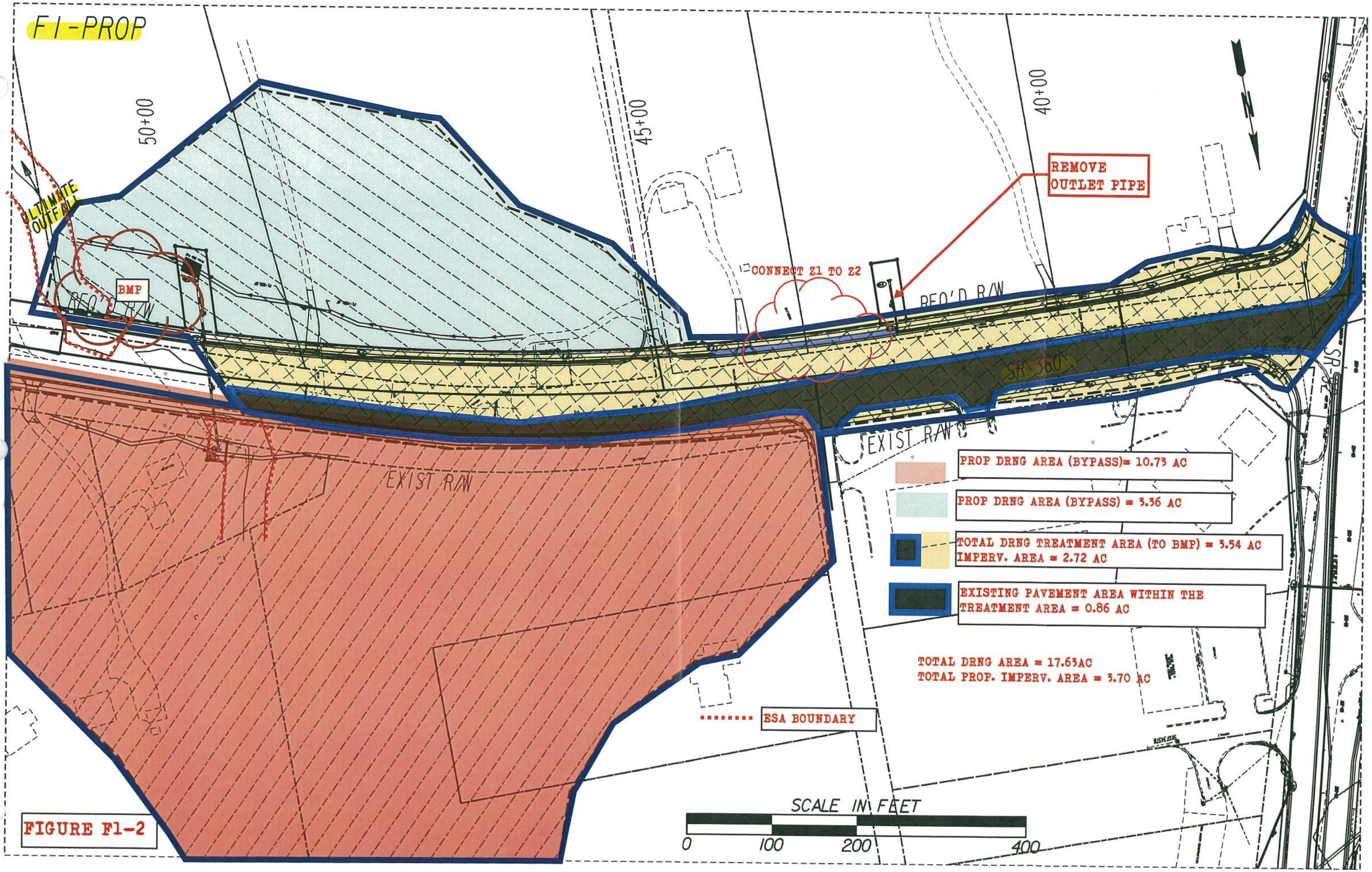

F1-PROP
50+00
45+00
40+00
ULTIMATE OUTFALL
BMP
REQ'D R/W
CONNECT Z1 TO Z2
REMOVE OUTLET PIPE
REQ'D R/W
SR 380
SR 37
EXIST R/W
EXIST R/W
PROP DRNG AREA (BYPASS)= 10.73 AC
PROP DRNG AREA (BYPASS) = 3.36 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 3.54 AC
IMPERV. AREA = 2.72 AC
EXISTING PAVEMENT AREA WITHIN THE TREATMENT AREA = 0.86 AC
TOTAL DRNG AREA = 17.63AC
TOTAL PROP. IMPERV. AREA = 3.70 AC
ESA BOUNDARY
SCALE IN FEET
0
100
200
400

FIGURE F1-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: F1

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov. 2014
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	16.71
Impervious Area =	1.51
Pervious Area=	15.2

(F1-1 & F1-2)

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	73

Time of Concentration (See Table A) = 0.20 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

= 18.58 AC
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.723

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.215	0.22
$I_a/P_{10\text{-}yr}$=	0.131	0.13
$I_a/P_{25\text{-}yr}$=	0.112	0.11
$I_a/P_{100\text{-}yr}$=	0.091	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.62

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.11
$Q_{d\ 10\text{-}yr}$=	2.73
$Q_{d\ 25\text{-}yr}$=	3.54
$Q_{d\ 100\text{-}yr}$ =	4.79

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	750
$q_{u10\text{-}yr}$=	785
$q_{u25\text{-}yr}$=	790
$q_{u100\text{-}yr}$=	800

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	21.77
$Q_{p10\text{-}yr}$=	56.05
$Q_{p25\text{-}yr}$=	72.93
$Q_{p100\text{-}yr}$=	100.04

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	17.63
Impervious Area =	3.7
Pervious Area =	13.93
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.20 hr
** See Table 2.1.5-1 Georgia Stormwater Management Manual*
Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i * (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*
*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.609

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.181	0.18
$I_a/P_{10\text{-}yr}$=	0.110	0.11
$I_a/P_{25\text{-}yr}$=	0.094	0.1
$I_a/P_{100\text{-}yr}$=	0.077	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.04

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.31
$Q_{d\ 10\text{-}yr}$=	3.03
$Q_{d\ 25\text{-}yr}$=	3.87
$Q_{d\ 100\text{-}yr}$ =	5.16

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	760
$q_{u10\text{-}yr}$=	790
$q_{u25\text{-}yr}$=	800
$q_{u100\text{-}yr}$=	800

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	27.35
$Q_{p10\text{-}yr}$=	65.99
$Q_{p25\text{-}yr}$=	85.22
$Q_{p100\text{-}yr}$=	113.77

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	3.54	Acre
Total Impervious Area - A_{POST}	2.72	Acre
Existing Pavement Area - A_{PRE} (5)	0.86	Acre
Area Required for Quantity - A_{QUAN} (4)	2.69	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
3.54	0.53	52.68	0.00	0.524	0.186	8,083

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)
(2) See GSMM section 1.4
(3) $R_v = 0.05 + 0.009\ (I)$
I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.856	0.16	0.134	5,857

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 6,735

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion
qo/qi: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.189	8,241

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 9,477

(1) See GSMM page 1.3.2.2 for Channel Protection discussion
qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.879	0.15	0.169	7,344

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 8,446

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion
qo/qi: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$
Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ (See GSMM Page 2.2-9)
A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure F-1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: F1

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	8,083	8,083
CP_v	9,477	17,560
Q_{p25}	6,735	14,818
Q_{f100}	8,446	16,529

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	2285	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	17566	ft^3	>	17560	ft^3

Swale Dimensions:

A swale that is 2285 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	17,560	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **1,001** ft^2

Actual Filter Bed Dimensions:	Width	24	ft
	Length	44	ft
		1056	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **1159** ft^2

Actual Sediment Chamber Dimensions:	Width	24	ft
	Length	49	ft
		1176	ft^2

Bioretention Area

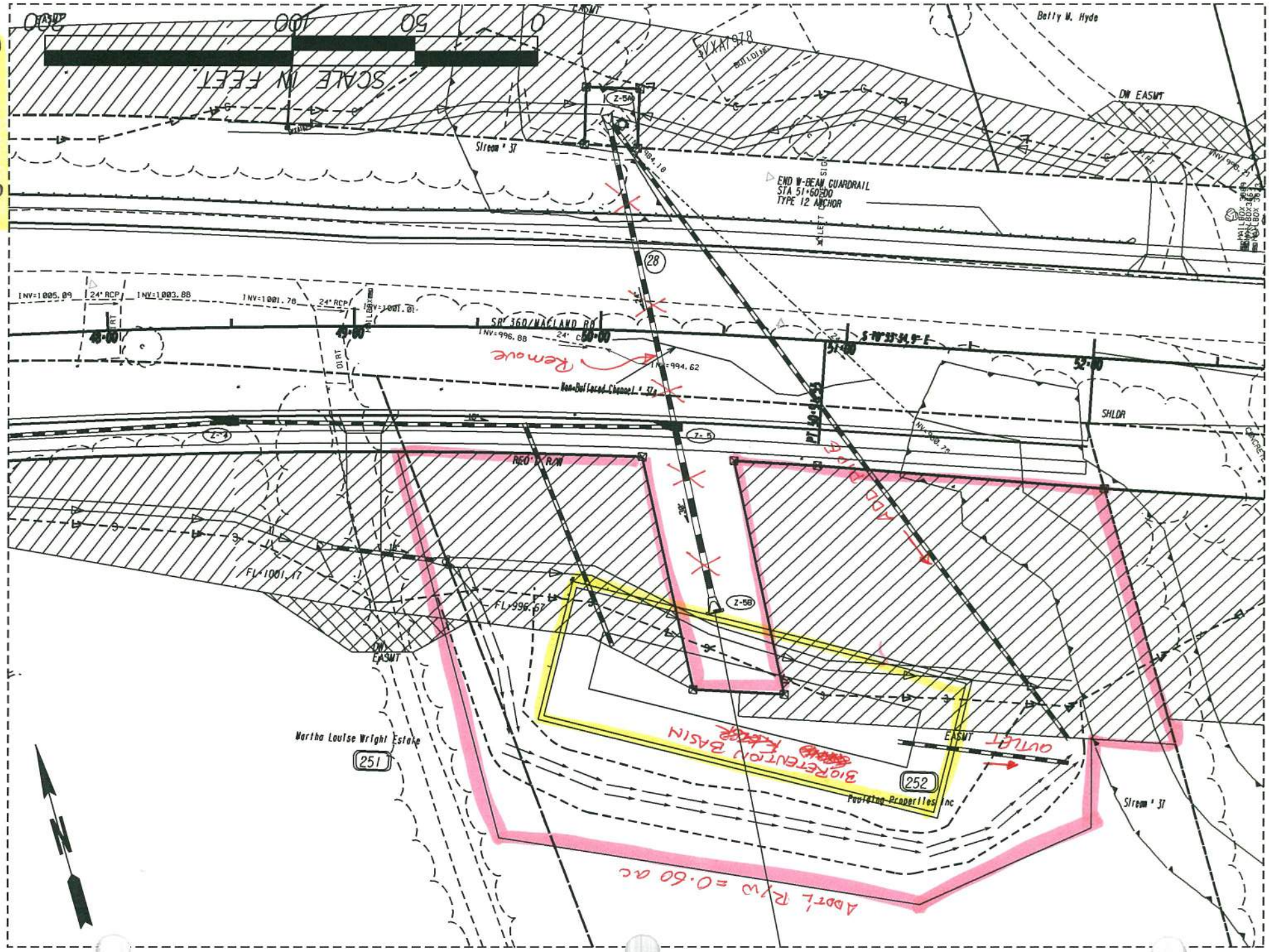
CP_v	=	17,560	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **7,394** ft^2

Actual Filter Bed Dimensions:	Width	135	ft
	Length	55	ft
		7425	ft^2

Figure F.1.b


SCALE IN FEET
0 50 100 200
Betty W. Hyde
DW EASWT
Stream # 3T
END W-BEAM GUARDRAIL
STA 51+60.00
TYPE 12 ANCHOR
INV=1005.09
24" RCP
INV=1003.88
INV=1001.78
24" RCP
INV=1001.01
SR 360/MACLAND RD
INV=996.88
24" CMP
INV=994.62
Non-Delineated Channel # 3T
Remove
S 10°35'34.9" E
SHLDR
REQ'D R/W
FL=1001.17
FL=996.67
DW EASWT
Martha Louise Wright Estate
251
252
EASWT
Poulsbo Properties Inc
Stream # 3T
Add R/W
Bioretention Basin
Outlet
Addl R/W = 0.60 ac

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin F1

Basin F1 700 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 204,875.00	$ 70,000.00	$ 25,000.00	$ 35,000.00
Utilities ✪	$ 53,661.74	$ -	$ -	$ -
Construction ✪	$ 457,326.90	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 7,500.00	$ 3,000.00	$ 4,000.00
Grading	$ -	$ 15,000.00	$ 7,200.00	$ 4,200.00
Drainage	$ -	$ 100,118.92	$ 76,233.00	$ 67,094.00
Total	$ 715,863.63	$ 192,618.92	$ 111,433.00	$ 110,294.00
	Percent of BMP Cost to Total	**26.9%**	**15.6%**	**15.4%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		1.25
Sub Total:	$	62,500.00
Residential Relocation Cost	$	40,000.00
		2
Sub Total:	$	80,000.00
Residential Perm Easmt @	$	25,000.00
		2.07
Sub Total:	$	51,750.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0.17
Sub Total:	$	10,625.00
Right of Way Cost Total:	$	204,875.00

✪ See General Summary Explaination for Cost Method

Figure F-1.6

Figure F-1.7

BMP Construction Cost Worksheet — Basin F1

Dry Enhanced Swale

Length:	2285	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	1.3	Ac	
Total:	$ 65,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2	Ac	
Total:	$ 5,000.00		
Sub Total:	$ 70,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
1.5	Disturbed Ac	
$ 7,500.00		

Grading

Cut	Fill	
850.000	1650.000	
$ 6.00	per CY	
Total: $ 15,000.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA	
	1	EA		2	EA	
	$ 2,300.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1693	CY	$ 30.00	$ 37,613.17
Uddrn Sys w/ Gravel	-	2315	LF	$ 20.00	$ 46,300.00
Additional Pipe	18	100	LF	$ 52.00	$ 5,200.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	127	SY		127	SY	
	$ 7,302.50			$ 603.25		

Sub Total: $100,118.92

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	44	49	ft
Width:	24	24	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.4	Ac	
Total:	$ 20,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2	Ac	
Total:	$ 5,000.00		
Sub Total:	$ 25,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.6	Disturbed Ac	
$ 3,000.00		

Grading

Cut	Fill	
300.000	900.000	
$ 6.00	per CY	
Total: $ 7,200.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Sand	-	58.67	CY	$ 45.00	$ 2,640.00
Uddrn Sys w/ Gravel	-	157	LF	$ 20.00	$ 3,140.00
Top Soil		10	CY	$ 20.00	$ 200.00
Outlet Pipe	18"	290	LF	$ 43.00	$ 12,470.00
Imperm Geotextile	-	1056	SF	$ 5.00	$ 5,280.00
Dist Wall Conc/Steel	-	5	CY	$ 1,020.00	$ 5,100.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	588	SY		588	SY	
	$ 33,810.00			$ 2,793.00		

Sub Total: $ 76,233.00

Bioretention Area

Length:	135	ft
Width:	55	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.6	Ac	
Total:	$ 30,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2	ea	
Total:	$ 5,000.00		
Sub Total:	$ 35,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.8	Disturbed Ac	
$ 4,000.00		

Grading

Cut	Fill	
250.000	450.000	
$ 6.00	per CY	
Total: $ 4,200.00		

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA	
	2	EA		2	EA	
	$ 10,000.00			$ 800.00		

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	550	CY	$ 30.00	$ 16,500.00
Uddrn Sys w/ Gravel	-	247.5	LF	$ 20.00	$ 4,950.00
Mulch	-	825	SY	$ 15.00	$ 12,375.00
Additional Pipe	18"	220	LF	$ 43.00	$ 9,460.00
Outlet Pipe	18"	70	LF	$ 43.00	$ 3,010.00
Shrubs	-	32	EA	$ 30.00	$ 960.00
Ground Cover	-	88	EA	$ 15.00	$ 1,320.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY	
	124	SY		124	SY	
	$ 7,130.00			$589.00		

Sub Total: $ 67,094.00

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(02S)

November 17, 2014
Designed By: FA
Checked By: SGF 11-19-14

Basin F-2 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin F2 was located and the existing and proposed basin drainage areas were delineated (See Figure F-2.1 and Figure F-2.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	2,211	2,211
Quantity	Channel Protection, CP_v	4,786	6,997
	Overbank Flood Protection, Q_{p25}	3,100	5,311
	Extreme Flood Protection, Q_{f100}	4,024	6,235

- The total area draining to the MS4 BMP is 1.87 Ac. The total impervious area is 1.10 Ac. The existing pavement area for the site is 0.64 Ac. The area required for storage and quantity management is 1.23 Ac (See Figure F-2.3).
- The flow produced by the existing paved area of 0.64 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a surface sand filter with a bottom width of 15' and minimum length of 99' (See Figure F-2.4). The surface sand filter was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure F-2.4). The area from approximately station 58+00 to the end of construction doesn't need water quality treatment because no new pavement was added.
- The BMP construction cost is 11.9% of the roadway construction cost within this basin making this basin infeasible (See Figure F-2.6).
- None of the other infeasibility criteria apply to this basin.

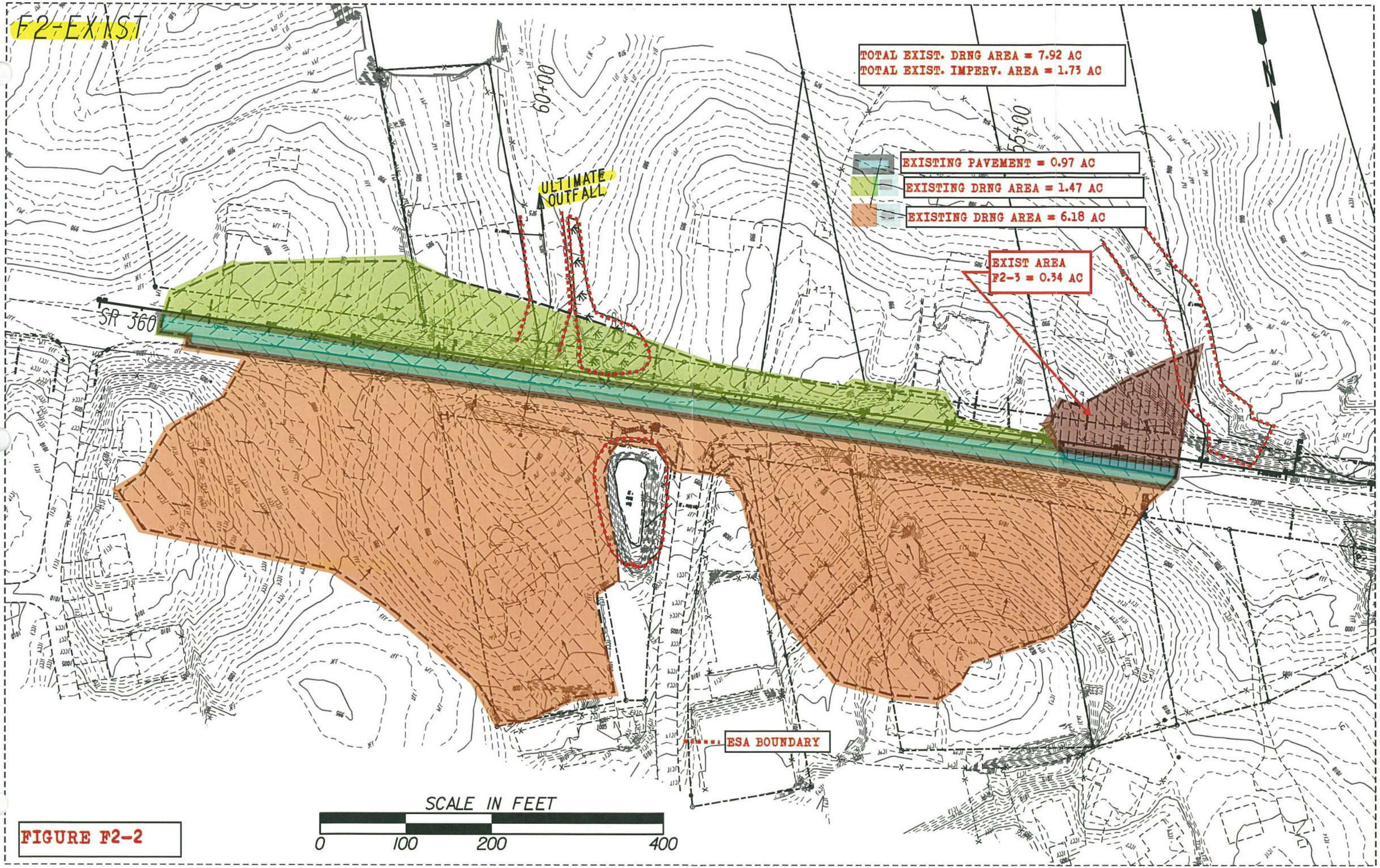

F2-EXIST
TOTAL EXIST. DRNG AREA = 7.92 AC
TOTAL EXIST. IMPERV. AREA = 1.73 AC
EXISTING PAVEMENT = 0.97 AC
EXISTING DRNG AREA = 1.47 AC
EXISTING DRNG AREA = 6.18 AC
EXIST AREA
F2-3 = 0.34 AC
ULTIMATE OUTFALL
60+00
55+00
SR 360
ESA BOUNDARY
N
SCALE IN FEET
0
100
200
400

FIGURE F2-2

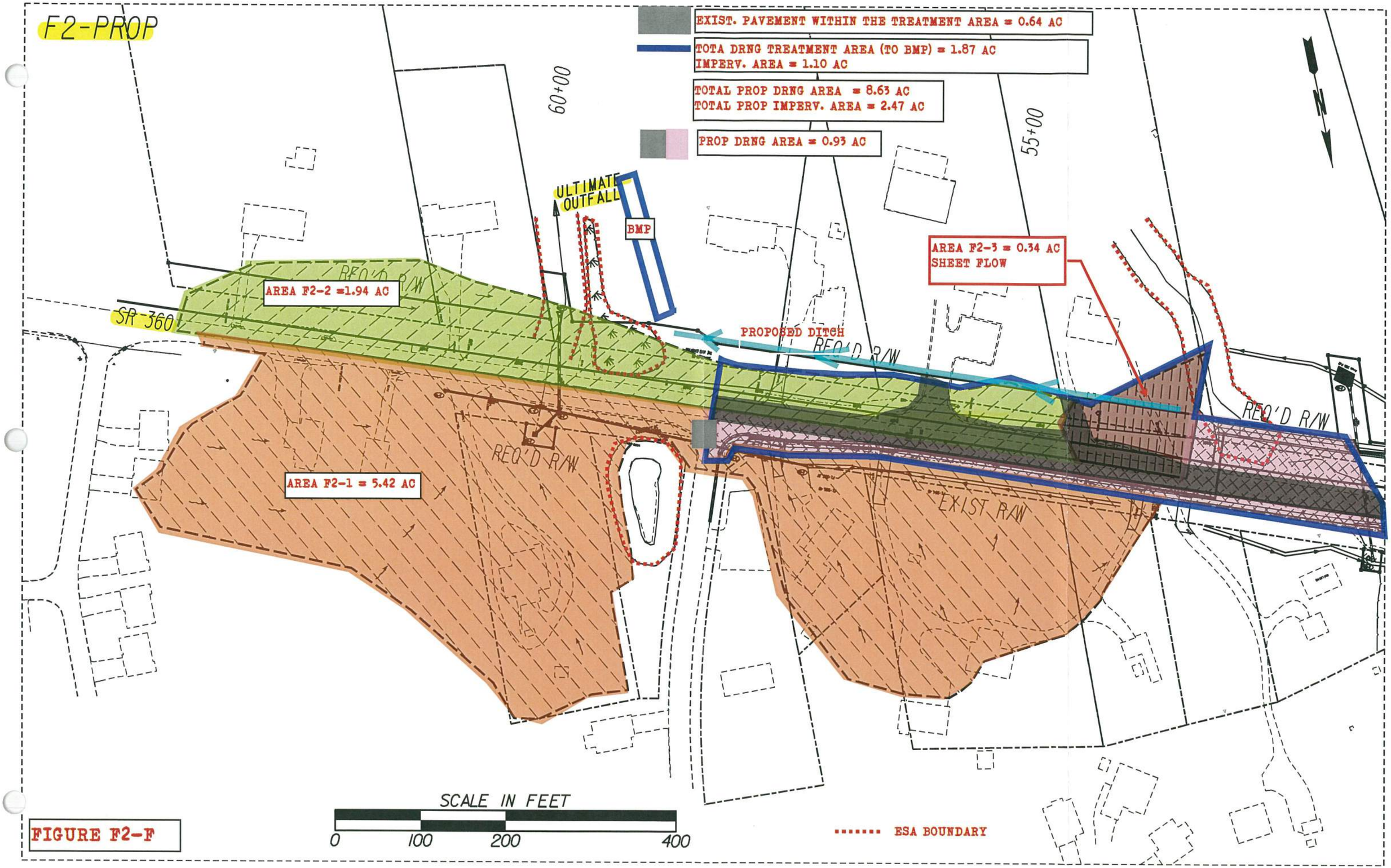

F2-PROP
EXIST. PAVEMENT WITHIN THE TREATMENT AREA = 0.64 AC
TOTA DRNG TREATMENT AREA (TO BMP) = 1.87 AC
IMPERV. AREA = 1.10 AC
TOTAL PROP DRNG AREA = 8.63 AC
TOTAL PROP IMPERV. AREA = 2.47 AC
PROP DRNG AREA = 0.93 AC
60+00
55+00
ULTIMATE OUTFALL
BMP
AREA F2-3 = 0.34 AC
SHEET FLOW
AREA F2-2 =1.94 AC
REQ'D R/W
SR 360
PROPOSED DITCH
REQ'D R/W
REQ'D R/W
AREA F2-1 = 5.42 AC
EXIST R/W
SCALE IN FEET
0
100
200
400
ESA BOUNDARY

FIGURE F2-F

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: F2 (AREAS F2-1, 2-2, 2-4)

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Jun-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)		
Total Area (ac) =	7.92	(F2-1 & F2-2)
Impervious Area =	1.73	(EXIST)
Pervious Area=	6.19	

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	77

Time of Concentration (See Table A) = 0.13 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch) **
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.601

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.179	0.18
$I_a/P_{10\text{-}yr}$=	0.109	0.11
$I_a/P_{25\text{-}yr}$=	0.093	0.1
$I_a/P_{100\text{-}yr}$=	0.076	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 3.00

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.32
$Q_{d\ 10\text{-}yr}$=	3.05
$Q_{d\ 25\text{-}yr}$=	3.89
$Q_{d\ 100\text{-}yr}$ =	5.19

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	900
$q_{u10\text{-}yr}$=	930
$q_{u25\text{-}yr}$=	925
$q_{u100\text{-}yr}$=	925

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	14.71
$Q_{p10\text{-}yr}$=	35.15
$Q_{p25\text{-}yr}$=	44.54
$Q_{p100\text{-}yr}$=	59.40

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	8.63
Impervious Area =	2.47
Pervious Area =	6.16
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	79

Time of Concentration (See Table A) = 0.13 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.540

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.161	0.16
$I_a/P_{10\text{-}yr}$=	0.098	0.1
$I_a/P_{25\text{-}yr}$=	0.083	0.1
$I_a/P_{100\text{-}yr}$=	0.068	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 2.70

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.44
$Q_{d\ 10\text{-}yr}$=	3.23
$Q_{d\ 25\text{-}yr}$=	4.08
$Q_{d\ 100\text{-}yr}$ =	5.40

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	890
$q_{u10\text{-}yr}$=	925
$q_{u25\text{-}yr}$=	925
$q_{u100\text{-}yr}$=	925

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	17.28
$Q_{p10\text{-}yr}$=	40.26
$Q_{p25\text{-}yr}$=	50.92
$Q_{p100\text{-}yr}$=	67.38

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	1.87	Acre
Total Impervious Area - A_{POST}	1.10	Acre
Existing Pavement Area - A_{PRE} (5)	0.64	Acre
Area Required for Quantity - A_{QUAN} (4)	1.23	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v(3)	WQ_v (ac-ft)	WQ_v (ft³)
1.87	0.25	24.60	0.00	0.271	0.051	2,211

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x {(Impervious area Post - Impervious area Pre) / Total area}

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.875	0.15	0.062	2,696

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 3,100

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.025	0.65	0.096	4,161

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,786

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.882	0.15	0.080	3,498

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,024

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure F-2.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: F2

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	2,211	2,211
CP_v	4,786	6,997
Q_{p25}	3,100	5,311
Q_{f100}	4,024	6,235

Dry Enhanced Swale

Average Depth	=	0.75	ft
Length	=	911	ft
Width	=	8	ft
Left Side Slope	=	3	:1
Right Side Slope	=	3	:1
Area	=	7.6875	ft^2
Slope	=	0.01	ft/ft
Storage Volume	=	7003	ft^3 > 6997 ft^3

Swale Dimensions:

A swale that is 911 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	6,997	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **399** ft^2

Actual Filter Bed Dimensions: Width 15 ft; Length 28 ft; 420 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **462** ft^2

Actual Sediment Chamber Dimensions: Width 15 ft; Length 31 ft; 465 ft^2

Bioretention Area

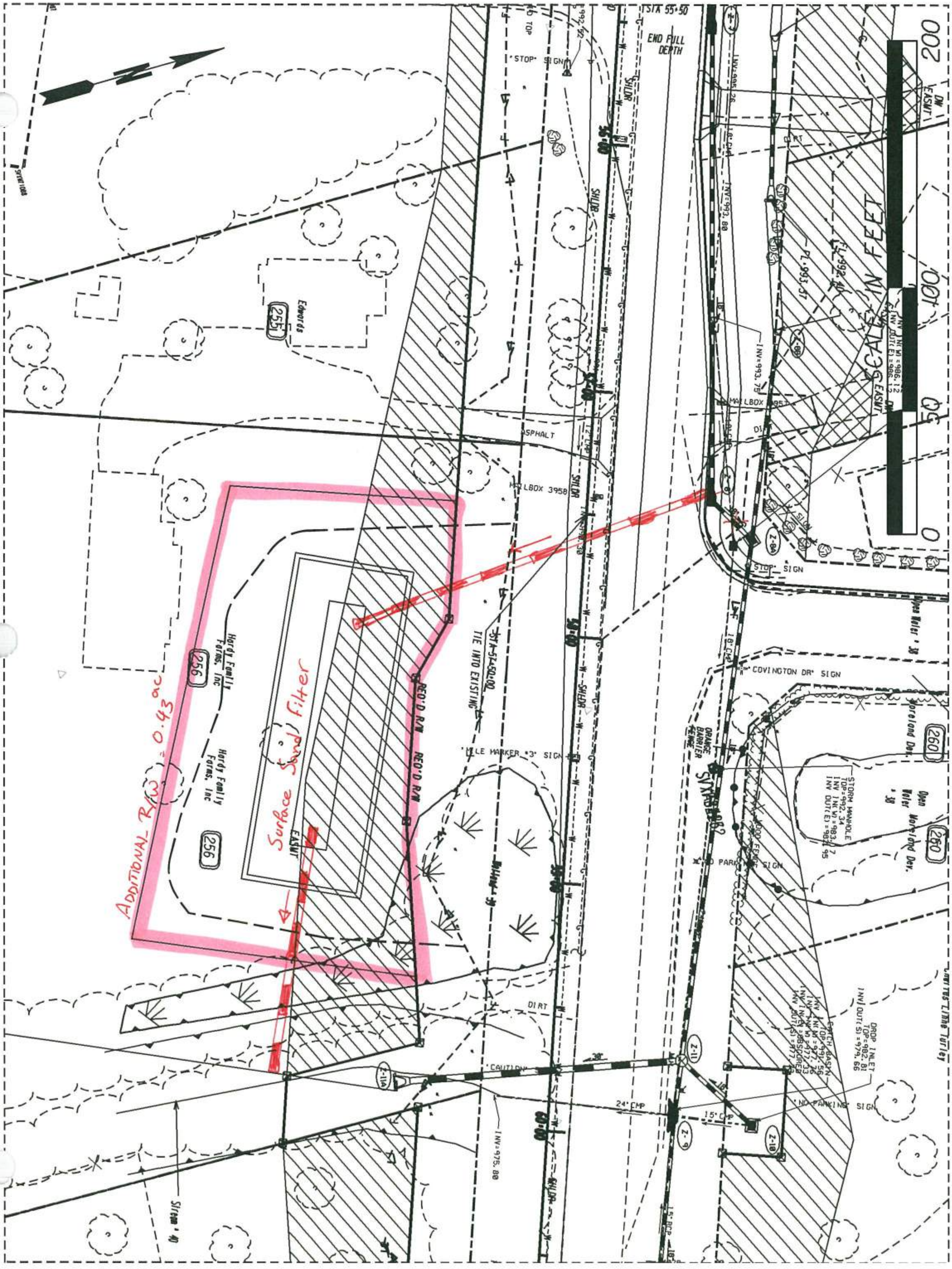
CP_v	=	6,997	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **2,946** ft^2

Actual Filter Bed Dimensions: Width 130 ft; Length 23 ft; 2990 ft^2

Figure F-2.5


ADDITIONAL R/W = 0.43 ac
Surface Sand Filter
SCALE IN FEET
0
50
100
200
END FULL DEPTH
TIE INTO EXISTING
REQ'D R/W
Hardy Family Farms, Inc
Edwards
COVINGTON DR SIGN
STOP SIGN
DROP INLET
STORM MANHOLE
24" CMP
15" CMP
DIRT
ASPHALT

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin F2

Basin F2 650 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 111,750.00	$ 80,000.00	$ 18,250.00	$ 30,000.00
Utilities ✪	$ 49,828.76	$ -	$ -	$ -
Construction ✪	$ 424,660.69	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,000.00	$ 2,150.00	$ 3,500.00
Grading	$ -	$ 10,200.00	$ 4,800.00	$ 4,500.00
Drainage	$ -	$ 51,790.63	$ 44,578.13	$ 38,242.50
Total	$ 586,239.45	$ 145,990.63	$ 69,778.13	$ 76,242.50
	Percent of BMP Cost to Total	**24.9%**	**11.9%**	**13.0%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0.77
Sub Total:	$	38,500.00
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		1.73
Sub Total:	$	43,250.00
Commercial Right of Way @	$	125,000.00
		0.17
Sub Total:	$	21,250.00
Commercial Perm Easmt @	$	62,500.00
		0.14
Sub Total:	$	8,750.00
Right of Way Cost Total:	$	111,750.00

✪ See General Summary Explaination for Cost Method

Figure F-2.6

Figure F-2.7

BMP Construction Cost Worksheet Basin F2

Dry Enhanced Swale

Length:	911	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.8	Ac	
Total:	$ 40,000.00		
Residential Relocation Cost @	$ 40,000.00	each	
	1	ea	
Total:	$ 40,000.00		
Sub Total:	$ 80,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.8 Disturbed Ac
$ 4,000.00

Grading

Cut	Fill
450.000	1250.000

$ 6.00 per CY
Total: $ 10,200.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	675	CY	$ 30.00	$ 14,995.88
Uddrn Sys w/ Gravel	-	941	LF	$ 20.00	$ 18,820.00
Additional Pipe	18	225	LF	$ 52.00	$ 11,700.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	51	SY		51	SY
	$ 2,932.50			$ 242.25	

Sub Total: $ 51,790.63

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	28	31	ft
Width:	15	15	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.3	Ac	
Total:	$ 15,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.13	Ac	
Total:	$ 3,250.00		
Sub Total:	$ 18,250.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.43 Disturbed Ac
$ 2,150.00

Grading

Cut	Fill
350.000	450.000

$ 6.00 per CY
Total: $ 4,800.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	23.33	CY	$ 45.00	$ 1,050.00
Uddrn Sys w/ Gravel	-	116	LF	$ 20.00	$ 2,320.00
Top Soil		4	CY	$ 20.00	$ 80.00
Outlet Pipe	18"	225	LF	$ 43.00	$ 9,675.00
Imperm Geotextile	-	420	SF	$ 5.00	$ 2,100.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	232.5	SY		232.5	SY
	$ 13,368.75			$ 1,104.38	

Sub Total: $ 44,578.13

Bioretention Area

Length:	130	ft
Width:	23	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.5	Ac	
Total:	$ 25,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.2	ea	
Total:	$ 5,000.00		
Sub Total:	$ 30,000.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.7 Disturbed Ac
$ 3,500.00

Grading

Cut	Fill
350.000	400.000

$ 6.00 per CY
Total: $ 4,500.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	222	CY	$ 30.00	$ 6,660.00
Uddrn Sys w/ Gravel	-	103.5	LF	$ 20.00	$ 2,070.00
Mulch	-	333	SY	$ 15.00	$ 4,995.00
Additional Pipe	18"	150	LF	$ 43.00	$ 6,450.00
Outlet Pipe	18"	75	LF	$ 43.00	$ 3,225.00
Shrubs	-	13	EA	$ 30.00	$ 390.00
Ground Cover	-	36	EA	$ 15.00	$ 540.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	50	SY		50	SY
	$ 2,875.00			$237.50	

Sub Total: $ 38,242.50

Basin F-3 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin F3 was located and the existing and proposed basin drainage areas were delineated (See Figure F-3.1 and Figure F-3.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	3,109	3,109
Quantity	Channel Protection, CP_v	8,413	11,522
	Overbank Flood Protection, Q_{p25}	7,580	10,689
	Extreme Flood Protection, Q_{f100}	9,539	12,684

- The total area draining to the MS4 BMP is 2.03 Ac. The total impervious area is 1.31 Ac. The existing pavement area for the site is 0.63 Ac. The area required for storage and quantity management is 1.40 Ac (See Figure F-3.3).
- The flow produced by the existing paved area of 0.63 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Extreme Flood Protection Volume. Therefore a downstream hydraulic analysis is necessary.
- It was determined from that analysis that the flows would not cause a downstream increase of more than 5%; therefore detention would not be necessary. Overbank and Extreme Flood Volumes are not required (See Figure F-3.4 and F-3.5)
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 35' and minimum length of 140' (See Figure F-3.6). The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure F-3.6).
- The BMP construction cost is 12.1% of the roadway construction cost within this basin making this basin infeasible (See Figure F-3.8).
- None of the other infeasibility criteria apply to this basin.

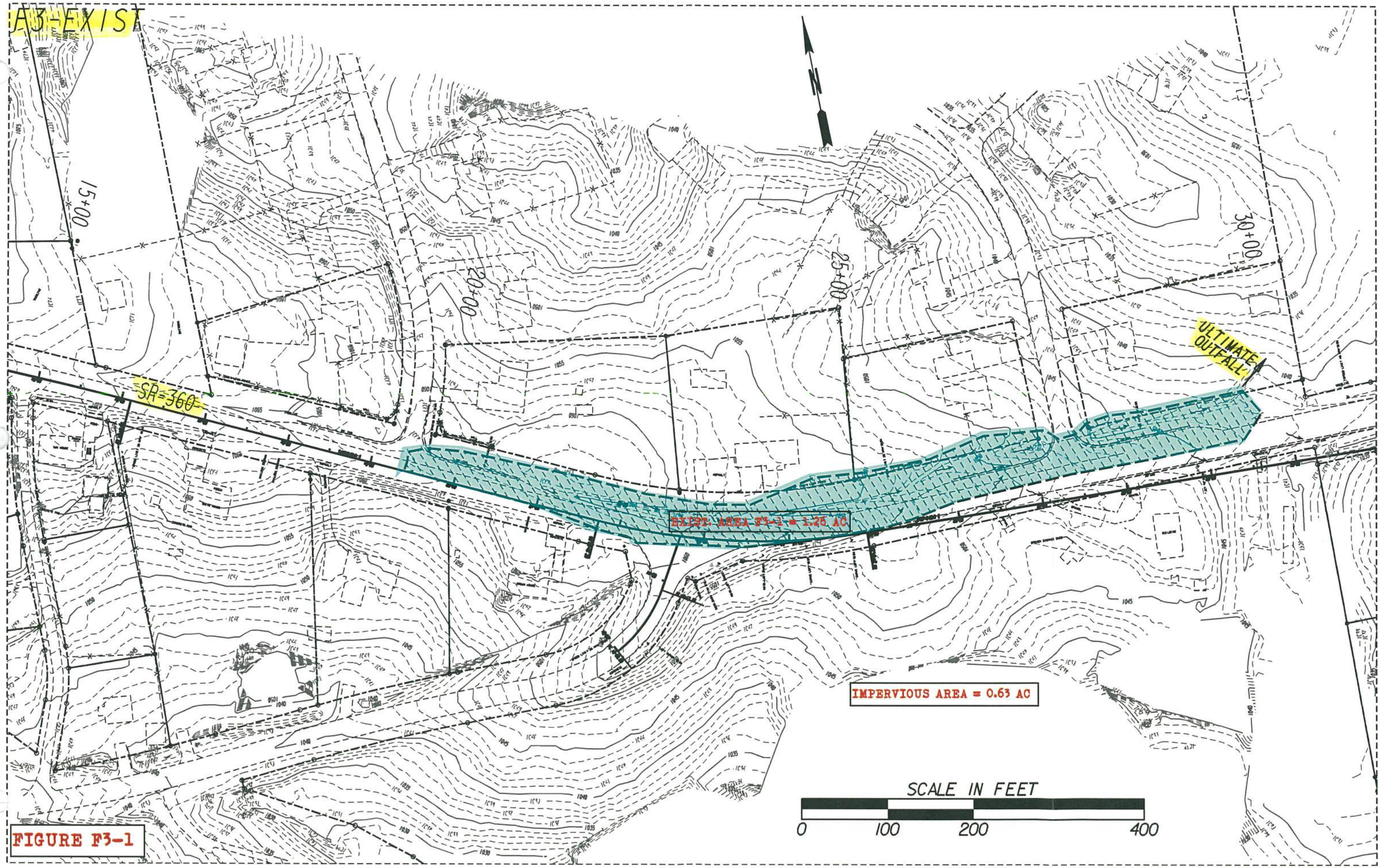

A3-EXIST
15+00
20+00
25+00
30+00
SR-360
ULTIMATE OUTFALL
EXIST. AREA F3-1 = 1.25 AC
IMPERVIOUS AREA = 0.63 AC
SCALE IN FEET
0
100
200
400

FIGURE F3-1

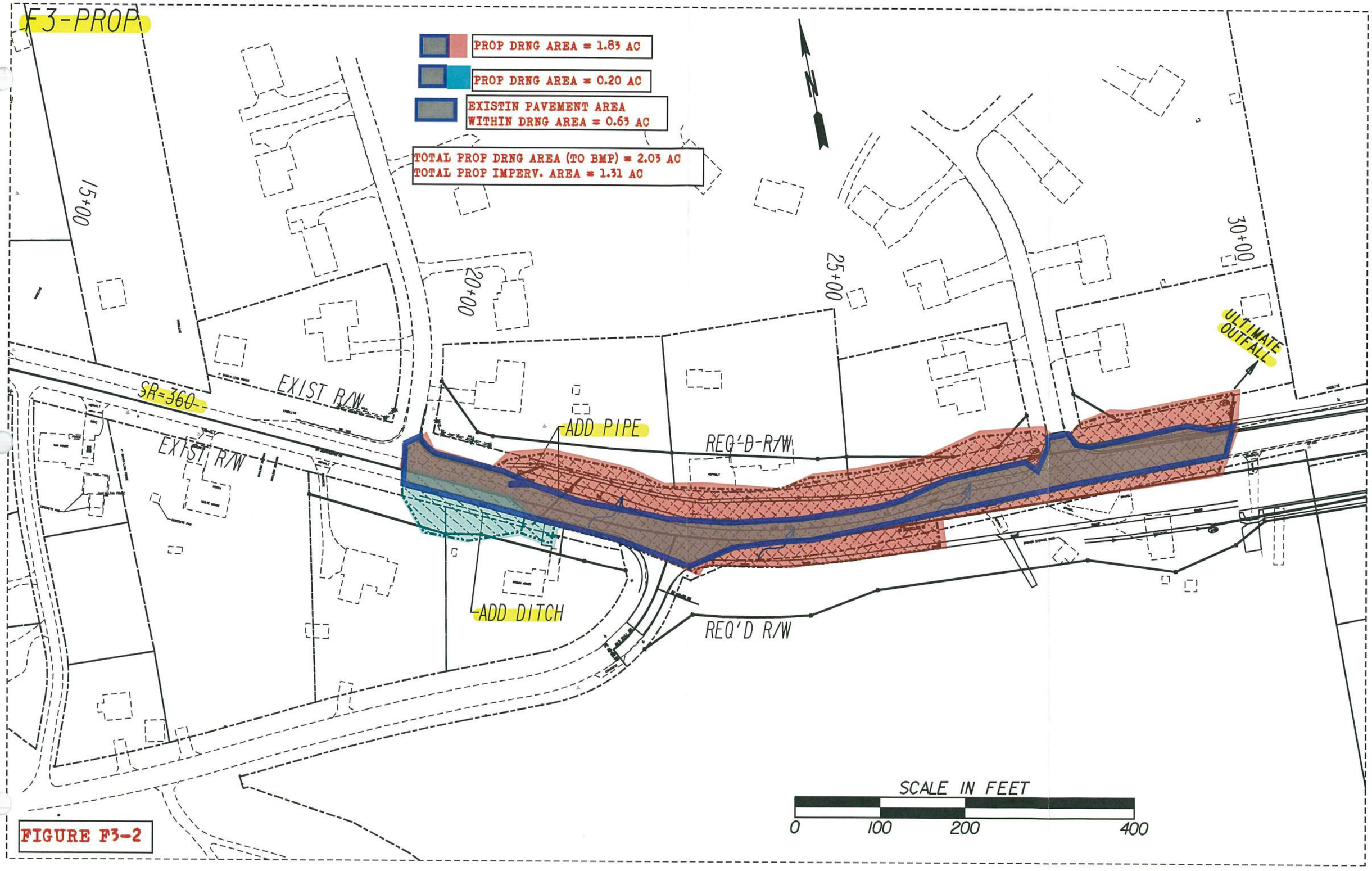

F3-PROP
PROP DRNG AREA = 1.83 AC
PROP DRNG AREA = 0.20 AC
EXISTIN PAVEMENT AREA
WITHIN DRNG AREA = 0.63 AC
TOTAL PROP DRNG AREA (TO BMP) = 2.03 AC
TOTAL PROP IMPERV. AREA = 1.31 AC
N
15+00
20+00
25+00
30+00
SR-360
EXIST R/W
EXIST R/W
ADD PIPE
REQ'D R/W
ADD DITCH
REQ'D R/W
ULTIMATE OUTFALL
SCALE IN FEET
0
100
200
400

FIGURE F3-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: F3

Unified Stormwater Sizing Criteria

PI: 621720
Jun-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	1.26
Impervious Area =	0.63
Pervious Area=	0.63

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	85

Time of Concentration (See Table A) = 0.13 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.367

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.109	0.11
$I_a/P_{10\text{-}yr}$=	0.066	0.1
$I_a/P_{25\text{-}yr}$=	0.057	0.1
$I_a/P_{100\text{-}yr}$=	0.046	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.83

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	1.86
$Q_{d\ 10\text{-}yr}$=	3.80
$Q_{d\ 25\text{-}yr}$=	4.70
$Q_{d\ 100\text{-}yr}$ =	6.08

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	935
$q_{u10\text{-}yr}$=	945
$q_{u25\text{-}yr}$=	945
$q_{u100\text{-}yr}$=	945

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	3.42
$Q_{p10\text{-}yr}$=	7.07
$Q_{p25\text{-}yr}$=	8.75
$Q_{p100\text{-}yr}$=	11.31

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	2.03
Impervious Area =	1.31
Pervious Area =	0.72
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	88

Time of Concentration (See Table A) = 0.12 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.262

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.078	0.1
$I_a/P_{10\text{-}yr}$=	0.047	0.1
$I_a/P_{25\text{-}yr}$=	0.040	0.1
$I_a/P_{100\text{-}yr}$=	0.033	0.1

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.31

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.18
$Q_{d\ 10\text{-}yr}$=	4.21
$Q_{d\ 25\text{-}yr}$=	5.14
$Q_{d\ 100\text{-}yr}$ =	6.54

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	950
$q_{u10\text{-}yr}$=	950
$q_{u25\text{-}yr}$=	950
$q_{u100\text{-}yr}$=	950

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	6.56
$Q_{p10\text{-}yr}$=	12.69
$Q_{p25\text{-}yr}$=	15.48
$Q_{p100\text{-}yr}$=	19.71

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	2.03	Acre
Total Impervious Area - A_{POST}	1.31	Acre
Existing Pavement Area - A_{PRE} (5)	0.63	Acre
Area Required for Quantity - A_{QUAN} (4)	1.40	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
2.03	0.33	33.50	0.00	0.351	0.071	3,109

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.015	0.66	0.168	7,315

(+15% ED)= 8,413

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.565	0.25	0.151	6,591

(+15% ED)= 7,580

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.574	0.25	0.190	8,295

(+15% ED)= 9,539

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\ 100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure F-3.4

November 2014

Outfall F3
10X Downstream Analysis Conclusions

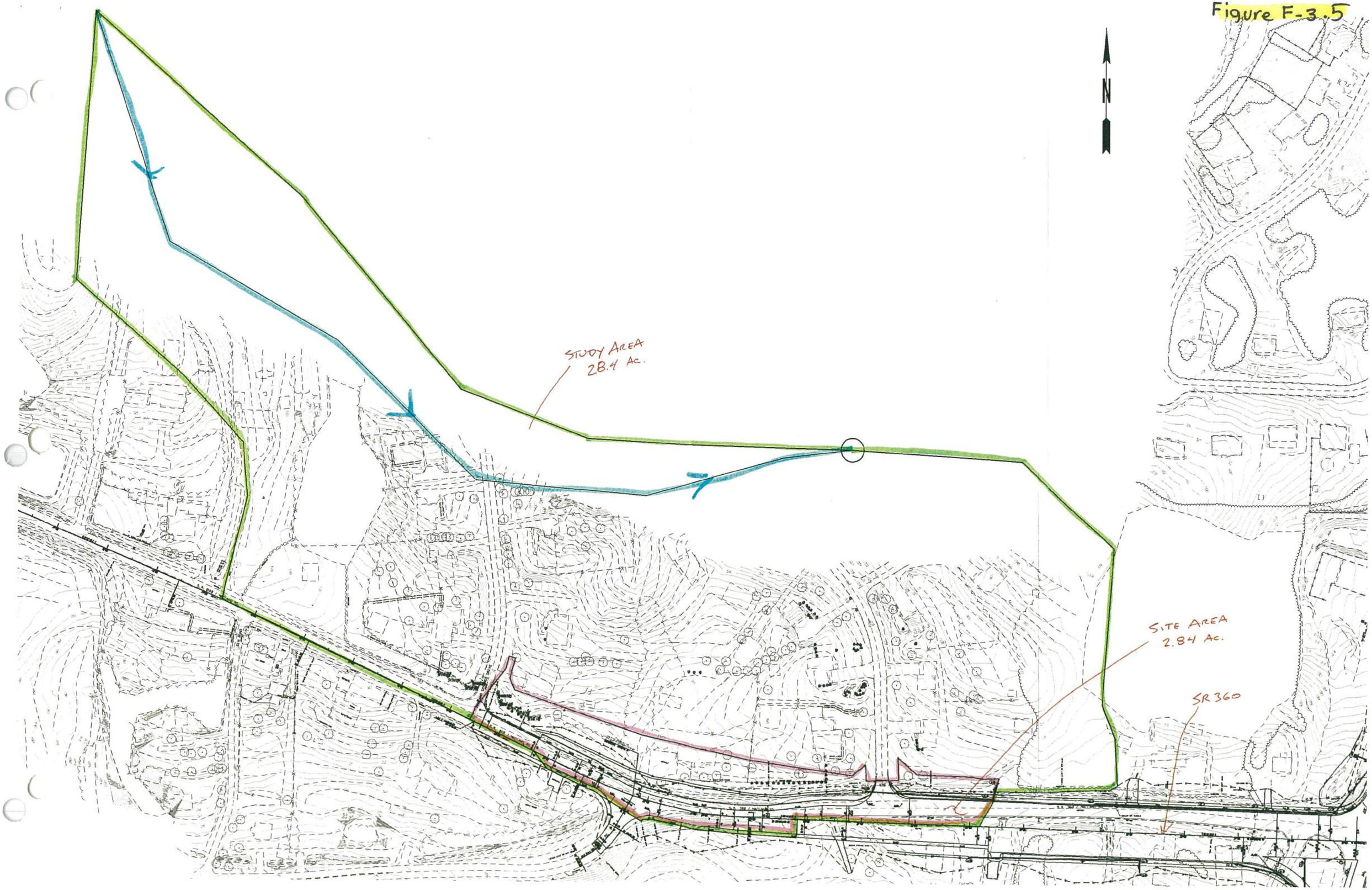
The drainage areas were delineated using a combination of the USGS quadrangle maps and the existing contours. The site area of the drainage outfall is 2.84 Ac. The 10 times watershed basin analysis area is 28.40 Ac, which is approximately 780 feet downstream of the drainage outfall. The time of concentration calculations and the curve number calculations for the downstream analysis have been included along with the hydrographs depicting the pre and post conditions of the 25 and 100 year storms.

Per GDOT requirements, Storm Detention is required when adverse impacts are caused by the post-development flow and where downstream structures are subject to increased depth of flooding. The following table summarizes the results of the downstream analysis.

Outfall F3	Storm Return Frequency	Pre-Developed Peak Discharge (cfs)	Post-Developed Peak Discharge (cfs)	Discharge Increase (cfs)	% Increase
Downstream Analysis	25	91.51	93.15	1.64	1.8
	100	118.11	120.22	2.11	1.8

The analysis of the 10X downstream conditions reflects an increase of over 5% for both the 25 and the 100 year return periods, which represent the Overbank Flood Protection and the Extreme Flood Protection, respectively. The discharge increase for both storm frequency's is above the GDOT maximum and could adversely affect the downstream watershed so therefore detention shall be provided at this location.

Figure F-3.5



Curve Number Calculation
10X Downstream Assessment for Outfall F3

Jun-14

PRE-CONDITION type "C" soil group	TOTAL AREA 27.90 Ac	
	IMPERVIOUS AREA 1.66 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 24.78 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 1.46	71
	COMPOSITE PRE CN	83

POST-CONDITION type "C" soil group	TOTAL AREA 28.4 Ac	
	IMPERVIOUS AREA 2.19 Ac	98
	RESIDENTIAL AREA (1/4 Ac) 24.75 Ac	83
	PERVIOUS AREA (FOREST/MEADOW) 1.46	71
	COMPOSITE PRE CN	83

COMP: MC

CHK :

10X Downstream Assessment for Outfall F3

TIME OF CONCENTRATION CALCULATION

Jun-14

PI No.: xxxxxx

Drainage Area No.	Segment 1- Sheet Flow [1,2]					Segment 2- Shallow Channel [3]				Segment 3 - Open Channel [4]								TIME OF CONCENTRATION (Tc) MINUTE	Computed Intensity			
	Manning Roughness(n)	Flow Length (L) - ft	Land Slope (S) - ft/ft	i(Just for Sheet Flow)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Slope (s) - ft/ft	Velocity (ft/s)	Time of Travel (Tt)- Minute	Flow Length (L) - ft	Estimated Q	Manning Roughness Coeeficient (n) [5]	Qn	Slope (S) - ft/ft	Vn	Velocity (ft/s)	Time of Travel (Tt)- Minute		I_{10}	I_{25}	I_{50}	I_{100}
10X F3 Pre	0.410	425	0.05	4.57	27.60	750	0.04	3.23	3.87	705	8.75	0.035	0.31	0.025	0.11	3.14	3.74	**35.21**	3.70	4.31	4.77	5.24
10X F3 Post	0.410	425	0.05	4.57	27.60	750	0.04	3.23	3.87	705	14.75	0.035	0.52	0.025	0.12	3.43	3.43	**34.90**	3.72	4.33	4.79	5.26

Notes:

1. Kinematic Wave Equation has been used for Segment-1 time of travel (*GDOT Drainage Design manual* Page 4.9).
2. For Segment-1, "I" Values have been compared with Table A-3 "*Georgia Stormwater Management Manual* " (Page A-3)- Per *GDOT Drainage Design Manual* (page 4.13).
3. For Segment 2 Formula see "*GDOT Drainage Design manual* " Page 4.12 .
4. For Segment 3 :
   - 4.1. Find concentrated Flow length (ft)
   - 4.2. find Estimated Q value (use i from Segment 1)
   - 4.3. Qn= $Q_{estimated}$ x Manning
   - 4.4. find Vn from Table 5-19 (see "*GDOT Drainage Design manual* " Page 5.56)
   - 4.5. Velocity = Vn / Manning
5. see "*GDOT Drainage Design manual* " Page 5-25 & 5-26

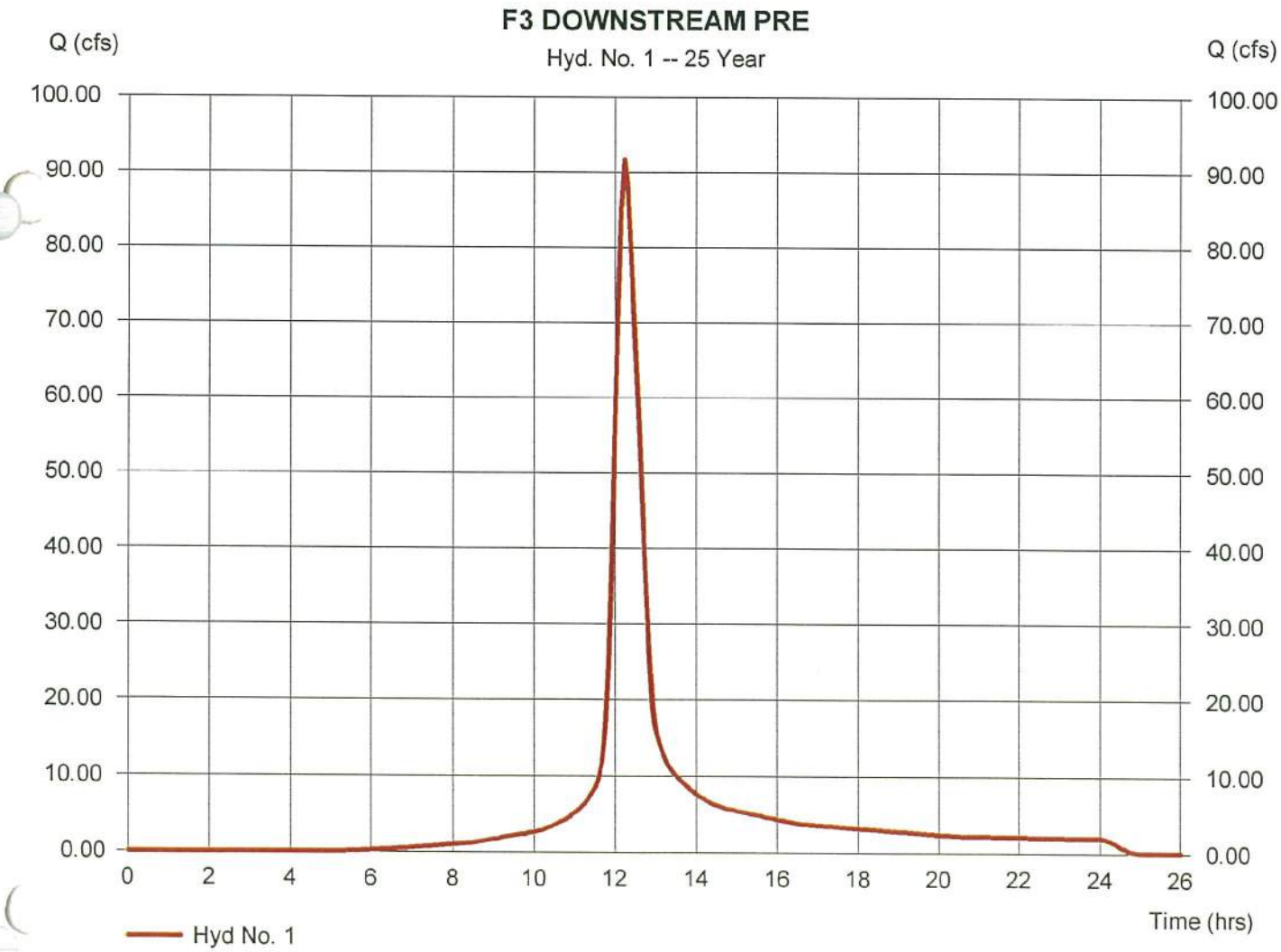
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Wednesday, 07 / 16 / 2014

Hyd. No. 1

F3 DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 91.51 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.25 hrs
Time interval	= 5 min	Hyd. volume	= 448,194 cuft
Drainage area	= 27.900 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 35.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



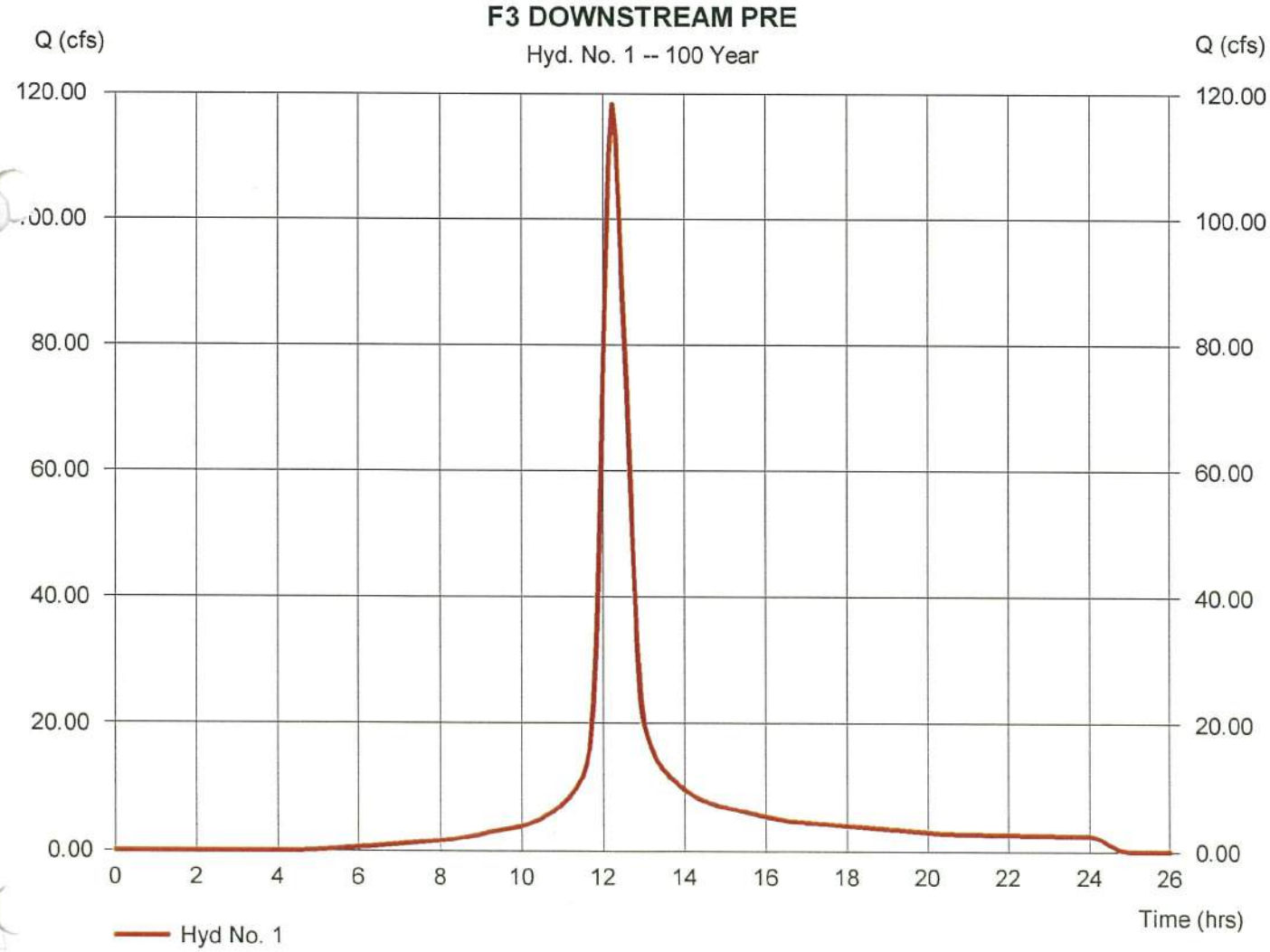
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Wednesday, 07 / 16 / 2014

Hyd. No. 1

F3 DOWNSTREAM PRE

Hydrograph type	= SCS Runoff	Peak discharge	= 118.11 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.25 hrs
Time interval	= 5 min	Hyd. volume	= 582,700 cuft
Drainage area	= 27.900 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 35.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



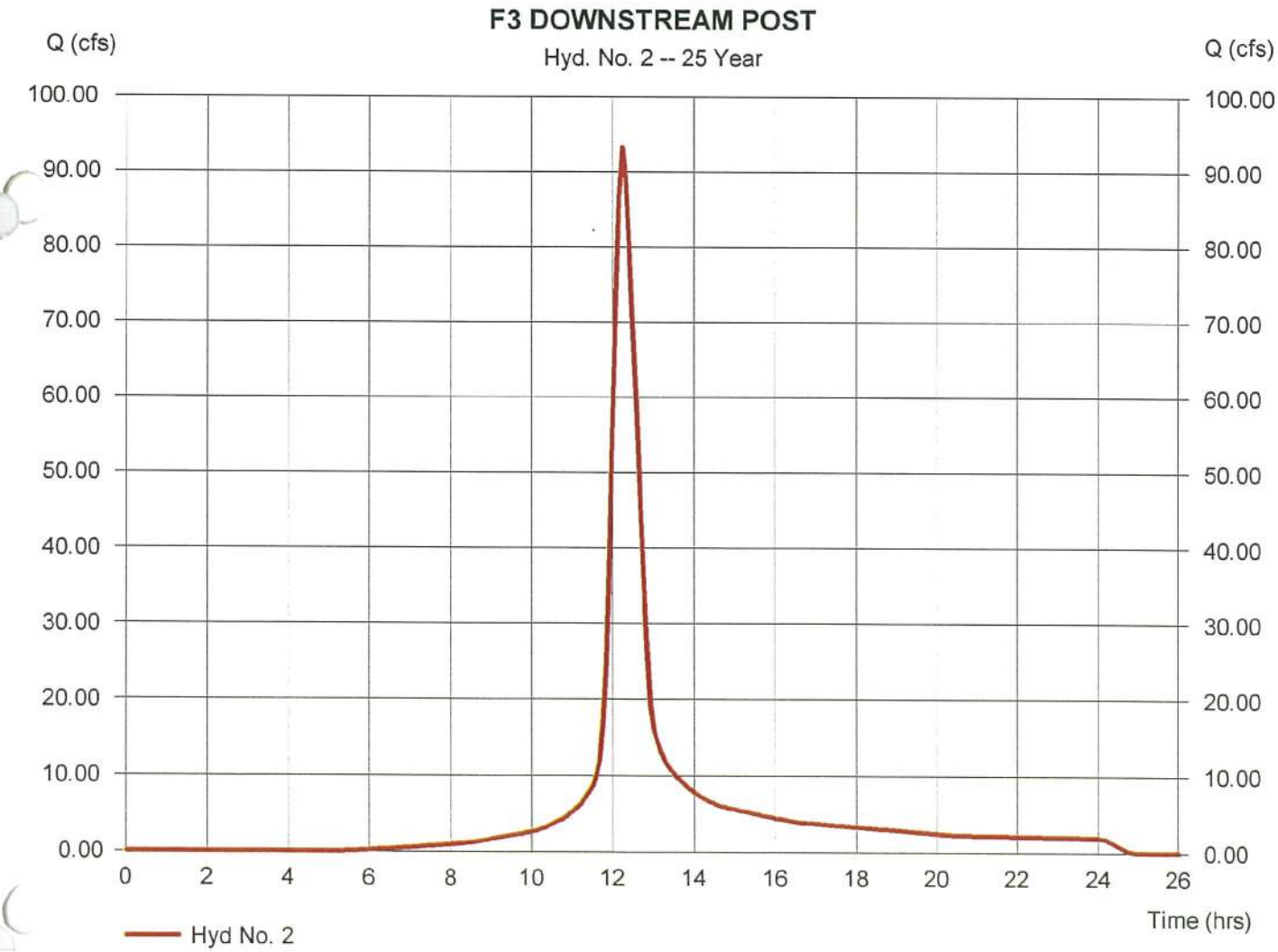
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Wednesday, 07 / 16 / 2014

Hyd. No. 2

F3 DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 93.15 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.25 hrs
Time interval	= 5 min	Hyd. volume	= 456,226 cuft
Drainage area	= 28.400 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 35.00 min
Total precip.	= 6.48 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10 Wednesday, 07 / 16 / 2014

Hyd. No. 2

F3 DOWNSTREAM POST

Hydrograph type	= SCS Runoff	Peak discharge	= 120.22 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.25 hrs
Time interval	= 5 min	Hyd. volume	= 593,142 cuft
Drainage area	= 28.400 ac	Curve number	= 83
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 35.00 min
Total precip.	= 7.92 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

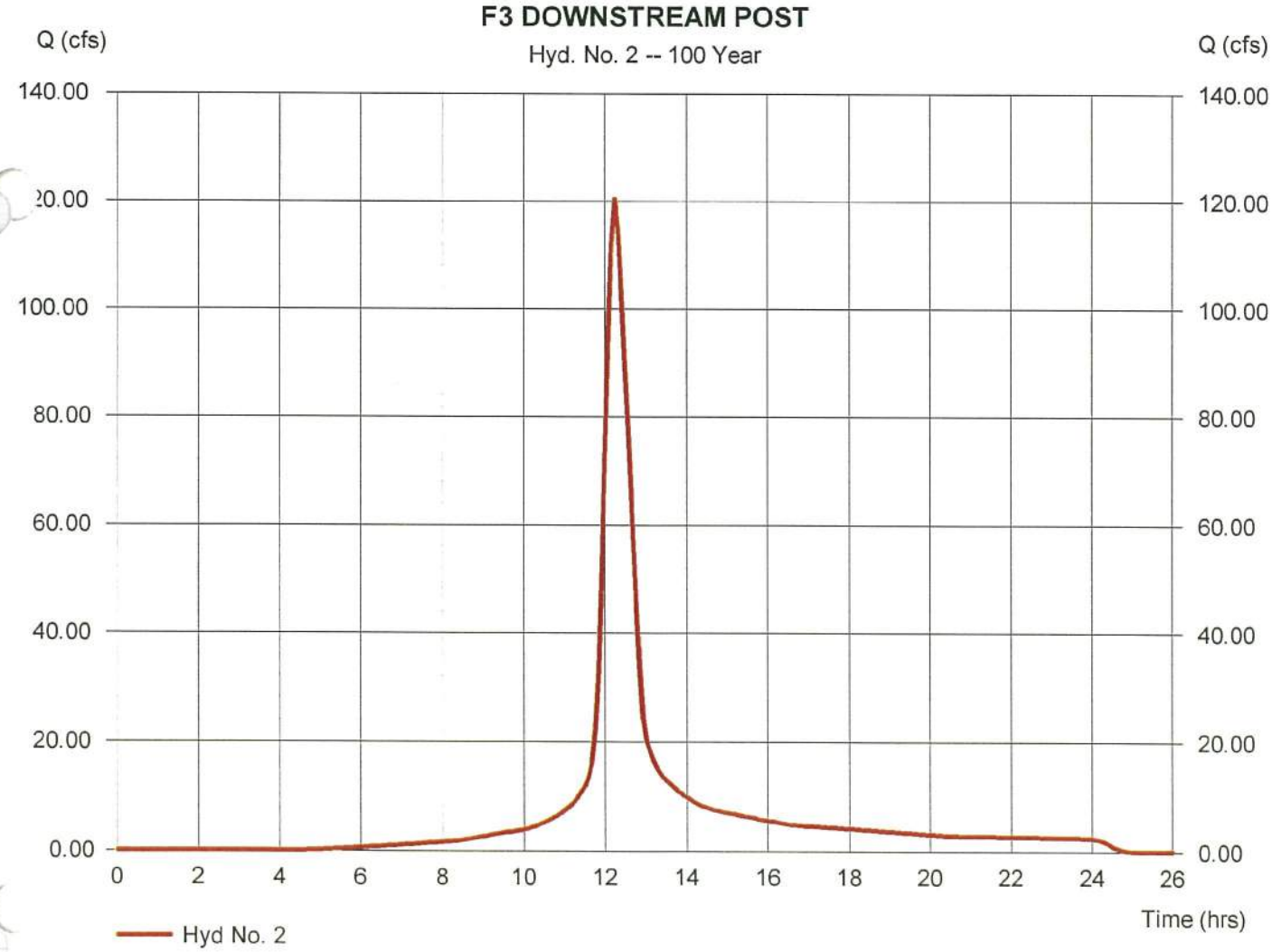


Figure F-3.6

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: F3

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	3,109	3,109
CP_v	8,413	11,522
Q_{p25}	7,580	10,689
Q_{f100}	9,539	12,648

Dry Enhanced Swale

Average Depth	=	0.75	ft
Length	=	1500	ft
Width	=	8	ft
Left Side Slope	=	3	:1
Right Side Slope	=	3	:1
Area	=	7.6875	ft^2
Slope	=	0.01	ft/ft
Storage Volume	=	11531	ft^3 > 11522 ft^3

Swale Dimensions:

A swale that is **1500** ft long and that is **8** ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	11,522	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **657** ft^2

Actual Filter Bed Dimensions: Width 19 ft; Length 36 ft; 684 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **760** ft^2

Actual Sediment Chamber Dimensions: Width 19 ft; Length 40 ft; 760 ft^2

Bioretention Area

CP_v	=	11,522	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,851** ft^2

Actual Filter Bed Dimensions: Width 140 ft; Length 35 ft; 4900 ft^2

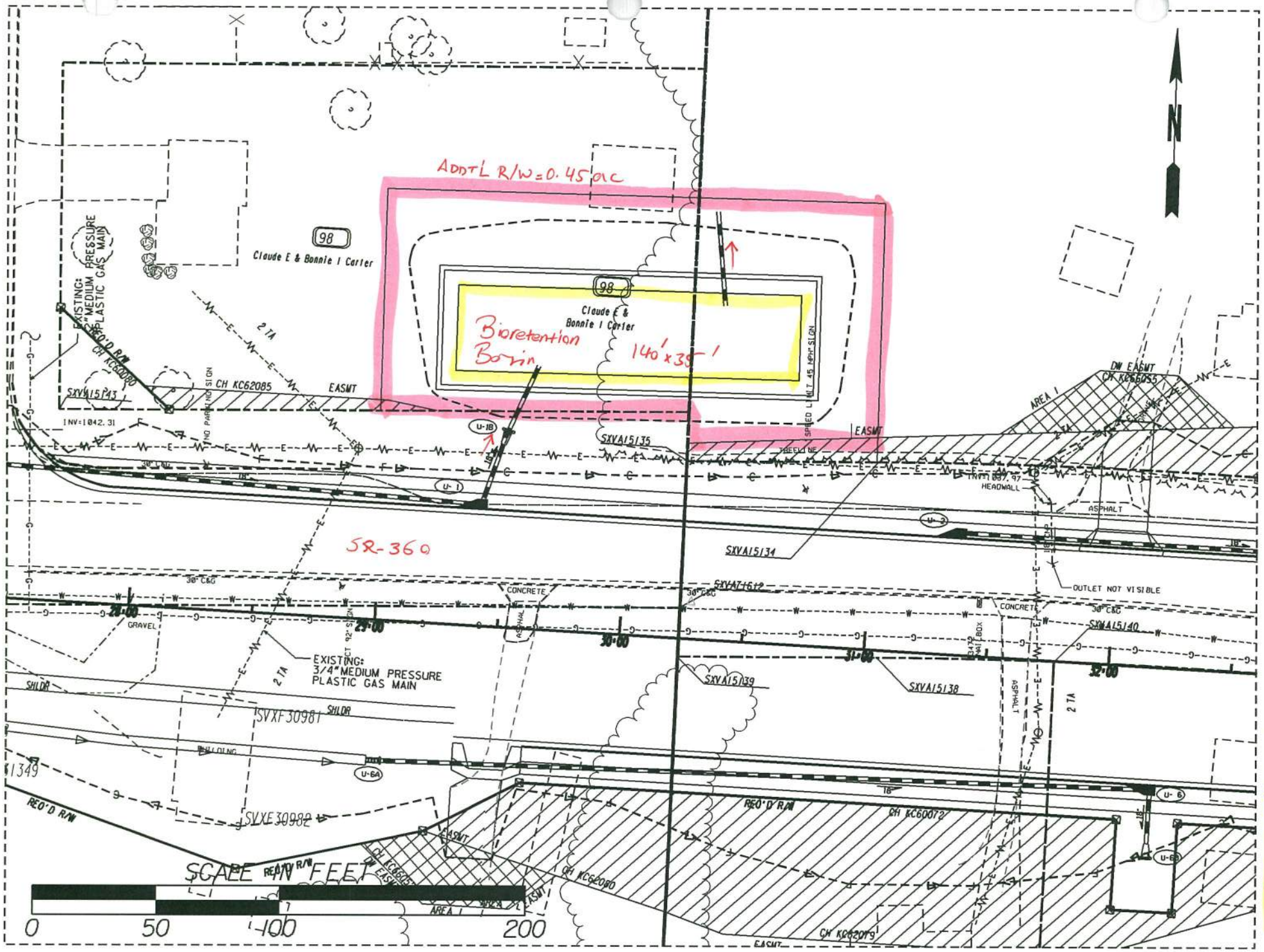

ADDT'L R/W=0.45 ac
Bioretention Basin
140'x35'
98
Claude E & Bonnie I Carter
EXISTING: 3/4" MEDIUM PRESSURE PLASTIC GAS MAIN
CH KC60080
SXVA15143
CH KC62085
EASMT
INV=1842.31
U-1B
SXVA15135
SPEED LIMIT 45 MPH SIGN
TREELINE
INV=1887.97
HEADWALL
DW EASMT
CH KC60055
AREA 1
ASPHALT
U-1
U-2
SR-360
SXVA15134
OUTLET NOT VISIBLE
30" C&G
SXVA7612
CONCRETE
GRAVEL
28+00
29+00
30+00
31+00
32+00
SXVA15140
SXVA15139
SXVA15138
EXISTING: 3/4" MEDIUM PRESSURE PLASTIC GAS MAIN
2 TA
SHLDR
SVXF30981
BUILDING
U-6A
SVXE30982
REQ'D R/W
CH KC60072
U-6
U-6B
CH KC62080
CH KC62079
SCALE IN FEET
0
50
100
200

Figure F3.7

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin F3

Basin F3 600 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 165,000.00	$ 42,500.00	$ 20,500.00	$ 22,500.00
Utilities ✪	$ 45,995.77	$ -	$ -	$ -
Construction ✪	$ 391,994.48	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 4,500.00	$ 2,050.00	$ 2,250.00
Grading	$ -	$ 11,700.00	$ 4,800.00	$ 4,800.00
Drainage	$ -	$ 68,758.11	$ 51,255.00	$ 43,274.50
Total	$ 602,990.26	$ 127,458.11	$ 78,605.00	$ 72,824.50
	Percent of BMP Cost to Total	**21.1%**	**13.0%**	**12.1%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		1.6
Sub Total:	$	80,000.00
Residential Relocation Cost	$	40,000.00
		2
Sub Total:	$	80,000.00
Residential Perm Easmt @	$	25,000.00
		0.2
Sub Total:	$	5,000.00
Commercial Right of Way @	$	125,000.00
		0
Sub Total:	$	-
Commercial Perm Easmt @	$	62,500.00
		0
Sub Total:	$	-
Right of Way Cost Total:	$	165,000.00

✪ See General Summary Explaination for Cost Method

Figure F- 3.8

BMP Construction Cost Worksheet — Basin F3

Dry Enhanced Swale

Length:	1500	ft
Width:	8	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac	
	0.8	Ac	
Total:	$ 40,000.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.1	Ac	
Total:	$ 2,500.00		
Sub Total:	$ 42,500.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.9	Disturbed Ac	
$ 4,500.00		

Grading

Cut	Fill	
550.000	1400.000	
	$ 6.00	per CY
Total:	$ 11,700.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1111	CY	$ 30.00	$ 24,691.36
Uddrn Sys w/ Gravel	-	1530	LF	$ 20.00	$ 30,600.00
Additional Pipe	18	100	LF	$ 52.00	$ 5,200.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	83	SY		83	SY
	$ 4,772.50			$ 394.25	

Sub Total: $ 68,758.11

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	36	40	ft
Width:	19	19	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac
	0.41	Ac
Total:	$ 20,500.00	
Residential Perm Easmt @	$ 25,000.00	per Ac
	0	Ac
Total:	$ -	
Sub Total:	$ 20,500.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.41	Disturbed Ac	
$ 2,050.00		

Grading

Cut	Fill	
250.000	550.000	
	$ 6.00	per CY
Total:	$ 4,800.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	38.00	CY	$ 45.00	$ 1,710.00
Uddrn Sys w/ Gravel	-	136	LF	$ 20.00	$ 2,720.00
Top Soil		7	CY	$ 20.00	$ 140.00
Outlet Pipe	18"	110	LF	$ 43.00	$ 4,730.00
Imperm Geotextile	-	684	SF	$ 5.00	$ 3,420.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	380	SY		380	SY
	$ 21,850.00			$ 1,805.00	

Sub Total: $ 51,255.00

Bioretention Area

Length:	140	ft
Width:	35	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac
	0.45	Ac
Total:	$ 22,500.00	
Residential Perm Easmt @	$ 25,000.00	per Ac
	0	ea
Total:	$ -	
Sub Total:	$ 22,500.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00	per Ac Disturbed	
0.45	Disturbed Ac	
$ 2,250.00		

Grading

Cut	Fill	
150.000	650.000	
	$ 6.00	per CY
Total:	$ 4,800.00	

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	363	CY	$ 30.00	$ 10,890.00
Uddrn Sys w/ Gravel	-	157.5	LF	$ 20.00	$ 3,150.00
Mulch	-	545	SY	$ 15.00	$ 8,175.00
Additional Pipe	18"	45	LF	$ 43.00	$ 1,935.00
Outlet Pipe	18"	40	LF	$ 43.00	$ 1,720.00
Shrubs	-	21	EA	$ 30.00	$ 630.00
Ground Cover	-	58	EA	$ 15.00	$ 870.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	82	SY		82	SY
	$ 4,715.00			$389.50	

Sub Total: $ 43,274.50

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin G-1 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin G1 was located and the existing and proposed basin drainage areas were delineated (See Figure G-1.1 and Figure G-1.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	2,514	2,514
Quantity	Channel Protection, CP_v	9,119	11,633
	Overbank Flood Protection, Q_{p25}	4,268	6,782
	Extreme Flood Protection, Q_{f100}	5,202	7,716

- The total area draining to the MS4 BMP is 3.44 Ac. The total impervious area is 2.64 Ac. The existing pavement area for the site is 2.19 Ac. The area required for storage and quantity management is 1.25 Ac (See Figure G-1.3).
- The flow produced by the existing paved area of 2.19 Ac will not be detained and will pass through the overflow structure.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a surface sand filter with a bottom width of 19' and minimum length of 117'. However the size of the BMP will require cost to cure for parking, driveway or drive through impacts (See Figure G-1.4). The surface sand filter was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure G-1.4).
- Offsite flows currently shown tying to the proposed system can be separated to avoid it coming in contact with treated flows. The offsite flows will be kept in the existing systems and additional proposed pipes will be added as needed to connect existing inlets (See Figure G-1.5).
- The BMP construction cost is 40.2% of the roadway construction cost within this basin making this basin infeasible (See Figure G-1.6).
- None of the other infeasibility criteria apply to this basin.

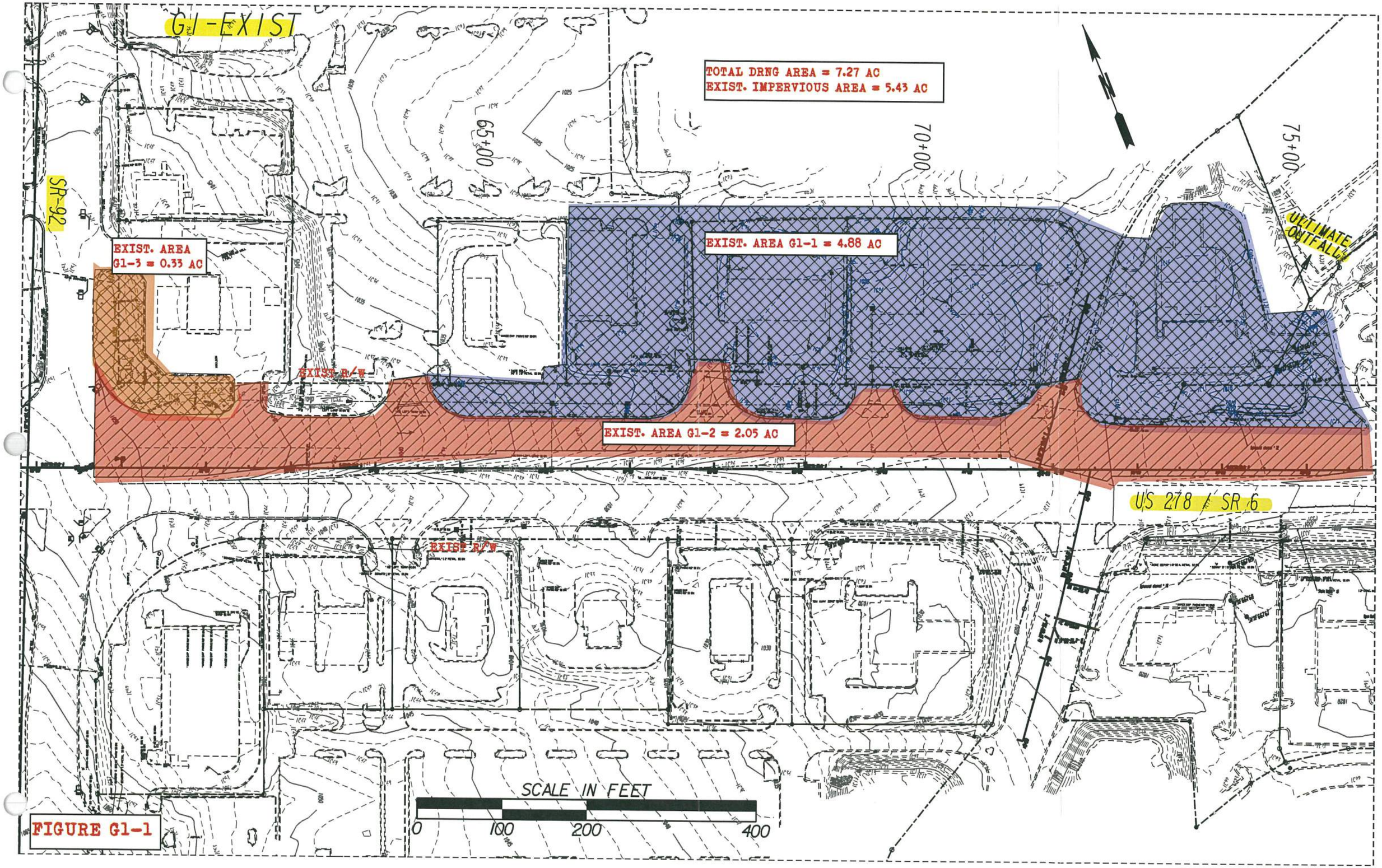

G1-EXIST
TOTAL DRNG AREA = 7.27 AC
EXIST. IMPERVIOUS AREA = 5.43 AC
65+00
70+00
75+00
SR-92
EXIST. AREA G1-3 = 0.33 AC
EXIST. AREA G1-1 = 4.88 AC
EXIST. R/W
EXIST. AREA G1-2 = 2.05 AC
ULTIMATE OUTFALL
US 278 / SR 6
EXIST R/W
SCALE IN FEET
0
100
200
400

FIGURE G1-1

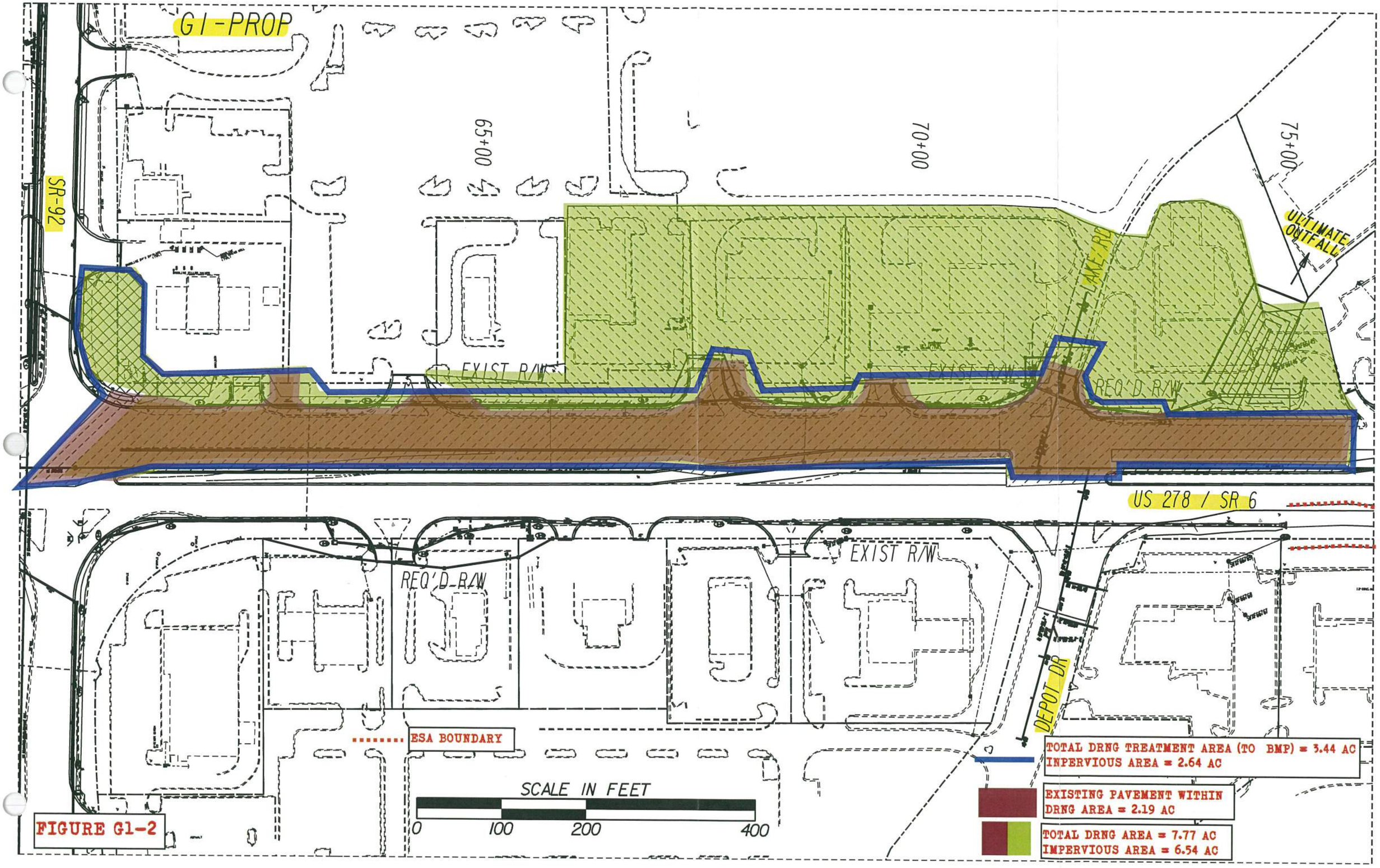

GI-PROP
SR-92
65+00
70+00
75+00
ULTIMATE OUTFALL
LAKE RD
EXIST R/W
REQ'D R/W
US 278 / SR 6
DEPOT DR
ESA BOUNDARY
SCALE IN FEET
0
100
200
400
TOTAL DRNG TREATMENT AREA (TO BMP) = 3.44 AC
INPERVIOUS AREA = 2.64 AC
EXISTING PAVEMENT WITHIN DRNG AREA = 2.19 AC
TOTAL DRNG AREA = 7.77 AC
IMPERVIOUS AREA = 6.54 AC

FIGURE G1-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: G1

Unified Stormwater Sizing Criteria

PI: 621720
Nov-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	7.27
Impervious Area =	5.43
Pervious Area=	1.84

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	91

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)**
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.194

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.058	0.10
$I_a/P_{10\text{-}yr}$=	0.035	0.10
$I_a/P_{25\text{-}yr}$=	0.030	0.10
$I_a/P_{100\text{-}yr}$=	0.024	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 0.97

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.42
$Q_{d\ 10\text{-}yr}$=	4.51
$Q_{d\ 25\text{-}yr}$=	5.45
$Q_{d\ 100\text{-}yr}$ =	6.87

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	900
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	24.78
$Q_{p10\text{-}yr}$=	46.07
$Q_{p25\text{-}yr}$=	55.68
$Q_{p100\text{-}yr}$=	70.19

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	7.77
Impervious Area =	6.54
Pervious Area =	1.23
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	94

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	i^* (in/hr)	time (hr)	P (inch)
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.134

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.040	0.10
$I_a/P_{10\text{-}yr}$=	0.024	0.10
$I_a/P_{25\text{-}yr}$=	0.021	0.10
$I_a/P_{100\text{-}yr}$=	0.017	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 0.67

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.67
$Q_{d\ 10\text{-}yr}$=	4.79
$Q_{d\ 25\text{-}yr}$=	5.74
$Q_{d\ 100\text{-}yr}$ =	7.17

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	900
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	29.19	0.849
$Q_{p10\text{-}yr}$=	52.35	
$Q_{p25\text{-}yr}$=	62.72	
$Q_{p100\text{-}yr}$=	78.34	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	3.44	Acre
Total Impervious Area - A_{POST}	2.64	Acre
Existing Pavement Area - A_{PRE} (5)	2.19	Acre
Area Required for Quantity - A_{QUAN} (4)	1.25	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area(2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
3.44	0.13	13.08	0.00	0.168	0.058	2,514

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.888	0.14	0.085	3,712

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 4,268

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.182	7,929

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 9,119

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.896	0.14	0.104	4,523

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(+15% ED)= 5,202

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$

$Vs/Vr = 0.682 - 1.43(qo/qi) + 1.64(qo/qi)^2 - 0.804(qo/qi)^3$ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure G_1.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: G1

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	2,514	2,514
CP_v	9,119	11,633
Q_{p25}	4,268	6,782
Q_{f100}	5,202	7,716

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	1515	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	11647	ft^3	>	11633	ft^3

Swale Dimensions:

A swale that is 1515 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	11,633	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **663** ft^2

Actual Filter Bed Dimensions:	Width	19	ft
	Length	36	ft
		684	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **768** ft^2

Actual Sediment Chamber Dimensions:	Width	19	ft
	Length	41	ft
		779	ft^2

Bioretention Area

CP_v	=	11,633	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **4,898** ft^2

Actual Filter Bed Dimensions:	Width	140	ft
	Length	35	ft
		4900	ft^2

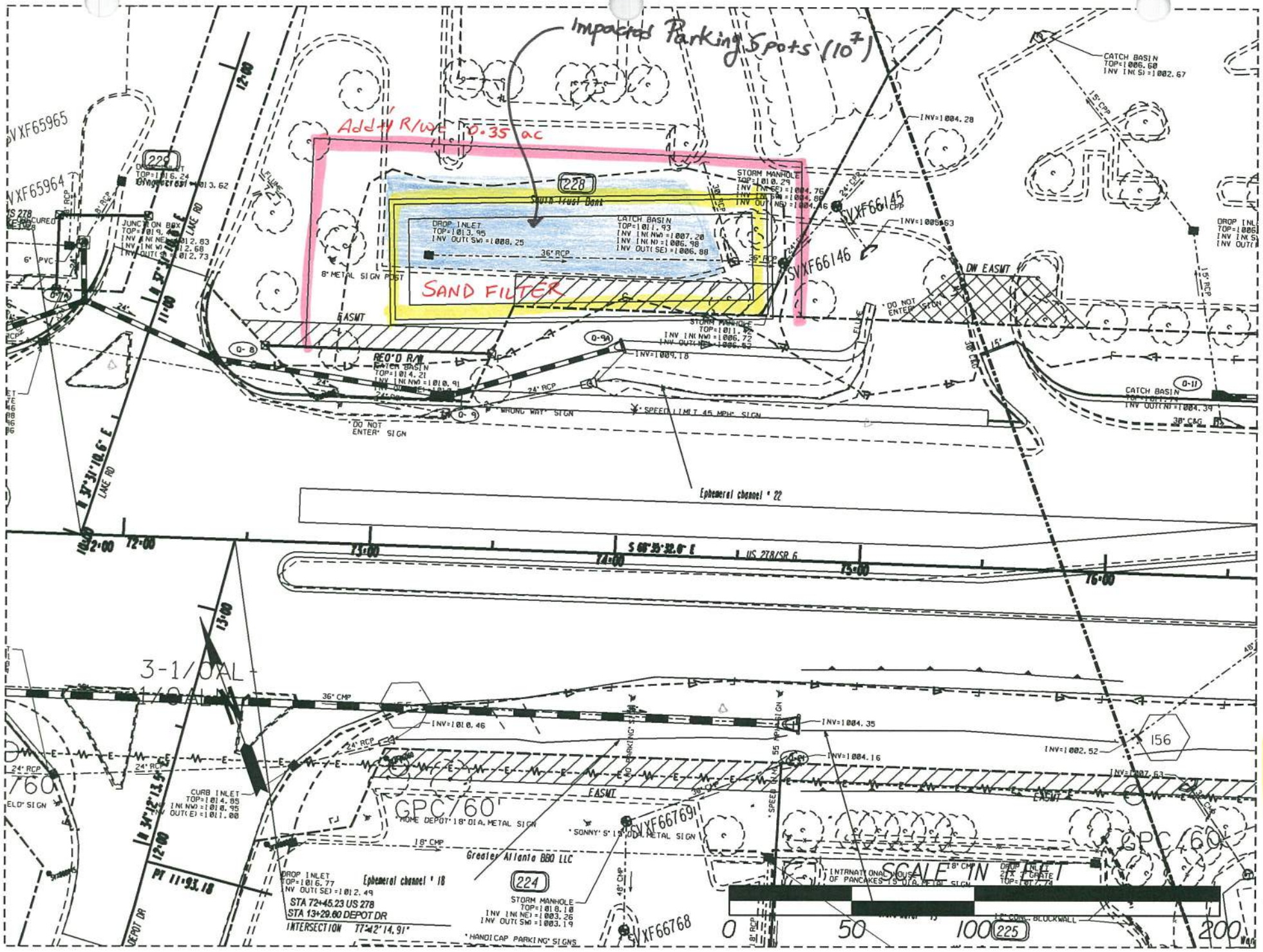

Impacted Parking Spots (10)
Add'l R/WE 0.35 ac
SAND FILTER
South Trust Bank
DROP INLET
TOP=1013.95
INV OUT(SW)=1008.25
CATCH BASIN
TOP=1011.93
INV IN(NW)=1007.20
INV IN(N)=1006.98
INV OUT(SE)=1006.88
36" RCP
8" METAL SIGN POST
EASMT
DW EASMT
REQ'D R/W
CATCH BASIN
TOP=1014.21
INV IN(NW)=1010.91
STORM MANHOLE
TOP=1010.29
STORM MANHOLE
TOP=1011.82
INV IN(NW)=1006.72
INV OUT(N)=1006.52
INV=1009.18
INV=1004.28
INV=1005.63
CATCH BASIN
TOP=1006.60
INV IN(S)=1002.67
CATCH BASIN
INV OUT(N)=1004.39
JUNCTION BOX
TOP=1019.
INV IN(NE)=1012.83
INV IN(W)=1012.68
INV OUT(S)=1012.73
DROP INLET
TOP=1016.24
Engineered=1013.62
6" PVC
24" RCP
15" CPP
24" CPP
SVXF65965
SVXF65964
SVXF66145
SVXF66146
SVXF66769
SVXF66768
"DO NOT ENTER" SIGN
"WRONG WAY" SIGN
"SPEED LIMIT 45 MPH" SIGN
Ephemeral channel # 22
LAKE RD
S 88°35'32.6" E
US 278/SR 6
72+00
73+00
74+00
75+00
76+00
12+00
11+00
13+00
3-1/0AL
36" CMP
INV=1010.46
INV=1004.35
INV=1004.16
INV=1002.52
INV=1007.63
156
GPC/60
CURB INLET
TOP=1014.85
INV IN(NW)=1010.95
OUT(E)=1011.00
"HOME DEPOT" 18" DIA. METAL SIGN
"SONNY'S" 15" DIA. METAL SIGN
"NO PARKING"
"SPEED LIMIT 55 MPH" SIGN
18" CMP
Greater Atlanta BBQ LLC
224
STORM MANHOLE
TOP=1018.10
INV IN(NE)=1003.26
INV OUT(SW)=1003.19
DROP INLET
TOP=1016.77
INV OUT(SE)=1012.49
Ephemeral channel # 18
STA 72+45.23 US 278
STA 13+29.60 DEPOT DR
INTERSECTION 77°42'14.91"
PT 11+93.18
DEPOT DR
"HANDICAP PARKING" SIGNS
INTERNATIONAL HOUSE OF PANCAKES 19' DIA. METAL SIGN
DROP INLET
2'x2' GRATE
TOP=1017.74
12" CONC. BLOCKWALL
225
SCALE IN FEET
0
50
100
200

Figure G-1.5

Infeasibility Criteria #1: Cost of Construction

11/17/2014

Basin G1

Basin G1 750 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 15,625.00	$ 140,750.00	$ 167,500.00	$ 183,750.00
Utilities ✪	$ 57,494.72	$ -	$ -	$ -
Construction ✪	$ 489,993.10	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 5,500.00	$ 1,750.00	$ 1,450.00
Grading	$ -	$ 11,700.00	$ 5,100.00	$ 3,600.00
Drainage	$ -	$ 69,367.27	$ 51,846.38	$ 43,274.50
Total	$ 563,112.82	$ 227,317.27	$ 226,196.38	$ 232,074.50
	Percent of BMP Cost to Total	**40.4%**	**40.2%**	**41.2%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0
Sub Total:	$	-
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0.06
Sub Total:	$	7,500.00
Commercial Perm Easmt @	$	62,500.00
		0.13
Sub Total:	$	8,125.00
Right of Way Cost Total:	$	15,625.00

✪ See General Summary Explaination for Cost Method

Figure G-1.6

Figure G-1.7

BMP Construction Cost Worksheet — Basin G1

Dry Enhanced Swale

Length:	1515	ft
Width:	8	ft

Right of Way

Commercial Right of Way @	$ 125,000.00	per Ac	
	1.1	Ac	
Total:	$ 137,500.00		
Residential Perm Easmt @	$ 25,000.00	per Ac	
	0.13	Ac	
Total:	$ 3,250.00		
Sub Total:	$ 140,750.00		

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
1.1 Disturbed Ac
$ 5,500.00

Grading

Cut	Fill
550.000	1400.000

$ 6.00 per CY
Total: $ 11,700.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 2,300.00	per EA	FES	$ 400.00	per EA
	1	EA		2	EA
	$ 2,300.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	1122	CY	$ 30.00	$ 24,938.27
Uddrn Sys w/ Gravel	-	1545	LF	$ 20.00	$ 30,900.00
Additional Pipe	18	100	LF	$ 52.00	$ 5,200.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	84	SY		84	SY
	$ 4,830.00			$ 399.00	

Sub Total: $ 69,367.27

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	36	41	ft
Width:	19	19	ft

Right of Way

Residential Right of Way @	$ 50,000.00	per Ac
	0.35	Ac
Total:	$ 17,500.00	
Cost to cure (property impact (Parking, Driveway or Drive through))	$ 150,000.00	LS
	1	LS
Total:	$ 150,000.00	
Sub Total:	$ 167,500.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.35 Disturbed Ac
$ 1,750.00

Grading

Cut	Fill
100.000	750.000

$ 6.00 per CY
Total: $ 5,100.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

	Size	Quantity	Unit	Cost	Total
Sand	-	38.00	CY	$ 45.00	$ 1,710.00
Uddrn Sys w/ Gravel	-	136	LF	$ 20.00	$ 2,720.00
Top Soil		7	CY	$ 20.00	$ 140.00
Outlet Pipe	18"	110	LF	$ 43.00	$ 4,730.00
Imperm Geotextile	-	684	SF	$ 5.00	$ 3,420.00
Dist Wall Conc/Steel	-	4	CY	$ 1,020.00	$ 4,080.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	389.5	SY		389.5	SY
	$ 22,396.25			$ 1,850.13	

Sub Total: $ 51,846.38

Bioretention Area

Length:	140	ft
Width:	35	ft

Right of Way

Commercial Right of Way @	$125,000.00	per Ac
	0.27	Ac
Total:	$ 33,750.00	
Cost to cure (property impact (Parking, Driveway or Drive through))	$150,000.00	LS
	1	LS
Total:	$150,000.00	
Sub Total:	$183,750.00	

Utilities

Gas Main	$ 22.00	per LF	
	0	LF	
	$ -		
16" Water Main	$ 75.00	per LF	
	0	LF	
	$ -		
Overhead Power	$ 25,000.00	per pole	
	0	poles	
	$ -		
Sub Total:	$ -		

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.29 Disturbed Ac
$ 1,450.00

Grading

Cut	Fill
150.000	450.000

$ 6.00 per CY
Total: $ 3,600.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures	$ 5,000.00	per EA	FES	$ 400.00	per EA
	2	EA		2	EA
	$ 10,000.00			$ 800.00	

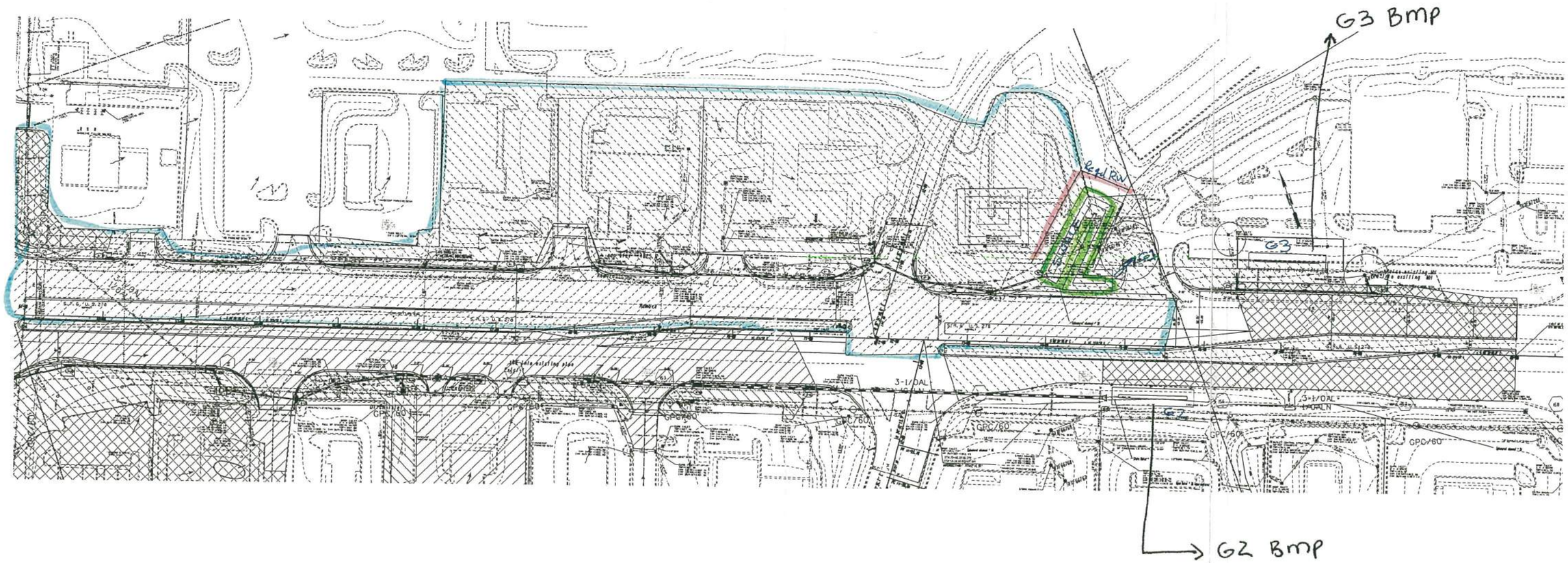
	Size	Quantity	Unit	Cost	Total
Engineered Media	-	363	CY	$ 30.00	$ 10,890.00
Uddrn Sys w/ Gravel	-	157.5	LF	$ 20.00	$ 3,150.00
Mulch	-	545	SY	$ 15.00	$ 8,175.00
Additional Pipe	18"	45	LF	$ 43.00	$ 1,935.00
Outlet Pipe	18"	40	LF	$ 43.00	$ 1,720.00
Shrubs	-	21	EA	$ 30.00	$ 630.00
Ground Cover	-	58	EA	$ 15.00	$ 870.00

Rip Rap TP3,18"	$ 57.50	per SY	Filter Fabric	$ 4.75	per SY
	82	SY		82	SY
	$ 4,715.00			$389.50	

Sub Total: $ 43,274.50

Proposed G1

Figure G-1.8



Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 17, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin G-2 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #5 – The BMP would displace a business if installed

The ultimate outfall of Drainage Basin G2 was located and the existing and proposed basin drainage areas were delineated (See Figures G-2.1 and G-2.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated and stacked. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	16,714	16,714
Quantity	Channel Protection, CP_v	35,598	52,312
	Overbank Flood Protection, Q_{p25}	19,600	36,314
	Extreme Flood Protection, Q_{f100}	24,115	40,829

- The total area draining to the MS4 structure is 6.36 Ac. The total impervious area is 5.51 Ac. The existing pavement area for the site is 1.60 Ac. The area required for storage and quality treatment is 4.76 Ac (See Figure G-2.3). The flow produced by the existing paved area of 1.60 Ac will pass through the BMP and will not be detained.
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention area. The selected BMP is a surface sand filter that is 39 feet wide by 207 feet long. The surface sand filter was deemed the smallest foot print option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure G-2.5).
- The location of the outfall for this basin is in a highly developed area. Displacement of at least one business would be necessary, making the basin infeasible (See Figure G-2.2).
- A cost analysis was not done because the basin failed infeasibility criteria #5 first.

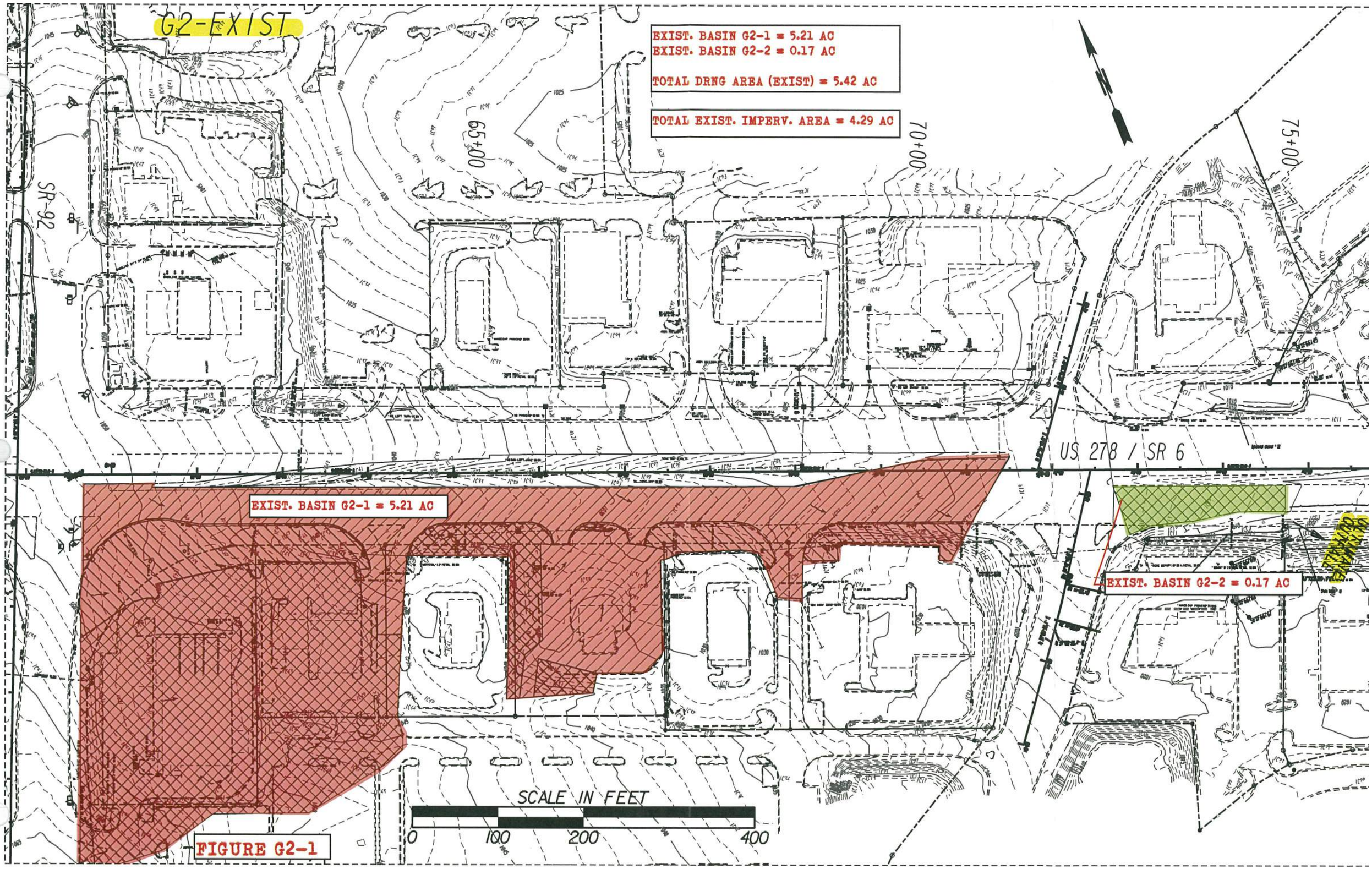

G2-EXIST
EXIST. BASIN G2-1 = 5.21 AC
EXIST. BASIN G2-2 = 0.17 AC
TOTAL DRNG AREA (EXIST) = 5.42 AC
TOTAL EXIST. IMPERV. AREA = 4.29 AC
65+00
70+00
75+00
SR-92
US 278 / SR 6
EXIST. BASIN G2-1 = 5.21 AC
EXIST. BASIN G2-2 = 0.17 AC
SCALE IN FEET
0
100
200
400

FIGURE G2-1

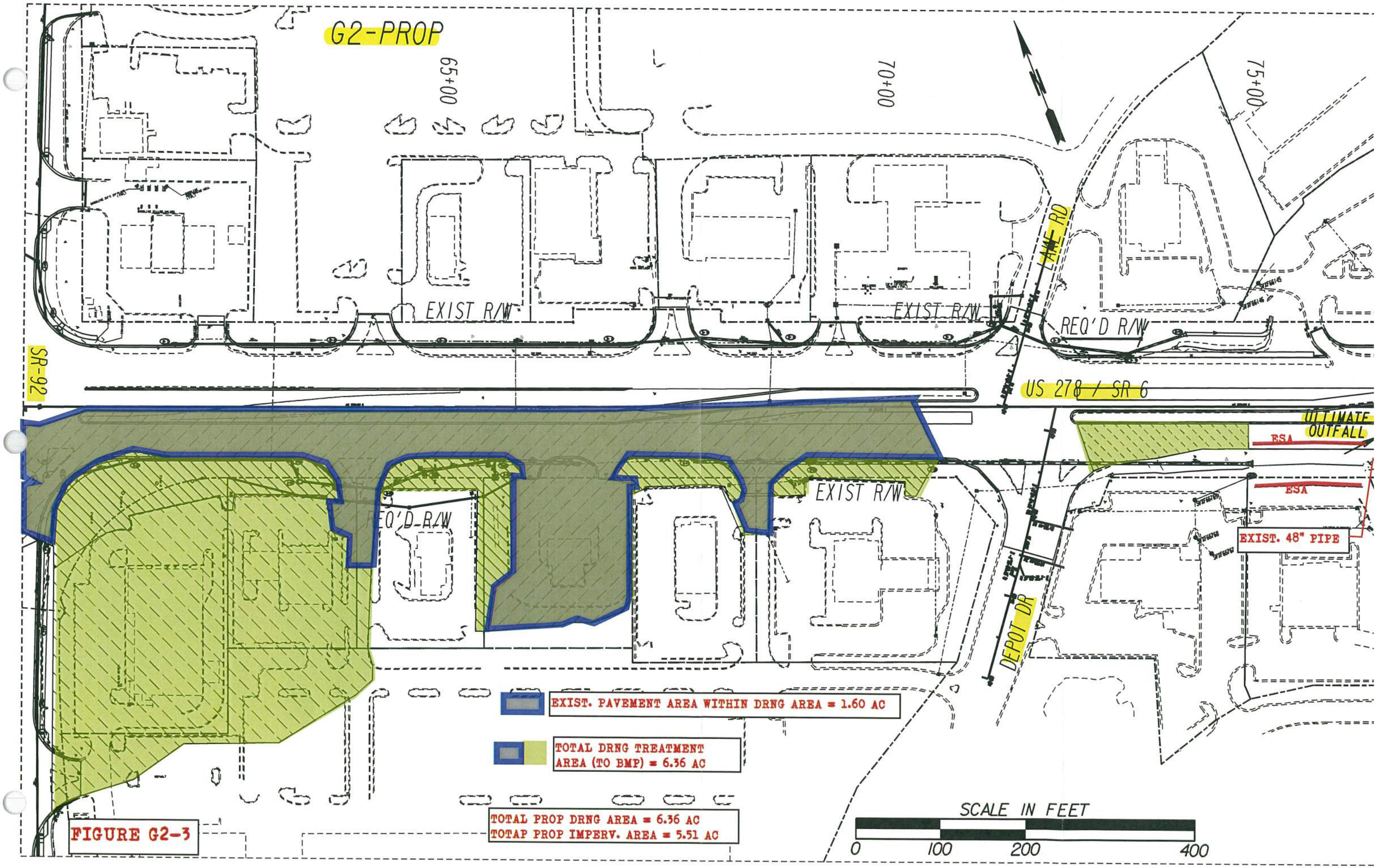

G2-PROP
65+00
70+00
75+00
EXIST R/W
EXIST R/W
REQ'D R/W
LAKE RD
SR-92
US 278 / SR 6
ULTIMATE OUTFALL
ESA
ESA
EXIST R/W
REQ'D R/W
EXIST. 48" PIPE
DEPOT DR
EXIST. PAVEMENT AREA WITHIN DRNG AREA = 1.60 AC
TOTAL DRNG TREATMENT AREA (TO BMP) = 6.36 AC
TOTAL PROP DRNG AREA = 6.36 AC
TOTAP PROP IMPERV. AREA = 5.51 AC
SCALE IN FEET
0
100
200
400

FIGURE G2-3

Project: SR 92 Widening & Reconstruction

H&L DESIGN

Pond #: *G2*

Unified Stormwater Sizing Criteria

PI: 621720

Nov-14

Calcs.: **FR**

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	5.42
Impervious Area =	4.29
Pervious Area=	1.13

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	92

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.165

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.049	0.10
$I_a/P_{10\text{-}yr}$=	0.030	0.10
$I_a/P_{25\text{-}yr}$=	0.025	0.10
$I_a/P_{100\text{-}yr}$=	0.021	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 0.83

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.54
$Q_{d\ 10\text{-}yr}$=	4.64
$Q_{d\ 25\text{-}yr}$=	5.58
$Q_{d\ 100\text{-}yr}$ =	7.01

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	900
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	19.35
$Q_{p10\text{-}yr}$=	35.36
$Q_{p25\text{-}yr}$=	42.56
$Q_{p100\text{-}yr}$=	53.42

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	6.36
Impervious Area =	5.51
Pervious Area =	0.85
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	94

Time of Concentration (See Table A) = 0.15 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.119

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.035	0.10
$I_a/P_{10\text{-}yr}$=	0.022	0.10
$I_a/P_{25\text{-}yr}$=	0.018	0.10
$I_a/P_{100\text{-}yr}$=	0.015	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 0.59

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.74
$Q_{d\ 10\text{-}yr}$=	4.87
$Q_{d\ 25\text{-}yr}$=	5.82
$Q_{d\ 100\text{-}yr}$ =	7.25

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	900
$q_{u10\text{-}yr}$=	900
$q_{u25\text{-}yr}$=	900
$q_{u100\text{-}yr}$=	900

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	24.50	0.790
$Q_{p10\text{-}yr}$=	43.52	
$Q_{p25\text{-}yr}$=	52.03	
$Q_{p100\text{-}yr}$=	64.83	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	6.36	Acre
Total Impervious Area - A_{POST}	5.51	Acre
Existing Pavement Area - A_{PRE} (5)	1.60	Acre
Area Required for Quantity - A_{QUAN} (4)	4.76	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
6.36	0.61	61.48	0.00	0.603	0.384	**16,714**

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)	
0.02	0.65	0.711	**30,954**	(+15% ED)= **35,598**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)	
0.818	0.17	0.391	**17,044**	(+15% ED)= **19,600**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre}$ / $Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)	
0.824	0.17	0.481	**20,970**	(+15% ED)= **24,115**

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d\,100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre}$ / $Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure G-2.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: G2

Stacked Volumes and BMP Dimensions Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	16,714	16,714
CP_v	35,598	52,312
Q_{p25}	19,600	36,314
Q_{f100}	24,115	40,829

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	6850	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	52659	ft^3	>	52312	ft^3

Swale Dimensions:

A swale that is 6850 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	52,312	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **2,983** ft^2

Actual Filter Bed Dimensions: Width 39 ft; Length 78 ft; 3042 ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_s = **3453** ft^2

Actual Sediment Chamber Dimensions: Width 39 ft; Length 89 ft; 3471 ft^2

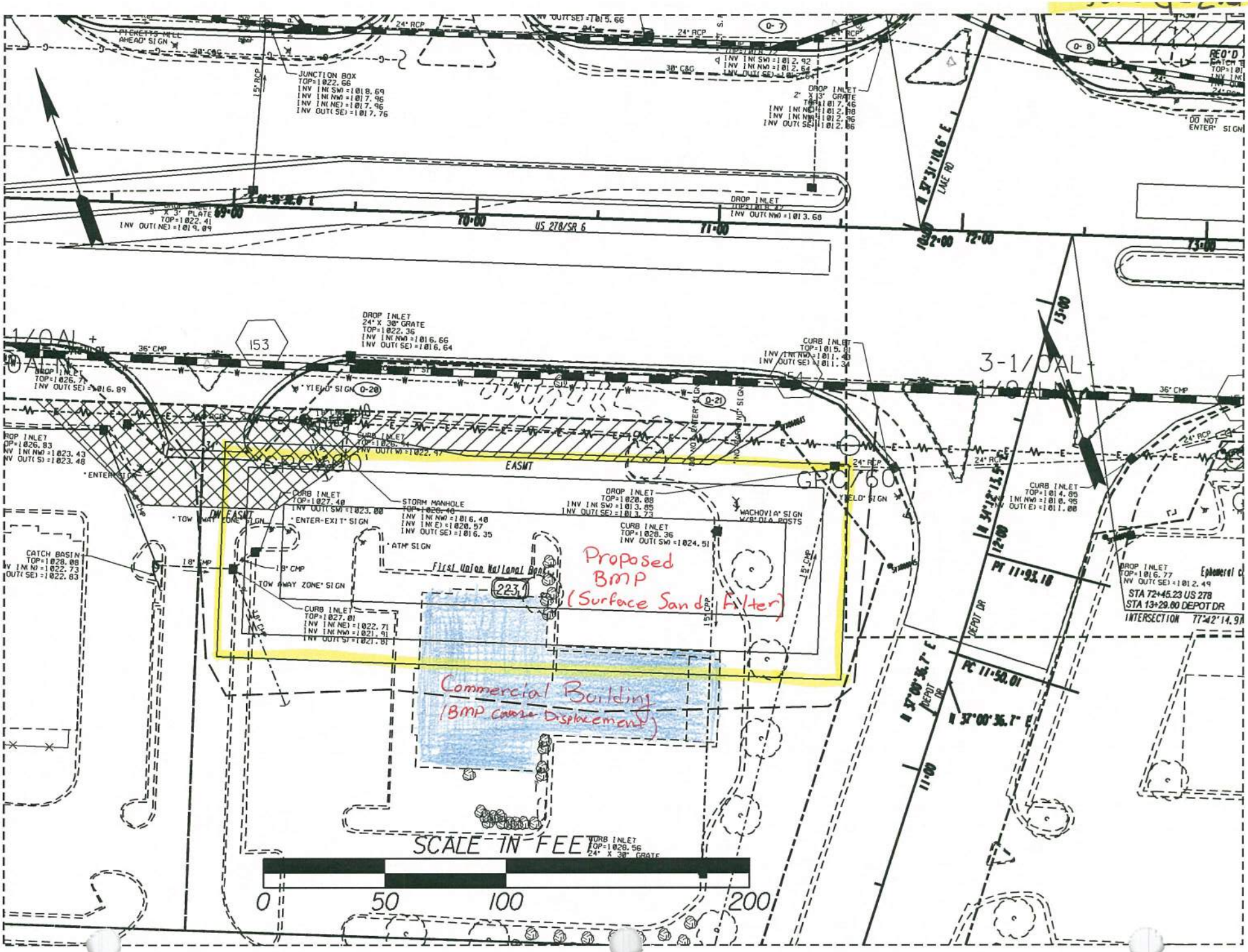
Bioretention Area

CP_v	=	52,312	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **22,026** ft^2

Actual Filter Bed Dimensions: Width 295 ft; Length 75 ft; 22125 ft^2


Proposed BMP (Surface Sand Filter)
Commercial Building (BMP causes Displacement)
EASMT
US 278/SR 6
LAKE RD
DEPOT DR
First Union National Bank
WACHOVIA SIGN
STORM MANHOLE
JUNCTION BOX
DROP INLET
CURB INLET
CATCH BASIN
SCALE IN FEET
0
50
100
200

Widening and Reconstruction of SR 92
MS4 Feasibility Study
STP00-0186-01(025)

November 18, 2014
Designed By: FA
Checked By: SCF 11-19-14

Basin G-3 Summary
BMP Recommendation – Infeasible
Fails Infeasibility Criteria #1 – Cost of BMP

The ultimate outfall of Drainage Basin G3 was located and the existing and proposed basin drainage areas were delineated (See Figure G-3.1 and Figure G-3.2). From those drainage areas the MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes were calculated. The following chart shows the computed volumes.

	MS4 Requirement	Calculated Volumes (ft^3)	Stacked Volumes (ft^3)
Quality	Water Quality, WQ_v	353	353
Quantity	Channel Protection, CP_v	619	972
	Overbank Flood Protection, Q_{p25}	249	602
	Extreme Flood Protection, Q_{f100}	302	655

- The total area draining to the MS4 BMP is 0.54 Ac. The total impervious area is 0.51 Ac. The existing pavement area for the site is 0.45 Ac. The area required for storage and quantity management is 0.09 Ac (See Figure G-3.3).
- See General Summary sheet for additional information and overall calculation process.
- After stacking the flows, the largest of the 3 quantity volumes is the Channel Protection Volume. Therefore a downstream hydraulic analysis is not necessary since the Overbank and/or the Extreme Flood Protections are not the controlling quantity volumes and will be stored within the Channel Protection Volume.
- 3 BMPs were studied; an enhanced swale, a surface sand filter, and a bioretention basin. The selected BMP is a bioretention basin with a bottom width of 7' and minimum length of 60' (See Figure G-3.4). The bioretention basin was deemed the lowest cost option between the 3 studied BMPs and will be designed to detain and release the Water Quality Volume and the stacked Channel Protection Volume (See Figure G-3.4). The flow produced by the existing paved area of 0.45 Ac will not be detained and will pass through the overflow structure.
- Approximately 0.06 acres of required Right of Way will be required to construct the BMP. This Right of Way will impact a commercial parking lot and will cause the business to lose 10 parking spots and will require additional cost to cure estimated at $5,000 per space.
- The BMP construction cost is 29.5% of the roadway construction cost within this basin making this basin infeasible (See Figure G-3.6).
- None of the other infeasibility criteria apply to this basin.

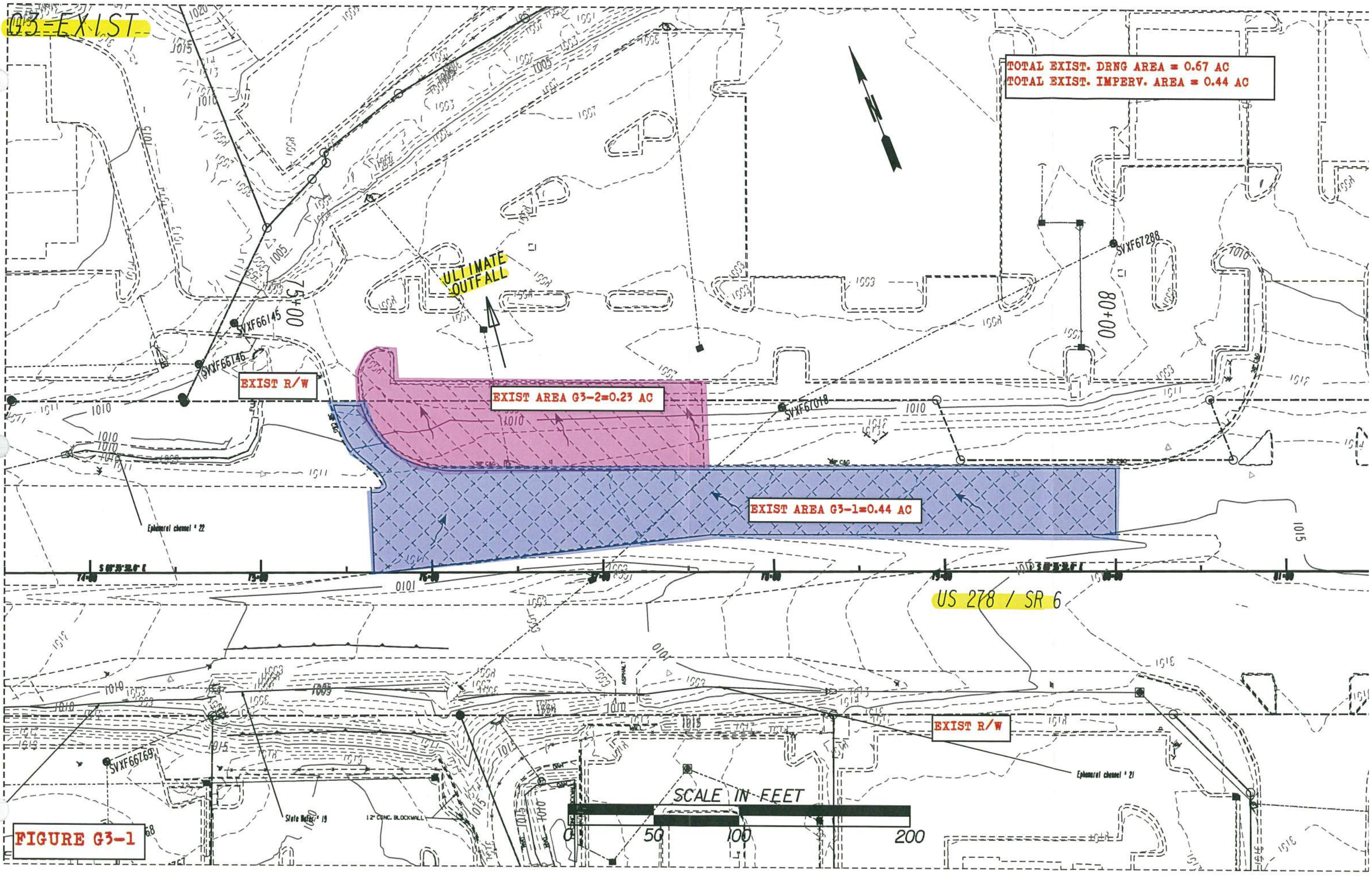

G3=EXIST
TOTAL EXIST. DRNG AREA = 0.67 AC
TOTAL EXIST. IMPERV. AREA = 0.44 AC
ULTIMATE OUTFALL
EXIST R/W
EXIST AREA G3-2=0.23 AC
EXIST AREA G3-1=0.44 AC
SVXF66145
SVXF66146
SVXF67288
SVXF67018
SVXF66769
Ephemeral channel # 22
Ephemeral channel # 21
US 278 / SR 6
EXIST R/W
SCALE IN FEET
0
50
100
200

FIGURE G3-1

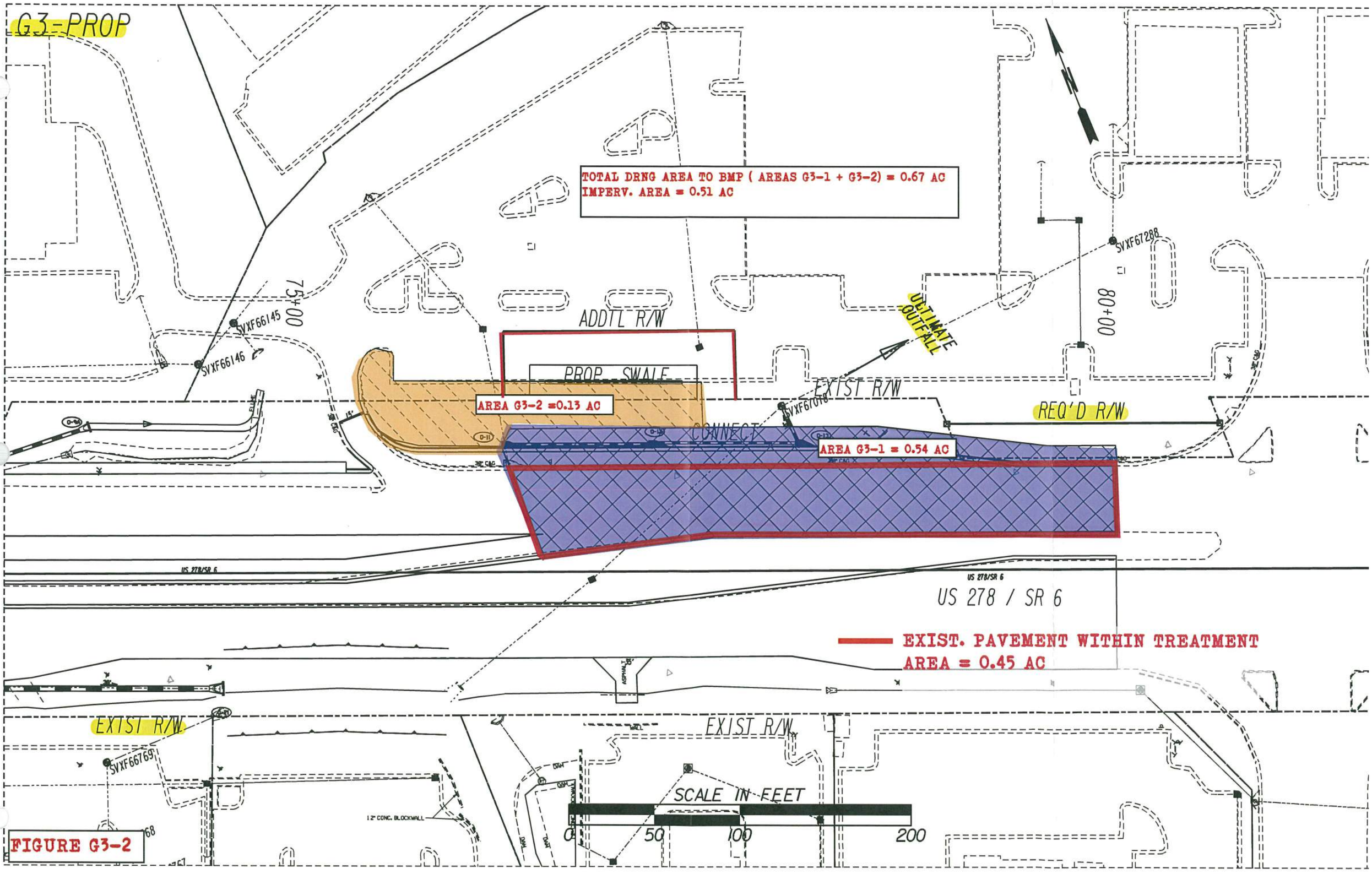

G3-PROP
TOTAL DRNG AREA TO BMP (AREAS G3-1 + G3-2) = 0.67 AC
IMPERV. AREA = 0.51 AC
ADDTL R/W
PROP SWALE
AREA G3-2 =0.13 AC
CONNECT
AREA G3-1 = 0.54 AC
EXIST R/W
REQ'D R/W
ULTIMATE OUTFALL
SVXF67288
SVXF67078
SVXF66145
SVXF66146
SVXF66769
75+00
80+00
US 278/SR 6
US 278 / SR 6
EXIST. PAVEMENT WITHIN TREATMENT
AREA = 0.45 AC
12" CONC. BLOCKWALL
SCALE IN FEET
0
50
100
200

FIGURE G3-2

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: G3

Unified Stormwater Sizing Criteria
Table B

PI: 621720
Nov-14
Calcs.: FR

Pre Development Calculation

1. Area - Curve No. - T_c

Existing Drainage Area:

Area (acre)	
Total Area (ac) =	0.67
Impervious Area =	0.44
Pervious Area=	0.23

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	89

Time of Concentration (See Table A) = 0.08 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch) ***
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.254

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.076	0.10
$I_a/P_{10\text{-}yr}$=	0.046	0.10
$I_a/P_{25\text{-}yr}$=	0.039	0.10
$I_a/P_{100\text{-}yr}$=	0.032	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 1.27

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.20
$Q_{d\ 10\text{-}yr}$=	4.24
$Q_{d\ 25\text{-}yr}$=	5.17
$Q_{d\ 100\text{-}yr}$ =	6.58

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	1000
$q_{u10\text{-}yr}$=	1000
$q_{u25\text{-}yr}$=	1000
$q_{u100\text{-}yr}$=	1000

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	2.31
$Q_{p10\text{-}yr}$=	4.44
$Q_{p25\text{-}yr}$=	5.41
$Q_{p100\text{-}yr}$=	6.88

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

Post Development Calculation

1. Area - Curve No. - T_c

Proposed Drainage Area:

Area (acre)	
Total Area =	0.67
Impervious Area =	0.51
Pervious Area =	0.16
Credit Area =	0.00

Curve Number *

Type	CN
Impervious	98
Pervious	71
Composite CN=	92

Time of Concentration (See Table A) = 0.08 *hr*

** See Table 2.1.5-1 Georgia Stormwater Management Manual*

Hydrological Soil Group: C

2. Precipitation (P)-(24 hr storm) - inch

	*i * (in/hr)*	*time (hr)*	*P (inch)*
$P_{1\text{-}yr}$ =	0.14	24	3.36
$P_{10\text{-}yr}$ =	0.23	24	5.52
$P_{25\text{-}yr}$ =	0.27	24	6.48
$P_{100\text{-}yr}$ =	0.33	24	7.92

** Use IDF table A-2 of GSMM*

*** P = i x time*

3. Initial Abstraction (I_a) - inch

$$I_a = \frac{200}{CN} - 2$$

I_a = 0.185

Note: or use Table 2.1.5-3 GSMM Page 2.1-29 to get I_a

4. I_a/ P

	Calculated	Used *
$I_a/P_{1\text{-}yr}$ =	0.055	0.10
$I_a/P_{10\text{-}yr}$=	0.033	0.10
$I_a/P_{25\text{-}yr}$=	0.028	0.10
$I_a/P_{100\text{-}yr}$=	0.023	0.10

** if calculated I_a/P <0.1 then assume I_a/P=0.1 to facilitate use of figure 2.1.5-6 - See GSMM Page 2.1-32 example problem 1*

5. Potential Max. Soil Retention (S) - inch

$$S = \frac{1000}{CN} - 10$$

S = 0.92

(see GSMM Page 2.1-18)

6. Accumulated Direct Runoff (Q_d) - inch

$Q_{d\ 1\text{-}yr}$=	2.46
$Q_{d\ 10\text{-}yr}$=	4.55
$Q_{d\ 25\text{-}yr}$=	5.49
$Q_{d\ 100\text{-}yr}$ =	6.91

$$Q_d = \frac{(P-0.2S)^2}{(P+0.8S)}$$

(See GSMM Page 2.1-18)

7. Unit Peak Discharge (q_u) - cfs/mi²/in

$q_{u1\text{-}yr}$=	1000
$q_{u10\text{-}yr}$=	1000
$q_{u25\text{-}yr}$=	1000
$q_{u100\text{-}yr}$=	1000

(1) Use Figure 2.1.5-6 of GSMM for q_u (type II rainfall distribution)

(2) See figure 2.1.5-1 for SCS rainfall distributiuons

8. Peak Discharge (Q_p) - cfs

$Q_{p1\text{-}yr}$=	2.58	0.896
$Q_{p10\text{-}yr}$=	4.76	
$Q_{p25\text{-}yr}$=	5.75	
$Q_{p100\text{-}yr}$=	7.24	

$Q_p = q_u \cdot A \cdot Q_d \cdot F_p$ (see GSMM page 2.1-28)

A: Total Area in mi²

F_p= 1

F_p (pond adjustment factor)- seeGSMM page 2.1-28

9. Treatment Area

Total Drainage Treatment Area - A_{TA}	0.54	Acre
Total Impervious Area - A_{POST}	0.51	Acre
Existing Pavement Area - A_{PRE} (5)	0.45	Acre
Area Required for Quantity - A_{QUAN} (4)	0.09	Acre

(4) Only the new proposed areas should be considered with respect to stormwater runoff quantity control measures. GDOT PCSM page 10.2-5

(5) The existing pavement area is subtracted from the total drainage area to compute the volumes needed for quantity.

Water Quality Volume - (WQ_v) (1)

A_{TA}	Impervious Area	Percent Impervious Cover	Credit Area (2)	R_v (3)	WQ_v (ac-ft)	WQ_v (ft³)
0.54	0.11	11.19	0.00	0.151	0.008	353

(1) See GSMM page 1.3.2.1 for Water Quality discussion (use just area that needs to be treated)

(2) See GSMM section 1.4

(3) R_v = 0.05 + 0.009 (I)

I = Percent Impervious Cover = 100 x [(Impervious area Post - Impervious area Pre) / Total area]

$$WQ_v = \frac{1.2 * Rv * A_{TA}}{12}$$

Overbank Flood Protection Volume- (Q_{p25}) (1)

q_o/q_i	V_s/V_r	Q_{p25} (ac-ft)	Q_{25} (ft³)
0.942	0.12	0.005	217

(+15% ED)= 249

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d25\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.3 for Overbank Flood Protection discussion

qo/qi: $Q_{p25\text{-}pre} / Q_{p25\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Channel Protection Volume - (CP_v) (1)

q_o/q_i	V_s/V_r	C_{pv} (ac-ft)	C_{pv} (ft³)
0.02	0.65	0.012	537

(+15% ED)= 619

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d1\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.2 for Channel Protection discussion

qo/qi: See GSMM figure 2.2.5-1 -(24hr extended detention time used for 1-year)

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Extreme Flood Protection Volume- (Q_f) (1)

q_o/q_i	V_s/V_r	Q_f (ac-ft)	Q_f (ft³)
0.952	0.11	0.006	262

(+15% ED)= 302

$$V_s = CP_v = \frac{\left(\frac{Vs}{Vr}\right) * Q_{d100\_YR} * A_{QUAN}}{12}$$

(1) See GSMM page 1.3.2.4 for Extreme Flood Protection discussion

qo/qi: $Q_{p100\text{-}pre} / Q_{p100\text{-}post}$

Vs/Vr= 0.682-1.43(qo/qi)+1.64(qo/qi)² -0.804(qo/qi)³ *(See GSMM Page 2.2-9)*

A_{QUAN} = Total Treatment Area - Existing Pavement Area - Credit Area

Figure G-3.4

Project: SR 92 Widening & Reconstruction
H&L DESIGN
Pond #: G3

Stacked Volumes and BMP Dimensions
Calculations

PI: 621720
Nov-14
Calcs.: FR

	Computed Volumes	Stacked Volumes
WQ_v	353	353
CP_v	619	972
Q_{p25}	249	602
Q_{f100}	302	655

Dry Enhanced Swale

Average Depth	=	0.75	ft			
Length	=	127	ft			
Width	=	8	ft			
Left Side Slope	=	3	:1			
Right Side Slope	=	3	:1			
Area	=	7.6875	ft^2			
Slope	=	0.01	ft/ft			
Storage Volume	=	976	ft^3	>	972	ft^3

Swale Dimensions:

A swale that is 127 ft long and that is 8 ft wide.

Pond Dimensions:

No detention pond is required at this location.

Surface Sand Filter

CP_v	=	972	cf	Controling Vol.
d_f	=	1.5	ft	Filter Bed Depth
k	=	3.5	ft/day	Coefficient of permeability of filter media
h_f	=	3	ft	Average height of water above filter bed
t_f	=	1.67	days	Design filter bed drain time

Filter Bed Surface Area:

A_f = **55** ft^2

Actual Filter Bed Dimensions:	Width	6	ft
	Length	10	ft
		60	ft^2

Sediment Chamber Surface Area: **(For I < 75%) 0.066*CP_v**

A_S = **64** ft^2

Actual Sediment Chamber Dimensions:	Width	6	ft
	Length	11	ft
		66	ft^2

Bioretention Area

CP_v	=	972	cf	Controling Vol.
d_f	=	2	ft	Filter Bed Depth
k	=	4	ft/day	Coefficient of permeability of filter media
h_f	=	0.375	ft	Average height of water above filter bed
t_f	=	0.5	days	Design filter bed drain time

Filter Bed Surface Area:

A_B = **409** ft^2

Actual Filter Bed Dimensions:	Width	7	ft
	Length	60	ft
		420	ft^2

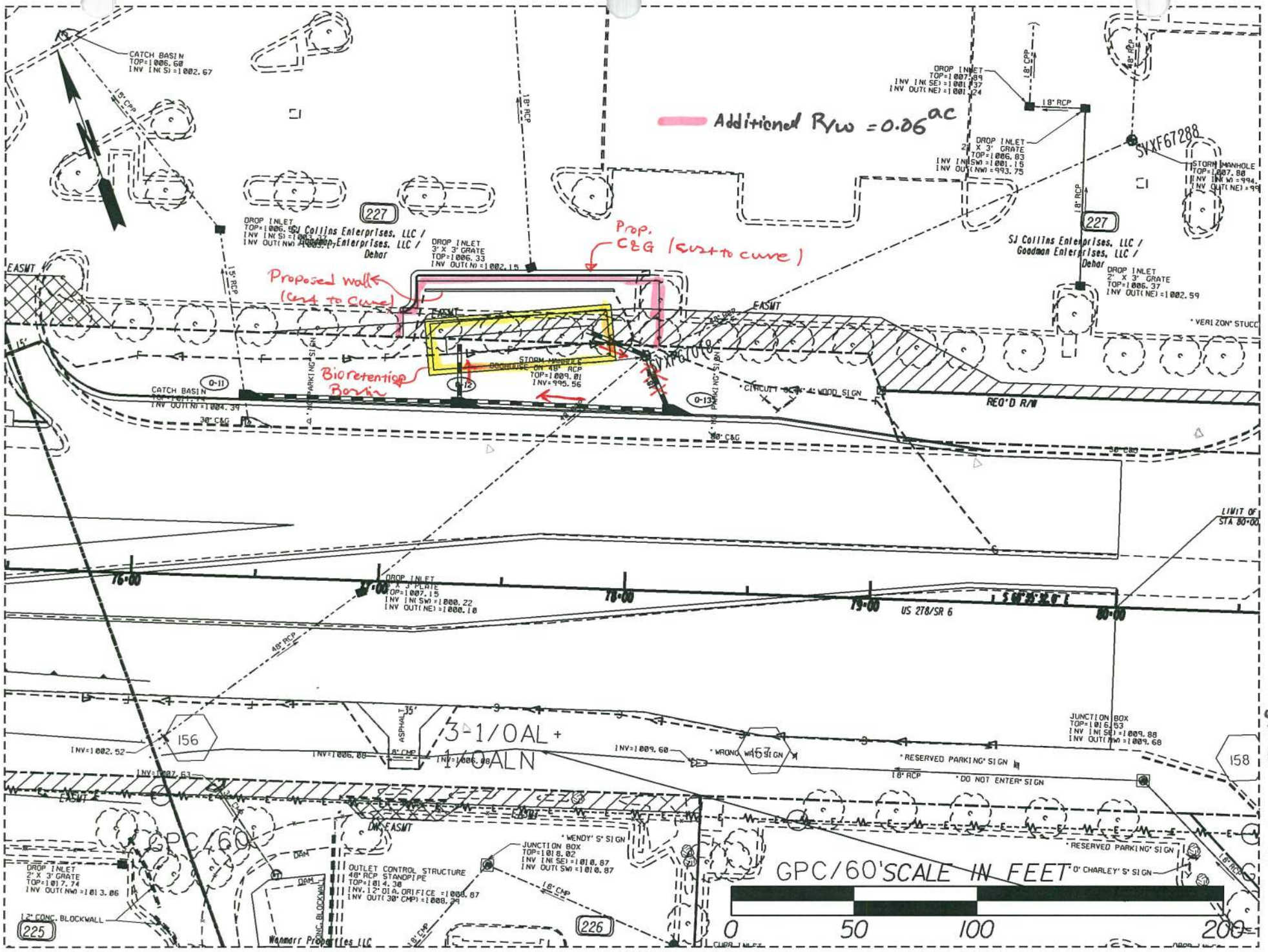

Additional R/w = 0.06 ac
Prop. C&G (cut to curve)
Proposed wall (cut to curve)
Bioretention Basin
CATCH BASIN TOP=1006.60 INV IN(S)=1002.67
DROP INLET TOP=1006.60 INV IN(S)=1003.33 INV OUT(NW)=1000.77
SJ Collins Enterprises, LLC / Goodman Enterprises, LLC / Dehor
DROP INLET 3' X 3' GRATE TOP=1006.33 INV OUT(N)=1002.15
DROP INLET TOP=1007.89 INV IN(SE)=1001.37 INV OUT(NE)=1001.24
DROP INLET 2' X 3' GRATE TOP=1006.03 INV IN(SW)=1001.15 INV OUT(NW)=993.75
STORM MANHOLE TOP=1007.88 INV IN(W)=994. INV OUT(NE)=99
DROP INLET 2' X 3' GRATE TOP=1006.37 INV OUT(NE)=1002.59
STORM MANHOLE GOODHUE ON 48" RCP TOP=1009.01 INV=995.56
CATCH BASIN TOP=1004.39 INV OUT(N)=1004.39
DROP INLET 3' X 3' PLATE TOP=1007.15 INV IN(SW)=1000.22 INV OUT(NE)=1000.18
JUNCTION BOX TOP=1016.53 INV IN(SE)=1009.88 INV OUT(NW)=1009.68
OUTLET CONTROL STRUCTURE 48" RCP STANDPIPE TOP=1014.30 INV. 12" DIA. ORIFICE =1008.87 INV OUT(30" CMP)=1008.39
JUNCTION BOX TOP=1018.02 INV IN(SE)=1010.87 INV OUT(SW)=1010.87
DROP INLET 2' X 3' GRATE TOP=1017.74 INV OUT(NW)=1013.06
12" CONC. BLOCKWALL
Wannarr Properties LLC
US 278/SR 6
REQ'D R/W
LIMIT OF STA 80+00
* VERIZON* STUCC
* CIRCUIT BOX & WOOD SIGN
* WRONG WAY SIGN
* RESERVED PARKING* SIGN
* DO NOT ENTER* SIGN
* WENDY'S* SIGN
* O' CHARLEY'S* SIGN
3-1/0AL + 1/0ALN
GPC/60'SCALE IN FEET
0 50 100 200

Figure G-3.5

Infeasibility Criteria #1: Cost of Construction

11/18/2014

Basin G3

Basin G3 450 LF of Roadway construction cost within basin

Item	Basin E5-1 Roadway Cost (not including BMP)	Swale BMP Cost	Sand Filter BMP Cost	Bioretention BMP Cost
Right of Way	$ 15,000.00	$ 90,750.00	$ 75,000.00	$ 79,500.00
Utilities ✪	$ 34,496.83	$ -	$ -	$ -
Construction ✪	$ 293,995.86	$ -	$ -	$ -
Clearing and Grubbing	$ -	$ 750.00	$ 1,750.00	$ 300.00
Grading	$ -	$ 3,000.00	$ 3,000.00	$ 2,100.00
Drainage	$ -	$ 15,640.53	$ 22,417.25	$ 19,298.75
Total	$ 343,492.69	$ 110,140.53	$ 102,167.25	$ 101,198.75
	Percent of BMP Cost to Total	**32.1%**	**29.7%**	**29.5%**

Roadway Right of Way/Easmt Cost within Drainage Area

Residential Right of Way @	$	50,000.00
		0
Sub Total:	$	-
Residential Relocation Cost	$	40,000.00
		0
Sub Total:	$	-
Residential Perm Easmt @	$	25,000.00
		0
Sub Total:	$	-
Commercial Right of Way @	$	125,000.00
		0.07
Sub Total:	$	8,750.00
Commercial Perm Easmt @	$	62,500.00
		0.1
Sub Total:	$	6,250.00
Right of Way Cost Total:	$	15,000.00

✪ See General Summary Explaination for Cost Method

Figure G-3.6

BMP Construction Cost Worksheet Basin G3

Dry Enhanced Swale

Length:	127	ft
Width:	8	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
0.15 Ac
Total: $ 18,750.00

Cost to cure (impacting 10 parking spots) $ 72,000.00 LS
(included wall ($7,600) and C&G ($4,600)) 1 LS
Total: $ 72,000.00
Sub Total: $ 90,750.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.15 Disturbed Ac
$ 750.00

Grading

Cut	Fill
200.000	300.000

$ 6.00 per CY
Total: $ 3,000.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 2,300.00 per EA
1 EA
$ 2,300.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	94	CY	$ 30.00	$ 2,090.53
Uddrn Sys w/ Gravel	-	157	LF	$ 20.00	$ 3,140.00
Additional Pipe	18	131	LF	$ 52.00	$ 6,812.00

Rip Rap TP3,18" $ 57.50 per SY
8 SY
$ 460.00

Filter Fabric $ 4.75 per SY
8 SY
$ 38.00

Sub Total: $ 15,640.53

Surface Sand Filter

	Filter Bed	Sediment Chamber	
Length:	10	11	ft
Width:	6	6	ft

Right of Way

Residential Right of Way @ $ 50,000.00 per Ac
0.06 Ac
Total: $ 3,000.00

Cost to cure (impacting 10 parking spots) $ 72,000.00 LS
(included wall ($7,600) and C&G ($4,600)) 1 LS
Total: $ 72,000.00
Sub Total: $ 75,000.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.35 Disturbed Ac
$ 1,750.00

Grading

Cut	Fill
200.000	300.000

$ 6.00 per CY
Total: $ 3,000.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
2 EA
$ 10,000.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Sand	-	3.33	CY	$ 45.00	$ 150.00
Uddrn Sys w/ Gravel	-	71	LF	$ 20.00	$ 1,420.00
Top Soil		1	CY	$ 20.00	$ 20.00
Outlet Pipe	18"	131	LF	$ 43.00	$ 5,633.00
Imperm Geotextile	-	60	SF	$ 5.00	$ 300.00
Dist Wall Conc/Steel	-	2	CY	$ 1,020.00	$ 2,040.00

Rip Rap TP3,18" $ 57.50 per SY
33 SY
$ 1,897.50

Filter Fabric $ 4.75 per SY
33 SY
$ 156.75

Sub Total: $ 22,417.25

Bioretention Area

Length:	60	ft
Width:	7	ft

Right of Way

Commercial Right of Way @ $ 125,000.00 per Ac
0.06 Ac
Total: $ 7,500.00

Cost to cure (impacting 10 parking spots) $ 72,000.00 LS
(included wall ($7,600) and C&G ($4,600)) 1 LS
Total: $ 72,000.00
Sub Total: $ 79,500.00

Utilities

Gas Main $ 22.00 per LF
0 LF
$ -

16" Water Main $ 75.00 per LF
0 LF
$ -

Overhead Power $ 25,000.00 per pole
0 poles
$ -
Sub Total: $ -

Clearing and Grubbing

$ 5,000.00 per Ac Disturbed
0.06 Disturbed Ac
$ 300.00

Grading

Cut	Fill
100.000	250.000

$ 6.00 per CY
Total: $ 2,100.00

Drainage (for the addition of the BMP and dividing the flow)

Addl Structures $ 5,000.00 per EA
2 EA
$ 10,000.00

FES $ 400.00 per EA
2 EA
$ 800.00

	Size	Quantity	Unit	Cost	Total
Engineered Media	-	32	CY	$ 30.00	$ 960.00
Uddrn Sys w/ Gravel	-	31.5	LF	$ 20.00	$ 630.00
Mulch	-	47	SY	$ 15.00	$ 705.00
Additional Pipe	18"	106	LF	$ 43.00	$ 4,558.00
Outlet Pipe	18"	25	LF	$ 43.00	$ 1,075.00
Shrubs	-	2	EA	$ 30.00	$ 60.00
Ground Cover	-	5	EA	$ 15.00	$ 75.00

Rip Rap TP3,18" $ 57.50 per SY
7 SY
$ 402.50

Filter Fabric $ 4.75 per SY
7 SY
$ 33.25

Sub Total: $ 19,298.75

Basin G4 Summary
BMP Recommendation- Not required per outfall level exclusion

- The ultimate outfall of Drainage Basin G4 was located and the existing and proposed basin drainage areas were delineated (See Figure G-4.1 and Figure G-4.2). The existing and proposed drainage areas were the same, as were the impervious areas. The MS4 requirements, Water quality, Channel Protection, Overbank Flood Protection, and Extreme Flood Protection Volumes, could not be calculated.
- According to the GDOT Policy on Post-Construction BMPs (section 1.2 Post-Construction BMP Exclusions), under the Outfall Level Exclusions, number 6 states that whereby the net impervious surface area within that outfall's drainage area has been reduced or remains the same as pre-developed conditions, post-construction stormwater requirements will not apply.

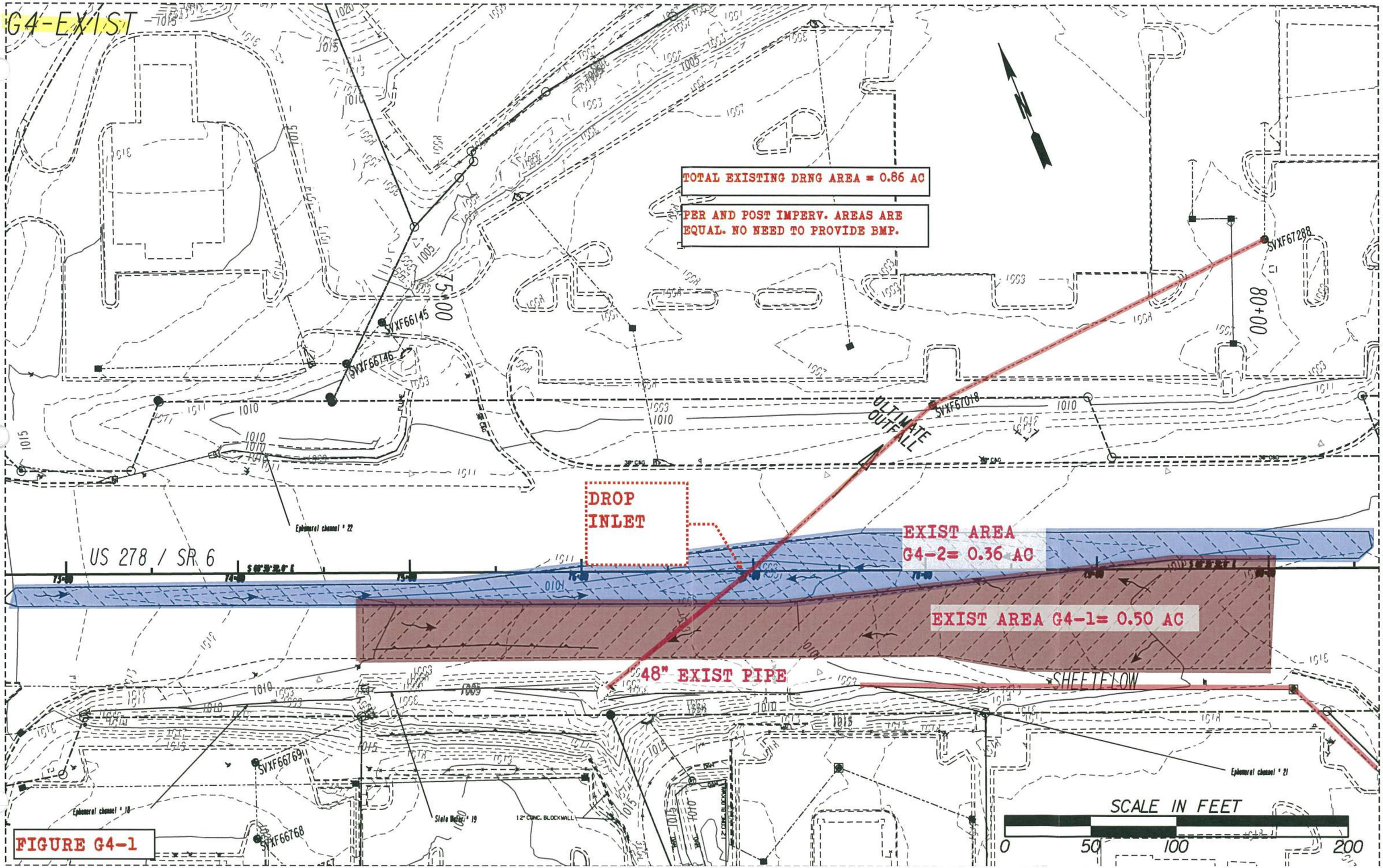

G4-EXIST
TOTAL EXISTING DRNG AREA = 0.86 AC
PER AND POST IMPERV. AREAS ARE EQUAL. NO NEED TO PROVIDE BMP.
SVXF67288
80+00
SVXF66145
SVXF66146
75+00
ULTIMATE OUTFALL
SVXF67018
DROP INLET
EXIST AREA G4-2= 0.36 AC
US 278 / SR 6
EXIST AREA G4-1= 0.50 AC
48" EXIST PIPE
SHEETFLOW
SVXF66769
SVXF66768
Ephemeral channel # 22
Ephemeral channel # 21
Ephemeral channel # 18
Stele Detail # 19
12" CONC. BLOCKWALL
SCALE IN FEET
0
50
100
200

FIGURE G4-1

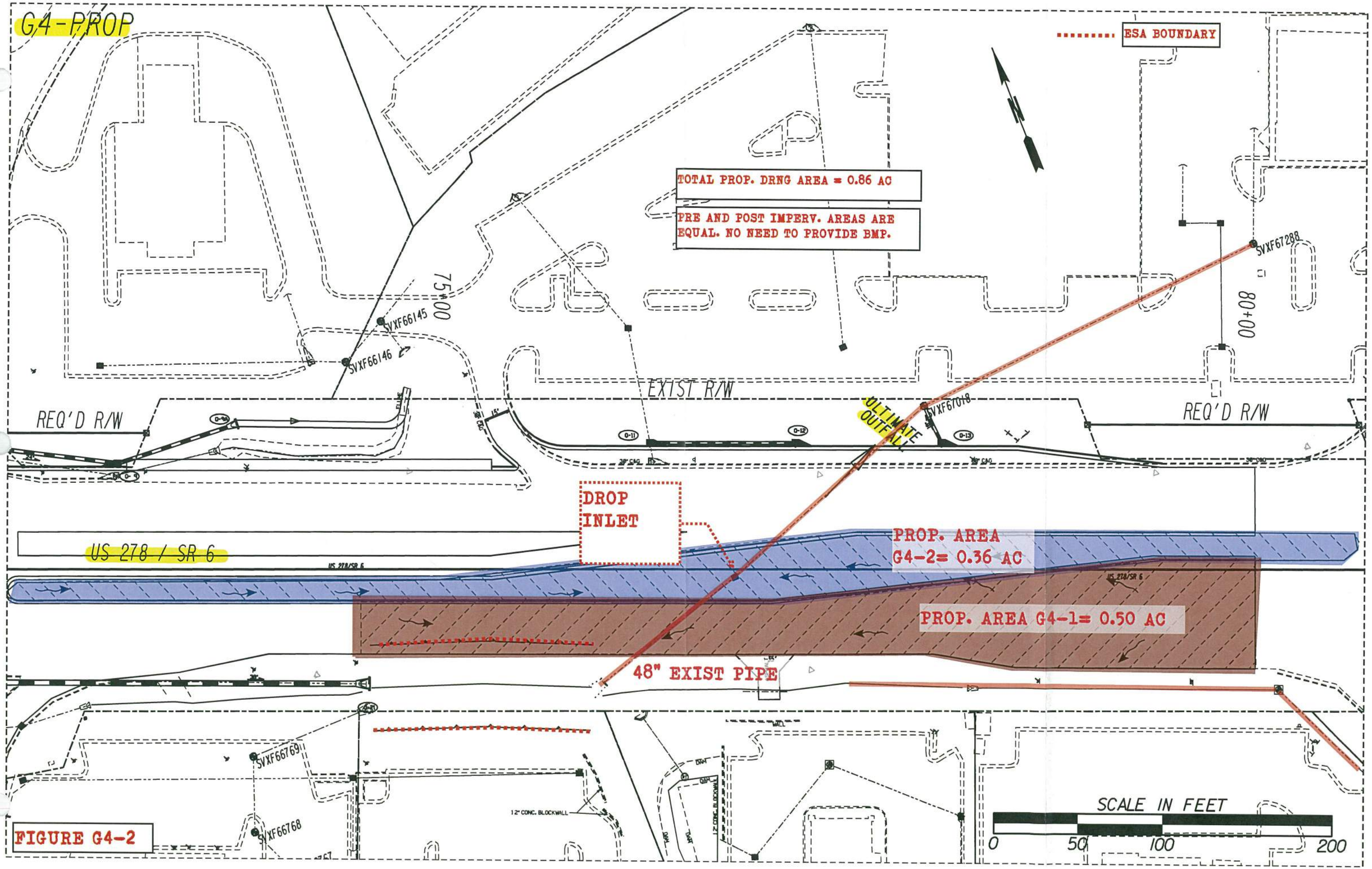

G4-PROP
ESA BOUNDARY
TOTAL PROP. DRNG AREA = 0.86 AC
PRE AND POST IMPERV. AREAS ARE EQUAL. NO NEED TO PROVIDE BMP.
N
SVXF67288
80+00
75+00
SVXF66145
SVXF66146
EXIST R/W
REQ'D R/W
REQ'D R/W
ULTIMATE OUTFALL
SVXF67018
DROP INLET
US 278 / SR 6
PROP. AREA G4-2= 0.36 AC
PROP. AREA G4-1= 0.50 AC
48" EXIST PIPE
SVXF66769
SVXF66768
12" CONC. BLOCKWALL
SCALE IN FEET
0
50
100
200

FIGURE G4-2